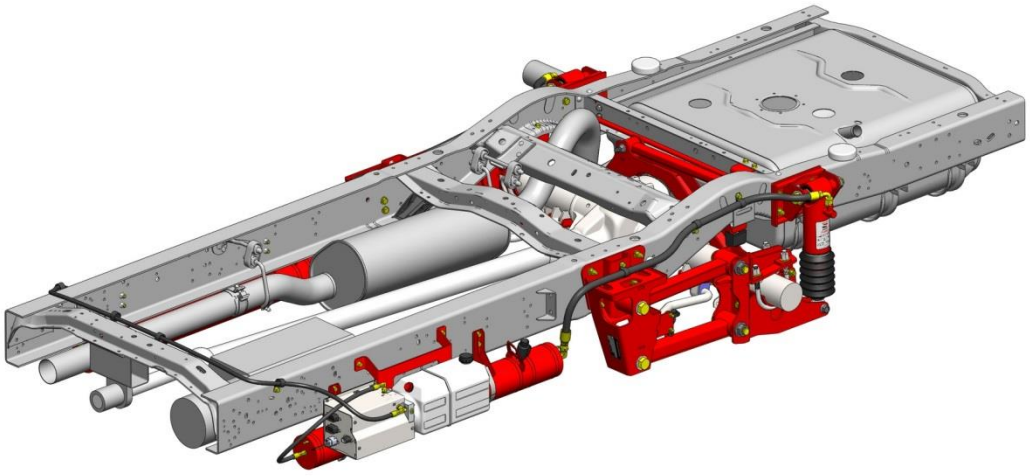
DS96F

DS96F-A
DS96F-B2

Rear Axle Suspension System
for Ford E450



LIQUIDSPRING™ LLC

Installation / Maintenance Manual

D10897 Rev V 12/2018

Contents

Introduction

This manual provides installation information for the LiquidSpring **CLASS**® DS96F series of rear axle suspension systems for the Ford E450 Cutaway Chassis.

Before you begin installation of the suspension system:

1. Read and understand all instructions and procedures prior to installation of components.
2. Read and observe all Warning and Caution hazard alert messages in this publication. They provide information that can help prevent serious personal injury, damage to components, or both.
3. Follow your company's maintenance and service, installation, and diagnostics guidelines.
4. Use special tools when required to help avoid serious personal injury and damage to components.

Throughout this manual, important product information is preceded by the terms "NOTE", "IMPORTANT", "CAUTION", and "WARNING". These terms are defined as follows:

NOTE: Includes additional information to enable accurate and easy performance of procedures.

IMPORTANT: Includes additional information that if not followed could lead to hindered product performance and/or product failure.

CAUTION: A caution indicates procedures that must be followed exactly. Damage to equipment or suspension components and personal injury can occur if the procedure is not followed.

WARNING: A warning indicates procedures that must be followed exactly. Serious personal injury can occur if the procedure is not followed.

LiquidSpring LLC reserves the right to modify the suspension and/or procedures and to change specifications at any time without notice and without incurring obligation.

Suspension Rating

The LiquidSpring DS96F suspension is rated for **9600 lbs.**

WARNING: Overloading suspension system may result in abnormal handling characteristics and premature wear of components.

Serial Number Tag Information

The serial number is found on an aluminum tag that is riveted to the Left Hand Suspension Hanger as shown in Figure 1. This information will aid you when contacting the chassis manufacturer or LiquidSpring LLC.

Figure 1. Suspension Identification

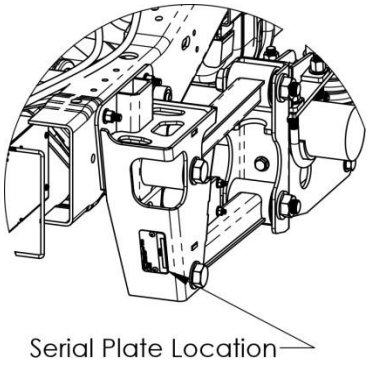


Figure 2. Serial Number Tag Location

Vehicle Towing and Jacking Information

Before attempting any type of towing procedures, the OEM/Coach Builder must be referred to for the recommended towing methods.

NOTE: Before towing vehicle, check with local authorities, such as Department of Transportation, for permissible towing methods. Some states do not permit towing vehicles by chains or towing straps.

Do not attach tow apparatus (hooks, chains, straps, etc.) to the suspension components.

WARNING: Attaching towing equipment to improper locations and failure to utilize OEM/Coach Builder recommended towing methods could result in one or more of the following:

Damage to the suspension and/or vehicle,

Loss of vehicle control,

Possible disconnect from the vehicle.

WARNING: Do not apply jack to bottom of front hanger or other suspension components. Appling a jack to improper locations can result in damage to the suspension and/or vehicle and severe personal injury

Torque Specifications

Most of the fasteners used in this suspension are graded fasteners. These fasteners have the strength and hardness properties required for their particular function. If replaced, they must be replaced with fasteners of the same grade, size, and form as the original in order to prevent failure.

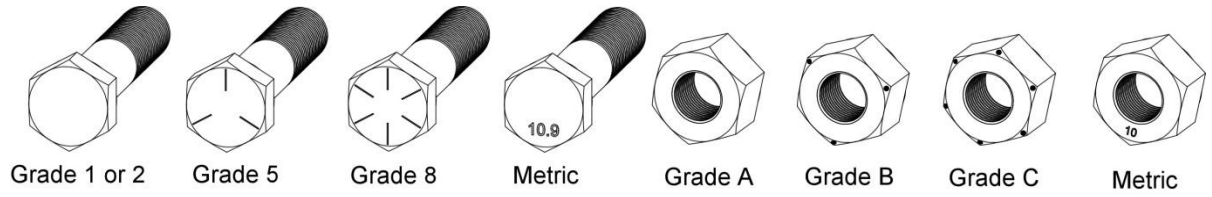


Figure 3. Identification of fastener grades.

Description	Size	Grade	Torque Specification	
			Lb-ft	Nm
Axle clamp attachment nuts	1/2”-13	C	85-105	115-142
Axle clamp u-bolt nuts	5/8”-18	8	175-200	237-271
Bleed Screws	3/8-24	N/A	13-18	1-2
Control arm attachment nuts	1”-8	G	600	815
Cross-member reinforcement bolts	1/2”-13	8	85-105	115-142
Front hanger mounting nuts	1/2”-13	C	85-105	115-142
Height sensor linkage ball stud nuts	5/16”-18	C	14-17	19-23
Height sensor mount nuts	5/16”-18	C	14-17	19-23
Hose Connections, -10	7/8-14	N/A	36-63	4-7
Hose Connections, -4	7/16-20	N/A	12	1
Jounce bumper attachment bolts	M10-1.5	10.9	25-35	34-47
Lower strut mount nuts	5/8”-11	C	175-200	237-271
Power module attaching u-bolt nuts (DS96F-M and DS96F-A)	1/4”-20	2	60-85 in-lbs	7-10
Power module frame bracket to frame nuts (DS96F-B2)	3/8”-16	G	35-43	47-61
Power module mount bracket to frame bracket (DS96F-B2)	3/8”-16	G	35-45	47-61
Power module mount bracket to reservoir	#10-16	N/A	Snug only	Snug only
Power module mounting bracket to pump head manifold	3/8”-16	8	35-43	47-61
Replacement cross-member button head cap screw	M12-1.75	10.9	75-92	102-125
Secondary volume mount clamps	5/16”-24	N/A	240 in-lbs	27
Secondary volume mount nuts	3/8”-16	C	35-43	47-58
Steering sensor attachment screws	#8-18	n/a	9 in-lbs	1
Track rod attachment nuts	5/8”-11	C	175-200	237-271
Track rod mount to axle bolts	M10-1.5	10.9	25-35	34-47
Track rod mount to frame nuts	3/8”-16	C	35-45	47-61
Upper strut mount nuts	1/2”-13	C	85-105	115-142
Upper strut mount nuts	1”-8	C	600	815

Hydraulic Fitting Assembly

SAE O-Ring Adjustable Fittings

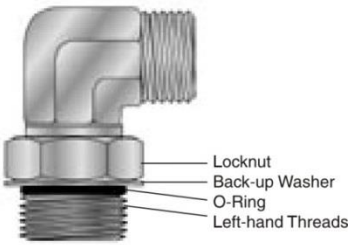


Figure 4. Adjustable SAE fitting

1. Inspect components to ensure that male and female port threads and sealing surfaces are free of burrs, nicks and scratches, or any foreign material.
2. If O-ring or seal is not pre-installed to fitting male port end, install proper size O-ring or seal, taking care not to damage it.
3. Lubricate O-ring with light coat of the system fluid or a compatible lubricant to help the O-ring slide smoothly into the port and avoid damage.

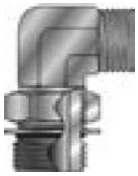


Figure 5. Locknut completely backed off.

4. Back off lock nut as far as possible. Make sure back-up washer is not loose and is pushed up as far as possible.
5. Screw fitting into port until the back-up washer or the retaining ring contacts face of the port. Light wrenching may be necessary. Over tightening may damage washer.
6. To align the tube end of the fitting to accept incoming hose assembly, unscrew the fitting by the required amount, but not more than one full turn.
7. Using two wrenches, hold fitting in desired position and tighten locknut to the proper torque value:
   -4 fitting: **14-16 ft-lbs (168-192 in-lbs)**
   -12 fitting: **75-83 ft-lbs.**
8. Inspect to ensure that O-ring is not pinched and that washer is seated flat on face of port.

SAE O-Ring Non-Adjustable Fitting

1. Inspect components to ensure that male and female port threads and sealing surfaces are free of burrs, nicks and scratches, or any foreign material.
2. If O-ring or seal is not pre-installed to fitting male port end, install proper size O-ring or seal, taking care not to damage it.
3. Lubricate O-ring with light coat of the system fluid or a compatible lubricant to help the O-ring slide smoothly into the port and avoid damage.
4. Screw fitting into port and tighten to proper torque:
   -4 fitting: **26-28 ft-lbs (310-341 in-lbs)**
   -12 fitting: **75-83 ft-lbs.**

JIC 37° Fitting

1. Inspect components to ensure that male and female threads and sealing surfaces are free of burrs, nicks and scratches, or any foreign material. Annular tool marks of 100µin with the thread are permissible.
2. Lubricate the threads and the entire surface of the cone with system fluid.
3. Align mating components for hand connection and turn flare nut until sealing surfaces make full contact.
4. Using two wrenches, hold fitting in desired position and tighten to the proper torque:

-4 fitting: **9-12 ft-lbs**	-10 fitting: **36-63 ft-lbs**
-8 fitting: **27-39 ft-lbs**	-12 fitting: **65-88 ft-lbs**

Pre-Installation

1. Check the vehicle wheel alignment prior to installation to insure pre-existing conditions do not exist.
2. It is suggested, but not required, to remove the attached body to ease installation.
3. A chassis lift can be used in assistance of the installation of the suspension system.
4. Measure and record the wheelbase and tire-to-frame dimensions on each side prior to disassembly.

Frame Preparation

1. Chock the front tires.
2. Jack up the rear frame of the vehicle to remove the load from the rear leaf springs.
3. Place jack stands under the frame and block the rear tires from moving.

Note: Jack stands can be placed under the axle and the tires removed for ease of access. It is recommended to place an additional jack stand under the pinion to prevent the axle from rotating.

4. Remove the OEM shock absorbers.
5. Remove the OEM leaf springs and rear shackles.
6. Remove the front leaf hanger and rear leaf shackle hanger brackets. The rivets can be removed by

grinding, air chiseling, or torching off the heads. Then use a hammer and punch to remove the remainder of the rivet. See Figure 6.

7. Drill out the six (6) front hanger mount holes to Ø.531" (17/32") on each side.

   Note: 2011 and prior model years have (4) holes.

8. Remove the lower outboard rivet from the aft of axle cross-member's lower only location. See Figure 7.

CAUTION: Do not remove the upper side rivet or top flange rivets on the cross-member.

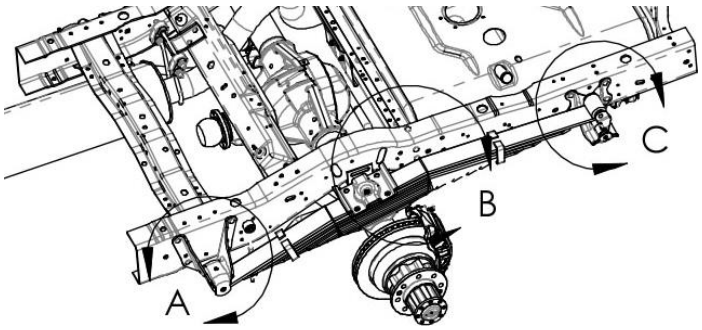
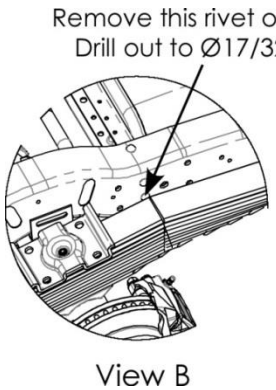


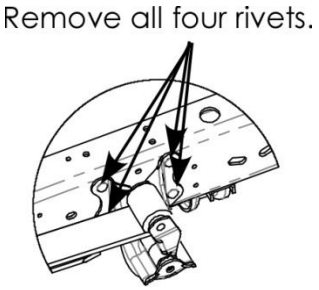
Figure 6. Rivet removal locations. Driver side shown. Remove rivets on passenger side also.

View A



View B

Note: Clamp cross member flange to frame prior to drilling to prevent flange distortion.



View C

Figure 7. Rivet removal details

9. Drill out the rivet hole to Ø.531" (17/32") if necessary.

10. Drill out the three (3) indicated holes on the top and bottom flanges of the aft of axle cross-member to Ø.406" (13/32"). See Figure 8.

11. Remove the OEM Axle Stop Bumpers from under the frame. Do not discard the bumpers or brackets.

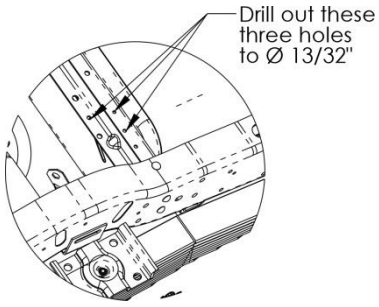


Figure 8. Cross-member drill holes

12. Locate the frame drilling template and place it along the driver side frame as shown in Figure 9.

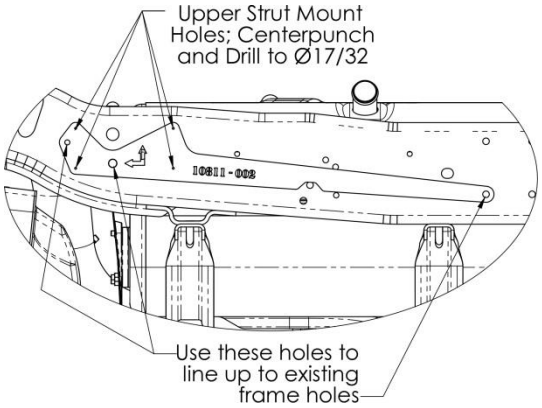


Figure 9. Frame Drilling Template Driver Side Location

13. Center punch, mark, or drill with 1/8" bit the holes indicated in Figure 9.

14. Remove the template and drill the marked holes to Ø17/32".

15. Place the template along the passenger side as shown in Figure 10.

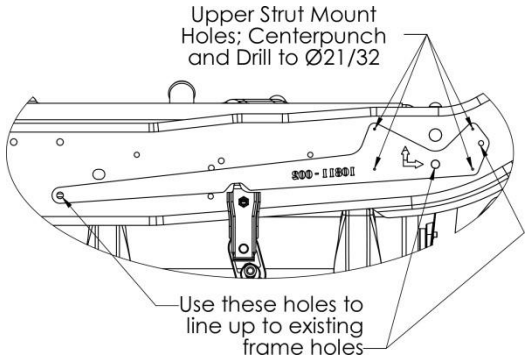


Figure 10. Frame Drilling Template Passenger Side Location

16. Center punch, mark, or drill with 1/8" bit the holes indicated in Figure 10.
17. Remove the template and drill the marked holes to Ø17/32".

Note: See *Secondary Volumes* section, page 11, for additional frame drill hole requirements.

Installation

Front Hangers

1. Locate the Front Hangers.
2. Install the Left Hand Front Hanger (with the serial tag) on to the drivers side of the frame, using the (6) 1/2-13 x 1.25 Hex Flange Bolts and (6) 1/2-13 Locking Flang Nuts.

   Note: 2011 and previous model years use only (4) four sets of fasteners.
3. Verify that the top of the hanger is parallel with the top of the frame.

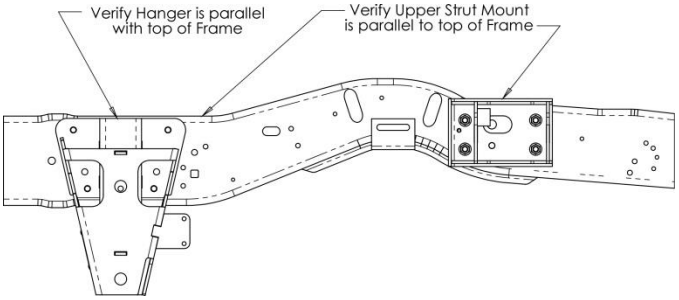


Figure 11. Verify Components level with frame.

4. Torque nuts to **85 – 105 ft-lbs.**
5. Repeat Step 2 for the Right Hand Front Hanger (without the serial tag) on to the passenger side of the frame.
6. Torque nuts to **85 – 105 ft-lbs.**
7. Remove Lower factory cross-member bolt. Replace bolt with Button Head Cap Screw M12-1.75x35. Torque to **75-92 ft-lbs.** See Figure 12.

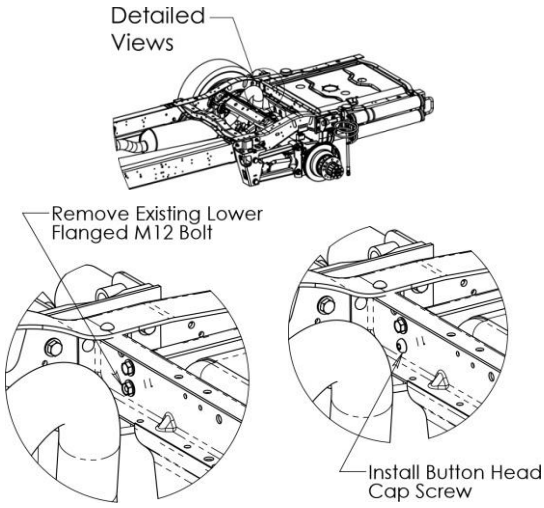


Figure 12. Cross-member bolt replacement

8. Locate (2) 3/8-16 x 1.00 Hex Flange Bolts.
9. Place the bolts in the lower holes of the aft of axle cross-member. See Figure 13.

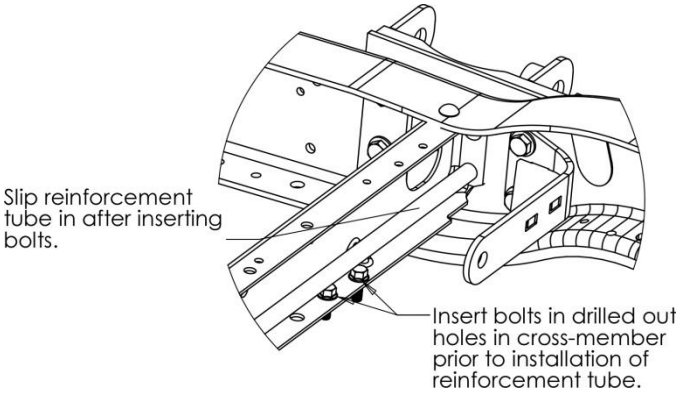


Figure 13. Track bar mount attachment bolts.

10. Place the Cross-member Reinforcement Tube inside the cross-member channel, on top of the two bolts inserted in the previous step. Do NOT fasten at this time.

    NOTE: Cross-member Reinforcement Tube must be put in place, but not fastened, before Track Rod Mount.

Upper Strut Mounts

1. Locate the Left Hand Upper Strut Mount, the Backing Plate, and the Track Rod Mount Weldment and loosely attach the components to the Drivers Side of frame, as shown in Figure 14, with the (4) 1/2-13 x 1.75 Hex Flange Bolts and (4) 1/2-13 Locking Flange Nuts.

CAUTION: The end of the Backing Plate with the hole closest is oriented up.

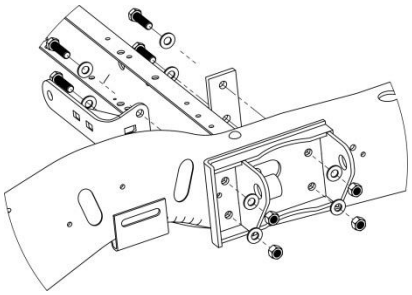


Figure 14. LH Upper Strut Mount Installation

2. Verify that the Upper Strut Mount is parallel to the top of the frame (see Figure 11).
3. Loosely install the Cross-member Reinforcement Tube as shown in Figure 16using the (1) 1/2-13 x 1.75 Hex Flange Bolt and the (1) Wedge Lock Washers.
4. Torque the rear two (2) 1/2-13 fasteners to **85-105 ft-lbs**.

   Note: Due to tight clearances around the driver side frame rail and the fuel tank, it is recommended to install and tighten the rear two (2) 1/2-13 fasteners prior to installing the front two (2) fasteners and the track rod mount.
5. Locate the Right Hand Upper Strut Mount and the Backing Plate and loosely attach the components to the Passenger Side of frame, as shown in Figure 15, with the (4) 1/2-13 x 1.75 Hex Flange Bolts and (4) 1/2-13 Lock Nuts.

CAUTION: The end of the Backing Plate with the hole closest is oriented up.

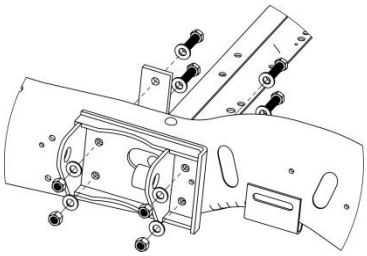


Figure 15. RH Upper Strut Mount Installation

6. Verify that the Upper Strut Mount is parallel to the top of the frame (see Figure 11).
7. Loosely install the Cross-member Reinforcement Tube as shown in Figure 13 using the (1) 1/2-13 x 1.75 Hex Flange Bolt and the (1) Wedge Lock Washers.
8. Torque the 1/2" fasteners to **85-105 ft-lbs**. To tighten the Cross-member Reinforcement Tube, hold the tube by hand until the fasteners on each side are snugged up. Then retain the bolt head on one side while applying torque to the opposite side.
9. Locate the Track Rod Mount and loosely attach to the aft of axle cross-member using the (4) 3/8-16 x 1.00 Hex Flange Bolts, two of which are already inserted in the cross-member and (4) 3/8-16 Locking Flange Nuts. See Figure 16.

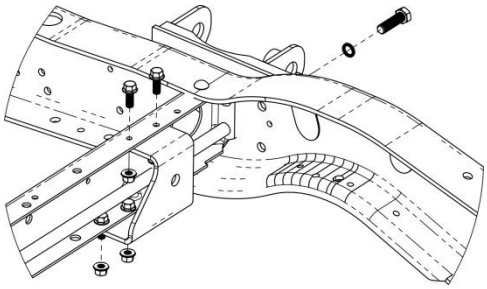


Figure 16. Track rod mount attachment. Some components not shown for clarity.

10. Torque the 3/8" fasteners to **35-45 ft-lbs.**

Jounce Bumpers

1. Locate (1) Bump Stop Spacer (1) M10 Coupler, and (1) M10-1.5 x 50mm Hex Flange Bolt.
2. Attach the Driver Side OEM Axle Stop Bumper to the Bump Stop Spacer using the M10 Coupler. Snug tight the coupler to the Bumper.

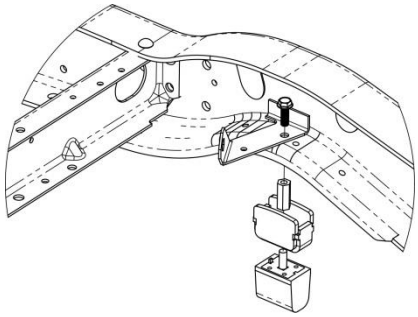


Figure 17. Jounce stop installation.

3. Slip the Spacer and Bumper assembly under the frame and reattach to the Driver Side frame and brake bracket using the M10-1.5 x 50mm Hex Flange Bolt. Torque to **25-30 ft-lbs.** See Figure 17.
4. Locate (1) Bump Stop Spacer, (1) M10 Coupler, and (1) M10-1.5 x 50mm Hex Flange Bolt.
5. Attach the Passenger Side OEM Axle Stop Bumper to the Bump Stop Spacer using the M10 Coupler. Snug tight the coupler to the Bumper.
6. Slip the Spacer and Bumper assembly under the frame and reattach to the Passenger Side frame using the M10-1.5 x 50mm Hex Flange Bolt. Torque to **25-30 ft-lbs.**

Axle Clamp Hangers

1. Locate the Left Hand Axle Seat Weldment, Axle Cradle, and 5/8" U-Bolts.

2. Place the Axle Seat on to the Drivers Side axle spring seat. The Axle Seat should be flush to the top of the axle spring seat with the locating pin in the center hole.

3. Place the Axle Cradle under the axle tube and loosely attach to the Axle Seat using the (1) 1/2 -13 x 3.25 Hex Flange Bolt and (1) 1/2-13 Locking Flange Nut at the rear connection point. Use (2) 1/2-13 x 1.25 Hex Flange Bolts and (2) 1/2-13 Locking Flange Nuts at the front connection point. See Figure 18.

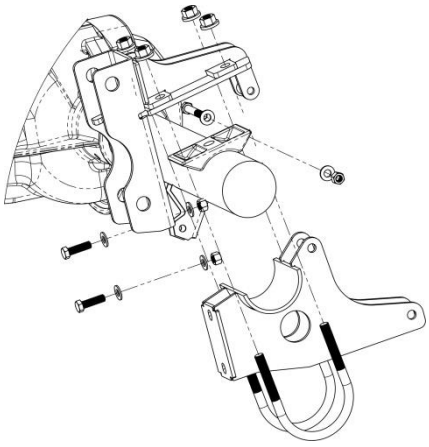


Figure 18. Axle Clamp assembly

4. Slip the 5/8" U-bolts into position. **Torque, the U-bolt nuts evenly in an X-type pattern in 5 stages:**

   - **Stage 1: Torque to 37 ft-lbs.**
   - **Stage 2: Torque to 75 ft-lbs.**
   - **Stage 3: Torque to 110 ft-lbs.**
   - **Stage 4: Torque to 150 ft-lbs.**
   - **Stage 5: Torque to 175-200 ft-lbs.**

5. Torque the 1/2" Fasteners to **85-105 ft-lbs.**

6. Repeat for other side.

Control Arms

1. Locate (1) Upper Control Arm Assembly and (1) Left Hand (Driver Side) Lower Control Arm Assembly. See Figure 17 for lower control arm identification.

2. Install the control arms between the driver side front hanger and axle hangers loosely with (4) 1"-8 x 5.50" Hex Cap Screws, (4) 1" Hardened Flat Washers, and (4) 1"-8 Locking Flange Nuts. See Figure 19.

   Note: Orientate the lower control arm with the height sensor linkage tab inboard and closer to the front hanger.

   IMPORTANT: Bolts inserted into the front hanger must point inboard (towards the frame). Bolts inserted at the axle hanger must point outboard (towards tire). Orienting the bolts incorrectly may result in damage to the frame rail.

3. Locate (1) Upper Control Arm Assembly and (1) Right Hand (Passenger Side) Lower Control Arm Assembly.

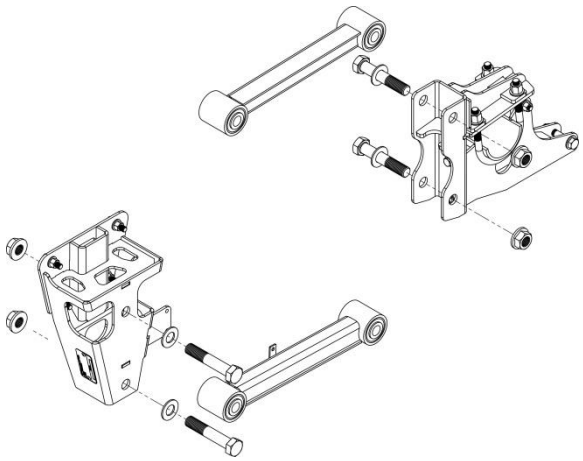


Figure 19. Control Arm installation. Driver side shown.

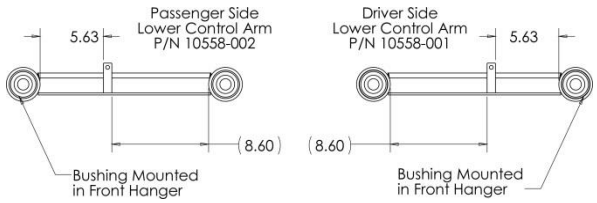


Figure 20. Lower Control Arm identification.

4. Install the control arms between the driver side front hanger and axle hangers loosely with (4) 1"-8 x 5.50" Hex Cap Screws, (4) 1" Hardened Flat Washers, and (4) 1"-8 Locking Flange Nuts.

   Note: Orientate the lower control arm with the height sensor linkage tab inboard and closest to the front hanger.

   IMPORTANT: Bolts inserted into the front hanger must point inboard (towards the frame). Bolts inserted at the axle hanger must point outboard (towards tire). Orienting the bolts incorrectly may result in damage to the frame rail.

Track Rod and Mount

1. Loosen and detach the sway bar and sway bar bushing from the axle. Do not remove bushings from sway bar.

2. Locate the Track Rod Mount Bridge.

3. Slip the Track Rod Mount Bridge on to the axle from the rear of the axle.

4. Loosely reattach the swaybar and sway bar bushings to the bottom of the Track Rod Mount Bridge and axle using the (4) M10-1.5 x 40mm Hex Flange Bolts and (4) M10 Fender Washers. Reuse the OEM Lock Nuts. See Figure 21.

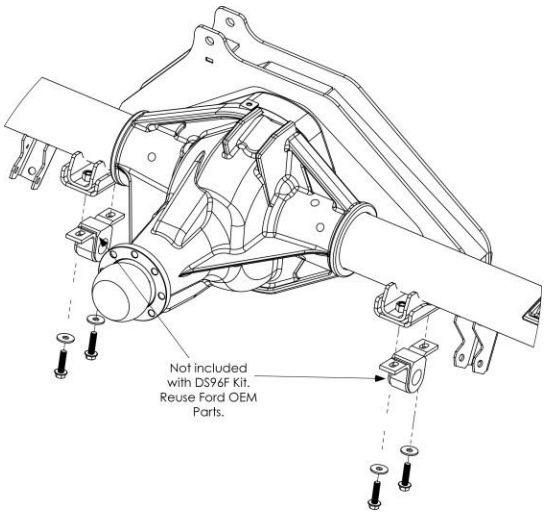


Figure 21. Track Rod Mount Bridge installation.

5. Locate the Track Bar.
6. Loosely attach the Track Bar to the Track Rod Mount Bridge and the frame attached Track Rod Mount using (2) 5/8”-11 x 4.00” Hex Flange Screws and (2) 5/8”-11 Locking Hex Flange Nuts.
7. Jack each side of the axle until approximately design ride height position. See Figure 22 and Figure 23.

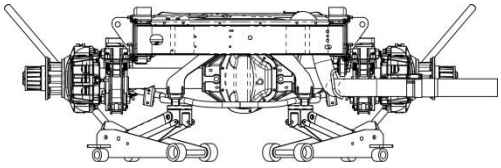


Figure 22. Jack under rear axle

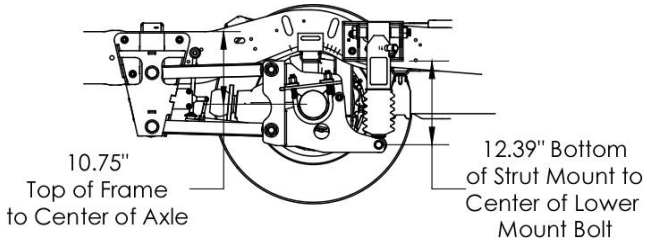


Figure 23. Design Ride Height

8. Slide the Track Rod Mount Bridge side to side, on the axle, until the mount bridge is centered on the axle.
9. Tighten the four (4) M10 Bridge mounting bolts to the axle. Torque to **25-35 ft-lbs.**
10. Torque the two (2) 5/8” Track Rod mounting bolts to **175-200 ft-lbs.**
11. Torque the eight (8) 1” Control Arm mounting bolts to **600 ft-lbs.**

Strut Assembly Installation

Note: Lowering the axle will ease installation of the Strut Assemblies.

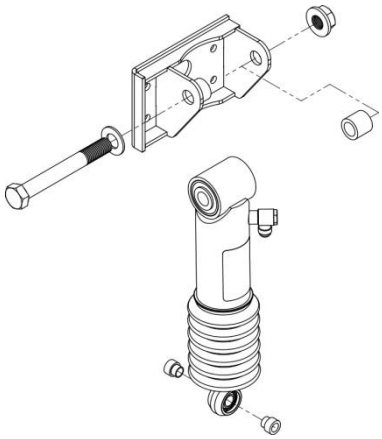


Figure 24. Strut Mount Spacer Orientation

1. Locate the Left Hand Strut Assembly and spacer.
2. Loosely attach the Strut Assembly and spacer to the Driver Side Upper Strut Mount using the 1”-8 x 8.00” Hex Bolt, 1” Hardened Flat Washer, and 1”-8 Locking Flange Nut. See Figure 24.
3. Locate the Right Hand Strut Assembly and spacer.
4. Loosely attach the Strut Assembly and spacer to the Passenger Side Upper Strut Mount using the 1”-8 x 8.00” Hex Bolt, 1” Hardened Flat Washer, and 1”-8 Locking Flange Nut.
5. Locate the Bearing Spacers and insert them into the Strut lower mount bearings on both sides of the vehicle.
6. Raise the axle until the lower strut bearings can be attached to the Axle Cradle lower strut mount using the 5/8”-11 x 3.50” Hex Flange Screw and 5/8”-11 Locking Hex Flange Nut.
7. Repeat for opposite side.
8. Torque the 5/8”-11 Lock Nuts to **175-200 ft-lbs.**
9. Torque the 1”-8 Lock Nuts to **600 ft-lbs.**
10. Release the jack under the axle and let the axle hang by the struts.

Height Sensors

1. Locate the Height Sensor, Linkage Assembly, and Ball Stud.
2. Attach the Ball Stud to the Left Hand (Driver Side) Lower Control Arm, orientated with the ball pointing outboard, using the 5/16”-18 Locking Flange Nut. Torque to **14-17 ft-lbs.**

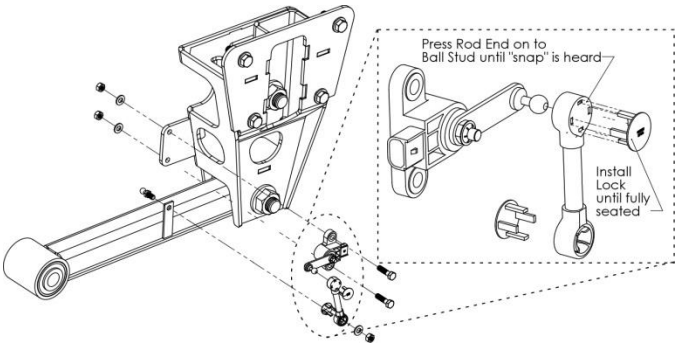


Figure 25. Height Sensor and Linkage installation.

3. Attach the Height Sensor to the Left Hand (Driver Side) Hanger using the 5/16”-18x1.25” Hex Flange Bolts and 5/16”-18 Locking Flange Nuts. Torque to **14-17 ft-lbs.** See Figure 25. **Do not over torque.**
4. Snap the Linkage Assembly to the ball stud on the Height Sensor arm and to the ball stud attached to the lower control arm. **Install rod end locks as shown.**
5. Repeat with the Right Hand (Passenger Side).

Secondary Volumes

1. Locate (2) Volume Mount Weldments, p/n 10830-013.
2. Place the mounts against the driver side frame, forward of the front hanger. Figure 26 shows suggested locations. The mounts can be relocated based on frame mounts, etc.

Important: Locate the mounts such that the distance between two mounts as wide as possible.

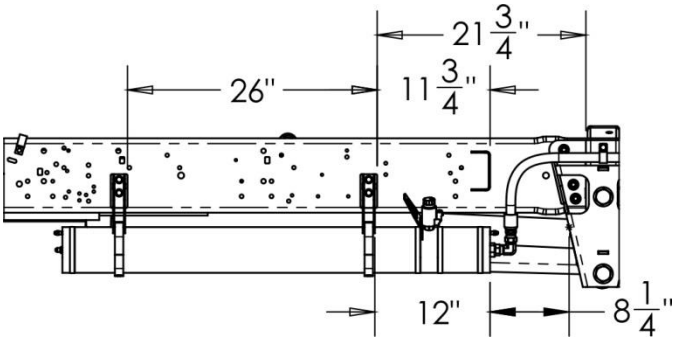


Figure 26. Secondary Volume suggested mount locations

3. Verifying the mounts are held flush to the bottom of the frame and utilizing the mount hole pattern, mark the locations of the mounting holes and drill (2) Ø7/16” holes per mount.
4. Locate (4) 3/8”-16 x 1.50” Hex Cap Screws, (4) 3/8”-16 Lock Nuts, and (8) 3/8” Hardened Flat Washers and attach the two mounts. **Torque to 35-43 ft-lbs**. Note: Orientate nuts outboard.
5. Repeat with (2) more Volume Mount Weldments on the passenger side of the frame.
6. Locate the Left Hand Secondary Volume Assembly, which includes the shorter -4 hydraulic hose attached.

WARNING: Each Volume Assembly is heavy (in excess of 100 lbs). Use of a portable lift, crane, or suitable jack is recommended to support the Volume Assembly during installation.

7. Raise the volume assembly until the volume contacts both mounts. Rotate the volume assembly until the bleed screws are located to the top and as vertical as possible. Ensure clearance to emergency brake cable past the guard. See Figure 27.
8. Locate (2) T-Bolt Clamps, open the mounts, and place them in the mounts, on top of the two pegs.
9. Secure both clamps around the volume and torque the T-Bolt nut to **240 in-lbs**.

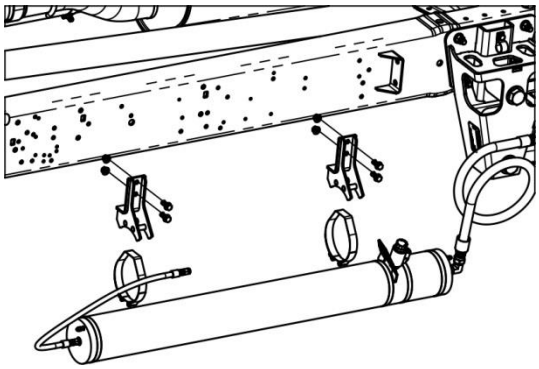


Figure 27. Secondary Volume Assembly mounting location.

10. Repeat for passenger side.

Power Module Installation (DS96F-B2 model)

1. Locate the Power Module Assembly and Power Module Mounting Kit.
2. Locate the Breather Cap. Replace Top Plug with Breather Cap.
3. Inside the Kit, locate the Power Module Frame Bracket, p/n 10891-001.
4. Using the bracket, locate and mark the center of the top two mount holes. Refer to Figure 28 for location of the mount.

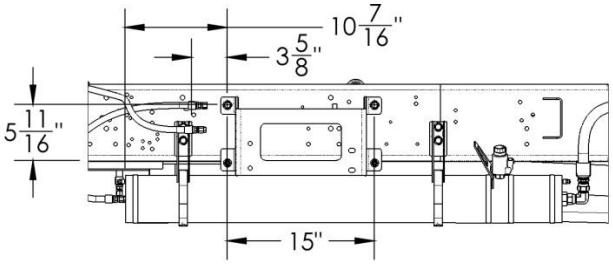


Figure 28. Suggested Power Module Mount Location.

5. Drill (2) 7/16” diameter holes.
6. Locate (2) 3/8”-16 J-Bolts, (2) 3/8”-16 x 1.00” Hex Flange Bolts, and (4) 3/8”-16 Locking Flange Nuts.

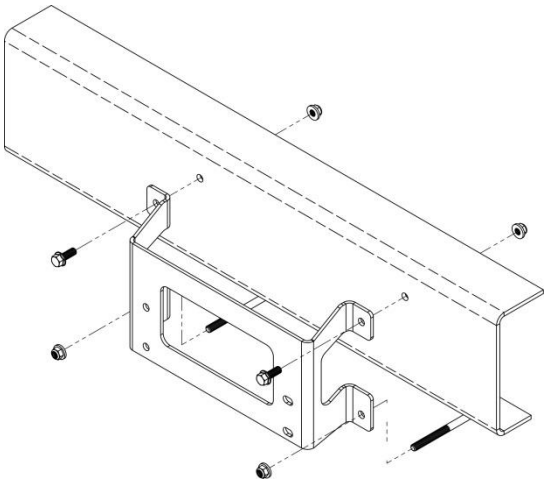


Figure 29. Attaching the Power Module Frame Mount.

7. Attach the bracket to the frame using the Hex Flange Bolts in the newly drilled holes and slipping the J-Bolts under the frame. **Torque to 35-45 ft-lbs.**
8. Locate the Power Module Manifold Mount bracket, p/n 10799-004 and (2) 3/8”-16 x .625” Serrated Flange Hex Screws.
9. Attach the bracket to the power module as shown in Figure 30. **Torque to 35-45 ft-lbs.**

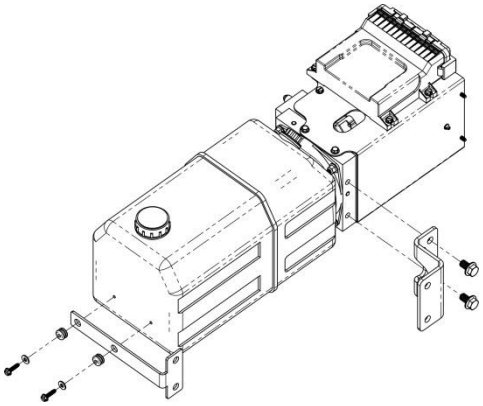


Figure 30. Attaching the mounting brackets.

10. Locate the Power Module Reservoir Mount, p/n 10798-004, (2) 3/16” ID x 9/16” OD Grommets, (2) #10 Flat Washers, and (2) #10-16 x .750” Self Tapping Screws.
11. Install the grommets into the Reservoir Mount bracket.
12. Attach the bracket to the reservoir using the washers and self-tapping screws. Refer to Figure 31.

IMPORTANT: Do not overtighten screws into reservoir. Bushings should not be deformed when attached. Overtightening of screws can damage plastic reservoir.

13. Locate (4) 3/8”-16 x 1.000” Hex Flange Bolts and (4) 3/8”-16 Locking Flange Nuts.

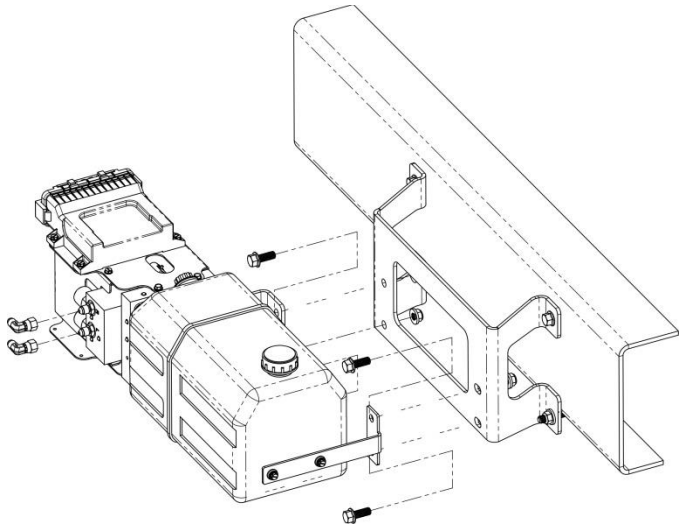


Figure 31. Attaching Power Module Assembly

14. Attach the Power Module assembly to the frame bracket. **Torque to 35-45 ft-lbs.**

15. Remove the (2) caps from the fittings on the power module.
16. Locate (2) -4 JIC Elbows.
17. Attach the elbows to the straight fittings located in the power module manifold, loosely.
18. Orientate the elbows as shown.
19. While holding the body of the fitting, tighten the swivel nut to **12 ft-lbs**.
20. Proceed to *Hydraulic Hose Attachment* section.

Power Module Installation (DS96F-A)

1. Locate the Power Module Assembly, Power Module Manifold Mount (p/n 10647-001), and (2) 3/8”-16 Serrated Flange Hex Screws.

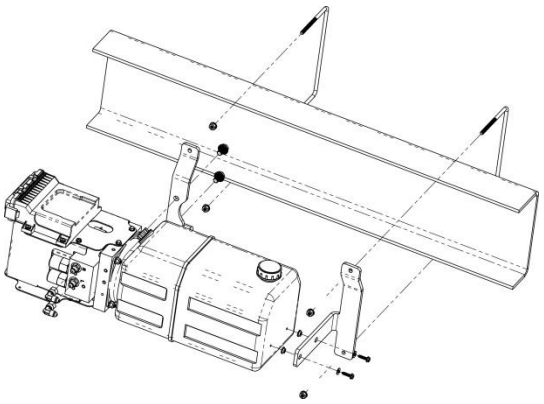


Figure 32. Power Module Assembly

2. Locate the Breather Cap. Replace top plug with Breather Cap.
3. Attach the bracket to the power module pump head manifold using the serrated flange screws. **Torque to 35-45 ft-lbs.**
4. Locate the Power Module Reservoir Mount (p/n 10648-001), (2) .189" ID x .175" Tall bushings, (2) #10 Flat Washers, and (2) #10-16 x .750" Self Tapping Screws.
5. Place the bushings between the bracket and the plastic reservoir.
6. Attach bracket to the reservoir using the flat washers and self-tapping screws.

   IMPORTANT: Do not overtighten screws into reservoir. Bushings should not be deformed when attached. Overtightening of screws can damage plastic reservoir.
7. Locate (2) 1/4"-20 U-Bolts, (4) 1/4" Flat Washers, and (4) 1/4"-20 Lock Nuts.
8. Locate the power module mounting location on the frame.

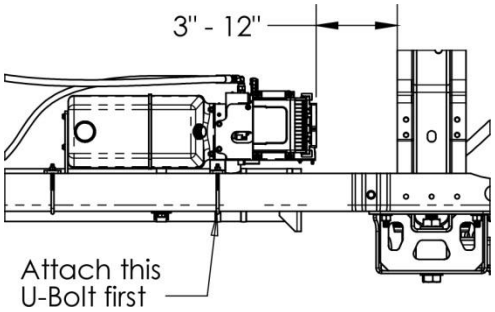


Figure 33. Recommended Power Module mounting location.

9. Attach the center bracket on the power module to the frame with (1) U-Bolt, (2) 1/4" Flat Washers, and (2) 1/4"-20 Lock Nuts. **Do not tighten fasteners.**

   Note: The long leg of the u-bolt fits over the top flange of the frame.
10. Attach the reservoir side of the power module to the frame using (1) U-Bolt, (2) 1/4" Flat Washers, and (2) 1/4"-20 Lock Nuts.
11. Torque all four (4) lock nuts to **60-85 in-lbs.**
12. Remove the (2) caps from the fittings on the power module.
13. Locate (2) -4 JIC Elbows.
14. Attach the elbows to the straight fittings located in the power module manifold, loosely.
15. Orientate the elbows as shown.
16. While holding the body of the fitting, tighten the swivel nut to **12 ft-lbs**.
17. Proceed to *Hydraulic Hose Attachment* section.

Hydraulic Hose Attachment

CAUTION: The DS96F-M Secondary Volume Assemblies are equipped with Normally-Closed Rate Valves, which separate the two chambers when power is not applied to the valve. Each chamber side must be bled separately.

CAUTION: Attachment of the hydraulic hoses may result in some spillage of fluid. Use of oil absorbent mats is recommended.

1. Locate -10 hose on Left Hand (driver side) Secondary Volume.
2. Route hose to strut area.
3. Locate 3/16" ID PVC Tubing (not included with kit). Note: Alternatively, a bleed kit similar to the Actron 7840 Bleed Kit can be used.
4. Attach the PVC tubing to the bleed screw on the -10 hose side of the Left Hand Secondary Volume Assembly and place the other end in a bucket.

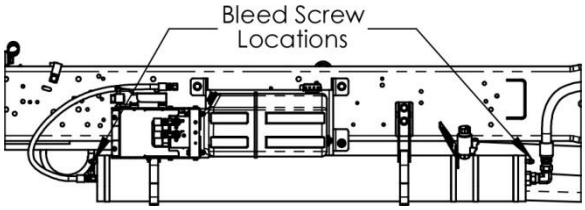


Figure 34. Bleed screw locations.

5. Open the bleed screw slightly to relieve any residual pressure.
6. After pressure is relieved, close the bleed screw and torque to **13-18 ft-lbs.**
7. Remove the cap from the strut port.

8. Raise the end of the -10 (5/8") hose, attached to the volume assembly, above the secondary volume to prevent fluid loss.
9. Remove the plug from the end of the hose.
10. Attach the hose end (-10 JIC fitting) to the strut port.
11. Torque to **36-63 ft-lbs.**
12. Repeat with the opposite side.
13. Use hose clamps to secure hoses from movement and chafing.

CAUTION: Make sure the hose is not chafing or in contact with any sharp edges.

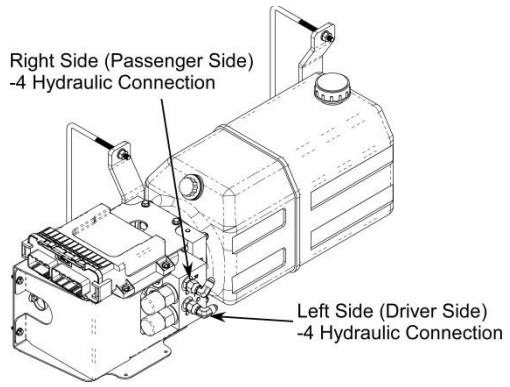


Figure 35. Power Module hydraulic connections

14. Attach the PVC tubing to the bleed screw on the -4 hose side of the Left Hand Secondary Volume Assembly and place the other end in a bucket.
15. Open the bleed screw slightly to relieve any residual pressure.
16. After pressure is relieved, close the bleed screw and torque to **13-18 ft-lbs.**
17. Route the Left Hand (Driver side) -4 (1/4") hydraulic hose, attached to the volume assembly, to the Power Module. Use of hose clamps is recommended to secure the hose from movement or chafing.

CAUTION: Make sure the hose is not chafing or in contact with any sharp edges.

18. Remove the cap from the -4 JIC fitting on top of the power module assembly.
19. Remove the plug from the hose end.
20. Attach the hose end to the top fitting. Torque to **12 ft-lbs. Do not over tighten.**
21. Repeat with the opposite side.
22. Clean up any fluid spillage.
23. Re-install tires and wheels as per OEM instructions.

Steering Sensor Installation

Note: Model year 2012 and newer Ford E450 under dash do not require the removal of the cover and brackets to gain access to the steering sensor installation.

1. Remove the Under Dash Steering Column Cover.

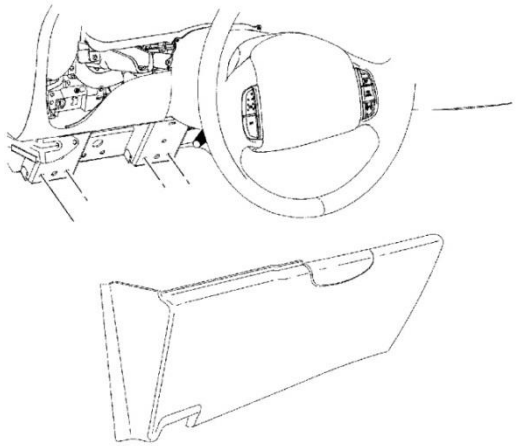


Figure 36. Under Dash Steering Column Cover removal.

2. Locate and remove fasteners that mount the data link connector. Retain hardware for reassembly in later steps.

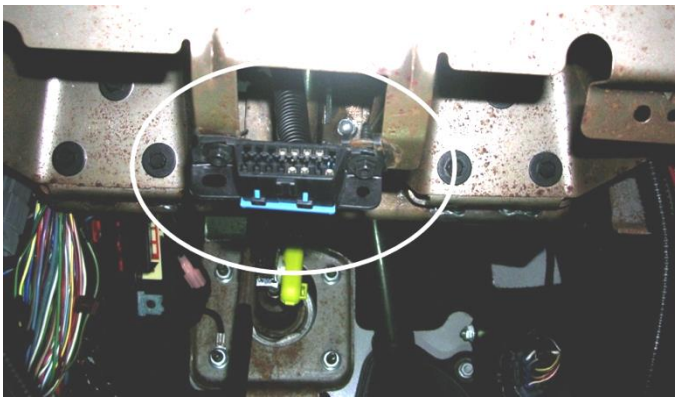


Figure 37. Data Link Connector.

3. Remove the under dash bolster brace by removing the six (6) bolts. Retain hardware.

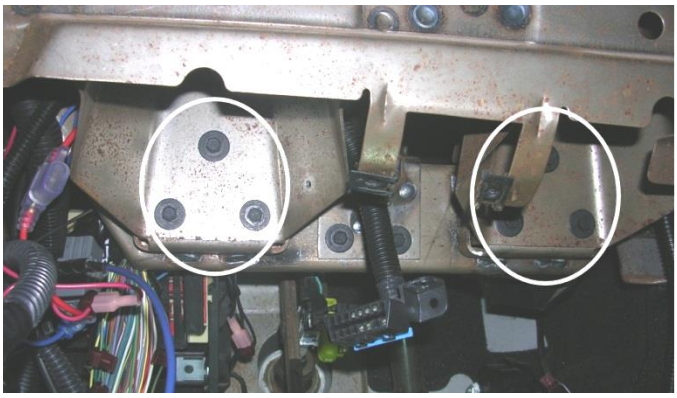


Figure 38. Bolster Brace Bolts.

4. Remove the bracket shown below by removing the two (2) bolts.

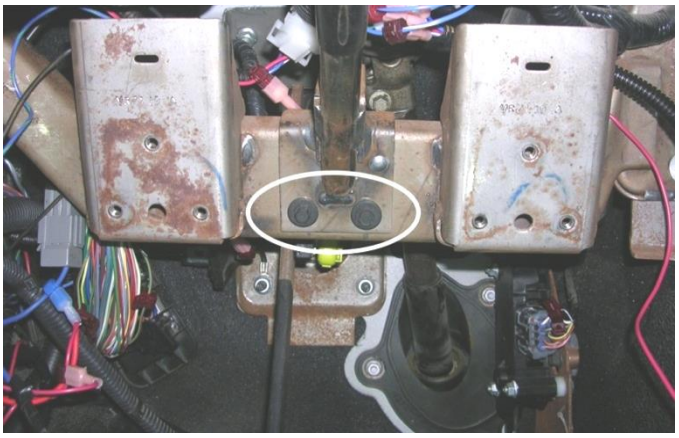


Figure 39. Bracket Bolts.

5. Locate the Steering Sensor and (2) #8 x .50 Pan Head Sheet Metal Screws
6. Install the Sensor as shown in Figure 40 and Figure 41.

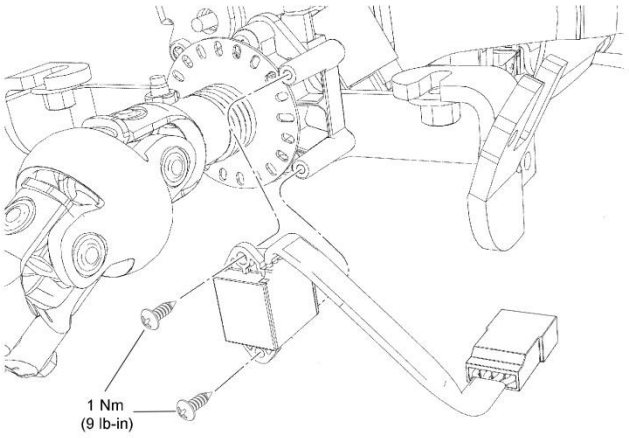


Figure 40. Steering Sensor Installation.

Figure 41. Steering Sensor Location

7. Reinstall the brackets and bolster brackets reusing the bolts removed. Torque to **80 in-lbs (9 Nm).**
8. Reinstall the Data Link
9. Reinstall the under dash steering column cover.

Wiring up the vehicle Pass-thru

1. Looking underneath the vehicle hood, locate the customer access upfitter wiring between the engine air induction tube and the brake master cylinder. Remove some of the plastic wiring harness tape to reveal the blunt-cut wires. Also, locate the Pass-thru wires and connector(C140) near the vehicle cowl. See Figure 42.

   Note: If Pass-thru wires and connector (C140) are already in use by the final stage vehicle manufacturer, please contact LiquidSpring LLC for alternative wiring use.

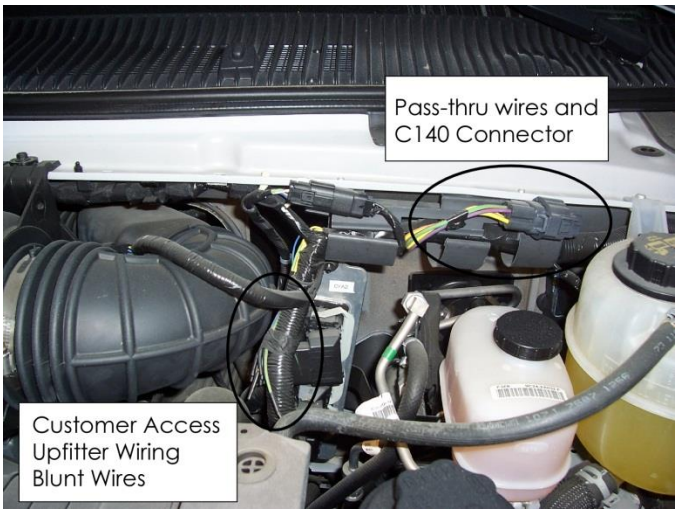


Figure 42. Under hood wiring

2. Cut the 12ga Violet/Grey wire and the 12ga Yellow Grey wire from just behind the Pass-thru wire connector.
   NOTE: Do not cut more than 1" away from C140 connector body.
3. Strip the two wires in preparation for butt splicing.
4. Crimp heat shrink butt-splices onto the ends of the two wires. NOTE: Do not apply heat to shrink the insulator at this time.
5. Locate the Gray/Brown wire labeled "TRO-P" from the blunt-cut upfitter wiring. Insert this wire into the butt-splice on the Yellow/Grey wire and crimp. Heat the insulator to seal the connection.
6. Locate the Violet/Orange wire labeled "VSOUT" from the blunt-cut upfitter wiring. Insert this wire into the butt-splice on the Violet/Grey wire and crimp. Heat the insulator to seal the connection.

External Electrical Harness Installation:

1. Locate the External Electrical Harness attached to the power module.
2. Unroll the wiring harness.
3. Locate the trunks containing the Height Sensor (J21 and J22) and the Rate Valve (J23 and J24) connectors.
4. Route the wires towards the height sensors and rate valves.
5. Connect the following:
   a. J21 to Left Height Sensor (Driver Side)
   b. J22 to Right Height Sensor (Passenger Side)
   c. J23 to Left Rate Valve (Driver Side)
   d. J24 to Right Rate Valve (Passenger Side)

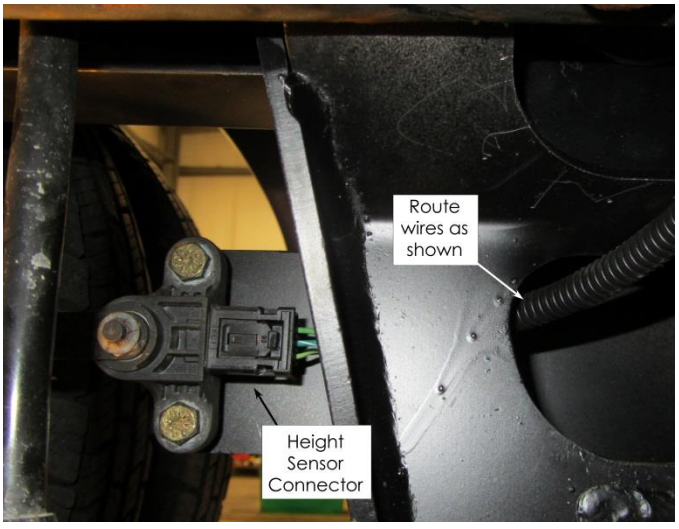


Figure 43. Height Sensor Electrical Connections

Note: Connection after routing the harness and prior to installation of the height sensor may aid in electrical connection.

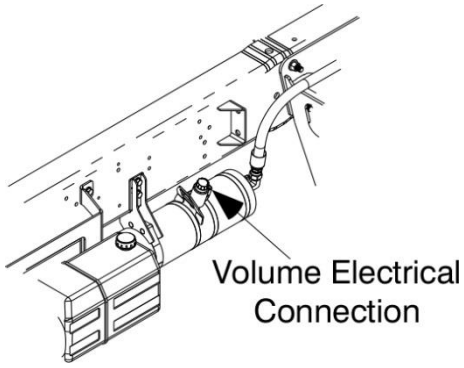


Figure 44. Secondary Volume Electrical Connections

6. Secure the harness.
7. Locate the 8 ga. wire ground ring terminal, J30, branch near the Power Module.
8. Attach the ground ring to the frame. Remove frame coating(s) as needed to ensure metal-to-metal contact between the ring terminal and frame. Sealant may be applied after secured.
9. Route the remaining trunk containing the blunt wires and steering sensor connector towards the cab. Secure the wire harness to OEM harness where appropriate. Do not secure directly to the chassis frame.
10. Route the harness through access hole in cab. See Figure 45.

Figure 45. Location of access hole

11. Route the external harness under the driver side door well cover and kick panel to underneath the dash on drivers side. Secure any excess accordingly to prevent entanglement with driver's feet.
12. Locate the 8 ga. battery connection branch.
13. Route branch to the passenger side auxiliary battery.

Secure harness to OEM wire harnesses or stanchions attached to chassis where appropriate. Do not allow harness to droop below frame or attach to fuel lines, brake lines, etc. Route harnesses inside the frame channel or near cross members where appropriate.

14. Locate the Battery Fuse Lead containing the 80 Amp fuse.
15. Crimp the fuse lead to the 8 ga. battery connection branch blunt end.
16. Melt the heat shrink on the crimped connection to seal the splice.
17. Remove the 80 Amp fuse and retain.
18. Connect to the positive terminal post per OEM Upfitter wiring instructions.

Dash Electrical Harness Installation:

1. Locate and identify the following 18 ga. wires in the external harness. These wires should be routed from the Power Module to the inside of the cab.
2. If existing on the dash harness, cut off the two 6-pin connectors labeled J9 and J10.
3. Butt splice the following wires between the dash harness and external harness:

Dash Harness	→	**External Harness**
Red (Battery)	→	Red (Battery)
Yellow (Ignition)	→	Yellow (Ignition)
Black (Ground)	→	Black (Ground)
White (CAN High)	→	White (CAN High)
White/Black (CAN Low)	→	White/Black (CAN Low)
Violet/White (Speed)	→	Violet/White (Speed)
Pink/Black (Brake)	→	Pink/Black (Brake)
Yellow/Black (Park)	→	Yellow/Black (Park)
The following are steering signal wires		
Orange/Black	→	Orange/Black
Brown/White	→	Brown/White
Gray	→	Gray

4. Connect each wire to the corresponding wire in the dash harness using appropriate butt splices. Heat shrink sealing is optional.
5. Attach Ground ring terminal (J32) to firewall stud for grounding. See Figure 46.

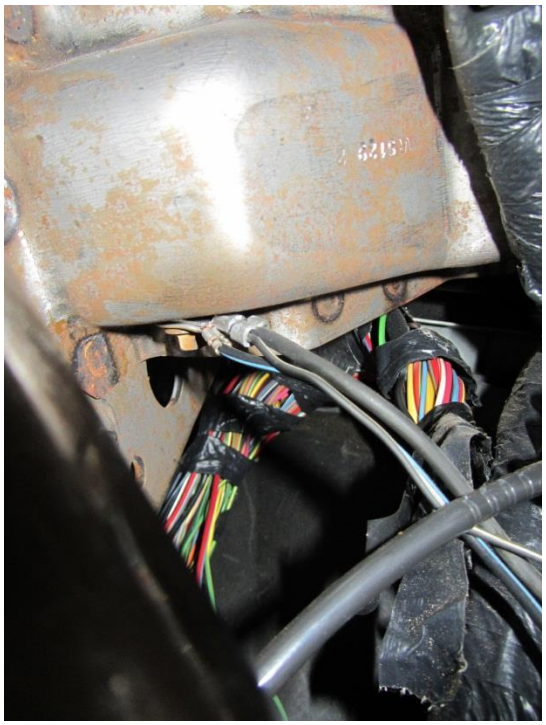


Figure 46. Firewall ground stud—driver side under dash

6. Connect the 6-pin connector (J11 on Dash Harness) to the steering sensor.
7. Locate Ford connector C219 and wire harness 14401 underneath driver side dash. See Figure 47 and Figure 48.

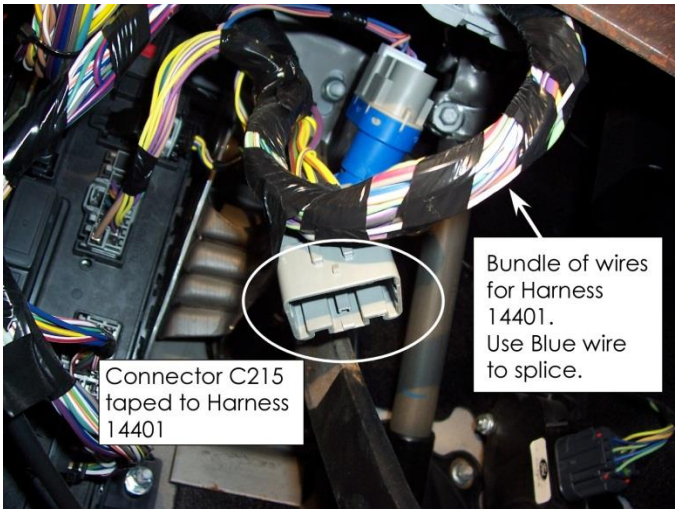


Figure 47. Under dash wiring. Note: Connector J31 not shown connected for clarity.

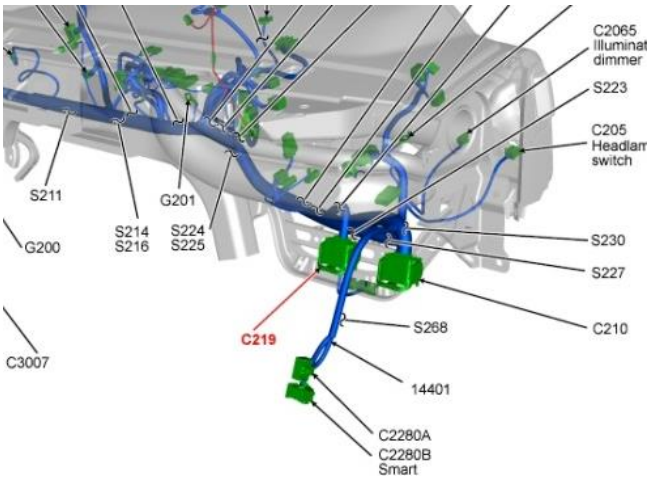


Figure 48. Connector C219 location under dash, driver side.

8. Locate the five (5) wires in the LS Dash Harness labeled "Chassis Connections".
9. The Pink/Black blunt wire needs to be spliced into the Violet/White wire of harness 14401 at connector C219.
10. Locate the Violet/White 18 ga. wire in pin #37 of connector C219. Unwind the plastic tape to gain access to the Violet/White wire at least 8" from connector C219 and cut the wire ≈6" from connector C219. See Figure 49.
11. Strip one cut end of the Violet/White wire and insert into one end of a heat shrinkable butt-splice and crimp.
12. Strip the Pink/Black blunt wire and the other cut end of the Violet/White wire and twist together. Insert the twisted pair into the other end of the heat shrinkable butt-splice and crimp.
13. Apply heat to the insulator to seal the connection.

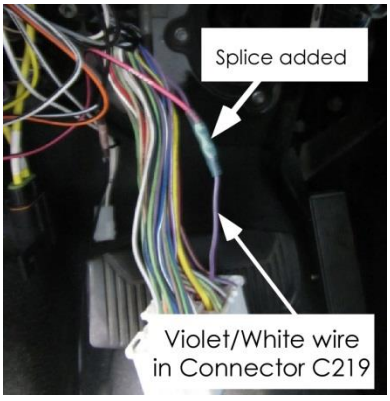


Figure 49. Violet/White wire in Connector C219 shown with splice.

14. Locate the Ford C215 connector under the dash.
15. Locate and splice the following wires to the LiquidSpring Dash Harness blunt wires:

OEM C215 Wires	→	LS Dash Harness Wires
Pin #1 (Violet/Gray) 12ga.	→	Violet/White (Speed)
Pin #2 (Yellow/Gray) 12ga.	→	Yellow/Black (Park)
Pin #3 (Green/Red) 10ga.	→	Red (Battery) 10ga
Pin #4 (Yellow/Orange) 12ga.	→	Yellow (Ignition) 10ga

16. For each connection:
    a. Unwind the plastic tape as necessary.
    b. Cut OEM wire approximately 6" from the connector.
    c. Strip one end of the OEM wire and insert into one end of the heat shrinkable butt-splice and crimp.
    d. Strip the other end of the cut OEM wire and the corresponding LiquidSpring Dash Harness blunt wire. Twist together.
    e. Insert the twisted pair into the other end of the heat shrinkable butt-splice and crimp.
    f. Apply heat to seal the connection.
17. Secure Dash Harness to prevent wires getting entangled in driver's feet.

Driver Interface Installation:

1. Locate driver interface.
2. Mount the driver display in appropriate location according to Ford QVM/Body Builder Guidelines or Final Stage Manufacturer requirements. Recommend using hook and loop strips as needed.
3. Route and secure driver interface harness accordingly to connect to dash harness connector J12 underneath dash on driver's side.

Optional Door Electrical Harness Installation:

The optional door harness can be used to remotely activate the system "kneeling" feature in which the suspension automatically lowers to a point slightly less than maximum jounce travel. The door harness can be utilized in two actuation methods.

IMPORTANT: Do not connect positive (12VDC) signal to either the W98 Tan/Blk or W93 Brown wires. Applying positive (12VDC) to either of these wires can result in ECU failure.

A. Single Wire - Ground Signal From Source

Ground is provided to the door harness Brown (W93) wire from a grounding source (e.g. multiplex signal, switch, etc.). If a remote switch is used, it is recommended to use a normally closed (NC) door switch which remains open

when the door is closed (or closed when the door is opened). One side of the switch must be connected to a ground source and the other side routed to the door harness. If multiple switches are used, they should be wired in a parallel arrangement with the door harness. Requires single wire routed from source to door harness.

B: Dual Wire – Ground Signal From System

Ground is provided by the suspension system when the Brown (W93) wire is connected to the Tan/Black (W98) wire of the door harness. This arrangement requires a remote switch that is a normally closed (NC) door switch which remains open when the door is closed (or closed when the door is opened). One side of the switch needs to be connected to the door harness Brown (W93) wire and the other side to the door harness Tan/Black (W98) wire. Requires two wires routed from switch to door harness.

1. Door harness wires are located on the main external wiring harness as a branch near the power module.
2. Unwrap the door harness wires.
3. Based on the selected actuation method above, strip the end(s) of the door harness blunt wire(s) and connect the end(s) to the signal source using a heat shrinkable butt-splice. Crimp the connection(s) accordingly and apply heat to the insulator to seal the connection(s).

Initial System Fill

1. Install the wheels and tires. Torque wheel nuts to OEM specifications.
2. Verify that the front wheels are steered straight ahead.
3. Lower the vehicle to the ground and remove any jack stands from under the vehicle. The suspension should be in the kneeled position.
4. Locate the container of Silicone Fluid.
5. Remove the breather cap from the Power Module reservoir.
6. Fill the reservoir approximately 2/3 full.
7. Turn the ignition key to "Run" and ensure that the LiquidSpring driver display LEDs light up and that the red "Warning" LED is not lit. If the red "Warning" LED is lit, proceed to the Trouble Shooting Section.

WARNING: Do not run vehicle in an enclosed building without adequate ventilation or without ducting exhaust fumes outside. Operation of a vehicle inside an enclosed building can lead to serious injury or death.

8. Press and release the Red ON/OFF button on the driver display. All LEDs on the driver display should go out.
9. Press and release the Red ON/OFF button again. The LEDs on the driver display should all flash and then only the four yellow arrow LEDs, one green ride mode indicator LED, and one green ride height indicator LED should remain lit.
10. The green ride height indicator LED should indicate "Low" and begin flashing as the pump/motor starts. If pump/motor does not start, check Trouble Shooting Electrical Section.
11. Monitor the fluid level in the reservoir. If the level drops below 1/4 of the tank, press and release the Red ON/OFF button to shut off the system, refill the reservoir, and turn the system back on by pressing the Red ON/OFF button.

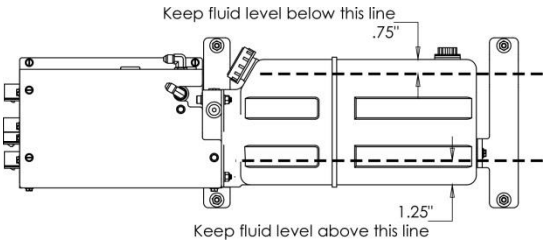


Figure 50. Fluid level while initially filling system.

12. If the suspension system does not begin to rise to a preset ride height after 3 minutes, stop the system and check the following first and then repeat this step:
    a. Check for any fluid leaks.
    b. Check that the hoses are properly connected.
    c. Completely depressurize the system. See Depressurizing the System section, under System Operation
13. After the suspension system stops leveling, check the fluid level in the reservoir. If low, fill to the indicated line.

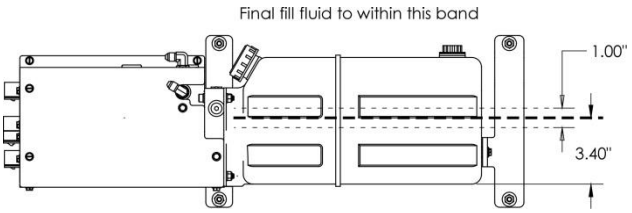


Figure 51. Final fill fluid level.

Bleeding the System

1. Verify system is turned OFF by either pressing the ON/OFF button on the driver interface until the lights are turned off or turning the ignition off.

2. Locate 3/16” ID PVC Tubing (not included with kit). Note: Alternatively, a bleed kit similar to the Actron 7840 Bleed Kit can be used.
3. Attach the PVC tubing to one of the upper bleed screws on the Left Hand Secondary Volume Assembly and place the other end in a bucket.

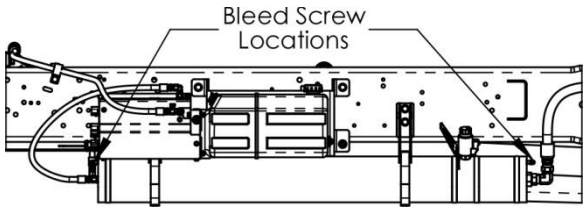


Figure 52. Bleed screw locations.

4. Open the bleed screw slightly.
5. After air bubbles are no longer present, close the bleed screw and torque to **13-18 ft-lbs.**
6. Repeat with remaining bleed screws. Note: the system may need to powered on and allowed to re-pressurize .
7. Repeat with other side.

Calibrating the System

IMPORTANT: Proper calibration of the system must be conducted with the vehicle loaded to the as delivered condition with body installed. For calibration on an empty chassis cab, LiquidSpring recommends weight be added to the frame approximately equal to the planned body to allow for proper bushing deflections.

Note: The LiquidSpring Calibration routine will automatically determine maximum and minimum suspension ride height. Based on those ride heights, the system will determine the correct normal design ride height. The calibration system will also calibrate the steering sensor.

1. Verify that the front wheels are steered straight ahead.
2. Lower the vehicle to the ground and remove any jack stands and any other obstructions from under the vehicle.
3. To begin the calibration, turn the ignition key to “Run” and ensure that the LiquidSpring driver display lights up and that the red Error light is not blinking.

WARNING: Do not run vehicle in an enclosed building without adequate ventilation or without ducting exhaust fumes outside. Operation of a vehicle inside an enclosed building can lead to serious injury or death.

4. Press and release the Red ON/OFF button on the driver display. All lights on the driver display should go out.
5. Press and release the Red ON/OFF button a second time. The lights on the driver display should all flash then only show the four yellow arrow lights, one green ride mode indicator, and one green ride height indicator.
6. Press and hold both Ride Height Adjustment Buttons simultaneously until the SPORT, COMFORT, HIGH, and LOW green LED’s begin to flash. The suspension system will begin to rise to the full high position, and then lower to the full lowered position.
7. After the system completes the calibration routine, the suspension will return to the original ride height.
8. Turn off the ignition for at least 3 minutes. Note: The suspension system will not use the calibrated ride height settings until power has been cycled.

   Note: Pressing the red ON/OFF button on the driver display does not cycle power to the LiquidSpring suspension system, but only will enable/disable the system.
9. Turn the ignition back to Run, then press the Red ON/OFF button twice and verify the suspension system moves to the new and correct ride height.
10. Calibration is now completed.

Post Installation Welding

WARNING: Prior to any chassis welding conducted after the installation of the LiquidSpring suspension system, disconnect cables from battery, disconnect ECU Header connectors (see below), and Power Module ground connection (see below).

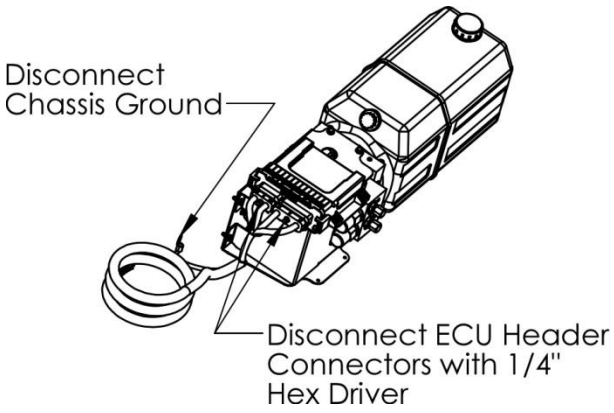
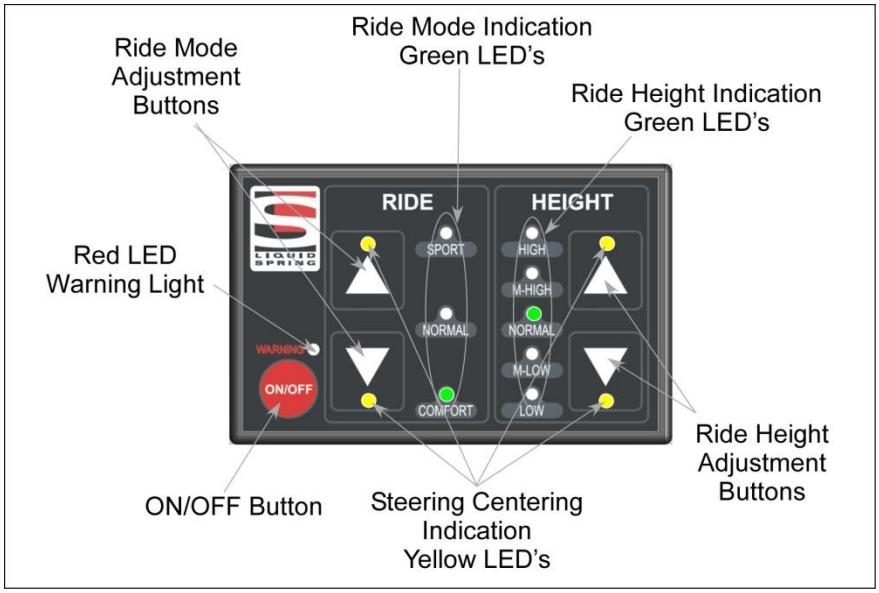


Figure 53. ECU disconnects prior to welding on chassis.

System Operation



System Start Up:

- In most instances, the suspension system can be left alone to operate automatically.
- After startup, all the indicator lights will flash on for 1-2 seconds, and then the Green Ride Height Indication LED and Green Ride Mode Indication LED will light to show the current Ride Mode and Ride Height.
- The four yellow LED's will light up if the steering wheel is approximately 10°-20° each side of straight ahead, but will not light up when steering wheel exceeds 20° from center. If the vehicle is steered straight ahead and the four yellow LED's are not lit (and the red warning LED is not lit) see Calibrating the Steering Sensor Only.
- When the steering wheel is turned more than 20° off center, the four Yellow Steering Centering Indication LED will not be lit.

ON/OFF Button:

Pressing the ON/OFF button will enable/disable the suspension. When the suspension is ON, relevant LED's are lit up. When the suspension is OFF, none of the LED's are lit. It is recommended to leave the suspension ON at all times unless the vehicle or suspension is being serviced.

IMPORTANT: After turning the vehicle ignition off, the suspension system will remain powered for 1 hour before shutting off.

Warning Light:

If the Red LED warning light is continuously illuminated along with one or more of the other indicator lights, please refer to the **Troubleshooting Section**.

Ride Mode Adjustment:

Press the UP/DOWN arrow buttons to change the ride mode between SPORT, NORMAL, and COMFORT. The Green indicator light will show the set mode.

- **Comfort Mode** provides a smooth, soft ride. Use for normal city and highway driving.
- **Sport Mode** provides more "feel" or response to the road conditions. Use where road conditions or personal preference demand more control.
- **Normal Mode** is a balance between Comfort and Sport. Use where more control than Comfort is desired, but better ride than Sport.

The setting can be changed at any time. Based on road conditions, steering wheel angle, and the vehicle speed, the system automatically adjusts to provide the best handling while providing a smooth ride. All three settings will feel similar on a smooth road.

Ride Height Adjustment:

Press the UP/DOWN arrow buttons to change ride height from NORMAL to HIGH (body up) or LOW (body down).

- A solid green LED will indicate the selected height. A flashing green LED will indicate the current height and that height adjustment is occurring. When a single solid green LED is lit, the selected height has been achieved.

- Two solid green LEDs will be lit if the current height is not the selected height and height adjustment is not occurring.
- If LOW or HIGH heights are selected while the vehicle is traveling at less than 10 mph or stopped, the suspension height is either lowered or raised.
- If LOW or HIGH heights are selected while the vehicle is traveling at greater than 10 mph, the suspension will ignore the selected height and remain in NORMAL height unless the vehicle speed goes below 10 mph within 2 minutes of selecting the height. In this instance, the NORMAL height green LED will flash and the selected height green LED will be lit solid until the speed goes below 10 mph within 2 minutes of selecting the height. If the vehicle speed doesn't go below 10mph within the 2 minute period, the suspension will remain in NORMAL height indicated by only the NORMAL height green LED lit solid.
- If LOW height is selected and the ignition is turned off before LOW height is achieved, the system will continue to lower to LOW height. When LOW height is selected the system will monitor and maintain the kneeled position by only lowering as needed for 1hour after the ignition is turned off.
- If HIGH height is selected and the ignition is turned off before HIGH height is achieved, the system will stop adjusting ride height. When HIGH height is selected the system will monitor and maintain the current position by only lowering as needed for 1 hour after the ignition is turned off.
- The door switch function (if equipped) is disabled when the driver display LOW or HIGH height is selected before the door is opened on vehicles equipped with a door switch for kneeling.

IMPORTANT: While parked for an extended time with the vehicle and/or suspension system turned off, suspension ride will change with temperature change. Increases in ambient temperature or parking in direct sunlight can cause the suspension ride height to increase. As temperature lowers, the suspension ride height can decrease.

Depressurizing the System

1. Turn the ignition key to "Run" and ensure that the LiquidSpring driver display LEDs light up and that the red "Warning" LED is not lit. If the red "Warning" LED is lit, proceed to the Trouble Shooting Section.

WARNING: Do not run vehicle in an enclosed building without adequate ventilation or without ducting exhaust fumes outside. Operation of a vehicle inside an enclosed building can lead to serious injury or death.

1. Press and release the Red ON/OFF button on the driver display. All LEDs on the driver display should go out.
2. Press and release the Red ON/OFF button again. The LEDs on the driver display should all flash and then only the four yellow arrow LEDs, one green ride mode indicator LED, and one green ride height indicator LED should remain lit.
3. Press and release the HEIGHT DOWN arrow button to lower the vehicle to the LOW height.
4. Press and hold the HEIGHT DOWN arrow button for approximately 2 minutes.
5. Release the HEIGHT DOWN arrow button.
6. Press and release the ON/OFF button to disable the system.
7. Turn off the vehicle ignition.

CAUTION: The DS96F-M Secondary Volume Assemblies are equipped with Normally-Closed Rate Valves, which separate the two chambers when power is not applied to the valve. Each chamber side must be bled separately.

If any of the hydraulic connected components is to be removed and serviced, it is recommended to also follow the following steps:

8. Locate 3/16" ID PVC Tubing. Note: Alternatively, a bleed kit similar to the Actron 7840 Bleed Kit can be used.
9. Attach the PVC tubing to one of the upper bleed screws on the Left Hand Secondary Volume Assembly and place the other end in a bucket.

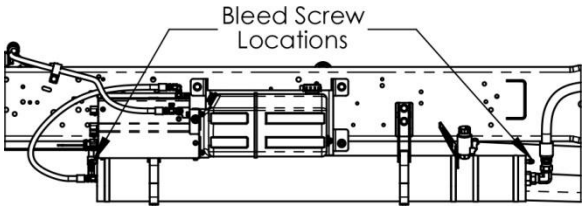


Figure 54. Bleed screw locations.

10. Open the bleed screw slightly to relieve any residual pressure.
11. After pressure is relieved, close the bleed screw and torque to 13-18 ft-lbs.

Notes:

- Jacking up the chassis of a lowered, depressurized chassis will cause a slight vacuum in the system and minimize fluid loss while disconnecting hoses.
- For service of non-hydraulic connected suspension components, the suspension system can be first raised to the HIGH height, appropriate jack stands placed under the chassis, then depressurized as listed above lowering the chassis onto the jack stands.

Calibrating the Steering Sensor Only

Note: The yellow lights only light up when the steering sensor indicates the center location. They will not be lit outside of 10°-20° off center.

IMPORTANT: The LiquidSpring CLASS® system includes an automatic self-centering routine. In conditions such as driving on highway with significant side wind, the yellow lights may temporarily not be lit when the steering wheel is exactly centered. Rotate slowly from center to full steering stop, then repeat the opposite direction. If the yellow lights momentarily light up during the travel in one or the other direction, the system is operating normally and the steering sensor does not need to be manually re-centered. Continue operating normally.

If the yellow lights do not light up at all during turning the steering wheel, following the instructions below.

1. Verify that the front wheels are steered straight ahead.
2. To begin the calibration, turn the ignition key to "Run" and ensure that the LiquidSpring driver display lights up and that the red "Warning" LED is not lit or flashing.

WARNING: Do not run vehicle in an enclosed building without adequate ventilation or without ducting exhaust fumes outside. Operation of a vehicle inside an enclosed building can lead to serious injury or death.

3. Press and release the Red ON/OFF button on the driver display. All LEDs on the driver display should go out.
4. Press and release the Red ON/OFF button again. The LEDs on the driver display should all flash and then only the four yellow arrow LEDs, one green ride mode indicator LED, and one green ride height indicator LED should remain lit.
5. Press and hold both Ride Height Adjustment Buttons simultaneously until the SPORT, COMFORT, HIGH, and LOW green LED's begin to flash.
6. As soon as the four green LED's begin to flash, press the ON/OFF button to stop the process.
7. Verify that the four yellow arrow LED's are lit.
8. Steering calibration is completed.

Special Tools

The following tools can assist in installation of the LiquidSpring system.

Bleed Kit (Actron 7840 shown, others similar).

Gallon Hand Pump (Autotec 57429 shown, other similar)

Troubleshooting

The LiquidSpring CLASS® system includes on-board diagnostics to assist in pin-pointing potential issues. When a fault in the system occurs, the red warning light on the Drivers Interface will light along with one or more of the other lights on the interface.

Driver Interface Lights	Condition	Cause	Correction
Warning + RIDE: SPORT	Battery Voltage in excess of 16VDC	Vehicle charging system providing incorrect voltage.	Inspect and replace as necessary.
		LiquidSpring system not connected to 12VDC electrical system	Inspect and replace as necessary
Warning + RIDE: NORMAL	Pump Motor runs in excess of 3 minutes	See *Issues with Vehicle Raising/Pump Section*	See *Issues with Vehicle Raising/Pump Section*
Warning + RIDE: COMFORT	Battery Voltage below 9 VDC	Vehicle charging system providing incorrect voltage	Inspect and replace as necessary
		80A fuse blown / Loss of battery voltage on circuit W25	Inspect / Repair Replace as necessary
Warning + HEIGHT: HIGH	Issue with Right Hand Height Sensor	See *Issues with Height Sensors Section*	See *Issues with Height Sensors Section*
Warning + HEIGHT: NORMAL	System kneels in excess of 3 minutes without suspension movement	See *Issues with Vehicle Lowering/Dump Valve Section*	See *Issues with Vehicle Lowering/Dump Valve Section*
Warning + HEIGHT: LOW	Issue with Left Hand Height Sensor	See *Issues with Height Sensors Section*	See *Issues with Height Sensors Section*

Issues with Vehicle Raising/Pump

Condition	Cause	Correction
Vehicle Leveled, Pump continues to run	Pump motor shorted out.	Contact LiquidSpring for further instructions.
	Software issue	Turn off ignition, wait 30 seconds, restart vehicle.
	Excessive noise in height sensor	See *Issues with Height Sensors*
Vehicle Not Leveled (or Raised), Pump runs	Reservoir fluid level low	Fill reservoir to specified level.
	Hydraulic leak in system	Check for fluid leaks and repair or replace.
	Vehicle overloaded	Check vehicle loading and correct.
	Air in pump	Check fluid level in reservoir and fill accordingly. Fully depressurize system and restart leveling.
	Internal leak in power module	Replace power module.
	Height sensor error	See *Issues with Height Sensors*
Vehicle Not Leveled (or Raised), Pump does not run	System not turned on.	Turn system on.
	Blown fuse	Check system fuses
	Loss of electrical power	Check wiring between power module and battery.
Pump runs for short time then stops	Motor controller over temperature	Contact LiquidSpring for further instructions.
Pump runs intermittently	Loose connector or wiring	Check wiring harness connections and battery connections. Repair as necessary.

Issues with Vehicle Lowering/Dump Valve

Condition	Cause	Correction
Vehicle does not lower (kneel).	System not turned on	Turn system on
	Blown fuse	Check system fuses and replace as necessary
	Obstacle under vehicle frame	Remove obstacle
	Wiring harness disconnected	Check wiring harness connections and reconnect
	Loss of electrical power	Check wiring between power module and battery
	Power module filters plugged	Contact LiquidSpring for further instructions
	Internal power module blockage	Contact LiquidSpring for further instructions
Vehicle slow lowering (kneeling)	Partial internal power module blockage	Contact LiquidSpring for further instructions

Issues with One Corner Not Leveling Properly

Condition	Cause	Correction
One side will not raise or lower	Internal power module blockage	Contact LiquidSpring for further instructions
	Low voltage	Check battery voltage.
	Wiring harness disconnected	Check wiring harness connections and reconnect
	Obstacle under vehicle frame	Remove obstacle
	Power module filters plugged	Contact LiquidSpring for further instructions
	Height sensor error	See *Issues with Height Sensors*
One corner raises and lowers slower than other corners	Internal power module blockage	Contact LiquidSpring for further instructions
	Filter partially clogged	Contact LiquidSpring for further instructions

Issues with Height Sensors

Condition	Cause	Correction
Vehicle or corner stops leveling at incorrect height	Damaged height sensor and/or linkage	Inspect height sensor components. Replace as necessary.
	Incorrect calibration	Recalibrate vehicle – see System Operation section.
	Incorrect height sensor installation	Inspect height sensor components and correct.
Corner height where leveling stops is inconsistent	Sensor or Linkage loose	Inspect installation of height sensor and linkages and tighten if necessary
	Loose connector / wire	Inspect wiring between sensor and power module for loose connection
Vehicle will not level - no height sensor signal	Height Sensor wiring shorted, broken, or disconnected	Inspect wiring between sensor and power module.
	Malfunction in Sensor	Replace sensor.
No Height Sensor Signal change while driving	Linkage broken/disconnected	Inspect installation of height sensor and linkages. Correct and/or replace.

Issues with Ride/Handling

Condition	Cause	Correction
Vehicle rolls side to side excessively	System inactive (Drivers interface dark)	Turn system on (press On/Off button)
	No electrical power to system	Inspect and replace as necessary
	Strut bushings worn	Inspect and replace as necessary
	Control arm bushings worn	Inspect and replace as necessary
	Sway bar bushings worn	Inspect and replace as necessary
	Strut mounting loose	Inspect and replace as necessary
	Rate Valve wiring shorted, broken, or disconnected	Inspect wiring and correct/replace as necessary.
	Voltage to Rate Valve solenoid too low	Check battery voltage.
	Rate Valve Poppet Jammed open	Contact LiquidSpring for further instructions
	No vehicle speed signal	See Issues with Vehicle Speed Signal section.
Excessive stiffness when on flat, straight road	Short to Rate Valve	Check wiring between rate valve (on secondary volume) and power module for signs of shorts. Replace as necessary.
	Wiring to Rate Valve incorrect	Inspect wiring and correct as necessary

Issues with Steering Sensor

Condition	Cause	Correction
No steering signal (reduced roll control when cornering)	Steering sensor wiring broke or incorrect.	Inspect wiring to steering sensor and correct as necessary.
	Steering sensor malfunction	Replace sensor
	Steering sensor not installed correctly	Inspect installation and correct as necessary
Yellow lights on driver display not lit when steered straight ahead.	Zero point of steering sensor incorrect.	See *Calibrating the Steering Sensor Only.*
Intermittent steering sensor signal	Loose connector / wire	Check wiring between Steering sensor and Power module for loose connection.

Issues with Vehicle Speed Signal

Condition	Cause	Correction
System leveling excessively while driving.	Speed Sensor wiring shorted, broken, or disconnected	Inspect wiring and repair/replace as necessary
	Speed signal malfunction	Replace OEM speed sensor. See OEM service manual.
Intermittent speed sensor signal	Loose connector / wire	Check wiring between Speed sensor and Power module for loose connection.

Issues with Vehicle Brake Signal

Condition	Cause	Correction
Vehicle will not level	Brake signal wire not correctly tapped.	Inspect wiring and repair/replace as necessary.
	Brake switch malfunction	Replace OEM speed sensor. See OEM service manual.
Intermittent leveling	Loose connector / wire	Inspect wiring and repair/replace as necessary.

Issues with Door Switch

Condition	Cause	Correction
Vehicle will not kneel when rear door opened	Short or break in wiring between door switch and power module.	Inspect wiring and repair/replace as necessary.
	Door switch malfunction	Inspect door switch and repair/replace as necessary
Vehicle kneels whenever speed below 5mph	Short or break in wiring between door switch and power module.	Inspect wiring and repair/replace as necessary.
	Door Switch out of adjustment	Check installation of door switch and adjust as necessary
	Door switch malfunction	Inspect and replace per body builder instructions.
Intermittent door switch signal	Loose connector / wire	Inspect wiring and repair/replace as necessary.

Issues with Vehicle Ignition Signal

Condition	Cause	Correction
System does not turn on (no leveling or stiffness control)	No ignition signal to controller or driver interface	Inspect wiring and repair/replace as necessary.
	Ignition "sensor" malfunction	Inspect and replace per OEM service manual.
System does not turn off once ignition switched off	Signal side short to battery	Inspect wiring and repair/replace as necessary.
	Ignition "sensor" malfunction	Inspect and replace per OEM service manual.
System intermittently works	Loose connector / wire	Inspect wiring and repair/replace as necessary.

Issues with Vehicle Park Signal

Condition	Cause	Correction
System will start up but won't level when parked	No park signal to controller	Inspect wiring and repair/replace as necessary.
	Park sensor malfunction	Inspect and replace per OEM service manual.
System levels when stopped and not in park	Park signal always on	Inspect wiring and repair/replace as necessary.
	Park sensor malfunction	Inspect and replace per OEM service manual.
Intermittent leveling when stopped in or out of park	Loose connector / wire	Inspect wiring and repair/replace as necessary.

Issues with Power Module

Condition	Cause	Correction
Pump exhibits high pitch whine immediately after pump stops or when vehicle lowering	The Check Valve is stuck open	Replace Power Module
Pump running under heavy load and leveling slow	The Check Valve is only partially open	Replace Power Module
Pump running under heavy load and no leveling	The Check valve is stuck closed	Replace Power Module
Hydraulic fluid leaking from Power Module	O-ring failure	Replace O-ring
	Manifold cracked	Replace Power Module
	Fitting loose	Tighten fittings
	Valve loose	Tighten valves to correct torque
	Bolts between manifolds loose/broken	Replace and /or tighten bolts to correct torque
	Hydraulic line loose	Tighten hydraulic line correctly
	Bolts between reservoir and manifold loose/broken	Replace and/or tighten bolts to required torque
	Broken / cracked reservoir	Replace reservoir

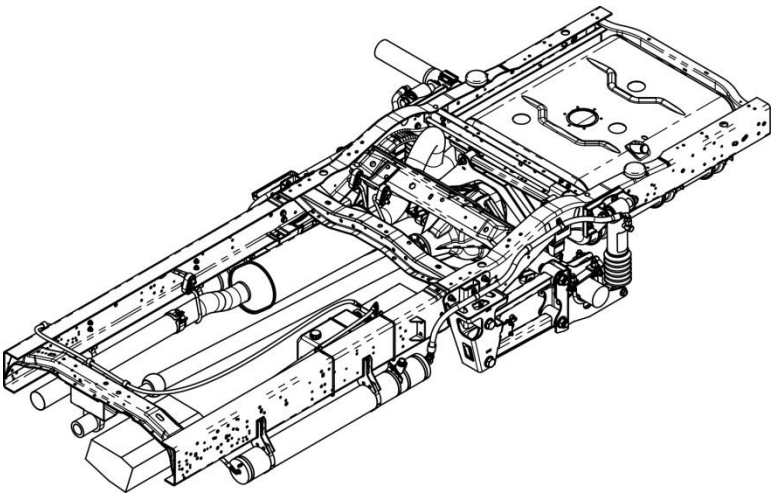
Issues with Strut Assembly

Condition	Cause	Correction
Hydraulic Leak	Weld failure between cylinder and end	Replace strut
	Cylinder fracture	Replace strut
	Threads stripped between cylinder and gland	Replace strut
	Seals worn out	Replace strut
	Rod severely scratched or dented	Replace strut
	Fitting loose	Tighten or replace fittings
	Hose failure	Replace failed hose
	Hose cut	Replace failed hose
Rod broken at bushing housing	Weld failure	Replace strut
Rod doesn't move freely in/out cylinder	Piston jammed in cylinder	Replace strut
Rod moves very easily in/out cylinder	Piston broken therefore no damping	Replace strut
Reduced damping level	Damping components broken/worn out	Replace strut
Strut upper mount not securely attached to frame or Strut	Bolts attaching bracket to frame broken / came out	Replace bolts and tighten to required torque
	Bolt attaching strut to bracket broke / came out	Replace bolts and tighten to required torque
	Weld Failure	Replace strut upper mount
	Structural failure	Replace strut upper mount
Strut lower mount not securely attached to axle or strut	Bolts attaching bracket to axle broken / came out	Replace bolts and tighten to required torque
	Bolt attaching strut to bracket broke / came out	Replace bolts and tighten to required torque
	Weld Failure	Replace strut lower mount
	Structural failure	Replace strut lower mount

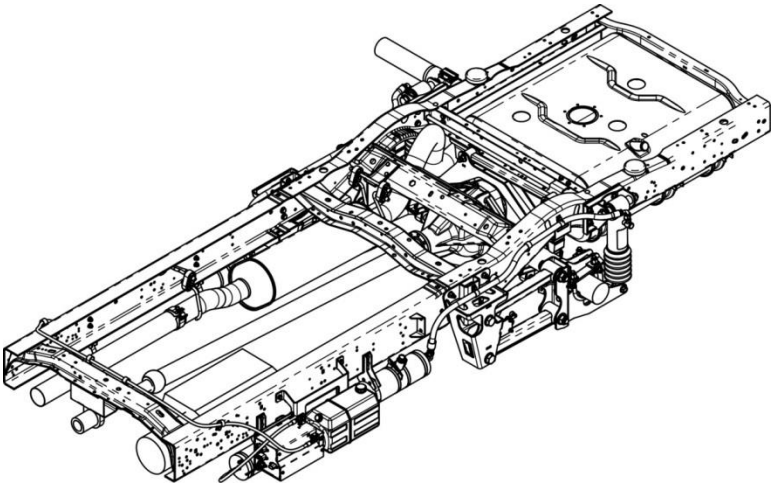
Issues with Secondary Volume Assembly

Condition	Cause	Correction
Hydraulic Leak	Weld failure between tube and end	Replace secondary volume welded assembly
	Weld failure between tube and manifold	Replace secondary volume welded assembly
	Cylinder fracture	Replace secondary volume welded assembly
	Bleed screw loose	Tighten bleed screws to appropriate torque
	Fitting loose	Tighten all fittings
	Hose failure	Replace failed hose
	Hose cut	Replace failed hose
loose or no longer attached	Bolts attaching bracket to frame broken / came out	Replace bolts and tighten to required torque
	Bolt attaching volumes to bracket broke / came out	Replace bolts and tighten to required torque
	Weld Failure	Replace brackets
	Structural failure	Replace brackets

Model Identification



DS96F-A



DS96F-B2

Parts List Information

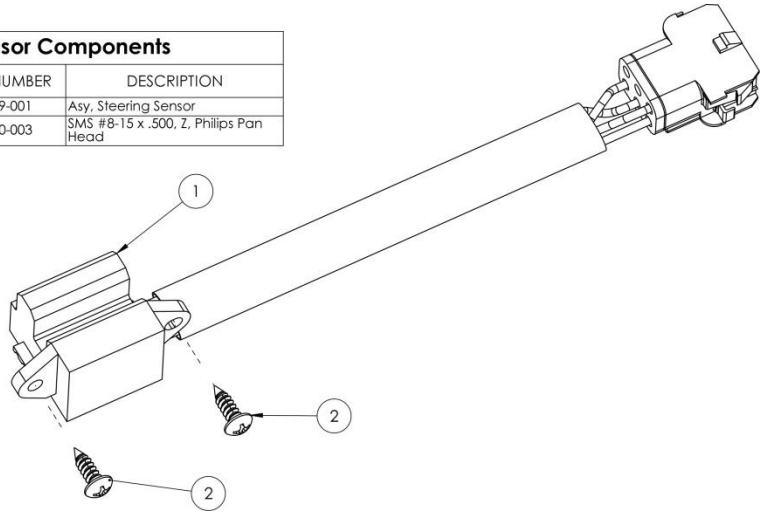
Abbreviations

HCS	Hex Cap Screw	HTCN	Hex Thin Castle Nut
HFB	Hex Flange Bolt	HFW	Hardened Flat Washer
SHCS	Socket Head Cap Screw	SLW	Spring Lock Washer
SFHS	Serrated Flange Hex Screw	SAE	SAE O-Ring Fitting
HN	Hex Nut, Non-locking	37°	SAE or JIC 37° Flare Fitting
LHN	Locking Hex Nut	LH	Left Handed Part
LFN	Locking Flange Nut	RH	Right Handed Part
CHN	Castle Hex Nut		

Part Identification

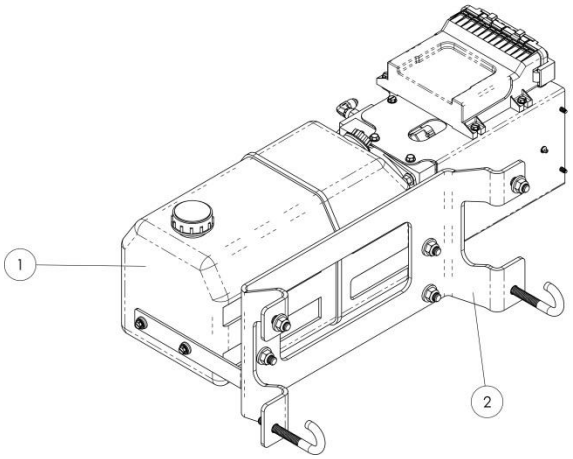
Steering Sensor Components

ITEM NO.	QTY.	PART NUMBER	DESCRIPTION
1	1	10649-001	Asy, Steering Sensor
2	2	10510-003	SMS #8-15 x .500, Z, Philips Pan Head

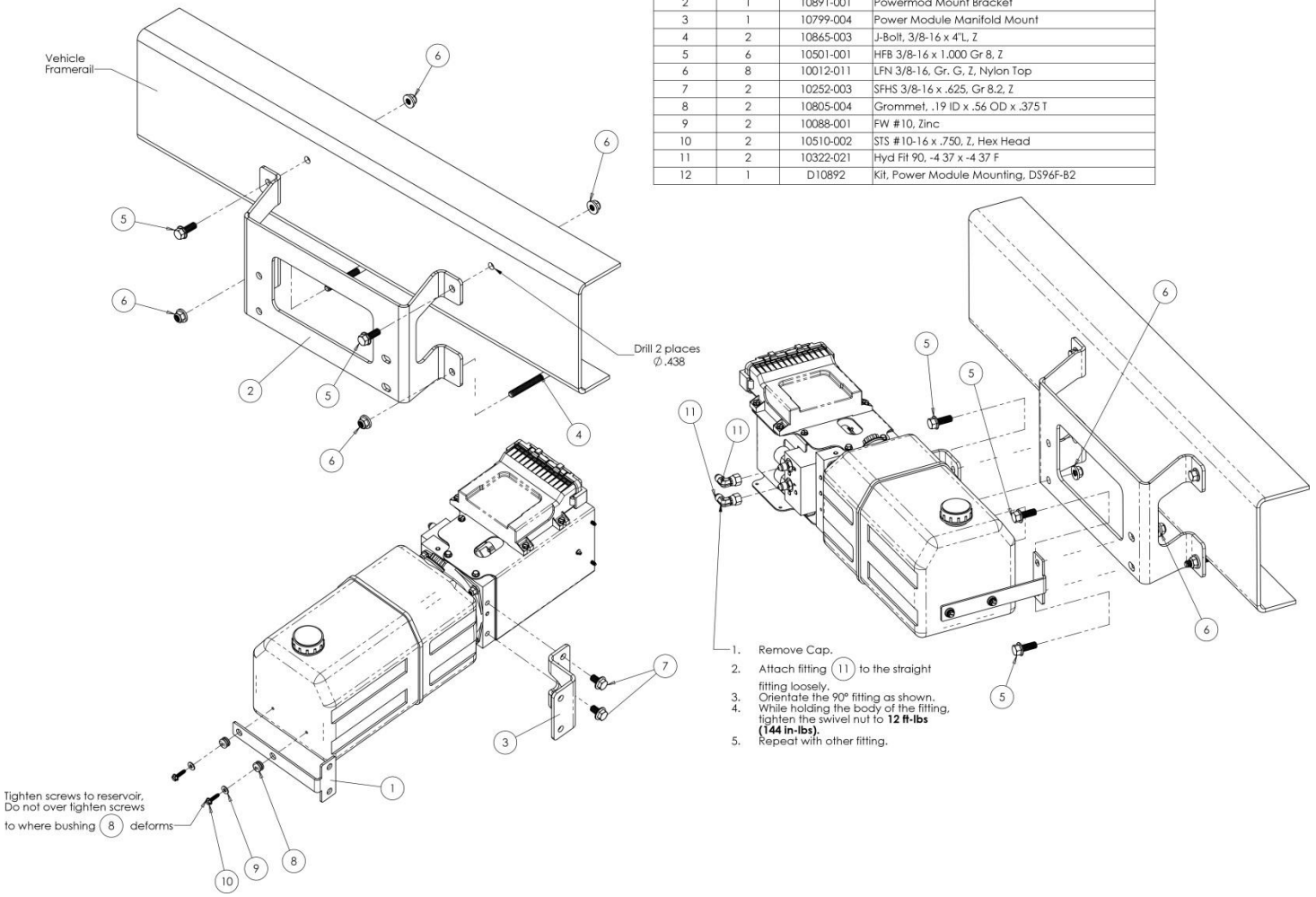


DS96F-B2 Power Module

Power Module Components			
ITEM NO	QTY.	PART NUMBER	DESCRIPTION
1	1	11013-001	Asy, Power Supply
2	1	10892	Kit, Power Module Mounting, DS96F-B2

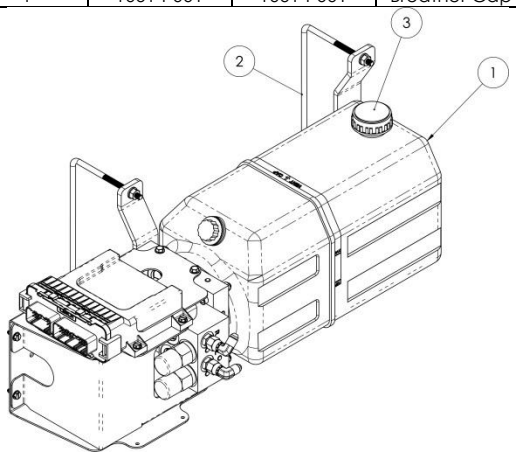


ITEM NO.	QTY.	PART NUMBER	DESCRIPTION
1	1	10798-004	Power Module Reservoir Mount
2	1	10891-001	Powermod Mount Bracket
3	1	10799-004	Power Module Manifold Mount
4	2	10865-003	J-Bolt, 3/8-16 x 4"L, Z
5	6	10501-001	HFB 3/8-16 x 1.000 Gr 8, Z
6	8	10012-011	LFN 3/8-16, Gr. G, Z, Nylon Top
7	2	10252-003	SFHS 3/8-16 x .625, Gr 8.2, Z
8	2	10805-004	Grommet, .19 ID x .56 OD x .375 T
9	2	10088-001	FW #10, Zinc
10	2	10510-002	STS #10-16 x .750, Z, Hex Head
11	2	10322-021	Hyd Fit 90, -4 37 x -4 37 F
12	1	D10892	Kit, Power Module Mounting, DS96F-B2

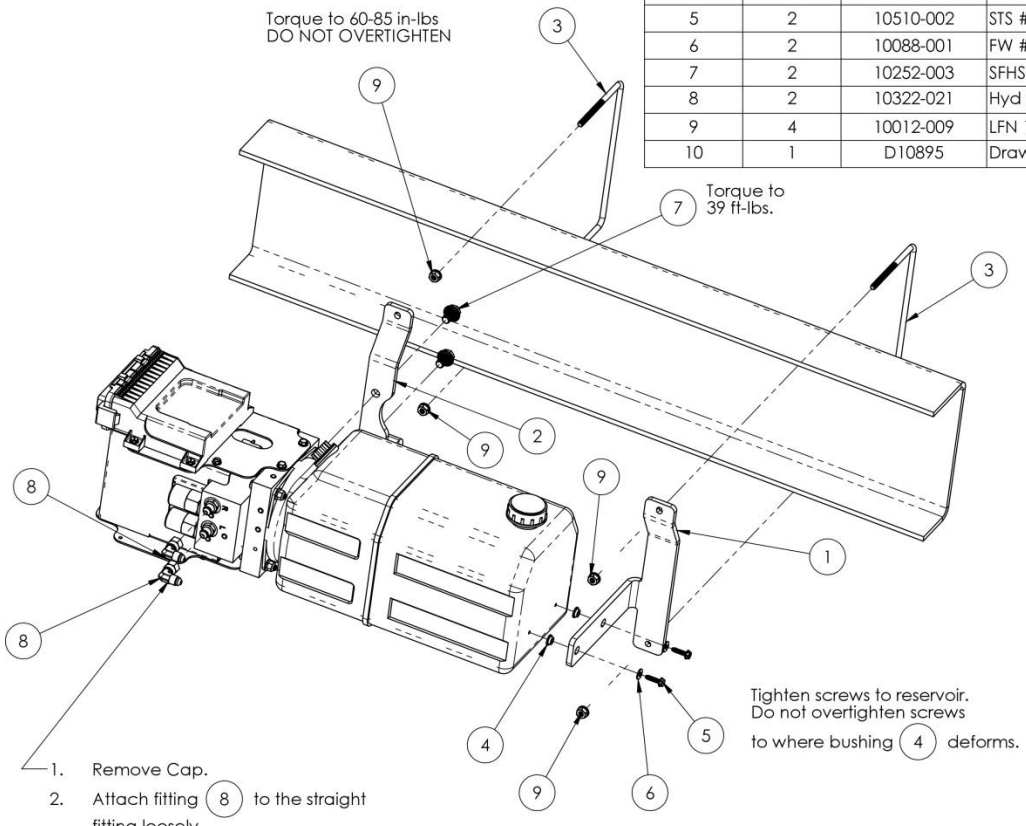


DS96F-A and DS96F-M Power Module

Power Module				
ITEM NO.	QTY	DS96F-A PART NUMBER	DS96F-M PART NUMBER	DESCRIPTION
1	1	11013-001	11013-002	Asy, Power Supply
2	1	10895	10895	Kit, Power Module Mounting
3	1	10614-001	10614-001	Breather Cap

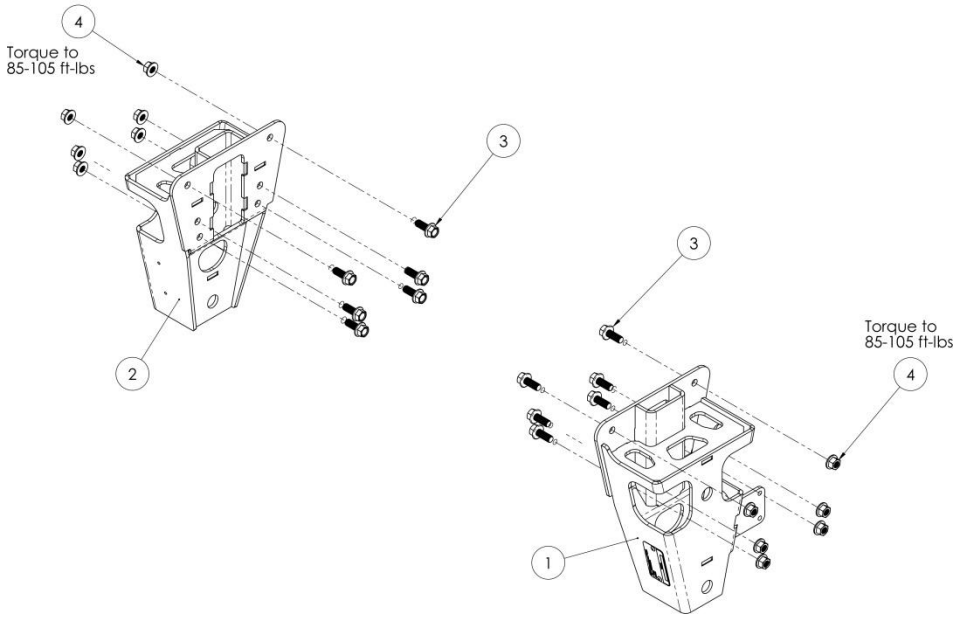


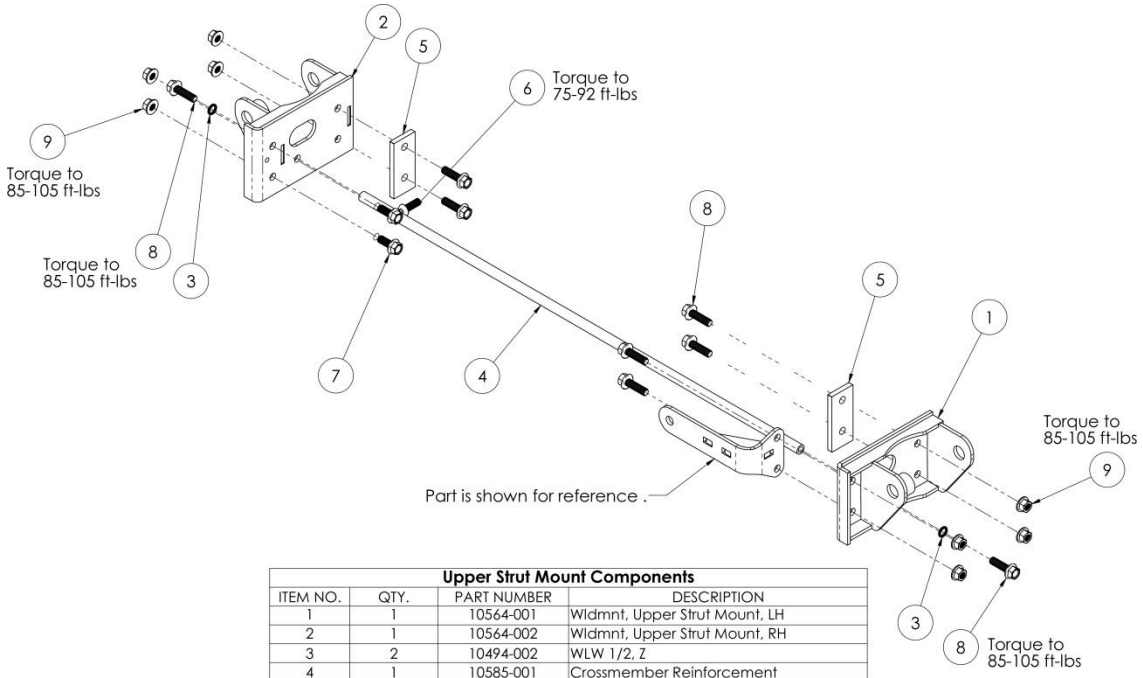
ITEM NO.	QTY	PART NUMBER	DESCRIPTION
1	1	10648-001	Power Module Reservoir Mount
2	1	10647-001	Power Module Manifold Mount
3	2	10669-001	U-Bolt
4	2	10670-001	Bushing, .189 ID x .175 T x.360 Mount
5	2	10510-002	STS #10-16 x .750, Z, Hex Head
6	2	10088-001	FW #10, Zinc
7	2	10252-003	SFHS 3/8-16 x .625, Gr 8.2, Z
8	2	10322-021	Hyd Fit 90, -4 37 x -4 37 F
9	4	10012-009	LFN 1/4-20, Gr. G, Black Phos
10	1	D10895	Drawing, Kit Installation



1. Remove Cap.
2. Attach fitting (8) to the straight fitting loosely.
3. Orientate the 90° fitting as shown.
4. While holding the body of the fitting, tighten the swivel nut to **12 ft-lbs (144 in-lbs)**.
5. Repeat with other fitting.

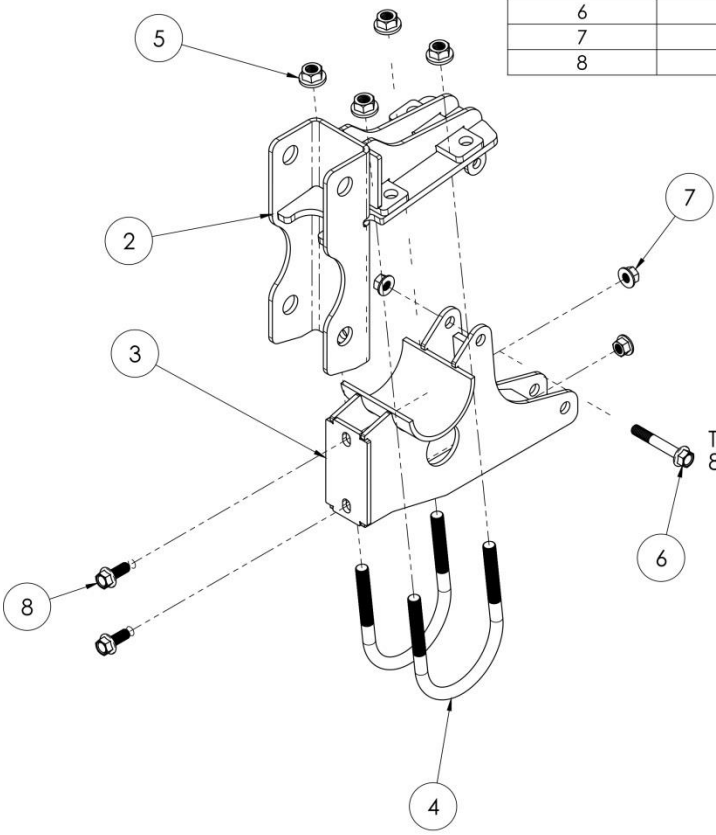
Front Hanger Components			
ITEM NO.	QTY.	PART NUMBER	DESCRIPTION
1	1	10538-001	Asy, Front Hanger, LH
2	1	10539-002	Weldment, Hanger, RH
3	12	10885-125	HFB 1/2-13x1.250, Gr. 8, BO
4	12	10012-007	LFN 1/2-13, Gr. G, Black Phos



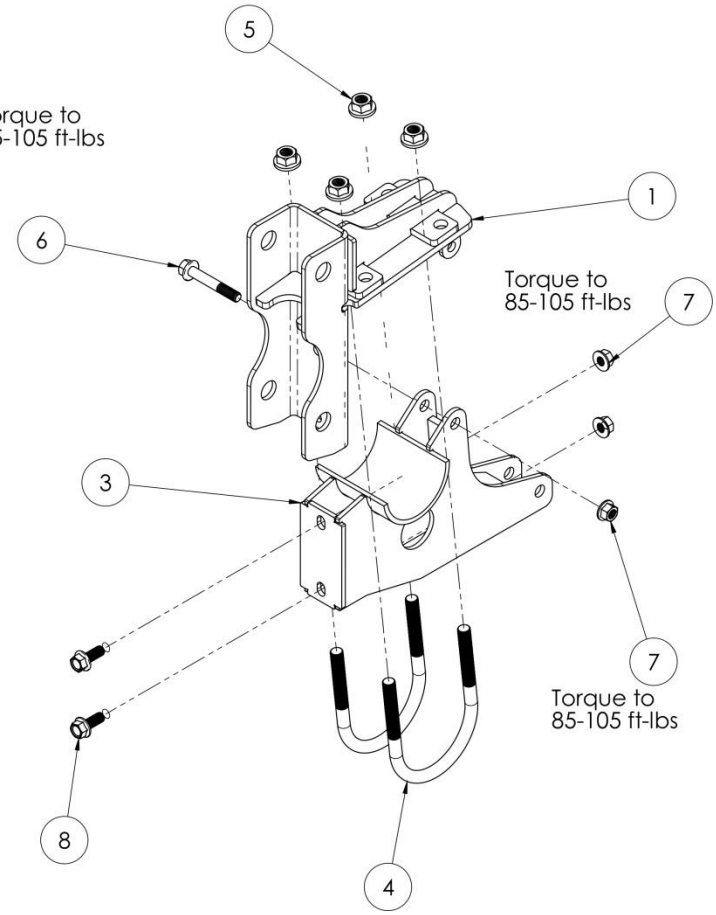


Upper Strut Mount Components			
ITEM NO.	QTY.	PART NUMBER	DESCRIPTION
1	1	10564-001	Wldmnt, Upper Strut Mount, LH
2	1	10564-002	Wldmnt, Upper Strut Mount, RH
3	2	10494-002	WLW 1/2, Z
4	1	10585-001	Crossmember Reinforcement
5	2	10569-001	Backing Plate
6	1	10512-001	BHCS M12-1.75x35 CL 10.9 BO
7	2	10885-125	HFB 1/2-13x1.250, Gr. 8, BO
8	8	10885-175	HFB 1/2-13 x 1.75, Gr 8, Z
9	8	10012-007	LFN 1/2-13, Gr. G, Black Phos

Axle Hanger Components			
ITEM NO.	QTY.	PART NUMBER	DESCRIPTION
1	1	10546-001	Wldmnt, Axle Seat, LH
2	1	10546-002	Wldmnt, Axle Seat, RH
3	2	10552-001	Weldment, Axle Cradle
4	4	10642-001	U-Bolt 5/8-18 x 7.00 Gr 8
5	8	10012-013	LFN 5/8-18, Gr. G, Black Phos
6	2	10885-325	HFB 1/2-13 x 3.25 Gr 8 Z
7	6	10012-007	LFN 1/2-13, Gr. G, Black Phos
8	4	10885-125	HFB 1/2-13x1.250, Gr. 8, BO

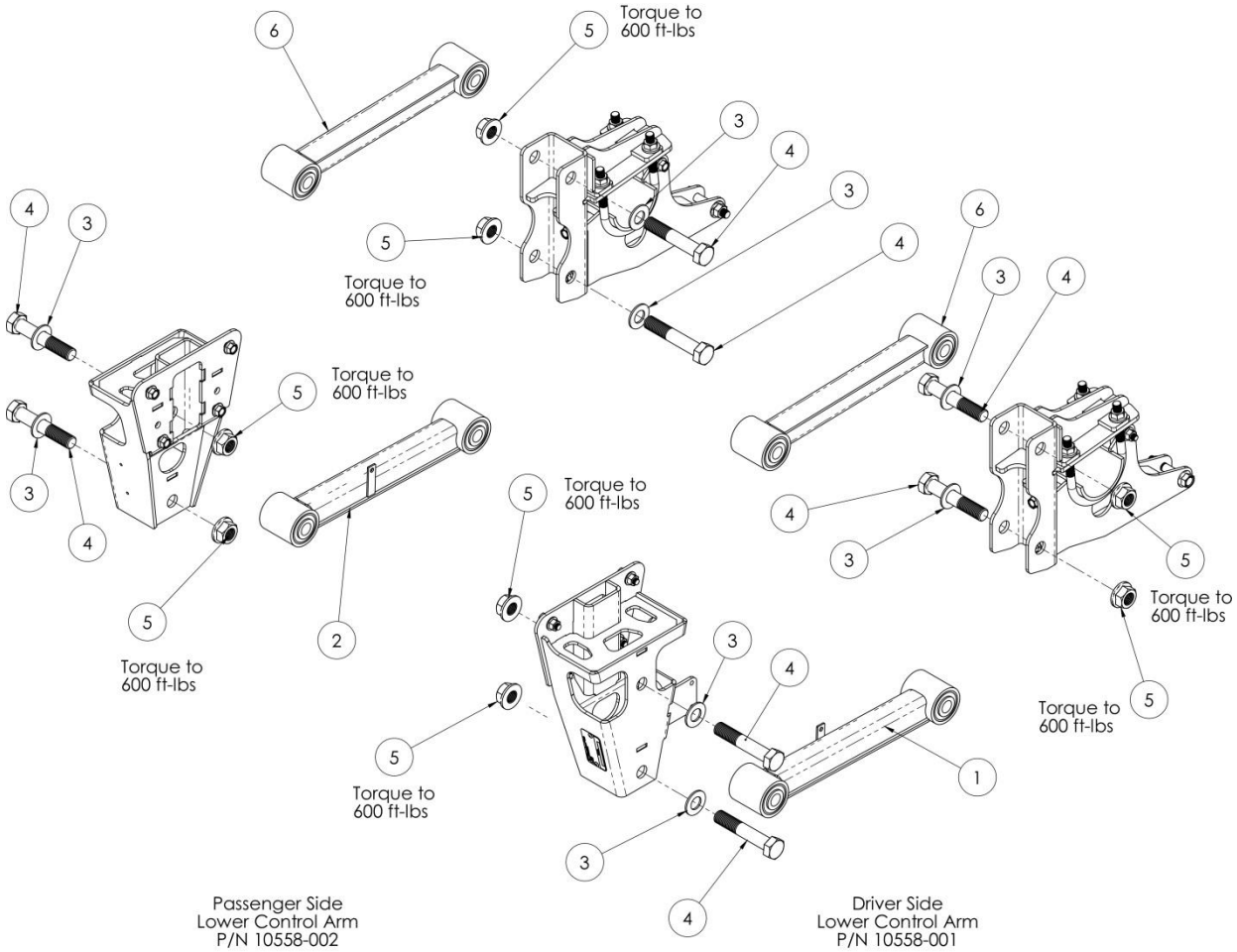


Torque U-Bolts evenly
in a X-type Pattern:
Stage 1: Torque to 75 ft-lbs
Stage 2: Torque to 150 ft-lbs
Stage 3: Torque to 175-200 ft-lbs



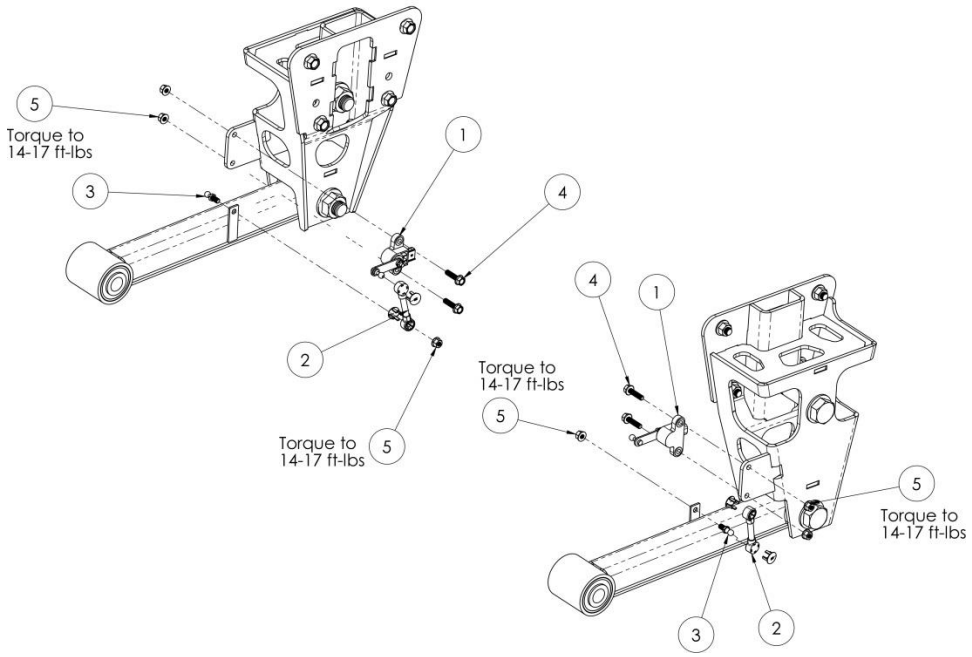
Control Arm Components			
ITEM NO.	QTY.	PART NUMBER	DESCRIPTION
1	1	10558-001	Asy, Control Arm, LH
2	1	10558-002	Asy, Control Arm, RH
3	8	10006-004	HFW 1.000, Zinc
4	8	10003-010	HCS 1-8x5.500, Gr. 8, Z
5	8	10012-003	LFN 1-8, Gr G, Z Top Lock
6	2	10720-001	Asy, Control Arm

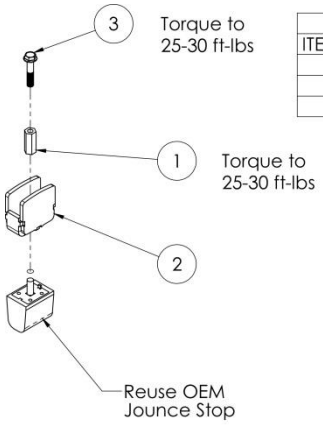
Some Components shown for reference only.



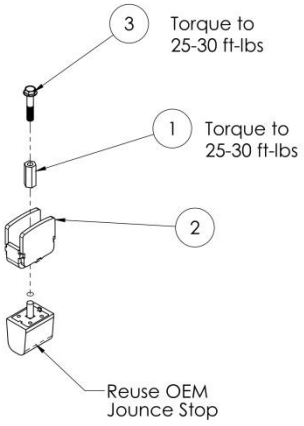
Height Sensor Components			
ITEM NO.	QTY.	PART NUMBER	DESCRIPTION
1	2	10586-001	Asy, Height Sensor
2	2	10587-001	Asy, Linkage
3	2	10591-001	Ball Stud, 10mm x 5/16-18
4	4	10886-125	HFB 5/16-18 x 1.25, Gr. 8, BO
5	6	10012-010	LFN 5/16-18, Gr. G, Black Phos

Some components shown for reference only.



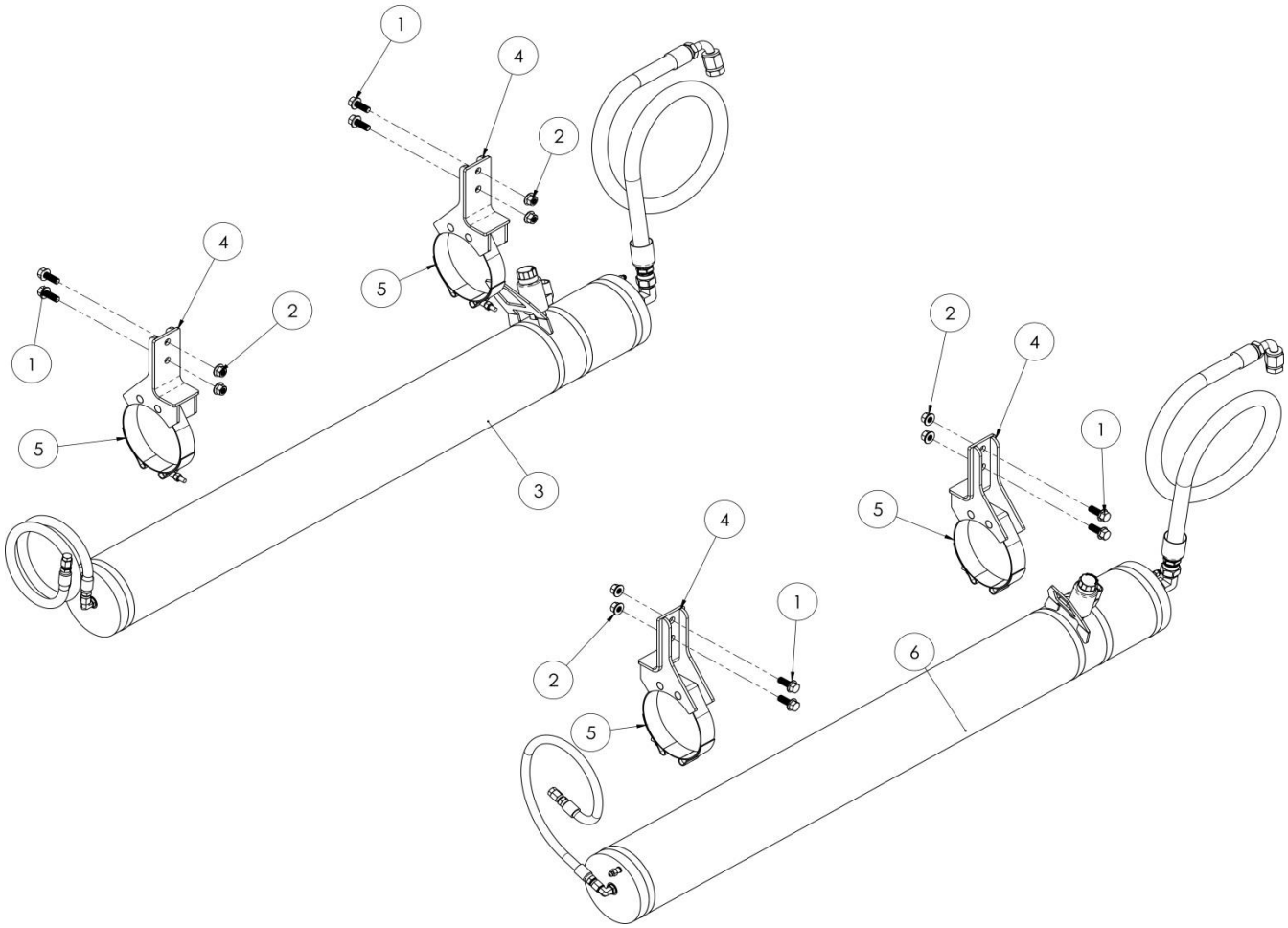


Jounce Bumper Components			
ITEM NO.	QTY.	PART NUMBER	DESCRIPTION
1	2	10595-001	Coupler, M10-1.5 x 1.500 in
2	2	10592-002	Wldmnt, Bump Stop Spacer
3	2	10502-050	HFB M10-1.5 x 50 CL 10.9 Z



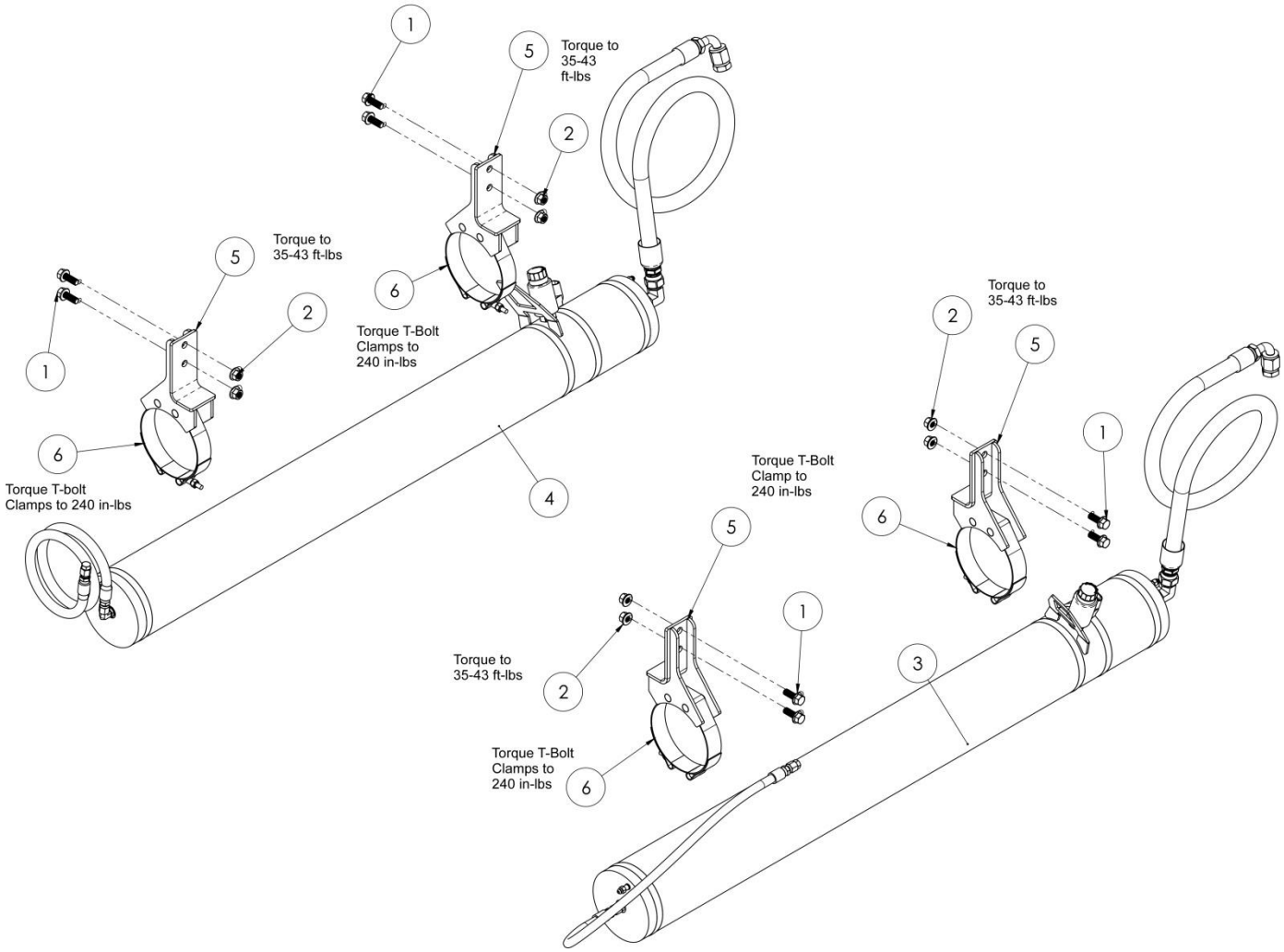
DS96F-A Secondary Volumes

Secondary Volume Components			
ITEM NO.	QTY.	PART NUMBER	DESCRIPTION
1	8	10501-001	HFB 3/8-16 x 1.000 Gr 8, Z
2	8	10012-005	LFN 3/8-16, Gr G, Z
3	1	10597-010	Asy, 2nd Vol 50 x 450, RH
4	4	10830-013	Wldmnt, Volume Mount, Bolt-on
5	4	10843-003	T-Bolt Clamp, Range 4.88-5.5
6	1	10597-020	Asy, 2nd Vol 50 x 450, LH

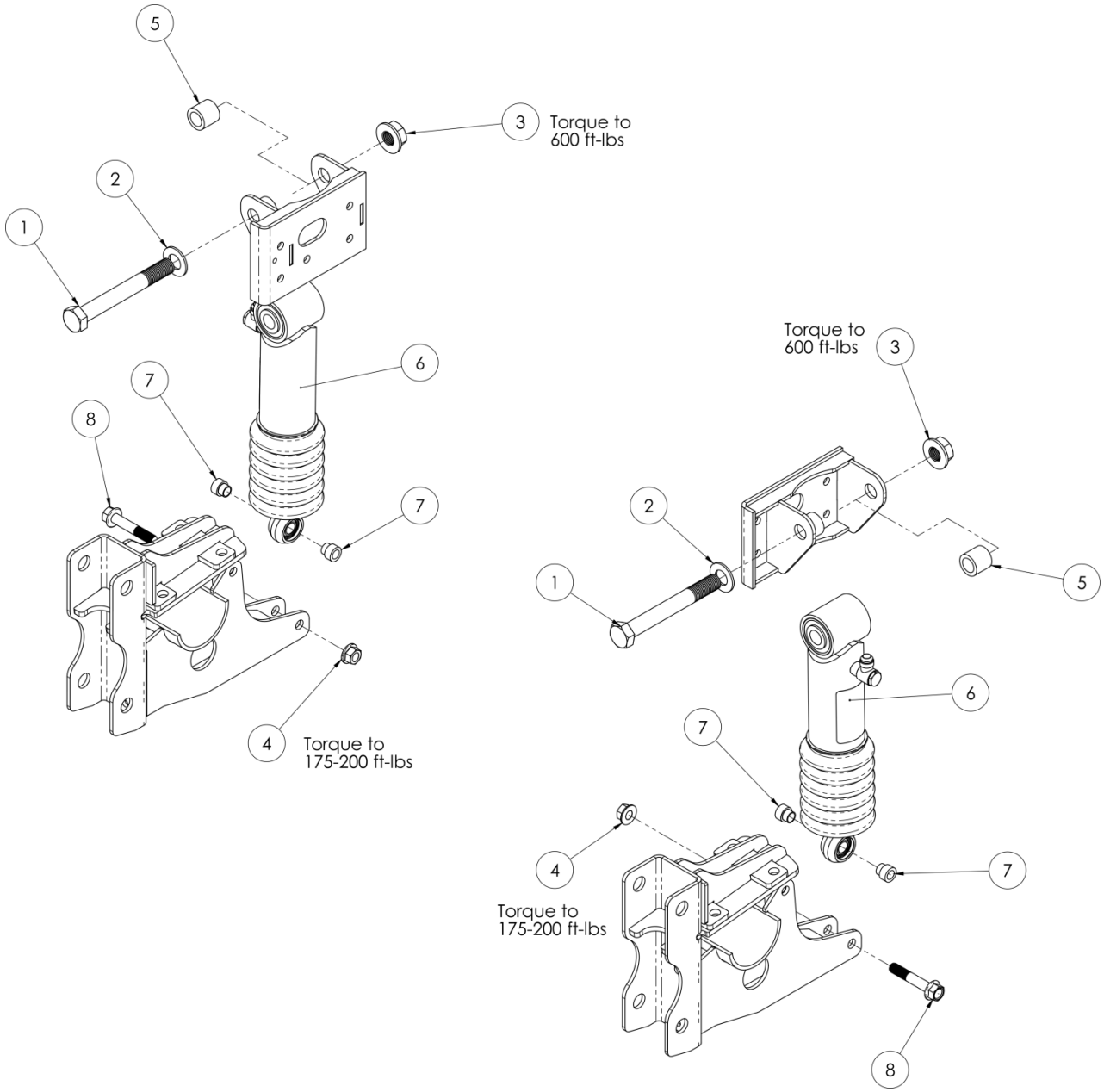


DS96F-B2 Secondary Volumes

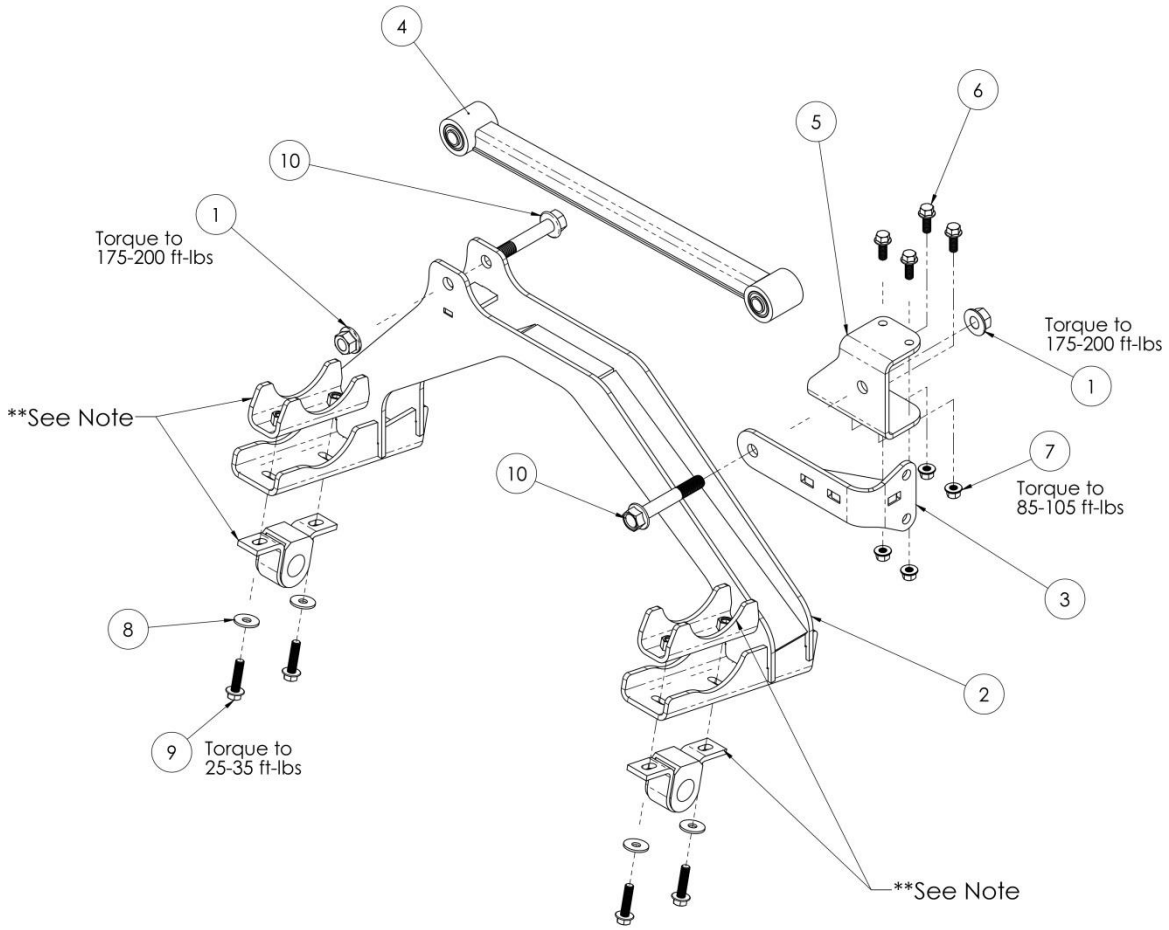
Secondary Volume Components			
ITEM NO.	QTY.	PART NUMBER	DESCRIPTION
1	8	10501-001	HFB 3/8-16 x 1.000 Gr 8, Z
2	8	10012-005	LFN 3/8-16, Gr G, Z
3	1	10597-009	Asy, 2nd Vol 50 x 450, LH
4	1	10597-010	Asy, 2nd Vol 50 x 450, RH
5	4	10830-013	Wldmnt, Volume Mount, Bolt-on
6	4	10843-003	T-Bolt Clamp, Range 4.88-5.5



Strut Components			
ITEM NO.	QTY	PART NUMBER	DESCRIPTION
1	2	10003-009	HCS 1"-8 x 8.000" Gr 8
2	2	10006-004	HFW 1"
3	2	10012-003	LFN 1"-8 Gr G
4	2	10012-008	LFN 5/8"-11 Gr. G
5	2	10567-002	Spacer, 1.5" OD x 1.06" ID x 1.355"
6	2	11071-001	Asy, Strut
7	4	10640-001	Bearing Spacer, 3/4" x 5/8" x 1/2"
8	2	10874-350	HFB 5/8"-11 x 3.500" Gr 8



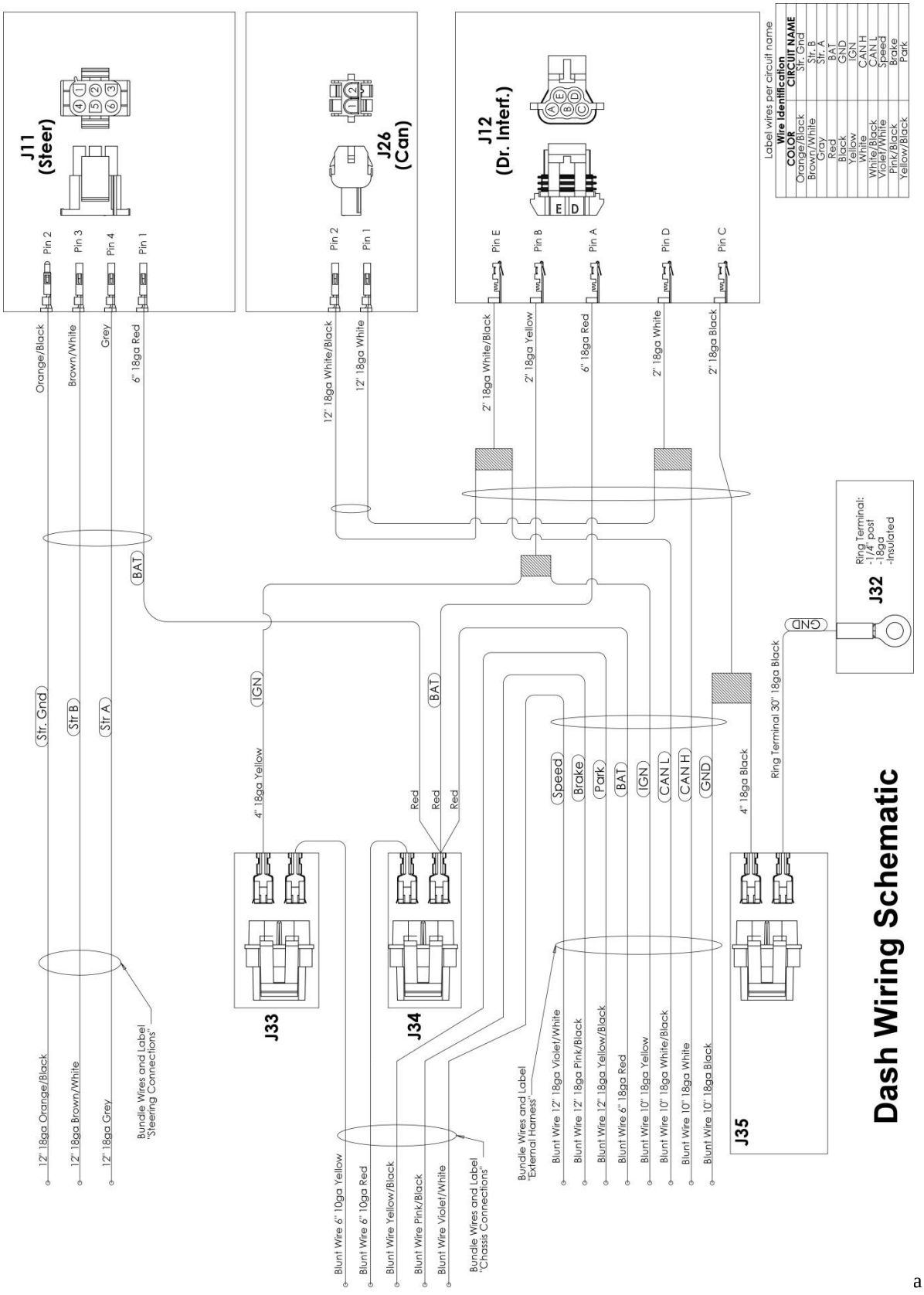
Track Rod Components			
ITEM NO.	QTY.	PART NUMBER	DESCRIPTION
1	2	10012-008	LFN 5/8-11 Gr G, Black Phos
2	1	10574-001	Wldmnt, Axle Bridge
* 3	1	10581-001	Wldmnt, Track Rod Mnt
* 4	1	10570-001	Asy, Track Rod
* 5	1	10584-001	Track Rod Mount
6	4	10501-001	HFB 3/8-16 x 1.000 Gr 8, Z
7	4	10012-005	LFN 3/8-16, Gr G, Z
8	4	10503-001	FW M10 30x10.5x2.5 Fender Z
9	4	10502-002	HFB M10-1.5x40 CL 10.9 Z
10	2	10874-400	HFB 5/8-11x4.00, Gr. 8, BO



* Items (3), (4), and (5) may be loosely assembled.

** OEM components, not supplied with kit.

Electrical Schematics



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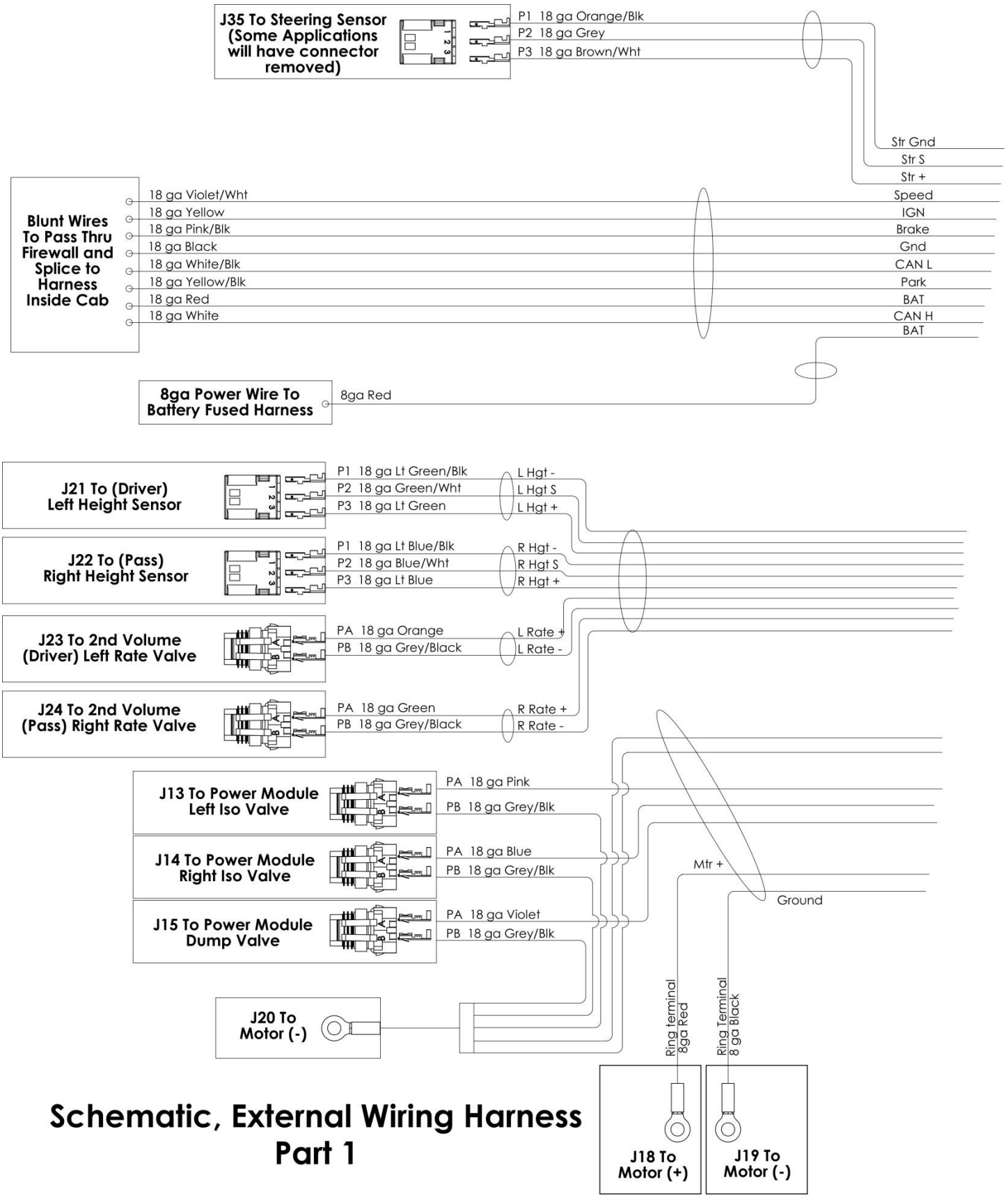
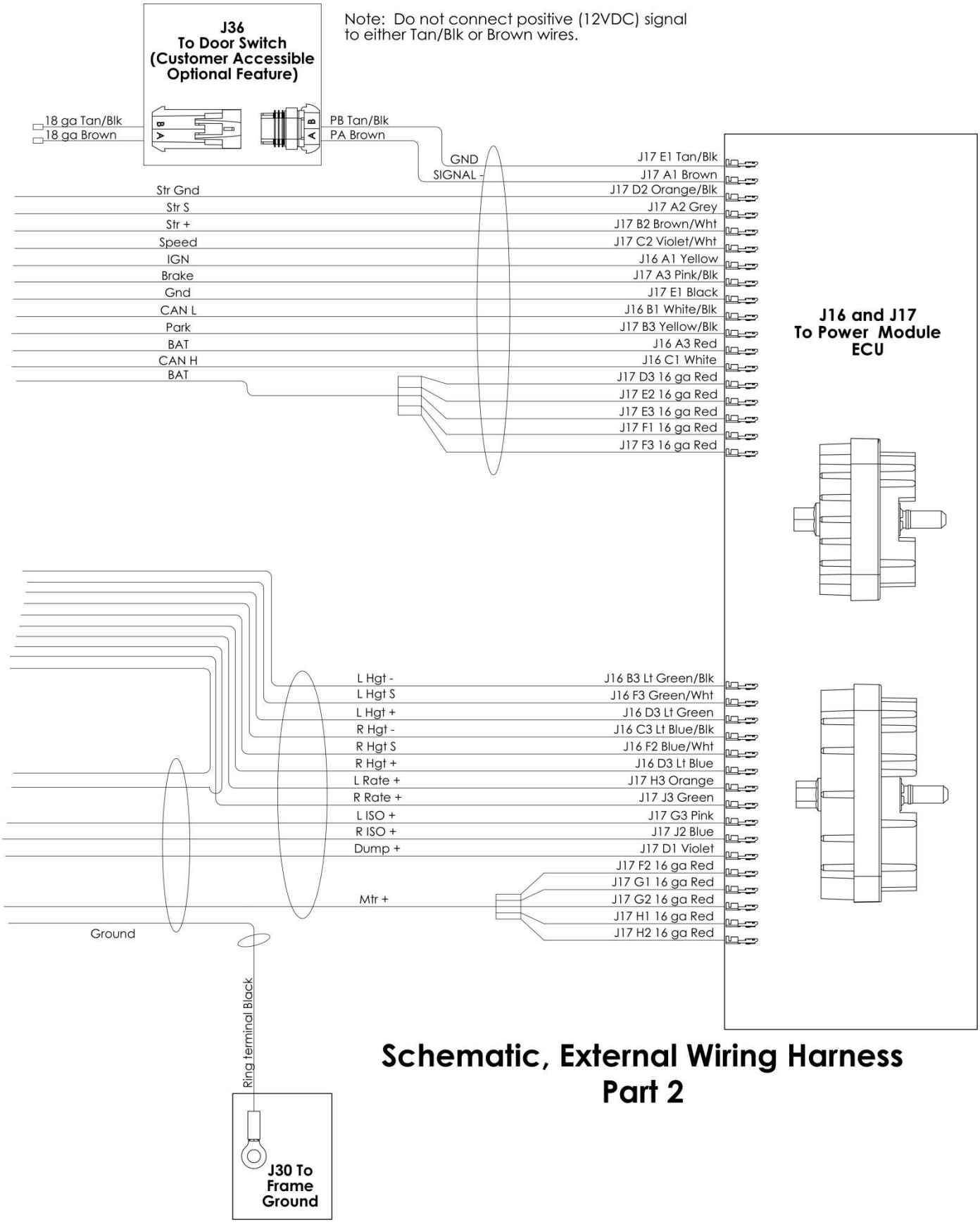
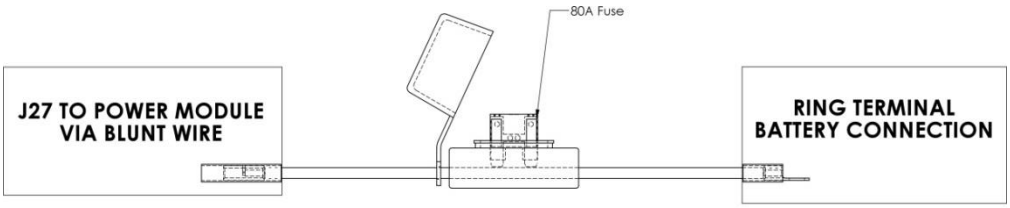


Schematic, External Wiring Harness Part 1



Schematic, External Wiring Harness Part 2



Schematic, Battery Fuse Lead

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