Navistar Electrical Systems HX Vocational Series Integration Guide

Table of Contents

1. Revision Summary Table

REVISION	DATE	SECTION	CHANGE DESCRIPTION	REASON FOR CHANGE	REVISED BY
01	11/08/2018	ALL	INITIAL DRAFT	INITIATION OF DOCUMENT	J. BISSONTZ
02	12/23/2020	6.	NEW SECTION	NEW FEATURE	D. MARKS

2. Forward:

Warning - In the pages of this document are a diverse set of truck chassis system and subsystem integration features which contain the potential for both simple and complex operational situations and interactions when integrated in combination with a truck chassis and truck mounted equipment. It is the responsibility of persons performing truck chassis and, or truck mounted equipment system integration and testing to fully understand the plurality of operational outcomes and take the appropriate as well as necessary precautions to avoid property damage, personal injury up to and including death when performing system integration and, or test in association with the content of this document.

Note - In this manual, International® Truck and Engine Corporation provides information about its different products to assist those who wish to modify these products for individual applications. International does not recommend or approve any firm nor make any judgements on the quality of the work performed by a particular firm. Individuals who use the services of a Body Builder must satisfy themselves as to the quality of the work.

The party installing a body, a fifth wheel, any other equipment, or making any modifications to complete the vehicle for delivery and make it road-ready is responsible to see that the completed vehicle complies with all applicable certification procedures and safety standards, as may be set forth in Federal, State, and local statutes, rules and regulations.

Specifications, descriptions and illustrative material in this literature are as accurate as known at time of publication but are subject to change without notice. Illustrations are not always to scale and may include optional equipment and accessories but may not include all standard equipment.

Safety Information:

IMPORTANT - Read the following before starting the service procedure.

You must follow your company safety procedures when you service or repair equipment. Be sure to understand all procedures and instructions before you begin

work on the unit. Some procedures require the use of special tools for safe and correct service. Failure to use these special tools when required can cause injury to service personnel or damage to vehicle components.

DISCLAIMER: INTERNATIONAL DOES NOT TAKE ANY RESPONSIBILITY FOR CUSTOMER OR BODY BUILDER WIRING.

NOTE - After-market installed wiring for engine speed control must comply with the following guidelines:

1. Sealed switches and connectors must be used for switches and connections that are exposed to the weather or to salt spray emanating from the vehicle's tires.

2. Route and clip wiring to minimize chafing and exposure to weather. Use conduit, loom, and/or tape to achieve this.

3. Fuse all power leads as close to the power source as possible. Remember fuses protect the wiring - size fuses accordingly.

4. All ground connections that will be made to the frame or body must be connected to clean bare metal. Remove all dirt, paint, grease and rust that would insulate the terminal from ground. After connecting the ground, seal the connection with a good quality grease or surface sealant to protect the connection from corrosion.

5. Spliced wires should be twisted together and soldered. Use a heat shrink tube with a meltable inner wall to seal the connection. Do not expose splices to the weather.

WARNING - To avoid serious personal injury, possible death, or damage to the vehicle, make sure the transmission is in neutral, parking brake is set, and the wheels are blocked before undertaking service procedures. In addition, turn off the engine when you leave the vehicle. Never leave the vehicle unattended with the engine running.

WARNING - To avoid personal injury, possible death, or damage to the vehicle when adding electrical features, disconnect batteries. Reconnect batteries when installation is complete.

Whenever disconnecting battery terminals; always disconnect the ground terminal first. When reconnecting, always connect the ground terminal last. To prevent injury to the eyes, face, limbs and body, it is imperative that lighted materials, flames or sparks be kept away from the vent openings of the battery. The gas mixture in the battery cells, which escapes through the vents, could ignite and/or cause an explosion. This is particularly true when jumper cables are being used.

In addition, inhaling of gas produced by the normal operation of the battery could result in partial or permanent damage to the respiratory system.
Always wear eye protection when working around batteries. Do not attempt to jump-start a vehicle having a frozen battery because the battery may explode. If a frozen battery is suspected, examine all fill vents on the battery. If ice can be seen, do not attempt to start with jumper cables as long as the battery remains frozen. Thaw out the battery and recharge.
Do not check battery condition by shorting (flashing) across terminals.
Failure to observe these instructions could result in personal injury and/or damage to the vehicle.

Battery cable terminals must be clean and tight. Use hot water and common baking soda for removing terminal corrosion and for cleaning the top of the battery. Brighten the contact surface with steel wool, apply a light coat of lubricant sealing grease such as Fleetrite ® 472141-C1 or equivalent and reassemble. Be sure the terminals are clamped tightly and that the battery is clamped securely in place.

When working around the terminals and battery, use extra care to avoid shorting. A good practice is to insulate pliers and screwdrivers.

3. Vehicle Architectures:

3.1. Multiplexing Architecture:

Unlike the electrical systems on previous models, which utilized point-to-point wiring for all input signals and output loads, this system uses multiplex technology to provide control and communication between major functional areas of the vehicle. Multiplexing simply means, communicating multiple pieces of information via a single twisted pair of wires (called the data link) without requiring a wire for each piece of information. This information could be gauge information such as engine oil pressure, or switch information that controls vehicle functions such as headlamps.

The electrical system relies on a collection of electronic circuit modules and software to perform vehicle functions instead of implementing similar features using complex wire harness designs with electromechanical relays and switches. These electronic module components are connected by data links. The data links can be thought of as computer networks that allow the electronic components on the vehicle to communicate with one another.

The concept of multiplexing is not new since data links for communicating between engine controllers, the instrument cluster and the diagnostic connector have been used for several years.

The goal of multiplexing is to reduce cab harness wiring and to simplify circuits. This is accomplished by using a low current data link for communicating between cab switches, the Body Controller and the Instrument Cluster. Other data links in the vehicle allow

other electrical controllers, the BC and the Instrument Cluster to communicate with each other

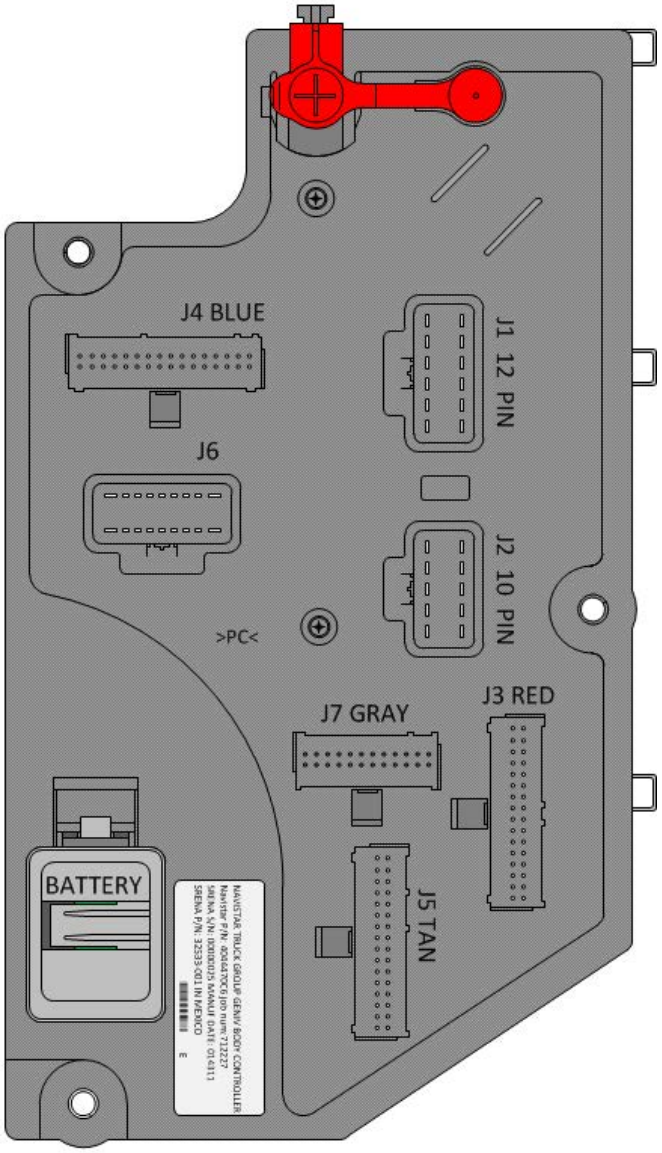
4. Body Controller

4.1. Body Control Module Gen IV:

At the center of the Diamond Logic® Electrical System is the Body Controller (BC). The BC is an electronic module that provides multiple analog and switched input/output interfaces to monitor vehicle sensors and control vehicle functions through solid state switches, relay driver outputs, and serial data communications. Serial datalinks connected to the BC include the following:

The BC is located under the IP behind a kick plate to the left of the driver's left foot. All connections are now located inside the cab except for the power connection that passes thru the dash panel to the engine compartment. The BC receives battery power from the maxi-fuse block and Ignition (IGN) power from the IP harness.
The Body Controller communicates with plurality of modules over a series of differing baud rate data links in an exchange of tens of thousands of digital messages ever second. It also receives input from various sensors and hard wire inputs throughout the truck. The BC converts these inputs, in accordance with the programmed "rules," into data to be transmitted on the datalinks. It is also the power source for circuits that feed the components, controlled by the multiplexed switches, inside and outside of the cab. The primary vehicle software programming resides in the Body Controller.

Body Control Module Gen IV (Connector Header View):



Body Controller Gen IV Part Information:

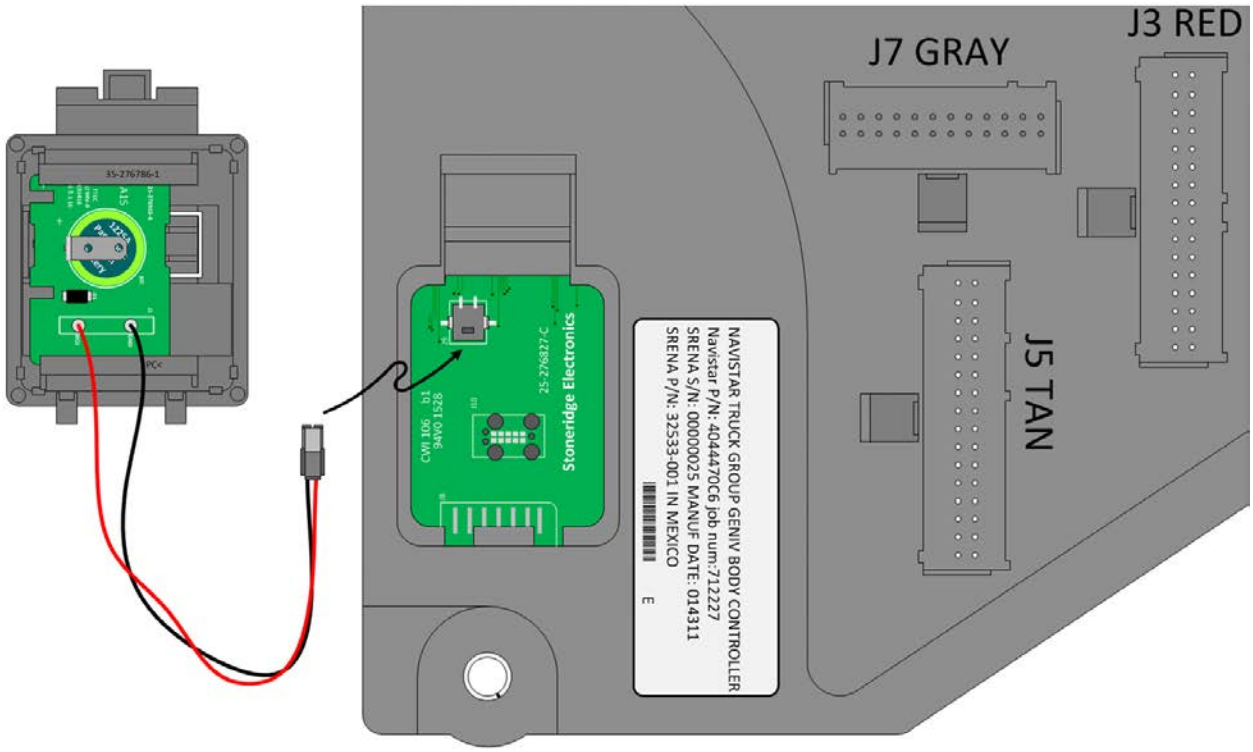
PART NUMBER	DESCRIPTION
4044470C6	BODY CONTROL MODULE GEN IV

Body Control Module Part Number

4.2. Body Control Module “Real-time Clock” Internal Power Source:

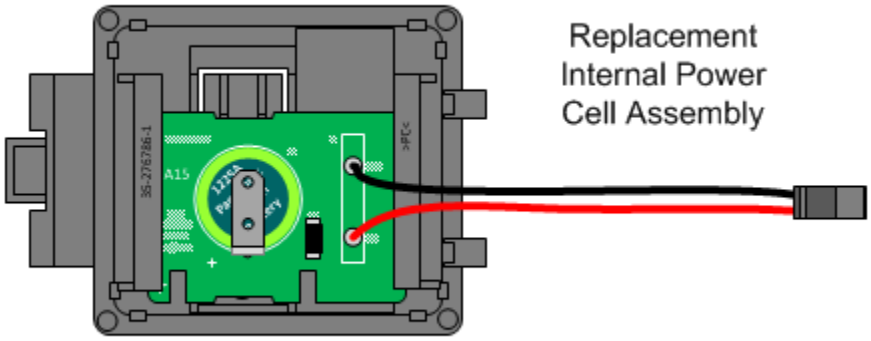
Note: Within the body control module is an internal power cell which powers the module’s internal “real-time clock” during times when there is insufficient electrical potential available from the main chassis battery electrical architecture to fully support the body control module’s full electrical and operational requirements. Over time this internal power cell will discharge and require replacement. The body control module’s original internal power cell is integral to the control module and is permanently mounted on the main printed circuit board and is not intended to be a serviceable component. However, positioned next to the original internal power cell is a 2-way electrical connector which is in parallel with, but diode blocked from the original internal power cell. A new internal power cell module assembly can be added by pinned it into the 2-way printed circuit board mounted mating connector to restore the internal power cell operation. The replacement internal power cell module is packaged in the form of a new body control module battery cover which includes a new power cell as well as a printed circuit board mounted to the underside/interior of the new body control module battery cover. Once the new internal power cell has been connected to the printed circuit board mounted mating connector, the module assembly will replace the body control module’s original plastic battery cover.

When the body controller’s internal power cell becomes discharge a fault code can be accessed through either the gauge cluster’s diagnostic display or through Navistar’s Diamond Logic Builder® service tool. The fault code suspect parameter number will be displayed as SPN:516824 and have the diagnostic fault code name, “RTC Battery”.



Preplacement Internal Power Cell

Body Controller Internal Power Cell – Uninstalled View:

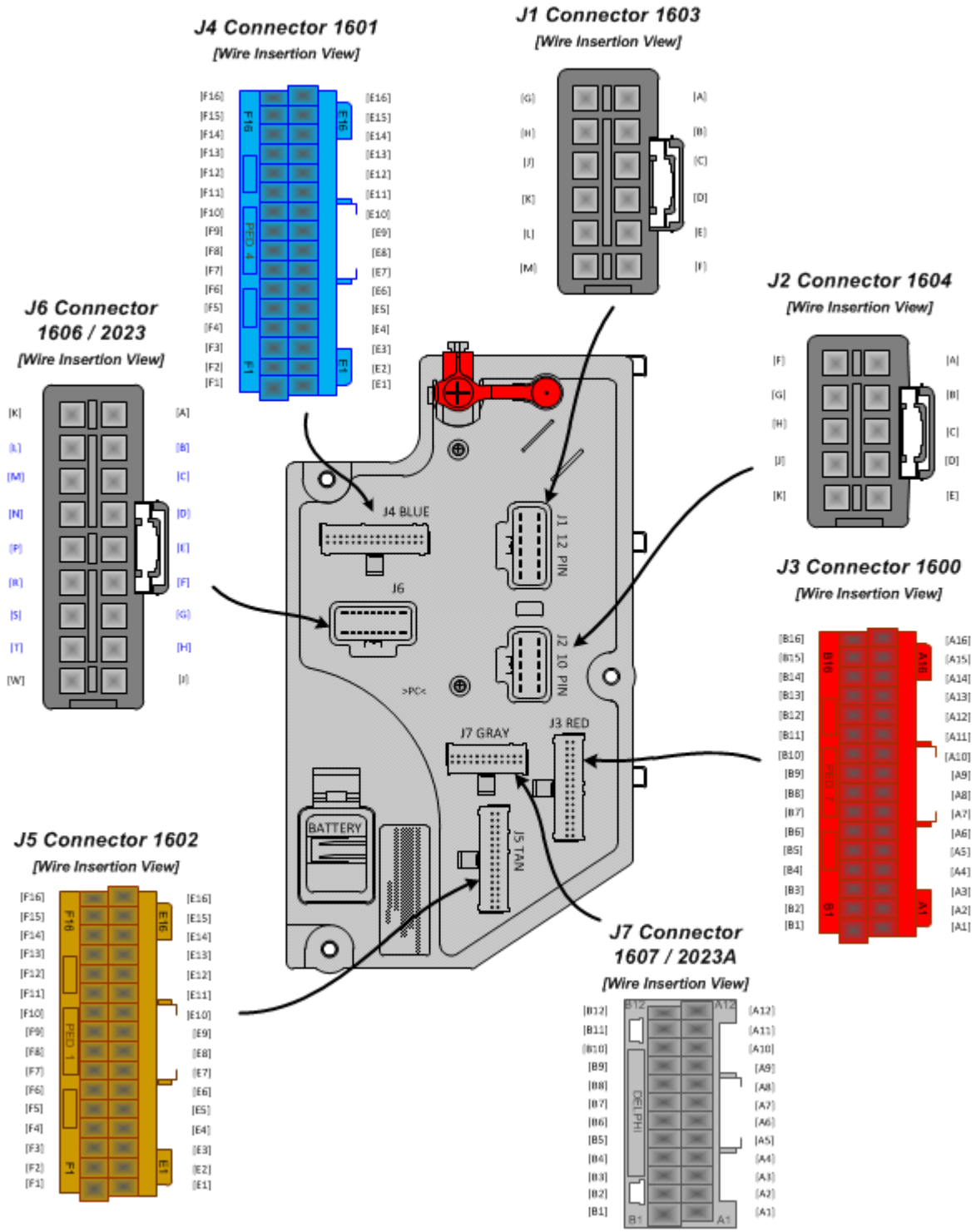


Body Controller Gen IV Replacement Battery Part Information:

PART NUMBER	DESCRIPTION
2514328C91	BODY CONTROL MODULE REPLACEMENT BATTERY (INTERNAL POWER CELL ASSEMBLY)

Body Control Module Internal Battery Part Number

4.3. Body Control Module Gen IV Connector Composite:



Body Controller Gen IV Connector Composite

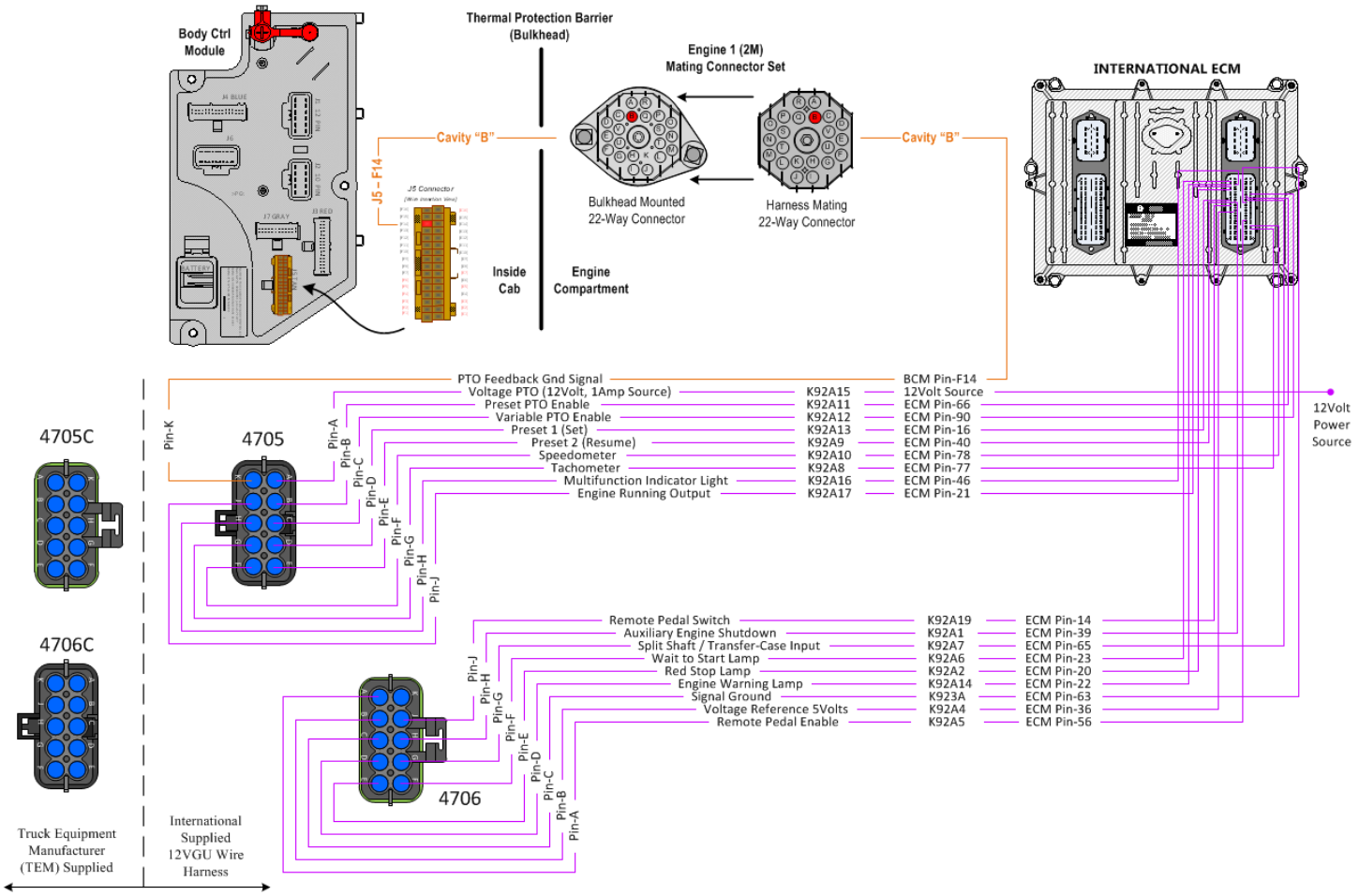
5. Engine Speed Control Feature and Accommodation Packages

5.1. 12VGA: ENGINE CONTROL, REMOTE MOUNTED Provision for, Includes Wiring for Body Builder Installation of PTO Controls, With Ignition Switch Control for International® N13/A26 Electronic Engines.

Extended Description: Feature 12VGA is for use with International N13/A26 engines. This feature provides two connectors for the Truck Equipment Manufacturer (TEM) or body builder to connect to the engine hardwired interface for remote engine speed control and monitoring. The connectors are in the engine compartment on the driver side near the firewall and include the mating connectors with plugs for the installer to replace desired cavity locations with terminated body wiring. With the proper wiring and appropriate engine parameter settings, the body builder can remotely control preset, variable, and remote pedal engine speed. The feature also includes interface wires for Transfer Case Feedback, Engine Warning Light (EWL), Tachometer, Vehicle Speed Pulse, Oil in Water LIGHT (OWL) and a PTO operational status datalink message for proper remote engine speed control operation.

Note: For proper remote engine speed control when in PTO or equivalent modes of vehicle operation, it is imperative that a body equipment source an appropriate ground signal at the 12VGA interface, failure to do so will result in an OBD fault condition. If features 12WPU Rear Engine PTO for N13/A26 or 12851 Front Engine PTO effects for N13/A26 are part of the vehicle's configuration and 12VGA is not present, the PTO feedback circuit will have to be added to the vehicle for proper engine operation during the PTO mode of operation.

System Block Diagram:

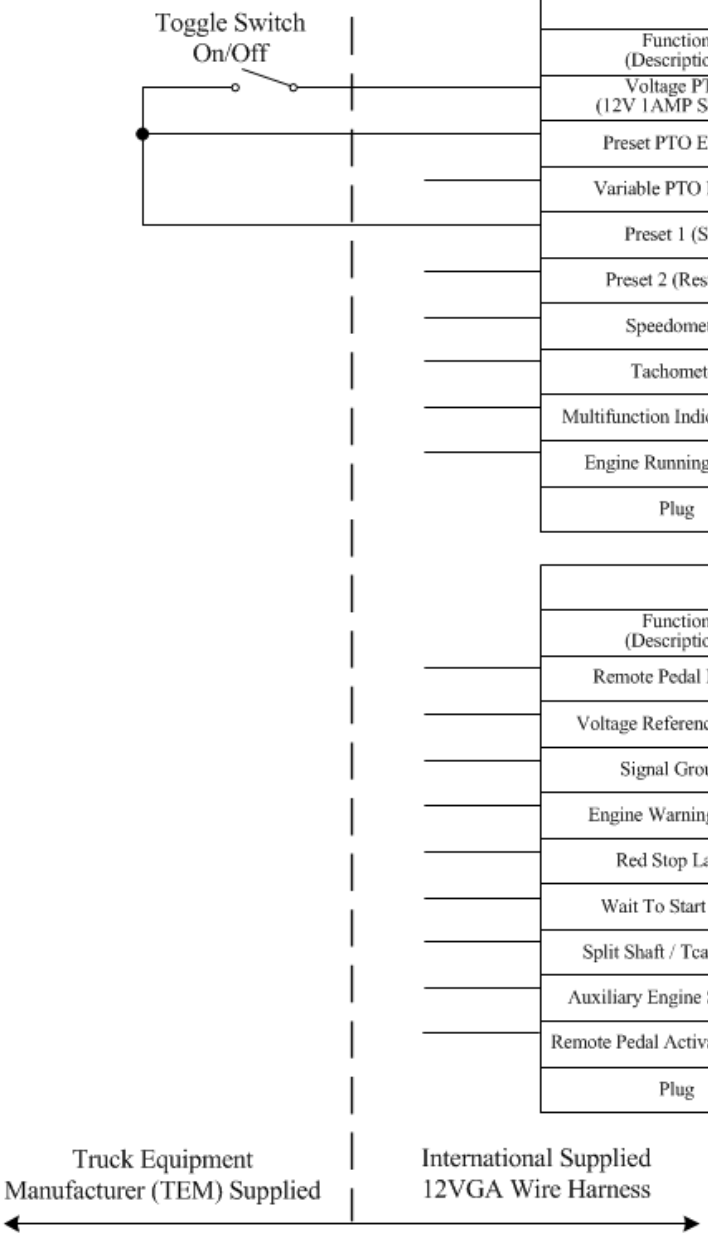


12VGA Interface Harness Block Diagram

Body Controller Software Feature Codes:

- 595BZJ*A* - BCM PROG, PTO ENGAGEMENT WITH A26 ENGINE *(Activates status messaging to engine)*

5.1.1.1. 12VGA: Preset Set Speed - Wiring Diagram:

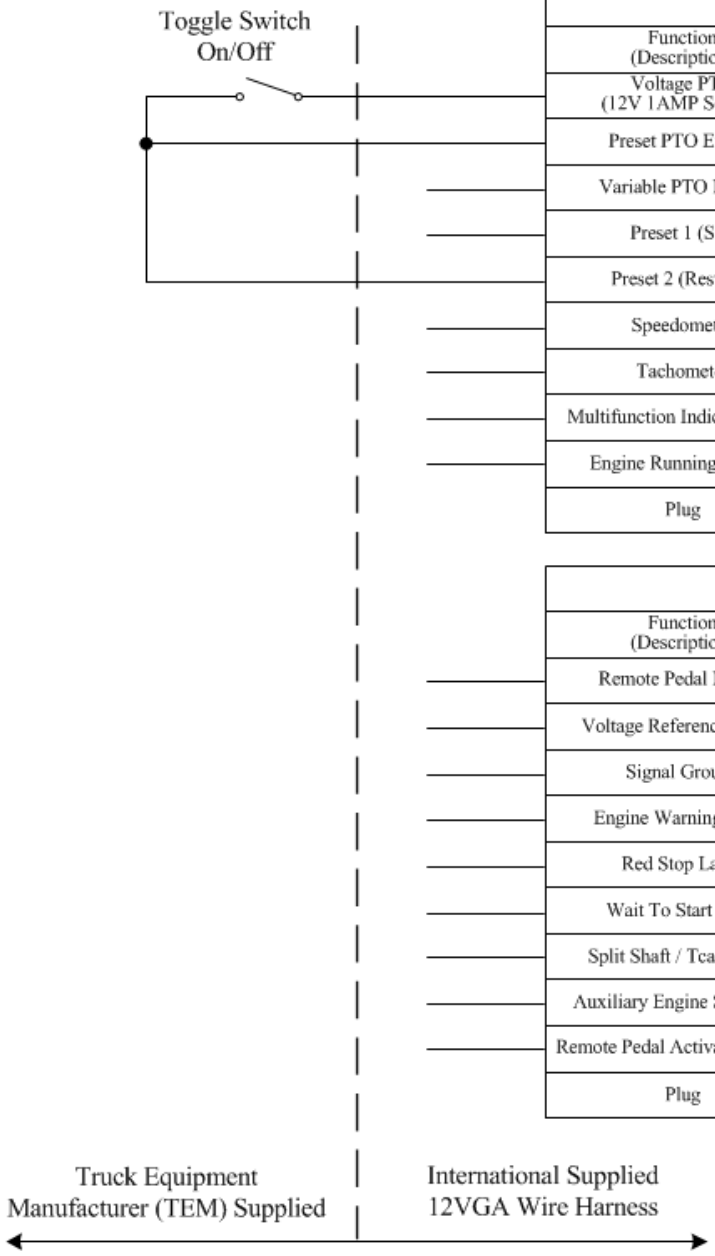


12VGA with N13/A26			
Function (Description)	Connector 4705 Cavity	Circuit Number	Engine ECM Pin Location
Voltage PTO (12V 1AMP Source)	A	K92A15	
Preset PTO Enable	B	K92A11	6019 (C1-66)
Variable PTO Enable	C	K92A12	6019 (C1-90)
Preset 1 (Set)	D	K92A13	6019 (C1-16)
Preset 2 (Resume)	E	K92A9	6019 (C1-40)
Speedometer	F	K92A10	6019 (C1-78)
Tachometer	G	K92A8	6019 (C1-77)
Multifunction Indicator Light	H	K92A16	6019 (C1-46)
Engine Running Output	J	K92A17	6019 (C1-21)
Plug	K		

12VGA with N13/A26			
Function (Description)	Connector 4706 Cavity	Circuit Number	Engine ECM Pin Location
Remote Pedal Enable	A	K92A5	6018 (C1-56)
Voltage Reference 5Volts	B	K92A4	6018 (C1-36)
Signal Ground	C	K92A3	6018 (C1-63)
Engine Warning Lamp	D	K92A14	6018 (C1-22
Red Stop Lamp	E	K92A2	6018 (C1-20)
Wait To Start Light	F	K92A6	6018 (C1-23)
Split Shaft / Tcase Input	G	K92A7	6018 (C1-65)
Auxiliary Engine Shutdown	H	K92A1	6019 (C1-39)
Remote Pedal Activation Switch	J	K92A19	6019 (C1-14)
Plug	K		

Wiring Diagram for 12VGA Preset Set Speed Function

5.1.1.2. 12VGA: Preset Resume Speed - Wiring Diagram:

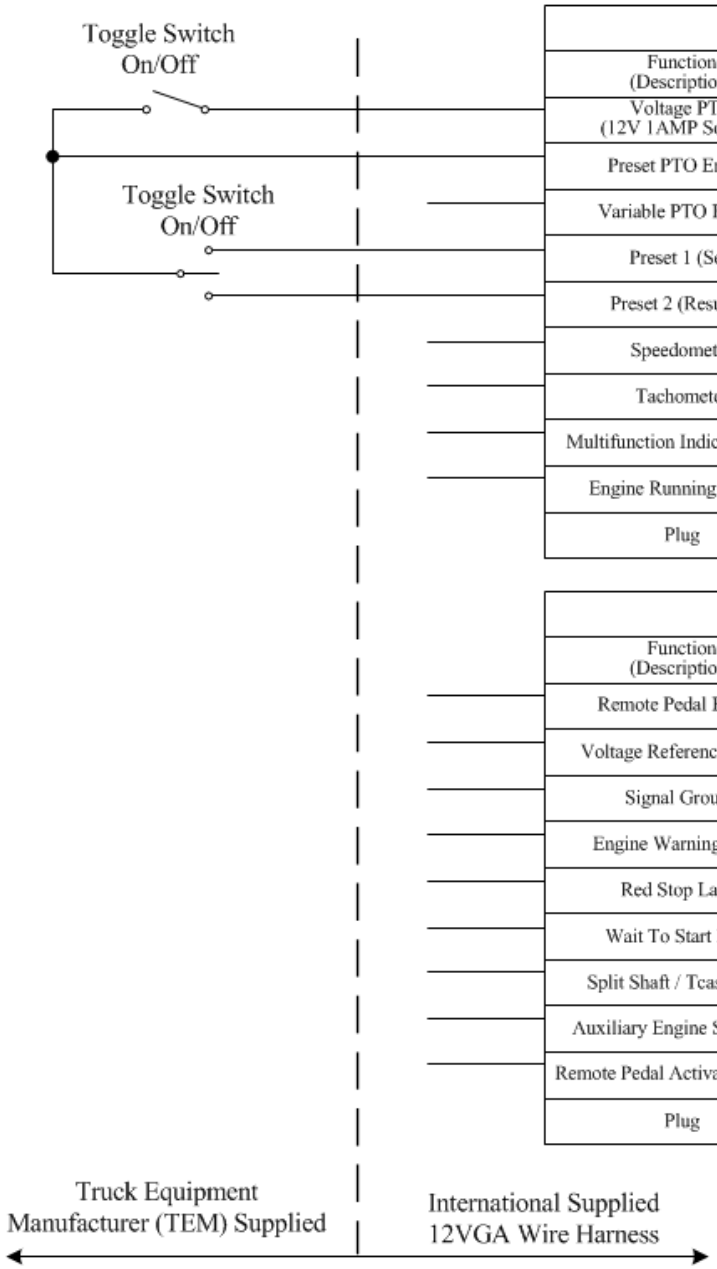


12VGA with N13/A26			
Function (Description)	Connector 4705 Cavity	Circuit Number	Engine ECM Pin Location
Voltage PTO (12V 1AMP Source)	A	K92A15	
Preset PTO Enable	B	K92A11	6019 (C1-66)
Variable PTO Enable	C	K92A12	6019 (C1-90)
Preset 1 (Set)	D	K92A13	6019 (C1-16)
Preset 2 (Resume)	E	K92A9	6019 (C1-40)
Speedometer	F	K92A10	6019 (C1-78)
Tachometer	G	K92A8	6019 (C1-77)
Multifunction Indicator Light	H	K92A16	6019 (C1-46)
Engine Running Output	J	K92A17	6019 (C1-21)
Plug	K		

12VGA with N13/A26			
Function (Description)	Connector 4706 Cavity	Circuit Number	Engine ECM Pin Location
Remote Pedal Enable	A	K92A5	6018 (C1-56)
Voltage Reference 5Volts	B	K92A4	6018 (C1-36)
Signal Ground	C	K92A3	6018 (C1-63)
Engine Warning Lamp	D	K92A14	6018 (C1-22
Red Stop Lamp	E	K92A2	6018 (C1-20)
Wait To Start Light	F	K92A6	6018 (C1-23)
Split Shaft / Tcase Input	G	K92A7	6018 (C1-65)
Auxiliary Engine Shutdown	H	K92A1	6019 (C1-39)
Remote Pedal Activation Switch	J	K92A19	6019 (C1-14)
Plug	K		

Wiring Diagram for 12VGA Preset Resume Speed Function

5.1.1.3. 12VGA: Preset Set Resume Speed - Wiring Diagram:

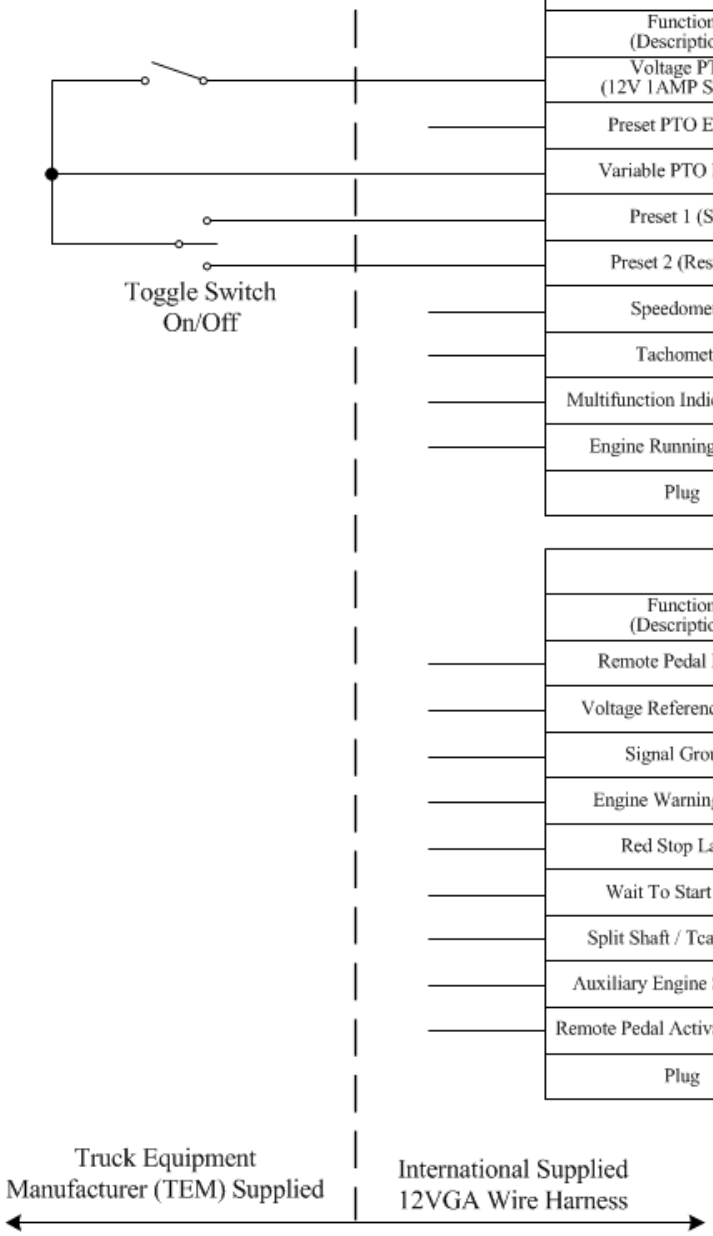


12VGA with N13/A26			
Function (Description)	Connector 4705 Cavity	Circuit Number	Engine ECM Pin Location
Voltage PTO (12V 1AMP Source)	A	K92A15	
Preset PTO Enable	B	K92A11	6019 (C1-66)
Variable PTO Enable	C	K92A12	6019 (C1-90)
Preset 1 (Set)	D	K92A13	6019 (C1-16)
Preset 2 (Resume)	E	K92A9	6019 (C1-40)
Speedometer	F	K92A10	6019 (C1-78)
Tachometer	G	K92A8	6019 (C1-77)
Multifunction Indicator Light	H	K92A16	6019 (C1-46)
Engine Running Output	J	K92A17	6019 (C1-21)
Plug	K		

12VGA with N13/A26			
Function (Description)	Connector 4706 Cavity	Circuit Number	Engine ECM Pin Location
Remote Pedal Enable	A	K92A5	6018 (C1-56)
Voltage Reference 5Volts	B	K92A4	6018 (C1-36)
Signal Ground	C	K92A3	6018 (C1-63)
Engine Warning Lamp	D	K92A14	6018 (C1-22
Red Stop Lamp	E	K92A2	6018 (C1-20)
Wait To Start Light	F	K92A6	6018 (C1-23)
Split Shaft / Tcase Input	G	K92A7	6018 (C1-65)
Auxiliary Engine Shutdown	H	K92A1	6019 (C1-39)
Remote Pedal Activation Switch	J	K92A19	6019 (C1-14)
Plug	K		

Wiring Diagram for 12VGA Preset Set Resume Speed Function

5.1.1.4. 12VGA: Variable Switch Control - Wiring Diagram:

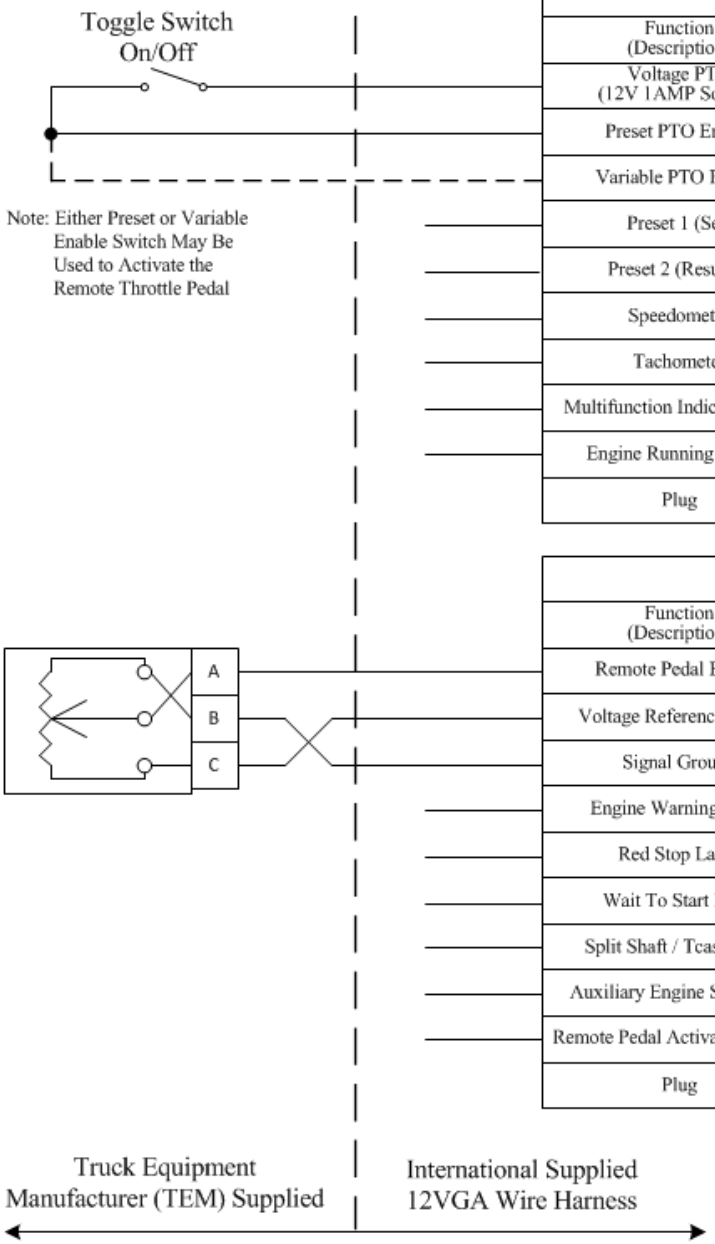


12VGA with N13/A26			
Function (Description)	Connector 4705 Cavity	Circuit Number	Engine ECM Pin Location
Voltage PTO (12V 1AMP Source)	A	K92A15	
Preset PTO Enable	B	K92A11	6019 (C1-66)
Variable PTO Enable	C	K92A12	6019 (C1-90)
Preset 1 (Set)	D	K92A13	6019 (C1-16)
Preset 2 (Resume)	E	K92A9	6019 (C1-40)
Speedometer	F	K92A10	6019 (C1-78)
Tachometer	G	K92A8	6019 (C1-77)
Multifunction Indicator Light	H	K92A16	6019 (C1-46)
Engine Running Output	J	K92A17	6019 (C1-21)
Plug	K		

12VGA with N13/A26			
Function (Description)	Connector 4706 Cavity	Circuit Number	Engine ECM Pin Location
Remote Pedal Enable	A	K92A5	6018 (C1-56)
Voltage Reference 5Volts	B	K92A4	6018 (C1-36)
Signal Ground	C	K92A3	6018 (C1-63)
Engine Warning Lamp	D	K92A14	6018 (C1-22
Red Stop Lamp	E	K92A2	6018 (C1-20)
Wait To Start Light	F	K92A6	6018 (C1-23)
Split Shaft / Tcase Input	G	K92A7	6018 (C1-65)
Auxiliary Engine Shutdown	H	K92A1	6019 (C1-39)
Remote Pedal Activation Switch	J	K92A19	6019 (C1-14)
Plug	K		

Wiring Diagram for 12VGA Variable Switch Control Function

5.1.1.5. 12VGA: Variable Pedal Control - Wiring Diagram:

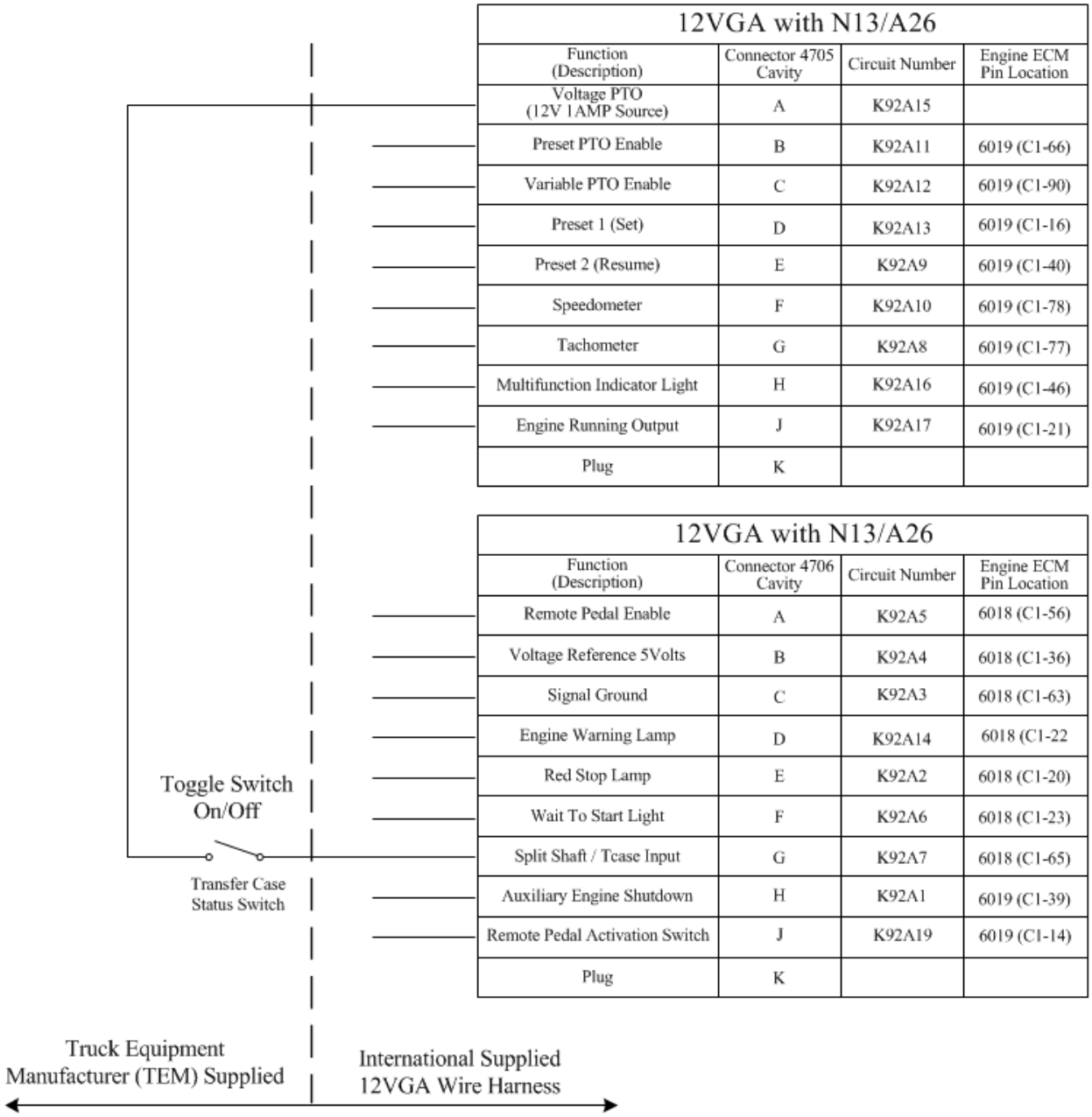


12VGA with N13/A26			
Function (Description)	Connector 4705 Cavity	Circuit Number	Engine ECM Pin Location
Voltage PTO (12V 1AMP Source)	A	K92A15	
Preset PTO Enable	B	K92A11	6019 (C1-66)
Variable PTO Enable	C	K92A12	6019 (C1-90)
Preset 1 (Set)	D	K92A13	6019 (C1-16)
Preset 2 (Resume)	E	K92A9	6019 (C1-40)
Speedometer	F	K92A10	6019 (C1-78)
Tachometer	G	K92A8	6019 (C1-77)
Multifunction Indicator Light	H	K92A16	6019 (C1-46)
Engine Running Output	J	K92A17	6019 (C1-21)
Plug	K		

12VGA with N13/A26			
Function (Description)	Connector 4706 Cavity	Circuit Number	Engine ECM Pin Location
Remote Pedal Enable	A	K92A5	6018 (C1-56)
Voltage Reference 5Volts	B	K92A4	6018 (C1-36)
Signal Ground	C	K92A3	6018 (C1-63)
Engine Warning Lamp	D	K92A14	6018 (C1-22
Red Stop Lamp	E	K92A2	6018 (C1-20)
Wait To Start Light	F	K92A6	6018 (C1-23)
Split Shaft / Tcase Input	G	K92A7	6018 (C1-65)
Auxiliary Engine Shutdown	H	K92A1	6019 (C1-39)
Remote Pedal Activation Switch	J	K92A19	6019 (C1-14)
Plug	K		

Wiring Diagram for 12VGA Variable Pedal Control Function

5.1.1.6. 12VGA: Transfer Case Speed Disable - Wiring Diagram:

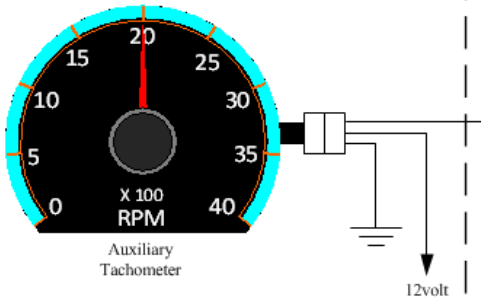


12VGA with N13/A26			
Function (Description)	Connector 4705 Cavity	Circuit Number	Engine ECM Pin Location
Voltage PTO (12V 1AMP Source)	A	K92A15	
Preset PTO Enable	B	K92A11	6019 (C1-66)
Variable PTO Enable	C	K92A12	6019 (C1-90)
Preset 1 (Set)	D	K92A13	6019 (C1-16)
Preset 2 (Resume)	E	K92A9	6019 (C1-40)
Speedometer	F	K92A10	6019 (C1-78)
Tachometer	G	K92A8	6019 (C1-77)
Multifunction Indicator Light	H	K92A16	6019 (C1-46)
Engine Running Output	J	K92A17	6019 (C1-21)
Plug	K		

12VGA with N13/A26			
Function (Description)	Connector 4706 Cavity	Circuit Number	Engine ECM Pin Location
Remote Pedal Enable	A	K92A5	6018 (C1-56)
Voltage Reference 5Volts	B	K92A4	6018 (C1-36)
Signal Ground	C	K92A3	6018 (C1-63)
Engine Warning Lamp	D	K92A14	6018 (C1-22
Red Stop Lamp	E	K92A2	6018 (C1-20)
Wait To Start Light	F	K92A6	6018 (C1-23)
Split Shaft / Tcase Input	G	K92A7	6018 (C1-65)
Auxiliary Engine Shutdown	H	K92A1	6019 (C1-39)
Remote Pedal Activation Switch	J	K92A19	6019 (C1-14)
Plug	K		

Wiring Diagram for 12VGA Transfer Case Speedo Disable Function

5.1.1.8. 12VGA: Auxiliary Tachometer – Wiring Diagram:



12VGA with N13/A26			
Function (Description)	Connector 4705 Cavity	Circuit Number	Engine ECM Pin Location
Voltage PTO (12V 1AMP Source)	A	K92A15	
Preset PTO Enable	B	K92A11	6019 (C1-66)
Variable PTO Enable	C	K92A12	6019 (C1-90)
Preset 1 (Set)	D	K92A13	6019 (C1-16)
Preset 2 (Resume)	E	K92A9	6019 (C1-40)
Speedometer	F	K92A10	6019 (C1-78)
Tachometer	G	K92A8	6019 (C1-77)
Multifunction Indicator Light	H	K92A16	6019 (C1-46)
Engine Running Output	J	K92A17	6019 (C1-21)
Plug	K		

12VGA with N13/A26			
Function (Description)	Connector 4706 Cavity	Circuit Number	Engine ECM Pin Location
Remote Pedal Enable	A	K92A5	6018 (C1-56)
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Signal Ground	C	K92A3	6018 (C1-63)
Engine Warning Lamp	D	K92A14	6018 (C1-22
Red Stop Lamp	E	K92A2	6018 (C1-20)
Wait To Start Light	F	K92A6	6018 (C1-23)
Split Shaft / Tcase Input	G	K92A7	6018 (C1-65)
Auxiliary Engine Shutdown	H	K92A1	6019 (C1-39)
Remote Pedal Activation Switch	J	K92A19	6019 (C1-14)
Plug	K		

Truck Equipment Manufacturer (TEM) Supplied

International Supplied 12VGA Wire Harness

Wiring Diagram for 12VGA Auxiliary Tachometer Function

5.1.1.9. 12VGA: Auxiliary Speedometer - Wiring Diagram:

12volt
Power Source

Transfer Case
Status Switch

12VGA with N13/A26			
Function (Description)	Connector 4705 Cavity	Circuit Number	Engine ECM Pin Location
Voltage PTO (12V 1AMP Source)	A	K92A15	
Preset PTO Enable	B	K92A11	6019 (C1-66)
Variable PTO Enable	C	K92A12	6019 (C1-90)
Preset 1 (Set)	D	K92A13	6019 (C1-16)
Preset 2 (Resume)	E	K92A9	6019 (C1-40)
Speedometer	F	K92A10	6019 (C1-78)
Tachometer	G	K92A8	6019 (C1-77)
Multifunction Indicator Light	H	K92A16	6019 (C1-46)
Engine Running Output	J	K92A17	6019 (C1-21)
Plug	K		

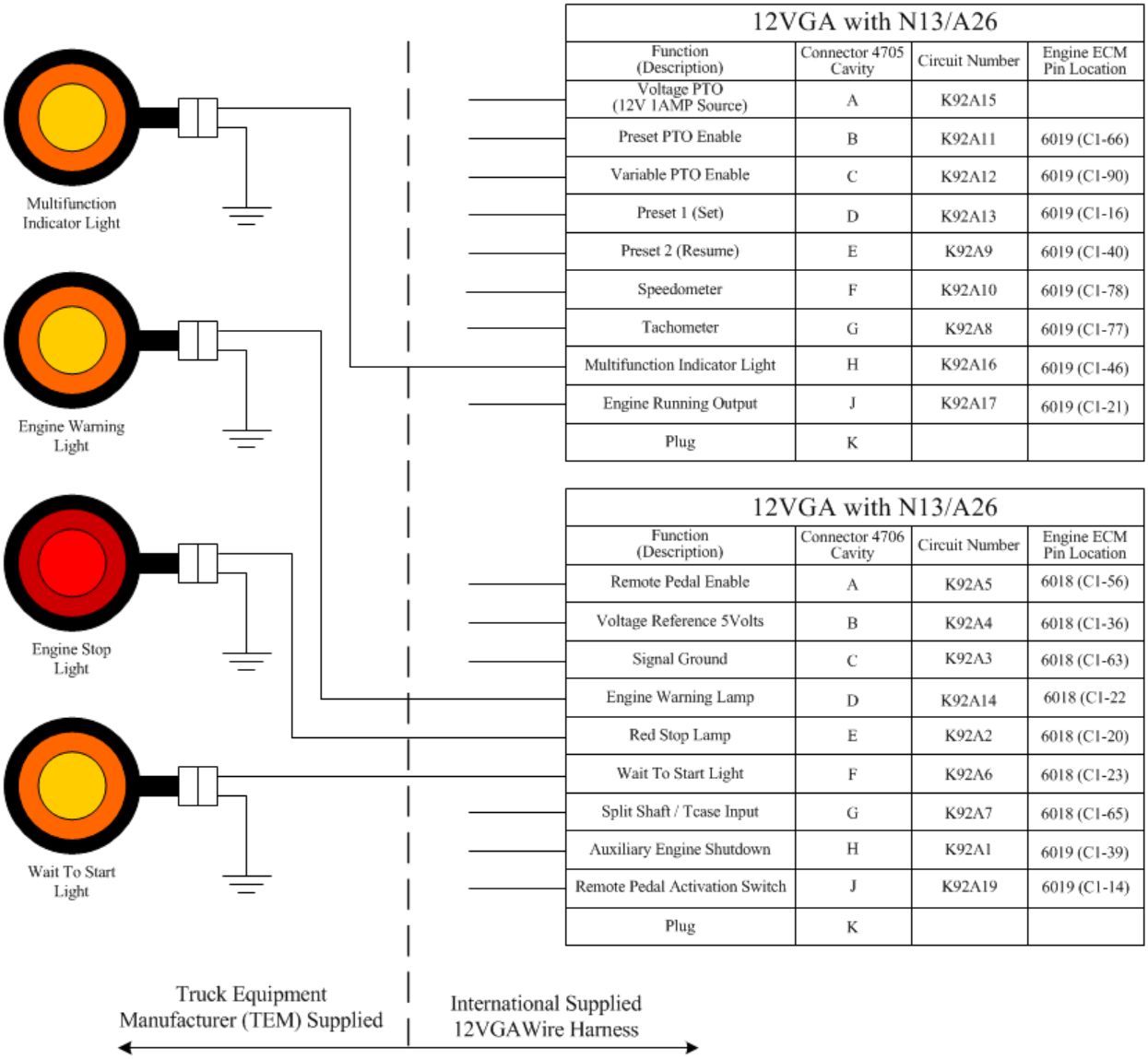
12VGA with N13/A26			
Function (Description)	Connector 4706 Cavity	Circuit Number	Engine ECM Pin Location
Remote Pedal Enable	A	K92A5	6018 (C1-56)
Voltage Reference 5Volts	B	K92A4	6018 (C1-36)
Signal Ground	C	K92A3	6018 (C1-63)
Engine Warning Lamp	D	K92A14	6018 (C1-22
Red Stop Lamp	E	K92A2	6018 (C1-20)
Wait To Start Light	F	K92A6	6018 (C1-23)
Split Shaft / Tcase Input	G	K92A7	6018 (C1-65)
Auxiliary Engine Shutdown	H	K92A1	6019 (C1-39)
Remote Pedal Activation Switch	J	K92A19	6019 (C1-14)
Plug	K		

Truck Equipment
Manufacturer (TEM) Supplied

International Supplied
12VGA Wire Harness

Wiring Diagram for 12VGA Auxiliary Speedometer Function

5.1.1.10. 12VGA: Engine “Warning”, “Stop”, “Wait to Start” Lamps - Wiring Diagram:

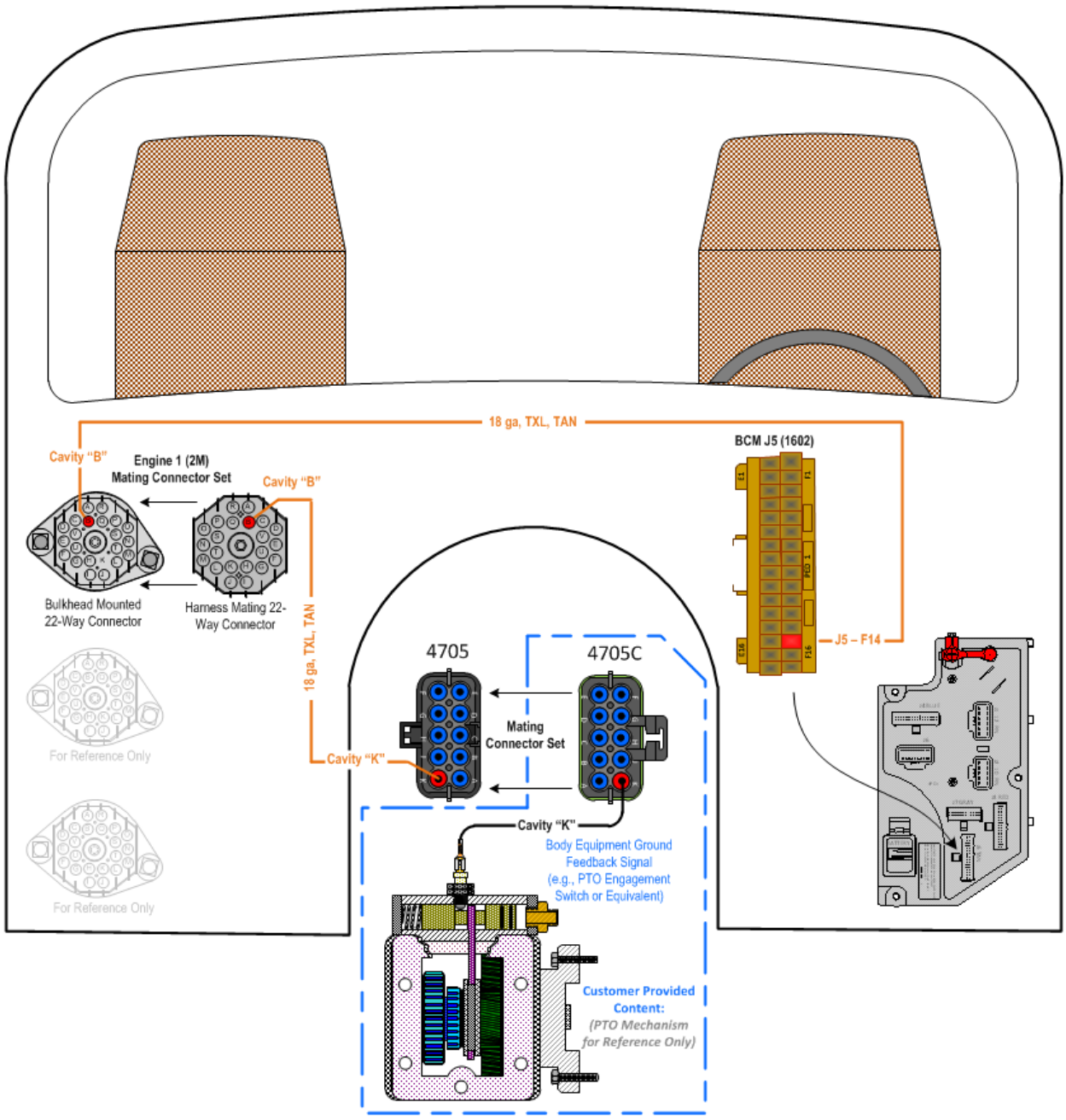


12VGA with N13/A26			
Function (Description)	Connector 4705 Cavity	Circuit Number	Engine ECM Pin Location
Voltage PTO (12V 1AMP Source)	A	K92A15	
Preset PTO Enable	B	K92A11	6019 (C1-66)
Variable PTO Enable	C	K92A12	6019 (C1-90)
Preset 1 (Set)	D	K92A13	6019 (C1-16)
Preset 2 (Resume)	E	K92A9	6019 (C1-40)
Speedometer	F	K92A10	6019 (C1-78)
Tachometer	G	K92A8	6019 (C1-77)
Multifunction Indicator Light	H	K92A16	6019 (C1-46)
Engine Running Output	J	K92A17	6019 (C1-21)
Plug	K		

12VGA with N13/A26			
Function (Description)	Connector 4706 Cavity	Circuit Number	Engine ECM Pin Location
Remote Pedal Enable	A	K92A5	6018 (C1-56)
Voltage Reference 5Volts	B	K92A4	6018 (C1-36)
Signal Ground	C	K92A3	6018 (C1-63)
Engine Warning Lamp	D	K92A14	6018 (C1-22
Red Stop Lamp	E	K92A2	6018 (C1-20)
Wait To Start Light	F	K92A6	6018 (C1-23)
Split Shaft / Tcase Input	G	K92A7	6018 (C1-65)
Auxiliary Engine Shutdown	H	K92A1	6019 (C1-39)
Remote Pedal Activation Switch	J	K92A19	6019 (C1-14)
Plug	K		

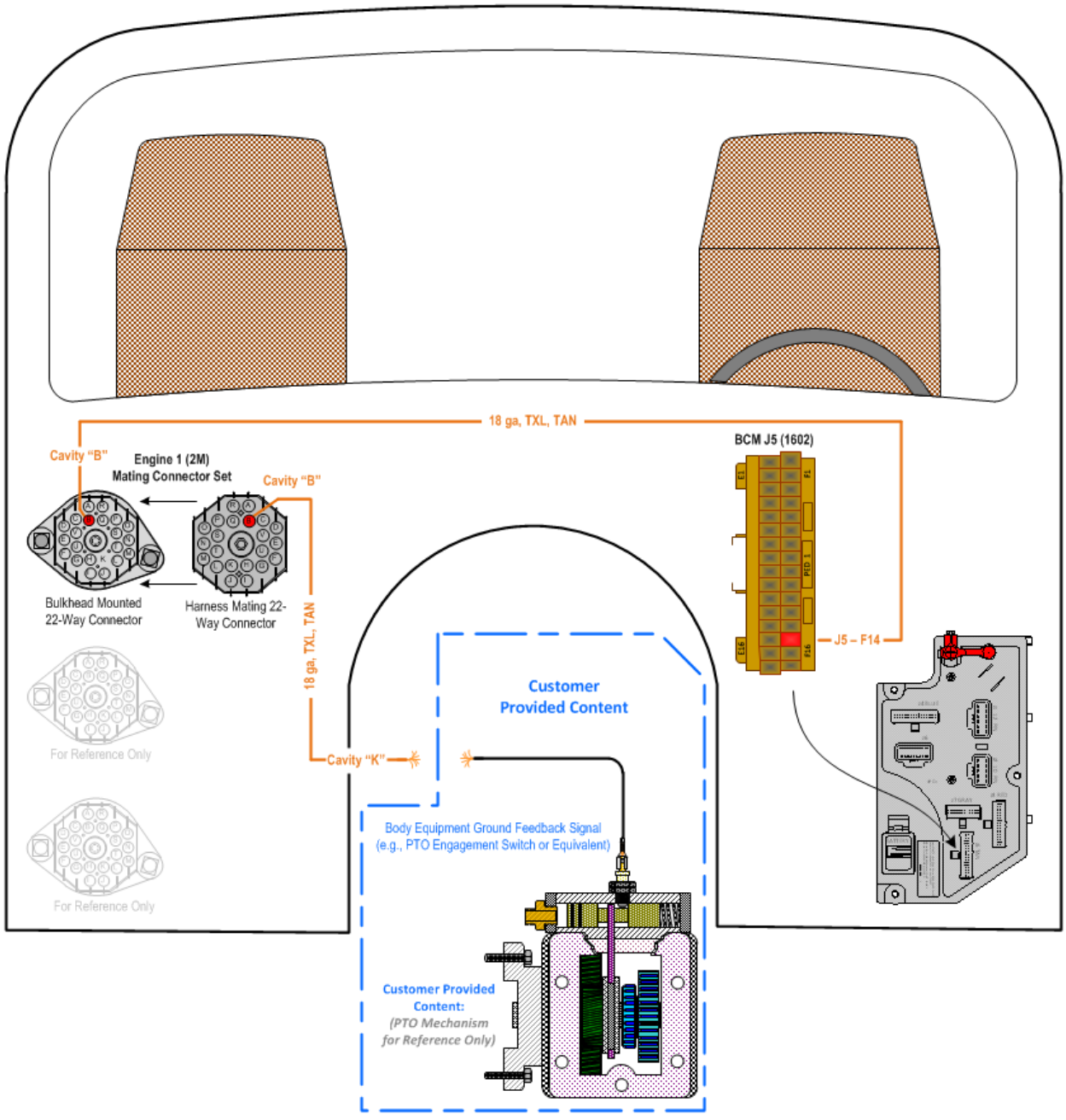
Wiring Diagram for 12VGA Various Engine Indicator Lamp Functions

5.1.1.11. 12VGA “PTO” Feedback Signal - Wiring Diagram:



OEM Provided “PTO” or Equivalent Feedback Signal Wiring

5.1.1.12. Body Builder Added “PTO” Feedback Signal – Wiring Diagram:



Customer Added “PTO” / Equivalent Feedback Signal Wiring

Parts Associated with This Feature:

PART NUMBER	DESCRIPTION
INTERNATIONAL 96-WAY CONNECTOR ENGINE CONTROLLER	
3952655C1	96-WAY ECM CONNECTOR BODY
3687804C1	WIRE TERMINAL 20-GUAGE (GOLD PLATED)
8-WAY CONNECTOR 4705 (ENGINE EXTENTION HARNESS)	
3538634C1	8-WAY CONNECTOR BODY
3538636C1	8-WAY CONNECTOR LOCK
1667742C1	WIRE TERMINAL 18-GAUGE
3568570C1	WIRE TERMINAL SEAL 18-GAUGE
2025431C1	CONNECTOR CAVITY PLUG
8-WAY MATING CONNECTOR FOR 4705C (BODY BUILDER HARNESS)	
3538635C1	8-WAY CONNECTOR
3538636C1	8-WAY CONNECTOR LOCK
1661875C1	WIRE TERMINAL 18-GAUGE
3568570C1	WIRE TERMINAL SEAL 18-GAUGE
2025431C1	CONNECTOR CAVITY PLUG
22-WAY CONNECTOR ENGINE 1 BULKHEAD (2M)	
593389C1	22-WAY CONNECTOR BODY
598333C1	2-WAY CONNECTOR LOCK
587576C1	WIRE TERMINAL 18-GAUGE
3517771C1	WIRE TERMINAL SEAL 18-GUAGE
587579C1	CONNECTOR CAVITY PLUG
22-WAY HARNESS CONNECTOR FOR ENGINE 1 BULKHEAD (2M)	
598332C1	2-WAY CONNECTOR BODY
598333C1	2-WAY CONNECTOR LOCK
587578C1	WIRE TERMINAL 18-GUAGE
3517771C1	WIRE TERMINAL SEAL 18-GUAGE
587579C1	CONNECTOR CAVITY PLUG
BODY CONTROL MODULE J5 CONNECTOR PARTS	
3522073C1	32-WAY BODY CONTROLLER J5 (1602) CONNECTOR WIRE TERMINAL 18/20-GAUGE

Parts Associated with 12VGA Feature

How to Test This Feature:

This feature is added and tested by using Navistar's Body Control Module and Engine Control Module software programming and diagnostic tools:

- Diamond Logic Builder (DLB) supports the Navistar Body Control Module
- Navistar Engine Diagnostics (NED) support the Navistar Engine Control Module

6. Secondary Road Speed Limit

6.1. Datalink Control for Secondary Road Speed Limit Control: J1939 DATALINK ENGINE CONTROL for Navistar A26 Engines.

Extended Description:

Physical Description: The implementation of the system consists of Body Control Module (BCM), Engine Control Module (ECM) and an optional body builder installed proximity sensor. The sensor is hardwired to BCM connector J5 (1602) pin F-11.

This feature is for use on vehicles with the following accessories:

- Snow plow
- Salt spreader
- Hi-rail
- Street sweeper
- Dump body
- Line painter
- X-ray unit

Functional Description: The Secondary Road Speed Limit is a customer requested feature that uses an optional proximity sensor or Advanced Logic signal to limit vehicle speed to a Programable Parameter (PP) setting when plow, buckets, bins, etc. are opened, lowered, or activated.

The Secondary Road Speed Limit feature limits vehicle speed to a set value. The feature is triggered by the state change of the proximity sensor or Advanced Logic signal input to the BCM. When the BCM detects the state change and the Interlock conditions are met, the BCM transmits the sensor status via SPN 1653 to ECM.

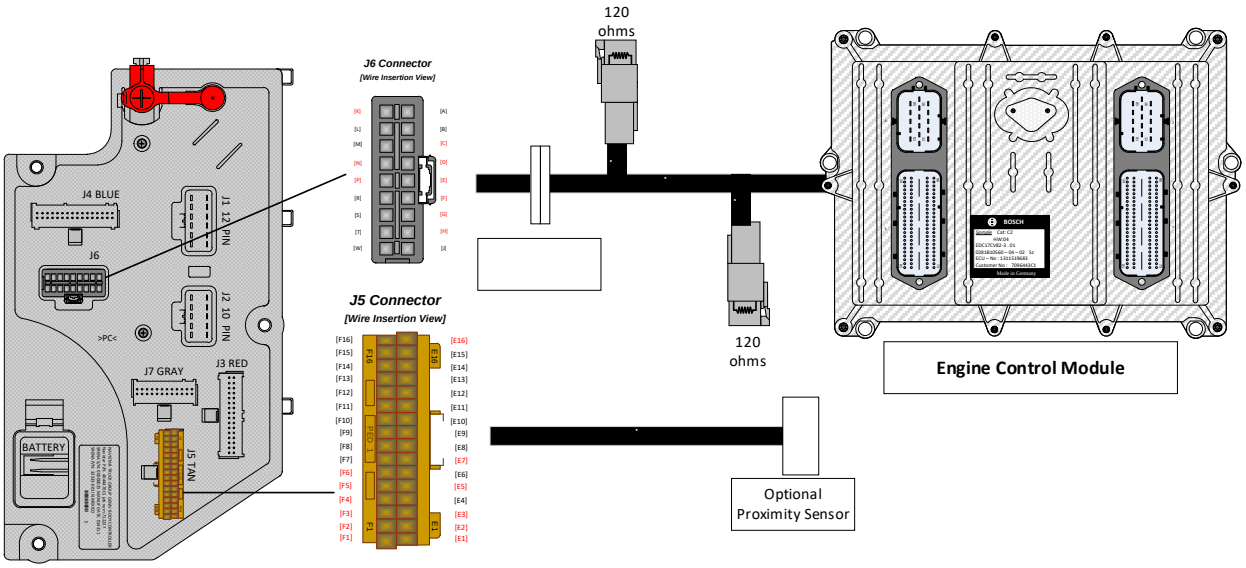
Secondary Road Speed limit activation is controlled by the ECM when BCM provided input is active and Secondary Road Speed Limit Enable (79310) is Enabled. The ECM will deactivate engine throttling until vehicle speed is below the Secondary Road Speed Limit (79330) set speed (24.85 - 74.56 mph).

If applicable, the body builder who installs the accessory (dump bed, snow plow, etc.) will customize the sensor error reactions.

Instructions: The implementation of the datalink control function for secondary road speed limit requires the following:

- Customer mounted proximity sensor sending ground to BCM connector J5 (1602) pin F-11 when plow, dump, etc. is active, or a Diamond Logic Builder (DLB) Advanced Logic signal.
- BCM software feature 0597525 enabled using DLB software.
- ECM programmable parameters ID (PPID) must be appropriately set in accordance with the customer's requirements using Navistar Electronic Service Tool. See "Engine Control Module PPID table" below for applicable settings.

System Block Diagram:



BCM Software Feature Code:

- 0597525 - BCM PROG, SEC ROAD SPEED LIMIT A26

This feature code enables BCM communication of the following CAN messages:

o *Send Vehicle_Limiting_Speed_Governor_Enable_Switch – PGN 57344 SPN 1653*

Engine Control Module PPID Table

ECM Secondary Road Speed Limit Software Programmable Parameter Identification (PPID):

PPID	Description	Recommended Value
79310	Secondary Road Speed Limit Enable	As desired by the customer
79330	Secondary Road Speed Limit	Customer Chosen

How to Test This Feature

- Verify software feature 0597525 is enabled in DLB software.
- Verify ECM PPIDs are set correctly.
- Depending on BCM input configured, verify one of the following:
    - Proximity sensor is pinned correctly to BCM connector J5 (1602) pin F-11 and sensor wires are not open or short to ground.
    - Advanced logic signal is programed correctly as BCM input.
- Road test vehicle with installed accessory in active and inactive states to verify vehicle speed is properly limited.

7. Appendix - General Electrical Section:

Description - International vehicle electrical systems are becoming increasingly complex with the addition of a BC, electronic engine and transmission controls, electronically driven instrument gauges, and Antilock Brake Systems (ABS) to name a few. While most systems still operate on battery voltage (12 volts), some systems operate at as high as 107 volts (electronic fuel injection) and as low as five (5) volts (electronic engine controls).

International publishes Electrical Circuit Diagram Manuals for all its models. Body builders and installers should refer to these manuals before connecting body lights and accessories to the vehicle electrical system to assure that circuits chosen are both appropriate and not overloaded. Modifications not defined in the circuit diagram book are not to be made to the vehicle electrical/electronic control systems without first contacting International for assistance at its Tech Central Department, telephone 1-800-336-4500.

7.1. Color Code System for International® Truck Wiring:

Wiring Color Code System:

COLOR	DESCRITION
RED	ALTERNATOR/BATTERY FEEDS
PINK	IGNITION FEEDS
LIGHT BLUE	ACCESSORY FEEDS
YELLOW	HEADLIGHT SYSTEM (DAYTIME RUNNING LIGHTS, FOG, HI-BEAM, ETC.); DATA LINK J1939 (+)
DARK BLUE	INTERIOR LIGHTS (DOME, PANEL, ETC.); DATA LINK J1708 (+)
BROWN	EXTERIOR LIGHTS (TAIL, MARKER, CLEARANCE, ETC.)
ORANGE	EXTERIOR LIGHTS (TURN, BACK-UP, ETC.)
GRAY	ENGINE / CHASSIS SYSTEMS (FUEL SOLENOID, HORN, ETC.); DATA LINK J1708 (-)
TAN	ENGINE / CHASSIS MONITORING SYSTEMS (GAUGES)
GREEN	DATA LINK J1939 (-)
LIGHT GREEN	DRIVER AID SYSTEMS (WINDSHIELD WASHER, HEATER, ETC.)
VIOLET	ENGINE CONTROLS - ELECTRONIC
WHITE	GND
BLACK	BATTERY GND CABLES OR COMPUTER DATA LINK SYSTEMS
NOTE: THE WIRING IN MULTIPLE CONDUCTOR JACKETED CABLE DOES NOT FOLLOW THE ABOVE COLOR CODE SYSTEM. SEE THE ELECTRICAL CIRCUIT DIAGRAM MANUAL FOR SPECIFIC COLORS AND CIRCUIT NUMBERS USED WITH EACH SYSTEM. USE ONLY “GXL", “SXL" OR “TXL" INSULATED WIRE. CRIMP AND SOLDER ALL CONNECTIONS.	

Wiring Color Code Table

7.2. Recommended Circuit Protection:

Circuit Protection by Wire Gauge:

WIRE GAUGE	PROTECTIVE DEVICE SIZE	MAXIMUM CURRENT (AMPS)
18-GUAGE	10 AMP FUSE/ CIRCUIT BREAKER	8 A
16-GUAGE	15 AMP FUSE/ CIRCUIT BREAKER	12 A
14-GUAGE	20 AMP FUSE/ CIRCUIT BREAKER	16 A
12-GUAGE	25 AMP FUSE/ CIRCUIT BREAKER	20 A
10-GUAGE	30 AMP FUSE/ CIRCUIT BREAKER	24 A
8-GUAGE	12 GAUGE FUSIBLE LINK	80 A
6-GUAGE	10 GAUGE FUSIBLE LINK	108 A
4-GUAGE	2–12 GAUGE FUSIBLE LINK	160 A
CAUTION - WIRE GAUGE IS DESIGNED TO MATCH FUSE / CIRCUIT BREAKER RATING. DO NOT INCREASE THE SIZE OF A CIRCUIT BREAKER OR FUSE. TO DO SO COULD CAUSE WIRING TO OVERHEAT AND BURN.		

Circuit Protection by wire Gauge Table

Circuit Protection Devices - Fuses and Circuit Breakers:

PART NUMBER	DESCRIPTION	SIZE	COLOR
CIRCUIT BREAKERS			
3536177C1	TYPE III — MANUAL RESET	7.5 A	BROWN
3536178C1	TYPE III — MANUAL RESET	10 A	RED
3536179C1	TYPE III — MANUAL RESET	15 A	BLUE
3536180C1	TYPE III — MANUAL RESET	20 A	YELLOW
3536181C1	TYPE III — MANUAL RESET	25 A	WHITE
3536182C1	TYPE III — MANUAL RESET	30 A	GREEN
3529688C1	TYPE III - MINI	20 A	YELLOW
3529690C1	TYPE III - MINI	30 A	GREEN
THERMAL FUSES			
3534208C1	MINI — SAE J2077	5 A	TAN
3546109C1	MINI — SAE J2077	7.5 A	BROWN
3534209C1	MINI — SAE J2077	10 A	RED
3534210C1	MINI — SAE J2077	15 A	BLUE
3534211C1	MINI — SAE J2077	20 A	YELLOW
3534212C1	MINI — SAE J2077	25 A	NATURAL
3534213C1	MINI — SAE J2077	30 A	GREEN
131224C1	AUTOFUSE	20 A	YELLOW
571691C1	AUTOFUSE	30 A	GREEN
INLINE SOCKET AND CABLE FOR CIRCUIT BREAKER/FUSE			
1676841C91	INLINE SOCKET WITH CABLE	20 A	BLACK
1682115C91	INLINE SOCKET WITH CABLE	30 A	BLACK

Fuse and Circuit Breaker Protection Device Table

7.3. Electrical Components Commonly Used by Equipment Installers:
Components Table:

PART NUMBER	DESCRIPTION
AT FUSE BLOCK	
3536294C1	TERMINAL, FUSE BLOCK (18/20 GAUGE)
3573312C1	TERMINAL, FUSE BLOCK (14/16 GAUGE)
3573311C1	TERMINAL, FUSE BLOCK (10/12 GAUGE)
AT TAIL LIGHTS	
589390C1	SEAL, WIRE - (BLUE) .165-.138 O.D. CABLE (12-14 GAUGE)
589391C1	SEAL, WIRE - (GRAY) .137-.111 O.D. CABLE (14-16 GAUGE)
1652325C1	SEAL, WIRE - (LT GN) .110-.080 O.D. CABLE (16-20 GAUGE)
1661375C2	BODY CONNECTOR, 5-WAY MALE
1661377C1	TERMINAL, FEMALE - 14/16 GAUGE
1661376C1	LOCK, 5-WAY MALE CONNECTOR
1677851C1	BODY CONNECTOR, 5-WAY FEMALE
1671609C1	TERMINAL, MALE - 14/16 GAUGE
1677914C1	LOCK, 5-WAY FEMALE CONNECTOR
587579C1	SEALING PLUG (FOR EMPTY CONNECTOR CAVITIES)
NOTE - ANY UNUSED CIRCUIT CAVITIES MUST BE PLUGGED WITH SEALING PLUGS PROVIDED WITH CHASSIS HARNESS.	

Commonly Used Electrical Integration Small Components Table

7.4. Wire Splicing and Termination - Standard Terminals and Splices:

Standard Terminals

1. Cut the cable just before the insulation wings on the terminal.

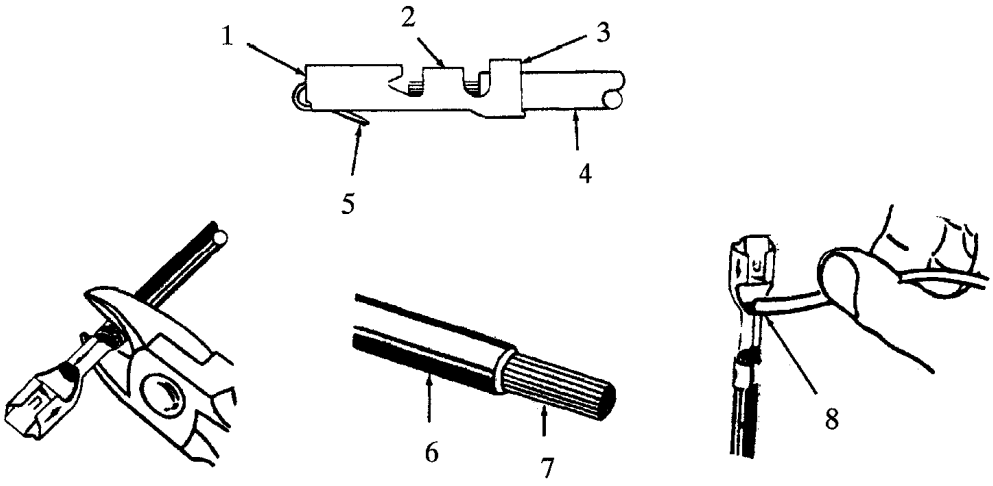
2. Remove the insulation being careful not to cut any of the wire strands.

3. Position cable in the new terminal.

4. Hand crimp the core wings first, then the insulation wings.

NOTE - Always use the recommended crimp tool for each terminal. A detailed crimp chart is included in the repair kit.

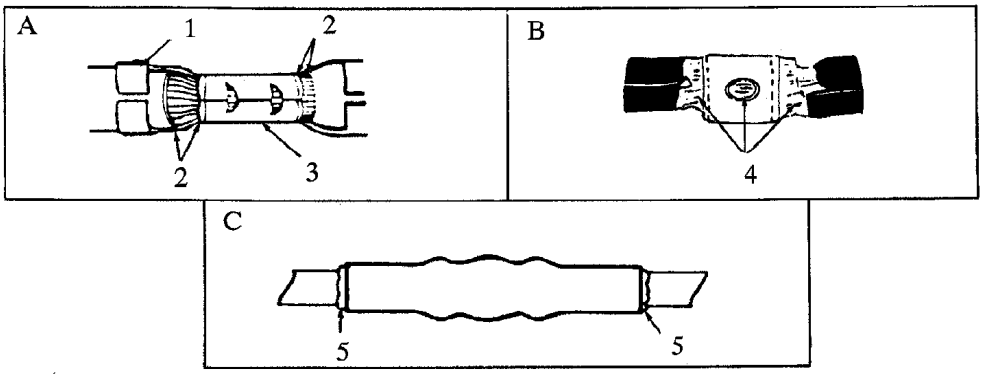
5. Solder all hand crimped terminals and electrically check for continuity.



Standard Terminal

1. MATING END
2. CORE WINGS
3. INSULATION WINGS
4. CABLE
5. LOCK TANG
6. INSULATION
7. WIRE STRANDS
8. SOLDER

Splice Inspection:



Splice Inspection

A. TERMINAL APPLICATION
1. INSULATION CRIMP
2. WIRE STRANDS VISIBLE IN THIS AREA
3. CORE CRIMP
B. SOLDER APPLICATION
4. GOOD SOLDER APPLICATION
C. CRIMP AND SEAL HEAT APPLICATION

5. EVIDENCE OF GLUE

Splice Clip Installation

NOTE - A new clip must be located a minimum of 1.5 inches (40 mm) from a connector, sleeve or another clip.

1. Cut off the old clip or bad section of wire.

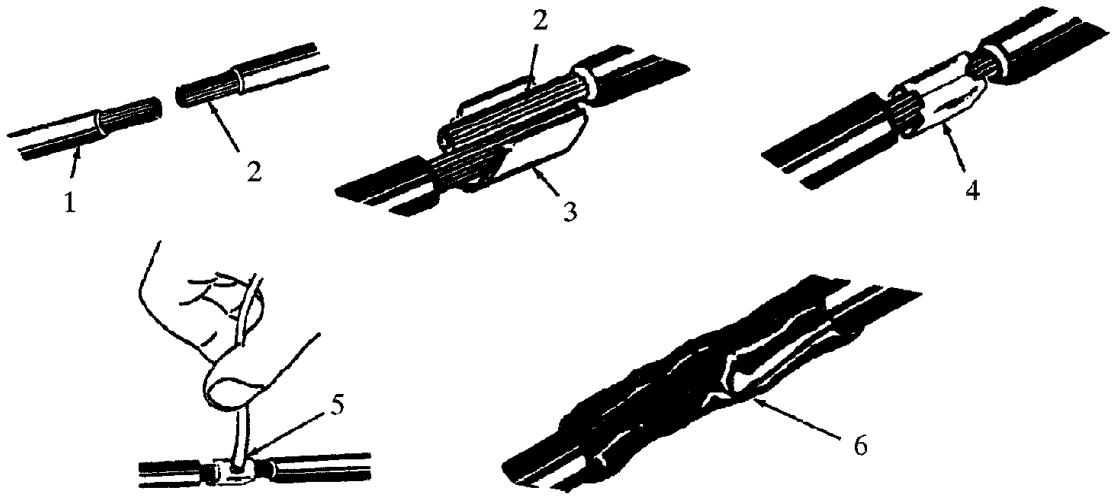
2. Remove the insulation being careful not to cut any of the wire strands.

3. Install the proper clip on the wire strands.

4. Hand crimp the clip until securely fastened.

5. Solder the clip and electrically check for continuity.

6. Cover the entire splice with splice tape. Extend the tape onto the insulation on both sides of the splice(s).



Splice Clip Installation

1. INSULATION
2. WIRE STRANDS
3. CLIP (POSITIONED CORRECTLY)
4. CRIMPED CORRECTLY
5. SOLDER
6. TAPE

Crimp and Seal Splice Sleeve Installation:
Parts Information:

Part Number	Description	Quantity
3517501C1	12-10 AWG Splice	2
3517502C1	16-14 AWG Splice	7
3517503C1	22-18 AWG Splice	2
2644000R1	Dual Wall Heat Shrink, 50mm	50

NOTE - A new sleeve must be located a minimum of 1.5 inches (40 mm) from a connector, clip or another sleeve.

1. Cut off the old sleeve or bad section of the wire.

2. Remove insulation being careful not to cut any of the wire strands.

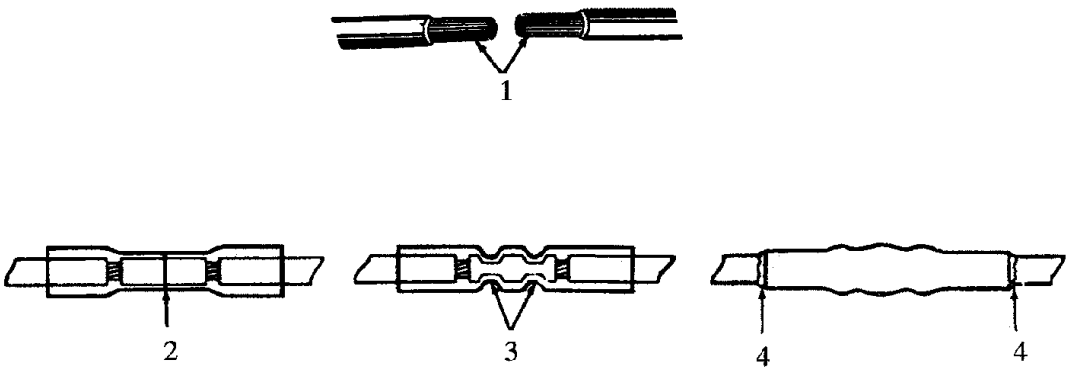
3. Install the proper sleeve on the wire strands, making sure the ends of the wire hit the stop.

4. Hand crimp to the sleeve. Gently tug on the wire to make sure that they are secure.

NOTE - Always use the recommended crimp tool for each sleeve. A detailed crimp chart is included in the Repair Kit.

CAUTION - Use appropriate heat gun. Do not use a match or open flame to heat the sleeve seal.

5. Electrically check the sleeve and wire cable for continuity.

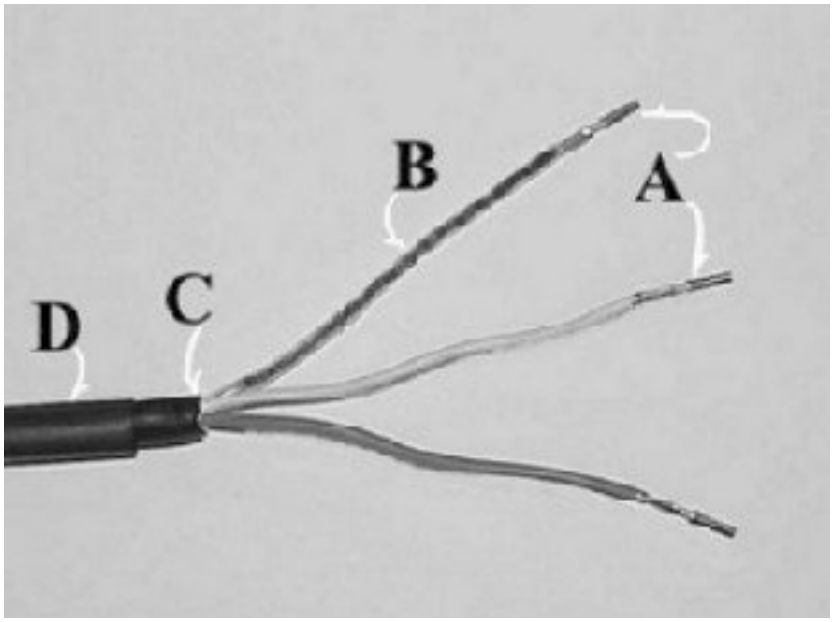


Crimp and Seal Splice Sleeve Installation

1. WIRE STRANDS
2. WIRE STOP
3. CRIMP CONNECTOR
4. EVIDENCE OF GLUE

Data Link Repair:
J1939/11 Shielded Only
Repairs to damaged J1939 circuits should be accomplished using identical types of wiring. Splices should be crimped, soldered and covered with heat shrink. Insure the twist in the wire pair is maintained and that any wire bundles in the engine compartment are shielded and covered with heat shrink.

Wire Repair
This instruction addresses termination and splicing of J1939 wire.



Preparation of J1939 Wire for Connection

1. Strip back (view C) outer shield 3 1/8 in. (76 mm).

2. Strip (view A) green wire and yellow wire 1/4 in. (6.35 mm) being careful not to cut individual strands.

3. Re-twist all three wires if they have separated.

4. Sleeve drain wire (view B) may be soldered to aid in sleeving.

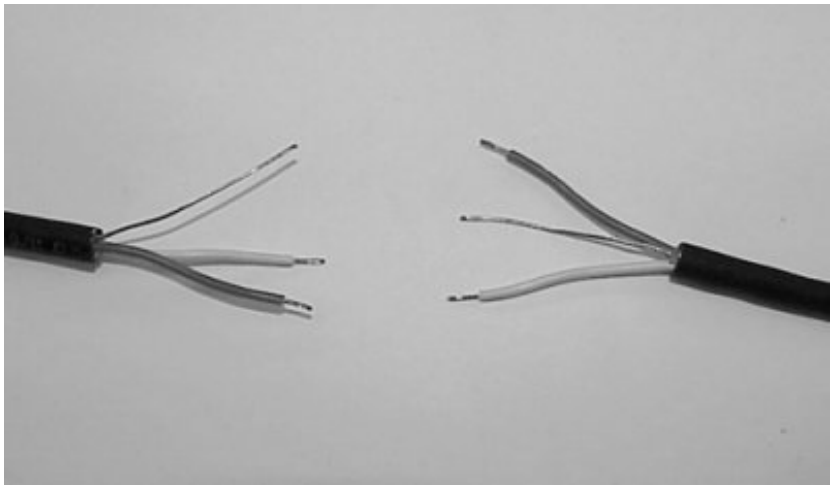
5. Install terminals on green and yellow wire ends, and crimp.

6. The 1/4" heat shrink tube (view D) will be shrunk later after the wires have been inserted into the crimp connector.

Wire Splicing

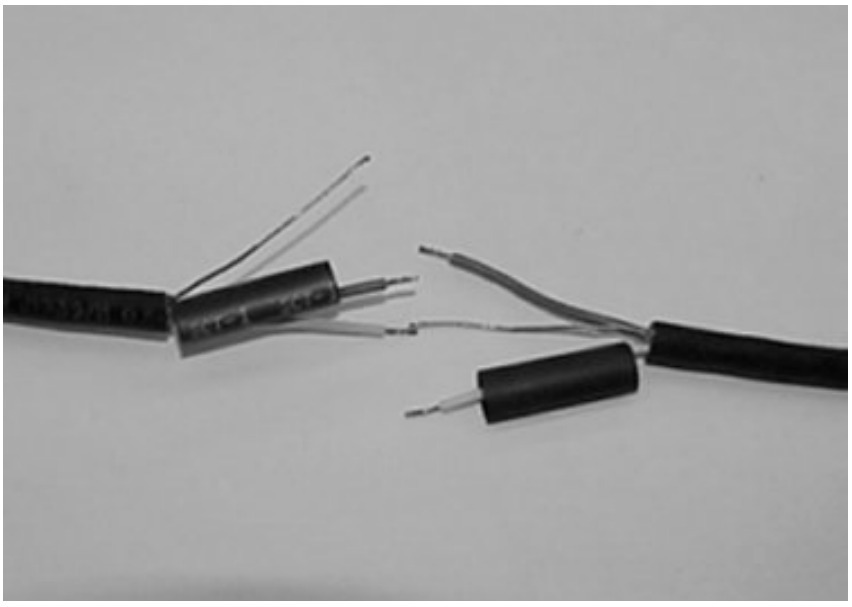
1. Strip wire ends 1/4 inch.

2. Re-twist any loose wires.



Re-Twist Any Loose Wires

3. Slide 2-inch pieces of heat shrink tube over wire for later use.



Put Heat Shrink Tube Over Each Wire

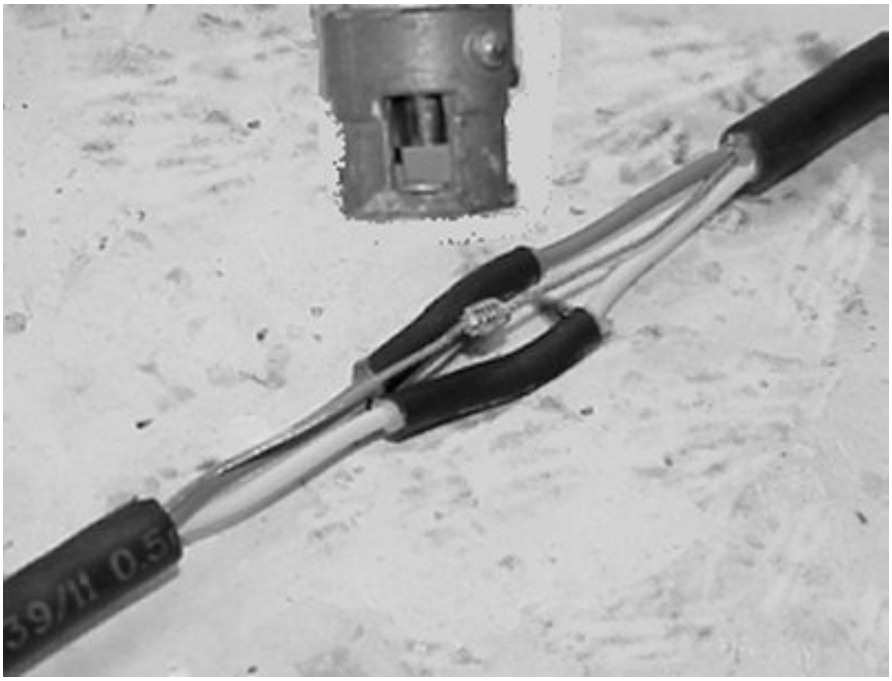
4. Put heat shrink tube over each wire.

5. Insert ends of wires into splice joint and crimp.

6. Solder the wires and crimp joint together.

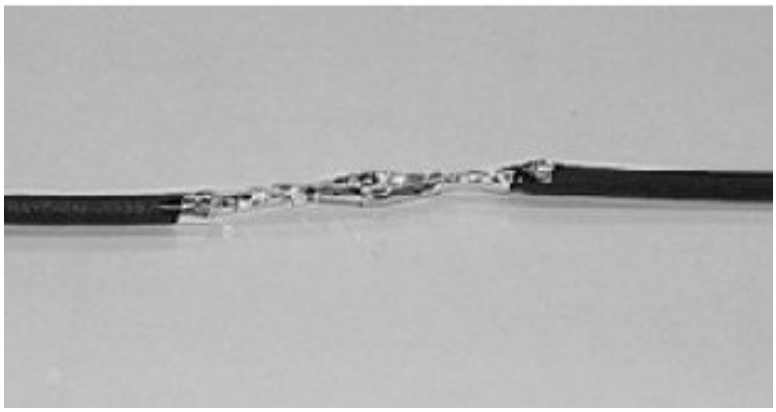
Solder Wires Together

7. Center heat shrink tube over splice and shrink.



Center Heat Shrink Tube Over Splice

8. Wrap wires with foil tape. Maintain at least 1/2 wrap overlap.



Center Heat Shrink Tube Over Cable

9. Center heat shrink tube over the splice and shrink.

Center Heat Shrink Tube Over Cable

J1939 HIGH SPEED DATA LINK CABLE (SAE J1939/15):
The information in this section applies to all severe and medium vocational series models.

Performing the proper repairs or modifications of the cable is critical to the integrity and performance of the vehicle systems. (For repair procedure see Electrical Troubleshooting Guide - S08250 or Data Link Repair in this manual.) This information based on SAE J1939/15 and TMC RP 142.

These instructions are intended for modifications that meet the SAE spec; i.e., no internal resistor. When extending the backbone, the proper materials must be used. The data link cable consists of a twisted pair of insulated wires and are covered by an insulating jacket. The data link cable must meet the SAE - specified characteristic impedance of 120-ohms. Never splice regular automotive type wire such as GXL, SXL, TXL into the data link cable. Use data link cable furnished by Raychem, part number 2021D0309.

The backbone is the main part of the cable. This is terminated at each end with a 120-ohm resistor. When adding a device, the backbone must be extended. This is done by removing the resistor, inserting the backbone extension, then plugging the resistor and the device into the extension.

J1939:
J1939 is a high-speed serial communications data link. The system requires two resistor caps. The first resistor cap for Body Builder J1939 currently starts in the engine compartment. The second resistor cap ends where the last module is placed. The wire between these two resistors is called the backbone. The backbone cannot be longer than 131.2 feet (40m). A module can tap into the backbone. This point is called the Node. The distance between two nodes cannot be less than 3.9 inches (0.1m). The cable length from the node to the module cannot be longer than 9.8 feet (3m).

7.5. HIGH VOLTAGE CIRCUITS (GREATER THAN 50 VOLTS) ON INTERNATIONAL TRUCKS AND BUSES:

WARNING - To avoid property damage, personal injury, or death, refer to the manufacturer's service information before working on any high voltage equipment. High voltage circuits and components contain voltage levels that may cause equipment damage, electrical shock, and/or electrocution if handled incorrectly.

Only a trained technician may perform service inside high voltage components. When working around or maintaining high voltage circuits, please seek high voltage training.

NOTE - The intent of this section is to provide some basic guidelines when working on or around International vehicles that are equipped with high voltage electrical equipment and circuits. For specific instructions, maintenance, or service information on specific equipment or options, refer to the service manuals for the specified truck models and component(s). It IS NOT the intent of this section to provide detailed service instructions for high voltage equipment and circuits.

High voltage systems require the maintainer to be familiar with two types of electrical systems.

DC (Direct Current)

Most DC systems on today's trucks use 12volt negative GND. Some systems can store DC electricity in batteries with operating voltages as high as 600 DC volts.

· **AC (Alternating Current)**

The main difference between AC and DC systems is that the voltage levels in DC systems remain constant while the voltage levels in AC systems are constantly changing. When measuring an AC system, it is important to know that the average voltage is zero, and that is why ***A VOLTMETER SET TO DC WILL NOT INDICATE THE PRESENCE OF AN AC VOLTAGE WHEN CONNECTED TO AN AC CIRCUIT!***

High voltage can be lethal. Always refer to the manufacturer of the high voltage component when maintenance or repairs are needed. In most cases, diagnostics and repair are performed after the high voltage circuits are disabled. If working around or maintaining high voltage circuits, please seek high voltage training.

WARNING - To avoid property damage, personal injury, or death, circuits must be checked using a voltmeter for the presence of both DC and AC voltages. A voltmeter set to DC will not indicate the presence of an AC voltage when connected to an AC circuit! Contacting an unknown AC or DC voltage may cause equipment damage, electrical shock, and/or electrocution.

Only a trained technician may perform service inside high voltage components. If working around or maintaining high voltage circuits, please seek high voltage training.

Understanding High Voltage Equipment and Circuits on International Products: Some examples of high voltage equipment that can be encountered on products are as follows:

— Auxiliary Power Units (APUs)

APUs are basically small diesel-powered generator units that are integrated into the vehicle electrical system. APUs are utilized in combination with inverters and battery chargers. APUs are often set up to automatically start when the electrical management system deems it necessary to maintain battery charge or electrical demand requires it.

NOTE - APU high voltage wiring may NOT be marked for easy identification as high voltage.

— Shore Power

Shore power is a connection from a vehicle to an external 120Volt AC power source. The vehicle is equipped with an exterior receptacle that allows connection to an external “shore” power source.

NOTE - High voltage shore power wiring may NOT be marked for easy identification as high voltage.

— Inverters

Inverters are electronic devices used to change DC (Direct Current) into AC (Alternating Current). Some inverters contain converters that also convert AC to DC for battery charging or running 12V equipment.

NOTE - High voltage wiring for inverters may NOT be marked for easy identification as high voltage.

— Hybrid Electric Vehicles (HEVs)

HEVs combine internal combustion engines with high voltage batteries, electric motors, and inverters to offer higher fuel efficiency and lower emissions without compromising power, range, and convenient fueling of conventional vehicles. Regardless of the HEV design, high electrical voltages and currents are present.

NOTE - The industry standard for high voltage cables is for the cables to be covered in ORANGE CONDUIT.

If orange conduit is observed on a vehicle, please review the safety precautions for that system.

How to Identify High Voltage Circuits:
High voltage circuits are not always connected with large wires. The best way to identify high voltage equipment or circuits is to be familiar with the equipment and circuit diagrams as well as to look for high voltage warning labels and orange conduit. **Inspect the vehicle for any equipment or circuits added after the truck was built (owner/operators may add high voltage components such as inverters or APUs).**

All electrical circuits associated with APUs, shore power, inverters, and HEVs should be considered high voltage. The standard for high voltage cabling on HEVs is orange. APUs, inverters, shore power, and cabin 110/120V outlet wiring may not indicate high voltage by visual inspection (they may not be marked and are NOT orange in color).

Servicing International Products:
The following steps outline the appropriate method to follow to identify and address any maintenance or service on International products with factory-installed high voltage equipment.

1. Complete related training prior to attempting to identify and service any high voltage system.

2. Review the line-set ticket provided with the vehicle or from ISIS and identify all high voltage components. Inspect the vehicle for any equipment or circuits added after the truck was built (owner/operators may add high voltage components such as inverters or APUs that could be live and powering circuits in the vehicle EVEN WITH THE IGN OFF AND THE BATTERIES DISCONNECTED).

3. Refer to manufacturer’s service publications for identified high voltage components.

4. Physically locate high voltage components on the vehicle and disable them according to manufacturer's instructions (some components may require a waiting period or special procedures to discharge the voltage completely).

5. Use Best Work Practices (see below) when performing work on electrical systems.

Best Work Practices:

WARNING - To avoid personal injury or death, permit only trained responsible and capable persons to operate or maintain the equipment. Carelessly operating or neglecting maintenance despite the safe design of any vehicle and its high voltage equipment may result in personal injury or death.

The danger of injury through electrical shock is possible whenever electrical power is present. Most fatal injuries result from high-voltage exposure; however, people can sustain severe injuries from low voltage power if it has a high current flow.

- Be aware of ALL high voltage equipment on the vehicle; review line-set/build ticket and the owner and service manuals of high voltage equipment **BEFORE** starting any work.
- When working on this equipment, remain alert at all times. Never work on the equipment when physically or mentally fatigued, and never work alone near high voltage equipment.
- Always stand on an insulated, dry surface when working on any electrical circuit. Do not handle any kind of electrical device while standing in water, while barefoot, or while hands or feet are wet.
- Always work in an adequately illuminated area.
- Always use appropriate protective equipment: insulated gloves, rubber gloves, goggles/face shield, safety shoes, protective clothing, and insulated tools when working on electrical components/circuits of the vehicle.
- Never wear jewelry when working on this equipment. Jewelry can conduct electricity resulting in electric shock or burns and may get caught in moving components causing injury.
- When working on vehicles that have high voltage devices or equipment, use appropriate alerting techniques in plain view to warn people that may be in the general area and to prevent inadvertent activation of any disabled high voltage circuit(s) during service: safety signs, safety symbols, tags, barricades, cones, etc.
- Keep a fire extinguisher close by at all times. Extinguishers rated "ABC" by the National Fire Protection Association are appropriate for use on the electrical system. Make sure the extinguisher is properly charged and be familiar with its use. Consult the local fire department with any question pertaining to fire extinguishers.
- Ensure that the high voltage power, high voltage power generating equipment, and high voltage storage devices are disconnected, locked out, or otherwise disabled BEFORE working on or around the vehicle, its electrical circuits, or components. Unless disabled, Auxiliary Power Units (APUs) may start at any time without warning; when this occurs, the circuits associated with the APU become energized

with potentially lethal high voltage. Some components may require a waiting period or special procedures to discharge the voltage completely.

- Use an appropriate electrical tester and procedures to confirm that the power is disconnected **BEFORE performing any work on or near any high voltage components/circuits**.
- Exercise caution around output circuits even when the input power is off. Parallel power sources and energy storage devices can still be dangerous. Be familiar with the high voltage equipment installed on the vehicle. Some systems contain high voltage condensers that may require time to discharge after power is removed.
- After disconnecting or exposing a high-voltage connector or terminal, insulate it immediately using insulation tape.
- After completion of any electrical work, **BEFORE restoring the power, verify that parts and/ or tools are removed from the work area and that the fasteners are firmly tightened to the specified torque and the connectors are correctly connected.**
- **Voltage can be fatal at levels greater than 60 volts. High voltage can jump a larger air gap than low voltage. If contact is made with high voltage, it may not be possible to simply "let go".**
- **Towing a HEV with its drive wheels on the ground may cause the motor to generate electricity. Consult the operator's/owner's manual for proper towing procedures.**
- **If a high voltage fuse or circuit protection device trips, do not re-energize the circuit until it has been determined that the circuit is safe. See manufacturer's troubleshooting procedures before servicing a high voltage system.**
- Reference OSHA Regulations as necessary and applicable.

Suppression:
International® strongly recommends these electromagnetic devices be electrically suppressed, when adding electromagnetic devices such as relays, magnetic switches, and solenoids.

Unsuppressed electromagnetic devices can generate large voltage spikes which are conducted into the vehicle electrical system. These voltage spikes may adversely affect customer added electronic devices and in some instances may affect International installed electronic components.

When installing electromagnetic devices, specify suppressed units. If suppressed units are not available, diode suppression may be added as shown below:

The following suppressed relays and magnetic switches are available from International.

Suppressed Relays and Magnetic Switches:

PART NUMBER	DESCRIPTION
1691520C91	MAGNETIC SWITCH - CONTINUOUS DUTY (SUPPRESSED) 100 AMP
1693479C91	MAGNETIC SWITCH - INTERMITTENT DUTY (SUPPRESSED) 100 AMP
3519350C1	MICRO RELAY – SPDT (SUPPRESSED), NO – 20 AMP, NC – 10 AMP

Welding Information:
Whenever electric welding is done on any part of the vehicle, it is not necessary to disconnect the International electronic modules in the cab such as the BC, RPM, and the instrument cluster. The welder's GND must be connected as close to the weld as possible. If the vehicle is equipped with an International engine, disconnect both the positive (+) and the negative (-) battery cables including the electronic power feeds prior to electric welding. If it is necessary to weld close to an electronic component, it is recommended that the component be temporarily removed.

Consult manufacturer’s instructions for all other electronic modules such as Allison Transmission, Eaton Auto Shift Transmission, Bendix ABS, Wabco ABS, Cummins Engine, Caterpillar Engine, and Detroit Diesel Engine.

Routing Guidelines:
Any hosing, tubing, battery cable, wiring or electrical harness must not rub on a sharp edge. However, due to the high abrasion resistance of synflex tubing, it is permissible for synflex tubing to contact the lower edge of the frame rail flange when the tubing is making the transition from the outside to down and under the rail. This does not mean that proper clearance or the need for protective wrap is not needed when synflex line contacts sharp edges or threaded fasteners.

Any hosing, tubing, battery cable, wiring or electrical harness must not rub or contact a hot surface. There should be 5" minimum clearance from the exhaust depending on the situation. The further back from the turbo, the less clearance required.

Nothing should rub or contact the copper compressor discharge tubing other than the clamp(s) that support it.

All hosing, tubing, battery cables or electrical harnesses should be supported at least every 18" to 20".

Strap locks used to directly clamp, or support battery cables or main engine wiring harnesses must be no less than 7/16" in width.

Strap locks are not to be used on any bulk hose materials (heater hoses, make-up lines, etc.).

Route and Clip Recommendations:

Heat Source:

HEAT SOURCE	DISTANCE FROM
EXHAUST MANIFOLD TO MUFFLER INLET	6”
AFTER TREATMENT	8”
MUFFLER INLET TO TAIL PIPE OUT	3”
OTHER (EGR DISCHARGE PIPE/HOSE)	1/2”

Electrical Harness:

PROBLEM	REQUIREMENT
SHARP OR ABRADING SURFACE	NO CONTACT
TENSION ALONG HARNESS/WIRES/HOSE	NONE
DISTANCE FROM MOVING PARTS	1”
CONNECTOR CLIPPED TO AVOID DAMAGE	YES
CONNECTORS ARE SEALED	YES
MAX EYELETS PER STUD	3
HARNESS PROTECTED FROM DAMAGE	YES
DRIP POINT FOR HARNESS	YES
DISTANCE OF HARNESS TO FLAMMABLE FLUIDS	1/2”
HARNESS LOCATION TO FLAMMABLE FLUIDS	NOT DIRECTLY UNDER
BATTERY CABLES TO FLAMMABLE FLUIDS	1” MINIMUM
BATTERY CABLE TO CONDUCTIVE SURFACE	1/2” MINIMUM
BATTERY CABLE TIE STRAP	1/2” (250 POUND) WIDE
HARNESS CONTACT WITH METAL SURFACE	NO RELATIVE MOTION
P-CLAMPS – ELECTRICAL	CUSHIONED ONLY
P-CLAMPS FASTENING SUPPORT	NO CANTILEVER
HIGH PRESSURE PIPE/HOSE (>200 PSI)	DON’T CLIP ANYTHING TO THEM
HARNESS THROUGH METAL HOLES	USE GROMMET
FULL ARTICULATED POSITION	OPERATES WITH OUT DAMAGE
CLIPPING FIXED MAX DISTANCE - HARNESS	14”
SPLICES	USE SHRINK WRAP