BODY BUILDER INSTRUCTIONS

Mack Trucks

Body Builder, General Guidelines and Certification
LR Electric

Introduction

The information in this document was developed to assist our customers throughout the body planning and installation process. This information will assist with the required specifications and guidelines for the completion of your specific applications.

The information in this document does not include each and every unique situation that you may encounter when working on Mack vehicles. Mack Trucks North America cannot possibly know, evaluate, or advise someone on all the types of work that can be done on a Mack vehicle and all the appropriate ways to do such work. This includes all of the possible consequences of performing such work in a certain manner. Therefore, any situations or methods of working on a Mack vehicle that are not addressed in this document are not necessarily approved by Mack Trucks North America.

If you require additional assistance, please contact Mack Body Builder Support at 877-770-7575.

Unless otherwise stated, following the recommendations listed in this document 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 North America vehicle warranty does not apply to any Mack vehicle that has been modified in any way, which in Mack's judgment might affect the vehicle's stability or reliability. The information, specifications, and illustrations in this document are based on information that was current at the time of publication. Please note that illustrations are typical and may not reflect the exact arrangement of every component installed on a specific vehicle.

All data provided is based on information that was current at the time of release. However, this information is subject to change without notice.

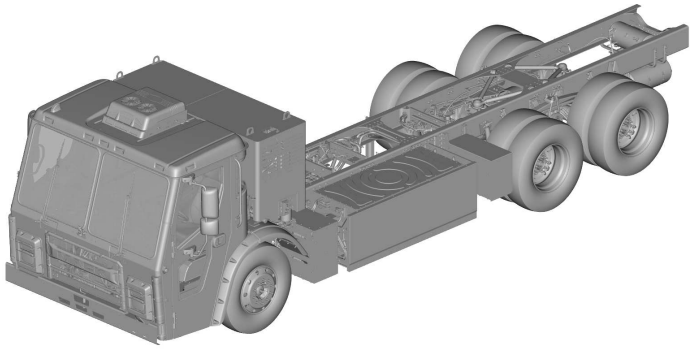
Contents:

BEV (Battery-Electric Vehicle)

General

Introduction

This document includes information that is specific to the truck model LR ELECTRIC. For all other common information related to all LR trucks, refer to the relevant MACK Body Builder Manual.



T8173079

Overview of battery-electric vehicle

General warnings

DANGER

Risk of electrical discharge
Traction voltage system, 600 V (nominal value)
Can cause dangerous electric shocks, arcing or burns, which can result in serious personal injury or death.
Service and installation must be carried out by qualified personnel. Always use correct personal protection equipment when working on the vehicle.

The components that contain traction voltage are marked with the warning decal.

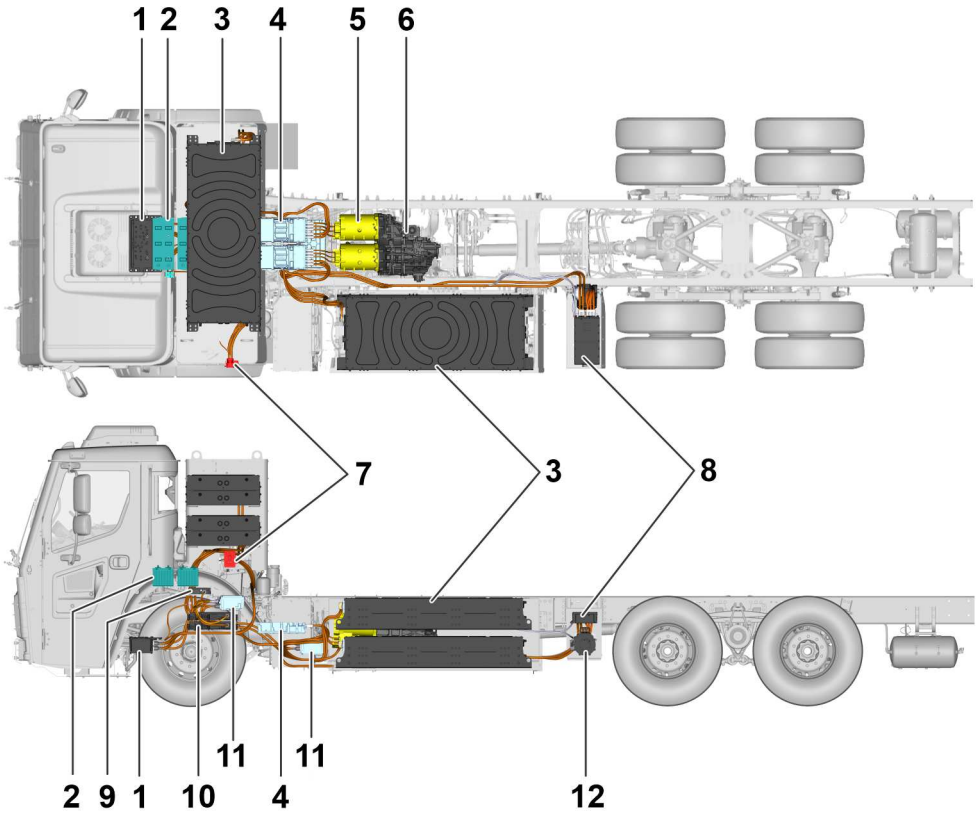
T3167712

General description

BEV (Battery-Electric Vehicle) Layout

LRBE 64R (ESS265K)

Model	Axle arrangement	Wheelbase	Vehicle maximum load capacity	Number of traction batteries	ESS Total Energy Capacity
LRBE64R	6x4	4700 mm (185 inches) 4725 mm (186 inches) 4800 mm (189 inches) 5005 mm (197 inches) 5205 mm (205 inches) 5335 mm (210 inches) 5460 mm (215 inches) 5590 mm (220 inches)	36 t (72,000 lb)	4	265 kWh



T8173078

1 CSU (Charging Switch Unit)
2 24 V system battery (quantity – 2)
3 Traction battery (quantity – 4)
4 EMD (Electric Motor Drive) (for motor) (quantity – 2)
5 EM (Electric Motor) (EM214–240) (quantity – 2)
6 Transmission
7 CCS (Combined Charging System)
8 EMD (Electric Motor Drive) (for ePTO)
9 TVMU (Traction Voltage Monitoring Unit)
10 DC/DC converter (quantity – 2)
11 TVJB (Traction Voltage Junction Box)
12 TVJB (Traction Voltage Junction Box)
13 ePTO

Abbreviations

ABS	Anti-lock Braking System
ATVSA	Automatic Traction Voltage System Activation
BMU	Battery Management Unit (in the ESS)
CAN	Control Area Network
CCS	Combined Charging System
CSU	Charging Switch Unit
Commissioning	Reversing the electrical safety process to return the vehicle to service
Decommissioning	Making the vehicle and personnel electrically safe before carrying out an operation
ECC/MCC	Electronic Climate Control/ Manual Climate Control
ECS	Electronically Controlled Suspension
EM	Electric Motor
EMD	Electric Motor Drive
ESS	Energy Storage System
EVCM	Electromobility Vehicle Control Module
EVAC	Electric Vehicle Air Compressor
FRC	Fuse and Relay Center
HVIL	Hazardous Voltage Interlock Loop
LIN	Local Interconnect Network
LHD	Left-hand drive
LHS	Left-hand side
mech. ePTO	Mechanical Electromobility Power Take-off
OBD	On-board Diagnostic
PCM	Powertrain Control Module
PE	Protective Earth
RHD	Right-Hand Driver
RHS	Right-hand side
SAE	Society of Automotive Engineering
SOC	State of charge
TGW	Telematics Gateway
TVJB	Traction Voltage Junction Box
TVMU	Traction Voltage Monitoring Unit
TVS	Traction Voltage System
VECU	Vehicle Electronic Control Unit
VIN	Vehicle Identification Number

Safety

Safety working rules

This vehicle is equipped with traction batteries and electric motors with a nominal voltage of 600 V.

Note: Contact Mack Trucks dealer for more information on decommissioning/commissioning procedure.

CAUTION
To perform any work on the commissioned vehicle, turn the chassis switch to the off position.

Note: In case of any doubts to perform a specific operation, contact Mack Trucks dealer.

Electrical safety

The electric system of the truck is designed to keep the person safe, as long as the instructions and safety precautions given in this document are followed.

Notes

The traction voltage system

The traction voltage system (600 V), which is used to drive the vehicle contains hazardous voltages. To avoid the risk of electric shock or hazardous electrical burn, follow the instructions and safety precautions.

The electric driveline includes the electric motors and the transmission that are located between the frame rails and to the rear of the cab. The traction batteries are mounted between the LHS of the vehicle chassis and the side protectors, and to the back of cab. In these two areas, and also in the area underneath the cab, there are numerous electrical components (600 V), cables, and connectors.

⚠ DANGER

Risk of electrical discharge
Incorrect handling of the traction voltage system (>60 V DC (Direct Current)) can cause electric shocks and arcs resulting in serious burns or death.
“Do not repair, dismantle, remove or replace any component, cable, connector, cover or electrical traction protection. Any operation must only be carried out by personnel with adequate training according to **Safety regulations, electric vehicles**. ”
Decommissioning and commissioning must only be carried out by personnel with adequate certification according to **Safety regulations, electric vehicles**.
Always use Personal Protective Equipment (PPE) as described in the **Safety regulations, electric vehicles**.
Always use appropriate measuring tools as described in the **Safety regulations, electric vehicles**.

⚠ CAUTION

It is strictly forbidden to connect to the 600 V circuit.

⚠ CAUTION

It is strictly forbidden to move any of the 600 V elements.

⚠ DANGER

Risk of electrical discharge
Do not touch or go near any damaged traction voltage components, cables or connectors.

⚠ WARNING

Risk of serious personal injury
The fans for cooling the traction batteries and other components in the traction voltage system can be energized automatically without any warning, even when the key is removed from the starter switch and the truck is parked.

⚠ WARNING

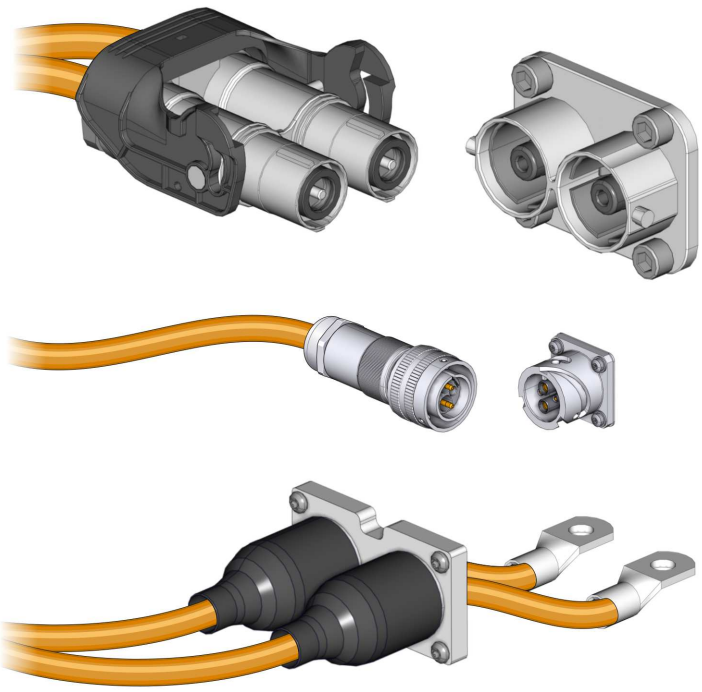
Risk of component damage
Decommissioning incorrectly can result in substantial damage, requiring costly repairs. For this reason, the decommissioning must be performed by a personnel who have received the necessary training (obtained at the Mack Trucks dealer or market company).

Note: The **Safety regulations, electric vehicles** information can be found in IMPACT, under function group 30 and info-type “Repair”.

⚠ DANGER

Risk of electrical discharge
Do not remove any covers, hatches or similar components that are marked with the warning decal.

TVS cables and connectors:



T3169719

Note: All orange colored cables in the vehicle are traction voltage (600 V) cables.

24 V system

⚠ CAUTION

Turn the chassis switch to off position, before performing any work on the 24 V system batteries (two 12 V batteries connected in series).

For any other work related to 24 V and 12 V systems, normal regulation and recommendations apply. Contact Mack Trucks dealer for more information.

Note: It is recommended not to perform any additional installation on the 24 V system.

Chassis switch

600 V is distributed based on few possibilities in the vehicle, for example:

- Key in + after START position, then motor starts
- During traction battery recharging with an offboard charger
- When the temperature of the traction batteries is maintained

A switch is installed in the chassis to stop the possible 600 V distributions in the vehicle (through a controlled shutdown sequence).

CAUTION

To perform any work in the commissioned vehicle, turn the chassis switch to off position.

CAUTION

Turning the chassis switch to off position, does not mean that the vehicle safety decommissioning procedure has been carried out.

CAUTION

Decommissioning and commissioning must only be carried out by personnel with adequate certification.

Position of chassis switch

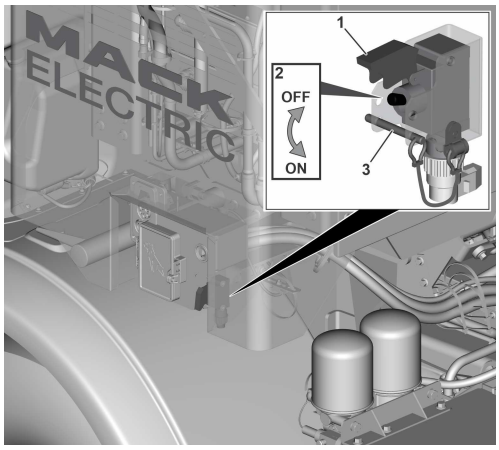
DANGER

If the chassis switch is in the On position, the ATVSA (Automatic Traction Voltage System Activation) function can be automatically activated without any special action being taken and irrespective of the position of the ignition key or of the connection to the offboard charger. There are various reasons why the 600 V circuit may be reactivated (to maintain charge in the 24 V system batteries, to maintain temperature of traction batteries etc.)

CAUTION

The voltage system of the electrical traction network is not energized when the chassis switch is in the off position.

The chassis switch is located on the left-hand side of the truck, next to the offboard charging interface.

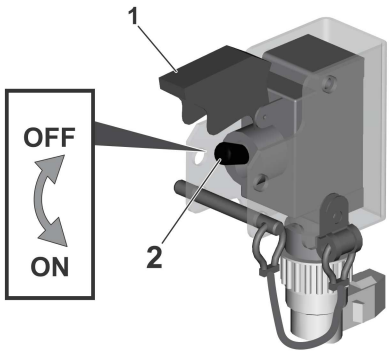


T8173073

1 Cap
2 Chassis switch
3 Lockout pin

When performing any work on the vehicle, to avoid accidental movement of the chassis switch from the off position to the on position, follow these steps:

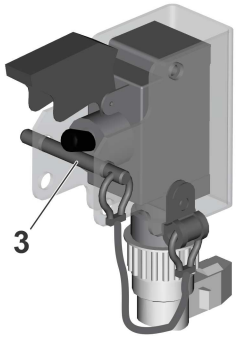
1 Open the cap (1) and move the chassis switch (2) from the on position to off position.



T8173074

Position ON

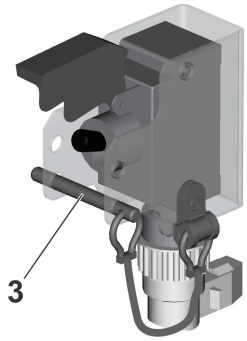
2 Pull the lockout pin (3) from the lower hole of the bracket and insert it into the upper hole of the bracket.



T8173075

Once the work is completed:

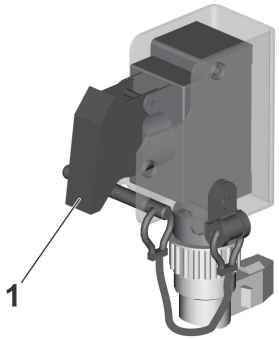
1 Remove the lockout pin (3) from the upper hole of the bracket and secure it in the lower hole of the bracket.



T8173076

2 Turn the chassis switch to an on or off position (based on your needs).

3 Close the cap (1).



T8173077

The lockout pin in the upper hole of the bracket is to restrict the movement of the chassis switch from the off position to the on position. Secure the lockout pin in the lower hole of the bracket when the vehicle is parked or being driven.

Basic principles – Working with lithium-ion batteries

Lithium-ion batteries are electrochemical storage system that use lithium in an ionic form.
The battery cells contain electrodes, an electrolyte (lithium hexafluorophosphate (LiPF6) dissolved in a mixture of organic solvents), and different products providing different chemical and physical characteristics.

Thermal risk

An internal event such as a shutdown (a quality problem, overload, failure in electronic components, etc.) or an external event (excessive external temperature, external fire start, mechanical shock, etc.) may be the origin of a thermal runaway. A battery cell is damaged when its temperature reaches 75 °C (167 °F). Exothermic decomposition reactions may result, leading to fire and/or explosion.

Chemical risk

The chemical products in battery cells can be dangerous to human health and the environment.
Decomposition or combustion products may also present a hazard to human health and the environment. These include hydrofluoric acid, phosphoric acid, fluorine compounds, carbon monoxide, and carbon dioxide. The nature and quantity of the flammable and toxic gases emitted depend on numerous parameters such as the composition of the battery cell (cathode, solvents and electrolyte salt, additives, etc.), the state of charge, the mode of failure, inflammation or not of the gases emitted, etc.

In the event of a fire, smoke or suspicious smell in the truck, it is important to take the correct actions. See the following instructions.

Guidelines for Electrical Accident

One of Mack's core values is safety. This is also reflected in the design of electric vehicles. Provided that the correct routines are followed and appropriate protective measures are taken, there is virtually no risk of electrical accidents.

Although such accidents are unlikely, it is still good to know what to do in case an electrical accident occurs. The following is a general guideline for how to handle such a situation.

1 **Shut off the electric power:** Use the chassis switch to cut off the electric power during emergency.
2 **Attend to the injured and notify rescue services:** Follow local procedures for emergency situations.
3 **Report the accident:** This is an important step in preventing the accident from happening again.

T3170874

Guidelines for Fire Incident

The following guidelines are to be considered general recommendations in case of thermal incidents related to electric vehicles.

In specific cases, other procedures may be more appropriate. Always follow local guidelines and regulations when dealing with thermal incidents.

In case of fires involving electric vehicles:

1 Alert nearby personnel and notify rescue services.
2 Prevent the fire from spreading to the traction batteries if possible. If not possible, evacuate the area.
3 Report the incident according to the current reporting procedure.

T3170875

In case of fire in the traction batteries:

1 Alert nearby personnel and notify rescue services.
2 Evacuate the area.
3 Report the incident according to the current reporting procedure.

T3170876

Fire, smoke, or suspicious smell in or near the traction batteries

DANGER

Risk of serious personal injury or death
Do not try to extinguish the fire yourself.

DANGER

Risk of serious personal injury or death
Do not inhale the smoke, it is very toxic.

If there is a fire in or near the traction batteries, or if smoke is coming from the traction batteries or the area around them, do the following:

1 Evacuate the truck immediately and quickly move away from the truck.
2 Alert anyone that is nearby and secure the area around the truck.
3 Contact the emergency service in the country you are in. Inform them that your electric truck is on fire.

Fire in another part of the truck

If there is a fire in another part of the truck (not in or near the traction batteries), do the following:

1 Get out of the truck immediately.
2 Contact the emergency service in the county you are in. Inform them that your electric truck is on fire.
3 If you think that it is safe and if ABC (powder) extinguisher is available, extinguish the fire other than the traction battery area.
4 If the fire reaches the traction battery area, move away from the truck immediately.

Note: Mack does not offer fire extinguishers with LR electric trucks.

DANGER

Risk of serious personal injury or death
Welding directly on the ESS is not permitted as this can cause dangerous electric shocks, arcing or burns, which can result in serious personal injury or death.

WARNING

Risk of component damage
Failure to follow the following instructions can result in damage to electrical components.

- Welding, in general, is allowed if the vehicle is decommissioned.
- Welding on the frame (in the overhang area) is allowed if the vehicle is decommissioned.
- Welding on the frame (in the wheelbase area) is not allowed – risk of damage to electromobility components, even if decommissioned.

The welding process that applies to conventional trucks also applies to electric trucks.

CAUTION

It is not permitted to weld on this vehicle without decommissioning.

CAUTION

Decommissioning and commissioning must only be carried out by personnel with adequate certification.

- Carry out the vehicle safety decommissioning procedure.
- Welding directly onto electrical components is not permitted.
- Electric components must be given adequate protection if the welding is carried out close to them.
- Ground the welding equipment as close as possible to the welding area.
- Protect the vehicle from splashing, which may occur during welding.

Plasma Cutting

Plasma cutting involves creating a high-voltage circuit between the tool head and the workpiece by grounding the plasma cutter to the workpiece, just like with welding. The only difference is that the current flows through the gas plasma instead of a stick electrode in contact with the workpiece. Therefore,

- Plasma cutting is allowed in general if the vehicle is decommissioned to protect the electromobility components.
- Plasma cutting is allowed on the frame (in the overhang area) if the vehicle is decommissioned.
- Plasma cutting is NOT allowed on the frame (in the wheelbase area) – risk of damage to electromobility components, even if decommissioned.

Notes

Drilling

The drilling process that applies to conventional trucks, also applies to electric trucks.

DANGER

Risk of serious personal injury or death
When drilling, make sure that there are no traction voltage (400/600 V) circuit components that could be damaged.

CAUTION

It is not permitted to drill on this vehicle without decommissioning.

CAUTION

Decommissioning and commissioning must only be carried out by personnel with adequate certification.

Painting

Contact the vehicle manufacturer before carrying out any painting work.

CAUTION

It is not permitted to paint the BEV without decommissioning and also in an enclosed area.

CAUTION

Decommissioning and commissioning must only be carried out by personnel with adequate certification.

CAUTION

To avoid damage to the traction battery (600 V battery), do not exceed the following drying process of the paint:
— The maximum drying temperature (80°C or 176°F).
— The maximum drying time (40 minutes).
If the BEV is painted with more than one color, allow the BEV to cool down to room temperature (20° C or 68°F) before it is sent to the drying oven.

The orange colored cables in the truck are traction voltage (600 V) cables. It is not permitted to paint the orange cables or in any other way that changes their colors.

Towing and shunting

CAUTION

The vehicle is allowed to tow or shut only when the propeller shaft is disconnected from the rear axle. Failure to remove the propeller shaft may cause damage to the transmission and driveline components may damage.

Please see the driver's handbook for more information on towing the vehicle.

Washing

CAUTION

Do not wash the truck if any connectors in the traction voltage system are not fully connected or if the truck is disassembled in any other way.

CAUTION

Before washing the truck, make sure that the cover for the charging interface is securely fastened and fully covers the charging interface.

General

Regular cleaning helps maintain the value of your truck. Wash the truck more often in winter conditions or other dirty driving conditions.

The wastewater from cleaning the truck contains chemicals and pollutants that are bad for the environment. Use environmental friendly detergents and ensure that the truck is cleaned in a facility where the wastewater is collected.

Notes

Washing with high pressure

Be careful when washing the truck with a high-pressure washer. If water and dirt penetrate components, then that can cause damage over time.

Do not use a high-pressure washer to clean the following:

- Traction batteries
- Components in the traction voltage system
- Universal joint crosses
- Support bearings
- Sliding interfaces
- Joints
- Sealings
- Connectors
- Electrical components
- Air inlets
- Ventilation, for example, transmission and oil reservoirs

Tires and air bellows can be cleaned with a high-pressure washer, but do not use pulsating high pressure as it can damage them. The damage is not visible but may eventually cause tires or bellows to rupture.

The radiator can also be cleaned with high pressure, but, be careful as the radiator fins can be easily damaged.

Note: Minimum distance between the high-pressure nozzle and the washing surface:
Approximately 70 cm (27.5 inches) with a round concentrated jet.
Approximately 30 cm (11.8 inches) with a flat widespread jet.

Washing the cab

CAUTION

When washing the windshield, ensure that the windshield wipers are switched off. Otherwise there is a risk of fingers being trapped by the wiper blades.

The truck should be washed when it is dirty. Especially in winter when road salt and moisture can cause corrosion.

The following points must be followed to avoid paint damage and to achieve good results when washing:

- Washing method: Use a pressure washer primarily. For the dirt that cannot be removed using this method, try to remove it with a brush or sponge with a best suited cleaning agent for the type of dirt. There is a risk of scratching the paint using brush washing without high pressure washing or washing in brush washers that are poorly maintained (worn, dirty brushes, etc.).
- Washing chemicals, general: Different agents are recommended for different types of dirt. Always follow the manufacturer's recommendations for use, dosage, and maximum temperature.
- Avoid chemicals drying into the paint surface.
- Washing detergent: Avoid using strong alkaline agents (pH >12). Do not wash the truck in direct sunlight. Rinse with plenty of cold water before chemicals are applied. If the temperature is above (30°), wash small areas and then rinse clean so that long exposure times or drying chemicals are avoided.

Washing the chassis

Both the chassis and the cab should be washed when they are dirty. Be careful with high pressure washing of axles, joints, and other moving parts, where water and dirt can be forced in. Avoid flushing away lubricant. Should this still happen, make sure to relubricate the components.

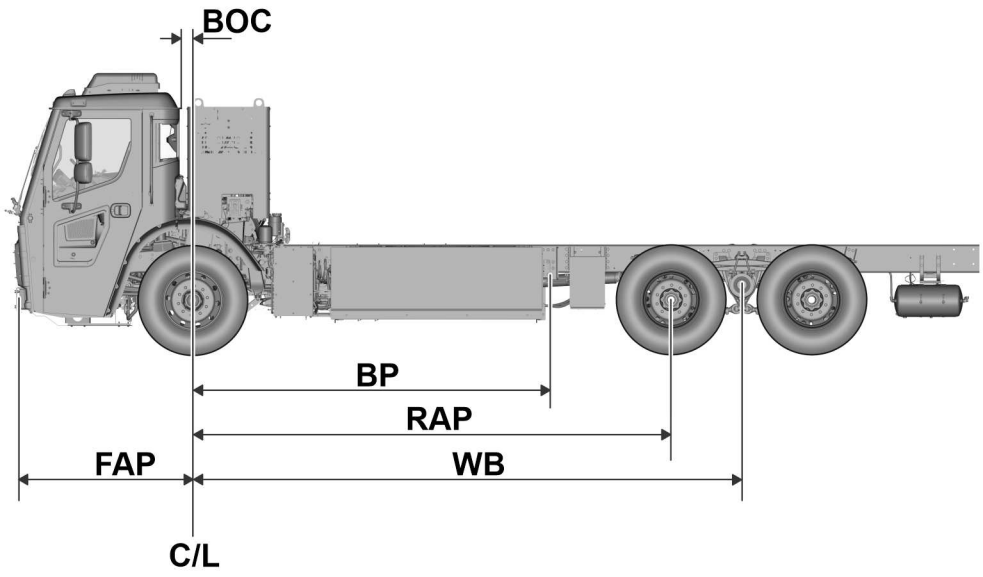
Washing detergent: Avoid using strong alkaline agents (pH >12). Do not wash the truck in direct sunlight. Rinse with plenty of cold water before chemicals are applied. If the temperature is above (30°), wash small areas and then rinse clean so that long exposure times or drying chemicals are avoided. Always rinse with plenty of water after using washing detergent.

Note: Never spray water directly onto the traction batteries or other components in the traction voltage system. Also, do not spray water directly onto sealings, gaskets, or electric equipment (such as cables or connectors) in the 24 V system.

Body attachments

For information about Body Attachments refer the Mack Body Builder manual section 7. **https://www.macktrucks.com/parts-and-services/support/body-builders/manuals/heavy-duty/**

Body start dimensions



T8173206

BP	3503 mm							
BOC	110 mm							
C/L	Centerline of front axle							
FAP	1775 mm							
RAP	4015 mm	4040 mm	4115 mm	4320 mm	4520 mm	4620 mm	4775 mm	4905 mm
WB	4700 mm	4725 mm	4800 mm	5005 mm	5205 mm	5335 mm	5460 mm	5590 mm

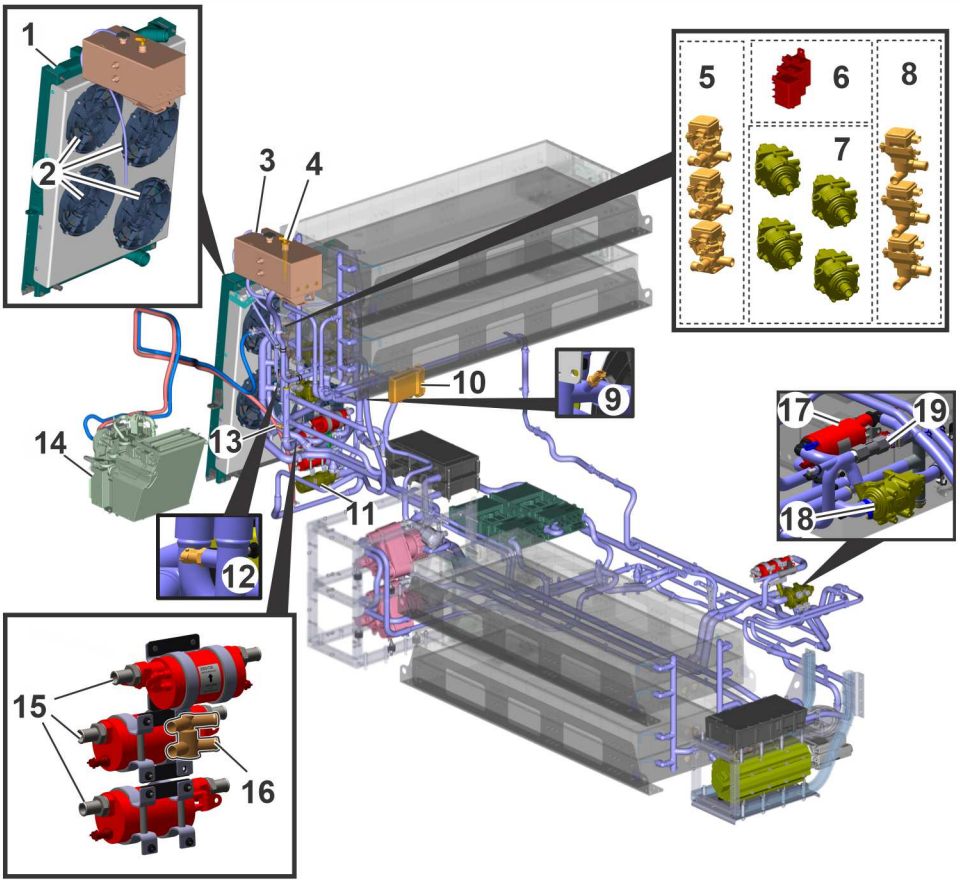
BEV cooling systems

CAUTION

Visually check the coolant level before starting the vehicle.

It is not permitted to connect an additional heating supply to the cooling system in BEV.

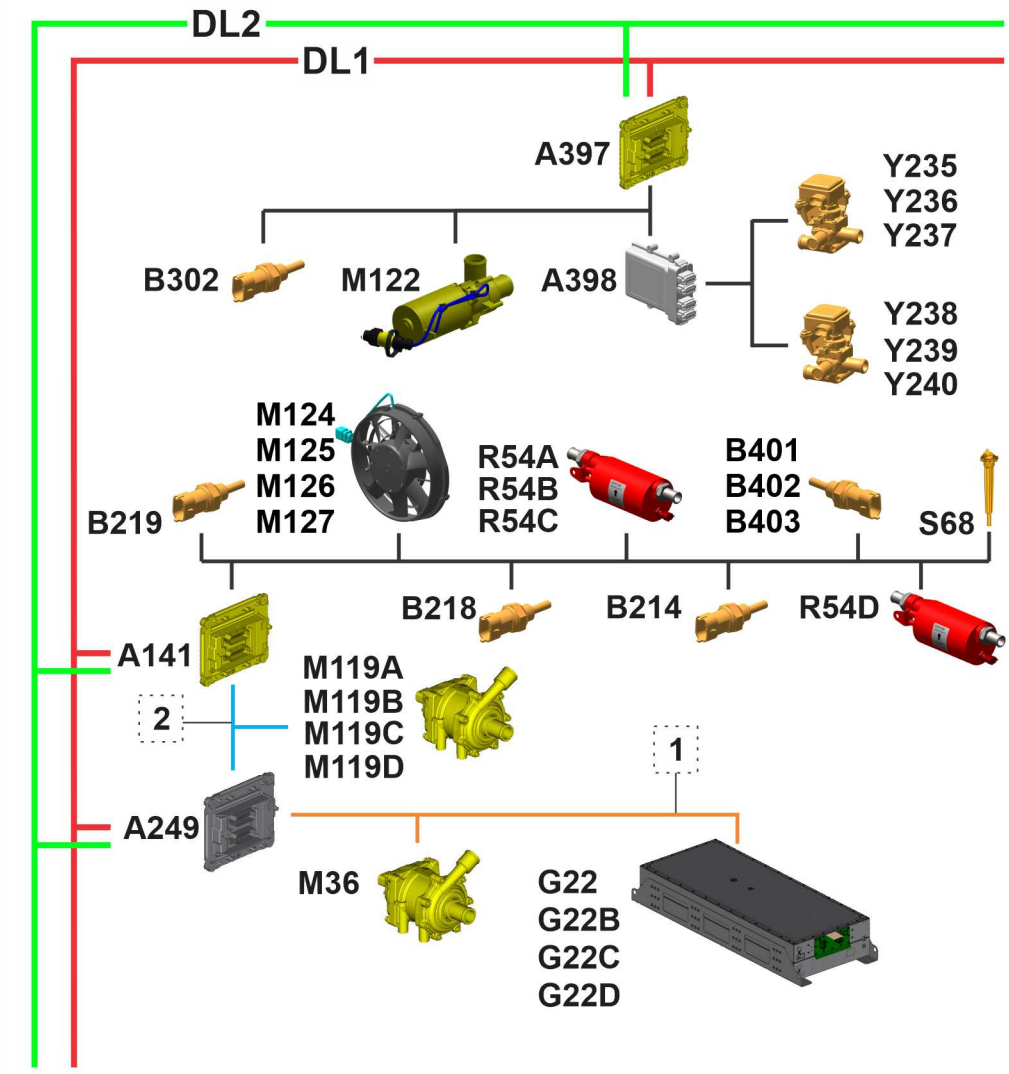
The total volume of coolant in the cooling system is 65 Liters (17.2 US gal.)



T2173207

1. Radiator	6. Heater relay	11. Coolant pump (cab heater)	16. Pressure valve (35 kPa)
2. Electric fan	7. Coolant pump	12. Coolant temperature sensor (traction battery inlet)	17. Traction battery heater
3. Expansion tank	8. Three-way valve (radiator outlet)	13. Coolant temperature sensor (electromobility components outlet)	18. Traction battery coolant pump
4. Coolant level sensor	9. Coolant temperature sensor (coolant pump outlet)	14. Climate unit	19. Check valve
5. Three-way valve (radiator inlet)	10. Cooling/conversion box	15. Cab heater	

Cooling system CAN (Controller Area Network) subnet

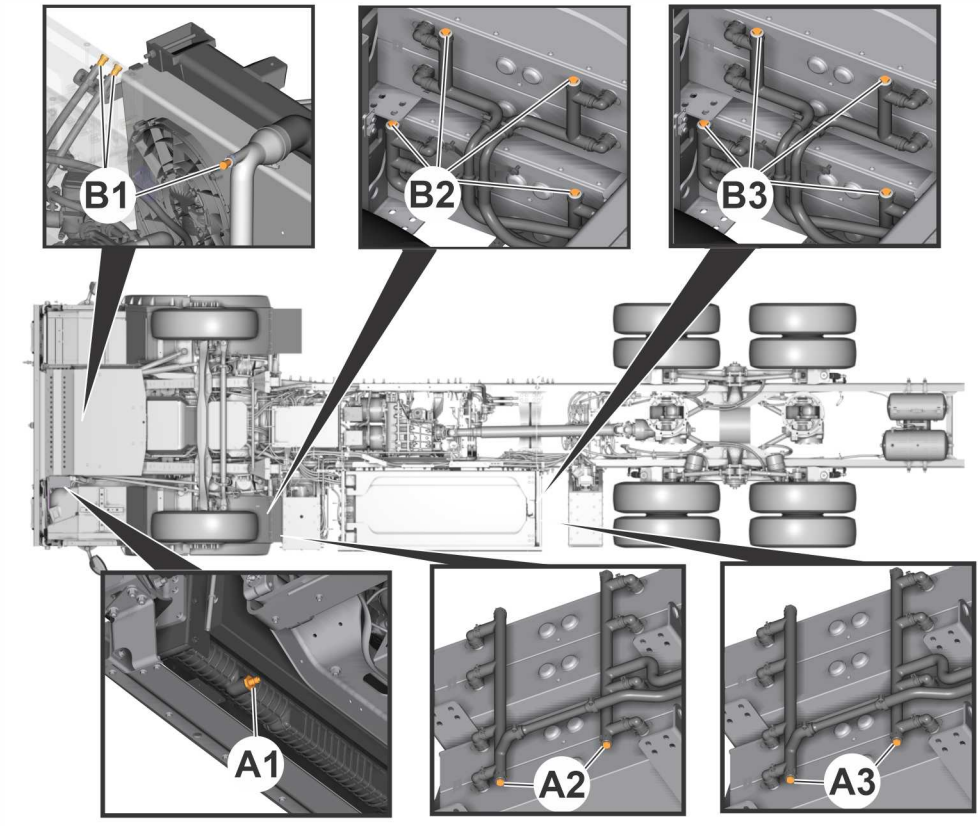


T2173208

DL 1	Data Link 1 (J1939)		B302	Coolant temperature sensor (electromobility components outlet)
DL 2	Data Link 2 (J2284)		G22, G22B, G22C, G22D	Traction battery
1	Electric propulsion subnet 1		M124, M125, M126, M127	Fan
2	Electric propulsion subnet 4		M119A, M119B, M119C, M119D	Coolant pump
A141	HPCU (Hybrid Powertrain Control Unit		M36	Coolant pump (Traction battery)
A249	ESCM (Energy Storage Control Module)		M122	Cab heater pump

A397	EVCM (Electromobility Vehicle Control Module)		R54A, R54B, R54C	Cab heater
A398	Cooling/conversion box		R54D	Traction battery heater
B401, B402, B403	Temperature sensor (cab heater)		S68	Coolant level sensor
B219	Temperature sensor (ESS (Energy Storage System) heater)		Y235, Y236, Y237	Three-way valves (radiator inlet)
B218	Coolant temperature sensor (coolant pump outlet)		Y238, Y239, Y240	Three-way valves (radiator outlet)
B214	Coolant temperature sensor (traction batteries inlet)			

Coolant draining and bleeding points



T2173209

A1	Drain plug (Radiator lower tank)
A2, A3	Drain screw, ESS (bottom side)
B1	Bleeder screw (front)
B2, B3	Bleeder screw (ESS cooling pipe)

Available cooling functions in the various truck modes

Truck Mode	Function				
	Traction Battery Heating	Cab Heating	Traction Battery Cooling	Electromobility Components Cooling	Air Conditioning
Running	X	X	X	X	X
Preconditioning	X		X	X	
Charging	X		X	X	
After-run	X		X	X	
Workshop	X		X		

The truck modes are:

1 **Running:** The truck driveline is active. The driver is operating the truck.

2 **Preconditioning:** The truck is parked and it prepares for the next task by ensuring the right level of temperature in the driveline and traction batteries.

3 **Charging:** The truck is parked and the charging connector is connected to an external source to charge the traction batteries.

4 **After-run:** The truck is not plugged in for charging. This mode maintains the temperature of cooling system within the specified limit to ensure the truck reliability and lifetime.
If cooling is needed, this mode is activated during every key-off. The main coolant pumps are kept activated at 50% for five minutes during every key-off. This is to reduce the number of pressure cycles in the radiator to limit risks.

5 **Workshop:** The truck is not plugged in for charging. It helps support various workshop operations.
There are two sub-modes:

- **Filling:** All three-way valves are set to 50% valve opening.
- **Deaerating:** The cooling system activates every 2 minutes.

When the starter switch is turned off and the chassis switch is closed (down position), the ATVSA (Automatic Traction Voltage System Activation) monitors the post-run modes and controls the cooling and heating in the electric truck.

Notes

CAUTION

Follow the parking recommendations whenever the vehicle needs to park for a longer period.
Failure to follow the parking recommendations can fully discharge the traction batteries and 24 V system batteries.

Battery Charging

24 V System Batteries Charging

The 24 V system has two 12 V batteries connected in series to provide a 24 V output. This system uses a battery analyzer to equalize the voltage between the two 12 V batteries.

The traction batteries charge the 24 V system batteries through the DC/DC converter. The DC/DC converter steps down 600 V from the traction batteries to 24 V to charge the 24 V system batteries. When the 24 V system batteries are fully discharged, always disconnect the battery cables and charge each battery separately. This prevents damage to other system circuits from the voltage coming into the battery.

Traction Battery Charging

CAUTION

Follow the parking recommendations whenever the vehicle needs to park for a longer period.
Failure to follow the parking recommendations can fully discharge the traction batteries.

Note: If the 24 V system batteries are fully discharged due to any unnoticed battery consumption or for any other reason, then it is important to charge the 24 V system batteries before charging the traction batteries.

Charging

There are two ways to charge the traction batteries:

- Charging while driving – recovery of braking energy (refer driver handbook)
- DC charging – upto 150 kW.

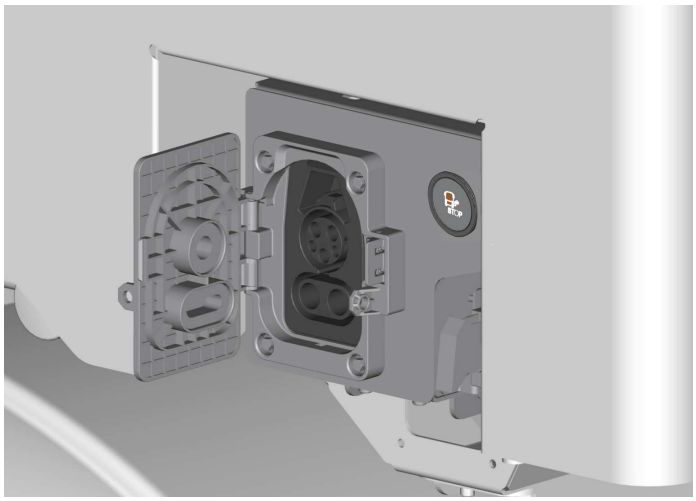
The actual time it takes to fully charge the traction batteries depends on the following conditions:

- The capacity of the traction batteries
- The current state of charge of the traction batteries
- The capacity of the charging station and the charging infrastructure
- The ambient temperature

The optimum charging strategy for the truck depends on the truck specification and how it is used. Contact Mack Trucks dealer for more information.

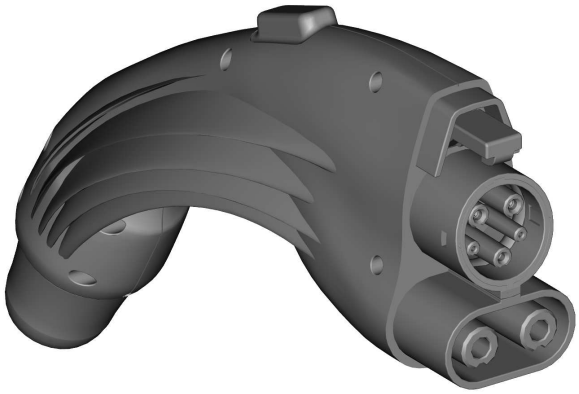
Charging interface and charging connector

The CCS1 is a charging interface between a charging station or power outlet and a vehicle. The CCS1 charging interface is compatible with the combo-1 connector. The combo-1 connector supports only DC charging.



T3173396

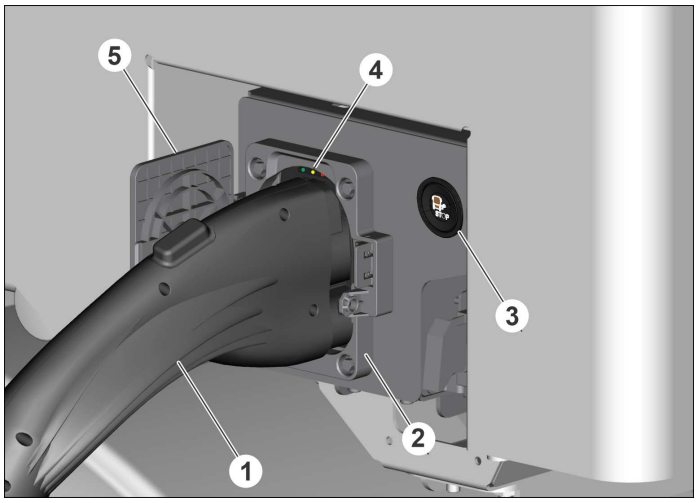
CCS1 charging interface



T3166316

Combo-1 Connector

Start charging



T3173395

1 Charging connector
2 Charging interface
3 Charging stop button
4 LED Indicators
5 Charging interface cover

The following conditions must meet to start charging the traction batteries:

- The truck is stationary
- The parking brake is applied
- The chassis switch is in On position (the switch lever pointing downwards)

DANGER

Risk of electrical discharge.
Damaged charging cable, connector, and charging interface can cause electric shocks and arcs resulting in serious burns or death.
Ensure that the charging cable, connector, and charging interface are not damaged, dirty, or wet.
Do not use charging equipment that is in bad condition.
Report to the responsible person if any damage is found.

DANGER

Risk of electrical discharge.
Cleaning the dirty or wet charging interface may cause electric shocks and arcs resulting in serious burns or death.
Do not attempt to clean the dirty charging interface.
Contact your local Mack Trucks dealer.

1 Ensure that the charging cable is properly connected to the charging station or power outlet.
2 Open the cover of the charging interface.
3 Align the connector with the charging interface and push the connector fully into the charging interface.

Note: To initiate charging, the charging connector must be connected to the charging interface properly.

When charging is initiated, the yellow LED in the charging interface blinks.

Note: It can take up to 15 seconds for the truck to prepare for charging.

4 If charging starts automatically, wait for the blinking yellow LED to switch to the blinking green LED.

If charging does not start automatically, wait for the blinking yellow LED to turn into a steady yellow LED, and then start the charging from the charging station.

5 During charging, the green LED blinks. When the traction batteries are fully charged, the blinking green LED turns into a steady green LED.

Note: During charging, it is normal for the connector and the charging interface to become warm. If the connector or the charging interface appears to be warmer than normal, stop the charging immediately. Contact your local authorized Mack Trucks dealer.

Stop charging

1 Press the stop button.

Wait until the yellow LED turns on and shows a steady light. Ensure that the locking pin is retracted and the charging is stopped.

2 Wait until the yellow LED turns off, and then disconnect the charging connector from the charging interface.

If you are not able to disconnect the charging connector, retract the locking pin manually. Perform the procedure given in the “Manually retracting the locking pin”, page 33 section.

3 Close the charging interface cover.

WARNING

Ensure that the cover is closed properly and it fully covers the charging interface. The cover protects the charging interface from dirt and water.

Signals during charging

The LED indicators in the charging interface give basic information about the charging.

LED Indicator Color	Steady/Blinking	Description	Action Required
Green	Steady	The traction batteries are fully charged	Disconnect the charging cable if you want to drive away, otherwise no action is needed
Green	Blinking	Charging is about to start or charging	No action is needed
Yellow	Steady	Charging is paused	Truck or charger has paused charging: If possible, start the charging from the charging station. If it is not possible to start the charging, wait for the scheduled charging to begin
		Charging stop switch is pressed	Disconnect the charging cable
Yellow	Blinking	A charging cable is connected to the charging interface but the charging has not started yet	Wait for the charging to start automatically or, if needed, start the charging from the charging station
Red	Steady	A fault prevents charging	Check that the charging equipment is in good condition and properly connected. Also, check that the charging station is connected to the mains and is working. Contact the authorized Mack dealer if the fault remains
Red	Blinking	The conditions are not met to start charging the traction batteries	Check the following: • Parking brake is applied • Chassis switch is in the On position • Truck is stationary

Accident While Charging

If the vehicle is involved in an accident while charging:

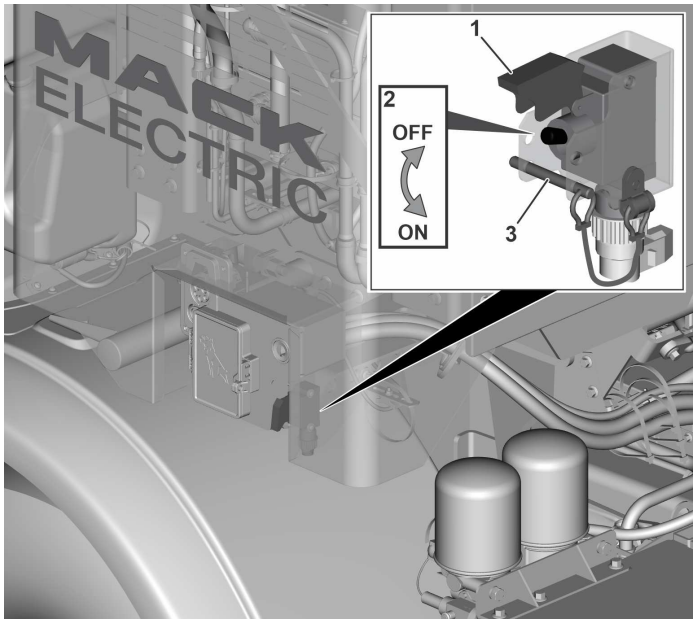
- Press the charging stop button and wait for the steady yellow LED.
- Wait until the steady yellow LED turns off, disconnect the charging connector from the charging interface.
- If the charging connector is not disconnected, retract the locking pin manually. Perform the procedure given in the “Manually retracting the locking pin”, page 33 section.

Manually retracting the locking pin

When the stop button is pressed and if the locking pin does not retract automatically, then manually retract the locking pin.

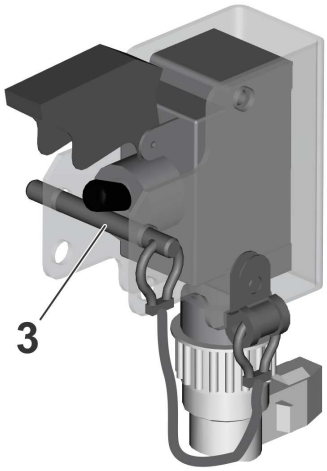
⚠ WARNING
Risk of arc flash. Turn off the chassis switch before manually retracting the locking pin.

1 Open the cap (1) and turn off the chassis switch (2).



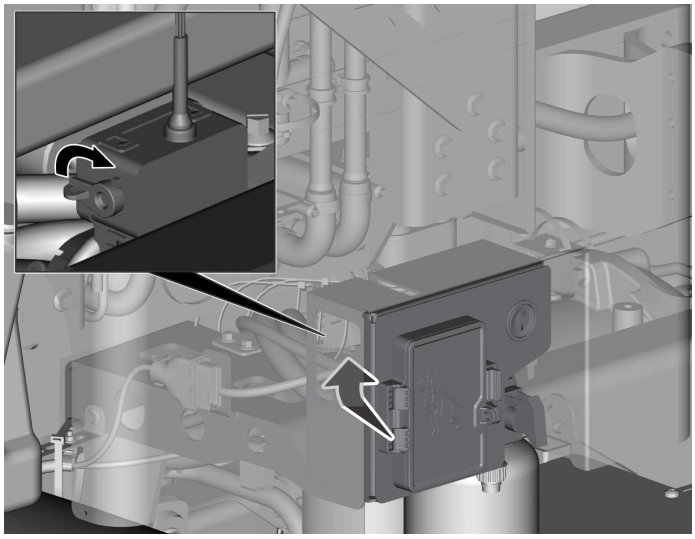
T8173073

2 Pull the lockout pin (3) from the lower hole of the bracket and insert it into the upper hole of the bracket.



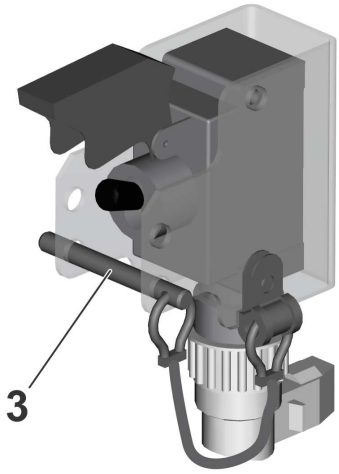
T8173075

3 Rotate the lever and remove the charging connector.



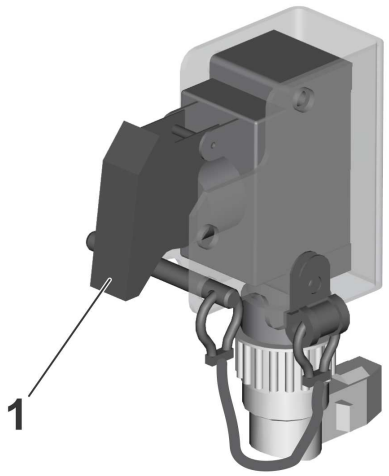
T3173397

4 Pull the lockout pin (3) from the upper hole of the bracket and insert it into the lower hole of the bracket.



T8173076

5 Turn On the chassis switch and close the chassis switch cover (1).



T8173077

Notes

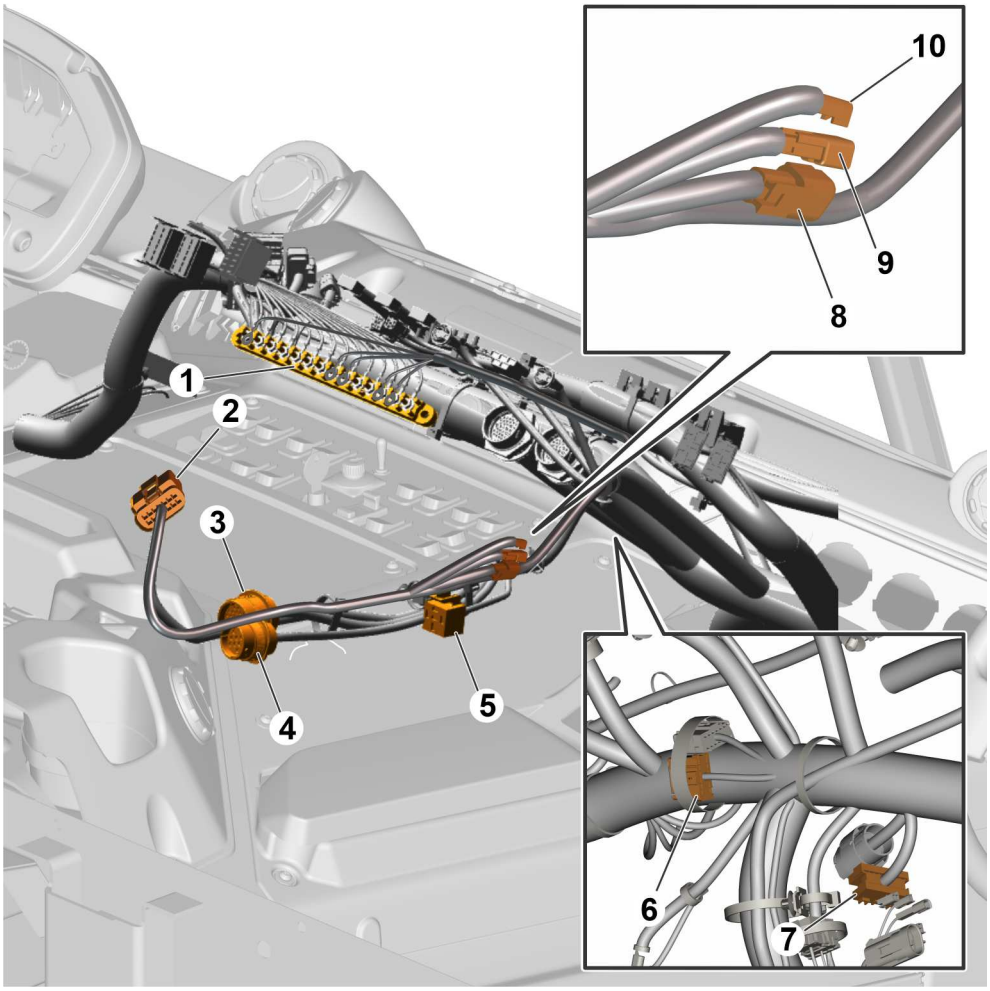
Parking recommendation

<table>
<tr><th>Description</th><th>Action when parking</th><th>Action when start</th></tr>
<tr><td>Parking the truck less than eight hours</td><td>Check the SOC (SOC must be a minimum of 50%).
If the SOC is less than the minimum, charge the traction batteries to 50% and disconnect the charger from the truck before parking. Do not disconnect the 24 V system batteries. Do not turn off the chassis switch.
or
Connect the charger to the truck during parking. Do not disconnect the 24 V system batteries. Do not turn off the chassis switch.</td><td rowspan="2">If the truck is connected to the charger, disconnect the charger.
CAUTION
Charge the traction batteries as soon as possible if the SOC warning lamp turns on in the instrument cluster.
WARNING
Do not start the truck if the SOC warning lamp flashes in the instrument cluster. Charge the traction batteries immediately.</td></tr>
<tr><td>Parking the truck less than two days</td><td>Check the SOC (SOC must be a minimum of 75%). If the SOC is less than the minimum, charge the traction batteries to 75% and disconnect the charger from the truck before parking. Do not disconnect the 24 V system batteries. Do not turn off the chassis switch.
or
Connect the charger to the truck during parking. Do not disconnect the 24 V system batteries. Do not turn off the chassis switch.</td></tr>
<tr><td rowspan="2">Parking the truck less than one week</td><td>Ambient Temperature above -10°C (14°F):
Check the SOC (SOC must be 100%). If the SOC is less than the 100%, charge the traction batteries to 100% and disconnect the charger from the truck before parking. Do not disconnect the 24 V system batteries. Do not turn off the chassis switch.
or
Connect the charger to the truck during parking. Do not disconnect the 24 V system batteries. Do not turn off the chassis switch.</td><td>If the truck is connected to the charger, disconnect the charger
CAUTION
Charge the traction batteries as soon as possible if the SOC warning lamp turns on in the instrument cluster.
WARNING
Do not start the truck if the SOC warning lamp flashes in the instrument cluster. Charge the traction batteries immediately.</td></tr>
<tr><td>Ambient Temperature below -10°C (14°F):
Check the SOC (SOC must be 100%). If the SOC is less than the 100%, charge the traction batteries to 100% and disconnect the charger from truck before parking. Do not disconnect the 24 V system batteries. Do not turn off the chassis switch. Check the SOC of the traction batteries once in every two</td><td>To restart the vehicle after a week long parking at ambient temperature of below -10°C (14°F):
Connect the charger to the vehicle at least 12 hours before operation. Ensure that the chassis switch is on position.</td></tr>
</table>

	days and charge the traction batteries if the SOC is less that 50%. **Note:** Do not connect the charger to the vehicle during parking when the ambient temperature is below -10°C (14°F).	
Parking the truck more than one week	Check the SOC (SOC must be a minimum of 20%). If the SOC is less than the minimum, charge the traction batteries to 20% and disconnect the charger from the truck before parking. Turn off the chassis switch and disconnect the 24 V system batteries. If possible, avoid parking at hot environment.	**To restart the vehicle after a long parking:** • Connect the 24 V system batteries. • Turn on the chassis switch and connect the charger to the vehicle before starting the vehicle.
		To restart the vehicle after a week long parking at ambient temperature of below -10°C (14°F): • Connect the 24 V system batteries. • Turn on the chassis switch and connect the charger to the vehicle at least 12 hours before operation.

Notes

Body builder connectors, cab



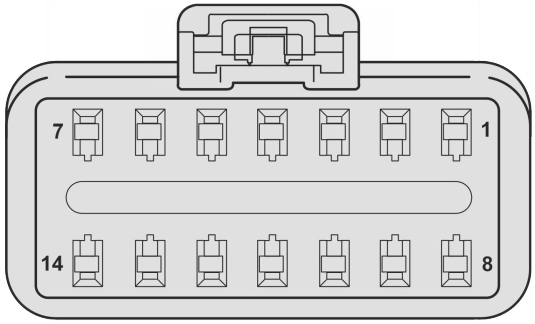
T3173643

1	Body builder junction block (X175)		6	Split Connector, Ground (X111)
2	Vehicle accessory connector (TMC RP1226 (A175A))		7	DCL connector (X21B)
3	TMC RP170 power (X21H)		8	Termination resistor (R08G)
4	TMC RP170 powertrain (X21F)		9	BBM-1939 socket
5	Relay (RLY95)		10	BBM-1939 plug

Vehicle Accessory Connector (RP1226)

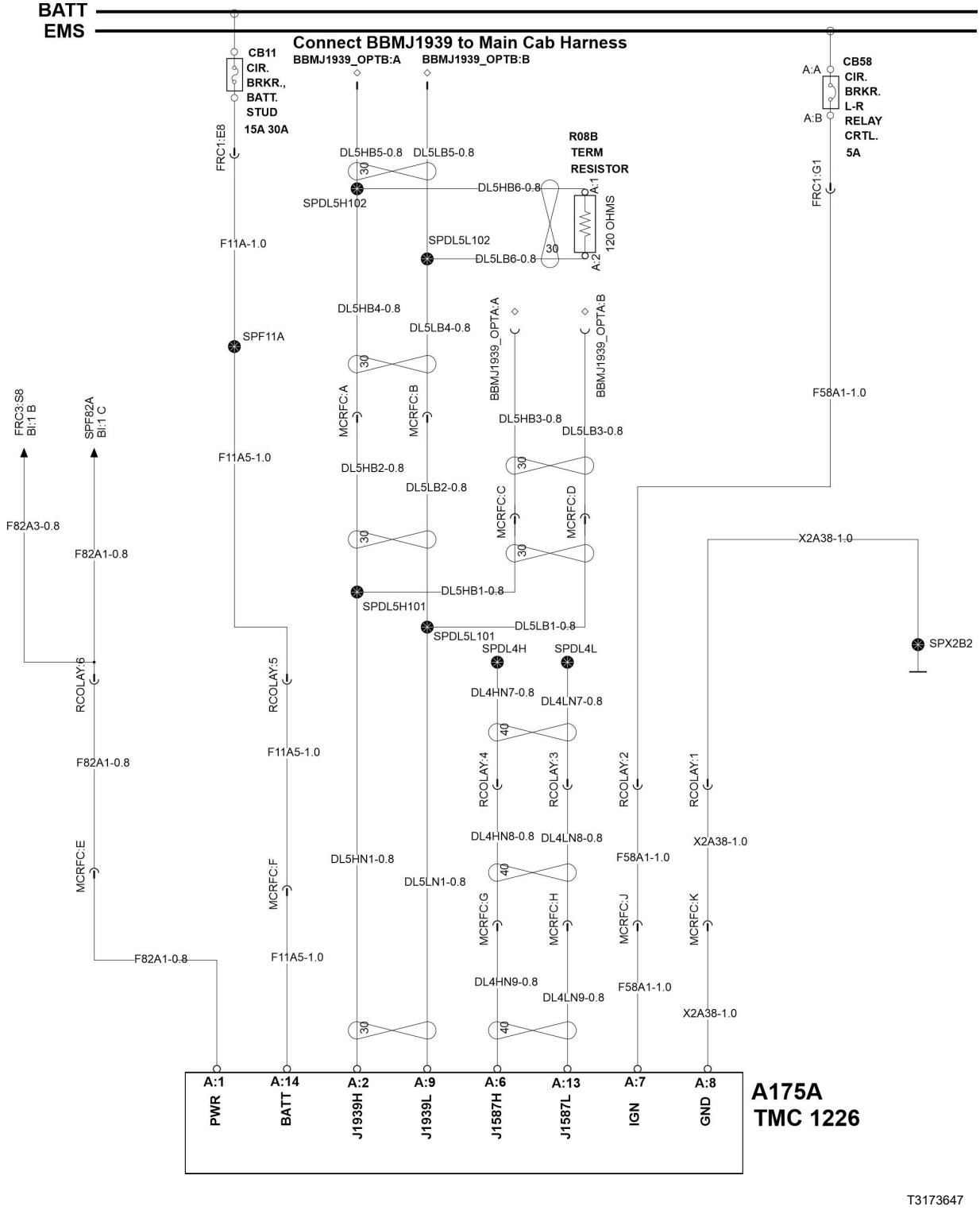
A TMP RP1226 Connector is used to connect an aftermarket Fleet Management device. Examples of aftermarket Fleet Management devices are telematics devices, drive camera, data logging equipment, tire pressure monitors and electronic logging devices (ELDs), etc.

Part name	Part number
Vehicle Accessory Connector (RP1226)	20734993



T3159520

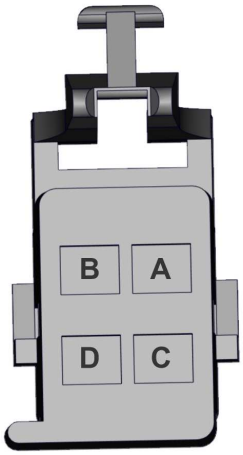
Pin numbers	Description
1	+12 V After battery switch (10 A shared)
2	CAN-1 High
3	—
4	—
5	—
6	J1587H
7	+12 V After ignition (10 A shared)
8	Ground
9	CAN-1 Low
10	—
11	—
12	—
13	J1587L
14	+12 V Battery (10 A shared)



Note: Remove the R08B resistor whenever the body builder is connecting to DL5 data link.

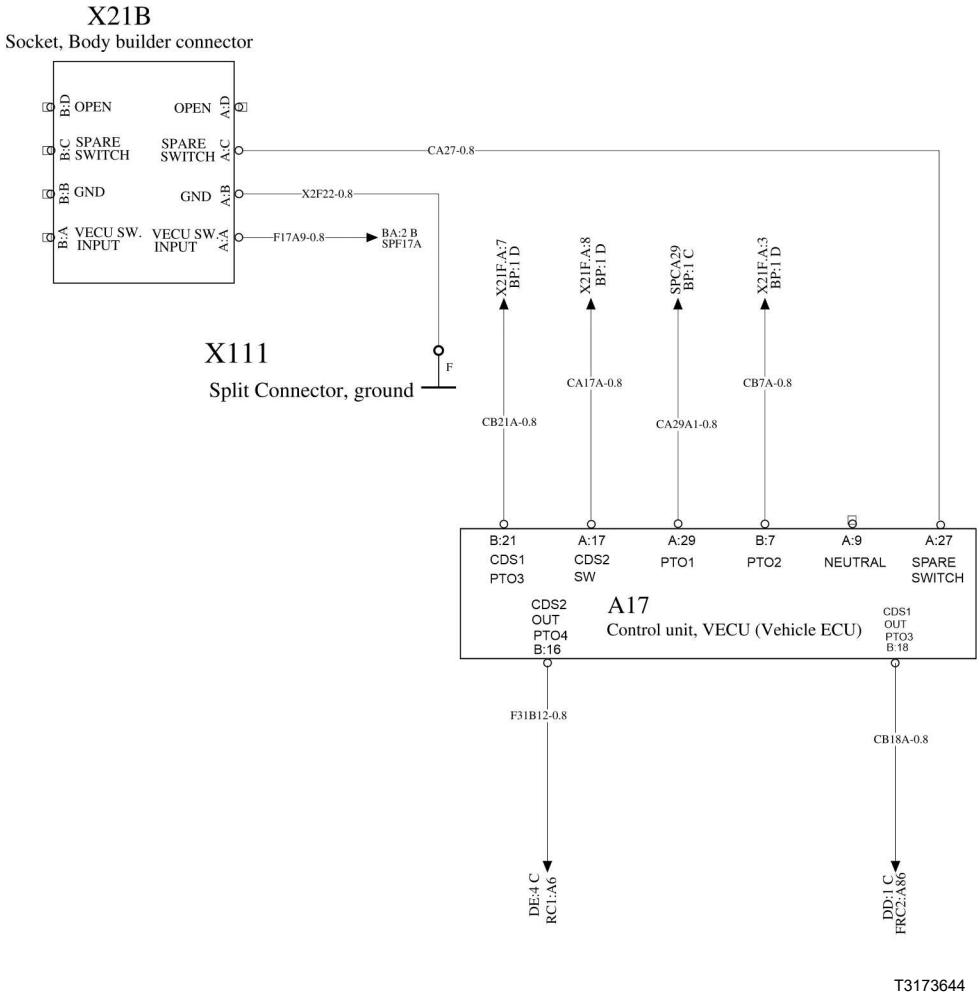
DCL Connector (X21B)

Part name	Part number
DCL Connector (X21B)	20579132



T3174266

Pin	Description
A	VECU switch input
B	Ground
C	Spare switch
D	Open

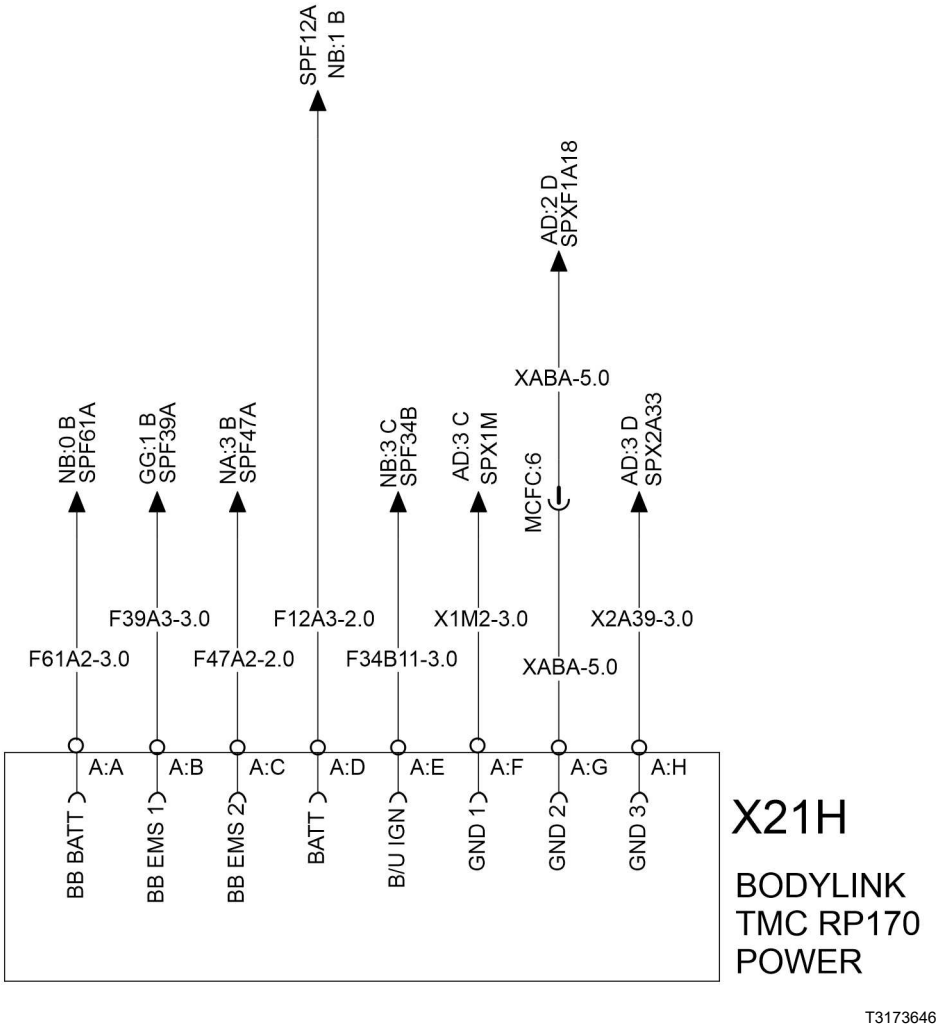


TMC RP170 Power (X21H)

Part name	Part number
TMC RP170 8-pin connector (X21H)	21811872

T3174268

Pin	Source	Type	Ampere rating	Wire gauge	Description
A	Chassis	Power	20	12	Battery (+) through the disconnect switch (If the disconnect switch is specified)
B	Chassis	Power	20	12	Start controlled battery (+) through the disconnect switch (If the disconnect switch is specified)
C	Chassis	Power	20	12	Start controlled battery (+) through the disconnect switch (If the disconnect switch is specified)
D	Chassis	Power	15	14	Battery (+) constant Hot
E	Chassis	Power	25	12	Start controlled battery (+) controlled through reverse circuit
F	Chassis	Ground	25	12	Ground (-) Battery Direct
G	Chassis	Ground	25	12	Ground (-) Battery Direct
H	Chassis	Ground	25	12	Ground (-) Battery Direct
Chassis side connector: HDP24-18-8SN (Variation for seals (N,E)) Body builder connector: HDP26-18-8PN (Variation for seals (N,E))					



Note: Refer to the wiring diagram section of the LR Electric for the wiring schematics of power connections (body builder).

TMC RP170 Powertrain (X21F)

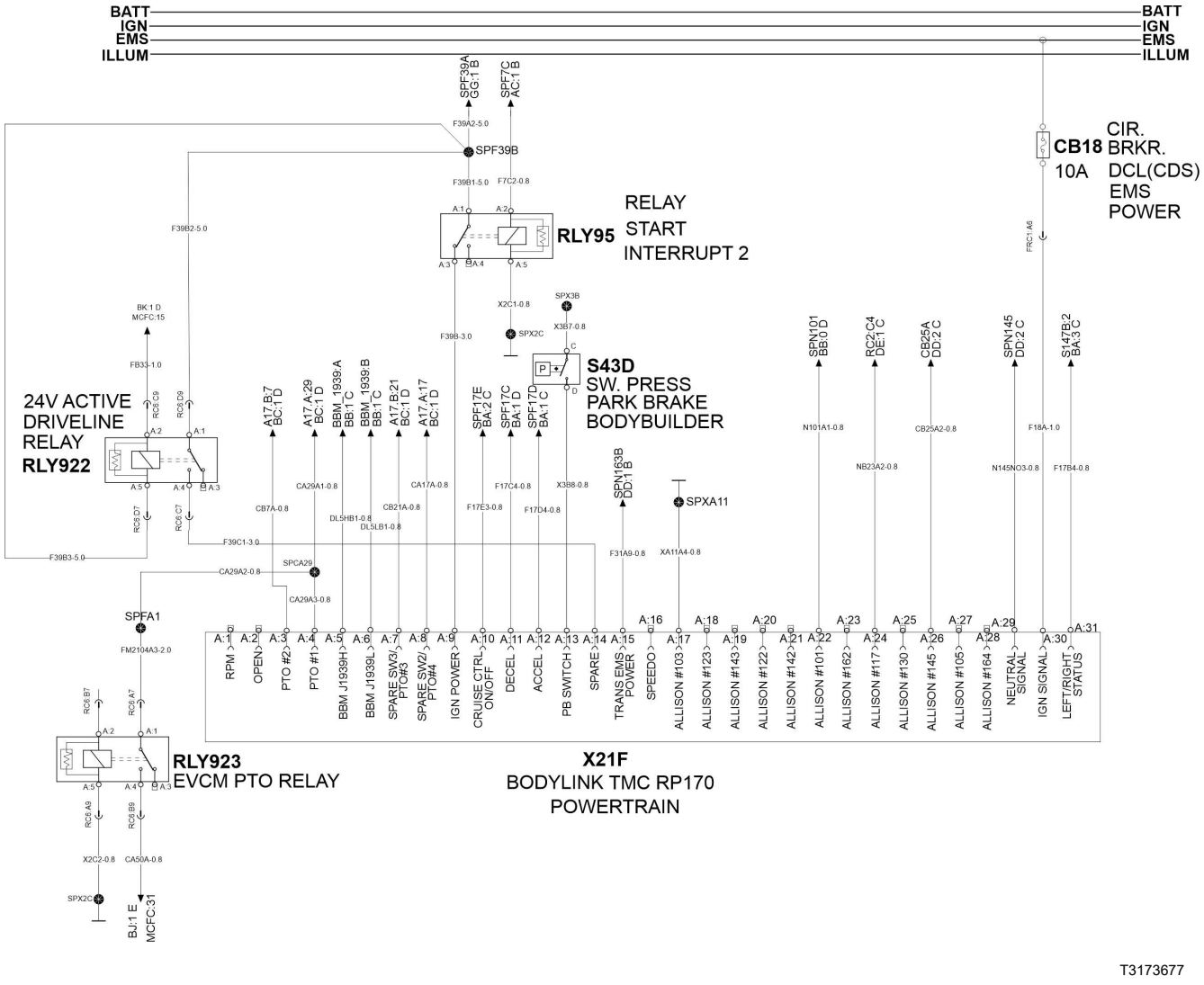
Part name	Part number
TMC RP170 31-pin connector (X21F)	21402251

T3174267

Pin		Source	Type	Function	Ampere rating	Wire gauge	Description
A:1	-	-	-	-	-	-	-
A:2	-	-	-	-	-	-	-
A:3	Throttle limit	Electric motor	Power	Input	0.1	18	Electric motor speed is limited to programmed value. The programmed limited value of electric motor is also used to limit the value of road speed limit. These two features are mutually exclusive. **Note:** Short to pin 9
A:4	Throttle advance	Electric motor	Power	Input	0.1	18	Electric motor speed jumps to programmed value **Note:** Short to pin 9
A:5	J1939	Electric motor	Power	Communi-cation	0.1	18	CAN H
A:6	J1939	Electric motor	Ground	Communi-cation	0.1	18	CAN L
A:7	Throttle Interlock	Electric motor	Ground	Input	0.1	18	Disables the primary accelerator **Note:** Short to pin 9
A:8	Road speed limit	Electric motor	Ground	Input	0.1	18	Road speed is limited to programmed value. The

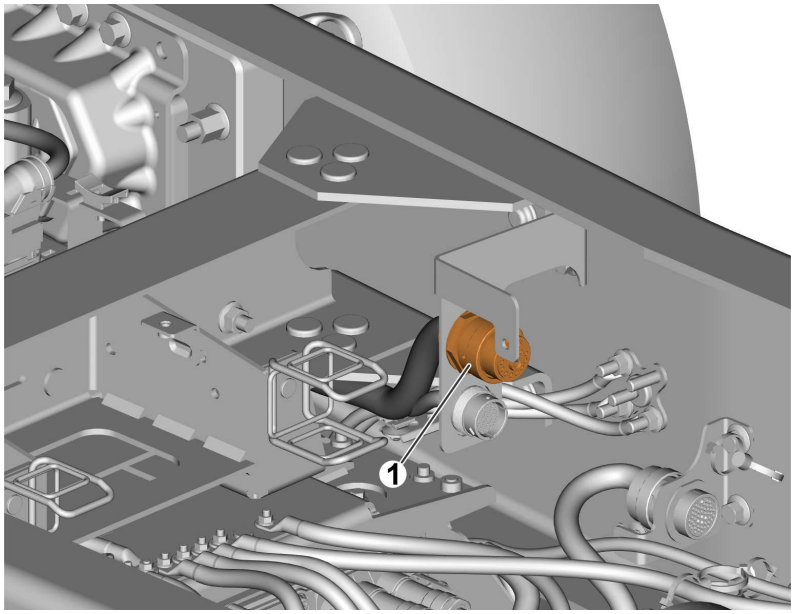
							RSL is mutually exclusive with Throttle limit (PIN A:3) **Note:** Short to pin 9
A:9	Input Reference	Electric motor	Reference	Electronic reference	1	18	ECU reference
A:10	Input 3	Electric motor	Signal	Reserved input	0.1	18	Reserved: This pin is not required for all applications. It is reserved as an optional input for applications that will utilize this feature. This will set or decrease road or electric motor set speed. **Note:** Short to pin 9
A:11	Input 4	Electric motor	Signal	Reserved input	0.1	18	Reserved: This pin is not required for all applications. It is reserved as an optional input for applications that will utilize this feature. This will set or decrease road or electric motor set speed. **Note:** Short to pin 9
A:12	Input 5	Electric motor	Signal	Reserved input	0.1	18	Reserved: This pin is not required for all applications. It is reserved as an optional input for applications that will utilize this feature. This will resume from a dropout of cruise or electric motor speed control or will increase set speed **Note:** Short to pin 9
A:13	Input 6	Vehicle	Signal	Parking brake applied	0.1	18	Ground signal is activated when the parking brake is applied
A:14	Driveline active	Spare	Spare	Spare	0.1	18	Active high when driveline engaged
A:15	Input reference	Transmis-sion	reference	electronic +12 V reference	1	18	+12V reference
A:16	Speedom-eter	Transmis-sion	Signal	Speedom-eter pulse	0.1	18	0 - (Vbat-2)V pulse. 50% duty cycle square wave. Pulses per rev adjusted via software.
A:17	TCM common	Transmis-sion	Ground	Electronic ground reference	1	18	TCM ground reference
A:18	-	-	-	-	-	-	-

A:19	-	-	-	-	-	-	-
A:20	-	-	-	-	-	-	-
A:21	-	-	-	-	-	-	-
A:22	Program input 6	Transmission	Signal	Shift selector transition type	0.1	18	short to pin 17
A:23	-	-	-	-	-	-	-
A:24	Program input 10	Transmission	Signal	Auto neutral type	0.1	18	short to pin 17
A:25	-	-	-	-	-	-	-
A:26	Program output 3	Transmission	Signal	Neutral indicator type	0.5	18	When the transmission is in neutral, the TCM activates this function to switch the wire from open to ground. The TCM also switches the wire from open to ground when the Auto Neutral function is active.
A:27	-	-	-	-	-	-	-
A:28	-	-	-	-	-	-	-
A:29	Program output 7	Transmission	Signal	Neutral indicator output	2	18	+12V neutral indicator
A:30	reference	vehicle	reference	+12V propulsion system start signal	5	18	+12V propulsion system start reference
A:31	-	-	-	-	-	-	-
Chassis side connector: HDP24-24-31SE Body builder connector: HDP26-24-31PE							



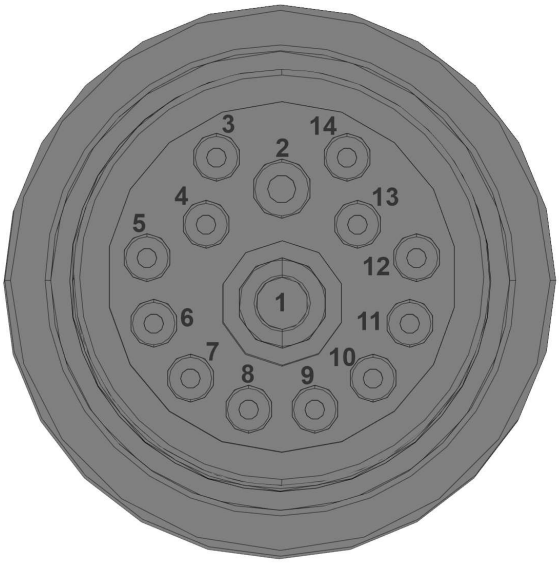
Body builder connector, chassis

TMC RP170 Lighting (X21G)



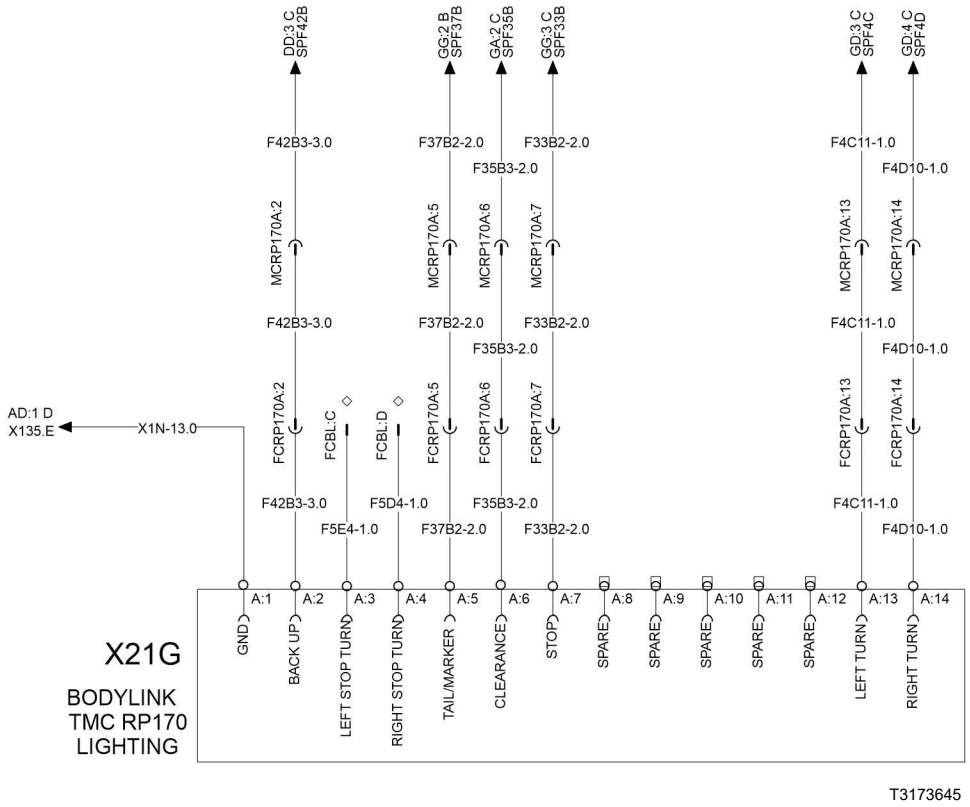
T3174248

1 TMC RP170 lighting (X21G)



T3174249

Pin	Description
A:1	Ground
A:2	Back up
A:3	Left stop turn
A:4	Right stop turn
A:5	Tail marker lamp
A:6	Clearance lamp
A:7	Stop lamp
A:8	Spare
A:9	Spare
A:10	Spare
A:11	Spare
A:12	Spare
A:13	Left turn
A:14	Right turn



Note: Refer to the wiring diagram section of the LR Electric for the wiring schematics of lighting connections (body builder).

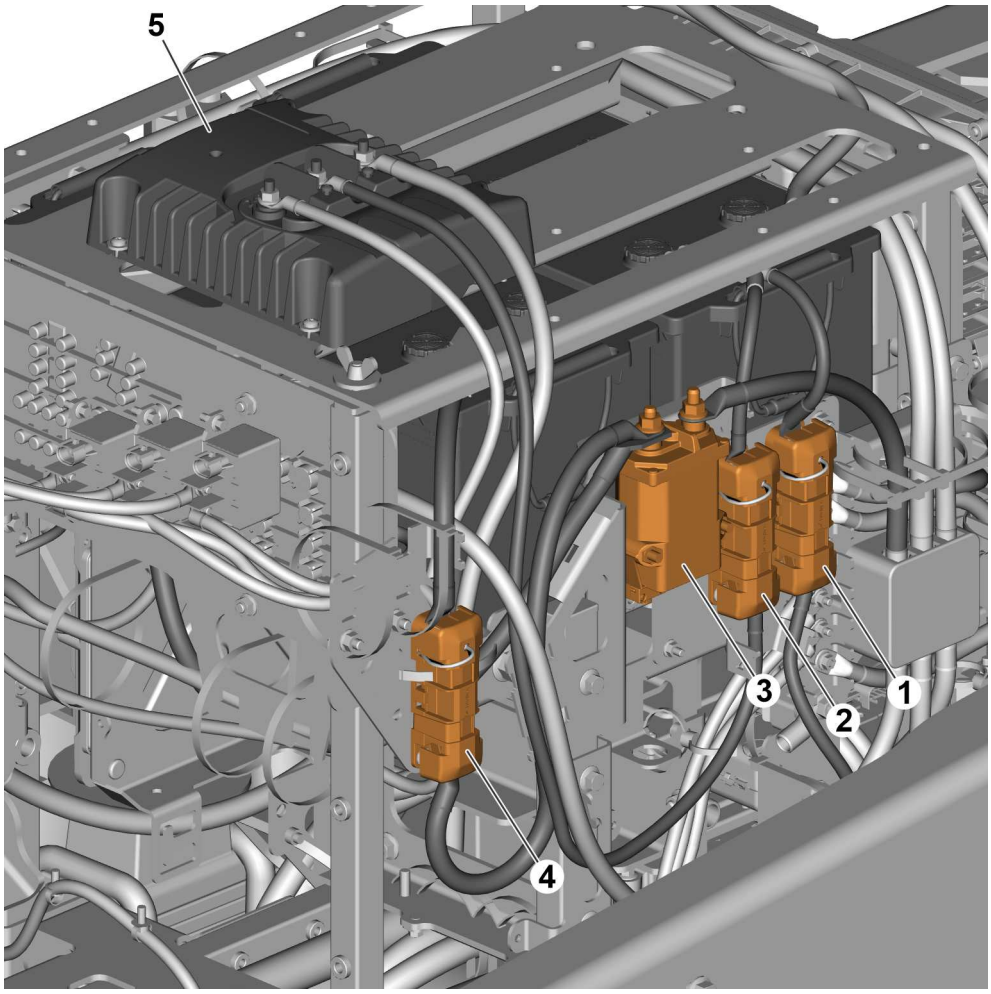
Notes

Fuse and relay box

WARNING

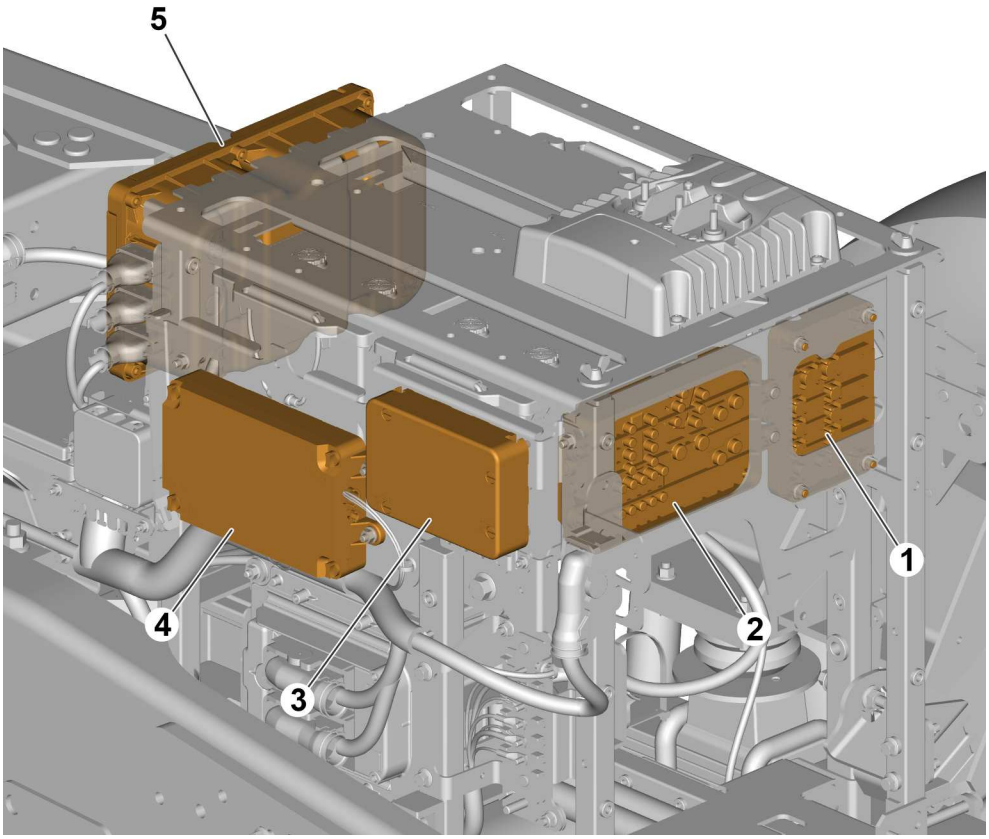
Always use fuses with the correct rating when changing. Never overfuse. Never install a fuse higher than the instructed rating.

The truck's fuses are designed to protect the electrical system's circuits from overload and are usually only tripped as a result of a short circuit. For this reason, if a fuse has blown you should always have an authorized Mack workshop determine the cause.



T3173749

1 Main circuit breaker (FM3 - 125 A)
2 Equalizer fuse (FH3)
3 Main switch (24 V system batteries)
4 Fuse 24 V main (FH1 - 500 A)
5 Battery analyzer

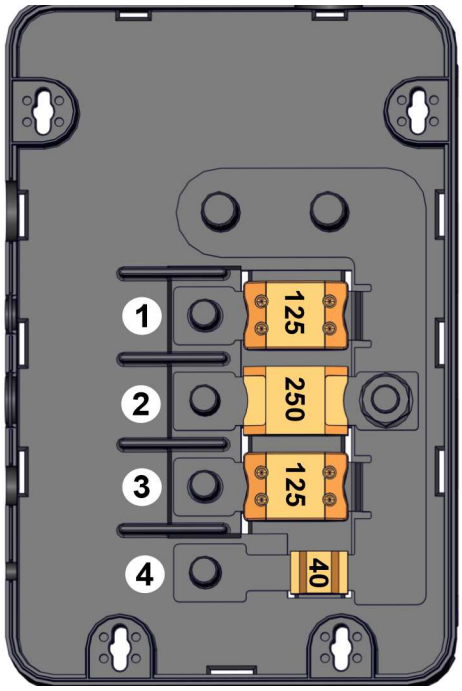


T3173748

1 Fuse box FM-20
2 Fuse box FM-23
3 Fuse box FM-21
4 Fuse box FM-22
5 Fuse and relay center, chassis

Fuse box

Layout (Fuse box FM–20)



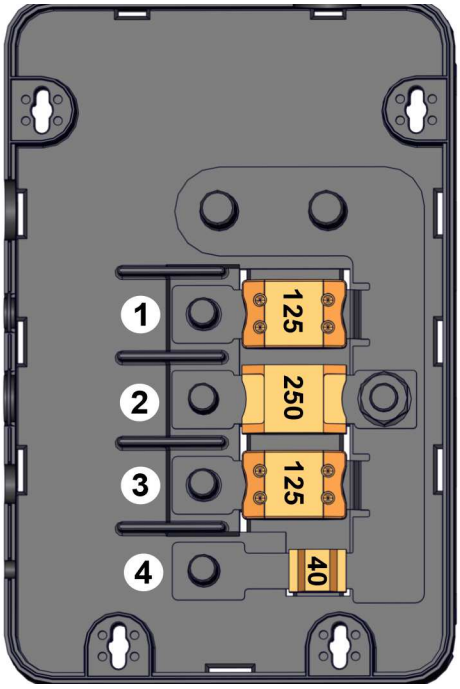
T3174424

Fuse positions

Positon	Rated current	Function
1	Fuse 125 A	Heater 3
2	Fuse 200 A	Open
3	Fuse 125 A	Heater 1
4	Fuse 40 A	Open

Notes

Layout (Fuse box FM–21)



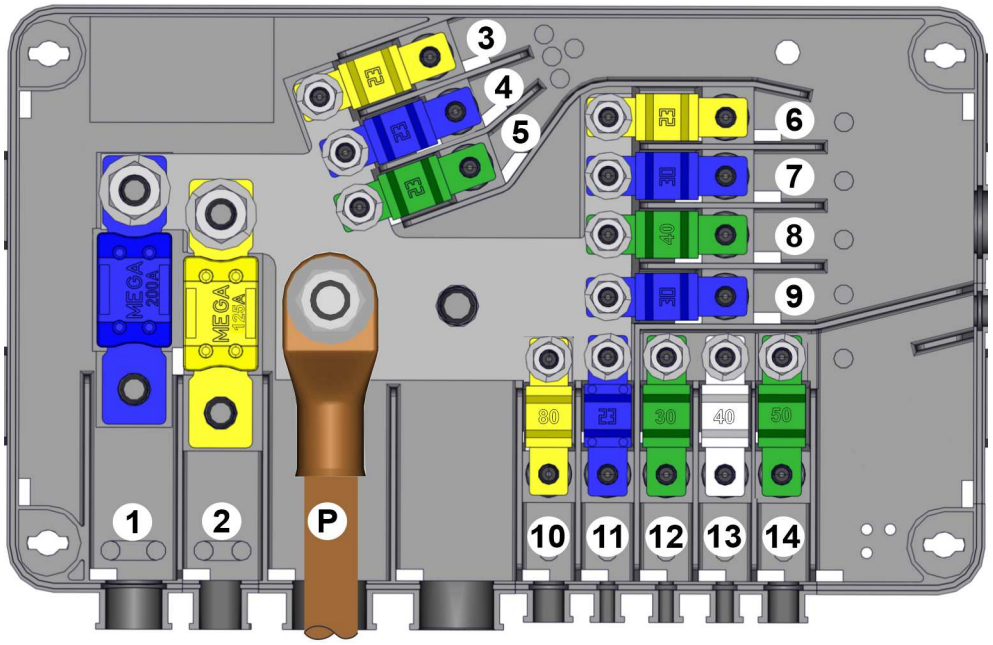
T3174424

Fuse positions

Positon	Rated current	Function
1	Fuse 125 A	EVAC 1
2	Fuse 250 A	EHPS 2
3	Fuse 125 A	Heater 2
4	Fuse 40 A	Open

Notes

Layout (Fuse box FM-22)

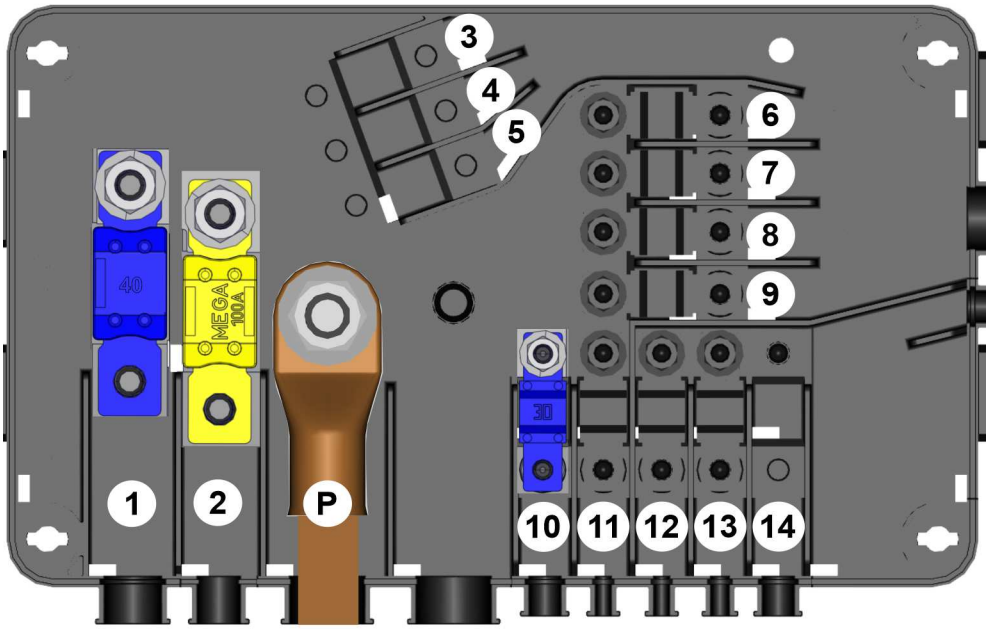


T3174416

Fuse positions

Position	Rated current	Functions
P	-	Power
1	Mega fuse 250 A	EHPS 1
2	Mega fuse 125 A	Heater 4
3	Fuse 23 A	Fan 1
4	Fuse 23 A	Fan 2
5	Fuse 23 A	Fan 3
6	Fuse 23 A	Fan 4
7	Fuse 30 A	Fuse and relay center, chassis Main 3
8	Fuse 40 A	Fuse and relay center, chassis Main 1
9	Fuse 30 A	Fuse and relay center, chassis Main 2
10	Fuse 80 A	Roof AC
11	Fuse 23 A	Cab/IGN 24 V
12	Fuse 30 A	Oil Pump
13	Fuse 40 A	Open
14	Fuse 50 A	Open

Layout (Fuse box FM-23)

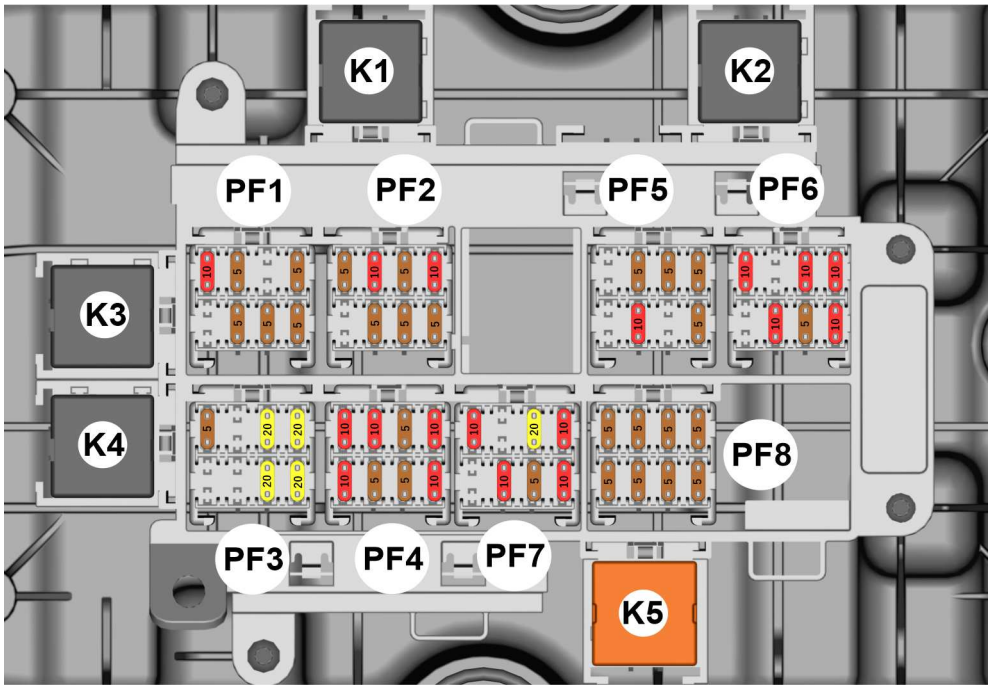


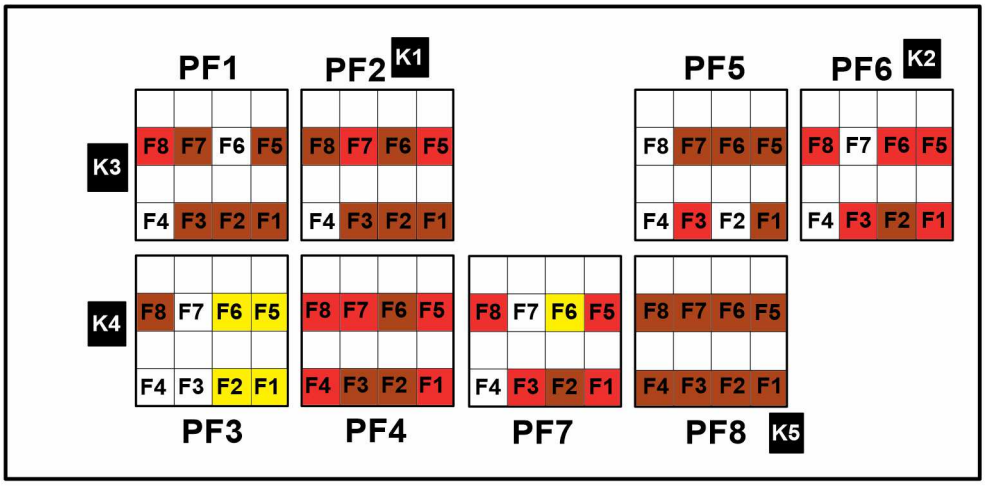
T3174417

Fuse positions

Position	Rated current	Functions
P	—	Power
1	Fuse 40 A	Equalizer
2	Mega fuse 125 A	EVAC 2
3	Fuse 23 A	Open
4	Fuse 23 A	Open
5	Fuse 23 A	Open
6	Fuse 23 A	Open
7	Fuse 23 A	Open
8	Fuse 23 A	Open
9	Fuse 23 A	Open
10	Fuse 30 A	Fuse and relay center, chassis Direct
11	Fuse 23 A	Open
12	Fuse 23 A	Open
13	Fuse 23 A	Open
14	Fuse 23 A	Open

Fuse and relay center layout (chassis)





T3169906

Fuse and relay center, chassis Fuse positions

Module	Position	Rated current	Function
PF1	F1	5 A	Supply, Main 24 V
	F2	5 A	Enable 15C K2
	F3	5 A	Supply, Main 24 V
	F4	-	-
	F5	5 A	Supply, Main 24 V
	F6	-	Supply K5 (IDEM main)
	F7	5 A	Enable 15C K2
	F8	10 A	Supply K5 (IDEM main)
PF2	F1	5 A	Supply, Main 24 V
	F2	5 A	Enable 15C K2
	F3	5 A	Supply, Main 24 V
	F4	-	-
	F5	10 A	Supply, Main 24 V
	F6	5 A	Enable 15C K2
	F7	10 A	Supply K5 (IDEM main)
	F8	5 A	Measure, Direct 24 V
PF3	F1	20 A	Supply, Main 24 V
	F2	20 A	Supply, Main 24 V
	F3	-	-
	F4	-	-
	F5	20 A	Supply, Main 24 V
	F6	20 A	Supply, Main 24 V
	F7	-	-
	F8	5 A	Enable 15C K2
PF4	F1	10 A	Supply, Main 24 V
	F2	5 A	Enable 15C K2
	F3	5 A	Enable 15C K2, TGW
	F4	10 A	24 V Direct Supply for BB
	F5	10 A	Supply, Direct 24 V
	F6	5 A	Supply, Direct 24 V
	F7	10 A	Supply, K3
	F8	10 A	Supply, K4
PF5	F1	5 A	Enable, 15 K1
	F2	-	Enable, 15 K1
	F3	10 A	Supply, K1
	F4	-	Enable K1

	F5	5 A	Enable K1
	F6	5 A	Supply, Direct 24 V
	F7	5 A	Enable 15C K2
	F8	-	Supply, Direct 24 V
PF6	F1	10 A	Enable 15C K2
	F2	-	Supply, Direct 24 V
	F3	10 A	Enable 15C K2
	F4	10 A	Supply, Direct 24 V
	F5	-	Enable 15C K2
	F6	10 A	New
	F7	5 A	New
	F8	10 A	New
PF7	F1	10 A	Supply, Direct 24 V
	F2	5 A	Enable 15C K2
	F3	10 A	Supply, Direct 24 V
	F4	-	Enable 15C K2
	F5	10 A	Supply, Direct 24 V
	F6	20 A	Supply, Main 24 V
	F7	-	Supply, Main 24 V
	F8	10 A	Enable 15C K2
PF8	F1	5 A	Supply, Main 24 V
	F2	5 A	Enable 15C K2
	F3	5 A	Supply, Main 24 V
	F4	5 A	Enable 15C K2
	F5	5 A	Supply, Main 24 V
	F6	5 A	Enable 15C K2
	F7	5 A	Supply, Main 24 V
	F8	5 A	Enable 15C K2

Relays

Position	Rated current	Function
K1	20 A	Ignition Power
15CK2	20 A	Plug key power
K3	20 A	EVCM power relay
K4	20 A	Oil Thermostat drive
K5	40 A	ESCM power relay

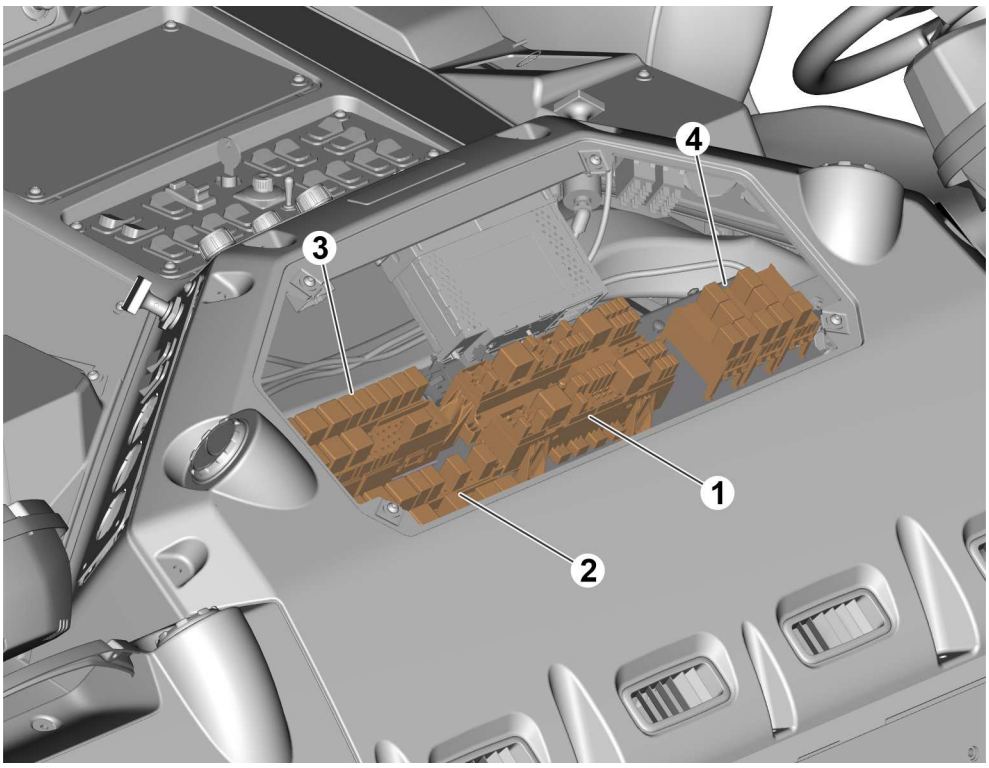
Fuses and Relay Center (FRC), Instrument Panel

⚠ WARNING
Always use fuses with the correct rating when changing. Never install a fuse higher than the instructed rating.

Note: If possible turn off the electrical component, before changing the fuse. The fuse holder may burn, if the electrical component remains switched on.

The fuses and relays are located under the center console of the instrument panel.

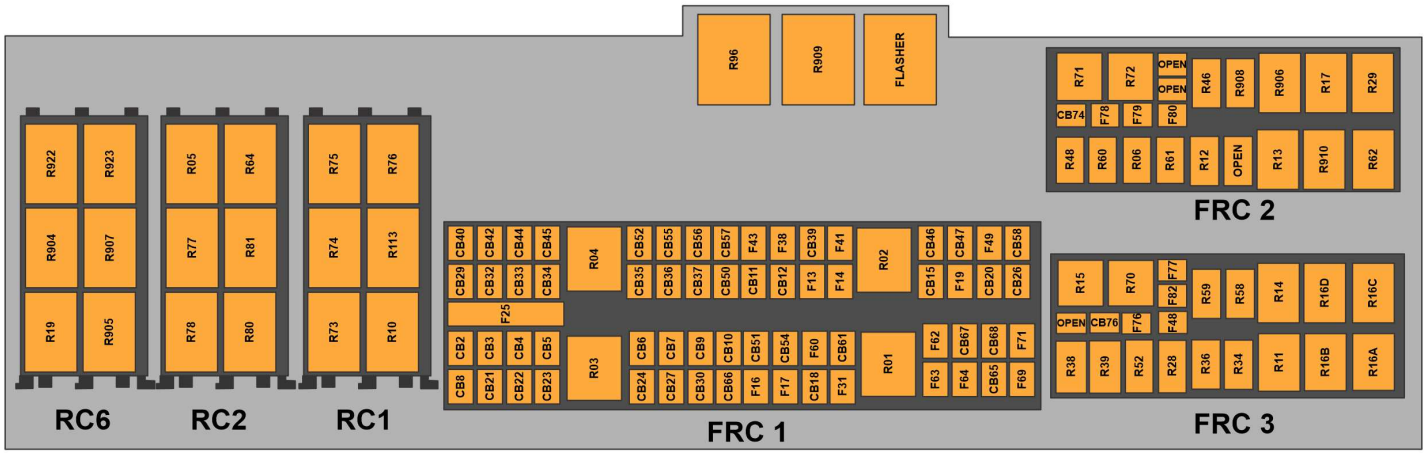
Back of the FRC cover, a decal is placed. The decal shows the location of fuses and relays and what they are used for.



T3173736

1 FRC 1 (Fuse and Relay Center 1)
2 FRC 2 (Fuse and Relay Center 2)
3 FRC 3 (Fuse and Relay Center 3)
4 RC (Relay Center

FRC Layout



T3173737

FRC 1 (Fuse and Relay Center 1)

Fuse or Circuit Breaker or Relay Position	Rated current	Function
CB40	25 A	RH window/Mirrors
CB42	10 A	HVAC
CB44	25 A	Driver heated seat/Cooler
CB45	30A	Driver 7-pass heated seats
CB29	10 A	Radio
CB32	15 A	Radio with amplifier
CB33	20 A	Open
CB34	30 A	RH sleeper power ports
CB52	10 A	LH sleeper power ports
CB55	20 A	Auxiliary switches 1
CB56	20 A	Auxiliary switches 2
CB57	20 A	USB charge ports
F43	15 A	Customer LVD2
F38	30 A	Open
CB39	30 A	Dashboard power ports
F41	—	LH window/Mirrors
CB35	25 A	Open
CB36	15 A	Open
CB37	25 A	Overhead socket
CB50	10 A	Auxiliary switches 3
CB11	15 A	Auxiliary switch 3 & 4
CB12	15 A	HVAC fan
F13	W - 15 A/ B - 30 A	ABS Battery

F14	—	Open
CB46	10 A	Power outlet
CB47	15 A	Spare EMS
F49	10 A	ABS Ignition
CB58	5 A	L-R Relay control
CB15	15 A	Beacon lamps
F19	5 A	Instrument Cluster, Battery
CB20	10 A	Mirror motor
CB26	15 A	Rear flood lamp
F25	40 A	HVAC Cab unit
CB2	15 A	High beam Headlights
CB3	15 A	Parking tail lamps
CB4	20 A	Turn Signal flasher
CB5	10 A	Tractor Stop lamps
CB8	15 A	Air solenoid
CB21	20 A	Left Windshield Wiper
CB22	20 A	Right Windshield Wiper
CB23	10 A	Windshield washer
CB6	10 A	Dome courtesy lamp
CB7	10 A	Key Switch
CB9	15 A	CB posts
CB10	5 A	Diagonal connector
CB51	10 A	Right low beam headlight
CB54	15 A	Daytime Running lamps
F60	15 A	Open
CB61	20 A	Body, Battery Stud
CB24	15 A	2 way radio option
CB27	15 A	Ignition Stud
CB30	10 A	Muncie PTO option
CB66	15 A	Rear view camera
F16	10 A	VECU Power
F17	10 A	VECU Control Switch input
CB18	10 A	DCL EMS Power
F31	10 A	EMS Power
F62	—	Open
CB67	10 A	Power door locks
CB68	15 A	Cigarette lighter
F71	10 A	HVAC power

F63	5 A	Instrument cluster
F64	—	Open
CB65	—	Open
F69	5 A	Open

FRC 2 (Fuse and Relay Center 2)

Fuse or Circuit Breaker or Relay Position	Function
R71	L-R Idle Valid
R72	L-R Directional
R46	Range/PTO Neutral
R908	Fuse and relay center, chassis IGN
R906	Regenerative Brake
R17	Reverse Power
R29	Neutral Power
F80	Spare
F79	Spare
F78	Spare
CB74 (5 A)	Radio Memory
R48	Stop Lamp
R60	Parking Brake Stop Lamp
R06	Emergency Stop Lamp
R61	Lift Axle
R12	Trailer Stop Lamp
R13	Clearance Lamp
R910	Driver L/R Control
R62	Reverse Body Power

FRC 3 (Fuse and Relay Center 3)

Position	Function
R15	Hazzard Bypass
R70	L-R Throttle
F77 (30 A)	HVAC FAN Power
F82 (5 A)	TGW
F48 (5 A)	DRL LED Lamps
F76 (15 A)	Spare
CB76 (15 A)	Spare
R59	Beacon Lamp Reverse
R58	Beacon Lamp PTO
R14	Horn Relay
R16D	Left Side High-Speed Wiper
R16C	Left Side Low-Speed Wiper
R16A	Right Side Low-Speed Wiper
R16B	Right Side High-Speed Wiper
R11	Trailer Tail Lamp
R34	Pre-EMS
R36	EVCM Start Control
R28	CB Posts
R52	Headlamp High Beam
R39	Right Headlamp Low Beam
R38	Left Headlamp Low Beam

RC6 (Relay Center6)

Relay Position	Function
R922	Driveline Active
R923	EVCM/PTO
R904	VECU Regenerative Service Brake
R907	R\L Regenerative Mode
R19	DRL with LED Headlamps
R905	R\L Regenerative Brake

RC2 (Relay Center2)

Relay Position	Function
R5	Beam EI High
R64	Spare
R77	Auto Neutral Packer

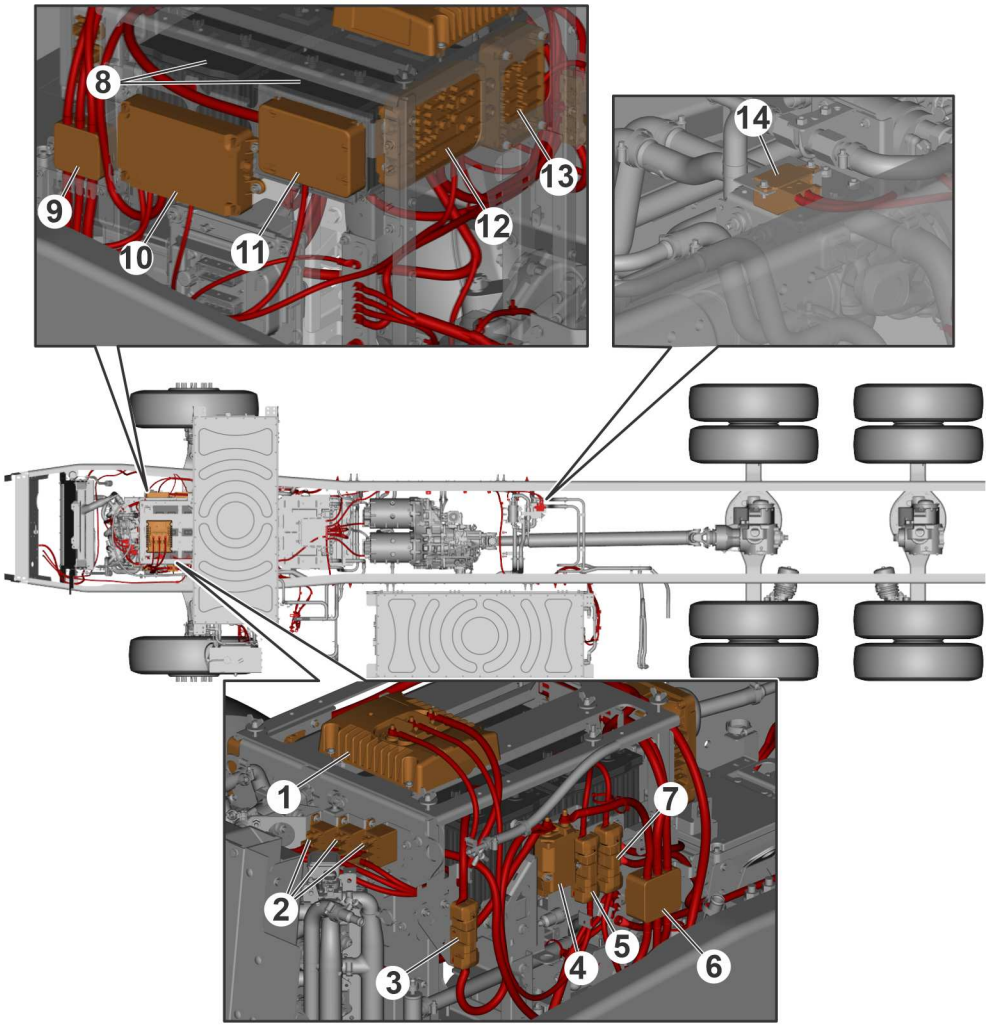
R81	Work Lamp, Left
R78	Auto Neutral Work brake
R80	Work Lamp, Left

RC1 (Relay Center1)

Relay Position	Function
R75	L-R Shift Inhibit
R76	L-R Service Brake Inhibit
R74	L-R High Beam
R113	Service Brakes
R73	L-R Comb Lamp
R10	L-R Comb Power

Notes

24 V Power Supply



T3174168

1 Battery equalizer
2 Heater relay (front)
3 Fuse 24 V main (FH1 - 500 A)
4 Main switch (24 V system batteries)
5 Equalizer fuse (FH3)
6 Six-way junction box
7 Main circuit breaker (FM3 - 125 A)
8 24 V system batteries
9 Six-way junction box
10 Fuse box (FM-22)
11 Fuse box (FM-21)
12 Fuse box (FM-23)
13 Fuse box (FM-20)
14 Heater relay (rear)

24 V system batteries disconnect

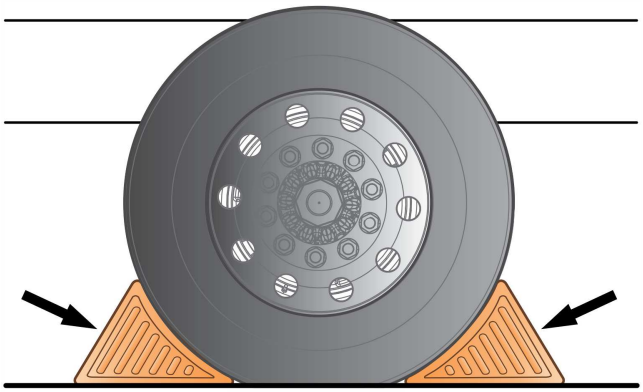
To fully disconnect the 24 V system batteries, remove the three fuses (FH1, FH3 and FM3) and disconnect the negative terminal of the 24 V system batteries.

Note: Disconnecting the negative cable alone will not cut off the power supply completely to the 24 V / 12 V systems.

Procedure to fully disconnect the 24 V system batteries:

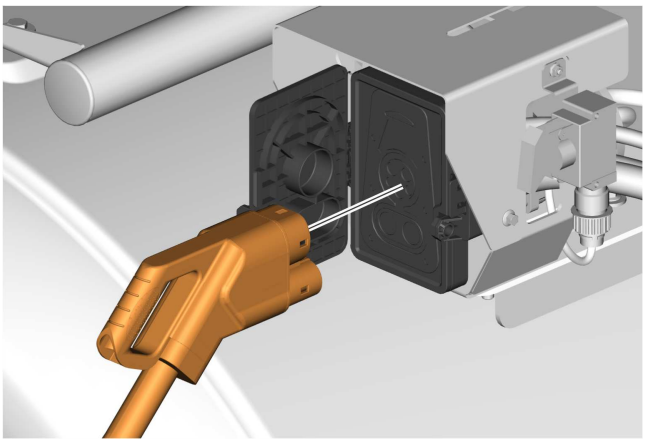
Removal:

1. Apply the parking brake.
2. Press and release the transmission neutral switch.
3. Remove the starter key.
4. Exit the cab and install the wheel chocks.



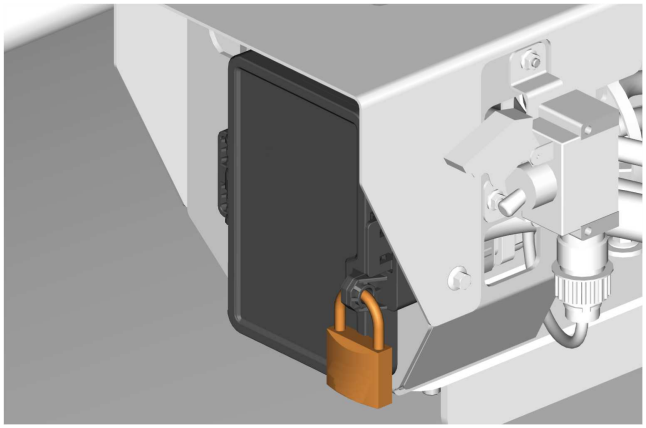
T3174439

5. Disconnect all external power supply or charging devices.



T3174440

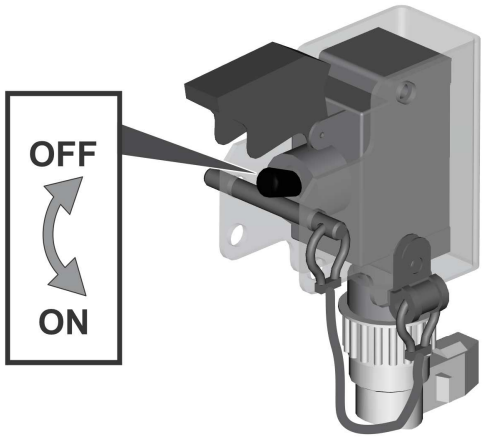
6. Lock the access to the charging interface.
Required material:
Padlock – 88890334



T3174441

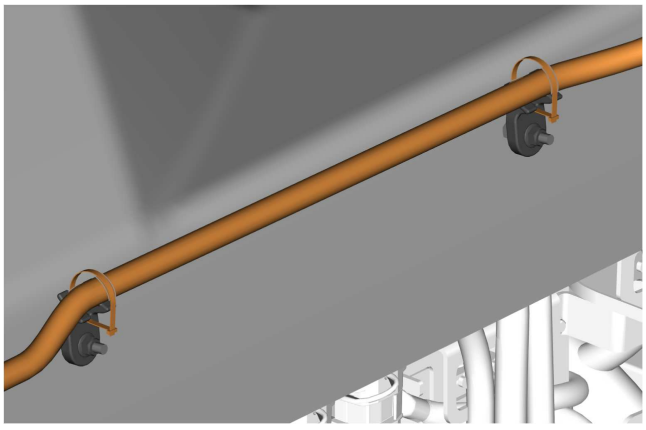
7. Turn the chassis switch to the off position.

Note: Use the lockout pin to restrict the movement of the chassis switch from the off position.



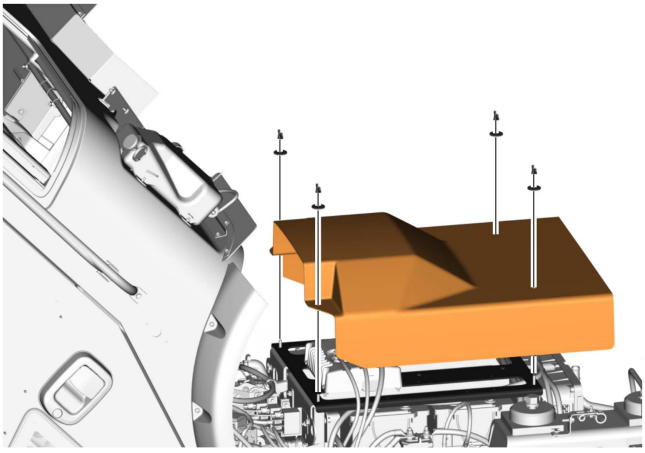
T3174442

8. Tilt the cab forward.
9. Remove the cable ties and move aside the hose.



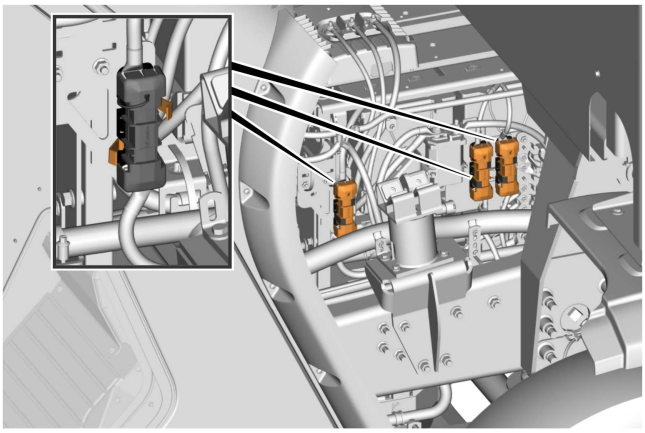
T3174443

10. Remove the wing nut and washers, and cover.



T3174444

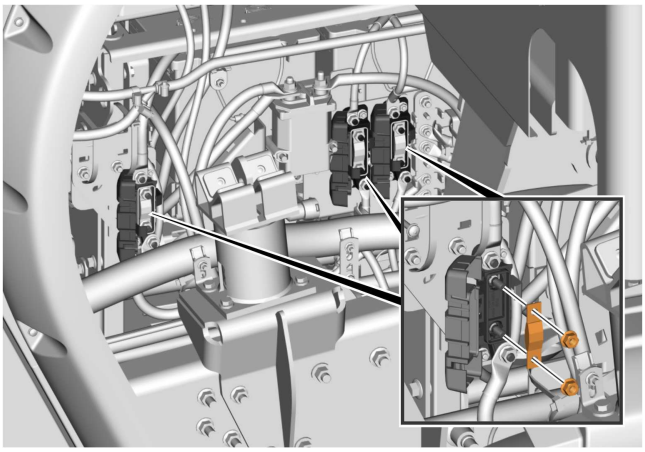
11. Release the clips.
12. Remove the covers.



T3174445

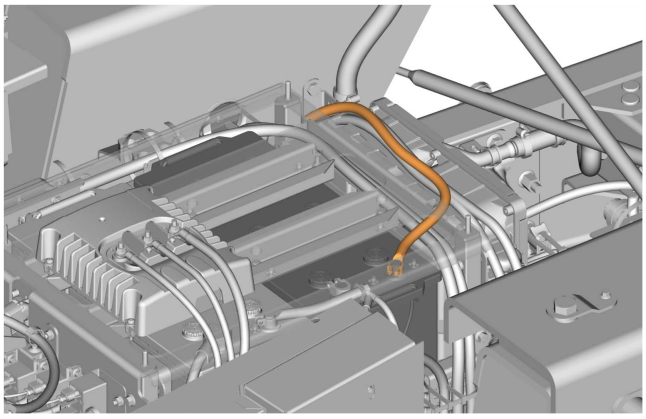
13. Remove the nuts.
14. Remove the fuses.

Note: Note the position



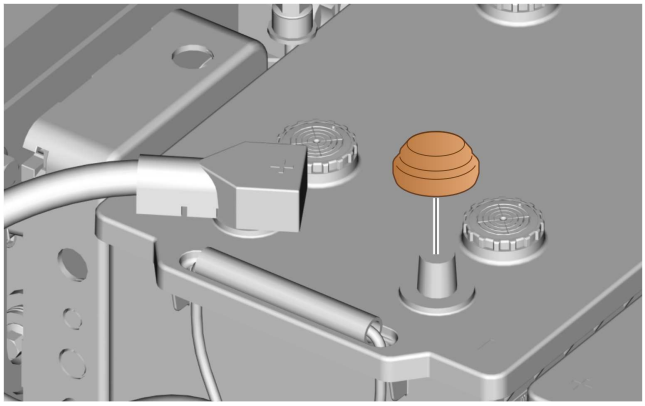
T3174446

15. Disconnect the cable from the negative terminal.



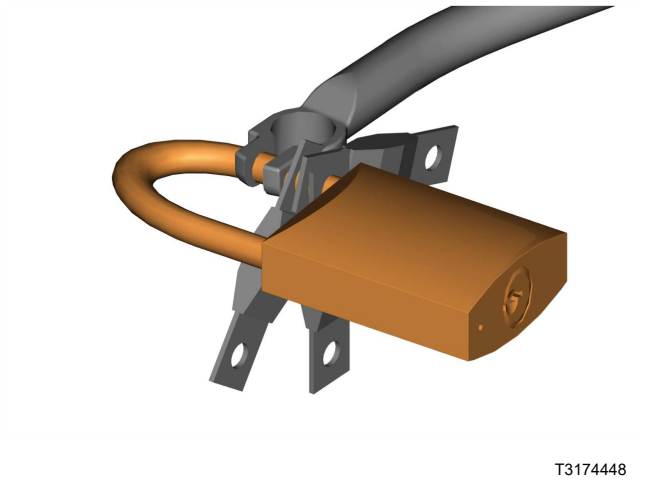
T3174447

16. Install the plug.
Required material:
Plug – 975827



T3174449

17. Lock the negative terminal along with the fuses.

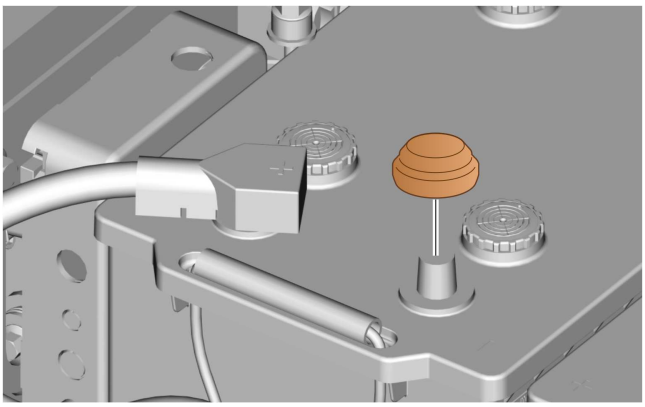


T3174448

Installation

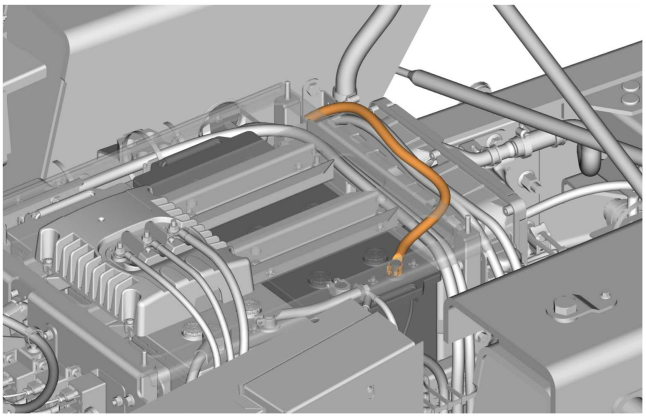
18. Unlock the negative terminal and the fuses.

19. Remove the plug.



T3174449

20. Apply corrosion inhibitor to terminal and connector.
Required material:
Corrosion inhibitor – 22185810
21. Connect the cable to the negative terminal.
22. Torque tighten the nut (5.6 – 7.9 Nm or 4 – 6 lb.ft).

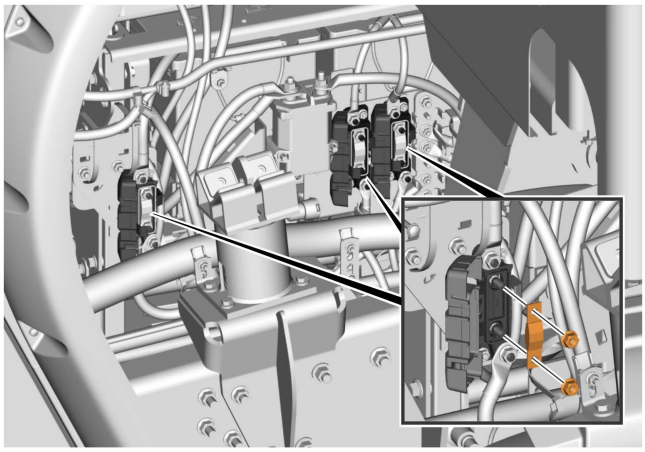


T3174447

23. Apply corrosion inhibitor to terminal and connector.
Required material:
Corrosion inhibitor – 22185810
24. Position the fuses and install the nuts.

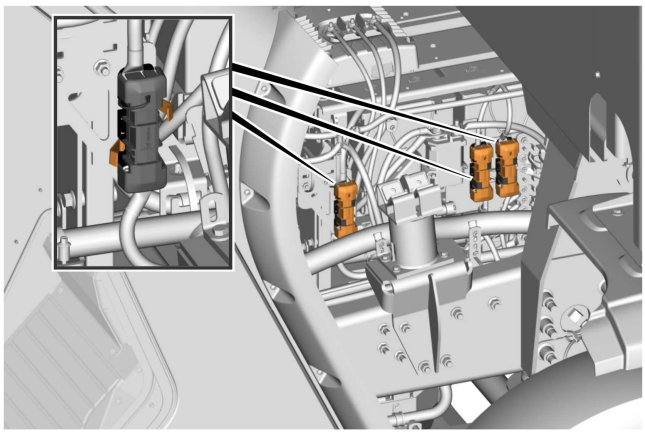
Note: Position the fuses as noted.

25. Torque tighten the nuts (20 ± 4 Nm or 15 ± 3 lb.ft).



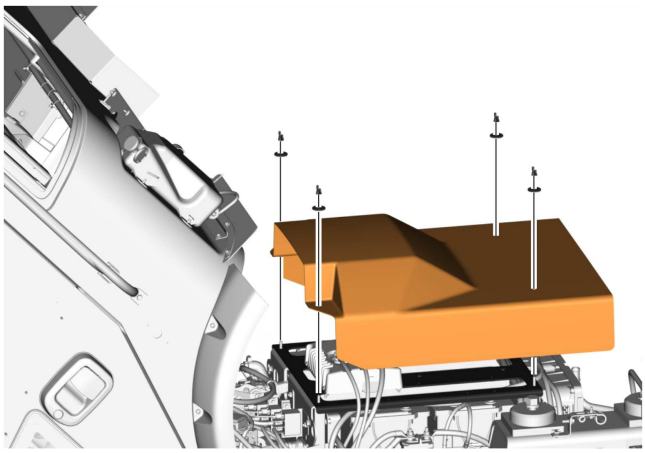
T3174446

26. Install the covers and lock the clips.



T3174445

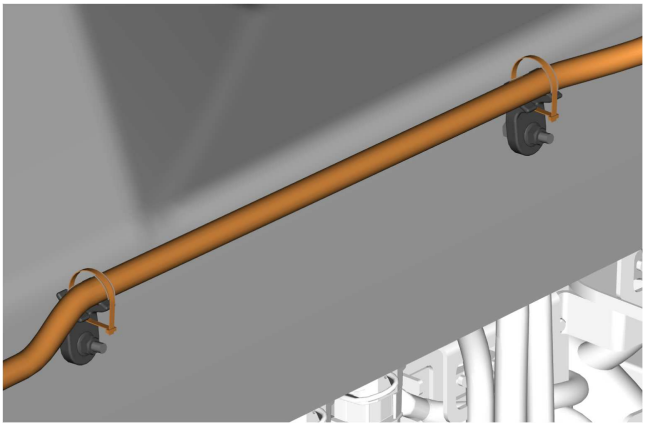
27. Install the cover, washers, and nuts.



T3174444

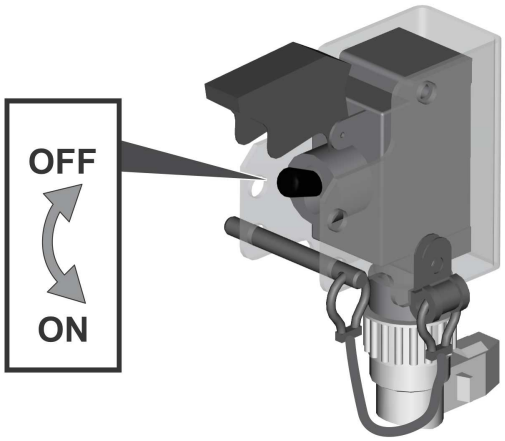
28. Position the hose and install the cable tie.

Note: Use the new cable tie.



T3174443

29. Tilt back the cab.
30. Remove the lockout pin and insert into the lower hole of the bracket.
31. Turn the chassis switch to the On position.

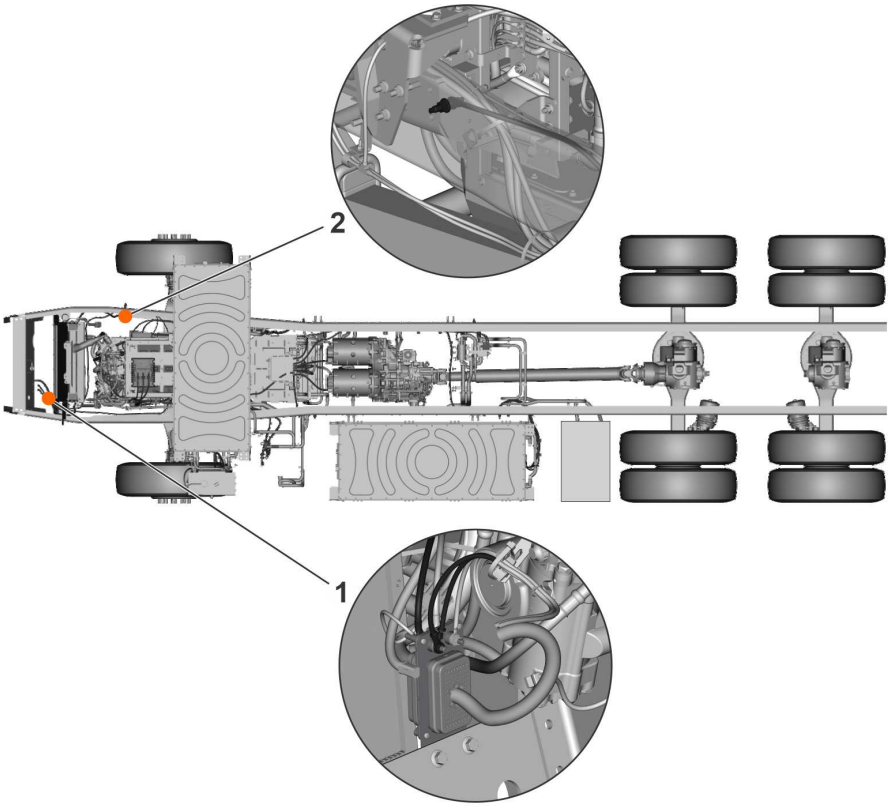


T3174455

Notes

Grounding locations

12 V grounding location

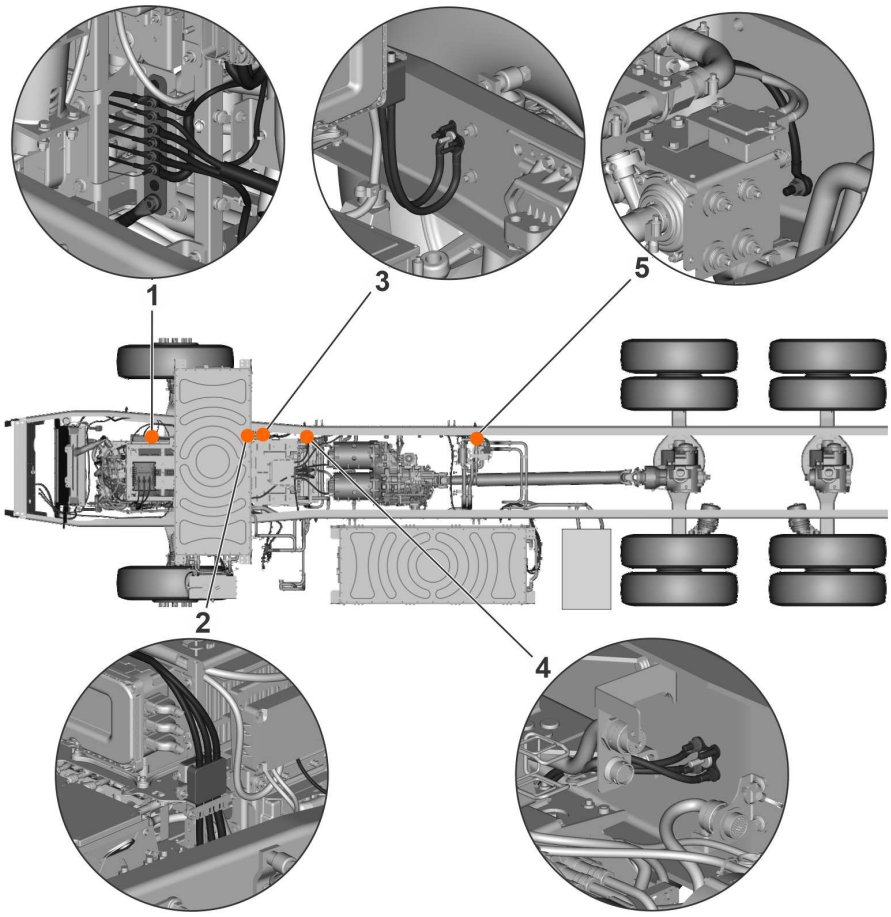


T3174196

1 Ground stud (cab pass through) (X136)
2 12 V ground stud (chassis front-right) (X135)

Notes

24 V Grounding locations

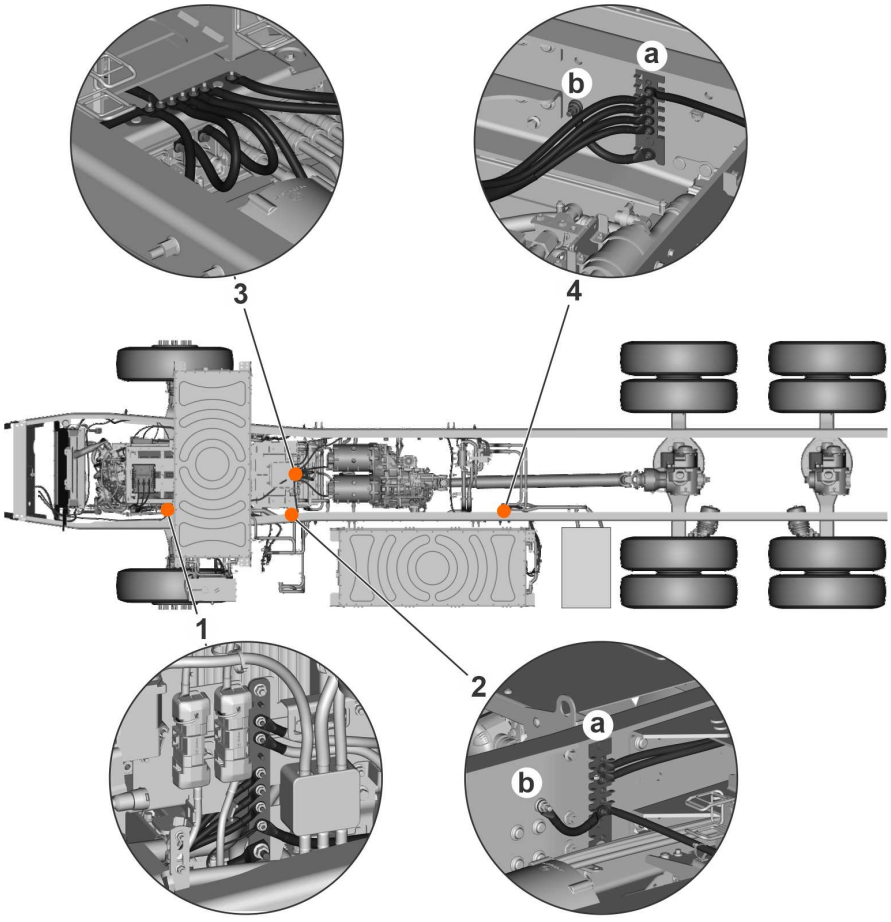


T3174197

1 Ground bar (MPB front-right) (X87)
2 Ground terminal box (MPB rear-right) (X86)
3 Busbar (chassis ground) (X911)
4 Busbar (chassis ground) (X912)
5 Chassis ground (rear-right chassis) (X913)

Notes

600 V (PE) grounding locations



T3174198

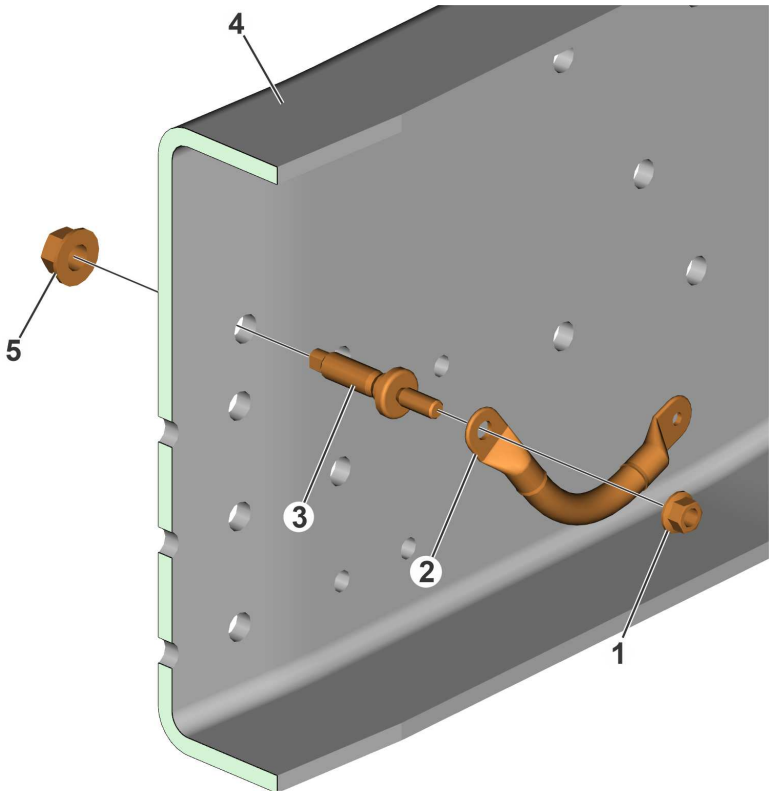
1 Ground bar (MPB rear-left) (X85)
2a Ground bar chassis front-left (X82)
2b Ground stud chassis front-left (X82s)
3 Ground stud central chassis (X81)
4a Ground bar chassis rear-left (X82)
4b Ground stud chassis rear-left (X82s)

Notes

Connection to chassis frame

The connection to the chassis should be done according to below.

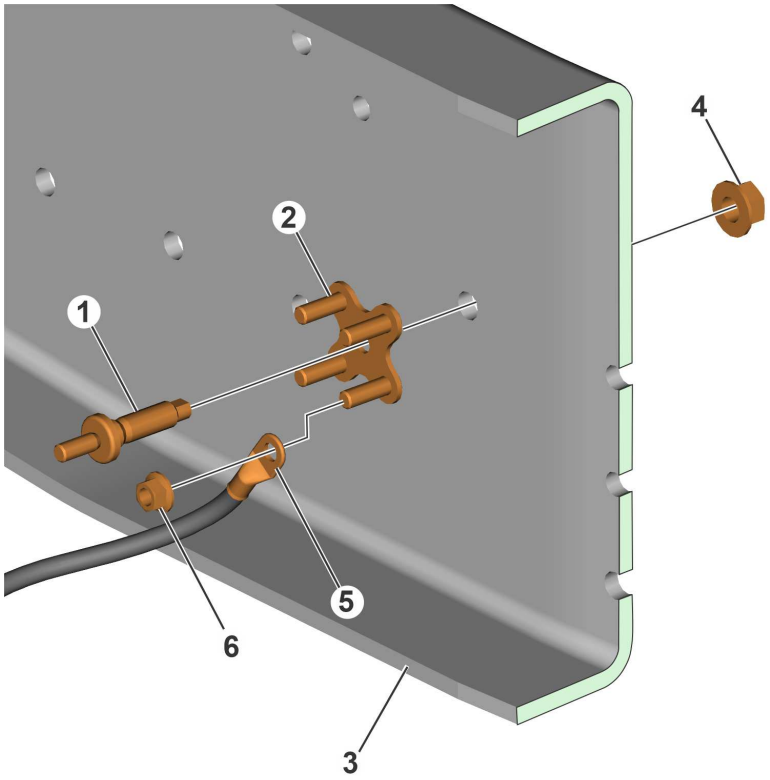
Single ground connection to chassis frame



T3174456

1 Nut (990941)
2 Ground terminal
3 Press screw (60113900)
4 Frame rail
5 Nut (990943)

Multiple ground connections to chassis frame



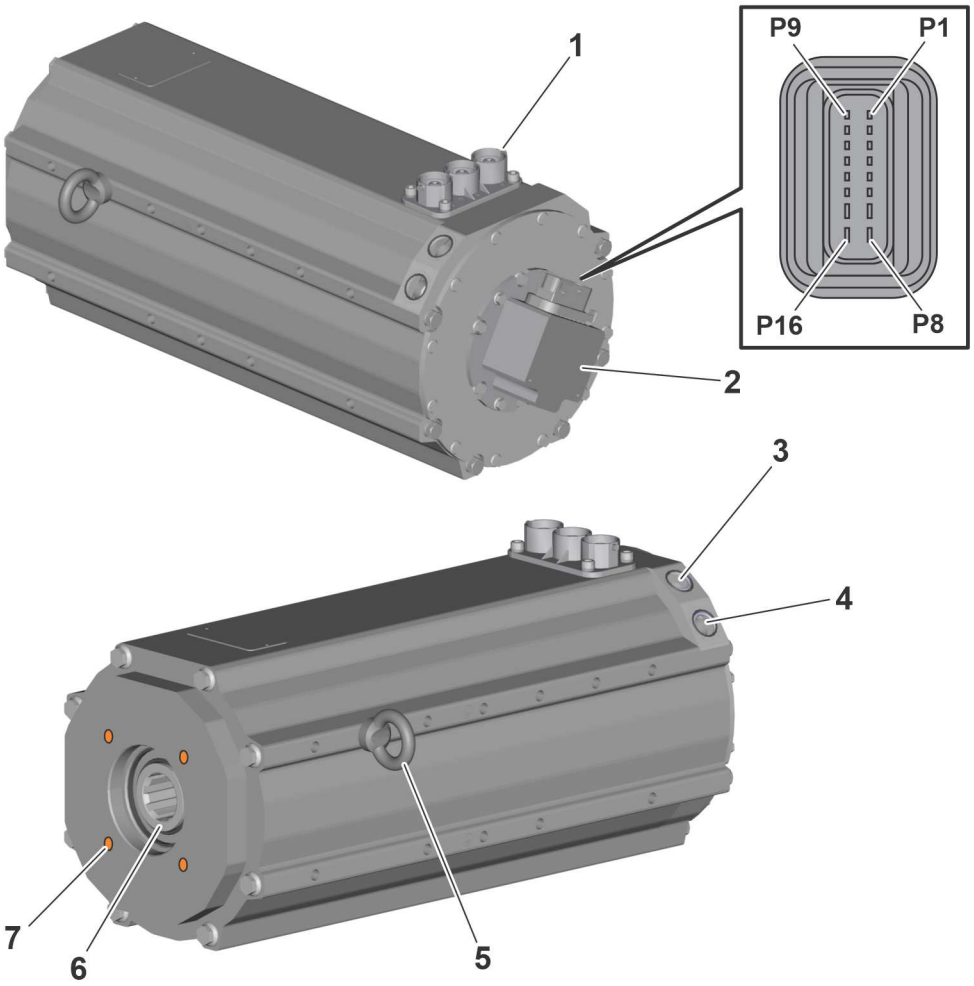
T3174457

1 Press screw (60113900)
2 Busbar (22300425)
3 Frame rail
4 Nut (990943)
5 Ground terminal
6 Nut (990941)

Notes

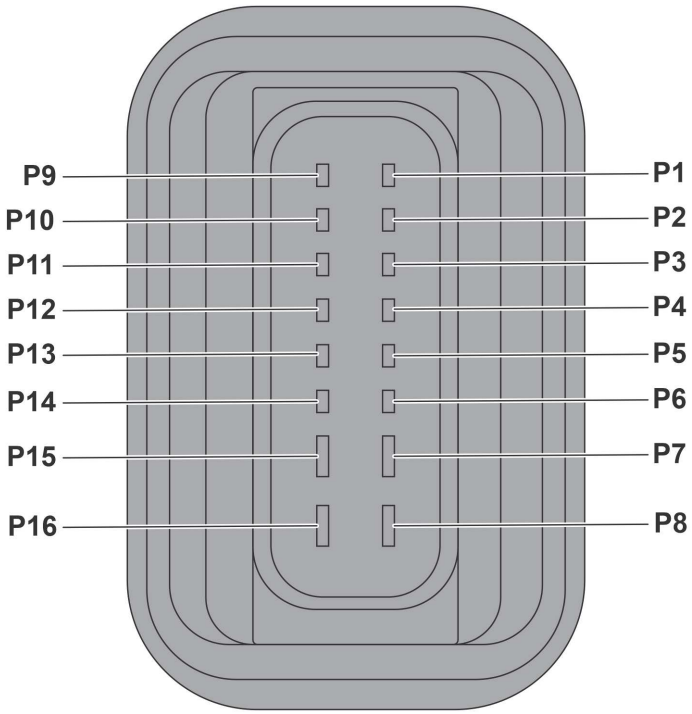
Mechanical ePTO

Overview



T3173468

1	AC power interface
2	Resolver connector
3	Coolant outlet
4	Coolant inlet
5	Lifting eye
6	Output shaft
7	Mounting screw hole for auxiliary equipment

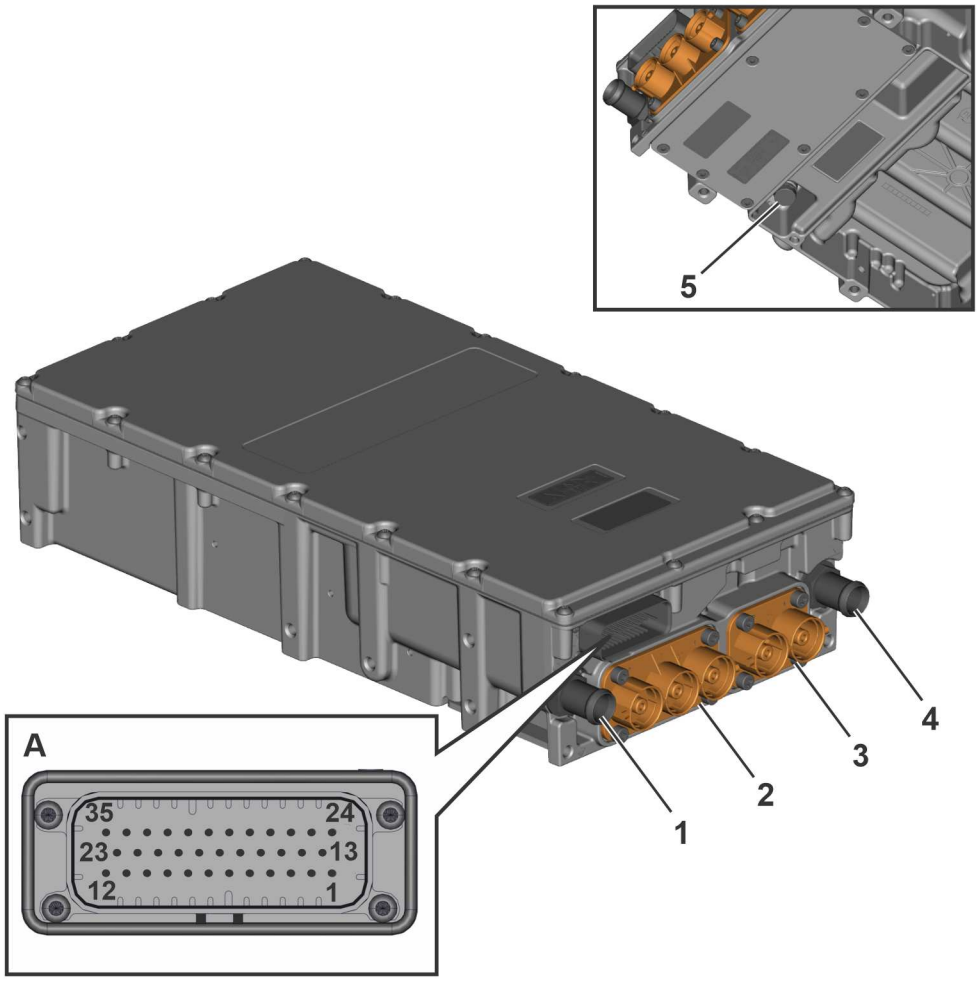


T3174385

Resolver Connector Pin-out			
P1	Sin (–) S2	P9	KTY2 Winding Therm (+)
P2	Sin (+) S4	P10	KTY2 Winding Therm (-)
P3	Ref (+) R1	P11	HVIL in
P4	Ref (-) Ground R1	P12	HVIL out
P5	Cos (-) S1	P13	Shielding ring
P6	Cos (+) S3	P14	Not connected
P7	KTY1 Winding Therm (+)	P15	Not connected
P8	KTY1 Winding Therm (-)	P16	Not connected

In an electric vehicle, the power take-off is an electric motor (Mech. ePTO) that converts the electric power to mechanical power. The electric motor (mech. ePTO), is an AC motor and is water cooled. It operates at 70 kW AC power. It is connected to a hydraulic pump or other auxiliary equipment.
The electric motor (mech. ePTO) receives voltage supply from the traction batteries through TVJB (Traction Voltage Junction Box), and EMD (Electric Motor Drive). The EMD also controls the speed of electric motor (mech. ePTO) and manages the power supply based on different driving condition.

EMD3

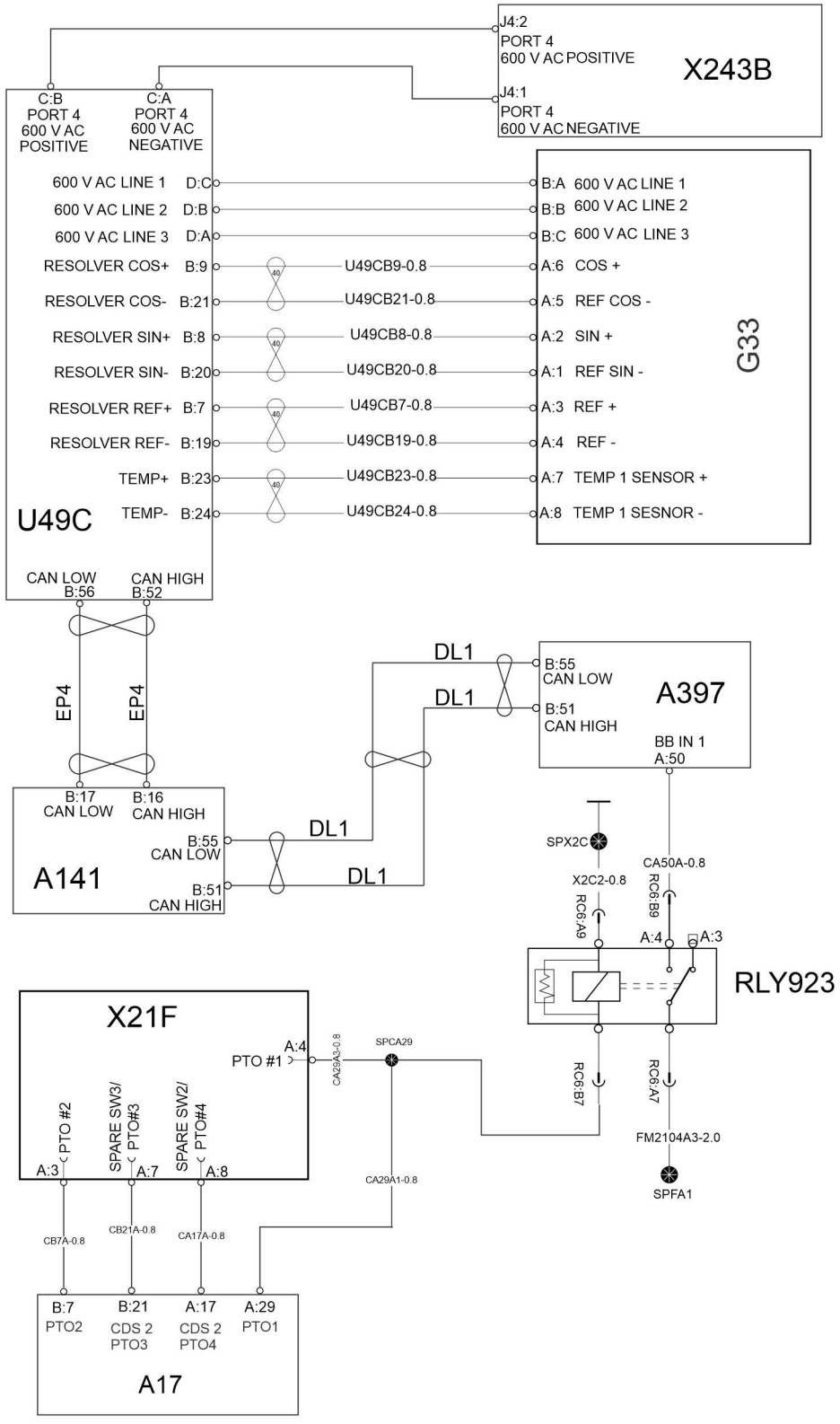


T3173467

1	Coolant outlet
2	AC power interface to Electric Motor (Mech. ePTO)
3	DC power interface to TVJB2 (Traction Voltage Junction Box)
4	Coolant inlet
5	Venting screw
A	EMD connector Interface

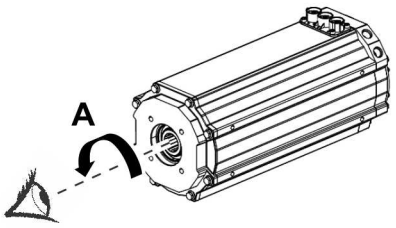
Pin number	Signal name	Type	Function description	Pin number	Signal name	Type	Function description
1	ECU supply	Input	12/24 V supply (supply range 8 V – 32 V DC)	**19**	Resolver REF+	Output	Resolver excitation
2	ECU enable	Input	Wake up signal	**20**	Resolver SIN+	Input	Resolver interface
3	HVIL IN	Input	HVIL (Current loop)	**21**	Resolver COS+	Input	Resolver interface
4	HVIL OUT	Output	HVIL (Current loop)	**22**	Reserved	Not applicable	Reserved (do not connect)
5	Reserved	Not applicable	Reserved (do not connect)	**23**	Temp+	Input	Electric motor sensor
6	Reserved	Not applicable	Reserved (do not connect)	**24**	Temp-	Input	Electric motor sensor
7	Resolver REF+	Output	Resolver excitation	**25**	Reserved	Not applicable	Reserved (do not connect)
8	Resolver SIN+	Input	Resolver interface	**26**	Reserved	Not applicable	Reserved (do not connect)
9	Resolver COS+	Input	Resolver interface	**27**	Node ID0	Input	Node ID coding Bit0
10	Reserved	Not applicable	Reserved (do not connect)	**28**	Reserved	Not applicable	Reserved (do not connect)
11	Reserved	Not applicable	Reserved (do not connect)	**29**	Reserved	Not applicable	Reserved (do not connect)
12	Node ID2	Input	Node ID coding Bit 2	**30**	Reserved	Not applicable	Reserved (do not connect)
13	ECU GND	Input	Ground for 12/24 V supply	**31**	Reserved	Not applicable	Reserved (do not connect)
14	CAN2_H	Bidirectional	Development CAN_H	**32**	Node ID1	Input	Node ID coding Bit1 (isolated digital input)
15	CAN2_L	Bidirectional	Development CAN_L	**33**	IP GND	Input	Designated ground for isolated digital input
16	CAN1_H	Bidirectional	J1939_H (Powertrain subnet)	**34**	Reserved	Not applicable	Reserved (do not connect)
17	CAN1_L	Bidirectional	J1939_L (Powertrain subnet)	**35**	Enclosure	Not applicable	Enclosure
18	ECU DO1	Output	Digital output				

Wiring schematic



T2173210

A17	VECU
A141	HPCU
A397	EVCM
DL1	Data link 1 (Chassis)
EP4	Electromobility Subnet 4
G33	Electric Motor 3
U49C	EMD3 (Electric Motor Driver 3)
RLY923	PTO Relay
X21F	TMC RP170 (Powertrain)
X243B	TVJB2



T2148171

A Direction of rotation (anti-clockwise by default).

Note: To change the direction of rotation of the mechanical ePTO, change the parameter configuration.

Related Parameter

CAUTION

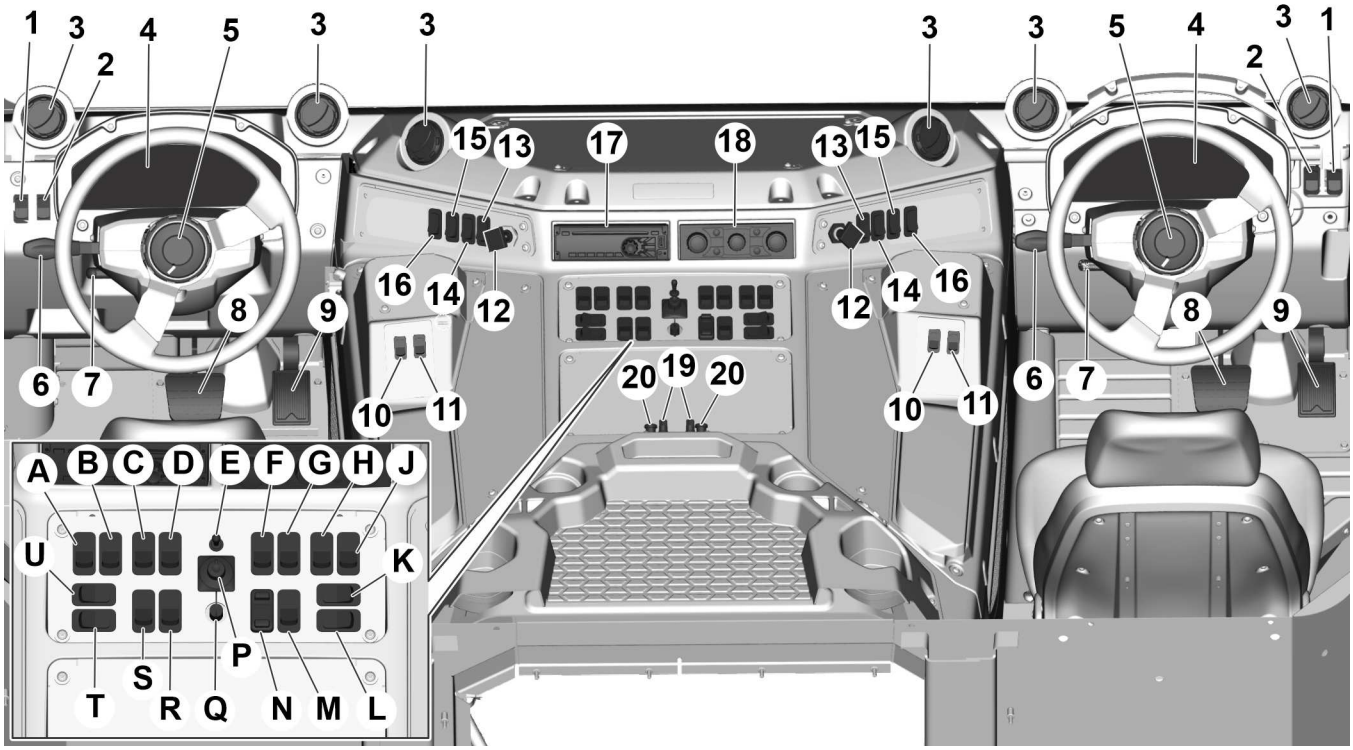
During parameter configuration, do not start the truck and the traction batteries must not be in charging.

All default values are given for guidance only. These values are subject to change and Mack Trucks may modify them without prior notice. Use body builder tool to modify these values.

Parameter code	Description	Minimum	Default value	Maximum	Unit
P1UW5	This parameter specifies the minimum power threshold above which use of the Mech. ePTO is permitted	0	50	255	kW
P1UXE	Motor direction of rotation (PWM control or set value) 0 = Anti-clockwise direction of rotation 1 = Clockwise direction of rotation	0	0	1	-
P1UXF	Mech. ePTO speed of rotation acceleration rate	0	225000	255000	rpm/s
P1UXG	Mech. ePTO speed of rotation deceleration rate	0	255000	255000	rpm/s
P1UW7	Maximum speed of rotation of Mech. ePTO (PWM control)	0	16000	16000	rpm
P1UW6	Mech. ePTO speed of rotation control mode: 0 = CAN 2 = set value	0	0	2	-
P1UW8	Mech. ePTO set value	0	900	16000	rpm
P1WWT	This parameter specifies maximum torque value when P1UW6 is equal to 1 or 2	0	100	100	%

Instrument Panel and Switch Layout

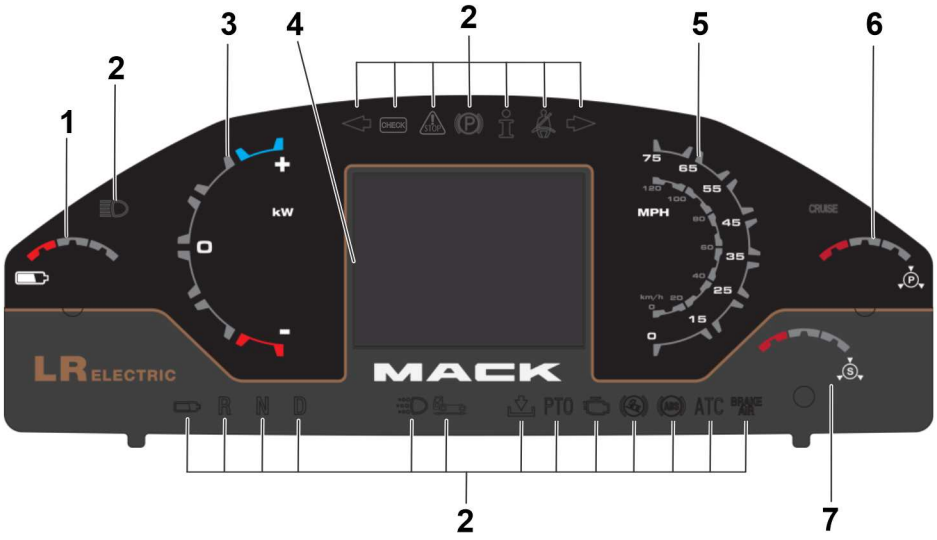
Before start working on this vehicle, check the instruments and controls, and become thoroughly familiar with their operation. Ensure that the instrument readings are normal.



T3173325

1. Enter/Escape Switch for Driver Information Display (DID)	14. Regenerative brake ON/OFF switch	G. Mirror defrost switch
2. Up/Down switch for Driver Information Display (DID)	15. Cruise control	H. Door locks switch
3. Air vent	16. Speed control	J. Window lift
4. Instrument cluster	17. Audio	K. ATC switch
5. Horn	18. Climate control panel	L. Dome lamp switch
6. Turn signal lever	19. CB radio connector (Positive and Negative)	M. Interwheel differential lock switch
7. Telescopic steering adjust lever	20. Auxiliary lighter	N. Wiper and washer switch or wiper switch
8. Brake pedal	A. Window lift switch	P. Mirror control 4-way switch
9. Accelerator pedal	B. Dimmer switch	Q. Starter switch
10. D/R (Drive/Reverse) switch	C. Hazard switch	R. Interaxle differential lock switch
11. Neutral switch	D. Headlamp switch	S. Grade gripper
12. Parking brake	E. Locking toggle switch	T. Dome lamp switch (LHS)
13. Regenerative brake switch (AUTO/LOW/HIGH)	F. Mirror memory switch	U. Cab overhead lamp switch

Instrument Cluster



T3173326

1 State of charge (SOC) gauge
2 Tell-tale indicators
3 Energy consumption / regenerative energy gauge
4 Diver Information Display (DID)
5 Speedometer
6 Primary air pressure gauge (P)
7 Secondary air pressure gauge (S)

Notes

Power Meter

The power meter shows the instantaneous use of energy for propelling the truck. The scale of the power meter is divided into two parts - negative and positive. Negative means that the propulsion system consumes energy from the traction batteries. Positive means that energy is recuperated.

When braking, the digital meter indication moves to the positive side, indicating the amount of energy recovered through braking. When braking gently, more braking energy is recovered than when braking hard.

During acceleration, the digital meter indication moves to the negative side.

State of charge

The state of charge (SOC) gauge shows the amount of energy stored in the traction batteries. When the energy stored is 15% of the traction batteries' capacity, the red warning lamp next to the gauge turns on with a steady light. Charge the traction batteries as soon as possible. When only 5% remains, the red warning lamp flashes. Charge the traction batteries immediately.

Based on your needs, you can adjust the SOC levels at which the warning lamp turns on with a steady or flashing light. To adjust, contact an authorized Mack Trucks dealer.

Speedometer

Indicates the speed of the vehicle. The speedometer is driven by the vehicle's electronic system.

Primary Air Pressure Gauge (P)

The primary air pressure gauge (P) displays the pressure of the air stored in the primary air tank. The primary and secondary air pressure gauges should display the same pressure under normal operating conditions.

Secondary Air Pressure Gauge (S)

The secondary air pressure gauge (S) displays the pressure of the air stored in the secondary air tank. The primary and secondary tank air pressure gauges should display the same pressure under normal operating conditions.

Notes

Tell-tale Indicators

Tell-tale indicators are shown in the instrument cluster. A tell-tale is a form of display that indicates the actuation of a device, or a correct or defective condition, or a failure to function. The operator should become familiar with these symbols to recognize and react (if necessary) to the indicated condition.

Colors:

To promote visual recognition internationally, specific colors for tell-tale indicators s have been established. Unless governmental regulations (in the area where the vehicle is to be used) or engineering directives specify otherwise, the standard colors are:

- Steady Blue — high-beam headlights
- Flashing Green — turn signals
- Flashing Red — hazard condition involving the safety of personnel
- Steady Green — system in operation
- Steady Red — warning, immediate action required
- Amber — early warning, such as Anti-Lock Brake System (ABS) malfunction

	Tell-tale	Meaning	Description
1	 T3167687	Malfunction Indicator Lamp	Indicates that a government Regulation on-board diagnostic (OBD) fault exists
2	T3173332	Grade Gripper Indicator	Indicates the Grade Gripper is active
3	 T3167690	Stop	Illuminates when conditions require the driver to stop the vehicle. This usually occurs when vehicle conditions fall below designated standards for operation. **⚠ DANGER** Failure to take necessary action when the STOP tell-tale is on can ultimately result in automatic shutdown and loss of power steering assist. Vehicle crash can occur, resulting in personal injury or death.
4	 T3167693	Turn Signal Indicator	Flashes when the turn signals are active

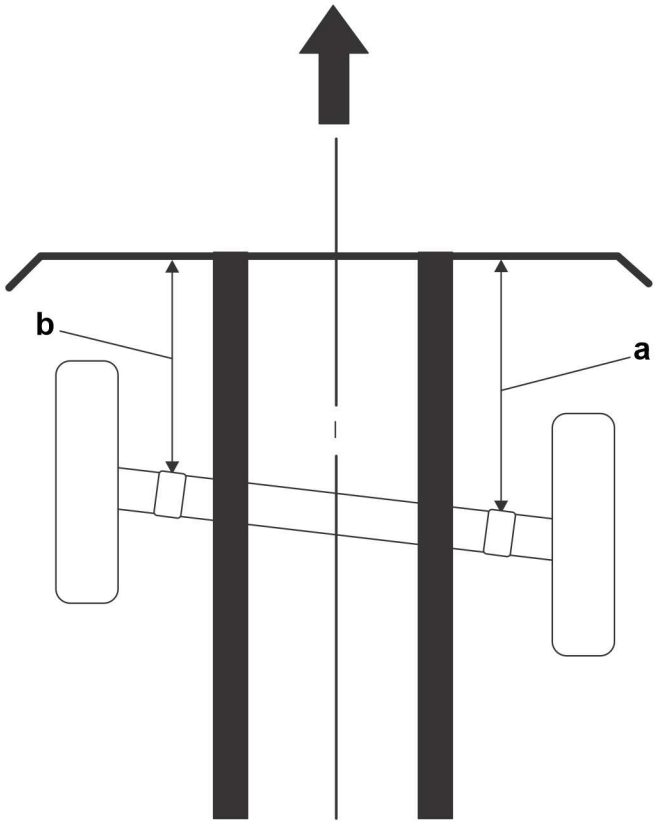
5	 T3167694	Parking Brake engaged	Indicates that the parking brake is engaged
6	 T3167695	Safety Belts Reminder	Indicates that a safety belt needs to be fastened
7	 T3167697	ABS Malfunction Tractor	Indicates a tractor Anti-lock Braking System (ABS) malfunction
8	 T3167698	High Beam Indicator	Illuminates when the high beam lights are engaged
9	 T3167699	Check Indicator	Illuminates when there is an electrical issue
10	 T3167702	Power take-off (PTO) Indicator **Note:** PTO option is not applicable. The ICON will not be powered ON.	Indicates that the power take-off (PTO) is active
11	 T3167704	Daytime Running Light (DRL) Indicator	Indicates that the Daytime Running Lights (DRL) are active
12	 T3173335	Driveline Engaged	Indicates that the propulsion system is on and the vehicle speed is below 3 mph (5 km/h)
13	 T3167591	Software Download In Progress	Indicates that the software download in progress

14	 T3167592	Traction Battery Low	Indicates that the traction battery is low and needs to recharge
15	 T3167593	Brake System Pressures (Metric)	Indicates that the air pressure in the brake system is low
16	BRAKE AIR T3167594	Brake System Pressures (English)	Indicates that the air pressure in the brake system is low
17	 T3173333	Information Indicator	Indicates a malfunction. See a Mack technician if illuminates.
18	CRUISE T3173331	Cruise Control Active	Indicates that the Cruise Control is active.
19	R T3173329	Reverse	Indicates that the transmission is in Reverse.
20	N T3173328	Forced Neutral	Indicates that the transmission is in Neutral.
21	D T3173330	Drive Mode	Indicates that the transmission is in Drive Mode.
22	ATC T3173327	Automatic Traction Control	Indicates that ATC is active.

Suspension

Front axle alignment

Axle set back



T8173080

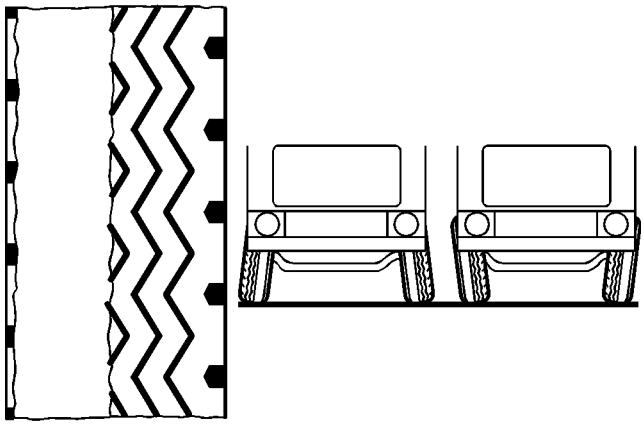
a. Distance measured from the front of vehicle to the front axle member (RHS).
b. Distance measured from the front of vehicle to the front axle member (LHS).
The difference between **a** and **b** is called axle setback. The axle setback is measured with the wheels of steering axle in a straight ahead position. It is used to identify chassis misalignment or assembly issues with the front suspension.

Front axle set back	0± 6 mm (0.25 inches)

Straight forward position

LHD:
When the thrust angle of the first drive axle measures as 0°± 0.02° on the left-hand side, a vehicle is in a straight forward position.
RHD:
When the thrust angle of the first drive axle measures as 0°± 0.02° on the right-hand side, a vehicle is in a straight forward position.
To measure the wheel toe-in or toe-out, ensure that the vehicle is in a straight forward position.

Wheel camber



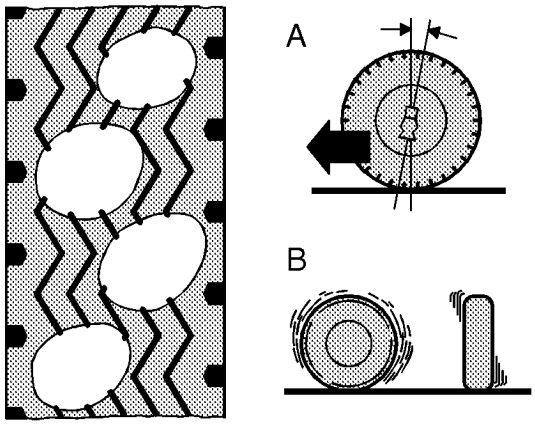
T1006458

Wheel camber (Mack front axle)	1/4° ± 7/16° (0.25° ± 0.43°)

Wheel camber is machined into the axle assembly at the time of manufacture and is not adjustable. Wheel camber is positive when the wheel is tilted outward at the top and is negative when the wheel is tilted inward at the top.
Wheel camber decreases when the axle load increases. The difference between RHS and LHS wheel camber values should not vary more than 0.5°. If the wheel caster angle is out of the given specifications, contact the axle manufacturer. Do not bend the axle or use other methods to adjust the wheel camber angle. Incorrect wheel camber causes tire wear.

Wheel caster

The angle that is formed when the steering axle king pin is tilted rearward or forward with reference to the vertical plane is called the wheel caster (A). The wheel caster is positive when the steering axis is tilted rearward and is negative when the tilt is forward.



T1006460

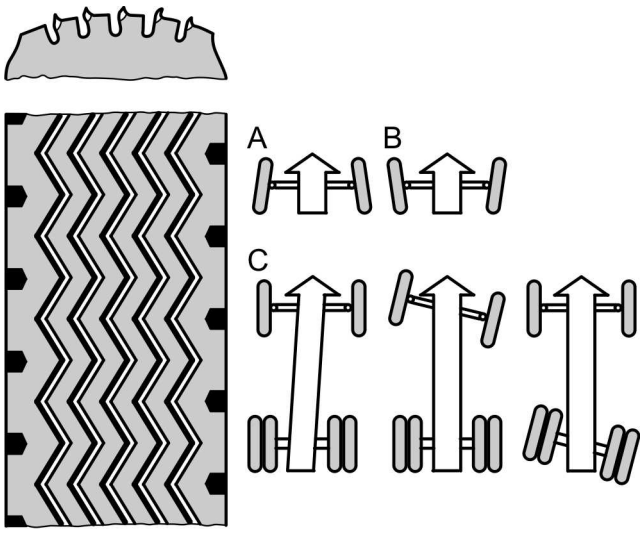
A Wheel caster angle
B Imbalance

Wheel caster	4° ± 1°

To measure the wheel caster, ensure that the vehicle is in an unloaded condition, and the steering axle and drive axles are on a level surface.
The difference between RHS and LHS wheel caster values should not vary more than 0.5°. If the wheel caster angle is out of the given specifications, use the caster shims to adjust the caster angle. Do not bend the axle or use other methods to adjust the wheel caster angle.

Note: The wheel caster is measured from ground.

Wheel toe



W1079988

A Toe-in
B Toe-out
C Out-of-line axle

Toe-in angle	1/16"± 1/32" (.06" ± .03") or 0.08°± .04° (.04° to .12°) or 1.5 mm/m ± 0.75 mm/m

To adjust the toe-in or toe-out, ensure that the vehicle is in unloaded condition. Measure the toe-in or toe-out at the tire's front and rear tread center at a distance above the ground equal to the tire's rolling radius. The toe-in or toe-out values are also measured with equipment that senses the difference between left and right-hand thrust angles.

Note: When adjusting the toe-in or toe-out, ensure that the clamp bolt of tie rod is in the vertical position. Improper orientation could result in a loss of adjustment.

Hendrickson multileaf spring suspension (FST-MUL)

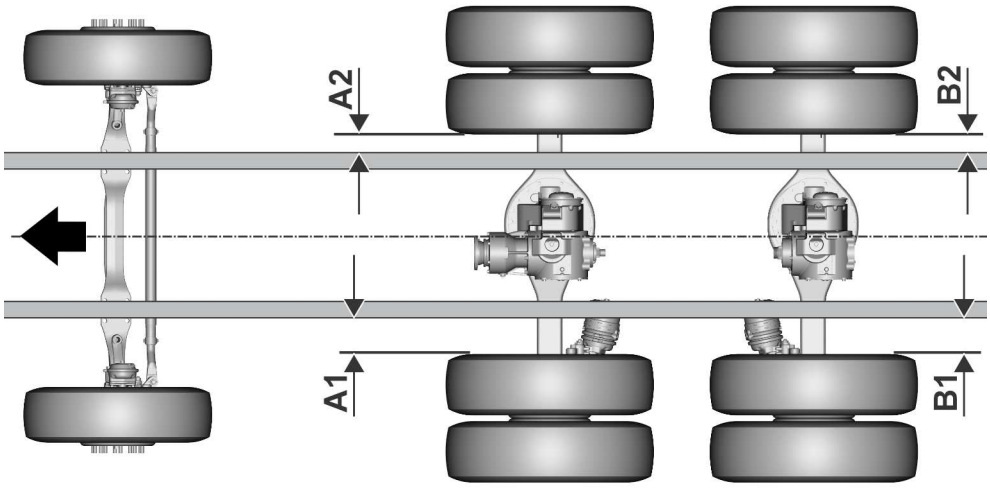
	Clamped	Unclamped
Rated load	9200 lbs	-
Maximum load	18400 lbs	-
Stress at rated load	54600 psi	-
Maximum stress	109200 psi	-
SAE rate: J510 (± 7%)	4100 lbs/in	3750 lbs/in
Load camber (± 0.38)	1120 inches	-
Free camber (± 0.25)	3.86 inches	-
Deflection to rated load	3.49 inches	-
Deflection to maximum load	5.73 inches	-

Parabolic leaf spring suspension (FST-PAR)

	Clamped	Unclamped
Rated load	5216 kg	-
Stress at rated load	482 MPa	-
Spring rate (± 7%)	1114 N/mm	-
Loaded camber (± 3)	44.5 mm	-
Free camber (± 3)	90 mm	-
Deflection to rated load	3.49 inches	-

Rear axle alignment

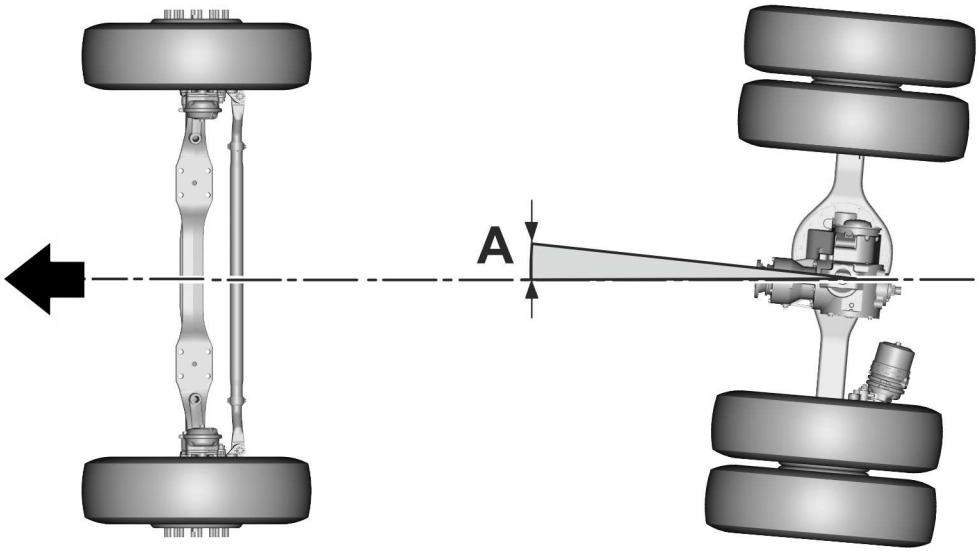
Axle centering



T7173256

All axles must be centered to the chassis (laterally). The maximum side to side difference of a rear axle is A1 – A2 = 0 ± 4 mm (0 ± 0.157). If the axle is not centered, check the transverse torque rod length (if equipped) and torque rod spacer. The maximum difference between the front drive axle to the rear drive axles is A1 – B1 or A2 – B2 = 8 mm (0.312 inches). If the axle is not centered, check the transverse torque rod length (if equipped) and torque rod spacers.

Thrust angle (axle perpendicularity)



T6173259

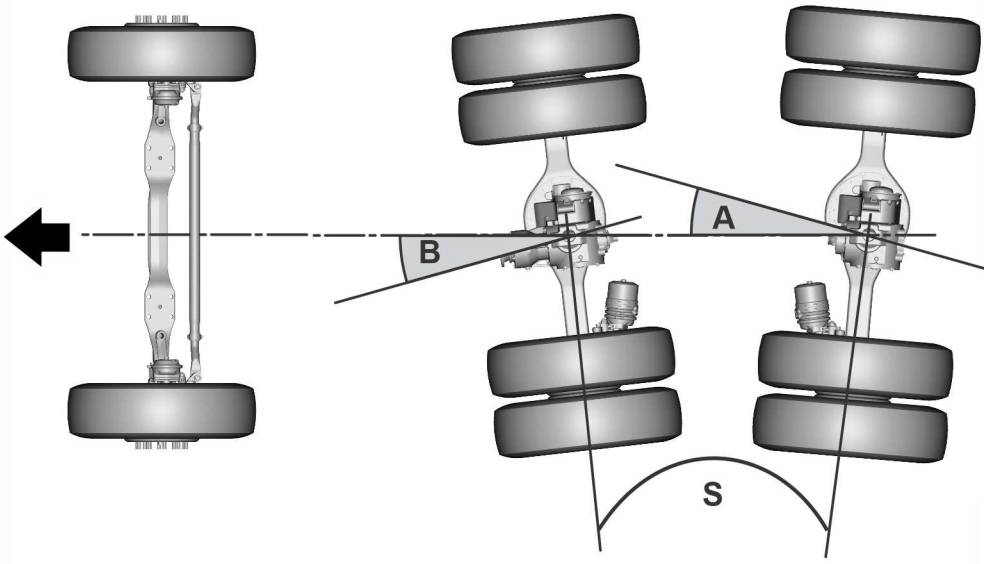
The thrust angle is an angle between the centerline of the chassis and the direction that the axle is pointed.

Thrust angle (A) B-ride (RADD-BR)	0° ± 0.08°

A thrust angle other than 0° pushes the truck sideways thus increases tire wear. When the thrust angle is 0°, the axle is perpendicular to the chassis centerline.

Scrub angle (axle parallelism)

The scrub angle is the angle between the centerline of the first drive axle and the second drive axle.



T6173258

Scrub angle (S) B-ride (RADD-BR)	0° ± 0.08°

It is important that all drive axles are parallel to each other and pointing towards the same direction. If the front drive axle has a 0.03° thrust angle (B), then set the thrust angle of rear drive axle (A) also to 0.03°. Any difference in thrust angle will cause the drive axles to work against each other and cause the vehicle to drift in different directions. This will greatly increase tire wear on all axles and increase drag from the scrubbing.

To meet the scrub angle tolerance, compare the thrust angle of the second drive axle (A) with the thrust angle of the front drive axle (B). Ideally, these two values should read the same with the same sign (+ or -). It is very important to have B and A with the same sign. Scrub angle (S) = B – A .

Rear Suspension

Pinion angle measurement

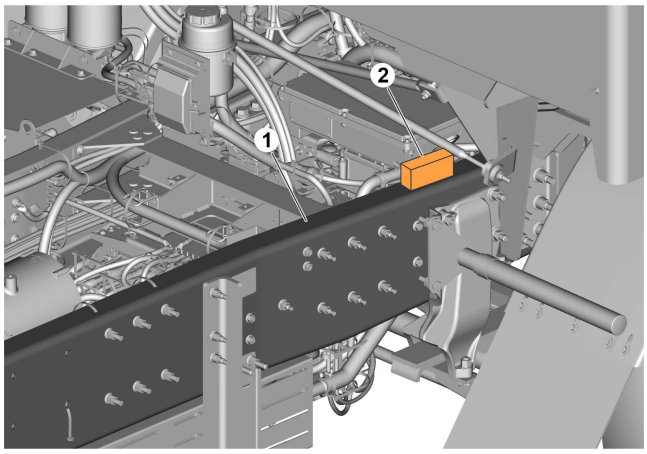
Precondition:

- Park the Vehicle on a smooth level surface.
- Adjust the thrust angles before measuring the pinion angle for the B-Ride. Measure the thrust angles with the wheels of steering axles in a straight ahead position.

Note: Measure the pinion angles relative to the frame.

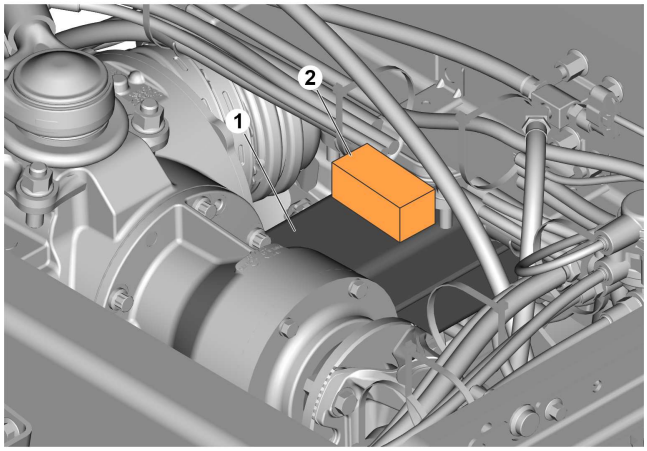
Pinion angle measurement:

1. Measure the frame slope of the RHS frame rail within 1 meter from the cab.



T7174453

2. Measure the pinion angle of the front drive axle.

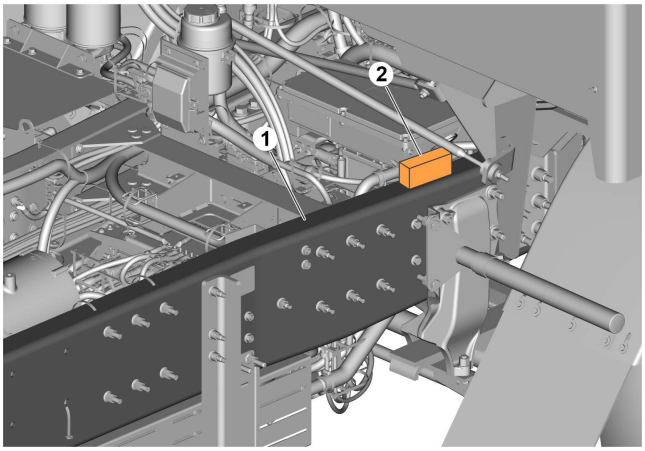


T7174454

3. Calculate the difference between the frame slope and the pinion angle (front drive axle).

- If the value is within a tolerance of 0 ± 0.5°, proceed to step-4.
- If the value is not within the tolerance, adjust the shim length on the lower torque rod of the front drive axle.

4. Measure the pinion angle of the second drive axle.

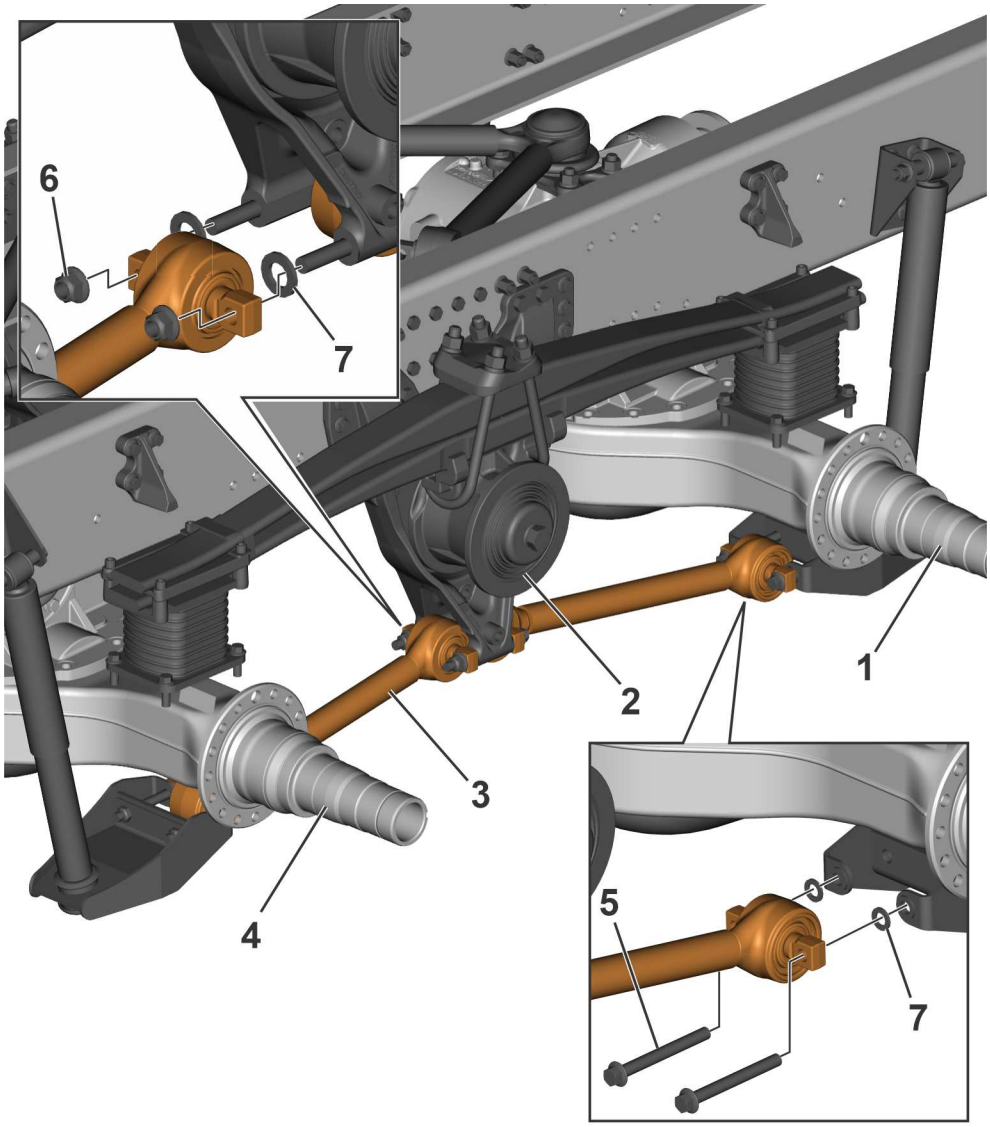


T7174453

5. Calculate the difference between the frame slope and the pinion angle (second drive axle).

- If the value is within a tolerance of 0 ± 0.5°, pinion angle adjustment is completed.
- If the value is not within the tolerance, adjust the shim length on the lower torque rod of the second drive axle.

	Axle inclination relative to frame		Front drive axle	Rear drive axle
Frame slope	**First drive axle**	**Second drive axle**	**Spacer length per joint (mm)**	**Spacer length per joint (mm)**
-1 to -0.25	2°	2°	6	6
-0.25 to 0.25	2°	2°	6	6
0.26 to 0.75	2°	2°	6	6
0.76 to 1.5	2°	2°	6	6



T6173257

1 Front drive axle
2 Bogie anchorage
3 Torque rod
4 Rear drive axle
5 Screw (axle side)
6 Nut (bogie anchorage side)
7 Shim

Pinion angle adjustment:

Add shims either at the axle side or at the bogie anchorage side to adjust the pinion angle.

1 Remove the screw or nut and hold the torque rod
2 Add the shim.
3 Position the torque rod.
4 Install the screw or nut.

First drive axle

- Thicker shim increases pinion angle
- Thinner shim decreases pinion angle

Second drive axle

- Thicker shim decreases pinion angle
- Thinner shim increases pinion angle

Note: 1° of pinion angle is equal to approximately 10 mm of shim.

Notes

ECU Functions and Parameter Programming

This section lists functionalities that are of interest to body builders and others who want to modify certain (programmable) aspects of the ECUs. If an ECU is not included in this section, it is because there are no adjustable functions which can be modified in the field.

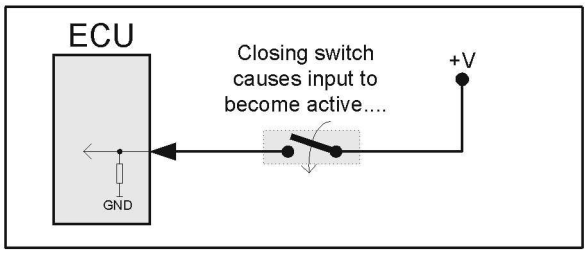
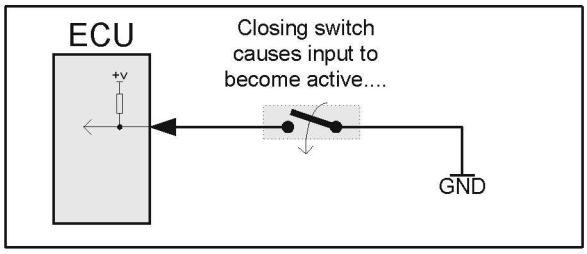
Not all functions or parameters listed in this document may apply to the vehicle you have, because of running changes and improvements made over time. Using each component's Main Software part number, the Premium Tech Tool knows which parameters apply, and shows only those which are adjustable for that particular vehicle.

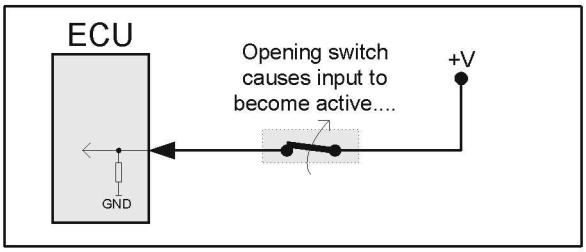
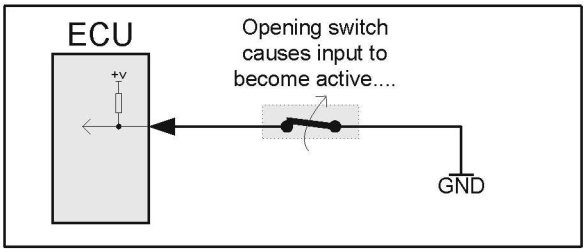
Whenever working on the electrical system of the vehicle, certain ECUs, such as the airbag (SRS) ECU, need special handling to avoid damage. Refer to the appropriate ECU sections, and to the individual ECU service manual, for the appropriate precautions.

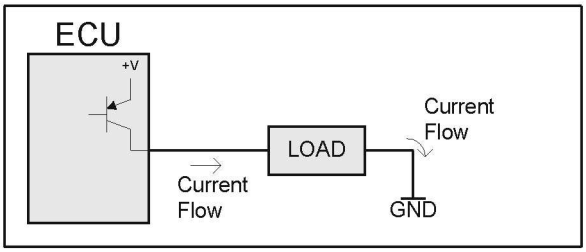
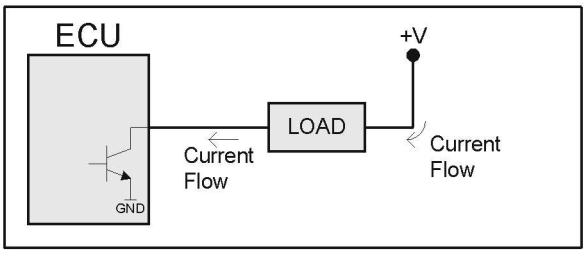
All ECUs use some form of input and output devices to perform their functions. These devices may include switches, sensors, solenoids, and relays. DO NOT tie or splice into an existing sensor or input device used by an ECU. Failure to follow may affect the proper operation of the sensor. Likewise, DO NOT tie into an output device that is controlled by an ECU unless authorized to do so in this document.

Always observe proper Electrostatic Discharge (ESD) precautions while working around the ECUs.

The Inputs and Outputs (I/O) of the ECUs follow a certain "logic" that are important to understand when interfacing to the ECUs. The following information explains the terminology used in this document:

Input/output Type	Definition
Active High (or Active +V)	This input is typically configured with a switch wired to + Voltage. The input has two states; either floating (switch open), or +V (switch closed). The input is considered active when +V is applied.  W9000629
Active Low (or Active ground)	This input is typically configured with a switch wired to ground. The input has two states; either floating (switch open), or grounded (switch closed). The input is considered active when grounded.  W9000630
NC switch to +V	This input type typically has a Normally Closed (NC) switch contact connected to +V. The input becomes active when the switch is opened or the circuit is otherwise broken.

Input/output Type	Definition
	 W9000631
NC switch to ground	This input type typically has a Normally Closed (NC) switch contact connected to the ground. The input becomes active when the switch is opened or the circuit is otherwise broken.  W9000632

I/O Type	Definition
Outputs	
Active High	This output source current (the voltage goes high) when active. The other side of the load or controlled device is connected to ground.  W9000633
Active Low	This output sinks current (the voltage goes low, usually to the ground) when active. The other side of the load-controlled device must be connected to +V.  W9000634

Many of the functions on today's vehicles are shared among different ECUs. Use the following guide to help decide which ECU controls which functions:

Feature/Function	ECU
Road Speed Limit Parameters	PCM
Auto Neutral Parameter	EVCM
Cruise Control Parameters	VECU
Regenerative Brake Levels	(not adjustable)
ATVSA disable/enable	HPCU
TVS Inhibition	HPCU

Road speed limit (RSL)

Road speed limit function gives ability to limit the vehicle speed. This limit is separate from all other vehicle speed limits (such as CC maximum set speed, maximum Road Speed Governor, etc.). When multiple road/vehicle speed limits are imposed, the lowest will have priority. The RSL is also used in refuse trucks to limit the speed when the vehicle requires someone to stand on the back of the vehicle.

PCM- Road speed limit parameters

Parameter code	Parameter caption	Parameter description	Minimum	Default value	Maximum	Unit
P1RWB	Vehicle acceleration limiter configuration (Pedal Control)	Vehicle acceleration limiter configuration (Pedal Control)	0	0	2	—
AI	Cruise control max speed	The maximum speed that can be set in the cruise control.	30	130	140	km/h
P1ALV	Legal Road Speed Limit	The legal RSL that is set to the vehicle.	30	Not applicable	140	km/h
P1AOC	Customer Road Speed Limit	Specifies the customer selectable maximum speed the vehicle can operate on a level road. The lowest of following limits the vehicle speed: • Customer Road Speed Limit (P1AOC) • Road Speed Limit (P1ALV) • Secondary Road Speed Limit (Request via CAN-signal from Body Builder Module) if available . For markets that use performance bonus: When the Performance Bonus feature grants any additional speed, the speed is added to the Customer Road Speed Limit (P1AOC), as long as the overall maximum speed is not exceeding 140 km/h (87 MPH). When	30	Not applicable	140	km/h

		the Differential Road Speed Governor imposes any speed penalty, the penalty speed is subtracted from this maximum value. The Customer Road Speed Limit (P1AOC) specifies the accelerator-pedal maximum speed. Always set the Maximum Cruise Control Speed less than or equal to the accelerator-pedal maximum speed.				
P1I16	RSL With Pedal	The parameter is used to set a higher or lower pedal vehicle speed. The intended use of this parameter along with the RSL function is to make the driver want to use cruise control.	0	Not applicable	140	km/h
P1KB7	Soft top default vehicle speed limit	Passing speed limit for soft top mode (legal setting).	0	Not applicable	6553.5	km/h
P1KB8	Soft top vehicle speed limit	Default speed limit for soft top mode (legal setting).	0	Not applicable	6553.5	km/h
P1KB9	Soft top expiration distance	Expiration mileage after which soft top mode is no longer active (legal setting).	0	Not applicable	4294967295	m
P1KCA	Soft top current available time	Current available minutes to use for soft top mode operation.	-2147483648	Not applicable	2147483648	Seconds
P1KCB	Soft top daily time	Time permitted in soft top mode per day (10 hours) of operation (soft top factor) (legal setting).	0	Not applicable	65535	minutes
P1KCC	Soft top total time	Total time spent in soft top operation.	0	Not applicable	4294967295	Seconds
P1KJ8	Cab type for soft top speed limit	Cab type: 0 = Day Cab 1 = Sleeper 2 = Not available	0	Based on cab type	255	—
P1MG2	RSL difference between loaded and unloaded vehicle	Difference in Road Speed Limit between the loaded and the unloaded vehicle. The lowered speed limit is relative to the Customer Road Speed Limit.	0	Not applicable	6553.5	km/h
P1MG3	Use lower road speed limit on loaded vehicle	Select if the negative offset shall be applied on loaded or unloaded vehicle. **No:** The offset is applied on an unloaded vehicle. **Yes:** The offset is applied on a loaded vehicle. For weight RSL, the offset is relative to the Customer Road Speed Limit (P1AOC).	0	Not applicable	1	—

P1MG4	Bellows pressure threshold for loaded vehicle	For weight-based Road Speed Limit, the vehicle is considered loaded if the pressure in the suspension bellows is above this value.	0	Not applicable	6553.5	kPa
P1Y0M	RSL reverse driving configuration	Configures the maximum vehicle speed used for reversing. When the vehicle is reversing, the lowest value of this configuration parameter and all other RSL limits the vehicle speed. When the vehicle is moving forward, this configuration parameter does not limits or affects the vehicle speed.	5	Not applicable	140	km/h

Cruise Control

The Cruise Control maintains a pre-set vehicle speed regardless of terrain or other vehicle load conditions.

Pin/Connector Information

See the VECU I/O table for pin locations of the Cruise Control On/Off, and Resume and Set switches inputs.

Prerequisites / Conditions for Activation

- CC function is enabled in the VECU
- Cruise Control switch set to the On position
- Current vehicle speed is between Cruise Control MAX and MIN vehicle speed parameters
- Brake pedal is released
- No Vehicle Speed Sensor (VSS) related faults
- No J1939 control data link related faults in the VECU or PCM

Press SET switch to select the current vehicle speed as the "set" speed. A Cruise Control ("CC") icon appears in the instrument cluster when the cruise control is engaged. Once CC is active, the SET switch is used to adjust the CC set speed within programmed limits. Speed changes are made either as a "ramp" (by holding the SET switch), or as a "step" change (by tapping the switch).

The cruise control Maximum Set Speed is the maximum vehicle speed allowed while in CC mode.

Note: The cruise control Maximum set speed may differ (higher or lower) from the overall maximum vehicle speed limit set in the PCM. If the overall speed limit is lower than the CC Maximum Set Speed, the PCM considers the overall speed limit.

If the CC is disengaged for any reason (any of the prerequisites above are no longer met), the CC RESUME switch re-engages cruise control and restores the last "set" speed.

If load or terrain conditions reduce the vehicle speed below the minimum governed speed while the Cruise Control is engaged, the cruise control governor drops out.

Parameter codes (VECU 4)

Parameter Name	Code	Default Value	Range	Description
F_ENABLE_CRUISE _CONTROL	AG	1	0/1	Enables the CC Function
CC Maximum Set Speed	AI	130 km/h (81 m/h)	30 km/h ~ 140 km/h (19 m/h ~ 87 m/h) must be > BK	Maximum CC Set speed allowed
CC Minimum Set Speed	BK	30 km/h (19 m/h)	30 km/h ~ 140 km/h (19 m/h ~ 87 m/h) must be < AI	Minimum CC Set speed allowed
CC Minimum Governed Speed	BL	15 km/h (9 mph)	15 km/h ~ 30 km/h (9 m/h ~ 19 m/h)	Vehicle speed below which the Cruise governor will no longer attempt to maintain preset speed
Cruise Trim Factor	GP	2 km/h per second (1 mph/ per second)	0 km/h ~ 10 km/h (0 m/h ~ 6 m/h) per second	Specifies the speed change ramp (in km/h per second) that will be requested when the SET switch is held
Cruise Trim Factor Minus	RR	2 km/h per second (1 mph/ per second)	0 km/h ~ 10 km/h (0 m/h ~ 6 m/h) per second	Specifies the speed change ramp (in km/h per second) that will be requested when the SET switch is held
Cruise Step Factor	RS	2 km/h (1 mph)	0 km/h ~ 10 km/h (0 m/h ~ 6 m/h)	Specifies the step speed change (in km/h) that will be requested when 'tapping' SET switch

Notes

Auto Neutral

When the parking brake is applied, the auto neutral function keeps the transmission in neutral. Once the parking brake is released, press the drive (D) switch to let the transmission engage in a gear. Auto neutral improves job-site safety for a variety of applications.

ATVSA Enable/Disable

When the chassis switch is in the On position, the ATVSA (Automatic Traction Voltage System Activation) function may activate automatically without any special action being taken and irrespective of the position of the starting key or the connection to the offboard charger. There are various reasons why the 600 V circuit may reactivate:

- To maintain charge in the 24 V system batteries to have the vehicle ready to run for next key cycle or starting cycle (when the truck is parked).
- To maintain the cell temperature of the traction batteries by preconditioning them (both by cooling and heating). Precondition improves the SOH (state of health) of the traction batteries.
- To maintain the cell temperature of the traction batteries by post conditioning (after-run mode) them (both by cooling and heating). Post condition improves the SOH the traction batteries.
- To activate 600 V power distribution for body builder function when requested, example fridge body.

The electromobility system periodically wakes-up the 24V system to check the 24 V system battery charge level and battery cell temperature of the traction batteries. After the preconditioning assessment, the traction voltage supply is enabled if required or else remains disabled.

When the body builder wants to use the vehicle with the chassis switch in the On position and the starter key is OFF, disable the ATVSA function to avoid automatic activation of cooling fans, heaters, and other components etc. Use the Premium Tech Tool operation “3650-05-03-01 Automatic Traction Voltage system Activation, control” to enable or disable the ATVSA function.

Note: “3650-05-03-01 Automatic Traction Voltage system Activation, control” disables or enables both the ATVSA and TVS together. Cannot disable the ATVSA function without inhibiting TVS.

HPCU - ATVSA Parameter

Parameter code	Parameter description	Minimum	Default value	Maximum	Unit
P1R0B	Electric Vehicle, ATVSA Function, Enable/Disable	0	1	1	—

TVS (Traction Voltage System) Inhibition

Inhibit the TVS before performing certain diagnostic operations that are otherwise prevented from being performed. Follow the TVS inhibition routine provided in the Premium Tech Tool.

HPCU-Routine

DOID code	DOID description
R1DYO	Traction Voltage System, Force Shutdown

Preconditions: The vehicle shall be in key on (Pre-running) but not running vehicle mode.

Test Sequence:

1 Check that the preconditions are fulfilled.

2 Run the routine. The TVS is commanded to de-energize.

3 When the routine is completed, check that the parameter P1V2F reports false. False refers that the TVS is de-energized.

Note: The parameter P1V2F is not editable or programmable. The parameter is to check the TVS status.

System Behavior: De-energize the TVS safely (if energized) and not re-energize until the starter key position changes.

Use the Premium Tech Tool operation “3650-05-03-01 Automatic Traction Voltage system Activation, control” to inhibit the TVS.

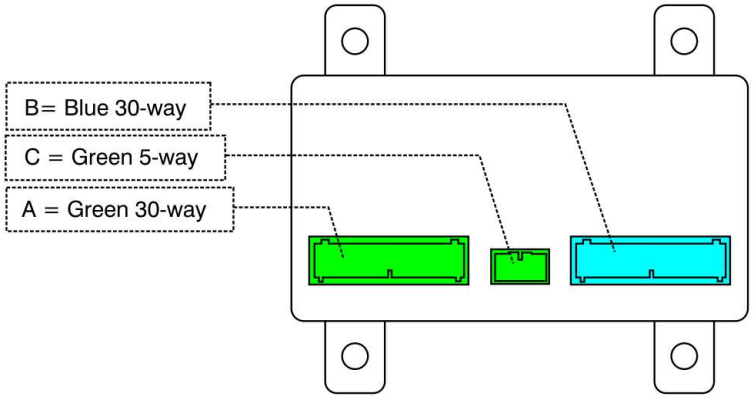
Note: “3650-05-03-01 Automatic Traction Voltage system Activation, control” disables or enables both the ATVSA and TVS together. Cannot inhibit the TVS without disabling the ATVSA function.

Notes

Vehicle Electronic Control Unit (VECU)

The VECU has many programmable features. The features listed here are included because they are of particular interest to body builders and others who want to modify certain aspects of the VECU. For a complete list of all programmable parameters, see the appropriate Premium Tech Tool parameter and reprogramming information.

Description of VECU Signals



W3088359

VECU Connector A (Green)

Pin	Pin Name/Description	I/O	Type	Comment
A1	CC Set (–) SW	Input	Active High	
A2	CC Set (+) SW	Input	Active High	
A3	CC On/Off SW	Input	Active High	
A4	SPARE	SPARE	SPARE	
A5	Brake Pedal Microswitch	Input	NC Switch to +V	NO switch installed. Wired to +V
A6	Key Switch: Start	Input	Active High	
A7	Brake Switch	Input	Active High	—
A8	No Connection	—	—	—
A9	Neutral	Input	Active High	
A10	Air Suspension	Input	Active High	
A11	Starter Control	Input	Active High	—
A12	ECU Ground	ECU Main Power Ground		
A13	ECU Main Power	Input	ECU Main Power	

Pin	Pin Name/Description	I/O	Type	Comment
A14	Spare Switch PTO 4	Input	Active High	
A15	CAN2-High (J1939H) DL5	Bidirectional Data Link		
A16	CAN2-Low (J1939L) DL5	Bidirectional Data Link		
A17	No Connection	—	—	—
A18	No Connection	—	—	—
A19	No Connection	—	—	—
A20	No Connection	—	—	—
A21	No Connection	—	—	—
A22	Not Used	Input	Active High	Do not connect; special use only
A23	Idle Validation Switch-1	Input	Active High	
A24	No Connection	—	—	—
A25	Interwheel Lock	—	—	—
A26	PDLO Active	Input	Active Low	
A27	Spare Switch	—	—	—
A28	Hood Tilt	Input	Active Low	Do not connect; special use only
A29	PTO1	—	—	—
A30	No Connection	—	—	—

Notes

VECU Connector B (Blue)

Pin	Pin Name/Description	I/O	Type	Comment
B1	Power relay 1	Output	Active Low	
B2	Power relay 1	Output	Active Low	
B3	Interwheel Lock (CDS)	—	—	—
B4	PDLO	Output	Active Low	
B5	Output Supply # 4 (-V batt)	Output	Switch Power	
B6	Vehicle Speed Sensor (+)	Input	Analog	
B7	PTO2	—	—	—
B8	Accelerator Pedal	Input	Analog Sensor	
B9	Air Tank Pressure	Input	Analog Sensor	ECADS
B10	Accelerator Pedal Supply-1 (~5 V)	Output	Sensor Power	
B11	Parking Brake	Input	Active Low	Ground connected N.C. air switch (No air = switch closed = PB applied)
B12	Torque Limit	Input	Active Low	
B13	Right-hand side Operation	Input	Active Low	
B14	Not Used	Input	Analog Sensor	Do not connect; special use only
B15	ECU Power Relay Control	Output	Active Low	
B16	CDS2 Output PTO4	Output	Active Low	—
B17	Buffered Idle Validation Switch-1	Output	Active High	
B18	CDS2 Output PTO3	Output	Active Low	
B19	Output Supply # 3 (~V batt)	Output	Switch Power	
B20	Vehicle Speed Sensor (-)	Input	Analog	
B21	CDS1 PTO3	Input	Active High	Do not connect; special use only
B22	Analog Ground	ECU Sensor Ground		
B23	Analog Ground	ECU Sensor Ground		
B24	Retarder Stalk	Input	Analog Sensor	
B25	No Connection	—	—	—
B26	Output Supply # 2 (~5 V)	Output	Sensor Power	
B27	Spare	—	—	—
B28	No Connection	—	—	—
B29	Not Used	Input	Active Low	Do not connect; special use only
B30	Shut down override	Input	Active High	

VECU Connector C (Green)

Pin	Pin Name/Description	I/O	Type	Comment
C1	J1587/1708 Information Data Link (B) (SAE J1708 (A))	Bidirectional data link		J1587/1708 Information Data Link (Slow Speed)
C2	J1587/1708 (A) (SAE J1708 (B))			
C3	No connection	—	—	—
C4	J1939 Control Data Link/A (CAN_H)	Bidirectional data link		J1939 Control Data Link (High Speed)
C5	J1939 Control Data Link/B (CAN_L)			

Notes

Data Link

The LR Electric has many Electronic Control Units (ECUs) to operate many of the vehicle's features. Most ECUs are linked together using one or more data links for sharing information.

Some ECUs operate independently of each other, but most rely on interaction with other ECUs to properly perform their functions. All ECUs use some form of input and output devices to perform their functions. These devices may include switches, sensors, solenoids, and relays. **NEVER** tie or splice into a sensor or input device. This could affect the proper operation of the sensor. Likewise, never tie into an output device, unless authorized to do so elsewhere in this document.

Data Link Communication

Communication between the different ECUs takes place via three data links:

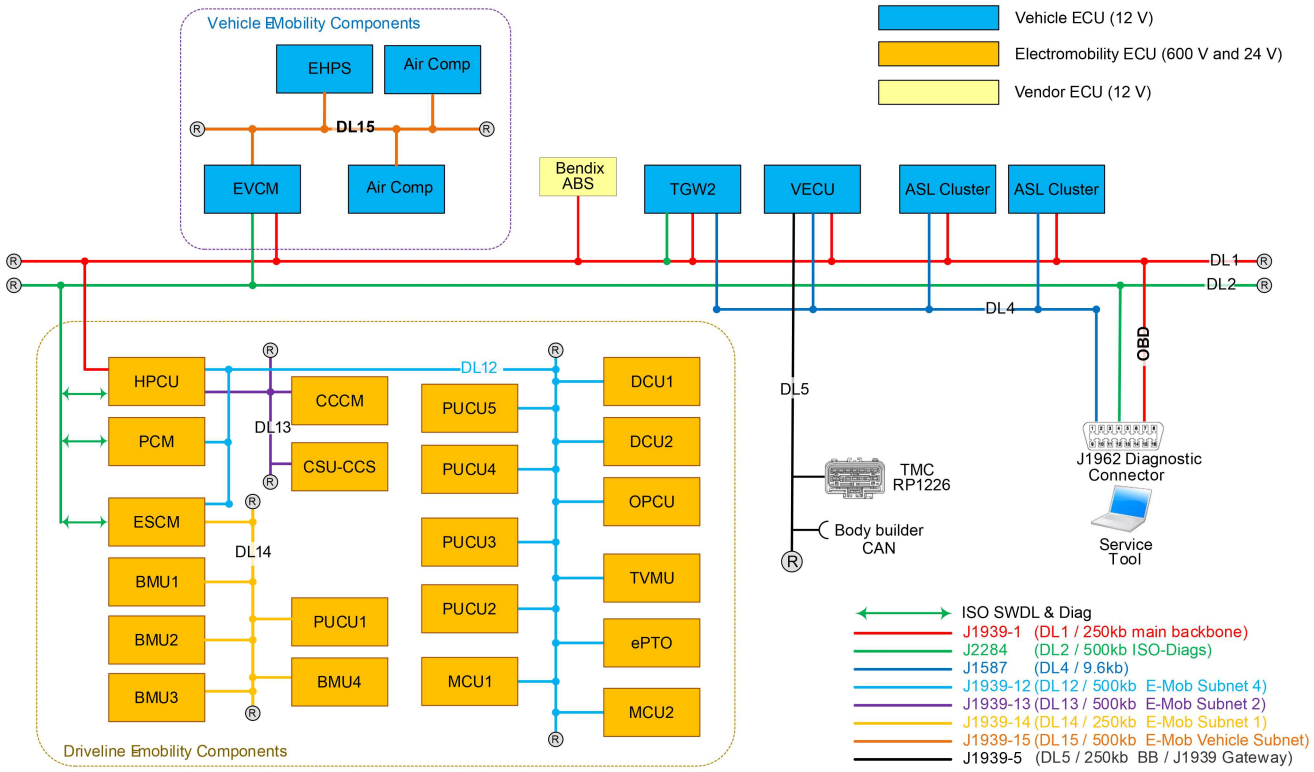
SAE J1939 data link – 250 kbit/s (communication speed)

SAE J1587/1708 data link – 9.6 kbit/s (communication speed)

SAE J2284 data link – 500 kbit/s (communication speed)

All data links and most subnets use CAN bus communication. CAN is a message-based protocol with a twisted pair of cables between control units. All the units within a CAN can initiate communication, but only one can send data at a given time.

Data link Link Flow



T3174383

Electronic Control Unit (ECU)	Description
ABS	Anti-lock Braking System
EVAC	Electric Vehicle Air Compressor
BB	Body Builder
BMU	Battery management unit

Electronic Control Unit (ECU)	Description
CAN	Control Area Network
CCCM	Combined Charging system Control Module
CSU-CCS	Charging Switch Unit-combined charging system
DCU	Direct Current Unit
EHPS	Electro-hydraulic power steering
ePTO	Mechanical Electromobility PTO
ESCM	Energy Storage Control Module
EVCM	Electromobility Vehicle Control Module
HPCU	Hybrid Powertrain Control Unit
IC-1	Instrument Cluster (Primary)
IC-2	Instrument Cluster (Secondary)
MCU	Motor Control Unit
PCM	Powertrain Control Module
PUCU	Pump Control Unit
OBD	On-board Diagnostic
OPCU	Oil Pump Control Unit
TGW	Telematics Gateway
TVMU	Traction Voltage Monitoring Unit
VECU	Vehicle Electronic Control Unit

Notes

SAE J1939 Control Data Link

Control signals of all systems are communicated via the J1939 data link.

The J1939 is the fastest data link, operating at 250 K bits per second (250K Baud rate). This operating speed allows a system to function more effectively and adapt quickly to changing conditions and vehicle requirements.

This data link complies with SAE standards. It consists of two twisted wires: a yellow wire (CAN_H), and a green wire (CAN_L). The wires are twisted at the rate of 0.89 twists per 25.4 mm (1 inch) or 33 twists per meter (3.28 feet). The twisted wires protect the data link from electrical interference.

CAUTION

No modifications or connections are allowed on the data link wires (CAN_H (yellow), or CAN_L (green)). These wires carry the high-speed communications between the electronic systems in the vehicle. **Any modification, connection to, or damage to these wires can result in the failure of the vehicle electronic systems.**

Terminating Resistor

Terminating resistors are connected to each end of the J1939 (DL1) data link.

It is allowed to have only two terminating resistors in a data link. Never install three in a data link. If the J1939 data link has more than two terminating resistors, damage to the ECU electronics can occur over time. To check whether the data link has two resistors or not, measure the resistance between circuits CAN_H and CAN_L using the diagnostic connector, with the starter key in the OFF position. When the data link has two resistors, the resistance should be between 50 - 70 Ω.

The resistors prevent signal reflections to the data link. They must remain connected to the system to function properly.

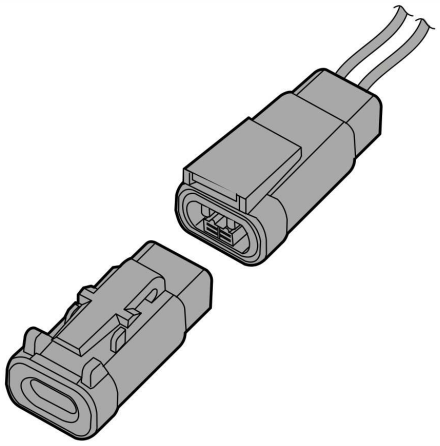


Fig. 1 J1939 Terminating Resistor

SAE J2284 Control Data Link

The system **Control signals** are communicated via the J2284 data link.

The J2284 is the very fastest data link, operating at 500 K bits per second (500 K Baud rate). This operating speed allows a system to function more effectively and adapt quickly to changing conditions and vehicle requirements.

This data link complies with SAE standards. It consists of two twisted wires: a yellow wire (CAN_H), and a green wire (CAN_L). The wires are twisted at the rate of 0.89 twists per 25.4 mm (1 inch) or 33 twists per meter (3.28 feet). The twisted wires protect the data link from electrical interference.

CAUTION

No modifications or connections are allowed on the data link wires (CAN_H (yellow), or CAN_L (green)). These wires carry the high-speed communications between the electronic systems in the vehicle. **Any modification, connection to, or damage to these wires can result in the failure of the vehicle electronic systems.**

Terminating Resistor

Terminating resistors are connected to each end of the J2284 (DL2) data link.

It is allowed to have only two terminating resistors in a data link. Never install three in a data link. If the J2284 data link has more than two terminating resistors, damage to the ECU electronics can occur over time. To check whether the data link has two resistors or not, measure the resistance between circuits CAN_H and CAN_L using the diagnostic connector, with the starter key in the OFF position. When the data link has two resistors, the resistance should be between 50 - 70 Ω.

The resistors prevent signal reflections to the data link. They must remain connected to the system to function properly.

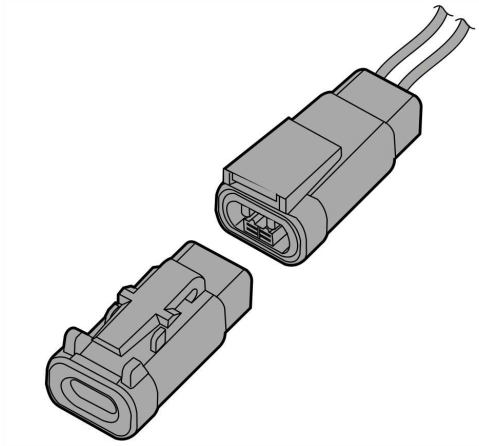


Fig. 2 J2284 Terminating Resistor

SAE J1587/1708 Information Data Link

Information and diagnostic signals are communicated via the SAE J1587/1708 data link. The data link also function as a backup when the J1939 control data link fails to function for any reason.

SAE J1708 is a standard that specifies hardware and a data link that operates with the speed of 9.6 K bits per second (9.6 K Baud rate). SAE J1587 is a protocol that provides a standard method for exchanging information between microprocessors.

The J1587 link consists of two wires [(SAE J1708 (A)) and (SAE J1708 (B)] that are twisted at the rate of 1 twist per 25.4 mm (1 inch) or 40 twists per meter (3.28 feet). The twisted wires protect the data link against electrical interference.

CAUTION

To have a new circuit added to the electrical system that carries high currents or frequencies, route it in a location AWAY from wires (SAE J1708 (A)) and (SAE J1708 (B). This prevents mutual inductance from interfering with the functions of the data link.

CAUTION

No modifications or connections are allowed on the data link wires (CAN_H (yellow), or CAN_L (green)). These wires carry the data for diagnostic messages and gauges. **Any modification, connection to, or damage to these wires can cause the failure of data carrying function.**

Notes

Diagnostic Connector

The diagnostic connector is located in the LHS kick panel. The diagnostic connector is connected to the ISO information link and gives the system a way to communicate with an external PC or diagnostic tool.

The diagnostic connector is an interface for a PC or diagnostic tool to connect and read the error codes from all the control units. This is important in fault tracing to carry out basic checks of all the vital parts of the vehicle electronics.

Also, a PC or diagnostic tool uses the diagnostic connector to program the control units.

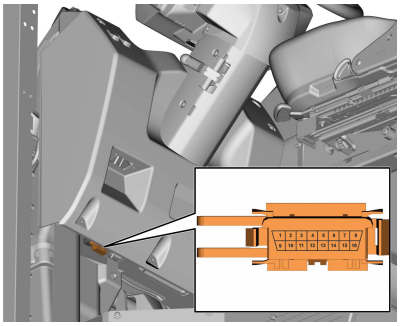


Fig. 3 Diagnostic Connector (16 Pin)

Pin allocation for the 2013 SAE J1962 16-pin Vehicle Diagnostic Connector (Global Commonality)

16 Pin Diagnostic Connector (OBD 13) Definitions

16 Pin Diagnostic Connector (OBD 13 SAE J1962-Type A Connector)	
Pin	**Definition**
1	OEM discretionary (assigned as: Key switch – start signal for AM tool)
2	Bus positive line of SAE J1850 (Not Used)
3	OEM discretionary (assigned as: SAE J1939-15_CAN_H)
4	Chassis ground
5	Signal ground 6 CAN_H line of ISO
6	CAN_H line of ISO 15765-4
7	K line of ISO 9141-2 and ISO 14230-4 (Not Used)
8	OEM discretionary (Not assigned)
9	OEM discretionary (Not assigned)
10	Bus negative line of SAE J1850 (Not Used)
11	OEM discretionary (assigned as: SAE J1939-15_CAN_L)
12	OEM discretionary (assigned as: SAE J1708 / J1587 positive)
13	OEM discretionary (assigned as: SAE J1708 / J1587 negative)
14	CAN_L line of ISO 15765-4
15	L line of ISO 9141-2 and ISO 14230-4 (Not Used)
16	Battery positive voltage

Body Builder CAN Gateway

Body builder CAN gateway is an interface to connect the vehicle internal CAN. This gateway helps the body builder to monitor the standard messages of the J1939 data link via the CAN bus.

Body builder equipment should comply with the standards defined for the following types of communication bus:

— SAE J1939-11 (twisted wires)

— SAE J1939 (physical layers)

— SAE J1939-71 (functional layers)

Note: The body builder CAN includes a 120-Ohm terminal resistor inside the VECU.
The external equipment installer is responsible for ensuring the CAN connection has the correct terminal.
For more detailed information, refer to standard SAE J1939.

Multiplexing Body Builder DL5 J1939 CAN

The multiplexing system BB J1939 CAN provides control and communication between all major functional areas of a vehicle. The system offers simplified communication between the body builder module and other related electrical systems. Multiple signals are sent over a single pair of twisted wires as opposed to individual wires for each function. The J1939 data link sends these signals.

The benefit of this arrangement is:

- fewer wires, and sensors
- fewer connections required for communication between the systems.

Also, there is greater signal consistency and reliability.

Multiplexing Parameters

SAE (PGN)	CAN Network	Source Address [Decimal (hex)]	Update Rate	PGN Signal Names (SPN)
ACC1 (65135)	J1939-X	42 (2A)	100 ms	Forward vehicle speed Forward vehicle distance ACC Set Speed ACC Mode ACC set distance mode Road curvature ACC Target Detected ACC System Shutoff Warning ACC Distance Alert Signal
ACC Status (65296)	J1939-X	42 (2A)	100 ms	Proprietary message from Bendix
AIR1	J1939-X	17 (11)	1 second	Pneumatic Supply Pressure 46
AMB (65269)	J1939-X	0 (0)	1 second	Ambient Air Temperature, Barometric pressure
B1 (65274)	J1939-X	23 (17)	1 second	Brake Application Pressure (SPN 116) Brake Primary Pressure (SPN 117) Brake Secondary Pressure (SPN 118) Parking Brake Red Warning Signal (SPN 3557)

SAE (PGN)	CAN Network	Source Address [Decimal (hex)]	Update Rate	PGN Signal Names (SPN)
CCSS (65261)	J1939-X	0 (0)	1 second	Maximum Vehicle Speed Limit
CCVS (65265)	J1939-X	17 (11)	100 ms	Vehicle speed, etc.
CI (65259)	J1939-X	0 (0)	10 second	Component ID, etc.
CM1 (57344)	J1939-X	17 (11)	1 second	Seat Belt Switch (SPN 1856)
CVW (65136)	J1939-X	3 (3)	10 second	Gross Combination Weight
DD (65276)	J1939-X	23 (17)	1 second	Washer fluid level (SPN 80)
DM1 (65226)	J1939-X	0 (0), 3 (3), 11 (B), 61 (3D)	1 second	Fault lamps, etc.
EBC1 (61441)	J1939-X	11 (B)	100 ms	Anti-lock braking system (ABS) Active, etc.
EBC2/WSI (65215)	J1939-X	11 (B)	100 ms	Wheel speeds
EBC5 (64964)	J1939-X	11 (B)	100 ms	Hill Holder Mode
EEC1 (61444)	J1939-X	0 (0)	20 ms	Engine Speed, etc
EEC2 (61443)	J1939-X	0 (0)	50 ms	Accelerator Pedal Position 1 Remote accelerator pedal position
ET1 (65262)	J1939-X	0 (0)	1 second	Coolant Temperature 110
ETC1 (61442)	J1939-X	3 (3)	10 ms	Driveline engaged status
ETC2 (61445)	J1939-X	3 (3)	100 ms	Current gear status, requested gear status
ETC7 (65098)	J1939-X	3 (3)	100 ms	Shift and mode indicators, etc.
HOURS (65253)	J1939-X	0 (0)	4 second	Total Hours of Operation 247 Total Revolutions 249
HRW (65134)	J1939-X	11 (B)	20 ms	Wheel speeds
LCMD (65089)	J1939-X	55 (37)	1 second and change of state	Light switches, etc.
OEL (64972)	J1939-X	55 (37)	1 second and change of state	Main Light Switch 2872 Turn Signal Switch 2876 Hazard Light Switch 2875 High-Low Beam Switch 2874 Operators Desired Back-light 2878
PTO (65264)	J1939-X	17 (11)	100 ms	Power take-off Set Speed 187 PTO Governor Enable Switch 980

SAE (PGN)	CAN Network	Source Address [Decimal (hex)]	Update Rate	PGN Signal Names (SPN)
				Remote PTO Governor Preprogrammed Speed Control Switch 979 Remote PTO Governor Variable Speed Control Switch 978 PTO Governor Set Switch 984 PTO Governor Coast/Decelerate Switch 983 PTO Governor Resume Switch 982
TD (65254)	J1939-X	23 (17)	1 second	Time & date
TIRE (65268)	J1939-X	51 (33)	100 ms	Tire pressure, Tire Temperature
TRF1 (65272)	J1939-X	3 (3)	1 second	Transmission Oil Temperature 177, etc.
VD (65248)	J1939-X	23 (17)	1 second	Total Vehicle Distance 245 Convert from VDHR
VDC1 (65103)	J1939-X	11 (B)	100 ms	VDC Information Signal, etc.
VDC2 (61449)	J1939-X	11 (B)	10 ms	Steering Wheel Angle, Yaw rate, etc
VDHR (65217)	J1939-X	23 (17)	1 second	High-Resolution Total Vehicle Distance 917
VI (65260)	J1939-X	0 (0)	3 second	VIN
VW (65258)	J1939-X	47 (2F)	1 second	Axle weights (Note: This is multiframe and it is difficult to respond to the gateway at the received rate.)
VEP1 (65271)	J1939-X	23 (17)	1 second	SPN 168 Battery Potential/Power Input 1

Note: Although the VECU sends output messages, the source address is set as the ECU originating the information.

Note: Messages that rates “on request” are requested by the J1939 request PGN 59904 described in J1939-21. For example, requesting engine hours is done by sending EAFF or EA00 with data E5 FE 00 (hex values).

Note: Not all messages are supported on all vehicles. For example, GFC is currently not available, even for natural gasoline engines. However, in the future, the engine could have GFC message support.

Commands Accepted on the DL5 Body Builder Connector J1939

Message	Update Rate	Content
EBC1 (PGN 61441)	100 ms	Remote Accelerator Pedal Enable Switch Accelerator Interlock Switch
EEC2 (61443)	50 ms	Accelerator Pedal Position 2 Remote Accelerator Pedal Position

Application Notes

By default, these commands are not accepted. To enable commands:

- QIW = 1 Bridge on J1939 for Body Builder Enable (1) Level 4 Dealer Programmable
- QKH = 1 External CAN Control Enable (1) Level 4 Dealer Programmable
- QKX = 229 (Body Builder must use this Source address 229)
- A Terminating resistor for the network needs to be installed.

For safety, a brake pedal application overrides the accelerator and speed command signals. If necessary, this option can be turned off with parameter QKD. Perform a safety analysis of the application before disabling.

Although the VECU accepts these messages, the destination address (DA) needs to be 0x00 for TSC1 and 0x03 for TC1.

The engine speed command is sent either through the accelerator command or by direct engine speed command.