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BOLLINGER B4 UPFITTER GUIDE

BOLLINGER MOTORS

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All printed material, specifications, and drawings contained in the Bollinger Motors B4 Upfitters Guide are based on the latest information available at the time of publication/posting. The manufacturer reserves the right to discontinue or change, at any time, without notice specifications, options, materials, equipment, design and models.

Information contained in the guide includes:

- OE recommendations
- Cautions for successful application up fitting and Frame modification procedures

1. INTRODUCTION

This guide has been provided as an aid to final stage manufacturers in determining conformity to the applicable Federal Motor Vehicle Safety Standards. Final stage manufacturers should maintain current knowledge of all state, provincial, and local laws and regulations and Federal Motor Vehicle Safety Standards and be aware of their specific responsibility in regard to each standard.

Any manufacturer making material alterations to this incomplete vehicle during the process of manufacturing the complete vehicle should be constantly alert to all effects, direct or indirect, on other components, assemblies or systems caused by such alterations. No alterations should be made to the incomplete vehicle that directly or indirectly results in any either component, assembly or system being in nonconformance with any applicable state, provincial, and local laws and regulations or Federal Motor Vehicle Safety Standards.

The information described herein is believed to be correct at the time of publication, but accuracy cannot be guaranteed. Bollinger Motors reserves the right to discontinue models or change specifications or designs at any time without notice and without incurring any obligation. Regulations such as those issued by the Federal Highway Administration (FHA) or issued pursuant to the Occupational Safety and Health Act (OSHA), and/or state, provincial, and local laws and regulations may require installation of additional equipment for the particular use intended for the vehicle. It is the responsibility of the vehicle upfitter and the vehicle purchaser to ascertain how the vehicle will ultimately be used, if FHA, OSHA, or state, provincial or local regulations apply and how the vehicle, as completed, will comply with those requirements. Nothing contained herein is to be construed as a representation that such equipment required for the particular use intended has been installed on the completed or incomplete vehicle.

Bollinger Motors will honor its warranty commitment (for the cab-chassis only), to the ultimate consumer, provided: (1) the final stage manufacturer has not made any alterations or modifications which do not conform to any applicable laws, regulations or standards, or adversely affect the operation of the cab-chassis; and (2) the final stage manufacturer complied with the instructions contained in this guide with respect to the completion of the vehicle. Otherwise, damages by a final stage manufacturer to a Bollinger Motors vehicle may not be repaired under warranty. Contact Bollinger Motors by email at upfitter@bollingermotors.com if more information is required.

The final stage manufacturer is solely responsible for the final certification of the vehicle and for compliance with any state, provincial, and local laws and regulations and Federal Motor Vehicle Safety Standards. The information contained in this guide has been provided for the final stage manufacturer's information and guidance.

This guide contains information pertaining to the:
BOLLINGER B4 CHASSIS CAB

2. WARNINGS & CAUTIONS

HIGH VOLTAGE WARNINGS

WARNING: NEVER SERVICE, MOVE, MODIFY, OR ALTER ANY HIGH VOLTAGE HARNESSSES, CABLES, COMPONENTS, OR DEVICES. DOING SO MAY RESULT IN SERIOUS INJURY OR DEATH.

WARNING: THE HIGH VOLTAGE DISABLING PROCEDURE MUST BE COMPLETED PRIOR TO PERFORMING ANY WORK ON, WITH, OR IN PROXIMITY TO ANY HIGH VOLTAGE COMPONENT, CABLE, OR CONNECTION. COMPLIANCE WITH ALL APPLICABLE PERSONAL PROTECTIVE EQUIPMENT ("PPE") REQUIREMENTS AND PRESCRIBED SAFETY PROCEDURES IS MANDATORY.

Before around any high voltage system, be sure to wear the following Personal Protection Equipment:

- Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.
- Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.
 - Visually and functionally inspect the gloves before use.
 - Wear the Insulation gloves with leather protectors at all times when working near the high voltage battery assembly, whether the system is energized or not.

Failure to follow the procedures may result in serious injury or death.

WARNING: HIGH VOLTAGE CIRCUITS SHOULD ONLY BE TESTED USING A DIGITAL MULTIMETER (DMM) AND TEST LEADS WITH AT LEAST A CAT III RATING. FAILURE TO FOLLOW THE PROCEDURES MAY RESULT IN SERIOUS INJURY OR DEATH.

- Always verify that the high voltage has been disabled before working around High Voltage harnesses, cables, components, or devices.
- Remove all metal objects such as rings and watches.
- Remove all keyless entry transmitters and secure in a place outside the vehicle.
- Always wear certified and tested high voltage insulation gloves when inspecting or testing any high voltage wires and components.
- Use the "One Hand" rule whenever possible:
 - Work with only one hand.
 - Keep the other hand behind your back.
- DO NOT carry any metal objects such as a mechanical pencil or a measuring tape that could fall and cause a short circuit.
- After removing exposed-terminal style high voltage wires, protect and insulate the terminal ends immediately with UL® Listed or equivalent insulation tape rated at a minimum of 600 V.
- Always tighten the high voltage terminal fasteners to the specified torque and recheck. Insufficient or excessive torque will cause malfunctions or damage.
- After finishing work on the high voltage systems and before disengaging the high voltage service lockout, inspect for the following:
 - Verify high voltage system integrity and that all connectors are installed.
 - Verify that all tools or loose components have been removed.

ELECTRICAL SENSITIVITY & BATTERY RELOCATION WARNING

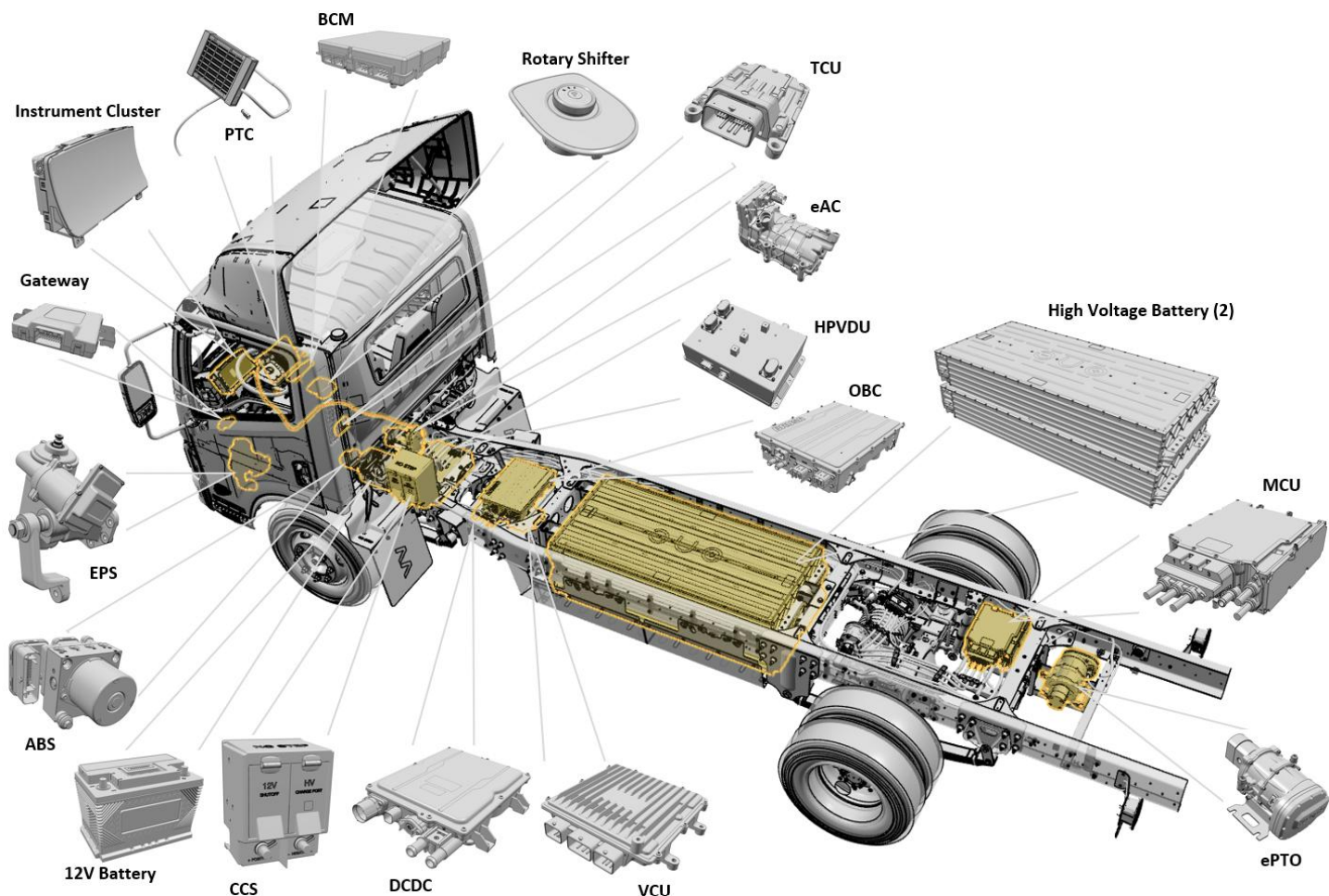
A relocation or modification of low voltage batteries, insufficient wire gauge, poor terminal crimps, weak conductivity to frame rails, terminal corrosion, or loose bolts may result in poor operation of isolated system(s) or the entire truck.

3. HIGH VOLTAGE ELECTRICAL SYSTEMS

WARNING: TO PREVENT THE RISK OF HIGH-VOLTAGE SHOCK, PRECISELY FOLLOW ALL WARNINGS, INCLUDING INSTRUCTIONS TO DISABLE THE HIGH VOLTAGE SYSTEM. FAILURE TO FOLLOW THESE INSTRUCTIONS MAY RESULT IN SERIOUS PERSONAL INJURY OR DEATH.

The High voltage system is comprised of following list of high voltage components:

- 12V Battery – Storage unit for 12V power. Used to supplement the DC-to-DC converter during times of high current demand and to supply 12V power when vehicle is turned off.
- Low Voltage Power Distribution Unit (LVPDU) – Used to control power to the low voltage system(s).
- High Voltage Fuse Panel – Used to protect the low voltage system(s) circuits.
- High Voltage Charge Port – Connects HV charger to HV battery from an external power supply.
- On-Board Charger (OBC) – Converts 120V/240V AC power from level 1 and level 2 chargers to DC power which is then used to charge the high voltage battery pack.
- DC to DC Converter (DCDC) – Converts 700VDC power from the HV battery to ~12VDC power used to charge 12V battery and power all low voltage vehicle modules.
- HV Cables and LV wiring and associated connectors, protective devices, and attachments – distribute high voltage power where needed.
- High Voltage Battery Pack – Twin O.N.E. Aries LFP79 battery packs wired in series to provide approximately 700V to the high voltage system.
- High Voltage Shut-Off Switch – Used to isolate the HV system if needed for upfitter operations or service.
- High Voltage Power Distribution Unit (HVPDU) – This module controls and distributes high voltage current to various HV components within the vehicle.
- Vehicle Control Unit (VCU) – This is an ECU (see above) but specifically referred to as a “Vehicle” controller since it is the main controller for the vehicle particularly in electric vehicles.
- Thermal Control Unit (TCU) – Monitors and controls HV Battery temperature.
- Motor Control Unit (MCU) – Part of the Rear Drive Unit / eAxle assembly. It converts 700VDC current to 3-phase AC current to be used by the drive motor. It is also responsible for modulation of current to the motor.
- eMotor Electric Drive Motor – Refers to Traction Motor powering EV wheels. Provides all of vehicle motive power.
- Electric Air Conditioning (eAC) – High voltage air conditioning compressor used to cool the passenger compartment.
- Positive Temperature Coefficient Heater (PTC) – High voltage heating element built into the Cab’s HVAC unit. Used to heat the passenger compartment when requested.
- Electronic Power Take-Off (ePTO) (if equipped) – Optional unit that converts high voltage electrical power to mechanical power in the form of a spinning shaft used by upfitters.
- Combined Charging System (CCS) – Charging port used to charge the high voltage batteries. This provides an interface for both Level 1&2 AC charging as well as DC fast charging.



The location of high voltage components within the vehicle can be identified in the following ways:

- All high voltage wiring is orange in color (may be wrapped in orange tape).
- All high voltage modules and batteries have warning symbol or other identification:



The high voltage system has a floating return reference, which is designed to completely isolate the HV system from the vehicle chassis and non-HV components and circuits. As part of the safety features built into the HV system, measurements between the HV bus and vehicle ground are monitored during key “on” state to detect high voltage leakage or stray current to the chassis.

The HV contactors of the high voltage battery are only activated when necessary for vehicle operation, including:

- When the vehicle is in key “on” or “accessory” state (“Ready” indicator lit in instrument cluster).
- When the 12v battery has a low state of charge - the HV battery will activate to charge the 12v battery through the DC-to-DC Converter, even in the vehicle key “off” state.
- When the vehicle is plugged into a charging station - the charge port, charge unit, HV battery and wiring between these components may be active, with high voltage present even in the vehicle key “off” state.

The high voltage system can be “depowered” to prevent the system from energizing. See the appropriate Service Information or Owner’s Information for detailed process instructions. If desired, the negative (ground) terminal can be removed from the 12v battery to deactivate the low voltage electrical system and further ensure that the HV system cannot be energized until work is completed. Any auxiliary power sources such as an additional 12v battery must also be disconnected.

WARNING: DEPOWERING THE HIGH VOLTAGE SYSTEM DOES NOT DISSIPATE VOLTAGE INSIDE THE HV BATTERY!

Vehicle upfitters should NOT plan to connect with or modify the high voltage system or components in any way. Integration with the vehicle electrical system must be done only with the low voltage (12 volt) electrical system.

Maintaining proper electrical grounding of high voltage components is essential for performance and safety of the vehicle. Wiring to and from any high voltage component must not be modified, including ground wires and straps. Ground paths may also exist through attachment hardware between high voltage components and the vehicle or supporting structure. Do not move, alter, or add circuits to OEM electrical ground points. Structural elements (mounting brackets, sub-frames etc.) supporting high voltage components are important to the vehicle safety and may also provide ground paths for the HV system, these structures and their attaching hardware must not be modified or tampered with.

No added components should be attached to HV components or associated structures. Any components added to the vehicle in proximity to a HV component should maintain clearance to avoid contact with HV components under any condition. High voltage batteries have vent features that may exhaust hot gasses in certain circumstances. Vents should not be blocked or modified in any way to protect for proper and safe battery venting.

Direct contact with high voltage components by personnel, tools or equipment should generally be avoided, including stepping on or leaning on them, setting tools on them, etc. Only qualified Bollinger Motors service personnel should attempt to diagnose or repair any high voltage components or systems. Any personnel involved in engineering, subsequent stage manufacturing, modifying, or servicing vehicles with high voltage systems (content other than the HV systems) should be trained in basic understanding and safety principles regarding HV systems.

All upfitters planning to perform manufacturing operations on vehicles with high voltage systems are recommended to do the following:

- Review and revise their manufacturing processes to incorporate HV safety procedures and minimize risk to personnel.
 - Consider depowering and locking out the vehicle HV system during manufacturing (note that vehicles cannot be driven in this state).
- Review and revise their manufacturing processes to minimize the risk of damage to HV components.
 - Consider providing temporary protection for high voltage components where there remains a risk of accidental damage.
- Develop an emergency response plan for accidental damage to HV components.
- Develop a vehicle charging plan.

The following manufacturing operations can be safely performed on your B4's high voltage systems:

- Installing a completed Second Unit Body (SUB) following all precautions and information contained in this guide.
- Interfacing with the low voltage electrical system through normal and provisioned customer connection points.
- Mechanical cutting and drilling operations away from HV components, following all precautions and information contained in this guide.
- Paint curing operations at or below 140° F (60° C) and not longer than 45 minutes.

The following manufacturing operations are not currently recommended:

- Welding anywhere on the chassis (excluding the frame rails where allowed) or installed body.
- Cutting or drilling operations near HV components.
- Operations generating significant heat near HV components, especially near the HV battery.
- Paint curing operations above 140° F (60° C) or longer than 45 minutes.

Vehicle Upfitters should develop a plan to potentially charge these vehicles.

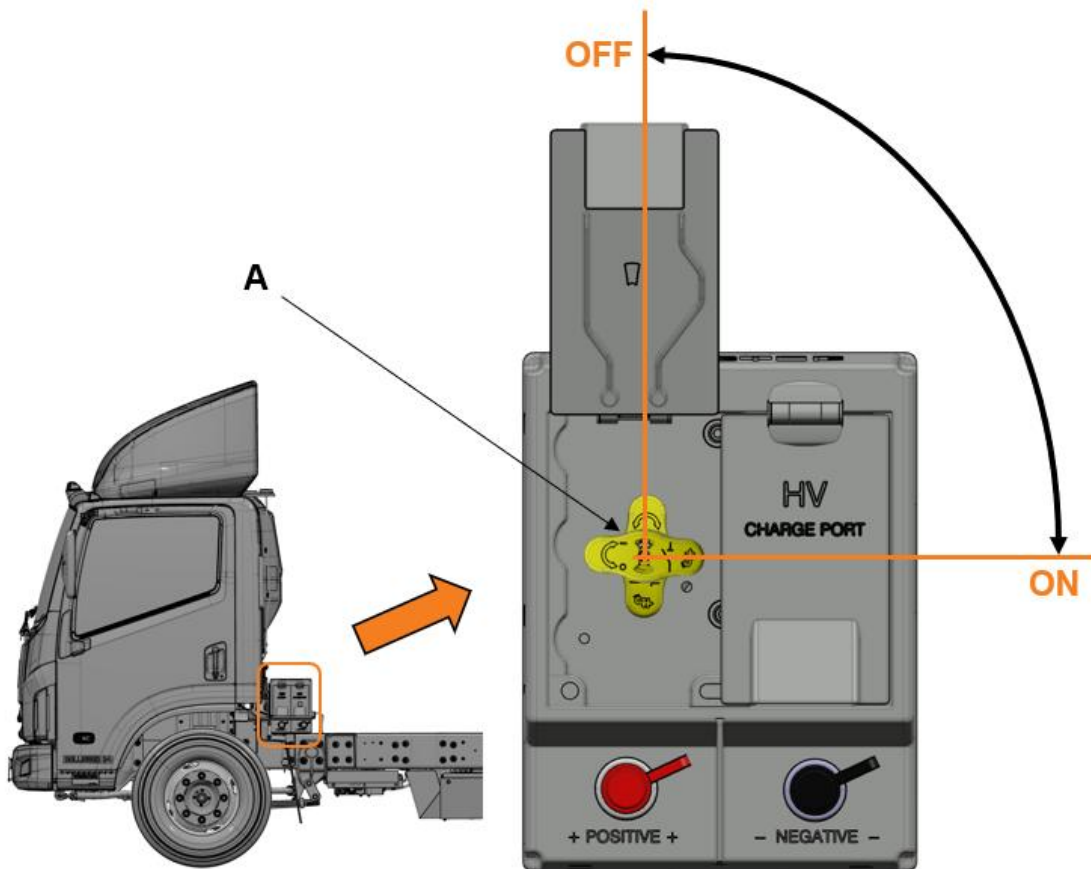
- Charging stations may be particularly important at vehicle receiving locations in case vehicles arrive with insufficient charge to maneuver through the manufacturing process.
- Charging stations are recommended at vehicle storage locations.
- Vehicle upfitters should also consider the vehicle state of charge as it leaves their facility.

4. HIGH VOLTAGE DISABLING PROCEDURE

WARNING: TO PREVENT THE RISK OF HIGH-VOLTAGE SHOCK, PRECISELY FOLLOW ALL WARNINGS, INCLUDING INSTRUCTIONS TO DISABLE THE HIGH VOLTAGE SYSTEM. FAILURE TO FOLLOW THESE INSTRUCTIONS MAY RESULT IN SERIOUS PERSONAL INJURY OR DEATH.

Always exercise caution and follow proper procedures when working with electric vehicles. If you are ever unsure, seek professional guidance or call for assistance.

1. **Turn High Voltage Shut-Off Switch to OFF (A)**
 - Rotate the High Voltage Shut-Off Switch counterclockwise to the OFF position.
2. **Disconnect the 12-Volt Battery or Auxiliary Power:**
 - When working on high-voltage components, it is crucial to disable the electric vehicle first.
 - Start by disconnecting the 12-volt or auxiliary power. This action stops any systems from turning on and prevents activation of relays or high-voltage components.
3. **Wait at Least 10 Minutes:**
 - Even after disabling the system, some high-voltage components may retain energy due to capacitors.
 - Wait for at least 10 minutes to allow the energy to dissipate fully.
 - Remember that you are still dealing with a high-voltage system, so prioritize safety throughout the process



5. GENERAL PRACTICES

WARNING: TO PREVENT THE RISK OF HIGH-VOLTAGE SHOCK, PRECISELY FOLLOW ALL WARNINGS, INCLUDING INSTRUCTIONS TO DISABLE THE HIGH VOLTAGE SYSTEM. FAILURE TO FOLLOW THESE INSTRUCTIONS MAY RESULT IN SERIOUS PERSONAL INJURY OR DEATH.

Note: When the battery cables are disconnected from the 12v battery, the radio and other memories will be lost.

Be cautious when connecting and disconnecting electrical connectors to avoid damage to contact pins and contamination of the connector interface. The wire removal is not practical, the wires must be shielded from damage due to the rework. All components and wiring should be reinstalled as closely as possible to the original factory installation.

Prior to any alterations of the vehicle electrical systems, the 12v battery negative (ground) cable(s) must be disconnected and positioned to prevent re-contact with the negative post. This precaution will minimize the potential for dead batteries and possible damage to vehicle circuitry.

Do not splice into the stop lamp switch as this can interfere with the proper functioning of speed control and anti-lock brake electronic modules.

The vehicle Ignition circuit should not be altered.

An electrical load analysis must be performed prior to adding loads to existing OEM fused circuits. The total circuit current draw (including additional load) must not exceed 80% of the OEM circuit current protection rating. Be very cautious not to exceed the circuit limitations. Relay selection is important and depends on current requirements, number of cycles expected in the relay lifetime, whether the relay is to be operated intermittently or for long periods of time, and how exposed it is to environmental conditions. When the current requirements of a circuit exceeds the capacity of an available relay, more than one relay can be used if the circuit is wired to split the load. When adding circuits with higher demands than the host OEM circuit can provide, relays should be incorporated into the system. The OEM wiring may be utilized as a signal source for the relay coil. Power to the added circuit should be supplied directly from the vehicle 12v battery or additional aftermarket battery(ies) through the relay. All installed equipment that utilizes electric motors should have a discharge path for the reverse voltage generated by the motors when power is turned off. Failure to provide a discharge path can result in damage to other electrical equipment installed by the modifier. Resultant damage to OEM installed electrical devices may not be repaired under warranty. The equipment manufacturer can provide information about the presence of a discharge path on their electric motors.

Do not move, alter, or add circuits to OEM electrical ground points. Ground the Second Unit Body to the frame in at least two locations to improve the ground path to the 12v battery.

After all electrical or vehicle modifications, clear all diagnostic trouble codes (DTCs). In addition, test all lighting outputs. Road test vehicle and rerun the on-board diagnostics to verify that no DTCs are present. All repairs must be made by an authorized Bollinger Motors service center.

ALL FLUIDS & LUBRICANTS CAUTION

Any fluids or lubricants added to the chassis during the final manufacturing process must meet Bollinger Motors' fluids and lubricants specifications. These fluids and lubricant specifications. A recommended fluids list based on model and model year can be found in the Service Information or Owner's Information.

COOLING SYSTEM

Note: Do not connect any auxiliary heating devices to the chassis cooling system.

To achieve expected performance of the vehicle cooling system, the following recommendations should be heeded:

- Equipment such as lights, sirens, spare tires, or any other accessories should not be installed where such equipment could impede the radiator or its air flow.
- Minimum Effective Front-End Opening (EFEO) areas must be met.
- Do not alter, change the locations of, or remove the original equipment fan, radiator, or shroud.
- If coolant is added or replaced, the original coolant type must be used. The appropriate coolant specification can be found in the Service Information or Owner's Information.
- All sections of hose with clearances less than 5 mm to adjacent components must have protective sleeve or covering.

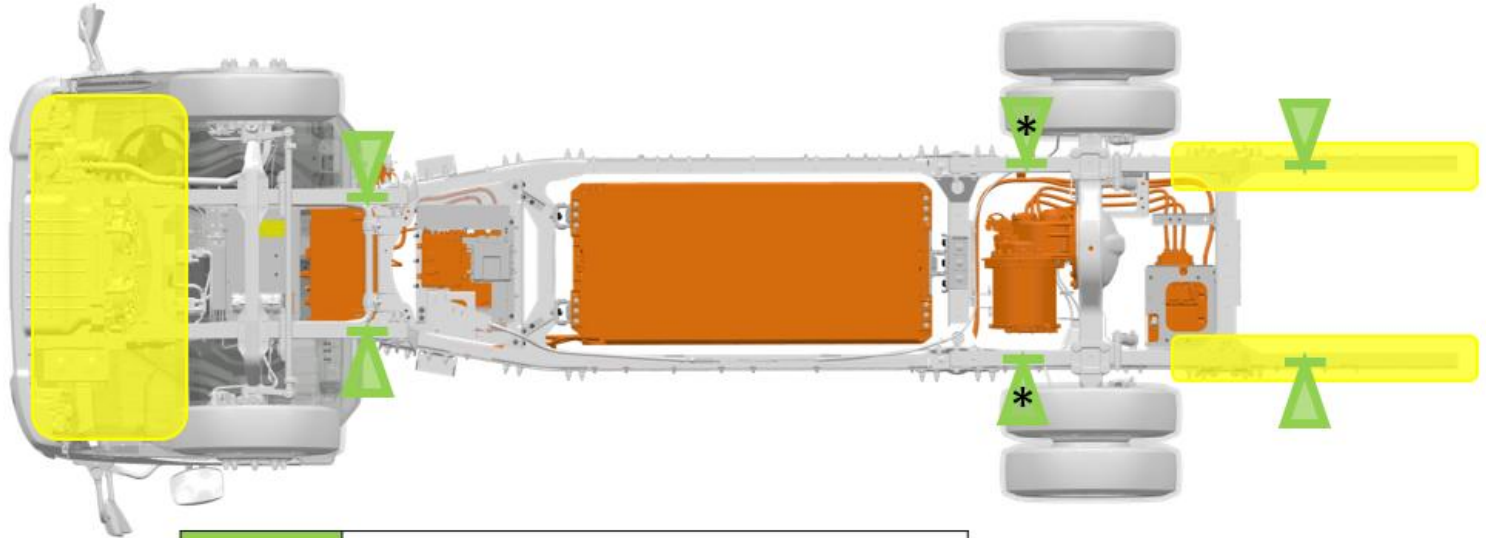
CLIMATE CONTROL SYSTEM

Modified or added heater and air conditioning system hose routings must consider the following:

- Dynamic body roll or any system component which has an operating zone. Make sure there is adequate clearance to accommodate movement.
- Routing clips or other aids should be used to keep components from rubbing or chaffing.
- Do not route lines or hoses in the wheelhouse area.
- Do not route lines or hoses by sharp edges or moving component parts. There must be shield protection from any potential abrasive source.
- When routing in stone kick-up area, lines should be protected by shields. Minimize the use of concentric protective heater hose shields. Limit length of concentric hose shields to 305 mm [12 in] maximum.
- Where possible, encase added suction lines in insulating foam from connector location under body to the secondary evaporator.

LIFTING AND JACKING POINTS

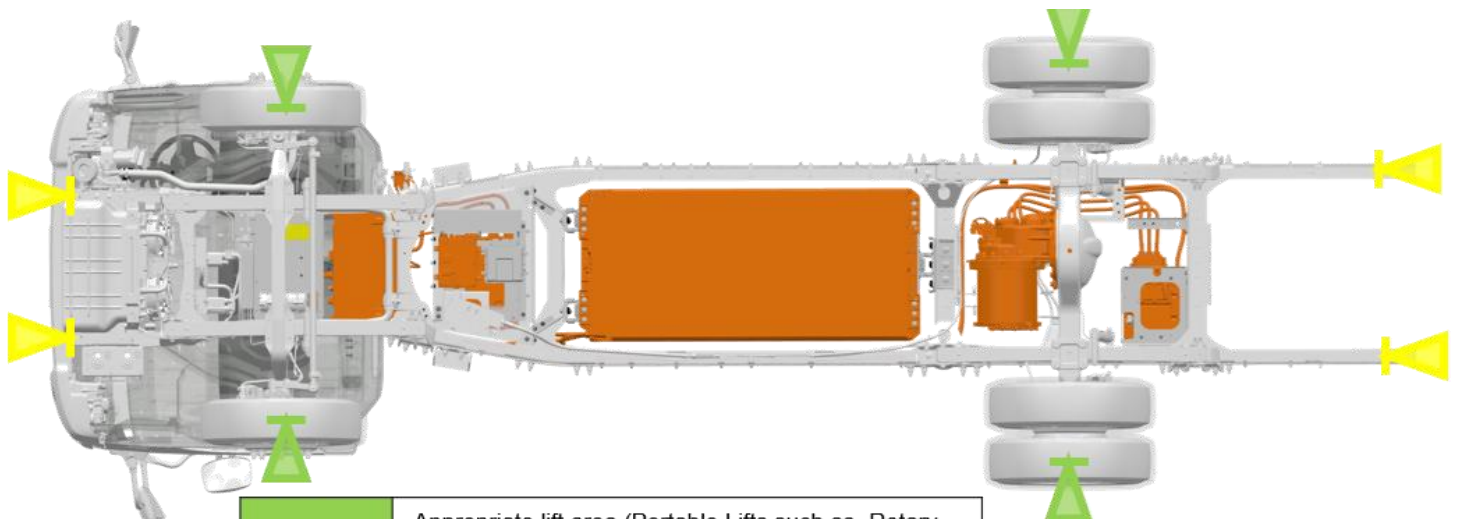
Stabilization / Lifting Points (Twin Post/In-Ground/Jacks)



	Appropriate lift area (Twin Post) <i>*Park Brake cable retention brackets must be removed and cable moved out of the way of the lift arm pad.</i>
	Safe stabilization points for truck resting on its side
	High Voltage (HV) Battery

*Always follow the hoist/lift manufacturers recommendations when operating vehicle lifting devices.

Stabilization / Lifting Points (Portable/Mobile, Drive-On Lifts)



	Appropriate lift area (Portable Lifts such as- Rotary Flex Lifts, Drive-On)
	Lift area use is limited based on upfit configuration. Not recommended for Bucket, Roll backs, Lift gates, Refrigeration & extended boxes.
	High Voltage (HV) Battery

*Always follow the hoist/lift manufacturers recommendations when operating vehicle lifting devices.

WHEELS & TIRES

WARNING: USE ONLY REPLACEMENT TIRES THAT ARE THE SAME SIZE, LOAD INDEX, SPEED RATING AND TYPE AS THOSE ORIGINALLY PROVIDED BY BOLLINGER MOTORS. THE RECOMMENDED TIRE AND WHEEL SIZE MAY BE FOUND ON THE INCOMPLETE VEHICLE CERTIFICATION LABEL WHICH IS LOCATED ON THE B-PILLAR OR EDGE OF THE DRIVER'S DOOR.

WARNING: THE DEALER OR UPFITTER MUST ENSURE THAT THE LUG NUTS ARE TORQUED TO THE PROPER SPECIFICATION BEFORE THE VEHICLE IS DELIVERED TO THE FINAL VEHICLE PURCHASER. IMPROPERLY TIGHTENED LUG NUTS COULD LOOSEN AND ALLOW THE WHEEL TO COME OFF WHILE THE VEHICLE IS IN MOTION, CAUSING LOSS OF CONTROL.

Use only wheels with the same load capacity, rim width, rim offset, and mounting configuration as those originally installed on the vehicle.

If the wheel lug nuts are loosened or removed for any reason, torque them to the specifications as listed in the applicable Owner Guide. Wheel lug torque is 475 ± 25 ft·lb or 644 ± 34 N·m.

BRAKE SYSTEM

WARNING: MODIFICATION TO THE BRAKE SYSTEM IS PROHIBITED.

WARNING: MODIFICATION TO THE PARKING BRAKE SYSTEM IS PROHIBITED.

WARNING: DO NOT WRAP BRAKE LINES WITH ANY MATERIAL THAT COULD CAUSE WATER, DIRT, SAND, OR OTHER FOREIGN MATERIAL TO ACCUMULATE AROUND THE LINES, POTENTIALLY CAUSING BRAKE LINE DAMAGE OR CORROSION.

SUSPENSION & STEERING SYSTEM

IMPORTANT: The final-stage manufacturer is responsible for verifying that the front wheel alignment is within specifications on completed vehicles. The steering wheel clear vision (horizontal or level orientation of the steering wheel) should also be maintained when resetting wheel alignment. These specifications can be found in the Service Information.

Note: Front end component warranty policy for incomplete vehicles is based upon the completed vehicle remaining within OEM weight ratings, wheel alignment specifications, vehicle attitude, suspension and wheel/tire guidelines, and other characteristics affecting wheel alignment. Exceeding or modifying these restrictions may jeopardize related warranty.

IMPORTANT: No steering components including the column, and steering wheel should not be altered nor relocated. Steering linkage travel should not be restricted.

IMPORTANT: The weight of the body structure and its center of gravity location (both horizontally and vertically), as well as the weight and positioning of the cargo load, are important to the handling of the completed vehicle. Subsequent stage manufacturers should note that matching a body to a chassis in a manner appropriate for the intended use of the vehicle is the responsibility of the final stage manufacturer. Following the representations in this guide, with respect to center of gravity locations and body weights for compliance with-Federal or Canadian Motor Vehicle Safety Standards is only part of the task of producing a completed vehicle that handles appropriately in service. Please see the "Vehicle Weight & Center Of Gravity" section of this guide for more information and guidance.

IMPORTANT: Modifications made by subsequent stage manufacturers, particularly those that significantly affect vehicle ride heights or off-loading of vehicle weight from the front of the chassis (addition of a lift gate, etc.) may cause increased tire wear and/or vehicle control problems, possibly leading to rollover or other accidents that could result in death or serious injury.

The following recommendations should be followed:

- General best practice is to perform a four-wheel alignment on all incomplete vehicles once they are completed. At a minimum, front wheel alignment is necessary to deliver the expected vehicle characteristics, tire wear and warranty coverage (see notes in this section). Rear wheel alignment is also

necessary if rear suspension or axle components are modified, repaired, or adjusted, or if the rear lateral weight balance of the vehicle is altered.

- Front or rear suspension components should not be drilled, cut, welded, or relocated for any reason.
- Welding to the frame in proximity to the steering gear is not recommended.
- Do not use any suspension component as a welding ground.
- When welding or cutting near suspension components, shield and protect all springs and rubber components from heat penetration and weld splatter.
- Any add-on device mounted on the steering column, shroud, multifunction switch, or gear selector lever, must not affect steering column angles, tilt mechanism (if so equipped), range of operation, or steering column mounting hardware. Any such device must not interfere with steering column collapse stroke travel during crash situations.

FRAME

WARNING: TO PREVENT THE RISK OF HIGH-VOLTAGE SHOCK, PRECISELY FOLLOW ALL WARNINGS, INCLUDING INSTRUCTIONS TO DISABLE THE HIGH VOLTAGE SYSTEM. FAILURE TO FOLLOW THESE INSTRUCTIONS MAY RESULT IN SERIOUS PERSONAL INJURY OR DEATH.

WARNING: FAILURE TO FOLLOW THE RECOMMENDATIONS BELOW MAY WEAKEN THE VEHICLE FRAME, WHICH COULD RESULT IN DEATH OR SERIOUS INJURY.

WARNING: PRIOR TO ARC WELDING OR PLASMA CUTTING ON THE VEHICLE, IT IS RECOMMENDED TO DISABLE THE HIGH VOLTAGE SYSTEM BY FOLLOWING THE HIGH VOLTAGE DISABLING PROCEDURE AND TO DISCONNECT THE 12V BATTERY NEGATIVE (GROUND) CABLE(S) AND ALL CONNECTORS LEADING TO SENSITIVE MODULES. THIS IS THE ONLY GUARANTEED METHOD OF PROTECTING THE 12V BATTERY AND ELECTRONIC MODULES FROM DAMAGE DUE TO THE HIGH VOLTAGE/CURRENT INTRODUCED BY THESE MANUFACTURING METHODS. USE OF PROPER WELDING TECHNIQUES (I.E., USING ROBUST WELDING GROUND NEAR WELDING AREA) AND INCREASED PHYSICAL DISTANCE BETWEEN MODULES AND WELDING ZONES MAY REDUCE THE RISK TO MODULES IF THEY REMAIN CONNECTED. DISCONNECTING THE 12V BATTERY CABLE(S) ALONE IS NOT ENOUGH TO PREVENT DAMAGE TO ELECTRONIC MODULES.

The following recommendations should be heeded to maintain proper function and performance of the vehicle frame:

- Use existing holes in the frame whenever possible for any modifications or additions like specialty hangers, shear plates, etc.

When using shear plates use existing holes in the frame ensuring there is no interference between mounting bolts and HV Cabling, LV Harness, or Cooling Lines. See SHEAR PLATE INSTALLATION & USE

- Avoid close vertical succession of fasteners (3 holes max).
- Holes are not to be drilled in the top or bottom flange of the frame side member, or in locations on the vertical frame side that would weaken the frame.
- Holes to mount brackets, out-riggers, and supports, may be drilled in the vertical frame side rail web with the following restrictions:
 - There must be a minimum of 1.5 inches between the edge of a hole and the inside surface of the upper or lower frame rail flange.
 - The minimum edge distance between any two holes up to 0.625-inch diameter must be 1.00 inch. For holes larger than 0.625-inch diameter, the minimum edge distance must be 1.5 times the diameter of the largest hole.
 - The maximum hole diameter for any hole in the frame is 0.75 inches.
 - Avoid drilling holes within 0.5 inch from the edge of any existing or added reinforcement.
- Adding holes or welding on frame cross members is not recommended.
- All attaching fasteners, including flat washers, must be of high strength steel (Grade 8 for SAE fasteners, Property Class 10.9 for metric bolts, PC 10 for metric nuts).
- Prior to welding, plasma cutting or any other operations creating heat, any parts which could be damaged

- by excessive temperatures should be removed or adequately shielded.
- Ensure the welder ground return clamp is positioned as close to the affected welding area as possible (not more than 12 inches). The welder ground return clamp should be on the same frame being welded upon. Welding cables should never be allowed to lay on, near, or across any electrical wiring or electronic component during welding. After welding, when parts are cool, carefully inspect wiring and electrical components for shorts or other damage which could draw excessive currents and possibly cause an electrical system short when the 12v battery is reconnected.
- Do not weld on frame flanges, including the bend radii.
- When welding steel side rails, emphasis should be placed upon weld application techniques to avoid stress risers that may adversely affect frame operating stresses.
- Do not weld within 4 inches of any frame fastener.
- Do not modify or alter the convoluted frame sections in the area behind the front bumper, if applicable. Modifications or alterations could have an adverse effect on vehicle performance in a crash situation.
- Use of aftermarket front tow hooks is not recommended. See the Owner's Information for towing instructions.

GROUND CLEARANCE

The following will be used to evaluate body builder designs of any overhangs relative to ground clearance.

Any part of the vehicle system which is likely to be damaged if the vehicle contacts the ground and, as a result, adversely affects the operation of the vehicle should be considered a vulnerable component. A minimum of 9 in (229 mm) between the ground and the lowest point of the vehicle MUST be maintained.

The Approach angle is the maximum angle of a ramp onto which a vehicle can climb from a horizontal plane without interference. It is defined as the angle between the ground and the line drawn between the front tire and the lowest-hanging part of the vehicle at the front overhang. Departure angle is its counterpart at the rear of the vehicle – the maximum ramp angle from which the vehicle can descend without damage. Approach and departure angles are also referred to as ramp angles.

Follow these guidelines when considering ground clearance:

- Vulnerable components should remain within a "protected area" defined as a minimum of 1.25 inches (30 mm) above the Primary Departure Angle (PDA) and no less than 8.25-inches (210 mm) above the ground.
- The PDA will use the end of the frame or rear bumper as Point B. Skid bars may not be used to redefine the PDA.
- Any "easily removable part", such as a rear entrance step, may extend below the Primary Departure Angle, but should not create a secondary departure angle of less than 9°.

OCCUPANT PROTECTION SYSTEMS

Occupants should only be seated in a designated seating position for determination of compliance to U.S. and Canadian Motor Vehicle Safety Standards which are configured to include a seat and seatbelt system.

Seat Systems

WARNING: SAFETY BELTS ARE DESIGNED TO WORK WITH THE SEATS ORIGINALLY DEVELOPED FOR THE VEHICLE. IF A MODIFIER USES DIFFERENT SEATS, THAT MODIFIER MUST ENSURE THE SAFETY BELTS AND REPLACEMENT SEATS MEET ALL FMVSS REQUIREMENTS AND WILL PERFORM SAFELY IN THE FIELD. FAILURE TO DO SO COULD RESULT IN SERIOUS INJURY AND OR DEATH IN THE EVENT OF A COLLISION. ANY ADDITIONAL SEATS AND SEAT ANCHORAGES INSTALLED BY SUBSEQUENT STAGE MANUFACTURERS MUST MEET F/CMVSS 207 REQUIREMENTS AND SPECIFICATIONS.

The following recommendations should be heeded to ensure proper function of the vehicle seating systems:

- Do not modify or alter Bollinger Motors furnished seating or occupant restraint system.
- If the seat or seat belt components are temporarily removed for any reason, they must be re-installed IN THE SAME VEHICLE in accordance with the instructions and specifications found in the applicable Service Information.
- Seating systems that include the attachment of lap belt or shoulder belt assemblies should also consider

the requirements of F/CMVSS 210 as part of the seating system.

- Seating system components should be free of sharp edges to prevent damage to seat belt systems when the belts could potentially contact the seating system components.
- Seats should be mounted with appropriate fasteners in the mounting holes provided, since these holes are located to utilize floor pan structural reinforcements.
- If additional holes are required in the floor for any reason, their locations should be carefully selected so that the structural integrity of the floor pan will not be compromised and damage to other components located below the floor will be prevented.
- Seating systems should be designed to be compatible with the seat belt systems, to permit proper adjustment, allow for occupant movement and provide convenient accessibility of the restraint system buckle release.
- Seats not designated for occupancy while the vehicle is in motion must be conspicuously labeled as such.
- If seats are removed during the upfit process, care must be taken to:
 - Not damage wiring/connectors when unclipping/removing from seat frame.
 - Avoid debris from entering the seat belt buckle system.
 - Avoid damage of wiring/sensors located under the seat frame (including properly routing and clipping as received to avoid pinched wires).
 - Cover and protect any unconnected connectors.
 - Carefully reconnect all electrical connectors, ensuring that they are fully seated.
 - Perform any testing procedures recommended in the Service Information.

Lap and Shoulder Belt Systems

The following recommendations should be heeded to ensure proper function of the Lap and Shoulder Belt System:

- Additional lap and shoulder belt assemblies, including hardware, must comply with the requirements of F/CMVSS 208 and 209.3.
- Additional lap and shoulder belt system anchorages must comply with the requirements of F/CMVSS 210.
- Lap and shoulder belt systems that are attached to the seat frame or base may affect compliance of the seating system with the requirements of F/CMVSS 207.
- Lap and shoulder belts, and attaching hardware should not be altered or modified in any way. The re-installation of these components should follow the instructions and specifications in the appropriate Service Information.
- Lap and shoulder belt assemblies should be compatible with the seat systems and anchorages so that lap belts will be properly positioned about the occupant's pelvis to provide proper adjustment and fit. The buckle and buckle release must be properly located with respect to the occupant and must comply with the requirements of F/CMVSS 208.
- Vehicle upfitter processes should be reviewed to determine potential for contaminants to enter the seat belt retractors, buckle ends, or electrical connectors. Temporary protective covers or other means (tape, plastic etc.) should be used to minimize potential for entry of contaminants.
- If any of the B-Pillar trim panels or cutaway retractor covers are removed to perform modifications, the upfitter must cover the retractor with (clean cover plate, tape, plastic etc.) to ensure contaminants do not enter the retractor housing.
- If drilling or cutting is done anywhere inside the vehicle, especially near the restraint system, due care must be used to cover/protect the restraint system (including the seatbelt webbing) to avoid damage or entry of contaminants (including covering all exposed trim holes on the B-pillars with tape).
- When seat belt assemblies (retractor, D-Ring, and webbing) are repositioned or removed from the vehicle they should be positioned or stored in a clean environment and covered, with the webbing flat as to not induce wrinkling or creasing.
- After upfit, no hard contact should exist between any added component (i.e., bulkhead partition, racks, second unit bodies or components) and any D-Ring, trim panel covering a retractor, or seat belt webbing.
- Seat belt warning system activation/deactivation, where applicable, should be provided by the lap and shoulder belt assembly.
- If seat belt retractors (and/ or D-Rings) are removed during the upfit process, or if any drilling/cutting is done inside the unit, vehicle upfitters are requested to pull out and cycle the webbing 8-10 times to ensure proper function and verify that any added upfit components are not causing a system restriction.

6. ACCESSING 12V POWER DISTRIBUTION

ELECTRICAL WIRING - GENERAL

All added wiring should be color coded or labeled to aid in identification during service. All added under cab and under body wiring must be cross linked polyethylene, high temperature (minimum 125°C) insulated wire. SAE Specification J1128 SXL, GXL, or TXL wire or equivalent is acceptable. Use SAE J1127 SGX or STX or equivalent for 12v battery cables. Interior wiring not exposed to high temperatures may be SAE approved, general purpose wire.

All added under cab and under body wiring should be protected with high temperature (minimum 125°C) nylon convoluted tubing.

Connectors, splices, and eyelets in any compartments, under body or otherwise are recommended to be sealed to prevent corrosion and short circuits. Ground the second unit body to the frame in at least two locations.

ELECTRICAL WIRING - WIRING GAUGE

When adding wiring, the wire gauge should be determined by the following considerations:

- Total load on the circuit (fuse rating).
- Total length of wire in the circuit.
- Acceptable voltage drop within the circuit (caused by wire resistance).
- Ambient temperature of the wiring environment.

Consult with the wire manufacturer or distributor for recommendations.

Where wire is spliced to extend a circuit, the added wire should have a gauge at least that of the circuit being modified.

The replacement or extension of any cable from the 12v battery(ies) must not increase the voltage drop in the circuit. This can be accomplished by increasing the wire gauge, or by adding a parallel cable. To reduce the possibility of environmental conditions resulting in increased voltage drop, all 12v battery cable connections should be coated with a corrosion protectant after all connections are torqued.

ELECTRICAL WIRING - ROUTING & RETENTION

Wire routings of installed components by upfitters must conform to the following:

- Before any welding, cutting, or grinding process, it is required to shield or remove any sensitive critical vehicle systems or components to prevent any incidental damages during the welding, cutting, or grinding processes. This precaution is required to maintain the integrity of all critical vehicle systems, such as any cooling and electrical components.
- Wires routed through holes in sheet metal, frame rails, or castings must have the edges of holes protected by a grommet. Use customer access pass-thru circuits where provided to avoid additional openings between vehicle compartments.
- Wires should be routed to avoid metal edges, screws, trim fasteners, and abrasive surfaces. When such routings are not possible, protective devices (shields, caps, convoluted tubing etc.) must be used to protect the wires. When wires must cross a metal edge, the edge should be covered with a protective shield and the wiring fastened within 3 inches of the edge.
- Wires must be routed to provide at least 3 inches clearance to moving parts, unless positively fastened or protected by conduit.
- All wiring should be properly routed and properly anchored away from any unfriendly surface such as sharp edges and moving parts.
- Existing heat shields, insulation, and wire shielding/twisting must be maintained.
- When wiring is routed between two members where relative motion can occur, the wiring should be secured to each member, with enough wire slack to allow flexing without damage to the wire.
- Wiring to all circuit components (switches, relays, etc.) in exposed locations must provide a drip loop to prevent moisture from being conducted into the device via the wire connection.
- Wiring should not be routed through wheel well areas where they may be damaged by tire or road debris, snow packing, excess water etc. When such routings cannot be avoided, protective shields are required.

- The wire retainers and grommets installed by Bollinger Motors are usually designed to accommodate only the OEM installed wires. Additional wiring or tubing should be retained by additional clips.
- All wiring connections to components of the factory installed system must be accomplished by using the proper mating wire termination. (Connections on studs and ground connections must use eyelet terminations, connections to female connectors must terminate in male connectors, etc.)
- Transmission of electrical power through a wire will generate an electro-magnetic field around the wire. Wires carrying low power signals may experience induced electric noise in excess of the low power signal if they are near a high-power transmission wire. For this reason, high power transmission wires should be routed away from any OEM harnesses. The spacing should be maximized and should never be less than 12 inches (304.8 mm) for 12v circuits or one inch (25.4 mm) per volt. Higher voltage alternating current (AC) circuits may require twisted pair or grounded shielding to allow their placement on the vehicle without affecting other circuits.
- All wiring should be protected from fastener damage during the build process (e.g., pinched underneath fastener head, or contacted by backside of fastener extending from joint).
- The use of generic plastic cable ties (aka zip ties) should be limited to bundling the harnesses.

In addition, for all added under cab and under body wiring:

- Electrical wire should not contact, or attach to HV cables, HV harnesses, or brake lines.
- HV cabling must not be rerouted in any manner.
- Added wiring should be located to avoid, or secured away from, rotating, or otherwise moving parts.

ELECTRICAL WIRING - SPLICE / REPAIR

WARNING: NEVER SERVICE, MOVE, MODIFY, OR ALTER ANY HIGH VOLTAGE HARNESSSES, CABLES, COMPONENTS, OR DEVICES. DOING SO MAY RESULT IN SERIOUS INJURY OR DEATH.

When splicing low voltage wire for repair or circuit length revisions, the following guide should be followed:

- When stripping wire ends, make sure that individual conductor strands are not damaged.
- When soldering, make sure an adequate mechanical joint exists before applying solder. Use only rosin core solder — never acid core.

IGNITION OFF LOADS

An ignition off load is defined as a current draw on the 12v battery when the ignition is in the off position. Ignition off loads are important because they will lower the charge in the battery between vehicle uses. The ignition off amperage draw of all equipment connected to the vehicle's main or multiple 12v batteries should not exceed 28 milliamps. If equipment inclusion into the vehicle's electrical system would cause the amperage draw to exceed 28 milliamps, the equipment should be connected to an auxiliary battery or an isolated battery bank.

12V BATTERY RELOCATION

Battery relocation is not recommended and should remain in the production position for system integrity.

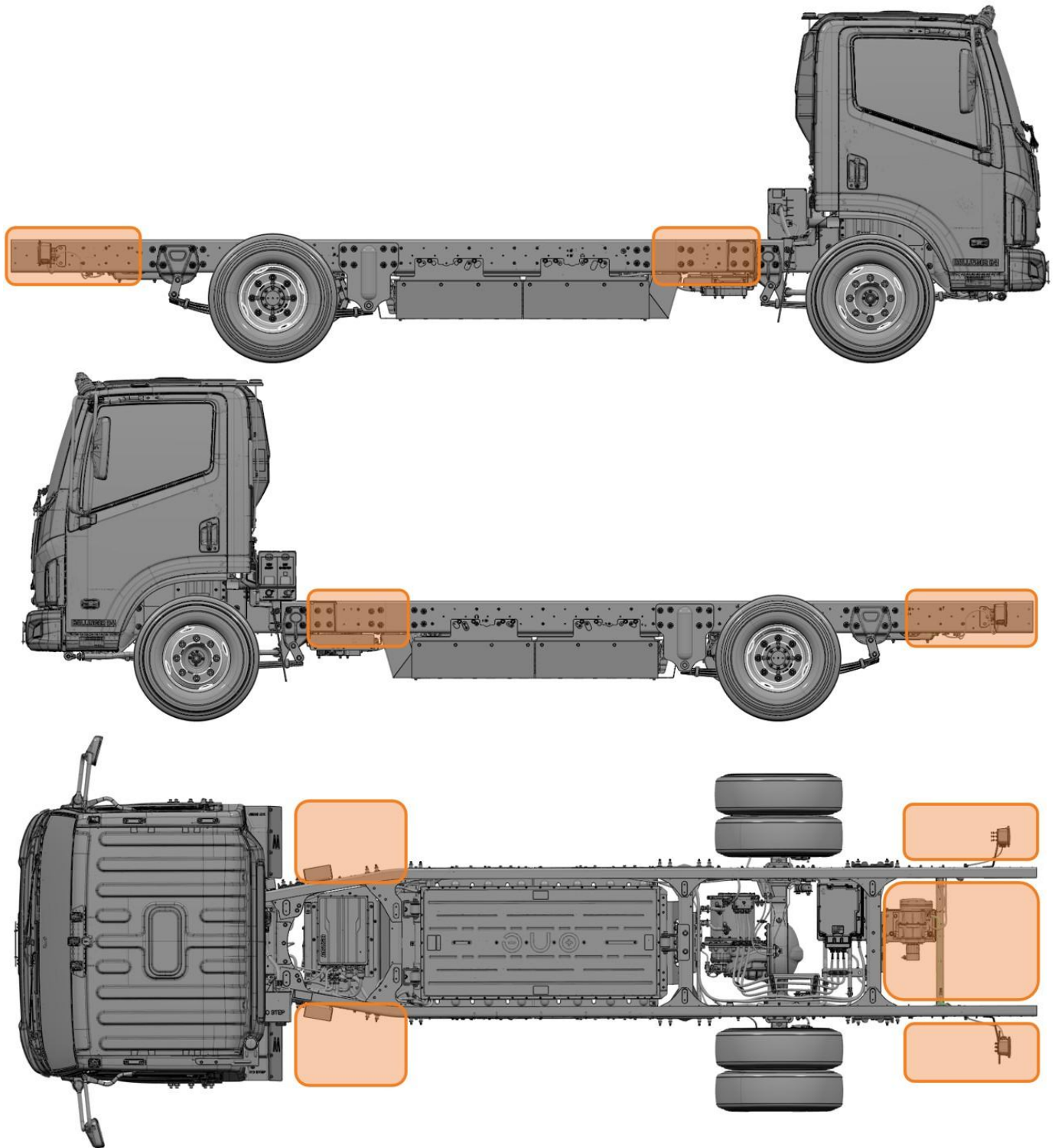
AUXILIARY 12V BATTERIES

An auxiliary 12v battery is a battery that is relay isolated from the primary battery. This 12v auxiliary battery is intended to provide power to auxiliary equipment "ignition off" loads (see "Ignition Off Loads" section for definition). Only circuits that are required to be 12V B+ or have significant ignition off load should be connected to an Auxiliary Battery. The following guidelines should be followed:

- The Upfitter is responsible for providing the additional items required for the addition of Auxiliary Batteries.
- Standard wiring cabling calculations such as wire gauge diameters and length of run must be calculated to properly calculate wire sizing for Upfits.
- Be aware of existing wiring and plumbing to prevent incidental damages during the auxiliary battery install.
- Use existing frame holes as much as possible to secure installed auxiliary battery components and wiring harness attachments.
- Auxiliary battery fuse sizing needs to be calculated and installed in the Low Voltage fuse array (reference section ELECTRICAL WIRING – UPFITTER TAKEOUTS).

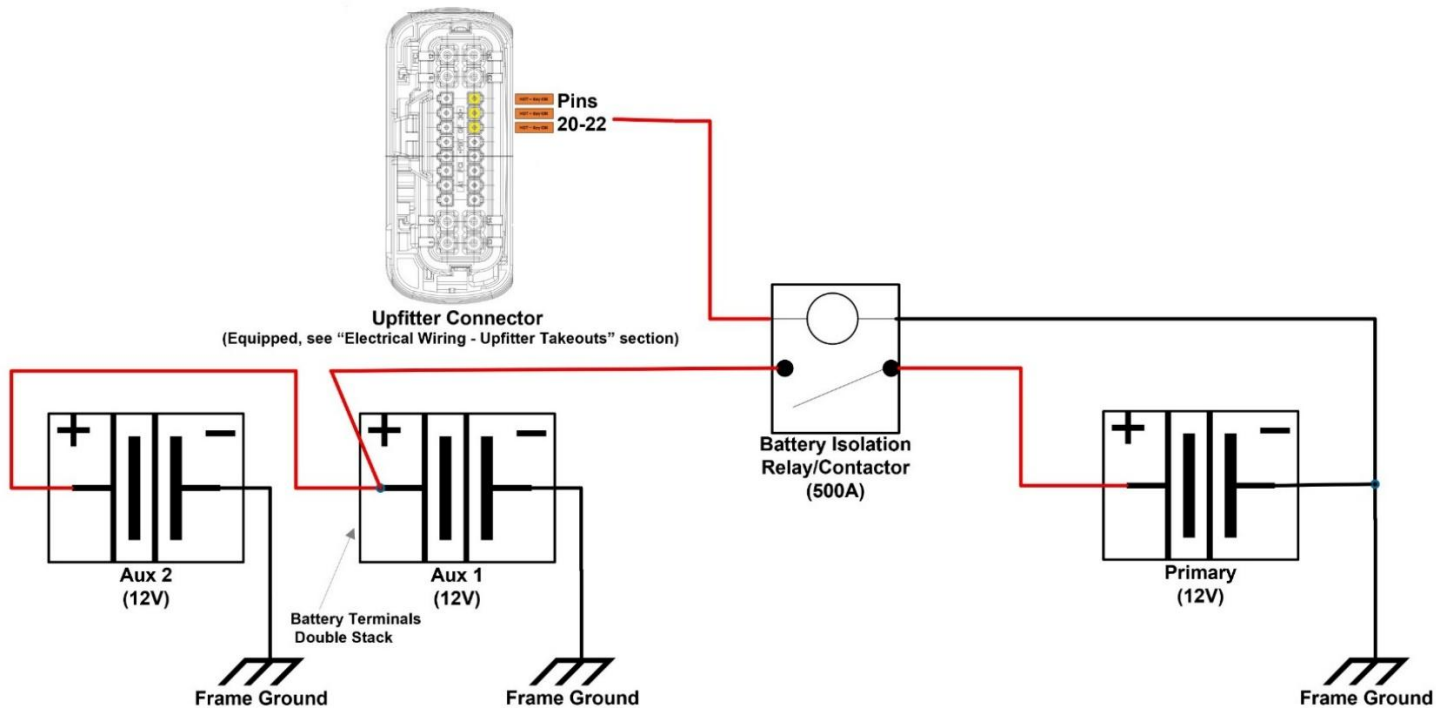
Recommended Locations

Possible auxiliary battery box locations on the outside of the frame rails are highlighted in orange.



Note: If no ePTO is present, an AGM auxiliary battery could be mounted on the side and accessed from the underside of the B4, while being supported by a battery tray or box.

Recommended Electrical Connections

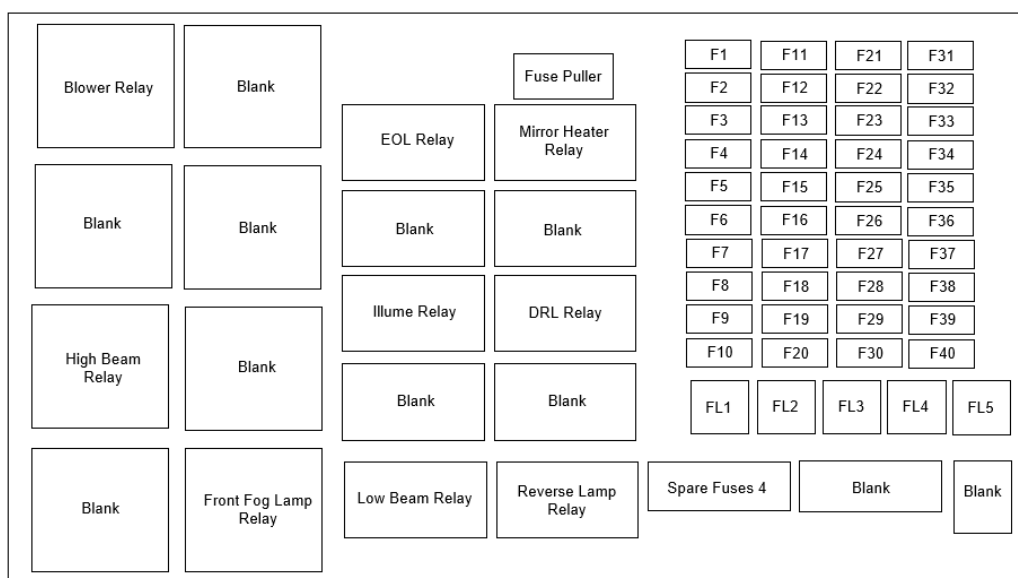
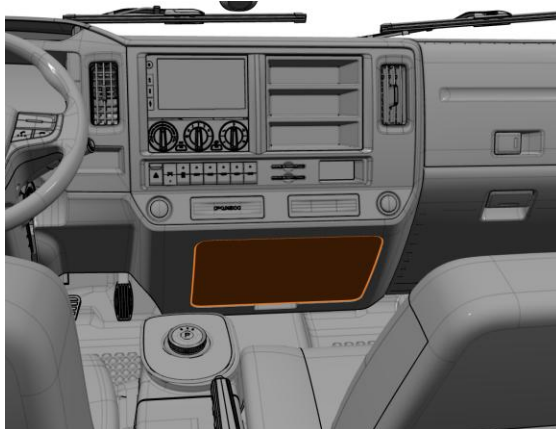


Recommended Additional Materials

Equipped Items	Description
Upfitter Connector	APTIV 13795018 (Included on B4)
Additional Materials Required	Description
Battery(ies)	Lead Acid, Recommend Group 48, approx. 70Ah Capacity C/20 rate
Battery Mounting Bracket	Recommended Mounting to LH Frame Rail
Relay	Altran AEV250-MN or equivalent, SPST, NO, 500A minimum rated, 12VDC Coil
Wire, Red	Calculate gauge, (minimum 1 awg / 40mm ²) Red
Wire, Black	Calculate gauge, (minimum 1 awg / 40mm ²) Black
Wire Terminal Eyelets	As Required, Sized for 40mm ² wire and Battery/Ground bolt attachments
Terminal (16-18 awg)	APTIV 13613157 or equivalent
Terminal (20-22 awg)	APTIV 13624983 or equivalent

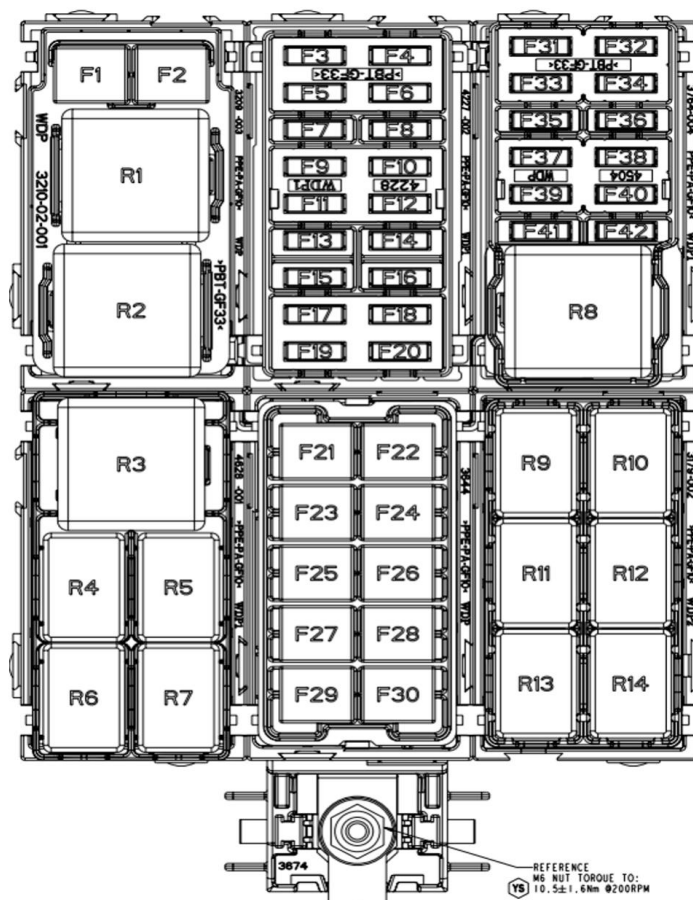
CAB POWER DISTRIBUTION UNIT FUSING

Remove the cover on the Instrument panel to access the Cab Power Distribution Unit.



Location	Rating	Function	Location	Rating	Function
F1	5A	Ignition Signal	F24	5A	Background Light
F2	10A	VCU IG	F25	7.5A	Position Lamp
F3	5A	Reverse Lamp	F26	5A	DRL
F4	5A	ABS	F27	-	Blank
F5	5A	Meter/BCM IG	F28	10A	GW B+
F6	5A	CDU	F29	10A	BCM B+
F7	7.5A	Drive Recorder IG	F30	10A	Central Lock
F8	5A	GW IG	F31	5A	Remote Monitoring
F9	-	Blank	F32	10A	Indoor Lamp/Diagnosis
F10	5A	Start Signal	F33	7.5A	Drive Recorder
F11	5A	A/C Control	F34	10A	Left Low Beam
F12	5A	IG2	F35	10A	Right Low Beam
F13	15A	Wiper, Washer	F36	15A	Left High Beam
F14	5A	Mirror Heater	F37	15A	Right High Beam
F15	5A	Radio ACC	F38	5A	Rear Fog Lamp
F16	15A	Cigar	F39	15A	Front Fog Lamp
F17	10A	VCU ACC	F40	5A	Stop Lamp
F18	10A	Remind	FL1	40A	Blower
F19	20A	Right Front Window	FL2	-	Blank
F20	20A	Left Front Window	FL3	-	Blank
F21	5A	Meter B+	FL4	-	Blank
F22	15A	Hazard Lamp	FL5	-	Blank
F23	5A	Radio			

LOW VOLTAGE POWER DISTRIBUTION UNIT (LVPDU) FUSING



Location	Rating	Function	Location	Rating	Function
F1	-	Blank	F29	40A	Upfitter Relay 1 KL15
F2	-	Blank	F30	40A	Upfitter Relay 2 KL15
F3	15A	HVPDU	F31	15A	Spare KL15
F4	30A	ABS Valves	F32	15A	Upfitter KL15 Fuse 32
F5	5A	KL30 Relay Coil Feed	F33	15A	Upfitter KL15 Fuse 33
F6	15A	Running Lights	F34	15A	Upfitter KL15 Fuse 34
F7	30A	Upfitter KL30 Fuse 7	F35	15A	Upfitter KL30 Fuse 35
F8	15A	HV Battery Lower	F36	7.5A	Thermal Control Unit (TCU) Wake
F9	7.5A	Thermal Control Unit (TCU)	F37	15A	Reverse Lights
F10	15A	SAIC Cab BCM, Cluster, Gateway	F38	15A	Coolant Pump High Temperature
F11	5A	Over The Air Module (OTA)	F39	60A	Horn
F12	5A	DC/DC	F40	5A	Thermal Sensor
F13	10A	Motor Control Unit (MCU)	F41	15A	Brake Lights
F14	15A	HV Battery Upper	F42	15A	Coolant Pump Low Temperature
F15	30A	Upfitter Relay 3 KL15	R1	-	HV Battery
F16	15A	Right Hand Rear Stop/Turn	R2	-	Upfitter 1, AUX Switch 1
F17	5A	On Board Charger (OBC)	R3	-	Upfitter 2, AUX Switch 2
F18	15A	MCU, ePAS, ABS, ePTO	R4	-	LH Stop/Turn
F19	30A	Vehicle Control Unit (VCU)	R5	-	RH Stop/Turn
F20	15A	Left Hand Rear Stop/Turn	R6	-	Vacuum Pump Front
F21	60A	ABS Pump Motor	R7	-	Upfitter 3, AUX Switch 3
F22	50A	Cooling Fan Right	R8	-	TCU Coolant Pumps, Valves, Sensors
F23	30A	Upfitter KL30 Fuse 23	R9	-	Running Lights
F24	50A	Cooling Fan Left	R10	-	MCU, ABS, EPS, ePTO
F25	50A	Parking Brake Actuator	R11	-	Reverse Lights
F26	40A	Upfitter KL30 Fuse 26	R12	-	Horn
F27	40A	Vacuum Pump Front	R13	-	Brake Lights
F28	40A	Vacuum Pump Rear	R14	-	Vacuum Pump Rear

ACCESSING POWER

12-volt Outlet Plug

Caution: Do not plug in any device into the 12-volt outlet plug that may contain a capacitor that will backfeed voltage to the accessory circuit, such as a 120vac power inverter, see figure 1.



An Excessive Filter Capacitance device, such as a 120VAC Power Inverter, that is plugged into the 12-Volt Outlet Plug, will discharge a voltage and cause the Accessory circuit to remain at 5+ VDC when the ignition switch is turned to the START Position. This will not allow the Vehicle to enter the READY position and may set a Turtle light on the instrument cluster. By unplugging the powered device from the 12-Volt Outlet Plug allows the Accessory circuit voltage to drop to zero VDC when the ignition is turned to the START position. Only when the Accessory circuit measures zero VDC will the vehicle display the READY indicator on the cluster.

Recommended Installation

If using a 120VAC Power Inverter or other Excessive Filter Capacitance device, it is recommended to make the positive 12VDC connection at either of the following:

- 12V battery positive terminal
- Upfitter Connector (reference section ELECTRICAL WIRING – UPFITTER TAKEOUTS)
- Auxiliary Fusebox F4 terminal (reference section ELECTRICAL WIRING – UPFITTER TAKEOUTS)

Use the chassis frame as the 12 VDC negative ground connection. Reference the Exterior to Interior Wire Pass Through areas section for routing wiring harnesses into the cab.

When the vehicle is not in operation unplug the device containing the capacitor, such as a power inverter. Normal use should be limited to only charging type devices during operation, such as cellphones and flashlights.

Electrical Wiring Taps

Your B4 is built with electrical wiring taps. Most taps are fused, having locations under the instrument panel, beneath the cab, and/or at the rear of the frame. The power supply wire for added circuits from the 12v battery should be properly sized, include appropriate fusing and for circuits requiring more than 30 amperes, make connections directly to the battery positive terminal.

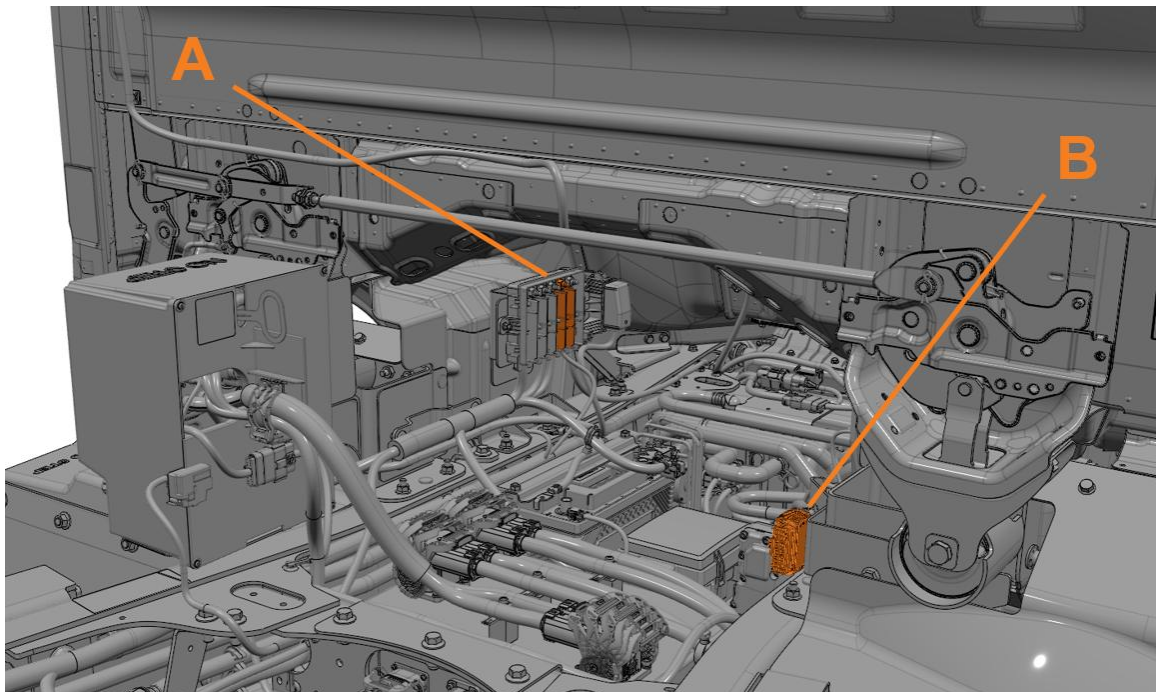
Caution: When connecting devices to the 12v battery, extreme caution must be taken to maintain clearance between any conductive surface connected to the B+ terminal and any surrounding conductive materials (such as the under cab inner panel). Any reduction in clearance between components as provided by Bollinger Motors may result in an electrical short (or arcing), which may lead to failures in the electrical system or result in fire.

All current load added by body builders should be evaluated for key off loads. If possible, a supply for the load should be ignition key controlled (i.e., ON only, ON/START only, etc.).

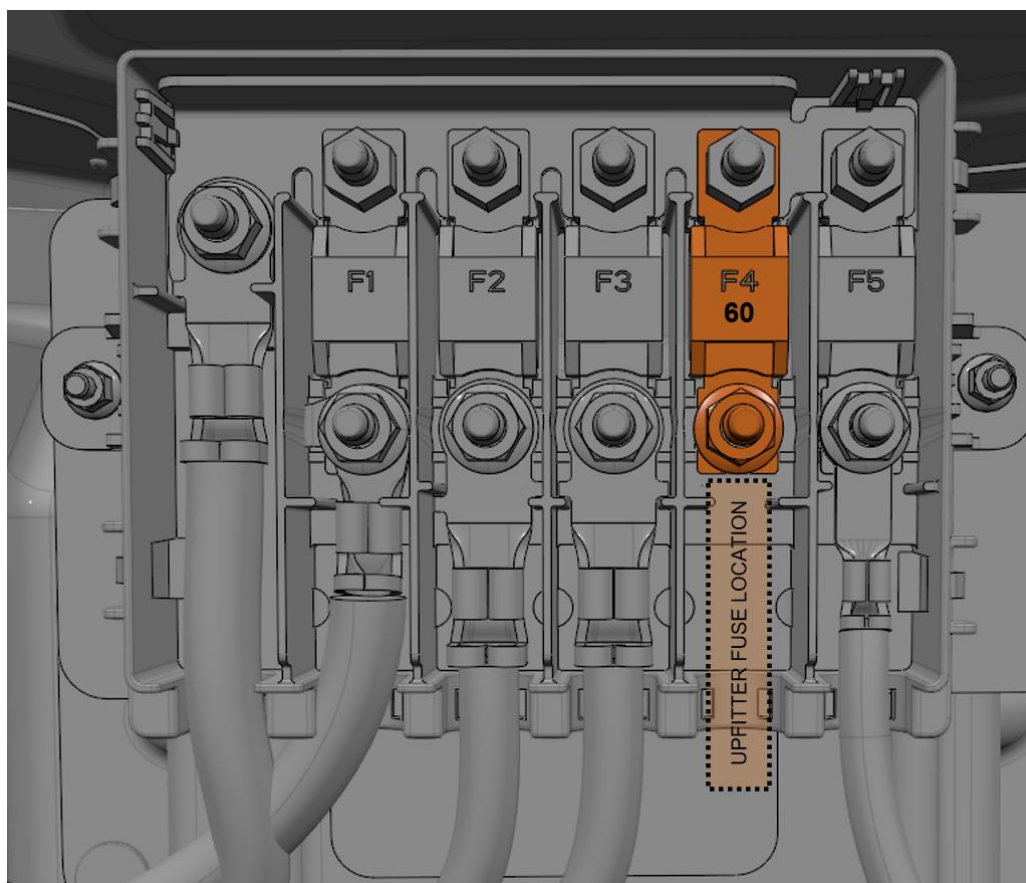
ELECTRICAL WIRING - UPFITTER TAKEOUTS

Under Cab Upfitter Connector & Auxiliary Fusebox

- A. 60 Amps 12V Fuse location (60 amp fuse is standard in the F4 location, lugs are capable of 200 amps.)
- B. Upfitter Connector 101A



- A. 60 Amps 12V Fuse location (60 amp fuse is standard in the F4 location, lugs are capable of 200 amps.)



B. Upfitter Connector 101A

NOTE: Upfitter connector body 13795018, Female terminal side, is included for upfit builder electrical connections and comes pre-installed onto the Truck Upfitter connector body 13672210, Male terminal side, of the B4 Chassis Harness, located at B. The Upfitter connector 13795018 is a fully functional connector, see figure 1.

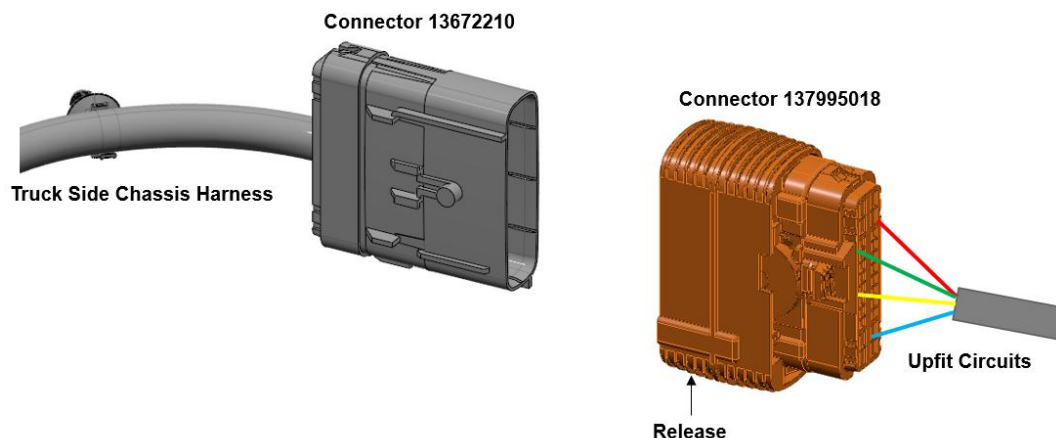
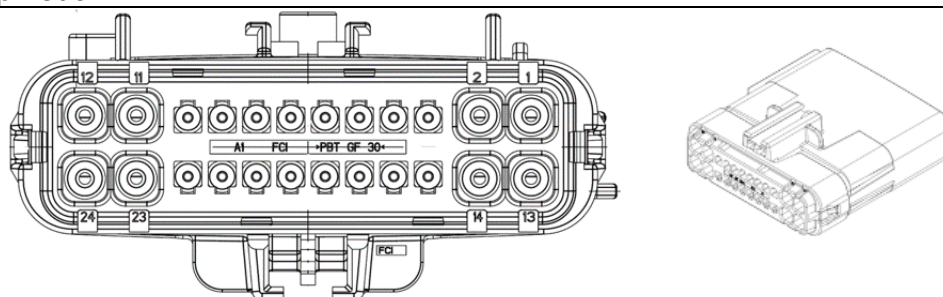


Figure 1

101A Connector pinout

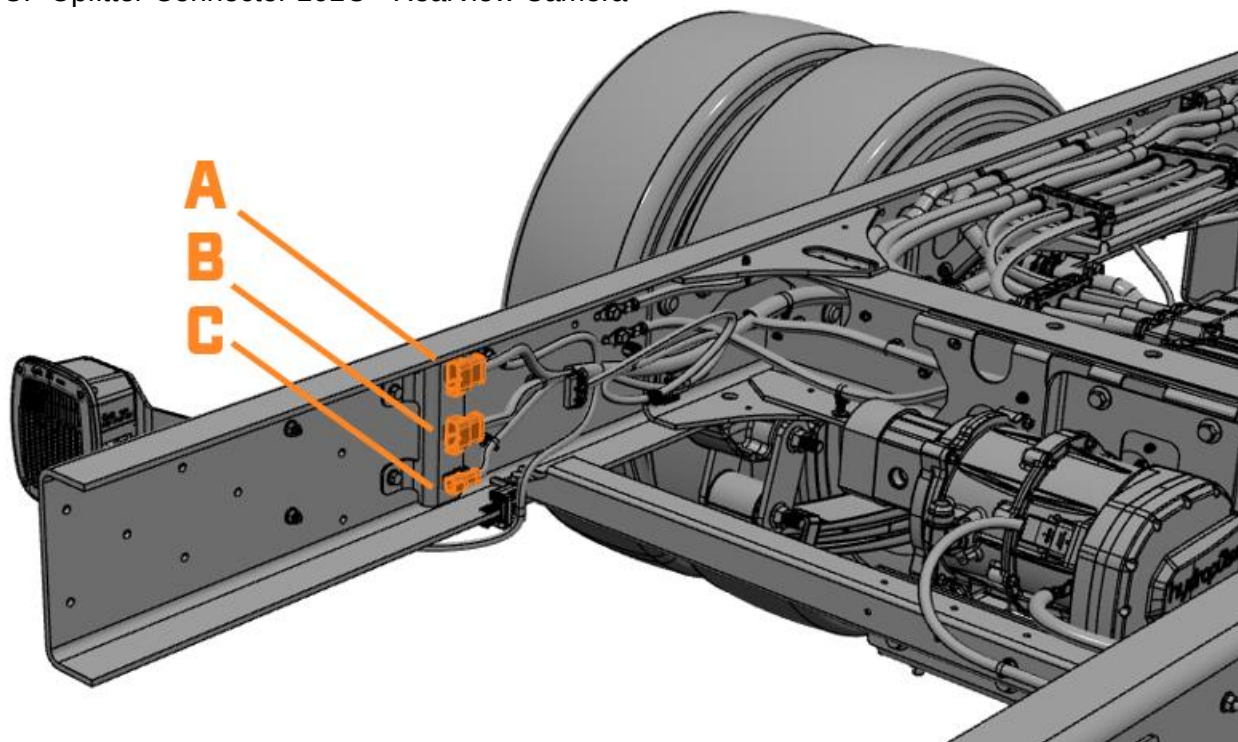


ICDe Inline Chassis - Upfitter C1 Front (Cab Position), C77-101A, Aptiv / Delphi, 13672210

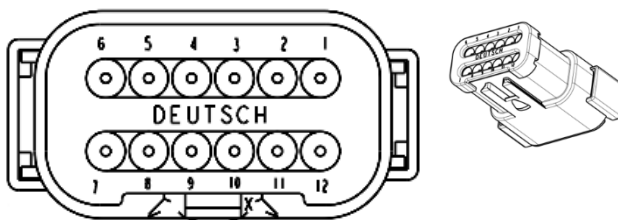
Pin	Signal Description	Circuit	Wire Size	Wire Color	Terminal PN	Cavity Plug PN	Mating Connector
1	Upfitter Relay #1 Output	P3114	3	LT BU	10762774		13795018
2	PWR Brake Lights 12V Relay Output	P3109	1	LT BU	10762775		13795018
3	LSD Upfitter #4 Switch Control	B0094	0.75	BR	13624759		13795018
4	LSD Upfitter #5 Switch Control	B0095	0.75	BR	13624759		13795018
5	PWR Push-Button (KL15) Relay 12V Enable	P4017	0.75	LT BU	13624759		13795018
6						13613164	13795018
7						13613164	13795018
8						13613164	13795018
9						13613164	13795018
10						13613164	13795018
11	Upfitter Relay #3 Output	P3132	3	LT BU	10762774		13795018
12	Upfitter Relay #2 Output	P3115	3	LT BU	10762774		13795018
13	Upfitter Fuse 1 KL30 PWR	P3133	3	RD	10762774		13795018
14	Upfitter Fuse 2 KL30 PWR	P3134	3	RD	10762774		13795018
15	ePTO HSCAN Low	CL024	0.5	GN	13624759		13795018
16	ePTO HSCAN High	CH024	0.5	YE	13624759		13795018
17						13613164	13795018
18						13613164	13795018
19						13613164	13795018
20	PWR Upfitter PWR Fuse 32 +12V KL15 Fused PWR	P3137	1	LT BU	13630404		13795018
21	PWR Upfitter PWR Fuse 33 +12V KL15 Fused PWR	P3138	1	LT BU	13630404		13795018
22	PWR Upfitter PWR Fuse 34 +12V KL15 Fused PWR	P3139	1	LT BU	13630404		13795018
23	Upfitter Fuse 35 KL30 PWR	P3135	3	RD	10762774		13795018
24						13765188	13795018

Rear Frame Connectors

- A. Upfitter Connector 101D - Tail Lights
- B. Upfitter Connector 101E - ePTO (if equipped)
- C. Upfitter Connector 101C - Rearview Camera



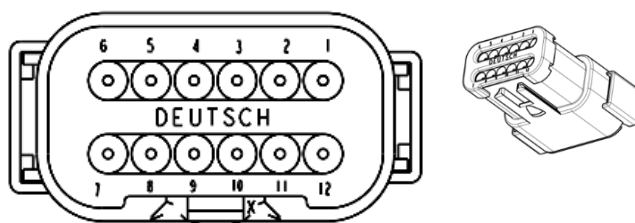
Connector pinout 101D - Tail Lights



ICDe Inline Chassis - Upfitter C4 Rear (Rear Frame Left, Upper Position, Black, Male Terminal)
C77-101D, TE Connectivity / DEUTSCH, DTM04-12PA-E005

Pin	Signal Description	Circuit	Wire Size	Wire Color	Terminal PN	Cavity Plug PN	Mating Connector
1	PWR License and Tail Running Lights	P3110	1	GN	0460-010-2031		DTM06-12SA
2						0413-204-2005	DTM06-12SA
3	PWR Stop / Turn Signal (Rear Left) 12V Light Power	P3103	1	RD	0460-010-2031		DTM06-12SA
4						0413-204-2005	DTM06-12SA
5	PWR Stop / Turn Signal (Rear Right) 12V Light Power	P3104	1	BR	0460-010-2031		DTM06-12SA
6	PWR Reverse Lights 12V Switched PWR	P3091	1	YE	0460-010-2031		DTM06-12SA
7						0413-204-2005	DTM06-12SA
8	GND Chassis Harness Rear Left 12V Exterior Light Return	GC136	1	BK	0460-010-2031		DTM06-12SA
9						0413-204-2005	DTM06-12SA
10						0413-204-2005	DTM06-12SA
11						0413-204-2005	DTM06-12SA
12						0413-204-2005	DTM06-12SA

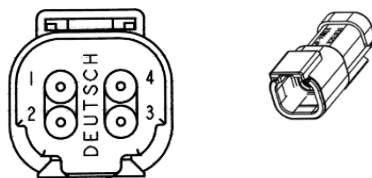
Connector pinout 101E – ePTO (if equipped)



ICDe Inline Chassis - Upfitter C5 ePTO (Rear Frame Left, Middle Position, Green, Male Terminal)
C77-101E, TE Connectivity / DEUTSCH, DTM04-12PB-E005

Pin	Signal Description	Circuit	Wire Size	Wire Color	Terminal PN	Cavity Plug PN	Mating Connector
1	CAN ePTO HSCAN Bus CAN1 HI	CH024	0.35	YE	0460-202-20141		DTM06-12SB
2	CAN ePTO HSCAN Bus CAN1 LO	CL024	0.35	GN	0460-202-20141		DTM06-12SB
3	HVIL ePTO Interlocks A	J0032	0.75	TN	0460-010-2031		DTM06-12SB
4	HVIL Optional Content Interlocks	J0031	0.75	TN	0460-010-2031		DTM06-12SB
5	PWR Push-Button (KL15) Relay 12V Enable	P4017	0.75	LT BU	0460-010-2031		DTM06-12SB
6						0413-204-2005	DTM06-12SB
7						0413-204-2005	DTM06-12SB
8	GND ePTO Module 12V Chassis Return	GC179	1	BK	0460-010-2031		DTM06-12SB
9						0413-204-2005	DTM06-12SB
10						0413-204-2005	DTM06-12SB
11						0413-204-2005	DTM06-12SB
12						0413-204-2005	DTM06-12SB

Connector pinout 101C - Rearview Camera



ICDe Inline Chassis - Upfitter C3 Camera (Rear Frame Left, Bottom position, Black, Female Terminal)
C77-101C, TE Connectivity / DEUTSCH, DTM04-4P-E005

Pin	Signal Description	Circuit	Wire Size	Wire Color	Terminal PN	Cavity Plug PN	Mating Connector Number
1	VIDEO Rear Camera SP+	F0002	0.5	RD	0460-202-20141		DTM06-4S
2	VIDEO Rear Camera HS+	F0004	0.5	RD/WH	0460-202-20141		DTM06-4S
3	VIDEO Rear Camera SP-	F0003	0.5	BK/WH	0460-202-20141		DTM06-4S
4						0413-204-2005	DTM06-4S

REARVIEW CAMERA

The B4 rearview camera is a rear-view camera system designed to be installed on the rear of the vehicle. The camera provides a visual aid for drivers to see behind their vehicles when reversing, especially in situations where traditional mirrors might offer limited visibility.

- The camera is standard equipment and located in a protective shipping envelope, as seen in figure 1, and then placed inside the vehicle's lower storage bin at the vehicle assembly plant for the Upfitter to install, as seen in figure 2.



Figure 1



Figure 2

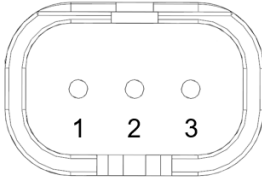
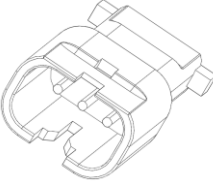
- The camera does not need to be installed and connected, the radio display will operate normally, if the camera is connected or not.
- The rearview camera should be mounted near the centerline of the vehicle.
- The rearview camera has an overall harness length of 7.75 inches or 197mm, as seen in figure 3.



Figure 3

- It is left up to the upfitter or installer to fabricate a jumper harness to connect to the frame connection to the camera connection at the mounting location. A jumper harness is not available from Bollinger Motors due to the various mounting locations and corresponding lengths.
- The fabricated jumper harness connects to the lower upfitter connector 101C on the rear left frame rail.
- It is recommended to remove the rearview camera connector and use an Upfitter supplied inline splice or similar weatherproof connection to the upfitter jumper harness.
- Please follow electrical best practice methods for the creating the harness jumper. Properly protect the harness jumper from any chaffing and rubbing on surrounding components, use clipping attachment methods often to secure the harness to surrounding components.

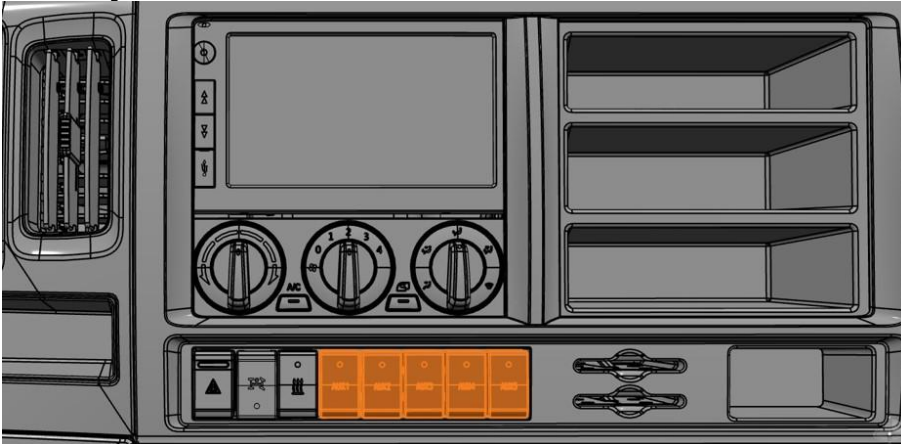
Connector pinout Rearview Camera

 				
Rearview camera – It is recommended to remove the connector and use an Upfitter supplied inline splice or similar weatherproof connection to upfitter jumper harness.				
Pin	Signal Description	Circuit	Wire Size	Wire Color
1	Camera Power	F0002	0.5	RD
2	Camera Video	F0004	0.5	YL
3	Ground	F0003	0.5	BK

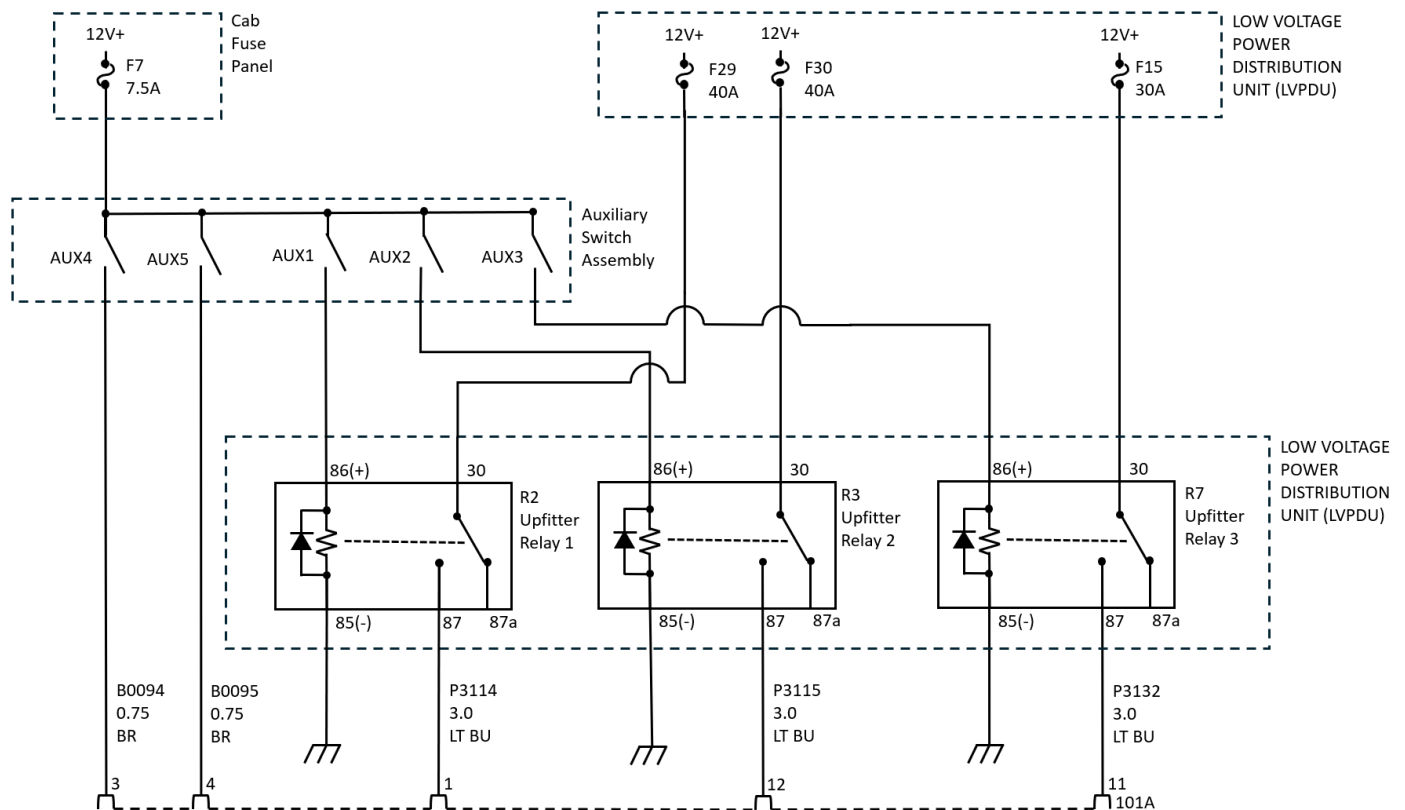
ACCESSORY POWER CONTROL

Accessory Power is controlled by the Auxiliary Switch Bank.

Auxiliary Switch Bank



UPFITTER - RELAYS & SWITCHES SCHEMATIC



UPFITTER - ACCESSORY COMPONENT & EQUIPMENT WIRING / HARNESS PASS-THROUGH ACCESS

In certain instances, it may be advantageous to route an Upfitter provided wiring harness into the cab for upfitting purposes. Access can be found in two locations on through the front wall and one through the floor.

FRONT WALL ACCESS

The front wall access exists under a protective cover on the chassis harness, where it connects to the cab, refer to Figure 1.

Note: Before proceeding make sure enough harness strain relief exists near and around the cab hinge point, then verify the new harness can be properly secured to the cab and chassis areas to prevent any rubbing or chaffing conditions to the harness on surrounding components.

- Remove the grille and front decorative cover, refer to Figure 1.
- Remove the protective cover on the chassis harness by remove four fasteners then lift and remove the protective cover, refer to Figure 1.
- Route the additional Upfitter wires along the chassis harness and into one of the available routing voids between the connectors and cover base and through to the interior of the cab, refer to Figure 1.
- Provide and verify enough wire harness strain relief remains near and around the cab hinge point and secure the wire harness appropriately.

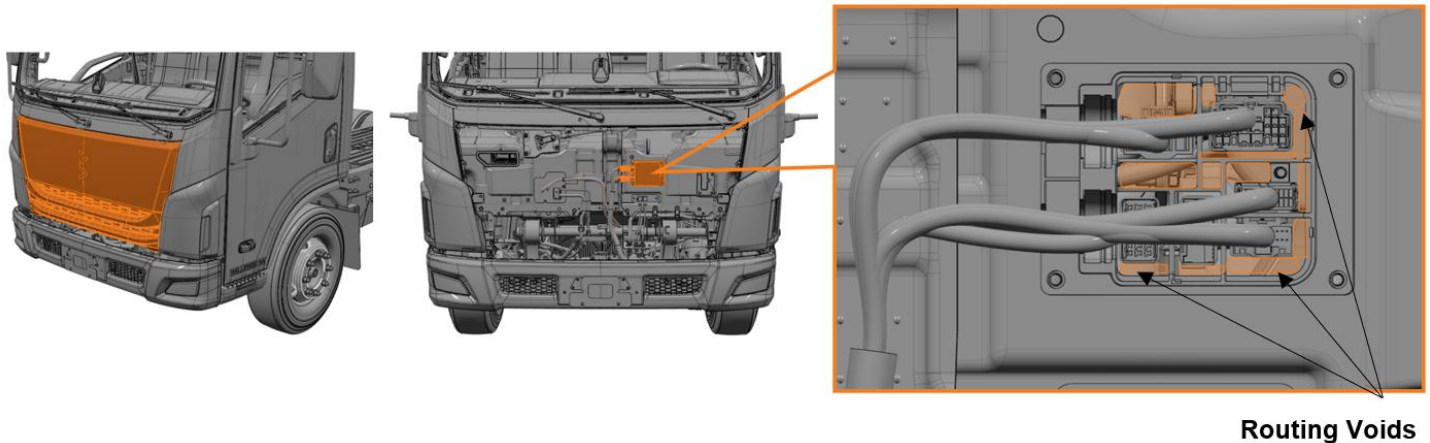


Figure 1

FLOOR ACCESS

The floor access exists through the Floor Block-Off Plate found under the cab near the center console area. This access point will route a harness up the shifter cover and to the center console area.

Note: Before proceeding make sure enough wiring harness strain relief exists near and around the cab hinge point, then verify the new harness can be properly secured to the cab and chassis areas to prevent any rubbing or chaffing conditions to the harness on surrounding components.

Note: Before proceeding a proper weatherproof grommet or seal is required for the new Upfitter harness to prevent any environmental elements from entering the interior of the cab.

- Raise the cab.
- Access the Floor Block-Off Plate, refer to Figure 2.
- Remove the four fasteners, refer to Figure 2.
- Remove the Floor Block-Off Plate and gasket, refer to Figure 2.
- Using the gasket as a template and verifying the sheetmetal has sufficient clearance to install a harness.
- Drill a hole through the Floor Block-Off Plate near the center of the plate and install an appropriate weatherproof grommet or seal.
- Route the new wire harness to the interior of the cab.
- Provide and verify enough wire harness strain relief remains near and around the cab hinge point, secure the wire harness appropriately.

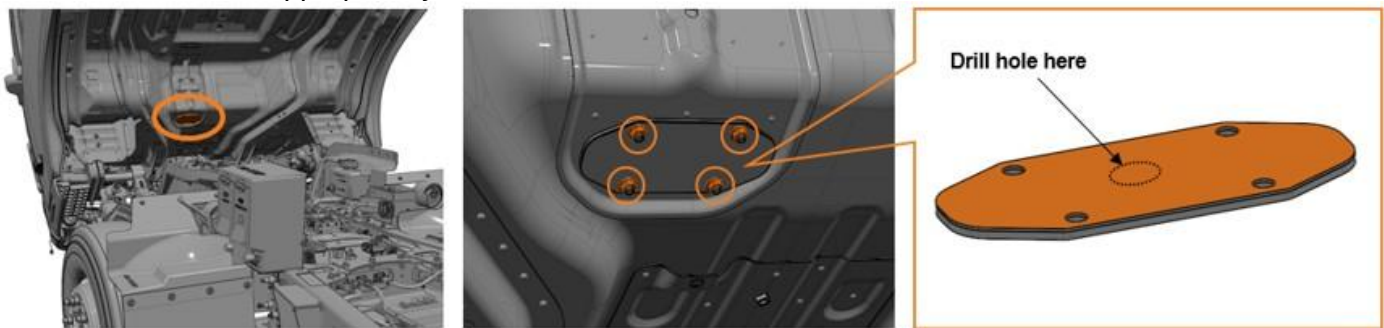


Figure 2

7. VEHICLE DIMENSIONS, WEIGHT, AND CENTER OF GRAVITY

A vehicle's weight and center of gravity location are very important characteristics for determining whether the completed vehicle meets regulatory requirements (FMVSS 105, 126, 135, 301, Emissions etc.), vehicle limitations (GAWRs, GVWR, etc.) and desired attribute targets (steering feel, vehicle stability, handling etc.).

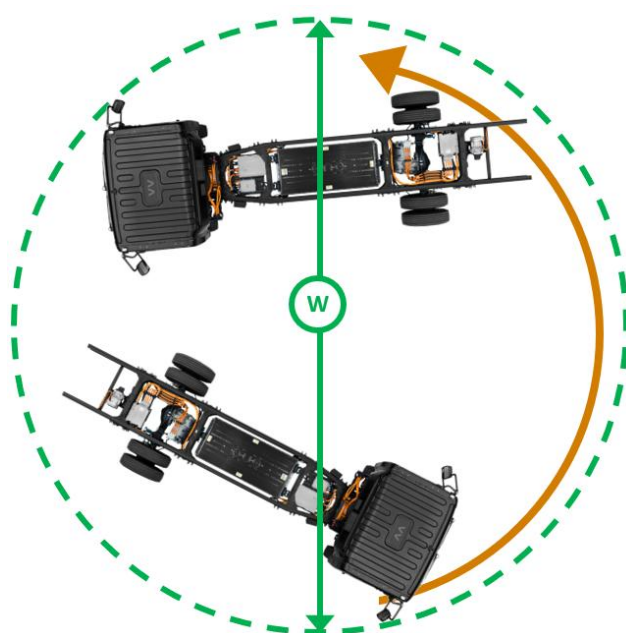
In addition to GVWR and GAWRs, the Unloaded Vehicle Weight (UVW) is critical information that Final Stage Manufacturers need to consider. The "Official" GVWR and GAWRs for a given incomplete vehicle are provided on the vehicle Incomplete Vehicle Label, which is affixed to the driver door opening. If a Final Stage Manufacturer revises the vehicle GVWR or GAWR values, those revised values will be reflected on the Certification Label they affix upon completion of the vehicle.

Outside dimensions (mirror to mirror) are factory installed at the 102" width. The mirror orientations may be modified by swapping driver and passenger side mirrors to provide a narrower 96" width, if desired.

GENERAL VEHICLE ARRANGEMENT

Model	Body Style	Wheelbase	GVWR	GAWR	Curb/Front/Rear	Max Payload
Bollinger B4	LCF	158 in 4013 mm	15500 lbs 7029 kg	Front: 6500 lbs 2945 kg Rear: 10500 lbs 4762 kg	Curb: 8175 lbs 3707 kg Front: 4223 lbs 1915 kg Rear: 3952 lbs 1792 kg	7325 lbs 3322 kg

TURNING DIAMETER



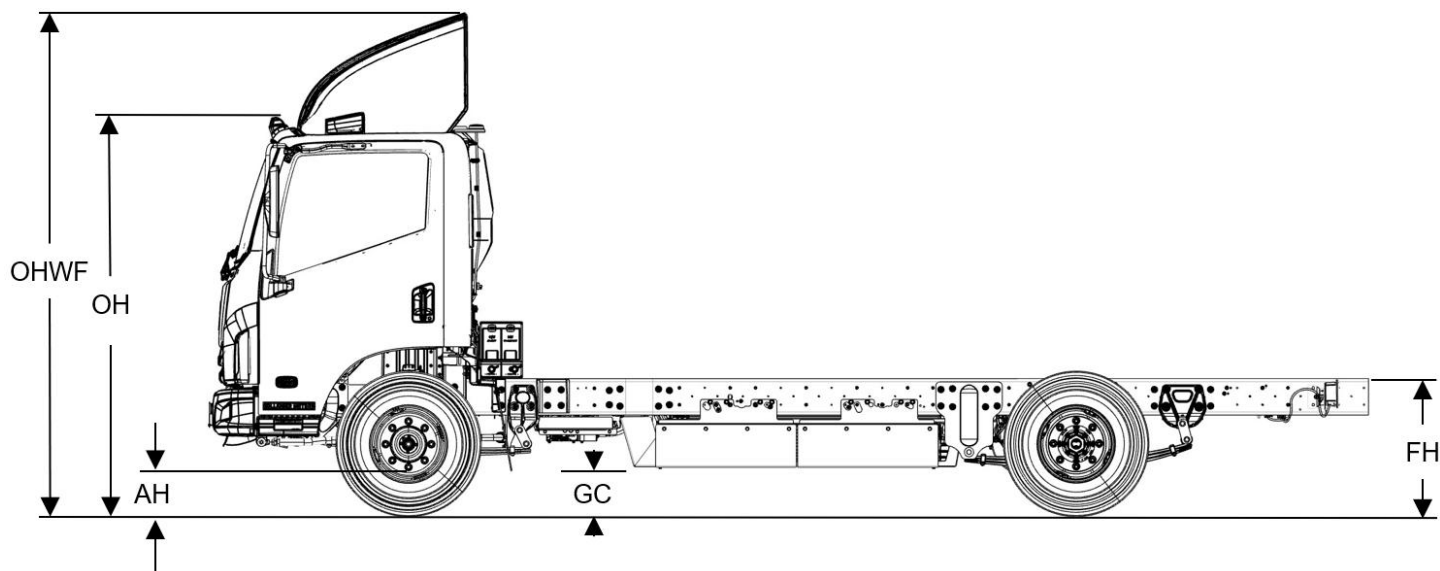
W = Minimum turning diameter wall to wall

Diameters (design value)	Wheelbase	Curb to Curb
	158 in 4013mm	46 ft 14 m

LIST OF ACRONYMS

WB = Wheelbase
 CA = Cab to Axle
 CE = Cab to End
 AF = Axle to Frame End
 OAL = Overall Length
 AW = Axle Width
 BA = Bumper to Axle
 BBC = Bumper to Back of Cab
 BOC = Back of Cab
 BW = Back Wheel Width
 CW = Center Wheel Width
 FW = Frame Width
 OW = Overall Width
 AH = Axle Height
 FH = Frame Height
 OH = Overall Height
 OHWF = Overall Height with Fairing
 GC = Ground Clearance

HEIGHT DIMENSIONS

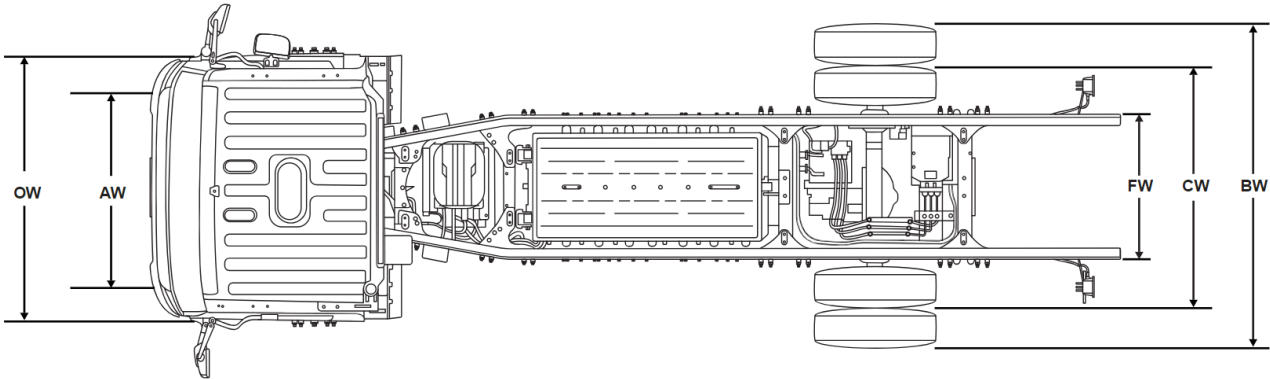


DIMENSIONS		AH	FH ¹	OH	OHWF	GC ²
	in	8.5	32	92.7	117.3	9
	mm	216	813	2354	2980	229

¹ Measured at the end of the frame – from top of the frame to ground at curb weight.

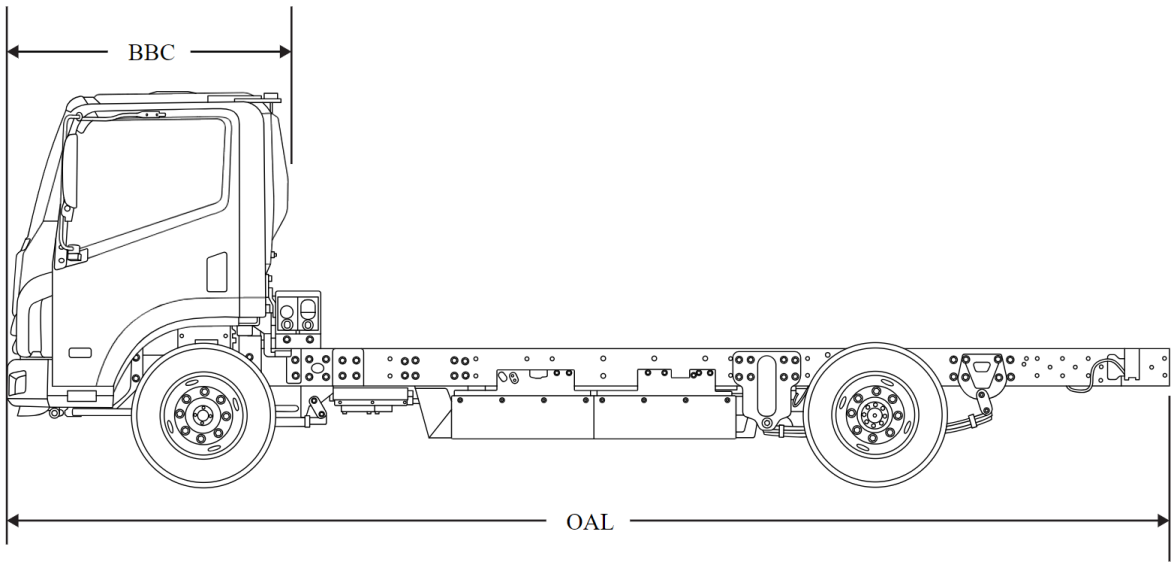
² Per SAE J1100, H156-Curb. Measured at battery shield.

WIDTH DIMENSIONS



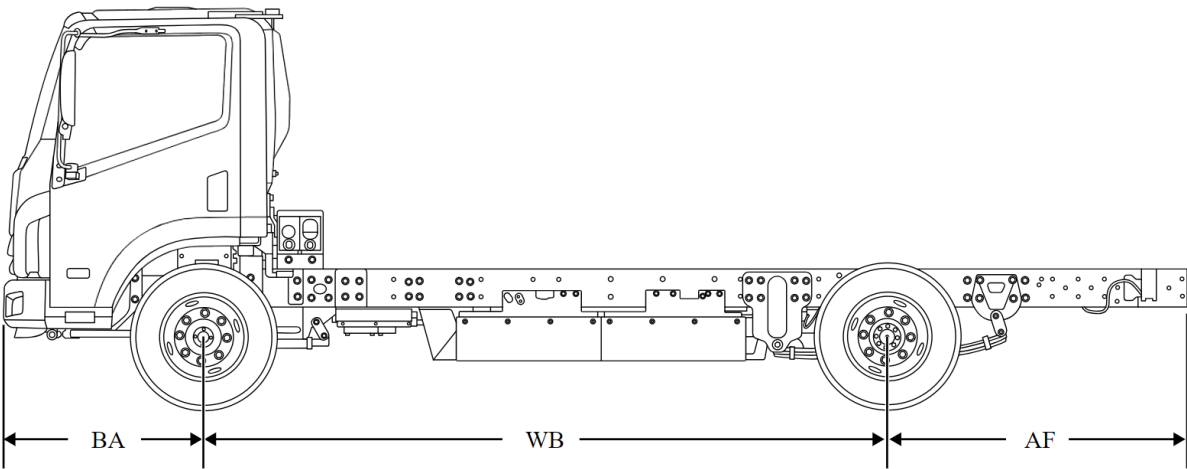
DIMENSIONS		OW	AW	FW	CW	BW
	in	75.3	62.5	40	68.3	88.4
	mm	1913	1588	1016	1734	2245

GENERAL LENGTH DIMENSIONS



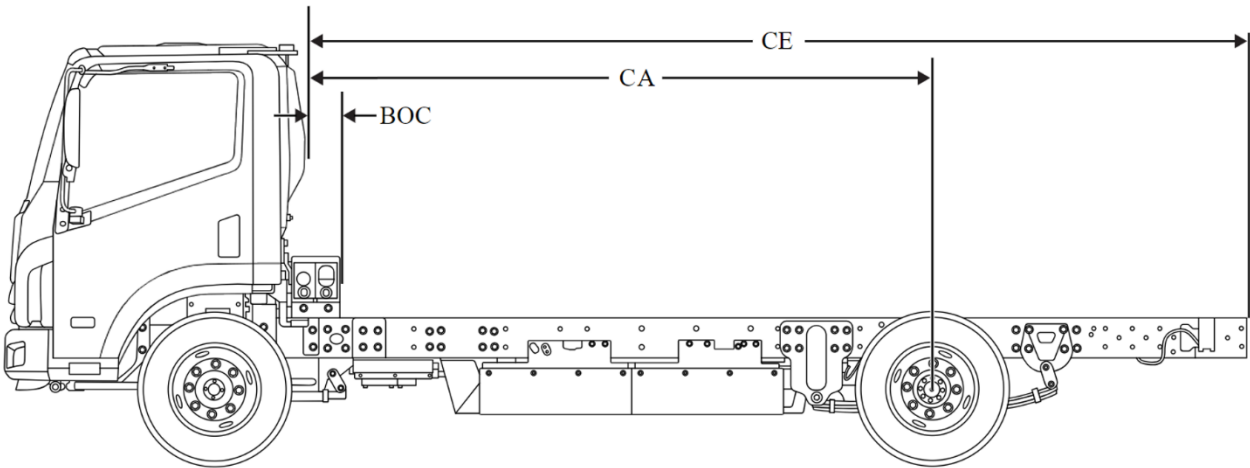
DIMENSIONS		OAL	BBC
	in	273.5	66.3
	mm	6947	1684

WHEELBASE LENGTH DIMENSIONS



DIMENSIONS		WB	AF	BA
	in	158	69	46.3
	mm	4013	1753	1176

CARGO AREA LENGTH DIMENSIONS



DIMENSIONS		CA ³	CE ⁴	BOC
	in	138	207.3	8
	mm	3505	5264	203

³ Effective CA is CA less BOC.

⁴ Effective CE is CE less BOC.

CAB TILT

WARNING: TO HELP AVOID PERSONAL INJURY WHEN TILTING CAB.

1. Park the vehicle on level ground and ensure ample space around cab before commencing this operation.
2. Set the parking brake firmly and block front wheels.
3. Ensure "P" (Park) is engaged.
4. Remove all objects from instrument panel, seat, and cab floor.
5. Be certain cab doors are closed.
6. Always insert the lock pin into the cab support when cab is in raised position.
7. Make sure the lock hood attached to the handle has been firmly engaged.
8. From the Drive's side, place your left hand, palm up, on the cab tilt handle (D) and pull the cab tilt lock safety release (A) toward you, see figure 1.

With the cab tilt lock safety release disengaged, with your right hand lift the cab tilt release lock (C) lever (rotating clockwise) to release it from the cab tilt latch receiver.

9. Stabilize the cab by grasping the cab tilt handle (D) with your left hand, grasp the cab tilt release (B) and pull the handle toward you to release the cab fully and tilt it forward, see figure 1.
10. Raise cab to full lift position and ensure cab tilt support arm (E) is fully locked, see figure 2.
11. Insert lock pin (G) into cab tilt support arm (E), see figure 2.

See Owner's Information for details.

Refer to owner's Information for cab tilt instructions.

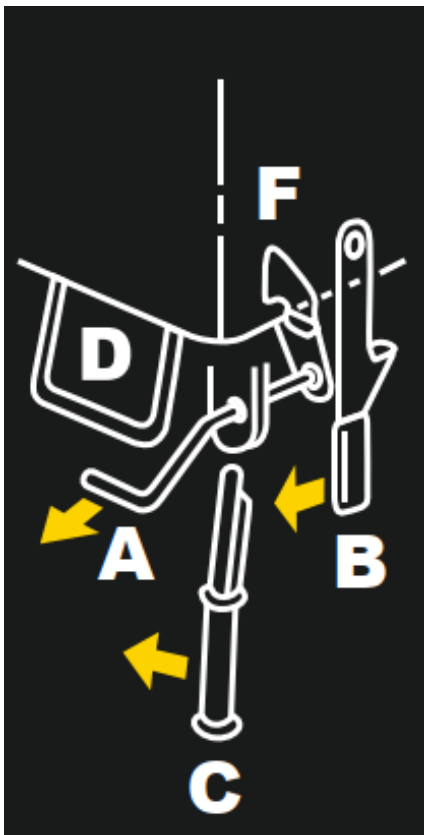
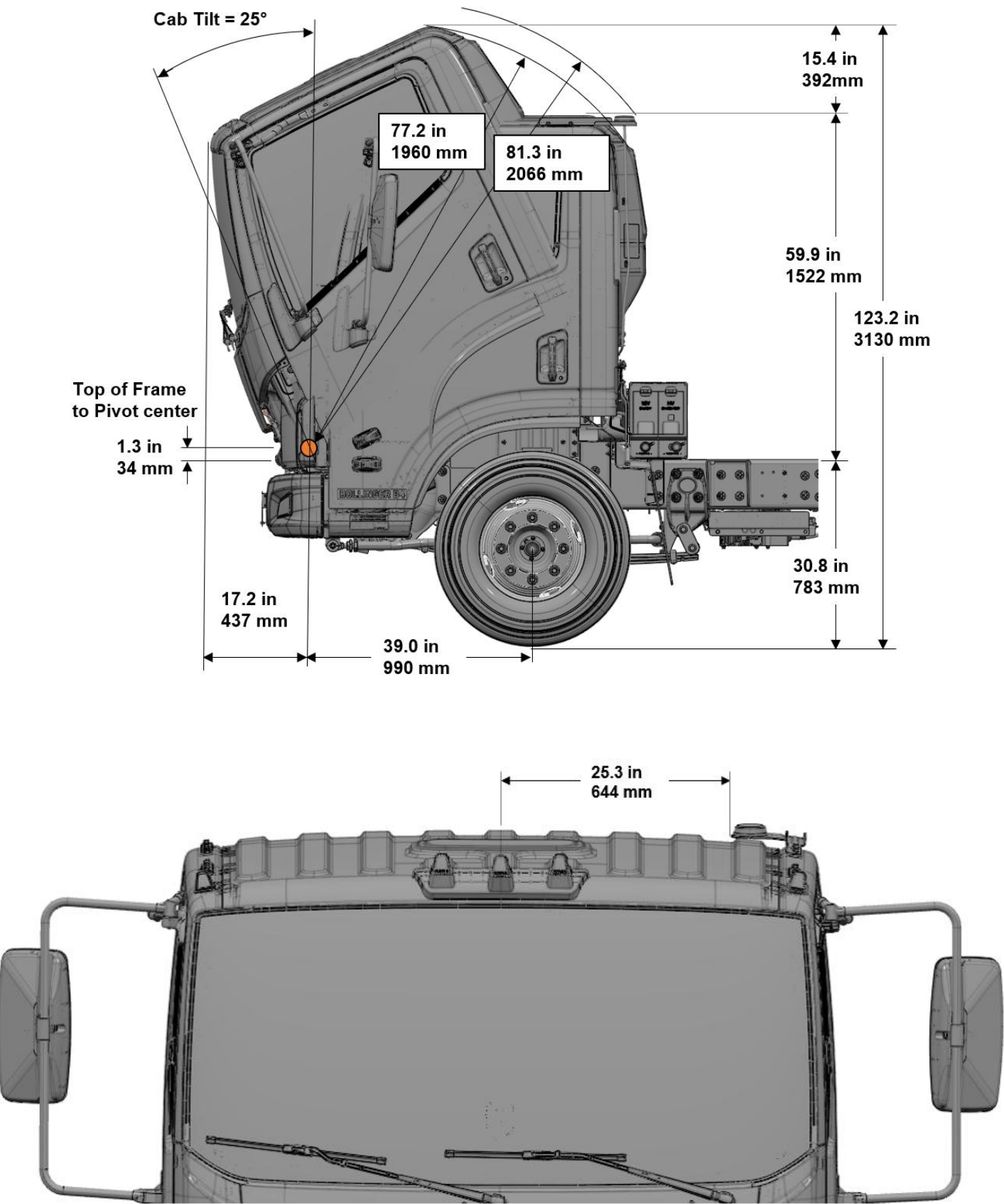


Figure 1

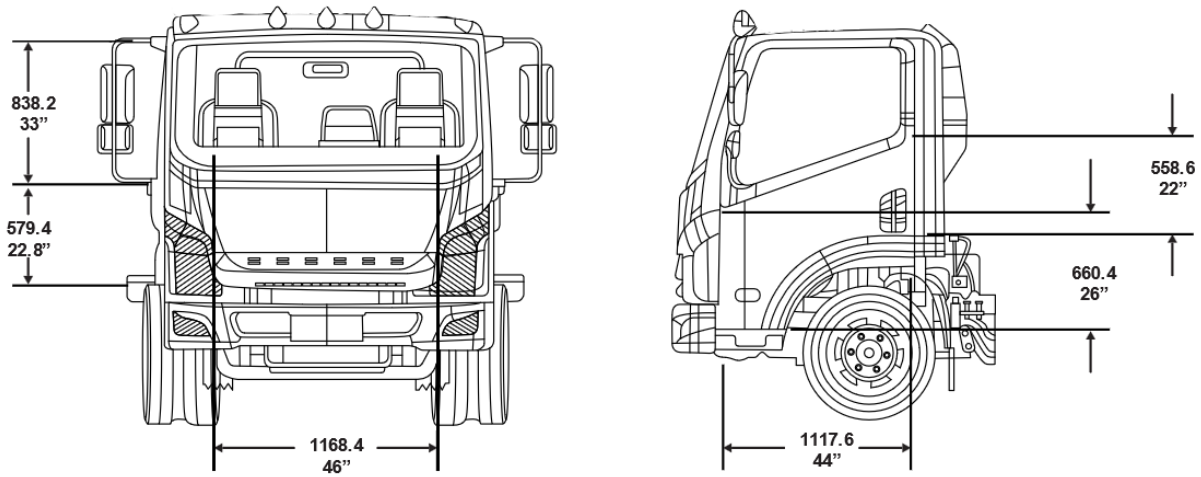


Figure 2

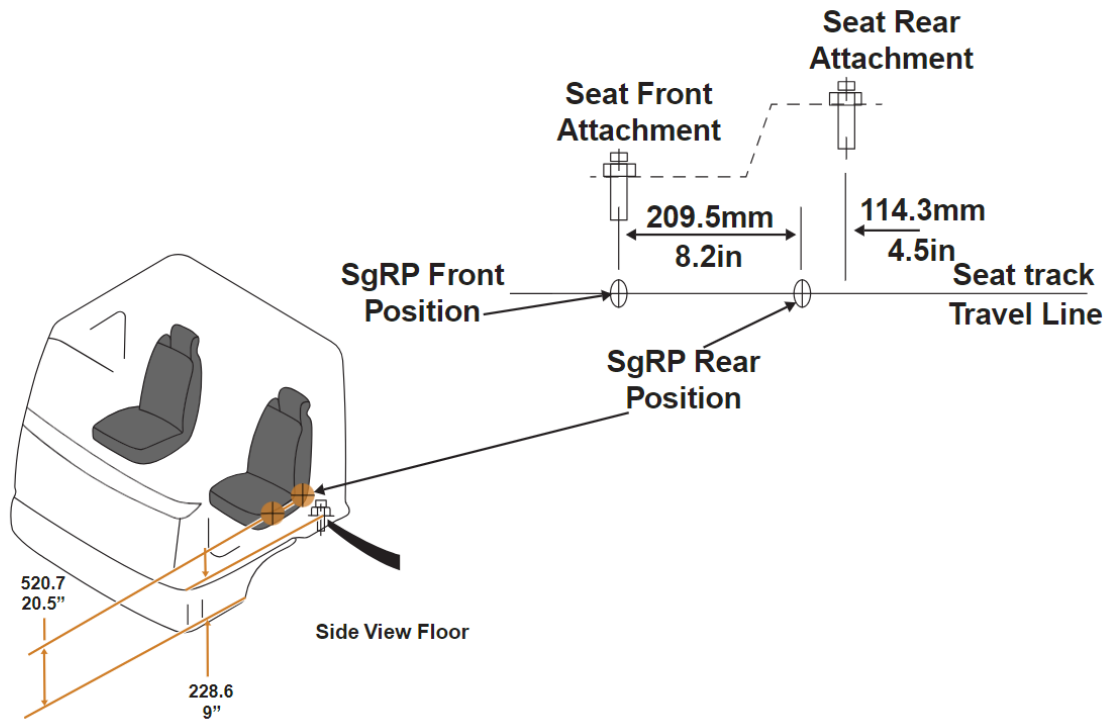
CAB TILT DIMENSIONS



CAB DIMENSIONS



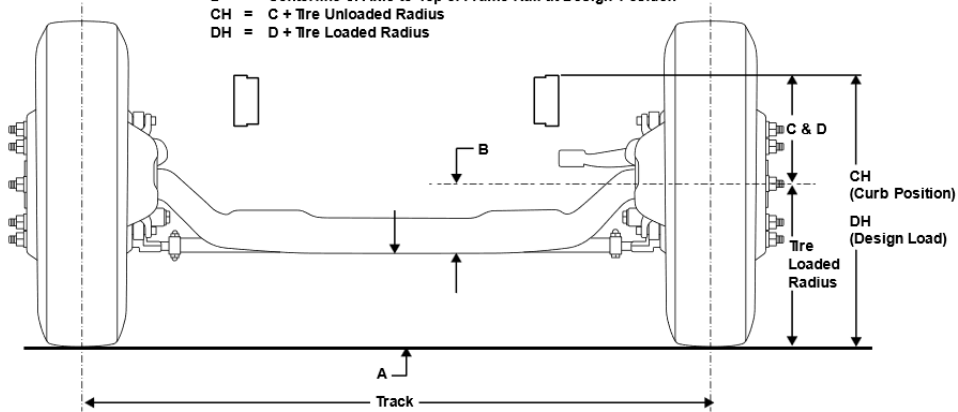
INTERIOR H-POINT



FRONT AXLE

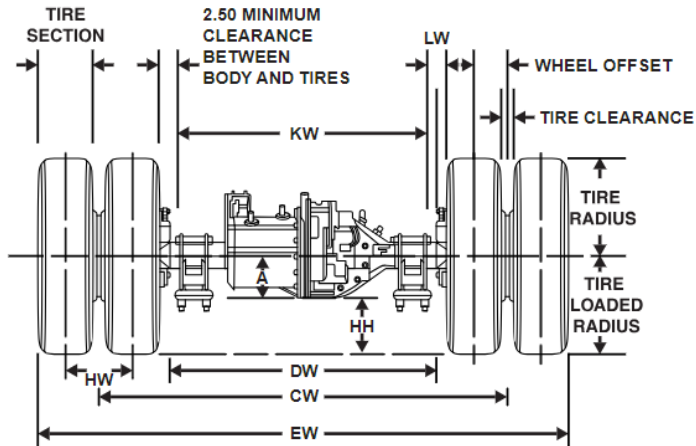
Formulas for Calculating height dimensions :

- A = Tire Loaded Radius - B
- C = Centerline of Axle to Top of Frame Rail at Curb Position
- D = Centerline of Axle to Top of Frame Rail at Design Position
- CH = C + Tire Unloaded Radius
- DH = D + Tire Loaded Radius



Tire Size	Front GAWR	A	B	C	D	CH	DH	Track	Tire Radius Unloaded/ Loaded
225/70R19.5	8016 lbs.	8.5 in	7.2 in	15.9 in	14.6 in	31.6 in	30.2 in	62.9 in	15.9/15.7 in
	3636 kg	216 mm	182 mm	405 mm	370 mm	803 mm	768 mm	1597 mm	405/398 mm

REAR AXLE WIDTH

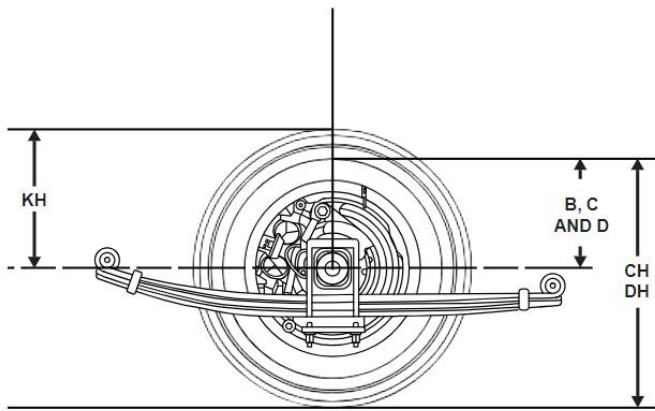


Tire Size	225/70R19.5
Rear GAWR	10,500 lbs. (4763 kg)

		IN.	MM.
Tire Radius Unloaded / Loaded		15.9 / 15.7	405 / 398
Definitions			
DW	Minimum distance between the inner surfaces of the rear tires.	48.1	1222
CW	Track Dual Rear Wheel Vehicles: Distance between the centerlines of the dual wheels measured at the ground line.	68.0	1727
EW	Maximum Rear Width: Overall width of the vehicle measured at the outermost surface of the rear tires.	88.4	2245
HH	Rear Tire Clearance: Minimum clearance between the rear axle and the ground line.	8.2	209
HW	Dual Tire Spacing: Distance between the centerlines of the minimum distance required for tire bounce as measured from the centerline of the rear axle and top of the rear tire when one wheel rides over a high spot.	11.2	286

* Refer to the [Calculations](#) section of this book for formulas on how to perform calculations.

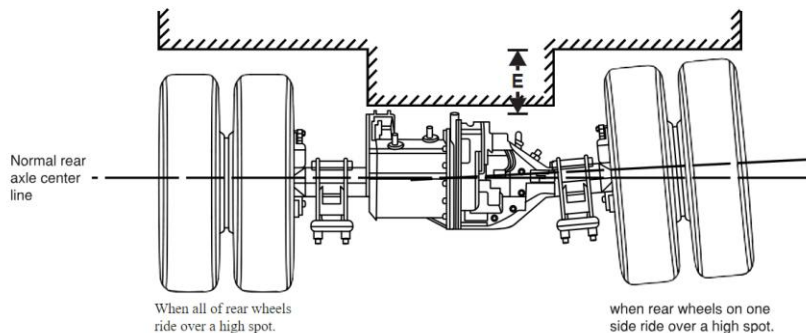
REAR AXLE HEIGHT



Tire Size	225/70R19.5
Rear GAWR	10,500 lbs. (4763 kg)

		IN.	MM.
Tire Radius Unloaded / Loaded		15.9 / 15.7	405 / 398
Definitions			
B	Centerline of axle to top of frame rail at metal to metal position.	11.7	298
C	Centerline of axle to top of frame rail at curb position.	15.4	392
D	Centerline of axle to top of frame rail at design load.	13.8	350
CH	Rear Frame Height: Vertical distance between the normal top of frame rail and the ground line through the centerline of the rear axle at curb position.	31.1	790
DH	Rear Frame Height: Vertical distance between the normal top of frame rail and the ground line through the centerline of the rear axle at design load.	29.4	748

REAR AXLE CENTERLINE



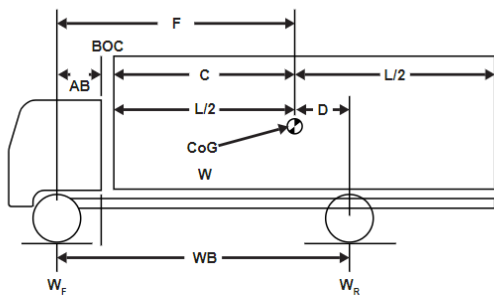
Tire Size	225/70R19.5
Rear GAWR	10,500 lbs. (4763 kg)

		IN.	MM.
Tire Radius Unloaded / Loaded		15.9 / 15.7	405 / 398
Definitions			
E	Rear Tire Clearance: Minimum clearance required for tires and chain measured from the top of the frame at the vertical centerline of the rear axle, when rear wheels on one side ride over a high spot.	7.4	187

CALCULATIONS

Formulas for Calculating Dimensions			
CW	= Track	HH	= Tire loaded radius - A
CH	= Tire loaded radius + C	JH	= KH - B
DH	= Tire loaded radius + D	KH	= Tire radius + 3.00 inches
DW	= Track + 2 tire sections - tire clearance	KW	= DW - 5.00 inches
EW	= Track + 2 tire sections + tire clearance	LW	= 1.00 - inch minimum clearance between tires and springs

VEHICLE WEIGHT & CENTER OF GRAVITY



- AB** - Front axle to back of cab
BOC - Distance between cab and body or trailer
C - Front of body to C.G or front of trailer to kingpin
D - Distance C.G of body or fifth wheel is ahead of rear axle
F - (AB + BOC + C) or distance C.G of weight of fifth wheel is behind front axle
WB - Wheelbase
W - Weight of body plus payload, or king pin load
Wf - Portion of W transferred to front axle
Wr - Portion of W transferred to rear axle
C - Length of body divided by 2
L/2 - Load location at half of body length
L - Distance over which the payload is spread with in the body

Weight Distribution Formulas

Basic Formulas

(a) $W \times D = W_f \times WB$
 (b) $W \times D = W_r \times WB$

or

(c) $WB = (AB + BOC + C + D) = (F + D)$
 (d) $W = W_f + W_r$

1. $W_f = \frac{W \times D}{WB}$
 2. $D = \frac{W_f \times WB}{W}$
 3. $WB = \frac{W \times D}{W_f}$
 4. $W = \frac{W_f \times WB}{D}$

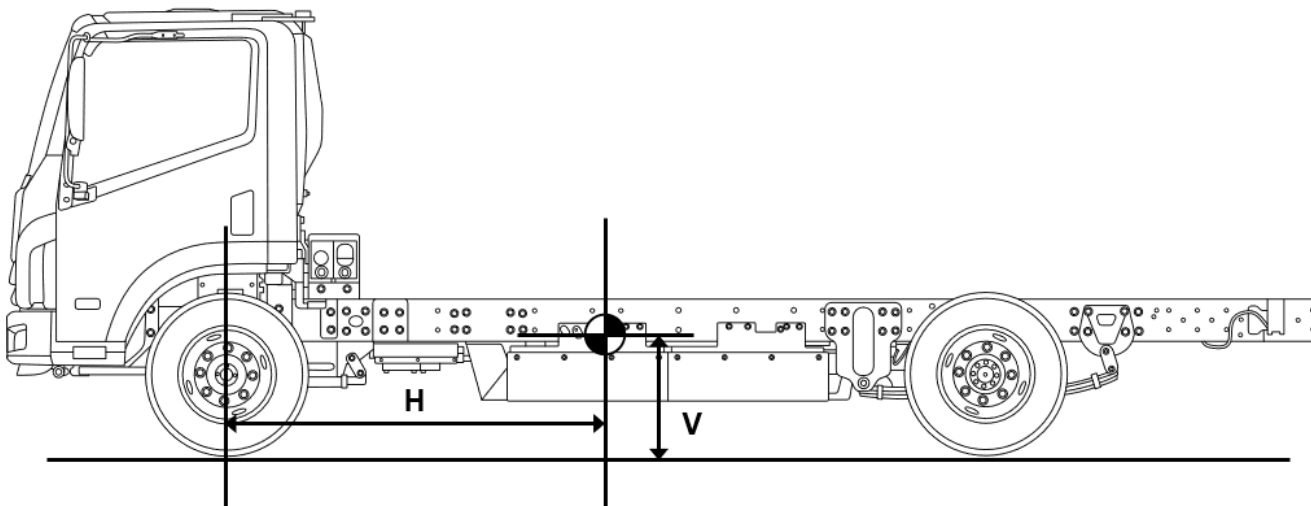
5. $W_r = \frac{W \times F}{WB}$
 6. $F = \frac{W_r \times WB}{W}$
 7. $WB = \frac{W \times F}{W_r}$
 8. $W = \frac{W_r \times WB}{F}$

Weight Distribution Formulas in words

To find:

- weight transferred to front axle = $\frac{(\text{Total weight}) \times (\text{Distance C.G is ahead of the rear axle})}{(\text{Wheelbase})}$
- Distance C.G must be placed ahead of rear axle = $\frac{(\text{Weight transferred to the front axle}) \times (\text{Wheelbase})}{(\text{Total weight})}$
- Wheel base = $\frac{(\text{Total weight}) \times (\text{Distance C.G is ahead of the rear axle})}{(\text{Weight to be transferred to the front axle})}$
- Total Weight = $\frac{(\text{Weight to be transferred to the front axle}) \times (\text{Wheelbase})}{(\text{Distance C.G is ahead of the rear axle})}$

HORIZONTAL & VERTICAL CENTER OF GRAVITY



Horizontal & Vertical C.G. Of Chassis		
Wheelbase	(V) Vertical CG	(H) Horizontal CG
158 in / 4013 mm	24.3 in / 618 mm	76.4 in / 1941 mm

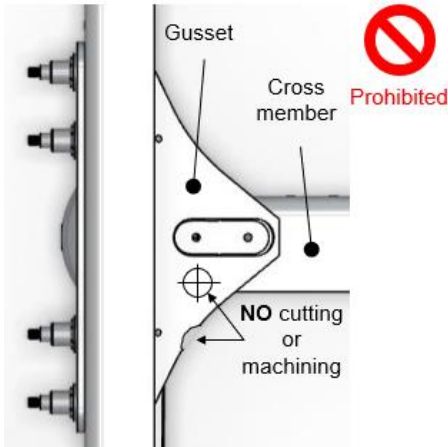
Note: The maximum vertical Center of Gravity specified above must not be exceeded at maximum GVWR and rated front and rear GAWR. The total vehicle, including upfit and cargo Center of Gravity (CG) maximum is 51.2" (1300 mm) above the ground. The total combined CG must be within the wheelbase.

8. NO MODIFICATION ZONES

Bollinger Motors recommends that the vehicle upfitters utilize the provided mounting points as described in this guide. If modifications must be done, they should be done with extreme caution avoiding any area that could damage the vehicle.

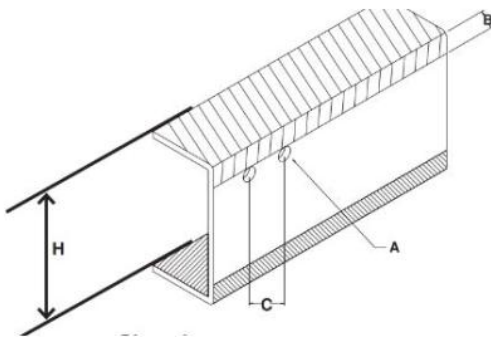
Modifications are NOT permitted on any HV part or component and only prohibited within zones not identified as a “Do Not Modify” zones and when done in accordance to the guidelines outlined within this publication and industry standard best practices. Modifications include but are not limited to any drilling, notching, welding, cutting, or other alteration.

No Modification Zone - Gusset



The following precautions should be followed when considering modifications:

Modification Guidelines



Dimensions:

A - no more than 0.75 inches in diameter

B - must be more than $H/5$ for welding and $H/7$ for holes

C - must be more than 1.57 inches

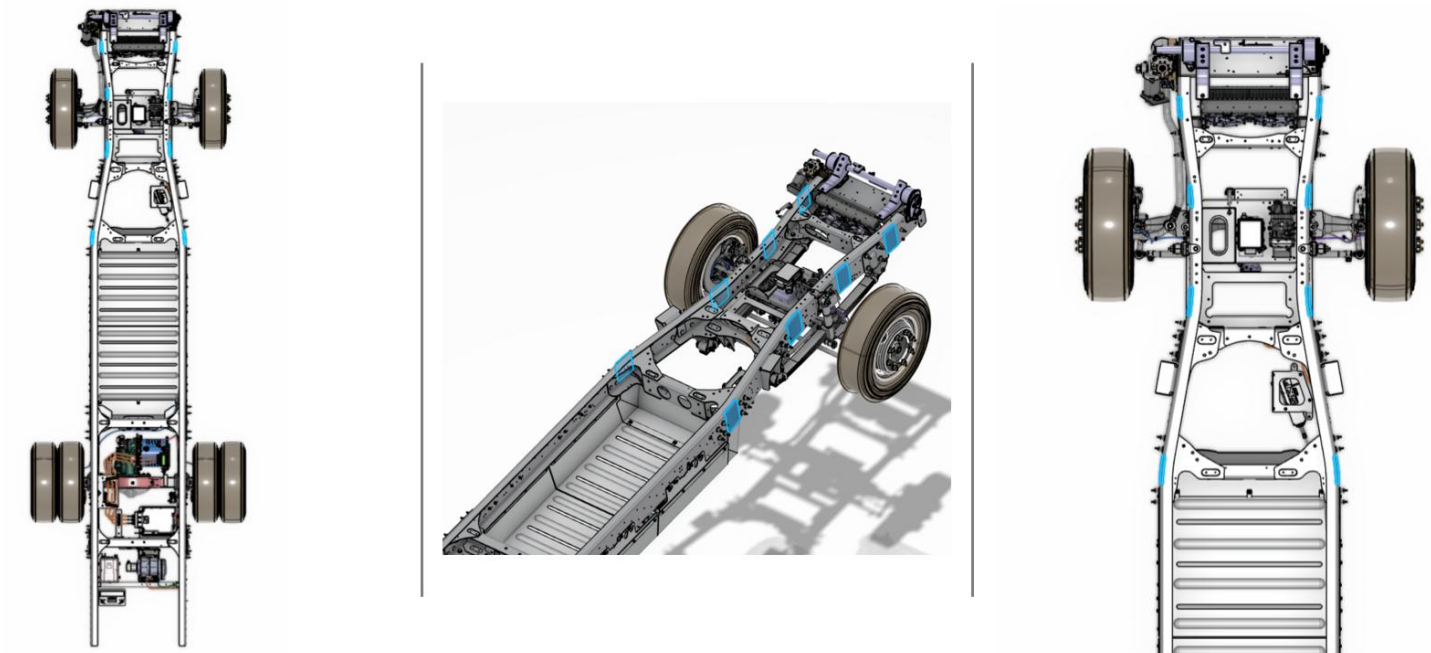
H = Frame Height

Note: Gusset hole drilling and notch making are prohibited.

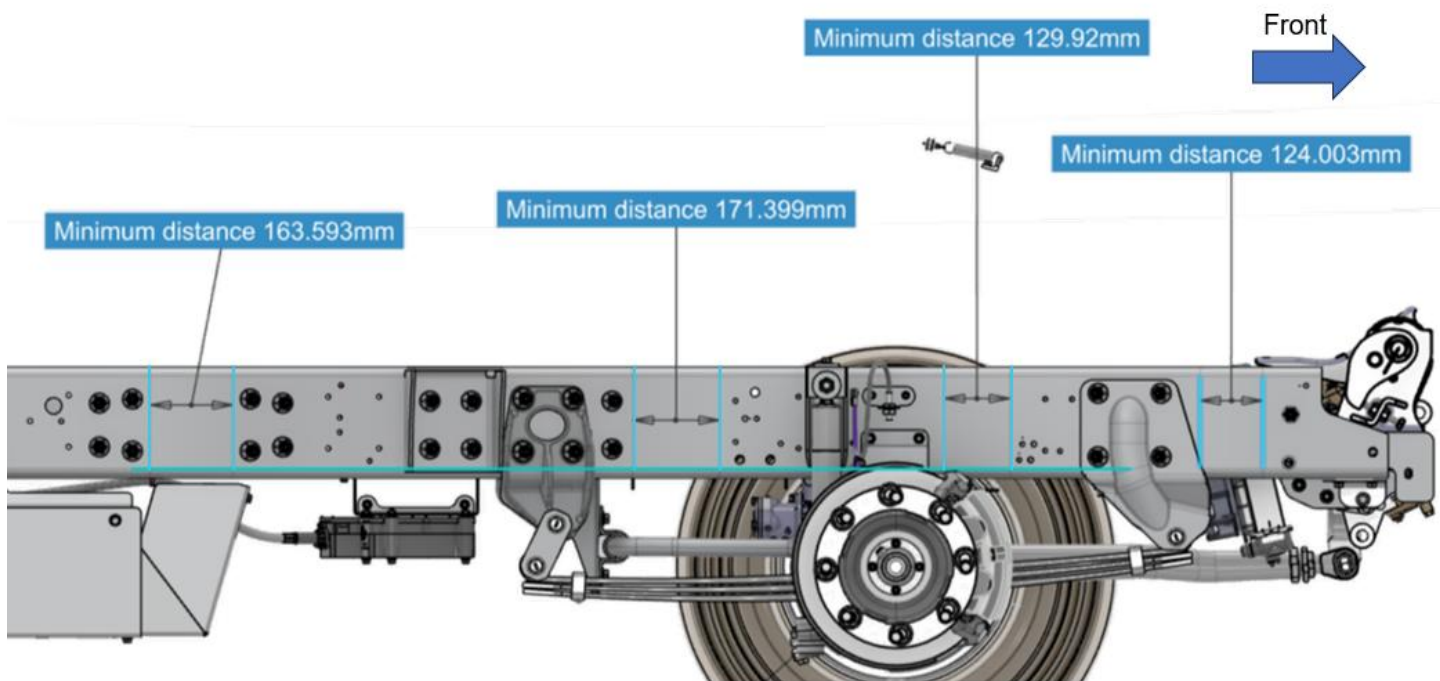
- Do not drill or weld in the shaded portions of the chassis frame and crossmembers.
- Do not weld within 0.8 inches from the edges of any existing holes.
- Hold the length of any welding beads within 1.2-2.0 inches. Allow at least 1.57 inches between adjacent welding beads.
- All holes must be drilled. Do not use a torch to make any holes.
- All riveting must be done with cold rivets. Do not use hot rivets.
- The flange of the chassis frame must not be cut under any circumstances.
- The subframe must be attached to the chassis frame with bolts. Do not weld.
- Repaint exposed metal after drilling.

NO FRAME MODIFICATION ZONES

Frame Points



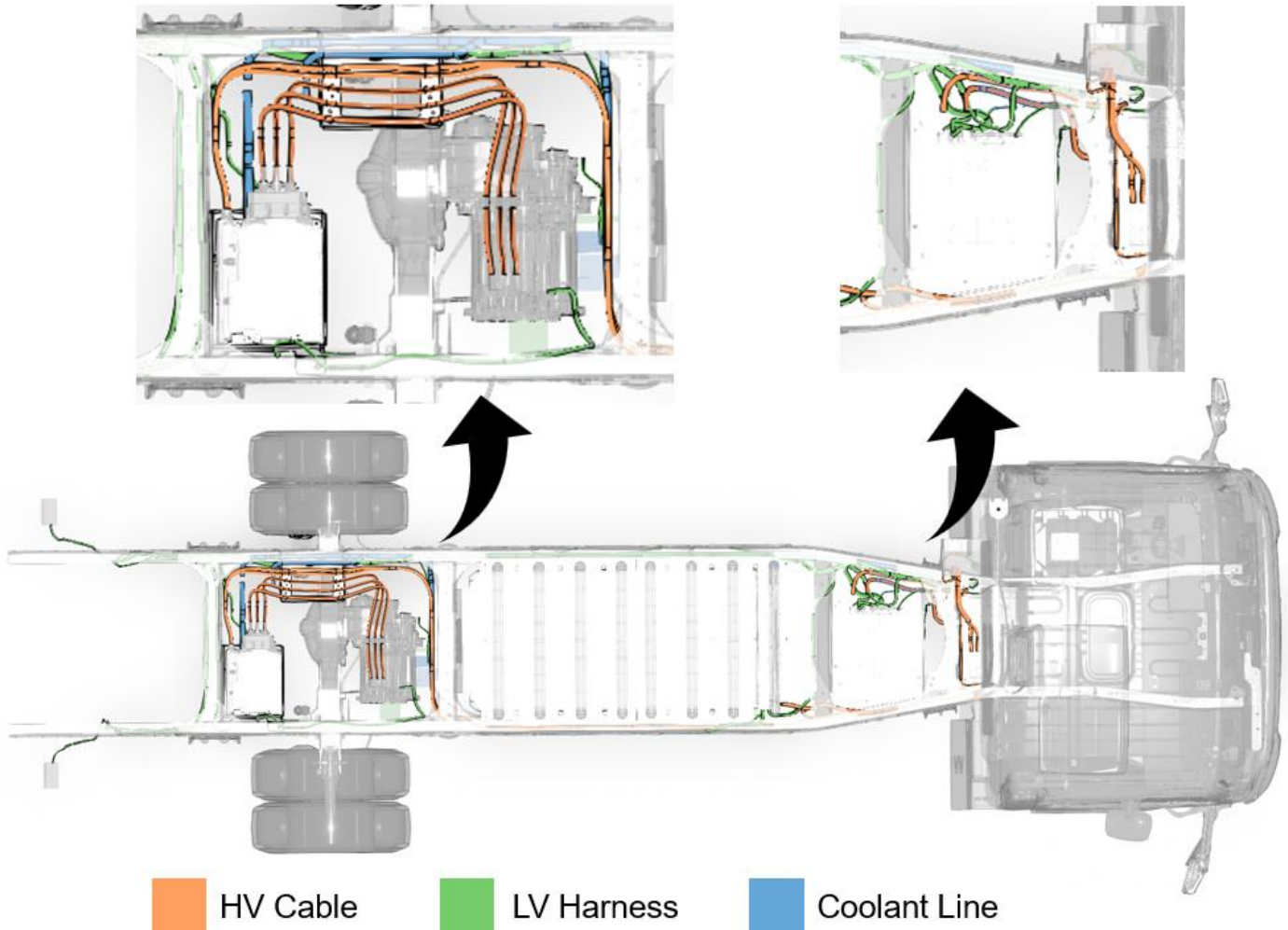
Frame Points Side View



NO DRILLING ZONES

Caution: An upfitter must exercise caution when making modifications to vehicles. Any alterations should not damage or jeopardize the vehicle's safety, integrity, or functionality. Ensuring that the modifications adhere to manufacturer guidelines is crucial. Ultimately, all responsibility lies with the upfitter to ensure a safe and effective modifications have been made. Use caution when working around all lines, hoses and electrical wiring.

Note: When using sheer plates use existing holes in the frame ensuring there is no interference between mounting bolts and HV Cabling, LV Harness, or Cooling Lines.



9. INSTALLATION OF UPFIT BODY AND SPECIAL EQUIPMENT

SPRAY/PAINT BOOTH BAKING/CURING

Note: Before baking or curing automotive finishes on a Bollinger Motors vehicle, please adhere to the following guidelines.

1. The vehicle must be stored at room temperature 21°C - 24°C (70-75°F) for at least two hours. This normalizes the internal temperatures of the high voltage batteries. So they are neither too cold nor too hot prior to the baking/curing process.
2. Bollinger Motors vehicles should not exceed 60°C (140°F) for more than 45 minutes while baking/curing single stage or base/clear paint applications.
3. Bollinger Motor vehicles should be allowed to cool down to room temperature for at least two hours before driving the vehicle in a “typical drive cycle”. This allows the heat absorption that occurred during the baking/curing process within the high voltage batteries to normalize prior to use. This will avoid excessive battery temperatures to be experienced during operation that can degrade the overall vehicle’s State of Charge (SOC) and set over temperature diagnostic trouble codes (DTCs).

SOLAR PROTECTIVE FILM – HIGH VOLTAGE BATTERY

A solar protective film is applied to the top of the high voltage battery to reduce thermal load on battery during storage and prior to upfit. During outdoor storage, prior to vehicle upfit, the high voltage battery may experience increased thermal solar loads due to direct sunlight exposure. The solar protective film is to prevent unnecessary battery thermal loading for this situation.

It is recommended to remove the film prior to final vehicle upfit, reference Figure 1.

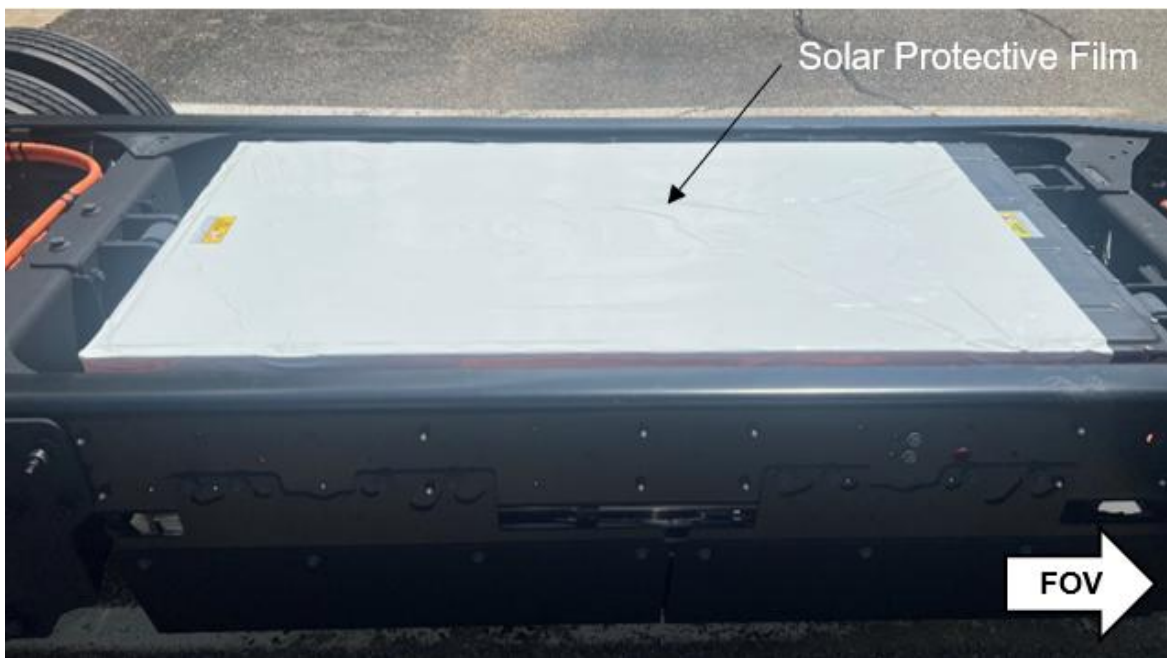


Figure 1

CLEARANCES

WARNING: Front of body must not extend beyond point identified, reference Figure 1.

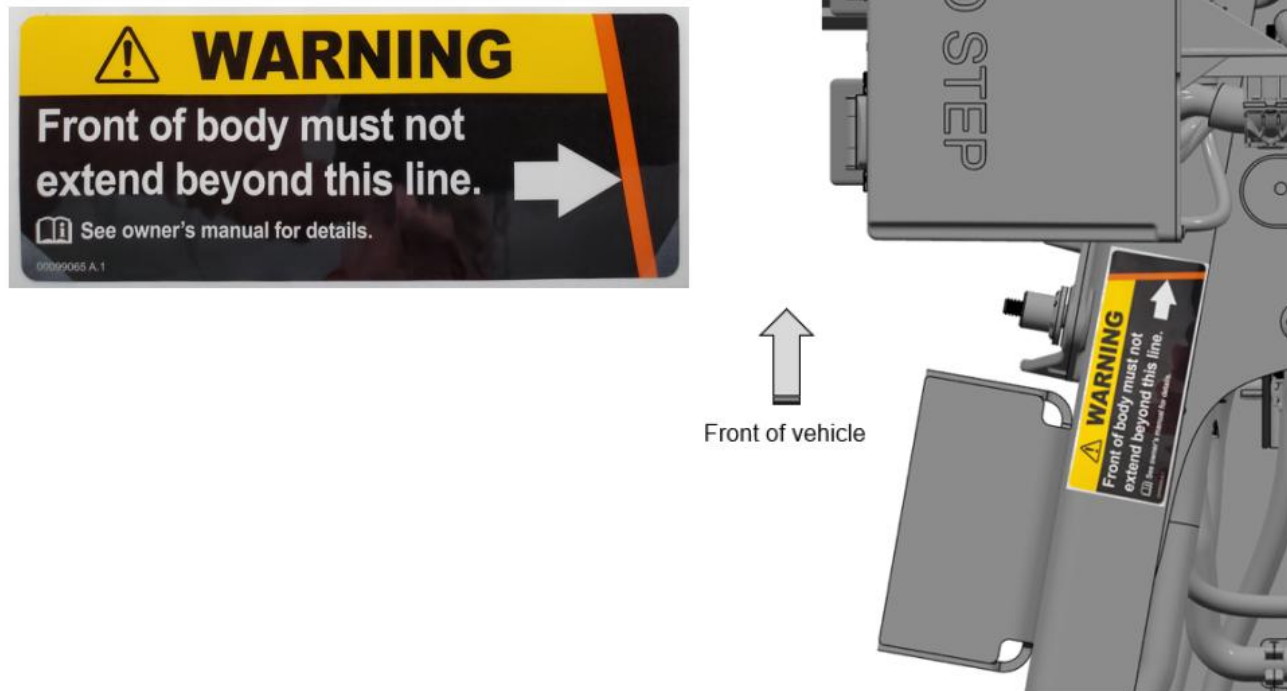


Figure 1

An upfitter must exercise caution when making modifications to vehicles. Any alterations should not damage or jeopardize the vehicle's safety, integrity, or functionality. Ensuring that the modifications adhere to manufacturer guidelines is crucial. Ultimately, all responsibility lies with the upfitter to ensure a safe and effective modifications have been made.

ePTO COOLING AND PLUMBING RECOMMENDATIONS - TERZO HYDRAPULSE EHSU (IF EQUIPPED)

For specific details please see the EHSU User Manual at terzopower.com

WARNING:

FAILURE OR IMPROPER SELECTION OR IMPROPER USE OF THE PRODUCTS AND/OR SYSTEMS DESCRIBED HEREIN OR RELATED ITEMS CAN CAUSE DEATH, PERSONAL INJURY AND PROPERTY DAMAGE.

WARNING:

THIS PRODUCT CAN EXPOSE YOU TO CHEMICALS INCLUDING LEAD, WHICH IS KNOWN TO THE STATE OF CALIFORNIA TO CAUSE CANCER. FOR MORE INFORMATION, VISIT WWW.P65WARNINGS.CA.GOV.

WARNING:

HIGH PRESSURE OIL CAN CAUSE SEVERE INJURY OR DEATH! DISCONNECT POWER AND RELIEVE PRESSURE PRIOR TO SERVICING THE HYDRAULIC EQUIPMENT.

WARNING:

DO NOT USE HANDS OR FINGERS TO FIND LEAKS. FLUID UNDER HIGH PRESSURE CAN BE INJECTED INTO SKIN CAUSING EXTREME INJURY AND SERIOUS INFECTION. USE A PIECE OF CARDBOARD TO LOCATE LEAKS. SMALL HIGH-PRESSURE JETS MAY BE HARD TO SEE. SPILLED HYDRAULIC OIL CAN CAUSE BURNS AND OTHER ACCIDENTS DUE TO SLIPPERY CONDITIONS AND CAN ALSO HARM THE ENVIRONMENT. TAKE CARE OF ALL SPILLED OIL AND HANDLE IT ACCORDING TO PROPER SAFETY AND ENVIRONMENTAL REGULATIONS. NEVER DISASSEMBLE HYDRAULIC COMPONENTS WHEN THE HYDRAULIC OIL IS HOT.

WARNING:

OPERATION OF THIS DEVICE INVOLVES HIGH VOLTAGE. EXTREME CARE MUST BE TAKEN TO AVOID INJURY.

ePTO Specifications

Terzo Hydrapulse ePTO specifications for Bollinger Motors B4:

Model	EHSU-2-105-650-U
Rated Voltage	650 Vdc
Rated Power	10kW (13.4 HP)
Rated Torque	21 N·m (15.5 ft·lbs) Continuous
Rated Torque	30 N·m (22.1 ft·lbs) Peak
Rated Current	17 A
IP Rating	67
Max Speed	3500 rpm
Operating Temp	-40° C to 85° C (-40° F to 185° F)
Storage Temp	-40° C to 125° C (-40° F to 257° F)
Weight	56 lbs. (25.4 kg)

Mounting Orientation

The Hydrapulse unit can be physically mounted in any orientation but depending on the pump type, reservoir location, other factors, it may be necessary to mount the unit in a specified position and/or direction. For mounting orientations that are not shown in each datasheet, please contact Terzo engineering prior to purchase with questions and application specifications.

Flooded Suction

It is always best practice to have any hydraulic pump installed with a flooded suction. While there are many applications that allow a non-flooded suction, it is always best to check with Terzo engineering support prior to system design or purchase.

Vibration Isolation

Vibration isolators for mounting of the Hydrapulse units are recommended but not required for standard mounting configurations. Terzo recommends a two-piece mounting isolators similar to the LORD CB-2200 Series.

Recommended Mechanical mounting hardware sizes for Terzo ePTO Frame Size 2, listed below.

Mounting Hardware	1/2"-13 UNC
SAE J428 Grade /SAE J1199 Class	8 / 10.9
Recommended Vibration Mount	Lord CB-2202-11 (Oil Resistant)

Fluid Compatibility

The Hydrapulse unit is compatible with most commercially available hydraulic fluids, steering fluids, and transmission fluids. When implementing any system with low viscosity or water-based fluids, consult the Terzo factory prior to operating any Hydrapulse unit.

Cooling - Terzo Low Pressure Return Technology

Terzo's low pressure return cooling technology allows a plug and play hydraulic power unit that does not require complex cooling via an external liquid cooling system, cooling fan, external fins, etc. Terzo uses the low pressure return oil from the hydraulic work function or valve bank to cool our motor and our electronics.

To cool the motor and electronics with potentially hot hydraulic oil, temperature is relative. The hot hydraulic oil is at a maximum around 60° C to 71° C (140°F to 160°F) which is still much cooler than what the Terzo electronics operate at. A normally operating hydraulic system will provide significant cooling to the Terzo power electronics and motor. This is one of the trade-offs for working in the harsh environment of fluid power.

Cooling fluid temperature fault is set to 85°C (185°F). Ideal cooling fluid temperature is below 60°C (140°F).

Regardless of what mode or application the Hydrapulse operates in, the motor and electronics are always automatically cooled with this integrated system.

Pressure on the cooling loop should be below 50psi (344.7 kPa or 3.45 Bars). If a cooler is required in the loop, it needs to be plumbed into the system before the cooling loop to reduce back pressure.

Plumbing

Caution: The Terzo unit is required to be plumbed to cool the internals and electronics of the unit, else ePTO failure will result, see Figure 1.

Terzo ePTO port thread size on unit is SAE ORB -12 or 1 1/16-12 Thread.

ORB fitting installation torque per SAE J1926-3:

1 1/6"-12 threads: 68 ft·lbs (92 N·m)

7/16"-20 threads: 15 ft·lbs (20 N·m)

Pump port thread size is manufacturer specific, Terzo offers different sizes, see Terzo for details.

Pressure Sensor Ports

SAE ORB -04 port 7/16-20 UNF-2B thread

Pump Mounting

SAE A spline 5/8" x 9T

SAE A 2-Bolt Flange

Before pump installation, grease shaft using molybdenum sulfide grease.

For pump installation, use 3/8"-16 grade 8 bolts and torque to 33 ft·lbs (45 N·m)

Terzo Pump Sizing recommendations

Recommended pump sizes using a CONTINUOUS ePTO torque of 21 N·m (15.5 ft·lbs)

Pump CC	Pump CIR	Max Pressure (PSI)	Max Pressure (BAR)	Min Flowrate (GPM)	Flow @ 2500 RPM (GPM)	Flow @ 2500 RPM (LPM)	Max Flowrate (GPM)	Max Flowrate (LPM)	Max RPM
4	0.244	4355	300	0.528	2.6	10.0	3.7	14.0	3500
5	0.305	3484	240	0.660	3.3	12.5	4.6	17.5	3500
6	0.366	2904	200	0.792	0.8	3.0	5.5	21.0	3500
7	0.427	2489	172	0.925	4.6	17.5	6.5	24.5	3500
8	0.500	2125	147	1.083	5.4	20.5	7.6	28.7	3500
9	0.549	1936	134	1.189	5.9	22.5	8.3	31.5	3500
10	0.610	1742	120	1.321	6.6	25.0	9.2	34.9	3500

Note: Continuous Torque rating assumes cooling fluid below 60c is being supplied to the cooling loop of the motor.

Recommended pump sizes using a PEAK ePTO torque of 30 N·m (22.1 ft·lbs)

Pump CC	Pump CIR	Max Pressure (PSI)	Max Pressure (BAR)	Min Flowrate (GPM)	Flow @ 2500 RPM (GPM)	Flow @ 2500 RPM (LPM)	Max Flowrate (GPM)	Max Flowrate (LPM)	Max RPM
4	0.244	6222	429	0.528	2.6	10.0	3.7	14.0	3500
5	0.305	4978	343	0.660	3.3	12.5	4.6	17.5	3500
6	0.366	4148	286	0.792	0.8	3.0	5.5	21.0	3500
7	0.427	3556	245	0.925	4.6	17.5	6.5	24.5	3500
8	0.488	3111	215	1.057	5.3	20.0	7.4	28.0	3500
9	0.549	2765	191	1.189	5.9	22.5	8.3	31.5	3500
10	0.610	2489	172	1.321	6.6	25.0	9.2	34.9	3500

Note: Duration at the peak torque range varies depending on cooling conditions and duty cycle, please consult the Terzo factory with any applications that will push the limits of the peak torque range.

ePTO Cooling Loop diagram

Note:

- Pump is not supplied with vehicle.
- Pump is specific per Upfitter application.
- Consult Terzo for application or system design details.

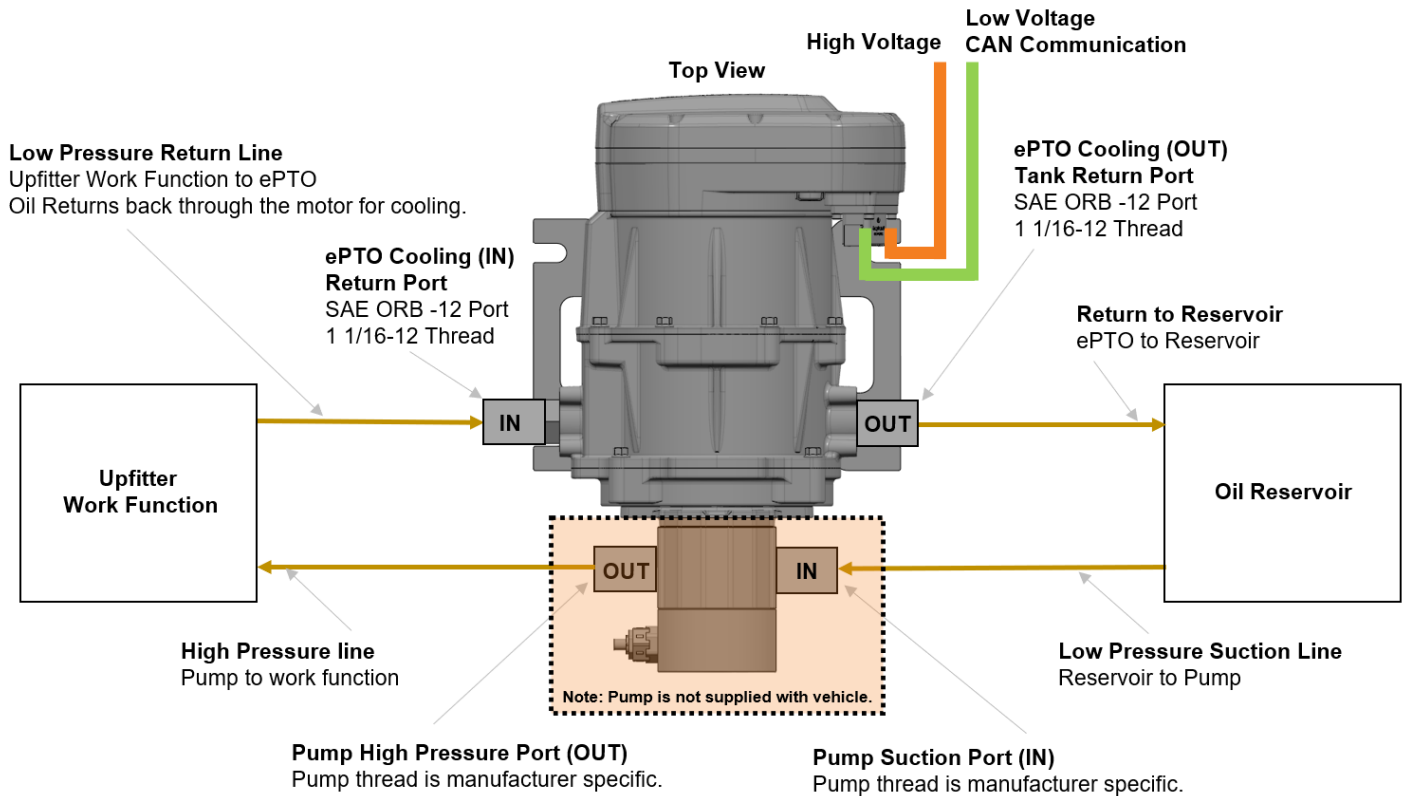
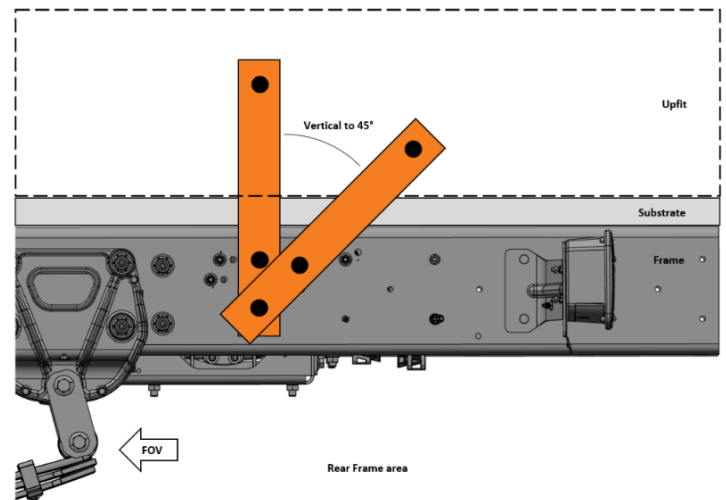
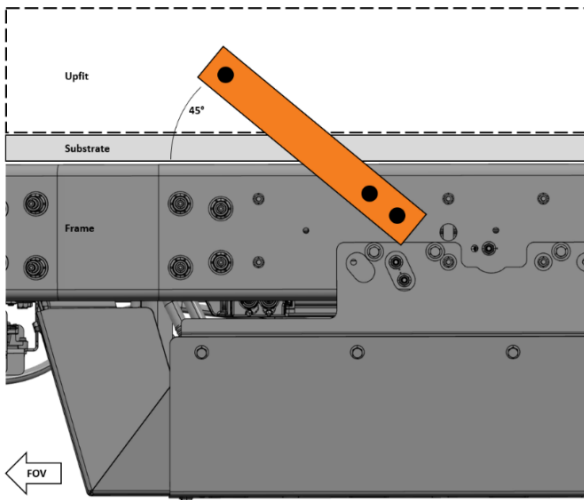
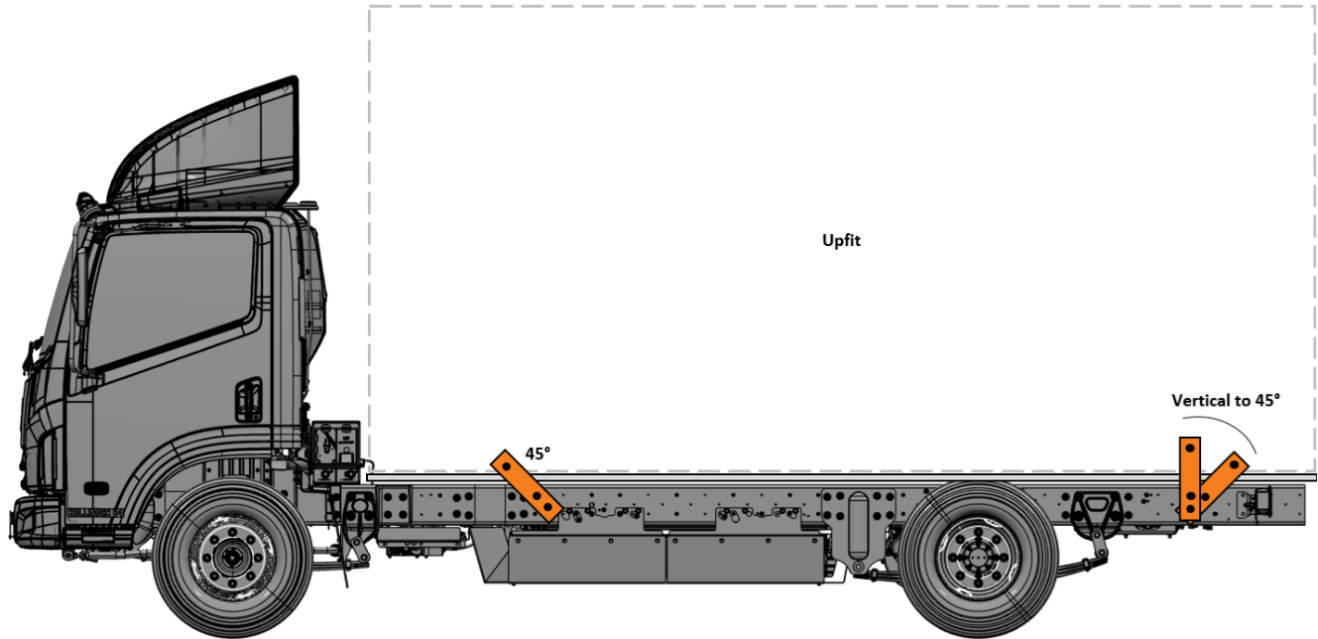


Fig. 1

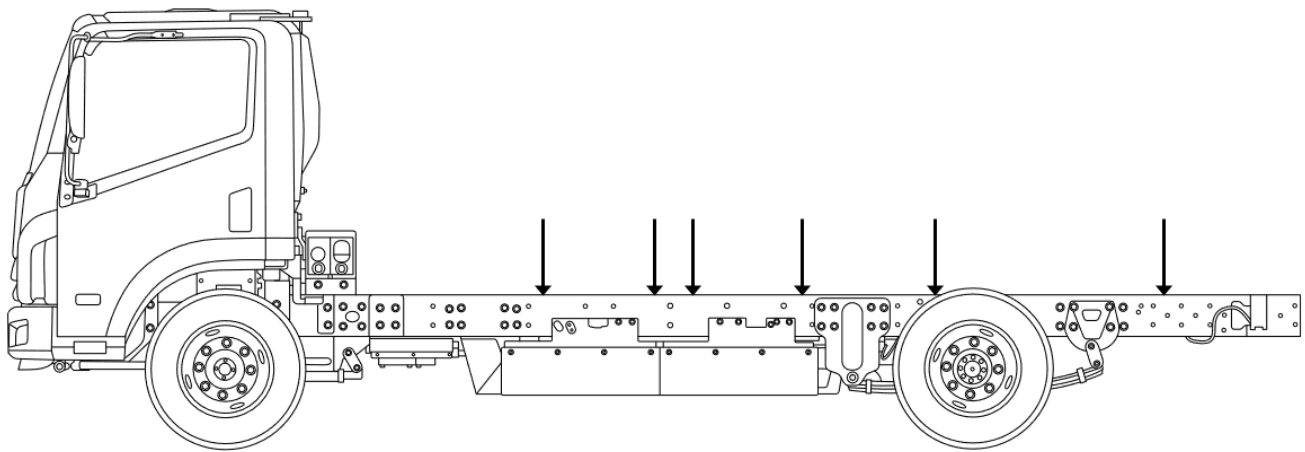
SHEAR PLATE INSTALLATION & USE

Note: When using shear plates use existing holes in the frame ensuring there is no interference between mounting bolts and HV Cabling, LV Harness, or Cooling Lines. See

If shear plates or straps are applied due to heavier load situation, then install front shear plates on a 45° angle with the top leaning forward in vehicle and the rear shear plates with the top leaning straight to leaning rearward at a 45° angle. Use a minimum of Grade 8, ½" diameter bolts. Install two bolts on the frame side and one bolt on the upfit side.



U-BOLT INSTALLATION & USE



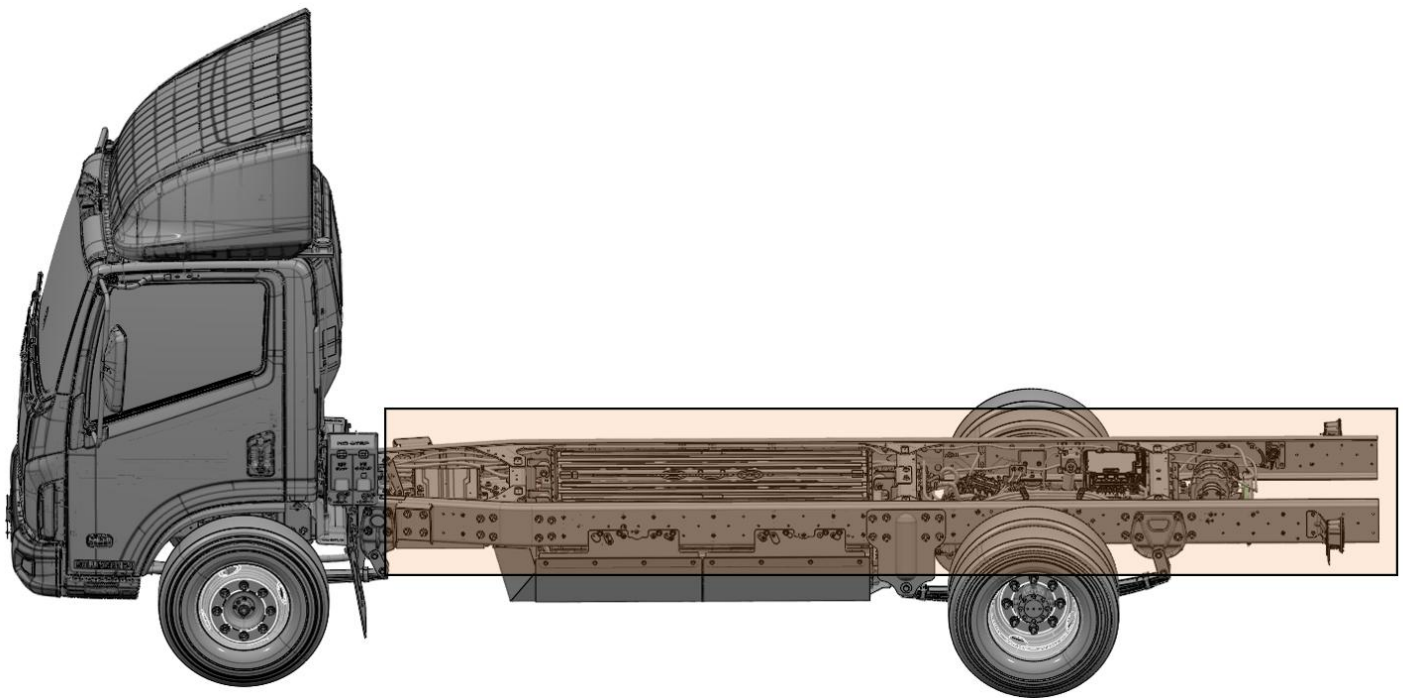
When using U-Bolts to attach a body structure, the points above are the only recommended positions for attachment.

OTHER UPFIT EQUIPMENT - FRAME MODIFICATIONS

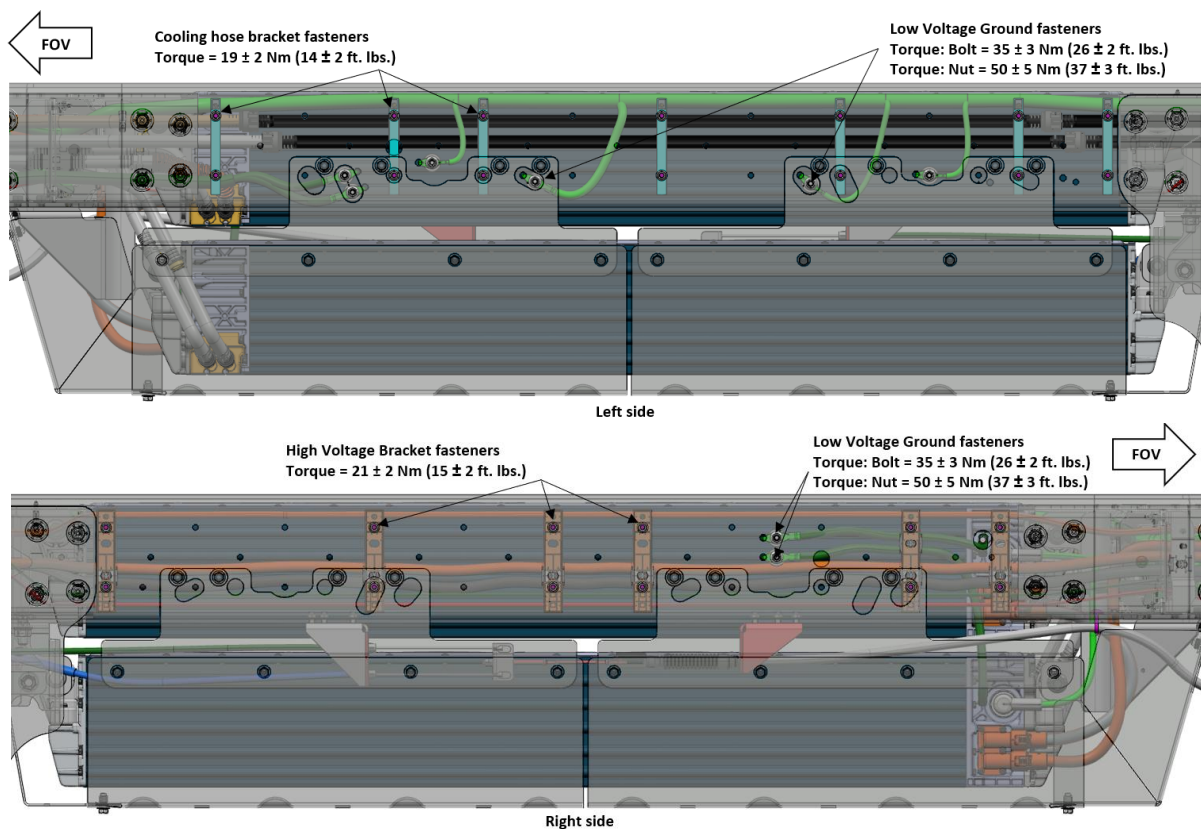
If installing additional Upfit equipment near the frame rails. It is required to remove the components without creating incidental damages with the intent to reuse the removed items in a production intent manner. Component brackets which are internal to the frame rails that are used to secure items such as cooling hose assemblies, brake lines, and High Voltage harness assemblies, Low Voltage harness assemblies, sensitive vehicle critical CAN Bus communication wiring assemblies, and low voltage grounding locations. By partially disassembling these components it will create additional access for the frame modifications and protect those items from potential damages during assembly. Retorque bracket fasteners to factory spec during reassembly.

Frame Area

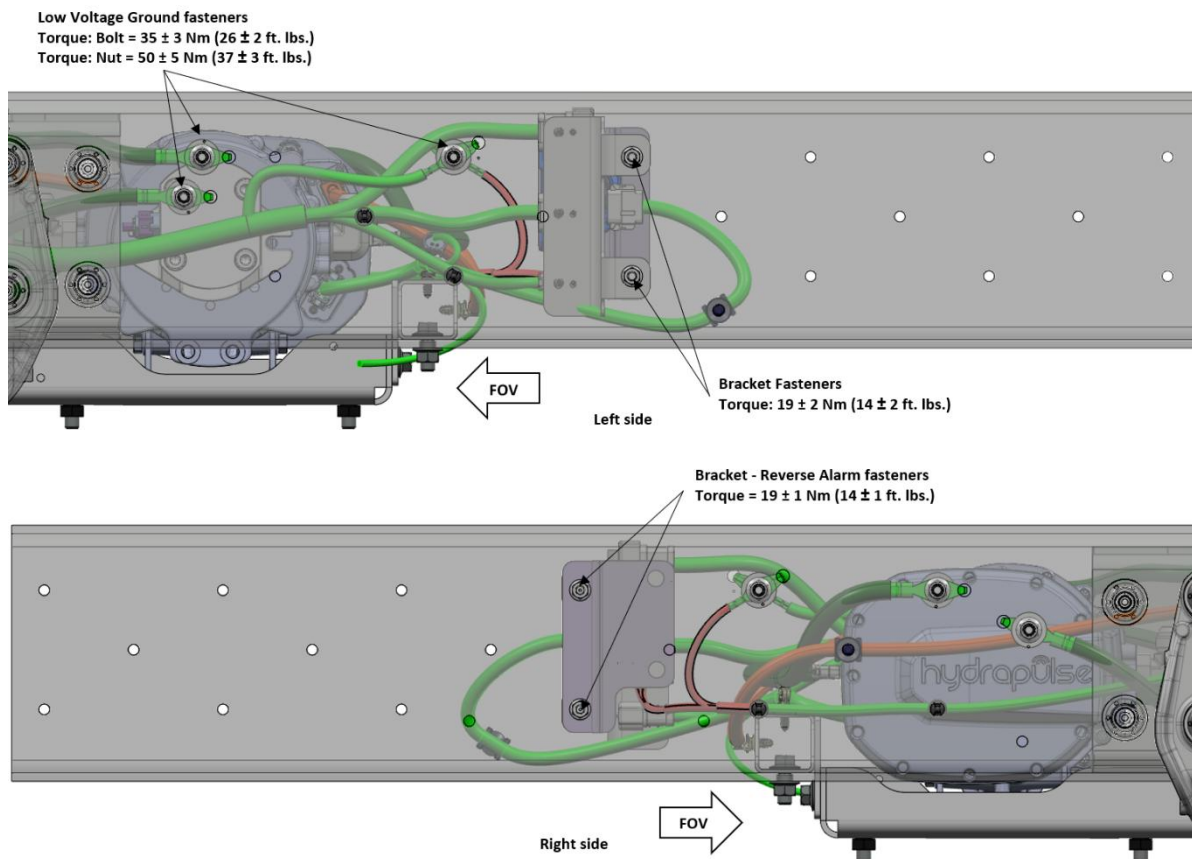
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FASTENER TORQUE VALUES - MIDDLE FRAME AREA



FASTENER TORQUE VALUES - REAR FRAME AREA



REAR OVERHANG MODIFICATION

If a body extends outward from the rear end of the chassis frame by 300 mm (11.8 in.) or more, lengthen the rear overhang of the chassis frame as indicated below.

If it is necessary to cut the chassis frame, ensure that the cut location does not split existing holes.

An extending example would be installing an 18' body on the B4 frame.

A shortening example would be installing a short landscaping bed with a beavertail ramp.

Warning: MODIFYING THE FRAME AT THE REAR OVERHANG

- THE FRAME EXTENSION IS DESIGNED TO MAINTAIN STRUCTURAL RIGIDITY AND PERFORMANCE.
- UPFITTERS MUST EXERCISE CAUTION TO AVOID ADVERSELY AFFECTING VEHICLE DYNAMICS.
- EXCESSIVE REAR EXTENSIONS COULD SIGNIFICANTLY UNLOAD THE FRONT END OF THE VEHICLE. THIS COULD AFFECT VEHICLE BRAKING, STEERING, AND HANDLING.
- REAR FRAME MUST BE LONG ENOUGH TO PROTECT VULNERABLE COMPONENTS, SUCH AS EPTO, IF EQUIPPED, AND BACKUP ALARM.
- REAR FRAME MUST BE SHORT ENOUGH TO AVOID A NEGATIVE EFFECT ON APPROACH, DEPARTURE, AND BRAKE-OVER ANGLES.

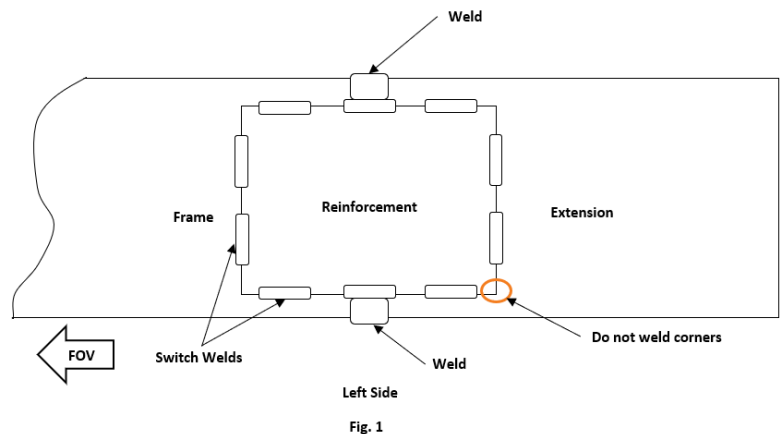
FRAME EXTENSION RECOMMENDATIONS

When it is necessary to add a frame extension to the Bollinger Motor B4 please follow these suggestions:

- Disconnect the 12V battery leads.
- Clean contaminants off the back portion of the frame.
- Protect surrounding components from welding sparks and splatter.
- Extensions and reinforcements should be made of matching steel, see Table 1 for B4 Frame Material Specifications.
- Chamfer both the back of the frame and the end of the extensions to be welded.
- Connect the welding ground cable to the frame closest to the extension weld as possible.
- Clamp the extension into place and weld around the top and sides, but not the lower flange, following normal welding practices.
- Grind the outer side of the vertical frame web down smooth, clamp on a reinforcement section and skip weld to the frame and extension, see figure 1.
- Do not weld at the corners of the reinforcement to minimize stress concentrations, see figure 1.
- The reinforcement can be combined with a rear shear plate, in which case the reinforcement would be an "L" shape to pick up the added attachment points to the Upfit.
- Apply a suitable protective primer and paint to any modified surface after modification.



Left frame extension – Outboard View



FRAME MATERIAL SPECS OF EXTENSION MATERIAL

- The extension material should be equivalent to the frame rails material with similar frame construction sections and metal thickness, as well as similar material properties, such as yield strength, section modulus, and resisting bending moment.

Table 1: B4 Frame Material Specifications	
Dimensions	72mm x 218mm C-Channel
Thickness	7.14mm
Inner Radius	11mm
Frame yield strength (σ_y)	72,000 psi
Frame section modulus (S)	8.56 cu.in.
Resisting Bending Moment (RBM)	658,007 in.lb.

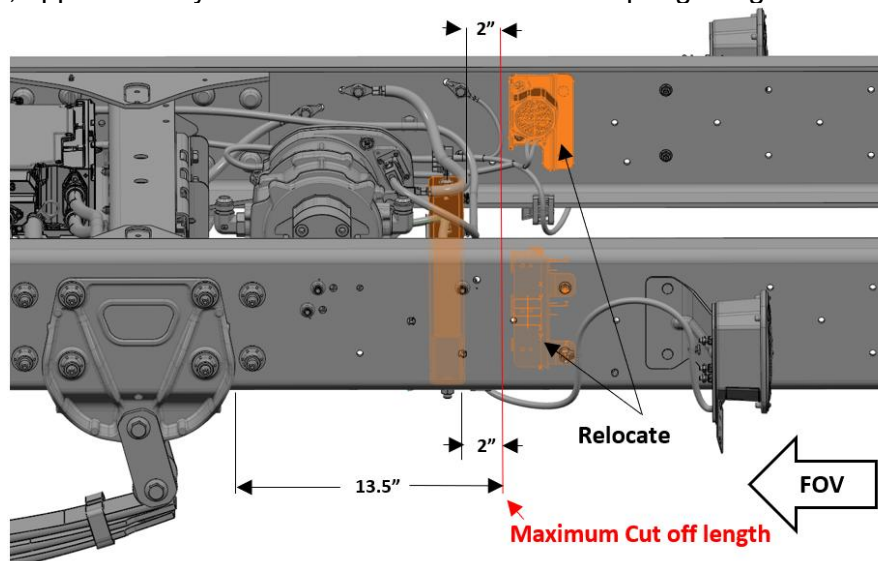
INSTALLING EXTENSION MATERIAL

- If the extension material is 300mm or shorter:
 - Join extension material and chassis frame with a continuous butt weld around the entire perimeter.
 - After welding, grind finish weld surface.
 - Apply a suitable protective primer and paint to any modified surface after modification.
- If the extension material is longer than 300mm:
 - Join extension material and chassis frame with a continuous butt weld around the entire circumference.
 - After welding, grind finish weld surface.
 - Then fit a reinforcement plate to the chassis frame and extension material, you may also include a shear plate addition in the reinforcement
 - Apply a suitable protective primer and paint to any modified surface after modification.

REAR FRAME OVERHANG SHORTENING

With ePTO:

- Do not use a torch to cut frame.
- Cut only with an abrasive cutting wheel, portable bandsaw, reciprocating saw, or cutting blade to reduce the heat effects on the frame.
- Proper relocation of electrical grounds and reverse speaker and bracket is a mandatory.
- Apply paint to any modified surface after modification.
- The Rear overhang area of the frame can be shortened to 2 inches rearward of the rear most ePTO support beam, approximately 13.5" rearward of the rear leaf spring hanger.



Without ePTO:

- Do not use a torch to cut frame.
- Cut only with an abrasive cutting wheel, portable bandsaw, reciprocating saw, or cutting blade to reduce the heat effects on the frame.
- Proper relocation of electrical grounds and reverse speaker and bracket is a mandatory.
- Apply paint to any modified surface after modification.
- The Rear overhang area of the frame can be shortened to 2 inches rearward of the rear most crossmember radius bracket as it connects to the outer frame rail, which is approximately 4.5" rearward of the rear leaf spring hanger.

