Installation Guide

Eaton Hybrid Transmissions TRIG2000 EN-US

June 2013

EH-8E406A-CD
EH-6E706B-CD
EH-6E706B-P
EH-8E406A-P
EH-8E406A-UP
EH-8E406A-UPG
EH-8E406A-T
EH-8E406A-CDG
EH-8E406A-CDR
EH-8FA0406A-PSB

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Warnings and Cautions

The description and specifications contained in this service publication are current at the time of printing.

Eaton Corporation reserves the right to discontinue or modify its models and/or procedures and to change specifications at any time without notice.

Any reference to brand name in this publication is made as an example of the types of tools and materials recommended for use and should not be considered an endorsement. Equivalents may be used.

WARNING: Before welding, the 12-volt batteries must be disconnected and isolated, the battery box must be protected from excessive heat, and must caution must be observed around the high-voltage lines (orange wire and conduit).

WARNING: The High Voltage components on this system are identified with a warning or danger label. The High Voltage wiring is covered in orange insulation or convoluted tubing.

WARNING: All high voltage AC and DC cables are required to contain a warning label at each connector end that is attached to the cable and easily viewable.The label must stay affixed to the cable and remain readable for the life of the product

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WARNING: Use CO2 or Dry Chemical Fire Extinguishers. Do not use water to extinguish a fire on this truck.

WARNING: Do NOT cut into high voltage cables - see High Voltage diagram in vehicle.

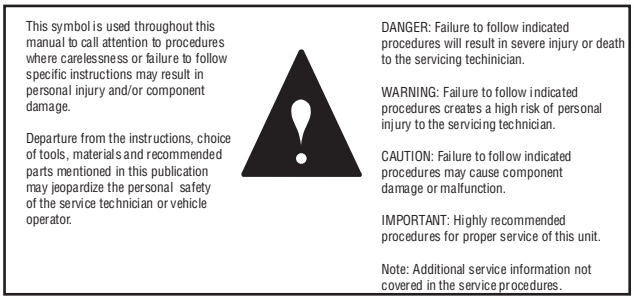
WARNING: Do NOT cut into, open or remove the PEC - see High Voltage diagram in vehicle.

WARNING: Do NOT cut into, open or remove the DC/DC converter - see High Voltage diagram in vehicle.

WARNING: Do NOT cut into, open or remove the Inverter - see High Voltage diagram in vehicle.

WARNING: High voltage cables should always be capped if they are not connected at both ends. If the vehicle is to be moved during phases of installation the components should be capped at the terminals and the cable removed until such time it can be connected at both ends.

Note: Refer to the High Voltage diagram in the vehicle for the location of high voltage components.



Failure to use genuine Eaton parts may cause damage and void warranty.

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How to Use this Manual

This Eaton publication is intended to be a reference guide for the installation of the Hybrid Transmission. General vehicle and transmission information is provided to cover the wide range of applications. This information benefits the OEM installer by providing the correct installation procedures to ensure the utmost in satisfactory operation and long service life. For additional transmission information, see the Suggested Tools section in the back of this manual. For specific engine information contact the engine OEM.

This Installation Guide provides installation procedures, requirements, and recommendations which are collectively required and necessary for the proper functioning of Eaton Hybrid Systems. Failure to follow these procedures, recommendations, and requirements will void the warranty in certain cases. Please contact your Eaton representative before taking any action departing from this Installation Guide. ATTENTION RISK OF VOIDING WARRANTY.

Hybrid transmissions are compatible with electronically governed engines equipped with a J1939 data link and certified by Eaton Corporation. Transmissions installed at OEM facilities must meet and be approved by Eaton Application Engineering. Contact Eaton Application Engineering or your OEM Application Engineering department for the proper application form. All applications must be submitted for approval.

OEM facilities must submit a design package to Eaton Corporation OEM Engineering Support Group for approval prior to any OEM build. A design package consists of the following information.

OEM Design Package

Electrical Systems

Wiring Schematic: This should show how the Hybrid would interface with the vehicle.

Individual Harness Drawings: This should show the construction of each harness.

Harness Routings: This should show how each harness is routed in the vehicle. The locations of relays, fuses, power connections, tie-downs, etc.

Hybrid Cooling System

Heat Exchanger sizing and requirements

Reservoir specifications

Water Pump flow

Wiring

Cooler line routing and requirements

Clutch System

Engine System

Chassis System

GVW

Tires

PTO

Axle Ratio

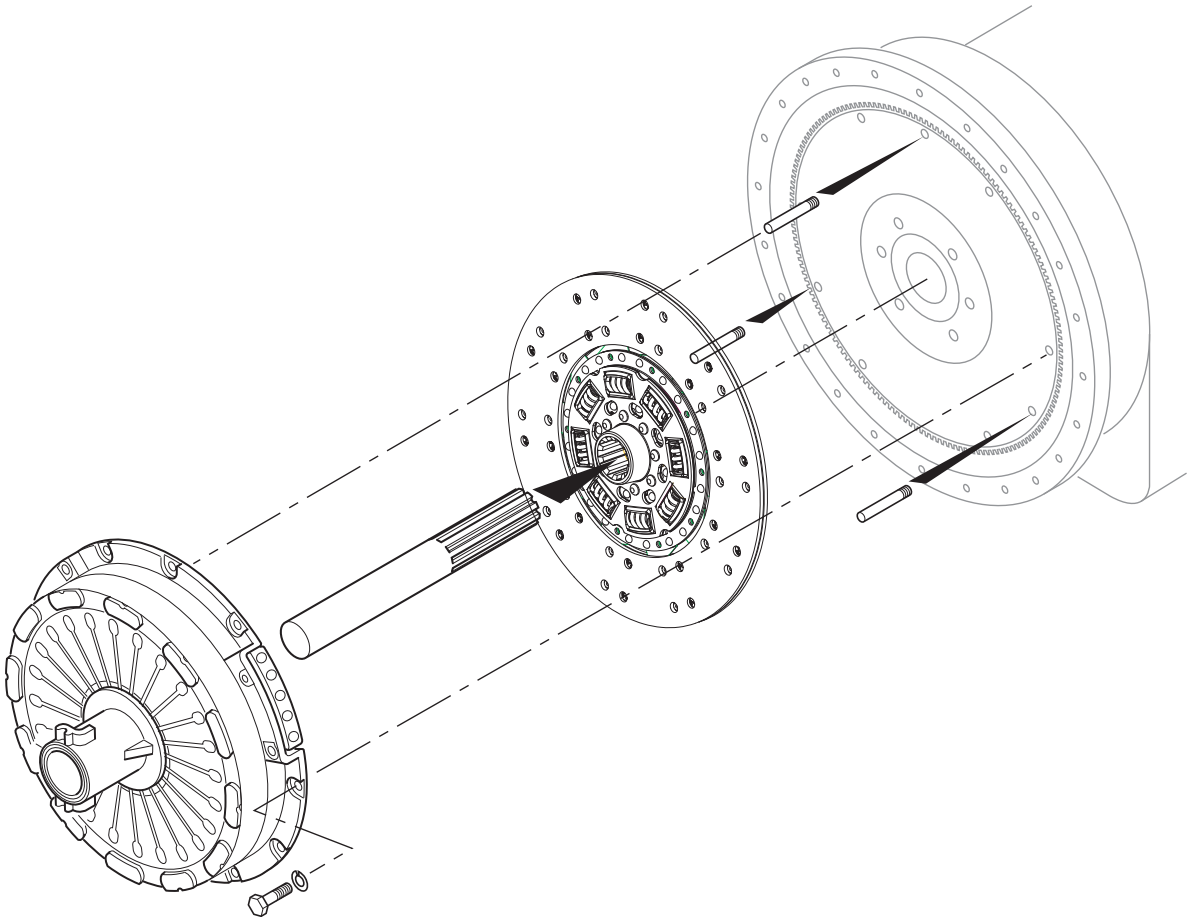
Cab Aerodynamic

J1939 Chassis Controller

Cab ICU requires J1939 interface

Every effort has been made to ensure the accuracy of the information contained in this manual. However, Eaton Corporation makes no warranty, either expressed or implied, based on the information provided. With each new application, engine manufactures should be contacted to make sure desired engines are compatible with these systems.

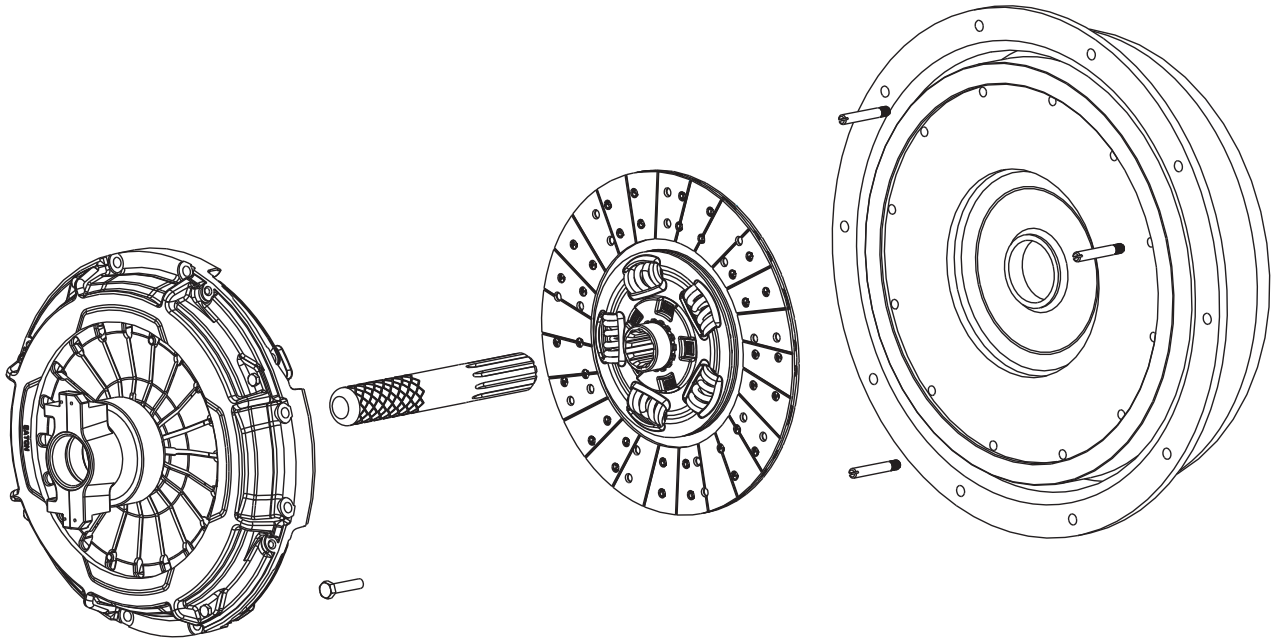
Clutch Requirements



Note: Eaton supplied 365mm clutch must be used.

365 Clutch Installation Requirements

1. Install three guide studs into mounting holes.
2. Install disc onto aligning tool. Follow the orientation instructions on the disc.
3. Put aligning tool with disc into flywheel. Verify aligning tool pilot is through the pilot bearing.
4. Slide clutch assembly over aligning tool and three guide studs.
5. Install lock washers and (9) 3/8 -16 x 1-1/4” grade 5 or better mounting bolts finger tight. Replace studs with lock washers and bolts. Progressively tighten bolts in a crisscross pattern starting with a lower bolt. Torque the 365mm clutch to 30-35 lb-ft. [40-47 N•m]
6. Remove aligning tool.

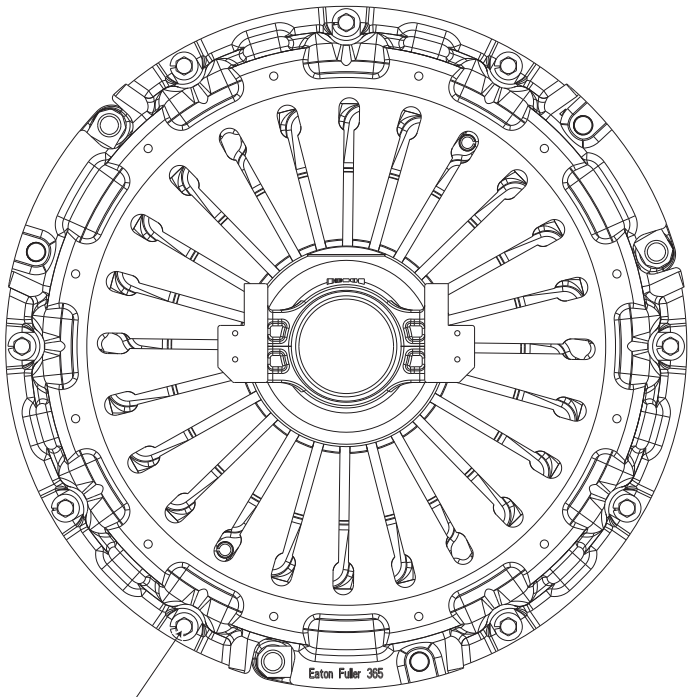


Note: Eaton supplied 395mm clutch must be used.

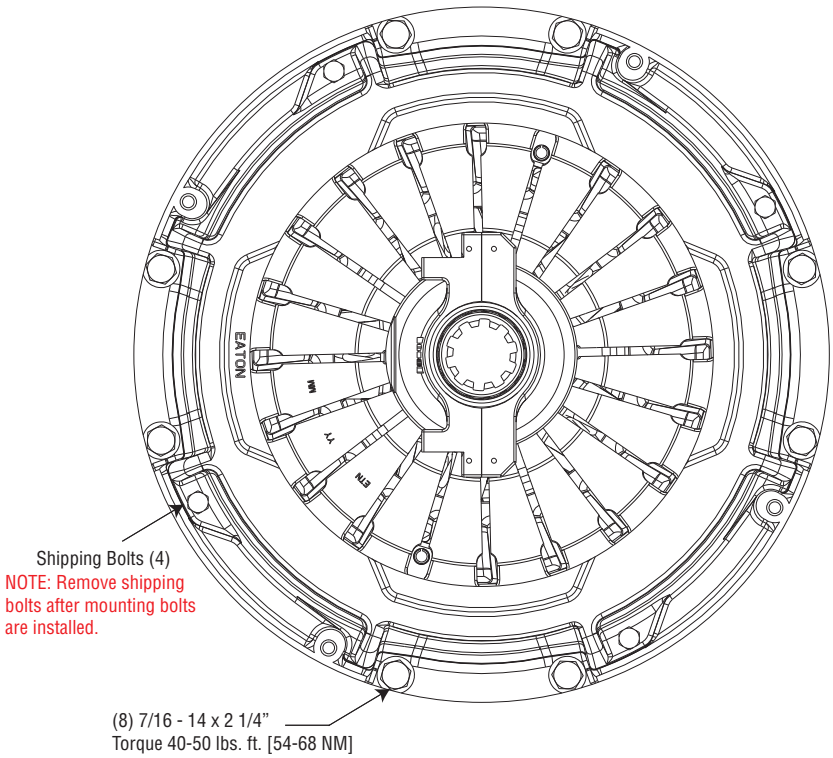
395 Clutch Installation Requirements

1. Install two guide studs into mounting holes.
2. Install disc onto aligning tool. Follow the orientation instructions on the disc.
3. Put aligning tool with disc into flywheel. Verify aligning tool pilot is through the pilot bearing.
4. Slide clutch assembly over aligning tool and two guide studs.
5. Install lock washers and (8) 7/16 -14 x 2 1/4" grade 5 or better mounting bolts finger tight. Replace studs with lock washers and bolts. Progressively tighten bolts in a crisscross pattern starting with a lower bolt. Torque the 395mm to 40-50 lb-ft. [54-68 N•m].
6. Remove (4) yellow shipping bolts.
7. Remove aligning tool.

365mm Mounting Bolts



395mm Mounting Bolts and Shipping Bolts



System Integration

The Hybrid Drive Unit interfaces with many different components installed on the vehicle such as the engine, shift input device, gear display, service lamp, body controller, ABS and electronic dash. SAE J1939 and J1587 data links are standard means to transfer data to other components. Successful system integration is essential to ensure the utmost satisfactory operation of the vehicle. The following sections summarize the Hybrid Drive Unit System Integration Requirements.

SAE J1939 Data Link Broadcast Messages

SPNs listed below are standard on Hybrid. Unused data in a PGN is broadcast as “Not Available.” The inability of Hybrid to distribute valid data will result in “Error Indicator” or “Not Available” being broadcast. Reference SAE J1939-71 and SAE J1939-73 for complete specification.

Active Diagnostic Trouble Codes 1 (DM1) - pgn65226

Source Address: 3 (Transmission #1)			
Transmission Repetition Rate: On change, 1 s			
Start Position	**Length**	**Parameter Name**	**SPN**
1.3	2 bits	Amber Warning Lamp Status	624

Source Address: EF (Hybrid Control Module #1)			
Transmission Repetition Rate: On change, 1 s			
Start Position	**Length**	**Parameter Name**	**SPN**
1.5	2 bits	Red Stop Lamp Status	623
1.3	2 bits	Amber Warning Lamp Status	624
5.6	19 bits	SPN	1214
5.1	5 bits	FMI	1215

Note: The Red and Amber lamps will light in response to the lamp status.

Electronic Transmission Controller 1 (ETC1) - pgn61442

Source Address: 3 (Transmission #1)			
Transmission Repetition Rate: 10 ms			
Start Position	**Length**	**Parameter Name**	**SPN**
1.1	2 bits	Driveline Engaged	560
1.5	2 bits	Shift In Process	574
2-3	2 bytes	Output Shaft Speed	191
5.1	2 bits	Momentary Engine Overspeed Enable	606
5.3	2 bits	Progressive Shift Disable	607
6-7	2 bytes	Input Shaft Speed	161

Electronic Transmission Controller 2 (ETC2) - pgn61445

Source Address: 3 (Transmission #1)

Transmission Repetition Rate: On change, 100 ms for display characters, 1 s for control characters

Start Position	Length	Parameter Name	SPN
1	1 byte	Selected Gear	524
2-3	2 bytes	Actual Gear Ratio	526
4	1 byte	Current Gear	523
5-6	2 bytes	Transmission Requested Range	162
7-8	2 bytes	Transmission Current Range	163

Note: The alphanumeric character in byte 7 is to be displayed to the left of the alphanumeric character in byte 8. If only one character is required, then byte 7 shall contain an ASCII space. Byte 8 shall contain the single character. See "Minimum Gear Display Alphanumeric Combinations" in this section for more details.

Defined Control Characters
When a control action is sent, the display characters shall not change. For example, if a '4' was shown prior to an arrow being displayed, then a '4' will remain on the display while the request for an arrow is given.

Control Type	Byte 7	Byte 8 Bits	8	7	6	5	4	3	2	1
Up / Down Arrow	0x00	No Arrow	-	-	-	-	-	-	**0**	**0**
		Up Arrow	-	-	-	-	-	-	**0**	**1**
		Down Arrow	-	-	-	-	-	-	**1**	**0**
		Up Arrow & Down Arrow	-	-	-	-	-	-	**1**	**1**
Tone (Cadence controlled by Gen 3)	0x00	Undefined	-	-	-	-	**1**	**0**	-	-
		Tone Off	-	-	-	-	**0**	**0**	-	-
		Tone On	-	-	-	-	**0**	**1**	-	-
		Undefined	-	-	-	-	**1**	**1**	-	-
Reserved	0x00	Default Unused State	**1**	**1**	**1**	**1**	-	-	-	-

Electronic Transmission Controller 7 (ETC7) – pgn65098

Source Address: 3 (Transmission #1)			
Transmission Repetition Rate: 100 ms			
Start Position	**Length**	**Parameter Name**	**SPN**
4	1 byte	Transmission Requested Gear Feedback	3289

Torque/Speed Control 1 (TSC1) - pgn0

Source Address: 3 (Transmission #1) to either 15 (Retarder – Engine) or 41 (Retarder, Exhaust, Engine #2) Note: TSC1 will be broadcast to the Source Address sending valid Actual Retarder Percent Torque (pgn61440, SPN 520). Actual Retarder Percent Torque is monitored for valid data from either Source Address 15 or 41. Source Address 41 shall be used anytime valid data is received from both addresses.			
Transmission Repetition Rate: When actively controlling brake, 50 ms.			
Start Position	**Length**	**Parameter Name**	**SPN**
1.1	2 bits	Override Control Mode	695
1.5	2 bits	Override Control Mode Priority	897
4	1 byte	Engine Requested Torque/Torque Limit	518

Torque/Speed Control 1 (TSC1) - pgn0

Source Address: 3 (Transmission #1) to 0 (Engine #1) Source Address: 239 (Hybrid) to 0 (Engine #1)			
Transmission Repetition Rate: When actively controlling engine, 10 ms.			
Start Position	**Length**	**Parameter Name**	**SPN**
1.1	2 bits	Engine Override Control Mode	695
1.3	2 bits	Engine Requested Speed Control Conditions	696
1.5	2 bits	Override Control Mode Priority	897
2-3	2 bytes	Engine Requested Speed/Speed Limit	898
4	1 byte	Engine Requested Torque/Torque Limit	518

Cruise Control/Vehicle Speed (CCVS) - pgn65265

Source Address: 0 (Engine #1), 17 (Cruise Control), 23 (Instrument Cluster #1), 33 (Body Controller)

Note: First Source Address supported with valid data is latched for power cycle. Source Address sending valid Brake Switch data will be monitored for valid Clutch Switch and Parking Brake Switch data. Wheel-Based Vehicle Speed can be sent from a different Source Address then that sending Brake Switch data.

Transmission Repetition Rate: 100 ms

Start Position	Length	Parameter Name	SPN
1.3	2 bits	Parking Brake Switch	70
2-3	2 bytes	Wheel-Based Vehicle Speed	84
4.5	2 bits	Brake Switch	597

Electronic Engine Controller 1 (EEC1) - pgn61444

Source Address: 0 (Engine #1)

Transmission Repetition Rate: Engine Speed Dependent

Start Position	Length	Parameter Name	SPN
2	1 byte	Driver's Demand Engine – Percent Torque	512
3	1 byte	Actual Engine – Percent Torque	513
4-5	2 bytes	Engine Speed	190

Electronic Engine Controller 2 (EEC2) - pgn61443

Source Address: 0 (Engine #1), 17 (Cruise Control), 23 (Instrument Cluster #1), 33 (Body Controller)

Transmission Repetition Rate: 50 ms

Start Position	Length	Parameter Name	SPN
2	1 byte	Accelerator Pedal Position 1	91

Electronic Engine Controller 3 (EEC3) - pgn65247

Source Address: 0 (Engine #1)

Transmission Repetition Rate: 250 ms

Start Position	Length	Parameter Name	SPN
1	1 byte	Nominal Friction – Percent Torque	514
5	1 byte	Estimated Engine Parasitic Losses – Percent Torque	2978

Electronic Retarder Controller 1 (ERC1) - pgn61440

Source Address: 15 (Retarder – Engine), 41 (Retarder, Exhaust, Engine #1)

Transmission Repetition Rate: 100 ms			
Start Position	**Length**	**Parameter Name**	**SPN**
1.5	2 bits	Retarder Enable – Brake Assist Switch	571
2	1 byte	Actual Retarder – Percent Torque	520

Engine Configuration (EC) - pgn65251

Source Address: 0 (Engine #1)			
Transmission Repetition Rate: On change of torque/speed points of more than 10% since last transmission. Alternatively, or every 5 s.			
Start Position	Length	Parameter Name	SPN
1-2	2 bytes	Engine Speed At Idle, Point 1	188
3	1 byte	Percent Torque At Idle, Point 1	539
4-5	2 bytes	Engine Speed At Point 2	528
6	1 byte	Percent Torque At Point 2	540
7-8	2 bytes	Engine Speed At Point 3	529
9	1 byte	Percent Torque At Point 3	541
10-11	2 bytes	Engine Speed At Point 4	530
12	1 byte	Percent Torque At Point 4	542
13-14	2 bytes	Engine Speed At Point 5	531
15	1 byte	Percent Torque At Point 5	543
16-17	2 bytes	Engine Speed At High Idle, Point 6	532
20-21	2 bytes	Reference Engine Torque	544
22-23	2 bytes	Maximum Momentary Engine Override Speed	533

Electronic Brake Controller 1 (EBC1) - pgn 61441

Source Address: 11 (Electronic Brake Controller 1)			
Transmission Repetition Rate: 100 ms			
Start Position	**Length**	**Parameter Name**	**SPN**
1.5	2 bits	Anti-Lock Braking (ABS) Active	563

Auxiliary Input/Output Status (AuxIO) - pgn65241

Source Address: 33 (Body Controller)			
Transmission Repetition Rate: 100 ms			
Start Position	**Length**	**Parameter Name**	**SPN**
1.3	2 bits	OK to Crank	703
1.5	2 bits	PTO Engaged	702
1.7	2 bits	Prohibit Driving	701
2.3	2 bits	Mechanical PTO request	707
2.5	2 bits	Request Engine Run	706
2.7	2 bits	Hydraulic Demand	705

Auxiliary Input/Output Status (AuxIO) - pgn65241

Source Address: 239 (Hybrid Control Module)			
Transmission Repetition Rate: 100 ms			
Start Position	**Length**	**Parameter Name**	**SPN**
1.1	2 bits	ePTO Request	704
1.5	2 bits	APG Mode Confirmation	702
1.7	2 bits	PTO Mode Confirmation	701
2.1	2 bits	Amber Warning Lamp	708
2.3	2 bits	Red Warning Lamp	707
2.5	2 bits	HCM PDM Mode Confirmation	706
3.5	2 bits	Mechanical PTO Confirmation	710

Engine Temperature 1 (ET1) - pgn65262

Source Address: 0 (Engine #1)			
Transmission Repetition Rate: 0.5 second			
Start Position	**Length**	**Parameter Name**	**SPN**
1	1 byte	Engine Coolant Temperature	110

Time/Date (TD) - pgn65254

Source Address: Global			
Transmission Repetition Rate: On request			
Start Position	**Length**	**Parameter Name**	**SPN**
1	1 byte	Seconds	959
2	1 byte	Minutes	960
3	1 byte	Hours	961
4	1 byte	Month	963
5	1 byte	Day	962
6	1 byte	Year	964
7	1 byte	Local minute offset	1601
8	1 byte	Local hour offset	1602

Vehicle Distance - pgn65248

Source Address: Global			
Transmission Repetition Rate: 100 ms			
Start Position	**Length**	**Parameter Name**	**SPN**
5-8	4 bytes	Total Vehicle Distance	245

SAE J1587 Data Link Broadcast Messages

Note: Unused data in a PID is broadcast as “Not Available.” Reference SAE J1587 for complete specification.

Broadcast Period	Parameter Name	PID
100 ms	Transmission Output Shaft Speed	191
400 ms	Text Message to Display **Note:** PID 226 controls the tone. Cadence of the tone is controlled by Hybrid.	226
500 ms	Transmission Range Selected	162
	Transmission Range Attained	163
1.0 s	Battery Potential (Voltage)	168
Upon change or 15 s while fault active	Transmitter System Diagnostic Code and Occurrence Count Table	194
On Request	Clutch Cylinder Position	33
	Transmission Synchronizer Brake Value	54
	Transmission Actuator Status #2	57
	Shift Finger Actuator Status	58
	Shift Finger Gear Position	59
	Shift Finger Rail Position	60
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	Vehicle Enabling Component Status	66
	Shift Request Shift Status	67
	Battery Potential (Voltage) - Switched	158
	Transmission Main Shaft Speed	160
	Transmission Input Shaft Speed	161
	Engine Speed	190
	Multi-Section Parameter	192
	Diagnostic Data Request/Clear Count	195
	Diagnostic Data/Count Clear Response	196
	Software Identification	234
	Component Identification Parameter	243
	Total Vehicle Hours	246

Service Lamp

The Hybrid HCM and TECU each contain a service lamp output at J1-23. This output should be wired into the 4-pin diagnostic connector that also contains the HCM powers and grounds. Refer to the wiring schematic or TECU and HCM interface for correct pin location.

Note: These lamp outputs may be used to power additional service lamps on the dash.

J1939 Service Lamps

The Hybrid System requires a J1939 smart dash that supports the “Check Hybrid (amber lamp)” and “Stop Hybrid (red lamp)” lamps.

Gear Display

The OEM is responsible for supplying the Gear Display, Wiring, and its location per FMVSS.

A Gear Display is required for proper operation of Hybrid Drive Unit. The Gear Display shall interface with Hybrid by either SAE J1939 (ETC2) or J1587 (PID 226). The Gear Display offers real-time information pertaining to current engaged gear, engagement status during gear shifting, transmission synchronization during shifting, transmission fault status and diagnostic code information.

Gear Display shall adhere to the following requirements.

1. For J1587, display time of a message shall be set to 5 seconds to avoid display blanking during heavy bus loads.
2. Driver shall be able to clearly see the display from the normal driving position continuously during vehicle operation.
3. Gear Display shall be blank upon initial power up.
4. Gear Display shall be capable of displaying messages within 2 seconds of ignition key-on.
5. In order to provide real-time feedback of the selection/shifting/engagement process of transmission, the device must be able to display the received message within 75 milliseconds.
6. Whenever bus communications are active and anytime ETC2/PID 226 message is not received within 5 seconds of the last valid message or message received contains a character not supported, the display shall be blank.
7. Whenever bus communications are not active, a “** ” shall be displayed. As a minimum, Gear Display must support two character alphanumeric messages with the addition of two sets of display arrows (up and down) either side of the numerals.
8. As a minimum, Gear Display shall be able to display all two character numeric combinations and alphanumeric combinations listed in the table below.
9. It is preferred that the Gear Display support all uppercase letters to support product enhancements.

Minimum Gear Display Alphanumeric Combinations

Display	First Character (dec. / hex / char)	Second Character (dec. / hex / char)	Comments
R4	82 / 52 / "R"	52 / 34 / "4"	“R” = “reverse”
R3	82 / 52 / "R"	51 / 33 / "3"	“R” = “reverse”
R2	82 / 52 / "R"	50 / 32 / "2"	“R” = “reverse”
R1	82 / 52 / "R"	49 / 31 / "1"	“R” = “reverse”
P	30/20/” “	80/50/”P”	“P” = “park”
N	32 / 20 / “ "	78 / 4E / "N"	“N” = “neutral”
1	32 / 20 / " "	49 / 31 / "1"	
2	32 / 20 / " "	50 / 32 / "2"	
3	32 / 20 / " "	51 / 33 / "3"	
4	32 / 20 / " "	52 / 34 / "4"	
5	32 / 20 / " "	53 / 35 / "5"	
6	32 / 20 / " "	54 / 36 / "6"	
7	32 / 20 / " "	55 / 37 / "7"	
8	32 / 20 / " "	56 / 38 / "8"	
9	32 / 20 / " "	57 / 39 / "9"	
10	49 / 31 / "1"	48 / 30 / "0"	
11	49 / 31 / "1"	49 / 31 / "1"	
12	49 / 31 / "1"	50 / 32 / "2"	
13	49 / 31 / "1"	51 / 33 / "3"	
14	49 / 31 / "1"	52 / 34 / "4"	
15	49 / 31 / "1"	53 / 35 / "5"	
16	49 / 31 / "1"	54 / 36 / "6"	
17	49 / 31 / "1"	55 / 37 / "7"	
18	49 / 31 / "1"	56 / 38 / "8"	
F	32 / 20 / " "	70 / 46 / "F"	“F” = “fault”
CA	67 / 43 / "C"	65 / 41 / "A"	“CA” = “clutch abuse”
L	32 / 20 / " "	76 / 4C / ”L”	“L” = “low gear”
ST	83 / 53 / "S"	84 / 54 / "T"	“ST” = “snap shot”
PD	80 / 50 / "P"	68 / 44 / "D"	“PD” = “product diagnostic”

Display	First Character (dec. / hex / char)	Second Character (dec. / hex / char)	Comments
-	32 / 20 / " "	45 / 2D / "-"	
	32 / 20 / " "	32 / 20 / " "	
**	42 / 2A / "*"	42 / 2A / "*"	

Shift Input Device

Shift Input Device shall be required for proper operation of Hybrid. Shift Input Device shall be on the Eaton proprietary HIL for all Hybrid systems except the Low Profile with Park which shall be an OEM supplied cable shift lever. A HIL Shift Input Device type shall be the only component that interfaces with the transmission via HIL.

Engine

Interface Requirements

Contact Eaton OEM Application Engineering for engine interface requirements.

Fan Drive Requirements

Accurate fan torque reporting with engine certification required.

Engine Configuration

Prior to shipment of Eaton Hybrid Transmission Systems installed at OEM plants, the engine ECU must contain the proper configuration settings. For the proper engine configuration settings required for Eaton Hybrid Transmission operation refer to the “Engine Configuration Settings Installation Guide (TRIG-0910)” on roadranger.com under the literature center.

Transmission Configuration

Prior to shipment of Eaton Hybrid Systems, the Transmission ECU and Hybrid HCM must go through the VEPS operation, so they contain the proper configuration settings and shift points.

Lubrication

Hybrid Transmission Gear Box Lubrication Requirements

Eaton Fuller transmissions are designed so the internal parts operate in a bath of lubricant circulated by the motion of gears and shafts. Thus, all parts will be amply lubricated if these procedures are closely followed:

⚠ CAUTION

CAUTION: When adding lubricant, types and brands of lubricant should not be mixed because of possible incompatibility.

CAUTION: Use clean lubricant and clean containers when filling the transmission. Containers that have been used for antifreeze or water should not be used for transmission lubricant.

CAUTION: Additives and friction modifiers are not recommended for use in Eaton Fuller transmissions.

Recommended Lubricant
Refer to Eaton publication TCMT-0020.

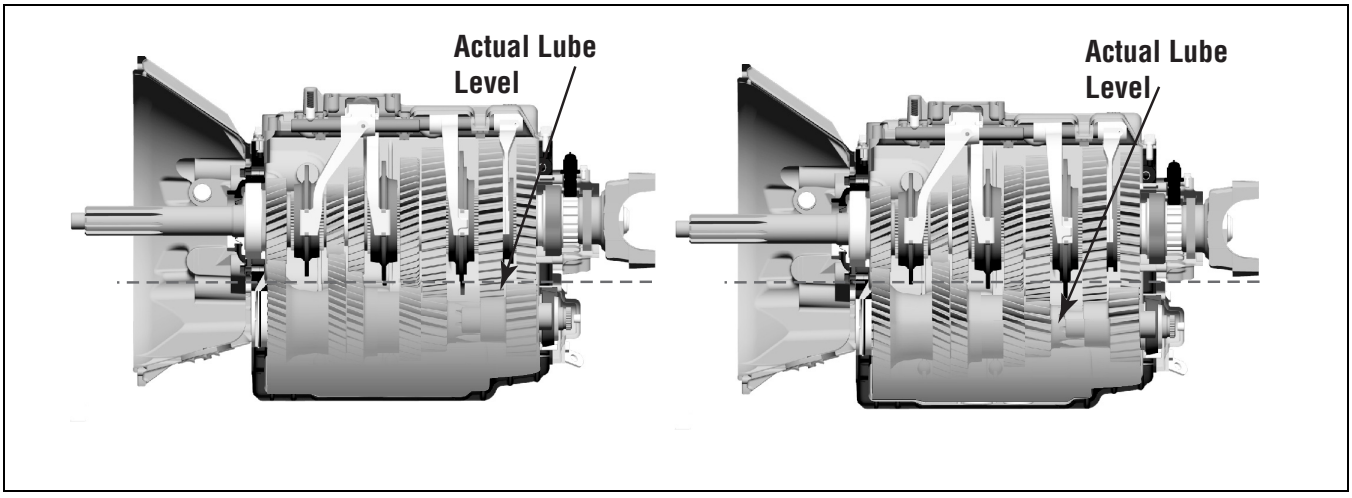
CAUTION: The quantity for proper fill level will vary from unit to unit. The exact amount of oil depends on the transmission inclination and cooling system capacity. Oil level should be checked at room temperature.

Transmission Capacity (Approximate)
Refer to TCMT0021 Lubrication Spec Guide

CAUTION: Failure to adhere to Eaton Installation Requirements may affect transmission performance and/or warranty coverage.

CAUTION: Make sure lubricant is level with fill hole opening. Because you can reach lubricant with your finger does not mean lubricant is at the proper level. (On heavy-duty transmissions, one inch of lubricant level equals about 8 pints of oil.)

CAUTION: DO NOT remove the Electric Shifter (X-Y Shifter) to fill the transmission with oil. The transmission must be filled through the fill hole.



Hybrid System Liquid Cooling

Note: If the Hybrid components, electrical or otherwise, are placed on the truck where they could obtain damage from road debris, spray, or will allow easy access or tampering to high voltage components they must be protected through appropriate coverings/brackets. The design and the manufacturing of these protective devices are the truck OEM's responsibility, however, Eaton application support engineering will provide assistance if the truck OEM requests.

1. A heat exchanger is required for the Hybrid drive unit.
   - Pickup and Delivery vehicles (no APG or ePTO) should be sized to dissipate 165 BTUs/min or 2.9 kW at 52°C.
   - Pickup and Delivery vehicles - It is recommended that if the heat exchanger does not include a fan that it is mounted in front of the engine radiator and air conditioning evaporator under the hood. This allows positive air flow during operation of the motor and vehicle without the additional packaging and power of a unit with a fan.
   - Pickup and Delivery - If the unit is not mounted underneath the hood, with or without a fan, it should be mounted perpendicular to the chassis or have proper shrouding to provide positive airflow and prevent buffeting when driving.
   - Utility vehicles (with APG and ePTO) should be sized to dissipate an additional 35.5 BTUs/min or 0.625 kW at 52°C per 5 kW APG (165 BTUs/min plus 35.5 BTUs/min per APG).
   - Utility vehicles - The heat exchanger must be equipped with a fan to provide positive airflow during stationary operation of the ePTO and APG.
   - Utility vehicles - If the unit is not mounted underneath the hood it should be mounted perpendicular to the chassis or have proper shrouding to provide positive airflow and prevent buffeting when driving.
2. The cooler and cooler connecting lines should be free of debris, dirt, grease, etc. before being attached to the transmission. If these conditions exist, cooler lines must be flushed or cleaned.
3. All fittings must comply with SAE J1926/1.
   - Fittings must have straight threads
   - Fittings must seal using o-rings
   - Nylon tape is prohibited
   - See specifications for more details
4. Cooler connecting lines should be routed in such a way as to prevent kinks, leaks and rubbing on other components. Use high temperature protection as required to protect against heat deterioration.
5. A minimum of 1" (25mm) I.D. cooler hose with at least one over braid (per SAE J20 rev 3) must be used for the Eaton Hybrid Cooling system. The cooler hose must meet the J20R3 or higher quality.
6. The recommended flow rate is 5.3 ± 0.3 gallons per minute with a minimum flow rate of 3.0 gallons per minute and a maximum flow rate of 9.0 gallons per minute.
7. Coolant:
   - 50/50 premix of Ethylene Glycol or Dexcool and distilled water are the only liquids to be used in the system.
   - The system is to be filled to the mid level of the reservoir.
8. Reservoir:
   - The reservoir is to be mounted above all the other components in the liquid cooling system to ensure any air is properly bled from the coolant.
   - A translucent material or sight glass is recommended to easily determine the level of the coolant.

- A minimum, recommended, and maximum level should be identified on the reservoir.
- It is recommended the inlet and outlet are not next to each other and at different heights (inlet above the outlet) to avoid air recirculating in the system.

9. Cooling System Components:

⚠ CAUTION

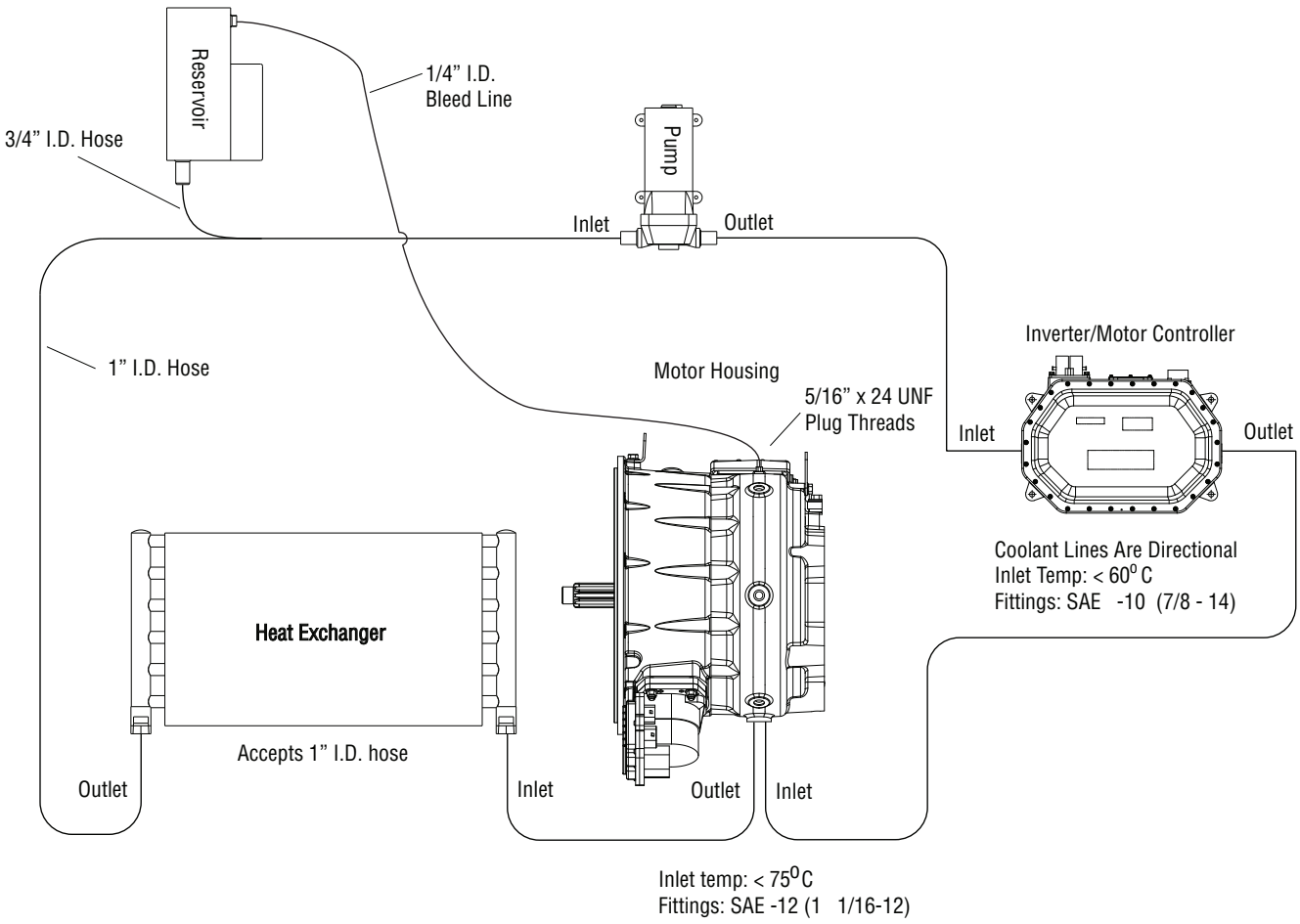
Inverter coolant connections are directional

Component Name	Order in the System	Inlet Fitting [SAE #]	Outlet Fitting [SAE #]	Pressure Drop @ 5.3 GPM (PSI)	Inlet Temperature
Inverter	1	7/8” - 14 UNF-2B [10]	7/8” - 14 UNF-2B [10]	2.4	<60°C
APG	2	1-1/16 - 12 UN-2B [12]	1-1/16 - 12 UN-2B [12]	3.8	<60°C
DC/DC Converter	3	7/8” - 14 UNF-2B [10]	7/8” - 14 UNF-2B [10]	0.6	<60°C
Motor Housing	4	1-1/16 - 12 UN-2B [12]	1-1/16 - 12 UN-2B [12]	7.6	<75°C
Heat Exchanger	5	Accepts 1” i.d. hose	Accepts 1” i.d. hose		
Reservoir	6				
Pump	7				

10. Testing Procedures: All OEM’s that install the hybrid system into their chassis/vehicles are required to complete the following testing to confirm their cooling systems meet the requirements defined above in this document.
    a. Any system that has ± 25 percent difference of hose length compared to any previously tested system must complete the flow testing defined below.
    b. All OEM’s must document test procedures, test data, and test results.
    c. Cooling System Flow - Flow test of the cooling system shall be performed to confirm that it meets the required flow rates. The system test shall include varying pump voltage from 9.0V to 15.0V for 12V system, and 21V to 27V for 24V systems.
    d. Heat rejection testing should be done to confirm that the liquid cooling system meets heat rejection specifications.
    e. For pickup and delivery applications the cooling system heat rejection should be tested as a sub-system on a bench. Additional in vehicle testing should be completed to verify the sub-system testing.
    f. For utility applications full sub-system and vehicle testing should be completed.
    g. Heat rejection testing should be done at various heat exchanger inlet temperatures, ambient, flow, and heat exchanger fan voltages.

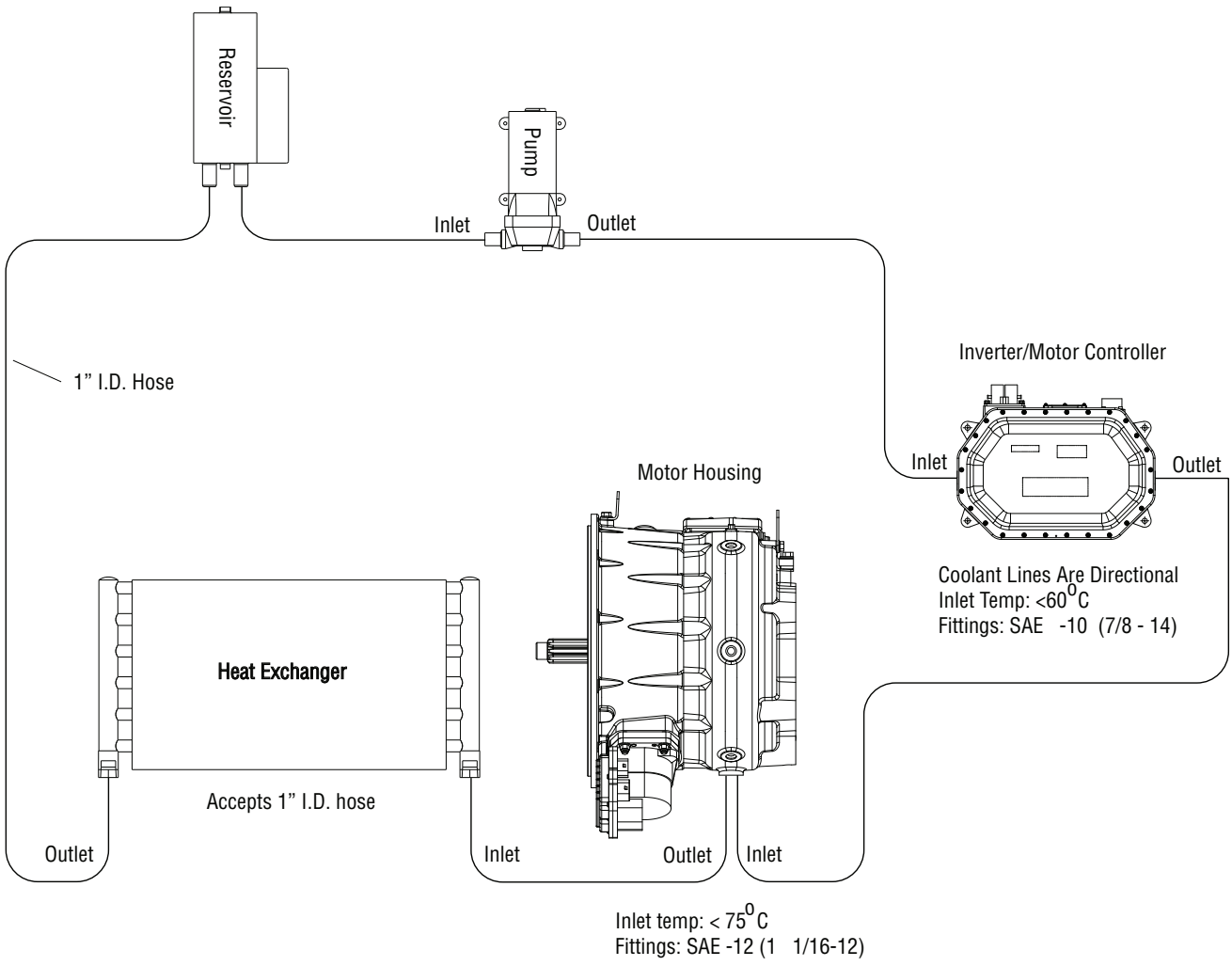
Base Hybrid System Cooling Circuit

Preferred Cooling Circuit

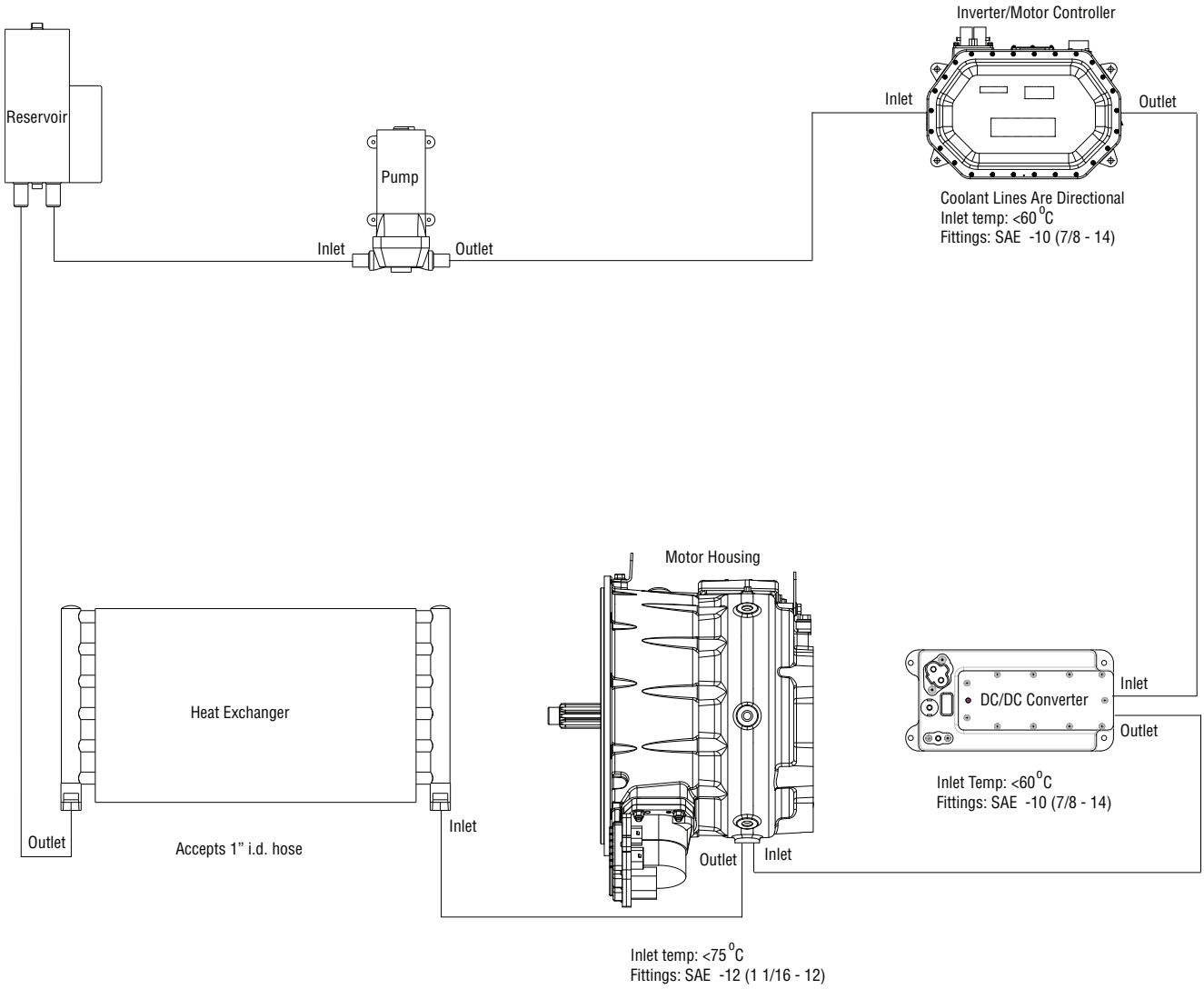


Base Hybrid System Cooling Circuit

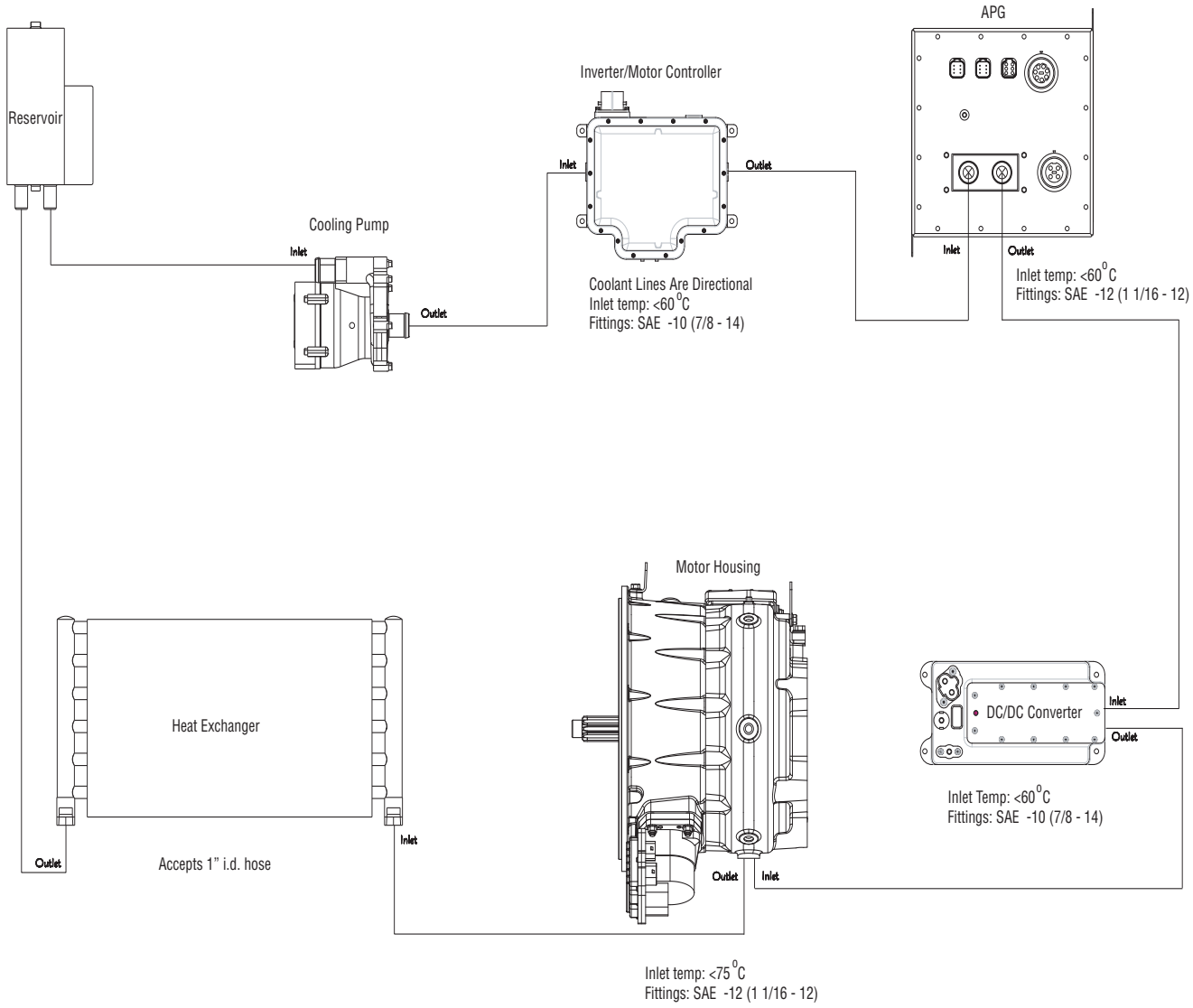
Standard Cooling Circuit



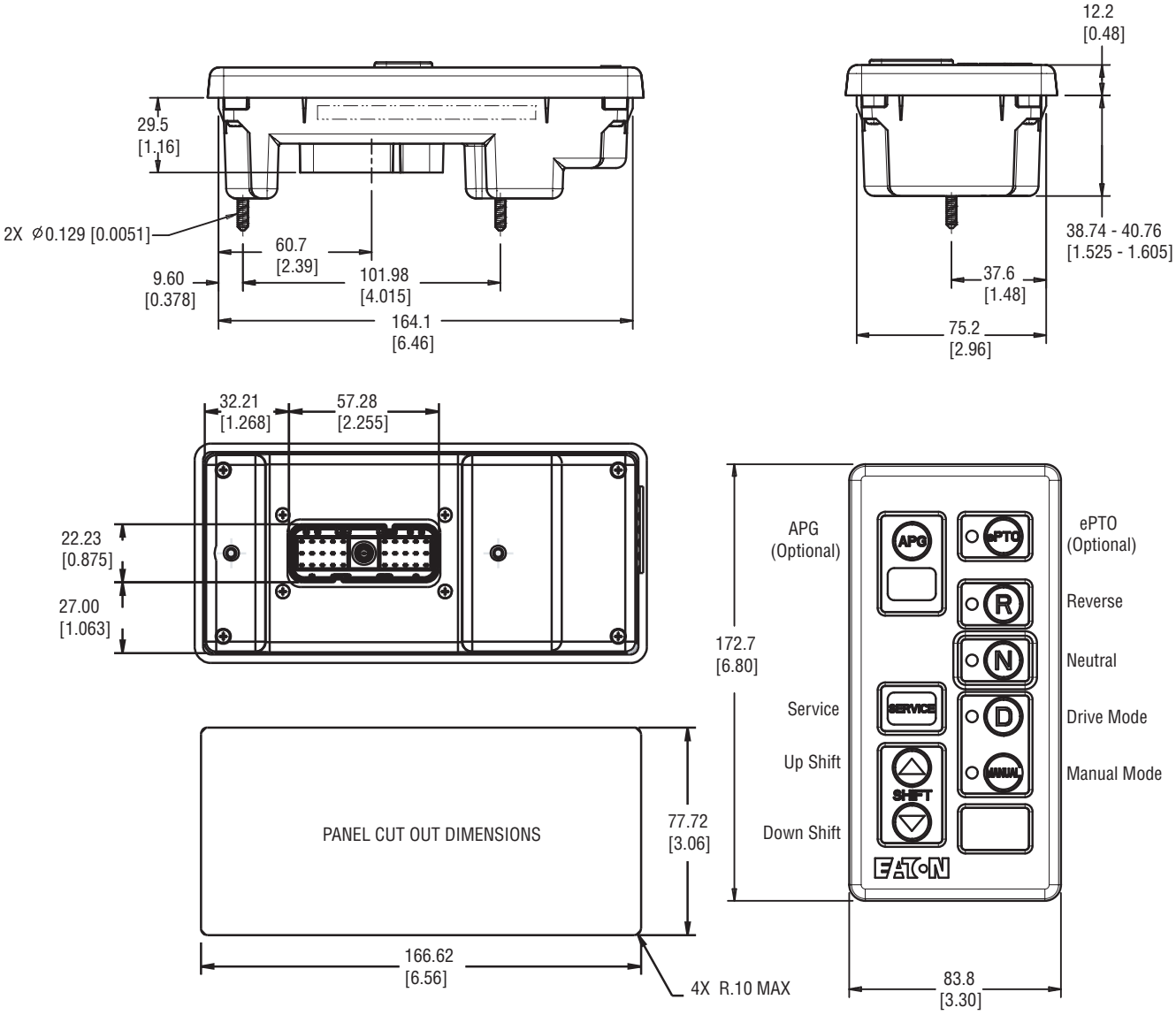
Base Hybrid System Cooling Circuit w/ DC/DC Converter



Base Hybrid System Cooling Circuit w/ DC/DC Converter and Alternative APG



Eaton Push Button Shift Control



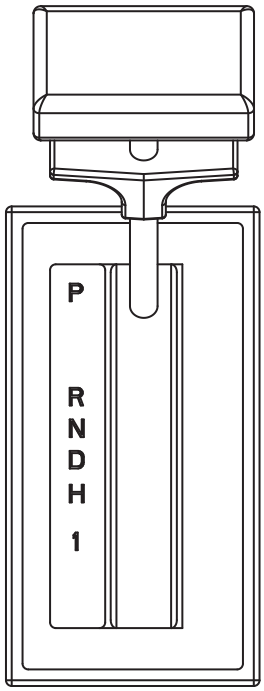
Eaton PBSC Installation Requirements

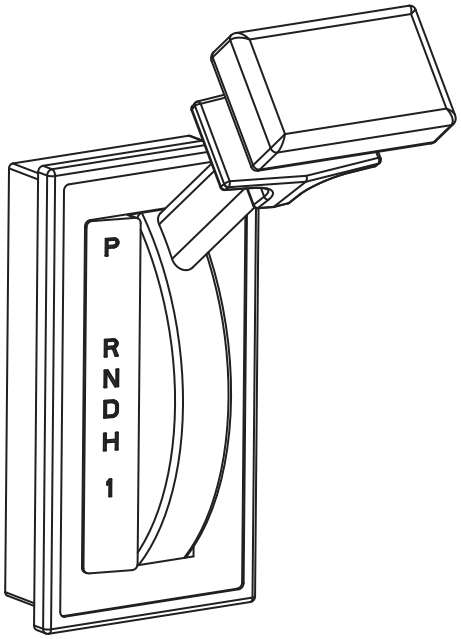
1. Delphi connector to Push Button Controller torque is 7.1 - 13.3 lb-in [0.8 - 1.5 N•m].
2. Backing plate nuts and lock washers should be torqued to 14 -16 lb-in [1.6 - 1.8 N•m].
3. Eaton Hybrid systems are only compatible with an Eaton Push Button Shift Control (see note).

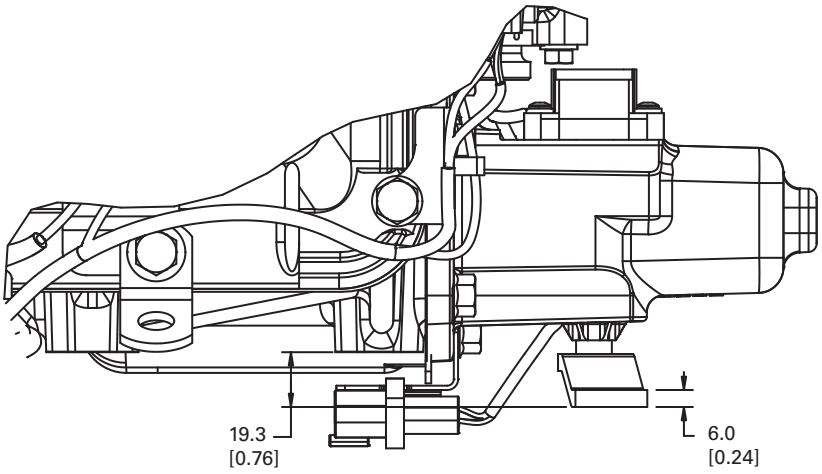
Note: Except for Low Profile with Park which is an OEM supplied cable shifter.

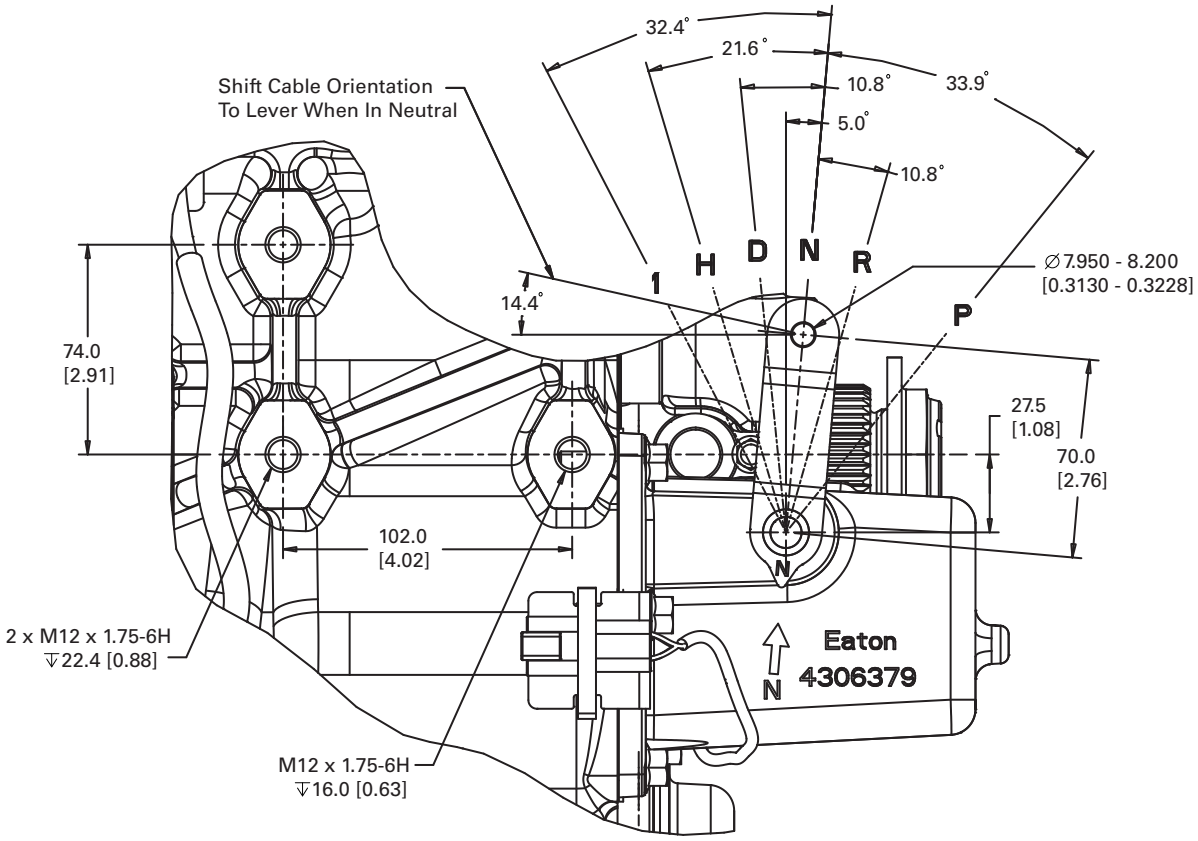
OEM Cable Shift Lever with Park (OEM Provided)

Note: The shifter shown below is a generic view of a cable shifter. The OEM is responsible for their own cable shifters. Eaton does not provide cable shifters.





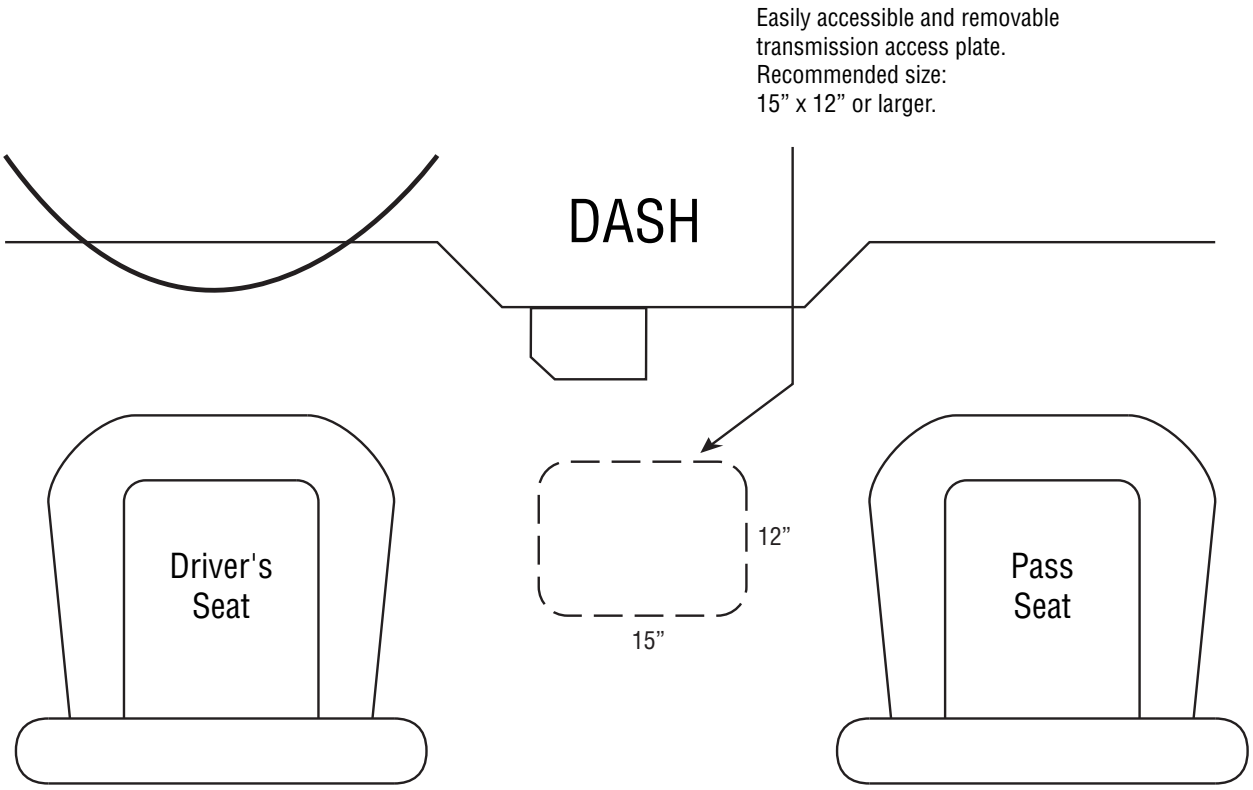

19.3
[0.76]
6.0
[0.24]


32.4°
21.6°
10.8°
33.9°
5.0°
10.8°
Shift Cable Orientation
To Lever When In Neutral
1
H
D
N
R
P
14.4°
∅7.950 - 8.200
[0.3130 - 0.3228]
74.0
[2.91]
27.5
[1.08]
70.0
[2.76]
102.0
[4.02]
2 x M12 x 1.75-6H
↧22.4 [0.88]
M12 x 1.75-6H
↧16.0 [0.63]
Eaton
4306379
N

Shift Mechanism Design Notes

1. All shift mechanism designs must be approved by Eaton engineering.
2. Shift lever must provide a brake pedal interlock to move from the park position.
3. Shift lever must lock in positions P, R, N, and D.
4. All adjustments must be made with the lever and transmission in the Neutral (N) position.
5. Shift lever must be back lighted to illuminate the selected mode.
6. Shift cable routing not to touch TECU and/or HCM.

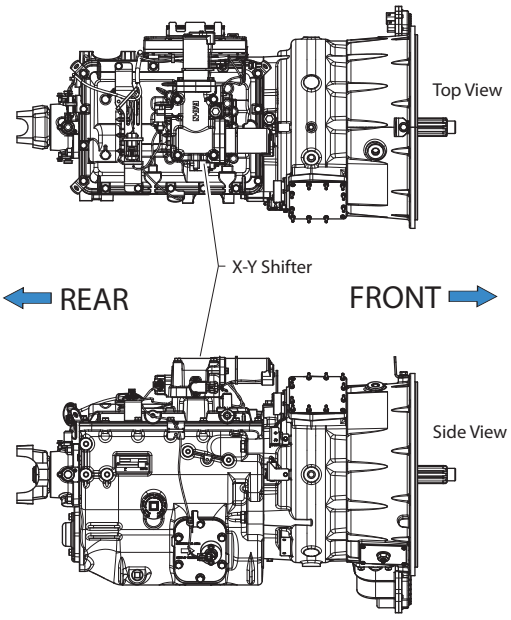
Cab Floor Access Plate Requirements

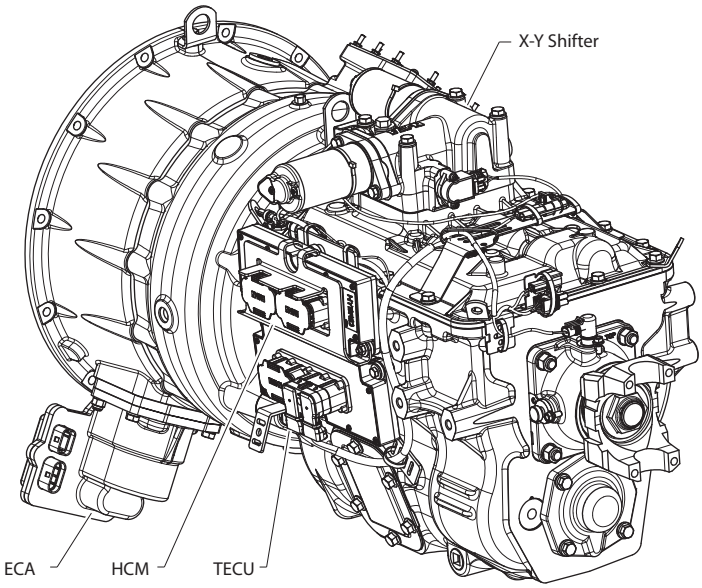


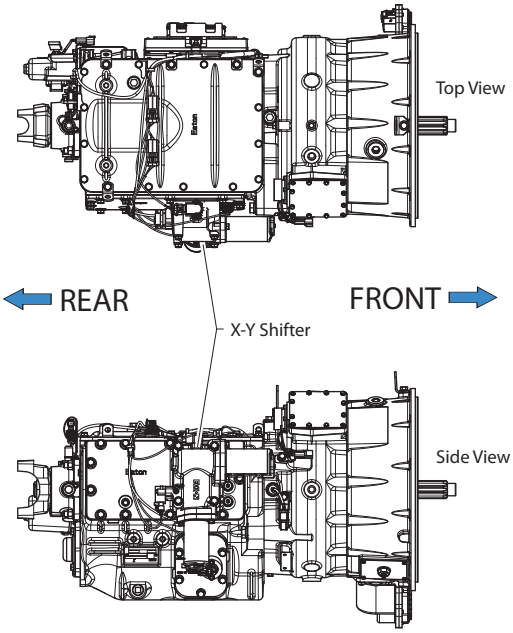
Cab Floor Access Plate Requirements

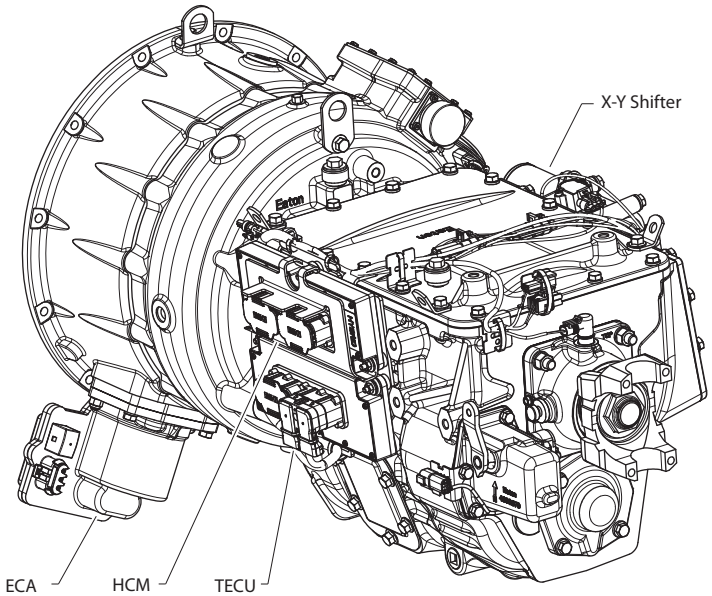
1. A cab floor access plate is necessary for access and removal of components from the transmission top. Plate size (minimum: 15”x12”) must be sufficient to allow removal of the Transmission Electronic Control Unit, Hybrid Control Module or the Electric Shifter.

Transmission Component Temperature Requirements





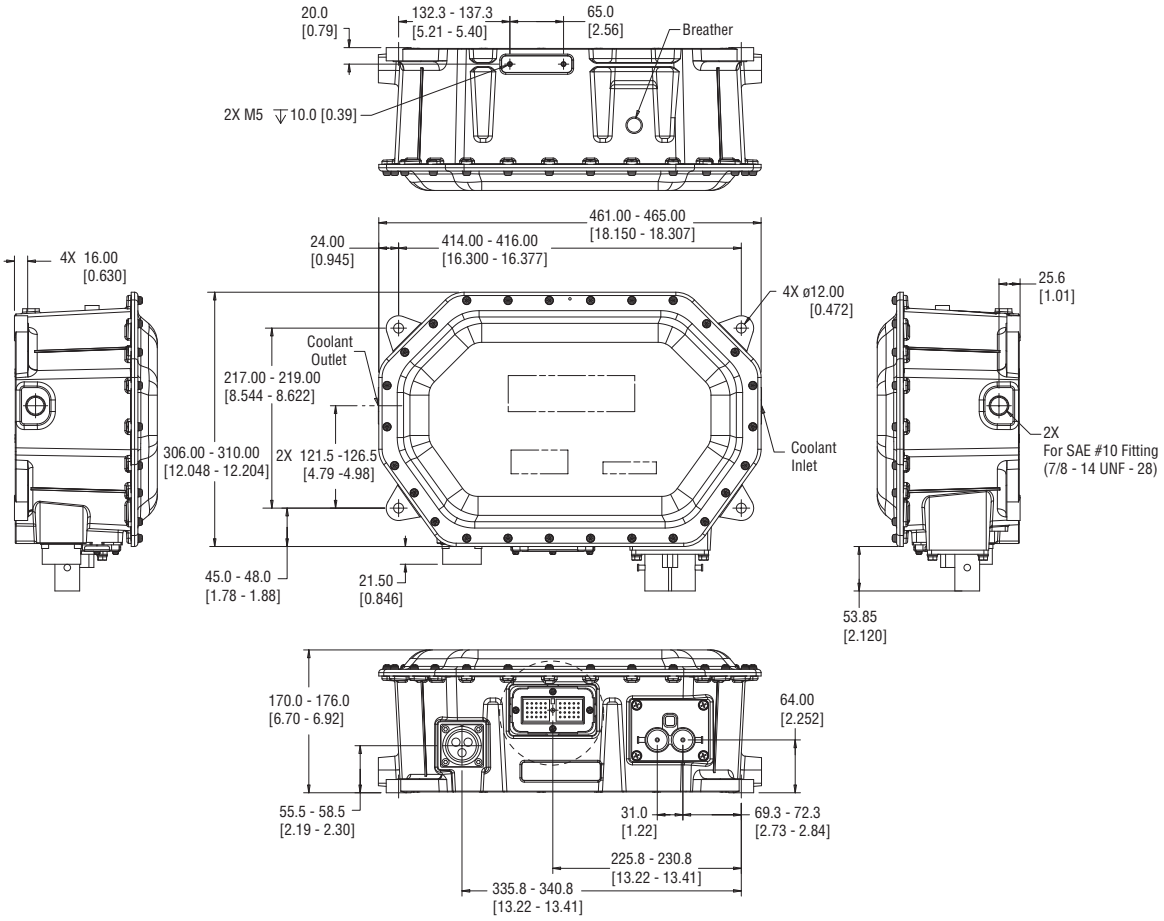




Transmission Component Temperature Requirements

1. The temperature limit for all electrical and air system components is 250°F (121°C). This temperature limit must not be exceeded. If sufficient air gap clearance can not be achieved, the OEM must provide Eaton approved heat shielding. The systems to be protected are the Shift Motors, Sensors, Solenoids, Wire Harness, Transmission Controller, Hybrid Controller, ECA, and the Transmission Case.

Inverter



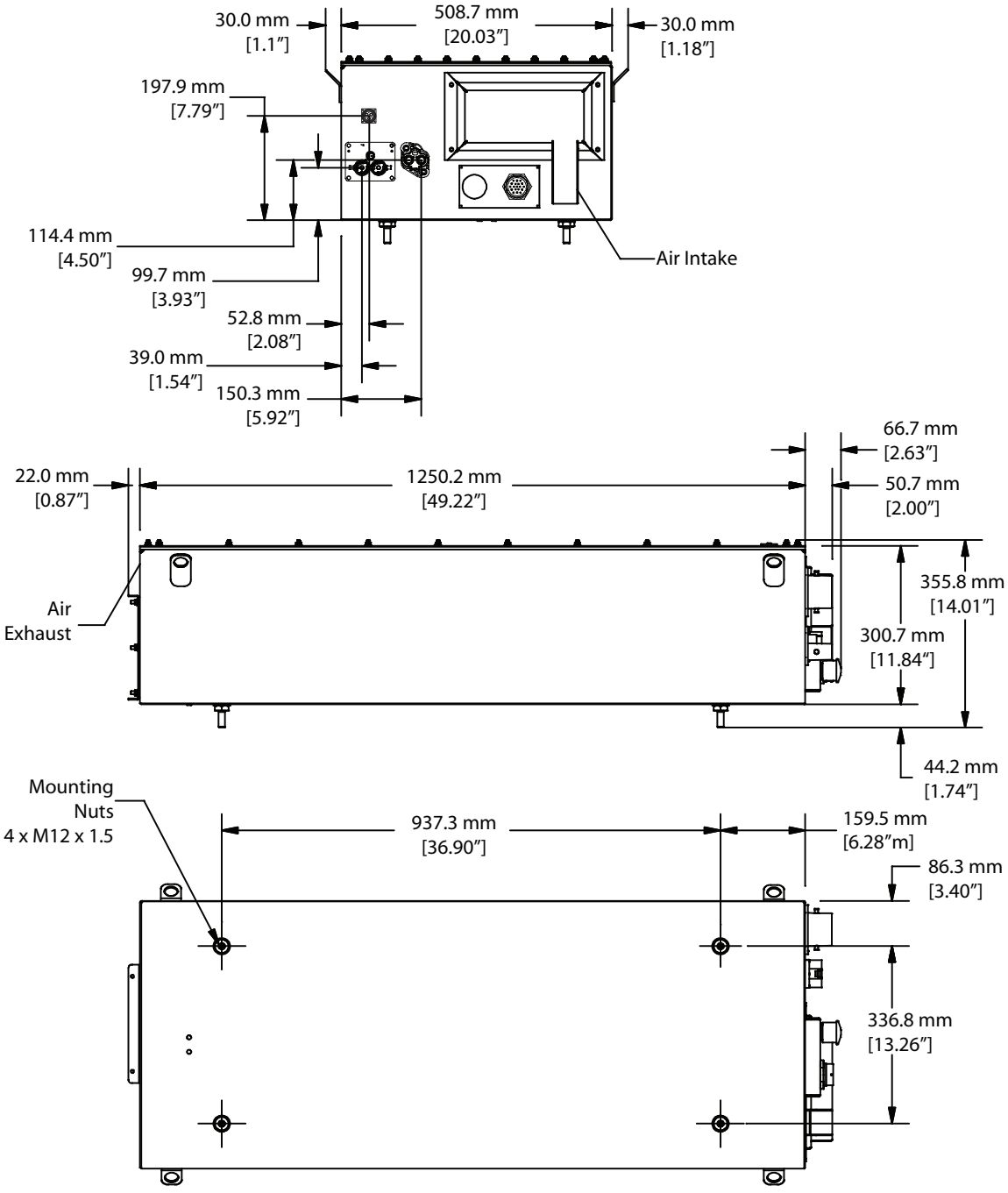
⚠ CAUTION

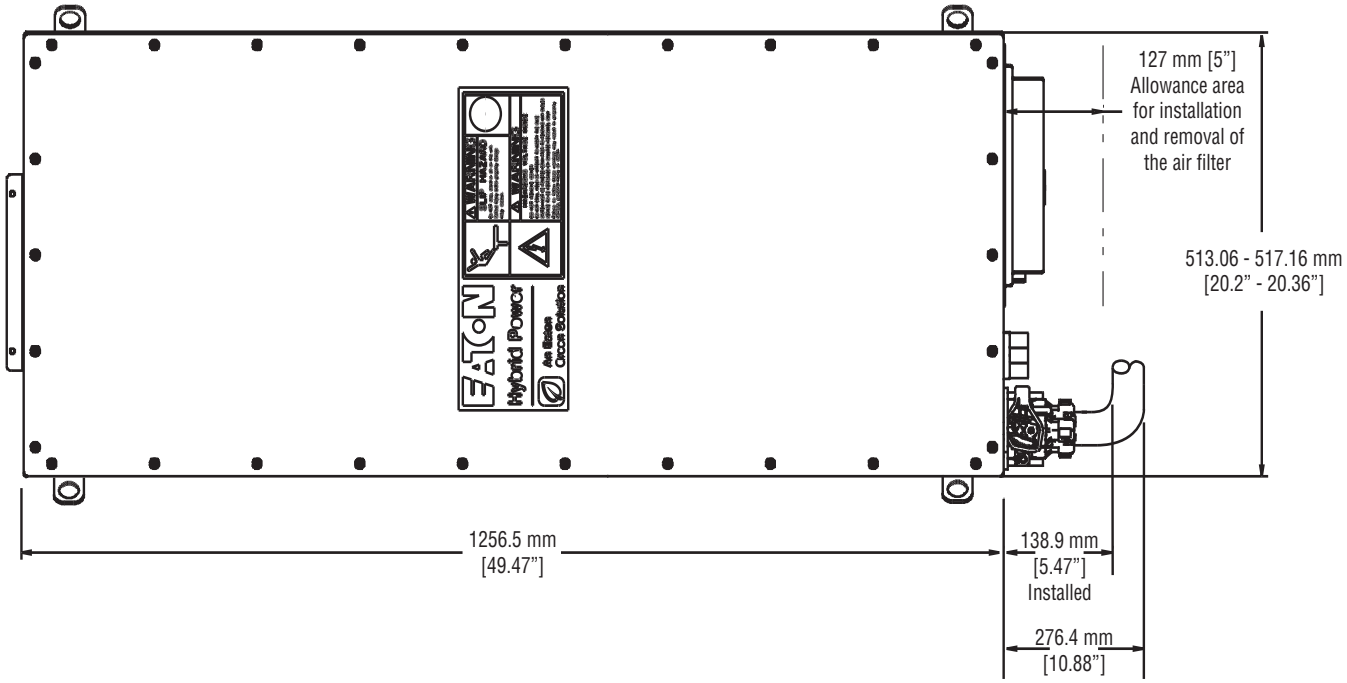
Coolant Lines are directional (see diagram).

Inverter Installation Requirements

1. The Inverter **cannot** be installed with the DC connector facing up.
2. The four Inverter cap screws (7/16 - 14 or M10 x 1.75) must be torque to 25-35 lb-ft [34 - 47 N•m].
3. Coolant line fittings: SAE -10 (7/8 - 14).
4. Temperature of inverter can not exceed 185°F (85°C).
5. The Inverter shall be placed on the truck such that the lowest point of the assembly will not be subjected to any contact or submersion with/in standing water.
6. If the Hybrid components, electrical or otherwise, are placed on the truck where they could obtain damage from road debris, spray, vehicle collision, or will allow easy access or tampering to high voltage components they must be protected through appropriate coverings/brackets. The design and manufacturing of these protective devices are the truck OEM's responsibility.
7. The inverter case vent (breather) must be covered if it is facing up.
8. Electrical connections are not water resistant unless mating connectors are properly installed.
9. Eaton should be contacted for original dimensional drawings.

Power Electronics Carrier (PEC)





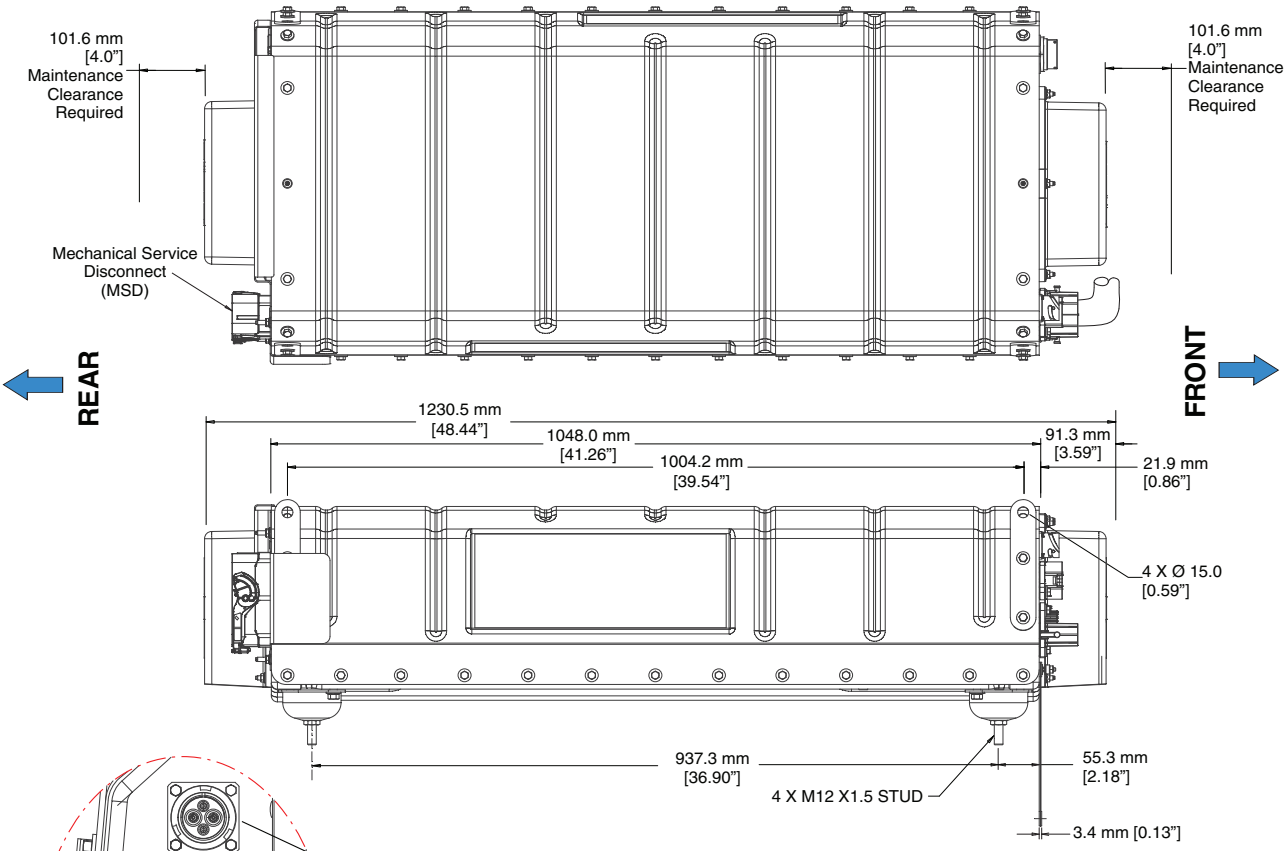
Installation Requirements

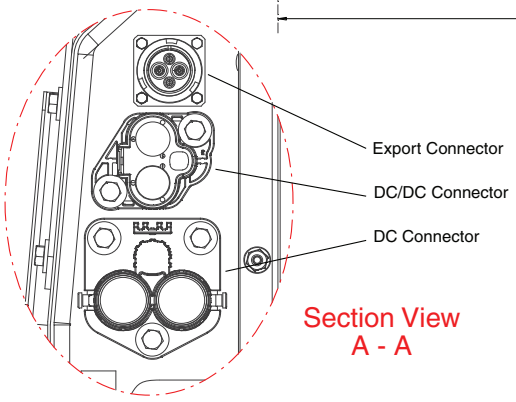
1. Torque the four PEC nuts (M12 x 1.5) to 40-50 lb-ft. [54.2 - 67.7 N•m].
2. Temperature of PEC can not exceed 185°F (85°C).
3. If the Hybrid components, electrical or otherwise, are placed on the truck where they could obtain damage from road debris, spray, vehicle collision, or will allow easy access or tampering to high voltage components they must be protected through appropriate coverings/brackets. The design and the manufacturing of these protective devices are the truck OEM’s responsibility, however, Eaton application support engineering will provide assistance if the truck OEM requests.
4. The PEC shall be placed on the truck such that the lowest point of the assembly will not be subjected to any contact or immersion with/in standing water.
5. The PEC must be mounted with the mounting studs facing down (+Z axis per SAE). If mounted to the chassis, the front of the PEC (wire connectors side) should be facing the front of the vehicle. If mounted on the body, the only orientation that the unit cannot be mounted is the front of the PEC facing the rear of the vehicle.

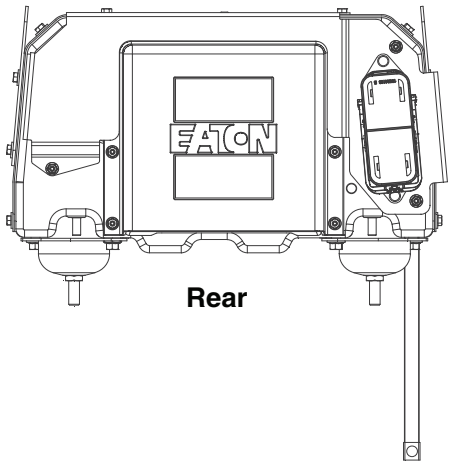
Note: Any deviations of the mounting must be approved by Hybrid Engineering.

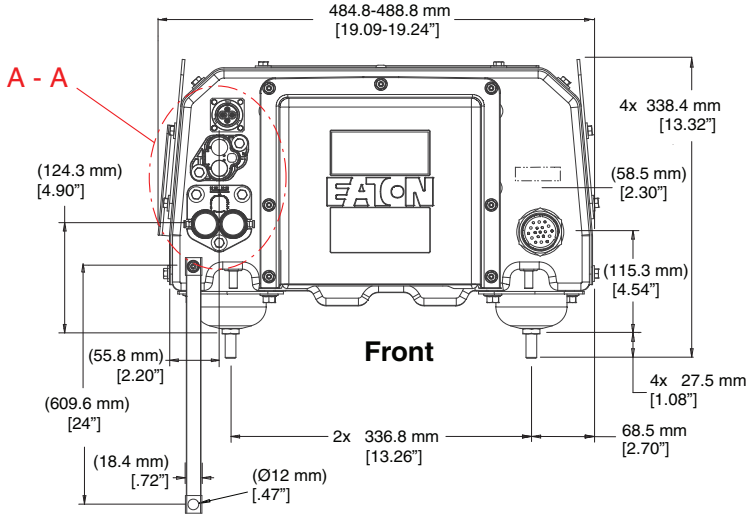
6. Eaton should be contacted for original dimensional drawings.

Alternative Power Electronics Carrier (PEC)









Installation Requirements

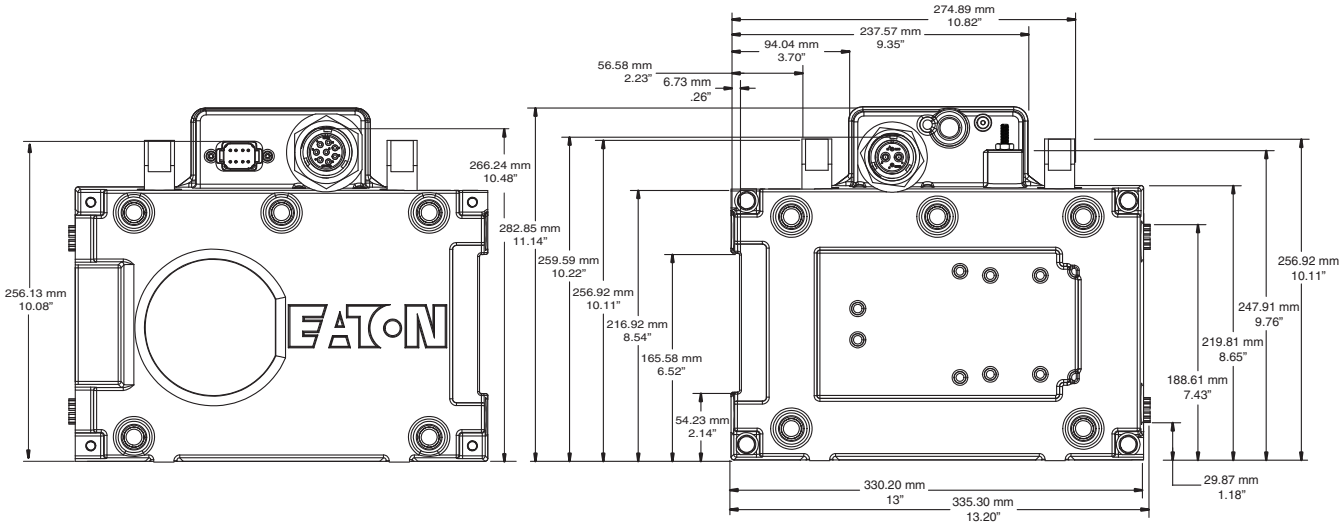
1. Torque the four OEM supplied PEC nuts (M12 x 1.5) to 40-50 lb-ft. [54.2 - 67.7 N•m].
2. PEC shall be protected from secondary heat sources (i.e. Exhaust, Heat Exchangers, ect.) and shall not exceed 113°F (45°C). Temperatures above the listed limit will affect battery life and system performance.
3. If the Hybrid components, electrical or otherwise, are placed on the truck where they could obtain damage from road debris, spray, vehicle collision, or will allow easy access or tampering to high voltage components they must be protected through appropriate coverings/brackets. The design and manufacturer of these protective devices are the truck OEM's responsibility, however, Eaton application support engineering will provide assistance if the truck OEM requests.
4. The PEC shall be placed on the truck such that the lowest point of the assembly will not be subjected to any contact or immersion with/in standing water.
5. The PEC must be mounted with the mounting studs facing down (+Z axis per SAE). If mounted to the chassis, the front of the PEC (wire connectors side) should be facing the front of the vehicle. If mounted on the body, the only orientation that the unit cannot be mounted is the front of the PEC facing the rear of the vehicle.

Note: Any deviations of the mounting must be approved by Hybrid Engineering.

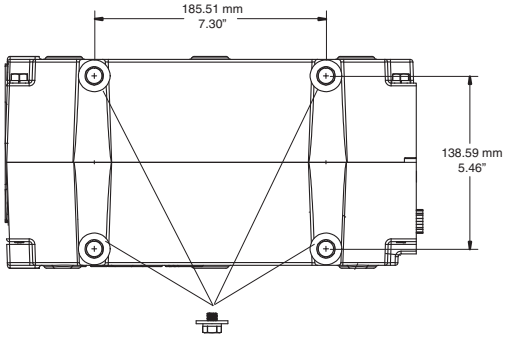
6. Grounding requirements:
    a. Clean surface finish from ground location.
    b. Apply dielectric grease to the contact surface on the chassis and the ground strap lug (fused end).
    c. Torque fastener to 15 lb-ft. [20 N•m].
7. Eaton should be contacted for original dimensional drawings.

Alternative Auxiliary Power Generator (APG)

Side Views

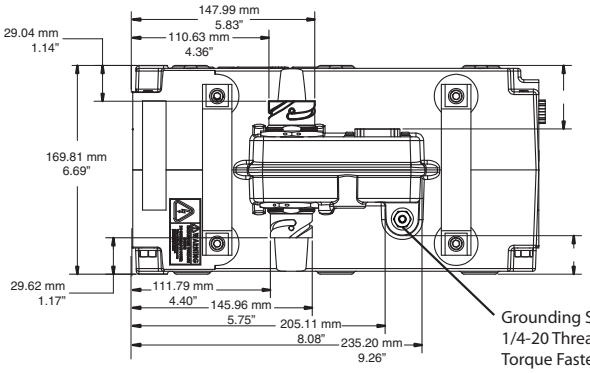


Bottom View

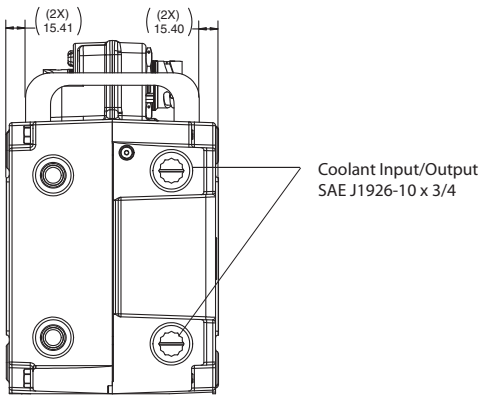


Note: Mounting Hardware to be provided by the OEM
M10x1.5
24 mm Max Depth
15 - 17 lb-ft Torque

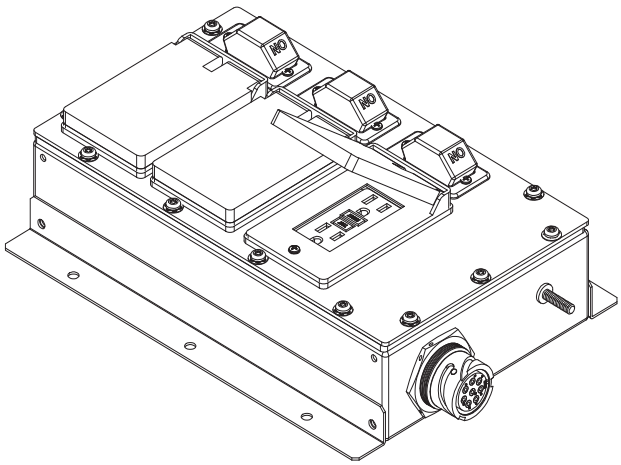
Top View

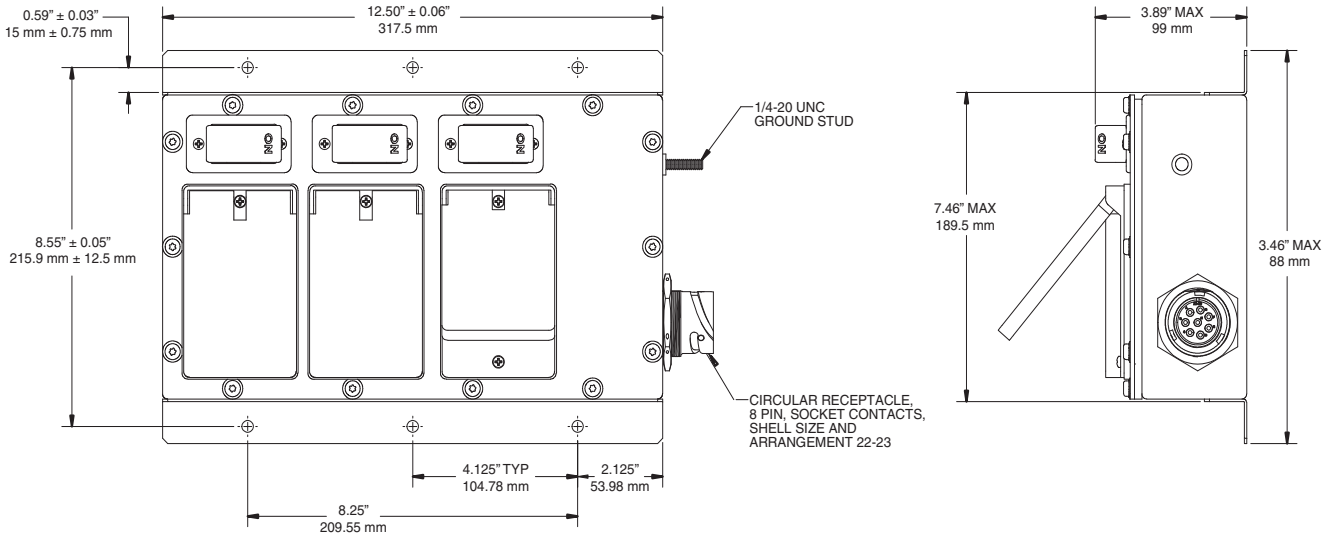


Coolant End View

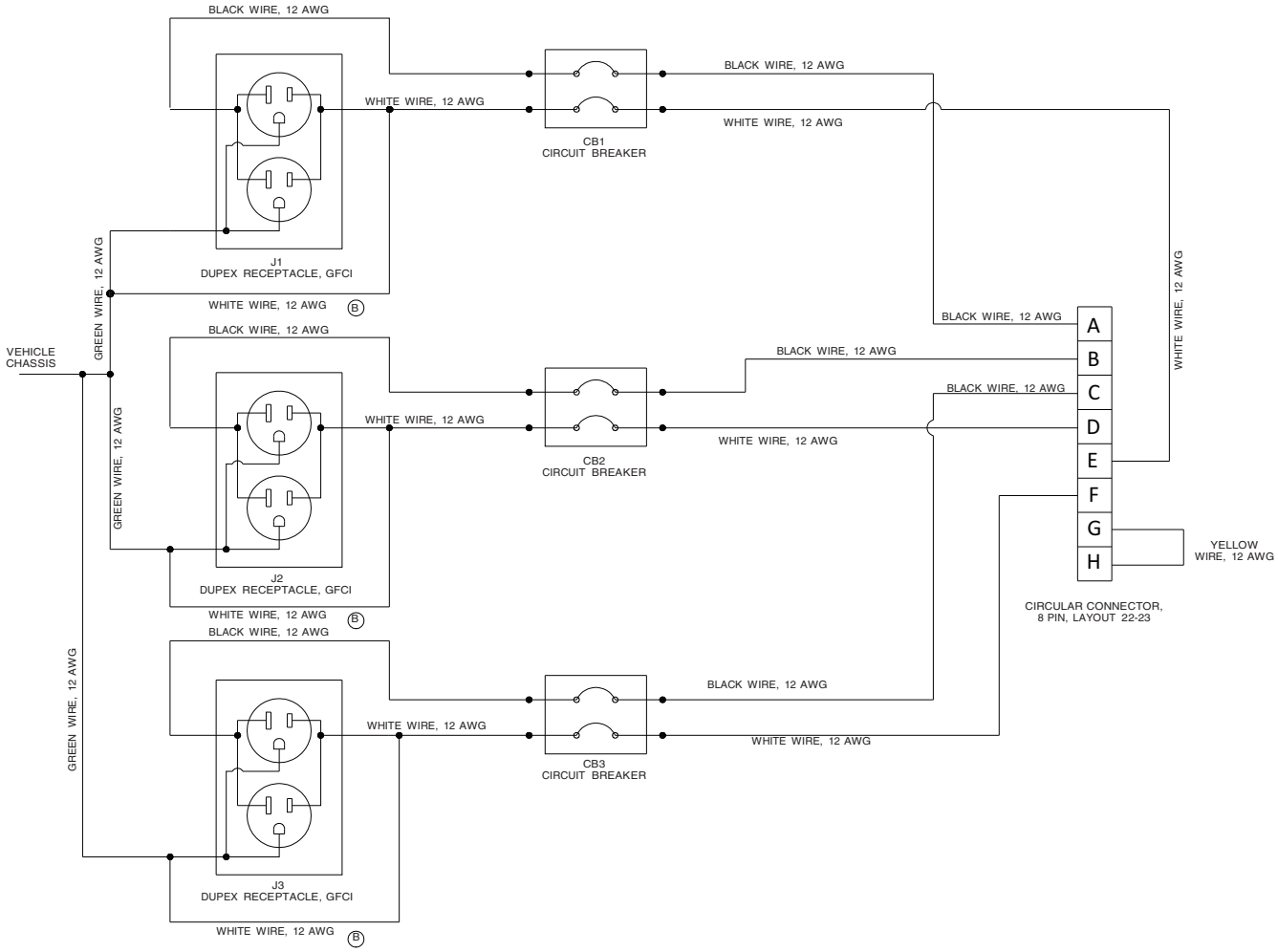


Alternative Power Panel





Alternative Power Schematic



Installation Requirements

⚠ WARNING

The Alternative Power Panel cannot be mounted to the APG and must be remotely mounted. The AC wiring between the APG and the power panel is the responsibility of the OEM.

Note: Third-party power panels are approved to be used with the APG. Use only Leviton 15A (white), Part Number 7599-NVW, ground-fault circuit-interrupter. Other types may fail to operate properly when connected to the base unit.

1. Torque the four (4) APG bolts with lock washers (M10 x 15) (max internal thread length not to exceed 24 mm) to 15-17 lb-in. [20 - 23 N•m]. All of the APG mounting locations must be used to ensure the unit is securely fastened to the vehicle. The APG can only be mounted in the upright orientation.

Note: The Power Panel is mounted remotely. The OEM is responsible for providing the wire harness from the APG to the Power Panel.

2. The coolant inlet temperature of APG can not exceed 140°F (60°C).
3. If the Hybrid components, electrical or otherwise, are placed on the truck where they could obtain damage from road debris, spray, or will allow easy access or tampering to high voltage components they must be protected through appropriate coverings/brackets. The design and manufacturer of these protective devices are the truck OEM's responsibility, however, Eaton application support engineering will provide assistance if the truck OEM requests.
4. The Power Panel must be mounted above the top of frame rails and can be mounted in any orientation. Panel is rain proof when the orientation is upright, but not submergible or splash proof.
5. Weight of the Alternative APG is 41 lbs. and the Power Panel weighs 12 lbs.
6. Connect the coolant line fittings (J1926-10 3/4" I.D.).
7. Eaton should be contacted for original dimensional drawings.

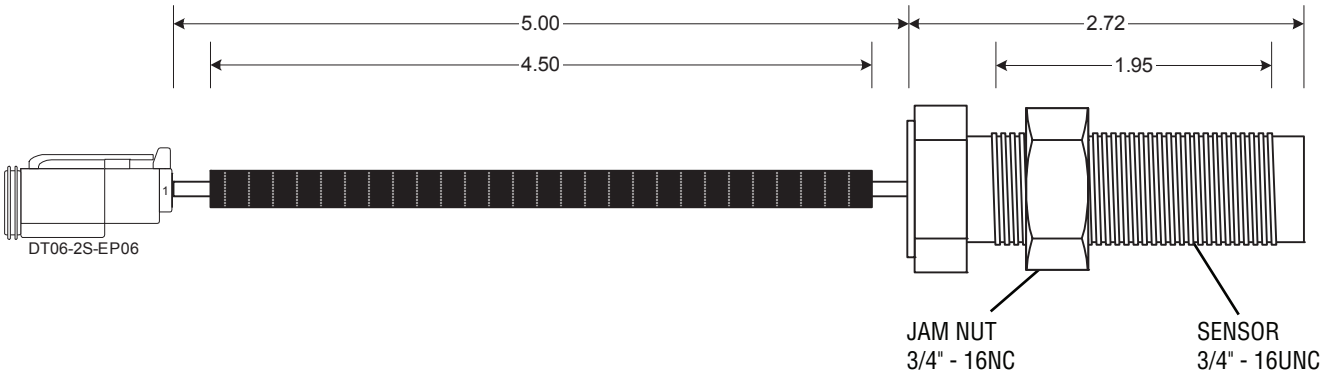
ECA Engine Speed Sensor Requirements

The OEM is required to install a dedicated engine speed sensor in this product. The use of the J1939 data bus engine speed signal is not a substitute for this sensor.

The ECA engine speed sensor is directly connected to the ECA and mounted in the engine flywheel housing.

Note: The ECA Engine Speed Sensor requires a port in the engine flywheel housing. The preferred location of the port is either between 3 and 5 o'clock or 7 and 9 O'clock positions, for serviceability and to prevent road debris damage.

Eaton Part Number 4306190



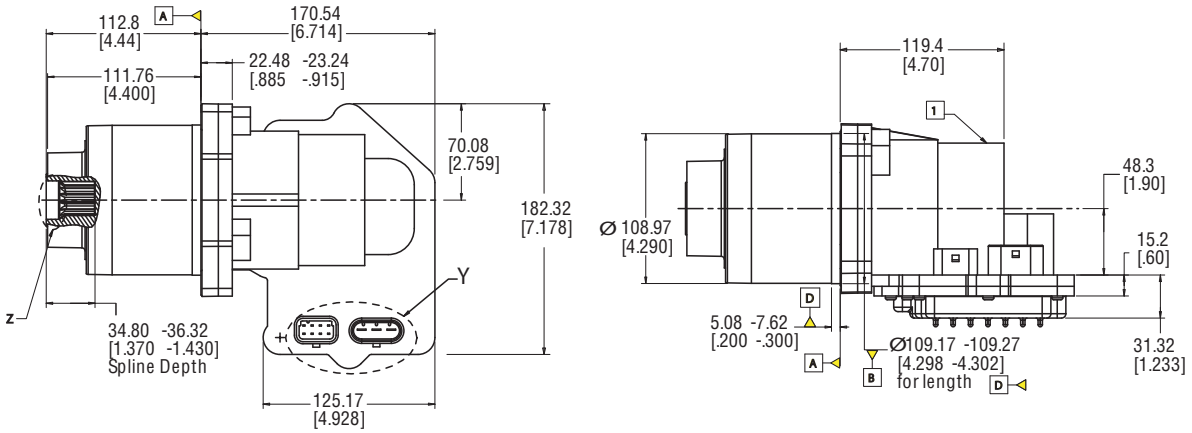
Threaded Engine Speed Sensor Installation Requirements

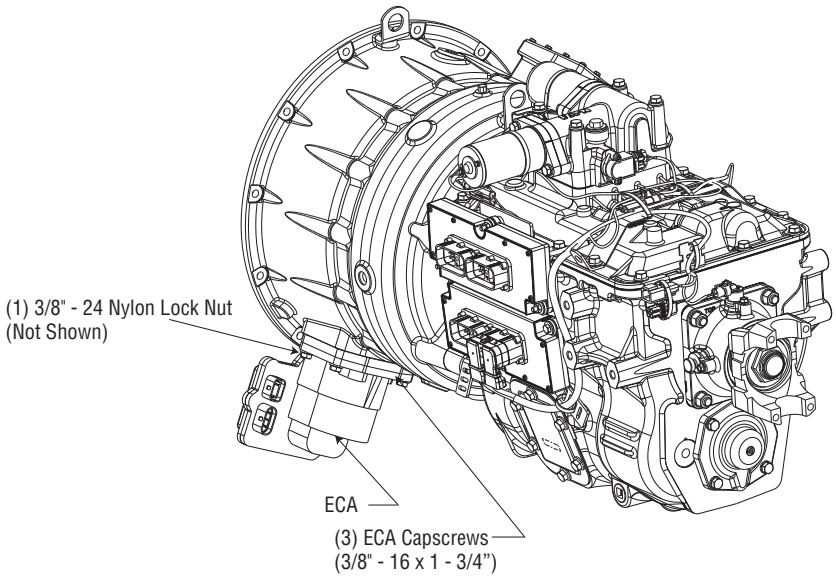
- Thread speed sensor into the engine bellhousing until it touches the flywheel.
- After the sensor touches the flywheel, rotate it counterclockwise 1/2 to 1 full turn.
- Set gap between sensor and flywheel to 0.055 inches +/- 0.020".
- Hold the sensor in place and tighten the 3/4”-16 jam nut to 15 lb-ft. [20.3 N•m].
- Connect engine speed sensor connector to the mating connector on the transmission and fasten harness to the ECA cover.

Engine Speed Sensor Electrical Specifications

- Output voltage: 2V p-p minimum, 100V p-p maximum with flywheel ring gear at 200 RPM
- Resistance: 147 - 179 ohms

Electric Clutch Actuator (ECA)



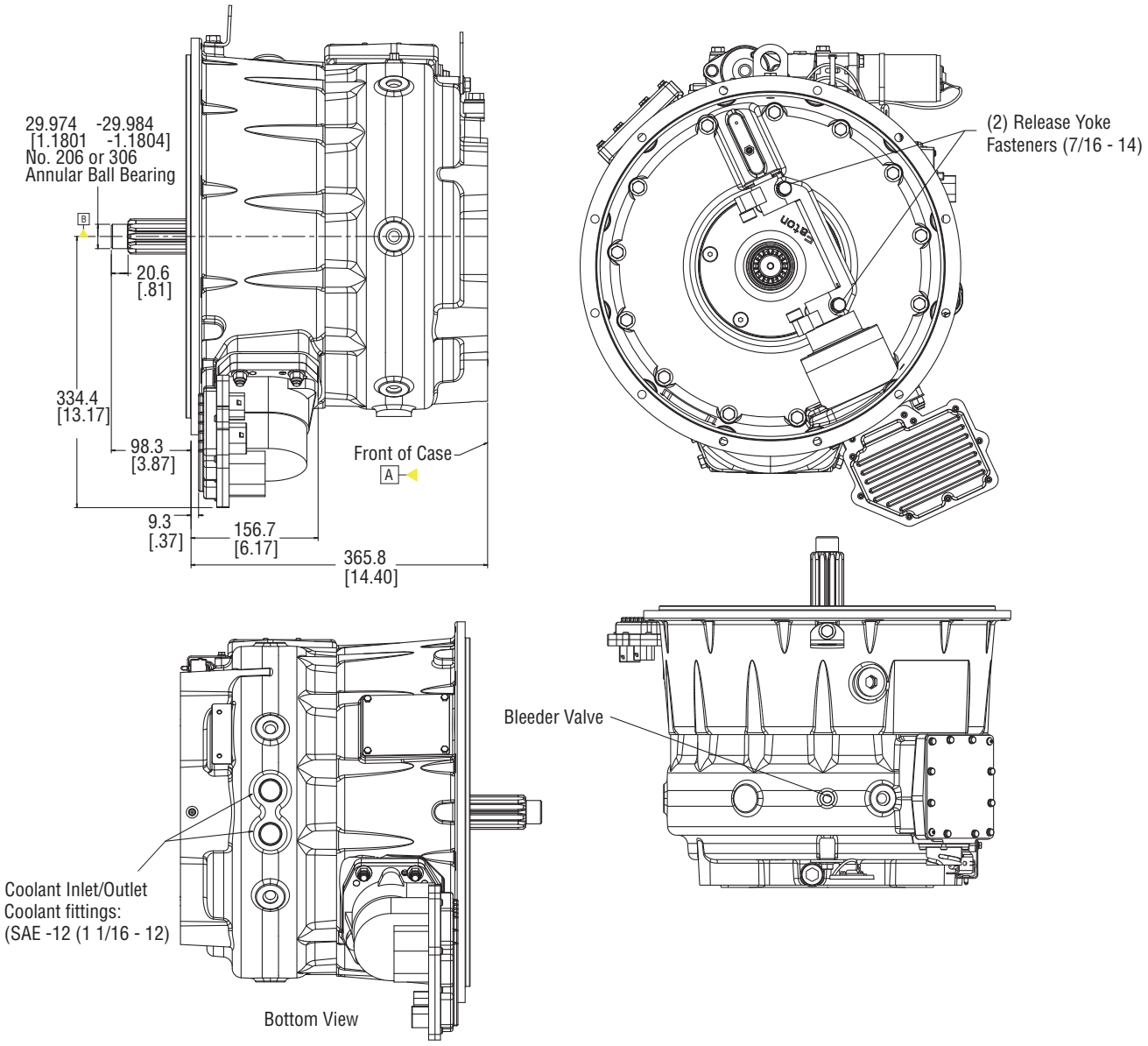


Installation Requirements

1. The three (3) ECA cap screws (3/8"-16 UN x 1-3/4" grade 5 or better hex head with lock washers) and either one (1) nylon lock-nut or one (1) nut with lock washer (3/8"-24) should be torque to 20 - 25 lbs.ft. [27 - 34 N•m].
2. Apply anti-seize to the inside diameter (ID) of the ECA bore.
3. Eaton should be contacted for original dimensional drawings.

Note: The ECA must remain off the transmission until the assembly is fastened to the engine to provide access to one of the transmission housing fasteners.

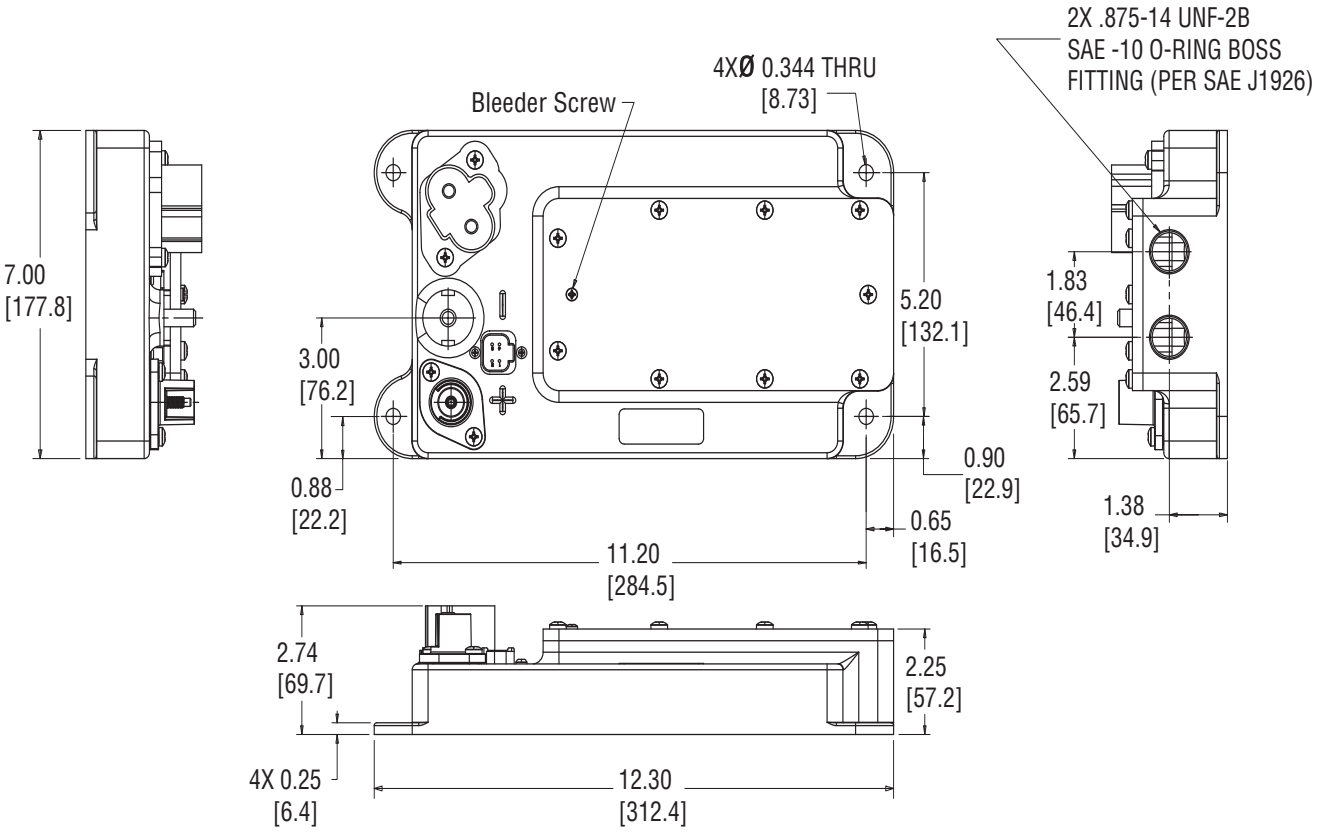
Motor/Generator



Installation Requirements

1. Coolant line fittings: SAE -12 (1 1/16 - 12).
2. Release Yoke Fasteners (7/16 - 14) should be torque to 40- 50 lbs.ft. [52.2 - 67.8 N•m].
3. Eaton should be contacted for original dimensional drawings.

DC/DC Converter



Installation Requirements

Note: Nominal output voltage of DCDC Converter is 13.5V.

Positive 12V Output Stud

- 1/4 - 20 stud ring terminal on 2 or 4 AWG wire
- Use Panduit part number LCAN2-14-Q for 2 AWG
- Use Panduit part number LCA4-14-L for 4 AWG

Positive 12V Output Stud Cover

- VTE, Inc. part number 226N2, Red terminal cover over (+) 12V connection

Ground Output Stud

- 3/8 - 16 stud ring terminal on 2 or 4 AWG wire
- Use Panduit part number P2-38R for 2 AWG
- Use Panduit part number P4-38R for 4 AWG

Lubricant/Corrosion Preventative

- Nye Lubricants, Inc. part number Nyogel 759G or 760G

⚠ WARNING

Disconnect the positive 12-volt start cable at the batteries.

Make sure all the 12V batteries are isolated from the vehicle chassis.

Make sure the Red Service Switch on the PEC is pushed in.

Perform the installation in the following order:

1. Mount the converter to the vehicle using four (4) fasteners, one in each corner of the unit. The converter may be mounted in any direction. Eaton suggests locking hardware to prevent fasteners from vibrating loose.

⚠ CAUTION

Ensure the converter housing has a good, low resistance ground connection to the vehicle chassis (<0.5 ohms)

2. Prepare the DC/DC 12V output cables before cable routing:
   a. Wrap the battery side negative terminal on the DCDC output cable with insulated tape. Cover all metal surfaces.
   b. Wrap the battery side positive terminal on the DCDC output cable with insulated tape. Cover all metal surfaces.

⚠ CAUTION

Never break off the protective Ryton plastic wall around the positive 12V output stud as this will void the warranty.

3. Install the 12V positive cable to the DC/DC converter.
   a. Brush the lubricant on the positive 12V stud.
   b. The 12V positive cable must use the appropriate Panduit ring terminal to fit over the 1/4 - 20 stud and inside the protective Ryton plastic wall. Use a washer, lock washer, and nut to tighten the positive cable connection. Torque the positive 12V connection, 7/16” nut, to 65 in-lbs.
   c. Once the connection is made coat with lubricant.
   d. Cover the connection with red terminal cover.
4. Install the 12V negative cable to the DC/DC converter.
   a. Brush the lubricant on the negative 12V Ground stud.
   b. The 12V negative cable must use the appropriate Panduit ring terminal to fit over the 3/8 - 16 stud. Use a washer, lock washer, and nut to tighten the negative (ground) cable connection. Torque the negative 12V connection, 5/8” nut, to 100 in-lbs.
   c. Once the connection is made coat with lubricant.

⚠ CAUTION

The signal connector is a water tight, polarity protected, latching connection. Any unused pins must be plugged to prevent moisture from entering the connector and causing corrosion in the other connections.

5. Connect the User Interface 4-pin Deutsch signal I/O connector to the converter.
6. Make connections to the battery:

⚠ WARNING

The 12-volt output cable leads should NOT touch the wrong battery terminals.

The positive 12-volt connection from the batteries to the DC/DC converter should be fused to protect the system in the event of a short circuit. Eaton suggests a fuse rating of 32V, 150A.

a. Remove the insulating tape from the battery side of the positive 12V DCDC output cable.

b. Connect the 12V positive battery cable to the 12V battery terminal cube fuse lead.

c. Remove the insulating tape from the battery side of the negative 12V DCDC output cable.

d. Connect the 12V negative battery cable to the 12V battery negative post.

7. Make the high-voltage connections:

   a. Connect one end of the Yazaki high-voltage cable to the converter first.

   b. Connect the other end of the Yazaki high-voltage cable to the PEC.

8. Check all electrical connections:

   - positive 12V output stud to positive 12V battery terminal (with 150A fuse block).
   - negative 12V output stud (ground) to negative 12V battery terminal.
   - high-voltage Yazaki cable mated and locked on the converter and PEC.
   - 4-pin Deutsch signal connector mated and locked.

9. Reinstate the 12V battery connections to the vehicle chassis and starter.
10. Install the coolant fittings: SAE - 10 (7/8 - 14). Converter temperature may not exceed 185°F (85°C).
11. If the Hybrid components, electrical or otherwise, are placed on the truck where they could obtain damage from road debris, spray, vehicle collision, or will allow easy access for tampering to high-voltage components they must be protected through appropriate coverings/brackets. The design and manufacturer of these protective devices are the truck OEM's responsibility, however, Eaton application support engineering will provide assistance if the truck OEM requests.
12. Eaton should be contacted for original dimensional drawings.

Hybrid Drive Unit (HDU) Mounting

Handling

As the transmission is removed from the shipping pallet and placed on the conveyor, special pallets or spacers must be placed between the units to prevent any contact with other units.

1. Use a hoist or transmission jack that permits precise control of the transmission movement during installation.

Transmission Preparations

Always remove banding and protective wrapping from the transmission and inspect for shipping damage as soon as possible upon receiving.

2. If a thread-in electronic speedometer system is used, tighten the sensor or sensor lock nut to 35 lbs.ft. [47 N•m], (3/4-16 threads). If a push-in electronic speedometer system is used, Eaton P/N 14142 (O-ring) and Eaton P/N 71206 (silicon lubricant) are used to seal the sensor.
3. To remove or replace a rear bearing cover, output shaft seal or output yoke/flange; refer to the appropriate service manual on the Roadranger web site.

Mounting Transmission to Engine

Use the three transmission lifting eyes provided. The lifting eye position must not be changed on the transmission. Do not remove the Electric Shifter at any time.

Note: For lifting eye and sensor retaining bolt locations. [see page 151]. These bolts cannot be used for brackets or for any other purpose.

4. Use a three point lift chain or transmission jack with a minimum capacity of 1500 lbs.

Note: When using lifting equipment the HUD assembly is nose heavy.

5. Inspect the engine to transmission mating surfaces for damage or debris prior to installation. Make sure the engine flywheel housing face, transmission clutch housing face, input shaft, etc. are free of paint, debris, rust, labels, and any type of damage before installation.
6. Input Shaft To Clutch Alignment: The transmission is shipped from Eaton with the transmission in gear. The transmission must be in gear in order to rotate the input shaft by turning the output shaft/yoke. The transmission will automatically reset to the neutral position as soon as the vehicle is powered up (key switched on). In the event that the transmission is not received in gear, the input shaft will have to be manually indexed to mate up with the clutch splines.

Note: DRIVESHAFT INSTALLATION: Since the transmission is in gear until the vehicle is powered up with the key switch, use a Pull-To-Neutral-Box to disengage the transmission or rotate the axles to align the transmission prop-shaft.

7. Adjust the lift chain or transmission jack to obtain the same relative angle as the engine. The face of the engine flywheel housing and the face of the transmission clutch housing must be parallel during installation. If the transmission is properly aligned and the clutch is installed properly, very little force is required to slide the input shaft through the clutch and into the pilot bearing.

8. If interference is encountered, move the transmission away from the engine to investigate the cause. The use of excessive force to overcome misalignment may cause damage to the transmission input shaft and the clutch.
9. Rotate the output shaft/yoke while sliding the input shaft into the clutch to line up the splines.
10. Once the transmission is seated against the engine flywheel housing, align the clutch housing bolt holes with the engine flywheel housing bolt holes and install all cap screws and tighten finger tight.

Note: The clutch housing must be flush against the engine flywheel housing before tightening any cap screws. Do not use the cap screws to seat housing.

11. Tighten four cap screws at 90° intervals around the clutch housing, then tighten the remaining transmission mounting cap screws using the recommended torque specifications.

Using Rear Supports

The OEM is responsible to determine if a rear support is required for each application.

1. The OEM is responsible for rear mount design.
2. Refer to OEM for rear mount fastener torque specifications.

Speciality OEM/Body Builder Installation Requirements

Additional Requirements

Note: The following instructions apply to body builders or speciality OEMs who provide configurations other than the typical OEM build. All typical installations requirement must be followed in addition to the following steps.

PEC Remote Mount

1. Service switch shall be accessible to a mechanic.
2. PEC shall be mounted securely to the truck per the power electronics carrier section of this guide.
3. Air filter shall be serviceable per space requirements detailed in the power electronics carrier section of this guide.
4. Sufficient air flow shall be provided to the PEC for battery cooling.
5. Restricted access and warning decals shall be positioned as close as possible to the high-voltage cables and PEC.
6. PEC shall provide sufficient drainage to prevent water collection.
7. PEC enclosures shall be protected from physical damage due to cargo, tools, use of step, falling objects, etc.
8. High-voltage DC cable
    a. Shall not be longer than 3 meters.
    b. Shall not be coiled.
    c. Shall conform to all other wiring requirements set forth in this guide.

ePTO

1. Hydraulic Demand
    a. The body controller has on/off control of the motor via the AuxIO hydraulic demand signal detailed in the integration section of this document once the truck is in ePTO mode.
2. Safety Interlocks
    a. Eaton does not implement any safety interlocks on the hydraulic demand signal once the truck is in ePTO mode. Safety interlocks on the hydraulic demand signal are the responsibility of the body builder.
    b. A hood open safety interlock is required for all ePTO equipped trucks to prevent an engine in ePTO mode with hood open.
    c. Eaton highly recommends that the body builder perform a thorough safety analysis to determine what additional safety interlocks are required.

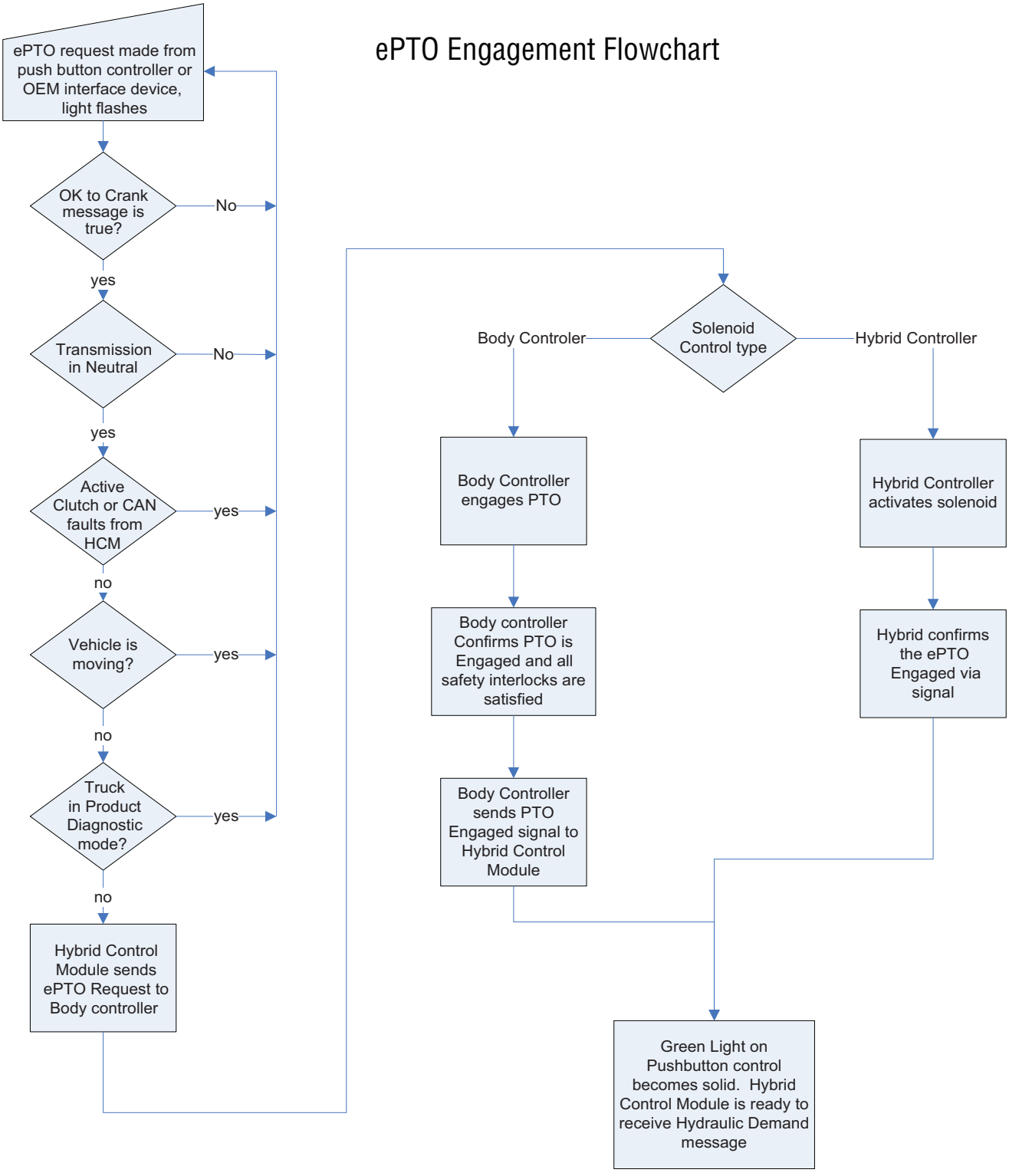
mPTO

1. Body builder is responsible for all interlocks.
2. HCM has no control over mobile PTO mode.
3. mPTO mode closes the clutch when certain conditions are met (speed = 0, transmission in N or P, engine speed > 950 rpm).
4. If PTO solenoid is analog, HCM will not disengage the solenoid until button is released, even when moving.
5. mPTO can only be used on city delivery (CD) models.

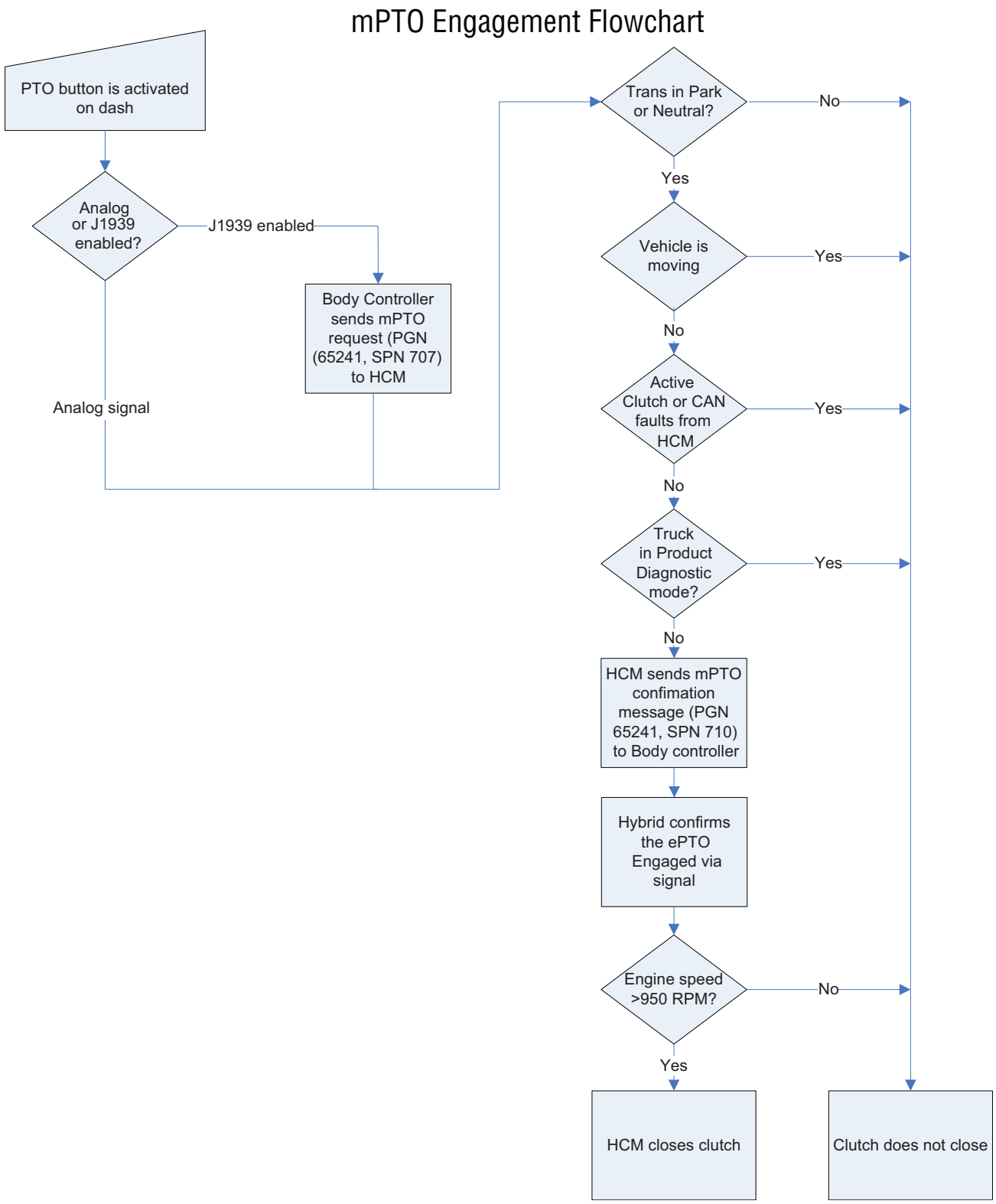
Final ePTO Checklist

1. Does the truck enter ePTO mode (solid green light on ePTO button).
2. Is the hydraulic demand generated by the appropriate action.
3. Does the hydraulic demand time out appropriately?
4. Has the truck been checked through a full engine off, recharge, and then shut back off cycle.
5. All interlocks work properly:
    a. Park Brake
    b. Boom out of stow generates “prohibit drive” signal (if equipped)
    c. Hood open switch disables ePTO mode
6. Engine run request works (ie for low air pressure)

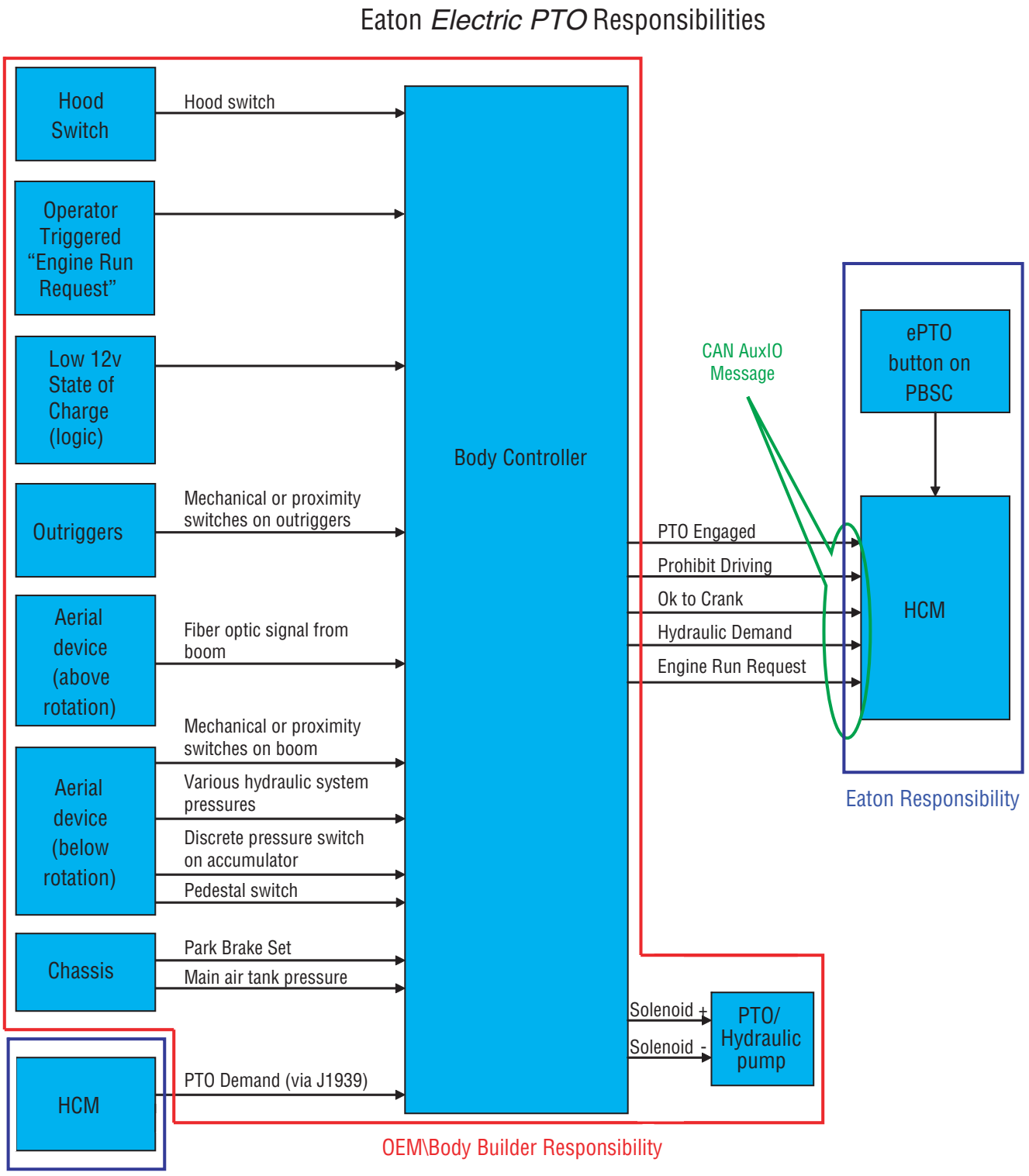
ePTO Engagement Flowchart



mPTO Engagement Flowchart



ePTO Responsibilities



Cable (Low and High Voltage)

⚠ WARNING

WARNING: Before welding to the body or chassis, the 12-volt batteries must be disconnected and isolated, the battery box must be protected from excessive heat, and caution must be observed around high-voltage lines (orange wire and conduit).

Note: OEM is required to create a High Voltage component location diagram to be placed in the vehicle.

Note: Any unauthorized tap, tampering, or connection into the Eaton Hybrid DC high-voltage lines will void the Hybrid system warranty.

Note: OEM is required to place a 'Hybrid' label on the external of the truck to allow the user to quickly and easily identify a Hybrid vehicle.

Note: If the Hybrid components, electrical or otherwise, are placed on the truck where they could obtain damage from road debris, spray, vehicle collision, or will allow easy access and tampering to high voltage components they must be protected through appropriate coverings/brackets. The design and manufacturer of these protective devices are the truck OEM's responsibility, however, Eaton application support engineering will provide assistance if the truck OEM requests.

All wiring installation shall conform to Federal Motor Carrier Safety Administration Regulations Sections 393.27 Wiring specifications; 393.28 Wiring to be protected; 393.29 Grounds; 393.31 Overload protective devices; 393.33 Wiring, installation; and SAE J1742 High Voltage Cable requirements.

Low Voltage Cable

Unless specified in the "typical circuit" sections for hybrid components, the low voltage cable for the Hybrid System shall be:

- 16 or 18 TXL for all Communication and control wires

  Note: See individual wiring specification.

  •10 or 12 GXL for all 12 volt Power Supply wires

  Note: See individual wiring specification.
- 12 GXL or 14 SXL for all V-Ignition wires
- 2 GXL for Power Supply wires from the DC/DC to the 12 volt Battery

These sizes are requirements for proper connector sealing and current carrying capacity.

SAE Wire Size mm^2	SAE Wire Size No.	Nominal Outside Diameter (mm)			Nominal Outside Diameter Inch		
		TXL	GXL	SXL	TXL	GXL	SXL
0.8	18	1.98	2.39	2.72	0.08	0.09	0.11
1	16	2.24	2.59	3.05	0.09	0.10	0.12
2	14	2.62	2.97	3.58	0.10	0.12	0.14
3	12	3.25	3.63	4.14	0.13	0.14	0.16
5	10	3.96	4.45	4.95	0.16	0.18	0.20

Cable Connector (Deutsch) - DRC26-38S01-P017, DRC26-38S02-P017							
Contact Size	**Description**	**Cable Diameter Min (mm^2)**	**Cable Diameter Max (mm^2)**	**Insulation Range (mm)**	**TXL**	**GXL**	**SXL**
#20	Signal	0.80	1.00	1.02 - 2.41	18	18	NR
#12	Power	2.00	3.00	3.40 - 4.95	NR	12	NR
#12	V-Ignition	2.00	3.00	3.40 - 4.95	NR	12	14

Cable Connector (Delphi) - 3 Way 12124685/ 8 Way 12047937							
Contact	**Description**	**Cable Diameter Min (mm^2)**	**Cable Diameter Max (mm^2)**	**Insulation Range (mm)**	**TXL**	**GXL**	**SXL**
12052386 (Green - No Seals)	Power/Gnd/V-Ignition	3.00	5.00	3.49 - 5.24	NR	10	10
12089678 (No Seals)	Signal	0.80	1.00	2.03 - 2.80	NR	18	18

Cable Connector (Deutsch) - HD36-24-19SE							
Contact Size	**Description**	**Cable Diameter Min (mm^2)**	**Cable Diameter Max (mm^2)**	**Insulation Range (mm)**	**TXL**	**GXL**	**SXL**
#16	Signal	0.80	2.00	1.35 - 3.05	18	18	NR
#12	Power/Gnd	2.00	3.00	2.46 - 4.01	NR	12	NR

Cable Connector (Deutsch) - DTM06-4S							
Contact Size	**Description**	**Cable Diameter Min (mm^2)**	**Cable Diameter Max (mm^2)**	**Insulation Range (mm)**	**TXL**	**GXL**	**SXL**
#20	Signal	0.80	1.00	1.02 - 2.41	18	18	18

Cable Connector (Deutsch) - DT06-2S-E005							
Contact Size	**Description**	**Cable Diameter Min (mm^2)**	**Cable Diameter Max (mm^2)**	**Insulation Range (mm)**	**TXL**	**GXL**	**SXL**
#16	Signal	0.50	2.00	1.35 - 3.05	18	18	18

Cable Connector (Deutsch) - DT06-6S-005							
Contact Size	**Description**	**Cable Diameter Min (mm^2)**	**Cable Diameter Max (mm^2)**	**Insulation Range (mm)**	**TXL**	**GXL**	**SXL**
#16	Signal	0.50	2.00	1.35 - 3.05	18	18	18

Cable Connector (Delphi) - 15492553							
Contact	**Description**	**Cable Diameter Min (mm^2)**	**Cable Diameter Max (mm^2)**	**Insulation Range (mm)**	**TXL**	**GXL**	**SXL**
12103881	Signal	0.80	1.00	2.03 - 2.40	16	18	NR

	Back Shell (Deutsch)	***Low Profile Backshell (Deutsch)**	**3-Way Metri-Pack**	**8-Way Metri-Pack**
Part Number	0528-004-3805	0528-005-3805	12124685	12047937
Conduit/OEM	Packard	Packard	Metri-Pack	Metri-Pack
Conduit P/N	*(R-69246 round) Convoluted Tubing; Size 13 mm [.500]; 125° C or higher temperature rating	(R-72506 profile) *(R-69246 round) Convoluted Tubing; Size 13 mm [.500]; 125° C or higher temperature rating		

Note: * Eaton recommended component

High Voltage Cable

⚠ CAUTION

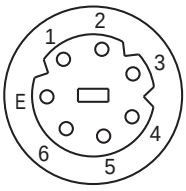
CAUTION: All high voltage AC and DC cables are required to contain a warning label at each connector end that is attached to the cable and easily viewable.The cable must stay affixed to the cable and remain readable for the life of the product.

CAUTION: High voltage cables should always be capped if they are not connected at both ends. If the vehicle is to be moved during phases of installation the components should be capped at the terminals and the cable removed until such time it can be connected at both ends.

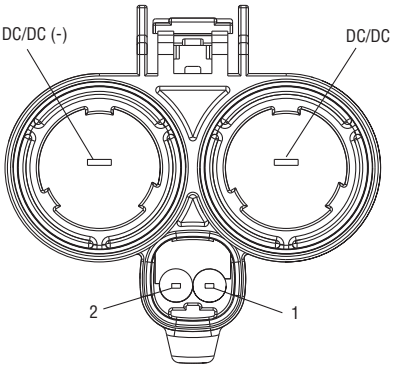
The High Voltage cable for the Hybrid System shall be:

- 4 GXL or SXL for all AC High-Voltage wires (must follow J1654 standards)
- 20mm^2 with high temperature insulation for all DC High-Voltage wires (must follow J1654 standards)
- 14 GXL for High Voltage to DC/DC from PEC (must follow J1654 standards)
- 10 GXL for APG DC High-Voltage cables (must follow J1654 standards)
- 12 GXL for APG AC High-Voltage cables (must follow J1654 standards)

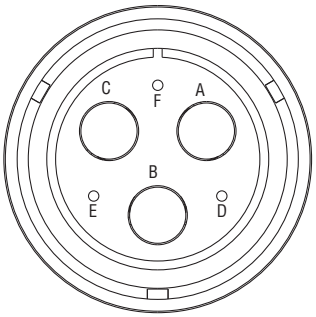
High Voltage Connector Views



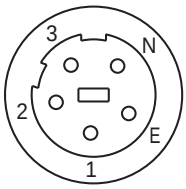
High Voltage AC Connector View
(Bulgin Connector) Front View



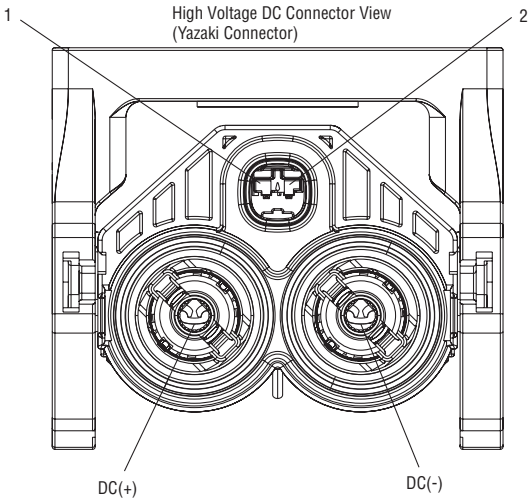
High Voltage DC/DC Harness Connector View
(Yazaki Connector)



High Voltage AC Connector View
(Amphenol Connector)



High Voltage DC Connector View
(Bulgin Connector) Front View



RECOMMENDED BEND RADIUS (6 X HARNESS DIAMETER)

Inch		Metric (mm)	
Diameter	**Bend Radius**	**Diameter**	**Bend Radius**
3/16 (0.188)	1.1	5	29
1/4 (0.250)	1.5	6	38
3/8 (0.375)	2.3	10	57
1/2 (0.500)	3.0	13	76
5/8 (0.625)	3.8	16	95
3/4 (0.750)	4.5	19	114
1/1 (1.000)	6.0	25	152

Electrical Wiring Requirements

Note: "Power" refers to both Power Positive and Power Negative supply. (This is typically Battery Plus and Battery Negative.)

Note: "Switched Ignition" refers to power that is enabled with ignition key operation.

Power Requirements

- The vehicle shall have a negative ground power system.
- The vehicle primary power system shall be either of the following types: 12 or 24 volt.
- It is permissible to lose power to both the Transmission Control Module (TCM) and Electric Clutch Actuator (ECA) due to a single point disconnect, ONLY IF that same single point disconnect ALSO removes power to the Engine Control Module (ECM) simultaneously. (This is typically performed via a power distribution panel.)
- If a disconnect switch is used for the ECM, it shall be configured such that it also removes power to the TCM and ECA.
- The OEM shall provide power wiring to the TCM such that the differential voltage (TCM negative subtracted from TCM positive) shall exceed 9 volts DC at a steady state load of 30 amps as configured for a 12 volt base system (18 volts DC at a steady state load of 30 amps as configured for a 24 volt base system.)
- The OEM shall provide power wiring to the transmission ECA such that the differential voltage (ECA positive minus ECA negative) shall exceed 9 volts DC at a steady state load of 50 amps as configured for a 12 volt base system (18 volts DC at a steady state load of 50 amps as configured for a 24 volt base system.)
- The OEM shall supply power to the TCM that does not exceed a steady state voltage of 32 volts DC.
- The OEM shall provide switched ignition power to the TCM such that it provides 10 amps at 12 volts DC.
- Power and switched ignition to the TCM shall not be switched off during the engine start process.
- The OEM shall include a starter relay.

Electrical Current Requirements - Operating Conditions over Temperature

- The Main Power 30 amp fuse connection for the TCM is required to be identified at the termination.
- The Switched Ignition 10 amp fuse connection for the TCM shall be identified at the termination.
- Operating current characteristics for the TCM:
  - Active Shifting Current = 30 amps
  - Maintaining current gear = 6 to 15 amps
  - Power down sequence = 6 to 15 amps
- The ECA Main Power 50 amp fuse connection for the ECA is required to be identified at the termination. The ECA power circuit shall be able to carry 50 amps at 9 volts. Duration of the 30 amp current draw will not exceed 200 milliseconds.

Mating Connector and Terminal Requirements

- Connectors shall be designed for use in the heavy-duty industry, conforming to SAE-J2030 and SAE-J1455.
- The OEM harness TCM mating connector shall be DRC26-38S01-P017 or equivalent. Mating Torque shall be 25 +/- 3 lb-in. (2.82 +/- 0.33 N•m).
- The OEM harness ECA mating connector shall be Delphi Metri-Pack 12124685 or equivalent.
- Connectors shall be fully mated.
- Connector latches shall be completely locked.
- Unused Connectors and terminal cavities shall have sealed mating connectors or plugged.
- Gold plated terminals shall be used for signal circuits.
- The TCM Deutsch connector's size 12 pins shall be nickel plated terminals and used for power circuits.
- The TCM Deutsch connector's size 20 pins shall be gold plated terminals and used for signal circuits.

Electrical Sealing Requirements

All electrical junctures outside of the cab are required to be sealed per SAE-J2030 standards.

Network Communications Requirements

- When the Eaton Push Button Shift Control is used, the Control Area Network (CAN) communications link between the Shift Control and the Transmission Controller must follow J1939/15.
- The J1939 (the communications link between the Transmission TCM and the Engine Controller (ECM) shall follow SAE J1939 specifications for either J1939/11 or J1939/15.
- Shielded Twisted Pair (STP) per SAE J1939/11 or SAE J1587 accordingly.
- Unshielded Twisted Pair (UTP) per SAE J1939/15 or SAE J1587 accordingly.
- During all operating conditions, the voltage potential between TCM negative and ECA negative, measured at the controllers, shall not exceed 2.0 volts DC.

Vehicle Service Requirements for Electronics

- Battery Positive and Negative must be disconnected PRIOR to any type of welding on any Fuller® Automated transmission equipped vehicles.
- Battery Negative must be disconnected PRIOR to removal or installation of TCM harness connectors.
- Removal and / or replacement of a battery shall not disturb the terminating connectors of the TCM and ECA.

Auto Neutral Requirements

An auto neutral feature is provided with this transmission which forces the transmission into neutral in all instances when the parking brake is applied. This Requires the OEM to “T” a pressure switch into the existing air line to the parking brake valve. Contact the brake manufacturer for pressure switch requirements. The pressure switch output and return wires are connected to the vehicle interface transmission TCM connector per the table in the “Connector Pin Descriptions” section.

Harness Routing Requirements

- Harness and in-line connectors shall be anchored to prevent free movement. An anchor point shall be no further than 6 in. [15.24 cm] (Recommended 3 in. [7.62 cm]) from a connector. The length of an unanchored section of harness should be no more than 12 in. [30.48 cm].
- Eaton has provided several brackets that can be used for clipping vehicle components to. Do not mount additional components to TCM, transmission brackets, mounting studs, or lifting eyes under any circumstances. This includes cap screws used to fasten the shift bar housing, rear housing, bearing covers, and PTO covers. Removal of these can compromise transmission system operation and overall system reliability.
- Tie wrap application and tightness shall conform to Section 14.1.1 of IPC/WHMA-A-620 Requirements and Acceptance for Cable and Wire Harness Assemblies", January 2002 revision or later. Tie wrap application shall meet the Target and Defect of a Class 3 product per IPC/WHMA-A-620. Use tie wraps on harness covering only, not individual wires. Do not anchor harness with tie wraps in contact with wire insulation. Tie wraps shall not pull on the harness so that connector cable seals are distorted. Allow cable to exit connector body with out pulling on the connector.
- A bend radius of six times the harness diameter is recommended.
- Recommended use of the fixed clip points on OEM harness - Fir trees, J-clips, P-clips.
- Harness routing shall not interfere with oil fill plugs, sensor locations, or manufacturing fixtures.

Electrical Wiring Recommendations

Contact Lubrication Recommendation

Note: Eaton recommends the use of (NyoGel 760G) on all electrical contacts. The preferred method of application is to use a metered dispensing mechanism that places the material on the socket of the connector. It is also preferred that the material be placed immediately prior to connector mating to reduce the probability of contamination.

- For further information contact your Eaton OEM Engineering Support Group.
- The NyoGel 760G material shall not be applied to the transmission ECU 38-Way (Vehicle Interface) connector jackscrew. No anti-seize, lubricating, or foreign compound shall be applied to the connector jackscrew threads. The use of such compounds may affect jackscrew torque and prevent proper sealing of the connector.

Harness Design Recommendations

The cable for the Deutsch connector (DRC26-38-S01) should be:

- 18 GXL max /18 TXL min. for Communication and control wires
- 12 GXL for Power Supply wires
- 12 GXL or 14 SXL for V-Ignition wires

The cable for the 3-Way Metri-Pack connector should be:

- 10 SXL for Power Supply wires to ECA

The cable for the 8-Way Metri-Pack connector shall be:

- J1939- 15 Twisted Pair for Communication
- 18ga. Twisted Pair for Speed Sensor

  Note: Must conform to SAE J1939-15.
- 18 TXL for V-Ignition wires

  Note: These sizes ensure proper connector sealing and current carrying capacity
- Splices must be ultrasonically welded per IPC/WHMA-A-620 and encapsulated and sealed to meet SAE-J1455
- Convoluted Conduit shall have a service temperature of at least 257° F (125° C)
- Braided Loom shall have a service temperature of at least 280° F (138° C). Coverage: A minimum of 10 / maximum of 12 picks per inch. TWISTED CABLES
  - 2 Cables = 10 Twists / 25.4 cm
  - 3 Cables = 8 Twists / 25.4 cm
  - (16 and 18 Gage Cable Only)

SAE Wire	SAE Wire	Nominal Outside Diameter (mm)			Nominal Outside Diameter Inch		
Size mm²	Size No.	TXL	GXL	SXL	TXL	GXL	SXL
0.8	18	1.98	2.39	2.72	0.08	0.09	0.11
1	16	2.24	2.59	3.05	0.09	0.10	0.12
2	14	2.62	2.97	3.58	0.10	0.12	0.14
3	12	3.25	3.63	4.14	0.13	0.14	0.16
5	10	3.96	4.45	4.95	0.16	0.18	0.20

Cable Connector (Deutsch) - DRC26-38S01-P017

Seal Range (mm) / (in)	Contact Size	Description	Cable Diameter Min (mm²)	Cable Diameter Max (mm²)	TXL	GXL	SXL
1.02 - 2.41 /.040 -.095	20	Signal	1.02	2.41	16	16	NR
3.40 - 4.95 /.134 -.195	12	Power	3.40	4.95	NR	12	NR
3.40 - 4.95 /.134 -.195	12	V-Ignition	3.40	4.95	NR	12	14

Cable Connector (Metri-Pack) - 3-Way 12124685

Seal Range (mm) / (in)	Contact Size	Description	Cable Diameter MIn (mm²)	Cable Diameter Max (mm²)	TXL	GXL	SXL
4.40 - 5.15 /.173 -.202	10	Power (ECA)	4.40	5.15	NR	NR	10

	Back Shell (Deutsch)	*Low Profile Backshell (Deutsch)
Part Number	0528-004-3805	0528-005-3805
Conduit/OEM	Packard	Packard
Conduit P/N	*(R-69246 round) Convoluted Tubing; Size 13 mm [.500]; 125° C or higher temperature rating	(R-72506 profile) *(R-69246 round) Convoluted Tubing; Size 13 mm [.500]; 125° C or higher temperature rating

Electrical Juncture Recommendations

- Do not use more than three (3) ring terminals per mounting stud. Terminals such as ring, bullet, spade, etc., shall be sized for the correct current capacity of the circuit as stated by the manufacturer. Terminals shall be plated and non insulated. Sleeves shall be insulated with a double wall shrink tubing. Sealing Dielectric grease over the top of the ring is recommended.
- Do not use Lock washers or Star washers for contact surfaces.
- Crimps shall be applied with a tool specified by the manufacturer of the terminal and in accordance to the manufacturer's specifications.

Harness Troubleshooting Recommendations and Test Equipment Design

- Removal of fuses is not recommended as the method of disconnecting power from the TCM. Making and breaking a circuit through tin plated terminals (e.g. ring terminals, fuses, and most connectors) will destroy the plating on the terminal. Opening a switch contact or the main power link is the recommended method of interrupting power.
- Harness Probing Damage Alert - Never puncture cable insulation with a probe to verify voltage or to check continuity. Damage to the wire insulation can lead to immediate or future failures of the harness or electronic control unit due to shore circuits, water entry, or corrosion.

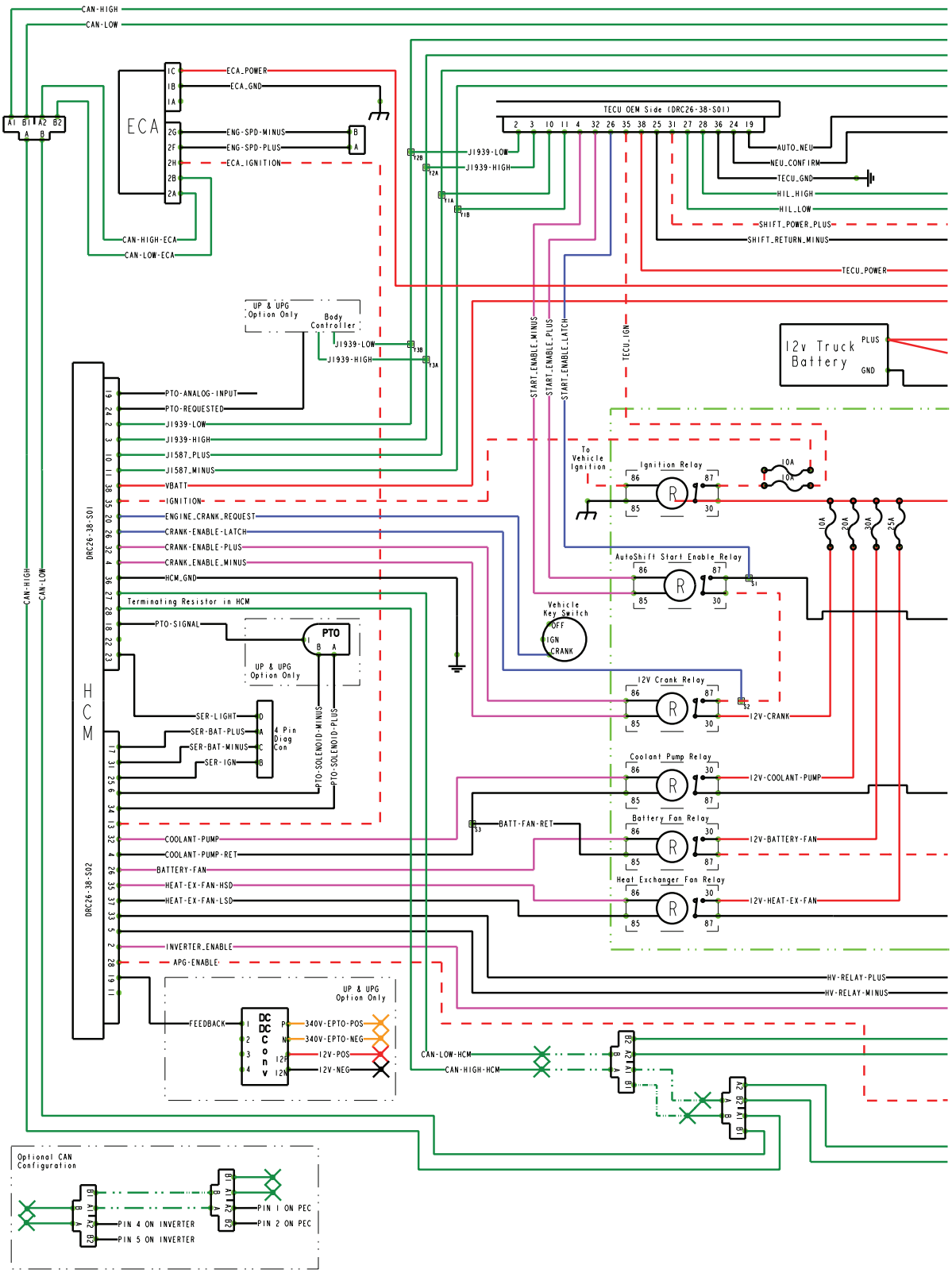
Note: If a connection to the harness or TCM is required before vehicle installation, Eaton recommends the use of a connector with a spring loaded contact rather than a standard mating connector. The spring loaded contact is intended to make the electrical connection with the tip of the terminal without touching the mating surface. This will protect the terminal plating, the NyoGel 760G™ and retain the original durability and reliability of the connector system.

Wiring Diagrams OEM Responsibility

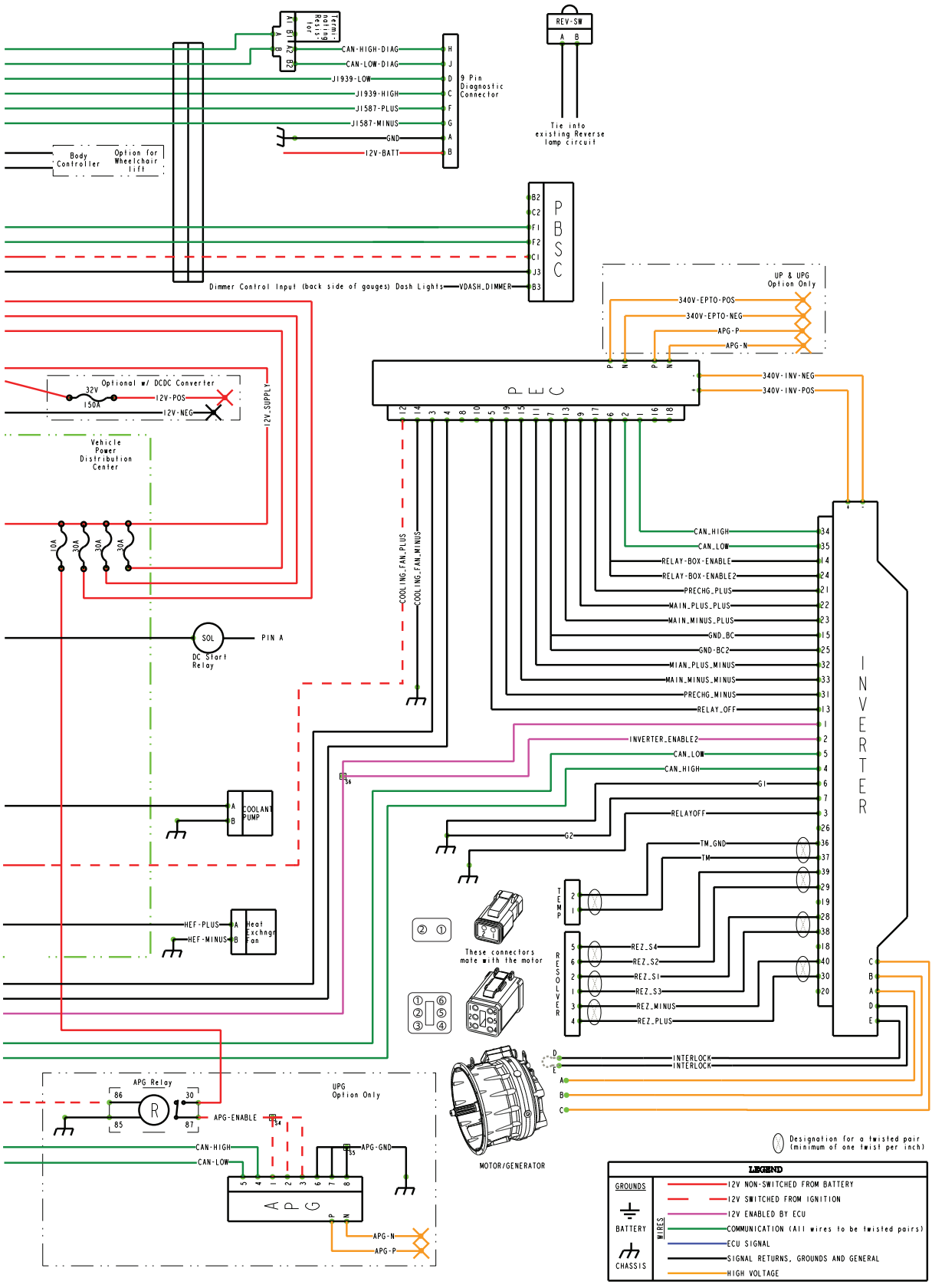
This section contains the following wiring diagrams:

- Enhanced MY09 for City Delivery and Utility
- Enhanced MY09 Low Profile with Park (LPwP)
- Enhanced MY09 with Alternative Components

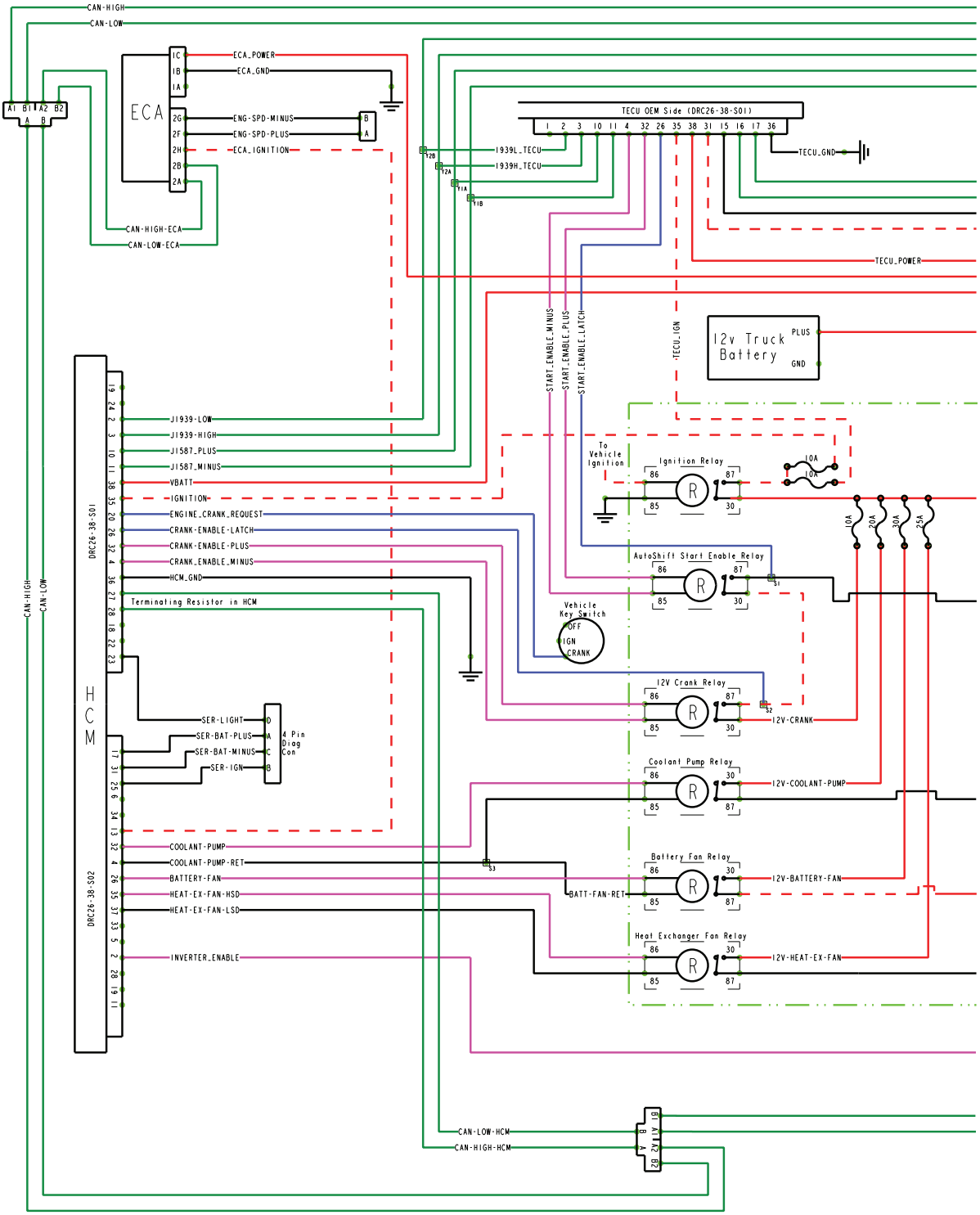
Enhanced MY09 for City Delivery and Utility



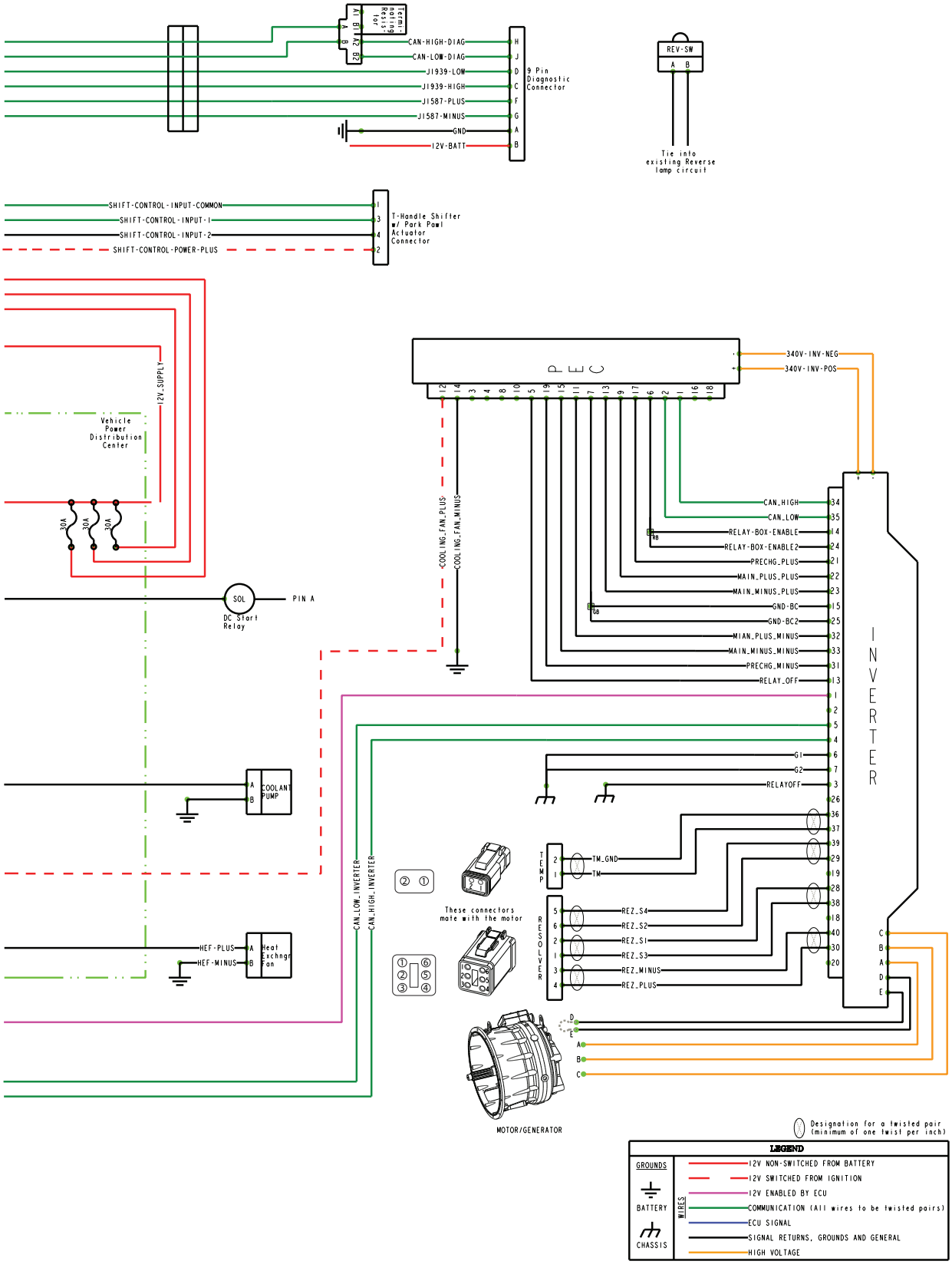
Enhanced MY09 for City Delivery and Utility (continued)



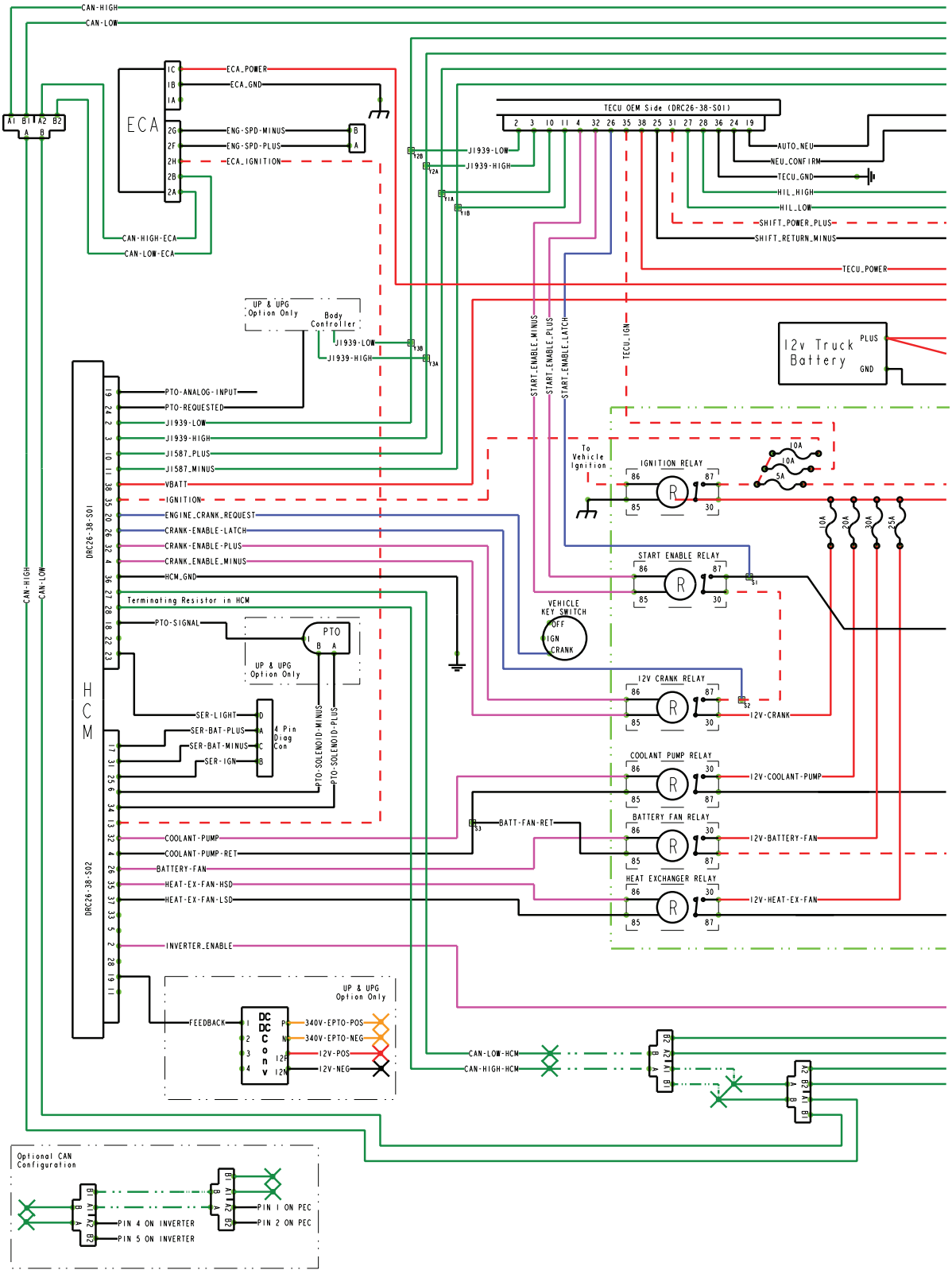
Enhanced MY09 Low Profile with Park (LPwP)



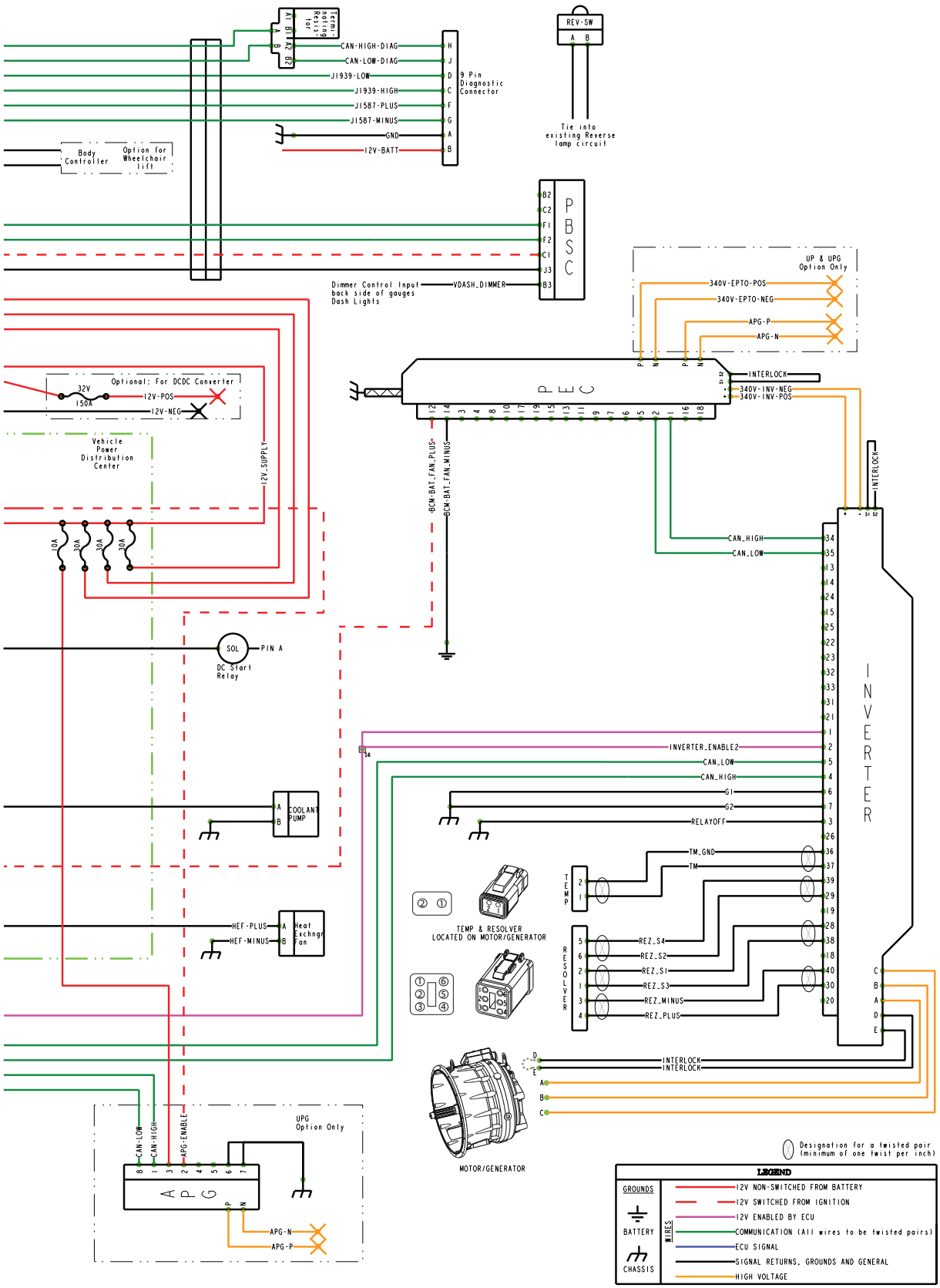
Enhanced MY09 Low Profile with Park (LPwP) (continued)



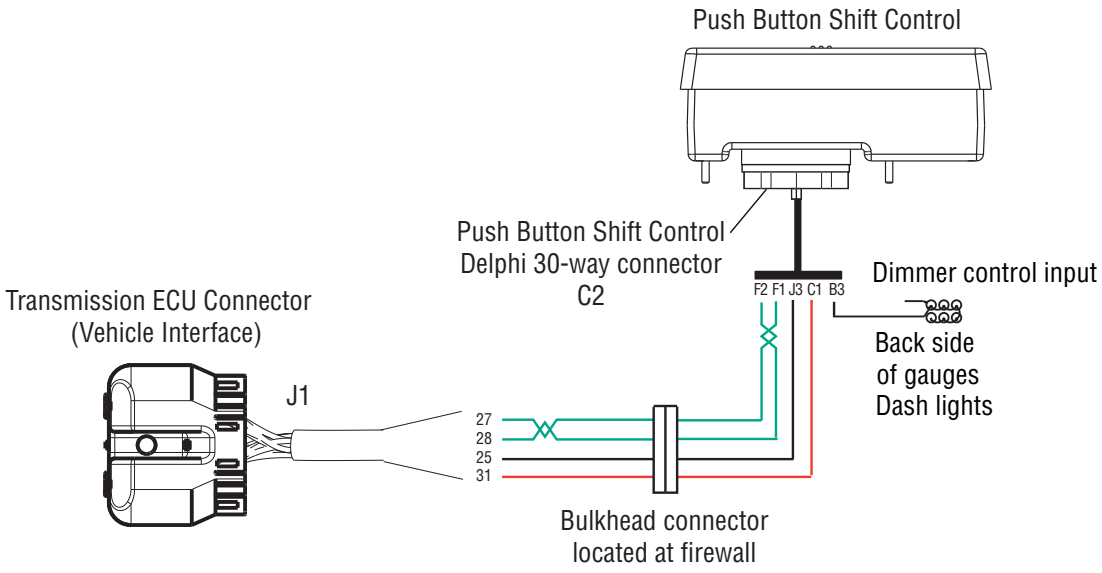
Enhanced MY09 with Alternative Components

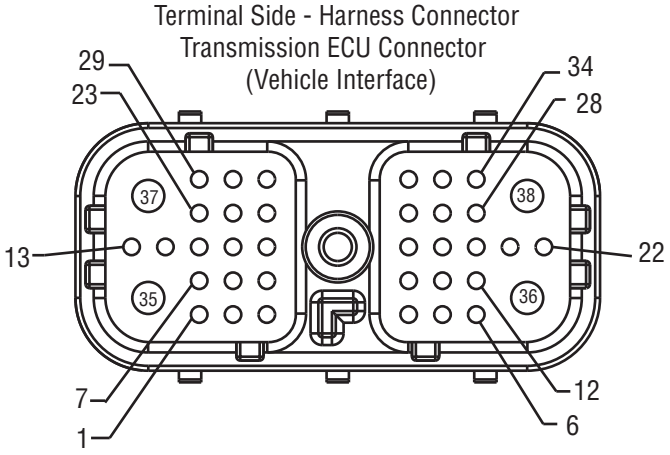


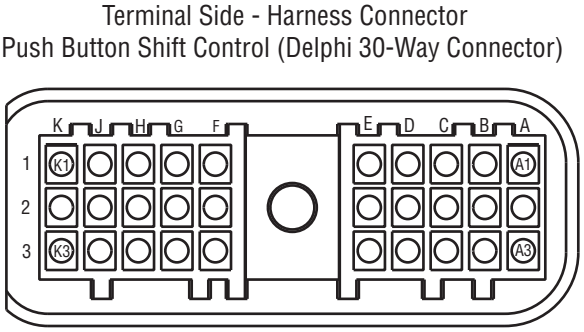
Enhanced MY09 with Alternative Components (continued)



Typical Eaton Push Button Shift Control Circuit







Push Button Shift Control 30-Way Connector

Description	From	Pin#	To	Pin#	AWG
HIL High	PBSC	F1	TECU	28	18
HIL Low	PBSC	F2	TECU	27	18
Shift Control Power Minus	PBSC	J3	TECU	25	18
Shift Control Power Plus	PBSC	C1	TECU	31	18
Vdash	PBSC	B3	Dimmer Control	Spliced	18

Mating Connector Information

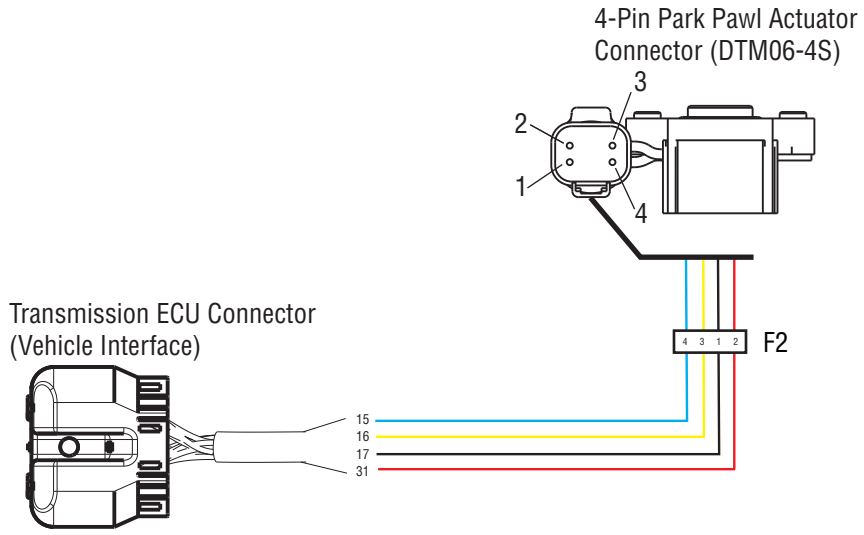
Delphi 30-Way Connector	
Connector	12048455
Terminal	12103881
Plug	12034413

Note: There is an equivalent Cinch connector available.

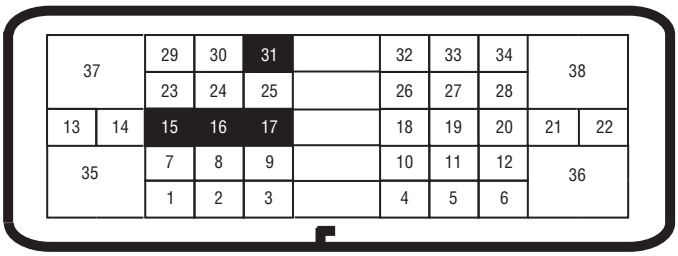
The CAN (Control Area Network communications link between the Shift Control and the Transmission Controller) must be a J1939/15 twisted pair cable.

Note: Connect VDASH to the dash lights. This input will dim the lights on the Shift Control when the lights are on. When VDASH input is off, the lights on the Shift Control will be on full.

Typical System with OEM Park Shift Lever

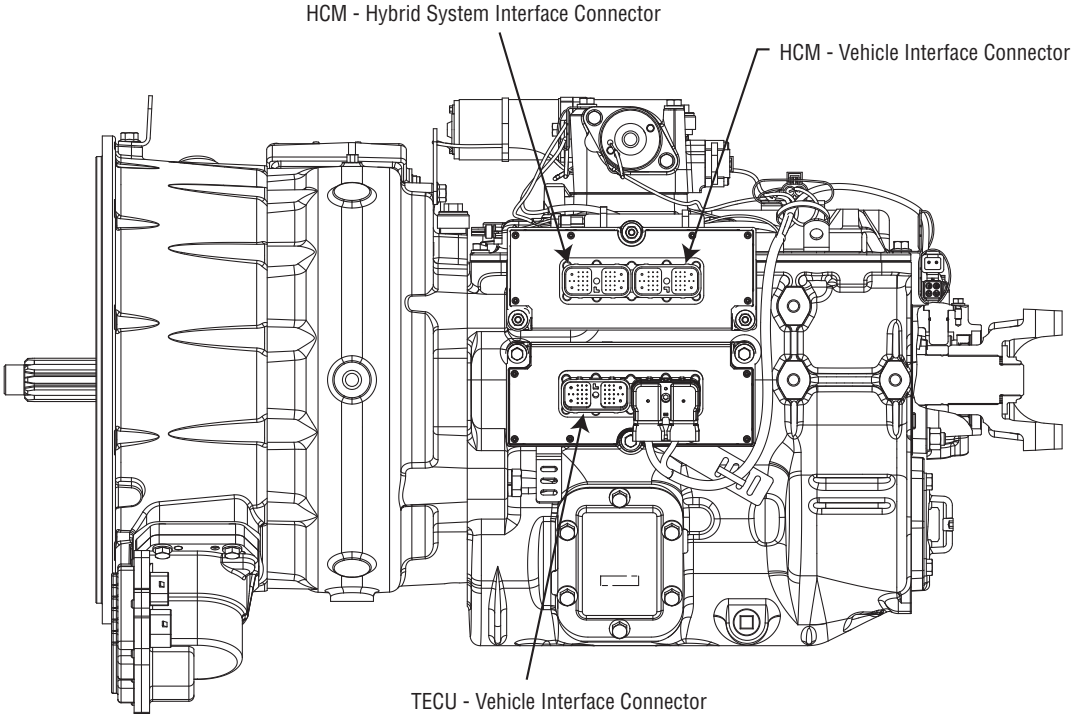


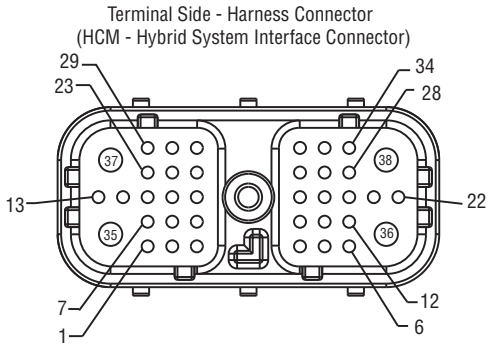
Front View
Transmission ECU Connector
(Vehicle Interface)

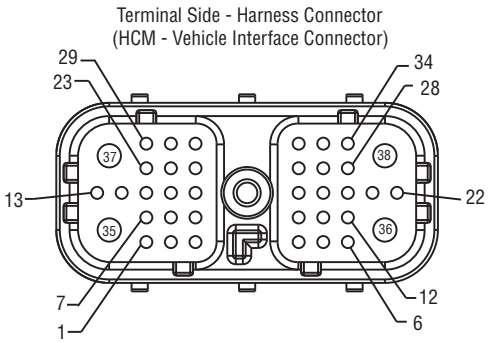


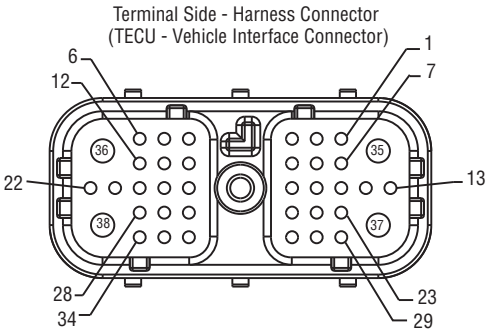
FROM	TO	DESCRIPTION
J1-15	F2-4	Shift Control Input 2
J1-16	F2-3	Shift Control Input 1
J1-17	F2-1	Shift Control Input Common
J1-31	F3-2	Shift Control Power Positive

Typical HCM & TECU Interfaces









⚠ CAUTION

Please note the location and orientation of the HCM and TECU connectors. The backshell should always face down on the harness connectors.

EH-8E306A-CD/U/UP/UPG/T

Transmission Controller 38-Way (Vehicle Interface Connector)

Description	From	Pin#	To	Pin#	AWG
Not Used		1			Plug
J1939 Low (CAN)	TECU	2	1939 Backbone	B	18 TXL
J1939 High (CAN)	TECU	3	1939 Backbone	A	18 TXL
Start Enable Relay Minus	TECU	4	AS Start Enable Relay	85	18 TXL
Not Used		5			Plug
Not Used		6			Plug
Not Used		7			Plug
Not Used		8			Plug
Not Used		9			Plug
J1587 Plus	TECU	10	Splice into 1587	A	18 TXL
J1587 Minus	TECU	11	Splice into 1587	B	18 TXL
Not Used		12			Plug
Not Used		13			Plug
Not Used		14			Plug
Not Used		15			Plug
Not Used		16			Plug
Not Used		17			Plug
Not Used		18			Plug
Auto Neutral (Optional Wheelchair Lift)	TECU	19	Body Controller		18 TXL
Not Used		20			Plug
Not Used		21			Plug
Not Used		22			Plug
Not Used		23			Plug
Neutral Confirmation (Optional Wheelchair Lift)	TECU	24	Body Controller		Plug
Shift Control Power Minus	TECU	25	PBSC	J3	18 TXL
Start Enable Latch	TECU	26	AS Start Enable Relay	87	18 TXL
HIL Low (Proprietary CAN)	TECU	27	PBSC	F2	18 TXL
HIL High (Proprietary CAN)	TECU	28	PBSC	F1	18 TXL
Not Used		29			Plug
Not Used		30			Plug
Shift Control Power Plus	TECU	31	PBSC	C1	18 TXL

Description	From	Pin#	To	Pin#	AWG
Start Enable Relay Plus	TECU	32	AS Start Enable Relay	86	18 TXL
Not Used		33			Plug
Not Used		34			Plug
Ignition	TECU	35	10A Fused Switched Power from Ignition Bus		12 GXL or 14SXL
Battery Minus	TECU	36	Ground at Battery or Starter		12 GXL
Not Used		37			Plug
Battery Plus	TECU	38	30A Fused Non-Switched		12 GXL

EH-6E606B-CD

Transmission Controller 38-Way (Vehicle Interface Connector)

Description	From	Pin#	To	Pin#	AWG
Not Used		1			Plug
J1939 Low (CAN)	TECU	2	1939 Backbone	B	18 TXL
J1939 High (CAN)	TECU	3	1939 Backbone	A	18 TXL
Start Enable Relay Minus	TECU	4	AS Start Enable Relay	85	18 TXL
Not Used		5			Plug
Not Used		6			Plug
Not Used		7			Plug
Not Used		8			Plug
Not Used		9			Plug
J1587 Plus	TECU	10	Splice into 1587	A	18 TXL
J1587 Minus	TECU	11	Splice into 1587	B	18 TXL
Not Used		12			Plug
Not Used		13			Plug
Not Used		14			Plug
Shift Control Input 2	TECU	15	Park Mechanism Sensor	4	18 TXL
Shift Control Input 1	TECU	16	Park Mechanism Sensor	3	18 TXL
Shift Control Input Common	TECU	17	Park Mechanism Sensor	2	18 TXL
Not Used		18			Plug
Auto Neutral (Optional Wheelchair Lift)	TECU	19	Body Controller		18 TXL
Not Used		20			Plug
Not Used		21			Plug

Description	From	Pin#	To	Pin#	AWG
Not Used		22			Plug
Not Used		23			Plug
Neutral Confirmation (Optional Wheelchair Lift)	TECU	24	Body Controller		Plug
Not Used		25			Plug
Start Enable Latch	TECU	26	AS Start Enable Relay	87	18 TXL
Not Used		27			Plug
Not Used		28			Plug
Not Used		29			Plug
Not Used		30			Plug
Shift Control Power Plus	TECU	31	Park Mechanism Sensor	1	18 TXL
Start Enable Relay Plus	TECU	32	AS Start Enable Relay	86	18 TXL
Not Used		33			Plug
Not Used		34			Plug
Ignition	TECU	35	10A Fused Switched Power from Ignition Bus		12 GXL or 14SXL
Battery Minus	TECU	36	Ground at Battery or Starter		12 GXL
Not Used		37			Plug
Battery Plus	TECU	38	30A Fused Non-Switched		12 GXL

All Hybrid Models

Hybrid Controller 38-Way (Vehicle Interface Connector)

Description	From	Pin#	To	Pin#	AWG
Not Used		1			Plug
J1939 Low (CAN)	HCM	2	1939 Backbone	B	18 TXL
J1939 High (CAN)	HCM	3	1939 Backbone	A	18 TXL
Crank Enable Minus	HCM	4	12v Cranking Relay	85	Plug
Not Used		5			Plug
Not Used		6			Plug
Not Used		7			Plug
Not Used		8			Plug
Not Used		9			Plug
J1587 Plus	HCM	10	Splice into 1587		18 TXL
J1587 Minus	HCM	11	Splice into 1587		18 TXL

Description	From	Pin#	To	Pin#	AWG
Not Used		12			Plug
Not Used		13			Plug
Not Used		14			Plug
Not Used		15			Plug
Not Used		16			Plug
Not Used		17			Plug
PTO Signal	HCM	18	PTO		18 TXL
mPTO Signal	HCM	19	PTO Ground Switch		18 TXL
Engine Crank Request	HCM	20	Crank Position on Switch		18 TXL
Not Used		21			Plug
Not Used		22			Plug
Service Lamp	HCM	23	4-pin Service Connector	D	18 TXL
PTO Request (Non J1939 BCU)	HCM	24	BCU		18 TXL
Not Used		25			Plug
12v Cranking Relay Latch	HCM	26	12v Cranking Relay	87	18 TXL
CAN Low (Proprietary CAN)	HCM	27	HEV Backbone	B	18 TXL
CAN High (Proprietary CAN)	HCM	28	HEV Backbone	A	18 TXL
Not Used		29			Plug
Not Used		30			Plug
Not Used		31			Plug
Crank Enable Plus	HCM	32	12v Cranking Relay	86	18 TXL
Not Used		33			Plug
Not Used		34			Plug
Ignition	HCM	35	Fused 10A to Ignition Relay		12 GXL or 14SXL
HCM Ground	HCM	36	Battery Ground		12 GXL
Not Used		37			Plug
Battery Plus	HCM	38	Fused 30A Battery		12 GXL

Hybrid Controller 38-Way (Hybrid System Interface Connector)

Description	From	Pin#	To	Pin#	AWG
Not Used		1			Plug
V-Batt1 (12V)	HCM	2	Inverter	1	18 TXL
V-Batt2 (12V)	HCM	2	Inverter	2	18 TXL
V-Batt1 (24V)	HCM	2	Inverter	9	18 TXL

Description	From	Pin#	To	Pin#	AWG
V-Batt2 (24V)	HCM	2	Inverter	10	18 TXL
Not Used		3			Plug
Coolant Pump & Battery Fan Relay Minus	HCM	4	Coolant Pump Relay & Battery Fan Relay	85	18 TXL
High Voltage Relay Minus	HCM	5	PEC	4	18 TXL
PTO Power Minus	HCM	6	PTO		18 TXL
Not Used		7			Plug
Not Used		8			Plug
Not Used		9			Plug
Not Used		10			Plug
Not Used		11			Plug
Not Used		12			Plug
ECA Ignition	HCM	13	ECA	H	18 TXL
Not Used		14			Plug
Not Used		15			Plug
Not Used		16			Plug
Service Battery Plus		17	Service Port	A	18 TXL
Not Used		18			Plug
DC/DC Converter Feedback	HCM	19	DC/DC Converter	1	18 TXL
Not Used		20			Plug
Not Used		21			Plug
Not Used		22			Plug
Not used		23			Plug
Not Used		24			Plug
Service Ignition	HCM	25	Service Port	C	18 TXL
Battery Cooling Fan Relay Plus	HCM	26	Battery Cooling Fan	86	18 TXL
Not Used		27			Plug
Not Used		28			Plug
Not Used		29			Plug
Not Used		30			Plug
Service Battery Minus	HCM	31	Service Port	B	18 TXL
Coolant Pump Relay Plus	HCM	32	Coolant Pump Relay	86	18 TXL
High Voltage Relay Plus	HCM	33	PEC	3	18 TXL
PTO Power Plus	HCM	34	PTO		18 TXL

Description	From	Pin#	To	Pin#	AWG
Heat Exchanger Plus	HCM	35	HEF Relay	86	12 GXL or 14SXL
Not Used		36			Plug
Heat Exchanger Minus	HCM	37	HEF Relay	85	18 TXL
Not Used		38			Plug

Mating Connector Information

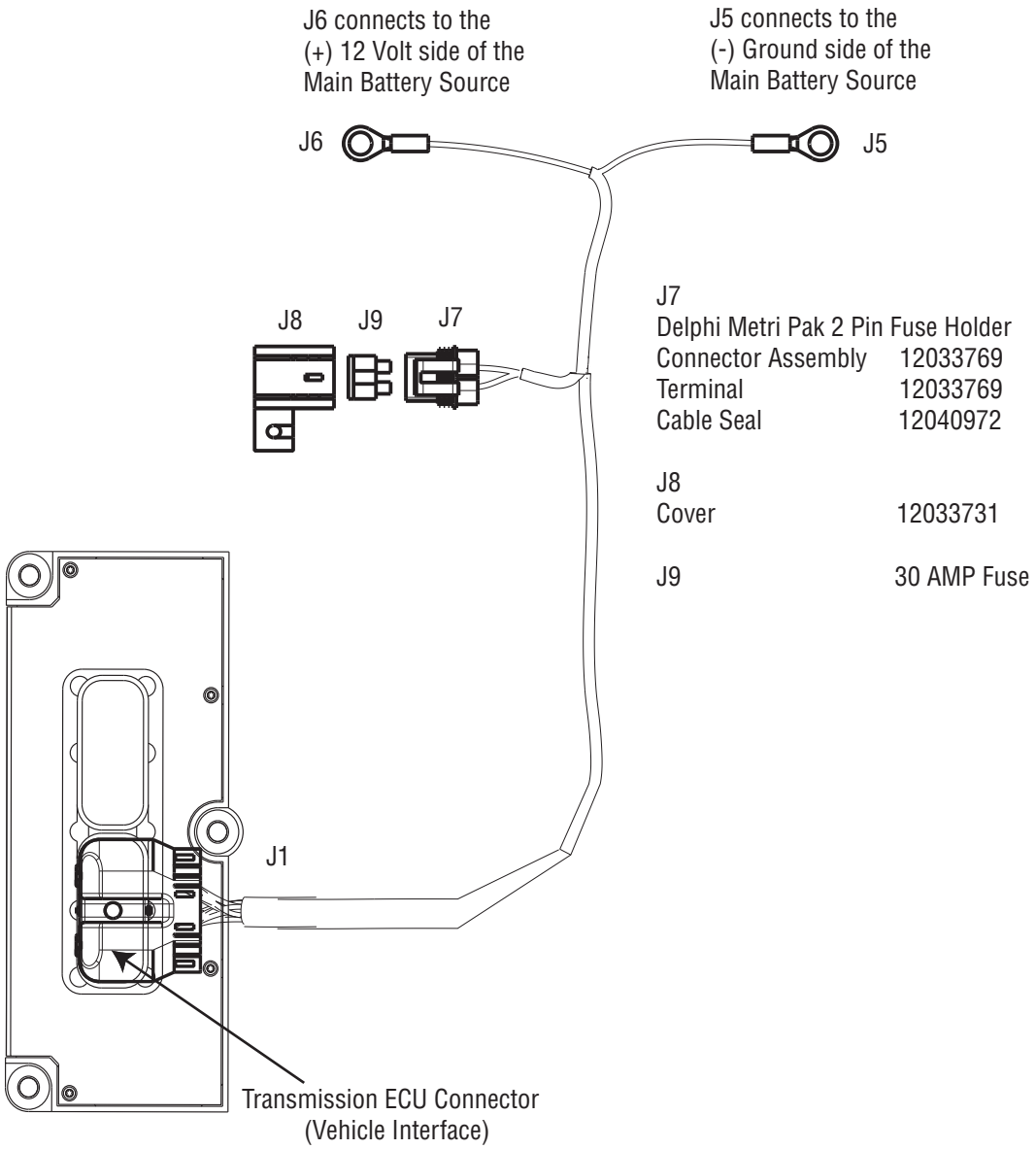
Deutsch 38-Way Connector	
Connector	DRC26-38S01-P017
Connector	DRC26-38S02-P017
Terminal	0462-201-2031
Plug	0413-204-2005
Terminal High Power	0462-203-12141
Plug	114017

Deutsch 4-Way Connector	
Connector	DTM06-4S
Terminal	0462-201-2031

Delphi 4-Way Service Connector	
Connector	12015024
Plug	12010300

Typical Power Harness Circuit

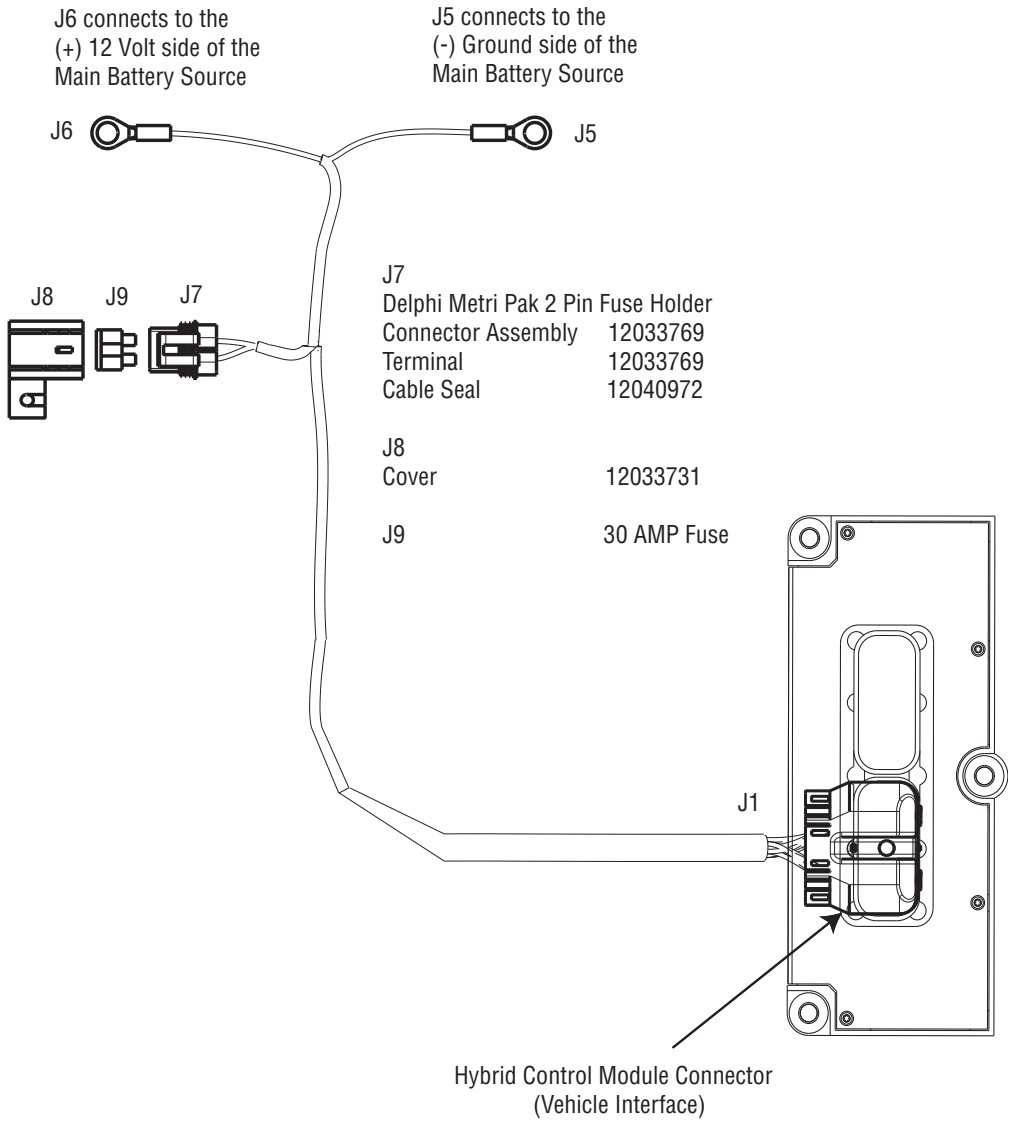
Transmission ECU (TECU) Power Harness



TECU 38-Way Connector

Description	From	Pin#	To	Pin#	AWG
Ground	Gnd at Battery	J5	TECU	36	12
Battery	Battery	J6	Fuse Holder	J7-B	12
Battery	Fuse Holder	J7-A	TECU	38	12

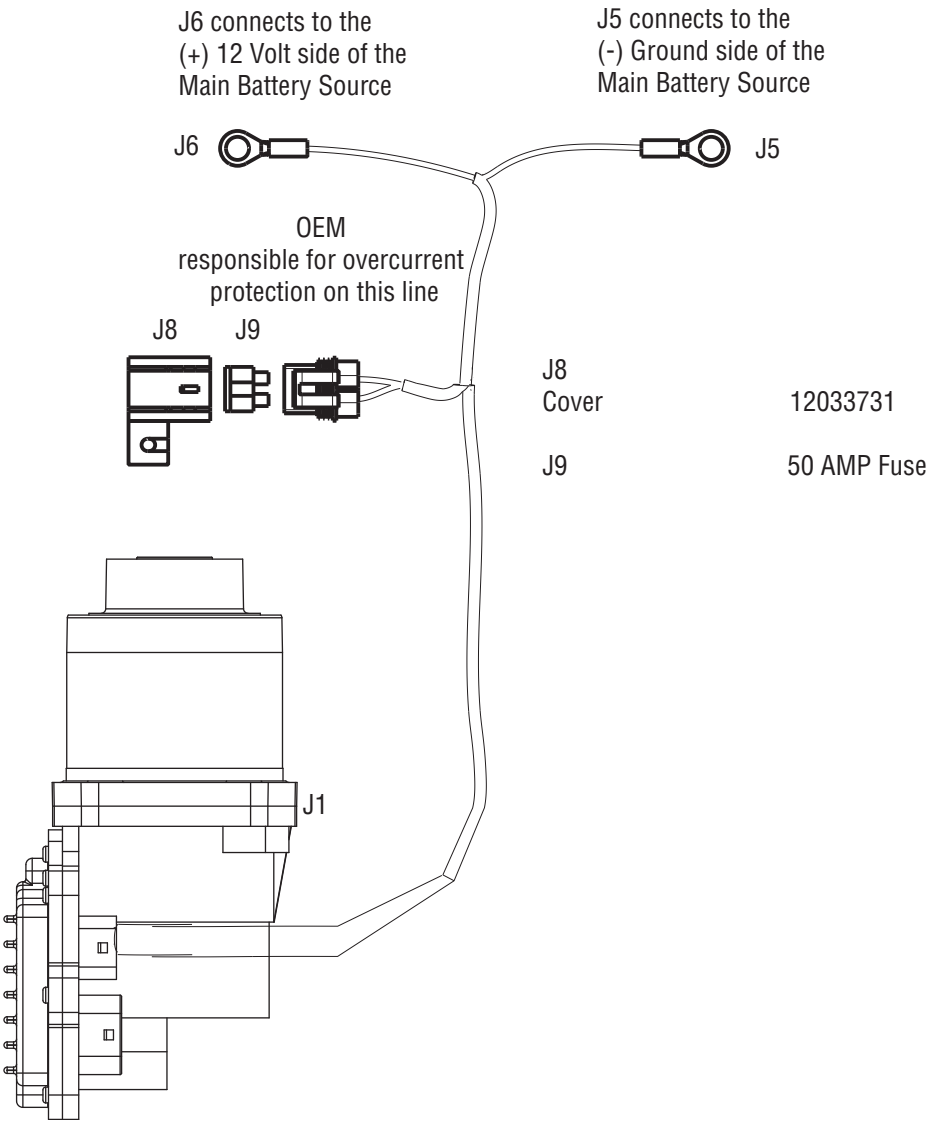
Hybrid Control Module (HCM) Power Harness



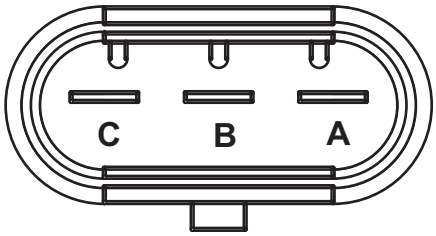
HCM 38-Way Connector

Description	From	Pin#	To	Pin#	AWG
Ground	Gnd at Battery	J5	HCM	36	12
Battery	Battery	J6	Fuse Holder	J7-B	12
Battery	Fuse Holder	J7-A	HCM	38	12

Electric Clutch Actuator (ECA) Power Harness



FROM	TO	WIRE DESCRIPTION
		Plugged
J6	J1-C (ECA)	Battery Positive (Fused)
J5	J1-B (ECA)	Battery Negative



ECA PIN OUT 3-WAY CONNECTOR	
A	Plugged (Not Used)
B	Battery Negative
C	Battery Positive (Fused)

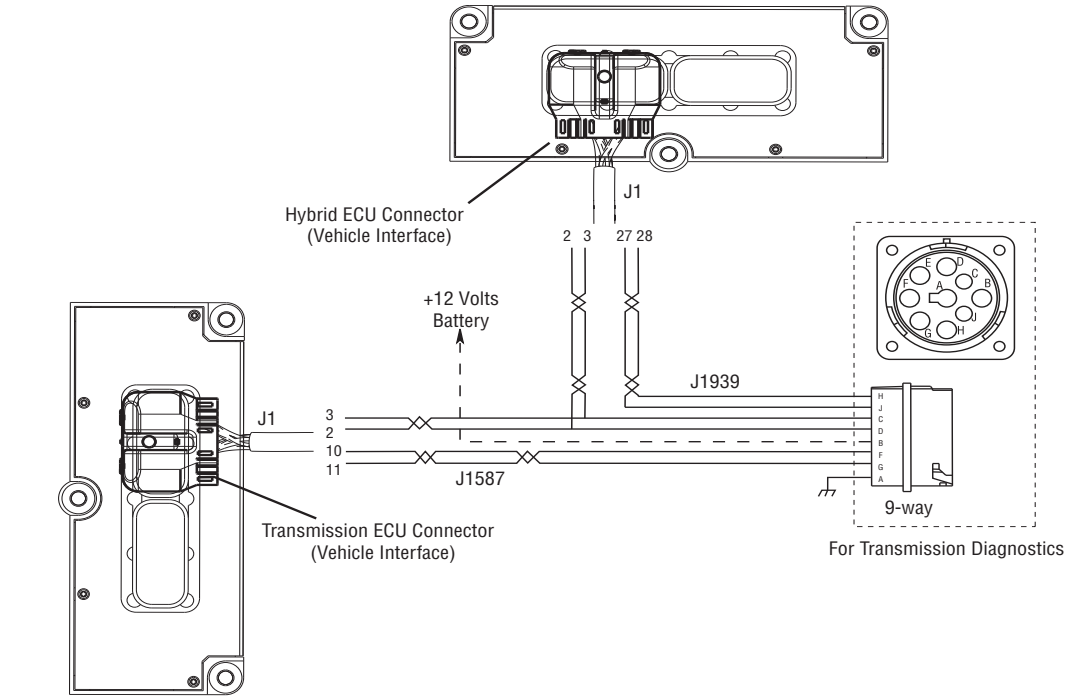
⚠ WARNING

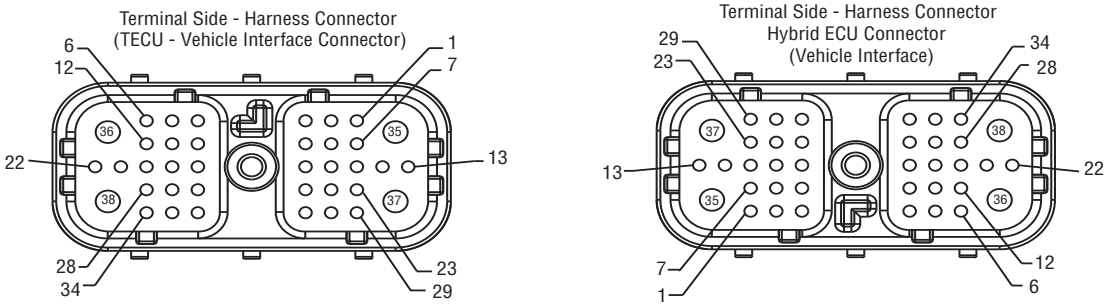
The ECA and ECU battery positive terminations shall be made in accordance to power requirements stated earlier in this section. The termination shall not be made on the battery, frame rail, or starter posts. This applies to battery positive and battery negative.

- The Transmission ECU, Hybrid Control Module, and ECA shall be wired to a non-switched reliable power source like a Power Distribution Module or direct battery source. If a disconnect switch is required, the recommended practice is to wait a minimum of three minutes before using the disconnect switch.
- It is the OEM responsibility to provide power and ground to the Transmission Electronic Control Unit (TECU), Hybrid Control Module (HCM) and Electric Clutch Actuator (ECA) from a reliable battery source. The power (+) connection must include overload protection per Federal Motor Carrier Safety Regulations, Section 393.31. The TECU Main Power and Ground must be able to carry 30 amps @ 9 volts with no more than.05 ohms per wire (0.1 ohms total) at 120°C. The HCM Main Power and Ground must be able to carry 30 amps @ 9 volts with no more than.05 ohms per wire (0.1 ohms total) at 120°C.
- Ground connections can not be shared between the ECA, TECU, and HCM. The grounds must be separated, independent, and a clean reliable power.
- The Main power 30 amp fuse connection for the Transmission ECU must be identified with a tag at the battery.
- The Main power 30 amp fuse connection for the Hybrid Control Module must be identified with a tag at the battery.
- The Main power 50 amp fuse connection for the Electric Clutch Actuator (ECA) must be identified with a tag at the fuse and at the ECA.
- 12 volt battery positive and negative must be disconnected PRIOR to any type of welding on any Hybrid equipped vehicles.
- 12 volt battery negative must be disconnected PRIOR to removal or installation of ECU harness connectors.
- Removal of fuses is not recommended as the method of disconnecting power from the ECU. Making and breaking a circuit through tin plated terminals (e.g. ring terminals, fuses, most connectors) will destroy the plating on the terminal. Opening a switch contact or the main power link is the recommended method of interrupting power.
- Application of more than 36 volts to the system (such as jump starting) will cause system shutdown and possible electrical component damage.

Data Link Interface w/9-Pin Diagnostic Connector

Note: The diagnostic connector (9-pin required) must be easily accessible and mounted on the drivers side of the cab.





TECU 38-Way Connector

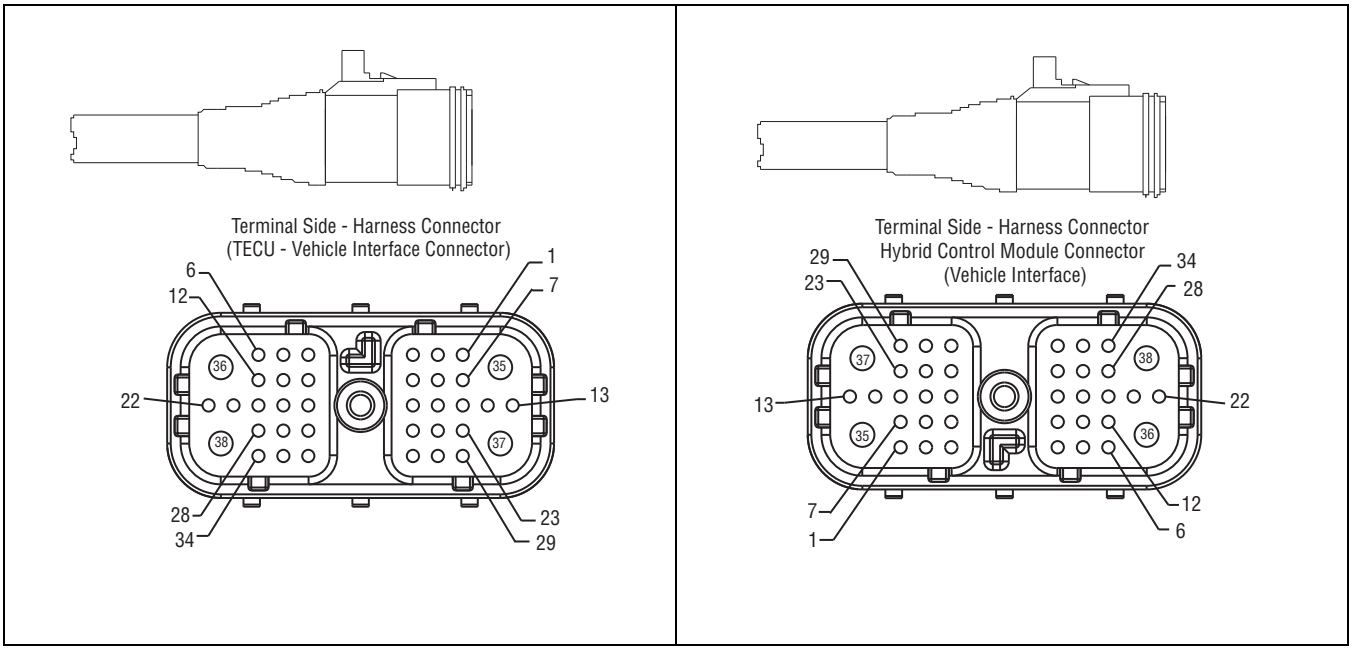
Description	From	Pin#	To	Pin#	AWG
J1587 Plus	TECU	10	9-Pin Connector	F	18
J1587 Minus	TECU	11	9-Pin Connector	G	18
J1939 High	TECU	3	9-Pin Connector	C	18
J1939 Low	TECU	2	9-Pin Connector	D	18

HCM 38-Way Connector

Description	From	Pin#	To	Pin#	AWG
J1939 High	TECU	3	9-Pin Connector	C	18
J1939 Low	TECU	2	9-Pin Connector	D	18

J1939/15 & Proprietary CAN Data Links

Maximum 40 meter Length.
Maximum 3 meter stub length.
Maximum 10 modules on segment.
Twisted pair (18 gauge) with 1 twist per inch.
120 Ohm terminating resistors must be used.
The third pin for shield is not used in 'in-line' and T-connectors for the J1939/15 datalink.
The J1939 link must follow SAE J1939 specifications for either J1939/11 or J1939/15.



TECU 38-Way Connector

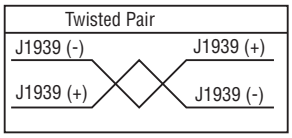
Description	From	Pin#	To	Pin#	AWG
J1939 Low	TECU	2	J1939 Backbone	B	18
J1939 High	TECU	3	J1939 Backbone	A	18

HCM 38-Way Connector

Description	From	Pin#	To	Pin#	AWG
J1939 Low	HCM	2	J1939 Backbone	B	18
J1939 High	HCM	3	J1939 Backbone	A	18
CAN Low	HCM	27	CAN Backbone	B	18
CAN High	HCM	28	CAN Backbone	A	18

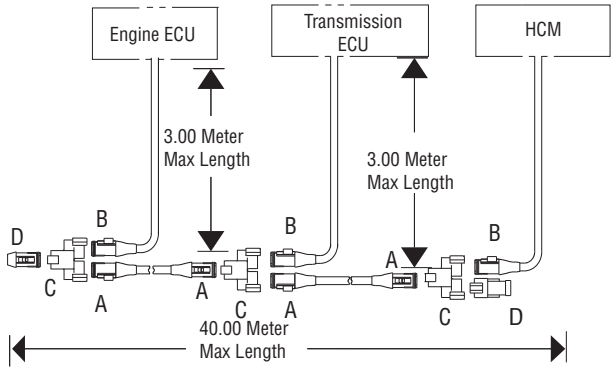
Datalink Structure

Recommended Cable Manufacturer	Cable Part Number	Round	J1939 (+) (PIN "A") Color	J1939 (-) (PIN "B") Color
Champlain	J1939/15	Yes	Yellow	Green



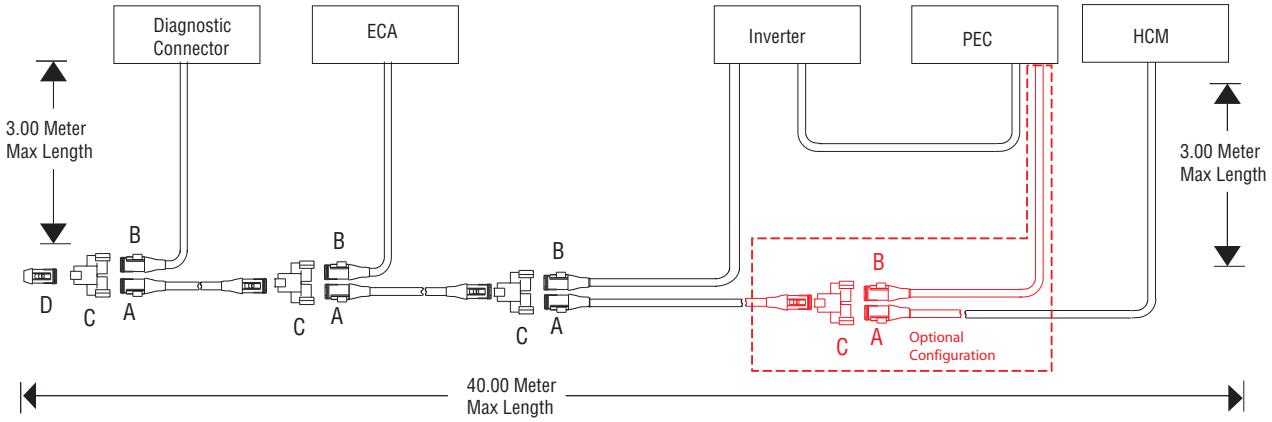
Ref.	Body	Signal Terminals (QTY)		Wedge	Function
A	DTM-06-2S	0462-201-2031 (2)		WM-2S	Through Connector
B	DTM-06-2S	0462-201-2031 (2)		WM-2SB	Stub Connector
C	DTM04-2P-P007	N/A		N/A	"T" Receptacle
D	DTM06-2S-EP10	N/A		WM-2SB	120 Ohm Termination
E	DTM04-2P	0460-202-2031 (2)		WM-2P	ECU Receptacle
G	DTM06-2S-EP10	N/A		WM-2SB	120 Ohm Termination

J1939 Data Link
(OEM supplied)



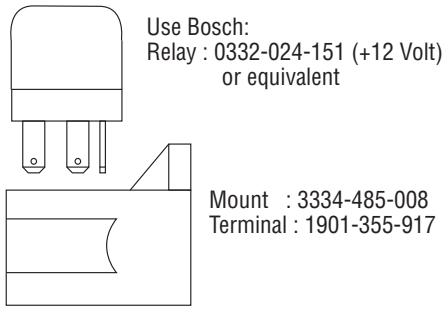
CAN Data Link
HCM Vehicle Interface Harness
(OEM) Supplied

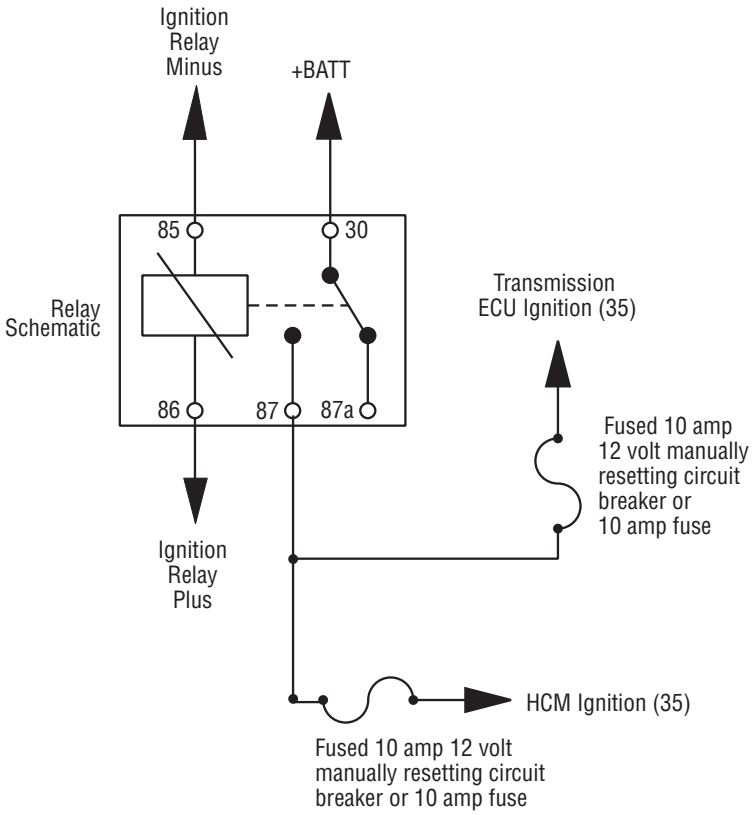
Terminating Resistor Internal

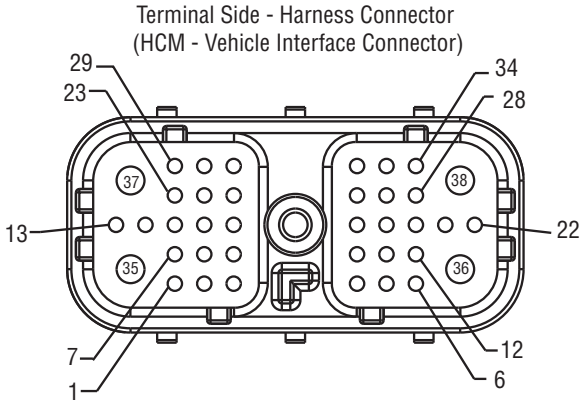


Typical Ignition Relay Circuit

Note: Additional relay is not required if ignition circuit is protected by OEM relay circuit







HCM 38-Way Connector

Description	From	Pin#	To	Pin#	AWG
Ignition	HCM	35	Ignition Relay	87	12

TECU 38-Way Connector

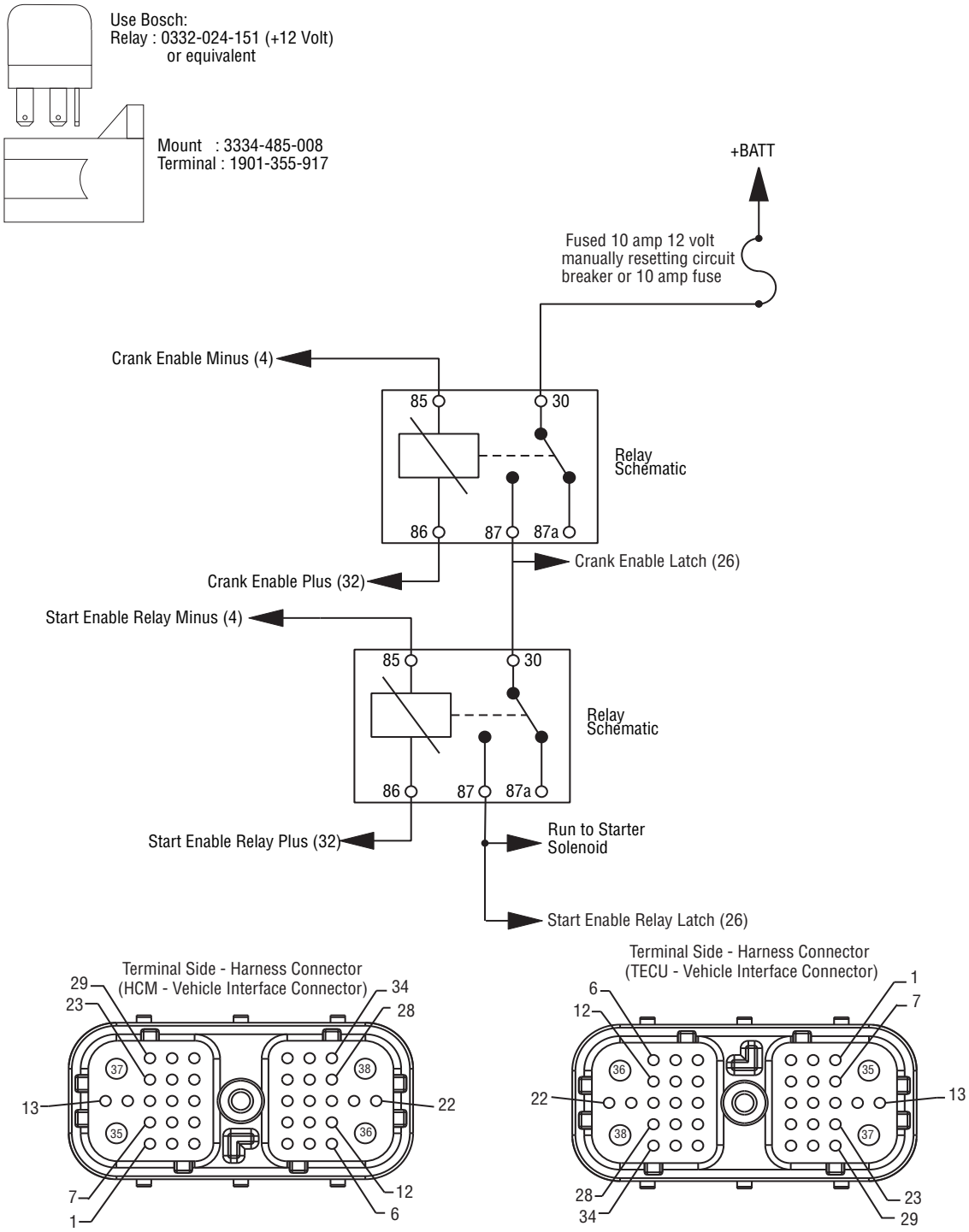
Description	From	Pin#	To	Pin#	AWG
Ignition	HCM	35	Ignition Relay	87	12

- On isolated battery systems, the ignition should be supplied by the “start” battery.
- Ignition Signal to the Transmission ECU and Hybrid Control Module must maintain battery voltage during engine cranking. The ignition signal must be directly wired into the Transmission ECU and Hybrid Control Module not provided from a Body Computer or any other Electronic Module.

Typical Start Enable Relay & 12v Cranking Relay Circuits

Start ability must meet FMVSS Standard 102, Section 3.1.3: “The engine starter shall be inoperative when the transmission shift lever is in a forward or reverse direction position.”

Note: All engine start devices shall pass through the start enable relay (key switch, remote starter, etc.).



Note: An additional Engine Crank Request wire is required for the Hybrid System. The 12volt start input is received on pin 20 of the Hybrid Control Module.

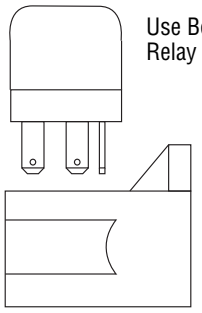
TECU 38-Way Connector

Description	From	Pin#	To	Pin#	AWG
Start Enable Relay Plus	TECU	32	Start Enable Relay	86	18
Start Enable Relay Minus	TECU	4	Start Enable Relay	85	18
Start Enable Relay Latch	TECU	26	Start Enable Relay	87	18

HCM 38-Way Connector

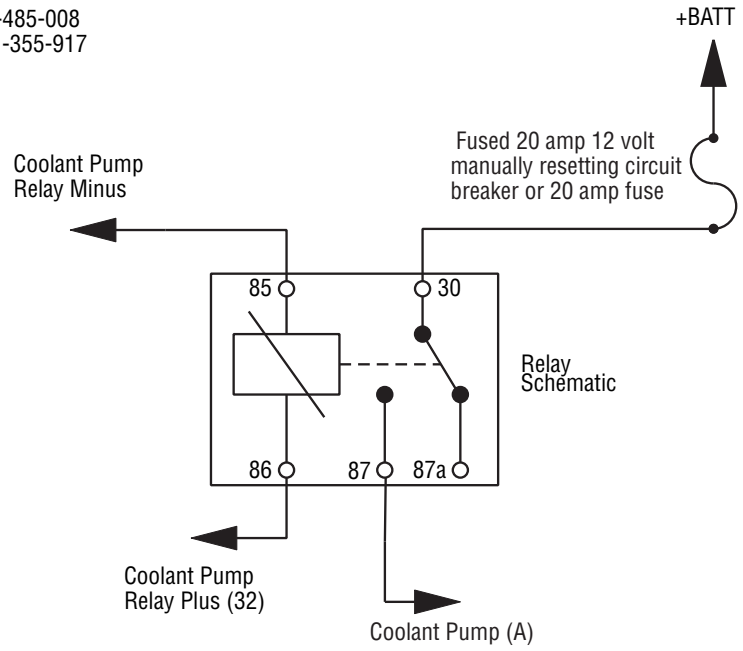
Description	From	Pin#	To	Pin#	AWG
Crank Enable Plus	HCM	32	12V Crank Relay	86	18
Crank Enable Minus	HCM	4	12V Crank Relay	85	18
Crank Enable Latch	HCM	26	12V Crank Relay	87	18

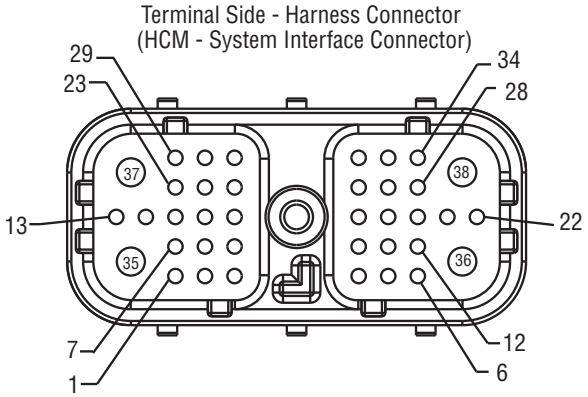
Typical Coolant Pump Relay Circuit



Use Bosch:
Relay : 0332-024-151 (+12 Volt)
or equivalent

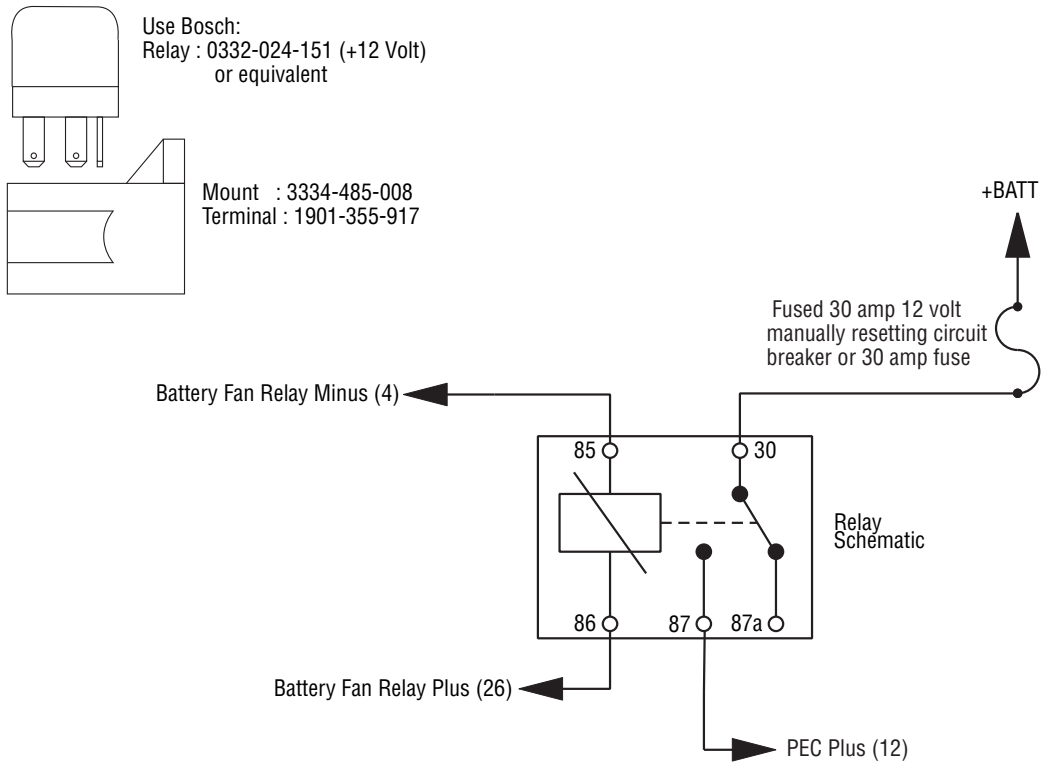
Mount : 3334-485-008
Terminal : 1901-355-917

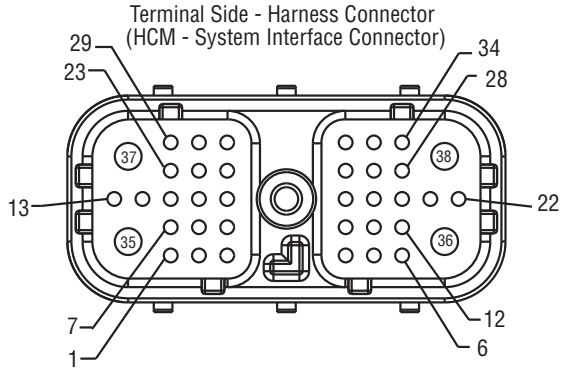




HCM 38-Way Connector					
Description	**From**	**Pin#**	**To**	**Pin#**	**AWG**
Coolant Pump Relay Plus	HCM	32	Coolant Pump Relay	86	18
Coolant Pump Relay Minus	HCM	4	Coolant Pump Relay	85	18

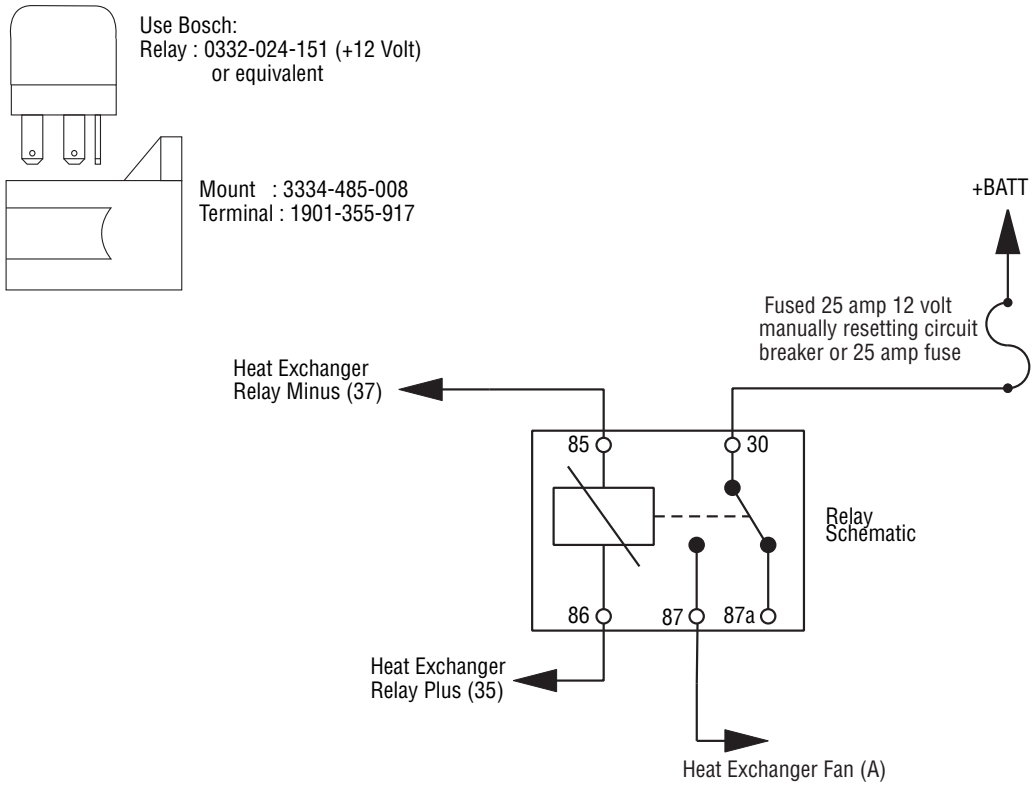
Typical PEC Battery Fan Relay Circuit

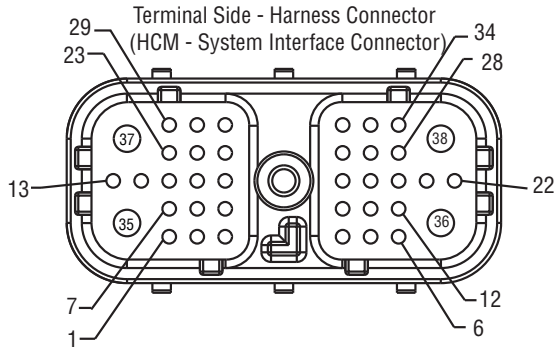




HCM 38-Way Connector					
Description	**From**	**Pin#**	**To**	**Pin#**	**AWG**
Battery Fan Relay Plus	HCM	26	Battery Fan Relay	86	18
Battery Fan Relay Minus	HCM	4	Battery Fan Relay	85	18
PEC Plus	PEC	87	Battery Fan Relay	12	12

Typical Heat Exchanger Fan Relay Circuit

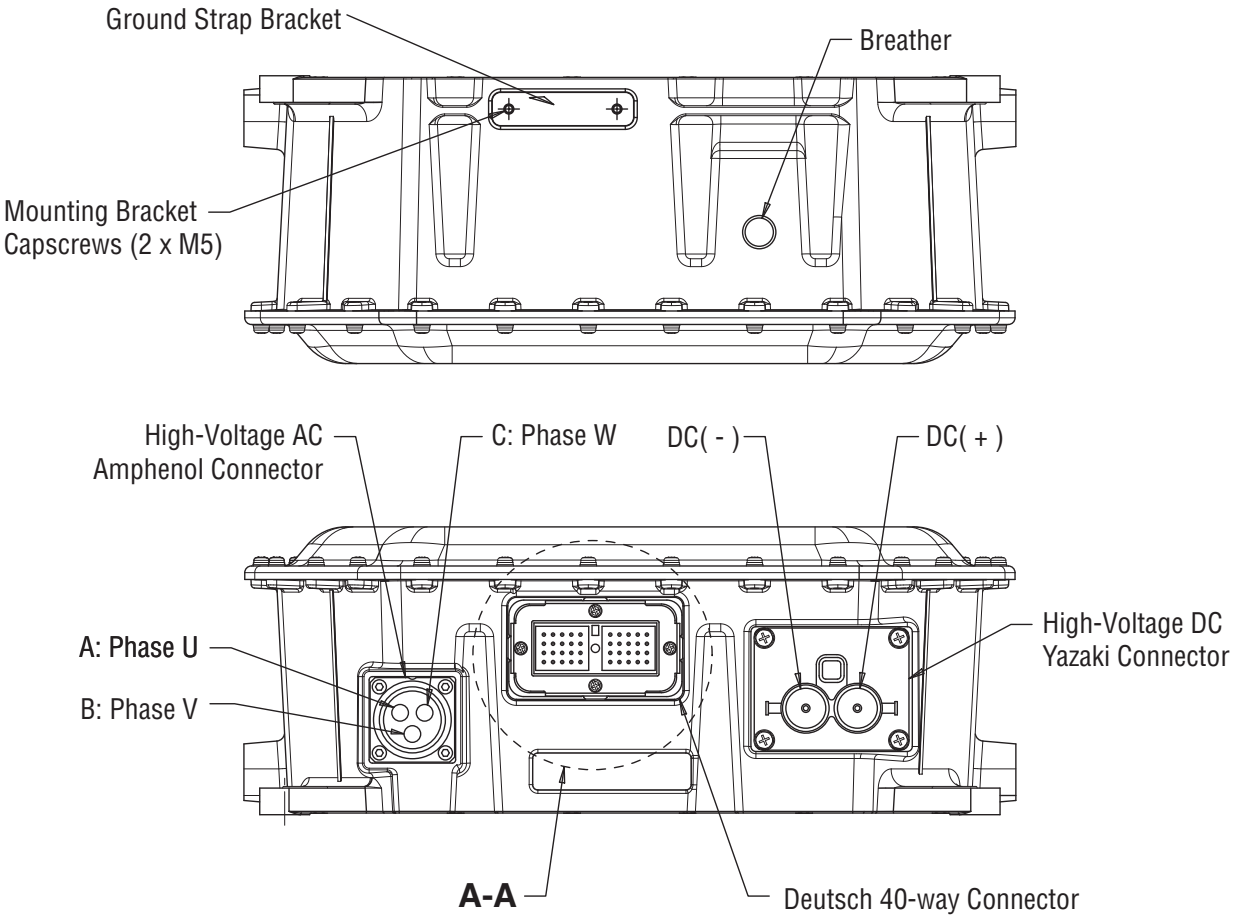


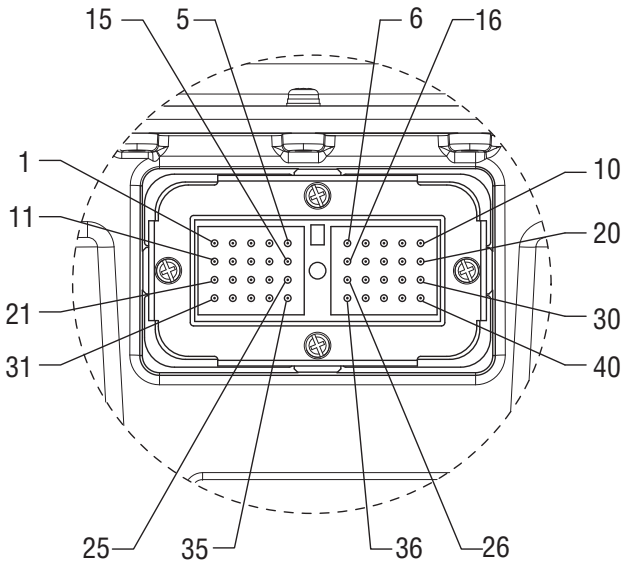


HCM 38-Way Connector

Description	From	Pin#	To	Pin#	AWG
Heat Exchanger Relay Plus	HCM	35	Heat Exchanger Fan Relay	86	12
Heat Exchanger Relay Minus	HCM	37	Heat Exchanger Fan Relay	85	12

Typical Inverter Circuit





Section View A-A

Inverter Electrical Requirements:

1. The CAN (Control Area Network communications link between the Hybrid Control Module and the Inverter) must be a J1939/15 twisted pair cable.
2. REZ_S4 is paired with REZ_S2, REZ_S1 is paired with REZ_S3, REZ_R1 is paired with REZ_R2 (twisted pairs).
3. Ground strap must meet the following requirements:
   a. Must be tinned copper flat braid and tested for proper resistance.
   b. Flat width of 1.375 to 2 inches
   c. Must meet ASTM-B-33
   d. Fasteners (M5 0.8-6H) must be torque to 21-27 lbs.in. [2.37 - 3.05 N•m].

Note: The mounting cap screws used to fasten the grounding strap to the Inverter and Motor/Generator need to resist the effects of galvanic reaction, and be removable without damage to the housing or fastener for the life of the product.

   e. Must be installed flat between bracket and housing.

Inverter 40-Way Connector (12-Volt)

Description	From	Pin#	To	Pin#	AWG
V-Batt1 (12V)	Inverter	1	HCM	2	18 TXL
V-Batt2 (12V)	Inverter	2	HCM	2	18 TXL
Relay Off (0)	Inverter	3	Chassis Ground		16 TXL
CAN High 1	Inverter	4	HEV Backbone	A	J1939-15 twisted pair
CAN Low 1	Inverter	5	HEV Backbone	B	J1939-15 twisted pair
GND1	Inverter	6	Chassis Ground		16 TXL
GND2	Inverter	7	Chassis Ground		16 TXL
Relay Off	Inverter	13	PEC	5	16 TXL
Relay Box Enable 1	Inverter	14	PEC	6	16 TXL
GND (BC1)	Inverter	15	PEC	7	16 TXL
PRECHRG (+)	Inverter	21	PEC	17	16 TXL
Main (+) (+)	Inverter	22	PEC	9	16 TXL
Main (-) (+)	Inverter	23	PEC	13	16 TXL
Relay Box Enable 2	Inverter	24	PEC	6	16 TXL
GND (BC2)	Inverter	25	PEC	7	16 TXL
REZ_S1	Inverter	28	Resolver	2	16 TXL twisted pair
REZ_S2	Inverter	29	Resolver	6	16 TXL twisted pair
REZ_Plus	Inverter	30	Resolver	4	16 TXL twisted pair
PRECHRG (-)	Inverter	31	PEC	19	16 TXL
Main (+) (-)	Inverter	32	PEC	11	16 TXL
Main (-) (-)	Inverter	33	PEC	15	16 TXL

Inverter 40-Way Connector (12-Volt)

Description	From	Pin#	To	Pin#	AWG
CAN High 2	Inverter	34	PEC	1	J1939-15 twisted pair
CAN Low 2	Inverter	35	PEC	2	J1939-15 twisted pair
TMGND	Inverter	36	Temp Sensor	2	16 TXL
TM	Inverter	37	Temp Sensor	1	16 TXL
REZ_S3	Inverter	38	Resolver	1	16 TXL twisted pair
REZ_S4	Inverter	39	Resolver	5	16 TXL twisted pair
REZ_Minus	Inverter	40	Resolver	3	16 TXL twisted pair

Inverter 40-Way Connector (24-Volt)

Description	From	Pin#	To	Pin#	AWG
Relay Off (0)	Inverter	3	Chassis Ground		16 TXL
CAN High 1	Inverter	4	HEV Backbone	A	J1939-15 twisted pair
CAN Low 1	Inverter	5	HEV Backbone	B	J1939-15 twisted pair
GND1	Inverter	6	Chassis Ground		16 TXL
GND2	Inverter	7	Chassis Ground		16 TXL
V-Batt1 (24V)	Inverter	9	HCM	2	18 TXL
V-Batt2 (24V)	Inverter	10	HCM	2	18 TXL
Relay Off	Inverter	13	PEC	5	16 TXL
Relay Box Enable 1	Inverter	14	PEC	6	16 TXL
GND (BC1)	Inverter	15	PEC	7	16 TXL
REZGS1	Inverter	18	Resolver Ground Shield 1		16 TXL twisted pair
REZGS2	Inverter	19	Resolver Ground Shield 2		16 TXL twisted pair
REZGR	Inverter	20	Resolver Ground R Shield		16 TXL twisted pair
PRECHRG (+)	Inverter	21	PEC	17	16 TXL
Main (+) (+)	Inverter	22	PEC	9	16 TXL
Main (-) (+)	Inverter	23	PEC	13	16 TXL
Relay Box Enable 2	Inverter	24	PEC	6	16 TXL
GND (BC2)	Inverter	25	PEC	7	16 TXL
TM_S	Inverter	26	Temp Sensor Shield		16 TXL
REZS1	Inverter	28	Resolver	2	16 TXL twisted pair
REZS2	Inverter	29	Resolver	6	16 TXL twisted pair
REZ_Plus	Inverter	30	Resolver	4	16 TXL twisted pair

Inverter 40-Way Connector (24-Volt)

Description	From	Pin#	To	Pin#	AWG
PRECHRG (-)	Inverter	31	PEC	19	16 TXL
Main (+) (-)	Inverter	32	PEC	11	16 TXL
Main (-) (-)	Inverter	33	PEC	15	16 TXL
CAN High 2	Inverter	34	PEC	1	16 TXL
CAN-Low 2	Inverter	35	PEC	2	16 TXL
TMGND	Inverter	36	Temp Sensor	2	16 TXL
TM	Inverter	37	Temp Sensor	1	16 TXL
REZS3	Inverter	38	Resolver	1	16 TXL twisted pair
REZS4	Inverter	39	Resolver	5	16 TXL twisted pair
REZ_Minus	Inverter	40	Resolver	3	16 TXL twisted pair

Inverter High-Voltage (AC) Connector

Description	From	Pin#	To	Pin#	Wire Diameter
Phase 1	Inverter	U	Motor/Gen	U	4 AWG
Phase 2	Inverter	V	Motor/Gen	V	4 AWG
Phase 3	Inverter	W	Motor/Gen	W	4 AWG
Loose Disconnect	Inverter	D	Motor/Gen	D	16 AWG
Loose Disconnect	Inverter	E	Motor/Gen	E	16 AWG

Inverter High-Voltage (DC) Connector

Description	From	Pin#	To	Pin#	Wire Diameter
DC +	Inverter	A	PEC	A	15mm²
DC -	Inverter	B	PEC	B	15mm²
Loose Disconnect	Inverter	1	Inverter	2	0.8 mm² (18 AWG)

Mating Connector Information (Inverter Low Voltage)

Deutsch 40-Way Connector	
Connector	DRC16-40SE
Terminal	0462-201-1631
Plug	114017
Wire Cover (Boot)	DRC26-40BT

Mating Connector Information (Temperature Sensor)

Deutsch (DT04-2P) 2-Way Connector	
Connector	DT06-2S

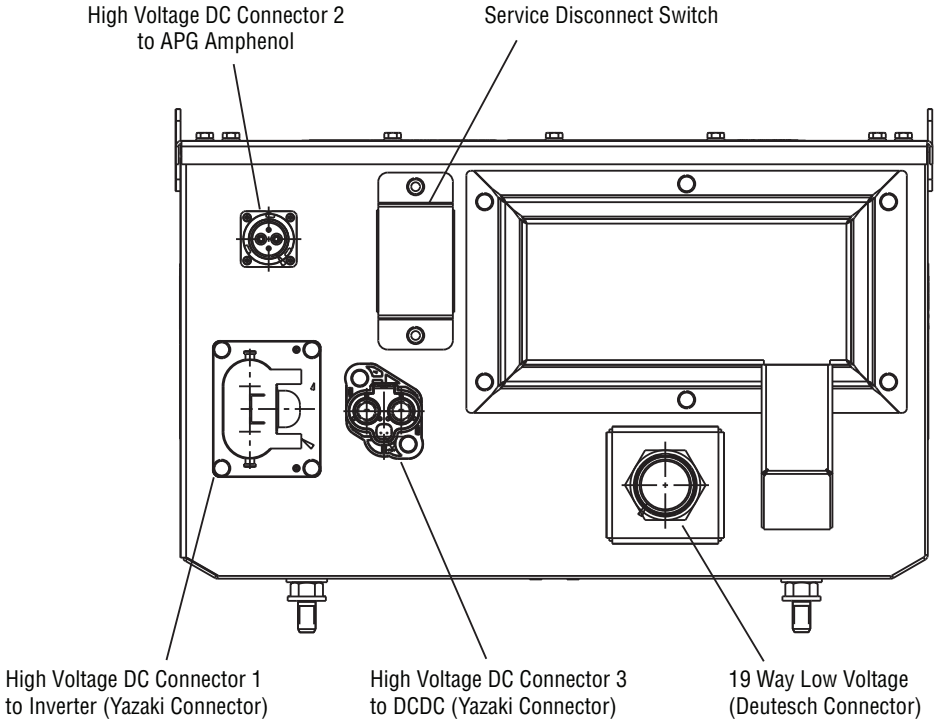
Mating Connector Information (Resolver)

Deutsch (DT04-6P) 6-Way Connector	
Connector	DT06-6S

Mating Connector Information (HV Motor Connector)

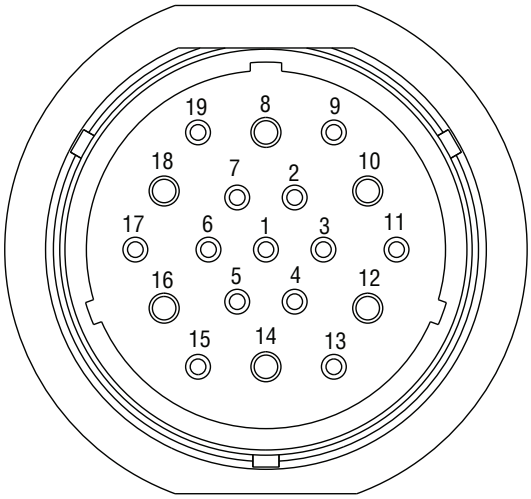
Amphenol 6-Way Connector	
Connector	GTCY06F28-22P
Terminal - Loose Detect (16 AWG)	10-606014-171
Terminal - 3-Phase (4 AWG)	10-40564
Plug - Blue	10-405996-16

Typical PEC Circuit



Caution: The PEC 19-way low-voltage connector needs to have the back shell and strain relief such that the unit will not allow water entry from direct spray.

Mating Connector View
(Deutsch 19 - Way)



PEC 19-Way Connector

Description	From	Pin#	To	Pin#	AWG
CAN High	PEC 19-way	1	Inverter	34	J1939-15
CAN Low	PEC 19-way	2	Inverter	35	J1939-15
HV Relay (+)	PEC 19-way	3	HCM	33	18

PEC 19-Way Connector

Description	From	Pin#	To	Pin#	AWG
HV Relay (-)	PEC 19-way	4	HCM	5	18 TXL
RelayOff	PEC 19-way	5	Inverter	13	16 TXL
Relay Box Enable	PEC 19-way	6	Inverter	14 and 24	16 TXL
GND (BC1 and BC2)	PEC 19-way	7	Inverter	15 and 25	16 TXL
Main (+) +	PEC 19-way	9	Inverter	22	16 TXL
Main (+) -	PEC 19-way	11	Inverter	32	16 TXL
Main (-) +	PEC 19-way	13	Inverter	23	16 TXL
Main (-) -	PEC 19-way	15	Inverter	33	16 TXL
PreChg +	PEC 19-way	17	Inverter	21	16 TXL
PreChg -	PEC 19-way	19	Inverter	31	16 TXL
Battery Fan Plus	PEC 19-way	12	Battery Fan Cooling Relay	87	12 GXL
Battery Fan Minus	PEC 19-way	14	Battery Negative	-	12GXL

PEC High Voltage (DC) Connector to Inverter

Description	From	Pin#	To	Pin#	Wire Diameter
DC +	PEC	A	Inverter	A	15mm²
DC -	PEC	B	Inverter	B	15mm²
Loose Disconnect	PEC	1	PEC	2	0.8 mm² (18 AWG)

PEC High Voltage (DC) Connector to DC/DC Converter

Description	From	Pin#	To	Pin#	Wire Diameter
DC +	PEC	A	DC/DC Converter	A	14 AWG
DC -	PEC	B	DC/DC Converter	B	14 AWG
Loose Disconnect	PEC	1	DC/DC Converter	1	0.8 mm² (18 AWG)
Loose Disconnect	PEC	2	DC/DC Converter	2	0.8 mm² (18 AWG)

PEC High Voltage (DC) Connector to APG

Description	From	Pin#	To	Pin#	AWG
Interlock	PEC DC Connector 2	A (Interlock)	APG 4-way	A	16
High Voltage DC (+)	PEC DC Connector 2	B (HV DC +)	APG 4-way	B	8
Interlock	PEC DC Connector 2	C (Interlock)	APG 4-way	C	16
High Voltage DV (-)	PEC DC Connector 2	D (HV DC -)	APG 4-way	D	8

Mating Connector Information (Low Voltage PEC)

Deutsch 19-Way Connector	
Connector	HD36-24-19SE-059
Terminal	0462-203-12141
Terminal	0462-201-1631
Plug	114017

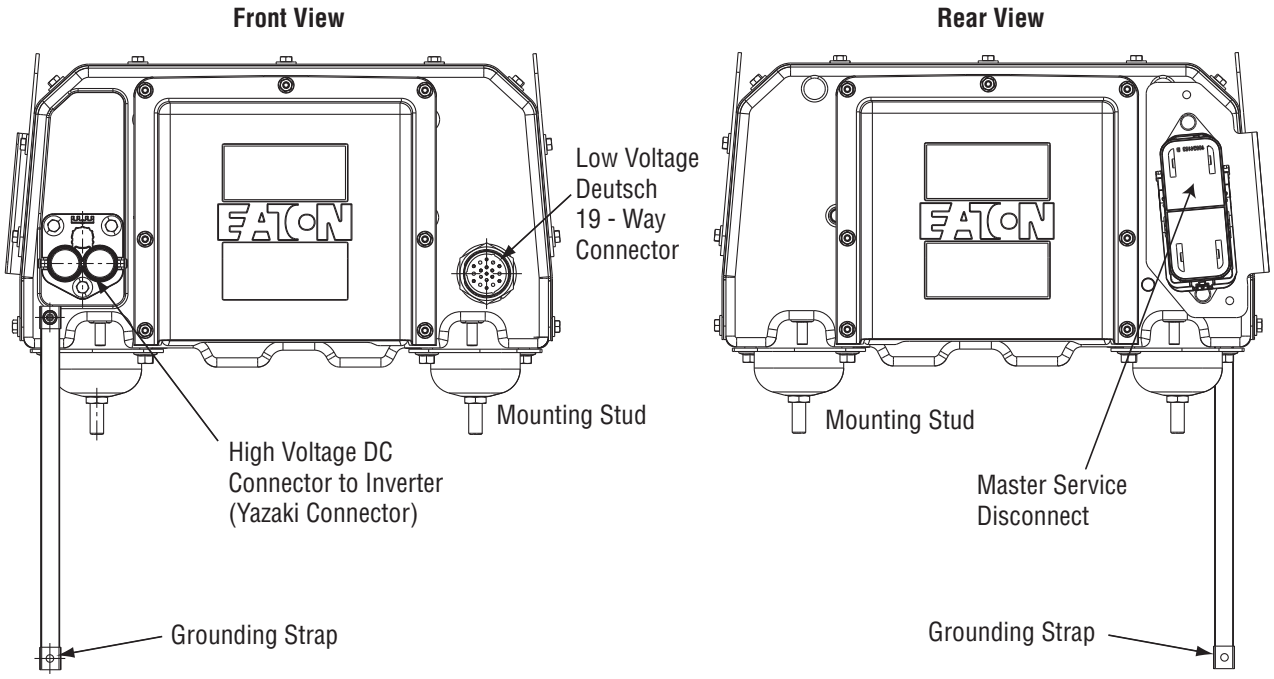
Mating Connector Information (High Voltage Inverter)

Yazaki 2-Way Connector for 4 AWG	
Connector	7325-8336-51

Mating Connector Information (High Voltage DC to DC if equipped)

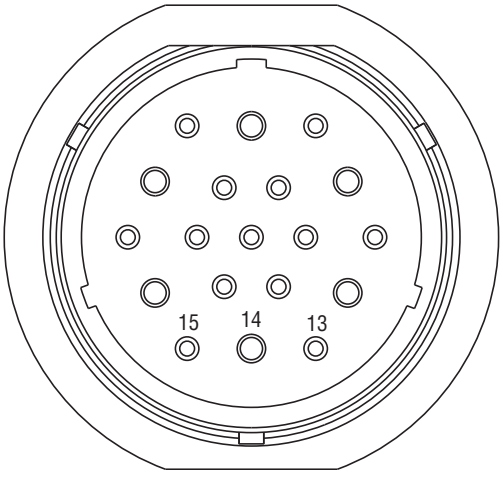
Yazaki 2-Way Connector for 14/0 AWG	
Connector	7325-6818-51

Alternative PEC Circuit



Caution: The PEC 19-way low-voltage connector needs to have the back shell and strain relief such that the unit will not allow water entry from direct spray.

Mating Connector View
(Deutsch 19 - Way)



PEC 19-Way Connector

Description	From	Pin#	To	Pin#	AWG
CAN High	PEC 19-way	1	Inverter	34	J1939-15
CAN Low	PEC 19-way	2	Inverter	35	J1939-15
Reserved for Future Use	PEC 19-way	5	Inverter	13	16 TXL
Reserved for Future Use	PEC 19-way	6	Inverter	14 and 24	16 TXL
Reserved for Future Use	PEC 19-way	7	Inverter	15 and 25	16 TXL
BECM and Fan Power	PEC 19-way	12	Battery Fan Cooling Relay	87	12 GXL
BECM and Fan Minus	PEC 19-way	14	Battery Negative	-	12 GXL

PEC High Voltage (DC) Connector to Inverter

Description	From	Pin#	To	Pin#	Wire Diameter
DC +	PEC	A	Inverter	A	15mm²
DC -	PEC	B	Inverter	B	15mm²
Loose Disconnect	PEC	1	PEC	2	0.8 mm² (18 AWG)

Mating Connector Information (PEC Low Voltage)

Deutsch 19-Way Connector	
Connector	HD36-24-19SE-059
Terminal	0462-203-12141
Terminal	0462-201-1631
Plug	114017

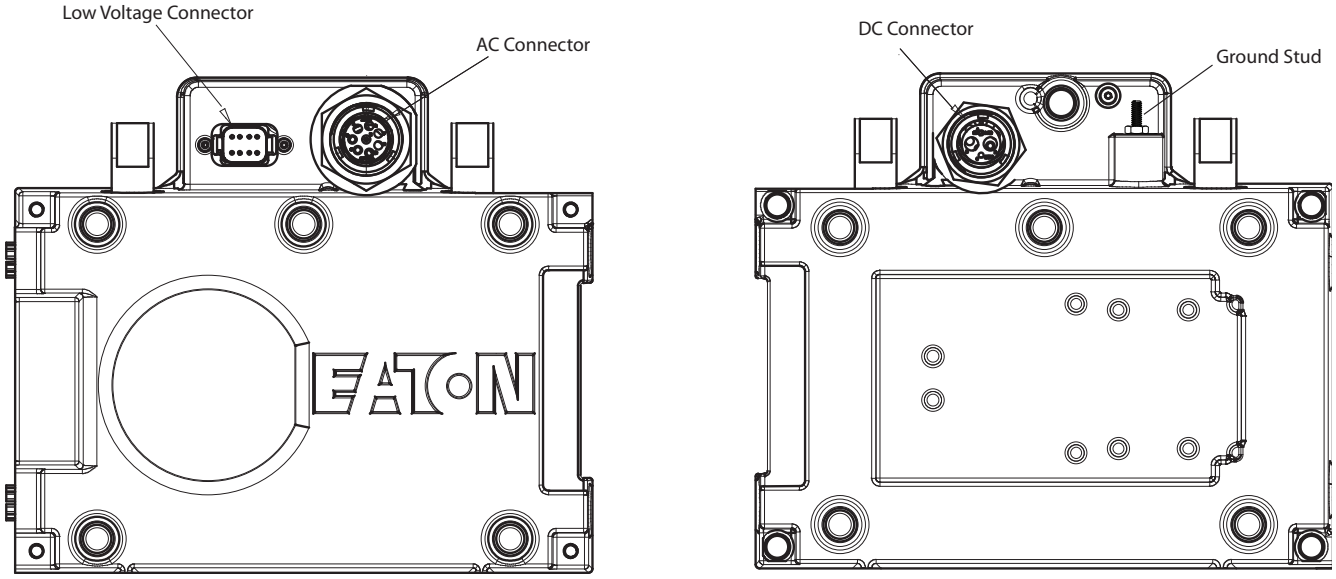
Mating Connector Information (HV DC to Inverter)

Yazaki 2-Way Connector for 4 AWG	
Connector	7325-8336-51

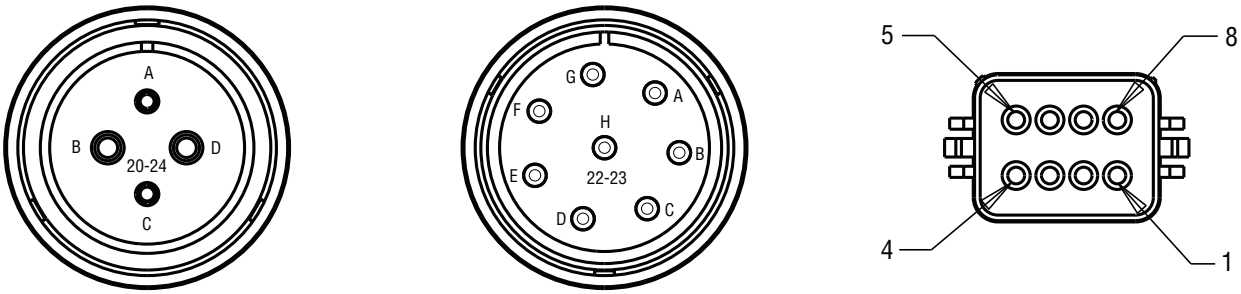
Mating Connector Information (DC to DC if equipped)

Yazaki 2-Way Connector for 14/0 AWG	
Connector	7325-6818-51

Typical Alternative APG Circuit



Harness Connectors



The APG must meet the following electrical requirements:

Cable gauge requirements:

1. High voltage DC: 8 gauge.
2. 12 Volt DC and Ground connections: 16 gauge.
3. Ground strap: minimum 8 gauge tinned copper braid strap.

Note: The power panel and APG have ground strap connections.

4. 120 Volt AC: 12 gauge.

Wire Insulation: UL 1015, 600 Volts

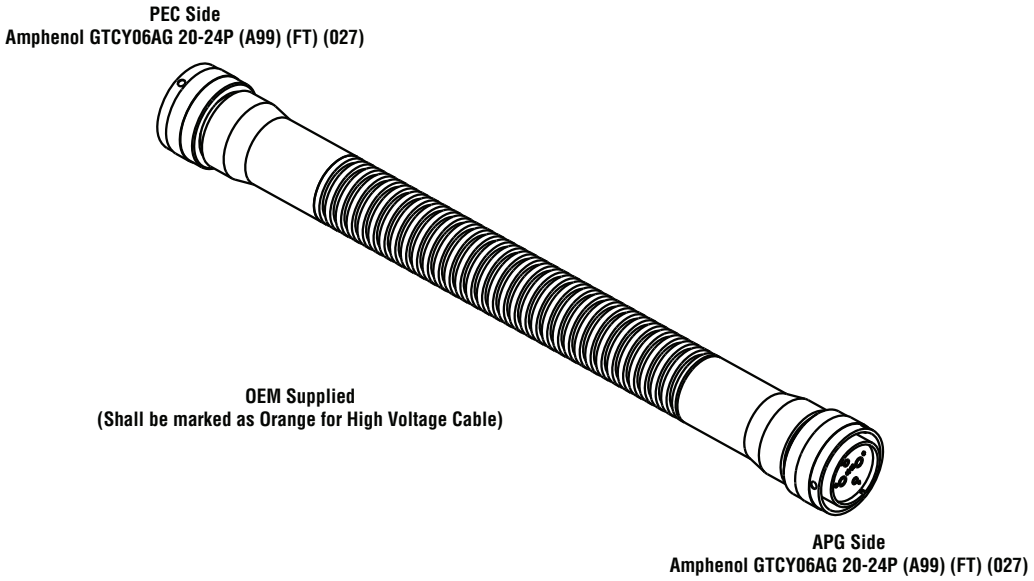
⚠ WARNING

The NEUTRAL circuit of the 120V AC output SHALL NOT be bonded to the chassis or any other ground.

Note: If an alternate power panel is used, double pole circuit breaker protection is needed, due to the isolated neutral.

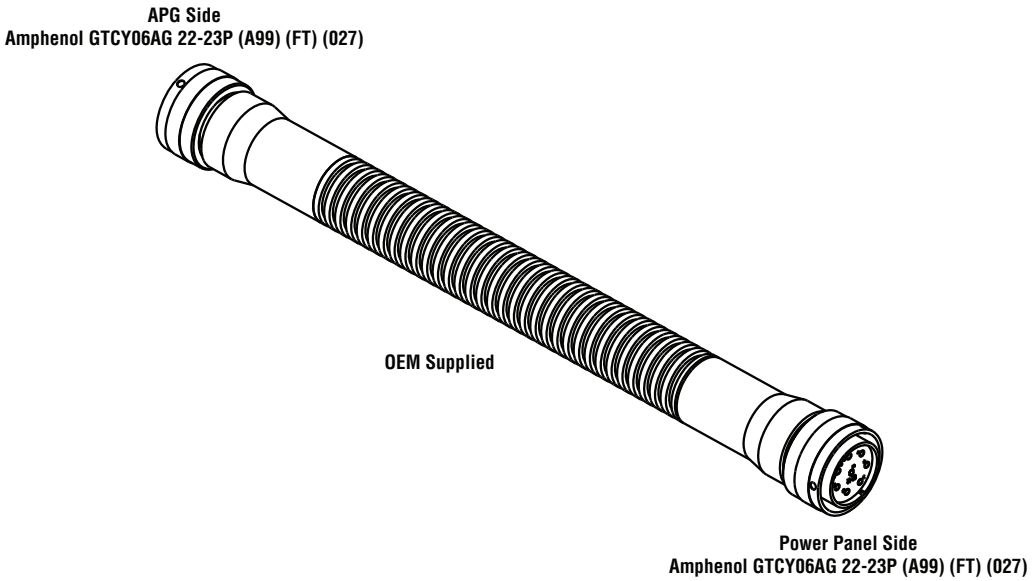
Important notes regarding APG 4-way High Voltage DC Cable (OEM Supplied)

1. The High voltage DC cable shall be shielded from end to end, where the terminating connector on the PEC side of the cable is Amphenol GTCY06AG 20-24P (A99)(FT)(027), and Amphenol GTCY06AG 22-23P (A99) (FT) (027) on the APG side.
2. Minimum wire size requirement for the Amphenol connector is 8 gauge (HV + and HV -).
3. Refer to the drawing below for cable illustration.



Important notes regarding APG 8-way 120V AC Cable (OEM Supplied to Power Panel)

1. The 120V AC cable shall be shielded from end to end.



Note: The cable between the APG and power panel is supplied by the OEM.

APG Base Unit Low-Voltage 8-way Connector 1

Description	From	Pin#	To	Pin#	AWG
Vehicle CAN High	APG 8-way	1	CAN Backbone	A	J1939-15 twisted pairs
APG Enable	APG 8-way	2 & 3	APG Enable Relay	87	16
Vehicle Chassis Ground	APG 8-way	6 & 7	Chassis Ground		16
Vehicle CAN Low	APG 8-way	8	CAN Backbone	B	J1939-15 twisted pairs

APG Base Unit High-Voltage DC 4-way Connector

Description	From	Pin#	To	Pin#	AWG
Interlock	APG 4-way	A	PEC DC Connector 2	A (Interlock)	16
High Voltage DC (+)	APG 4-way	B	PEC DC Connector 2	B (HV DC +)	8
Interlock	APG 4-way	C	PEC DC Connector 2	C (Interlock)	16
High Voltage DV (-)	APG 4-way	D	PEC DC Connector 2	D (HV DC -)	8

APG Base Unit AC Voltage 8-way Connector

Description	From	Pin#	To	Pin#	AWG
Phase 1	APG 8-way	A	Power Panel 8-way	A	12
Phase 2	APG 8-way	B	Power Panel 8-way	B	12
Phase 3	APG 8-way	C	Power Panel 8-way	C	12
Neutral 1	APG 8-way	D	Power Panel 8-way	D	12
Neutral 2	APG 8-way	E	Power Panel 8-way	E	12
Neutral 3	APG 8-way	F	Power Panel 8-way	F	12
Interlock	APG 8-way	G	Power Panel 8-way	G	12
Interlock	APG 8-way	H	Power Panel 8-way	H	12

APG Power Panel AC Voltage 8-way Connector

Description	From	Pin#	To	Pin#	AWG
Phase 1	APG 8-way	A	Power Panel 8-way	A	12
Phase 2	APG 8-way	B	Power Panel 8-way	B	12
Phase 3	APG 8-way	C	Power Panel 8-way	C	12
Neutral 1	APG 8-way	D	Power Panel 8-way	D	12
Neutral 2	APG 8-way	E	Power Panel 8-way	E	12
Neutral 3	APG 8-way	F	Power Panel 8-way	F	12
Interlock	APG 8-way	G	Power Panel 8-way	G	12
Interlock	APG 8-way	H	Power Panel 8-way	H	12

Mating Connector Information

⚠ IMPORTANT

Field fabricated wiring harnesses MUST be sealed so that ingress of water (liquid or vapor) into the APG enclosure can not occur.

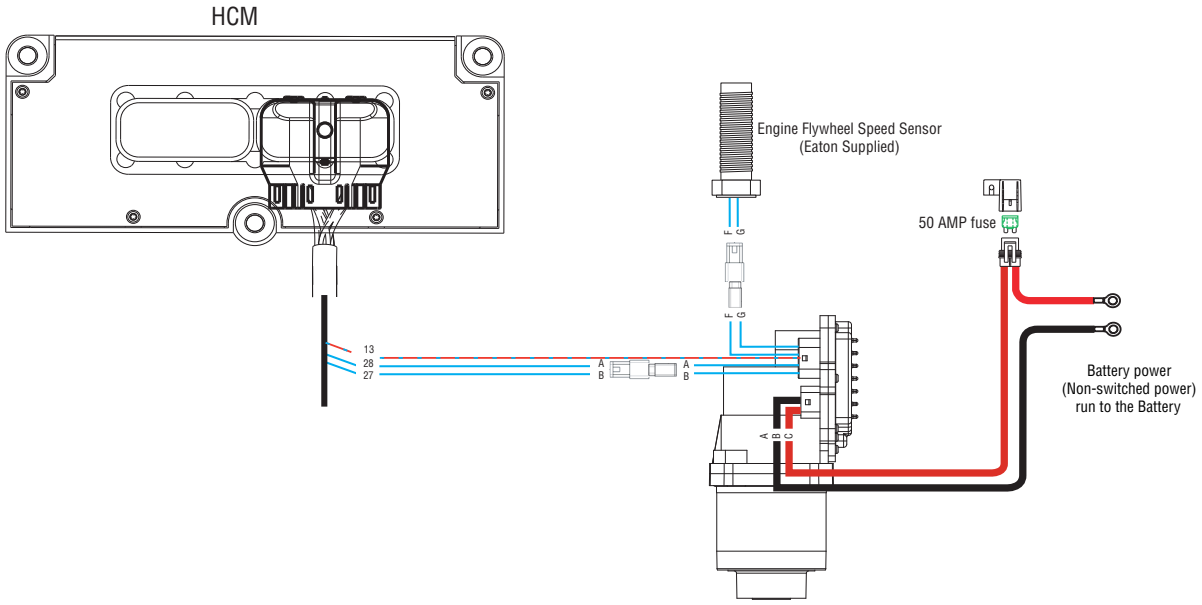
Deutsch 8-Way Connector	
Connector	DT06-08SA-CE01
Wedge Lock	W8S
Terminals	0462-201-1631

Amphenol 4-Way Connector	
Connector	GTCY06AG 20-24P (A99) (FT) (027)or equivalent*
Cable Seal	See Amphenol website for proper wire seal application

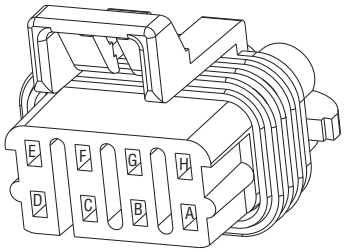
Amphenol 8-Way Connector	
Connector	GTCY06AG 22-23P (A99) (FT) (027)or equivalent*
Cable Seal	See Amphenol website for proper wire seal application

* Or equivalent, requires Eaton Engineering approval - Contact connector sales representatives for additional connector options.

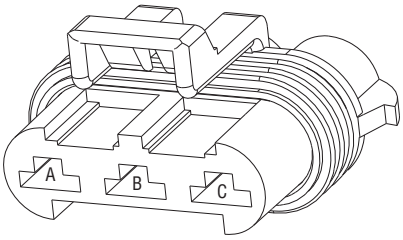
Typical Electric Clutch Actuator & Engine Speed Sensor Circuits



Terminal Side - Harness Connector
Metri-Pack 8-Way Connector



Terminal Side - Harness Connector
Metri-Pack 3-Way Connector



ECA 3-Way Connector

Description	From	Pin#	To	Pin#	AWG
Ignition	ECA	A	Not Used		Plug
Battery Minus	ECA	B	Chassis Ground	Battery -	10 GXL
Battery Plus	ECA	C	Fused 50 amp from Vbatt	Battery +	10 GXL

ECA 8-Way Connector

Description	From	Pin#	To	Pin#	AWG
CAN High	ECA	A	CAN Backbone	A	J1939-15 twisted pairs
CAN Low	ECA	B	CAN Backbone	B	18
CAN - Pass	ECA	C	Not Used		Plug
Signal	ECA	D	Not Used		Plug
CAN + Pass	ECA	E	Not Used		Plug
Engine Flywheel Speed Sensor Plus	ECA	F	Speed Sensor +	A	18 TXL

ECA 8-Way Connector

Description	From	Pin#	To	Pin#	AWG
Engine Flywheel Speed Sensor Minus	ECA	G	Speed Sensor -	B	18 TXL
ECA Ignition	ECA	H	HCM	13	18 TXL

The CAN (Control Area Network communications link between the Hybrid Control Module and the Electric Clutch Actuator) must be a J1939/15 twisted pair cable.

Mating Connector Information (Signal to ECA)

Metri-Pack 8-Way Connector	
Connector	12047937
Terminal	12048074
Cable Seal	12048086
TPA	12066304

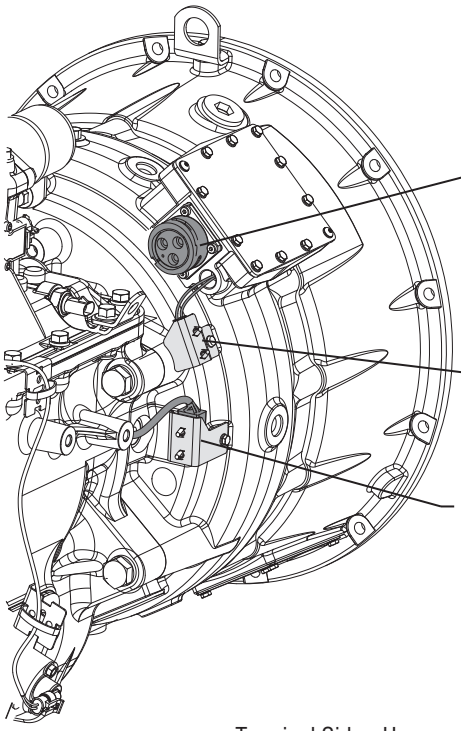
Mating Connector Information

Metri-Pack 3-Way Connector	
Connector	12124685
Terminal	12052456
Cable Seal	12052387
Sec Lock	12045699

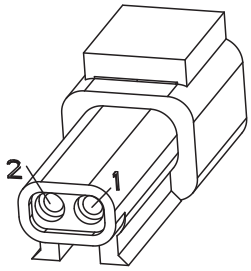
Mating Connector Information (OEM Supplied ECA Speed Sensor)

Deutsch 2-Way Connector	
Connector	DT04-2P-E003
Terminal	0460-202-16141
Wedge Lock	W2P

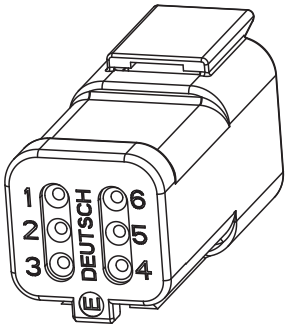
Typical Motor/Generator Circuit



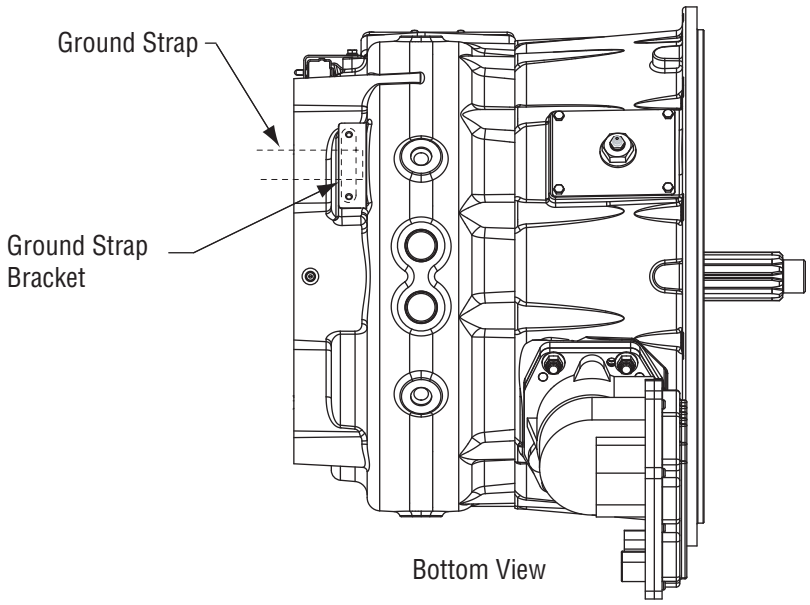
Terminal Side - Harness Connector
Temperature Sensor
(Deutsch 2-pin connector)



Terminal Side - Harness Connector
Resolver
(Deutsch 6-pin connector)



Views looking into connectors with wires exiting the opposite side.



Requirements:

1. Ground strap must meet the following requirements:
   a. Must be tinned copper flat braid and tested for proper resistance.
   b. Flat width of 1.375 to 2 inches
   c. Must meet ASTM-B-33
   d. Fasteners (M5 0.8-6H) must be torque to 21-27 lbs.in. [2.37 - 3.05 N•m]

Note: The mounting cap screws used to fasten the grounding strap to the Inverter and Motor/Generator need to resist the effects of galvanic reaction, and be removable without damage to the housing or fastener for the life of the product.

   e. Must be installed flat between bracket and housing.

2. Resolver signal wires 1 and 3 must be a twisted pair cable and resolver wires 2 and 4 must be a twisted pair cable.

Motor/Generator Resolver Connector

Description	From	Pin#	To	Pin#	AWG
REZS3	Motor/Gen	1	Inverter	38	16 TXL
REZS2	Motor/Gen	6	Inverter	29	16 TXL
REZS1	Motor/Gen	2	Inverter	28	16 TXL
REZS4	Motor/Gen	5	Inverter	39	16 TXL
REZ_Minus	Motor/Gen	3	Inverter	40	16 TXL
REZS_Plus	Motor/Gen	4	Inverter	30	16 TXL

Motor/Generator Temperature Sensor Connector

Description	From	Pin#	To	Pin#	AWG
Motor Temp	Motor/Gen	1	EPS Inverter	37	16 TXL
Motor Temp Gnd	Motor/Gen	2	EPS Inverter	36	16 TXL

Motor/Generator High Voltage (AC) Connector

Description	From	Pin#	To	Pin#	Wire Diameter
Phase 1	Motor/Gen	U	Inverter	U	4 AWG
Phase 2	Motor/Gen	V	Inverter	V	4 AWG
Phase 3	Motor/Gen	W	Inverter	W	4 AWG
Loose Disconnect	Motor/Gen	D	Inverter	D	16 AWG
Loose Disconnect	Motor/Gen	E	Inverter	E	16 AWG

Mating Connector Information

Deutsch 6-Way Connector	
Connector	DT04-6S-E005
Terminal	0426-201-1631
Wedge	W6S

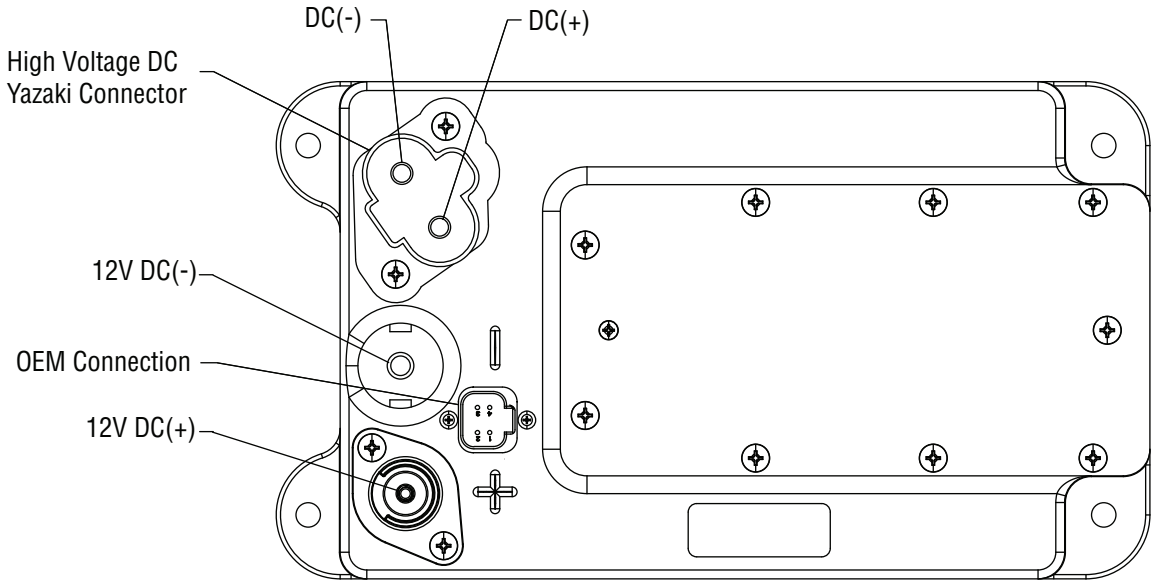
Mating Connector Information

Deutsch 2-Way Connector	
Connector	DT04-2S-E005
Terminal	0426-201-1631
Cable Seal	W2S

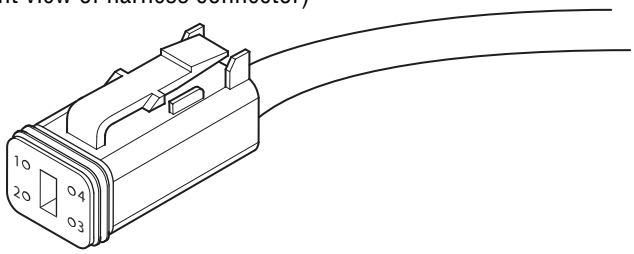
Mating Connector Information

Ampehnol 3-Way Connector for 4/0 AWG	
Connector	GTCY06F28-22P

Typical DC/DC Converter Circuit



Deutsch 4-Way OEM Connector
(Front view of harness connector)



⚠ WARNING

Remove the 12 volt battery cables prior to working on the DC/DC converter.

⚠ WARNING

Remove the DC/DC converter fasteners prior to working on the DC/DC converter.

DC/DC Converter 4-way Deutsch OEM Connector

Description	From	Pin#	To	Pin#	AWG
Not Used	DC/DC	4	Not Used		Plugged
Not Used	DC/DC	3	Not Used		Plugged
Not Used	DC/DC	2	Not Used		Plugged
DCDC Feedback	DC/DC	1	HCM	19	18 TXL

Converter High Voltage (DC) Connector

Description	From	Pin#	To	Pin#	AWG
DC +	DC/DC Converter	A	PEC HV DC #3	A	14
DC -	DC/DC Converter	B	PEC HV DC #3	B	14
Loose Disconnect	DC/DC Converter	1	PEC HV DC #3	1	18
Loose Disconnect	DC/DC Converter	2	PEC HV DC #3	2	18

Converter 12volt Studs

Description	From	Pin#	To	Pin#	AWG
12volt +	DC/DC		Battery Positive Post		2
12volt -	DC/DC		Battery Negative Post		2

Mating Connector Information

Deutsch 4-Way Connector	
Connector	DT06-4-S-E003

Mating Connector Information

Yazaki 2-Way Connector for 14/0 AWG	
Connector	7325-6818-51

Vehicle Harness Routing

Requirements

Harness and in-line connectors shall be anchored to prevent free movement. An anchor point shall be no further than 6 in. [15.24 cm] (recommended 3 in. [7.62 cm]) from a connector. The length of an unanchored section of harness should be no more than 12 in. [30.48 cm].

Use tie wraps on harness covering only, not individual wires. Do not anchor harness with tie wraps in contact with wire insulation. Tie wraps shall not pull on the harness so that connector cable seals are distorted. Allow cable to exit connector body without pulling on the connector. A bend radius of six times the harness diameter is recommended.

Recommended use of the fixed clip points on OEM harness - Fir trees, J-clips, P-clips.

Harness routing shall not interfere with oil fill plugs, sensor locations, or manufacturing fixtures.

Ensure that all connectors are fully mated and that latches are locked. All connector jackscrews must be properly torqued. To prevent cross threading start all cap screws and nuts by hand then use a DC torque driver.

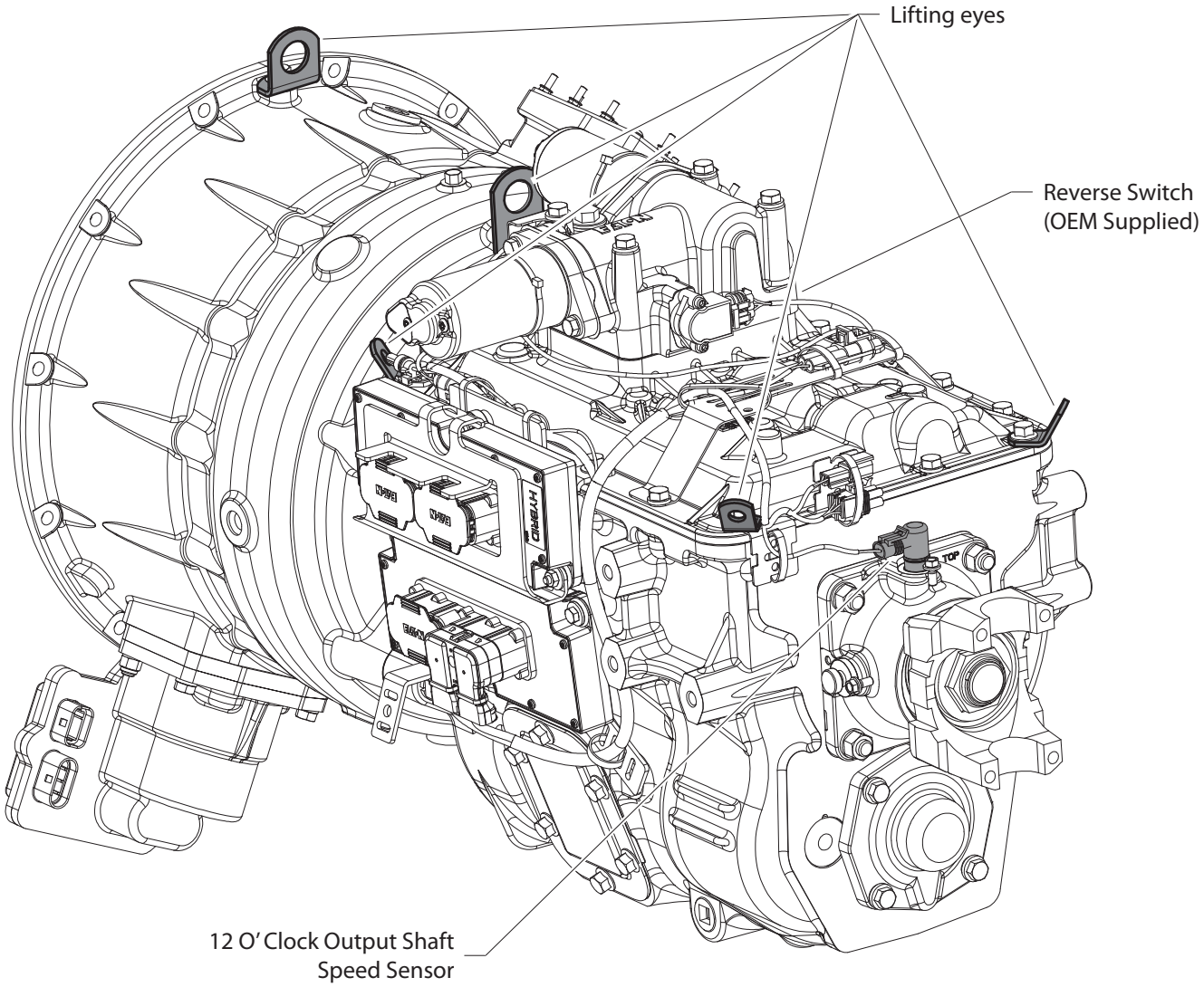
All unused connectors require sealed mated connectors.

There should be nothing mounted to the TECU and HCM, brackets, mounting studs, or contacting the case electrically or mechanically.

The transmission wire harness should not be tie wrapped to any cables, coolant lines or hoses. Anchor points on the transmission may be used as long as addition of cables or hoses do not interfere with the existing harness.

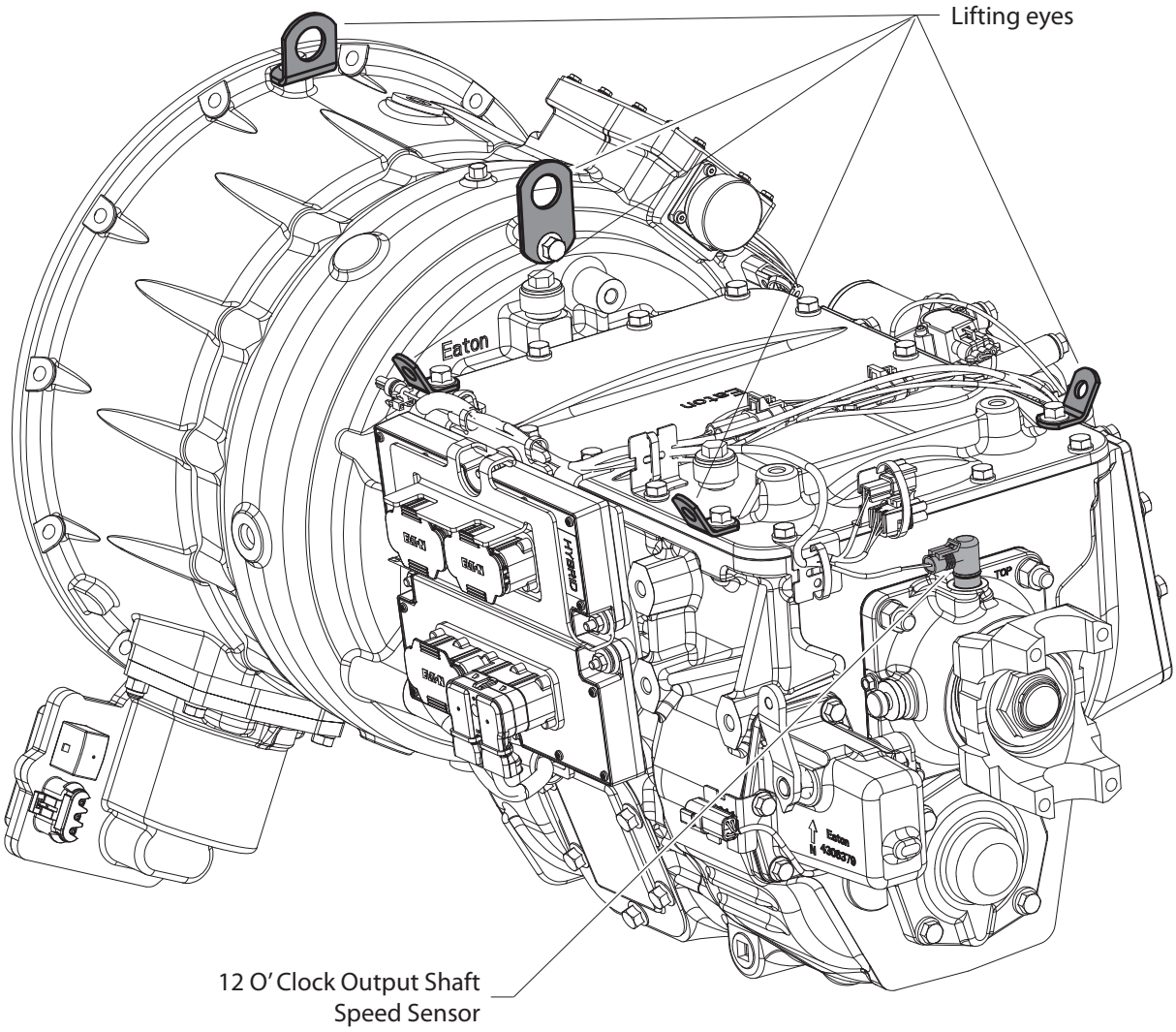
High voltage and low voltage cabling should not be run in the same loom.

Hybrid Medium-Duty (EH-8E306A-CD/U/UP/UPG)



NOTE: All other tabs are used for harness tiedowns, DO NOT use for lifting

Hybrid Medium-Duty (EH-6E606B-CD)



NOTE: All other tabs are used for harness tiedowns, DO NOT use for lifting

Power Take-Off “Countershaft driven”

Eaton recommends the OEM provide a connector and wiring coming from the Hybrid Control Module 38-Way (Vehicle Interface) with the PTO wires installed.

Note: Connector used must be compatible with 18 TXL.

Note: Refer to Cable section for correct wire and pin sizes [see page 63].

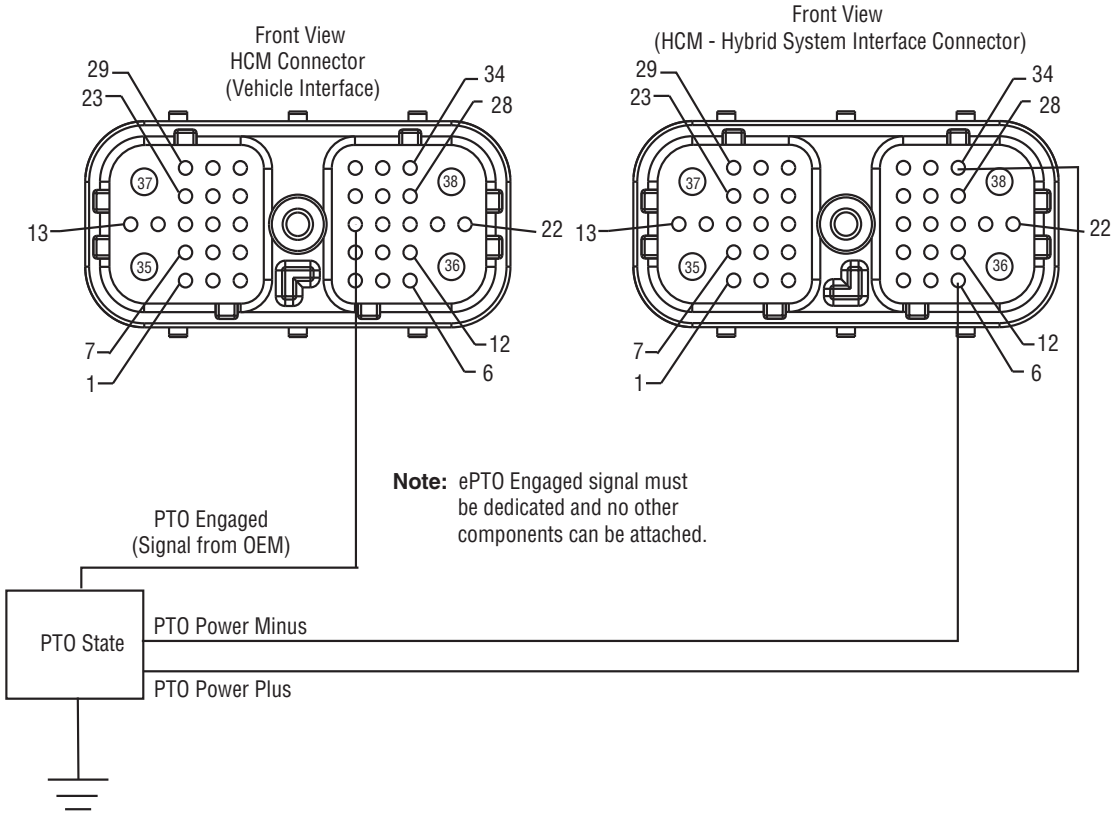
Option 1 - ePTO selection input comes from the Push Button Shift Control, which is sent from the TECU over J1939 to the HCM. The transmission is confirmed in neutral and this message is sent to the vehicle Body or Chassis controller, which enables the PTO and then provides feedback to the HCM.

Option 2 - ePTO selection input comes from the Push Button Shift Control, which is sent from the TECU over J1939 to the HCM. The transmission will go to neutral and then the HCM will activate PTO pins 6 and 34, which enables the PTO. The PTO switch is grounded whenever the PTO is activated. This input (active when pin 18 is shorted to ground) verifies the countershaft PTO operation.

Note: The active signal will illuminate the “ePTO” indicator on the Eaton Push Button Shift Control.

The PTO request signal from the Push Button Shift Control will only be available on J1939. Any devices that require the PTO state must be compatible with J1939.

ePTO



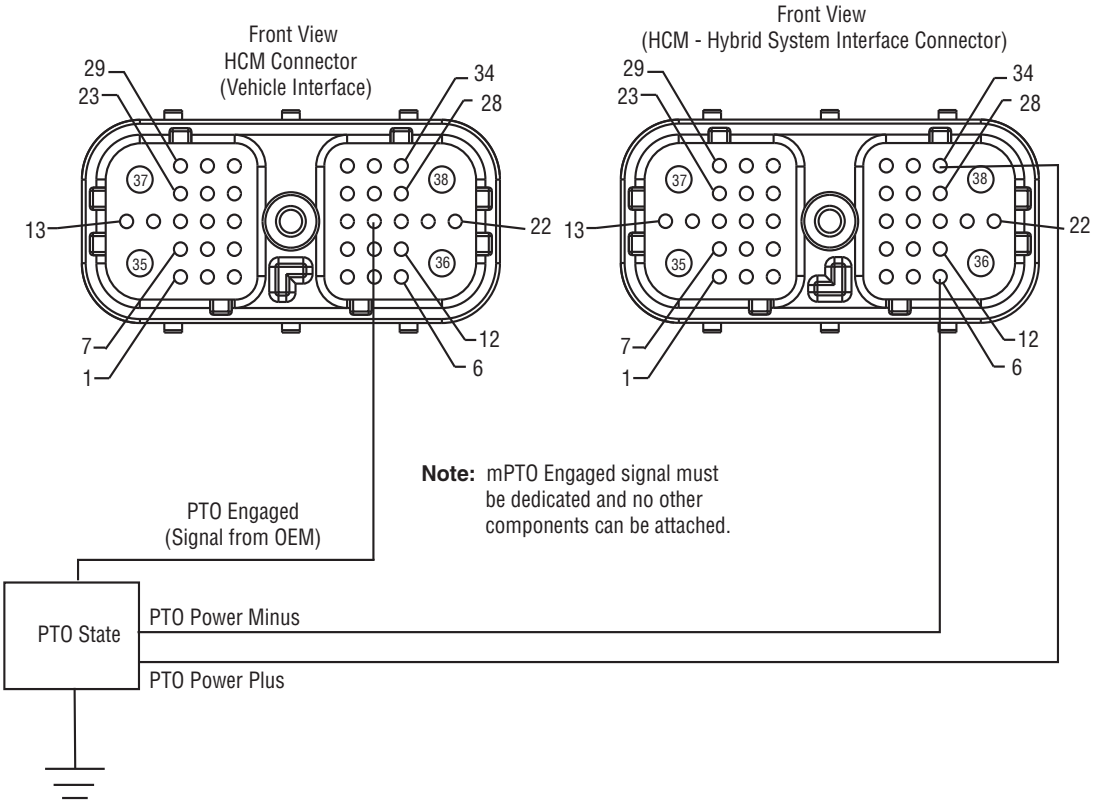
ePTO (HCM Analog Controlled)

Description	From	Pin#	To	Pin#	AWG
PTO Signal	HCM	18	ePTO		18 TXL
PTO Power Plus	HCM	34	ePTO		18 TXL
PTO Power Minus	HCM	6	ePTO		18 TXL

ePTO (HCM J1939 Controlled)

Description	From	Pin#	To	Pin#	AWG
J1939 Low (CAN)	HCM	2	J1939 Backbone	2	18 TXL
J1939 High (CAN)	HCM	3	J1939 Backbone	3	18 TXL

mPTO



Note: The mPTO uses pin 19 and is only available on city delivery (CD) models and needs to be enabled.

mPTO (HCM Controlled)

Description	From	Pin#	To	Pin#	AWG
PTO Signal	HCM	19	mPTO	PTO Grnd Switch	18 TXL

Line Inspection and Road Test Instructions

The checklist was developed as an installation tool for line personnel to ensure the correct operation of each vehicle and to assist the vehicle OEM to identify transmission quality related issues as well as OEM line quality issues. Used correctly, this checklist identifies transmission issues and aids in tracking the problem until corrected.

The recommended use of the checklist is as follows:

1. A separate checklist should be filled out for each vehicle built with Eaton Fuller transmissions. If these checks and information can be combined with an existing form, the Line Inspection form does not need to be used.
2. The section identified as PRE-START CHECKS should be performed prior to the initial start-up of the vehicle. This section ensures the transmission has the correct power supplies, sufficient lubricant, and correct transmission shift tables.
3. Perform any necessary corrective action prior to the dyno or road testing.
4. The DYNO/ROAD TEST section is used to verify that all transmission systems are functional and the Drivers Manual and Shift Label are supplied in the cab.
5. With a record of transmission related information and repairs made to each unit, the OEM is able to track and correct repeated quality issues.
6. A copy of the checklist should be recorded for installation history (OEM line personnel should become familiar with the checklist for the transmission prior to a scheduled build.) Eaton OEM Engineering Support Group can coordinate training and information to expedite this process. Only trained line personnel should assemble those components involving connection to the high voltage sources.

This checklist represents a generic system which can be tailored to the individual OEM to achieve the best possible method of transmission installation verification. Eaton recommends the use of this system to maintain the utmost in satisfactory operation and long service life.

Each transmission system installed at the OEM must pass the line checklist requirements per the Eaton Line Inspection Form prior to shipment from the OEM plant.

Line Inspection

This transmission is equipped with a neutral interlock system that when properly installed prevents the engine from cranking with the transmission in-gear.

⚠ WARNING

Failure to perform installation pre-start checks may result in the engine cranking immediately when ignition is moved to the "START" position or to the "ON" position.

To prevent undesired vehicle movement for new installations, always set the parking brake prior to turning the ignition key "ON" and also prior to attempting "START".

Checklist Instructions/Details for the Line Inspection Forms

Refer to the line inspection form while performing the following procedures

Note: All information must be filled on the Line Inspection Form.

Pre-Start Checks

1. Visually verify that the TECU ignition power supply is protected by a manual resetting 10 AMP circuit breaker or fuse and verify that main power is protected by a 30 AMP fuse.
2. Visually verify that the HCM ignition power supply is protected by a manual resetting 10 AMP circuit breaker or fuse and verify that main power is protected by a 30 AMP fuse.
3. Visually verify that the transmission Electric Clutch Actuator (ECA) main power is protected by a 50 AMP fuse.
4. Verify polarity of main power connection.
5. Verify the transmission has been filled with the correct amount and type of lubricant before starting the engine. Failure to add sufficient lubricant could damage the transmission. See Lubrication Manual TCMT-0021 for details.
6. When the liquid cooling system is used it must be plumbed and filled. Verify the Hybrid liquid cooling system has been filled with the correct type of fluid and to the appropriate level.
7. Turn the key switch to the "On" position and visually observe the power up procedure. Gear Display will show a solid "N" or "P" when power up is complete.
8. Visually verify a 'Hybrid' label is affixed to the outside of the truck where it easily viewable.
9. Visually verify a high voltage component diagram is located in the truck where it is easily viewable.
10. Visually verify all high voltage cables are connected and warning labels are attached next to each connector.

Note: Make sure a Neutral or Park gear mode is selected.

Note: The transmission will automatically reset to neutral position as soon as the vehicle is powered up (key switch on).

⚠ WARNING

Improper installation of the OEM Start Enable Circuit could result in enabling the vehicle to be started in gear.

Note: Failure to perform this step will set a clutch disengagement fault and inhibit transmission gear engagement.

Dyno/Road Test

1. With Engine not running, select drive and attempt to start the engine. Repeat for each of the forward and reverse mode positions to verify the engine will not start.
2. Verify forward and reverse gears can not be obtained without having the service brake applied.

Note: The service brake input is required while selecting a starting gear. If the service brake is not applied while selecting a starting gear, the initial start gear will not be found and the driver will have to re-select neutral and press the brake while re-selecting the desired mode.

3. Verify all forward and reverse gears are obtained.
4. Verify forward and reverse gears are obtained with electric motor control.
5. Verify through normal operations that the transmission temperature gauge (if installed) is functional.
6. Visually verify that the gear display module is easily visible and lights up when the ignition is turned on.

Note: When testing on a dynamometer which decelerates quickly, the display module may not appear to function correctly. Should this occur, drive the vehicle off the dynamometer and note how the display functions. If it functions correctly when driving, the problem is that the dynamometer decelerates too quickly.

7. Verify through normal operation that the engine brake (if equipped) functions correctly per the manufacturer's specifications.
8. Verify that the panel lights on the Shift Input Device illuminate when the vehicle dash lights are turned on.
9. Visually check for lubricant drips or residue on the transmission and related cooler lines (if used).
10. Make sure the correct transmission Shift Label is present and that the Drivers Manual is included with the other vehicle information.
11. Verify the diagnostic connector (9-pin required) is easily accessible and mounted on the drivers side of the cab.
12. Verify that a label to alert the customer of type and brand of lubricant used in the transmission is attached to the transmission fill plug.
13. Clear historical fault codes by using the key switch. To do this, place the Shift Input Device in neutral and set the parking brakes. Begin with the switch in the on position. Turn the key off and back on six times within five seconds (off/on/off/on/off/on/off/on/off/on/off/on).
14. Prior to shipment of Eaton Hybrid Transmission Systems installed at OEM plants, the engine ECU must contain the proper configuration settings. For the proper engine configuration settings required for Eaton Hybrid Transmission operation refer to the "Engine Configuration Settings Installation Guide (TRIG-0910)" on roadranger.com under the literature center.

Line Inspection Form - EH-8E306A-CD or EH-6E606B-CD

Eaton® Hybrid	OEM:			
	Chassis S/N:			
Line Inspection	Trans Model:		Trans S/N:	

	Description	Yes	No	Corrected
Pre-Start Checks				
1.	Ignition Bus Check: Does service light turn on and tone sound?			
2.	Power Supply check: (manual reset type) or fuse (TECU,HCM and ECA)			
	Min. 10 amp Ignition Bus Min. 30 amp Main Power			
3.	Oil Fill (see lubricant section for details)			
4.	Coolant Fill			
5.	Power up procedure: System powers up and “N” or “P” on Gear Display			
6.	Visually verify all high voltage cables are connected and contain a warning label next to each connector.			
7.	Visually verify a ‘Hybrid’ label is affixed to the outside of the truck.			
8.	Visual verify a High Voltage Component diagram is easily viewable inside vehicle.			
DYNO/Road Test Checks				
1.	Verify the engine doesn't crank in any position other than neutral or park			
2.	Verify all forward and reverse gears obtained with electric motor control			
3.	Verify forward and reverse gear not obtained without service brake applied			
4.	Verify transmission temperature gauge is functional - if equipped			
5.	Verify gear display module works correctly			
6.	Verify engine retarder is functional - if equipped			
7.	Verify shift input device panel lights are functional			
8.	Verify no transmission oil leaks or residue			
9.	Verify the transmission diagnostic connector is accessible			
10.	Verify lubricant type and brand label affixed to transmission fill plug			
11.	Verify correct shift label			
12.	Clear Fault Codes and verify diagnostic connector functions			
13.	Prior to shipment of Eaton Automated Transmission Systems installed at OEM plants, the engine ECU must contain the proper configuration settings. For the proper engine configuration settings required for Eaton Automated Transmission operation refer to the “Engine Configuration Settings Installation Guide” on roadranger.com under the literature center.			

Line Inspection Form - EH-8E306A-U and UP

Eaton® Hybrid Line Inspection		OEM:			
		Chassis S/N:			
		Trans Model:		Trans S/N:	
		Clutch Size/Type:			
	Description		Yes	No	Corrected
Pre-Start Checks					
1.	Ignition Bus Check: Does service light turn on and tone sound?				
2.	Power Supply check: (manual reset type) or fuse (TECU,HCM and ECA)				
	Min. 10 amp Ignition Bus				
	Min. 30 amp Main Power				
	Min. 50 amp ECA				
3.	Oil Fill (see lubricant section for details)				
4.	Coolant Fill				
5.	Power up procedure: System powers up and “N” on Gear Display				
6.	Visually verify all high voltage cables are connected and contain a warning label next to each connector.				
7.	Visually verify a ‘Hybrid’ label is affixed to the outside of the truck.				
8.	Visual verify a High Voltage Component diagram is easily viewable inside vehicle.				
DYNO/Road Test Checks					
1.	Verify the engine doesn't crank in any position other than neutral				
2.	Verify all forward and reverse gears obtained with electric motor control				
3.	Verify forward and reverse gear are not obtained without service brake applied				
4.	Verify transmission temperature gauge is functional - if equipped				
5.	Verify gear display module works correctly				
6.	Verify engine retarder is functional - if equipped				
7.	Verify shift input device panel lights are functional				
8.	Verify no transmission oil leaks or residue				
9.	Verify the transmission diagnostic connector is accessible				
10.	Verify lubricant type and brand label affixed to transmission fill plug				
11.	Verify correct shift label				
12.	Verify hydraulic controls operate with electric motor control in ePTO mode				
13.	Verify safety interlocks and hydraulic demand messages via ServiceRanger.				
14.	Clear Fault Codes and verify diagnostic connector functions				
15.	Prior to shipment of Eaton Automated Transmission Systems installed at OEM plants, the engine ECU must contain the proper configuration settings. For the proper engine configuration settings required for Eaton Automated Transmission operation refer to the “Engine Configuration Settings Installation Guide” on roadranger.com under the literature center.				

Line Inspection Form OEM Wiring Connector/Harness

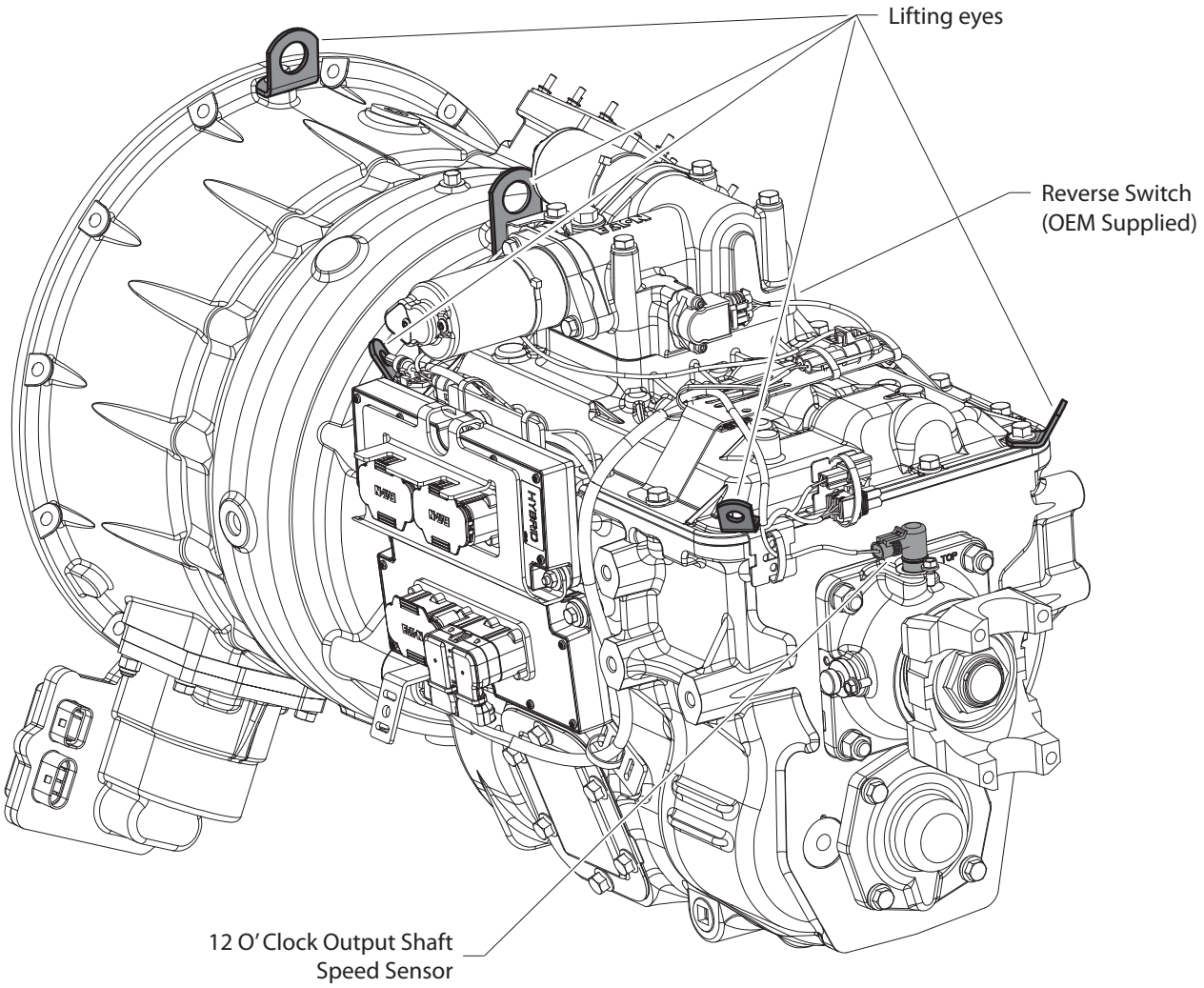
Description	Yes	No	Corrected
Deutsch Connector to Transmission ECU 25 +/- 3 lb-in. [2.82 +/-.33 N•m]			
Deutsch Connector to Hybrid Control Module 25 +/- 3 lb-in. [2.82 +/-.33 N•m]			
Delphi Connector to Push Button Controller 10 +/- 3 lb-in. [1.1 +/-.33 N•m]			
No lubricant or foreign material on connector jackscrew			
No contaminants on connector contacts			
Harness anchor points within 6 in. [15.24 cm] of connectors			
No unanchored length of harness greater than 12 in [30.48 cm]			
No sharp bends in the harness			
Tie wraps on Harness Jacketing only			
Harness not anchored to objects that are free to move			
All connectors are fully mated and latches locked			
All unused connectors or pins should be plugged			
Ground strap from Motor/Generator to Inverter is installed flat between bracket and mounting surface on housing			

Lifting Eyes and Sensor Positions

The Eaton shift bar housing, ECU, sensor, and lifting eye retaining fasteners as well as those associated with any surface containing a gasket are not intended for use in securing additional OEM brackets. Removal of these can compromise transmission system operation and overall system reliability.

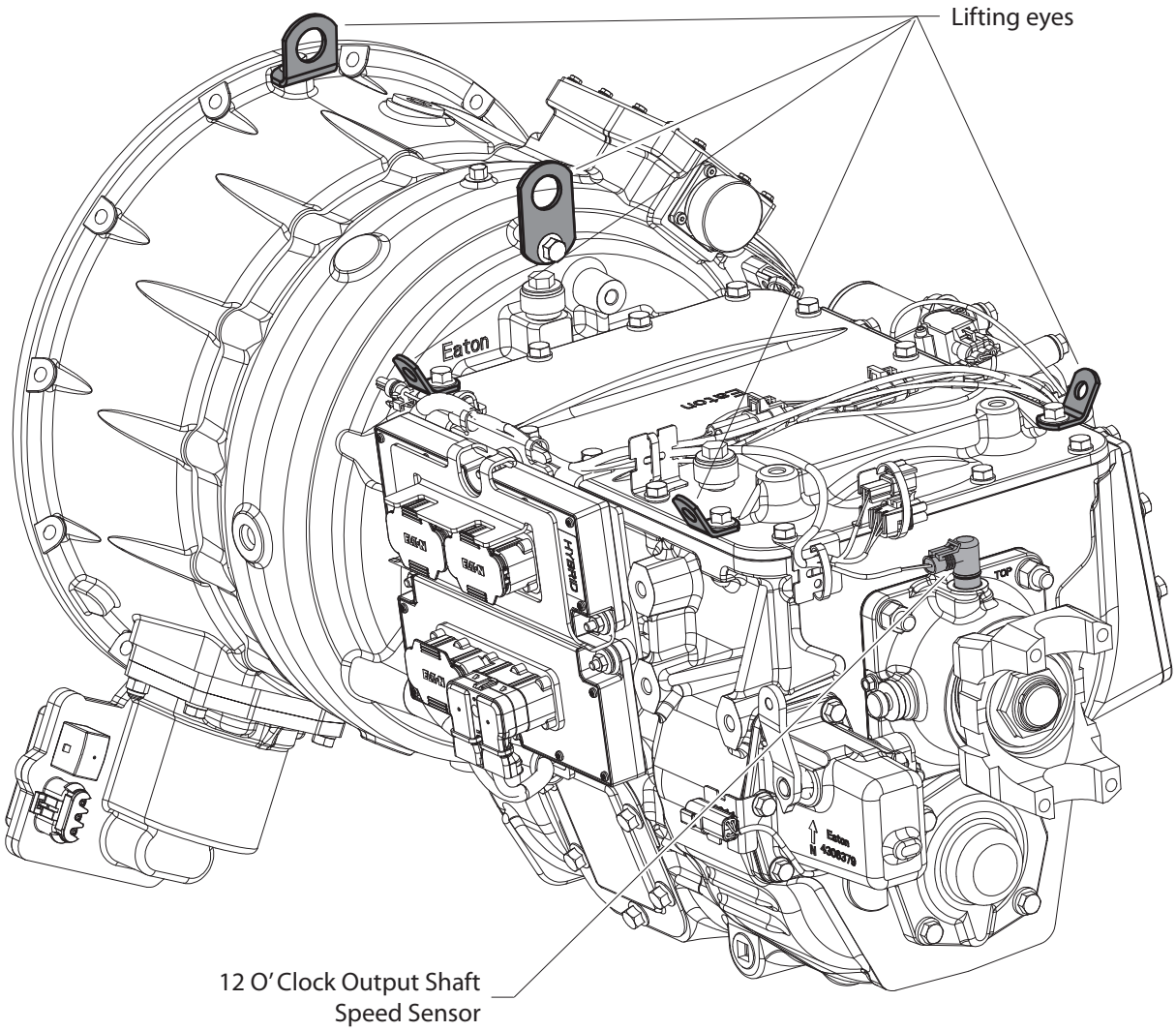
No mechanical speedometers. The 12 o'clock position on Medium Duty is reserved for the Eaton speed sensor.

EH-8E406A-CD/UP/UPG/T/CDG/CDR/P



NOTE: All other tabs are used for harness tiedowns, DO NOT use for lifting

EH-6E706B-CD/P



NOTE: All other tabs are used for harness tiedowns, DO NOT use for lifting

Suggested Tools/Publications

O.E. Tool & Equipment Group/Kent-Moore SPX Corporation 1(800) 520-2584

Kent-Moore Part no.	Description
5505027	Volt/Ohm Meter (Standard commercially available VOM)

O.E. Tool & Equipment Group/Kent-Moore SPX Corporation 1(800) 328-6657

Kent-Moore Part no.	Description
J-43318	Eaton Test Adapter Kit

Eaton Service Parts 1 (800) 826-HELP (1-800-826-4357)

Part No.	Description

Deutsch 951-765-2250

Part No.	Description
DTT-20-02	Hand crimping tool - Low Power Pins (size 20)
DTT-12-00	Hand crimping tool - High Power Pins (size 12)

McMaster Carr (732) 392-6200

Part No.	Description
5333T79 (Size 11 class 0)	High Voltage Glove (Part number varies by size)

Service Publications

TRSM-2000	Service Manual for External components
TRTS-2000	Troubleshooting Guide
TRDR-2000	Drivers Instructions for the Hybrid product
TCMT-0021	Lubrication Guide

For more information contact your OEM quality representative.

Appendix

Torque Specifications

Description	Torque Value lb-ft. [N•m]	Thread size	Additional Comments
Transmission-to-Engine Cap Screws	**Refer to OEM for specification**		
Clutch-to-Flywheel Cap Screws			
3/8 - 16 x 1-1/4”	30 - 35 lb-ft. [41 - 47 N•m]	3/8” - 16	
6 PTO Cover Cap Screws	20 - 25 lb-ft. [27 - 34 N•m]	3/8” - 16	Apply Loctite 242 to threads.
4 Electric Shifter Cap Screws	30 - 45 lb-ft. [48 - 61 N•m] cast and 20 - 25 lb-ft. [27 - 34 N•m] aluminum	3/8” - 16	Apply Loctite 242 to threads.
1 Reverse Switch	20 - 25 lb-ft. [27 - 34 N•m]	9/16” - 18	
1 Neutral Switch/Cap	20 - 25 lb-ft. [27 - 34 N•m]	3/4” - 16	
3 ECU Cap Screws (TECU)	7 - 9 lb-ft. [9.5 - 12.2 N•m]	1/4” - 20	Apply Loctite 242 to threads.
3 ECU Nuts (HCM)	7 - 9 lb-ft. [9.5 - 12.2 N•m]	0.250 - 20 UNC	
2 TECU 38-Way Connectors Cap Screws	25 +/- 3 lb-in. [2.82 +/-.33 N•m]	M5 x 0.8	
2 HCM 38-Way Connectors Cap Screws	25 +/- 3 lb-in. [2.82 +/-.33 N•m]	M5 x 0.8	
1 Push Button Shift Controller 30-Way Connector Cap Screw	10 +/- 3 lb-in. [1.1 +/-.33 N•m]		
2 Push Button Shift Controller Backing Plate Nuts and Lock Washers	14 - 16 lb-in. [1.6-1.8 N•m]		
3 ECA Cap Screws	20 - 25 lb-ft. [27 - 34 N•m]	3/8”-16 x 1-3/4”	
1 ECA Engine Speed Sensor Jam Nut	15 lb-ft. [20 N•m]	3/4”	Turn in until touches and then back off 1/2 to 1 turn. The jam nut is then torqued down to hold the sensor in place.
1 ECA Engine Speed Sensor Cap Screw	8-12 lb-ft. [11-16 N•m]	1/4” - 20	
1 Output Shaft Speed Sensor Cap Screw	8 - 10 lb-ft. [10.8-13.6 N•m]	1/4” - 20	

1 Input Shaft Speed Sensor Cap Screw	8 - 10 lb-ft. [10.8-13.6 N•m]	1/4” - 20	
2 Rail Sensor Cap Screws	21 - 27 lb-in. [2.4-3.1 N•m]		
2 Gear Sensor Cap Screws	21 - 27 lb-in. [2.4-3.1 N•m]		
1 Lubricant Fill Plug	45 - 55 lb-ft. [61 - 75 N•m]	3/4” - 14 NPT	
3 Lifting Bracket Cap Screws	35 - 45 lb-ft. [47 - 61 N•m]	3/8” - 16	Apply Loctite 242 to threads.
1 Output Yoke Nut	500 +/- 25 lb-ft. [678 +/- 34 N•m]		
4 Rear Bearing Cover Cap Screws	60 - 70 lb-ft. [81 - 95 N•m]	1/2”-20	Apply Loctite 242 to threads.
Front Motor Bearing Cover Screws	20 - 23 lb-ft. [27 - 31 N•m]	M8 x 1.25	
Transmission Rear Mount Nuts/Cap Screws	Refer to OEM for Specification		
Hand Hole Cover Screws	25 - 35 lb-in. [2.82 - 3.95 N•m]	M5 x 0.8	
2 Release Yoke to Cross Shaft Screws	50 - 60 lb-ft. [67.8 - 81.3 N•m]	7/16” - 14	
2 Inverter Ground Strap Fasteners	21 - 27 lb-in. [2.37 - 3.05 N•m]	M5 x.8	
2 Motor Housing Ground Strap Fasteners	21 - 27 lb-in. [2.37 - 3.05 N•m]	M5 x.8	
4 PEC Nuts	40 - 50 lb-ft. [54.2 - 67.7 N•m]	1/2” - 13	
DC/DC Converter Cap Screws	14 - 20 lb-ft. [18.9 - 27.1 N•m]	5/16” - 18	
DC/DC Converter 12V Positive Cable Post	65 lb-in. [7.3 N•m]	1/4” - 20	
DC/DC Converter 12V Negative Cable Post	100 lb-in. [11.29 N•m]	3/8” - 16	
Inverter Cap Screws	25 - 35 lb-ft. [34 - 37 N•m]	7/16” - 14 (M5 x 0.8)	
10 APG Cap Screws and Lock Washers	75 - 80 lb-in. [8.5 - 9 N•m]	1/4” - 20	
3 APG Power Panel Cap Screws and Lock Washers	75 - 80 lb-in. [8.5 - 9 N•m]	1/4” - 20 x 0.50”	
4 Alternative APG Mounting	15 - 17 lb-ft. [20.33-23.04 N•m]	M10 x 1.5	Max internal thread length is 24 mm.

Vendor List

Amphenol World Headquarters

(High Voltage AC connectors/wiring)
358 Hall Ave.
Wallingford, CT 06492
Ph: 877-267-4366
Ph: 203-265-8900

BELDEN WIRE AND CABLE

(HIL and J1939 Cable)
P.O. Box 1980
Richmond, IN 47375
(317) 983-5200
Fax (765) 983-5294
www.Belden.com

BRAND-REX CO.

(J1939 Cable)
300 Brickston Square
Andover, MA 01801
(978) 933-5100
www.brand-rex.com

Bulgin Components

(APG cables - Buccaneer 900 Series)
31-315 Plantation Drive
Thousand Palms, CA
760-343-3650

CHAMPLAIN CABLE CO.

(J1939 Cable)
12 Hercules Dr.
Colchester, VT 05446
(802) 655-2121
Fax (802) 654-4224
www.champcable.com

DEUTSCH

(Connectors)
Industrial Products Division
37140 Industrial Ave.
Hemet, CA 92545
(909) 765-2250
Fax (909) 765-2255
www.deutschipd.com
www.laddinc.com (Ladd Industries)

Delphi Electric

(Connectors)
Pioneer-Standard Electronics, Inc.
Packard Branch
5440 Naiman Parkway
Solon, OH 44139
1-800-PARKARD (722-5273)
Fax (219) 378-6650
www.delphiconnect.com

Eaton Vehicle Controls Business Unit

J1939 Auto Shift Display
Contact Phone Number: 919 202 5220
http://commercialcontrols.eaton.com

Leviton Mfg Company Inc

(APG GFCI Panels)
201 North Service Road
Melville, NY 11747
Phone: 1-800-824-3005
Fax: 1-800-832-9538

MTG Moltec

(High-Voltage AC connectors/wiring)
2320 Bristol Circle #5
Oakville, Ontario L6H 5S3
Canada
(905) 829-9922
Fax (905) 829-9923
www.mtgmoltec.com

Nye Lubricants, Inc

(DCDC corrosion preventative)
12 Howland Road
Fairhaven, MA 02719
Phone: 508-996-6721
www.nyelubricants.com

Panduit

(DCDC stud ring terminals)
17301 South Ridgeland Avenue
Tinley Park, IL 60477
www.panduit.com

RAYCHEM

(Wire)
Electronics OEM Components Division
300 Construction Drive
Menlo Park, CA 94025-1164
1-800-260-9909
Fax United States (800) 260-9999
Fax Worldwide (650) 361-5579
www.raychem.com

ROBERT BOSCH CORPORATION

(Relays)
2800 South 25th Avenue
Broadview, IL 60153
(708) 865-5301
Fax (708) 865-5203
www.bosch.de

VTE, Inc

(DCDC red terminal cover)
Pellston, MI 49769
Phone: 1-800-527-9256
www.vteworld.com

Yazaki North America, Inc.

(High Voltage DC connectors/wiring)
North American Headquarters
6801 Haggerty Road
Canton, MI 48187
734-983-1000

Change Control Log

Last Revised Date	Description of Clarifications and Updates
March 2010	Updated Resolver Pins in Typical Motor/Generator Circuit section
	Changed Deutsch 8-way connector from DT06-8S-CE01 to DT06-08SB-CE01
	Corrected ECA fuse from 50 amp to 30 amp in Cable and Power Harness Sections
	Updated ECA wiring for pins B and C in Wiring Diagrams OEM Responsibility section
	Corrected ECA wiring gauge from 12 to 10 AWG in the ECA and Engine Speed Sensor Circuits section
March 2011	Created Typical APG Circuit Section
	Created Alternative Auxiliary Power Generator Section
	Updated graphics
August 2011	Updated graphics to include inch / mm dimensions.
	Changed language where required. See markups file.
	Corrected grammatical errors along with call outs.
February 2012	**Installation Requirements Section:** - Added “Base Hybrid System Cooling Circuit” - “Preferred Cooling Circuit” page with Schematic. - Edited original “Base Hybrid System Cooling Circuit” schematic by rotating -90 degrees and adding schematic name of “Standard Cooling Circuit”. - Edited “Transmission Component Temperature Requirements” image to show current ECA design. - Edited “Power Electronics Carrier (PEC)” image to show current PEC design. - Edited “Alternative Power Electronics Carrier (A-PEC)” image to show current A-PEC design, also added a note between item 5 and 6 in the Installation Requirements section. - Edited “Alternative Auxiliary Power Generator (APG)” image to current design and added image of “Alternative Power Panel” and “Alternative Power Schematic”. - Edited “ePTO Engagement Flowchart” for call some outs. - Edited “mPTO Engagement Flowchart” for call some outs. - Rotated “ePTO Responsibilities” flowchart.

Change Control Log

Last Revised Date	Description of Clarifications and Updates
February 2012	**Electrical Requirements Section:** - Edited the “Low Voltage Cable” wire gauge and type for a select few. - Removed the “Cable Connector (Deutsch) - DTM06-4S” table and replaced it with “Cable Connector (Deutsch) - DT06-12SA-C015” - Added tables “Cable Connector (Yazaki) - 7123-1424-40” and “Cable Connector (Yazaki) - 7123-7464-40”. - Edited wire type and added a note to the “Electrical Wiring Recommendations” section under “Harness Design Recommendations”. - Replaced the following schematic under the “Wiring Diagrams OEM Responsibility” section called, “Hybrid EH-8E306A-CD,U,UP, T with Eaton Push Button Shift Control” with “Enhanced MY09 for City Delivery and Utility”, “Enhanced MY09 Low Profile with Park (LPwP)” and “Enhanced MY09 with Alternative Components”. - Added table “Deutsch 4-Way Connector” to the “Mating Connector Information” section. - Changed the Main Power “30 amp” fuse for the ECA to “50 amp”. - Changed the “Typical Inverter Circuit” image to be more user friendly. - Edited some of the table information for the “Inverter 40-Way Connector (24-Volt)” and “Inverter 40-Way Connector (24-Volt)” tables. - Changed the call outs in the “Typical PEC Circuit” image and some of the information in the “PEC 19-Way Connector” table. - Changed the image in the “Alternative PEC Circuit” and some of the information in the “PEC 19-Way Connector” table. - Changed the information and images on the “APG 4-Way High Voltage DC Cable” and the “APG 8-Way High Voltage DC Cable” pages under the “Typical Alternative APG Circuit” section. - Changed the Part numbers for the Amphenol Connectors in the “Mating Connector Information” tables. - Added a “Deutsch 2-Way Connector” table to the “Typical Electric Clutch Actuator & Engine Speed Sensor Circuits” section under the “Mating Connector Information (OEM Supplied ECA Speed Sensor)” - Edited the “Typical DC/DC Converter Circuit” image to be more user friendly.
	Features: - Edited the “Hybrid Medium-Duty (EH-8E306A-CD/U/UP/UPG)” image to reflect current design”. - Edited the “Hybrid Medium-Duty (EH-6E606B-CD)” image to reflect current design”. - Added a note to the ePTO and mPTO images under the “Power Take-Off “Countershaft driven” section.
	Line Inspection: - Removed the Troubleshooting flowchart completely.
	Appendix: - Edited the images in section “Lifting Eyes and Sensor Positions” for both “EH-8E406A-CD/UP/UPG/T/CDG/CDR/P” and “EH-6E706B-CD/P”.

Last Revised Date	Description of Clarifications and Updates
March 2012	**Removed the following book sections:** - Auxiliary Power Generator (APG) - Typical APG Circuit **Special OEM Body Builder Installation Requirements Book Section:** - Edited the ePTO Responsibilities schematic to include “Operator Triggered Engine Run”, “Low 12v State of Change” **Electrical Wiring Requirements Book Section:** - Edited the 30 amp note to read 50 amp where necessary on last bullet under “Electrical Current Recommendations” **Typical Power Harness Circuit Book Section:** - Edited the table under the “Electric Clutch Actuator (ECA) Power Harness” **Data Link Interface w/9-Pin Diagnostic Connector Book Section:** - Edited Datalink/s to Data Link - Edited image to include HCM 27 to J and HCM 28 to H **J1939/15 & Proprietary CAN Data Links Book Section:** - Edited image on the “Data Link Structure” to include transpose the call outs for the J-1939 Transmission ECU and the Engine ECU **Typical Inverter Circuit Book Section:** - Edited tables to add Twisted Pairs and TXL / GXL where needed - Edited the 40-Way Connector PN# from DRC18-40SAE-PO13 to RDRC16-40SE **Typical PEC Circuit Book Section:** - Edited tables to add Twisted Pairs and TXL / GXL where needed **Alternative PEC Circuit Book Section:** - Edited tables to add Twisted Pairs and TXL / GXL where needed **Typical Alternative PEC Circuit Book Section:** - Edited tables to add Twisted Pairs and TXL / GXL where needed **Typical Electric Clutch Actuator & Engine Speed Sensor Circuits Book Section:** - Edited tables to add Twisted Pairs and TXL / GXL where needed **Typical DC/DC Converter Circuit Book Section:** - Edited tables to add Twisted Pairs and TXL / GXL where needed **Power Take-Off “Countershaft driven” Book Section:** - Edited tables to add Twisted Pairs and TXL / GXL where needed
June 2013	**Cover and Back Cover** - Updated to current design standards **Typical Alternative APG Circuit Book Section:** - Edited mating connector part IDs for graphic image files on page 124 - Updated table on page 126 accordingly **Power Take-Off "Countershaft driven" Book Section:** - Corrected page number cross-reference to Cable section from "[see page 46]" to "[see page 63]"

Note: Features and specifications listed in this document are subject to change without notice and represent the maximum capabilities of the software and products with all options installed. Although every attempt has been made to ensure the accuracy of information contained within, Eaton makes no representation about the completeness, correctness or accuracy and assumes no responsibility for any errors or omissions. Features and functionality may vary depending on selected options.

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In Mexico, call 001-800-826-4357.

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