7SA826 OCTOBER 2003

Application and Installation

MBE Electronic Controls

VCU Software Version 13
PLD-MR Software Version 53 and 56

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CALIFORNIA
Proposition 65 Warning

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

ATTENTION

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

MBE ELECTRONIC CONTROLS

ABSTRACT

MBE Electronic Controls offers engine controls and an 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 MBE Electronic Controls.

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1 INTRODUCTION

The MBE Electronics system is an electronic control system that monitors and determines all values required for the operation of the engine. A diagnostic interface is provided to connect to an external diagnosis tester.

Besides the engine related sensors and the engine-resident control unit (PLD-MR), this system has a cab-mounted control unit for vehicle engine management. There several different modules used for vehicle engine management such as the Vehicle Control Unit (VCU) and ADM2. The specific vehicle control unit used is application dependent. The connection to the vehicle is made via a CAN interface which digitally transmits the nominal values (e.g. torque, engine speed specification, etc.) and the actual values (e.g. engine speed, oil pressure, etc.). There are five different architectures used for the different vehicle engine management modules and the PLD-MR.

The engine control system monitors both the engine and the datalink connecting the electronic control units. The vehicle control unit then broadcasts all information on the J1587 and J1939 datalinks, where it can be read by minidiag2 and the other vehicle systems. When a malfunction or other problem is detected, the system selects an appropriate response; for example, the emergency running mode may be activated.

1.1 ADVANTAGES

The operating advantages offered by the MBE Electronic Engine Control are:

- ☐ Effective protection of engine from overloading
- ☐ Engine parameters easily set for particular applications
- ☐ Integrated backup computer keeps engine operational if main computer fails
- ☐ Engine continues to operate if CAN connection is interrupted
- ☐ Warning signals issued in critical states
- ☐ Electronic fault store reduces costs of service

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2 SAFETY PRECAUTIONS

The following safety measures are essential when installing any engine with MBE Electronic Controls.

CAUTION:
Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm. ☐ **Always start and operate an engine in a well ventilated area.** ☐ **If operating an engine in an enclosed area, vent the exhaust to the outside.** ☐ **Do not modify or tamper with the exhaust system or emission control system.**

2.1 STANDS

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

2.2 GLASSES

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

2.3 WELDING

Use caution when welding.

CAUTION:

To avoid injury from arc welding, gas welding, or cutting, wear required safety equipment such as an arc welder's face plate or gas welder's goggles, welding gloves, protective apron, long sleeve shirt, head protection, and safety shoes. Always perform welding or cutting operations in a well-ventilated area. The gas in oxygen/acetylene cylinders used in gas welding and cutting is under high pressure. If a cylinder should fall due to careless handling, the gage end could strike an obstruction and fracture, resulting in a gas leak leading to fire or an explosion. If a cylinder should fall resulting in the gage end breaking off, the sudden release of cylinder pressure will turn the cylinder into a dangerous projectile.Observe the following precautions when using oxygen/acetylene gas cylinders:

- **Always wear required safety shoes.**
- **Do not handle tanks in a careless manner or with greasy gloves or slippery hands.**
- **Use a chain, bracket, or other restraining device at all times to prevent gas cylinders from falling.**
- **Do not place gas cylinders on their sides, but stand them upright when in use.**
- **Do not drop, drag, roll, or strike a cylinder forcefully.**
- **Always close valves completely when finished welding or cutting.**

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.

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

2.4 WORK PLACE

Organize your work area and keep it clean.

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

Eliminate the possibility of a fall by:

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

A fall could result in a serious injury.

After installation of the engine is complete:

CAUTION:

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

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

2.5 CLOTHING

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

CAUTION:

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

2.6 ELECTRIC TOOLS

Improper use of electrical equipment can cause severe injury.

CAUTION:

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

2.7 AIR

Use proper shielding to protect everyone in the work area.

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

2.8 FLUIDS AND PRESSURE

Be extremely careful when dealing with fluids under pressure.

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

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

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

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

2.9 BATTERIES

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

CAUTION:

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

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

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

2.10 FIRE

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

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

Table 2-1 The Correct Type of Fire Extinguisher

2.11 FLUOROELASTOMER

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

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

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

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3 HARDWARE AND WIRING

Section **Page**

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3.1 OVERVIEW

MBE Electronic Controls requires several electronic control units and their harnesses.

The engine control system monitors and determines all values which are required for the operation of the engine. The engine-resident control unit is the PLD-MR (refer to section 3.2).

The vehicle control system monitors the vehicle systems. The vehicle control system broadcasts all information on the J1587 and J1939 Data Links, where it can be read by minidiag2 The only vehicle control system module that changes with software version 13 is the Vehicle Control Unit (VCU) (refer to section 3.3).

The harnesses connect the electronic control units to sensors and switches, injectors, and miscellaneous application devices like throttle controls, instrument panel gages and lights. This chapter describes the functionality of the harnesses and the electronic control units.

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3.2 PLD-MR – ENGINE-RESIDENT CONTROL UNIT

The PLD-MR monitors and determines all values which are required for the operation of the engine.

The PLD-MR control unit (see Figure 3-1) is located on the left-hand side of the engine.

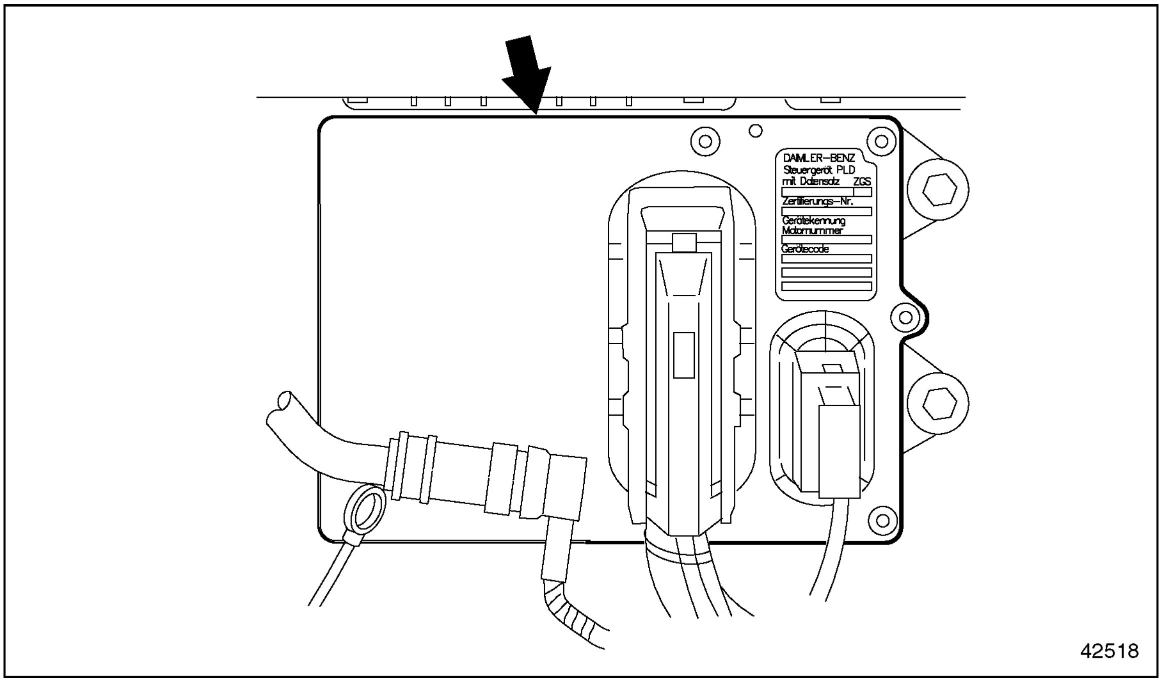


Figure 3-1 PLD-MR Control Unit on Engine

The PLD-MR processes the data received from the Vehicle Control Unit (VCU) for engine control management.

The data is then compared to the parameters stored in the PLD-MR.

From these data, quantity and timing of injection are calculated and the unit pumps are actuated accordingly through the solenoid valves.

The part numbers for the PLD-MR versions in production in NAFTA are listed in Table 3-1.

PLD-MR	Part Number	Software Version
D21	000 446 78 40	Rel. 53 (12/24 V), 4 cylinder
D21	000 446 74 40	Rel. 53 (12/24 V), 6 cylinder
D3	000 446 85 40	Rel. 56 (12/24 V), 4 cylinder
D3	000 446 84 40	Rel. 56 (12/24 V), 6 cylinder

Table 3-1 PLD-MR Part Numbers and Software Versions

NOTE:
To obtain a replacement control unit, all the data given on the control unit data plate are required (see Figure 3-2).

Figure 3-2 PLD-MR Control Unit Data Plate

3.2.1 ENVIRONMENTAL CONDITIONS

Temperature, atmospheric conditions, and vibration must be considered. The PLD-MR is resistant to all fluids and toxic gases occurring in the engine compartment.

Temperature

The ambient operating temperature range is -40°F to 257°F (-40°C to 125°C).

Vibration

The vibration load for the PLD-MR is maximum 3 g at 10 Hz – 1000 Hz with damping elements.

Water Intrusion

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

3.2.2 ENGINE HARNESS

The Engine Harness (EH) is factory installed and delivered connected to the engine sensors and the PLD-MR. See Figure 3-3 and for the MBE 900 EH for non-EGR engine. See Figure 3-4 for the MBE 4000 EH (non-EGR).

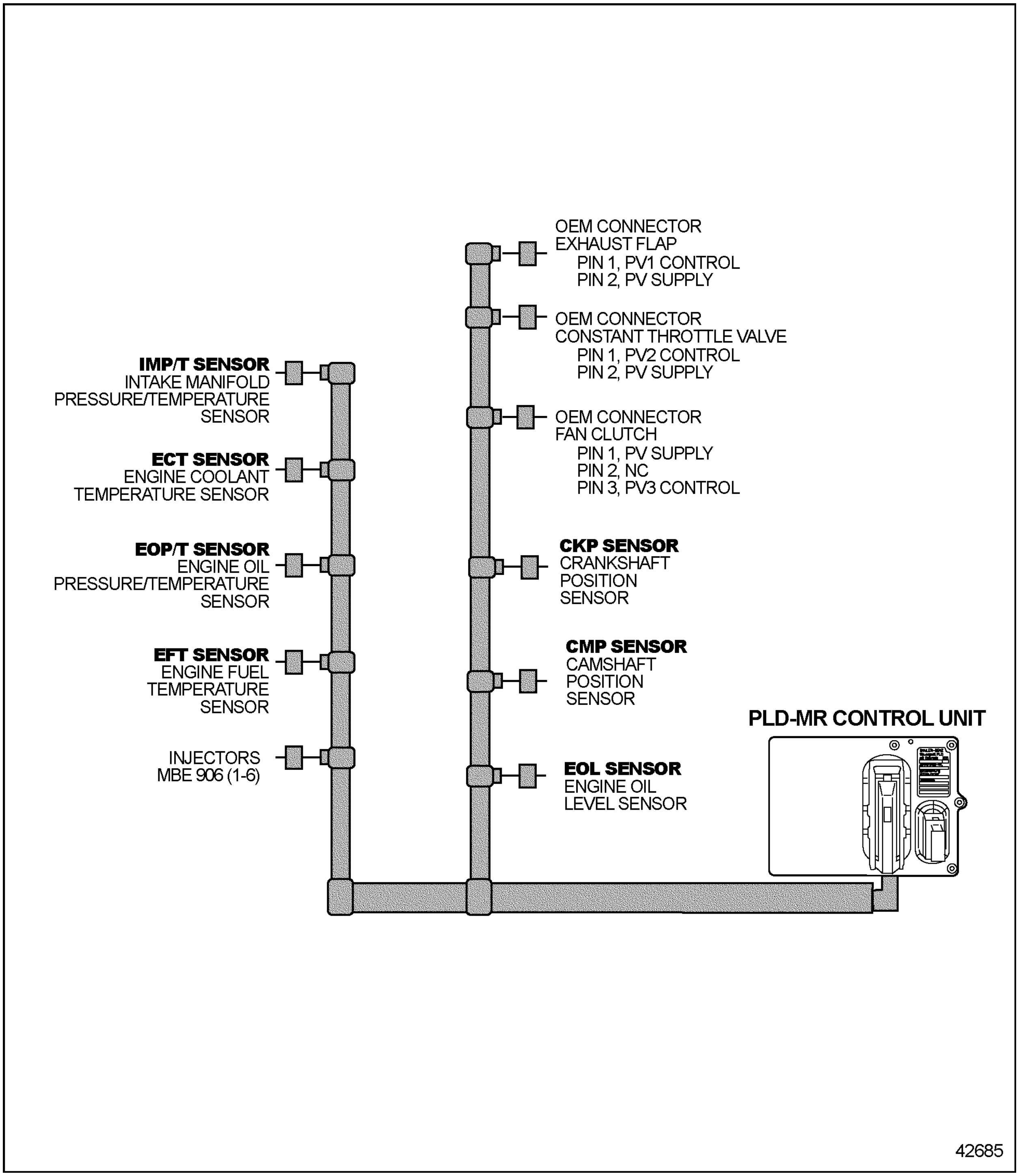


Figure 3-3 Typical On-highway MBE 900 Engine Harness — Non-EGR Engine

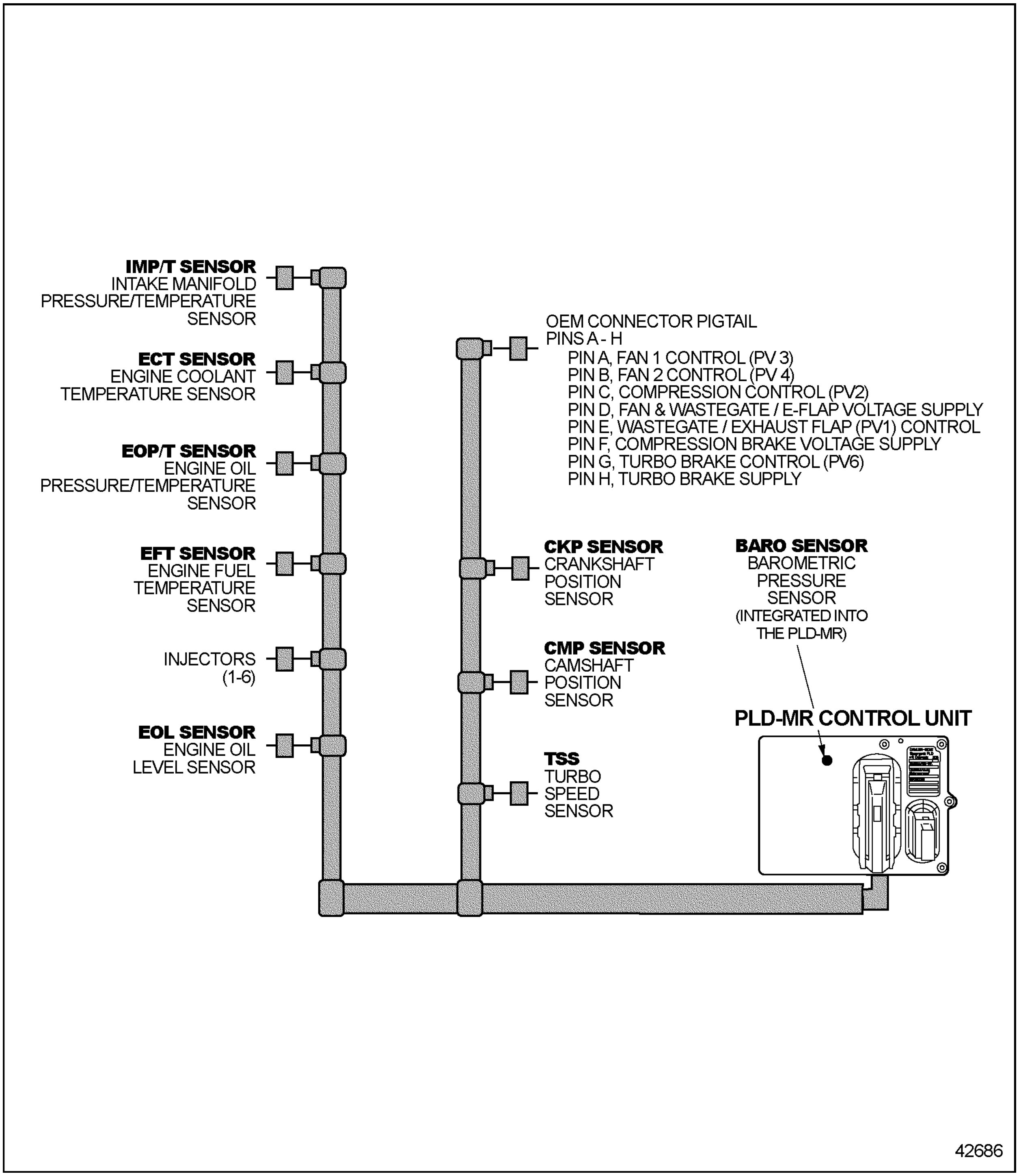
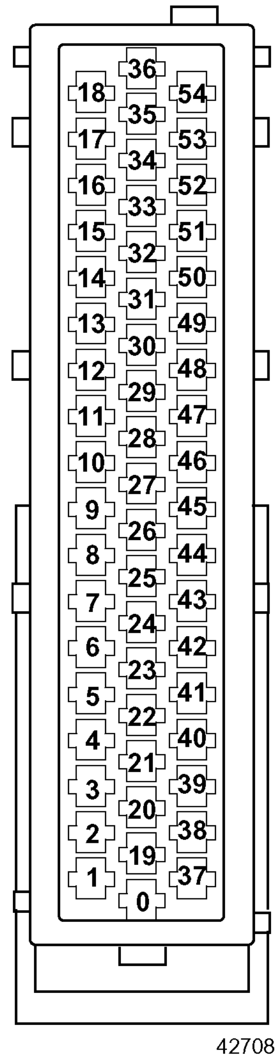


Figure 3-4 Typical MBE 4000 Engine Harness — Non-EGR Engine

The wiring for the 55–pin EH connector to the PLD-MR is listed in Table 3-2 , and Table 3-3 . The side of the connector shown is looking into the pins.

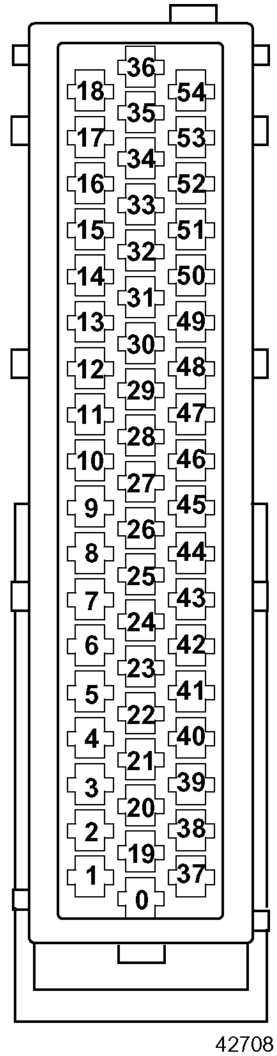
Pin	Wire Color		Signal Type	Function	Connector
	900	4000			
0	N/A	N/A	Digital Input	Oil Separator Diagnosis	
1	Blk/Yel	Blk/Yel	Sensor Return	CKP Sensor (-)	
2	Blk/Viol	Blk/Viol	Sensor Return	CMP Sensor (-)	
3	Wht/Yel	Wht/Yel	Sensor Return	Engine Coolant Temp Sensor	
4	Brn/Grn	Brn/Grn	Sensor Return	Supply Fuel Temp Sensor	
5	N/A	Grn/Wht	Sensor Return	Passive Engine Oil Press / Booster / Fan Speed Sensor	
6	Brn/Gray	Wht/Blk	Sensor Supply	Active Engine Oil Press Sensor	
7	Grn	Grn	Sensor Supply	Intake Manifold Press Sensor	
8	N/A	N/A	Frequency Input	Turbo Speed #2 Sensor	
9	Red/Blu	Red/Blu	Injector Return	Injector Valves Bank 2 (B - D - F - H)	
10	Gray/Yel	N/A	Sensor Return	Active Engine Oil Press Sensor Alternative Oil Combination Sensor, each w/ Speed Sensor	
11	N/A	Brn/Wht	Output Return	Proportional Valve - Ground	
12	Red/Blk	Brn/Red	Output Supply	Proportional Valve Bank (PV 1 - 4)*	
13	N/A	N/A	Sensor Supply	Optional Fuel Press / P3	
14	N/A	N/A	Sensor Supply	Scavenging Gradient Sensor / Fan Speed Sensor	
15	Brn/Wht	Gray/Yel	Sensor Return	Engine Oil Temp / Scavenging Gradient Sensor	
16	Red/Grn	Red/Grn	Injector Return	Injector Valve Bank 1 (A - C - E - G)	
17	N/A	N/A	Frequency Input	Fan Speed Sensor	
18	N/A	N/A	High Side Control Output	Starter	
19	Brn/Viol	Brn/Viol	Frequency Input	CMP Sensor (+)	
20	Brn/Yel	Brn/Yel	Frequency Input	CKP Sensor (+)	
21	Grn/Yel	N/A	Sensor Return	Intake Manifold Temp Sensor	
22	N/A	N/A	Sensor Return	Optional Fuel Pressure	
23	N/A	Blu	Sensor Return	Intake Manifold Press Sensor	
24	N/A	Grn/Viol	Frequency Input	Turbo Speed # 1 Sensor	
25	N/A	N/A	Digital Input	Service Engine Switch - Start	
26			Digital Input	Passive Engine Oil Press Sensor	
27	N/A	N/A	High Side Control	Proportional Valve 5	



Front
Looking into the Pins

Table 3-2 Engine Harness – Pins 0–26

Pin	Wire Color		Signal Type	Function	Connector
	900	4000			
28	N/A	N/A	Analog Input	Optional Fuel Pressure	
29	Viol	Viol	Analog Input	Intake Manifold Pressure Sensor	
30	N/A	N/A	Sensor Supply	Service Engine Switch (Start/Stop)	
31	N/A	N/A	Analog Input	Optional Press Gradient (Boost/Exhaust)	
32	Grn/Blu	Brn/Gray	Analog Input	Active Engine Oil Press Sensor	
33	Wht	Wht	Analog Input	Engine Oil Level Sensor	
34	Red/Yel	Red/Yel	Analog Input	Engine Coolant Temp Sensor	
35	N/A	N/A	Digital Input	Service Engine Switch - Stop	
36	Brn/Blu	Brn/Blu	Analog Input	Supply Fuel Temp Sensor	
37	N/A	N/A	Injector Output – High Side	Injector/Solenoid Valve H	
38	Wht/Blu	Wht/Blu	Injector Output – High Side	Injector/Solenoid Valve F	
39	Gray/Brn	Gray/Brn	Analog Input	Engine Oil Temp Sensor	
40	N/A	Brn/Blk	PWM/Digital Output – Low Side	Proportional Valve 6	
41	Blu/Wht	Red	PWM/Digital Output – Low Side	Proportional Valve 3	
42	N/A	Blu/Blk	Sensor Supply	Proportional Valve 6	
43	Blu/Red	Blk/Wht	PWM/Digital Output – Low Side	Proportional Valve 4*	
44	Gray/Yel	Wht/Blu	Injector Output – High Side	Injector/Solenoid Valve D	
45	Gray/Viol	Gray/Grn	Injector Output – High Side	Injector/Solenoid Valve B	
46	N/A	N/A	Injector Output – High Side	Injector/Solenoid Valve G	
47	Gray/Blu	Gray/Viol	Injector Output – High Side	Injector/Solenoid Valve E	
48	Brn	Brn	Analog Input	Intake Manifold Temp Sensor	
49	Yel	Yel	Sensor Return	Engine Oil Level Sensor	
50	Grn/Wht	Gray/Viol	PWM/Digital Output – Low Side	Proportional Valve 2	
51	Red/Wht	Wht/Red	PWM/Digital Output – Low Side	Proportional Valve 1	
52	Brn/Red	Gray/Viol	Output Supply	Proportional Valve 2	
53	Gray/Grn	Gray/Blu	Injector Output – High Side	Injector/Solenoid Valve C	
54	Gray/Blk	Gray/Blk	Injector Output – High Side	Injector/Solenoid Valve A	



Front
Looking into the Pins

Table 3-3 Engine Harness – Pins 27–54

3.2.3 POWER SUPPLY

NOTE:
The PLD-MR and VCU must be powered from the same battery voltage source.

The voltage supply for the PLD-MR is listed in Table 3-4.

Voltage Supply	Voltage Version	
	24 V	12 V
Nominal Voltage	22 V ≤ V≤ 30 V	11 V ≤ V≤ 16 V
Low Voltage	8 V ≤ V≤ 22V Limited Operating Range	6.5V ≤ V≤ 11V Limited Operating Range
Overload Switch-off	V > 33 V	V > 33 V

Table 3-4 PLD-MR Voltage Supply

The polarity/overload protection for the PLD-MR is listed in Table 3-5.

Polarity/Overload Protection	Voltage Version	
	24 V	12 V
Polarity Protection	Continuous polarity of battery (+) and battery (-) without damage of system	Continuous polarity of battery (+), battery (-) and ignition without damage of system
Overload Resistance	58 V	58 V
Overload Resistance	100 V (see SAE J1455)	100 V (see SAE J1455)

Table 3-5 PLD-MR Polarity/Overload Protection

The current consumption for the PLD-MR is listed in Table 3-6.

Current Consumption	Voltage Version	
	24 V	12 V
Peak Power Consumption (without solenoid drivers)	8.0 A, cyclic, depending on engine rpm and series	12.5 A, cyclic, depending on engine rpm and series
Standby Voltage Supply (ignition off and after completion backup phase)	I < 1 mA	I < 1 mA

Table 3-6 PLD-MR Current Consumption

The short circuit recognition thresholds for the PLD-MR are listed in Table 3-7.

Short Circuit Recognition Thresholds	Voltage Version	
	24 V	**12 V**
Ground Short	20 A	20 A
Starter to Ground	2.5 A	2.5 A
Solenoid Valve to Return Line	32 A	32 A
Proportional Valve Supply to Ground	14 A	14 A
Proportional Valve to Ground*	2 A	2 A

* Open circuit fault greater than 40 kΩ resistance

Table 3-7 PLD-MR Short Circuit Recognition Thresholds

3.2.4 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 PLD-MR's maximum voltage of 32 volts.

CAUTION:

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

CAUTION:

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

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

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

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

Bussmann ATC-40 and Delphi Packard Electric Systems MaxiFuse 40 amp rated fuses or equivalent will satisfy these requirements. Acceptable blow times versus current and temperature derating characteristics are listed in listed in Table 3-8 and listed in Table 3-9.

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

Table 3-8 Fuse Current and Blow Time

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

Table 3-9 Fuse Temperature and Current

3.2.5 PROPORTIONAL VALVE CONTROL

The proportional valve control on the PLD-MR controls external setting and switching elements. The output function of the proportional valves is determined by the configuration. The outputs of the control unit can be configured as pulse width modulated (PWM) or digital outputs. The proportional valve control outputs can be enabled or disabled by minidiag2.

The output function of the proportional valves is listed in Table 3-10.

Valve	Signal	Function Non-EGR Engine	Function EGR Engine	Low Side Control Pin	Power Supply Pin (Switched V Bat)
PV1	PWM/Digital Output	Exhaust Flap or Wastegate	Exhaust Flap or Wastegate	55/51	55/12
PV2	PWM/Digital Output	Compression Brake	EGR Valve	55/50	55/52
PV3	PWM/Digital Output	Fan 1	Fan 1	55/41	55/12
PV4	PWM/Digital Output	Fan 2	Fan 2	55/43	55/12
PV5	PWM/Digital Output	Unused	Compression Brake	55/11 – Ground	55/27 — High Side Control
PV6	PWM/Digital Output	Second Wastegate/VNT or Turbo Brake	Second Wastegate/VNT or Turbo Brake or Grid Heater	55/40	55/42

Table 3-10 Proportional Valves

3.2.6 CONNECTORS

See Figure 3-5 for the connectors to the PLD-MR.

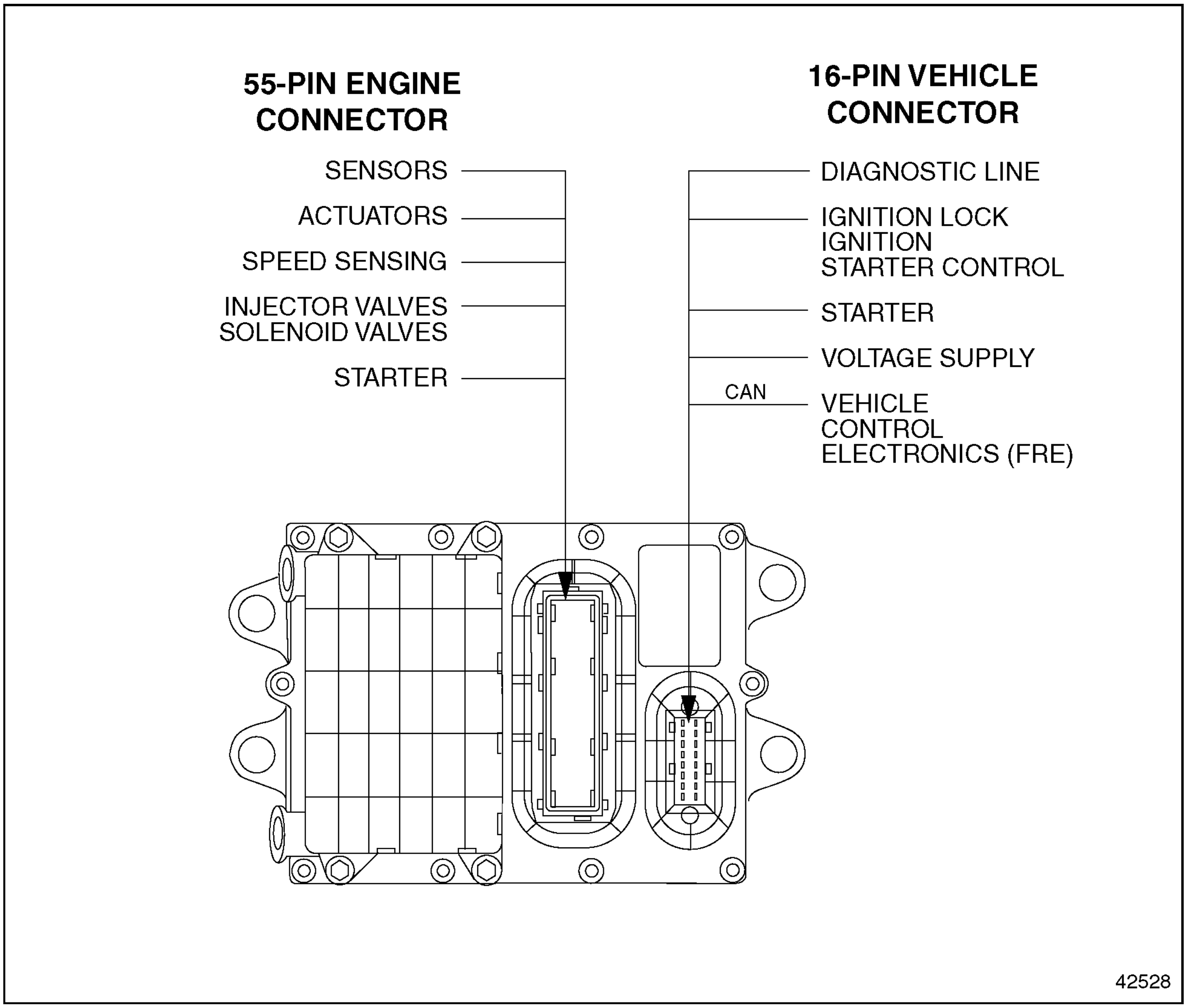


Figure 3-5 PLD-MR Connectors

3.3 VEHICLE CONTROL UNIT— ON-HIGHWAY

The Vehicle Control Unit (VCU) is the interface between the PLD-MR and the truck for engine control and manages other vehicle functions.

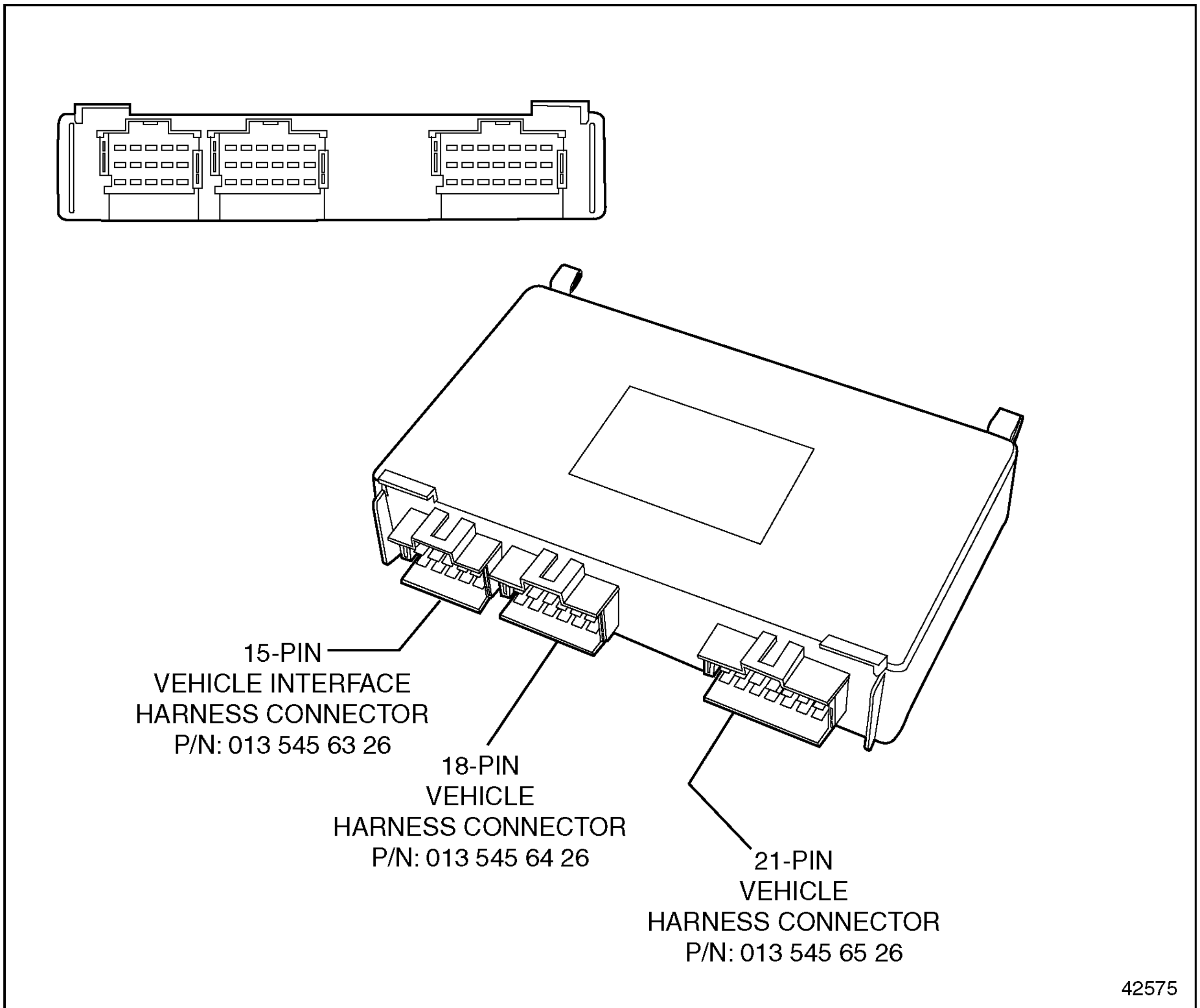


Figure 3-6 The Vehicle Control Unit

The OEM is responsible for mounting this part in a cab environment. The mounting bracket is the responsibility of the OEM. There must be 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.

NOTE:
The VCU should be mounted with the connectors pointing down.

The VCU also communicates over the J1587 and J1939 Data Links to the vehicle (see Figure 3-7).

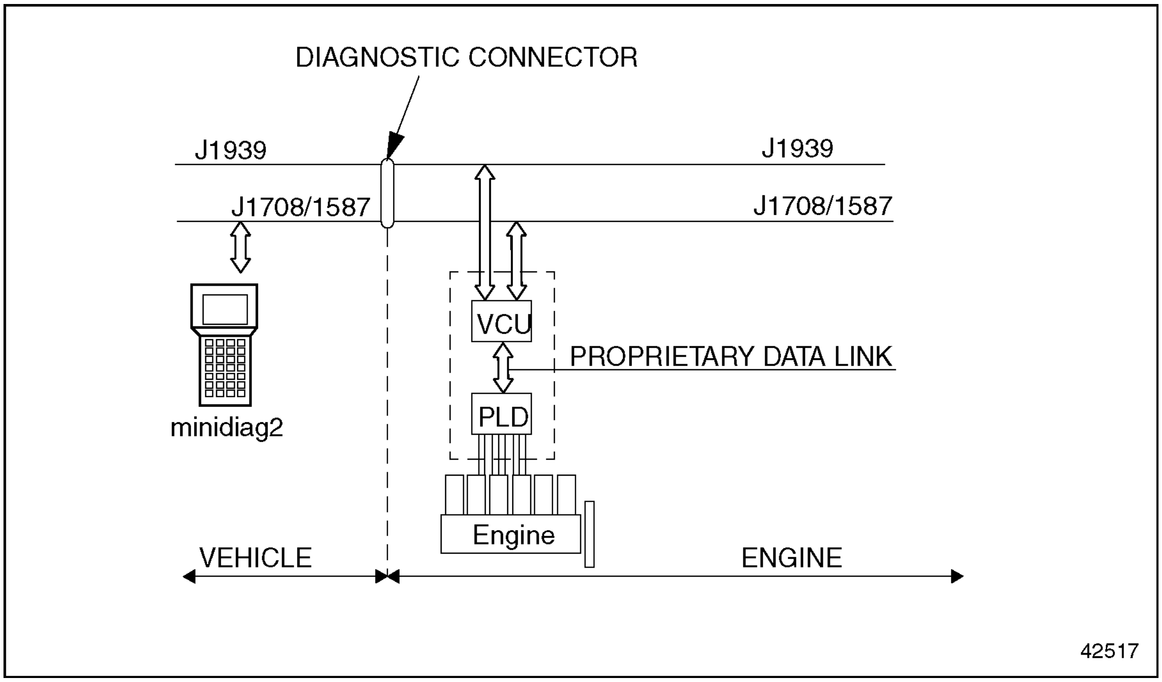


Figure 3-7 NAFTA Architecture

Within the VCU, sets of data for specific applications are stored. These include idle speed, maximum running speed, and speed limitation.

The VCU receives data from the operator (accelerator pedal position, switches, various sensors) and other electronic control units (for example, the anti-lock brake system, transmission controllers).

From this data, instructions are computed for controlling the engine and transmitted to the PLD-MR via the proprietary data link.

3.3.1 ENVIRONMENTAL CONDITIONS

Temperature, vibration, and water intrusion must be considered.

Temperature

The ambient operating temperature range is –40°F to 185°F (-40°C to 85°C).

Water Intrusion

The VCU is not water tight and cannot be subject to water spray. It must be mounted in a cab environment.

3.3.2 VEHICLE INTERFACE HARNESS DESIGN

The OEM supplied Vehicle Interface harness (VIH) connects the VCU to the PLD-MR and other vehicle systems (see Figure 3-8). Refer to Appendix B for a harness schematic.

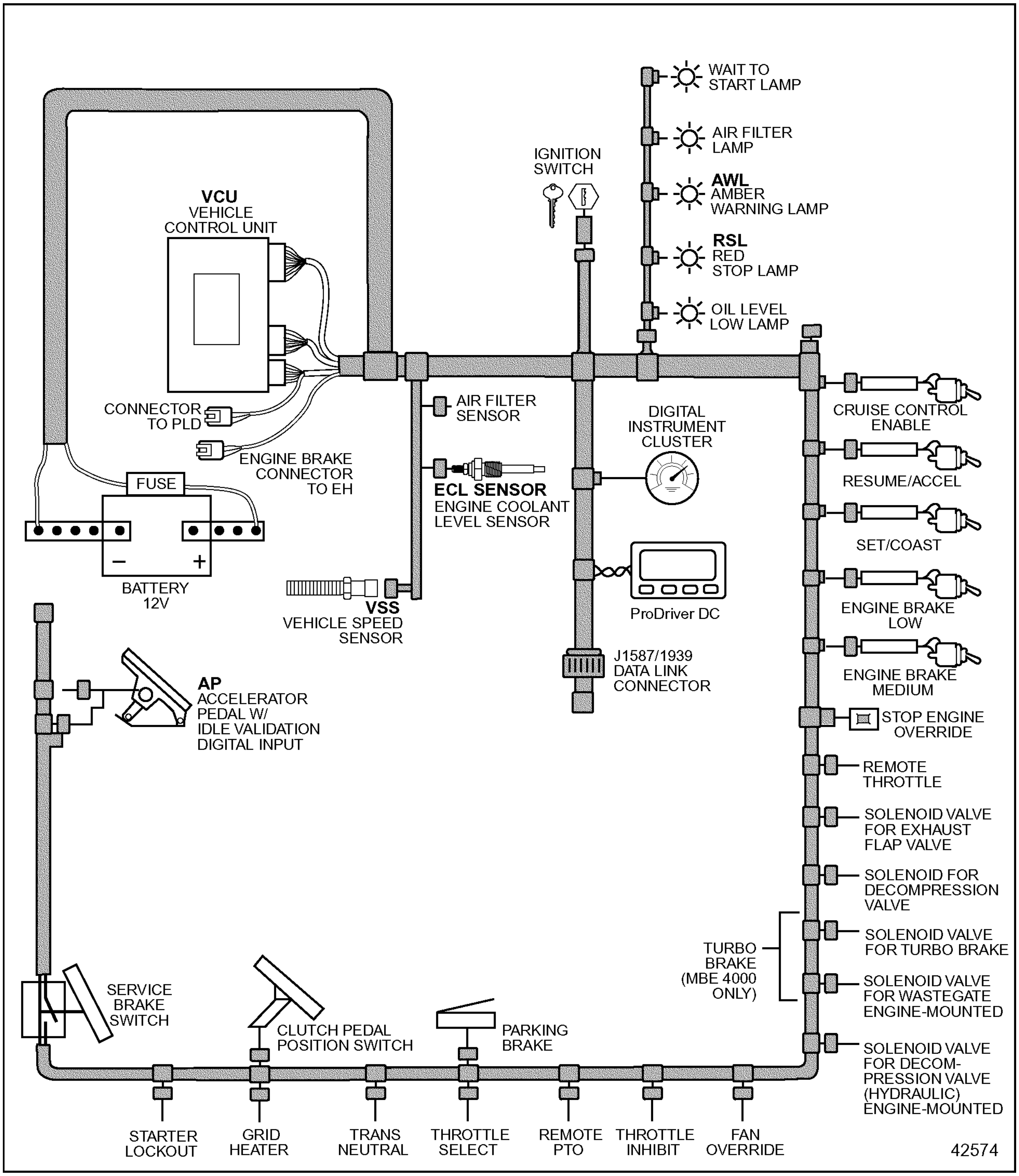


Figure 3-8 Typical On-highway Vehicle Interface Harness with a VCU

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

Criteria: VIH Design

The three vehicle connectors are designed to accept 18 AWG wires for all circuits except power and ground. These circuits should use 14 AWG wire.

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:
J1939 cable is required for the J1939 datalink wires. Refer to SAE J1939–11 spec for specific requirements.

The low speed propriety IES-CAN link between the PLD-MR and the VCU must be a twisted shielded cable with 0.75 mm diameter wire (approximately 20 AWG), bundle shielded with drain wire and 30 twists per meter. The insulation is rated to 105°C. Termination resistors for the IES-CAN link are located in the VCU and PLD-MR.

Frequency Input

The VCU has one frequency input on the VIH that can accept a variable reluctance sensor. A typical frequency input functions is the Vehicle Speed Sensor (VSS). Requirements for a variable reluctance signal interface are listed in Table 3-11.

Parameter	Range
Input Amplitude Range	3 V, 40 V Peak to Peak
Input Frequency Range	1 to 3000 Hz

Table 3-11 Variable Reluctance Signal Interface

Digital Inputs

The VCU has 18 digital inputs located on the VIH. These inputs are in low state by providing a connection to battery ground and placed in high state by providing an open circuit.

Digital Input Requirements:

High State:	Battery (+) >E_{in}> 7.0 V
Low State:	V_{in} < 3.0 V
Isink:	Capable of sinking 5–20 mA

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

The digital inputs are listed in Table 3-12.

Connector Pin	Description	V_{max}	V_{min}	Pull-up Resistor	Input Requirement
VCU 15/1	Transmission Neutral	V_{Bat}	0 V	2.35 kΩ	Von<3.0 V Voff>7.0 V
VCU 15/2	Dual Speed Axle	V_{Bat}	0 V	5 kΩ	Von<3.0 V Voff>7.0 V
VCU 18/2	Clutch Switch	V_{Bat}	0 V	5 kΩ	Von<3.0 V Voff>7.0 V
VCU 18/4	Cruise Control Set/Coast	V_{Bat}	0 V	5 kΩ	Von<3.0 V Voff>7.0 V
VCU 18/5	Cruise Control Resume/Accel	V_{Bat}	0 V	5 kΩ	Von<3.0 V Voff>7.0 V
VCU 18/6	Cruise Control On/Off Switch	V_{Bat}	0 V	5 kΩ	Von<3.0 V Voff>7.0 V
VCU 18/7	Throttle Select	V_{Bat}	0 V	5 kΩ	Von<3.0 V Voff>7.0 V
VCU 18/8	Engine Brake Low	V_{Bat}	0 V	5 kΩ	Von<3.0 V Voff>7.0 V
VCU 18/9	Engine Brake High	V_{Bat}	0 V	5 kΩ	Von<3.0 V Voff>7.0 V
VCU 18/10	Remote VSG Switch	V_{Bat}	0 V	5 kΩ	Von<3.0 V Voff>7.0 V
VCU 18/11	Limiter 2	V_{Bat}	0 V	5 kΩ	Von<3.0 V Voff>7.0 V
VCU 18/12	Dual Vehicle Sp[eed Limiter	V_{Bat}	0 V	2.35 kΩ	Von<3.0 V Voff>7.0 V
VCU 18/13	Shutdown Override Switch	V_{Bat}	0 V	5 kΩ	Von<3.0 V Voff>7.0 V
VCU 18/14	Air Conditioner Status	V_{Bat}	0 V	2.35 kΩ	Von<3.0 V Voff>7.0 V
VCU 18/15	Fan Override	V_{Bat}	0 V	5 kΩ	Von<3.0 V Voff>7.0 V
VCU 18/16	Throttle Inhibit	V_{Bat}	0 V	5 kΩ	Von<3.0 V Voff>7.0 V
VCU 21/15	Service Brake Switch	V_{Bat}	0 V	2.35 kΩ	Von<3.0 V Voff>7.0 V
VCU 21/16	Park Brake Switch	V_{Bat}	0 V	2.35 kΩ	Von<3.0 V Voff>7.0 V

Table 3-12 Digital Inputs

Analog Inputs

The analog inputs are listed in Table 3-13.

Pin	Description	V_{Bat}	V_{min}	Pull-up or Pull-down Resistor
15/7	Coolant Level Sensor	5 V	0 V	440 Ω to 5 V Pull-up
15/8	Air Filter Sensor	5 V	0 V	200 kΩ to 5 V Pull-up
18/18	Remote Throttle Signal	5 V	0 V	200 kΩ to 5 V Pull-up
21/11	Throttle Pedal Signal	5 V	0 V	Williams Pedal Terminal A, 47 kΩ to Ground Pull-down

Table 3-13 Analog Inputs

Digital Outputs

The digital outputs are listed in Table 3-14.

Pin	Description	I_{Max}	V_{Bat}	P_{Max} Lamp	Output Type
VCU 15/5	Power Supply Throttle Pedal PWM	2 A	V_{Bat}	—	High-side Driver
	Gear Out 1				
VCU 15/6	Engine Brake 2, Exhaust Flap	2 A	V_{Bat}	—	High-side Relay Driver
VCU 15/9	Relay 2	2 A	V_{Bat}	—	Low-side Relay Driver
VCU 15/10	Engine Brake 1, Constant Throttle	1.8 A	V_{Bat}	—	High-side Relay Driver
VCU 15/11	Relay 3	250 mA	V_{Bat}	—	Low-side Relay Driver, Short Protected
VCU 15/12	Relay 1	1.3 A	V_{Bat}	—	Low-side Relay Driver, Short Protected
VCU 18/1	Relay 4	1.3 A	V_{Bat}	—	Low-side Relay Driver, Short Protected
VCU 18/3	Idle Validation Switch Ground	250 mA	0 V	—	Input for William's Pedal Terminal F
VCU 21/4	Oil Level Lamp	250 mA	V_{Bat}	2 W at 12 V	Low-side Relay Driver, Short Protected
VCU 21/5	Red Stop Lamp	250 mA	V_{Bat}	2 W at 12 V	Low-side Relay Driver, Short Protected
VCU 21/6	Amber Warning Lamp	150 mA	V_{Bat}	2 W at 12 V	Low-side Relay Driver, Short Protected
VCU 21/7	Wait to Start Lamp	250 mA	V_{Bat}	2 W at 12 V	Low-side Relay Driver, Short Protected
VCU 21/8	Air Filter Lamp	250 mA	V_{Bat}	2 W at 12 V	Low-side Relay Driver, Short Protected

Table 3-14 Digital Outputs

Data Links

The Data Links that provide the communication interface are listed in Table 3-15.

Pin	Description	Potential	U_{Bat}	U_{min}	Further Data
15/15	Engine-CAN (Low)	—	2/3 V_{Bat}	1/3 V_{min}	ISO/DIS 11992, One Wire Capability
15/14	CAN-HF-Ground	GND	—	—	100 nF to Ground
15/13	Engine-CAN (High)	—	2/3 V_{Bat}	1/3 V_{min}	ISO/DIS 11992, One Wire Capability
21/17	SAE 1708, A	—	—	—	Only Partly Implemented
21/18	SAE 1708, A	—	—	—	Only Partly Implemented
21/19	SAE J1939 CAN (High)	5 V	—	—	—
21/20	CAN-HF-Ground	GND	—	—	100 nF to ground
21/21	SAE J1939 CAN (Low)	5 V	—	—	—

Table 3-15 Communication Interface Data Links

Ignition

The ignition source is 12 volts. The VCU and PLD-MR 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 25 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 3-16.

Part	Part Number
Fuse Holder	12033769
Cover	12033731
Terminals	12066614

Table 3-16 Fuse Holder Part Numbers

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

VIH Installation

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.

3.3.3 VEHICLE INTERFACE HARNESS WIRING

The OEM is responsible for wiring three connectors to the VCU and one connector to the PLD-MR. For connector and terminal part numbers, refer to section 3.3.6.

The wiring for the VIH 15–pin connector to the VCU is listed in Table 3-17. The side of the connector shown is looking into the pins.

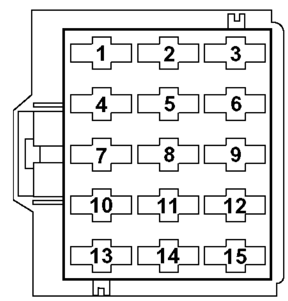
Pin	Signal Type	Function	Connector
15/1	Digital Input – Switch to Ground, Normally Open, Disables Engine Start if Closed	Transmission Neutral Switch	
15/2	Digital Input – Switch to Ground, Normally Open, Sets Speed Ratio if Closed	Dual Speed Axle	
15/3	Signal (+)	Vehicle Speed Sensor Signal Input for Tachometer	
15/4	Signal (-)	Ground	
15/5	Configurable High Side Digital Output	Power Supply for PWM Pedal	 42705 Front Looking into the Pins on the Harness
		Gear Out 1, Output for Modulation Valve (e.g. Allison Automatic Transmission)	
15/6	Configurable High Side Digital Output	Engine Brake 2, Exhaust Flap	
15/7	Analog Input	Coolant Level Sensor	
15/8	Analog Input	Air Filter Sensor	
15/9	Configurable High Side Digital Output	Relay 2 The configurable parameters are listed in Table 3-18.	
15/10	Configurable High Side Digital Output	Decompression Valve	
15/11	Configurable Low Side Digital Output	Relay 3 The configurable parameters are listed in Table 3-18.	
15/12	Configurable Low Side Digital Output	Relay 1 The configurable parameters are listed in Table 3-18.	
15/13	Data Link	MBE Proprietary CAN (+) (PLD-MR)	
15/14	Data Link	MBE Proprietary CAN Shield (PLD-MR)	
15/15	Data Link	MBE Proprietary CAN (-) (PLD-MR)	

Table 3-17 VCU 15–Pin VIH Connector Pin Assignments

Pin	Function	Parameters
15/12	Relay 1	0 = Disabled 1 = Starter Protection 2 = Acc. Pedal Kick Down position 3 = Transmission Output 1
15/9	Relay 2	0 = Disabled 1 = Grid Heater 2 = Acc. Pedal Idle Position
15/11	Relay 3	0 = Acc. Pedal Idle Position 1 = Actual Torque 2 = Vehicle Speed 3 = Engine Speed 4 = Coolant Temperature 5 = Acc. Pedal Torque 6 = Booster Temperature 7 = Oil Pressure Warning Lamp 8 = Coolant Temp Warning Lamp
18/1	Relay 4	0 = Kickdown Position 1 = Actual Torque 2 = Vehicle Speed 3 = Engine Speed 4 = Coolant Temp 5 = Pedal Torque 6 = Booster Air Temp 7 = Oil Pressure Warning Lamp 8 = Coolant Temp Warning Lamp
18/8	Engine Brake Low, Engine Brake Switches Low and High	0 = Not Active 1 = Active
18/9	Engine Brake High	High/Low 0 0 = Engine Brakes Disabled 0 1 = Engine Brake Step 1: Decompression Valve Enabled 1 0 = Engine Brake Step 2: Decompression Valve and Exhaust Flap Enabled 1 1 = Not Implemented

Table 3-18 Configurable Parameters on the VCU 15– and 18–pin Connectors

The wiring for the VIH 18–pin connector to the VCU is listed in Table 3-19. The side of the connector shown is looking into the pins.

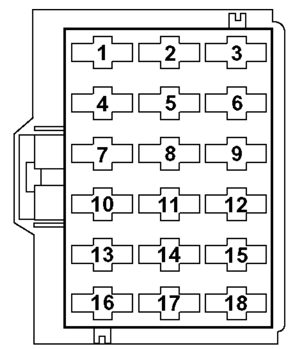
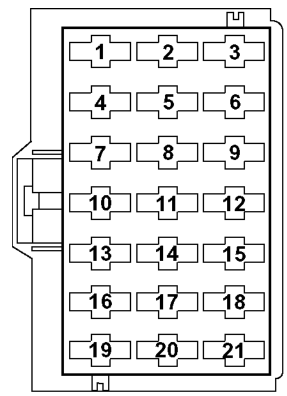
Pin	Signal Type	Function	Connector
18/1	Configurable Low Side Digital Output	Relay 4 The configurable parameters are listed in Table 3-18.	
18/2	Digital Input – Normally Closed (open if clutch is pressed)	Clutch Switch	
18/3	Digital Input	Idle Validation Switches	
18/4	Digital Input – Normally Open	Cruise Control, Set/Coast	
18/5	Digital Input – Normally Open	Cruise Control, Res/Accel	
18/6	Digital Input – Normally Open	Cruise Control, On/Off	
18/7	Digital Input – Normally Open	Throttle Select Switch	
18/8	Digital Input – Normally Open	Engine Brake Low, Engine Brake Switches Low and High The configurable parameters are listed in Table 3-18.	 42706 Front Looking into the Pins on the Harness
18/9	Digital Input – Normally Open	Engine Brake High The configurable parameters are listed in Table 3-18.	
18/10	Digital Input – Normally Open	Remote VSG Switch	
18/11	Digital Input – Normally Open	Limiter 2	
18/12	Digital Input – Normally Open	Dual Vehicle Speed Limiter	
18/13	Digital Input – Normally Open	Engine Shutdown Override	
18/14	Digital Input – Normally Open	Air Condition Status	
18/15	Digital Input – Normally Open	Fan Override	
18/16	Digital Input – Normally Open	Throttle Inhibit	
18/17	Sensor Supply	Remote VSG Power Supply and Air Cleaner Sensor	
18/18	Analog Input	Remote Throttle Signal	

Table 3-19 VCU 18–Pin VIH Connector Pin Assignments

The wiring for the VIH 21–pin connector for the VCU is listed in Table 3-20. The power and communication links are wired through this connector. The side of the connector shown is looking into the pins.

Pin	Signal Type	Function	Connector
21/1	—	Battery Voltage	
21/2	Digital Input	Ignition (+12 V)	
21/3	—	Battery Ground	
21/4	Digital Output – Low Side	Oil Level Lamp*	
21/5	Digital Output – Low Side	Red Stop Lamp*	
21/6	Digital Output – Low Side	Amber Warning Lamp*	
21/7	Digital Output – Low Side	Wait to Start Lamp	
21/8	Digital Output – Low Side	Air Filter Warning Lamp	
21/9	Sensor Supply	Throttle Pedal Power Supply (+5 V supply)	
21/10	Digital Input – Normally Open	Plug (not used, must be plugged)	
21/11	Analog Input	Throttle Pedal Signal	
21/12	Pulse Input	PWM Throttle Signal, Path 1	
		Idle Validation 2 (Throttle Active)	
21/13	Pulse Input	PWM Throttle Signal, Path 2	
		Idle Validation 1 (Idle Active)	
21/14	—	PWM Throttle Pedal Ground	
		Analog Pedal Ground	
21/15	Digital Input – Normally Closed	Service Brake Switch	
21/16	Digital Input – Normally Open	Park Brake Switch	
21/17	Data Link	SAE J1708 (+)	
21/18	Data Link	SAE J1708 (-)	
21/19	Data Link	SAE J1939 (+)	
21/20	Data Link	J1939 Shield	
21/21	Data Link	SAE J1939 (-)	



42707

Front
Looking into the Pins on the Harness

* If output is active while engine is running, shut down the engine immediately and initiate an error diagnosis.

Table 3-20 VCU 21–Pin VIH Connector Pin Assignments

VIH to PLD-MR Connector Wiring

The wiring for the VIH 16–pin to the PLD-MR is listed in Table 3-21. The side of the connector shown is looking into the pins.

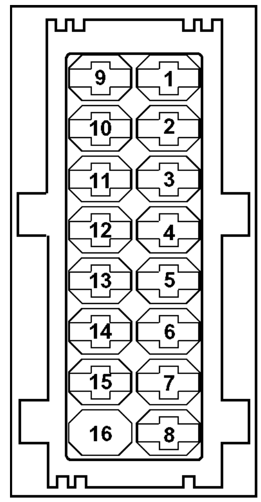
Pin	Signal Type	Function	Connector
1	Data Link	CAN Interface (High Line)	 Front Looking into the Pins on the Harness
2	Data Link	CAN Interface (Low Line)	
3	Data Link	CAN HF Ground	
4	Data Link	CAN HF Ground	
5	Power Supply	Battery Voltage (+)	
6	Power Supply	Battery Voltage (+)	
7	NC	NC	
8	Digital Output	Starter Control Signal	
9	Ground	Battery Ground (-)	
10	Digital Output	Proportional Valve 1–4 High Side Supply	
11	Ground	Battery Ground (-)	
12	Digital Output	Starter High Side Control	
13	Digital Data Link	Diagnostic Link K-line (ISO)	
14	Digital Output	Proportional Valve 3 Low Side Control	
15	Ignition Input	Ignition	
16	Digital Output	Proportional Valve 4 Low Side Control	

Table 3-21 16–Pin Connector to the PLD-MR

VIH to EH Connector Wiring

The wiring for the eight-pin connector to the Engine Harness required for engine brakes and fan control for the MBE 4000 is listed in Table 3-22.

Description	Engine Harness 8–pin Connector	PLD-MR 55–pin Connector
Fan Control —Control 31, Switch to Bat- (PV3)	A	41
Fan Control #2, Switch to Bat- (PV4)	B	43
Compression Brake Control, Switch to Bat- (PV2)	C	50
Fan and Wastegate/E-Flap Voltage Supply (PV1,3,4)	D	12
Exhaust Flap/Wastegate Control, Switch to Bat- (PV1)	E	51
Compression Brake Voltage Supply (PV2)	F	52
Turbo Brake Control, Switch to Bat-(PV6)	G	40
Turbo Brake Voltage Supply (PV6)	H	42

Table 3-22 Engine Harness Connector for Engines with Two Solenoid Air Valves for Engine Brakes — MBE 4000 Only

See Figure 3-9 for an engine brake schematic.

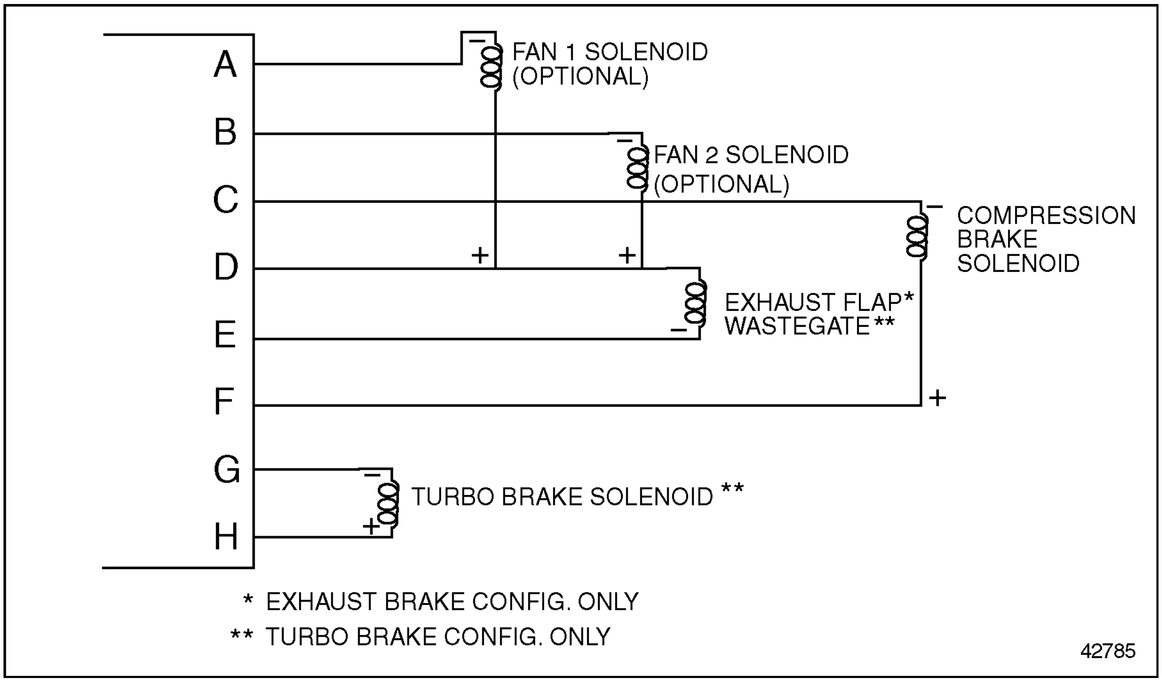


Figure 3-9 MBE 4000 Engine Brake

The wiring for the eight-pin connector to the Engine Harness required for engine brakes and fan control for the Non-EGR MBE 900 is listed in Table 3-23. See Figure 3-10 for a schematic.

Description	Engine Harness Connector/Pin	PLD-MR 55 Pin Connector
Fan Control, Switch to Bat- (PV3, PV4)	Y70/Pin 1	41
Fan Control Power	Y70/ Pin 2	12
Compression Brake Control, Switch to Bat- (PV2)	Y49/ Pin 1	50
Compression Brake Power	Y49/Pin 2	52
Exhaust Flap Control, Switch to Bat- (PV1)	Y91/Pin 1	51
Exhaust Flap Power	Y91/Pin 2	12

Table 3-23 Engine Harness Connector for MBE 900 Non-EGR Engine

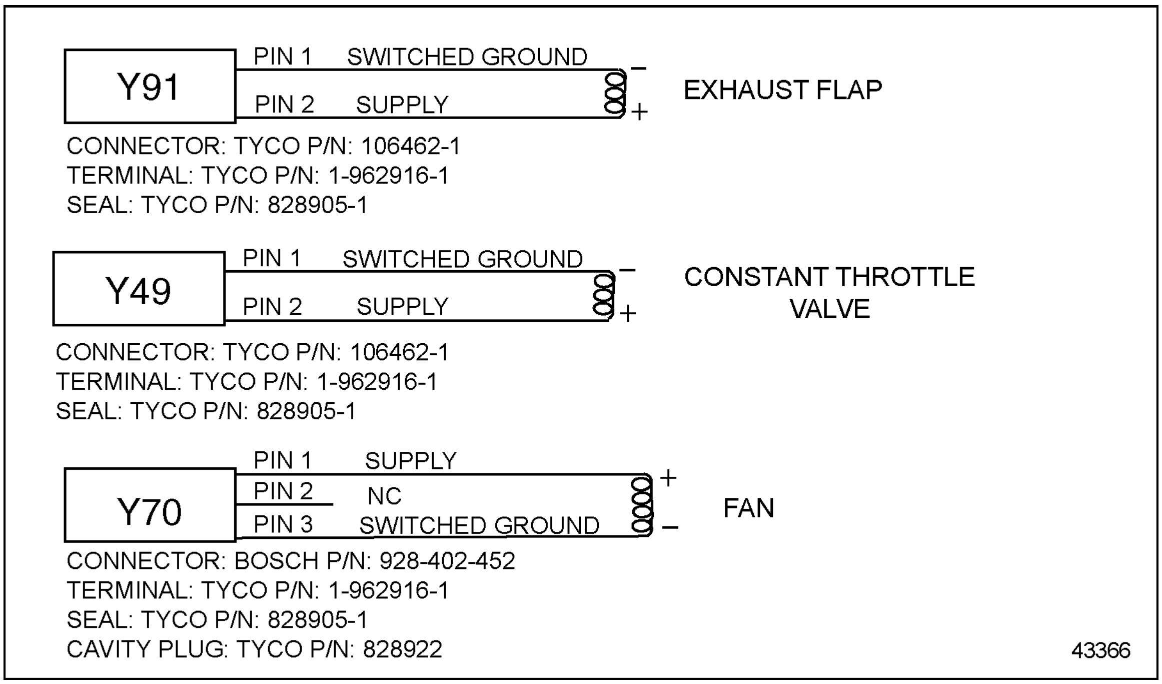


Figure 3-10 MBE 900 Non-EGR VIH to EH Wiring

VIH Power Wiring

The OEM-supplied VIH power wiring (see Figure 3-11) supplies 12 volts to the VCU and PLD-MR. The system must be sourced directly from the battery. The terminals are designed to accept 14 AWG standard wall wire.

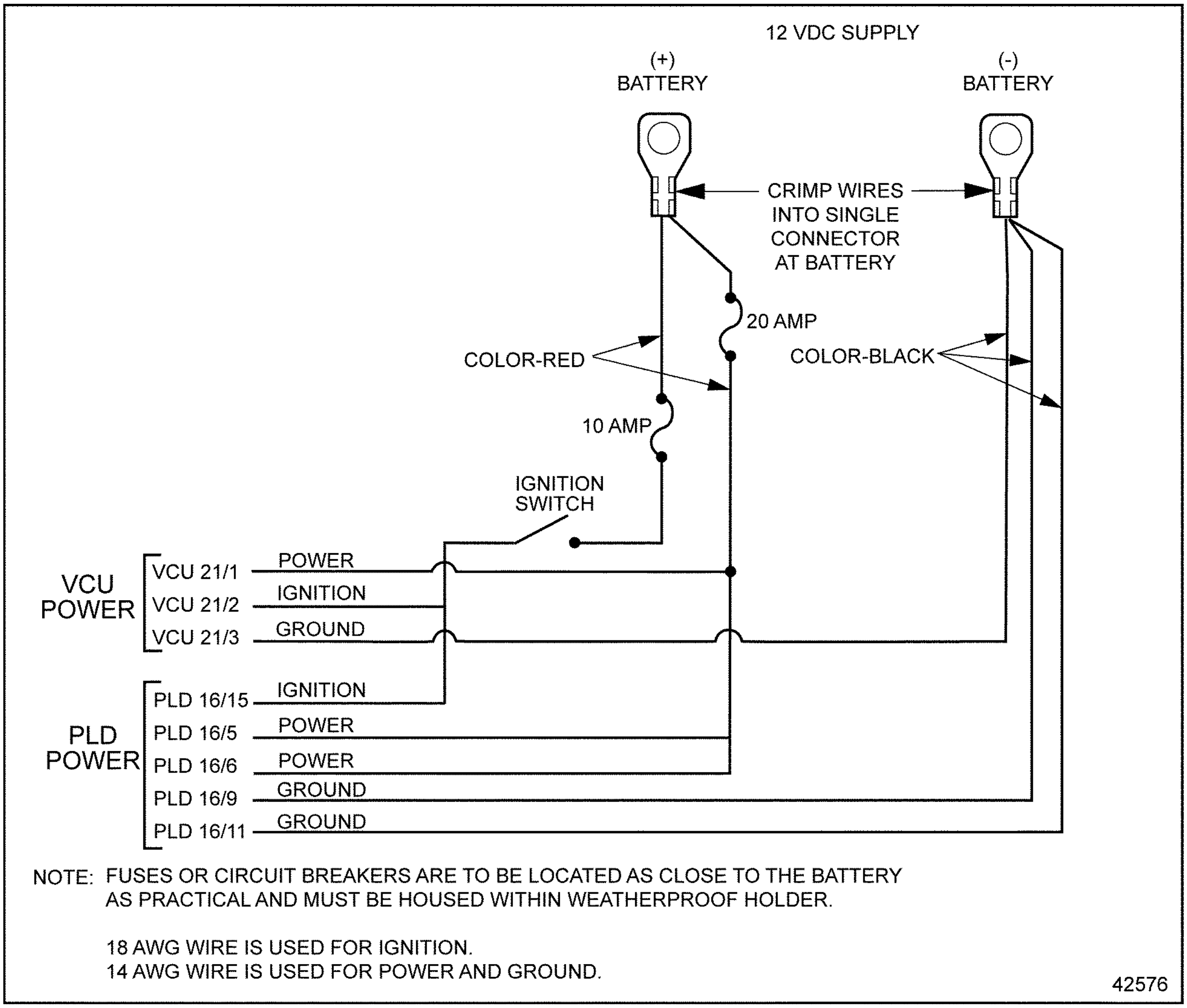


Figure 3-11 Power Wiring

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

NOTE:
The 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.

A 20 amp fuse must be used and installed as close to the battery as possible (see Figure 3-11).

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.

Communications – SAE J1939 Data Link

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.

The VCU connector pin assignments for SAE J1939 are listed in Table 3-24.

Pin	Signal Type	Function
21/19	Data Link	SAE J1939 (+)
21/20	Data Link	J1939 Shield
21/21	Data Link	SAE J1939 (-)

Table 3-24 J1939 VCU to VIH Connector Pin Assignments

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

SAE J1939	Top Layer (Overview)
SAE J1939/11	Physical Layer
SAE J1939/21	Data Link Layer
SAE J1939/71	Vehicle Application Layer
SAE J1939/01	Truck and Bus Applications
SAE J1939/73	Application Layer — Diagnostics

J1939 cable is available from the following sources:

Belden Electronics Division
2200 U.S. 27 South
Richmond, IN 47374
Phone: 1–800–235–3361
www.belden.com

Tyco Electronics Corporation
Raychem Wire & Harnessing
300 Constitution Drive
Menlo Park, CA 94025
www.raychem.com

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

Communications – SAE J1587/J1708 Data Link

SAE J1587 Data Link+ and SAE J1587 Data Link- are used for the SAE J1708/J1587 communication link.

The VCU connector pin assignments for SAE J1708/J1587 are listed in Table 3-25.

Pin	Signal Type	Function
21/17	Data Link	SAE J1708 (+)
21/18	Data Link	SAE J1708 (-)

Table 3-25 J1708/1587 VCU to VIH Connector Pin Assignments

The following SAE documents cover the SAE J1587/J1708 Data Link. Contact the Society of Automotive Engineers to obtain documents.

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

Communications – Propriety IES-CAN Data Link

The low speed propriety IES-CAN link between the PLD-MR and the VCU must be a twisted shielded cable with 0.75 mm diameter wire (approximately 20 AWG), bundle shielded with drain wire and 30 twists per meter. The insulation is rated to 105°C. Termination resistors for the IES-CAN link are located in the VCU and PLD-MR. The wiring for the PLD-MR 16–pin connector and the VCU 15–pin connector are listed in Table 3-26.

VCU 15–Pin	Function	PLD-MR 16–Pin
15/13	IES-CAN Data Link (+)	16/1
15/14	IES-CAN Data Link (Shield)	16/2
15/15	IES-CAN Data Link (-)	16/3

Table 3-26 Propriety IES-CAN Data Link

NOTE:
A special cable must be used for the propriety IEC-CAN data link.

3.3.4 POWER SUPPLY – 12 VOLT SYSTEM

Normal operating voltage for the VCU and PLD-MR is 11-16 VDC.

NOTICE:
Operating the VCU or PLD-MR over the voltage limits of 16 volts will cause damage to the VCU or PLD-MR.

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

NOTICE:
Reversing polarity will cause damage to the VCU and/or PLD-MR if the Power Harness is not properly fused.

NOTE:
All output loads, ignition and VCU power must be powered from the same battery voltage source.

Average Current Draw

The maximum average current draw is listed in Table 3-27. This information should be used to size the alternator.

System	Maximum Average Current Draw (12 V Nominal Supply)	
	Idle	Full Load/Rated Speed
PLD-MR – Engine Loads	1–2 A total	12.5 A total
VCU – Vehicle Loads*	350 mA total	5.4 A total

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

Table 3-27 Maximum Average Current Draw

The current draw for a VCU/PLD-MR configuration is listed in Table 3-28.

Configuration	Condition	Current
VCU	Ignition Off	100 µA
	Ignition On and Engine Stopped	200 mA

Table 3-28 Current Draw for VCU Configuration

The current draw for a PLD-MR is listed in Table 3-29.

Configuration	Condition	Current
PLD-MR	Ignition Off	1 mA
	Ignition On and Engine Stopped	400 mA

Table 3-29 Current Draw for PLD-MR Configuration

Battery Isolator

MBE Electronic Controls do not require a battery isolators. However, some applications require a battery that is dedicated to the engine and completely isolated from the rest of the vehicle. Commercially available battery isolators can be used.

Main Power Shutdown

The main power supply shutdown schematic shows the DDC approved method for main power switch implementation. See Figure 3-12.

NOTE:
Switches must remain closed for 30 seconds after ignition is off for the PLD-MR and VCU to write non-volatile data.

NOTE:
Disconnecting positive power is not sufficient to isolate the VCU 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.

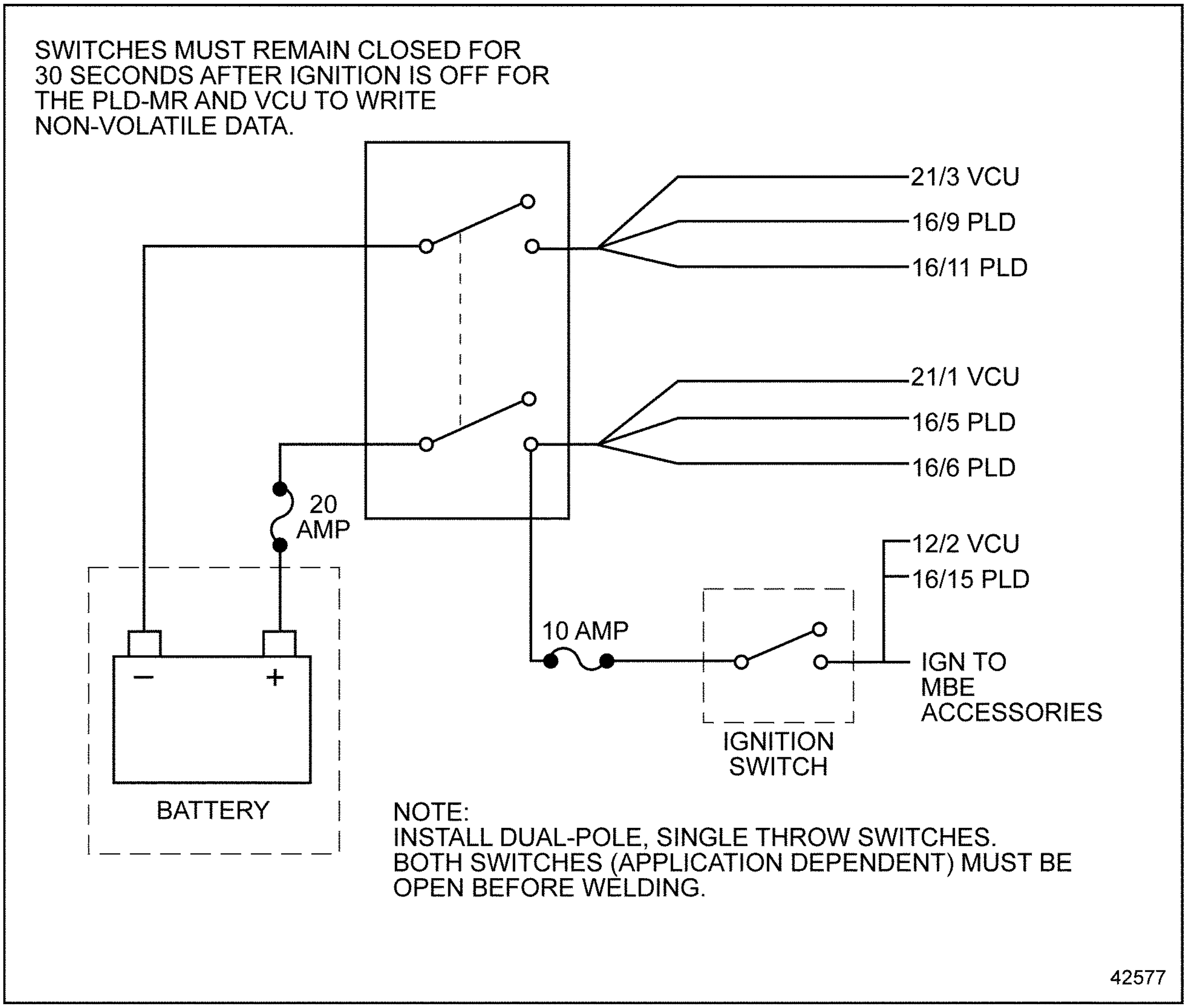


Figure 3-12 Main Power Supply Shutdown 12 or 24 Volt Systems

NOTE:

The alternator should be connected directly to the battery for isolation purposes.

3.3.5 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 VCU – PLD-MR's maximum operating voltage of 16 volts.

CAUTION:

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

CAUTION:

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

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

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

- Must not open during normal operation
- Must open before the PLD-MR or VCU is damaged during a reverse battery condition

Bussmann ATC-20 and Delphi Packard Electric Systems MaxiFuse 20 amp rated fuses or equivalent will satisfy these requirements. Acceptable blow times versus current and temperature derating characteristics are listed in Table 3-30 and Table 3-31.

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

Table 3-30 Fuse Current and Blow Time

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

Table 3-31 Fuse Temperature and Current

3.3.6 CONNECTORS

There are three connectors to the VCU, a 21–pin connector, an 18–pin connector and a 15–pin connector. The OEM is responsible for the three connectors at the VCU and the one connector at the PLD-MR.

NOTE:
The connectors are not water tight and cannot be subject to water spray.

The part numbers for the VCU 21–pin connector are listed in Table 3-32.

Part	DDC Part Number
VCU 21–pin connector	013 545 65 26
Terminal (Vehicle) 0.5–1.0 mm wire	013 545 76 26
Terminal (Power) 1.5–2.5 mm wire	013 545 78 26
Seals — 1.0 mm wire	000 545 28 39
Seals — 1.5 — 2.5 mm wire	000 545 29 39
Plug	000 545 62 80

Table 3-32 VCU 21–pin Connector Part Numbers

The part numbers for the VCU 18–pin connector are listed in Table 3-33.

Part	DDC Part Number
VCU 18–pin connector	013 545 64 26
Terminal (Vehicle) 0.5–1.0 mm wire	013 545 76 26
Terminal (Power) 1.5–2.5 mm wire	013 545 78 26
Seals — 1.0 mm wire	000 545 28 39
Seals — 1.5 — 2.5 mm wire	000 545 29 39
Plug	000 545 62 80

Table 3-33 VCU 18–pin Connector Part Numbers

The part numbers for the VCU 15–pin connector are listed in Table 3-34.

Part	DDC Part Number
VCU 15–pin connector	013 545 63 26
Terminal (Vehicle) 0.5–1.0 mm wire	013 545 76 26
Terminal (Power) 1.5–2.5 mm wire	013 545 78 26
Seals — 1.0 mm wire	000 545 28 39
Seals — 1.5 — 2.5 mm wire	000 545 29 39
Plug	000 545 62 80

Table 3-34 VCU 15–pin Connector Part Numbers

The part numbers for the VCU-to-PLD-MR connector is listed in Table 3-35.

Part	DDC Part Number
PLD-MR 16–pin connector	000 153 00 22
Terminal (VCU) 0.5–1.0 mm wire	011 545 77 26
Terminal (power) 1.0–2.5 mm wire	011 545 76 26
Seals — 1.0 mm	000 545 28 39
Seals — 1.5–2.5 mm	000 545 29 39
Plug	000 545 62 80
Cover	000 153 00 82

Table 3-35 VCU–to–PLD-MR 16–pin Connector Part Numbers

The part numbers for the OEM connectors (see Figure 3-10) for engine brakes and fan control and constant throttle valve/exhaust flap for the MBE 900 Non-EGR and EGR engine are listed in Table 3-23.

Part	Part Number
Constant Throttle/Exhaust Flap 2–pin Connector	Tyco 106462 1
Terminal	Tyco 1 962916 1
Seal	Tyco 828905 1
Fan 3–pin Connector	Bosh 928 402 452
Terminal	Tyco 1 962916 1
Seal	Tyco 828905 1
Cavity Plug	Tyco 828922

Table 3-36 OEM Connectors for Exhaust Flap/Constant Throttle Valve and Fan on MBE 900 EGR and Non-EGR Engines

The part numbers for the OEM 8–pin connector for the MBE 4000 non-EGR engine are listed in Table 3-37.

Part	DDC Part Number
8–pin Delphi Connector, 8WM M/P 150 Blk	030 545 8828
8–pin Delphi Connector, TPA	000 545 4073
Terminal, M/P 150M 0.35–0.50 mm	034 545 0028
Terminal, M/P 150M 0.75–1.00 mm	665 545 9026
Terminal, M/P 150M 0.50–1.00 mm	030 545 4128
Terminal, M/P 150M 1.00–1.50 mm	030 545 9026
Seal, 1.29–1.70	001 5545 1280
Seal, 1.60–2.15	001 5545 1380
Seal, 2.03–2.85	001 5545 1480

Table 3-37 OEM 8–pin Connector for MBE 4000 Non-EGR Engine

Data Link Connector

The connector used to connect the data links is a nine-pin Deutsch connector for the SAE J1939 Data Link and the SAE J1708/J1587 Data Link. DDC recommends that the OEM-supplied Data Link Connector be conveniently positioned in a well protected location facilitating subsequent diagnostic usage (i.e., reprogramming, diagnostics, etc.).

The components listed in Table 3-38 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 3-38 Required Components to Incorporate an SAE J1939/J1587 Data Link in the VIH with the Nine-pin Connector

The following illustration shows the wiring for the nine-pin connector (see Figure 3-13).

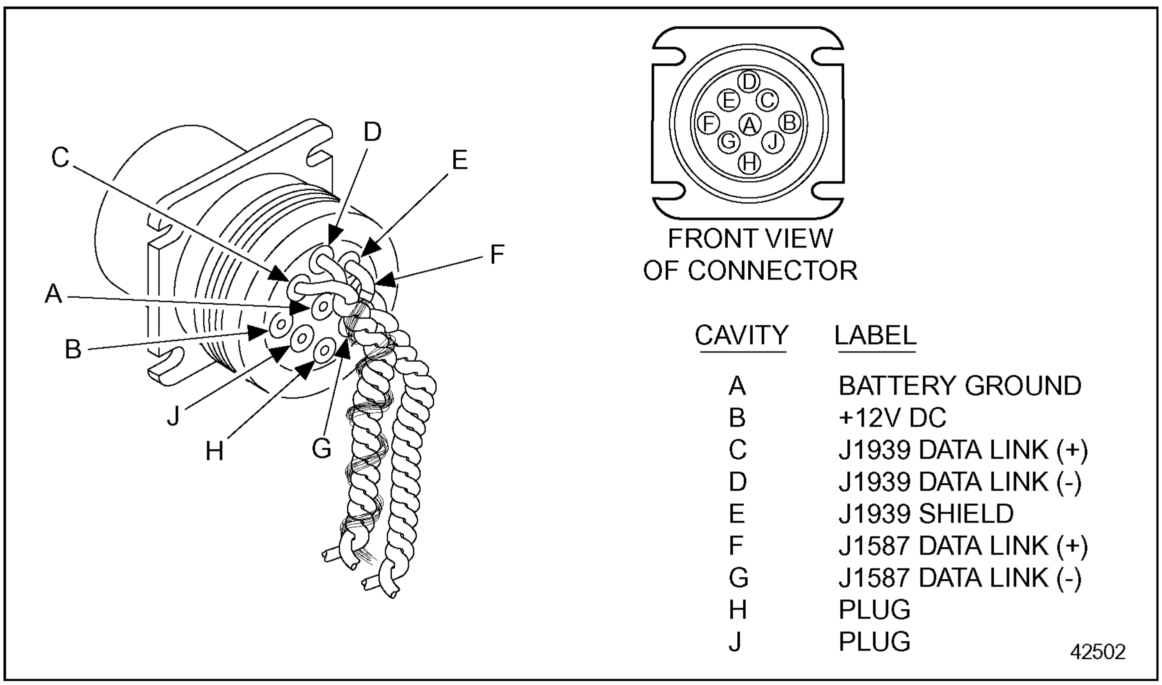


Figure 3-13 Wiring for Nine-pin Data Link Connector

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).

SAE J1708/J1587 Data Link Six-pin Connector

The components are required to incorporate a SAE J1708/J1587 Data Link in a VIH so a diagnostic devices can be attached without a unique jumper are listed in Table 3-39.

Component	DDC Part Number	Deutsch Part Number
Six-pin Deutsch Connector	23513052	HD10-6-12P
Connector Cover	23507154	HDC 16–6
Two (2) Cavity Plugs	23507136	114017
Four (4) Terminals	23513053	0460-220-1231

Table 3-39 Required Components to Incorporate an SAE J1939/J1587 Data Link in the VIH with the Six-pin Connector

The following illustration shows the wiring for the 6-pin connector (see Figure 3-14).

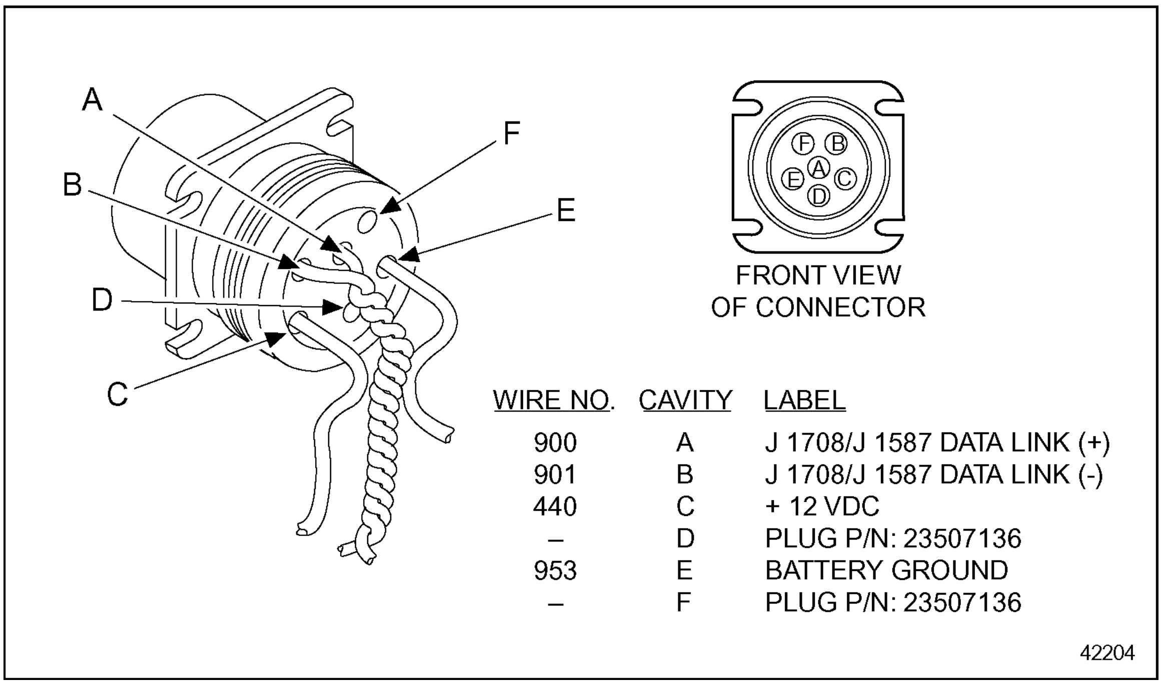


Figure 3-14 Wiring for Six-pin Data Link Connector

3.3.7 GRID HEATER

The grid heater (see Figure 3-15) is driven by a load relay switched to supply voltage. The installation of a fused high current, as well as the recommended monitoring of the load contact of the load relay, is the responsibility of the vehicle manufacturer.

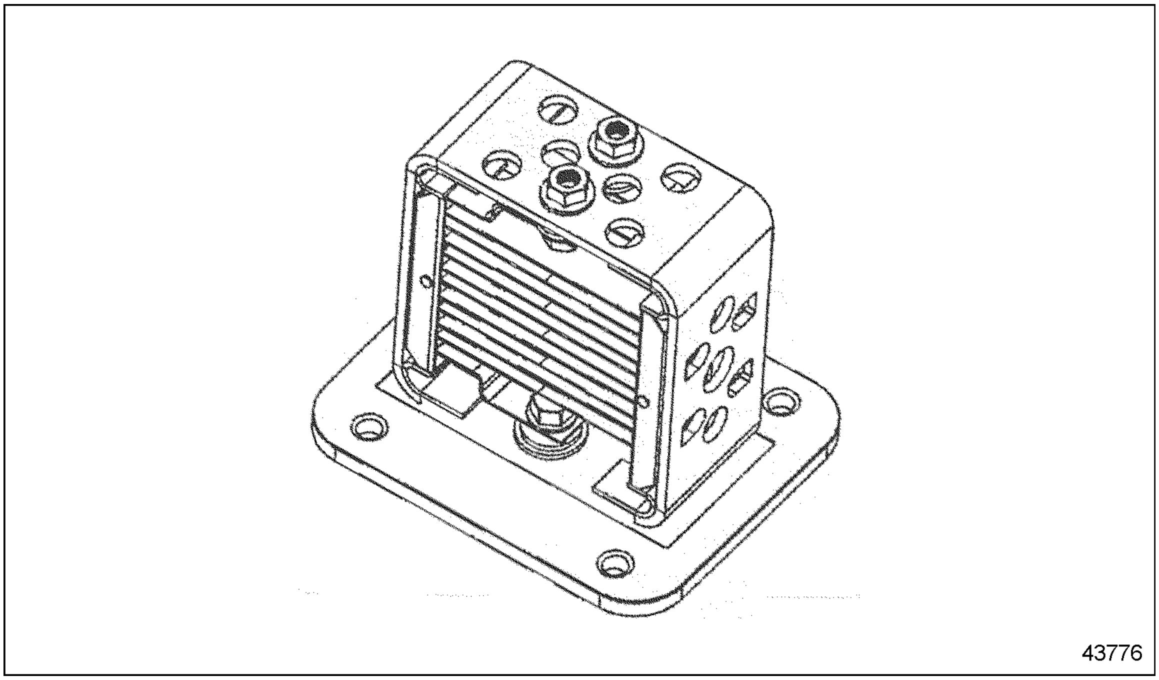


Figure 3-15 Grid Heater

Nominal power and resistance for the 12 V and 24 V grid heaters are listed in Table 3-40.

Data	12 Volt	24 Volts
Nominal Power at 1000°C (1832°F)	1.9 KW ± 10%	1.9 KW ± 10%
Resistance at Rated Temperature	62 mΩ ± 10%	250 mΩ ± 10%

Table 3-40 Nominal Power and Resistance

NOTE:
The grid heater requires a 250 Amp relay.

Wiring the Grid Heater

The output (21/7) activates the grid heater control lamp. The output (15/9) activates the load relay for the grid heater. See Figure 3-16.

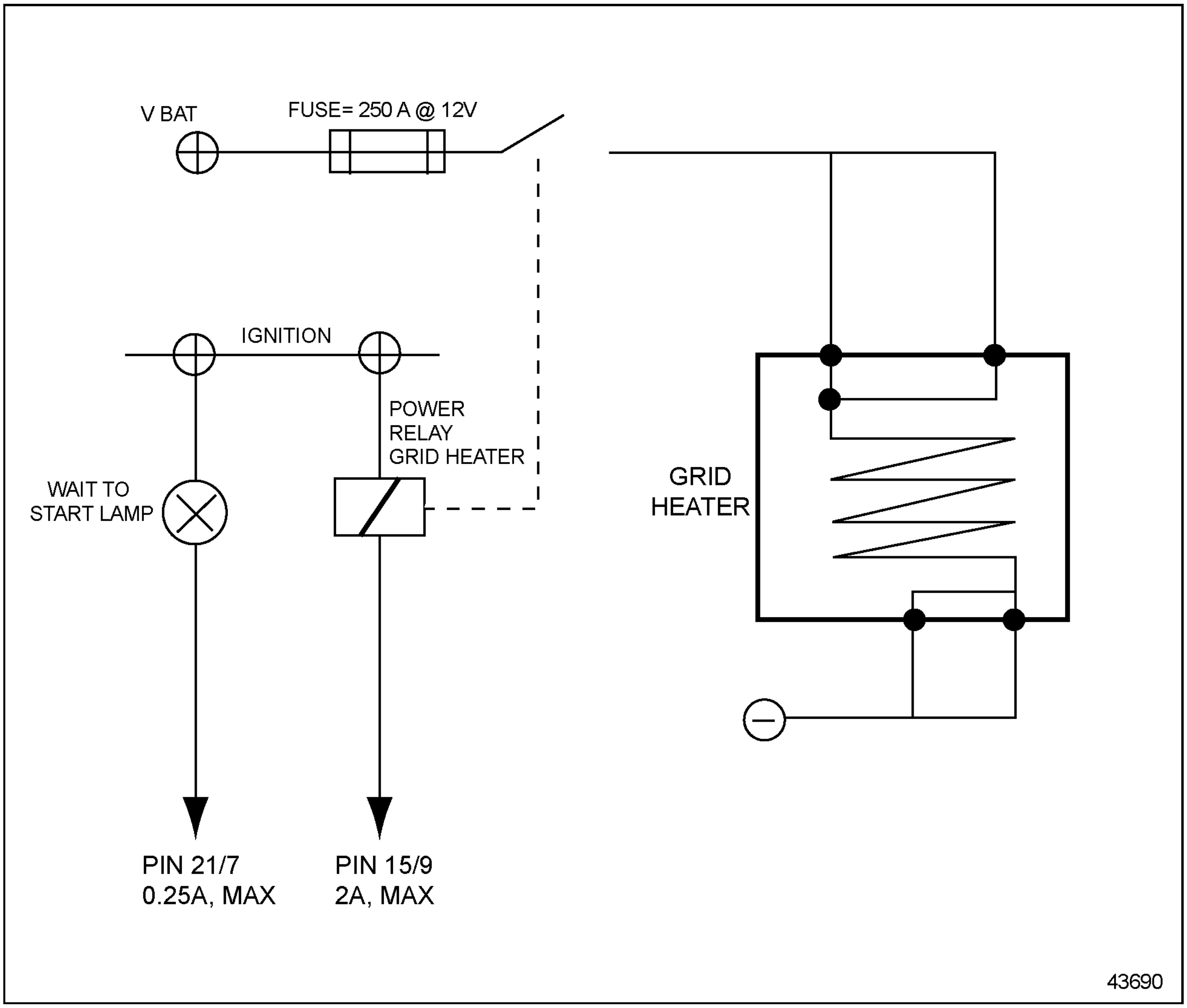


Figure 3-16 VCU Grid Heater Wiring

3.4 WIRES AND WIRING

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

3.4.1 GENERAL REQUIREMENTS

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

3.4.2 GENERAL WIRE

All wires used in conjunction with the MBE Electronic Controls must meet the following criteria:

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

NOTICE:
Insulation must be free of nicks.

Criteria: Wires

Tape, conduit, loom or a combination thereof must be used to protect the wires. Refer to sections 3.5 and 3.6.

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

All wires must comply with SAE J1128.

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

3.4.3 DEUTSCH TERMINAL INSTALLATION AND REMOVAL

The method of terminal installation and removal varies. The following sections cover Deutsch terminal installation and removal.

Deutsch Terminal Installation Guidelines

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

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

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

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

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

Use the following instructions for installing Deutsch terminals:

1. Strip approximately .25 inch (6 mm) of insulation from the cable.
2. Remove the lock clip, raise the wire gage selector, and rotate the knob to the number matching the gage wire that is being used.
3. Lower the selector and insert the lock clip.
4. Position the contact so that the crimp barrel is 1/32 of an inch above the four indenters. See Figure 3-17. Crimp the cable.

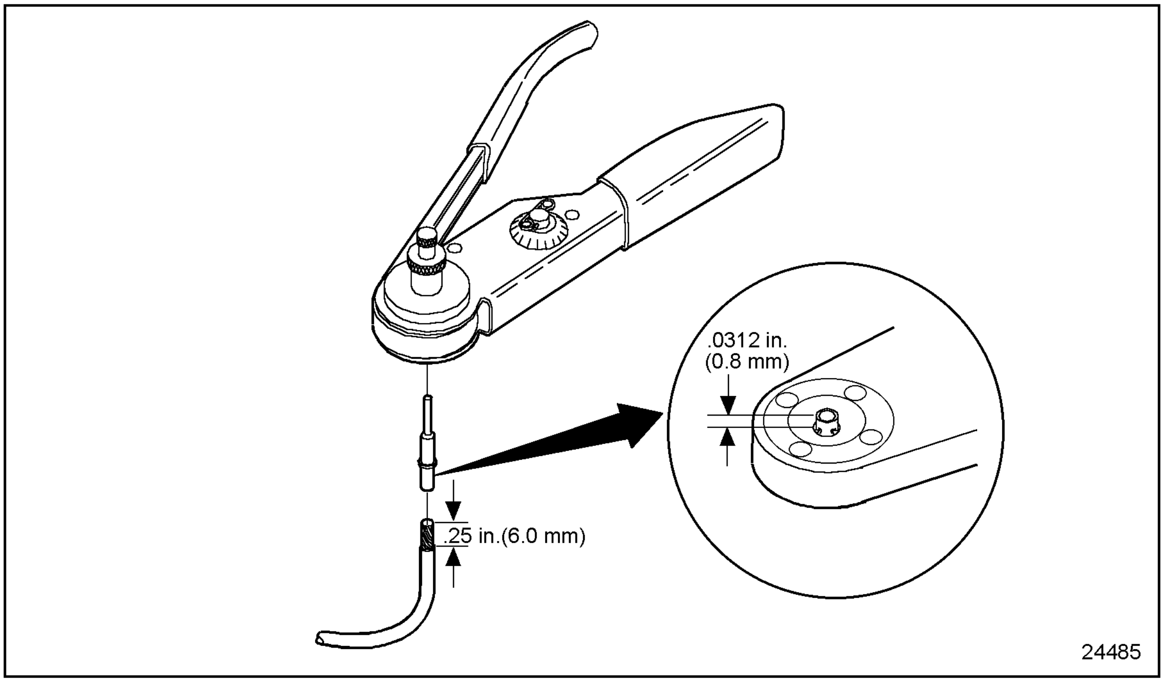


Figure 3-17 Setting Wire Gage Selector and Positioning the Contact

5. Grasp the contact approximately one inch behind the contact crimp barrel. Hold the connector with the rear grommet facing you. See Figure 3-18.

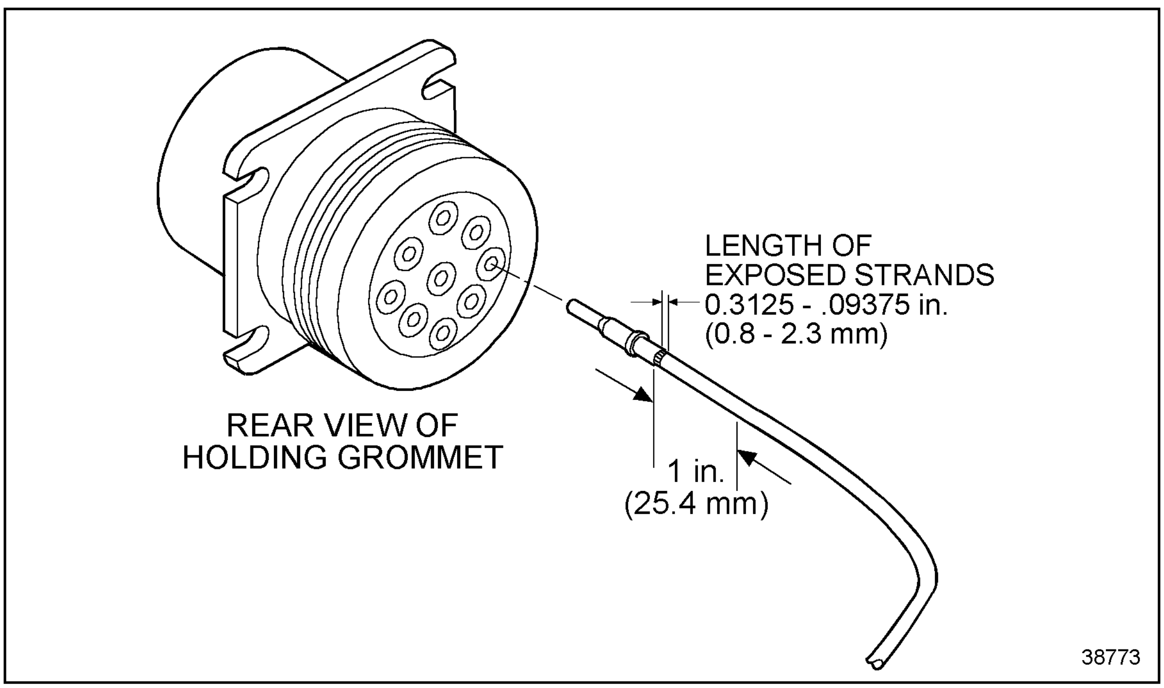


Figure 3-18 Pushing Contact Into Grommet

6. Push the contact into the grommet until a positive stop is felt. See Figure 3-18. A slight tug will confirm that it is properly locked into place. See Figure 3-19.

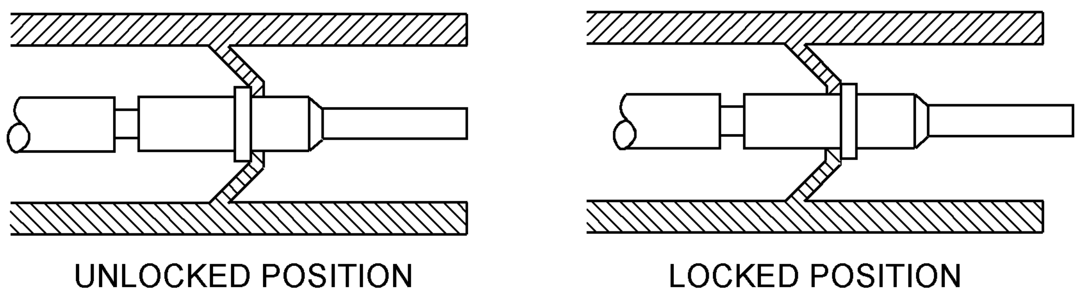


Figure 3-19 Locking Terminal Into Connector

Deutsch Terminal Removal

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

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 cable of contact to be removed. See Figure 3-20.

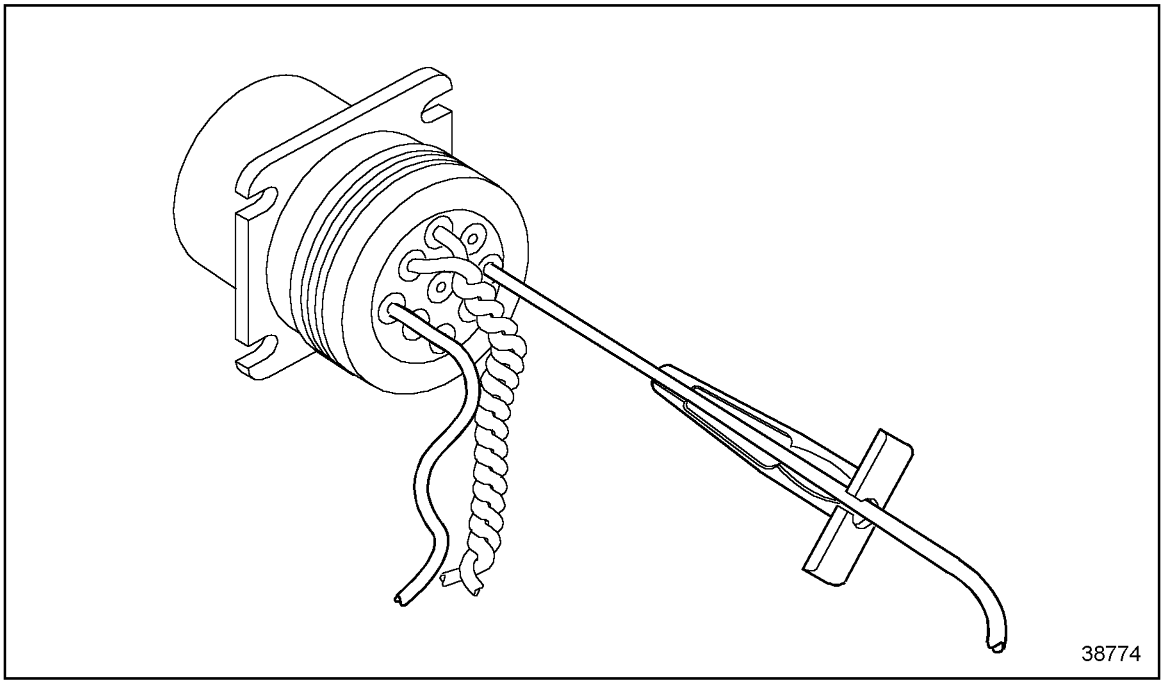


Figure 3-20 Removal Tool Position

2. Slide the tool along the cable into the insert cavity until it engages and resistance is felt. Do not twist or insert tool at an angle. See Figure 3-21.

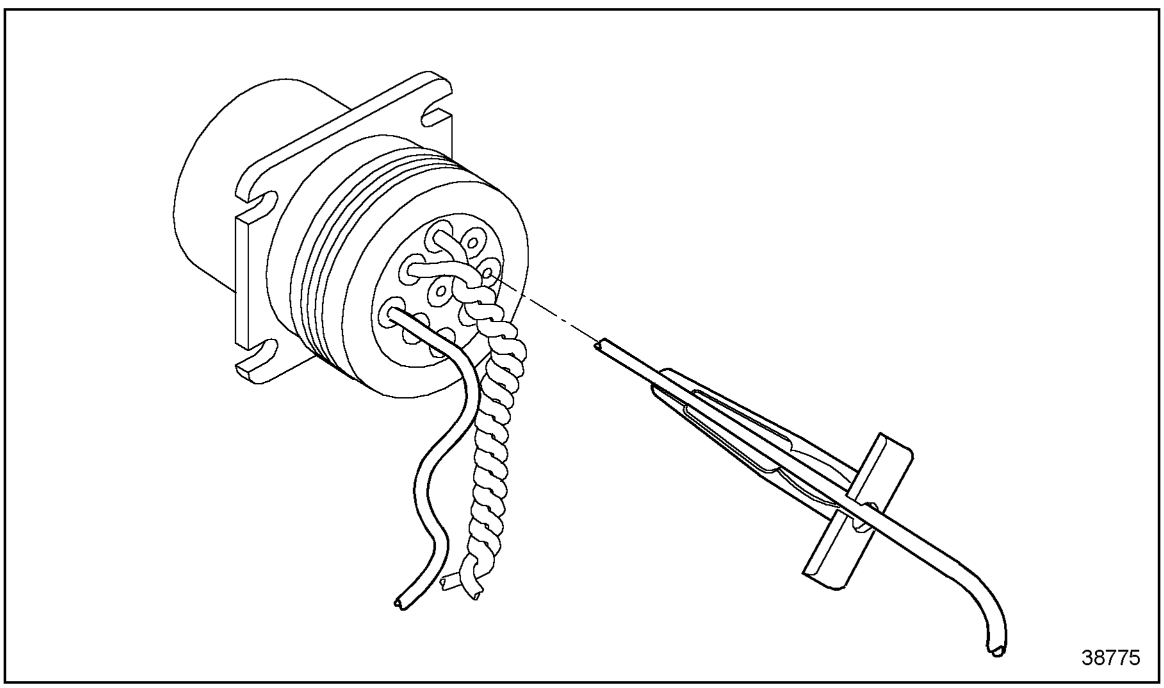


Figure 3-21 Removal Tool Insertion

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

3.4.4 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 3-22.

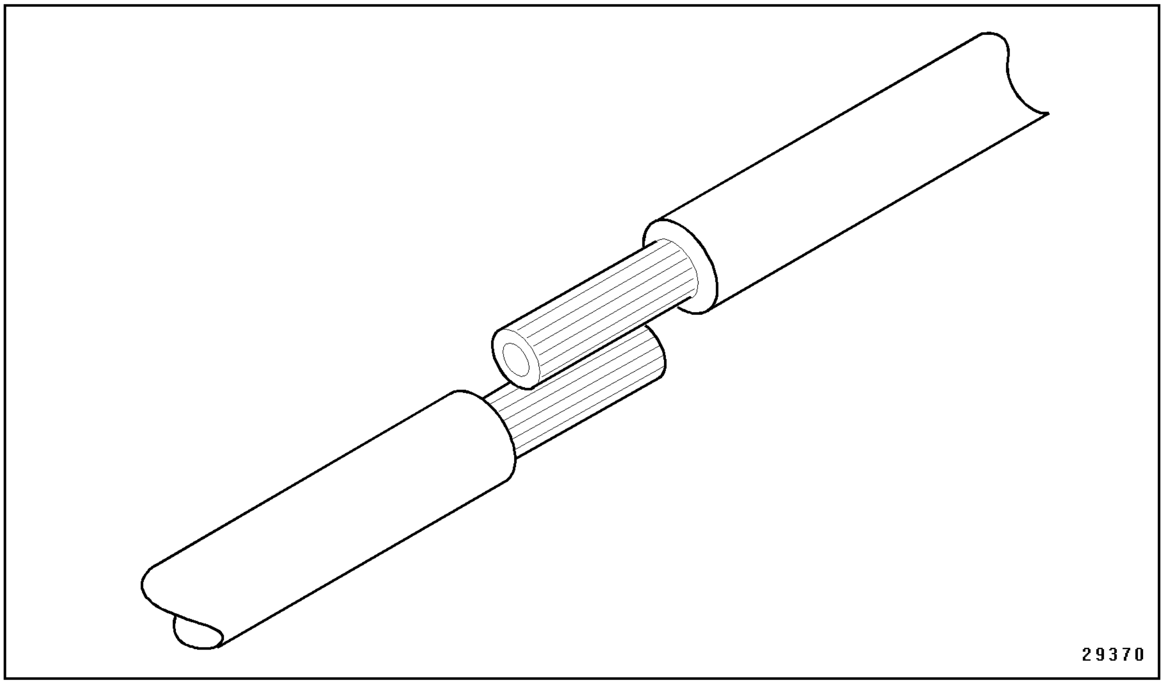


Figure 3-22 Positioning the Leads

2. Secure the leads with a commercially available clip and hand tool. See Figure 3-23.

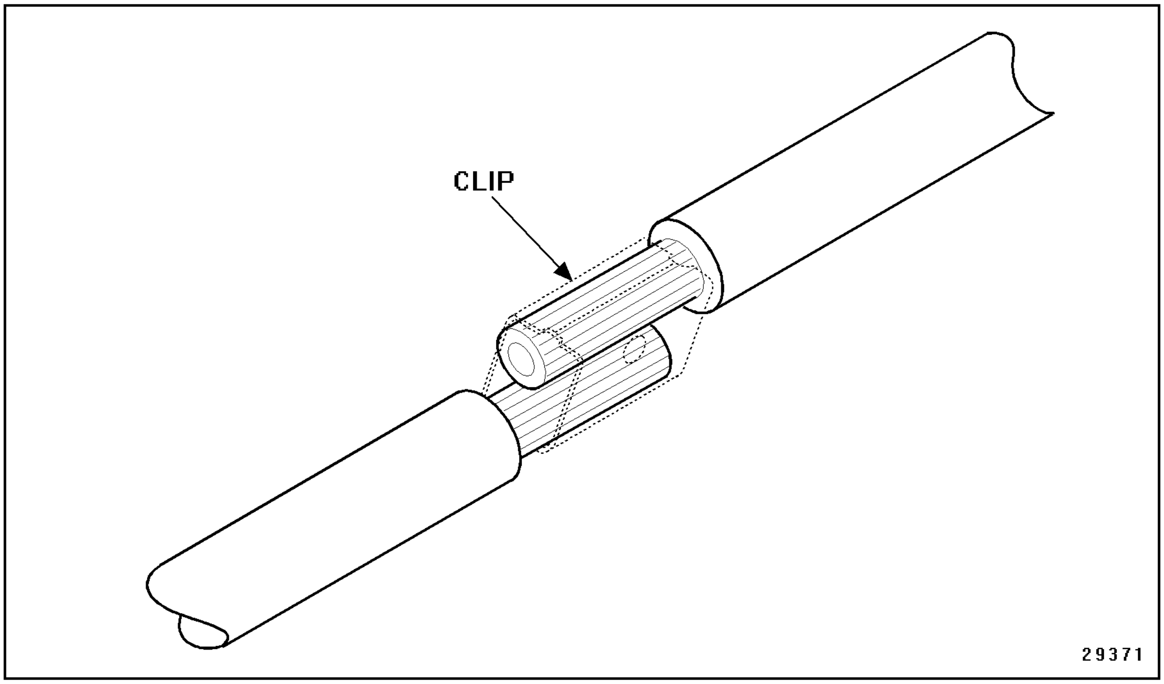


Figure 3-23 Securing the Leads With a Clip

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

Table 3-43 Applied Load Criteria for Terminals

5. Loop the lead back over the spliced joint and tape. See Figure 3-24.

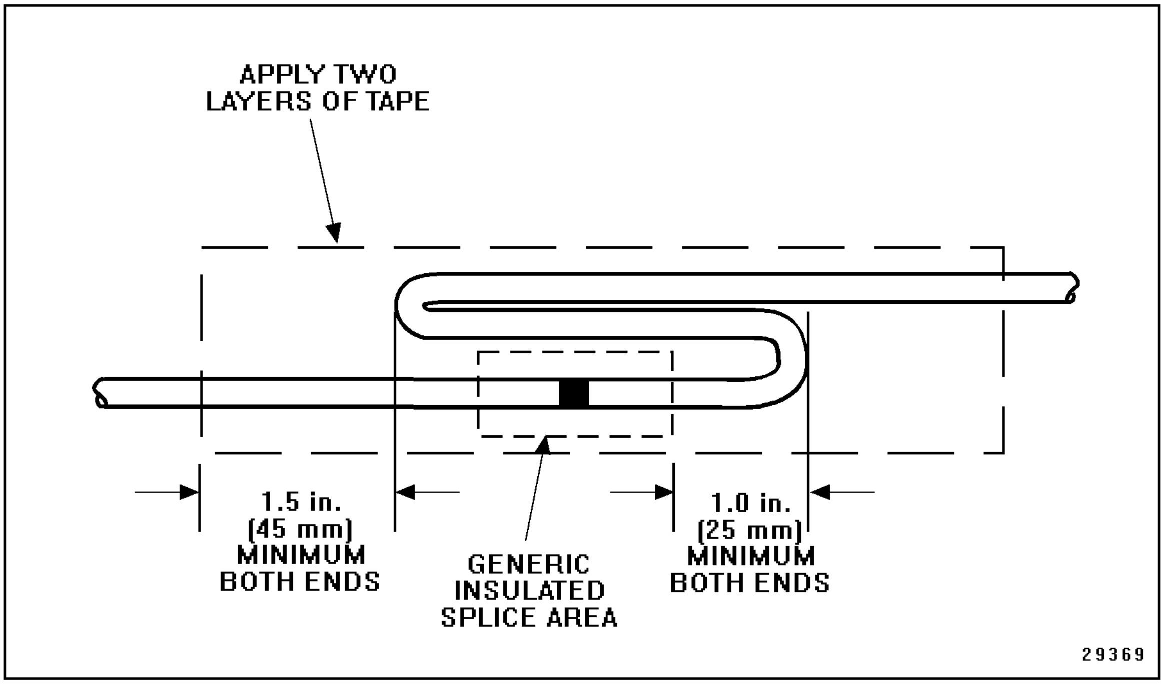


Figure 3-24 Recommended Strain Relief of Spliced Joint

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
Terminal Crimper for Metri-Pack 280 (12 AWG)	Kent-Moore J 38125-6
Terminal Crimper for Metri-Pack 280 (18 AWG)	Kent-Moore J 39848
Terminal Crimper for Weather Pack	Kent-Moore J 35606
Terminal Crimper for Deutsch	Kent-Moore J 34182
Terminal Crimper for Metri-Pack 150	Kent-Moore J 35123

Table 3-44 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 3-25, A).
4. Insert the other wire into the splice clip until it butts against the clip stop (see Figure 3-25, 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.

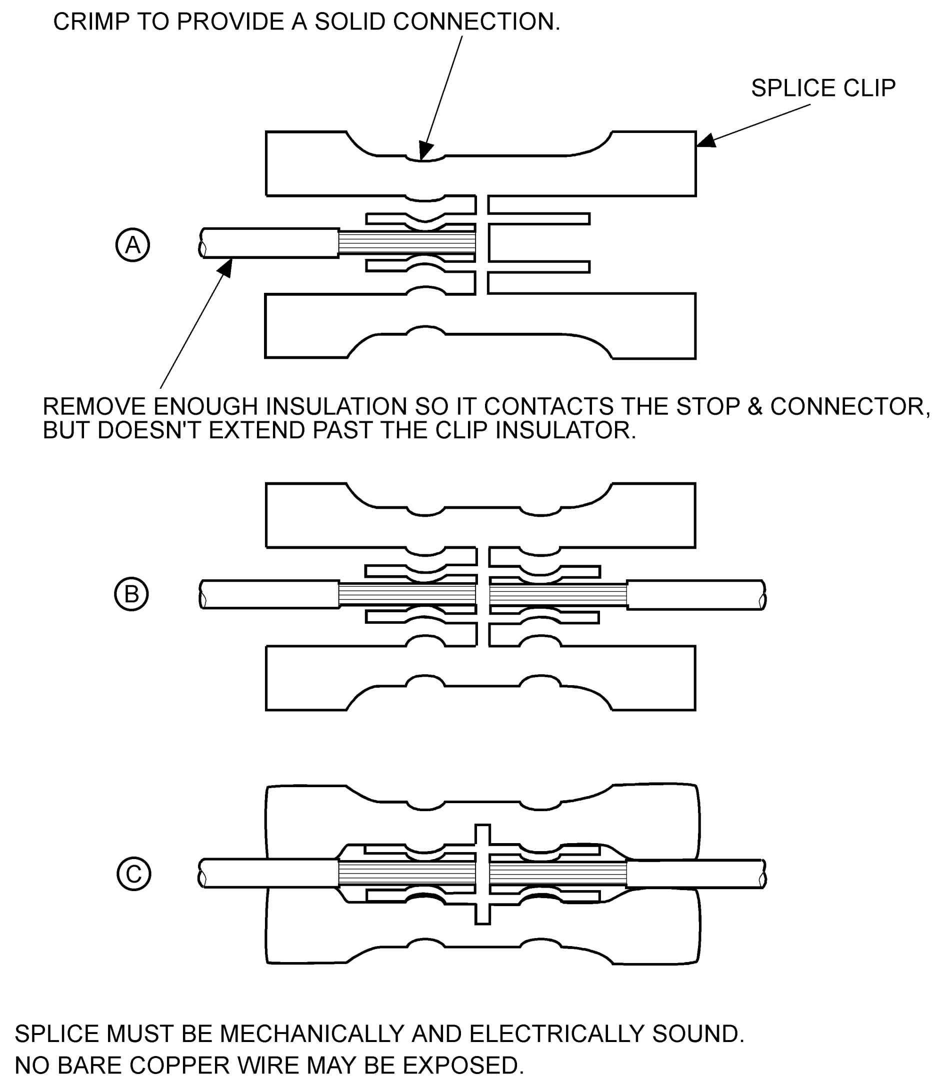
Wire Gage	Must Withstand Applied Load
14 AWG	45 lb (200 N)
16 AWG	27 lb (120 N)
18 AWG	20 lb (90 N)

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 3-25, C).

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

8. Loop the lead back over the spliced joint and tape. See Figure 3-24.



NOTICE:

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

37245

Figure 3-25 Splicing Straight Leads - Alternate Method 1

Splicing and Repairing Straight Leads - Alternate Method 2

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

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
Terminal Crimper for Metri-Pack 280 (12 AWG)	Kent-Moore J 38125-6
Terminal Crimper for Metri-Pack 280 (18 AWG)	Kent-Moore J 39848
Terminal Crimper for Weather Pack	Kent-Moore J 35606
Terminal Crimper for Deutsch	Kent-Moore J 34182
Terminal Crimper for Metri-Pack 150	Kent-Moore J 35123

Table 3-46 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 .25 in. (6 mm) on both sides (see Figure 3-26, A).
4. Insert one wire into splice clip until it butts against the splice clip. Stop and crimp (see Figure 3-26, 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 3-26, 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 3-26, C).
8. Shrink tubing with a heat gun to seal the splice (see Figure 3-26, 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 3-24.

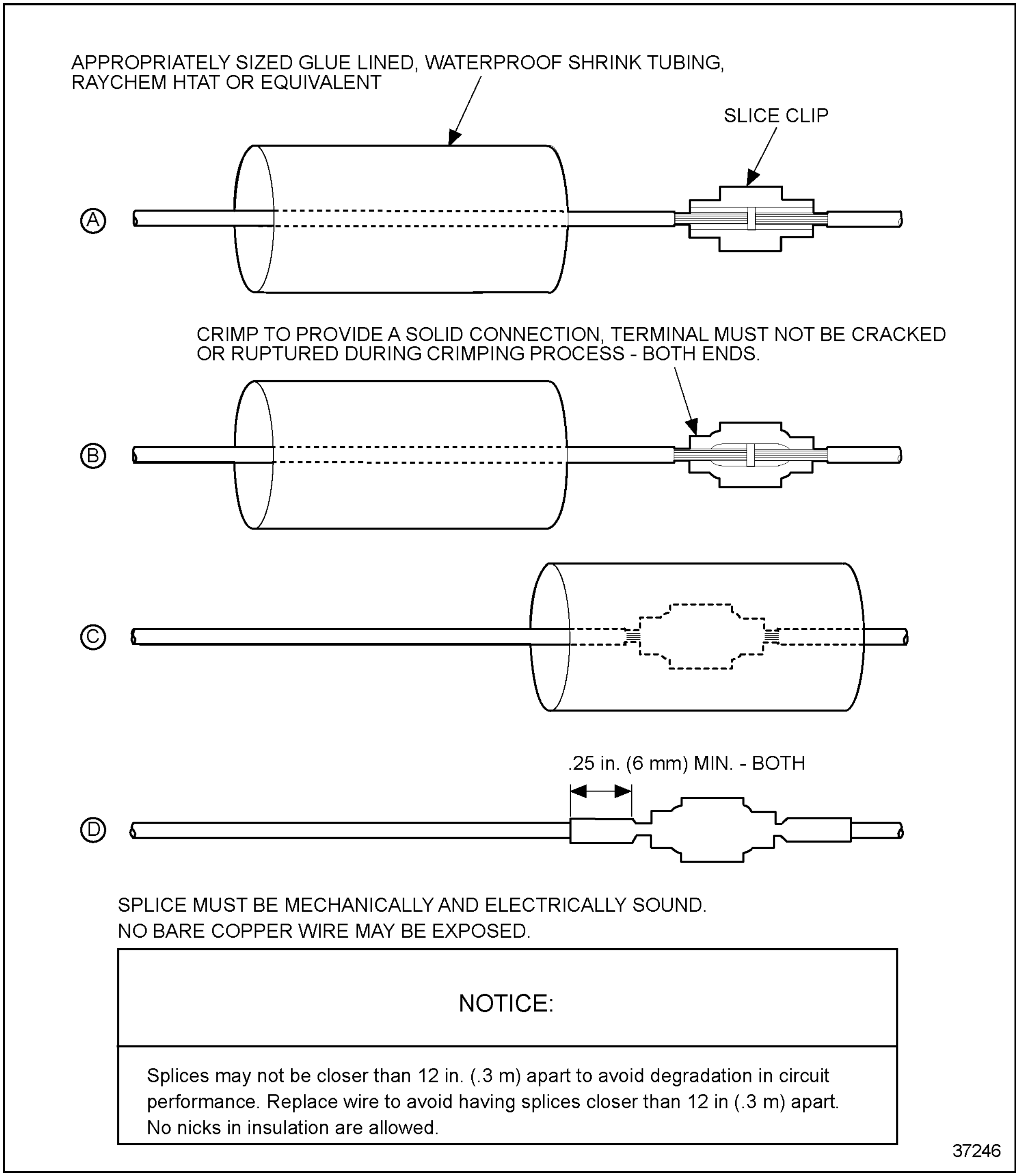


Figure 3-26 Splicing Straight Leads - Alternate Method 2

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	**Tyco Electronics Corporation**
711 Lidgerwood Ave	Raychem Cable Identification and Protection
P.O. Box 711	300 Constitution Drive
Elizabeth, New Jersey 07207-0711	Menlo Park, CA 94025
1-800-52ALPHA	Phone: 1–800–926–2425
www.alphawire.com	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 3-27) so there is at least a 2.5 in. (65 mm) separation between splices.

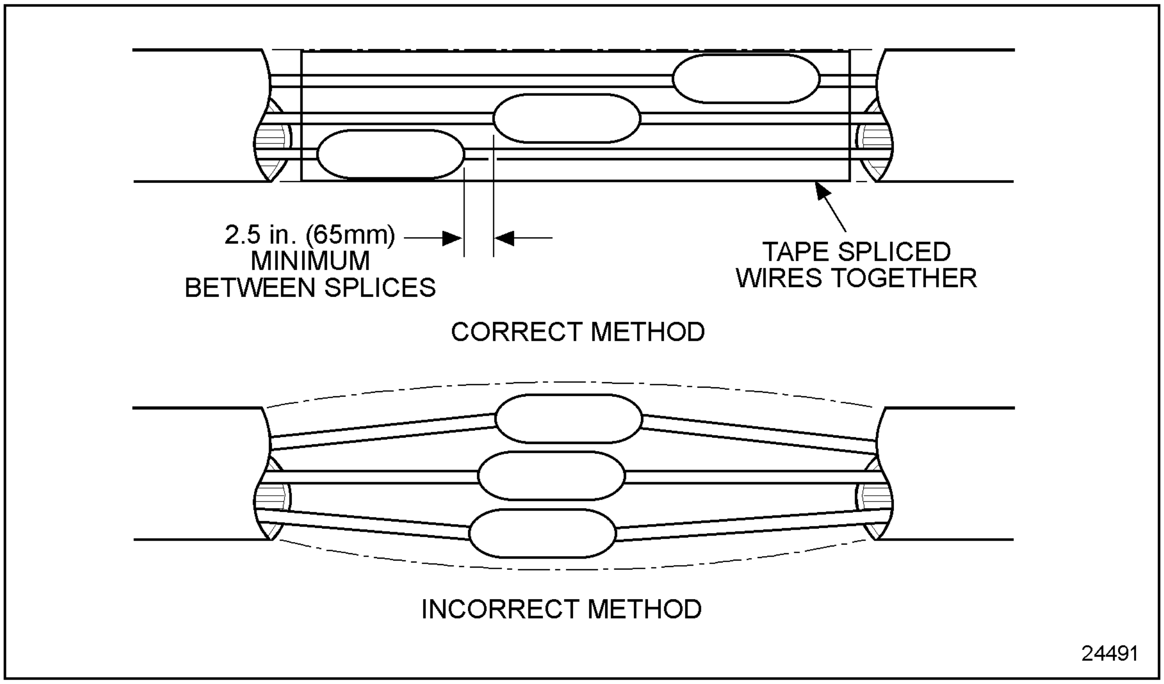


Figure 3-27 The Correct and Incorrect Method of Staggering Multiple Splices

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

2. Heat shrink a minimum of two layers of heat shrink tubing.
3. Tape the spliced wires to each other. Refer to section 3.6.

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3.5 CONDUIT AND LOOM

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

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

The following guidelines should be used when designing a harness:

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

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

Criteria: Conduit and Loom

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

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

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

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3.6 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 3.5). Be sure to firmly secure the start and finish ends of tape.

Criteria: Tape

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

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

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

Criteria: Taping

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

The tape must be crossed over butted conduit ends.

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

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3.7 SENSORS

The MBE Electronic Controls system is designed to operate with several types of sensors as listed in Table 3-47.

Sensor Type	Description
Variable Reluctance/Magnetic Pick-up	Used to monitor the crankshaft position, engine speed, turbo speed (MBE 4000 only), and vehicle speed.
Thermistor	Used to monitor temperatures.
Variable Capacitance	Used to monitor manifold, and oil gallery pressures.
Variable Resistance (Potentiometer)	Used to sense throttle position.
Switch	Used to signal coolant level, inlet air restriction, and oil level.

Table 3-47 Sensor Types

The sensors integrated into the Engine Harness are factory-installed (refer to section 3.7.1). The sensors integrated into the Vehicle Interface Harness are installed by the OEM (refer to section 3.7.2).

3.7.1 FACTORY-INSTALLED SENSORS

The sensors integrated into the factory-installed Engine Harness are listed in Table 3-48.

Sensor	Function
Camshaft Position Sensor (CMP Sensor)	Senses crankshaft position and engine speed for functions such as fuel control strategy.
Crankshaft Position Sensor (CKP Sensor)	Indicates a specific cylinder in the firing order.
Engine Coolant Temperature Sensor (ECT Sensor)	Senses coolant temperature for functions such as engine protection, fan control and engine fueling.
Engine Oil Level Sensor EOL Sensor (optional)	Senses oil level for functions such as engine protection.
Engine Oil Pressure Sensor (EOP Sensor)	Senses gallery oil pressure for functions such as engine protection.
Engine Oil Temperature Sensor (EOT Sensor)	Senses oil temperature for functions such as reducing variation in fuel injection and fan control.
Intake Manifold Pressure Sensor (IMP Sensor)	Senses turbo boost for functions such as smoke control and engine protection.
Intake Manifold Temperature Sensor (IMT Sensor)	Senses boost temperature
Supply Fuel Temperature Sensor (SFT Sensor)	Senses fuel temperature for functions such as engine fueling.
Turbo Speed Sensor (MBE 4000 only)	Monitors turbo speed.

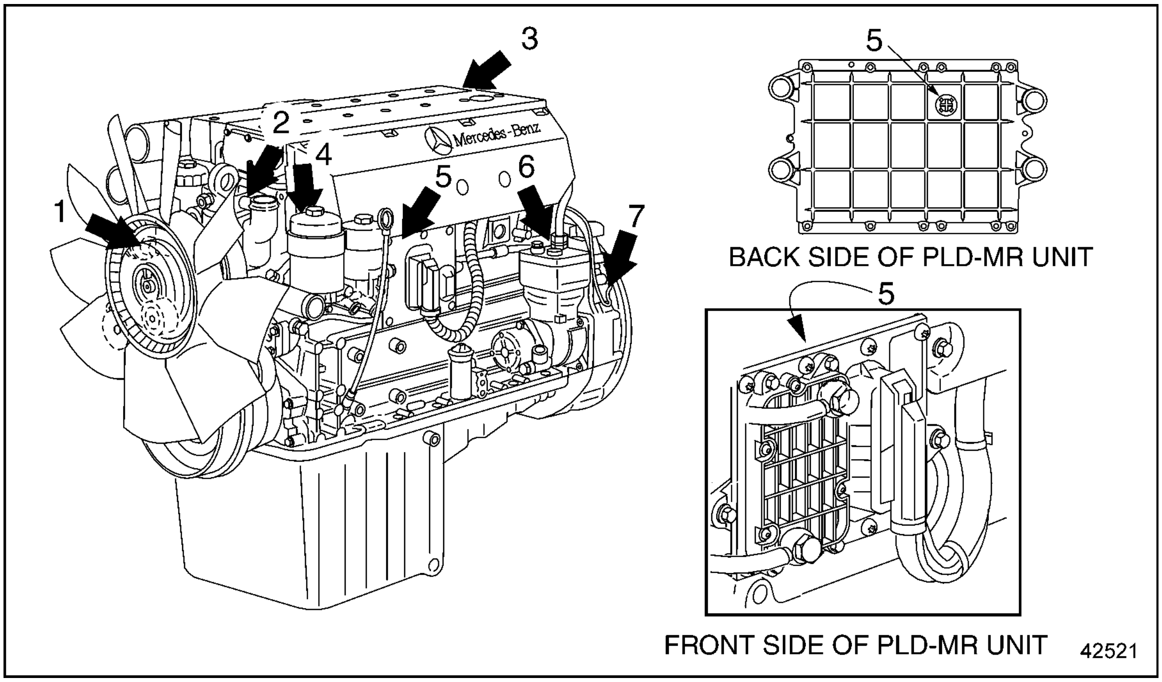
Table 3-48 Function of Factory-installed Sensors

See Figure 3-28 for sensor locations on the MBE 900 engine

NOTE:
The 6–cylinder engine is shown; sensor locations are similar on the 4–cylinder engine.

NOTE:
The Barometric Pressure Sensor (BARO Sensor) is integrated into the PLD-MR control unit.

NOTE:
The Engine Oil Level Sensor, if used, is located at the bottom of the oil pan.

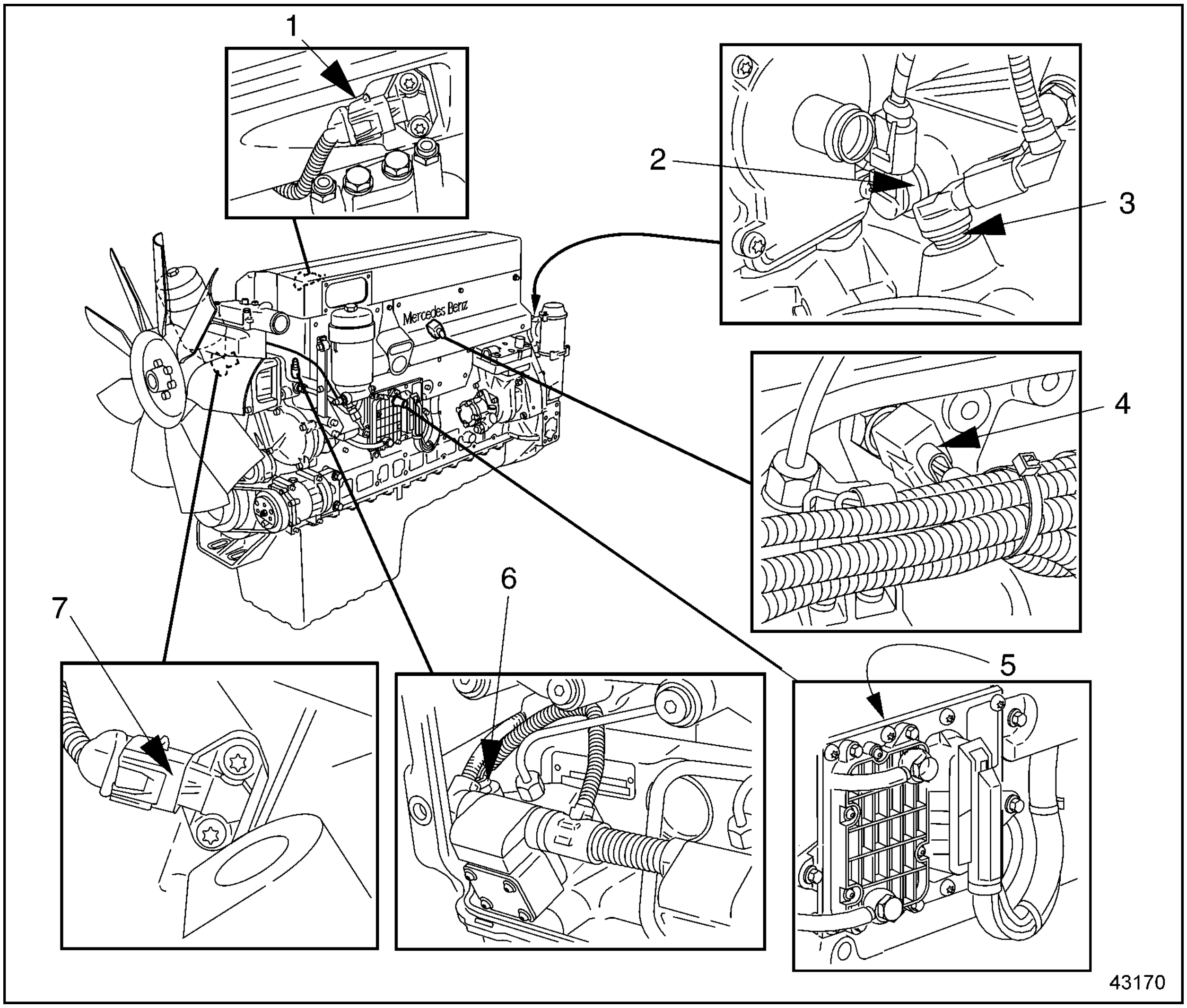


1. Engine Oil Pressure/Temperature Sensor
2. Engine Coolant Temperature Sensor
3. Intake Manifold Pressure/Temperature Sensor
4. Supply Fuel Temperature Sensor
5. Barometric Pressure Sensor (integrated into PLD-MR)
6. Camshaft Position Sensor (on camshaft)
7. Crankshaft Position Sensor (on timing case)

Figure 3-28 Sensor Location on the MBE 900 Engine

Two sensors are not easily visible from the left-hand side of the MBE 4000 engine. The Intake Manifold Pressure/Temperature Sensor is located on the right-hand side of the charge air manifold, behind the #2 cylinder head. The Engine Oil Pressure/Temperature Sensor is located at the base of the oil filter. See Figure 3-29 for sensor locations on the MBE 4000 engine.

NOTE:
The Engine Oil Level Sensor, if used, is located at the bottom of the oil pan.



1. Intake Manifold Pressure/Temperature Sensor
2. Camshaft Position Sensor (on camshaft)
3. Crankshaft Position Sensor
4. Engine Coolant Temperature Sensor
5. Barometric Pressure Sensor (integrated into PLD-MR)
6. Supply Fuel Temperature Sensor
7. Engine Oil Pressure/Temperature Sensor

Figure 3-29 Sensor Location on the MBE 4000 Engine

3.7.2 OEM-INSTALLED SENSORS

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

The OEM is responsible for installing the sensors listed in Table 3-49.

Sensor	Part Number	Function
Engine Coolant Level Sensor (ECL Sensor)	23522855 23520380 23520381	Senses coolant level for engine protection. Refer to section 3.7.3.
Vehicle Speed Sensor (VSS)	--	Senses vehicle speed for Cruise Control and Vehicle Speed Limiting. Refer to section 3.7.5.

* Available in some applications

Table 3-49 Function and Guidelines for OEM-installed Sensors

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.

3.7.3 ENGINE COOLANT LEVEL SENSOR

The ECL Sensor provides 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 VCU/ADM2 (see Figure 3-30).

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.

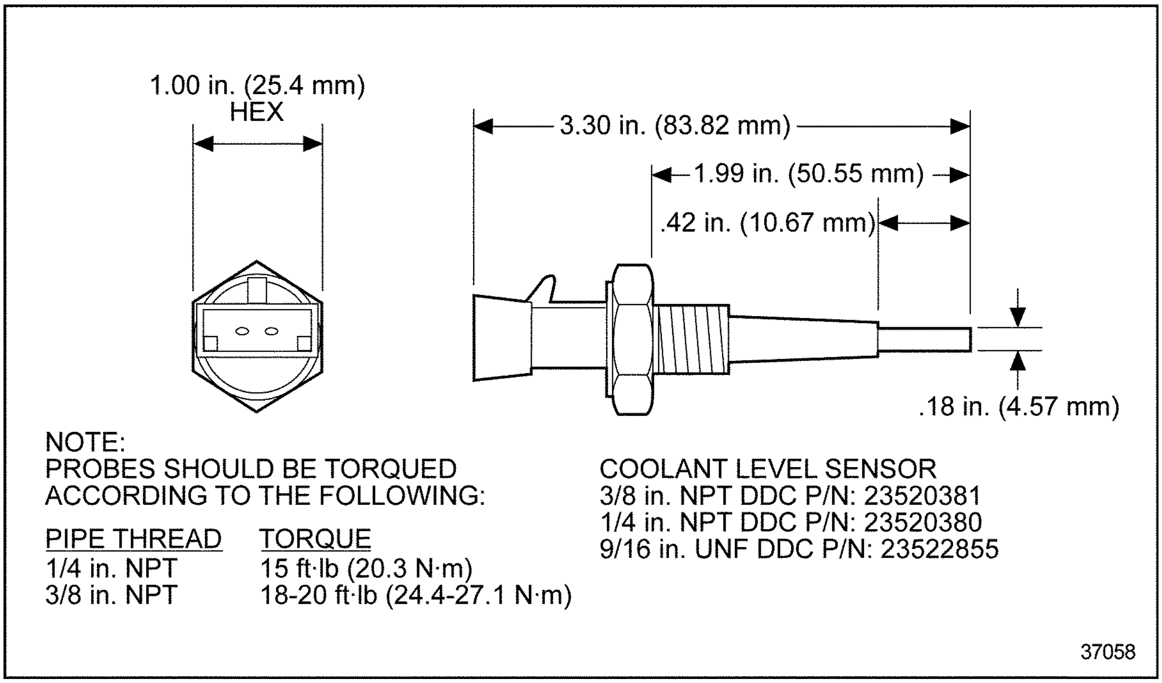


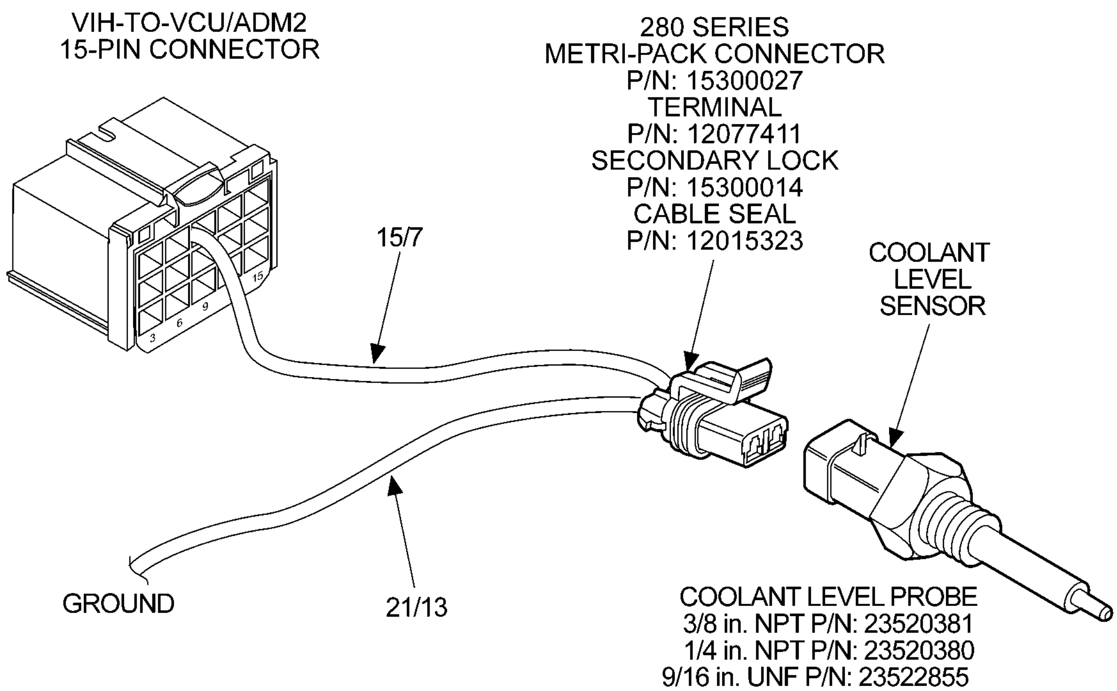
Figure 3-30 Engine Coolant Level Sensor Specifications

The connector listed in Table 3-50 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 3-50 Metri-Pack 280 Connectors and Part Numbers

The OEM must connect the ECL Sensor probe as shown in the next illustration (see Figure 3-31). Polarity of the ground and signal must be correct for proper operation.



LABEL	VIH-TO-VCU/ADM2 CONNECTOR CAVITY	WIRE COLOR	CLS CAVITY
COOLANT LEVEL	15/7	ORN	A
GROUND	21/13	BLK/WHT	B

43028

Figure 3-31 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 3-32.

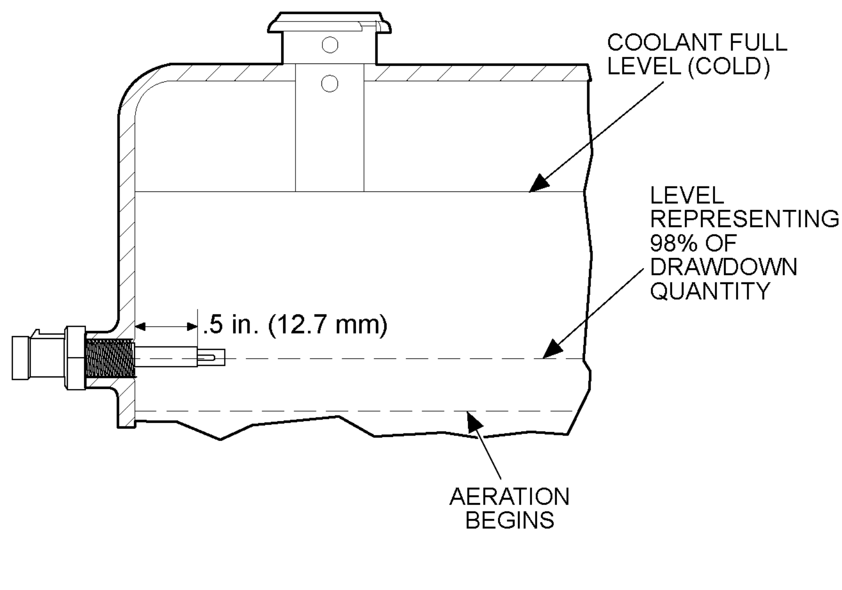


Figure 3-32 Engine Coolant Level Sensor Location - Top of Radiator Tank

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 3-51 and Table 3-52 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	23520380
Metri-Pack Connector Kit	15300027
Metri-Pack Terminals	12077411
Secondary Lock	15300014
wire Seal	12015323
Terminal	12103881

Table 3-51 ECL Sensor Installation Kit 1/4 in. NPTF P/N: 23515397

Component	Part Number
ECL Sensor	23520381
Metri-Pack Connector Kit	15300027
Metri-Pack Terminals	12077411
Secondary Lock	15300014
wire Seal	12015323
Terminal	12103881

Table 3-52 ECL Sensor Installation Kit 3/8 in. NPTF P/N: 23515398

The sensor must be enabled with VEPS or the minidiag2 as listed in Table 3-53.

Parameter	Range	Default	Parameter ID
Enable ECL Sensor Input	0 = Disabled 1 = Dual Level Sensor 2 = Single Level Sensor	1	1 13 01

Table 3-53 Enabling the Engine Coolant Level Sensor

3.7.4 DUAL ENGINE COOLANT LEVEL SENSOR

The Dual ECL Sensor consists of a two part assembly, the float with a magnet and the sensor assembly with the electronic circuitry. The sensor is inserted in the hollow cylinder of the surge tank with the float assembly in the tank and the sensor assembly outside the tank. See Figure 3-33.

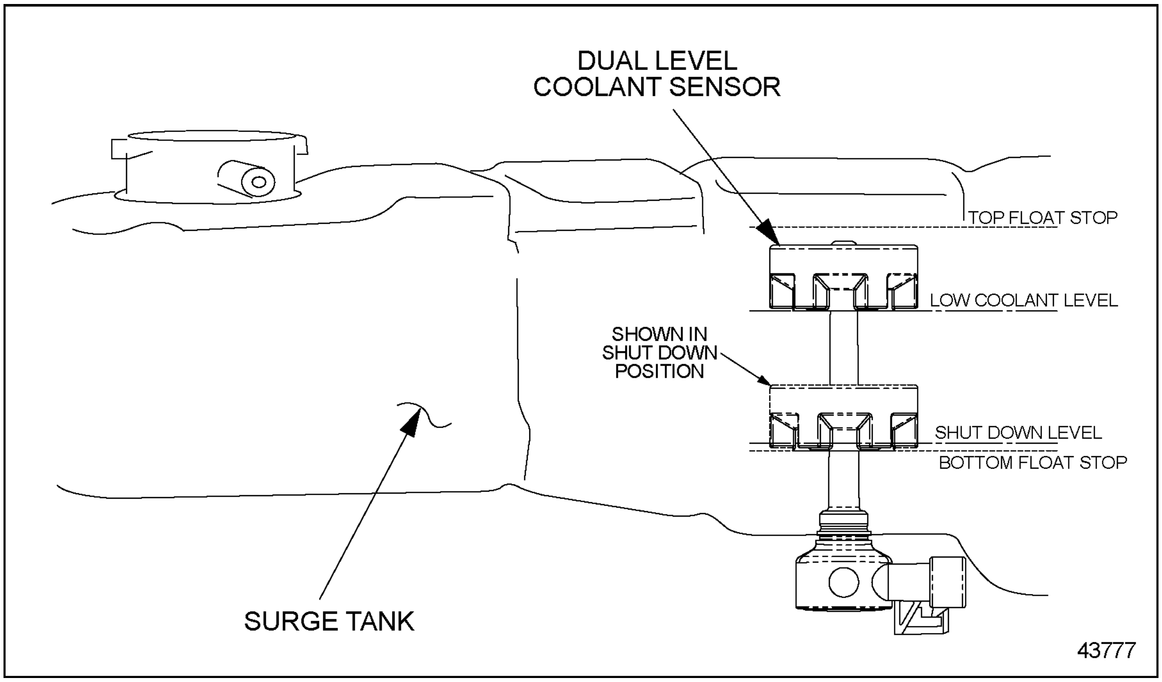


Figure 3-33 Dual Engine Coolant Level Sensor

The sensor is capable of detecting two coolant levels. Each level has a predetermined output voltage that the VCU/ADM2 processes to determine the current coolant level.

NOTE:
This sensor is available in Freightliner vehicles only.

See Figure 3-34 for the wiring for the Dual Engine Coolant Level Sensor.

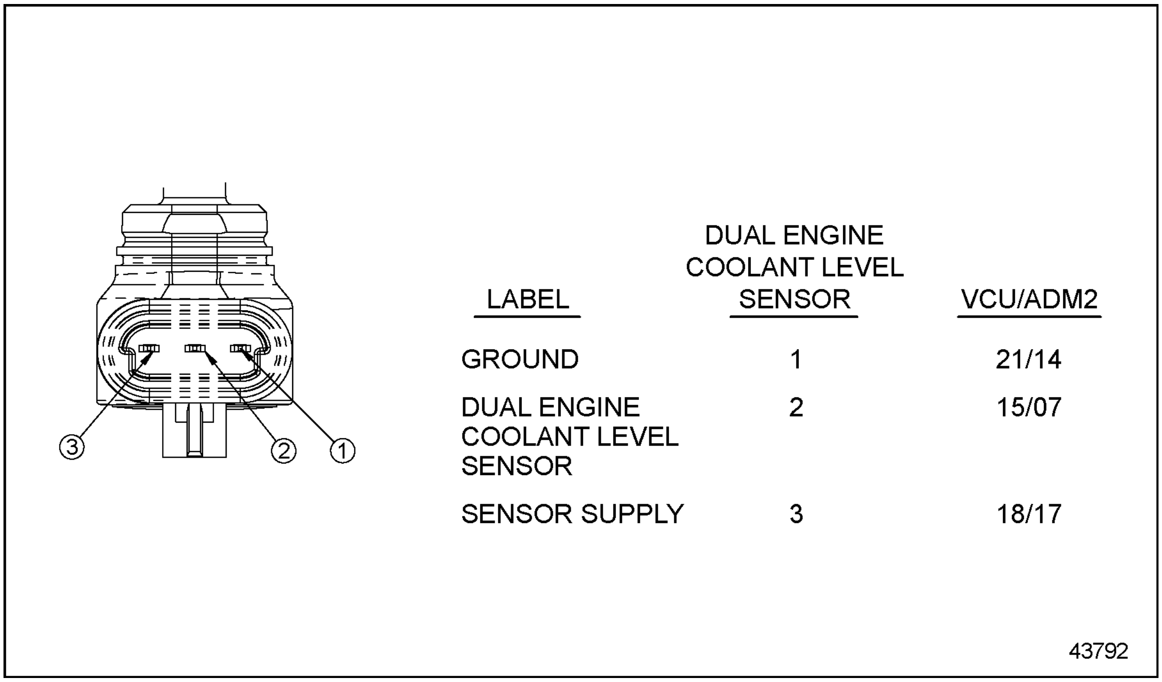


Figure 3-34 Dual Engine Coolant Level Sensor Wiring

The Delphi Packard 3–pin Metri-Pak 150 series connector for the sensor and its part numbers are listed in Table 3-54.

Part	Part Number
Delphi Packard 3–pin Connector	12110294
Terminal	12048074
Seal	12052842
Secondary Lock	12052845

Table 3-54 Dual Engine Coolant Level Sensor Connector

The parameters for the sensor are listed in Table 3-55.

Parameter	Range	Default	Parameter ID
1 Coolant Level Sensor Input	0 = Disable 1 = Single Level 2 = Dual Level	0	1 13 01

Table 3-55 Dual Engine Coolant Level Sensor Parameters

See Figure 3-35 for the Dual Coolant Level Sensor voltage ranges.

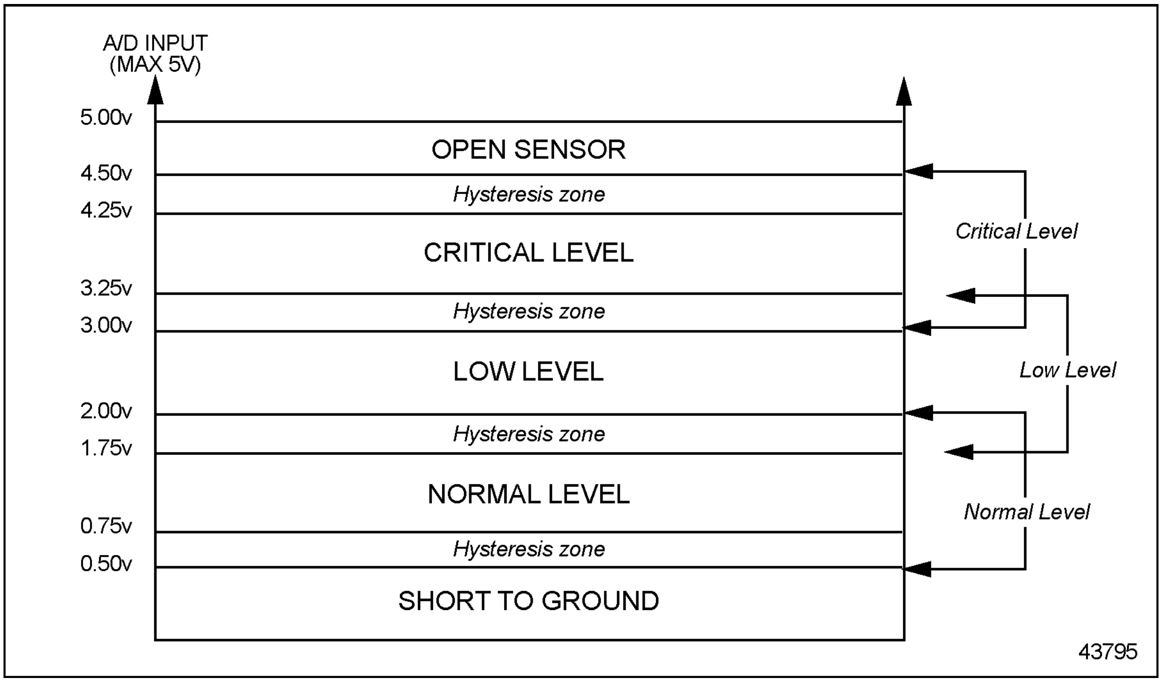


Figure 3-35 Dual Coolant Level Sensor Voltage Ranges

3.7.5 VEHICLE SPEED SENSOR

The VCU can calculate vehicle speed providing that it is properly programmed and interfaced with a Vehicle Speed Sensor (VSS) that meets MBE requirements. The VSS (see Figure 3-36) 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 minidiag2.

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

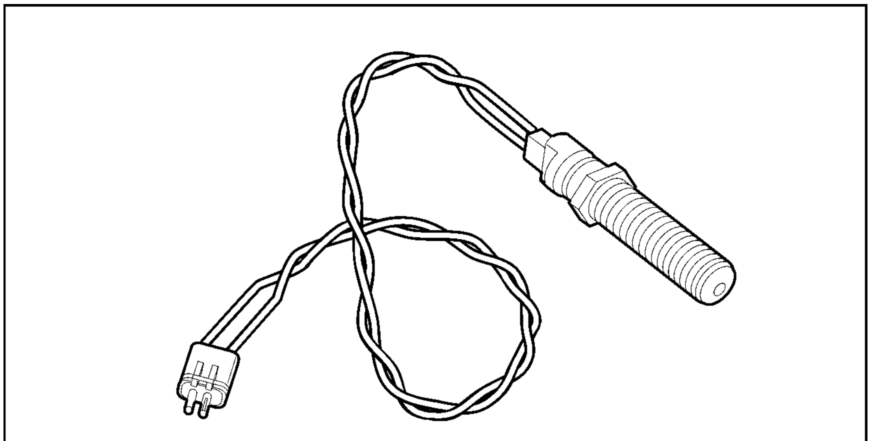


Figure 3-36 Vehicle Speed Sensor

To obtain accurate vehicle mileage, the parameters listed in Table 3-56 must be programmed with VEPS or the minidiag2.

Parameter	Range	Default	Parameter ID
VSS Input Configuration	0 = No Sensor 2 = Magnetic 3 = Speed over J1939 (ETCI)	2 = No VSS	1 08 01
Axle Ratio	1 – 20.0	5.29	1 08 03
Number of Output Shaft Teeth	0 – 250	16	1 08 04
Tire Revs/Kilometer	160 – 1599	312	1 08 05
Top Gear Ratio	0.1 – 2.55	1	1 08 06
Two Speed Axle — Second Axle Ratio	1 – 20.0	5.29	1 08 09
Anti-tamper	0 – 1	0 = No Anti-tamper	1 08 10
Second Highest Gear Ratio	0.1 — 2.55	2.55	1 08 07

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.

Parameters	Range
Frequency Range	1 - 3000 Hz
Low Threshold Voltage	>1.7 Volts

Table 3-57 Magnetic Pickup Vehicle Speed Sensor Requirements

The Vehicle Speed Sensor is wired to the 15–pin connector of the VCU/ADM2 as listed in Table 3-58.

Connector/Pin	Function
15/3	VSS (+)
15/4	VSS (-)

Table 3-58 Vehicle Speed Sensor Wiring

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

Wabash Technologies	**Airpax Instruments**	**Invensys Electro Corporation**
1375 Swan Street	Phillips Technologies	1845 57th Street
Huntington, Indiana 46750-0829	150 Knotter Drive	Sarasota, Florida 34231
Tel: 260-356-8300	Chesire, Connecticut 06410	Tel: 1–800–446–5762
www.wabashtech.com	Tel: 800-643-0643	Fax: 941-355-3120 www.electrocorp.com

SAE J1939 Data Link

A VSS wired to the VCU/ADM2 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 VEPS or the minidiag2.

Parameter	Range	Default	Parameter ID
VSS Input Configuration	3 = Transmission output shaft speed on the SAE J1939 Data Link*	2 = Magnetic	1 08 01
Axle Ratio	1 – 20.0	5.29	1 08 03
Tire Revs/Kilometer	160 – 1599	312	1 08 05
Top Gear Ratio	0.1 – 2.55	1	1 08 06
Two Speed Axle — Second Axle Ratio	1 – 20.0	5.29	1 08 09
Anti-tamper	0 – 1	0 = No Anti-tamper	1 08 10
Second Highest Gear Ratio	0.1 — 2.55	2.55	1 08 07

* Range must be set to 3.

Table 3-59 Vehicle Speed Sensor Parameters

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 5.18 for more information on VSS Anti-tamper.

3.7.6 WATER-IN-FUEL SENSOR

The Racor Fuel Filter assembly used on the MBE 906 EGR engine contains an integrated fuel heater and Water in Fuel Sensor. These devices run independent from the MBE Electronics and are available for use by the OEM.

The kit (P/N: RK 30880) can be used with a 12 or 24 VDC system and with Racor collection bowls that have a 1/2 — 20 size threaded water probe port.

4 INPUTS AND OUTPUTS

Section **Page**

4.1 OVERVIEW

MBE Electronic Controls has 21 digital input ports and 10 digital outputs located on the Vehicle Interface Harness. These inputs can be configured for various functions. These functions can be configured by VEPS. Some digital input features can be enabled or disabled with the minidiag2.

Five digital outputs are located on the PLD-MR.

4.2 DIGITAL INPUTS

The VCU has 21 digital input pins. The digital input functions and their associated pins are listed in Table 4-1.

Digital Input Functions	VCU Connector / Pin
Air Condition Status	18/14
Clutch Switch	18/02
Cruise Control On/Off	18/06
Cruise Control Set/Coast	18/04
Cruise Control Resume/Accel	18/05
Dual Vehicle Speed Limiter	18/12
Dual Speed Axle	15/02
Engine Brake High	18/09
Engine Brake Low	18/08
Engine Shutdown Override	18/13
Fan Override	18/15
Idle Validation 1	21/13
Idle Validation 2	21/12
Limiter 2 (Eng Rating, Torque Limit)	18/11
Park Brake Switch	21/16
Remote VSG Switch	18/10
Service Brake Switch	21/15
Throttle Inhibit	18/16
Throttle Switch	18/07
Transmission Neutral Switch	15/01

Table 4-1 Digital Inputs

The digital input can be either a switch or an OEM interlock depending on the function.

The following sections contain a description of the available options.

4.2.1 AIR CONDITION STATUS

This digital input indicates that the air conditioner is inactive. When the digital input is open, then the fan is turned on. High Idle will be enabled (if configured) if vehicle speed is zero. There is a 10 second delay when the digital input is grounded before returning to regular idle.

The AC Enable Switch or the AC High Pressure Switch can be used for this input. These switches are normally closed. The Air Condition function is normally disabled.

Installation

The Air Conditioner Switch is wired to the VCU on pin 18/14.

Programming Requirements and Flexibility

This digital input is always active and is also called LIM 2. Its parameters are listed in Table 4-2. This parameter can be set with VEPS, DDDL or the Nexiq DDR.

Parameter	Setting	Default	Parameter ID
Enable LIM 2	0 – Disable 1 – Enable	0 – Disable	1 06 01

Table 4-2 Air Condition Status Programming Options

4.2.2 CLUTCH SWITCH

This input indicates that the clutch is released and is used for suspending Cruise Control and Auto Resume. When the clutch is released, the input is at battery ground. Refer to section 5.3 for additional information on Cruise Control and Auto Resume.

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

If the transmission type is 2, the engine will know that there is no clutch on the vehicle and will ignore the clutch switch input.

The Clutch Switch is a normally closed switch. It is customer selectable and is normally disabled.

Installation

The Clutch Switch is wired to the VCU on pin 18/02. Alternatively the Clutch switch may be multiplexed on J1939. Refer to section 4.3, "Switch Inputs Received Over J1939 Data Link" for additional information.

Programming Requirements and Flexibility

This digital input can be configured by VEPS or minidiag2 as listed in Table 4-3.

Parameter	Setting	Default	Parameter ID
Clutch Switch Input Configuration	0 – Hardwired 1 – Source Address 1 (SA1) 2 – Source Address 2 (SA2) 3 – Source Address 3 (SA3)	0 – Hardwired	1 13 15

Table 4-3 Clutch Switch Programming Options

4.2.3 CRUISE CONTROL ON/OFF SWITCH

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

The Cruise Control Master switch is a normally open switch.

Installation

The Cruise Control Master Switch is wired to the VCU on pin 18/06. Alternatively, this input may be multiplexed on J1939. Refer to section 4.3, "Switch Inputs Received Over J1939 Data Link"for additional information on multiplexing this input.

Programming Requirements and Flexibility

This digital input can be configured by VEPS or minidiag2 as listed in Table 4-4.

Parameter	Setting	Default	Parameter ID
Cruise Control On/Off Switch Input Configuration	0 – Hardwired 1 – Source Address 1 (SA1) 2 – Source Address 2 (SA2) 3 – Source Address 3 (SA3)	0 – Hardwired	1 13 11

Table 4-4 Cruise Control On/Off Switch Programming Options

4.2.4 CRUISE CONTROL RESUME/ACCEL SWITCH AND SET/COAST SWITCH

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

ACCEL – When Cruise Control is active, the Resume/Accel input can be used to increase the power and speed by toggling the switch. Momentarily toggling and releasing the Resume/Accel switch will increase the set point by 1 MPH increments. Holding the Resume/Accel will increase the set point by 1 MPH per second. When released, the cruise control set point will be at the new speed.

The Resume/Accel Switch is a momentary normally open switch.

SET – Cruise Speed is set by momentarily contact the switch to the ON position (switching the digital input to battery ground). Cruise Control will become active and maintain the 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. Holding the Set/Coast will decrease the set point by 1 MPH per second. When released the Cruise Control set point will be at the new speed.

The Set/Coast Switch is a momentary normally open switch.

Installation

The Resume/Accel Switch is wired to the VCU on pin 18/05. The Set/Coast Switch is wired to the VCU on pin 18/04. Alternatively, either may be multiplexed on J1939. Refer to section 4.3, “Switch Inputs Received Over J1939 Data Link” for additional information on multiplexing this input.

Programming Requirements and Flexibility

This digital input can be configured by VEPS or minidiag2 as listed in Table 4-5.

Parameter	Setting	Default	Parameter ID
Cruise Control Resume/Accel (Set/Coast) Switch Input Configuration	0 – Hardwired 1 – Source Address 1 (SA1) 2 – Source Address 2 (SA2) 3 – Source Address 3 (SA3)	0 – Hardwired	1 13 12

Table 4-5 Cruise Control Resume/Accel (Set/Coast) Switch Programming

Diagnostics

If both the Cruise Control Set/Coast and Resume/Accel switches are grounded for more than a programmed number of consecutive samples, a diagnostic fault is logged. All cruise control switch functions will be disabled.

4.2.5 DUAL VEHICLE SPEED LIMITER SWITCH

This input indicates that the dual vehicle speed limitation is ON.

The vehicle road speed switch is a normally open switch.

Refer to section 5.17, "Vehicle Speed Limiting," for more information

Installation

The Dual Vehicle Speed Limiter switch is wired to the VCU on pin 18/12.

4.2.6 DUAL SPEED AXLE SWITCH

This input indicates that the dual speed axle ratio has been switched when the input is grounded. When the switch is open, the dual speed axle ratio is normal.

The Dual Speed Axle switch is a normally open switch.

Installation

The Dual Speed Axle switch is wired to the VCU on pin 15/2. Alternatively, it may be multiplexed on J1939. Refer to section 4.3, "Switch Inputs Received Over J1939 Data Link" for additional information.

Programming Requirements and Flexibility

This digital input can be configured by VEPS or minidiag2 as listed in Table 4-6.

Parameter	Setting	Default	Parameter ID
Dual Speed Axle Switch Input Configuration	0 – Hardwired 1 – Source Address 1 (SA1) 2 – Source Address 2 (SA2) 3 – Source Address 3 (SA3)	0 – Hardwired	1 13 14

Table 4-6 Dual Speed Axle Switch Programming Options

4.2.7 ENGINE BRAKE LOW & HIGH

The Engine Brake Low and Engine Brake High switches select the level of engine braking as listed in Table 4-7. Refer to section 5.6, “Engine Brake Controls,” for additional information.

Engine Brake Low Digital Input	Engine Brake High Digital Input	Engine Brake Status
OPEN	OPEN	OFF
GND	OPEN	LOW
OPEN	GND	MEDIUM
GND	GND	HIGH

Table 4-7 Level of Engine Braking

The Engine Brake Low and Engine Brake High switches are normally open switches.

Installation

The Engine Brake Low Switch is wired to the VCU on pin 18/8 and Engine Brake High Switch is wired to the VCU on pin 18/9.

Programming Requirements and Flexibility

This digital input can be configured by VEPS or minidiag2 as listed in Table 4-8.

Parameter	Setting	Default	Parameter ID
Engine Brake Switch Configuration	0 – Hardwired 1 – J1939 EBCI	0 – Hardwired	1 13 16

Table 4-8 Engine Brake SwitchSwitch Programming Options

4.2.8 FAN OVERRIDE

This digital input is used to activate the fan when the input is switched to battery ground.

The fan override switch is a normally open switch. Refer to section 5.9, “Fan Control,” for additional information.

Installation

The Fan Override Switch is wired to the VCU on pin 18/15.

4.2.9 IDLE VALIDATION 1 & IDLE VALIDATION 2

The idle validation switch consists of two contacts. Idle Validation 2 is normally closed and indicates that the accelerator pedal is in the idle position when the input is grounded. Idle Validation 1 is normally open and indicates that the accelerator pedal is not in the idle position when it is grounded.

NOTE:
An Idle Validation Switch is required.

Installation

The Idle Validation 1 Switch is wired to the VCU on pin 21/13. The Idle Validation 2 Switch is wired to the VCU on pin 21/12.

4.2.10 PARK BRAKE SWITCH

This input indicates that the park brake is engaged when switched to battery ground.

The park brake switch is a normally open switch and is customer selectable.

Installation

This input is wired to the VCU pin 21/16. Alternatively, this input may be multiplexed on J1939. Refer to section 4.3, "Switch Inputs Received Over J1939 Data Link," for additional information on multiplexing this input.

Programming Requirements & Flexibility

This digital input can be configured by VEPS or minidiag2 as listed in Table 4-9.

Parameter	Setting	Default	Parameter ID
Enable Park Brake Input	0 – Disable 1 – Enable	1 – Enable	1 13 08
Park Brake Input Configuration	0 – Hardwired 1 – Source Address 1 (SA1) 2 – Source Address 2 (SA2) 3 – Source Address 3 (SA3)	0 – Hardwired	1 13 09

Table 4-9 Configuring the Park Brake Switch Input

4.2.11 REMOTE VSG SWITCH

The Remote VSG Switch allows the use of a customer selected high idle speed instead of the hot idle engine speed.

The Remote VSG speed is active when a digital input is switched to battery ground and the parking brake is enabled. The preset speeds are selected by enabling the remote VSG switch once for VSG speed #1, twice for VSG speed #2 or three times for VSG speed #3. These VSG speeds can be set with VEPS or minidiag2. The Remote VSG will override the Cab VSG mode and cab throttle unless “VSG Throttle Override” is disabled.

Refer to section 5.15, “Throttle Controls” for additional information.

The Remote VSG Switch is a normally open switch.

Installation

This input is wired to the VCU pin 18/10.

4.2.12 SERVICE BRAKE SWITCH

This input indicates that the brake is released when switched to battery ground. If the brake is activated, then the input is not grounded. This input will suspend cruise control when the brake is activated.

The service brake switch is a normally closed switch. This input is customer selectable and is normally disabled.

Installation

This input is wired to the VCU pin 21/15. Alternatively, this input may be multiplexed on J1939. Refer to section 4.3, “Switch Inputs Received Over J1939 Data Link,” for additional information on multiplexing this input.

Programming Requirements & Flexibility

This digital input can be configured by VEPS or minidiag2 as listed in Table 4-10.

Parameter	Setting	Default	Parameter ID
Enable Service Brake Input	0 – Disable 1 – Enable	1 – Enable	1 13 04
Service Brake Input Configuration	0 – Hardwired 1 – Source Address 1 (SA1) 2 – Source Address 2 (SA2) 3 – Source Address 3 (SA3)	0 – Hardwired	1 13 05

Table 4-10 Configuring the Service Brake Switch Input

4.2.13 SHUTDOWN OVERRIDE SWITCH

The shutdown override switch is a momentary normally open switch. When the input is switched to battery ground, a shutdown override is enabled.

Shutdown Override Switch is a momentary normally open switch.

Installation

This input is wired to the VCU pin 18/13.

4.2.14 THROTTLE INHIBIT

If the throttle inhibit switch is switched to battery ground, the engine will only run at low idle speed. The engine will not respond to the foot pedal or remote throttle. Refer to section 5.15, “Throttle Control/Governors,” for additional information.

The Throttle Inhibit switch is a normally open switch.

Installation

The Throttle Inhibit switch is wired to the VCU on pin 18/16.

4.2.15 REMOTE ACCELERATOR SELECT SWITCH

This digital input when switched to battery ground indicates that the remote accelerator is active. The switch information will only be used if the remote accelerator input is configured. Refer to section 5.15, “Throttle Control/Governors,” for additional information.

The remote accelerator enable switch is a normally open switch.

Installation

This input is wired to the VCU pin 18/07.

Programming Requirements & Flexibility

This digital input can be configured by VEPS or minidiag2 as listed in Table 4-11.

Parameter	Setting	Default	Parameter ID
Enable Remote Accelerator Input (Throttle Select)	0 – Disable 1 – Enable	0 – Disable	1 20 01

Table 4-11 Configuring the Throttle Select Input

4.2.16 TRANSMISSION NEUTRAL SWITCH

This digital input when switched to battery ground indicates that the transmission is NOT in neutral. An open circuit indicates neutral.

This input is customer selectable and is normally disabled.

Installation

This input is wired to the VCU pin 15/01.

Programming Requirements & Flexibility

This digital input can be configured by VEPS or minidiag2 as listed in Table 4-12.

Parameter	Setting	Default	Parameter ID
Transmission Neutral Switch	0 – Disable 1 – Enable	0 – Disable	1 13 07

Table 4-12 Configuring the Transmission Neutral Switch Input

4.3 SWITCH INPUTS RECEIVED OVER J1939 DATA LINK

Multiplexing is available for several switch inputs over the SAE J1939 Data Link. The VCU supports this feature for the following switch inputs:

- ☐ Cruise Control On/Off Switch
- ☐ Cruise Control Set/Coast
- ☐ Cruise Control Resume/Accel
- ☐ Service Brake Switch
- ☐ Park Brake Switch
- ☐ Clutch Brake Switch
- ☐ Engine Brake Switches – EBC1 Message
- ☐ Dual Speed Axle Switch

To use the multiplexing feature with the VCU, the parameters listed in Table 4-13 must be set up correctly. There are three different source addresses (SA) possible for receiving the Cruise Control message. Every switch in this message must be programmed to react on one programmed SA. The SA is programmed by the vehicle OEM.

If an error is detected (wrong data on J1939 CC message or the message is not sent) an error is logged. If the error is caused by wrong data or missing data, the error will be logged and will be held active until the ignition is switched off. Cruise Control will also be disabled.

Parameter	Setting	Default	Parameter ID
Source Address 1 (SA1) for receiving Switch Status	0-255	23	1 01 09
Source Address 2 (SA2) for receiving Switch Status	0-255	33	1 01 10
Source Address 3 (SA3) for receiving Switch Status	0-255	49	1 01 11
Source Address for receiving EBC1 Message for Engine Brake Switch	0-255	33	1 01 12
Input Configuration of Cruise Control On/Off	0 - Hardwired 1 – SA1 2 – SA2 3 – SA3	0	1 13 11
Input Configuration of Cruise Control for Set/Coast & Resume/Accel Switch	0 - Hardwired 1 – SA1 2 – SA2 3 – SA3	0	1 13 12
Input Configuration for Service Brake Switch	0 - Hardwired 1 – SA1 2 – SA2 3 – SA3	0	1 13 05
Input Configuration for Park Brake Switch	0 - Hardwired 1 – SA1 2 – SA2 3 – SA3	0	1 13 09
Input Configuration for Clutch Switch	0 - Hardwired 1 – SA1 2 – SA2 3 – SA3	0	1 13 15
Input Configuration for Dual Speed Axle Switch	0 - Hardwired 1 – SA1 2 – SA2 3 – SA3	0	1 13 14
Input Configuration for Engine Brake Switches	0 - Hardwired 1 – SA EBC1	0	1 13 16

Table 4-13 Parameters for Multiplexing

4.4 DIGITAL OUTPUTS

The VCU has 10 digital output pins, seven low side and three high side. The PLD-MR has five digital outputs. The VCU digital output functions and their associated pins are listed in Table 4-14.

Digital Output Function	Driver	VCU Connector/Pin
Vehicle Power Shutdown	Low Side	18/01
Decompression Valve	High Side	15/10
Grid Heater Control	High Side	15/9
Wait to Start Lamp	Low Side	21/07
Gear Out 1	High Side	15/05
Oil Level Lamp	Low Side	21/04
Starter Lockout	Low Side	15/12
Amber Warning Lamp	Low Side	21/06
Red Stop Lamp	Low Side	21/05

Table 4-14 Digital Outputs

4.4.1 VEHICLE POWER SHUTDOWN

This digital output actuates a relay that shuts down the rest of the electrical power to the vehicle when an idle shutdown or engine protection shutdown occurs. For additional information, refer to section 5.10, “Idle Shutdown.”

This function is available with the VCU only.

Installation

This digital output circuit is designed to sink no more than 2 A (DC) current.

The Vehicle Power Shutdown is wired to pin 18/01 of the VCU.

4.4.2 GRID HEATER CONTROL

This digital output controls the relay for the Grid Heater.

Installation

This digital output circuit is designed to source no more than 2.5 A (DC) current.

The Grid Heater Control digital output is wired to pin 15/9 of the VCU.

Programming Requirements and Flexibility

This digital output can be configured by VEPS or minidiag2 as listed in Table 4-15.

Parameter	Setting	Default	Parameter ID
Grid Heater	0 – Disable 1 – Enable	0 – Disable	1 02 06

Table 4-15 Grid Heater Parameters

4.4.3 WAIT TO START LAMP

This digital output is switched to battery ground when the Wait to Start (Cold Start) system is active. This output is used to drive a light to alert the operator. As long as the lamp is illuminated the engine should not be started.

Installation

A 12 or 24 volt lamp of less than 500 mA DC is needed depending on the ignition source. This digital output circuit is designed to sink no more than 500 mA (DC) current.

The Wait to Start Lamp is wired to pin 21/07 of the VCU.

4.4.4 GEAR OUT 1

The AT500 and MT600 transmissions require a throttle position input from the engine in order to get an indication of the current power level at any given time. This input is used to raise the shift points and apply the clutches more firmly with increasing engine power.

The MBE 900 engine needs to provide a digital output that switches high (Vbatt) under certain conditions and switches open (strike through or low [ground]) under other conditions. When switched high, the output needs to have the ability to source 0.5 amps minimum when using a relay or 3 amps minimum if driving the modulator directly.

When Cruise Control and Vehicle Speed Limiting are not active:

- If the Gear Out 1 output is enabled, it will be disabled (open [strike through or low]) if the engine is not running or the accelerator pedal position is <45%.
- If the Gear Out 1 output is disabled, it will be enabled (switched high) when the engine is running or the accelerator pedal position is >60%.

When Cruise Control is active or near the road speed limit:

- If the Gear Out 1 output is enabled, it will be disabled if the engine is running and the accelerator pedal position is >60%
- If the Gear Out 1 output is disabled, it will be enabled when vehicle speed is within one (1) mph of the cruise set speed or road speed limit speed or the percent load at the current speed is >80%.

Installation

This digital output circuit is designed to sink no more than 1 A (DC) current.

The Gear Out 1 digital output is wired to pin 15/05 of the VCU.

4.4.5 OIL LEVEL LOW LAMP

This digital output is switched to battery ground when the oil level falls below the oil fill threshold as read by an Oil Level Sensor. This output is used to drive a light to warn the operator. The AWL will illuminate when an oil level fault is logged in the VCU.

Installation

A 12 or 24 volt lamp of less than 500 mA DC is needed depending on the ignition source. This digital output circuit is designed to sink no more than 500 mA (DC) current.

The Oil Level Low Lamp is wired to pin 21/04 of the VCU.

4.4.6 STARTER LOCKOUT

This digital output drives a normally closed relay which interrupts the starting signal when the output has been activated. For additional information, refer to section 5.14, "Starter Lockout."

Installation

This digital output circuit is designed to sink no more than 2.0 A (DC) current.

The Starter Lockout digital output is wired to pin 15/12 of the VCU.

4.4.7 AMBER WARNING LAMP

The Amber Warning Lamp is illuminated for all active faults. The AWL will also flash when an engine shutdown occurs.

Installation

This digital output circuit is designed to sink no more than 300 mA (DC) current.

The AWL is wired to pin 21/06 of the VCU.

NOTE:
This digital output is REQUIRED.

4.4.8 RED STOP LAMP

The Red Stop Lamp (RSL) is illuminated for all active serious faults, which require the engine to be shutdown immediately. The AWL will also flash when an engine shutdown occurs.

Installation

This digital output circuit is designed to sink no more than 300 mA (DC) current.

The RSL is wired to pin 21/05 of the VCU.

NOTE:
This digital output is REQUIRED.

5 FEATURES

Section **Page**

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5.1 ANTI-LOCK BRAKE SYSTEMS

Anti-lock Brake Systems (ABS) are electronic systems that monitor and control wheel speed during braking. The systems are compatible with standard air brake systems. The system monitors wheel speed at all times, and controls braking during emergency situations. Vehicle stability and control are improved by reducing wheel lock during braking.

5.1.1 OPERATION

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

SAE J1939 transmits/receives data at 250 K baud. SAE J1939 has a high bit rate so messages reach their destination very quickly.

5.1.2 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

The calibration parameters for ABS are listed in Table 5-1. These parameters can be set with VEPS or minidiag2. None of the parameters are automatically configured.

Description	Choice	Default	Parameter ID
ABS/Automatic Traction Control (ACT)	0 = No ABS 1 = ABS only 2 = ABS with ATC	0	10 20 2

Table 5-1 ABS Parameters

5.2 COLD START

The VCU has optional support for an electric Grid Heater for use as a cold start aid. The Grid Heater element is operated by a high current relay. If the heater is enabled, the PLD-MR will turn the Grid Heater relay on and off as required.

5.2.1 OPERATION

The cold start procedure has several states. The cold start states and outputs during a successful engine start are listed in Table 5-2 and described in the following sections.

State	Grid Heater	
	Wait to Start Lamp	Grid Heater Relay
Initialization	Off	Off
Preheating	On	On - Preheat Time
Ready for Engine Start	Off	Off
Engine Starting	Off	Off
Post-heating	Off	On - Post Heat Time
Cooling Off	Off	Off
OFF	Off	Off

Table 5-2 Cold Start States and Outputs

NOTE:
If ignition switch off is detected, the VCU remains in the current state for 5 seconds. If the ignition is switched on again, cold start proceeds. Otherwise the VCU changes to the cooling off state.

Initialization

When ignition is switched on and engine speed is 0 rpm, the VCU determines preheating time, post-heating time and the coolant switch off temperature. The preheating time is shortened when the cold start device is not cold.

A preheating time of 0 indicates, that no cold start is needed for the following engine start. If the preheating time is greater than 0, the VCU enters the preheating state.

Preheating State

Engine cranking detection during preheating will stop the Preheating process and the canceling of the Cold Start function. The Cold Start function will also be canceled when low battery voltage codes are active.

When the Preheat time has elapsed, the Wait to Start lamp will go off and the engine is ready to start.

Waiting for Engine Start

A cranking detection before the end of time waiting for start leads to the engine starting state. If the engine does not start then Cold Start is canceled.

Engine Start

If engine start is successful or if the engine starting time ends, the post-heating state starts.

Post-heating State

When the engine start is successful, the grid heater will be switched on until the post-heating time expires or the coolant temperature exceeds the switch off temperature.

Cooling Off

This time is used to determine the preheating time at the beginning of the next cold start.

Off

End of the Cold Start procedure, all outputs are switched off.

5.2.2 INSTALLATION

The grid heater control is performed using the VCU high side driver output Grid Heater Control on VCU pin 15/10. This output can source up to 2.5 amps.

The Wait to Start Lamp is driven by a low side output on VCU pin 21/7.

5.2.3 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

The Cold Start parameters listed in Table 5-3 can be set by VEPS or the minidiag2.

Parameter	Setting	Default	Parameter ID
Grid Heater	0 = Disabled 1 = Grid Heater	0	01 02 06

Table 5-3 Cold Start Parameters

5.2.4 DIAGNOSTICS

The digital output for the grid heater relay is monitored for high/low state conformity. At the beginning of the preheating state and the starting state, and the first two 2 seconds of the preheating state, the intake air manifold temperature is measured to check if the cold start device works.

A fault code (PID 45) is recorded if one of the errors listed in Table 5-4 occurs.

Failure	Action Taken
Output relay grid heater is not valid	Cold Start is cancelled
Voltage drop below switch off voltage	Cold Start is cancelled
No increase of intake air manifold temperature during preheating state	Cold Start is cancelled

Table 5-4 Cold Start Failures and Action Taken

5.3 CRUISE CONTROL

Cruise Control will operate in Vehicle Speed Mode and maintain a targeted speed by increasing or decreasing fueling. The targeted speed can be selected and adjusted with dash-mounted switches. Up to five digital inputs are required (four for automatic transmission) for Cruise Control operation. A Vehicle Speed Sensor (VSS) is required for Vehicle Speed Cruise Control or an output shaft speed message over the J1939 data link.

5.3.1 OPERATION

There is are several types of Cruise Control.

Vehicle Speed Cruise Control

Vehicle Speed Cruise is enabled when "Enable Cruise" and a Vehicle Speed Sensor (VSS) is installed or output shaft speed is received over J1939. Engine speed and power are varied under Vehicle Speed Cruise Control to maintain the set vehicle speed. The vehicle speed must be above 20 mph (32 km/hr) .

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

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

Cruise Control can be overridden at any time with the foot pedal if the vehicle is operating at less than the programmed Vehicle Speed Limit.

Clutch pedal, service brake pedal, and throttle interlock input, if configured, are monitored to abort fueling the engine in Cruise Control Active Mode if there is driver action.

There are three Cruise Control operation modes as listed in Table 5-5.

Cruise Control Mode	Conditions	Set Speed	Engine Fuel Controlled By Cruise Control
Off	Cruise Control ON/OFF switch is in OFF position or Cruise Control ON/OFF is switched to ON position although Cruise Control is not allowed.	0 MPH	No
Active	Cruise Control ON/OFF switch in ON position and Cruise Control is allowed and set speed has already been set. The set speed can be increased or decreased by using the Resume/Accel and Set/Coast switches.	Set Speed (+/-)	Yes
Standby	Cruise Control ON/OFF switch in On position and Cruise Control formally active but not allowed anymore or no set speed has been set after switching Cruise Control On and Cruise Control is allowed.	Last Set speed on Hold in Memory	No

Table 5-5 Three Cruise Control Operation Modes

Engine Brakes in Cruise Control (Optional)

When there is vehicle acceleration above set speed, engine brakes (if configured) are activated to keep the desired road speed.

Cruise Auto Resume (Optional)

The Cruise Auto Resume feature will resume Vehicle Speed Cruise Control based on the calibration setting.

1 = Cruise Control is resumed immediately after the clutch pedal is released.

2 = Cruise Control is resumed if the clutch has been pushed twice and released within three (3) seconds.

Cruise Enable

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

The Cruise Enable switch is a normally open switch.

Set / Coast

The Set/Coast switch is a momentary switch.

Set: Cruise Speed is set by momentarily contacting the switch to the ON position (switching the digital input to battery ground). Cruise Control will become active and maintain the 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 1.24 mph (2 km/hr) increments. Holding the Set/Coast will decrease the set point by 1.24 mph (2 km/hr) per second. When released the Cruise Control set point will be at the new speed.

Resume / Accel

The Resume/Accel switch is a momentary switch.

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

Accel: When Cruise Control is active, the Resume/Accel input can be used to increase power and speed by toggling the switch. Momentarily toggling and releasing the Resume/Accel switch will increase the set point by 1.24 mph (2 km/hr) increments for Vehicle Speed Cruise Control. Holding the Resume/Accel will increase the set point by 1.24 mph (2 km/hr) per second. When released the Cruise Control set point will be at the new speed.

Clutch Released (Manual Transmissions)

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

When the clutch is released, the input is at battery ground. Cruise Control is suspended if the clutch is pressed once. If the clutch pedal is pressed twice within three seconds, Cruise Control is automatically resumed if Cruise Auto Resume is configured depending on the calibration setting selected (refer to "Cruise Auto Resume").

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

This switch is a normally closed switch.

Service Brake Released (Automatic and Manual Transmissions)

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

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

This switch is a normally closed switch.

Throttle Inhibit Switch

This input indicates that the throttle inhibit function is active when switched to battery ground. Cruise Control is deactivated if the throttle inhibit switch is grounded.

Cruise Control Modes

Separate programmable thresholds are available for increasing and decreasing set speed using the Cruise Control switches Resume/Accel and Set/Coast. The difference between the new set speed and road speed is limited to the programmable thresholds.

All Cruise Control modes, conditions, and action taken are listed in Table 5-6.

Cruise Control Mode Status Change	Condition	Action Taken
Standby/Active to Off	Cruise Control ON/OFF switch is switched to OFF position	Set Speed = 0 MPH
Off to Standby	Cruise Control ON/OFF switch is switched from OFF to ON position	Set Speed = Set Speed
Standby to Active	Cruise Control switch is toggled to Set/Coast position	Set Speed = Road Speed
	Cruise Control switch is toggled to Resume/Accel position and the desired road speed has already been set (> 0 MPH)	Set Speed = Set Speed
	Cruise Control switch is toggled to Resume/Accel position and no desired road speed has been set before (=0 MPH)	Set Speed = Road Speed
	Cruise auto resume	Set Speed = Set Speed
Active	Cruise Control switch is toggled to Set/Coast position	Set Speed = Set Speed – Speed Step Down
	Cruise Control switch is held in Set/Coast position for more than one second	Set Speed = Set Speed – Speed Ratio Down Time
	Cruise Control switch is toggled to Resume/Accel position	Set Speed = Set Speed + Speed Step Up
	Cruise Control switch is held in Resume/Accel position for more than one second	Set Speed = Set Speed + Speed Ration up Time
	Cruise Control switch is not toggled	Set Speed Hold in Memory
Active to Standby	Brake switch, clutch switch toggled, vehicle speed drops below min cruise speed	Set Speed Hold in Memory

Table 5-6 Cruise Control Mode Status Change

5.3.2 INSTALLATION

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

- ☐ Cruise Control ON/OFF (Switch or J1939)
- ☐ Service Brake (Switch or J1939)
- ☐ Clutch Released for Manual Transmission (Switch or J1939)
- ☐ Set/Coast (Switch or J1939)
- ☐ Resume/Accel (Switch or J1939)

☐ Vehicle Speed Sensor (or J1939)

See Figure 5-1 for a diagram of the Cruise Control circuit.

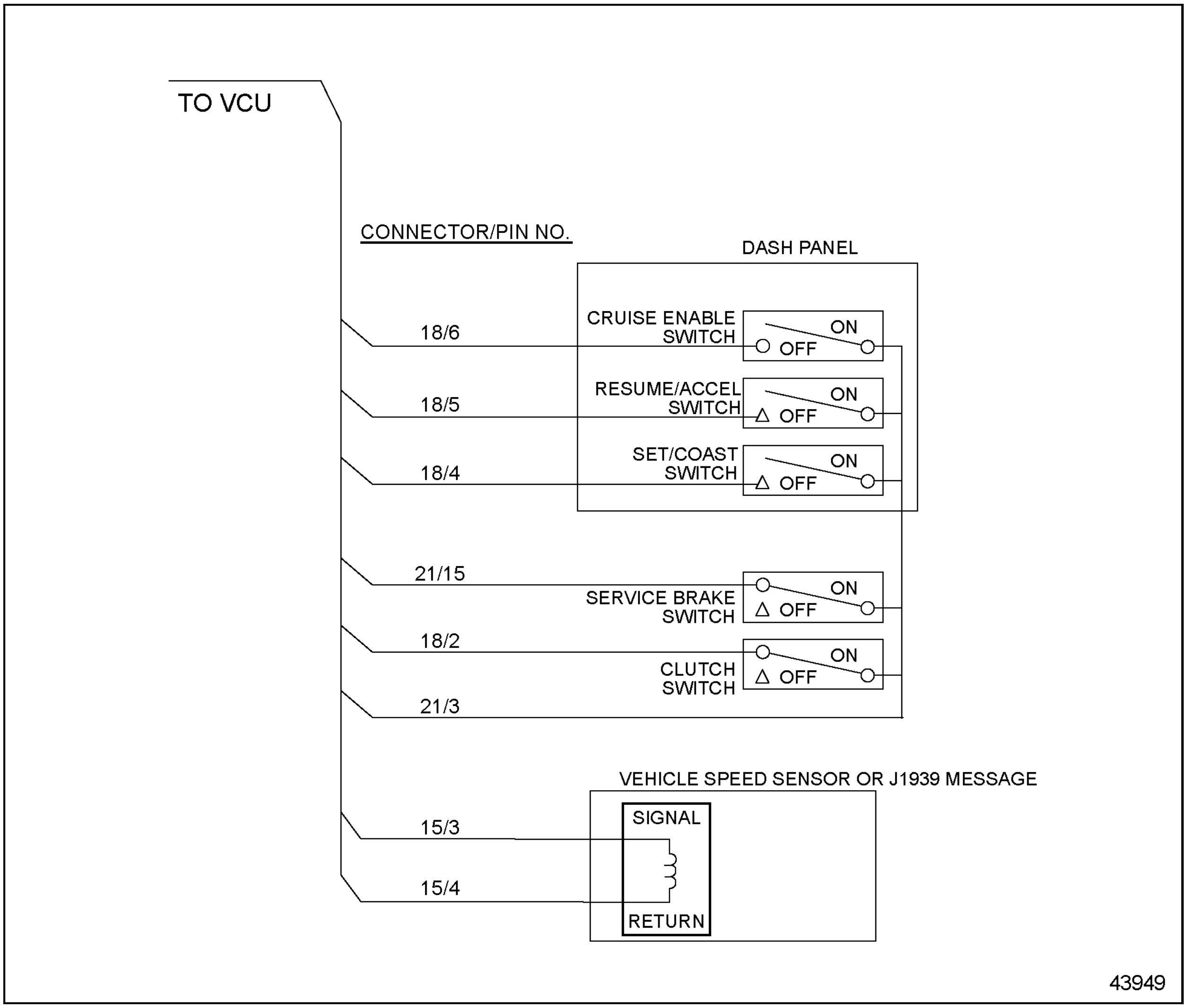

Figure 5-1 Cruise Control Circuit

5.3.3 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

To configure an engine for Cruise Control, the digital inputs listed in Table 5-7 must be selected. These parameters can be set with VEPS or minidiag2. Refer to section 4.2, “Digital Inputs,” for more information.

Parameter	Setting	Default	Parameter ID
Enable Service Brake Input	1 = Enable 2 = Disable	1 = Enable	1 13 04
Service Brake Input Configuration	0 = Hardwired 1 = Source Address 1 (SA1) 2 = Source Address 2 (SA2) 3 = Source Address 3 (SA3)	0 = Hardwired	1 13 09
Cruise Control On/Off Switch Configuration	0 = Hardwired 1 = Source Address 1 (SA1) 2 = Source Address 2 (SA2) 3 = Source Address 3 (SA3)	0 = Hardwired	1 13 11
Cruise Control Set/Coast and Resume/Control Switches Configuration	0 = Hardwired 1 = Source Address 1 (SA1) 2 = Source Address 2 (SA2) 3 = Source Address 3 (SA3)	0 = Hardwired	1 13 12
Clutch Switch Configuration	0 = Hardwired 1 = Source Address 1 (SA1) 2 = Source Address 2 (SA2) 3 = Source Address 3 (SA3)	0 = Hardwired	1 13 15
Source Address 1 (SA1) for Receiving Multiplexed Switch Status	0 — 55	23	1 01 09
Source Address 2 (SA2) for Receiving Multiplexed Switch Status	0 — 255	33	1 01 10
Source Address 3 (SA3) for Receiving Multiplexed Switch Status	0 — 255	49	1 01 11

Table 5-7 Cruise Control Input Configuration

A Vehicle Speed Sensor must be configured for Vehicle Speed Cruise Control. Refer to section 3.7.5, "Vehicle Speed Sensor," for additional information.

The Cruise Control parameters listed in Table 5-8 can be set by minidiag2.

Parameter	Description	Range	Default	Parameter ID	Access
Min Road Speed	Minimum road speed for Cruise Control	32152 km/hr	48 km/hr	1 15 01	Nexiq DDR, DDDL, VEPS, minidiag2
Max Set Speed	Cruise Control vehicle set speed cannot be faster than this value.	48–152 km/hr	152 km/hr	1 15 02	Nexiq DDR, DDDL, VEPS, minidiag2
Cruise Set Speed Increment	Set Speed increment for every Resume/Accel switch momentary press.	0–10 km/hr	2 km/hr	1 15 03	VEPS, minidiag2
Cruise Set Speed Decrement	Set Speed decrement for every Set/Coast switch momentary press.	0–10 km/hr	2 km/hr	1 15 04	VEPS, minidiag2
Cruise Set Speed Ramp Up	Set Speed increment for Resume/Accel switch continuous press.	0–20 km/hr/sec	2 km/hr	1 15 05	VEPS, minidiag2
Cruise Set Speed Ramp Down	Set Speed decrement for Set/Coast switch continuous press.	0–20 km/hr/sec	2 km/hr	1 15 06	VEPS, minidiag2
Enable Cruise Auto Resume	Enables or disables the auto resume feature.	0 = Disable 1 = Enable after 1st clutch release 2 = Enable after clutch released twice	0	1 15 07	Nexiq DDR, DDDL, VEPS, minidiag2
Enable Engine Brakes on Cruise Control	Enables or disables the engine brakes during Cruise Control.	0 = Disable 1 = Enable	0	1 10 06	Nexiq DDR, DDDL, VEPS, minidiag2

Table 5-8 Cruise Control Parameters

5.4 DIAGNOSTICS

Diagnostics is a standard feature of MBE Electronic Controls. The purpose of this feature is to provide information for problem identification and problem solving in the form of a code. The PLD-MR and VCU continuously perform self diagnostic checks and monitors the other system components. Information for problem identification and problem solving is enhanced by the detection of faults, retention of fault codes and separation of active from inactive codes.

5.4.1 OPERATION

The engine-mounted PLD-MR 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 PLD-MR and VCU regarding various engine and vehicle performance characteristics. The information is used to regulate engine and vehicle performance, provide diagnostic information, and activate the engine protection system.

Instrument panel warning lights, the Amber Warning Lamp (AWL) and the Red Stop Lamp (RSL), warn the engine operator. The AWL is an amber light and the RSL is a red light.

NOTE:
The PLD-MR and VCU save error codes into memory during a six second period after the ignition is turned off. The codes will not be stored if there is an interruption of battery power or recycling of the ignition.

The AWL is illuminated and a code is stored if an electronic system fault occurs. This indicates the problem should be diagnosed as soon as possible. The VCU illuminates the AWL and RSL and stores a malfunction code if a potentially engine damaging fault is detected. These codes can be accessed in one of three ways:

- ☐ Using the minidiag2 diagnostic reader
- ☐ By ProDriver® DC, Electronic Display Module (EDM), or other display
- ☐ Commercially available J1587 diagnostic tools

There are two types of diagnostic codes:

- ☐ An *active code* - a fault present at the time when checking for codes
- ☐ An *inactive code* - a fault which has previously occurred; inactive codes are logged into the VCU and time stamped with the following information:
  - ☐ First occurrence of each diagnostic code in engine hours
  - ☐ Last occurrence of each diagnostic code in engine hours
  - ☐ Number of fault occurances

5.4.2 DEFINITIONS AND ABBREVIATIONS

Parameter Identification Character (PID): A PID is a single byte character used in SAE J1587 messages to identify the data byte(s) that follow. PIDs in the range 0-127 identify single byte data, 128-191 identify double byte data, and 192-253 identify data of varying length.

Subsystem Identification Character (SID): A SID is a single byte character used to identify field-repairable or replaceable subsystems for which failures can be detected or isolated. SIDs are used in conjunction with SAE standard diagnostic codes defined in SAE J1587 within PID 194.

Failure Mode Identifier (FMI): The FMI describes the type of failure detected in the subsystem and identified by the PID or SID. The FMI and either the PID or SID combine to form a given diagnostic code defined in SAE J1587 within PID 194.

Message Identification Character (MID): The first byte or character of each message is the 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.

Refer to Appendix A for a list of codes, the SAE J1587 number and a description of each code.

5.5 DUAL SPEED AXLE

The Dual Speed Axle feature allows a digital input to be configured to switch between two axle ratios for calculation of vehicle speed.

5.5.1 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.

5.5.2 PROGRAMMING FLEXIBILITY & REQUIREMENTS

The digital input listed in Table 5-9 can be configured by VEPS, or minidiag2.

Description	Setting	Default	Parameter ID
Dual Speed Axle Switch	0 = Hardwired 1 = Source Address 1 (SA1) 2 = Source Address 2 (SA2) 3 = Source Address 3 (SA3)	0 = Hardwired	1 13 14

Table 5-9 Dual Speed Axle Digital Input

Both axle ratios listed in Table 5-10 must also be programmed with VEPS or minidiag2.

Parameter	Description	Choice/Display	Parameter ID
Axle Ratio	Indicates the first axle ratio of the vehicle.	1.0 to 20.00	1 08 03
Second Axle Ratio	Indicates the second axle ratio of the vehicle.	1.0 to 20.00	1 08 09

Table 5-10 Programming the Axle Ratios

5.6 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 constant throttle valve over all cylinders 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. The constant throttle valves are open over all cycles, not just the exhaust cycle.

5.6.1 OPERATION

A dash mounted On/Off Switch is used to enable the Engine Brake option. Engine Brake operations are allowed only when all of the following conditions are met:

- ☐ Percent throttle = 0 except if exceeding Vehicle Speed Limit
- ☐ Engine speed is within a programmed range
- ☐ ABS is not active (J1939)
- ☐ Clutch pedal is released
- ☐ Fuel quantity = 0%
- ☐ Engine is not in VSG mode
- ☐ Engine Brake switchs are turned on
- ☐ Torque converter locked up (automatic transmission)

If all of these conditions are met, engine brake will be activated when the engine brake switches are on low or medium (for exhaust flap Engine Brake configuration) or on low, medium or high (for turbo Engine Brake configuration). Engine brakes will be deactivated when at least one of these conditions is no longer met or the engine brake switch is turned back to the OFF position.

Stage	Engine Brake High Digital Input	Engine Brake Low Digital Input	Constant Throttle and Exhaust Flap Action	Constant Throttle and Turbo Brake Action
Off	Open	Open	No Brakes Active	No Brakes Active
1	Open	Ground	Constant Throttle Only	Constant Throttle Only
2	Ground	Open	Constant Throttle and Exhaust Flap	Constant Throttle + Turbo Brake 50%
3	Ground	Ground	Not Available	Constant Throttle + Turbo Brake 100%

Table 5-11 Engine Brake Switches

Cruise Control with Engine Brake, Service Brake Control of Engine Brakes, and Engine Brake with Vehicle Speed Limit are options for Engine Brake:

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 VCU will control the amount of Engine Brake with respect to the Cruise Control set speed. Engine brakes will be activated automatically when the road speed exceeds a programmed maximum over-speed limit above the Cruise Control set speed. Engine brakes are deactivated when the road speed falls under a programmed minimum over-speed limit above the cruise set speed. different speed limits are available for activating and deactivating the engine brakes for low and medium braking. Cruise Control with Engine Brake can be set with can be set by minidiag2.

Service Brake Control of Engine Brakes

This option will allow the service brake pedal to engage the engine brakes when pressed independent of the engine brake switch position. A digital input must be programmed for service brake. Refer to section 4.2, “Digital Inputs” for additional information.

Engine Brakes with Vehicle Speed Limit

This option enables engine brake operations when the current road speed is higher than the sum of the programmed offset and the set road speed limit. Engine brakes remain on until the road speed is lower than the set road speed limit and the road speed governor allows fueling the engine again

5.6.2 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

Engine Brake must be specified at the time of engine order or by contacting Detroit Diesel Technical Service.

The digital inputs listed in Table 5-12 must be configured by VEPS or minidiag2.

Description	Pin Number
Engine Brake Low	18/8
Engine Brake Medium/High	18/9
Clutch Switch (required for manual transmissions)	18/2

Table 5-12 Required Digital Inputs for Engine Brake Controls

Engine Brake configuration listed in Table 5-13 must be configured by VEPS or minidiag2.

Parameter	Choice/Range	Default	Parameter ID
Engine Brake Configuration	0 = Compression Brake and Exhaust Flap (Low/High) 1 = Compression Brake and Turbo Brake (Low/Med/High)	0	1 10 13

Table 5-13 Engine Brake Parameter

Configuration for MBE 900 Compression Brake (Constant Throttle) Only Application

The configuration parameters for **Compression Brake Only** applications are listed in Table 5-14. These parameters can be configured or changed with VEPS or minidiag2.

Parameter	Description	Range	Recom-mended Setting	Parameter ID
Engine Brake Configuration	Enables the type of engine brake required	0 = Engine Brake configuration with Compression Brake & Exhaust Flap 1 = Engine Brake Configuration w/ Compression Brake & Turbo Brake	0 = Low/High	1 10 13
Engine Brake Stage 1 Mask for Low Braking	Mask determines which device turns on for low braking	64 = Constant Throttle Valve Only 80 = Constant Throttle & Exhaust Flap 81 = Constant Throttle Valve & Turbo Brake High	64	1 10 14
Engine Brake Stage 1 Factor for Low Braking	Factor determines the amount of low braking	0 – 100%	100	1 10 15
Engine Brake Stage 2 Mask for Medium Braking	Mask determines which device turns on for medium braking	64 = Constant Throttle Valve Only 80 = Constant Throttle & Exhaust Flap 81 = Constant Throttle Valve & Turbo Brake High	64	1 10 16
Engine Brake Stage 2 Factor for Medium Braking	Factor determines the amount of medium braking	0 – 100%	100	1 10 17
Engine Brake Stage 3 Mask for High Braking*	Mask determines which device turns on for high braking	64 = Constant Throttle Valve Only 80 = Constant Throttle & Exhaust Flap 81 = Constant Throttle Valve & Turbo Brake High	64	1 10 18
Engine Brake Stage 3 Factor for High Braking	Factor determines the amount of high braking	0 – 100%	100	1 10 19
Engine Brake Transmission Mask		64 = Constant Throttle Valve Only 80 = Constant Throttle & Exhaust Flap 81 = Constant Throttle Valve & Turbo Brake High	64	1 10 20
Engine Brake Transmission Factor	Factor determines the amount of high braking	0–100%	100	1 10 21

* The Engine Brake Stage 3 mask is used when the vehicle is exceeding the Road Speed limit. Therefore the Engine Brake Stage 3 mask should always be set to a non-zero value for engines having an engine brake. For Constant Throttle only or Exhaust Flap applications, the Stage 3 mask must be the same value as the Stage 2 mask.

Table 5-14 VCU Configuration Parameter for Compression Brake Only Applications

For PLD-MR software 53 (Diagnostic Version 5), the parameters listed in Table 5-15 for **Compression Brake Only** applications must be set in the PLD-MR and the configuration parameters listed in Table 5-14 must be set in the VCU. These parameters can be changed with VEPS or minidiag2.

Parameter	Description	Range	Recommended Setting	Parameter ID
PWM1 – Exhaust Flap Enable	Enables the Exhaust Flap or Turbo Brake on PWM1	0 = No Function 1 = Wastegate Control 2 = Exhaust Flap (VEPS) 3 = Exhaust Flap (minidiag2)	0 = No Function	0 06 01
PWM2 – Compression Engine Brake Enable	Enables the Compression brake on PWM2	0 = No Function 1 = Not Used 2 = Compression Brake (VEPS) 3 = Compression Brake (minidiag2)	2 for VEPS OR 3 for minidiag2	0 06 02
PWM6	Turbo Brake Sleeve	0 = No Function 1 = Not Used 2 = Not Used 3 = Exhaust Flap	0 = No Function	0 35 02

Table 5-15 PLD-MR Software 53 (Diagnostic Version 5) Parameters for Compression Brake Only Applications

For PLD-MR software 56 (Diagnostic Version 5), the parameters listed in Table 5-16 for **Compression Brake Only** applications must be set in the PLD-MR and the configuration parameters listed in Table 5-14 must be set in the VCU. These parameters can be changed with VEPS or minidiag2.

Parameter	Description	Range	Recommended Setting	Parameter ID
PWM1 – Exhaust Flap Enable	Enables the Exhaust Flap or Turbo Brake on PWM1	0 = No Function 1 = Wastegate Control 2 = Exhaust Flap (VEPS) 3 = Exhaust Flap (minidiag2)	0 = No Function	0 03 01
PWM2 – Compression Engine Brake Enable	Enables the Compression brake on PWM2	0 = No Function 1 = Not Used 2 = Compression Brake (VEPS) 3 = Compression Brake (minidiag2)	2 for VEPS OR 3 for minidiag2	0 03 02
PWM6	Turbo Brake Sleeve	0 = No Function 1 = Not Used 2 = Not Used 3 = Exhaust Flap	0 = No Function	0 03 06

Table 5-16 PLD-MR Software 56 (Diagnostic Version 6) Parameters for Compression Brake Only Applications

Configuration for MBE 900 Compression Brake and Exhaust Brake Applications

The configuration parameters listed in Table 5-17 for **Compression Brake and Exhaust Brake** for the MBE 906. These parameters can be configured or changed with VEPS or minidiag2.

Parameter	Description	Range	Recom-mended Setting	Parameter ID
Engine Brake Configuration	Enables the type of engine brake required	0 = Engine Brake configuration w/ Compression Brake & Exhaust flap 1 = Engine Brake Configuration w/ Compression Brake & Turbo Brake	0 = Low/High	1 10 13
Engine Brake Stage 1 Mask for Low Braking	Mask determines which device turns on for low braking	64 = Constant Throttle Valve Only 80 = Constant Throttle & Exhaust Flap 81 = Constant Throttle Valve & Turbo Brake High	64	1 10 14
Engine Brake Stage 1 Factor for Low Braking	Factor determines the amount of low braking	0 – 100%	100	1 10 15
Engine Brake Stage 2 Mask for Medium Braking	Mask determines which device turns on for medium braking	64 = Constant Throttle Valve Only 80 = Constant Throttle & Exhaust Flap 81 = Constant Throttle Valve & Turbo Brake High	80	1 10 16
Engine Brake Stage 2 Factor for Medium Braking	Factor determines the amount of medium braking	0 – 100%	100	1 10 17
Engine Brake Stage 3 Mask for High Braking*	Mask determines which device turns on for high braking	64 = Constant Throttle Valve Only 80 = Constant Throttle & Exhaust Flap 81 = Constant Throttle Valve & Turbo Brake High	80	1 10 18
Engine Brake Stage 3 Factor for High Braking	Factor determines the amount of high braking	0 – 100%	100	1 10 19
Engine Brake Transmission Mask	—	64 = Constant Throttle Valve Only 80 = Constant Throttle & Exhaust Flap 81 = Constant Throttle Valve & Turbo Brake High	64	1 10 20
Engine Brake Transmission Factor	Factor determines the amount of high braking	0–100%	100	1 10 21

* The Engine Brake Stage 3 mask is used when the vehicle is exceeding the Road Speed limit. Therefore the Engine Brake Stage 3 mask should always be set to a non-zero value with engine brake. For Constant Throttle only or Exhaust Flap applications, the Stage 3 mask must be the same value as the Stage 2 mask.

Table 5-17 VCU Configuration Parameter for Compression and Exhaust Brake Applications - MBE 906 Engine

For PLD-MR software 53 (Diagnostic Version 5), the parameters listed in Table 5-18 for **Compression Brake and Exhaust Brake** applications must be set in the PLD-MR and the configuration parameters listed in Table 5-17 must be set in the VCU. These parameters can be changed with VEPS or minidiag2.

Parameter	Description	Range	Recommended Setting	Parameter ID
PWM1 – Exhaust Flap Enable	Enables the Exhaust Flap or Turbo Brake on PWM1	0 = No Function 1 = Wastegate Control 2 = Exhaust Flap (VEPS) 3 = Exhaust Flap (minidiag2)	2 for VEPS or 3 for minidiag2	0 06 01
PWM2 – Compression Engine Brake Enable	Enables the Compression brake on PWM2	0 = No Function 1 = Not Used 2 = Compression Brake (VEPS) 3 = Compression Brake (minidiag2)	2 for VEPS or 3 for minidiag2	0 06 02
PWM6	Turbo Brake Sleeve Control	0 = No Function 1 = Not Used 2 = Not Used 3 = Exhaust Flap	0 = No Function	0 35 02

Table 5-18 PLD-MR Software 53 (Diagnostic Version 5) Configuration Parameter for Compression and Exhaust Brake Applications - MBE 906 Engine

For PLD-MR software 56 (Diagnostic Version 6), the parameters listed in Table 5-19 for **Compression Brake and Exhaust Brake** applications must be set in the PLD-MR and the configuration parameters listed in Table 5-17 must be set in the VCU. These parameters can be changed with VEPS or minidiag2.

Parameter	Description	Range	Recommended Setting	Parameter ID
PWM1 – Exhaust Flap Enable	Enables the Exhaust Flap or Turbo Brake on PWM1	0 = No Function 1 = Wastegate Control 2 = Exhaust Flap (VEPS) 3 = Exhaust Flap (minidiag2)	2 for VEPS or 3 for minidiag2	0 03 01
PWM2 – Compression Engine Brake Enable	Enables the Compression brake on PWM2	0 = No Function 1 = Not Used 2 = Compression Brake (VEPS) 3 = Compression Brake (minidiag2)	2 for VEPS or 3 for minidiag2	0 03 02
PWM6	Turbo Brake sleeve Control	0 = No Function 1 = Not Used 2 = Not Used 3 = Exhaust Flap	0 = No Function	0 03 06

Table 5-19 PLD-MR Software 56 (Diagnostic Version 6) Configuration Parameter for Compression and Exhaust Brake Applications - MBE 906 Engine

Configuration for Compression Brake and Exhaust Brake Applications for MBE 4000 One-solenoid Engine

The configuration parameters for **Compression Brake and Exhaust Brake** applications for the MBE 4000 are listed in Table 5-20. They can be configured/changed with VEPS or minidiag2.

Parameter	Description	Range	Recom-mended Setting	Parameter ID
Engine Brake Configuration	Enables the type of engine brake required	0 = Engine Brake configuration w/ Compression Brake & Exhaust flap 1 = Engine Brake Configuration with Compression Brake & Turbo Brake	0 = Low/High	1 10 13
Engine Brake Stage 1 Mask for Low Braking	Mask determines which device turns on for low braking	64 = Constant Throttle Valve Only 80 = Constant Throttle & Exhaust Flap 81 = Constant Throttle Valve & Turbo Brake High	64	1 10 14
Engine Brake Stage 1 Factor for Low Braking	Factor determines the amount of low braking	0 – 100%	100	1 10 15
Engine Brake Stage 2 Mask for Medium Braking	Mask determines which device turns on for medium braking	64 = Constant Throttle Valve Only 80 = Constant Throttle & Exhaust Flap 81 = Constant Throttle Valve & Turbo Brake High	80	1 10 16
Engine Brake Stage 2 Factor for Medium Braking	Factor determines the amount of medium braking	0 – 100%	100	1 10 17
Engine Brake Stage 3 Mask for High Braking*	Mask determines which device turns on for high braking	64 = Constant Throttle Valve Only 80 = Constant Throttle & Exhaust Flap 81 = Constant Throttle Valve & Turbo Brake High	80	1 10 18
Engine Brake Stage 3 Factor for High Braking	Factor determines the amount of high braking	0 – 100%	100	1 10 19
Engine Brake Transmission Mask		64 = Constant Throttle Valve Only 80 = Constant Throttle & Exhaust Flap 81 = Constant Throttle Valve & Turbo Brake High	80	1 10 20
Engine Brake Transmission Factor	Factor determines the amount of high braking	0–100%	100	1 10 21

* The Engine Brake Stage 3 mask is used when the vehicle is exceeding the Road Speed limit. Therefore the Engine Brake Stage 3 mask should always be set to a non-zero value with engine brake. For Constant Throttle only or Exhaust Flap applications, the Stage 3 mask must be the same value as the Stage 2 mask.

Table 5-20 VCU Configuration Parameter for Compression Brake and Exhaust Brake Applications - MBE 4000 One-solenoid Engine

For PLD-MR software 53 (Diagnostic Version 5), the parameters listed in Table 5-21 for **Compression Brake and Exhaust Brake** applications must be set in the PLD-MR and the configuration parameters listed in Table 5-20 must be set in the VCU. These parameters can be changed with VEPS or minidiag2.

Parameter	Description	Range	Recommended Setting	Parameter ID
PWM1 – Exhaust Flap Enable	Enables the Exhaust Flap or Turbo Brake on PWM1	0 = No Function 1 = Wastegate Control 2 = Exhaust Flap (VEPS) 3 = Exhaust Flap (minidiag2)	2 for VEPS OR 3 for minidiag2	0 06 01
PWM2 – Compression Engine Brake Enable	Enables the Compression brake on PWM2	0 = No Function 1 = Not Used 2 = Compression Brake (VEPS) 3 = Compression Brake (minidiag2)	0 = No Function	0 06 02
PWM6	Turbo Brake Sleeve Control	0 = No Function 1 = Not Used 2 = Not Used 3 = Exhaust Flap	0 = No Function	0 35 02

Table 5-21 PLD-MR Software 53 (Diagnostic Version 5) Configuration Parameter for Compression Brake and Exhaust Brake Applications - MBE 4000 One-solenoid Engine

For PLD-MR software 56 (Diagnostic Version 6), the parameters listed in Table 5-22 for **Compression Brake and Exhaust Brake** applications must be set in the PLD-MR and the configuration parameters listed in Table 5-20 must be set in the VCU. These parameters can be changed with VEPS or minidiag2.

Parameter	Description	Range	Recommended Setting	Parameter ID
PWM1 – Exhaust Flap Enable	Enables the Exhaust Flap or Turbo Brake on PWM1	0 = No Function 1 = Wastegate Control 2 = Exhaust Flap (VEPS) 3 = Exhaust Flap (minidiag2)	2 for VEPS OR 3 for minidiag2	0 03 01
PWM2 – Compression Engine Brake Enable	Enables the Compression brake on PWM2	0 = No Function 1 = Not Used 2 = Compression Brake (VEPS) 3 = Compression Brake (minidiag2)	0 = No Function	0 03 02
PWM6	Turbo Brake Sleeve Control	0 = No Function 1 = Not Used 2 = Not Used 3 = Exhaust Flap	0 = No Function	0 03 06

Table 5-22 PLD-MR Software 56 (Diagnostic Version 6) Configuration Parameter for Compression Brake and Exhaust Brake Applications - MBE 4000 One-solenoid Engine

The configuration parameters for **Compression Brake and Exhaust Brake** applications arelisted in Table 5-23. These configuration parameters are for the MBE 4000 - **two-solenoid engine**. These parameters can be configured or changed with VEPS or minidiag2.

Parameter	Description	Range	Recommended Setting	Parameter ID
Engine Brake Configuration	Enables the type of engine brake required	0 = Engine Brake Configuration w/ Compression Brake & Exhaust Flap 1 = Engine Brake Configuration with Compression Brake & Turbo Brake	0 = Low/High	1 10 13
Engine Brake Stage 1 Mask for Low Braking	Mask determines which device turns on for low braking	64 = Constant Throttle Valve Only 80 = Constant Throttle & Exhaust Flap 81 = Constant Throttle Valve & Turbo Brake High	64	1 10 14
Engine Brake Stage 1 Factor for Low Braking	Factor determines the amount of low braking	0 – 100%	100	1 10 15
Engine Brake Stage 2 Mask for Medium Braking	Mask determines which device turns on for medium braking	64 = Constant Throttle Valve Only 80 = Constant Throttle & Exhaust Flap 81 = Constant Throttle Valve & Turbo Brake High	80	1 10 16
Engine Brake Stage 2 Factor for Medium Braking	Factor determines the amount of medium braking	0 – 100%	100	1 10 17
Engine Brake Stage 3 Mask for High Braking*	Mask determines which device turns on for high braking	64 = Constant Throttle Valve Only 80 = Constant Throttle & Exhaust Flap 81 = Constant Throttle Valve & Turbo Brake High	80	1 10 18
Engine Brake Stage 3 Factor for High Braking	Factor determines the amount of high braking	0 – 100%	100	1 10 19
Engine Brake Transmission Mask		64 = Constant Throttle Valve Only 80 = Constant Throttle & Exhaust Flap 81 = Constant Throttle Valve & Turbo Brake High	64	1 10 20
Engine Brake Transmission Factor	Factor determines the amount of high braking	0–100%	100	1 10 21

*The Engine Brake Stage 3 mask is used when the vehicle is exceeding the Road Speed limit. Therefore the Engine Brake Stage 3 mask should always be set to a non-zero value for engines having an engine brake. For Constant Throttle only or Exhaust Flap applications, the Stage 3 mask must be the same value as the Stage 2 mask.

Table 5-23 VCU Configuration Parameter for Compression Brake and Exhaust Brake Applications - MBE 4000 Two-solenoid Engine

For PLD-MR software 53 (Diagnostic Version 5), the parameters listed in Table 5-24 for **Compression Brake and Exhaust Brake** applications must be set in the PLD-MR and the configuration parameters listed in Table 5-23 must be set in the VCU. These parameters can be changed with VEPS or minidiag2.

Parameter	Description	Range	Recommended Setting	Parameter ID
PWM1 – Exhaust Flap Enable	Enables the Exhaust Flap or Turbo Brake on PWM1	0 = No Function 1 = Wastegate Control 2 = Exhaust Flap (VEPS) 3 = Exhaust Flap (minidiag2)	2 for VEPS or 3 for minidiag2	0 06 01
PWM2 – Compression Engine Brake Enable	Enables the Compression brake on PWM2	0 = No Function 1 = Not Used 2 = Compression Brake (VEPS) 3 = Compression Brake (minidiag2)	2 for VEPS or 3 for minidiag2	0 06 02
PWM6	Turbo Brake Sleeve Control	0 = No Function 1 = Not Used 2 = Not Used 3 = Exhaust Flap	0 = No Function	0 35 02

Table 5-24 PLD-MR Software 53 (Diagnostic Version 5) Configuration Parameter for Compression Brake and Exhaust Brake Applications - MBE 4000 Two-solenoid Engine

For PLD-MR software 56 (Diagnostic Version 6), the parameters listed in Table 5-25 for **Compression Brake and Exhaust Brake** applications must be set in the PLD-MR and the configuration parameters listed in Table 5-23 must be set in the VCU. These parameters can be changed with VEPS or minidiag2.

Parameter	Description	Range	Recommended Setting	Parameter ID
PWM1 – Exhaust Flap Enable	Enables the Exhaust Flap or Turbo Brake on PWM1	0 = No Function 1 = Wastegate Control 2 = Exhaust Flap (VEPS) 3 = Exhaust Flap (minidiag2)	2 for VEPS or 3 for minidiag2	0 03 01
PWM2 – Compression Engine Brake Enable	Enables the Compression brake on PWM2	0 = No Function 1 = Not Used 2 = Compression Brake (VEPS) 3 = Compression Brake (minidiag2)	2 for VEPS or 3 for minidiag2	0 03 02
PWM6	Turbo Brake Sleeve Control	0 = No Function 1 = Not Used 2 = Not Used 3 = Exhaust Flap	0 = No Function	0 03 06

Table 5-25 PLD-MR Software 56 (Diagnostic Version 6) Configuration Parameter for Compression Brake and Exhaust Brake Applications - MBE 4000 Two-solenoid Engine

Configuration for Compression Brake and Turbo Brake Applications

The configuration parameters for **Compression Brake and Turbo Brake** applications are listed in Table 5-26. These parameters can be configured or changed with VEPS or minidiag2.

Parameter	Description	Range	Recom-mended Settings	Parameter ID
Engine Brake Configuration	Enables the type of engine brake required	0 = Engine Brake configuration with Compression Brake & Exhaust flap 1 = Engine Brake Configuration w/ Compression Brake & Turbo Brake	0 = Low/High	1 10 13
Engine Brake Stage 1 Mask for Low Braking	Mask determines which device turns on for low braking	64 = Constant Throttle Valve Only 80 = Constant Throttle & Exhaust Flap 81 = Constant Throttle Valve & Turbo Brake High	64	1 10 14
Engine Brake Stage 1 Factor for Low Braking	Factor determines the amount of low braking	0 – 100%	100	1 10 15
Engine Brake Stage 2 Mask for Medium Braking	Mask determines which device turns on for medium braking	64 = Constant Throttle Valve Only 80 = Constant Throttle & Exhaust Flap 81 = Constant Throttle Valve & Turbo Brake High	81	1 10 16
Engine Brake Stage 2 Factor for Medium Braking	Factor determines the amount of medium braking	0 – 100%	50	1 10 17
Engine Brake Stage 3 Mask for High Braking*	Mask determines which device turns on for high braking	64 = Constant Throttle Valve Only 80 = Constant Throttle & Exhaust Flap 81 = Constant Throttle Valve & Turbo Brake High	81	1 10 18
Engine Brake Stage 3 Factor for High Braking	Factor determines the amount of high braking	0 – 100%	100	1 10 19
Engine Brake Transmission Mask		64 = Constant Throttle Valve Only 80 = Constant Throttle & Exhaust Flap 81 = Constant Throttle Valve & Turbo Brake High	64	1 10 20
Engine Brake Transmission Factor	Factor determines the amount of high braking	0–100%	100	1 10 21

* The Engine Brake Stage 3 mask is used when the vehicle is exceeding the Road Speed limit. Therefore the Engine Brake Stage 3 mask should always be set to a non-zero value with engine brake. For Constant Throttle only or Exhaust Flap applications, the Stage 3 mask must be the same value as the Stage 2 mask.

Table 5-26 VCU Configuration Parameter for Compression Brake and Turbo Brake Applications

For PLD-MR software 53 (Diagnostic Version 5), the parameters listed in Table 5-27 for **Compression Brake and Turbo Brake** applications must be set in the PLD-MR and the configuration parameters listed in Table 5-26 for Compression Brake and Turbo Brake must be set in the VCU. These parameters can be changed with VEPS or minidiag2.

Parameter	Description	Range	Recommended Setting	Parameter ID
PWM1 – Exhaust Flap Enable	Enables the Exhaust Flap or Turbo Brake on PWM1	0 = No Function 1 = Wastegate Control 2 = Exhaust Flap (VEPS) 3 = Exhaust Flap (minidiag2)	1	0 06 01
PWM2 – Compression Engine Brake Enable	Enables the Compression brake on PWM2	0 = No Function 1 = Not Used 2 = Compression Brake (VEPS) 3 = Compression Brake (minidiag2)	2 for VEPS OR 3 for minidiag2	0 06 02
PWM6	Turbo Brake Sleeve Control	0 = No Function 1 = Not Used 2 = Not Used 3 = Exhaust Flap (Turbo Brake Sleeve)	3	0 35 01

Table 5-27 PLD-MR Software 53 (Diagnostic Version 5) Parameters for Compression Brake and Turbo Brake Applications

For PLD-MR software 56 (Diagnostic Version 6), the parameters listed in Table 5-28 for **Compression Brake and Turbo Brake** applications must be set in the PLD-MR and the configuration parameters listed in Table 5-26 must be set in the VCU. These parameters can be changed with VEPS or minidiag2.

Parameter	Description	Range	Recom-mended Setting	Parameter ID
PWM1 – Exhaust Flap Enable	Enables the Exhaust Flap or Turbo Brake on PWM1	0 = No Function 1 = Wastegate Control 2 = Exhaust Flap (VEPS) 3 = Exhaust Flap (minidiag2)	1	0 03 01
PWM2 – Compression Engine Brake Enable	Enables the Compression brake on PWM2	0 = No Function 1 = Not Used 2 = Compression Brake (VEPS) 3 = Compression Brake (minidiag2)	2 for VEPS OR 3 for minidiag2	0 03 02
PWM6	Turbo Brake Sleeve Control	0 = No Function 1 = Not Used 2 = Not Used 3 = Exhaust Flap (Turbo Brake Sleeve)	3	0 03 06

Table 5-28 PLD-MR Software 56 (Diagnostic Version 6) Parameters for Compression Brake and Turbo Brake Applications

Cruise Control of Engine Brake Option with Cruise Control

The parameters listed in Table 5-29 can be set by VEPS or minidiag2 for the Engine Brake option with Cruise Control.

Parameter	Description	Choice / Display	Default	Parameter ID	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.	0 = Disable 1 = Enable	0	1 10 06	VEPS, Nexiq DDR, DDDL, or minidiag2
MAX CRUISE OVERSPEED FOR LOW ENGINE BRAKE	Engine Brake LOW will be activated when the road speed exceeds the maximum over speed limit above the cruise set speed.	0–48 km/hr	4.8 km/hr	1 10 07	VEPS, minidiag2
MIN CRUISE OVERSPEED FOR LOW ENGINE BRAKE	Engine Brake LOW will be deactivated when the road speed falls under the minimum over speed limit above the cruise set speed for engine brake low.	0–48 km/hr	1.6 km/hr	1 10 08	VEPS, minidiag2
MAX CRUISE OVERSPEED FOR HIGH ENGINE BRAKE	Engine Brake HIGH will be activated when the road speed exceeds the maximum over speed limit above the cruise set speed.	0–48 km/hr	10 km/hr	1 10 11	VEPS, minidiag2
MIN CRUISE OVERSPEED FOR HIGH ENGINE BRAKE	Engine Brake HIGH will be deactivated when the road speed falls under the minimum over speed limit above the cruise set speed for engine brake low.	0–48 km/hr	6 km/hr	1 10 12	VEPS, minidiag2
MAX CRUISE OVERSPEED FOR MED ENGINE BRAKE	Engine Brake MED/HIGH will be activated when the road speed exceeds the maximum over speed limit above the cruise set speed.	0–48 km/hr	5 km/hr	1 10 10	VEPS, minidiag2
MIN CRUISE OVERSPEED FOR MED ENGINE BRAKE	Engine Brake MED/HIGH will be deactivated when the road speed falls under the minimum over speed limit above the cruise set speed for engine brake low	0–48 km/hr	7 km/hr	1 10 09	VEPS, minidiag2

Table 5-29 Cruise Control Engine Brake Parameters

Engine Brake Option with Service Brake

The parameter listed in Table 5-30 can be set by VEPS, Nexiq DDR, DDDL, or minidiag2.

Parameter	Description	Choice / Display	Default	Parameter ID
ENGINE BRAKE SERVICE BRAKE ENABLE	When this function is enabled, an input from the service brake is required in order to activate the engine brake.	0 = Disable 1 = Enable	0	1 10 03

Table 5-30 Service Brake Control of Engine Brake Parameter

Engine Brakes Option with Minimum KPH

The minimum KPH for the Engine Brakes option is listed in Table 5-31.

Parameter	Description	Choice / Display	Default	Parameter ID	Access
ENGINE BRAKE MIN KPH	The minimum vehicle speed required before engine braking will occur.	0-40 km/hr	0 km/hr	1 05 04	Nexiq DDR, DDDL, VEPS, or minidiag2
ENGINE SPEED MIN RPM	Minimum engine speed for engine brake operation	0–4000 RPM	1100 RPM	1 1001	VEPS, minidiag2

Table 5-31 Minimum KPH for Engine Brakes Option

Vehicle Speed Limiting for Engine Brake Option with Vehicle Speed Limit

Engine Brake with road speed limiting can be configured by Nexiq DDR, DDDL, VEPS or minidiag2 as listed in Table 5-32.

Parameter	Description	Choice/Display	Default	Parameter ID
ROAD SPEED LIMITING WITH ENGINE BRAKE	Offset to turn on engine brakes when the road speed limit is exceeded.	0–48 km/hr	0 km/hr (disable)	1 10 05

Table 5-32 Road Speed Limiting for Engine Brake Option

5.6.3 INTERACTION WITH OTHER FEATURE

MBE Electronic Controls will respond to requests from other vehicle systems via the J1939 data link to disable or enable engine brake.

5.7 ENGINE PROTECTION

The MBE Electronic Controls 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 Stop Lamp (RSL) illuminate. The malfunction codes are logged into the ECM's memory.

The standard parameters which are monitored for engine protection are:

- Low coolant level
- High coolant temperature
- Low oil pressure

5.7.1 OPERATION

Engine protection is a vital part of PLD-MR/VCU programming and software. The PLD-MR 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 code logged if there is an electronic system fault. This indicates the problem should be diagnosed as soon as possible. The VCU illuminates the AWL and RSL and stores a malfunction code if a potentially engine damaging fault is detected. Once a critical fault is reached, the AWL and RSL are illuminated and a 60 or 30 second timer starts a countdown to the desired level of protection. The AWL will flash for 20 seconds (programmable) and the RSL will flash for 10 seconds (programmable) before the engine shuts down. 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
- Shutdown

Warning Only

The AWL and RSL will illuminate if a fault is detected. There is 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.

Shutdown

The engine shuts down 60 seconds (30 seconds for oil pressure) after the RSL is illuminated for coolant level, coolant temperature or oil level. The engine shuts down 30 seconds after the RSL is illuminated for oil pressure (see Figure 5-2). (The initial torque and/or speed which is used for reduction, is the torque and/or speed which occurred immediately prior to the fault condition.) The Stop Engine Override Switch is available to prevent engine shutdown at the operator's discretion.

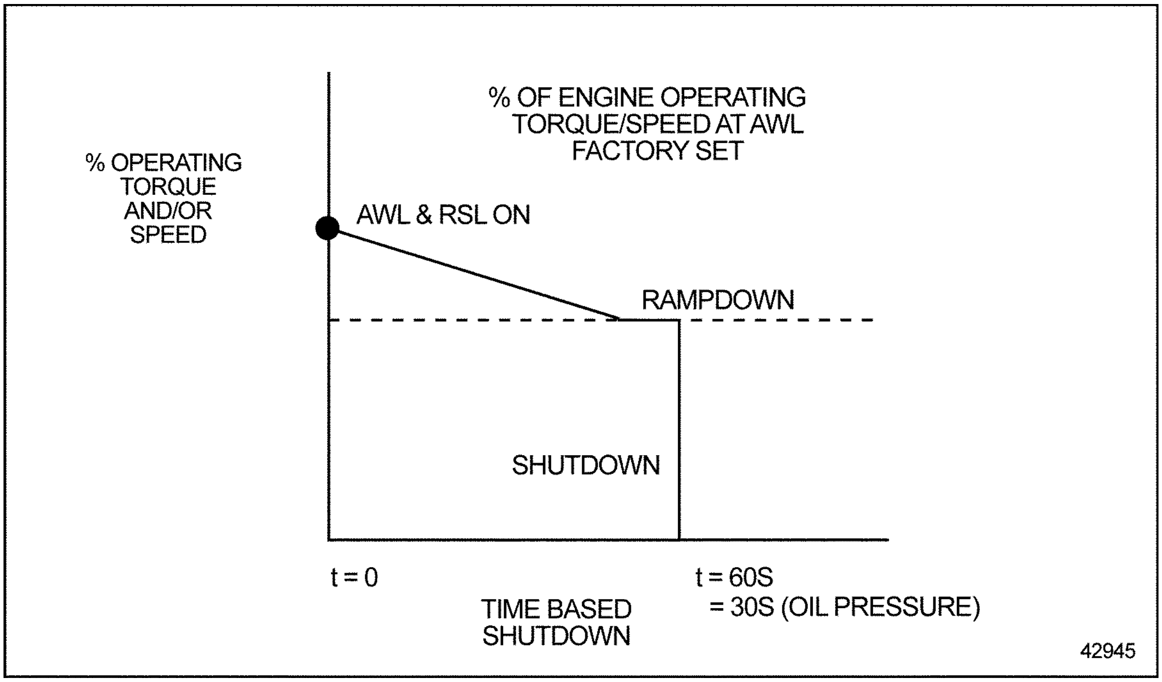

Figure 5-2 Engine Shutdown

An SEO Switch is required when this engine protection option is selected. Refer to section 5.7.3. The SEO options are available to prevent engine shutdown at the operator's discretion.

5.7.2 ENGINE OVERTEMPERATURE PROTECTION

Engine Overtemperature Protection (EOP) is additional logic programmed into the PLD-MR and used in conjunction with standard coolant 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 fault code is logged when the EOP calibrated temperature is reached. If the temperature does not decrease as torque/speed is reduced, the RSL will illuminate when a still higher temperature is reached.

The subsequent action taken by the PLD-MR depends on customer selection of one of the following:

- ☐ Warning only (see Figure 5-3)
- ☐ Rampdown/Shutdown (see Figure 5-4)

Torque reduction is based on the average torque/speed in use prior to the fault condition.

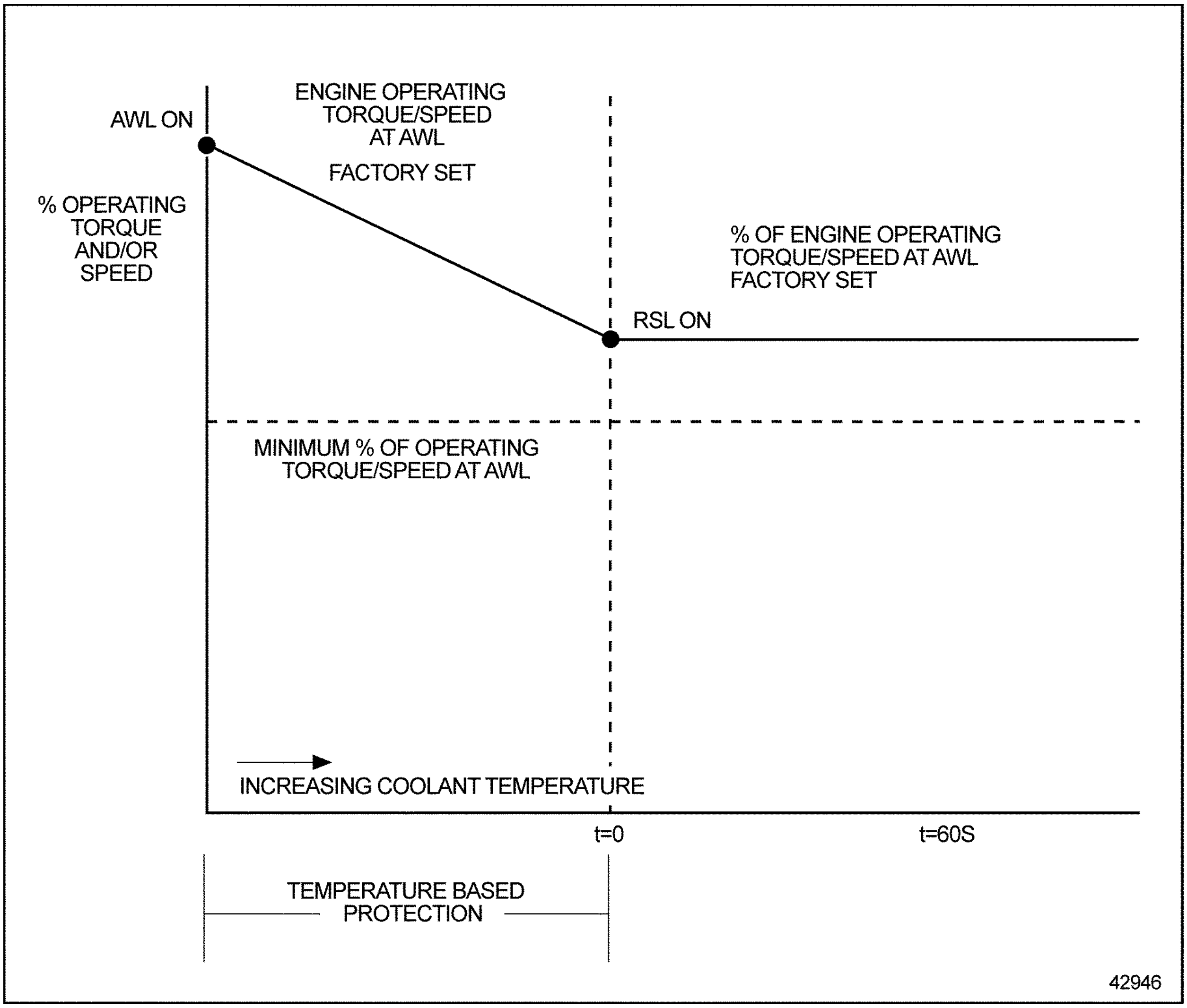

Figure 5-3 Engine Overtemperature Protection and Warning Only

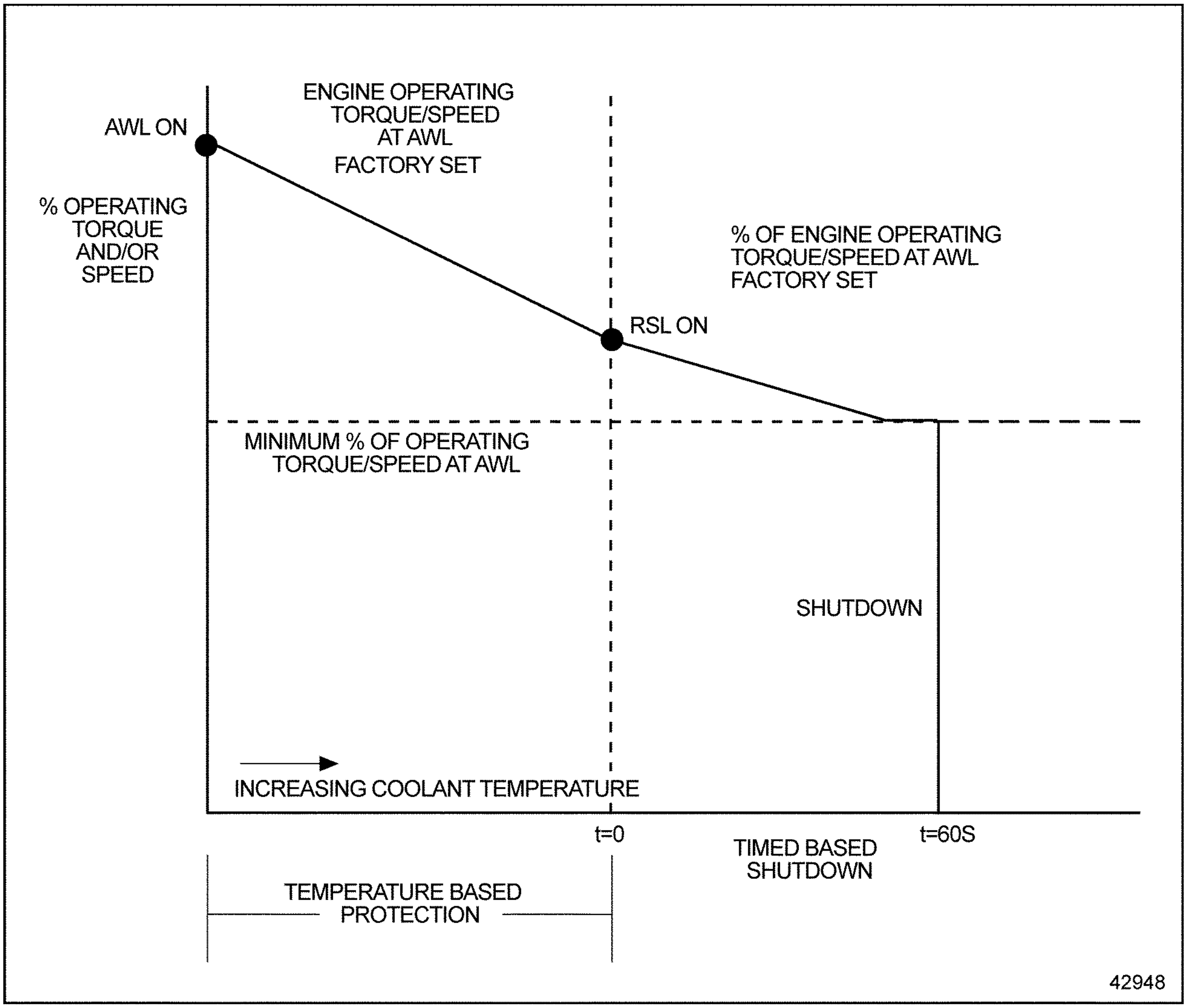

Figure 5-4 Engine Overtemperature Protection and Rampdown/Shutdown

5.7.3 STOP ENGINE OVERRIDE OPTION

The Stop Engine Override Switch is used for a momentary override. The PLD-MR will record the number of times the override is activated after a fault occurs. Continuous Override using the SEO switch is not available.

Momentary Override - An SEO switch is used to override the shutdown sequence (see Figure 5-5). This override resets the 60 second shutdown timer, restoring power to the level when the RSL was illuminated. The switch must be recycled after five seconds to obtain a subsequent override. See Figure 5-6.

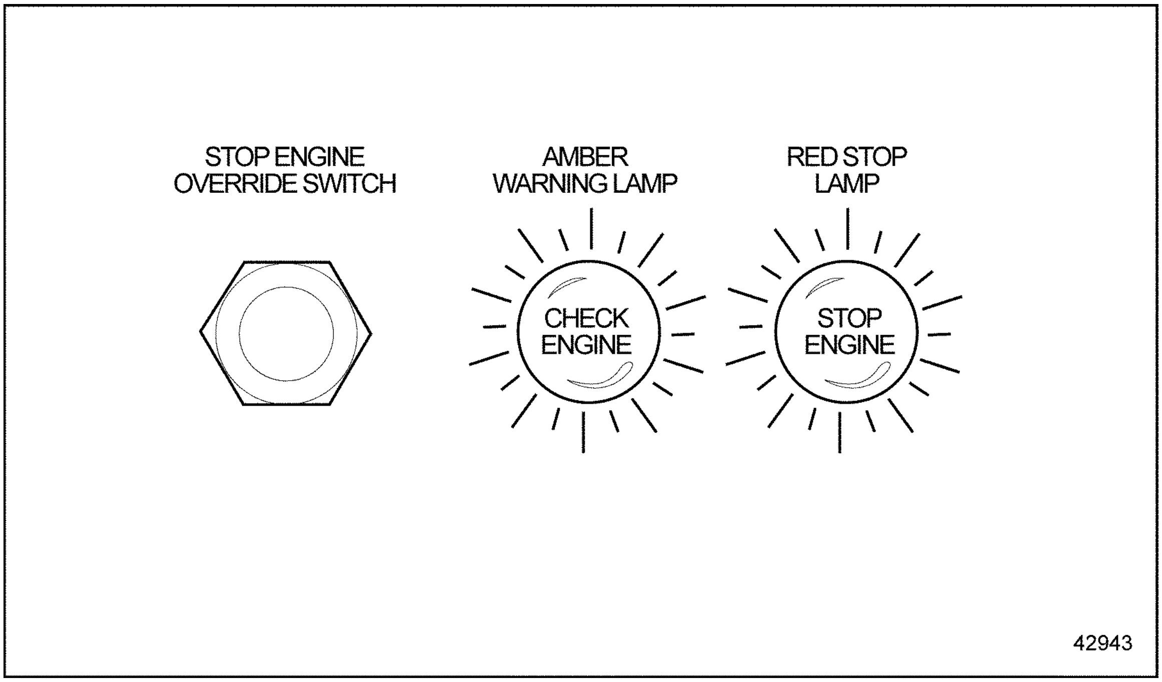

Figure 5-5 Typical SEO Switch and Warning Lamps

NOTE:
The operator has the responsibility to take action to avoid engine damage.

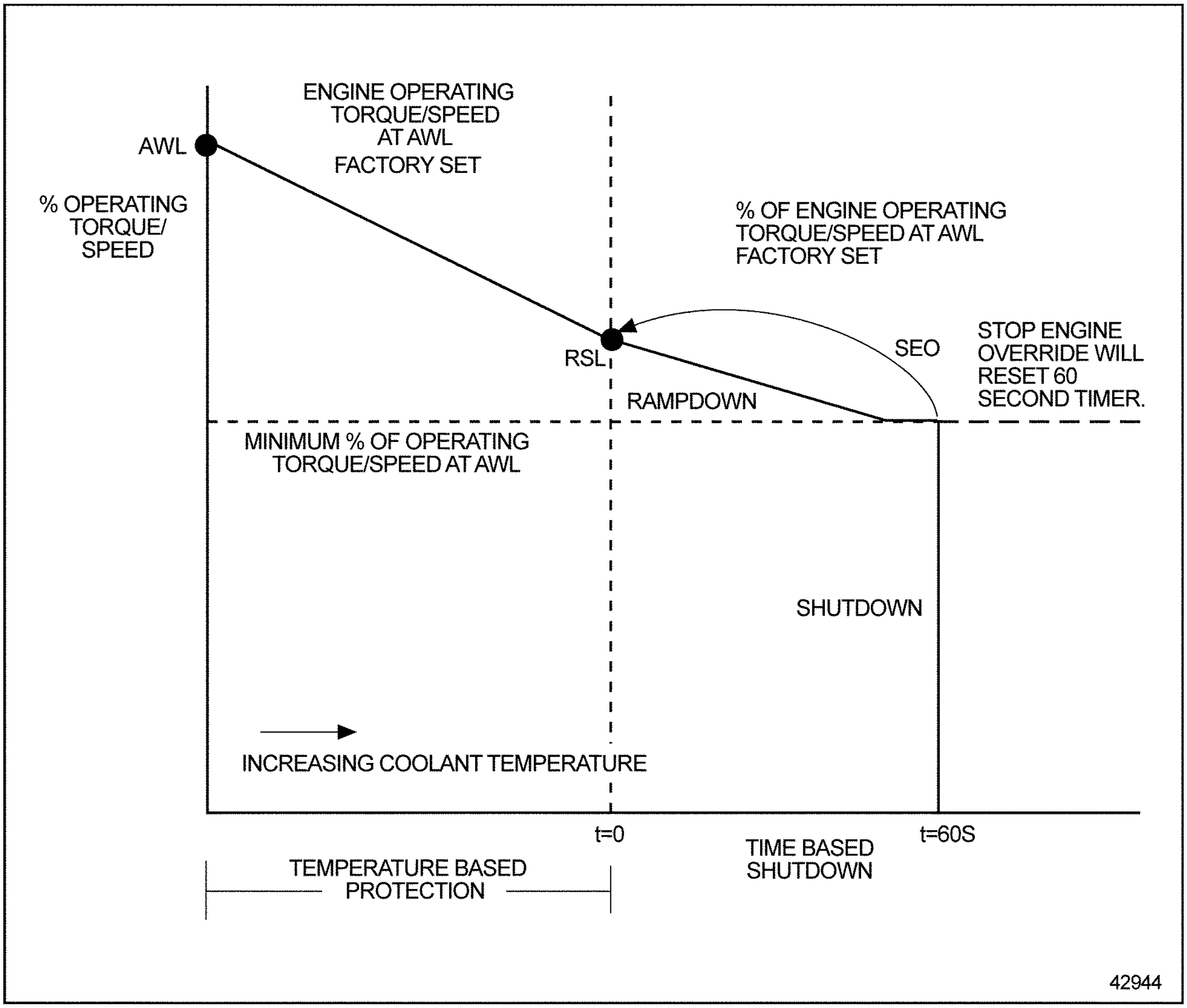

Figure 5-6 Engine Overtemperature Protection and Rampdown/Shutdown Protection with Stop Engine Override

5.7.4 PROGRAMMING FLEXIBILITY

All PLD-MRs are programmed with pressure, temperature, and level protection limits. The level of protection can be one of the two engine protection features (Warning, or Rampdown/Shutdown) for each parameter monitored by the PLD-MR.

The MBE Electronic Controls engine protection system parameters are listed in Table 5-33 .

Parameter	Description	Choice/Range	Default	Parameter ID	Access
Enable Engine Protection Shutdown on Coolant Temperature	Enable/Disable shutdown for high coolant temperature	0 = Disable 1 = Enable	1 = Enable	1 18 01	Nexiq DDR, DDDL, VEPS, or minidiag2
Enable Engine Protection Shutdown on Coolant Level	Enable/Disable shutdown for low coolant level	0 = Disable 1 = Enable	0 = Disable	1 18 02	Nexiq DDR, DDDL, VEPS, or minidiag2
Enable Engine Protection Shutdown on Oil Pressure	Enable/Disable shutdown for low oil pressure	0 = Disable 1 = Enable	1 = Enable	1 10 03	Nexiq DDR, DDDL, VEPS, or minidiag2
Enable Counter for Engine Protection Overrides	Holds the count of shutdown overrides that have occurred (Read Only)	0–255	0	1 18 07	minidiag2
AWL Engine Protection Shutdown Time	Time for the AWL to flash before the shutdown occurs	3–120 sec	20 sec	1 18 08	VEPS, or minidiag2
RSL Engine Protection Shutdown Time	Time for the RSL to flash before the shutdown occurs	3–120 sec	10 sec	1 18 09	VEPS, or minidiag2

Table 5-33 Engine Protection

5.8 ENGINE STARTER CONTROL

MBE engine starters may be enabled by either the ignition-run key switch (KL-50) (see Figure 5-7).

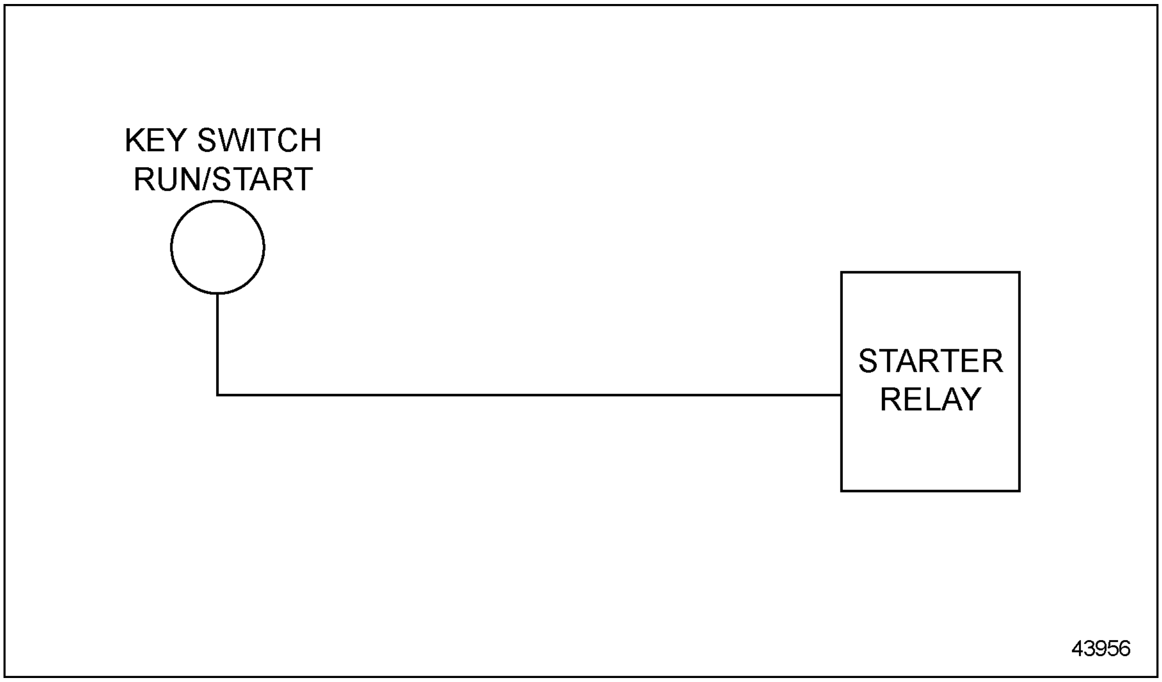

Figure 5-7 Key Switch - Controlled Starter

NOTE:
Direct starter control by the ignition key switch is only configuration used in North America.

5.8.1 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

The Engine Starter Control settings are listed in Table 5-34.

Parameter	Settings	Default	Parameter ID PLD-MR Software 53	Parameter ID PLD-MR Software 56
Starter Type (JE / KB)	0 = Starter activated via PLD-MR 1 = Starter activated via key switch	0	0 06 09	0 01 03

Table 5-34 Engine Starter Control Settings

NOTE:
If the parameter is set for PLD-MR Starter Control and the starter is wired for Key Switch control, the engine will crank but will not start.

5.9 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. MBE Fan Controls are designed to optimally control the engine cooling fan(s) based on engine cooling requirements. Fan Controls are designed to use other system inputs such as A/C pressure switches and operator requested fan operation.

NOTE:
Fan Controls are required for some on-highway truck and on-highway bus applications.

5.9.1 OPERATION

The PLD-MR continuously monitors and compares the coolant, oil, and intake manifold air temperature, engine torque, engine operation mode, and various optional inputs to calibrated levels stored within the PLD-MR. These limits are factory configured based on application.

When these temperature levels exceed the preset fan ON temperature value, the PLD-MR will enable the fan control digital output(s) that activate the fan. The fan will remain on, cooling the engine with the increased air flow until the temperature levels reach the preset fan OFF temperature. At this point, the PLD-MR will open the fan control circuit, which will deactivate the fan, effectively maintaining the coolant or intake manifold air temperature between the two preset levels.

MBE Electronic Controls provides fan control for four different fan configurations:

- Single fan (refer to section 5.9.2, page 5-41)
- Dual fans (refer to section 5.9.3, page 5-42)
- Two-speed fan (refer to section 5.9.4, page 5-44)
- Variable speed single fan (PWM) (refer to section 5.9.5, page 5-47)

NOTE:
The MBE 900 on-highway engine cannot be configured for a two-speed fan due to the PV3/PV4 splice contained in the engine harness.

NOTE:
When the manifold air temperature or coolant temperature reaches the alarm limit, the AWL will illuminate and the fan will be enabled. The PLD-MR fan threshold parameters must be set below the alarm limits to insure the fan is enabled before the alarm level is reached.

5.9.2 SINGLE FAN

The single-fan control uses one digital output to drive a single-speed fan. The digital output is called Fan Control #1. Fan Control #1 is deactivated to turn the fan OFF. The fan remains ON for 30 seconds when turned ON. The fan output will not be enabled until five seconds after the engine has started.

NOTE:
Fan output circuits are designed to sink no more than 2.0 A (DC) current.

Fan Control #1 is enabled (grounded) when at least one of the following conditions occur:

- ☐ Coolant temperature above factory set levels
- ☐ Intake manifold temperature above factory set levels
- ☐ Air conditioner is active (OEM supplied A/C switch is opened) – optional
- ☐ Coolant, or intake manifold air temperature sensor fails
- ☐ Engine Brake is active at high level
- ☐ Fan Control Override Switch is enabled
- ☐ VSG is enabled and active – optional

The digital inputs and outputs for a single fan are listed in Table 5-35.

Fan State	Fan Control Output 1	A/C Input	VSG Active	Override Input	Engine Brake Status	Primary Control
Off	Open	Grounded	Off	Open	Not in High Mode	Intake Manifold or Coolant Temperature
On	Grounded	Grounded	Off	Open	Not in High Mode	Intake Manifold or Coolant Temperature
On	Grounded	Don't Care	Don't Care	Don't Care	Don't Care	Sensor Fault
On	Grounded	Open	Don't Care	Don't Care	Don't Care	A/C Switch
On	Grounded	Don't Care	On	Don't Care	Don't Care	VSG Active
On	Grounded	Don't Care	Don't Care	Grounded	Don't Care	Fan Override Switch
On	Grounded	Don't Care	Don't Care	Don't Care	High Mode	Engine Brake High

Table 5-35 Single Fan Digital Inputs and Outputs

Installation

This section provides a schematic of the specific connection from the ECM to the fan. See Figure 5-8 and Figure 5-9 for the input and outputs used for fan control.

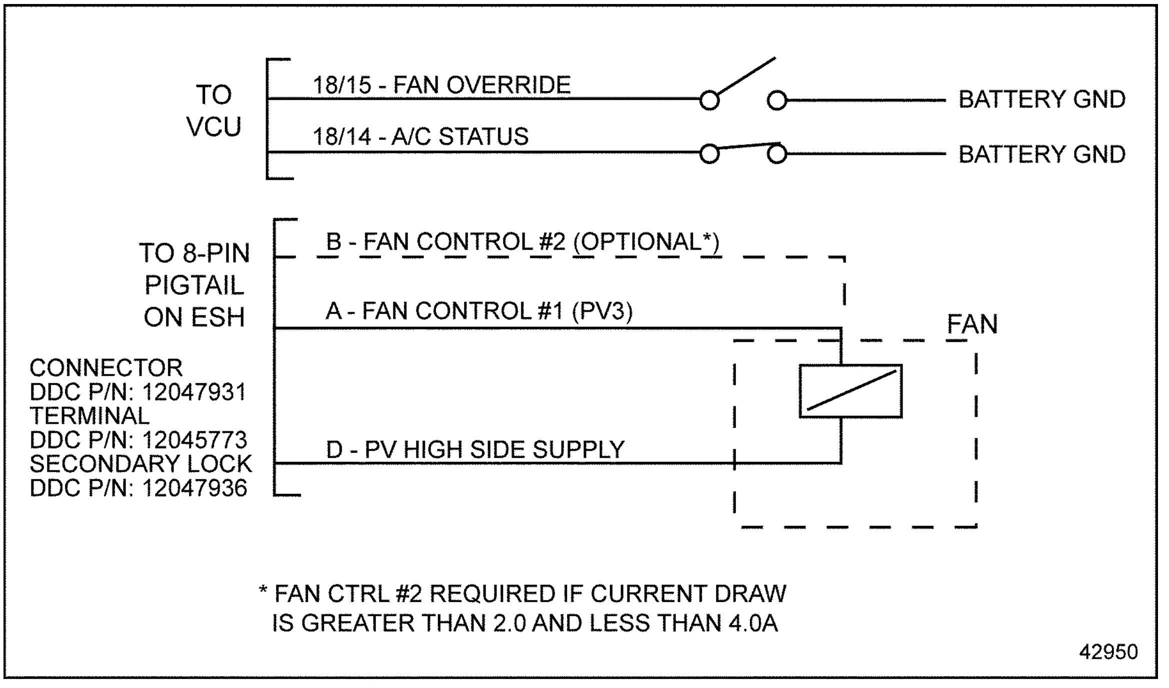

Figure 5-8 Single Speed Fan (Fan Type 4) — MBE 4000

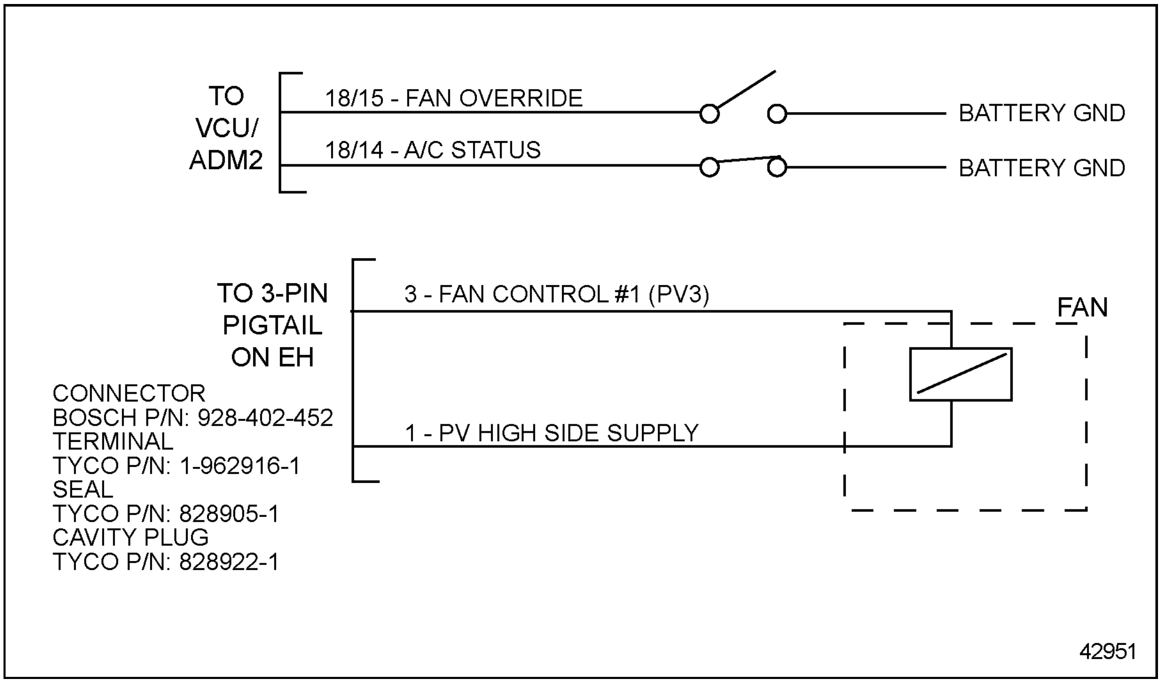

Figure 5-9 Single Speed Fan (Fan Type 4) — MBE 900

Compatible fans may be obtained from several vendors.

5.9.3 DUAL FANS

This configuration uses two digital outputs, Fan Control #1 and Fan Control #2, to drive two separate single-speed fans. Fan Control #1 and Fan Control #2 are opened to turn OFF each fan respectively. The fan remains on for 30 seconds whenever it is turned ON. The fan outputs will not be enabled until five seconds after the engine has started.

NOTE:
Fan output circuits are designed to sink no more than 2.0 A (DC) current.

The two fans are independent of one another and are controlled by different conditions. Both fans will be activated when either the Fan Control Override is enabled or when the conditions are met for Fan Engine Brake.

Fan Control #1 is enabled (grounded) when at least one of the following conditions occur:

- ☐ Intake manifold or coolant temperature above factory set levels
- ☐ Intake manifold or coolant temperature sensor fails
- ☐ Air conditioner is active (OEM supplied A/C switch is opened) – optional
- ☐ Engine Brake level is active at high level
- ☐ Fan control override switch is enabled
- ☐ VSG is enabled and active – optional

Fan control #2 is enabled (grounded) when one of the following conditions occur:

- ☐ Intake manifold or coolant temperature above DDC factory set levels
- ☐ Intake manifold or coolant temperature sensor fails
- ☐ Engine Brake level is active at high level
- ☐ Fan control override switch is enabled
- ☐ VSG is enabled and active – optional

The digital inputs and outputs for dual fans are listed in Table 5-36.

Fan State	Fan Control Output 1	Fan Control Output 2	A/C Input	VSG Status	Override Input	Engine Brake Status	Primary Control
1-On 2-On	Grounded	Grounded	Grounded	Off	Open	Not in High Mode	Engine Temperature Sensors
1-On 2-Off	Grounded	Open	Grounded	Off	Open	Not in High Mode	Engine Temperature Sensors
1-Off 2-On	Open	Grounded	Grounded	Off	Open	Not in High Mode	Engine Temperature Sensors
1-Off 2-Off	Open	Open	Grounded	Off	Open	Not in High Mode	Engine Temperature Sensors
1-On 2-Off	Grounded	Open	Grounded	Off	Open	Not in High Mode	Sensor Fault Low
1-On 2-On	Grounded	Grounded	Don't Care	Don't Care	Don't Care	Don't Care	Sensor Fault High
1-On 2-On	Grounded	Grounded	Open	Don't Care	Don't Care	Don't Care	A/C Switch
1-On 2-On	Grounded	Grounded	Don't Care	Don't Care	Open	Don't Care	Fan Override Switch
1-On 2-On	Grounded	Grounded	Don't Care	Don't Care	Don't Care	High Mode	Engine Brake
1-On 2-On	Grounded	Grounded	Don't Care	Active	Don't Care	Don't Care	VSG Status

Table 5-36 Dual Fans Digital Inputs and Outputs

Installation - Dual Fans

See Figure 5-10 for fan installation for an MBE 4000 engine.

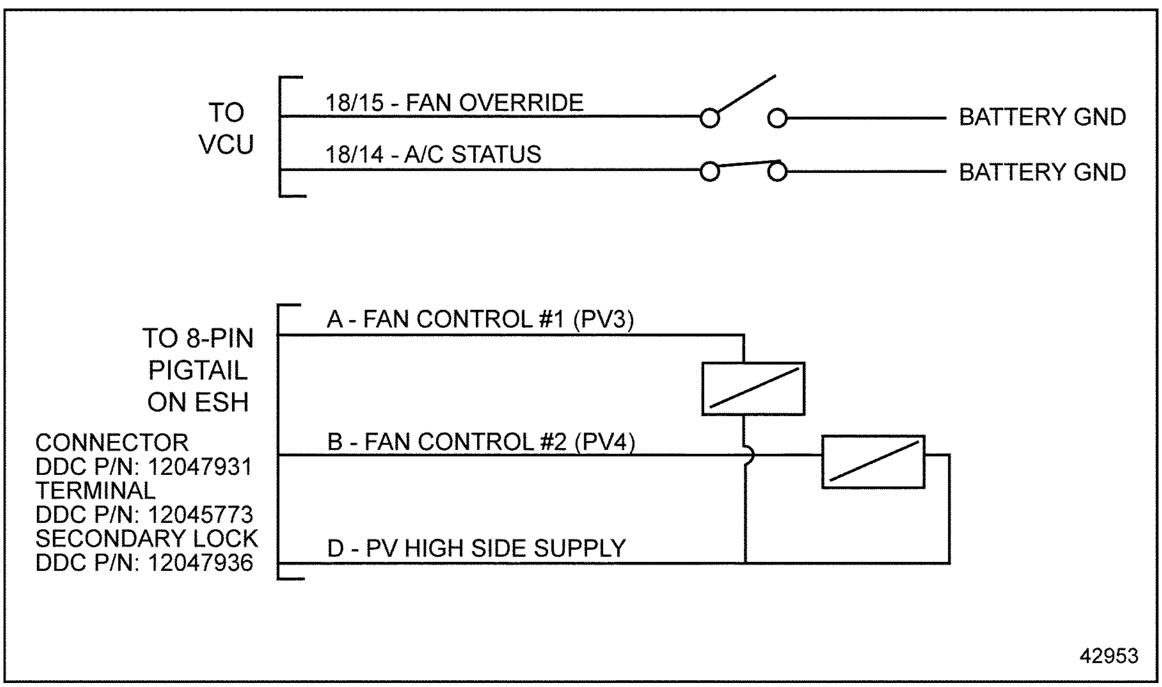

Figure 5-10 Dual Fan (Fan Type 6) – MBE 4000 Only

5.9.4 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 grounded, the fan operates in low-speed mode. When Fan Control #1 and Fan Control #2 are both grounded, the fan operates in high-speed mode.

NOTE:
Fan output circuits are designed to sink no more than 2.0 A (DC) current.

Fan Control #1 is enabled (grounded) when at least one of the following conditions occur:

- ☐ Coolant temperature above factory set levels
- ☐ Intake manifold air temperature above factory set levels

Fan control #2 is enabled (grounded) when one of the following conditions occur:

- ☐ Coolant temperature above factory set levels
- ☐ Intake manifold air temperature above factory set levels
- ☐ Coolant, or intake manifold air temperature sensor fails
- ☐ Air conditioner is active (OEM supplied A/C switch is opened) – optional
- ☐ Engine Brake level is active at high level
- ☐ Fan control override switch is enabled
- ☐ VSG enabled and active – optional

The digital inputs and outputs for a two-speed fan are listed in Table 5-37.

Fan State	Fan Control Output 1	Fan Control Output 2	A/C Input	VSG Status	Override Input	Engine Brake Status	Primary Control
Off	Open	Open	Grounded	Off	Open	Not in High Mode	Engine Temperature Sensors
Low	Grounded	Open	Grounded	Off	Open	Not in High Mode	Engine Temperature Sensors
High	Grounded	Grounded	Grounded	Off	Open	Not in High Mode	Engine Temperature Sensors
Low	Grounded	Open	Grounded	Off	Open	Not in High Mode	Sensor Fault Low
High	Grounded	Grounded	Don't Care	Don't Care	Don't Care	Don't Care	Sensor Fault High
High	Grounded	Grounded	Open	Don't Care	Don't Care	Don't Care	A/C Switch
High	Grounded	Grounded	Don't Care	Don't Care	Open	Don't Care	Fan Override Switch
High	Grounded	Grounded	Don't Care	Don't Care	Don't Care	High Mode	Engine Brake
High	Grounded	Grounded	Don't Care	Active	Don't Care	Don't Care	VSG Status

Table 5-37 Two-speed Fan Digital Inputs and Outputs

Installation -Two-speed Fans

See Figure 5-11 for two-speed fan installation.

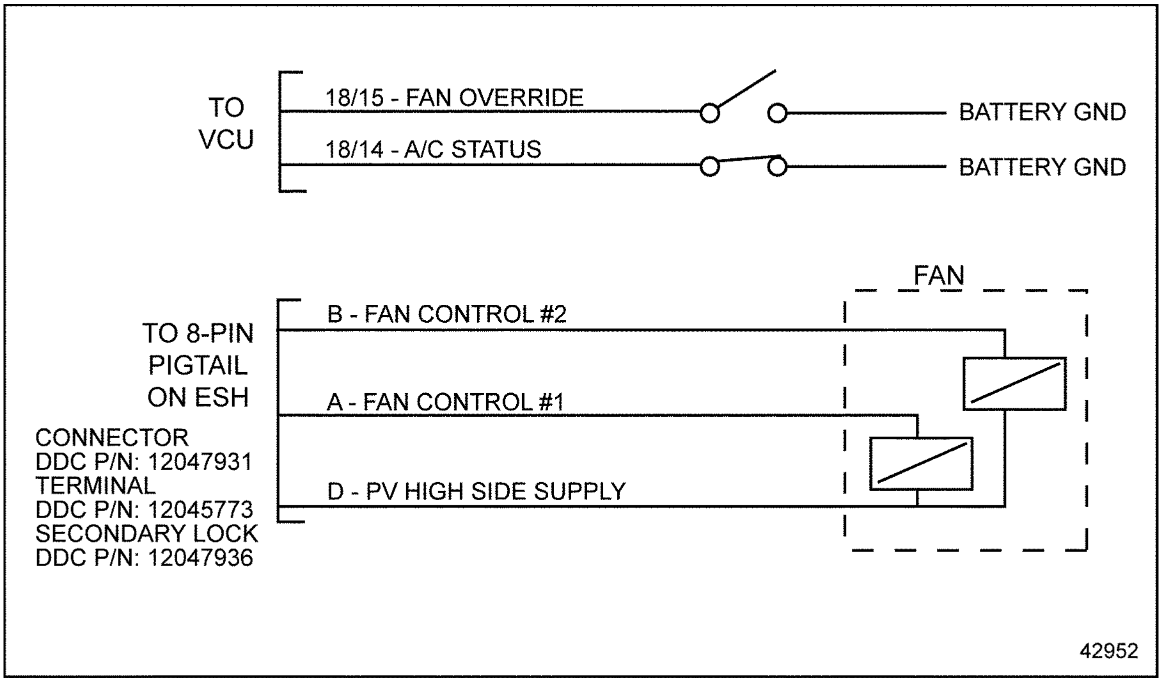

Figure 5-11 Two-speed Fan (Fan Type 0 or 1) — MBE 4000

5.9.5 VARIABLE SPEED SINGLE-FAN

MBE Electronic Controls uses a pulse width modulated (PWM) output to drive a variable speed fan.

The fan may be enabled by specific engine temperature sensors and various other inputs. The fan will ramp up to the requested speed in order to reduce noise, shock-loading, and belt slippage. If the fan is turned on for any reason other than high temperature, it will ramp up to the full fan speed (i.e. 5% or 10% duty cycle, application dependent). 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.

NOTE:
Fan output circuits are designed to sink no more than 2.0 A (DC) current.

The PWM output is initiated when at least one of the following conditions occur:

- ☐ Intake manifold or coolant temperatures above factory set limits
- ☐ Air conditioner is active (OEM supplied A/C switch is opened) – optional
- ☐ Intake manifold or coolant temperature sensor fails
- ☐ Fan Control Override Switch is enabled
- ☐ VSG is enabled and active – optional

The digital inputs and outputs for PWM fan control are listed in Table 5-38.

Fan State	PWM Output	A/C Input	VSG Status	Override Input	Engine Brake Status	Primary Control
Off	Open >31% Duty Cycle	Grounded	Off	Open	Not in High Mode	Engine Temperature Sensors
On	Modulated	Grounded	Off	Open	Not in High Mode	Engine Temperature Sensors
On	Modulated	Grounded	Off	Open	Not in High Mode	Sensor Fault
Max Speed	Grounded <6% Duty Cycle	Grounded	Off	Open	Not in High Mode	Sensor Fault
Max Speed	Grounded <6% Duty Cycle	Open	Don't Care	Don't Care	Don't Care	A/C Switch
Max Speed	Grounded <6% Duty Cycle	Don't Care	Don't Care	Open	Don't Care	Fan Override Switch
Max Speed	Grounded <6% Duty Cycle	Don't Care	Don't Care	Don't Care	High Mode	Engine Brake
Max Speed	Grounded <6% Duty Cycle	Don't Care	Active	Don't Care	Don't Care	VSG Status

Table 5-38 PWM Fan Control Digital Inputs and Outputs

Installation

See Figure 5-12 and Figure 5-13 for variable-speed fan installation.

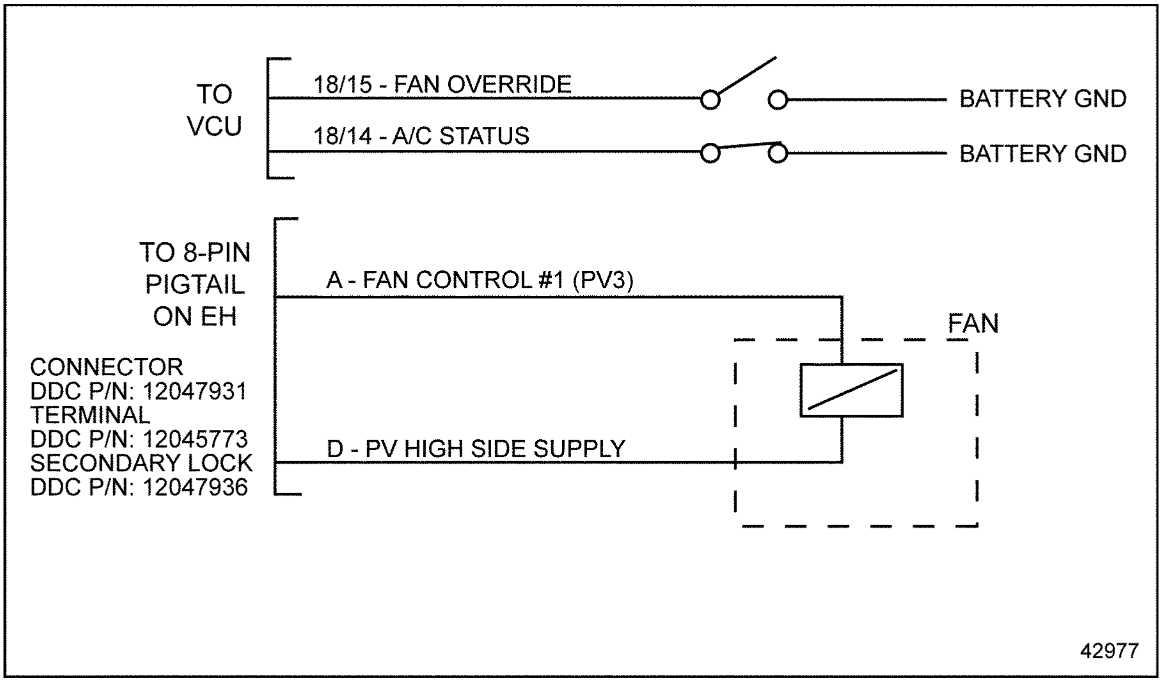

Figure 5-12 Variable Speed Fan (Fan Type 5) – MBE 4000

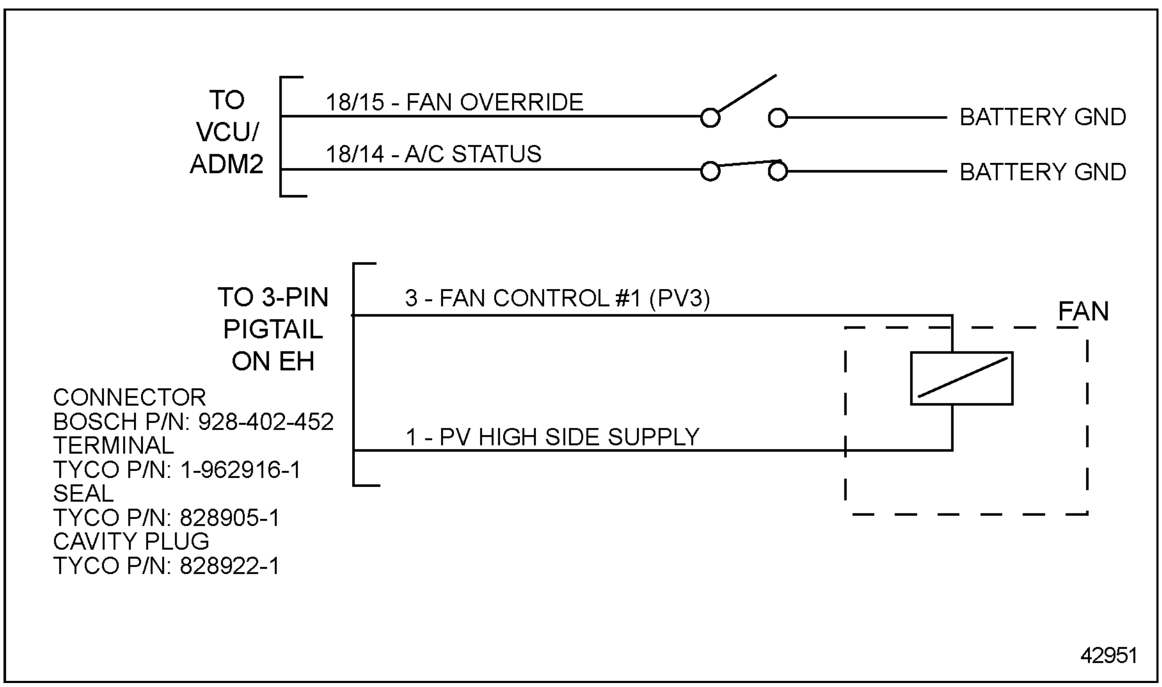

Figure 5-13 Variable Speed Fan (Fan Type 5) – MBE 900

5.9.6 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

The VCU fan control parameters are listed in Table 5-39 are set by VEPS or minidiag2.

Parameter	Description	Choice/Range	Default	Parameter ID
Fan Activation on Engine Brake	Enables/Disables fan activation when engine brakes are on high.	0 = Disable 1 = Enable	0 = Disable	1 19 01
Fan Activation on VSG	Enables/Disables fan activation when VSG is active	0 = Disable 1 = Enable	0 = Disable	1 19 05
Fan Activation on A/C Status	Enables/Disables fan activation when the air conditioning is on.	0 = Disable 1 = Enable	0 = Disable	1 19 03

Table 5-39 Fan Control Parameters

For PLD-MR software 53 (Diagnostic Version 5), the parameters listed in Table 5-40 for Fan Control must be set in the PLD-MR and the configuration parameters listed in Table 5-39 must be set in the VCU with VEPS or the minidiag2.

Parameter	Description	Choice/Range	Default	Parameter ID
Fan Control	Enables Fan Control	0 = Linnig Clutch – Two Speed (on-highway) 1 = Linnig Clutch – Two Speed (off-highway) 2 = Electronically Controlled Viscous Fan – Variable Speed w/ Fan Speed Sensor 3 = Hydrostatic Fan – Variable Speed 4 = Horton Clutch – Single Speed (Hydrostatic) 5 = Hydrostatic Fan – Variable Speed 6 = Hydrostatic Fan – Dual Fans		0 28 02
PV3 Enable	Enable/Disable Output 3	0 = Disable 1 = Enable	0	0 06 03
PV4 Enable	Enable/Disable Output 4	0 = Disable 1 = Enable	0	0 06 04
Fan, Step 1 Coolant Temp	Fan Coolant Temp Threshold for 1 or 2–speed Fan	Degrees C	96°C	0 36 01
Fan, Step 2 Coolant Temp	Fan Coolant Temp Threshold for 1 or 2–speed Fan*	Degrees C	96°C	0 38 01
Fan, Step 1 Manifold Air Temp	Fan Manifold Threshold for 1 or 2–speed Fan	Degrees C	150°C	0 37 01
Fan, Step 2 Manifold Air Temp	Fan Manifold Threshold for 1 or 2–speed Fan†	Degrees C	150°C	0 39 01

* For 1–speed installation this parameter should be set to the value in 0 36 01
† For 1–speed installation this parameter should be set to the value in 0 37 01

Table 5-40 Fan Control Software 53 (Diagnostic Version 5) Fan Control Parameters

For PLD-MR software 56 (Diagnostic Version 6), the parameters listed in Table 5-41 for Fan Control must be set in the PLD-MR and the configuration parameters listed in Table 5-39 must be set in the VCU.

Parameter	Description	Choice/Range	Default	Parameter ID
Fan Control	Enables Fan Control	0 = Linnig Clutch – Two Speed (on-highway) 1 = Linnig Clutch – Two Speed (off-highway) 2 = Electronically Controlled Viscous Fan – Variable Speed w/ Fan Speed Sensor 3 = Hydrostatic Fan – Variable Speed 4 = Horton Clutch – Single Speed (Hydrostatic) 5 = Hydrostatic Fan – Variable Speed 6 = Hydrostatic Fan – Dual Fans		0 04 01
PV3 Enable	Enable/Disable Output 3	0 = Disable 1 = Enable	0	0 03 03
PV4 Enable	Enable/Disable Output 4	0 = Disable 1 = Enable	0	0 03 04
Switch on Threshold on Coolant Temp Speed 1	Fan Coolant Temp Threshold for 1 or 2–speed Fan	Degrees C	96°C	0 04 02
Switch on Threshold on Coolant Temp Speed 2	Fan Coolant Temp Threshold for 1 or 2–speed Fan	Degrees C	96°C	0 04 04
Switch on Threshold on Air Intake t Temp Speed 1	Fan Air Intake Temp Threshold for 1 or 2–speed Fan	Degrees C	150°C	0 04 03
Switch on Threshold on Air Intake t Temp Speed 2	Fan Air Intake Temp Threshold for 1 or 2–speed Fan	Degrees C	150°C	0 04 05

Table 5-41 PDL-MR Software 56 (Diagnostic Version 6) Fan Control Parameters

5.10 IDLE SHUTDOWN TIMER AND VSG SHUTDOWN

The Idle Shutdown Timer will shutdown the engine if it remains idling for a specified period of time. The options that can operate with Idle Shutdown Timer are Idle Shutdown Override, Vehicle Power Shutdown or Shutdown on Variable Speed Governor (VSG).

5.10.1 OPERATION

Certain conditions must be met for the entire time-out period for shutdown to occur. These conditions include:

- ☐ Coolant temperature above 14°F (–10°C)
- ☐ Engine operation at idle
- ☐ The parking brake interlock digital input switched to battery ground (if configured)
- ☐ 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 AWL will flash 20 seconds before the shutdown occurs. The RSL will flash 10 seconds before shutdown occurs. The AWL will blink until the ignition is turned off to indicate shutdown has occurred. The ignition switch must be cycled to OFF (wait 10 seconds) and back to ON before the engine will restart, if shutdown occurs.

Idle Shutdown and VSG Shutdown may be configured to either:

- ☐ Require the park brake to be on to activate the timer
- ☐ Activate the timer regardless of park brake state and reset if the accelerator pedal is above idle
- ☐ Activate the timer regardless of park brake state and reset only if there is a change in the accelerator pedal

A Park Brake Switch may be installed (see Figure 5-14). Idle Shutdown Timer operates with a digital input configured as a park brake and switched to battery ground. The time can range from 1 to 5000 seconds (approximately 1hr and 38 minutes).

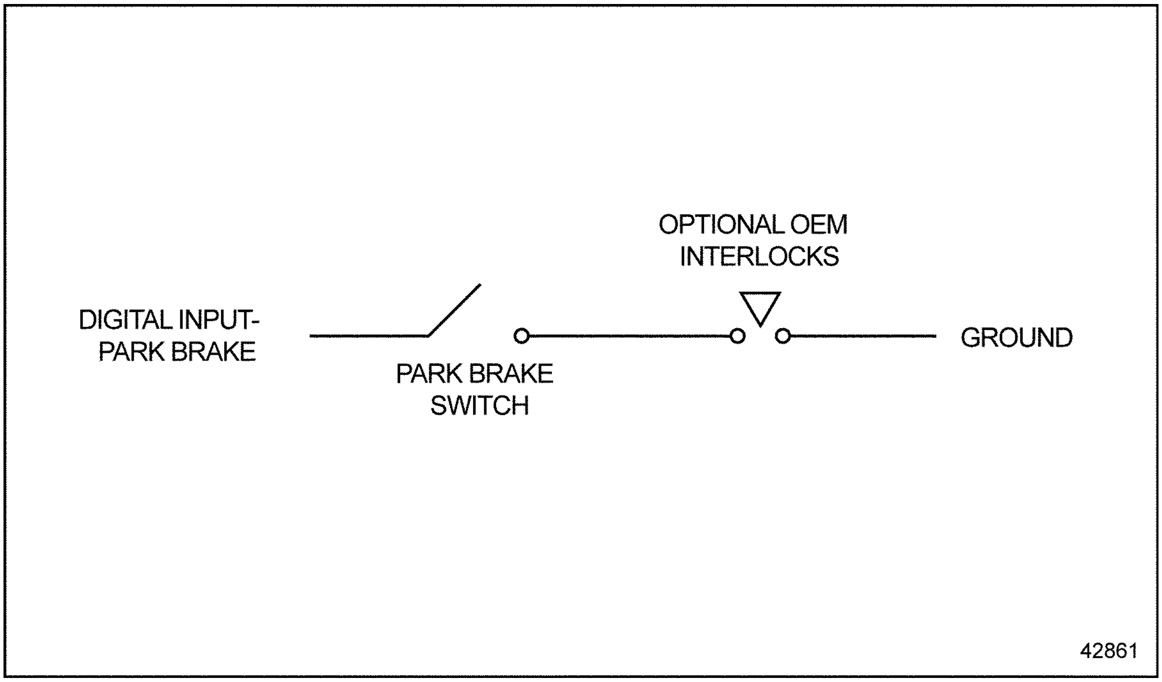

Figure 5-14 Park Brake Digital Input

Idle Shutdown Override - Optional

Idle Shutdown Override allows the operator to override the idle shutdown to keep the engine idling if this feature is enabled.

The timer can be reset by one of the following configurable conditions:

- ☐ Engine Shutdown override button has been pressed
- ☐ Clutch pedal has been pressed
- ☐ Service brake has been pressed
- ☐ Accelerator has been pressed above the idle position or has been fully pressed and released
- ☐ Park Brake has been released

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 5-15). The engine will shutdown after the specified idle time and will reset the relay (ignition circuit).

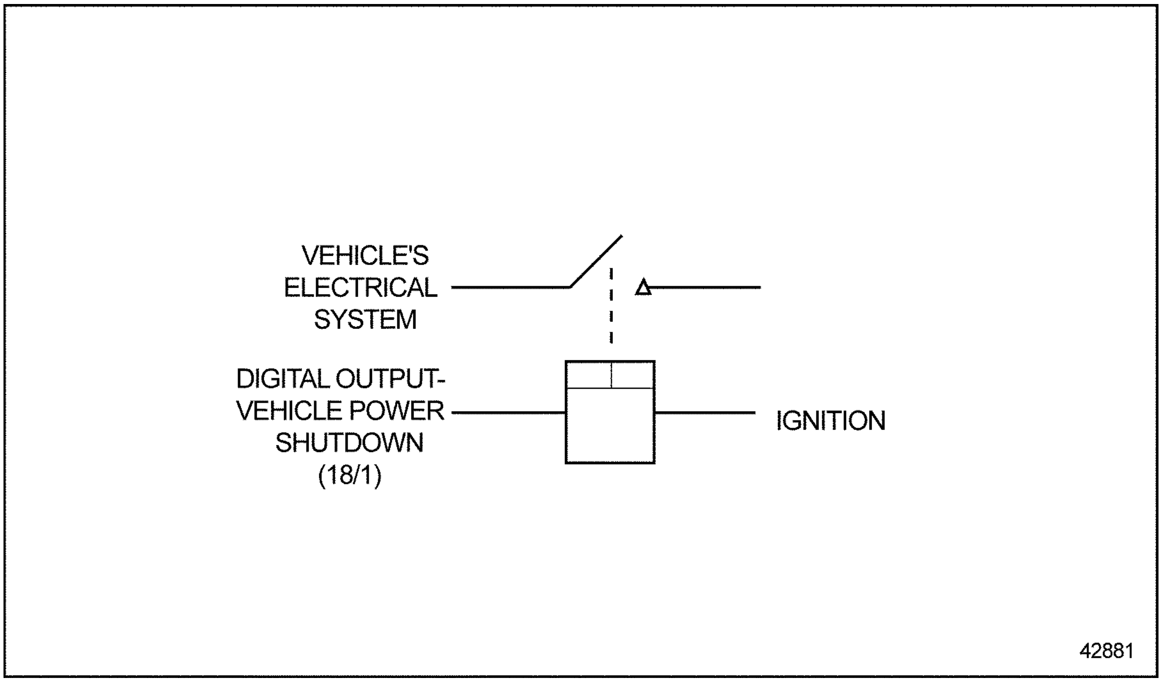

Figure 5-15 Vehicle Power Shutdown Relay

All electrical loads that should be turned OFF when the engine shuts down should be wired through this relay.

Shutdown on VSG - Optional

This option, when enabled, allows the engine to be shutdown when operating on VSG when the conditions are met for the Idle Timer Shutdown.

Maximum Engine Load Shutdown — Optional

This option, when enabled, allows the setting of a maximum load above which idle shutdown is disabled.

5.10.2 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

To program the Idle Shutdown timer, the digital inputs listed in Table 5-42 must be configured.

Description	Pin	Type	Setting	Default	Parameter ID
Park Brake	21/16	Digital Input	0 = Disabled 1 = Enabled	0	1 13 08
Park Brake Input Configuration	—	Digital Input	0 – Hardwired 1 – Source Address 1 (SA1) 2 – Source Address 2 (SA2) 3 – Source Address 3 (SA3)	0	1 13 09

Table 5-42 Idle Shutdown Timer Digital Input

The Idle Shutdown timer options listed in Table 5-43 can be programmed by VEPS or minidiag2.

Parameter	Description	Choice / Range	Default	Parameter ID	Access
IDLE SHUTDOWN ENABLE	Enables or Disables the Idle Shutdown feature.	0 = Disable 1 = Enable with Park Brake 2 = Enable without Park Brake, Reset for Accelerator Position > Idle 3 = Enable without Park Brake, Reset for Change in Accelerator Pedal Position	0	1 17 01	Nexiq DDR, DDDL, VEPS, minidiag2
IDLE SHUTDOWN TIME (MIN)	The amount of engine idle time that is allowed before the Idle Shutdown feature stops fueling the engine.	1 to 5000 seconds	60 sec	1 17 02	Nexiq DDR, DDDL, VEPS, minidiag2
VSG SHUTDOWN ENABLE	Enables or disables the Idle Timer Shutdown feature when operating on the Variable Speed Governor.	0 = Disable 1 = Enable with Park Brake 2 = Enable without Park Brake, Reset for Accelerator Position > Idle 3 = Enable without Park Brake, Reset for Change in Accelerator Pedal Position	0	1 17 03	Nexiq DDR, DDDL, VEPS, minidiag2
VSG SHUTDOWN TIME	The amount of engine idle time that is allowed before the idle shutdown feature stops fueling the engine.	1 to 5000 seconds	60 sec	1 17 04	Nexiq DDR, DDDL, VEPS, minidiag2
MIN COOLANT TEMP FOR SHUTDOWN	Minimum coolant temperature before an idle shutdown will occur	-40°C to 200°C	-10°C	1 17 08	VEPS, minidiag2
ENABLE IDLE/VSG SHUTDOWN OVERRIDE	Enables/disables override of Idle or VSG Shutdown	0 = Disable 1 = Enable	1	1 17 09	Nexiq DDR, DDDL, VEPS, minidiag2
MAX ENGINE LOAD FOR VSG SHUTDOWN	VSG shutdown disabled for engine loads greater than this value	0–5000 Nm	100	1 17 05	VEPS, minidiag2

Table 5-43 Idle Shutdown Timer Programming Options

5.11 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 particular gear's peak torque rating.

5.11.1 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 low gear torque rating.

For example, the customer wants to hold the torque to 550 ft lbs (on an engine rated at 860 ft lbs) up to 8th gear. The transmission operates with the ratios listed in Table 5-44.

Gear	Ratio	Low Gear Threshold* VCU – Output/Input Shaft Speed
5	3.57	0.280
	Desired Gear Down Protection Ratio	Gear Down Protection Ratio Parameter
6	2.79	0.358
7	2.14	0.467
	Desired High Gear Power Ratio	High Gear Power Ratio Parameter
8	1.65	0.606
9	1.27	0.787
10	1.00	1.0

*The low gear threshold is determined by taking the inverse of the gear ratios and choosing a value in between the gears you want to limit.

Table 5-44 Transmission Ratios

Under Low Gear Torque Limit, set the "torque factor" to the value found by dividing the desired torque by the rated torque and the "threshold" to the value between the gear you want to limit and the previous gear's ratio. The ratio = output shaft rpm/input shaft rpm.

Gear Down Protection will limit torque in the lowest gears. High Gear Power will limit torque in the intermediate gears.

To summarize, the customer wants to limit torque up to the 8th gear to 550 ft·lb. Estimate the ratio between 7th and 8th (0.5). From 8th gear on up, the full rated torque will be available.

5.11.2 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

A VSS or output shaft speed message over SAE J1939 is required (refer to section 3.7.5, "Vehicle Speed Sensor"). VEPS or minidiag2 can enable the parameters listed in Table 5-45.

Parameter	Description	Range	Default	Parameter ID
Torque Factor* Gear Down Protection	Provides a limit on the available torque if the ratio of vehicle speed to engine speed is below a set point.	0.00 to 1.00	1.00	1 23 01
Gear Ratio for Gear Down Protection	The gear ratio below which torque is limited. (output shaft rpm/input shaft rpm)	0.000 to 2.00	0.01	1 23 02
Torque Factor* High Gear Power	Provides a limit on the available torque if the ratio of vehicle speed to engine speed is below a set point.	0.000 to 1.00	1.00	1 23 03
Gear Ratio for High Gear Power	The gear ratio below which torque is limited. (output shaft rpm/input shaft rpm)	0.00 to 2.00	0.02	1 23 04

* % of maximum torque at the current engine speed

Table 5-45 Low Gear Torque Limiting Parameters

5.12 PASSWORDS

MBE Electronic Controls contains a single password (Password #1) that protects the changing of all parameters. When a VCU is locked, a service tool may read parameters, read actual values (measurements), and read/clear fault codes.

5.12.1 OPERATION

The Password is a numeric value from 1 to 99999999 and is selected when the protection is activated with a Service Tool. A Password of zero is used to deactivate the protection. A Password may be activated with DDDL, VEPS or minidiag2. Once activated, the parameters may not be changed until the correct Password is reentered. When the correct Password is entered, all parameters with write access by the Service tool may be changed. In addition, the Password itself may be changed. The VCU is automatically locked at the next ignition cycle. Changing the Password to a value of “0” will disable Password protection.

Back Door Password

In cases where the Password for a locked module is not available, a separate “back door” Password may be obtained from Detroit Diesel Technical Service. Detroit Diesel requires the “A” and “B” values read from the locked module with the Service Tool. The new unlock code will be provided by Detroit Diesel Technical Service for entry into the Service Tool. When the correct Back Door Password is entered, all parameters with write access by the Service tool may be changed.

Changing the Password

The Password itself may be changed. The VCU is automatically locked at the next ignition cycle. Changing the Password to a value of “0” will disable Password protection. When the Password is changed, the ignition must be off for at least 15 seconds.

5.13 PROGRESSIVE SHIFT

The Progressive Shift option offers a high range maximum vehicle speed limit to encourage the use of high (top) gear during cruise operation. Progressive Shift encourages the driver to upshift from a lower to a higher gear prior to reaching the engine's governed speed. The resulting lower engine speed in high range should result in improved fuel economy. Progressive shifting techniques should be practiced by every driver, but can be forced if fleet management considers it necessary. The benefits from progressive shifting are best realized during stop-and-go driving cycles.

The maximum engine speed will be limited below the programmed MPH to encourage up shifting.

- Progressive Shift should be used in applications where the reduced driveability will not impede trip times or productivity.
- Progressive Shift is not compatible with most automatic transmissions.

5.13.1 OPERATION

The Progressive Shift option has a gear ratio threshold that can be set and engine speed limit parameters, which are programmable with minidiag2. The example shift pattern chart (see Figure 5-16) reflects default values when the Progressive Shift option is chosen and the gear threshold and engine speed limit parameters are modified to a typical value.

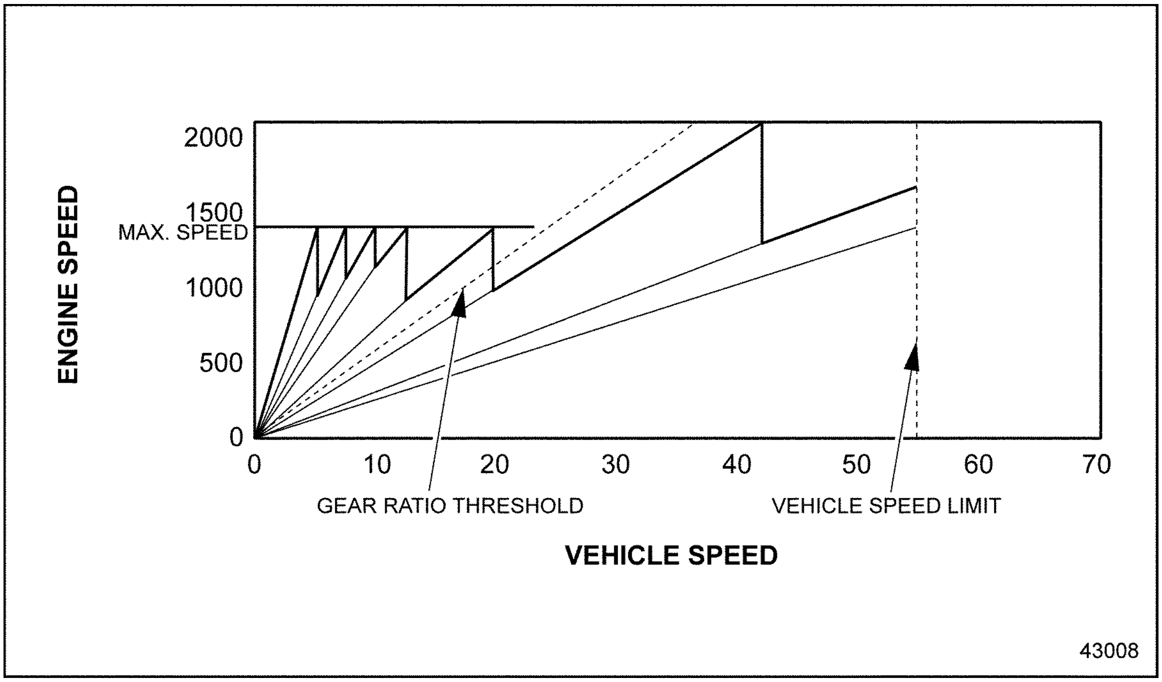

Figure 5-16 Progressive Shift Chart - Represents Default

An alternate use for the Progressive Shift option would be to encourage a driver into top gear. Normally this condition exists when the gearing selected at the time of order allows a vehicle speed limit to be reached in a gear lower than top gear.

5.13.2 GEAR RATIO THRESHOLD

The low range threshold of operation is defined by a Gear Ratio (VCU parameter ID 1:23:07). The maximum engine speed will be limited to a maximum progressive shifting engine speed (VCU parameter ID 1:23:06) when the transmission is a ratio less than the Gear Ratio. The engine will be allowed to run up to maximum rated engine speed when the transmission is in a ratio greater or equal to the Gear Ratio.

The Gear Ratio for progressive shifting may be calculated as follows:

Gear Ratio = Transmission Output Shaft Speed (rpm)/Engine Speed (rpm)

The ratio should be selected to be the lowest gear in which full engine speed is desired. The calculated number for calibration should be decreased by 10% to prevent engine limitation cycling due to changing conditions.

5.13.3 INSTALLATION INFORMATION

A Vehicle Speed Sensor (VSS) must be installed. It must be enabled, and all proper calculations entered into the VCU with VEPS or the minidiag2. Refer to section 3.7.5, "Vehicle Speed Sensor," for additional information.

5.13.4 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

Progressive Shift parameters that can be set by the Nexiq DDR, DDDL, VEPS or minidiag2 are listed in Table 5-46.

Parameter	Description	Default	Range	Sample Values	Parameter ID
Gear Ratio for Progressive Shifting	Gear ratio for which engine speed is limited when transmission gear is below this ratio	0.015	0.000 - 2.000	0.5	1 23 07
Max Engine Speed for Progressive Shifting	Maximum engine speed (rpm) when driving in lower gear	3000 rpm	500 – 3000 rpm	1600	1 23 06

Table 5-46 Progressive Shift Programming

5.14 STARTER LOCKOUT

The starter lockout function protects the starter motor from over-speed damage, e.g. reengaging the starter motor while the engine is running.

5.14.1 OPERATION

The starter lockout output circuit drives a normally closed relay, which interrupts the starting signal when the output has been activated.

If enabled, the starter lockout output will be activated when the engine speed exceeds the minimum speed for the starting motor for a maximum amount of time. To ensure that the engine would start even under worst conditions, the over-speed time condition will be added to the engine speed condition before the starter is locked out. Both values, maximum speed and minimum over-speed time, are dependent on the coolant temperature. The output is disabled when the ignition switch has been cycled to off or the engine is not running, i.e. the engine speed has a value of zero.

The cranking time is limited to a programmed value to keep the starting motor from over crank damage. The starter lockout relay will be activated when cranking time exceeds this lockout limit.

Since the starter signal is not available, the engine speed will be monitored to detect when the engine is cranking. When the starter engages, engine speed rises from zero to starter cranking speed. After this has been detected, engine speed will not be below the programmed speed for over-crank detection for the programmed maximum starter crank time.

If the driver is still turning the start key and the engine doesn't start while the maximum crank time expires, the starter lockout relay will be activated to shut off the starting engine. In this instance, the starter lockout relay will remain activated until the programmed lockout time expires and the engine has stopped. This allows the starting motor to cool down before the driver is permitted to start the engine again.

5.14.2 INSTALLATION

The starter lockout output circuit drives a normally closed relay, which interrupts the starting signal when the output has been activated. See Figure 5-17.

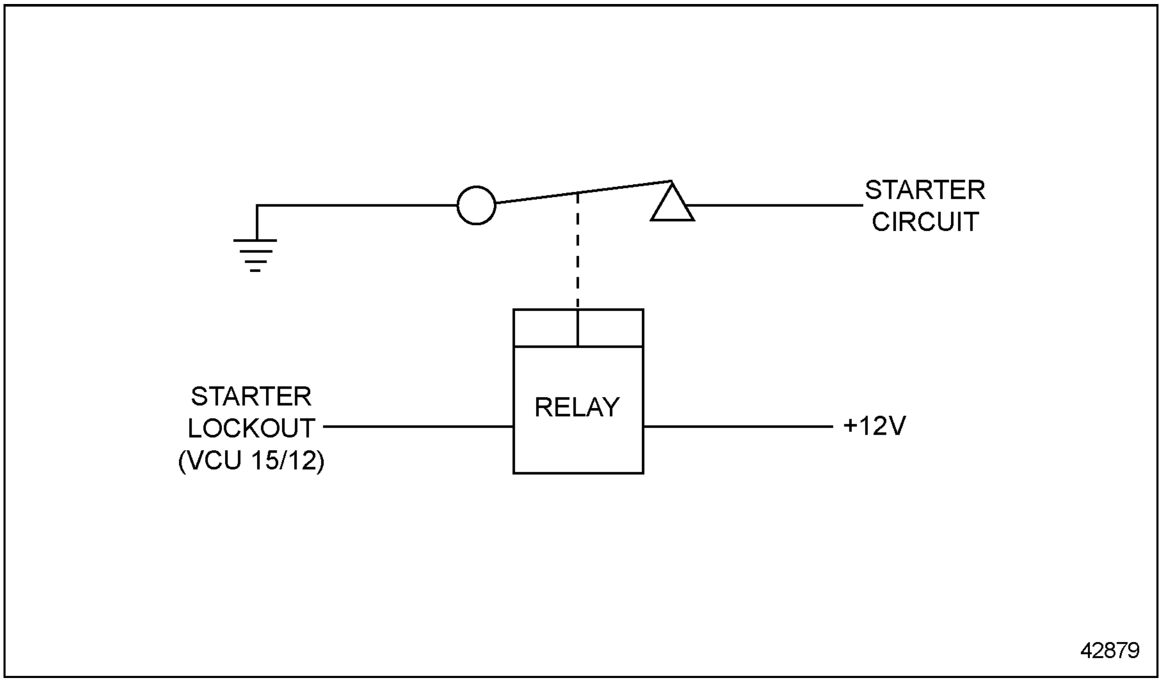

Figure 5-17 Starter Lockout

5.14.3 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

The starter lockout may be enabled or disabled as listed in Table 5-47 with minidiag2.

Parameter	Description	Range	Default	Parameter ID
Enable Starter Lockout	Enables/Disables the Starter Lockout function	0 = Disable 1 = Enable	0	1 16 01

Table 5-47 Starter Lockout

5.15 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 5.15.1)
- ☐ The Variable Speed Governor (VSG) for speed control, typical governor for off-highway applications (refer to section 5.15.2)

5.15.1 AUTOMOTIVE LIMITING SPEED GOVERNOR - ON-HIGHWAY

In on-highway applications and some nonroad 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.

ALSG Accelerator Pedal

The accelerator pedal (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

MBE Electronic Controls are compatible with an AP which has an output voltage that meets SAE J1843 and has less than 5% of voltage supply closed throttle variability.

The AP is an OEM supplied part. Vendor sources that may be contacted for additional design and installation details.

NOTE:
An Idle Validation Switch is required.

Williams Controls
14100 S.W. 72nd Avenue
Portland, Oregon 97224
Phone: (503) 684-8600
www.williamscontrols.com

See Figure 5-18 for installation requirements.

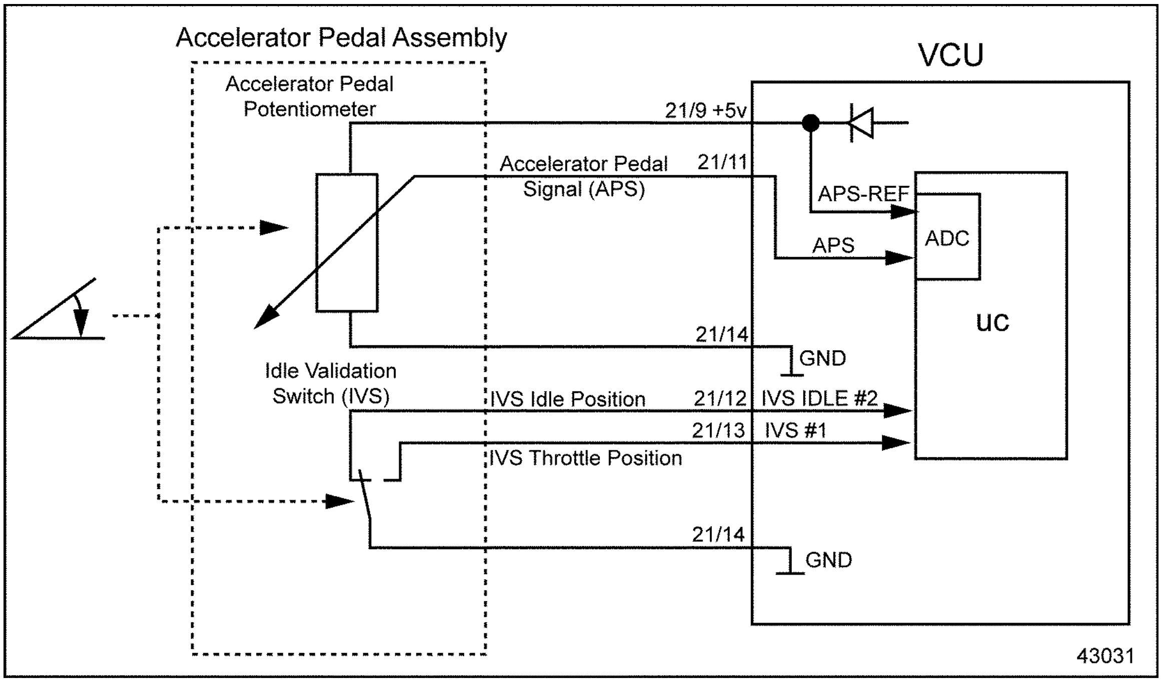

Figure 5-18 Accelerator Pedal Installation

An Idle Validation Switch is required and uses two digital inputs. Refer to section 4.2, "Digital Inputs," for additional information.

ALSG Electronic Foot Pedal Assembly Diagnostics

An Idle Validation Switch inputs provide redundancy to assure that the engine will be at idle in the event of an AP in-range malfunction. The Idle Validation Switch is connected to two digital inputs on the VCU. When the Idle Validation Switch on the AP is switched to battery ground, the engine speed will be at idle.

5.15.2 VARIABLE SPEED GOVERNOR

VSG control is available to fuel the engine in order to keep the selected VSG speed regardless of engine torque without driver interaction. The engine torque cannot exceed a programmed limit. Upon startup the engine will go to the speed selected by the VSG throttle position.

The VSG throttle control options are:

- ☐ Cab VSG – Cruise Switch VSG
- ☐ Remote VSG
- ☐ Analog VSG

NOTE:
Software version Rel. 12.0 or later, the park brake function could be enabled/disabled and the logic for the park brake may be inverted.

See Figure 5-19 for a diagram of VSG logic.

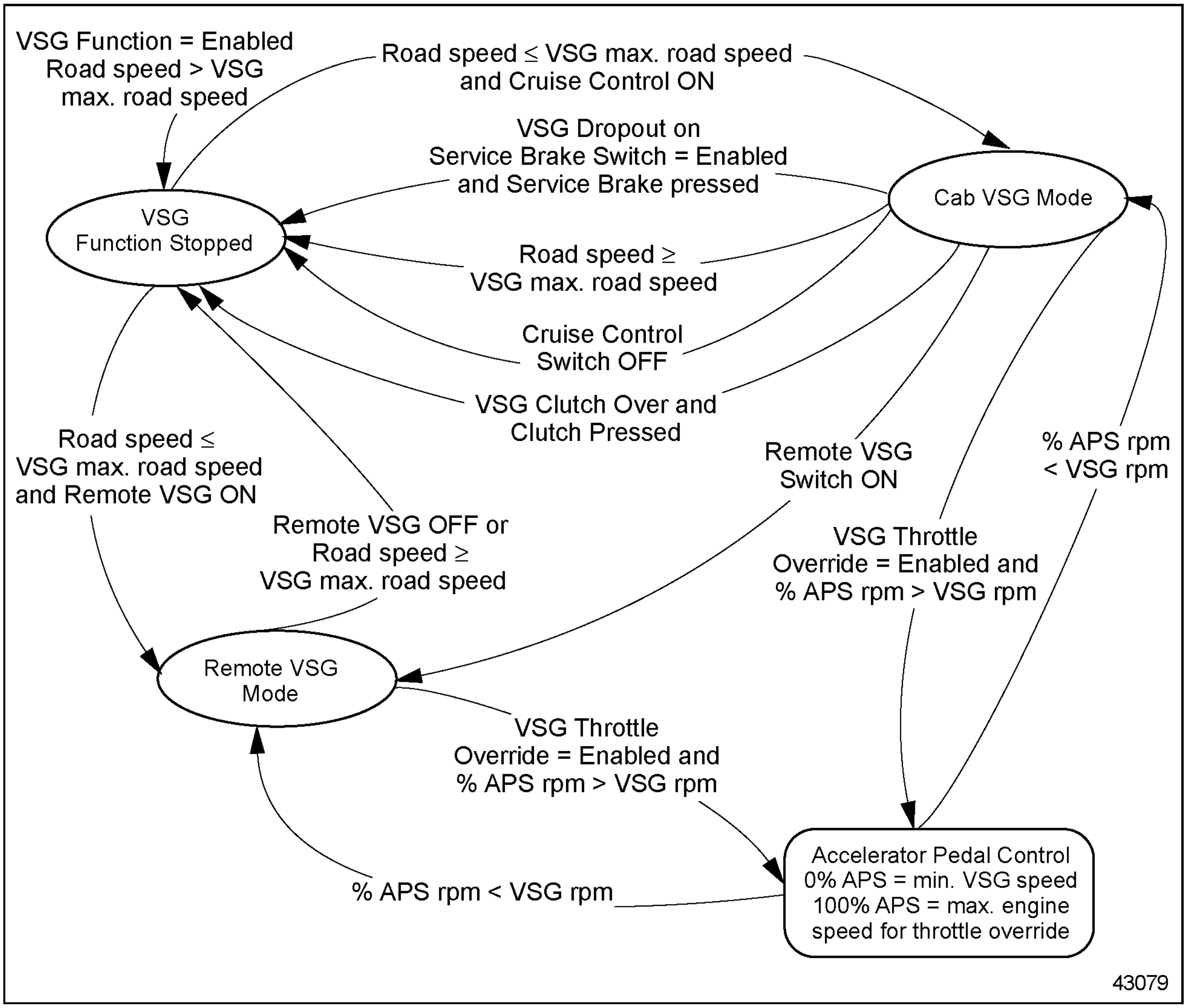

Figure 5-19 VSG Logic

Cab VSG – Cruise Switch VSG

The Cruise Control switches are used to activate and control the Cruise Switch VSG (Cab VSG) option.

NOTE:
Cab throttle and remote throttle can be overridden with the accelerator pedal unless “VSG Throttle Override” is disabled.

The Cruise On/Off switch must be turned ON and the park brake must be engaged (if configured). 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 Resume VSG Speed. Pressing and releasing the Set/Coast Switch will activate Cruise Switch VSG at the Set VSG Speed. The Resume VSG Speed and the Set VSG Speed can be programmed with the VEPS or minidiag2 and cannot be greater than the VSG maximum speed or lower than the VSG minimum speed.

Once the VSG set speed is established, the Resume/Accel Switch can be used to increment the set speed at a rate of 200 rpm/sec (programmable). Releasing the Resume/Accel Switch will set the engine speed at the current operating speed.

The Set/Coast Switch will decrement the set speed at a rate of 200 rpm/sec (programmable), down to the minimum VSG speed. Releasing the Set/Coast Switch will set the engine speed at the current operating speed.

Remote VSG speed is disabled for any of the following:

- ☐ Turning the Cruise Master Switch off
- ☐ Vehicle speed is greater than Max Vehicle Speed in VSG (programmable – default 9.6 km/h)
- ☐ VSS fault
- ☐ Clutch Released Pedal or Service Brake Pedal are pressed - optional
- ☐ Park Brake is off (if configured)

If VSG Throttle Override is enabled, the throttle pedal can override the VSG engine speed up to the maximum engine speed for Throttle Override. Throttle pedal or remote throttle engine speed can override once the current VSG engine speed is reached. The previous VSG set speed will become active again, if it is greater than the engine speed equivalent to the throttle pedal percentage.

See Figure 5-20 for a diagram of Cab VSG Mode

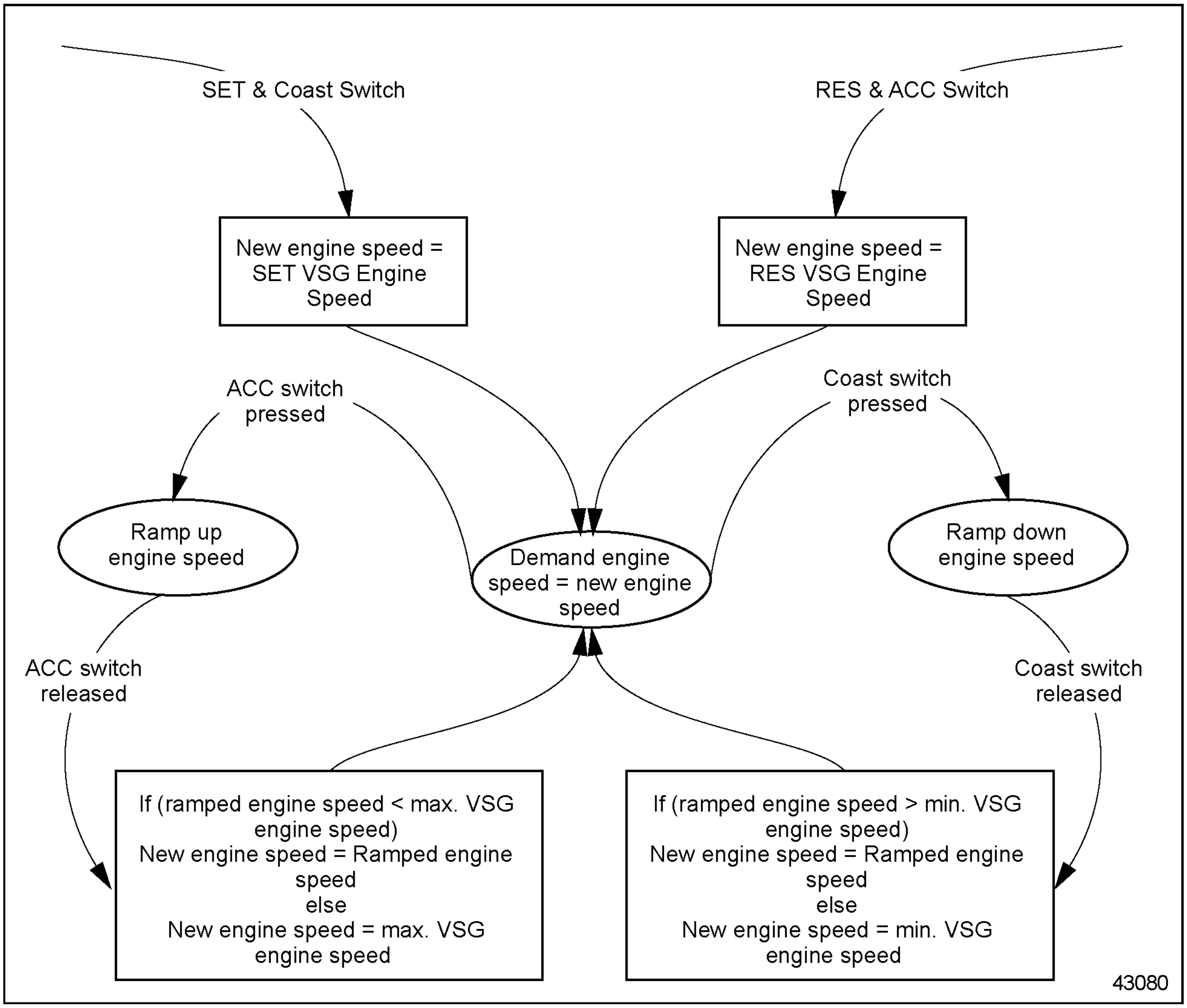

Figure 5-20 Cab VSG Mode

Cruise Switch VSG Programming Requirement and Flexibility

The digital inputs listed in Table 5-48 are required for Cruise Switch VSG. These digital inputs may be configured with VEPS or the minidiag2.

Digital Input	Setting	Default	Parameter ID
Enable Service Brake Input	1 = Enable 0 = Disable	1 = Enabled	1 13 04
Service Brake Input Configuration	0 = Hardwired 1 = Source Address 1 (SA1) 2 = Source Address 2 (SA2) 3 = Source Address 3 (SA3)	0 = Hardwired	1 13 05
Cruise Control On/Off Switch Configuration	0 = Hardwired 1 = Source Address 1 (SA1) 2 = Source Address 2 (SA2) 3 = Source Address 3 (SA3)	0 = Hardwired	1 13 11
Cruise Control Set/Coast & Resume/Accel Switch Configuration	0 = Hardwired 1 = Source Address 1 (SA1) 2 = Source Address 2 (SA2) 3 = Source Address 3 (SA3)	0 = Hardwired	1 13 12
Clutch Switch Configuration	0 = Hardwired 1 = Source Address 1 (SA1) 2 = Source Address 2 (SA2) 3 = Source Address 3 (SA3)	0 = Hardwired	1 13 15
Enable Park Brake Input	1 = Enable 0 = Disable	1 = Enabled	1 13 08
Park Brake Switch Configuration	0 = Hardwired 1 = Source Address 1 (SA1) 2 = Source Address 2 (SA2) 3 = Source Address 3 (SA3)	0 = Hardwired	1 13 09

Table 5-48 Cruise Switch VSG Digital Inputs

The Cruise Switch VSG parameters are listed in Table 5-49 and Table 5-50.

Parameters	Description	Default	Range	Parameter ID	Access
VSG Control on VSG and Cruise Control Pin	Enables/disables the VSG function	0	0 = Disabled 1 = Enabled 2 = Enabled if neutral 3 = Enabled if neutral and park brake* 4 = Enabled if park brake*	1 07 01	Nexiq DDR, DDDL, VEPS, minidiag2
Max VSG Speed	Sets the max VSG speed	3000 RPM	500 – 3000 RPM	1 07 02	VEPS, minidiag2
Min VSG Speed	Sets the min VSG speed	500 RPM	500 – 3000 RPM	1 07 03	VEPS, minidiag2
VSG Throttle Override	Enables/disables the throttle pedal from overriding VSG mode.	1 = Enabled	0 = Disabled 1 = Enabled	1 07 04	Nexiq DDR, DDDL, VEPS, minidiag2
Max Engine Speed for Throttle Override	Sets the max engine speed that the throttle can obtain when in VSG mode.	3000 RPM	0 – 3000 RPM	1 07 05	VEPS, minidiag2
VSG Dropout on Service Brake or Park Brake	Enables/Disables the status of the Service Brake or Park Brake for disabling of VSG	0 = VSG independent of Service Brake or Park Brake	0 = Allows VSG to run independent of Service Brake or Park Brake 1 = VSG drops out on either Service Brake or Park Brake 2 = VSG drops out on Service Brake 3 = VSG drops out on Park Brake	1 07 06	VEPS, minidiag2
VSG Dropout on Clutch Switch	Enables/Disables the status of the Clutch Switch for disabling of VSG	0 = Disabled (Clutch switch will not disable VSG)	0 = Disabled 1 = Enabled	1 07 07	Nexiq DDR, DDDL, VEPS, minidiag2
Max Vehicle Speed in VSG	Sets the max vehicle speed over which VSG is disabled	10 km/h	0 – 128 km/h	1 07 08	VEPS, minidiag2

* See parameter 1 07 06

Table 5-49 Cruise Switch VSG Parameters (1 of 2)

Parameters	Description	Default	Range	Parameter ID	Access
Cruise Set VSG Speed	Sets the initial speed when the Set/Coast Switch is used to enable Cab VSG	500 RPM	Min VSG Speed to Max VSG Speed	1 07 09	VEPS, minidiag2
Set VSG Max Engine Torque	Sets the max engine torque that becomes active once the Set/Coast Switch is activated	500 Nm	0-5000 Nm	1 07 11	VEPS, minidiag2
Cruise Resume VSG Speed	Sets the initial speed when the Resume/Accel Switch is used to enable Cab VSG	500 RPM	Min VSG Speed to Max VSG Speed	1 07 12	VEPS, minidiag2
Resume VSG Max Engine Torque	Sets the max engine torque that becomes active once the Resume/Accel Switch is activated	5000 Nm	0-5000 Nm	1 07 14	VEPS, minidiag2
VSG Ramp Rate	Sets the rate of increase or decrease.	1000 RPM/sec	25 – 2500 RPM/sec	1 07 15	VEPS, minidiag2

Table 5-50 Cruise Switch VSG Parameters (2 of 2)

Remote VSG Mode

The Remote VSG will override the Cab VSG mode when the Remote VSG Switch input on the VCU (18/10) is grounded. Remote VSG will also override throttle pedal and remote throttle unless “VSG Throttle Override” is disabled. The active throttle will override Remote VSG if “VSG Throttle Override” is enabled.

The preset speed is selected by enabling the remote VSG switch once for VSG Speed #1, twice for VSG Speed #2, and three times for VSG Speed #3. These preset speeds can be set with the minidiag2.

Remote VSG speed is disabled for any of the following:

- ☐ Turning the Remote VSG switch off for more than two seconds
- ☐ Vehicle speed is greater than Max Vehicle Speed in VSG (programmable – default 9.6 km/h)
- ☐ VSS fault
- ☐ Clutch Released Pedal or Service Brake Pedal are pressed
- ☐ Park Brake is off (if configured)

If VSG Throttle Override is enabled, the throttle pedal can override the VSG Engine speed up to the Maximum Engine Speed for Throttle Override. If the throttle pedal or remote throttle engine speed is less than current VSG engine speed, the engine will not respond to throttle requests less than the current VSG engine set speed. The previous VSG set speed will become active again, if it is greater than the engine speed equivalent to the throttle pedal percentage.

NOTE:
If remote VSG is active and then disabled due to one or more disabling condition, VSG mode will automatically reactivate when the disabling condition is removed.

See Figure 5-21 for a diagram of Remote VSG Mode.

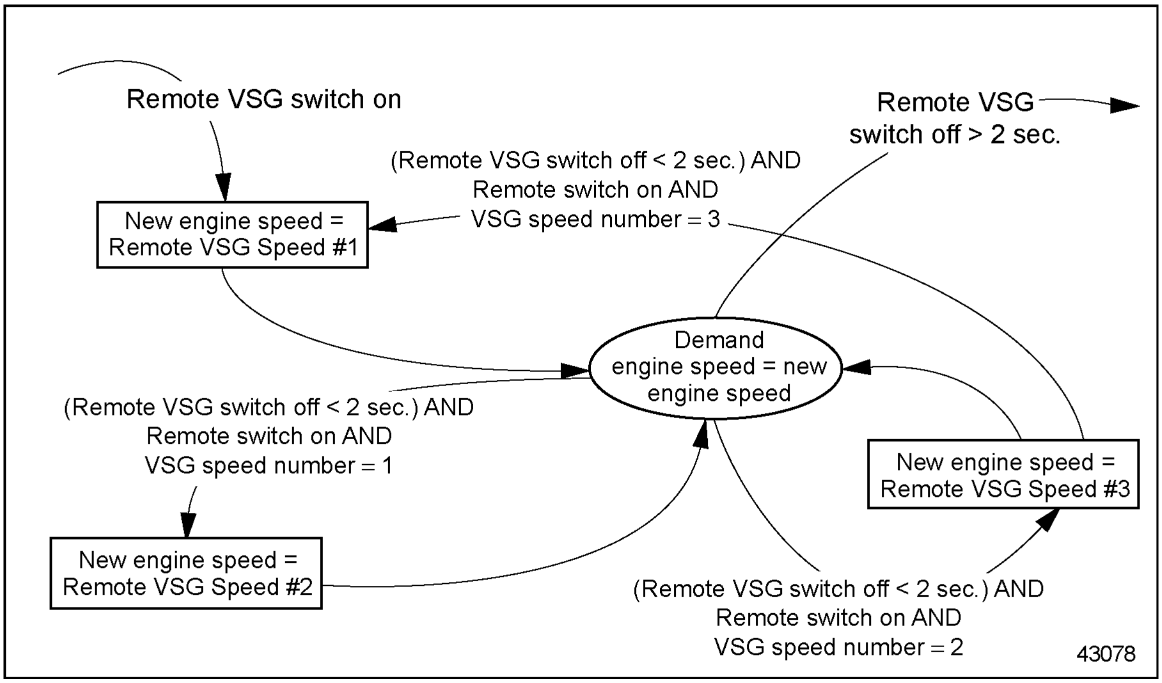

Figure 5-21 Remote VSG Mode

Remote VSG Programming Requirement and Flexibility

The Remote VSG parameters are listed in Table 5-51 and Table 5-52.

Parameters	Description	Range	Recommended Setting	Parameter ID	Access
VSG Control on VSG and Cruise Control Pin	Enables/disables the VSG function	0 = Disabled 1 = Enabled 2 = Enabled if neutral 3 = Enabled if neutral and park brake* 4 = Enabled if park brake*	0	1 07 01	Nexiq DDR, DDDL, VEPS, minidiag2
Max VSG Speed	Sets the max VSG speed	500 – 3000 RPM	3000 RPM	1 07 02	VEPS, minidiag2
Min VSG Speed	Sets the min VSG speed	500 – 3000 RPM	500 RPM	1 07 03	VEPS, minidiag2
VSG Throttle Override	Enables/disables the throttle pedal from overriding VSG mode.	0 = Disabled 1 = Enabled	0 = Disabled	1 07 04	Nexiq DDR, DDDL, VEPS, minidiag2
Max Engine Speed for Throttle Override	Sets the max engine speed that the throttle can obtain when in VSG mode.	0 – 3000 RPM	1400 RPM	1 07 05	VEPS, minidiag2
VSG Dropout on Service Brake or Park Brake	Enables/Disables the status of the Service Brake or Park Brake for disabling of VSG	0 = Allows VSG to run independent of Service Brake or Park Brake 1 = VSG drops out on either Service Brake or Park Brake 2 = VSG drops out on Service Brake 3 = VSG drops out on Park Brake	0 = VSG independent of Service Brake or Park Brake	1 07 06	VEPS, minidiag2
VSG Dropout on Clutch Switch	Enables/Disables the status of the Clutch Switch for disabling of VSG	0 = Disabled 1 = Enabled	0 = Disabled (Clutch switch will not disable VSG)	1 07 07	Nexiq DDR, DDDL, VEPS, minidiag2
Max Vehicle Speed in VSG	Sets the max vehicle speed over which VSG is disabled	0 – 128 km/h	9.6 km/h	1 07 08	VEPS, minidiag2

* See parameter 1 07 06

Table 5-51 Remote VSG Parameters (1 of 2)

Parameters	Description	Range	Recommended Setting	Parameter ID	Access
VSG Ramp Rate	Sets the rate of increase or decrease when in VSG mode.	25 – 2500 RPM/sec	1000 RPM/sec	1 07 15	VEPS, minidiag2
Number of Remote VSG Speed	Sets the number of remote VSG speeds that can be enabled	1 to 3	1	1 07 16	Nexiq DDR, DDDL, VEPS, minidiag2
VSG Speed #1	Sets the VSG #1 set speed	Min VSG RPM to Max VSG RPM	950 RPM	1 07 17	Nexiq DDR, DDDL, VEPS, minidiag2
VSG Speed #1 Max Engine Torque	Sets the max engine torque for VSG Speed #1	Low Idle - 5000 Nm	5000 Nm	1 07 19	Nexiq DDR, DDDL, VEPS, minidiag2
VSG Speed #2	#2 VSG set speed	Min VSG RPM to Max VSG RPM	1250 RPM	1 07 20	Nexiq DDR, DDDL, VEPS, minidiag2
VSG Speed #2 Max Engine Torque	Sets the max engine torque for VSG Speed #2	Low Idle - 5000 Nm	5000 Nm	1 07 22	Nexiq DDR, DDDL, VEPS, minidiag2
VSG Speed #3	#3 VSG set speed	Low Idle - 5000 Nm	1850 RPM	1 07 23	Nexiq DDR, DDDL, VEPS, minidiag2
VSG Speed #3 Max Engine Torque	Sets the max engine torque for VSG Speed #3	Low Idle - 5000 Nm	5000 Nm	1 07 25	Nexiq DDR, DDDL, VEPS, minidiag2

Table 5-52 Remote VSG Parameters (2 of 2)

Installation

The Remote VSG Switch is wired to pin 18/10 of the VCU. See Figure 5-22.

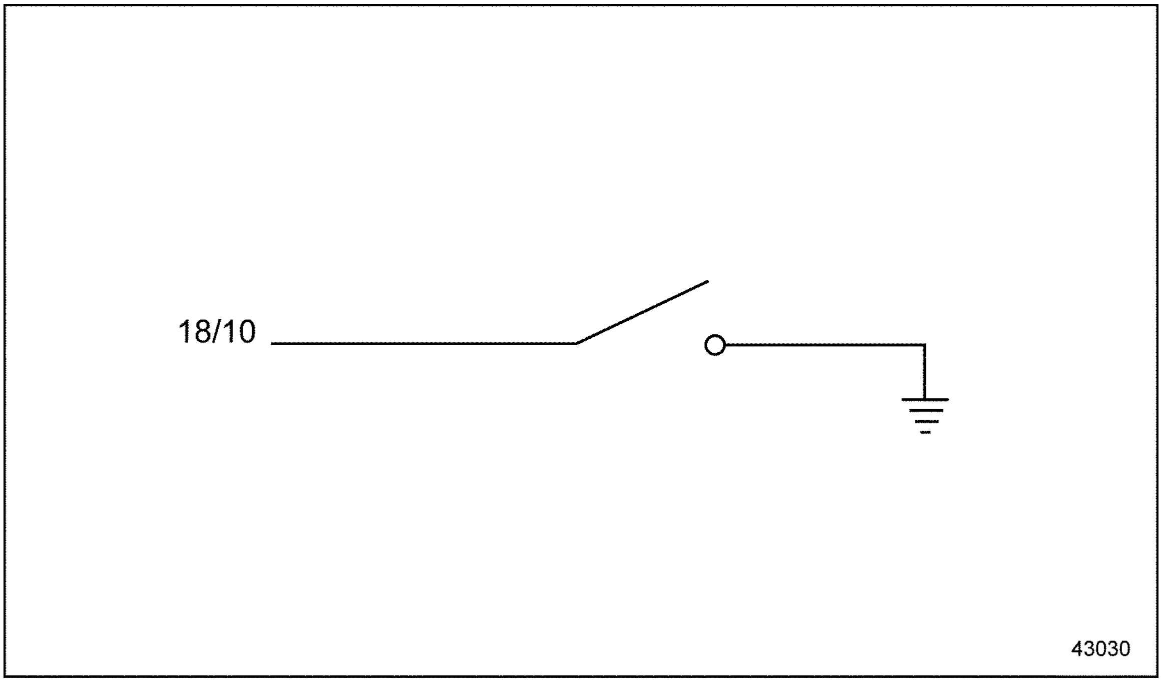

Figure 5-22 Remote VSG Switch

Analog VSG

A Remote Accelerator Pedal can be installed to control either an analog Remote VSG (VSG) or analog Remote Accelerator Pedal (ALSG).

The Remote VSG will start when the Remote VSG switch is switched to battery ground. The Remote VSG logic will override the Cab VSG. Cab throttle and remote throttle are also overridden unless "VSG Throttle Override" is disabled. When ALSG operation is required, the Remote Accelerator Switch is switched to battery ground.

The Remote Accelerator Switch Select input (VCU, 18/7) determines the active throttle control. When this pin is grounded, the engine will respond to the remote throttle input. When this input is not grounded, the engine will respond to the cab throttle pedal.

The VSG Enable input (VCU, 18/10) determines if the engine will be in VSG or ALSG mode.

If remote VSG is active and then disabled due to one or more disabling condition, VSG mode will automatically reactivate when the disabling condition is removed.

Installation

See Figure 5-23 for installation of a Remote Accelerator Control for VSG or ALSG.

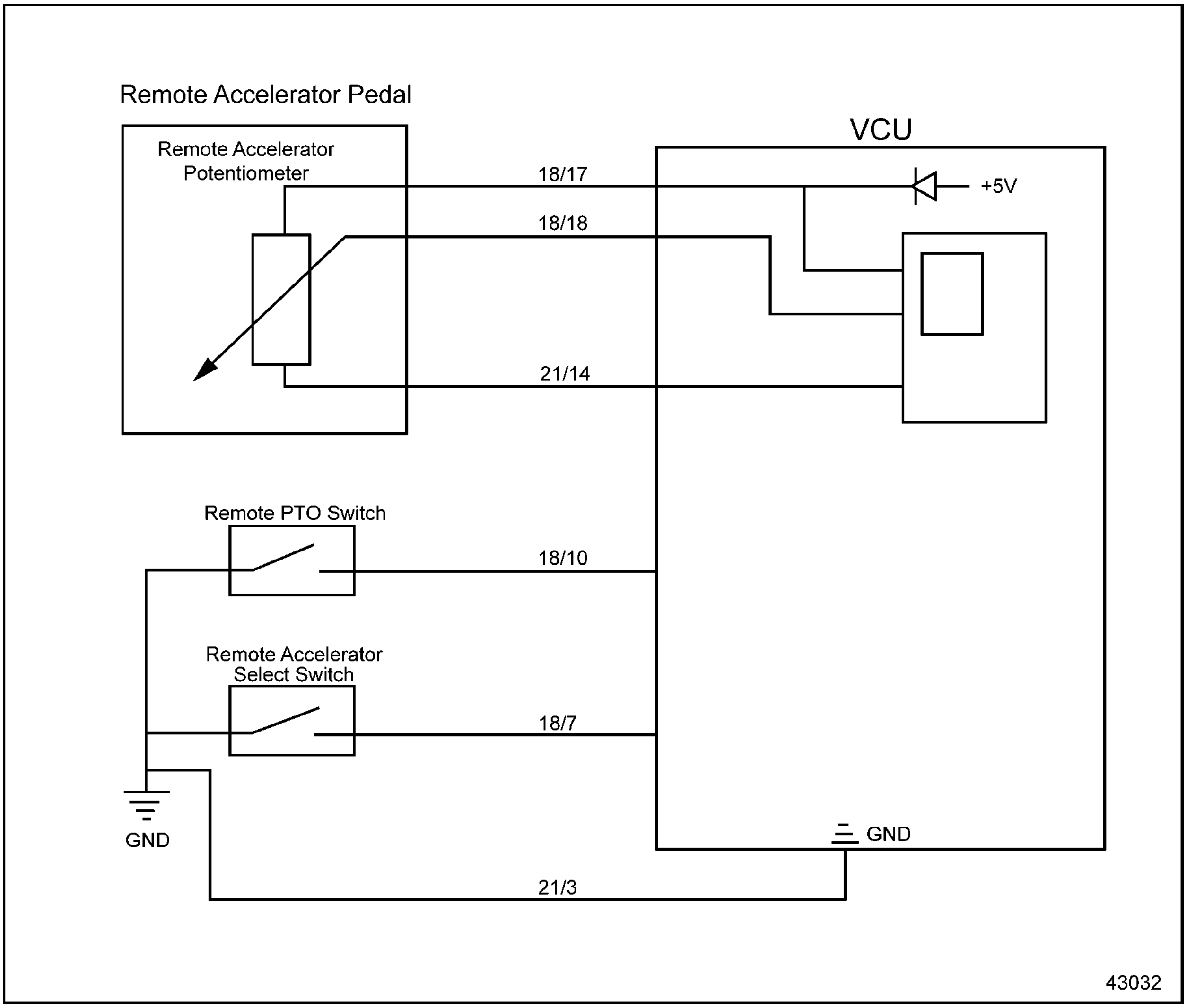

Figure 5-23 Remote Accelerator Control for VSG or ALSG

5.16 TRANSMISSION INTERFACE

MBE Electronic Controls can be interfaced to manual or automatic/automated transmission over the J1939 data link.

5.16.1 INSTALLATIONS

The interface for automatic and automated transmissions is provided through the J1939 data link. Refer to section 3.3.3 and look for the title "Communication – J1939" for proper wiring of the J1939 data link.

5.16.2 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

The correct transmission type, listed in Table 5-53, must be programmed by VEPS or minidiag2. The minidiag2 number is 1 11 26. The default is 0, Manual Transmission.

Transmission Type	Transmission	Clutch	Clutch Source	VCU Starter Lockout*	VCU Driveoff Function	Automatic with VCU
0	Manual	Switch / Multiplexed	Pin 18/2 via J1939	0	1	0
1	Automated Eaton Autoshift 3 Pedal	Switch / Multiplexed	Pin 18/2 via J1939	0	1	0
2	Automatic (AGS2, Alison)	—	—	0	1	1
3	Manual / Automated	Switch / Multiplexed	Pin 18/2 via J1939	1	1	0
4	Automated	ETCI	J1939 ETCI Byte 1, Bit 2, 1	1	1	0
5	Automatic	—	—	1	1	1
6	Automatic	—	—	1	0	1

* 0 = No, 1 = Yes

Table 5-53 Transmission Type

The parameter listed in Table 5-54 must be set for PLD-MR Software 58-Type 8 and Software 59 Type 9.

Parameter	Description	Range	Parameter ID
Transmission Type	Selects Manual/Auto Transmission	0 = Manual 1 = Automatic/Automated	0 01 02

Table 5-54 Engine Identification

5.17 VEHICLE SPEED LIMITING

A Vehicle Speed Sensor is necessary for the Vehicle Speed Limiting feature.

5.17.1 OPERATION

Vehicle Speed Limiting discontinues engine fueling at any vehicle speed above the programmed limit. The VCU stops fueling when maximum vehicle speed is reached. If the Dual Road Speed Limiter Switch is OFF, the minimum of the First Road Speed Limit or Global Vehicle Road Speed Limit (whichever is lowest) will be the limit for the road speed. If the Dual Road Speed Limiter Switch is ON, the minimum of the Second Road Speed Limit or Global Vehicle Road Speed Limit will be the limit for the road speed.

Setting any of the limits to the maximum value will disable that road speed limit.

5.17.2 INSTALLATION

An OEM supplied Vehicle Speed Sensor or output shaft speed over the SAE J1939 Data Link is required. Refer to section 3.7.5, "Vehicle Speed Sensor," for additional information.

If the Dual Road Speed Limiter switch is required, it is wired to VCU pin 18/12 (LIM 1). This is a normally open switch. A third Road Speed Limit is available using VCU pin 18/11 (LIM 0).

5.17.3 PROGRAMMING REQUIREMENTS AND FLEXIBILITY

The Vehicle Speed Limit is programmable by VEPS, DDDL, the Nexiq DDR, or the minidiag2 as listed in Table 5-55.

Parameter	Description	Range	Default	Parameter ID
Maximum Road Speed (Legal)	Maximum vehicle speed. Alternate Road Speed Limit 1 cannot exceed this speed.	10 – 152 km/hr*	152 km/hr	1 03 03
Alternate Road Speed Limit 1 (LIM 0)	Maximum vehicle speed when VCU pin 18/10 is connected to ground.	0 – 152 km/hr	152 km/hr	1 05 03
Alternate Road Speed Limit 2 (LIM 1)	Maximum vehicle speed when VCU pin 18/11 is connected to ground.	0–152 km/hr	152 km/hr	1 05 07

Table 5-55 Vehicle Speed Limiting Parameters

Additional limiters programmable by VEPS, DDDL, the Nexiq DDR, or the minidiag2 are listed in Table 5-56.

Limiter Type	Limiter	Description	Range	Default	Parameter ID
1	Alternate Minimum Engine Speed 1	Minimum engine speed when VCU pin 18/10 is connected to ground.	0–4000 RPM	500 RPM	01 05 01
2	Alternate Maximum Engine Speed 1	Maximum engine speed when VCU pin 18/10 is connected to ground.	0–4000 RPM	4000 RPM	01 05 02
3	Alternate Maximum Engine Torque 1	Maximum engine torque when VCU pin 18/10 is connected to ground.	0–5000 Nm	5000 Nm	01 05 04
4	Alternate Minimum Engine Speed 2	Minimum engine speed when VCU pin 18/11 is connected to ground.	0–4000 RPM	500 RPM	01 05 05
5	Alternate Maximum Engine Speed 1	Maximum engine speed when VCU pin 18/11 is connected to ground	0–4000 RPM	4000 RPM	01 05 06
6	Alternate Maximum Engine Torque 1	Maximum engine torque when VCU pin 18/11 is connected to ground.	0–5000 Nm	5000 Nm	01 05 08

Table 5-56 Additional Limiters

5.17.4 INTERACTION WITH OTHER FEATURES

The Cruise Control maximum set speed cannot exceed the Vehicle Speed Limit.

When Vehicle Speed Limiting is enabled and a VSS code is logged, the engine speed in all gears will be limited for the duration of the ignition cycle to engine speed at the Vehicle Speed Limit in top gear.

NOTE:
Due to VSS signal quality at low speeds, the vehicle speed limit may be set to a minimum of 48 kph to insure smooth road speed limiting. DDC cannot guarantee smooth speed limiting for maximum speeds set below 48 kph.

5.18 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 VCU.

NOTE:
Enabling VSS anti-tampering for use with SAE J1939, automatic, semi-automatic, or torque converter transmissions may cause false codes.

5.18.1 PROGRAMMING FLEXIBILITY

The minidiag2 can enable VSS anti-tampering. Vehicle Speed Limiting must also be enabled. The parameters are listed in Table 5-57.

Parameter	Description	Setting	Parameter Number
Vehicle Speed Sensor		2 = magnetic VSS Range 0 — 3 Default = 2	1 08 01
Axle Ratio		Range 1 - 20 Default = 5.29	1 08 03
Number of Output Shaft Teeth		Range 0 - 250 Default = 16	1 08 04
Tire Revolutions per Kilometer		Range 160 - 1599 Default = 312	1 08 05
Top Gear Ratio	Output Shaft/Input Shaft	Range 0.1 - 2.55 Default = 1	1 08 06
Anti-tamper	Enables or disables VSS Anti-tamper feature.	0 = Disable 1 = Enable Default = 0	1 08 10

Table 5-57 VSS Anti-tampering Parameters

6 COMMUNICATION PROTOCOLS

Section **Page**

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6.1 OVERVIEW

Key components of the MBE Electronic Controls system are the serial communication links SAE J1587 and SAE J1939. Using these communication links allows MBE to offer the following functionality:

- ☐ Transmitting sensor information from the PLD 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 minidiag2 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, Recommended Practice for a Serial Control and Communication Vehicle Network*
- ☐ *SAE J1939/71, Vehicle Application Layer*
- ☐ *SAE J1939/01, Truck and Bus Applications*
- ☐ *SAE J1939/11, Physical Layer*
- ☐ *SAE J1939/73, Application Layer — Diagnostics*
- ☐ *SAE J1939/21, Data Link Layer*

To obtain a copy of the above documents contact the Society of Automotive Engineers (SAE).

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

6.2 SAE J1587 – VCU ONLY

SAE RP J1587 defines the recommended format of messages and data being communicated between microprocessors used in heavy-duty vehicle applications. J1587 (+) and J1587 (-) as shown on the Vehicle Interface Harness schematic are used as the J1587 communication link. These circuits also exist in the nine-pin diagnostic connector for use with the diagnostic and reprogramming 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 MBE parameters is provided within this section of the manual. The VCU and ADM2 transmit 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 MBE Electronic Controls is 128.

The VCU reacts on the MIDs listed in Table 6-1.

MID	Description
130	Transmission Control Unit (TCU)
136	Anti-lock Brake System (ABS)
140	Instrument Cluster Unit (ICU)
172	Service Link
179	Second Diagnostic Device
180	Off-board diagnostics
181	Satellite
182	Vehicle Electronic Programming System (VEPS)
219	Collision Avoidance
231	Cellular
171	ProDriver/ProDriver DC

Table 6-1 VCU MIDs

Subsystems also require identifiers. The subsystem identifier character (SID) is a single byte character used to identify field-repairable or replaceable subsystems for which failures can be detected or isolated. SIDs are used in conjunction with SAE standard diagnostic codes defined in J1587 within PID194.

The identifiers used by MBE Electronic Controls are defined and listed in Table 6-2.

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 MBE1587 serial communication link originated the information.
Parameter Identification Character (PID)	A PID is a single byte character used in MBE 1587 messages to identify the data byte(s) that follow. PIDs identify the parameters transmitted.
Subsystem Identification Character (SID)	A SID is a single byte character used to identify field-repairable or replaceable subsystems for which failures can be detected or isolated.

Table 6-2 Identifiers Used by MBE

SAE J1587 Parameters Available with MBE Electronic Controls

MBE Electronic Controls supports the J1587 parameter identifiers (PIDs) listed in Table 6-3 and Table 6-4.

PID	Description
25	Air Conditioner Status #2
33	Clutch Cylinder Position
40	Engine Retarder
41	Cruise Control Switch Status
43	Ignition Switch Status
44	Attention/Warning Indicator Lamps Status
62	Retarder Inhibit Status
64	Direction Switch Status
65	Brake Switch Status
70	Parking Brake Switch Status
84	Vehicle Speed
85	Cruise Control Switch Status
86	Cruise Control Set Speed
89	VSG Switch Status
91	Percent Engine Load
92	Percent Engine Load
93	Output Torque
98	Engine Oil Level
100	Engine Oil Pressure
102	Turbo Boost Pressure
105	Intake Manifold Temperature
106	Air Inlet Pressure
107	Air Filter Differential Pressure
108	Barometric Pressure
110	Coolant Temperature
111	Coolant Level
121	Engine Retarder Status
168	Battery Potential (Voltage)

Table 6-3 SAE J1587 PIDs (part 1 of 2)

PID	Description
174	Fuel Temperature
175	Engine Oil Temperature
182	Trip Fuel
183	Fuel Rate
184	Instantaneous Fuel Economy, (mile/gal)
185	Average Fuel Economy, (mile/gal)
189	Rated Engine Speed
190	Engine Speed
194	Transmitter System Diagnostic Code and Occurrence Count Table
234	Software Identification
235	Total Idle Hours
236	Total Idle Fuel Used
237	Vehicle Identification Number (VIN)
240	Last Customer Calibration Change Hours
243	Device Identification
244	Trip Miles
245	Total Miles
247	Total Engine hours
248	Total VSG Hours
249	Total Engine Revolution
250	Total Fuel Used
251	Clock
252	Date

Table 6-4 SAE J1587 PIDs (part 2 of 2)

6.2.2 J1708/J1587 MESSAGE PRIORITY

Each message sent by MBE Electronic Controls 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 6-5. All devices transmitting messages across MBE Electronic Controls 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 6-5 Message Priority Assignments

6.2.3 SAE J1587 PIDS REQUIRING ACTION

MBE Electronic Controls 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:
MBE Electronic Controls responds with the appropriate data provided the MID in byte (b) matches the MID stored in calibration. The primary MID for MBE Electronic Controls is 128.

Transmitter Data Request / Clear Count

The format for a transmitter data request is shown below.

PID 195

Data: 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 -	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:
MBE Electronic Controls responds with the appropriate data using PID 196.

source: ECM calculated; outputs represent intended state

J1587 Outputs - Single Byte Parameters

PID 25 - Air Conditioner System Status #2

update rate: 10.0 s or on change

format:

PID	Data		
25	a		
		a – Air Conditioner Status #2	
	Bits 8–7:		Compressor Discharge Side
			00 - Not at high pressure
			01 - Is at high pressure
			10 - Error
			11 - Not Available
	Bits 5–6:		Compressor Discharge Side – N/A
	Bits 3–4		Compressor Suction Side – N/A
	Bits 2–1:		Evaporator Temperature – N/A

PID 33 - Clutch Cylinder Position

update rate: On Request

format:

PID	Data	
33	a	
		a – Clutch Cylinder Position

PID 40 - Engine Retarder Switches Status

update rate: 0.2 s or on state change

format:

PID	Data	
40	a	
	a – Engine Retarder Switches Status	
	Bits 8–7:	Reserved – all bits set to 1
	Bits 6–3::	Engine Retarder level Switch
		0 - 0 Cylinders
		1 - 2 Cylinders
		3 - 3 Cylinders
		4 - 4 Cylinders
		5 - 5 Cylinders
		6 - 6 Cylinders
		7 - 7 Cylinders
		8 - 8 Cylinders
		9 - 13 – Reserved
		14 – Error
		15 – Not Available
	Bits 2–1:	Engine Retarder Switch
		00 - Off
		01 - On
		10 - Error
		11 - Not Available

PID 41 - Cruise Control Switches Status
update rate: 1.0 s or on state change
format:

PID	Data
41	a

a – Cruise Control Switches Status

Bits 8–7:	Reserved - all bits set to 1
Bits 6–5:	Cruise Control On/Off Switch Status
	00 - Off
	01 - On
	10 - Error
	11 - Not Available
Bits 4–3:	Cruise Control Set Switch Status
	00 - Off
	01 - On
	10 - Error
	11 - Not Available
Bits 2–1:	Cruise Control Resume Switch Status
	00 - Off
	01 - On
	10 - Error
	11 - Not Available

PID 43 - Ignition Switch Status
update rate: 1.0 s or on state change
format:

PID	Data
43	a

a – Ignition Switch Status

Bits 8–7:	Start Aid Contacts Status – N/A
Bits 6–5:	Crank Contacts Status – N/A
Bits 4–3:	Run Contacts Status
	00 - Off
	01 - On
	10 - Error
	11 - Not Available
Bits 2–1:	Accessory Contacts Status – N/A

PID 44 - Attention/Warning Indicator Lamps Status

update rate: 10 time/s or 1 time/s when changing

format:

Bit: 1,2	Stop Engine Light Status 00 - off 01 - on 10 - error 11 - Not Available
Bit: 3,4	Check Engine Light Status 00 - off 01 - on 10 - 11 - Not Available
Bit: 5-8	Reserved, All Bits set to 1

PID 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 64 - Direction Switch Status

update rate: On Request

format:

PID	Data
64	a

a – Direction Switch Status

Bits 8–7:	Reserved – both bits set to 1
Bits 6–5:	Forward Switch Status – N/A
Bits 4–3:	Neutral Switch Status 00 - Off 01 - On 10 - Error 11 - Not Available
Bits 2–1:	Reserve Switch Status – N/A

PID 65- Service Brake Status
update rate: 1 time/s
format:

Bits:	5–8	Uncommitted, all Bits set to 1
Bits:	4,3	Engine Brake Status 0 – Not Active 1 – Active Parking Brake Switch Status
Bits:	1,2	0 - off 1 - on

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 83- Road Speed Limit Status
update rate: 1 time/s
format:

Bits:	8	1 = Active 0 = Not active
Bits:	1-7	Undefined

PID 84 - Vehicle Speed
update rate: 10 times/s
resolution: 0.5 mph/Bit (Uns/SI)
source: Vehicle Speed Sensor input

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
resolution:	0.5 mph/Bit (Uns/SI)
source:	Cruise Control switch inputs
comments:	If no set speed, then all bits are set to 1.

PID 89 - VSG Switch Status
update rate: 1 time/s
format:

Bit: 1	On/off switch 0-Off 1-On	
Bit: 2	Set switch 0-Off 1-On	
Bit: 3	Coast switch 0-Off 1-On	
Bit: 4	Resume switch 0-Off 1-On	
Bit: 5	Accel switch 0-Off 1-On	
Bit: 6	Brake 0-Off 1-On	
Bit: 7	Clutch 0-Off 1-On	
Bit: 8	VSG 0-Off 1-On	

source: VSG switch inputs/ECM calculated

PID 91 - Percent Throttle
update rate: 10 times/s
resolution: 0.4%/Bit (Uns/SI)
source: Throttle Sensor input

PID 92 - Percent Engine Load
update rate: 10 times/s
resolution: 0.5%/Bit (Uns/SI)
source: ECM calculated
comments: Percent engine load is the ratio of actual torque and the minimum of the requested torque and digital torque limit.

PID 93 - Output Torque
update rate: 1 time/s
resolution: 20 ft-lb/Bit (S/SI)
source: ECM calculated

PID 98 - Engine Oil Level
update rate: 0.1 time/s
resolution: 0.5%/Bit (Uns/SI)
source: Oil Level 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 102 - Turbo Boost Pressure (Gage)
update rate: 2 times/s
resolution: 0.125 psig/Bit (Uns/SI)
source: Turbo Boost Pressure 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.H_2O/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 ECM calculated

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 121 - Engine Retarder Status

update rate: 5 times/s

format:

Bit: 1	Set to 0
Bit: 2	Set to 0
Bit: 3	Set to 0
Bit: 4	Set to 0
Bit: 5	Set to 0
Bit: 8	1 - Retarder active

comments: Transmitted only if engine brakes are configured.

Double Byte Parameters

PID 168 - Battery Voltage

update rate:	1 time/s
resolution:	0.05 volts/Bit (Uns/I)
source:	Battery voltage measured at input to ECM
comments:	The ECM input battery voltage does fluctuate as injectors fire and will require filtering if used for display purposes.

PID 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:	ECM calculated

PID 183 - Fuel Rate

update rate:	5 times/s
resolution:	1/64 gal/hour/Bit (Uns/I)
source:	ECM calculated

PID 184 - Instantaneous Fuel Economy (MPG)

update rate:	5 times/s
resolution:	1/256 mpg/Bit (Uns/I)
source:	ECM calculated

PID 185 - Average Fuel Economy (MPG)

update rate:	0.1 times/s
resolution:	1/256 mpg/Bit (Uns/I)
source:	ECM calculated

PID 189 - Rated Engine Speed
update rate: On request only
resolution: 0.25 rpm/Bit (Uns/I)
source: Calibration value

PID 190 - Engine Speed
update rate: 10 times/s
resolution: 0.25 rpm/Bit (Uns/I)
source: ECM calculated

PID 439 (255 183)- Extended Range Boost Pressure
update rate: 1 times/s
resolution: 0.125 kPa/Bit (Uns/I)

Variable Length Parameters

PID 194 - Transmitter System Diagnostic Code / Occurrence Count Table

update rate: On Request only

format:

PID Data

194 n a b c a b c a b c a b c a b c...

n - Byte count of data that follows this character. This excludes characters MID, PID 194 and n but includes a, b, c type characters.

a - SID or PID of a standard diagnostic code.

b - Diagnostic code character

Bits: 1-4 FMI of a standard diagnostic code

Bit: 5 Byte (a) Identifier
- 1 - Byte (a) is a SID
- 0 - Byte (a) is a PID

Bit: 6 Type of Diagnostic Code
- 1 - standard diagnostic code
- 0 - expansion diagnostic codes (PID/SID from page 2)

Bit: 7 Current Status of Fault
- 1 - fault is inactive
- 0 - fault is active

Bit: 8 Occurrence count
- 1 - count is included
- 0 - count is not included

c - Occurrence count for the diagnostic code defined by the preceding 2 characters. The maximum occurrence count is 255. Bit 8 of byte (b) of the diagnostic code is used to determine if it is included.

source: ECM calculated

comment: comments: Diagnostic codes are transmitted periodically while active. When the active code becomes inactive, the code is transmitted once to indicate that the fault became inactive. Inactive diagnostic codes are available by request of PID 194. If more than 6 codes are active at any point, PID 194 is sectioned as described in PID 192.

PID 234- Software Identification
update rate: On Request only
format:

PID	Data
234	n a a b c c

n = number of bytes: 5
a = Major software release level in ASCII
b = ASCII "."
b = Minor software release level in ASCII
Example: "01.05" is interpreted as Major release 1, Minor release 5
source: ECM calculated

PID 235- Total Idle Hours
update rate: On Request only
format:

PID	Data
235	n a a a a

n = number of bytes: 4
a = Total idle hours; scaled 0.05 hours/Bit (Uns/LI)
source: ECM calculated
comment: Accumulates time while the engine is operating at idle.

PID 236- Total Idle Fuel Used
update rate: On Request only
format:

PID	Data
236	n a a a a

n = number of bytes: 4
a = Idle fuel used; scaled 1/8 hours/Bit (Uns/LI)
source: ECM calculated
comment: Accumulates while the engine is operating at idle.

PID 237- Vehicle Identification Number (VIN)
update rate: On Request only
format:

PID	Data	
237	n a a a ...	
	n =	number of bytes: up to 17
	a =	VIN in ASCII characters

source: Calibration value

PID 240- Last Customer Calibration Change Hours
update rate: On Request only
format:

PID	Data	
240	n a a a a	
	n =	number of bytes: 4
	a =	Last customer calibration change hours; scaled 0.05 h/Bit (Uns/LI)

source: ECM calculated
comment: Used to identify the last customer reprogramming occurrence, stored in engine hours.

PID 243- Device Identification
update rate: On Request only
format:

PID	Data	
243	n a b b b b b c d d d d d d d d e f f f f f f f f f f	
	n =	number of bytes
	a =	component ID = MID
	b =	ATA/VMRS manufacturer ID (5 bytes)
	c =	delimiter: ASCII '*'
	d =	engine model number (8 bytes)
	e =	delimiter: ASCII '*'
	f =	engine serial number (10 bytes)

source: Calibration value
comment: This parameter may be sectioned using PID 192.

PID 244- Trip Miles
update rate: 0.1 times/s
format:

PID	Data
244	n a a a a
	n = number of bytes: 4
	a = trip miles 0.1 mile/Bit (Uns/LI)

source: ECM calculated

PID 245- Total Miles
update rate: 0.1 times/s
format:

PID	Data
245	n a a a a
	n = number of bytes: 4
	a = trip miles, 0.1 mile/Bit (Uns/LI)

source: ECM calculated

PID 247- Total Engine Hours
update rate: On request only
format:

PID	Data
247	n a a a a
	n = number of bytes: 4
	a = total engine hours 0.05 hour/Bit (Uns/LI)

source: ECM calculated
comment: Used to identify the total hours that the engine is operating. Time accumulated while the engine speed is above 60 rpm.

PID 248- Total VSG Hours

update rate: On request only

format:

PID	Data
248	n a a a a
	n = number of bytes: 4
	b = total VSG hours 0.05 hour/Bit (Uns/LI)

source: ECM calculated

comment: Used to identify total engine hours the engine is operating in the following modes:

-Hand throttle VSG

-High idle using cruise switches

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: ECM calculated

PID 251- Clock

update rate: On request only

format:

PID	Data
251	n a b c

n = number of bytes: 3

a = Seconds 0.25 sec/Bit, range 0 to 59.75 seconds

b = Minutes 1.0 min/Bit, range 0 to 59 minutes

c = Hours 1.00 hour/Bit, range 0 to 23 hours

comment: Transmitted if clock data is considered valid. The time is broadcast in Greenwich Mean Time.

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.

6.3 SAE J1939 – VCU SUPPORTED MESSAGES

J1939 (+), J1939 (-), and J1939 Shield are used as the J1939 communication link.

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 MBE Electronic Controls, 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:		10 ms
Data Length:		8 bytes
Data Page:		0
PDU format:		240
PDU specific:		4
Default priority:		3
PGN:		61,444 (0x00F004)
Byte : 1	Status_EEC1	
	Bits: 8-5	Not Defined
	Bits: 4-1	Engine / Retarder Torque Mode
		0000: Low Idle Governor/No Request (Default Mode)
		0001: Accelerator Pedal/Operator Selection
		0010: Cruise Control
		0011: VSG Governor
		0100: Road Speed Governor
		0101: ASR Control
		0110: Transmission Control
		0111: ABS Control – N/A
		1000: PLD Engine Protection
		1001: High Speed Governor
		1010: Braking System – N/A
		1011: Remote Accelerator - N/A
		1100: Not Defined
		1101: Not Defined
		1110: Trans Requested Engine Brake and Engine Speed >800 RPM
		1111: Not Available
Byte: 2	Drivers Demand Engine - Pct Torque	
	Resolution:	1% / Bit, -125% offset
Byte: 3	Actual Engine - Percent Torque	
	Resolution:	1% / Bit, -125% offset
Bytes: 4,5	Engine Speed	
	Resolution:	0.125 rpm / Bit, 0 rpm offset
Byte: 6	Source address of controlling device for engine control – N/A	
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	
	Bits: 6-5	Road Speed Limit Status	
		00:	Active
		01:	Not Active
	Bits: 4-3	AP Kickdown Switch	
		00:	Kickdown Passive
		01:	Kickdown Active
		11:	Not Configured
	Bits: 2,1	AP Low Idle Switch	
		00:	Not In Low Idle Condition
		01:	In Low Idle Condition
		10:	Error Detected
		11:	Not Configured
Byte: 2	Accelerator Pedal Position (TPS)		
	Resolution:	0.4% / Bit, 0% offset	
Byte: 3	Percent Load At Current Speed		
	Resolution:	1% / Bit, 0% offset	
Byte: 4	Remote Accelerator (if configured)		
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	
	Resolution:	1% / Bit, -125% offset
Bytes: 2,3	Engine's Desired Operating Speed – N/A	
Byte 4:	Engine's Desired Operating Speed Asymmetry Adjustment — N/A	
Bytes: 5-8	Not Defined	

Engine Temperature

Transmission Rate :		1 sec
Data Length:		8 bytes
Data Page:		0
PDU format:		254
PDU specific:		238
Default priority:		6
PGN:		65,262 (0x00FEEE)
Byte: 1	Engine Coolant Temperature	
	Resolution:	1°C / Bit, -40°C offset
Byte: 2	Fuel Temperature – N/A	
Bytes: 3,4	Engine Oil Temperature	
	Resolution:	0.03125°C / Bit, -273°C offset
Bytes: 5,6	Turbo Oil Temperature -N/A	
Byte: 7	Engine Intercooler Temperature -N/A	
Byte 8:	Engine Intercooler Thermostat Opening–N/A	

Engine Fluid Level/Pressure

Transmission Rate :	0.5 sec
Data Length:	8 bytes
Data Page:	0
PDU format:	254
PDU specific:	239
Default priority:	6
PGN:	65,263 (0x00FEEF)

Byte: 1	Fuel Delivery Pressure -N/A	
Byte: 2	Extended Crankcase Blowby Pressure – N/A	
Byte: 3	Engine Oil Level (if configured)	
	Resolution:	0.4% / Bit, 0% offset
Byte: 4	Engine Oil Pressure	
	Resolution:	4 kPa / Bit, 0 kPa offset
Byte: 5,6	Crankcase Pressure – N/A	
Byte: 7	Coolant Pressure – N/A	
Byte: 8	Coolant Level – N/A	

Cruise Control / Vehicle Speed

Transmission Rate :		100 ms
Data Length:		8 bytes
Data Page:		0
PDU format:		254
PDU specific:		241
Default priority:		6
PGN:		65,265 (0x00FEF1)
Byte: 1	Measured_SW1	
	Bits: 8,7	Not Defined
	Bits: 6,5	Cruise Control Pause Switch–N/A
	Bits: 4,3	Parking Brake Switch
		00: Park Brake Not Set
		01: Park Brake Set
		11: Not Configured
	Bits: 2,1	Two Speed Axle Switch
		00: Low Speed Range
		01: High Speed Range
Byte: 2,3	Wheel Based Vehicle Speed	
	Resolution:	1/256 km/h/Bit, 0 km/h offset
Byte: 4	Measured_CC_SW1	
	Bits: 8,7	Clutch Switch
		00: Clutch Pedal Released
		01: Clutch Pedal Depressed
		11: Not Configured
	Bits: 6,5	Brake Switch
		00: Brake Pedal Released
		01: Brake Pedal Depressed
		11: Not Configured
	Bits: 4,3	Cruise Control Enable Switch
		00: Cruise Control Disabled
		01: Cruise Control Enabled
		11: Not Configured
	Bits: 2,1	Cruise Control Active
		00: Cruise Control Active
		01: Cruise Control Not Active
		11: Not Configured
Byte: 5	Measured _CC_SW2	
	Bits: 8,7	Cruise Control Accelerate Switch
		00: Accelerate Switch Off
		01: Accelerate Switch On
		11: Not Configured

Bits: 6,5 — Cruise Control Resume Switch
- 00: Resume Switch Off
- 01: Resume Switch On
- 11: Not Configured

Bits: 4,3 — Cruise Control Coast Switch
- 00: Coast Switch Off
- 01: Coast Switch On
- 11: Not Configured

Bits: 2,1 — Cruise Control Set Switch
- 00: Set Switch Off
- 01: Set Switch On

Byte: 6 — Cruise Control Set Speed

Resolution: 1 km/h/Bit, 0 km/h offset

Byte: 7 — State_CC

Bits: 8–6 — Cruise Control State
- 000: Off/Disabled
- 001: Hold
- 010: Accelerate
- 011: Decelerate/Coast
- 100: Resume
- 101: Set
- 110: Accelerator Override
- 111: Not Available

Bits: 5-1 — VSG State
- 00000: Off/Disabled
- 00001: Hold
- 00010: Remote Hold
- 00011: Standby
- 00100: Remote Standby
- 00101: Set
- 00110: Decelerate/Coast
- 00111: Resume
- 01000: Accelerate
- 01001: Accelerator Override
- 01010: Preprogrammed Set Speed 1
- 01011: Preprogrammed Set Speed 2
- 01100: Preprogrammed Set Speed 3
- 01101: Preprogrammed Set Speed 4
- 01110: Preprogrammed Set Speed 5
- 01111: Preprogrammed Set Speed 6
- 10000: Preprogrammed Set Speed 7
- 10001: Preprogrammed Set Speed 8
- 10010–11110: Not Defined

		11111: Not Available
Byte: 8	Measured_idle_SW1	
	Bits: 8,7	Not Defined
	Bits: 6,5	Engine Test Mode Switch - N/A
	Bits: 4,3	Idle Decrement Switch
	Bits: 2,1	Idle Increment Switch

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) - N/A	
Bytes: 7,8	Battery Potential (Voltage), Switched	
	Resolution:	0.05 V / Bit, 0 V offset

Electronic Retarder Controller #1 - ERC1

Transmission Rate :		100 ms	
Data Length:		8 bytes	
Data Page:		0	
PDU format:		240	
PDU specific:		0	
Default priority:		6	
PGN:		61,440 (0x00F000)	
Byte : 1	Status_ERC1		
	Bits: 8,7	Retarder Enable - Shift Assist Switch - N/A	
	Bits: 6,5	Retarder Enable - Brake Assist Switch - N/A	
	Bits: 4-1	Engine/Retarder Torque Mode	
		0000:	No Request (Default Mode)
		0001:	Accelerator Pedal/Operator Selection
		0010:	Cruise Control
		0011:	VSG Governor
		0100:	Road Speed Governor - N/A
		0101:	ASR Control
		0110:	Transmission Control
		0111:	ABS Control
		1000:	Torque Limiting - N/A
		1001:	High Speed Governor - N/A
		1010:	Braking System
		1011:	Remote Accelerator - N/A
		1100:	Not Defined
		1101:	Not Defined
		1110:	Other
		1111:	Not Available
Byte: 2	Actual Retarder - Percent Torque		
	Resolution:	1% / Bit, -125% offset	
Byte: 3	Intended Retarder Percent Torque - N/A		
Byte: 4	Coolant Load Increase – N/A		
	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–N/A		
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		

Component Identification

Transmission Rate :	On Request
Data Length:	18 bytes
Data Page:	0
PDU format:	254
PDU specific:	235
Default priority:	6
PGN:	65,259 (0x00FEEB)

Bytes: 1-18 “MRCBN*” + 3 byte engine type + “*” + 6 bytes engine number + “**”

Engine Type:	460 = MBE 4000 6–cylinder Inline
	904 = MBE 904 4–cylinder Inline
	924 = MBE 924 4–cylinder Inline
	906 = MBE 906 6–cylinder Inline
	926 = MBE 926 6–cylinder Inline

Engine Configuration — EC

Transmission Rate :		5 sec.
Data Length:		28 bytes
Data Page:		0
PDU format:		254
PDU specific:		227
Default priority:		6
PGN:		65,251 (0x00FEE3)
Bytes: 1,2	Engine Speed At Idle, Point 1 Resolution: 0.125 rpm / Bit, 0 rpm offset	
Byte: 3	Percent Torque At Idle, Point 1 Resolution: 1% / Bit, -125% offset	
Bytes: 4, 5	Engine Speed At Point 2 Resolution: 0.125 rpm / Bit, 0 rpm offset	
Byte: 6	Percent Torque At Point 2 Resolution: 1% / Bit, -125% offset	
Bytes: 7,8	Engine Speed At Point 3 Resolution: 0.125 rpm / Bit, 0 rpm offset	
Byte: 9	Percent Torque At Point 3 Resolution: 1% / Bit, -125% offset	
Bytes: 10, 11	Engine Speed At Point 4 Resolution: 0.125 rpm / Bit, 0 rpm offset	
Byte: 12	Percent Torque At Point 4 Resolution: 1% / Bit, -125% offset	
Bytes: 13, 14	Engine Speed At Point 5 Resolution: 0.125 rpm / Bit, 0 rpm offset	
Byte: 15	Percent Torque At Point 5 Resolution: 1% / Bit, -125% offset	
Bytes: 16, 17	Engine Speed At High Idle, Point 6 Resolution: 0.125 rpm / Bit, 0 rpm offset	
Bytes: 18, 19	(KP) Of Endspeed Governor - N/A	
Bytes: 20, 21	Reference Engine Torque Resolution: 1 Nm / Bit, 0 Nm offset	
Byte: 22, 23	Maximum Momentary Engine Override Speed, Point 7 Resolution: 0.125 rpm / Bit, 0 rpm offset	
Byte: 24	Maximum Momentary Engine Override Time Limit Resolution: 0.1 s / Bit, 0 s offset	
Byte: 25	Requested Speed Control Range Lower Limit - 300 RPM – N/A	
Byte: 26	Requested Speed Control Range Upper Limit – N/A	
Byte: 27	Requested Torque Control Range Lower Limit – N/A	
Byte: 28	Requested Torque Control Range Upper Limit – N/A	

Bytes: 29, 30 Extended Range Request Speed Control Range upper Limit – N/A

Bytes: 31, 32 Engine Moment of Inertia
Resolution: 0.004 Kg-m^2 per bit
Offset: 0 Kg-m^2

Torque Speed Control — TSC1

Reception Rate :		10 ms when active to the engine, 50 ms when active to the retarder
Data Length:		8 bytes
Data Page:		0
PDU format:		0
PDU specific:		Destination Address
Default priority:		3
PGN:		0 (0x000000)
Byte : 1	Control Bits	
	Bits: 8,7	Not Defined
	Bits: 6,5	Override Control Mode Priority
		00: Highest
		01: High
		10: Medium
		11: Low
	Bits: 4,3	Requested Speed Control Conditions (PLD–MR dependent)
		00: Transient optimized for driveline disengaged and non-lockup conditions
		01: Stability optimized for driveline disengaged and non-lockup conditions
		10: Stability optimized for driveline engaged and/or in lockup condition 1
		11: Stability optimized for driveline engaged and/or in lockup condition 2
	Resolution:	1%/bit, –125% offfset
	Bits: 2,1	Override Control Modes – N/A
Byte: 2,3	Requested Speed / Speed Limit	
	Resolution:	0.125 rpm / Bit, 0 rpm offset
Byte: 4	Requested Torque / Torque Limit	
	Resolution:	1% / Bit, -125% offset
		0-125% for engine torque requests
		-125-0% for retarder torque requests
Bytes: 5-8	Not Defined	

Electronic Transmission Controller #1 – ETC1

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 – N/A	
	Bits: 4,3	Torque Converter Lockup Engaged	
		00:	Torque Converter Lockup Disengaged
		01:	Torque Converter Lockup Engaged
	Bits: 2,1	Driveline Engaged - N/A	
Byte: 2,3	Output Shaft Speed		
	Resolution:	0.125 rpm / Bit, 0 rpm offset	
Byte: 4	Percent Clutch Slip - N/A		
Byte: 5	Command_ETC1		
	Bits: 8-5	Not Defined	
	Bits: 4-3	Progressive Shift Disabled – N/A	
	Bits: 2,1	Momentary Engine Overspeed Enable	
		00:	Momentary Engine Overspeed Is Disabled
		01:	Momentary Engine Overspeed Is Enabled
		11:	N/A
Bytes: 6,7	Input Shaft Speed - N/A		
Byte: 8	Source Address of Controlling Device for Transmission Control–N/A		

Electronic Transmission Controller #2 – ETC2

Reception Rate :		100 ms
Data Length:		8 bytes
Data Page:		0
PDU format:		240
PDU specific:		5
Default priority:		6
PGN:		61,445 (00F005)
Byte : 1	Selected Gear – N/A	
Byte: 2,3	Actual Gear Ratio – N/A	
Byte: 4	Current Gear	
	Resolution:	1 Gear Value/Bit, – 125 Offset
Byte: 5-6	Transmission Requested Range – N/A	
Byte: 7-8	Transmission Current Range – N/A	

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		
	Defination:	0–4.8% = Engine Brake Off	
		25.2–50% = Stage 1 On	
		50.4–74.8% = Stage 2 On	
		75.2–100% = Stage 3 On	
	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		

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.

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.

Fuel Economy

Transmission Rate:		100 ms
Data Length:		8 Bytes
Data Page:		0
PDU Format:		254
PDU Specific:		242
Default Priority:		6
PGN:		65,266 (0x00FEF2)
Bytes: 1,2	Fuel Rate	
	Resolution:	0.05 L/h/bit, 0 km/L offset
Bytes: 3,4	Instantaneous Fuel Economy	
	Resolution:	1/512 km/ l/bit, o km/ l offset
Bytes: 5–6	Average Fuel Economy	
	Resolution:	1/512 km/ l/bit, o km/ l offset
Bytes: 7–8	Not Defined	

Inlet/Exhaust Conditions

Transmission Rate:		500 ms
Data Length:		8 Bytes
Data Page:		0
PDU Format:		254
PDU Specific:		246
Default Priority:		6
PGN:		65,270 (0x00FEF6)
Byte: 1	Particulate Trap Inlet Pressure — N/A	
Byte: 2	Boost Pressure	
	Resolution: 2 kPa/bit, 0kPa/bit offset	
Byte: 3	Intake Manifold Temperature	
	Resolution: 1°C/bit, -40°C/bit offset	
Byte: 4	Air Inlet Pressure — N/A	
Byte: 5	Air Filter Differential Pressure — N/A	
Byte: 6	Exhaust Gas Temperature — N/A	
Byte: 8	Coolant Filter Differential Pressure — N/A	

Engine Hours, Revolutions

Transmission Rate:		500 ms
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	
	Resolution: 0.05 hr/bit, 0 hr/bit offset	
Bytes: 5–8	Total Engine Revolutions	
	Resolution: 1000 rev/bit, 0 rev/bit offset	

Fuel Consumption

Transmission Rate:	On Request
Data Length:	8 Bytes
Data Page:	0
PDU Format:	254
PDU Specific:	233
Default Priority:	6
PGN:	65,257 (0x00FEE9)

Bytes: 1–4	Trip Fuel	
	Resolution:	0.05 L/bit, 0 L/bit offset
Bytes: 5–8	Total Fuel Used	
	Resolution:	0.05 L/bit, 0 L/bit offset

6.3.4 SAE J1939/73 DIAGNOSTIC LAYER

The Diagnostic Layer Parameter Group Number (PGN) response definitions are described in the following sections:

Active Diagnostic Trouble Codes – DM1

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 00: Lamp Off 01: Lamp On
	Bits: 6–5	Red Stop Lamp Status 00: Lamp Off 01: Lamp On
	Bits: 4–3	Amber Warning Lamp Status 00: Lamp Off 01: Lamp On
	Bits: 2–1	Protect lamp Status 00: Lamp Off 01: Lamp On
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
Byte: 4	Bits:8–1	SPN. 8 second byte of SPN
Byte: 5	Bits:8–6 Bits:5–1	SPN, 3 most significant bits FMI
Byte: 6	Bit: 8 Bits:7–1	SPN Conversion Method Occurrence Count
Byte: 7	Bits:8–1	Not Defined (Set to 0xFF)
Byte: 8	Bits:8–1	Not Defined (Set to 0xFF)

Engine Start/Stop – ESS

Transmission Rate:		50 ms
Data Length:		8 Bytes
Data Page:		
PDU Format:		
PDU Specific:		
Default Priority:		
PGN:		61,184
Byte: 1	Bits: 8–7	Not Defined
	Bits: 6–5	Inhibit Engine Start
	Bits: 4–3	Engine Start
	Bits: 2–1	Inhibit Fuel Injection
Bytes: 2–8	Not Defined	

Tachograph #1– TCO1

Transmission Rate:		50 ms
Data Length:		
Data Page:		
PDU Format:		
PDU Specific:		
Default Priority:		
PGN:		65,132
Byte: 1	Drive Recognize — N/A	
Byte: 2	Overspeed — N/A	
Byte: 3	Not Defined — N/A	
Byte: 4	Direction Indicator — N/A	
Bytes: 5–6	Tachograph Output Shaft Speed	
	Resolution:	0.125 rpm/Bit, 0 rpm offset
Bytes: 7–8	Tachograph Vehicle Speed	
	Resolution:	1/256 km/h/Bit, 0 km/h offset

APPENDIX A: CODES

Refer to section A.1 for VCU fault codes.

A.1 VCU FAULT CODES

J1939 SPN	J1587 PID	J1587 SID	FMI	Description
45	45	—	3	Flame Start Gate Open Circuit
45	45	—	4	Flame Start Gate Shortened to Ground
45	45	—	14	Flame Start Gate Special Instructions
45	45	—	12	Grid Heater Defect
84	84	—	3	Vehicle Speed Sensor Open Circuit
84	84	—	4	Vehicle Speed Sensor Short to Ground
84	84	—	2	Vehicle Speed Sensor Data Erratic (Output shaft speed from J1939 ETCI not in normal range)
84	84	—	14	Vehicle Speed Sensor not Plausible
91	91	—	3	Accelerator Pedal Voltage Above Normal or Shorted High
91	91	—	2	Accelerator Pedal Data Erratic
91	91	—	4	Accelerator Pedal Voltage Below Normal or Shorted Low
94	94	—	3	Fuel Pressure Sensor Open Circuit
94	94	—	4	Fuel Pressure Sensor Short to Ground
94	94	—	0	Fuel Pressure High
94	94	—	1	Fuel Pressure Low
94	94	—	2	Fuel Pressure Sensor Data Not Correct
94	94	—	14	Fuel Pressure Sensor Measured Data Not Correct
98	98	—	14	Engine Oil Level Data Valid but Very low
98	98	—	0	Engine Oil Level High
98	98	—	1	Engine Oil Level Low
98	98	—	3	Engine Oil Level Sensor Voltage High
98	98	—	4	Engine Oil Level Sensor Voltage Low
98	98	—	5	Engine Oil Level Sensor Open Circuit
98	98	—	2	Engine Oil Level Reading Erroneous
98	98	—	2	Engine Oil Level Too High or Too Low
100	100	—	14	Engine Oil Pressure Very Low
100	100	—	1	Engine Oil Pressure Low
100	100	—	3	Engine Oil Pressure Sensor Open Circuit

J1939 SPN	J1587 PID	J1587 SID	FMI	Description
100	100	—	2	Engine Oil Pressure Sensor Data Erratic
100	100	—	4	Engine Oil Pressure Sensor Short to Ground
100	100	—	14	Engine Oil Pressure Too Low
102	102	—	0	Boost Pressure High
102	102	—	1	Boost Pressure Low
102	102	—	2	Boost Pressure Sensor Data Erratic
102	102	—	3	Boost Pressure Sensor Open Circuit
102	102	—	4	Boost Pressure Sensor Short to Ground
102	102	—	13	Boost Pressure Regulator for Same Speed at Limit Boost Pressure Control Target Out of Range Boost Pressure Out of Range Boost Brake Torque Out of Range
105	105	—	3	Intake Manifold Temperature Open Circuit
105	105	—	4	Intake Manifold Temperature Short to Ground
105	105	—	0	Intake Manifold Temperature High
107	107	—	3	Air Filter Sensor Open Circuit
107	107	—	4	Air Filter Sensor Short to Ground
110	110	—	14	Engine Coolant Temperature Very High
110	110	—	0	Engine Coolant Temperature High
110	110	—	4	Engine Coolant Temperature Short to Ground
110	110	—	3	Engine Coolant Temperature Open Circuit
111	111	—	1	Coolant Level Low
111	111	—	3	Coolant Level Sensor Open Circuit
111	111	—	4	Coolant Level Sensor Short to Ground
158	158	—	0	Switched Battery Voltage High
158	158	—	1	Switched Battery Voltage Low
158	158	—	2	Switched Battery Voltage Does Not match PLD-MR and VCU
168	168	—	3	Battery Voltage High
168	168	—	4	Battery Voltage Low
174	174	—	3	Fuel Temperature Open Circuit
174	174	—	4	Fuel Temperature Short to Ground
175	175	—	3	Engine Oil Temperature Open Circuit
175	175	—	4	Engine Oil Temperature Short to Ground
190	190	—	0	Engine Speed High
527	—	254		
558	—	230	5	Idle Validation Switch Open Circuit

J1939 SPN	J1587 PID	J1587 SID	FMI	Description
558	—	230	12	Both Idle Validation Switches Closed Idle Validation Switch not Idle and Accelerator Pedal Signal Idle Idle Validation Switch Idle and Accelerator Pedal Signal not Idle
599	—	242	12	Cruise Control Switch Contact Set + Coast — Both SET and RES Contacts Closed at the Same Time
601	—	243	12	Cruise Control Switch Contact
609	—	233	2	Anti-Theft Device Wrong Key
609	—	233	14	Anti-Theft Counter Overflow
609	—	233	9	Anti-Theft – No Transponder Code on Hardwire
609	—	233	2	Anti-Theft – No Transponder Code on Proprietary Data Link
609	—	233	11	Anti-Theft – Self-locking Active
609	—	233	0	Anti-Theft – No Additional Key Can be Learned
609	—	233	14	PLD-MR EEPROM Check Sum Error
609	—	233	12	PLD-MR Bad Device – Starter Driver Path 2 Failed PLD-MR Bad Device – High Side Driver Failed PLD-MR Bad Device – PVB1 Defect PLD-MR Bad Device – PVB2 Defect PLD-MR Bad Device – PVB5 Defect PLD-MR Bad Device – RAM Area for CAN Failed
609	—	233	11	PLD-MR Bad Device – Data Map Manipulated/Delayed “Switch Off” Defect
609	—	233	14	PLD-MR Programming – Wrong # of Cylinders Programmed PLD-MR Programming – # of Cylinders Does Not Match Engine Type PLD-MR Programming – Calibration PWM Outputs not Valid PLD-MR Programming – Wrong Hardware Reference
620	—	232	3	Throttle Pedal Supply Above Normal
620	—	232	4	Throttle Pedal Supply Below Normal
625	—	248	14	Proprietary Data Link CAN High Line Failed Proprietary Data Link CAN Low line Failed
625	—	248	2	Proprietary Data Link – No Communication to PLD Proprietary Data Link – PLD Data Erroneous Proprietary Data Link – VCU Data Erroneous Proprietary Data Link – No Communication to VCU
629	—	254	12	VCU Internal Error – Checksum Fault Flash VCU Internal Error – Checksum Fault EEPROM VCU Internal Error – DLU Status VCU Internal Error – FMS Status VCU Internal Error – FSS Status
633	—	21	1	Crankshaft Position Sensor Signal Voltage Too Low
633	—	21	7	No Match of Camshaft and Crankshaft Signals

J1939 SPN	J1587 PID	J1587 SID	FMI	Description
633	—	21	8	Crankshaft Position Sensor Time Out
633	—	21	14	Crankshaft Position Sensor Pins Swapped
633	—	21	4	Crankshaft Position Sensor Short to Ground
633	—	21	3	Crankshaft Position Sensor Open Circuit
651	—	1	6	Injector Cylinder #1 Shorted Circuit
651	—	1	7	Injector Cylinder #1 No Plunger
651	—	1	5	Injector Cylinder #1 Current Below Normal or Open Circuit
651	—	1	4	Injector Cylinder #1 – Short to Ground on Bank 1 Injector Cylinder #1 – Short to Ground on Bank 2
651	—	1	3	Injector Cylinder #1 – Short to Ubat on Bank 1 Injector Cylinder #1 – Short to Ubat on Bank 2
651	—	1	12	Injector Cylinder #1 – Idle Smoothness Governor at Limit
651	—	1	14	Injector Cylinder #1 – Single Cylinder Correction at Limit
652	—	2	6	Injector Cylinder #2 Shorted Circuit
652	—	2	7	Injector Cylinder #2 No Plunger
652	—	2	5	Injector Cylinder #2 Current Below Normal or Open Circuit
652	—	2	12	Injector Cylinder #2 – Idle Smoothness Governor at Limit
652	—	2	14	Injector Cylinder #2 – Single Cylinder Correction at Limit
653	—	3	6	Injector Cylinder #3 Shorted Circuit
653	—	3	7	Injector Cylinder #3 No Plunger
653	—	3	5	Injector Cylinder #3 Current Below Normal or Open Circuit
653	—	3	12	Injector Cylinder #3 – Idle Smoothness Governor at Limit
653	—	4	14	Injector Cylinder #3 – Single Cylinder Correction at Limit
654	—	4	6	Injector Cylinder #4 Shorted Circuit
654	—	4	7	Injector Cylinder #4 No Plunger
654	—	4	5	Injector Cylinder #4 Current Below Normal or Open Circuit
654	—	4	12	Injector Cylinder #4 – Idle Smoothness Governor at Limit
654	—	4	14	Injector Cylinder #4 – Single Cylinder Correction at Limit
655	—	5	6	Injector Cylinder #5 Shorted Circuit
655	—	5	7	Injector Cylinder #5 No Plunger
655	—	5	5	Injector Cylinder #5 Current Below Normal or Open Circuit
655	—	5	12	Injector Cylinder #5 – Idle Smoothness Governor at Limit
655	—	5	14	Injector Cylinder #5 – Single Cylinder Correction at Limit
656	—	6	6	Injector Cylinder #6 Shorted Circuit

J1939 SPN	J1587 PID	J1587 SID	FMI	Description
656	—	6	7	Injector Cylinder #6 No Plunger
656	—	6	5	Injector Cylinder #6 Current Below Normal or Open Circuit
656	—	6	12	Injector Cylinder #6 – Idle Smoothness Governor at Limit
656	—	6	14	Injector Cylinder #6 – Single Cylinder Correction at Limit
657	—	7	6	Injector Cylinder #7 Shorted Circuit
657	—	7	7	Injector Cylinder #7 No Plunger
657	—	7	5	Injector Cylinder #7 Current Below Normal or Open Circuit
657	—	7	12	Injector Cylinder #7 – Idle Smoothness Governor at Limit
657	—	7	14	Injector Cylinder #7 – Single Cylinder Correction at Limit
658	—	8	6	Injector Cylinder #8 Shorted Circuit
658	—	8	7	Injector Cylinder #8 No Plunger
658	—	8	5	Injector Cylinder #8 Current Below Normal or Open Circuit
658	—	8	12	Injector Cylinder #8 – Idle Smoothness Governor at Limit
658	—	8	14	Injector Cylinder #8 – Single Cylinder Correction at Limit

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