

# BODY BUILDER INSTRUCTIONS

Mack Trucks



## Electrical Wiring and Connections MD Section 3

### Introduction

This information provides design and function, specification and procedure details for Electrical Wiring and Connections for MACK vehicles.

**Note:** For information on transmission PTO installation and wiring see Section 9 PTO Installation.

**Note:** For information on PTO parameter programming see Section 9 PTO Parameter Programming.

Unless stated otherwise, following a recommendation listed in this manual does not automatically guarantee compliance with applicable government regulations. Compliance with applicable government regulations is your responsibility as the party making the additions/modifications.

Please be advised that the Mack Trucks, Inc. vehicle warranty does not apply to any MACK vehicle that has been modified in any way, which in MACK's judgment might affect the vehicles stability or reliability.

### Contents

- "ISO 26262 Functional Safety Manual", page 2
- "Abbreviations", page 3
- "General Wiring Definitions", page 4
- "Routing and Clipping Guidelines", page 5
- "Electrical Wiring and Connections", page 16
- "Wiring J1939", page 30
- "Data Link System", page 35
- "Road Speed Signal", page 39

# ISO 26262 Functional Safety Manual

## Scope

This section describes the functional safety aspects related to the interface between the vehicle and the body builder equipment.

## Introduction

ISO 26262 is the functional safety standard for road vehicles. Functional safety addresses safety-related functionality implemented in electronics and software. Mack has during 2018 initiated development of new vehicle functions and systems according to ISO 26262 after the standard became applicable to trucks, buses and trailers. Before ISO 26262, Mack followed other internal processes addressing functional safety.

The truck will gradually be made compliant to ISO 26262. However, it will take several years until the complete truck is compliant to the standard.

The status of the truck related to functional safety with regards to ISO 26262 will be described in this status. Continuous updates will be made to reflect the current status of the truck.

The ASILs of the body builder interface characteristics will be documented and it will be described in which sense the interfaces meet the different ASILs. This section will also contain information on requirements and constraints for the usage of the body builder interface. In case-specific safety measures have to be applied by the body builder, this shall be stated in this section.

When a body builder needs anything that is not described or when the ASIL of the characteristic is not according to the body builders expectations, the body builder shall contact Mack for guidance. This section is referenced from other body builder sections when applicable.

## Current status of the truck in relation to ISO 26262

The existing trucks are developed according to Mack internal processes addressing functional safety, applicable before ISO 26262.

Presently no functions or systems in the trucks have been developed according to ISO 26262.

# Abbreviations

- ACC Adaptive Cruise Control
- BOC Back of Cab
- CAN Controller Area Network
- CDS Custom Defined Statement (replaced by DCL)
- DCL DataMax Control Language
- ECM Engine Control Module
- EHT Electronic Hand Throttle
- EMS Engine Management System
- ESC Engine Speed Control
- FMI Failure Mode Identification
- GMT Greenwich Mean Time
- MID Message Identifier (J1587 source)
- PGN Parameter Group Number (J1939 message ID)
- PID Parameter Identification (J1587)
- PID Product Identification (order code)
- PTO power take-off
- PTT2 Premium Tech Tool 2
- SA Source Address (J1939 unit identifier)
- SID Subsystem Identification (J1587)
- SPN Suspect Parameter Number (J1939 parameter)
- SSC Single Speed Control
- TECU Transmission Electronic Control Unit
- VDA Vehicle Data Administration (OEM database)
- VECU Vehicle Electronic Control Unit

# General Wiring Definitions

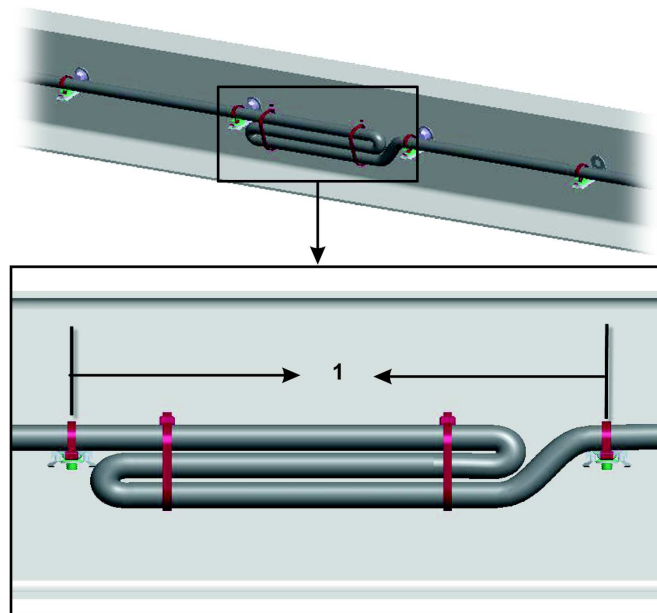
The general wiring definitions provide a standardized list of terminology used in running wires, hoses, and cables throughout the vehicle.

<b>Abrasive Surface</b>	Items capable of causing damage to the routed commodity in a rubbing condition during vehicle operation
<b>AWG</b>	American Wire Gauge
<b>Bundled With</b>	A number of items tied, wrapped, or otherwise held together
<b>Cable Tie</b>	A nylon plastic self-sizing strap, UV resistant, capable of bundling specified load(s) during vehicle operation
<b>Chafing</b>	To wear away by rubbing
<b>Contacts</b>	Items touching each other.
<b>Crimped</b>	A routed commodity that is bent or pressed into ridges
<b>Damaged</b>	An item that differs from its original condition
<b>Drooping</b>	Routed items hanging downward, which are detrimental to safe vehicle operation
<b>Dual Fall</b>	(Pertaining to the Compressor Discharge Line) A high point in the routing of the Compressor Discharge Line (located on the engine) whereby any collected moisture is allowed to fall in two different directions where it is either dissipated by heat or is purged
<b>High Current Electrical Cables</b>	Wire sizes 13 mm sq. (0.5 inches sq.) (6 AWG) and larger
<b>High Nut</b>	Extended clamp length
<b>Kinked</b>	A tight bend, curl, or twist in the routed commodity causing flow to be restricted
<b>Low Current Electrical Cables</b>	Wire sizes 8 mm sq. (0.3-inches sq) (8 AWG) and smaller
<b>Low Nut</b>	Standard clamp length
<b>Material Grade 30</b>	Minimum yield strength of 30,000 psi
<b>Material Grade 50</b>	Minimum yield strength of 50,000 psi
<b>May</b>	Verb typically used in a statement of practice that is a permissive condition and carries no requirement or recommendation. It can be included to alter statements of mandate or recommendation
<b>Not Secured</b>	Items not fastened, bundled or tied
<b>Plastic Conduit</b>	Corrugated or smooth wall tubing used to protect hoses, harnesses, cables, tubing, pipes, etc.
<b>Puncture</b>	Small hole or wound
<b>Routed With</b>	Items taking the same path but not attached to each other (i.e., parallel but separate)
<b>Rubbing</b>	Items that contact each other and have independent movement
<b>Shall</b>	Verb typically used in a statement of required, mandatory or specifically prohibitive practice regarding routing and clipping
<b>Sharp Edge</b>	A surface capable of cutting or piercing the routed commodity during vehicle operation
<b>Should</b>	Verb typically used in a statement of recommended, but not mandatory, practice in typical situations with deviations allowed if Engineering judgment or Engineering study indicates that the deviation is appropriate

<b>Twisted</b>	Distorted from the routed commodities' original shape about it's cross-sectional centerline
<b>Touch</b>	Items that contact each other but do not have relative movement

## Routing and Clipping Guidelines

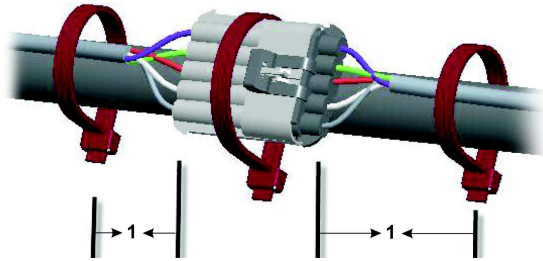
- 1 Brackets used in routing and clipping should be Material Grade 50 or better to ensure sufficient clamp load when sharing joint connections with cross members or other structural members. This applies only to joint connections using a low nut. Brackets of Material Grade 30 are acceptable provided the shared joint is using a high nut. The area of the clip bracket under the bolt head must be a least as large as the bolt head itself.
- 2 Clips that scratch exterior mounting surfaces shall not be used (i.e., barbed/spring type) unless the material is non-corroding (i.e., plastic). Clips must have rust protection.
- 3 Clip sizes should adequately secure the bundle without restricting flow, causing collapse, or preventing relative movement.
- 4 Bundles shall be supported at 24 inches (600 mm) maximum intervals. A cable tie should be used between clip points on bundles with the exception of electrical wiring harness. The electrical wiring harness can have a maximum support distance of 18 inches (450 mm) and a cable tie on bundles between clip points. When air and electrical lines are bundled together, the commodity with the greater cross-sectional area may determine the support spacing. A minimum of two cable ties shall be used between clip points to bundle electrical lines when the larger interval is used.



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1 Support electrical cables every 18 inches (450 mm)

## Support Distances, Continued



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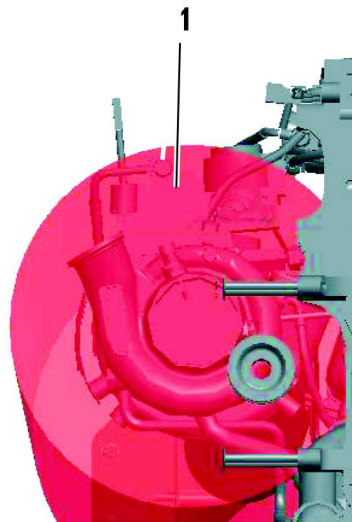
1 Support cables near connectors every 4 inches (100 mm)

- 1 Electrical cables and wiring harnesses are to be secured 4 inches (100 mm) from the wire insertion end of the connector or clipped to the body.
- 2 Routing and clipping on purchased components (i.e., engine/transmission) should not include removing or replacing a bolt(s), nut(s) or screw(s) installed by the manufacturer. In such cases where this is unavoidable, the bolt(s), nut(s) or screw(s) shall be reinstalled to the manufacturer's specifications.
- 3 Bundles should not contact sharp edges of cross members. Contact may occur if it is against a smooth surface, a smooth radiused edge or a coined edge and the bundle is secured to prevent independent movement.
- 4 Hoses, tubing, pipes and electrical conduits shall not rub each other but may touch.
- 5 The fabric braided portion of the compressor discharge hose is compatible to be bundled with all routed air lines.
- 6 The compressor discharge pipe shall be routed independent of all other routing.
- 7 Electric cables/harnesses must not be bundled with fuel or hydraulic lines. The electrical cables/harnesses may be routed parallel with fuel or hydraulic lines, however must remain separated by approved clipping materials. When design control is possible, electrical cables/harnesses will be routed above fuel or hydraulic lines. If fuel or hydraulic lines must route above circuit protected electrical cables /harnesses, the fuel or hydraulic lines will have no fittings or potential leak points above electrical cables/harnesses and shall be minimized to the shortest distance possible over low current electrical cables/harnesses.
- 8 All associated markings on air and electrical harnesses should have a corresponding clipping apparatus.
- 9 Critical clipping locations shall be designated on the component to insure proper placement in the vehicle (i.e., tape).
- 10 Maximum support distance for compressor discharge rigid pipe, 30 inches (762 mm). Pipe to be isolated from support brackets (i.e. rubber isolator).
- 11 Maximum support distance for compressor discharge flex hose, 24 inches (600 mm).
- 12 Compressor discharge line should have a constant fall from compressor to air dryer. A dual fall is allowable provided it occurs on the engine and within 24 inches (600 mm) of the compressor.
- 13 Maximum allowable dip in compressor discharge pipe/hose is one half the outer diameter of the pipe/hose. Preferred routing should have no dips in any of the routings. This is to avoid line blockage due to water collecting and freezing in the line.

# Heating Specifications

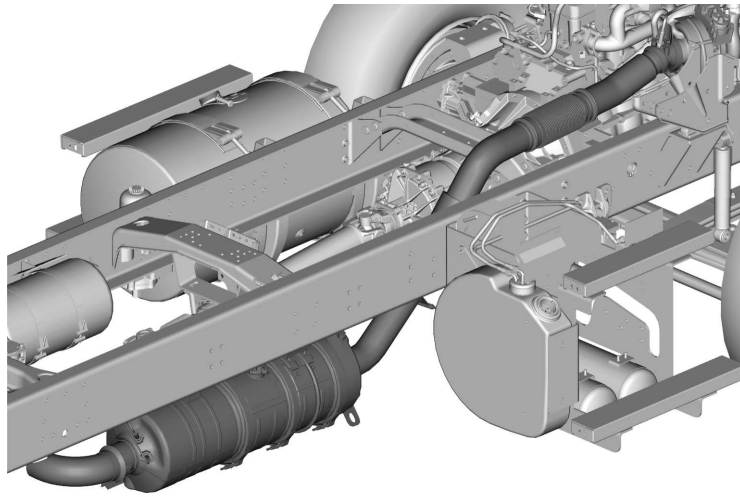
In order to maintain the integrity of the cables and hoses, observe the following specifications for routing near a heat source.

Cable, hose, or harness type	Specification
Electrical cables and wiring harnesses	5 inches (130 mm) in all directions from turbocharger, exhaust components, and other high heat components
Unprotected hoses, tubing, harnesses, and cables	6 inches (150 mm) above, 5 inches (130 mm) beside and 4 inches (100 mm) below
Hoses, tubing, harnesses, and cables protected by reflective heat sheathing	3 inches (76 mm) above, 2 ½ inches (63.5 mm) beside and 2 inches (51 mm) below
Silicone transmission coolant hoses	2 inches (51 mm) from exhaust manifold and turbo (with reflective heat sleeving), 1 inch (25 mm) from exhaust pipe
Hoses, tubing, harnesses, and cables protected by a heat shield (no reflective sheathing)	3/8 inch (10 mm) between the component and the heat shield. (Not valid for fuel lines)
Refrigerant suction hoses	8 inches (200 mm)



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1 Heat Radius from the Turbocharger, Front: 5 inches (130 mm)



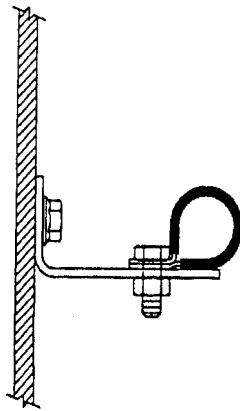
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The DOC, DPF, SCR, and exhaust piping generate substantial heat. Keep electrical cables away from these components.

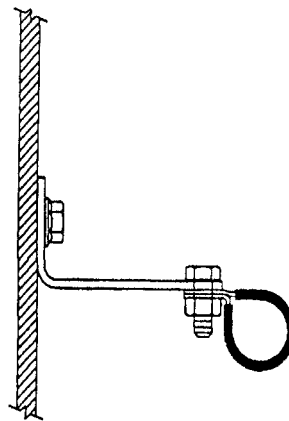
## Clipping Guidelines

Clipping brackets should be designed and mounted to adequately support the bundle. Clips should be mounted in a hanging position or supported along three-quarters of the horizontal mounting surface. Orientations that do not conform to the illustrations shall be tested.

- 1 When hoses, wires, and cables cross one another, secure them with a clamp. This prevents the sawing motion that could abrade them.
- 2 When routing flex hoses that are bent in two planes, clip them to prevent twisting. Clamp the hose at the point where the hose changes planes. The clamp has the effect of dividing the hose into two assemblies. If the section of the hose is bent in the same plane as the movement, the bend restricts the movement and the hose will not twist.



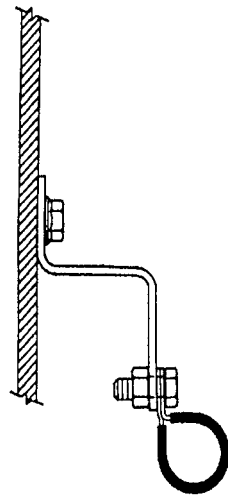
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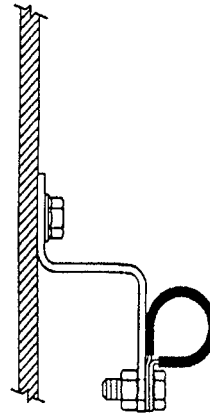
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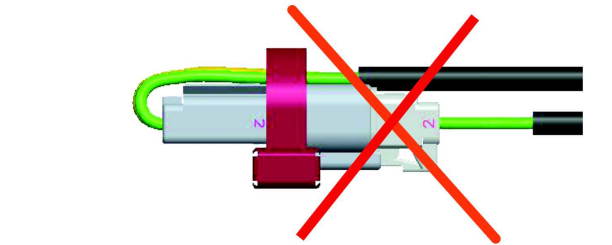
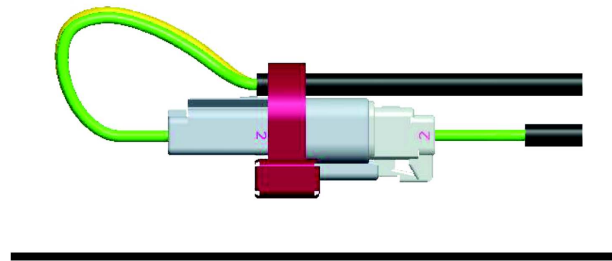
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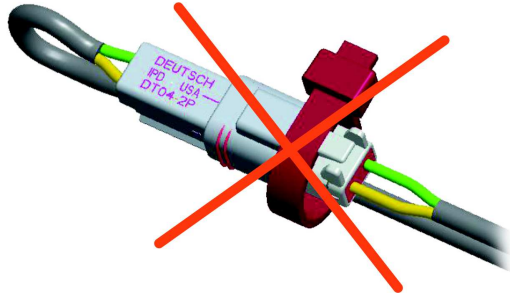
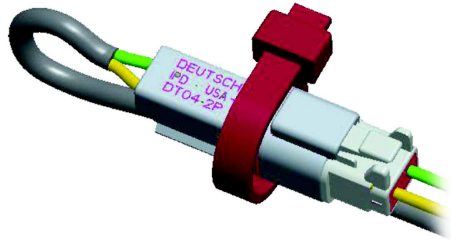
**NOT ACCEPTABLE**

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When routing connectors with cable ties, ensure that the cable ties do not contact the connector locking tab. Cable ties should also not contact the bare wire.



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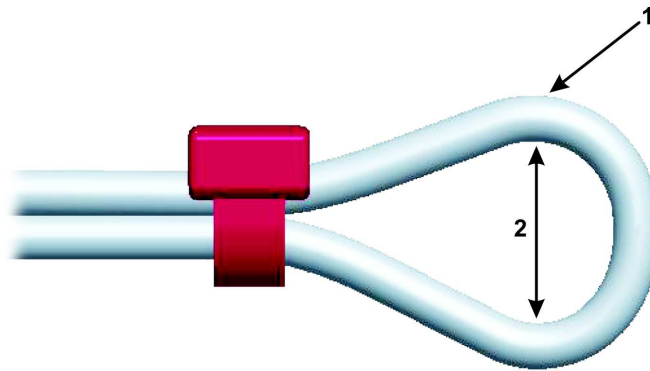


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# Battery Cable Guidelines

The battery cable guidelines prevent electrical interference that can occur from improperly routed cables. In addition, the guidelines prevent cable damage through abrasion.

- 1 Battery cables with standard SAE stranding shall be supported at 16 inches (400 mm) maximum intervals. A separator type cable tie or an independent separator with cable tie may be used between clip points. No relative movement may occur between cables. If two (2) cable separators are used, they are to be installed equidistant from each other and arranged on a straight line, a maximum span between clip points of 24 inches (600 mm) may be used.
- 2 Strain relief clipping shall be provided for the battery and starter motor terminals. The strain relief clip shall be located with no relative motion to the terminals. The strain relief clip should be located close to these terminals and shall be within 20 inches (500 mm) cable length to the starter terminals.
- 3 Grommets shall be installed at points where cables pass through sheet metal or frames.
- 4 Routing shall avoid exposed edges of frame members, abrasive surfaces, and all sharp edges. When routing inside the frame, ensure that no contact with the frame is made with uncovered cables. Uncovered battery cables, external of the battery box, shall be routed independent of all other conduits. Covered cables may be bundled with other similarly covered conduits and air piping with a secured separator. **Do not route with/under fuel lines.**
- 5 Cables should be clipped as close as possible to all cable bends.
- 6 Battery cables shall not be located within 5 inches (130 mm) of engine exhaust related components or other heat sources without heat coverings or heat shielding. Testing shall be performed to determine effects of closer allowances and the use of heat shields. Battery cables should not be installed in any area directly above engine exhaust related components.
- 7 Where cables flex between moving parts, the last supporting clip shall be securely mounted such that relative movement does not promote chaffing.
- 8 Battery cables shall not support any mechanical loads other than their own mass.
- 9 Minimum bend radii of battery cables should be 3 times the cable diameter for standard SAE strand cable.



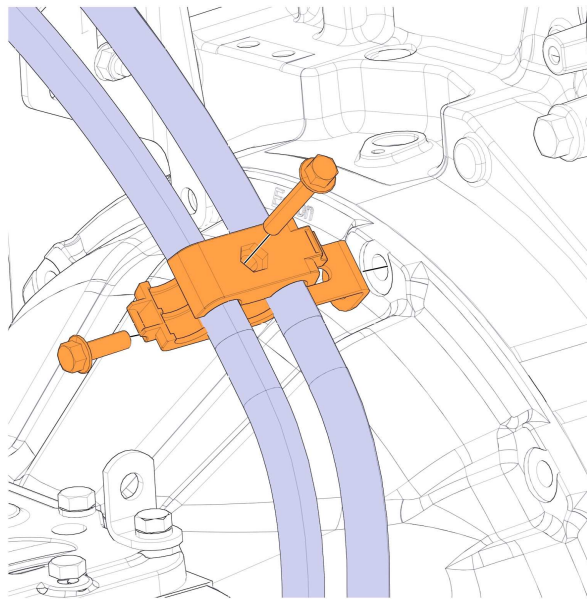
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1 Tube Diameter

2 Circle Diameter (3 x Tube Diameter)

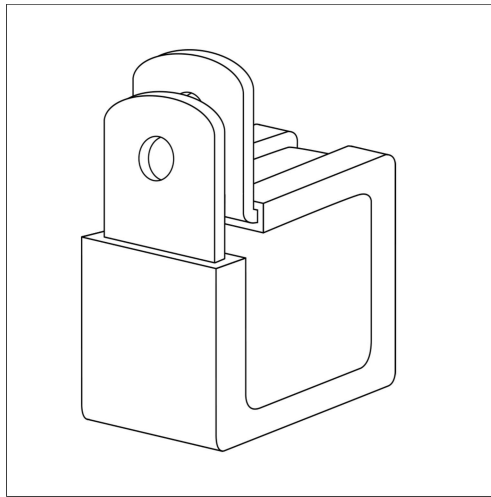
## Battery Guidelines, Continued

- 1 Star washers shall not be used on current path connections including grounds.
- 2 Asphalt type loom shall not be used for battery cable protection applications.
- 3 Battery cables shall not rub each other or surrounding items, but may touch when all items have no independent movement. Uncovered battery cables may not touch each other outside the battery box.
- 4 All exposed exterior to cab circuit ends shall be coated with a dielectric protective coating. Thickness to be 0.13 – 0.3 inches (3.5 – 7 mm) wet, full coverage, 3 inches (76.2 mm) diameter, or shall be completely covered with required inhibitor.
- 5 Clip orientations should be per illustration or installation drawings utilizing compression or heavy-duty clip.
- 6 Plastic conduit may be bundled and cable tied with covered battery cables when all items have no independent movement with each other. Battery cables may touch each other, plastic conduit or the battery, inside the battery box.
- 7 Covered battery cables may be securely tied or clamped to each other if no independent movement exists. Cables attached to the same terminal stud may be tied or clamped to each other.
- 8 Battery cable ends at the starter motor posts should be installed and positioned first with the engine harness terminals assembled after. Starter terminals that come with the starter may be first on the starter studs. Terminals shall not be reconfigured or bent.
- 9 Frame bolt placement, adjacent to the battery box, should have the bolt or screw threaded end facing away from the battery box and any related cables. Wrench grip type bolts should not be used in the frame at the battery box area. Non-wrench grip type bolt or screw threaded ends may face toward the battery box only if clip bracketing or shielding shall be provided to prevent any possible cable contact with frame-mounted hardware. Bolts that mount the battery box to the frame may be oriented toward the battery box.
- 10 Added abrasion protection should be used where the cable contacts other routed commodities or surfaces with no independent movement such as frame rail surfaces or transmission and engine castings. Polyethylene, polypropylene, nylon conduit and thick wall heat-shrinkable tubing may be used for added abrasion protection.
- 11 Cables should be located to afford protection from road splash, stones, abrasion, grease, oil and fuel. Cables exposed to such conditions should be further protected by either, or a combination of, the use of heavy wall thermoplastic insulated cable, additional tape application, plastic sleeve or conduit.
- 12 Anytime an existing fastener is used to secure a clipping bracket (or any similar device), the fastener shall be retorqued to the value specified in the original documentation given for the fastener.
- 13 Each exposed exterior circuit end must be coated with a dielectric protective coating. Thickness to be 0.13 – 0.3 inches (3.5 – 7 mm) wet, full coverage, 3 inches (76.2 mm) diameter.
- 14 Do not use box clamps to secure battery cables.
- 15 In addition to berringer clamps, use double-head tie clamps.



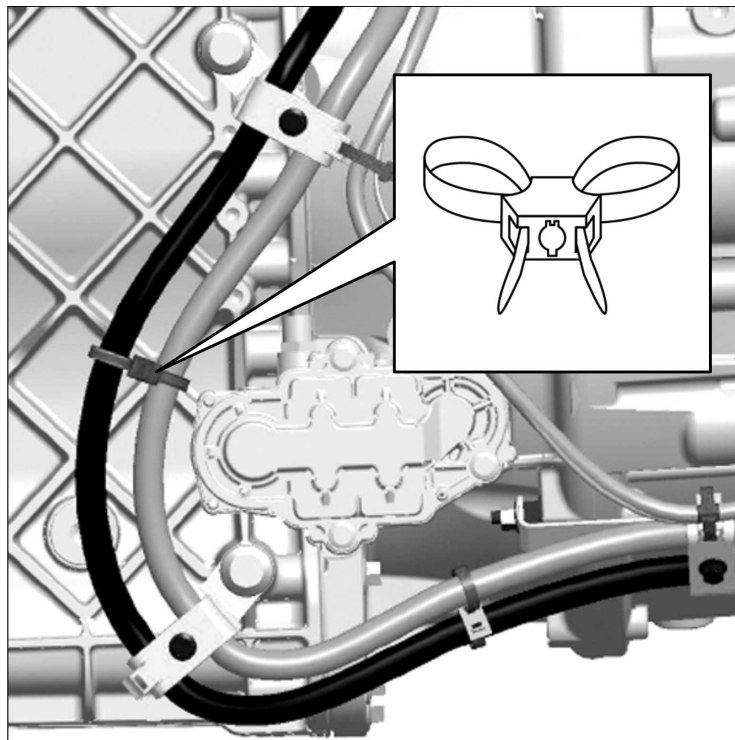
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Berringer clamps are recommended for securing battery cables to each other.



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Box Clamps (shown above) are NOT to be used for securing battery cables to each other.

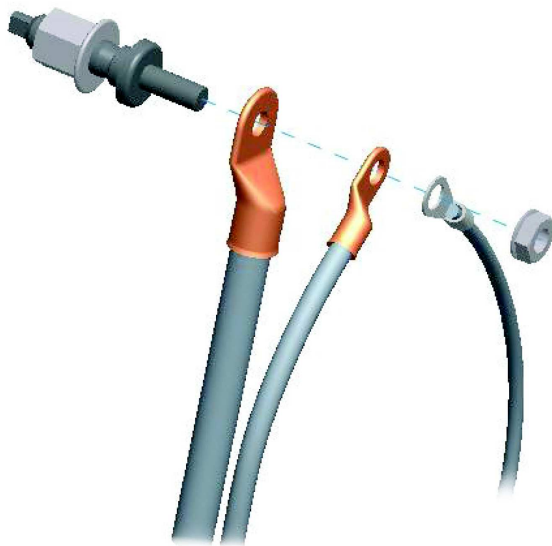


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Double-head tie clamps may be used to route battery cables.

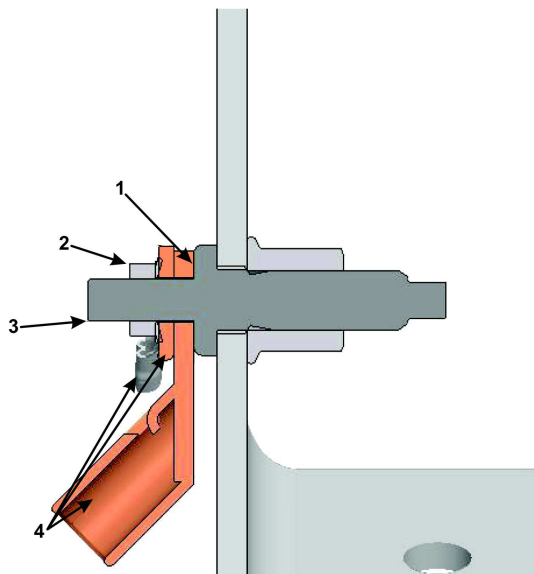
# Ring Terminal Assembly

Assemble terminal carrying the highest current (largest gauge wire) first, then graduate to the smallest gauge up to the fastener. Use a maximum of three (3) terminals per stud (unless otherwise specified on an illustration drawing).



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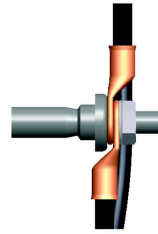
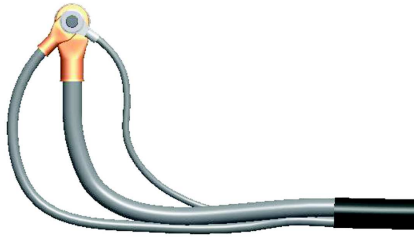
When attaching ring terminals with a fastener, tighten the fastener to appropriate torque so that the contact area touches the terminal at any point, in a full circle that is part of the terminal.



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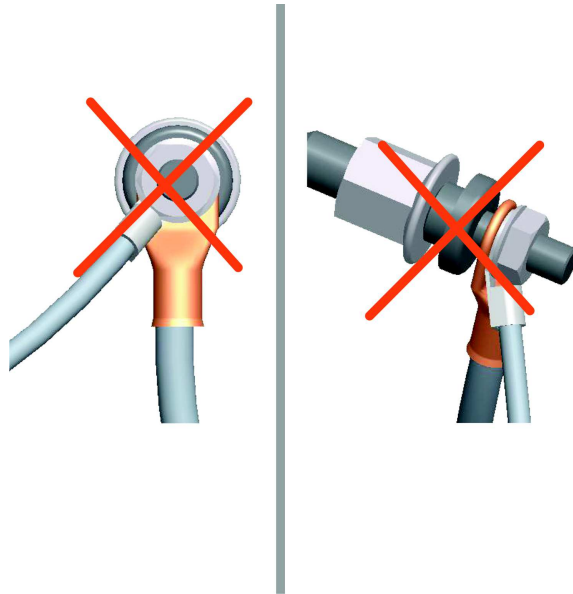
- 1 Contact Area
- 2 Fastener
- 3 Stud
- 4 Terminals

When attaching multiple terminals, position the terminals at an angle to allow maximum contact of the terminal surface. Terminals are not allowed to bend other than their natural form. Terminals may be stacked back to back.



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Improperly installed terminals result in unacceptable bends.



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# Terminating Resistors

Terminating resistors are wired to each end of the SAE J1939 data link to prevent signal reflections. They must remain connected for the data link to function properly. The resistance value of each termination resistor is 110 – 130  $\Omega$ . When properly installed in the data link, their combined resistance is 50 – 70  $\Omega$  since they are connected in parallel.

The termination resistor at one end of the SAE J1939 data link is located in the fuse/relay center (FRC) near the vehicle electronic control unit (VECU) and the other near the engine control module (ECM). On vehicles equipped with Cummins engine, the termination resistor is located in the harness area just outside of the ECM.

A SAE J1939 data link connection is located at the transmission area in the chassis harness. On vehicles equipped with an electronically controlled transmission (Allison), the connection to the transmission is located at the chassis harness.

Only two termination resistors are used in each data link. Never install more than two terminator resistors in one data link. If more than two resistors exist in the SAE J1939 data link circuit, incorrect or absent signals may occur. You can easily check to see if you have two resistors by measuring the resistance between pin C and D for the 9-pin diagnostic connector, or pin 3 and 11 for the 16-pin diagnostic connector, with the ignition key in OFF position. The correct resistance is 50 – 70  $\Omega$ . The termination resistors should each have a resistance of 110 – 130  $\Omega$  when tested individually.

## Notes

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# Electrical Wiring and Connections

## Main Power and Starting Circuits

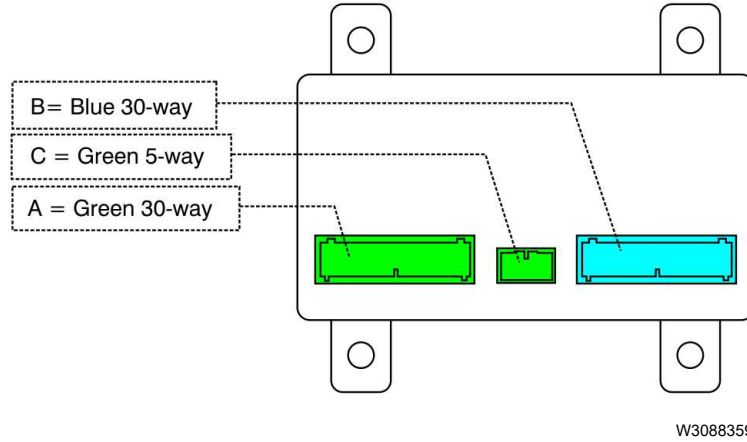
Figure 1 shows the starter circuits. Note that the ECM and VECU directly control the starter relay. The ECM inhibits starter when the engine is running, starter is overheat and PTO is engaged. The VECU inhibits the starter when the transmission is in gear.

Figure 2 shows the main power circuits. Ignition and “ECM” power are controlled by the VECU through relays. “ECM” power is connected after the key is turned on and remains on during crank and for some seconds after key off, mainly to service the Engine Management System. Ignition power is similar, but is disconnected during crank and supplies items not necessary for engine start.





# Vehicle Control Unit (VECU) Connections



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Fig. 2 Vehicle Control Unit (VECU) Connectors

## Notes

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## Description of VECU Pin Layout

### VECU Connector A (Green)

Pin Number	Pin Description	Mack Name
PA-1	DIH1	Cruise Control: Set/Deceleration
PA-2	DIH2	Cruise Control: Resume/Acceleration
PA-3	DIH3	Cruise Control: On/Off
PA-4	DIH4	A/C (Air Conditioning) On
PA-5	DIH5	Service Brake
PA-6	DIH6	Key Switch Crank
PA-7	DIH7	—
PA-8	DIH8	—
PA-9	DIH9	—
PA-10	DIH10	Air Suspension
PA-11	DOL8	—
PA-12	GND	Ground
PA-13	—	ECM power

Pin Number	Pin Description	Mack Name
PA-14	DIH11	Key Switch Ignition
PA-15	—	—
PA-16	—	—
PA-17	DIH12	ACC time gap (+)
PA-18	DIH13	—
PA-19	DIH14	Fan Override
PA-20	DIH15	Engine Compression Brake Select-2
PA-21	DIH16	Engine Compression Brake Select-1
PA-22	EOL	—
PA-23	DIH18	IVS 1
PA-24	DIL1	—
PA-25	DIL2	Interwheel Differential Lock
PA-26	DIL3	—
PA-27	DIL4	—
PA-28	DIL5	Forward Interwheel Differential Lock
PA-29	DIH19	PTO1
PA-30	DIH20	—

**VECU Connector B (Blue)**

Pin Number	Pin Description	Mack Name
PB-1	DOL1	—
PB-2	DOL2	Ignition Relay Power Relay #2 (load shedding)
PB-3	DOL3	Interwheel Differential Lock
PB-4	DOL4	—
PB-5	A05	Output Supply 4 (12 v, 50 mA)
PB-6	F11 (Frequency Input)	Vehicle Speed Sensor +
PB-7	DIH21	PTO 2
PB-8	AI2 (4K)	Throttle Pedal Signal
PB-9	AI5 (2 - 10K)	—
PB-10	A01 (5 V, 10 mA)	Output Supply 1 (throttle pedal supply)
PB-11	DIL6	Parking Brake
PB-12	DIL7	RSL (Road Speed Limit)
PB-13	DIL8	—
PB-14	AI3 (1.5 – 4 K)	—
PB-15	DOL5 (0.2A)	ECM Relay
PB-16	DOL6 (1A)	Cummins IVS/Forward Differential Lock
PB-17	DOH1 (10 mA)	Buffered IVS 1 (Only ECM)
PB-18	DOL7 (1A)	PTO1 enable
PB-19	AO4 (12 V, 70 mA)	Output Supply 3
PB-20	F11 GND	Vehicle Speed Sensor -
PB-21	DIH22	ACC time gap (-)
PB-22	GND analogue	Analogue Ground
PB-23	GND analogue	Analogue Ground
PB-24	AI4 (2 - 10K)	—
PB-25	AO3 (6.5 – 9 V, 15 mA)	Output Supply 5
PB-26	AO2 (5 V, 10 mA)	—
PB-27	AI6	Brake Pressure Switch
PB-28	DOH2 (2A)	Starter Control (ASSIST or starter protection)
PB-29	DIL9	—
PB-30	DIH23	Shut Down Override

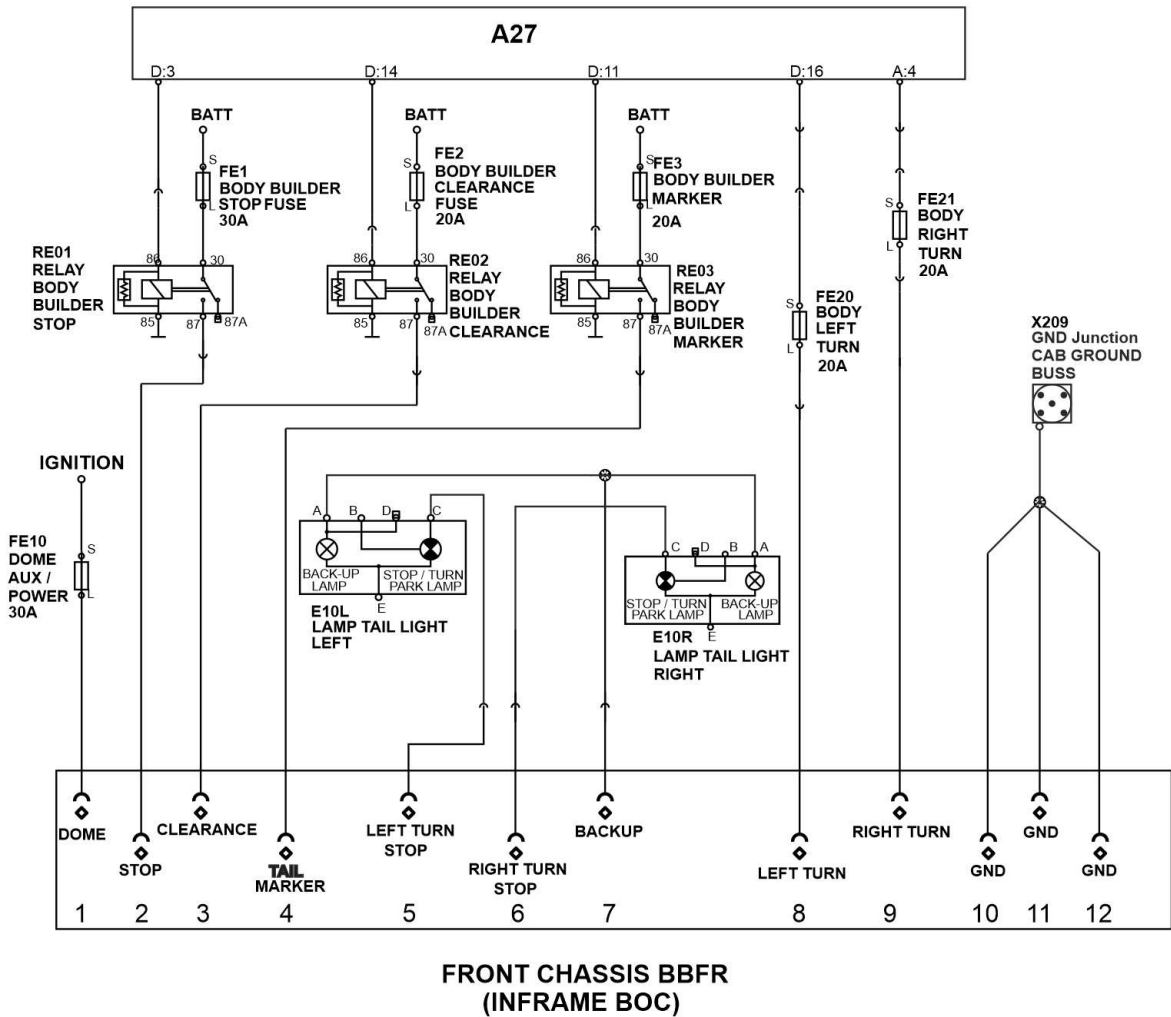
**VECU Connector C (Green)**

Pin Number	Mack Name
PC-1	J1587 B
PC-2	J1587 A
PC-3	—

Pin Number	Mack Name
PC-4	J1939 (+)
PC-5	J1939 (-)

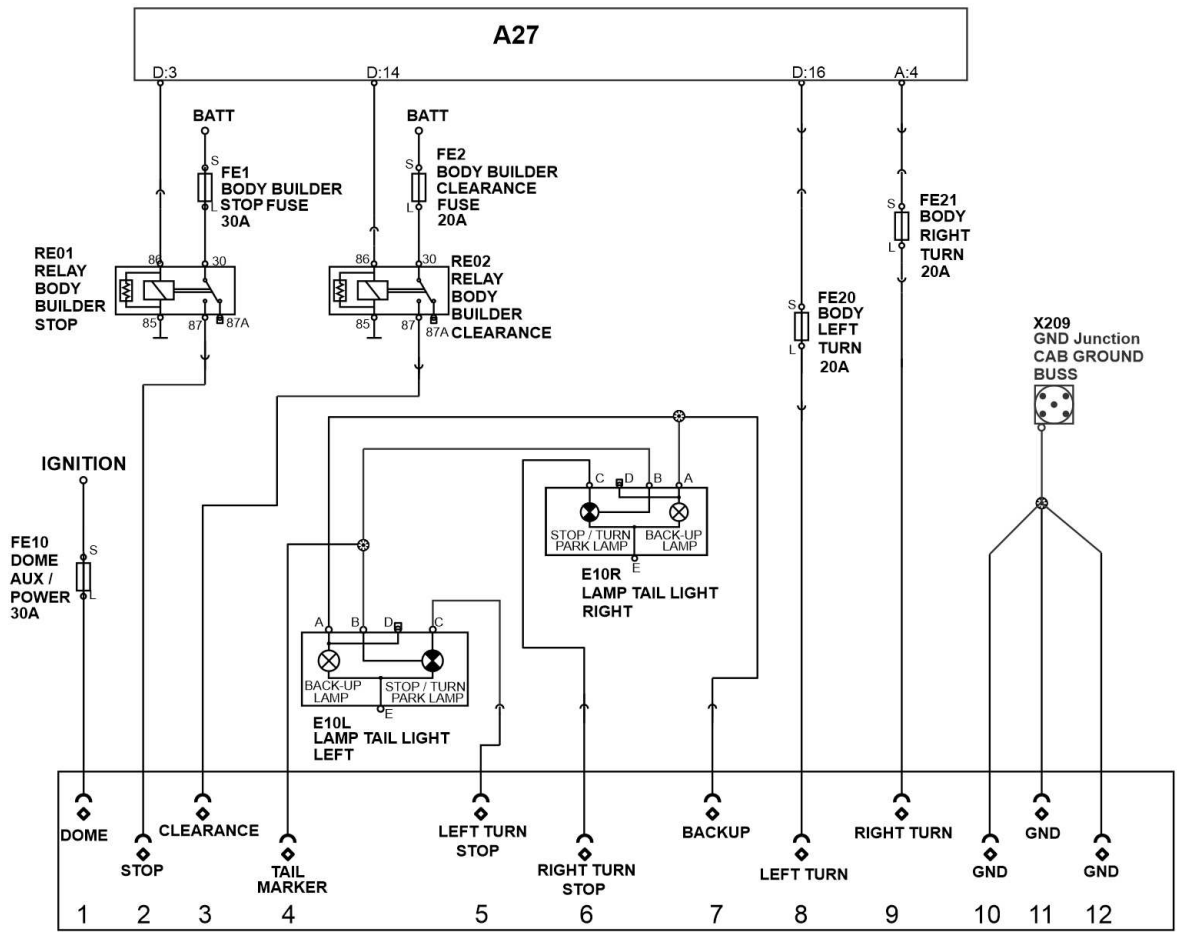
## Body Builder Wiring Inframe Connections

### Body Builder Interface – Front Chassis BOC (Back Of Cab)



T3183468

# Body Builder Interface – Rear Chassis EOF (End Of Frame)

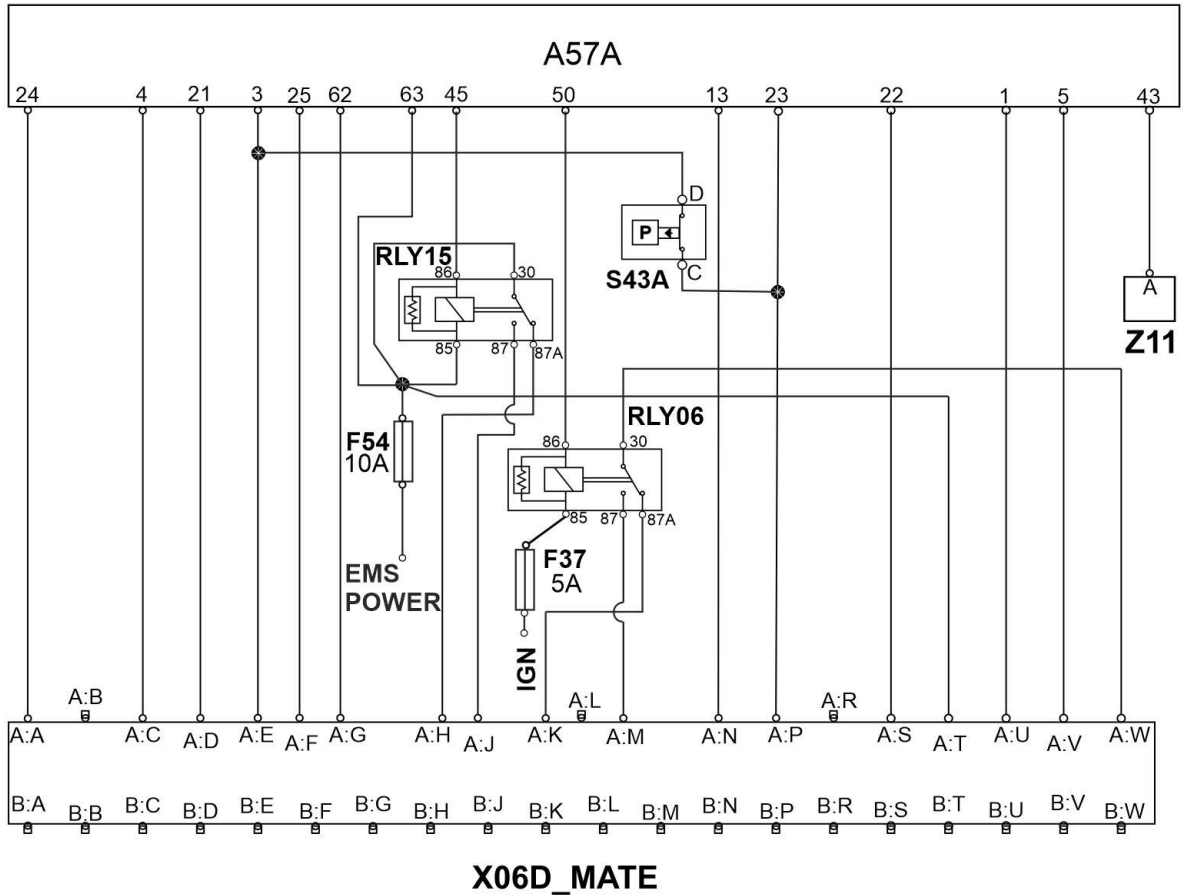


**REAR CHASSIS BBRR (INFRAME EOF)**

T3159407

POST DESCRIPTION	
Front Chassis BBFR — Inframe BOC	Rear Chassis BBRR — Inframe EOF
1. Dome light	1. Dome light
2. Stop	2. Stop
3. Clearance	3. Clearance
4. Tail Lamp	4. Tail Lamp
5. Left turn stop	5. Left turn stop
6. Right turn stop	6. Right turn stop
7. Reverse	7. Reverse
8. Left turn	8. Left turn
9. Right turn	9. Right turn
10. Ground	10. Ground
11. Ground	11. Ground
12. Ground	12. Ground

# Transmission Interface X06 – Allison 2000 Series



T3182484

A57A – Transmission Electronic Control unit

F54 – Transmission/Parker PTO

F37 – PTO, Allison bodybuilder

RLY15 – Relay, Allison bodybuilder

RLY06 – Relay, Allison bodybuilder

S43A – Switch, Pressure Park brake

X06D\_MATE – body builder connector interface

Z11 – body builder RELS (Reduced Engine Load At Stop) connector

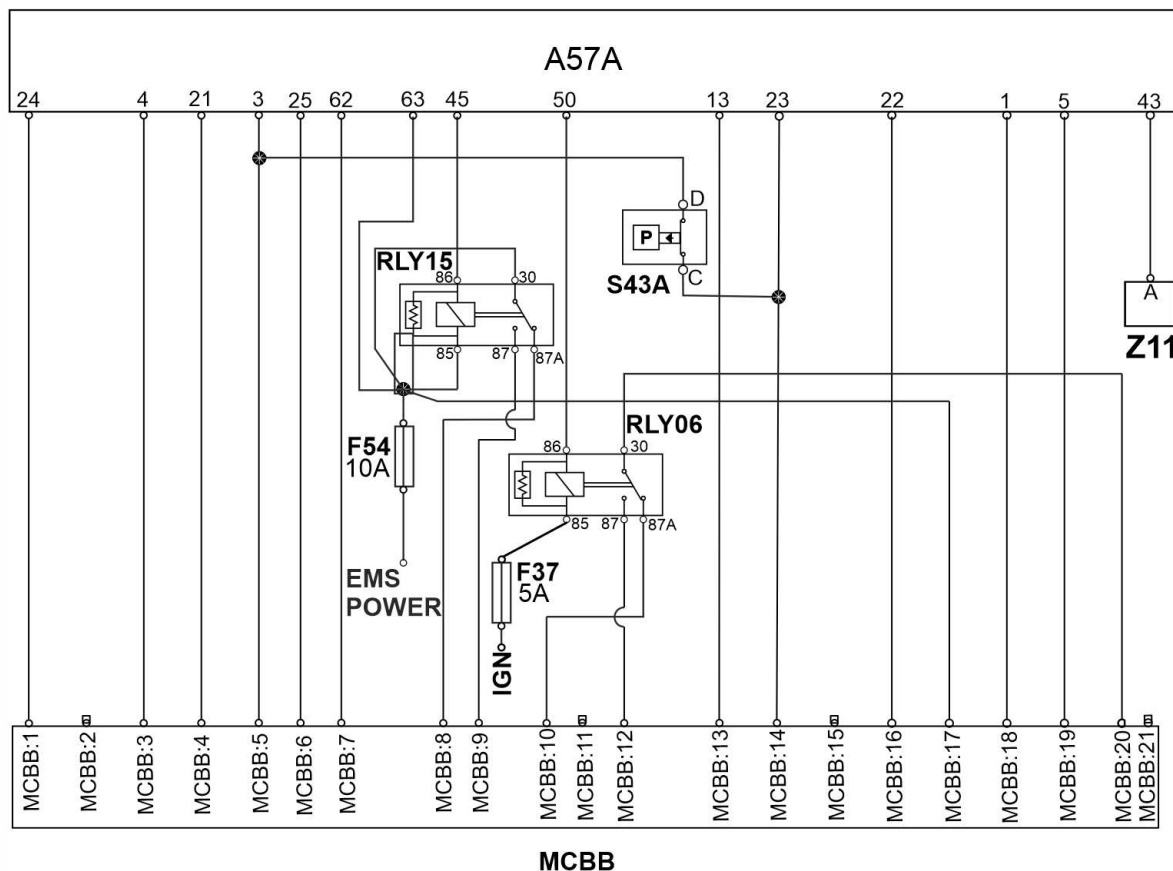
**Note:** Terminal part #7526-12084912 for the X06D mating connector.

## Pin Description

TECU Pin	TECU Pin description	X06D_MATE – body builder connector interface pin
1	Range inhibit	A:U
3	Signal return	A:E
4	Engine brake	A:C
5	Output speed	A:V
13	Transmission service indicator	A:N
21	ABS (Anti-Lock Brake System)	A:D
22	Direct change	A:S
23	Auto neutral	A:P
24	Range inhibit indicator	A:A

25	Speedometer	A:F
43	RELS (Reduced Engine Load At Stop)	Z11 A:A — body builder RELS (Reduced Engine Load At Stop) connector
45	Range indicate	RLY15
50	PTO enable	RLY06
62	PTO drive input	A:G
63	Ignition	A:T

*Transmission Interface MCBB – Allison 2000 Series with A57A*



T3182586

A57A – Transmission Electronic Control unit

F54 – Transmission/Parker PTO

F37 – PTO, Allison bodybuilder

RLY15 – Relay, Allison bodybuilder

RLY06 – Relay, Allison bodybuilder

S43A – Switch, Pressure Park brake

MCBB – body builder connector interface

Z11 – body builder RELS (Reduced Engine Load At Stop) connector

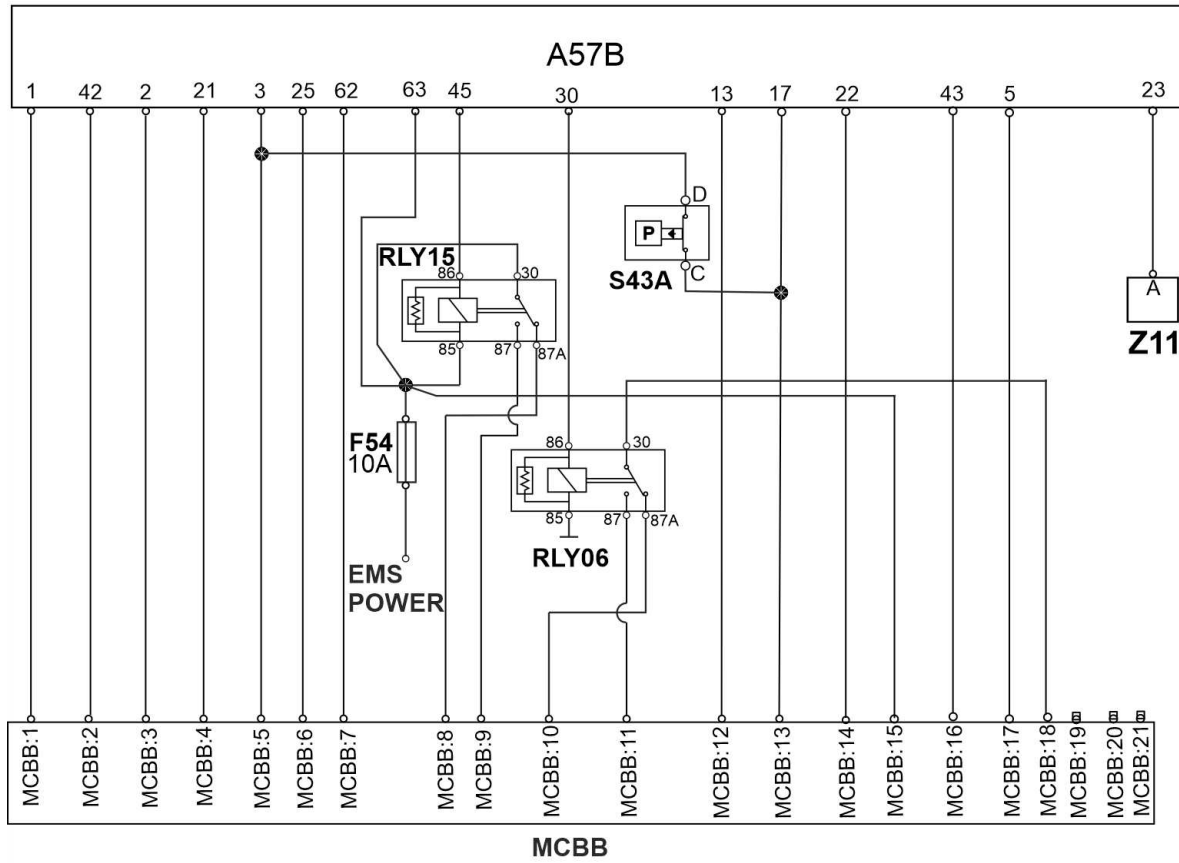
**Note:** Terminal part #978295 for the MCBB mating connector.



## Pin Description

TECU Pin	TECU Pin description	MCBB – body builder connector interface pin
1	Range inhibit	MCBB:18
3	Signal return	MCBB:5
4	Engine brake	MCBB:3
5	Output speed	MCBB:19
13	Transmission service indicator	MCBB:13
21	ABS (Anti-Lock Brake System)	MCBB:4
22	Direct change	MCBB:16
23	Auto neutral	MCBB:14
24	Range inhibit indicator	MCBB:1
25	Speedometer	MCBB:6
43	RELS (Reduced Engine Load At Stop)	Z11 A:A — body builder RELS (Reduced Engine Load At Stop) connector
45	Range indicate	RLY15
50	PTO enable	RLY06
62	PTO drive input	MCBB:7
63	Ignition	MCBB:15

# Transmission Interface MCBB – Allison 3000 Series with A57B



T3182587

A57B – Transmission Electronic Control unit

F54 – Transmission/Parker PTO

RLY15 – Relay, Allison bodybuilder

RLY06 – Relay, Allison bodybuilder

S43A – Switch, Pressure Park brake

MCBB – body builder connector interface

Z11 – body builder RELS (Reduced Engine Load At Stop) connector

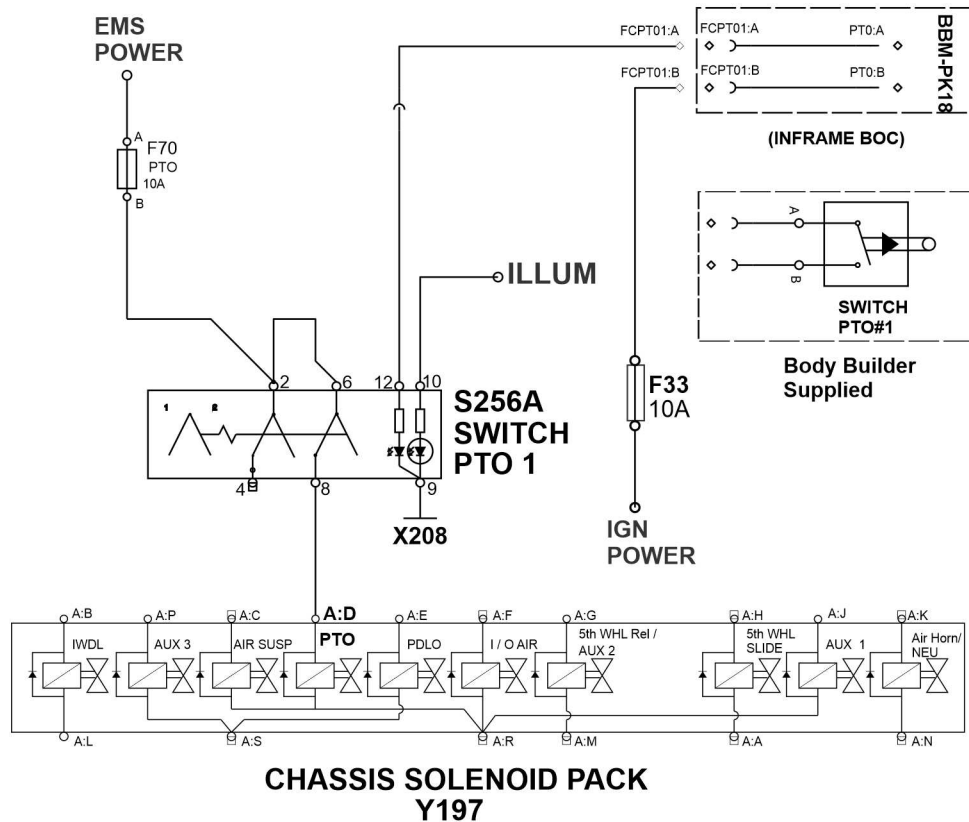
**Note:** Terminal part #978295 for the MCBB mating connector.

## Pin Description

TECU Pin	TECU Pin description	MCBB – body builder connector interface pin
1	Range inhibit	MCBB:1
2	Engine brake	MCBB:3
3	Signal return	MCBB:5
5	Output speed	MCBB:17
13	Transmission service indicator	MCBB:12
17	Auto neutral	MCBB:13
21	ABS (Anti-Lock Brake System)	MCBB:4
22	Direct change	MCBB:14

23	RELS (Reduced Engine Load At Stop)	Z11 A:A — body builder RELS (Reduced Engine Load At Stop) connector
25	Speedometer	MCBB:6
30	PTO enable	RLY06
42	Auxiliary hold	MCBB:2
43	PTO Request	MCBB:16
45	Range indicate	RLY15
62	Service break	MCBB:7
63	Ignition	MCBB:15

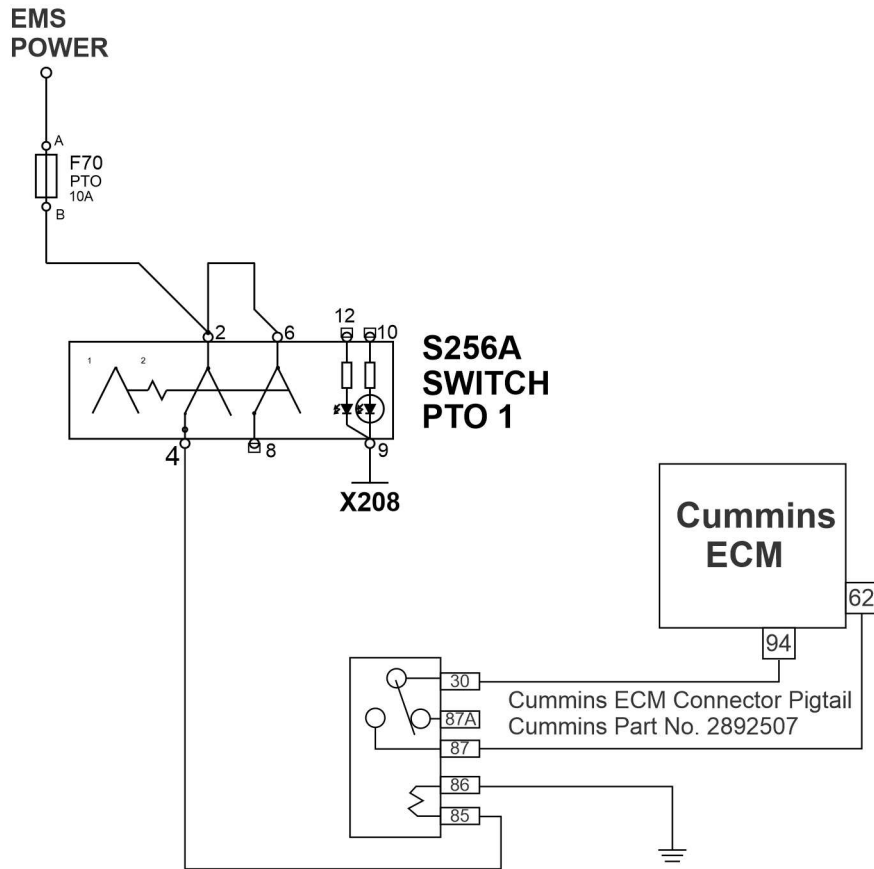
**PTO- Allison Transmission**



T3159409

The PTO inputs are programmable and can affect a conditional output, engine ramp, engine limits, etc. See programming section for details. Note that full safety evaluation of the system should be carried out. I.E., adequate interlocks should be programmed or wired, so that the engine will not accelerate in unintended situations. Interlocks can be done by powering switches using switched power (for example neutral power) or by software parameters or both. For example, most applications should only have the engine ramp using body controls when the parking brake is on and the transmission is in neutral. Exceptions should be carefully considered..

## PTO Relay to Cummins ECM wiring Instructions



T2163045

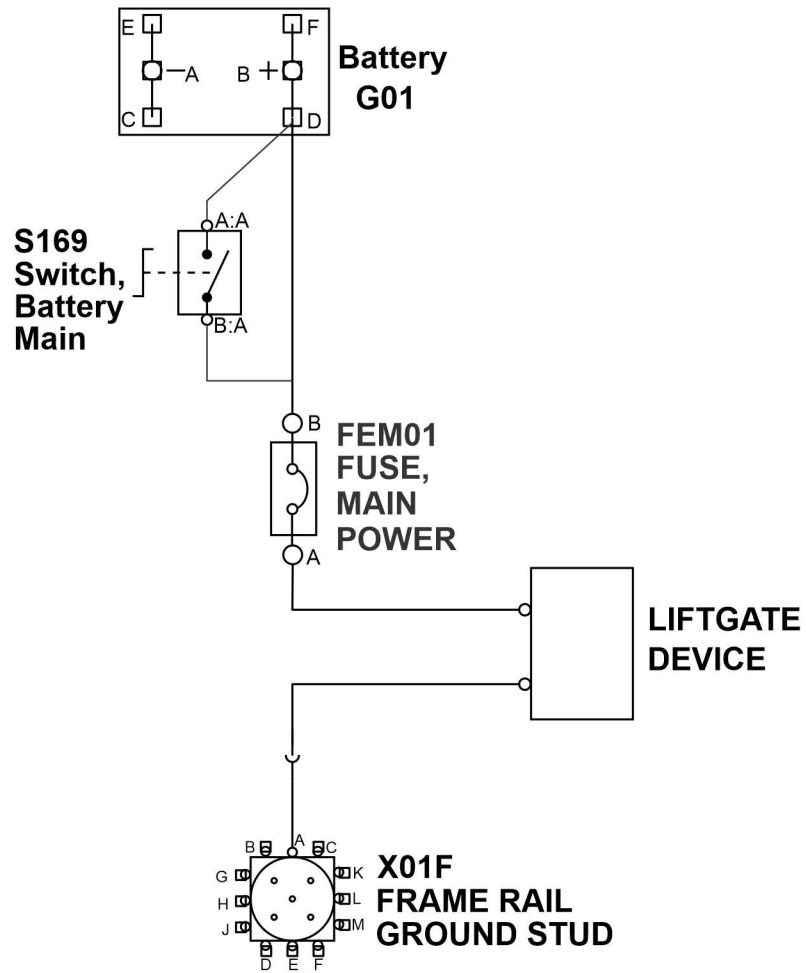
- 1 Insert wire in cavity 4 of the PTO switch connector.
- 2 Add the relay and wire in to the Cummins ECM.

### Part List

Non-Sealed Relay	25171095
Relay Connector housing	20865681
Terminals (0.5–1.0 MWG)	20865693
Secondary lock	25154889

**Note:** If the relay is mounted outside the cab use a Sealed Relay. If the relay is mounted in the cab a non-sealed Relay can be used.

Power Liftgate – body builder Supplied



T3159408

**Note:** When the vehicle is offered with battery disconnect switch, the liftgate wiring harness must not be wired directly to the battery. The liftgate wiring harness must be wired to the battery disconnect switch.

**Note:** Properly sized/recommended cable must be used to carry the load.

**Note:** Use ground stud to ground the circuit. Never connects the Grounding circuit directly to the battery or ground fuse-link.

The ground stud is located on the frame rail near to the battery box. The ground stud is supplied with liftgate preparation and body builder package.

**Notes**

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# General

## Wiring J1939

Mack doesn't necessarily recommend or condone tapping into the J1939 databus. This is the main control bus and even devices only listening can improperly load the line and cause communication problems. The signals are fast enough that they are affected by the physics of the electrical charges traveling through the lines. So it matters how the device is designed and where it is placed in relation to other devices. However this method can save wiring and gives the body builder more flexibility and control in developing applications. To that end the following information is provided. However, it is recommended applications be implemented with sufficient field testing to uncover any problems.

Here are two ways to properly connect to J1939 without damaging the cab harness.

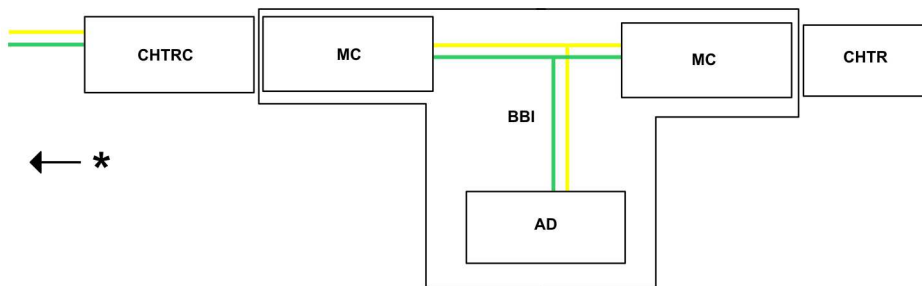
### 1. Connect at the diagnostic connector.

The diagnostic port contains J1939 lines mainly for temporary connection for diagnostic tools. Since it also contains power and ground for diagnostic tools, it is a convenient choice for connection of control and monitoring devices. However, note that J1939 specifies one device per node. So, it would be incorrect to place two devices there.

### 2. Add the device at the terminating resistor.

The terminating resistor for the main CAN bus is found in the dashboard. This method effectively lengthens the "backbone" of the main can line and adds a node. To do this the body builder would make a "T" harness to insert between the terminating resistor and it's connector (see figure). Theoretically, more than one node could be placed this way. However, some trucks are already at or near the theoretical limit

Mack follows SAE J1939 meaning it uses an unshielded, twisted pair and is theoretically limited to 10 devices.



W3083536

Fig. 3 Adding a Node at the Terminating Resistor

\* To Truck

The following parts can be used in the above “T” harness. Critical is that only two terminating resistor remain on the network (one is in the ECM). It may also be possible to have one terminating resistor in the aftermarket device if it is replacing the terminating resistor.

**T Harness Part Numbers**

T Harness		
Abbreviation	Connector	Part Number
		<b>MACK #</b>
CHTRC	Cab Harness Terminating Resistor Connector	21430472
CHTR	Cab Harness Terminating Resistor 120 Ω	21430457
	Connection to Cab harness	20500398
AD	Aftermarket Device	N/A
MC	Mating Connector	N/A
BBI	Body Builder Installed	N/A

*Notes*

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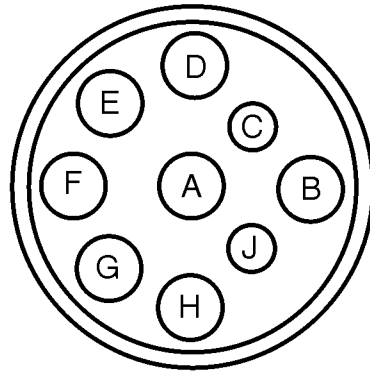
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Another more convenient way to connect to J1939 (or J1587) is through the diagnostic connector.

### 9-pin Diagnostic Connector



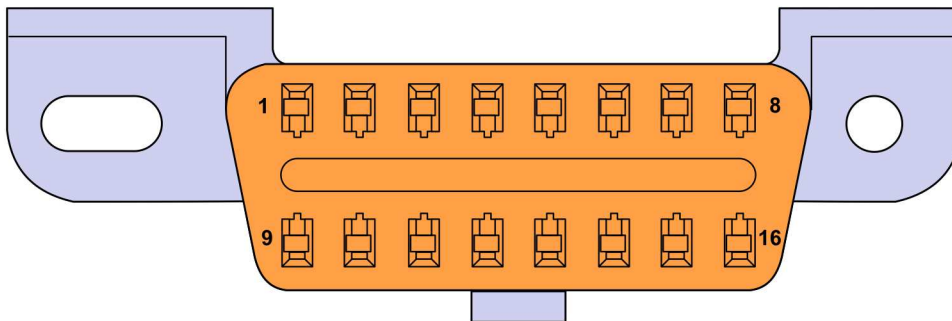
W9000628

Fig. 4 9-pin Diagnostic Connector

### 9-pin Diagnostic Connector

9-pin Diagnostic Connector	
PIN	Definition
A	Ground
B	Battery
C	DL10 (J1939 H-Yellow)
D	DL10 (J1939 L-Green)
E	Not used (Shield)
F	CAN H – DL1 (J1939 H-Yellow)
G	CAN L – DL1 (J1939 L-Green)
H	Not Used
J	Ignition + (Key Switch)

### 16-pin Diagnostic Connector



W3085011

Fig. 5 16-pin Diagnostic Connector (OBD 13)



## 16-pin Diagnostic Connector (OBD 13) Pin Allocation

16-pin Diagnostic Connector (OBD 13 SAE J1962-Type A Connector)	
Pin	Definition
1	OEM discretionary (assigned as: Key switch – ignition signal for AM tool)
2	(Not Used)
3	OEM discretionary (assigned as: SAE J1939-1_CAN_H)
4	Chassis ground
5	Chassis ground
6	CAN_H line of ISO
7	(Not Used)
8	(Not Used)
9	(Not Used)
10	(Not Used)
11	OEM discretionary (assigned as: SAE J1939-1_CAN_L)
12	OEM discretionary (assigned as: SAE J1587_CAN_H positive)
13	OEM discretionary (assigned as: SAE J1587_CAN_L negative)
14	CAN_L line of ISO
15	(Not Used)
16	Battery positive voltage

## Serial Communications and Programming Abbreviations

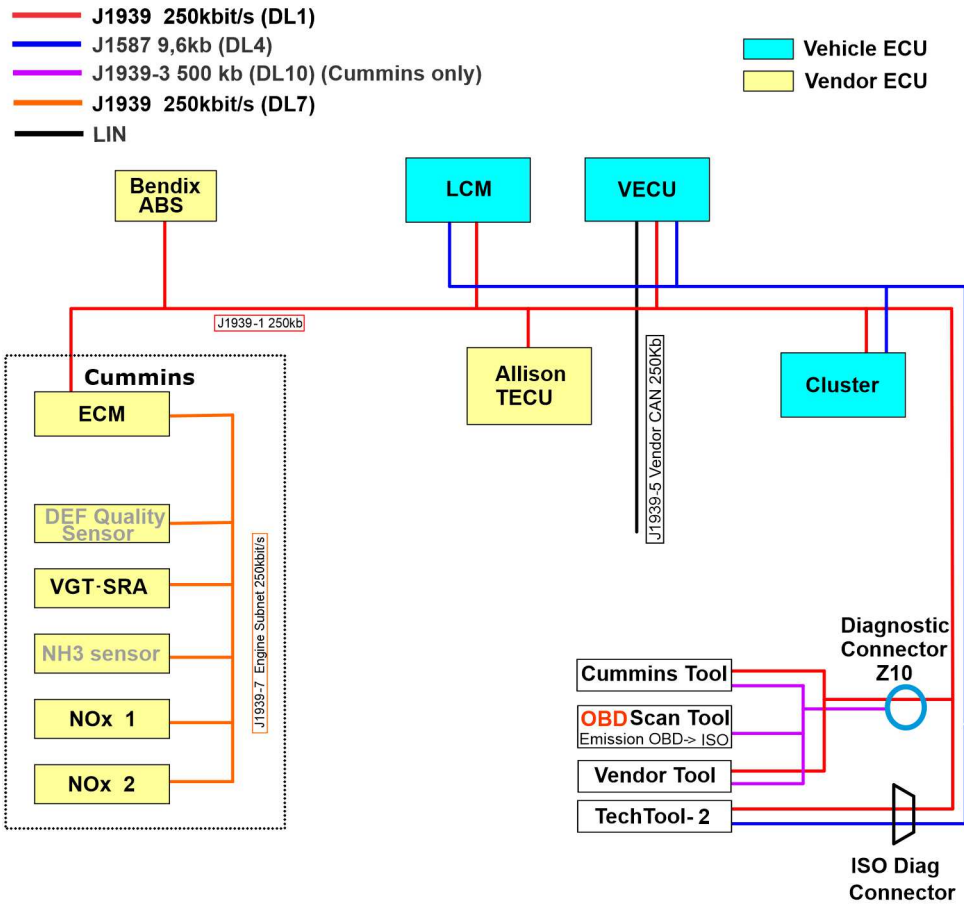
Acronym	Description
BBM	Body Builder Module
CAN	Controller Area Network
CDS	Customer Defined Statement
DCL	DataMax Control Language
ECC/MCC	Electronic Climate Control/ Manual Climate Control
ECM	Engine Control Module
EHT	Electronic Hand Throttle
ECS	Electronic Speed Control
FMI	Failure Mode Identifier
GSECU	Gear Selector ECU
LCM	Light Control Module
NOx	Nitrogen Oxide
PGN	Parameter Group Number (J1939)
PID	Parameter Identification (J1587)
PTO	Power Take-Off

Acronym	Description
SA	Source Address (J1939 Sender)
SCU	Satellite Control Unit (Qualcomm)
SID	Subsystem Identification (J1587)
SPN	Suspect Parameter Number (J1939)
SRS	Supplemental Restraint System
SSC	Single Speed Control
TCM	Transmission Control Module
TPM	Tire Pressure Monitor
VDA	Vehicle Data Administration (OEM database)
VECU	Vehicle ECU

# Data Link System

## Data link Topology

### US2017 Emissions Engine



T3159410

Acronym	Description
ECM	Engine Control Module
NOx	Nitrogen Oxide
GSECU	Gear Selector ECU
TECU/TCM	Transmission Electronic Control Unit/Transmission Control Module
DEF	Diesel Exhaust Fluid
VECU	Vehicle Electronic Control Unit
ABS	Anti-Lock Braking System
BBM	Body Builder Module

## Source Addresses and Unit Acronyms

Control Unit	ECU	Source address (SA) or Destination Address (DA) in Hex
Engine Control Module	ECM	0x00
Transmission Electronic Control Unit/ Control Module	TECU/TCM	0x03
Anti-lock Brake System	ABS	0x0B
Gear Shift Electronic Control Unit	GSECU	0x05
Engine Brake	EB	0x0F
Vehicle Electronic Control Unit	VECU	0x11
Instrument Cluster	IC	0x17

This section provides information on the design and function of the vehicle communications data links. These communication links are based on SAE J1587, J1708 and J1939 Recommended Practices and the ISO 14229 Standard. For more specific information about the ISO 14229 Standard, please refer to the ISO website ([www.iso.org](http://www.iso.org)).

The data links are used to relay shared vehicle information between control modules and diagnostic, service and (in the case of onboard diagnostic (OBD) information) scan tools. The data link types used are SAE J1939 and SAE J1587/J1708.

### SAE J1939 (DL1)

DL1 is the primary data link for communication between vehicle modules and powertrain control modules. Vehicle and powertrain control modules utilize the SAE J1939 communication protocol on DL1 to share information with vehicle and engine control. Limited diagnostic functionality takes place on this data link.

DL1 consists of a pair of 18 gauge, unshielded, twisted wires. The designations of the individual wires are DL1H (yellow) and DL1L (green). The nominal twist rate required is 0.89 twists per 25.4 mm (1 inch) or 33 twists per metre (3.28 feet). This twist protects against electrical interference.

DL1 is electrically terminated at each end with a termination resistor. Each DL1 network has two termination resistors. The termination resistor can be located externally as part of the wiring harness, or integrated internally in the ECM (Engine Control Module). An ECM that does not contain the termination resistor is referred to as Type 1. An ECM that contains the termination resistor is referred to as TYPE II. The correct number of termination resistors can be checked by measuring the resistance across the DL1 circuit at the 16-pin diagnostic connector. The correct resistance is 50- 70 ohms. The terminating resistors should each have a resistance of 110 – 130 ohms when tested individually.

Do not splice into a VECU, ABS/ATC or any other electronic control unit harness.

**Note: Do not cut or tap into the J1939 green/yellow twisted wires or any other wire or harness used on this vehicle. Use the provided connectors, and only add approved J1939 components with validated software. Failure to comply may result in personal injury or equipment damage. Any cutting, splicing, alteration or modification to the wiring will Void the Mack Trucks Warranty on the Electrical System.**

## SAE J1939 for Cummins engine (DL10)

The SAE J1939 (DL10) data link is a dedicated data link for emissions diagnostics and Cummins specific diagnostics.

The J1939 data link consists of a pair of 18 gauge unshielded twisted wires. The designations of the individual wires are DL1H (yellow) and DL1L (green). The nominal twist rate required is 0.89 twists per 25.4 mm (1 inch) or 33 twists per metre (3.28 feet). This twist protects against electrical interference.

The J1939 data link is electrically terminated at each end with a termination resistor. Each J1939 network has two termination resistors associated with it. Only two termination resistors are allowed within a network. The termination resistor can be located externally as part of the wiring harness, or integrated internally in the ECU/ECM. Any ECU/ECM that does not contain the termination resistor is referred to as Type 1, and an ECU/ECM that contains the termination resistor is referred to as TYPE II. The correct number of termination resistors can be easily checked by measuring the resistance across the DL10 circuit at the 9-pin diagnostic connector. The correct resistance is 50 – 70 ohms. The terminating resistors should each have a resistance of 110 – 130 ohms when tested individually.

## SAE J1587/J1708

SAE 1587/1708 is a communications link between stand-alone vehicle modules.

It is used primarily to transmit shared information between stand-alone modules. Fault messages or diagnostic information also transmits across this link. J1587/J1708 defines parameters that relate primarily to hardware and basic software compatibility. J1587/1708 defines the actual data to be transmitted by particular modules.

The J1587/1708 data link consists of a pair of 18 gauge twisted wires. The nominal rate of twist required is 1 twist per 25.4 mm (1 inch) or 40 twists per meter (3.28 feet). This twist helps protect against electrical interference. A fault in this data link can affect the transfer of information, and can make it difficult to communicate with the source in order to carry out tests. An indication that there is a problem with SAE J1587/1708 can be that faults from a certain control unit cannot be corrected, erased or reset.

## LIN (Local Interconnect Network)

A local interconnect network allows modules or components to communicate. A local interconnect network is not connected to a data link and does not have a diagnostic connector.

The following components communicate using a LIN:

- Turn signal stalk switch to instrument cluster
- Wiper-washer stalk switch to instrument cluster

## Data Link Faults

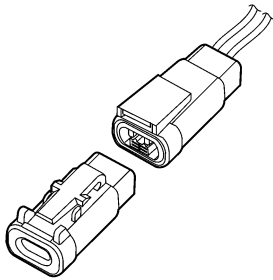


W3005017

Whenever a data link fault is present, refer to Guided Diagnostics found in the manufacturer's scan tool (Premium Tech Tool or PTT) for diagnostic information.

- The type of FMI/FTB that an individual electronic control unit (ECU) can monitor is dependent on the software in the ECU. All FMIs/FTBs cannot be recognized by all ECUs.
- The ECU reporting the diagnostic trouble code (DTC) may not be the ECU that is involved at the site of the specific failure. For example, The engine control module (ECM) may report a data link fault that is actually at the vehicle electronic control unit (VECU). The VECU would not be able to report if the data link is broken between the VECU and data link backbone.

# Termination Resistor



W3005518

Termination Resistor, 2-pin

## *Termination Resistor – J1939*

Termination resistors are wired to each end of the SAE J1939 data link to prevent signal reflections. They must remain connected for the data link to function properly. The resistance value of each termination resistor is 110 – 130  $\Omega$ . When properly installed in the data link, their combined resistance is 50 – 70  $\Omega$  since they are connected in parallel.

The termination resistor at one end of the SAE J1939 data link is located in the fuse/relay center (FRC) near the vehicle electronic control unit (VECU) and the other near the engine control module (ECM). On vehicles equipped with MACK engines, the termination resistor at the engine end is located inside the ECM. On vehicles equipped with Cummins engine, the termination resistor is located in the harness area just outside of the ECM.

A SAE J1939 data link connection is located at the transmission area in the chassis harness. On vehicles equipped with an electronically controlled transmission (Allison/Autoshift II/Meritor Freedom Line), the connection to the transmission is located at the chassis harness. On vehicles equipped with a manual non-electronically controlled transmission - the connector stub will have an unterminated blanking plug installed.

Only two termination resistors are used in each data link. Never install more than two terminator resistors in one data link. If more than two resistors exist in the SAE J1939 data link circuit, incorrect or absent signals may occur. You can easily check to see if you have two resistors by measuring the resistance between pin C and D for the 9-pin diagnostic connector, or pin 3 and 11 for the 16-pin diagnostic connector, with the ignition key in OFF position. The correct resistance is 50 – 70  $\Omega$ . The termination resistors should each have a resistance of 110–130  $\Omega$  when tested individually.

## Road Speed Signal

**Note:** Allison transmission provides a road speed signal at the Allison Body Builder connector located left of the steering column behind the kick panel.

MCBB connector pin 6 wire #N125.

X06D connector pin F wire #N125. (See Connector Below)



T3183667

Fig. 6 New style MCBB Connector (Trucks built after 6/2022) Part #3987483 Terminal #978295



T3183668

Fig. 7 Old style X06D connector Part #20897253 Terminal #7526-12084912