



FAILSAFE EMERGENCY BRAKE WORKSHOP MANUAL

VOLVO FMX 6X6



1. Revision History

Revision	Issue Date	Author	Comments
1	18 Sep 2020	M. O'Driscoll	Initial release.

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3. Important Information

This manual applies to the fourth generation ABT™ Failsafe for the Volvo FMX 6x6. The manual details how to install the ABT™ Failsafe system correctly to ensure optimum safety and performance. All information contained in this manual is based on the latest ABT™ Failsafe product information available at the time of publication.

This manual should be read in conjunction with the appropriate Volvo vehicle manual for further information on removal and installation of any standard Volvo components.

While every effort has been made to address all aspects of installation and servicing, please advise Advanced Braking of any omissions or suggestions on how this manual may be improved.

Advanced Braking Pty Ltd reserves the right to change the manual at any time without prior notice.

The most up to date version of the manual can be obtained by contacting the ABT Customer Service Manager.

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4. Terminology

ATF	Automatic transmission fluid
DPS	Door proximity system
Driveline Brake	Single brake unit acting on the rear axle differential
Emergency Brake	Brakes automatically applied in an emergency
EMMA™	Electronically Modulated Mechanically Applied
OEM	Original equipment manufacturer
Park Brake	Brakes applied independently of the service brake
PWI	Pad wear indicator
ABT™ Failsafe Emergency	Differential mounted fully sealed brake with SAHR
ABT™ Cooling Fluid	Specially formulated cooling fluid for use in ABT™ Failsafe and Failsafe Emergency brakes
SAHR	Spring Applied Hydraulic Release

5. Brake Description

The ABT™ Failsafe Emergency is a Spring Applied Hydraulic Release system operating in isolation from any other braking system fitted to the vehicle. ABT™ Failsafe Emergency has been configured for mounting to the driveline of heavy goods vehicles. The brake is bolted to the input side of the rear differential carrier. The torque generated by the brake is transmitted to the rear wheels via the differential and axle shafts.

The ABT™ Failsafe Emergency brake operates as a spring applied hydraulic release emergency driveline brake only. The hydraulic system has been designed to modulate the application preventing shock loads damaging the driveline.

ABT™ Failsafe Emergency is an enclosed single rotor high-speed disc brake. It provides greater reliability in a compact enclosed package. The brake is designed for harsh mining environments and can be submerged for short periods without affecting operation.

6. Important Emergency Brake Information

1. The brake is intended as an emergency brake only for use in the event of a service brake system failure. The system is not designed as an additional service brake.
2. The brake also acts as an additional parking brake.
3. Do not perform dynamic stops unless in an emergency situation. If the brake is used in an emergency situation it is recommended to strip and inspect the brake and diff components.
4. The ABT™ Failsafe Emergency driveline brake is not designed as a vehicle retarder and should only be used in the case of an emergency.
5. *The ABT™ Failsafe Emergency Driveline Brake System HV19 is designed for “off highway” use. Whilst it is possible to operate the vehicle with the brake attached at highway speeds without damage, unintended application of the brake will rapidly and effectively arrest the vehicle. ABT™ recommends that the brake is disabled for highway use or when the vehicle is to be driven above speeds of 60kph by installing the supplied retractor bolts. This recommendation applies to delivery of the vehicle to site and any other extended “on highway” or “above speeds of 60kph” use.*

WARNING:



Before operating the vehicle on a mine site, the retractor bolts **MUST** be removed and replaced with plugs and pad wear indicator. Power to the control box **MUST** be restored.

IMPORTANT:

Ensure the ABT™ Failsafe caution and warning labels are attached to a prominent position on the windshield. Refer Section 14.

IMPORTANT:

Ensure the Control Box Tag is attached to the Control Box if the brake has been made inoperable due to the fitment of retractor bolts. While retractor bolts are fitted the Failsafe Emergency control system must be made inoperable by disconnecting the control box on the dash or by removing the main fuses from the battery power harness.

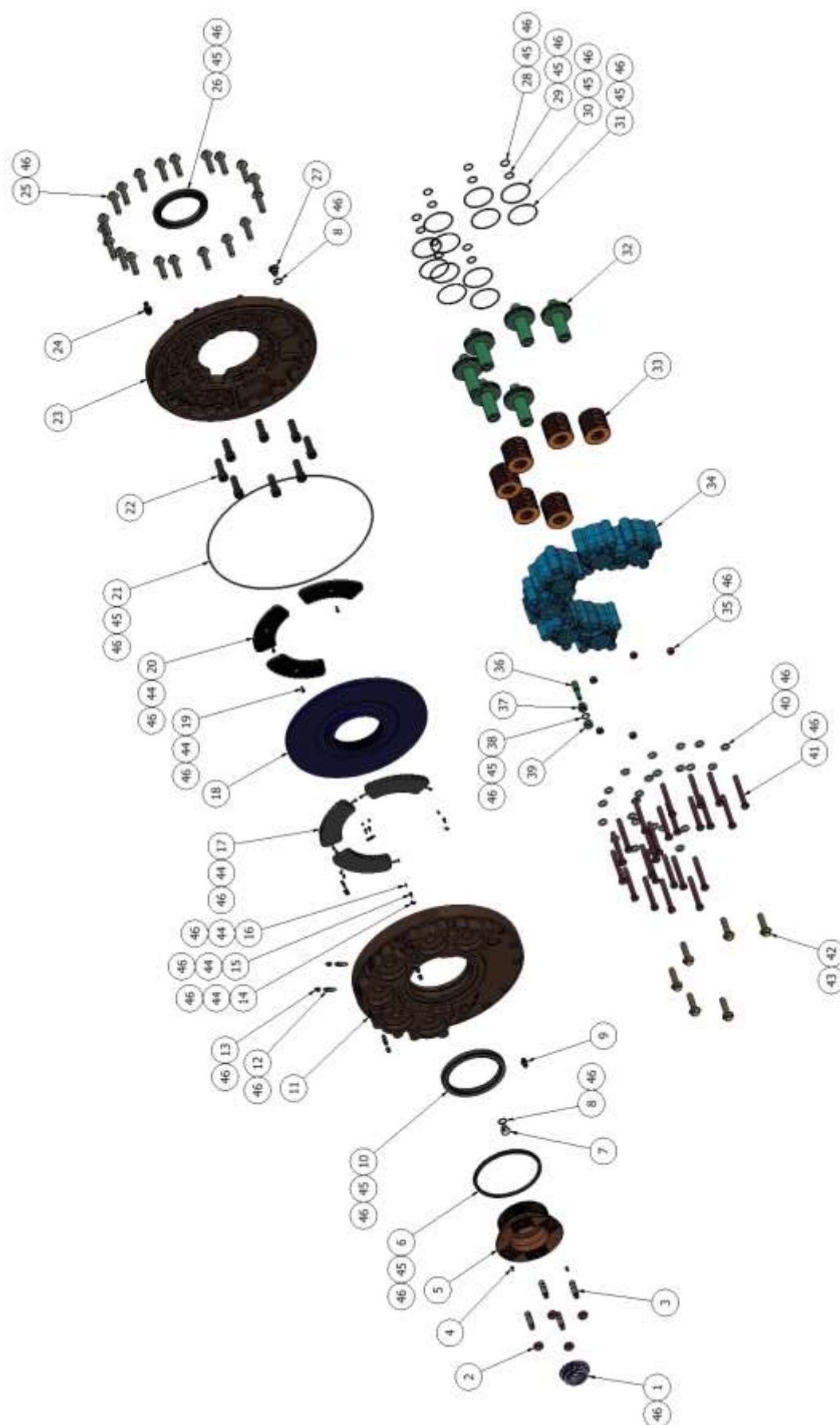
IMPORTANT:

If the vehicle is to be used on public roads it will require approval for road use.

- a. All vehicles can be fitted with an aftermarket modification plate.
- b. Please contact ABT™ customer service for details regarding Failsafe Emergency brake equipped vehicles requiring approval.

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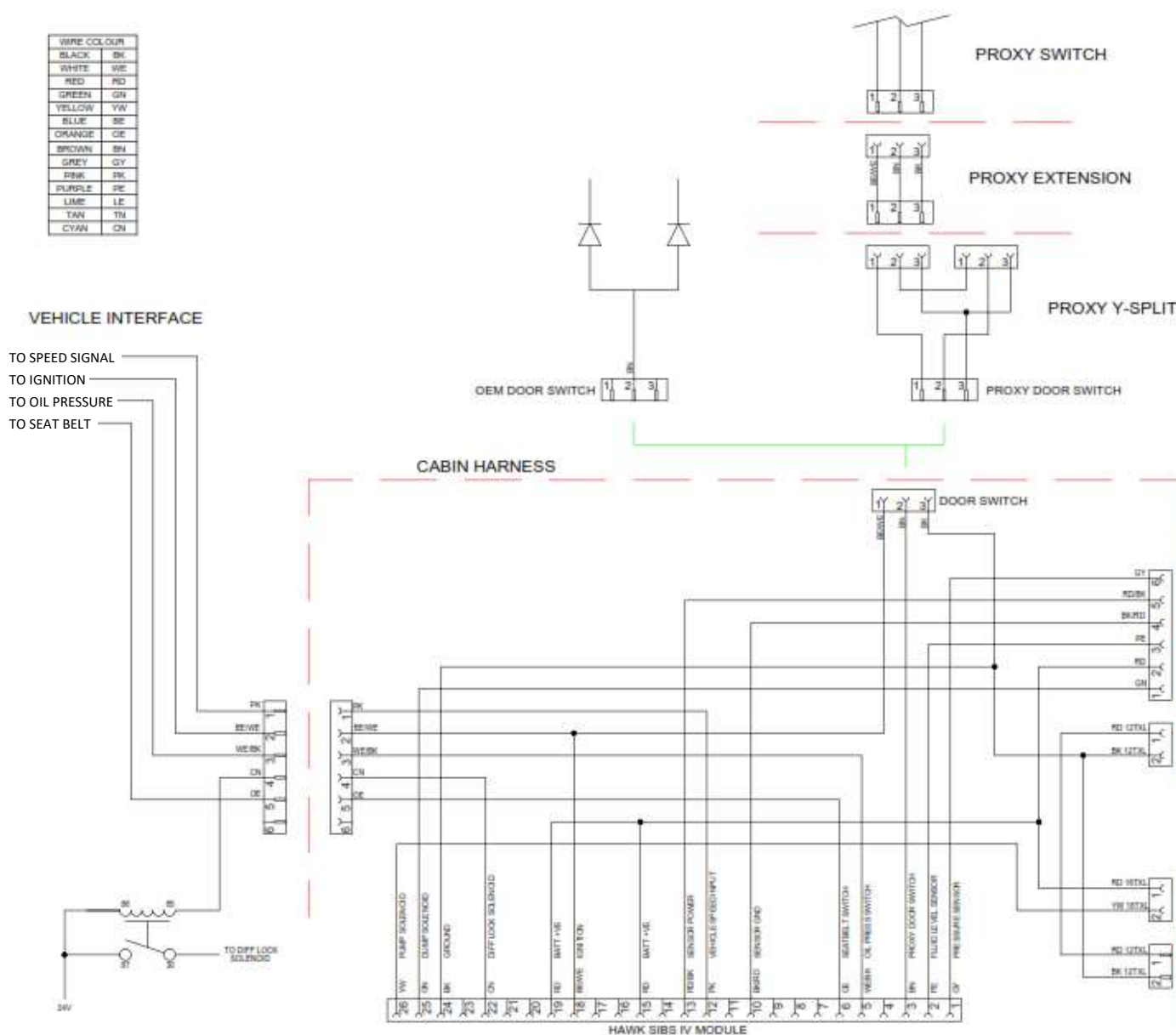
7. Exploded Views & Parts Lists - Differential Brake Assembly

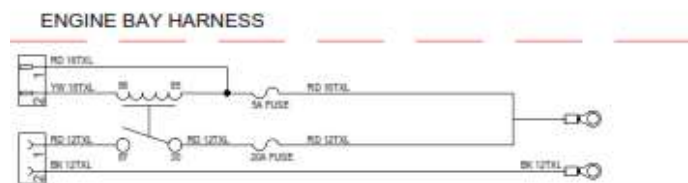
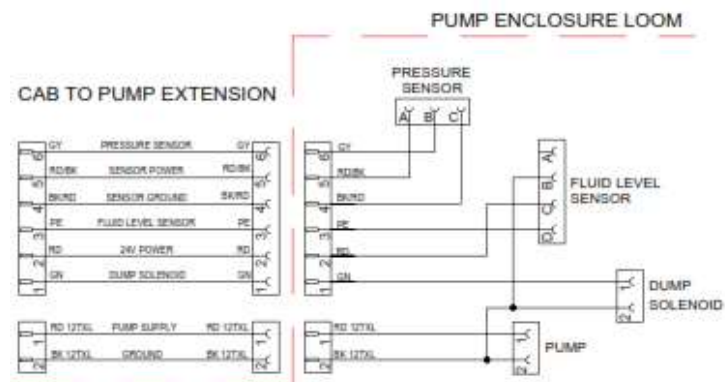


ITEM	PART NO.	DESCRIPTION	QTY/ BRAKE	TORQUE (Nm)
1	19-9045	DRIVE PINION NUT VOLVO	1	2000-2200
2	19-9034	NUT MOUNTING YOKE VOLVO	4	180
3	16-2010	STUD DRIVE YOKE M14	4	100
4	31-5015	GREASE NIPPLE	2	5
5	19-2060	YOKE ROTOR CARRIER HV19 VOLVO	1	-
6	31-4014	SEAL V-LIP	1	-
7	31-5035	FILL PLUG	1	20
8	30-2003	WASHER SEALING COPPER	2	-
9	31-5000	CONNECTOR HOSE EMMA	1	10
10	31-4010	CASSETTE SEAL	1	-
11	19-2016	HOUSING OUTER	1	-
12	31-5001	BLEED NIPPLE	4	15
13	31-9000	CAP BLEED NIPPLE	4	-
14	19-2006	BRACKET BRAKE PAD RETAINING	6	-
15	30-0011	BOLT BRACKET PAD RETAINING	6	5
16	19-2017	SPRING BRAKE PAD RETAINING	6	-
17	16-4002	BRAKE PAD OUTER	3	-
18	19-2003	BRAKE ROTOR	1	-
19	30-0031	BOLT BRAKE PAD RETAINING	3	5
20	16-2008	BRAKE PAD INNER	3	-
21	31-2018	O-RING HOUSING	1	-
22	30-0118	BOLT BRAKE MOUNTING VOLVO	8	280-320
23	19-2020	HOUSING INNER	1	-
24	31-5032	CONNECTOR BARB BREATHER HOSE	1	20
25	30-0028	BOLT BRAKE HOUSING	20	158
26	31-4026	PINION SEAL VOLVO 6x6	1	-
27	25-2039	DRAIN PLUG	1	20

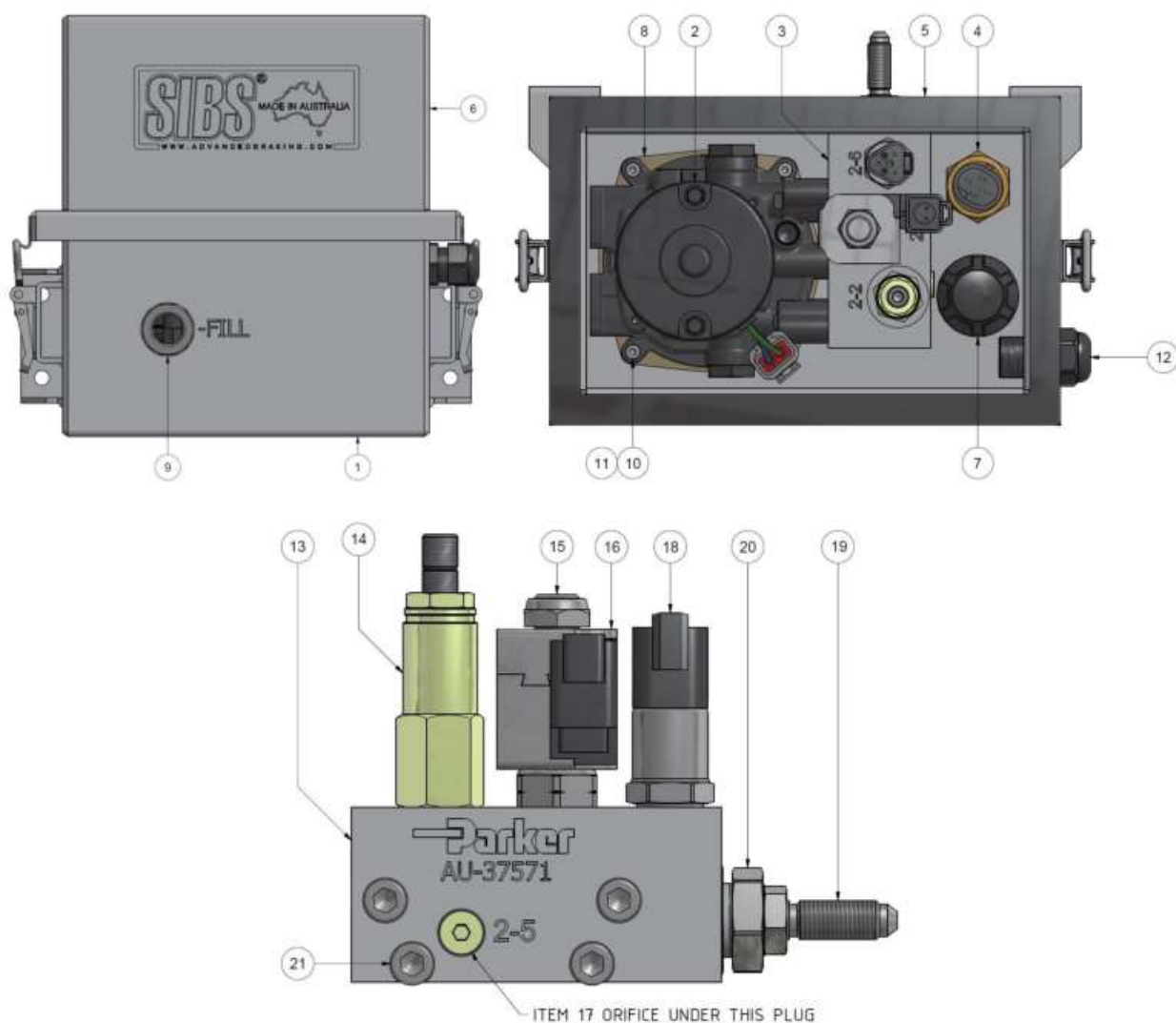
28	31-2001	BACK-UP WASHER SMALL EMMA PISTON	6	-
29	31-2000	O-RING SMALL EMMA PISTON	6	-
30	31-2002	O-RING LARGE EMMA PISTON	6	-
31	31-2003	BACK-UP WASHER LARGE EMMA PISTON	6	-
32	19-2004	PISTON EMMA	6	-
33	31-0002	DISC SPRING	96	-
34	19-2023	COVER SPRING EMMA	3	-
35	31-5028	PLUG SPRING COVER	5	12
36	19-2013	PLUNGER PAD WEAR INDICATOR	1	15
37	25-2041	PLUG PAD WEAR INDICATOR	1	15
38	30-2005	WASHER PAD WEAR INDICATOR	1	-
39	25-2042	CAP PAD WEAR INDICATOR	1	10
40	30-2015	WASHER FLAT SPRING COVER	24	-
41	30-0040	SPRING COVER BOLT	24	120
42	30-2025	WASHER RETRACTOR BOLT	6	-
43	30-0028	RETRACTOR BOLT	6	-
44	19-5000	KIT BRAKE PAD	1	-
45	19-5009	KIT SEAL VOLVO 6X6	1	-
46	19-5010	KIT MAJOR SERVICE VOLVO 6X6	1	-

8. Wiring Diagram





9. Pump Hardware Parts List



ITEM	PART NO.	DESCRIPTION	QTY/KIT
-	18-4025	ENCLOSURE HYDRAULIC ASSEMBLY 24V	1
1	18-9015	ENCLOSURE BASE/RESERVOIR	1
2	18-9019	MOTOR ELECTRIC 24V	1
3	18-9025	MANIFOLD ASSEMBLY 24V	1
4	18-9027	LEVEL SENSOR	1
5	18-9028	ENCLOSURE GASKET	1
6	18-9028	ENCLOSURE LID	1
7	18-9024	FILL CAP	1

8	18-9029	POWER UNIT GASKET	1
9	18-9030	LEVEL WINDOW	1
10	18-9031	SCREW POWER UNIT	4
11	18-9032	WASHER SPRING POWER UNIT	4
12	18-9033	CABLE GLAND	1
13	18-9034	MANIFOLD BLOCK	1
14	18-9035	RELIEF VALVE	1
15	18-9036	SOLENOID VALVE	1
16	18-9022	COIL 24V	1
17	18-9037	ORIFICE 0.5mm	1
18	18-9017	PRESSURE SENSOR	1
19	18-9038	BULKHEAD FITTING	1
20	18-9039	ADAPTER FITTING MANIFOLD TO BULKHEAD	1
21	18-9040	SCREW MANIFOLD BLOCK	4
22	18-4033	MANIFOLD O-RING SEAL KIT	1

10. Installation – Driveline Brake (Heavy Trucks)

WARNING:


Always wear a respirator when working around brakes or brake lining dust. Always wear eye and hand protection.

2. Ensure vehicle inter axle diff lock is in working order prior to installation.
3. The ABT™ Failsafe Emergency driveline brake is installed on the rear most differential carrier.

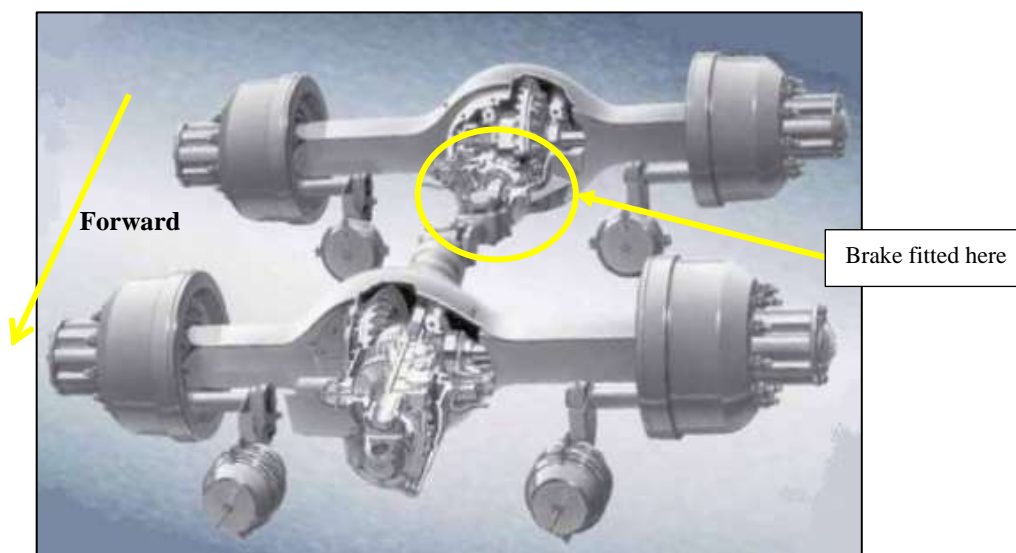


Figure 1: Rear Tandem Drive Axles.

IMPORTANT:

A special brake mounting adapter flange frame and mounting studs are required to fit the ABT™ Failsafe Emergency driveline brake to the differential.

4. Drain and keep enough diff oil from the rear-rear differential carrier to prevent spillage as the differential carrier will be removed for Failsafe Emergency brake installation.
5. Remove drive shaft from the vehicle.

IMPORTANT:

The driveshaft must be shortened by 85 mm and then rebalanced.

6. Remove the rearmost differential carrier.
 - a. Remove the 2x rearmost axle half-shafts.
 - b. Remove and discard the 4x M16 mounting nuts and the 12x M16 mounting bolts from the differential carrier.

- c. Carefully remove the differential carrier assembly from the axle.

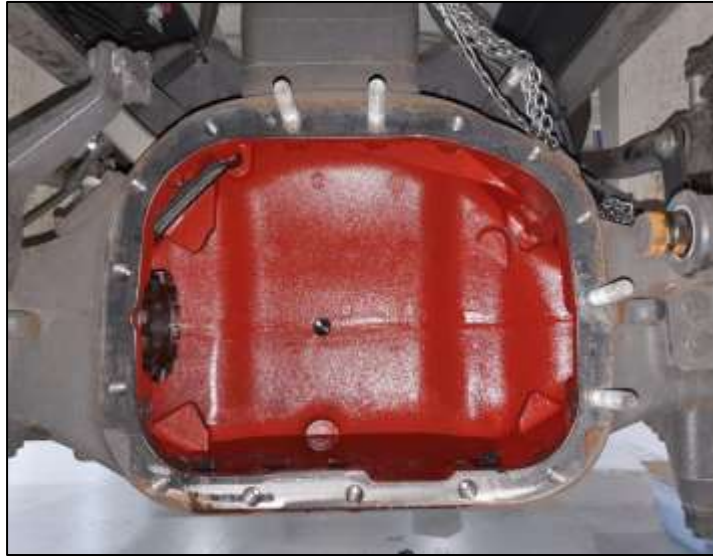


Figure 2: Differential carrier removed.

- d. Remove and discard the 4x M16 mounting studs from the axle.
- e. Clean off any traces of liquid gasket or sealant from the differential carrier and axle flanges.
- f. Mount the differential carrier securely on a clean bench or carrier stand.
- g. Remove and discard the pinion nut.
- h. Remove and discard the yoke.
- i. Remove and discard the pinion seal.
- j. Ensure no dirt ingress into the diff centre.
7. Apply Loctite 243 to the threads on the short end of the special 16x differential carrier mounting studs.
8. Attach the 16x mounting studs to the axle housing and torque 70 – 80 Nm.
9. Insert the pinion seal into the adapter flange frame.
10. Attach the O-ring seal to the adapter flange frame.

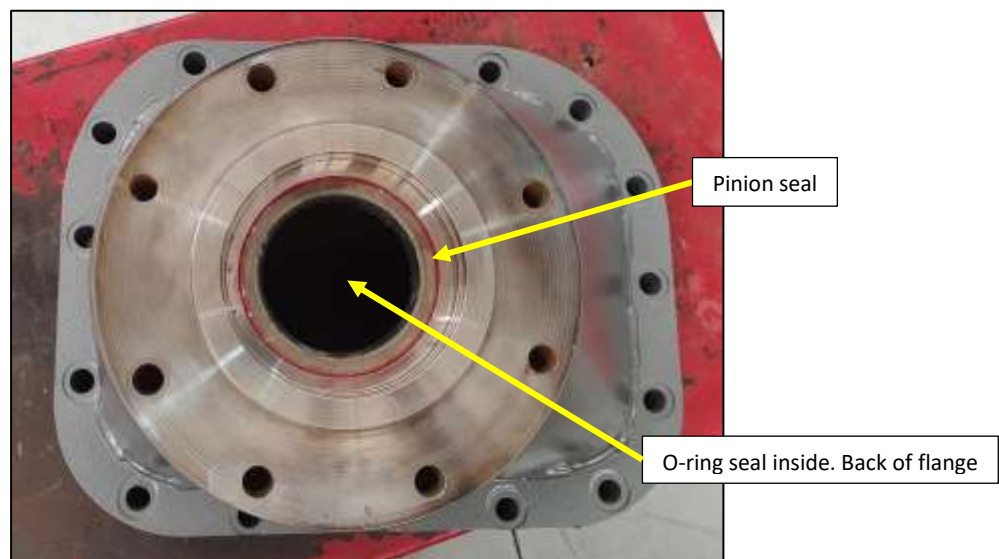


Figure 3: Brake mounting adapter flange with pinion seal.

11. Apply a continuous bead of sealing compound to the rear axle differential carrier flange as per Volvo/Meritor manual.
12. Attach the differential carrier to the axle housing.



Figure 4: Outer housing, yoke and rotor assembly.

13. Attach the brake mounting adapter flange frame to the differential carrier. Ensure they are aligned correctly and the O-ring seal does not get pinched.
14. Attach 16x hardened flat washers over the ends of the mounting studs.
15. Attach 16x flange nuts and tighten in a star pattern. Torque 280 – 320 Nm.

Apply Loctite 515 to flange

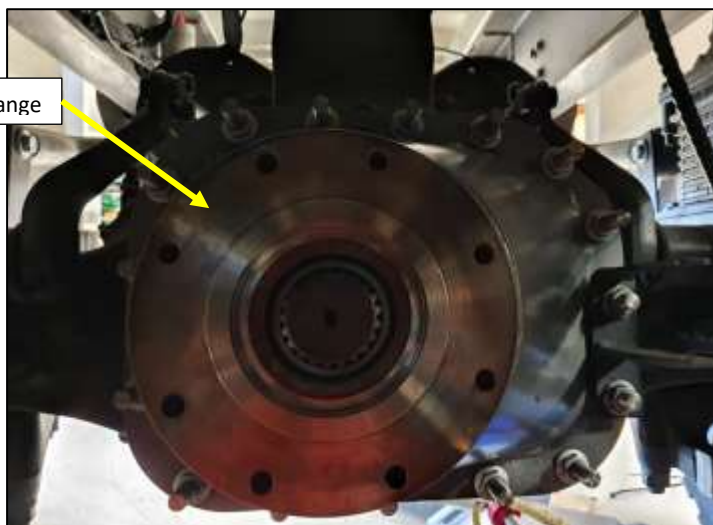


Figure 5: Outer housing, yoke and rotor assembly.

16. Apply Loctite 515 between the brake mounting adapter flange and the Failsafe Emergency inner brake housing.
17. Attach the inner housing with the brake pads positioned to the top of the brake.
18. Apply Loctite 243 to the first five threads of the 8x brake mounting bolts.
19. Attach the mounting bolts. Torque 280 – 320 Nm. Repeat 3 times over 5 minutes.
20. Wipe away any excess Loctite 515.
21. Apply a light smear of silicone grease to the housing O-ring and attach to the inner brake housing.

22. Ensure the brake pads are attached to the inner brake housing.

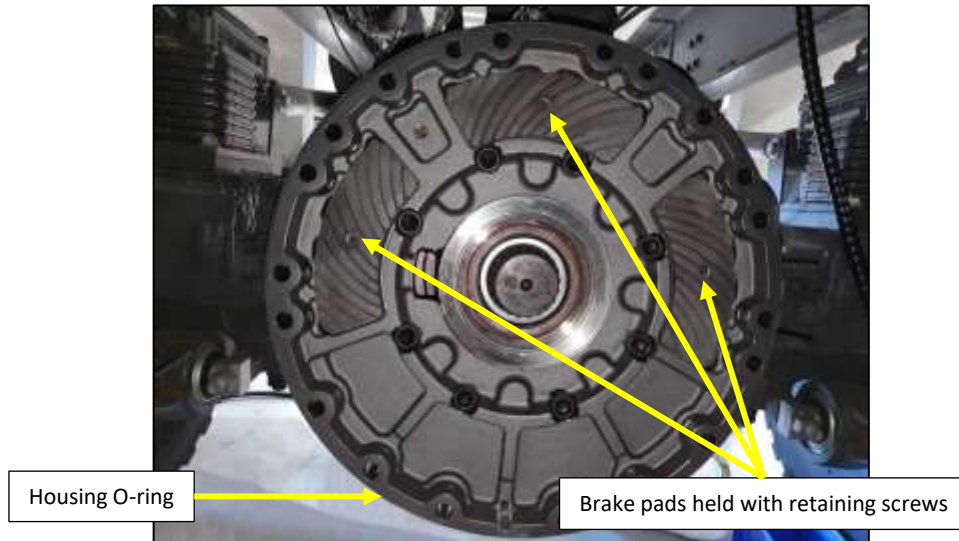


Figure 6: Diff centre with inner housing attached.

23. The preassembled outer housing should be attached to the yoke and rotor. Ensure brake pads are attached to the outer housing and the v-seal is correctly attached to the yoke (wide side against the yoke and thin sealing lip against the brake housing).

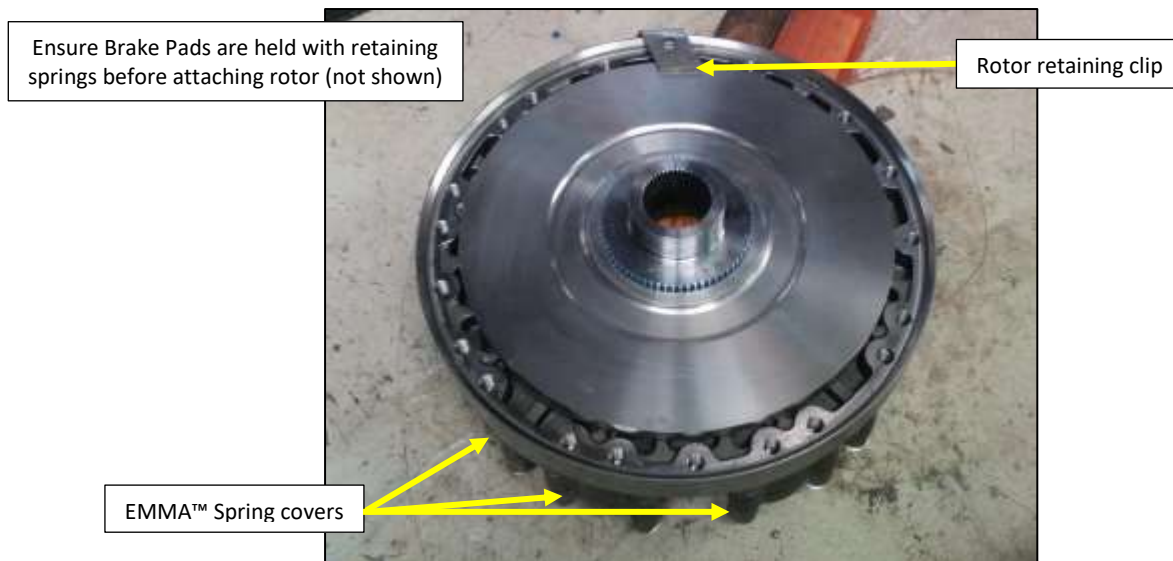


Figure 7: Outer housing, yoke and rotor assembly.

24. Attach the outer housing, yoke and rotor to the inner brake housing. Use of a jack or lifting table is recommended to assist with lifting the assembly into position.
25. Hold the brake rotor to prevent it from detaching from the yoke during assembly.
26. Lift outer assembly and align the yoke with the pinion shaft with the EMMA™ spring covers positioned towards the bottom of the brake.
27. Once the brake is held by the pinion shaft, rotate the outer housing until the EMMA™ spring covers are positioned towards the top of the brake.
28. Remove any rotor retaining devices once the inner and outer housings are as close to each other as possible.

29. Fit the 20x M14 bolts and torque to 158Nm in sequence. Ensure each bolt is torqued twice.

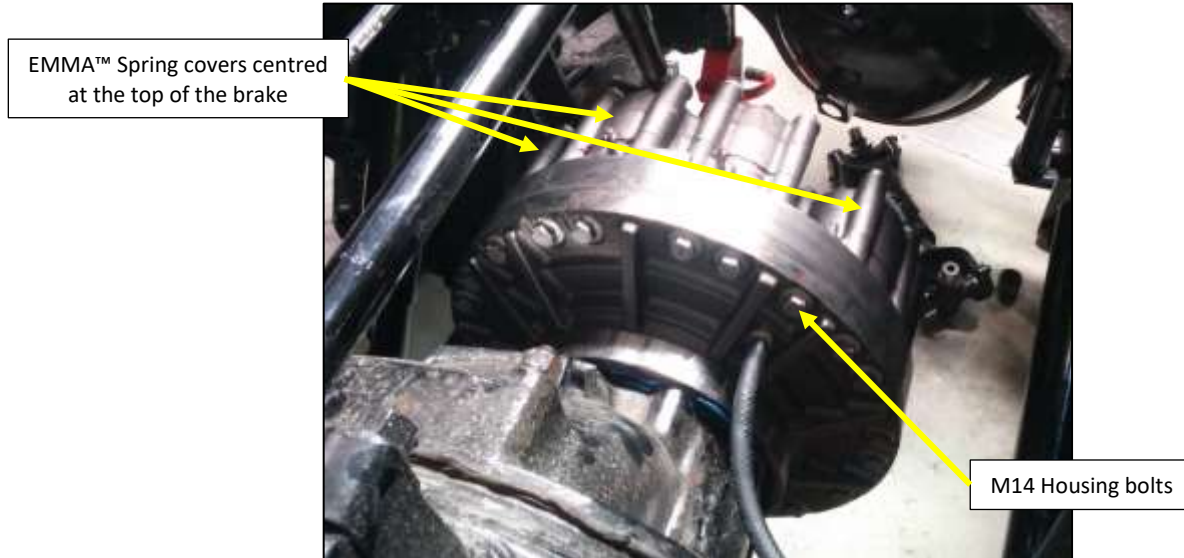


Figure 8: Brake mounted in position on the forward side of the rear most diff centre.

30. Attach the pinion shaft nut. Torque to correct Volvo/Meritor specifications, 2000 – 2200Nm.
31. Knock over locking tab on pinion nut.
32. Ensure the diff rotates freely when the ABT™ Failsafe Emergency brake is released.



Figure 9: Brake assembled with yoke.

33. Apply Loctite 243 to the threads on short end of the 4x drive studs.
34. Attach the 4x driveshaft mounting studs to the yoke and torque to 100Nm.
35. Assemble the drive shaft onto the yoke.
36. Attach the 4x mounting nuts onto the drive studs. Torque to 180Nm.
37. Attach the driveshaft to the output yoke on the forward tandem axle as per Volvo/Meritor manual.
38. Mount the expansion chambers as high as possible in a protected location on the vehicle. ABT™ recommends mounting to the chassis cross-member.
39. Secure using the supplied mounting hardware.
40. Run a length of breather hose between the expansion chamber and the brake unit.

41. Route the hose away from the exhaust and any moving components. Allow extra length for axle articulation.
42. Protect areas of the hose that may abrade using spiral guard and ensure the hose will not kink due to axle movement.
43. Ensure ABT™ “Blend 20” fluid can easily drain back into the brake units.
44. Secure the hose using supplied P-clips.

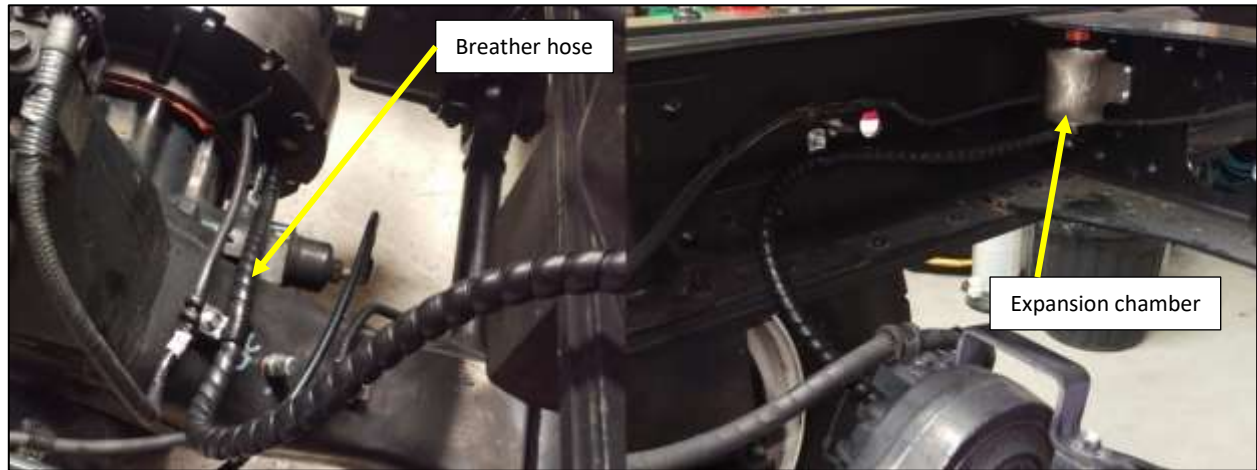


Figure 10: Brake breather hose and expansion chamber.

11. Installation – Hydraulic System

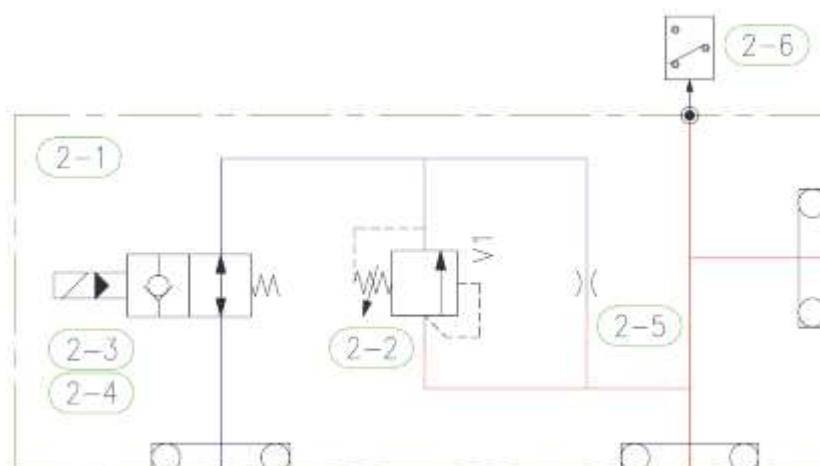


Figure 11: ABT™ Failsafe Hydraulic Schematic.

45. Mount the ABT™ pump enclosure in a suitable location on the vehicle chassis as close to the battery as possible.
46. Use existing holes on the chassis rail where possible. Otherwise, follow the bodybuilders instructions.
47. Drill the pump mounting bracket as required and mount the ABT™ pump using provided mounting hardware.



Figure 12: ABT™ Failsafe Emergency brake pump enclosure and hydraulic connections.

48. Connect one end of the short Failsafe Emergency brake hydraulic hose to the bulkhead fitting at the rear of the pump enclosure.
49. Attach bulkhead fitting to the vehicle chassis rail behind the pump enclosure.
50. Attach the other end of the short hydraulic hose to this bulkhead fitting on the outside of the vehicle chassis.

51. Attach one end of the long hydraulic hose to the bulkhead fitting on the inside of the chassis rail.
52. Route the other end of the hydraulic hose down along the chassis rail to the brake on the rear diff centre and connect. Secure the hose along the chassis using supplied P-clips.

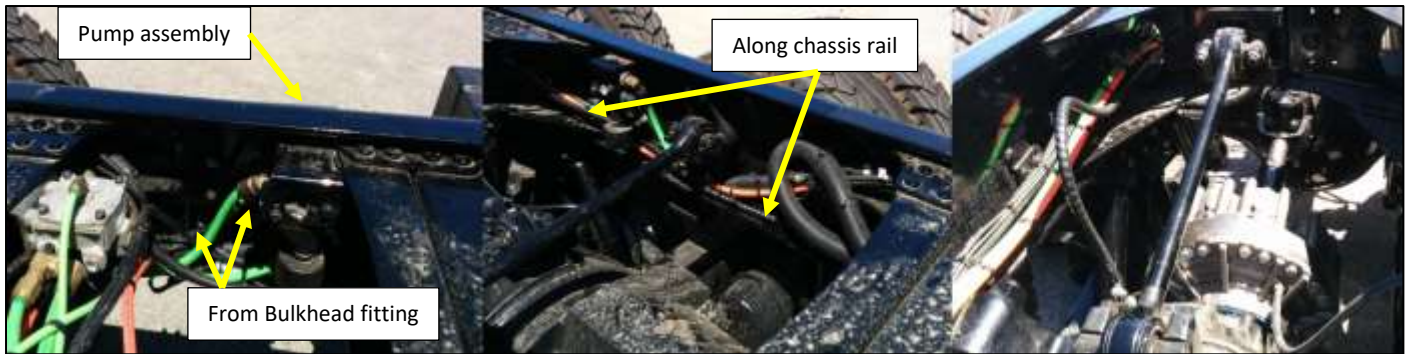


Figure 13: Hydraulic hose routing to brake.

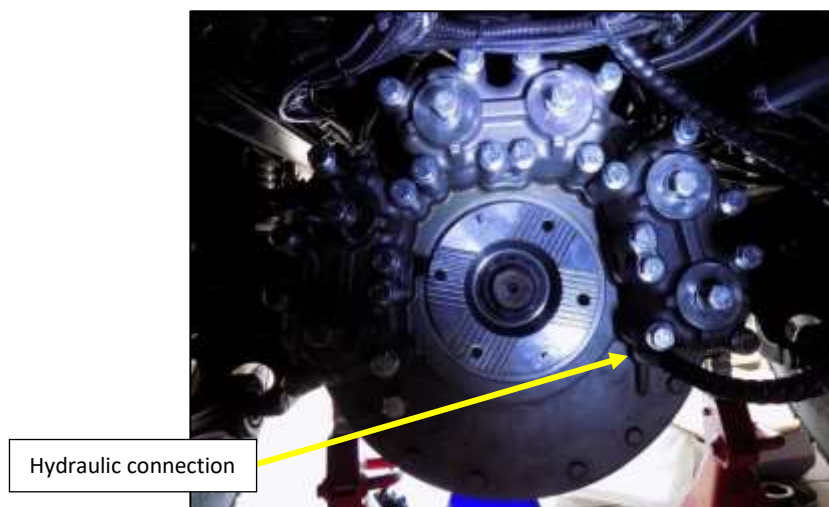


Figure 14: Hydraulic connection to brake.

12. Installation – Electrical System

1. Isolate the vehicle battery.

IMPORTANT:

Do not test the control system functions until the system is fully installed as this will confuse the control unit while learning – details on control unit setup can be found in Section 14.

2. Mount the control unit to the dash:
 - a. Mount the ABT™ Failsafe Emergency control unit on the removable cover on the dash using the provided bracket. Position so that bracket is close to the driver and aligned with the vehicle axis. 4x holes will need to be drilled.
 - b. For LH drive vehicles the control unit bracket can be reversed so that it is always facing the vehicle operator.

IMPORTANT:

Ensure the ABT Failsafe brake controller e-stop button is unobstructed and easily reachable by the operator.



Figure 15: ABT™ Failsafe Emergency control unit mounted on dash.

3. Fit the ABT™ Failsafe Emergency cabin harness 18-7012:
 - a. Open the top of the dash above the centre console.

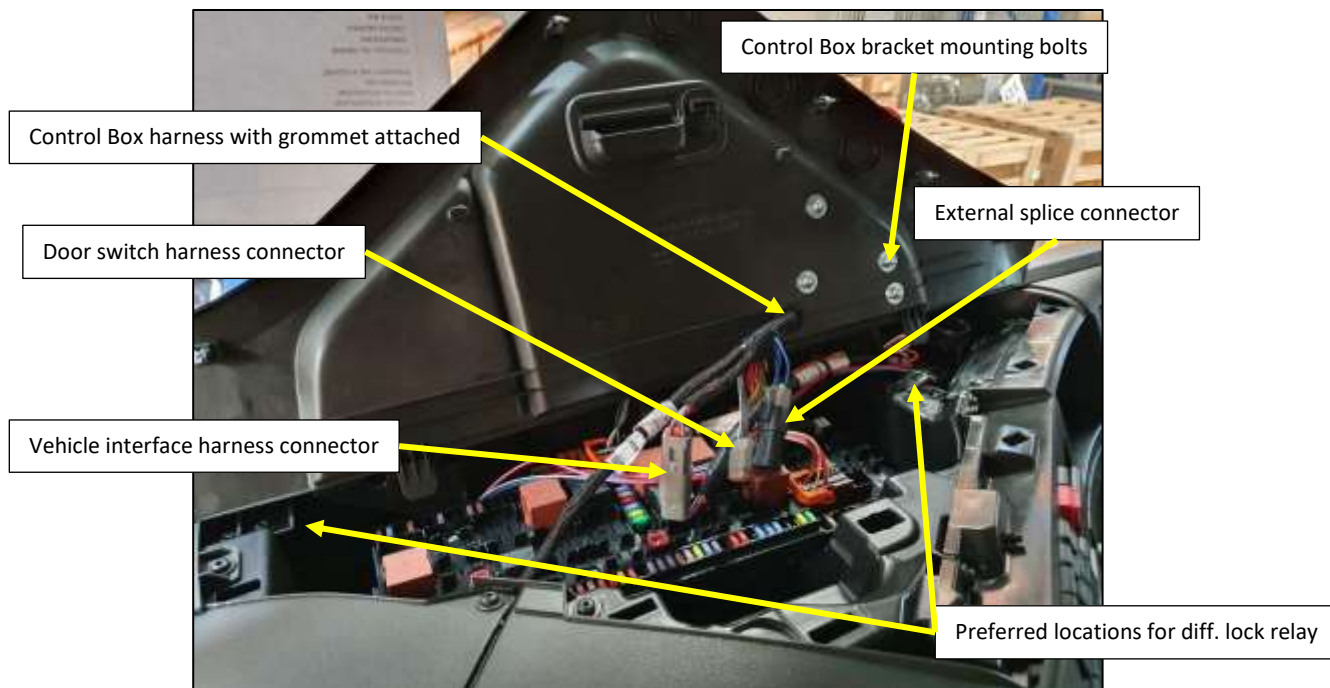


Figure 16: Top of dash open.

- b. Connect cabin harness branch to the rear of the control unit by passing up through the dash. A hole will need to be drilled in the dash to achieve this.
- c. It may be easier to route the cabin harness with the Deutsch connectors de-pinned. Note the pin locations.
 - i. Locate the connectors for the battery power and relay, approximately 2 metres from the end of the harness.
 - ii. De-pin both the 2-pin connector plug with the red and yellow cables attached and the large 2-pin connector socket next to it.
- d. Remove the panels from the passenger footwell and from in front of the passenger seat. The handrail may need to be removed first.

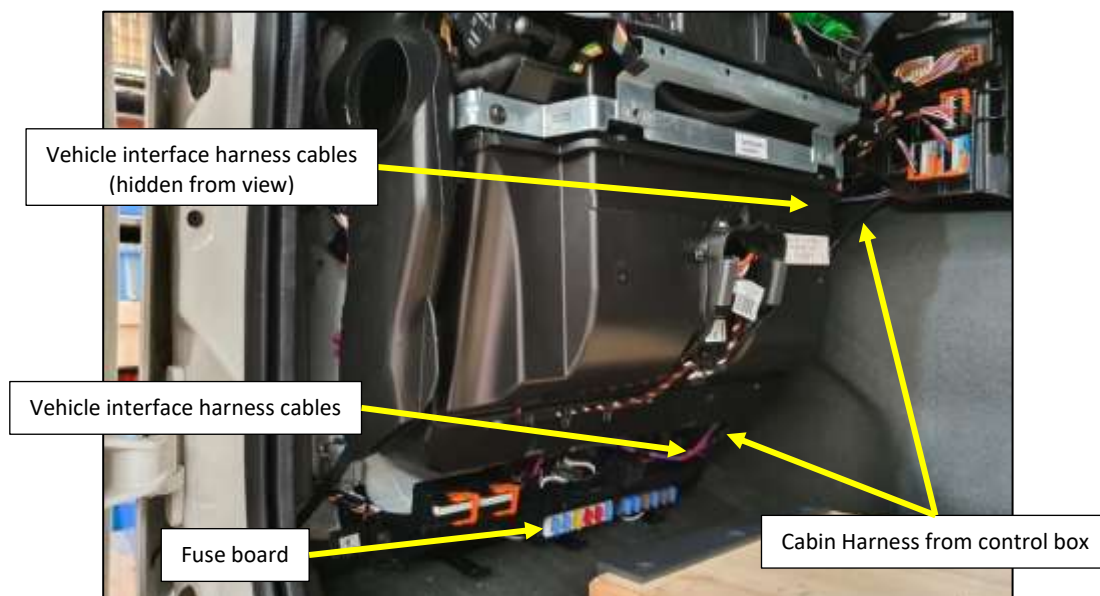


Figure 17: Cabin harness and vehicle interface cable routing.

- e. Route the harness down behind the dash towards the passenger footwell and out through the front of the vehicle.

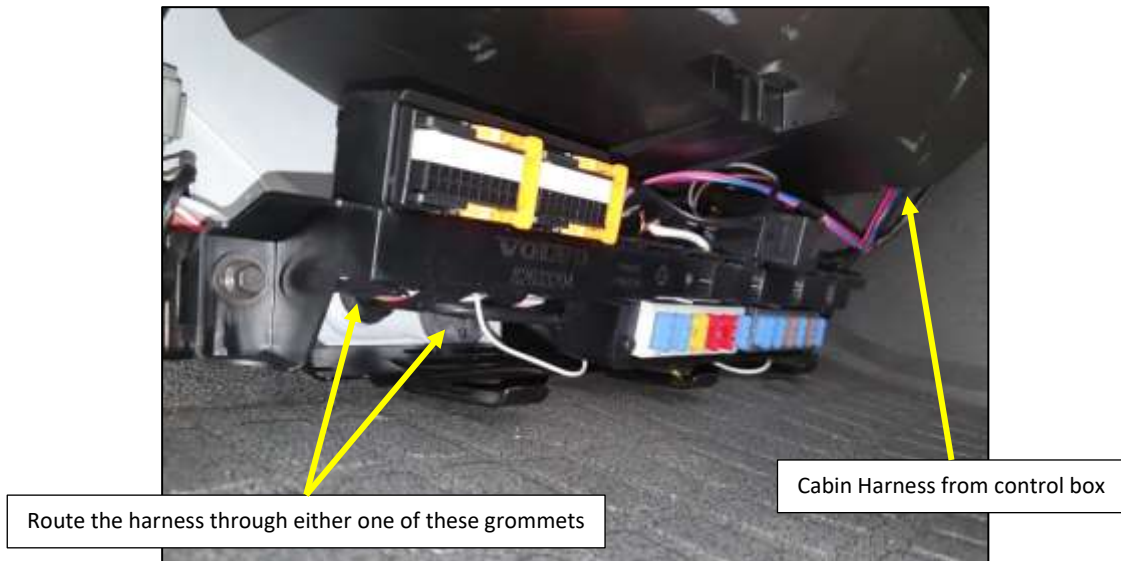


Figure 18: Cabin harness routing.

- f. Open front grille of vehicle.

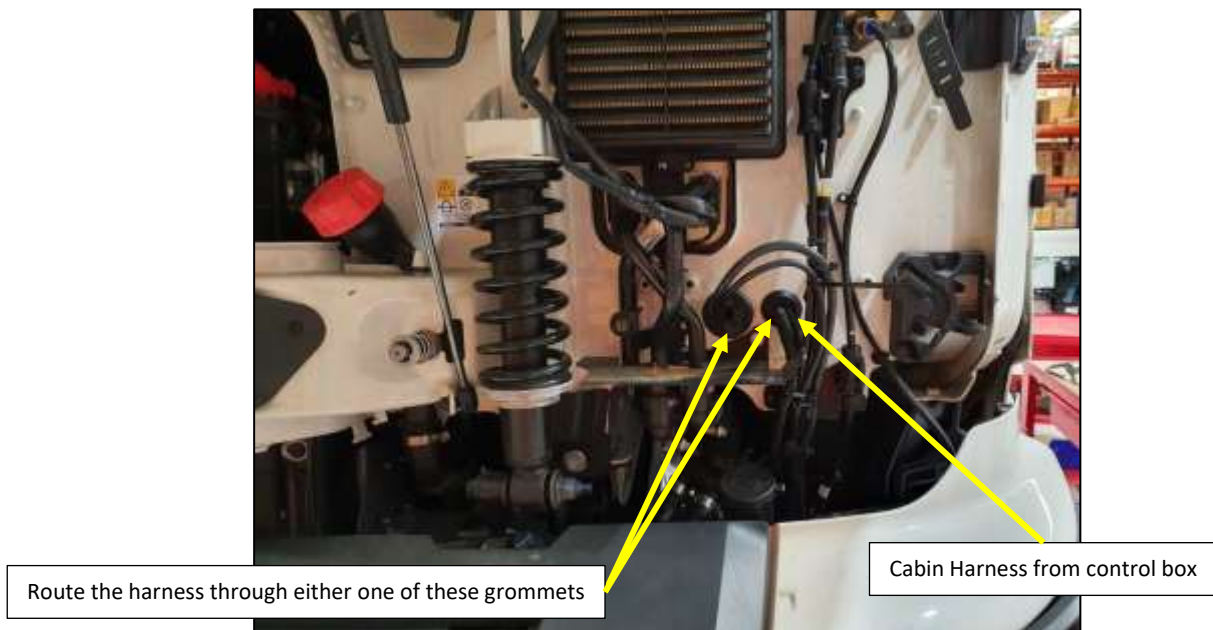


Figure 19: Cabin harness routing under vehicle front grille.

- g. Follow the main vehicle electrical harnesses under the cab and along the chassis rail.
- h. Secure the harness where necessary using P-clips and cable ties.
- i. Re-pin the connectors. Re-pin to the previously noted orientation.
4. Fit the vehicle interface harness:
- Connect the Deutsch end of the vehicle interface harness to the 6-pin connector on the ABT™ Failsafe Emergency cabin harness located under the top of the dash.
 - Mount the relay in a suitable location.
 - De-pin any interlock cables which are not required.
 - Route the harness down behind the dash toward the fuse board in the passenger footwell.
 - Extend the cables as required. Use the same colours if possible.

- f. Connect the interface harness to the desired interlocks.

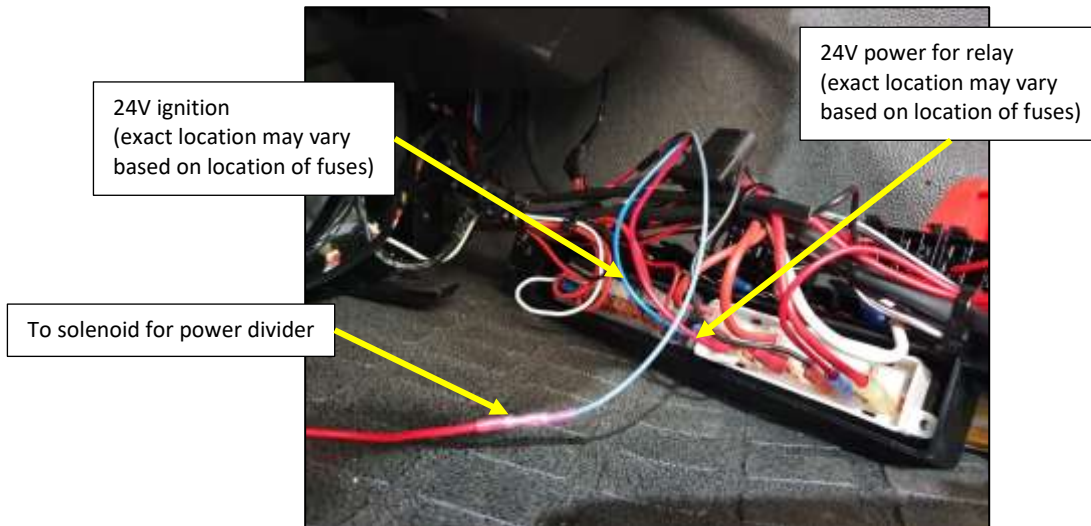


Figure 20: Connection for interface cables back of fuse board.

- g. Route a twin 2-core cable through the same grommet as the ABT™ cabin harness from the control box.
 h. Connect the red wire from the 2-core cable to the solenoid connection on the interface harness.
 i. Connect the black wire to a suitable earth location inside the cab.



Figure 21: Connection for interface cables back of fuse board.

- j. Route the 2-core cable externally to the ABT™ solenoid for the power divider.
5. Fit the OEM door harness 18-7008 (optional):
- The OEM door harness is supplied with the vehicle interface harness – simply connect the additional 3-pin Deutsch connector to the ABT™ Failsafe Emergency cabin harness located under the top of the dash.
 - Connect the dioded ends of the ABT cable to the OEM door switch cable located behind the panel and between the air vents in front of the passenger's seat. One diode required per connection.
 - Do not connect if ABT door proximity sensors are to be fitted.
6. Fit the Battery power harness:
- Extension harnesses may be required depending on vehicle battery location. If not required connect the cabin harness directly to the battery power harness and move to section 'e'.
 - Connect the battery power extension harness to the 2x 2-pin connectors on the cabin harness located on the chassis rail beside the gearbox.
 - Route the battery power extension harness towards the vehicle battery.

- d. Connect the battery power extension harness to the battery power harness.
- e. Remove the vehicle battery.

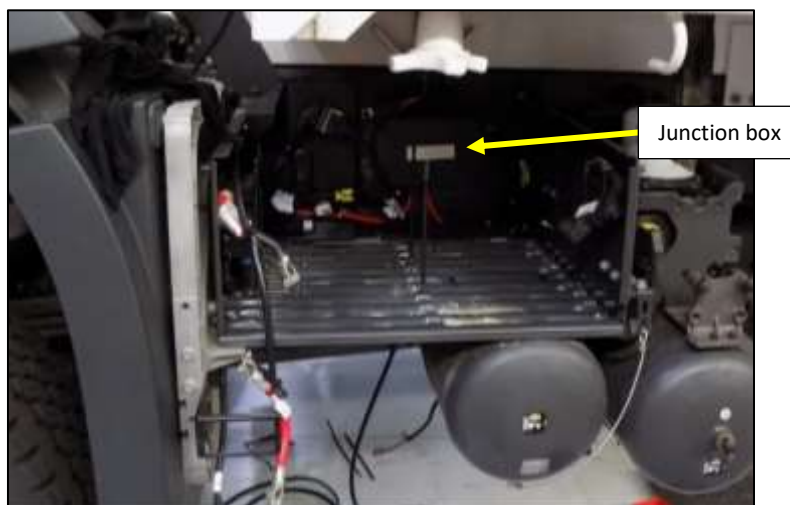


Figure 22: Battery removed.

- f. Remove the cover from the electrical junction box located behind the battery.
- g. Connect the red wires to a positive battery terminal inside the junction box via the eyelet.

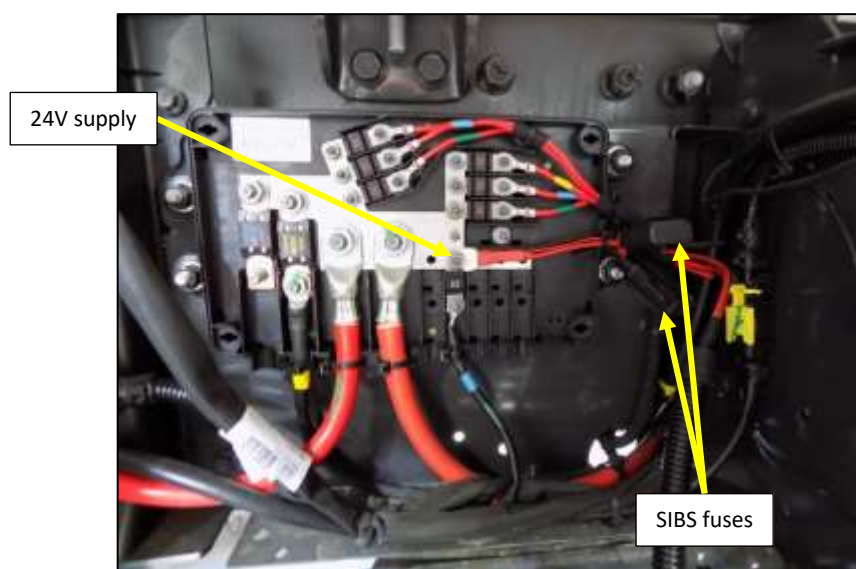


Figure 23: Battery power harness.

- h. Connect the black wire to a vehicle earth point via the eyelet.
- i. Secure the relay using existing fasteners in the vehicle battery box.

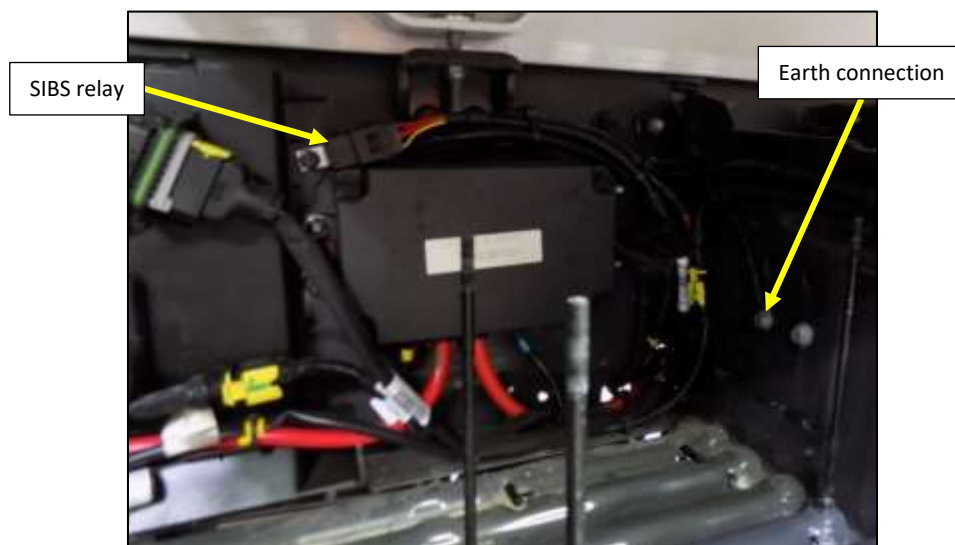


Figure 24: Battery power harness.

- j. Secure the harness where necessary using P-clips.
 - k. Reattach the vehicle battery.
7. Connect to the Pump harness:
- a. Extension harnesses may be required depending on EMMA pump assembly location. If not required connect the cabin harness directly to the pump harness.

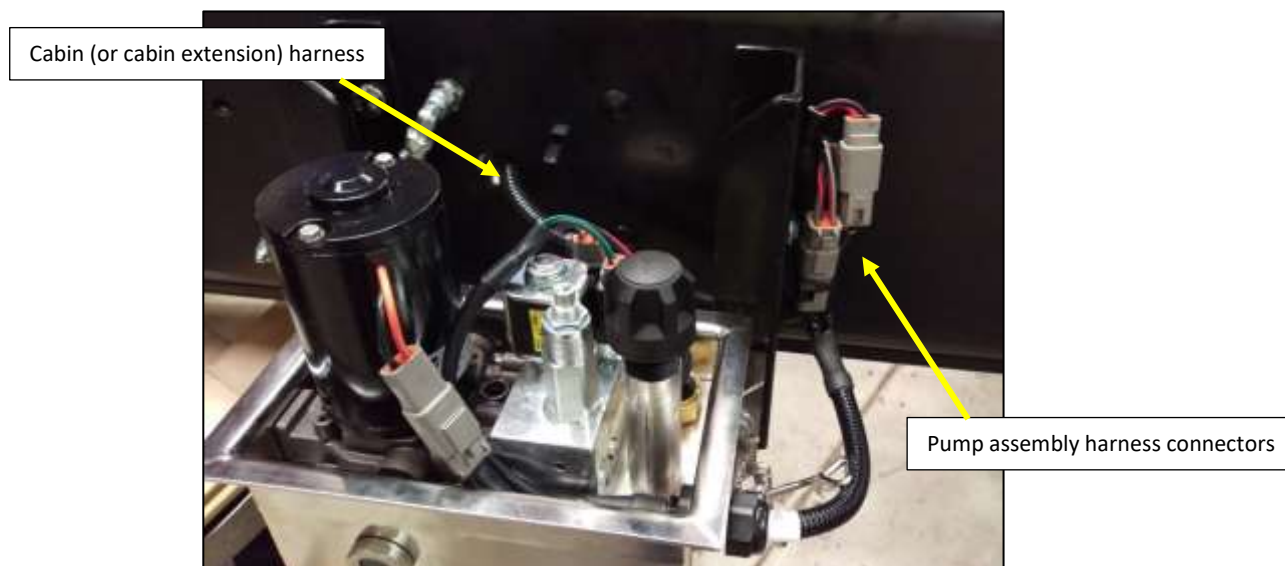


Figure 25: Pump harness connection.

- b. Secure the harness where necessary using P-clips.

8. Fit the door proximity harness (optional):

IMPORTANT:

Read the vehicle manufacturer bodybuilder's manual prior to fitting door proximity sensors.

- a. Find a suitable location around the driver's door for the proximity sensor.
- b. In some cases, there may be an existing hole on the bottom of the B-pillar that may be utilised to mount the proximity sensor. If this hole is not available, read the vehicle manufacturer bodybuilder's manual to find a suitable location. Drill a pilot hole followed by a 12mm finishing hole. Ensure there are no obstructions behind the hole.

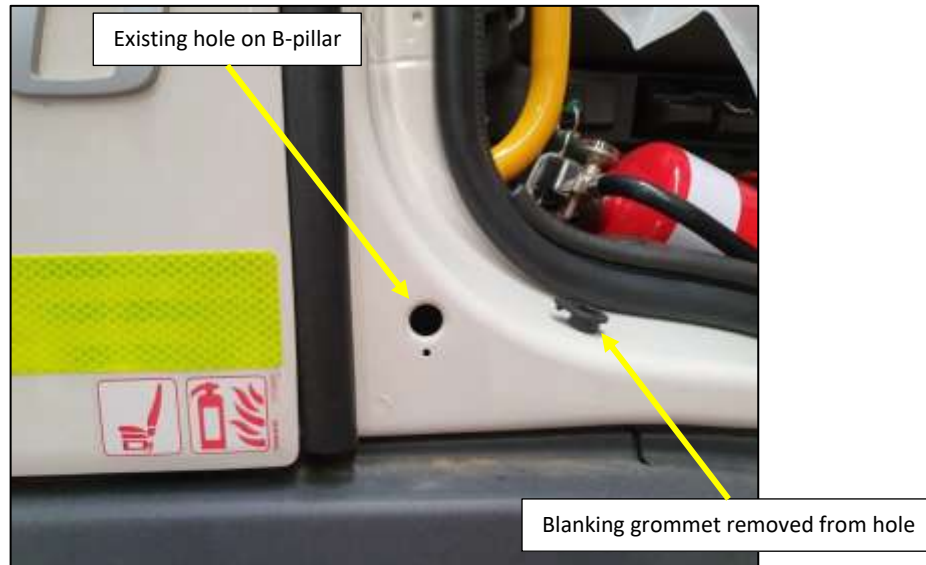


Figure 26: Pump harness connection.

- c. Take the door proximity switch and adjust the rear nut so that it is approximately 10mm from the sensing end of the switch.
- d. Ensure all metal surfaces are repainted and sealed with a corrosion preventative treatment. Paint or a site preferred corrosion inhibitor may be used.
- e. Place a toothed washer on the inner mounting face of the switch and push the switch through the B-pillar from behind.
- f. Apply a smear of silicone sealant to the face of the outer washer that sits against the B-pillar.
- g. Fit the outer retaining nut and tighten the nut to 10 Nm. The nut should be secured flush with the sensing face of the proximity switch.
- h. Apply a ball of Plasticine/Blu tack (or similar) on the sensing face and gently close the door to ascertain the sensing gap. This is the gap between the switch and door when the door is closed.
- i. Adjust the switch to achieve a sensing gap of 1 mm approx. then tighten the nut to 15Nm.

- j. Connect the door proximity sensor harness to the 3-pin connector on the door proxy extension harness.
- k. Route the harness behind the instrument cluster and across to the centre console under the ABT™ Failsafe Emergency control box.

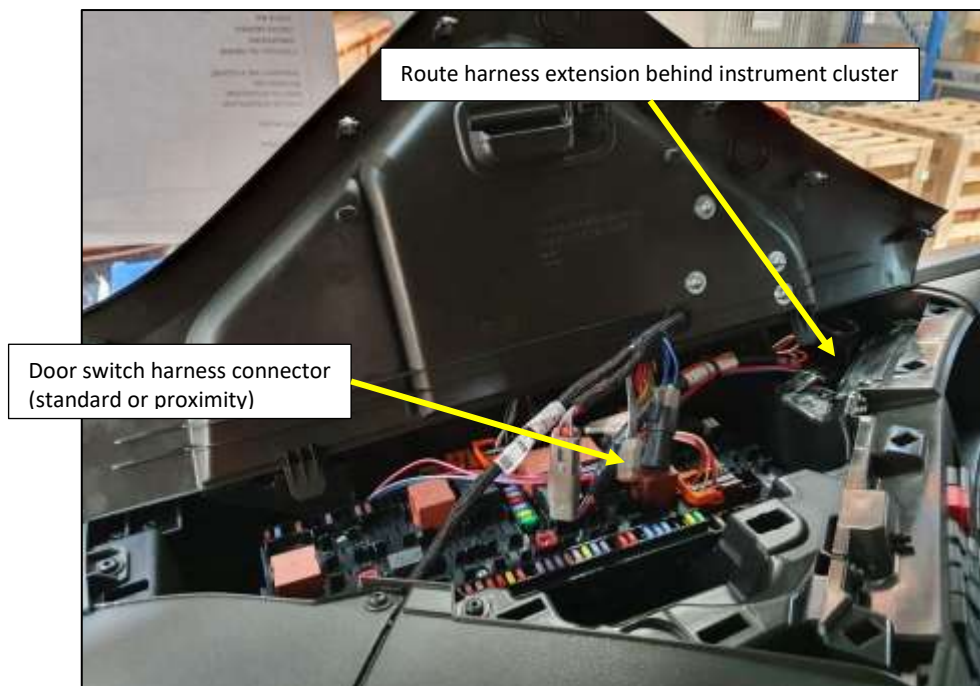


Figure 27: Door proximity harness routing.

- l. Connect the door proxy harness to the 3-pin connector on the cabin harness (the OEM door connector may need to be unplugged first).
 - m. Dependent on how many doors have been specified will affect the number of proximity switches included in the harness.
9. Replace the instrument cluster, top of dash, panels in front of passenger's seat, mats and all vehicle trim.

13. Installation – Pneumatic System

1. Vehicles equipped with CAN Bus require an additional pneumatic solenoid to activate the power divider when the ABT™ Failsafe Emergency brake system is applied.
2. Locate the bank of pneumatic solenoids on the vehicle adjacent to the battery.
3. Determine which solenoid is used for activating the power divider.

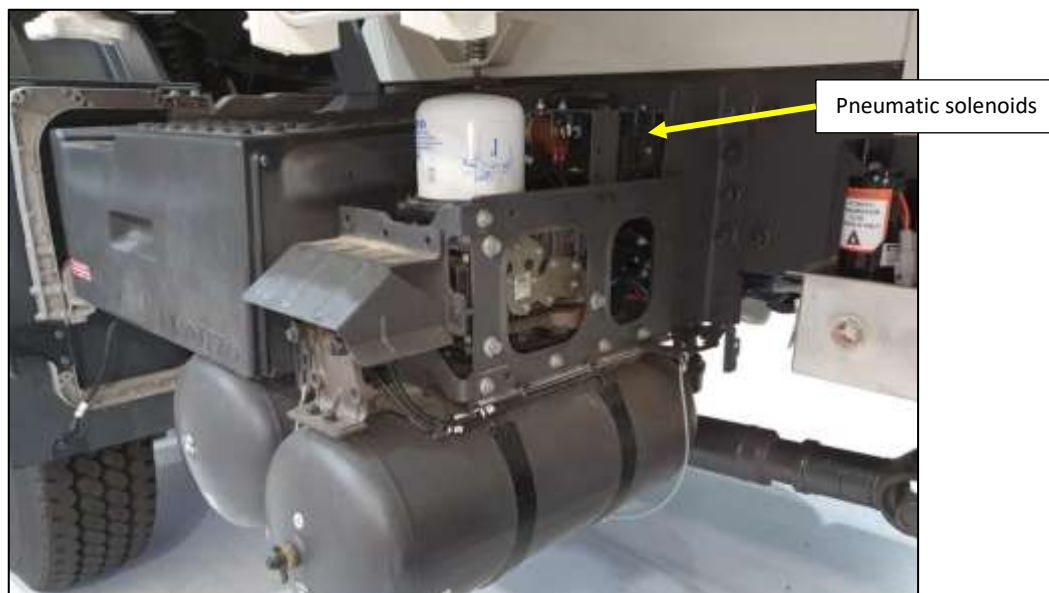


Figure 28: Pneumatic solenoids.

4. Mount the ABT supplied solenoid adjacent to the vehicle solenoids.

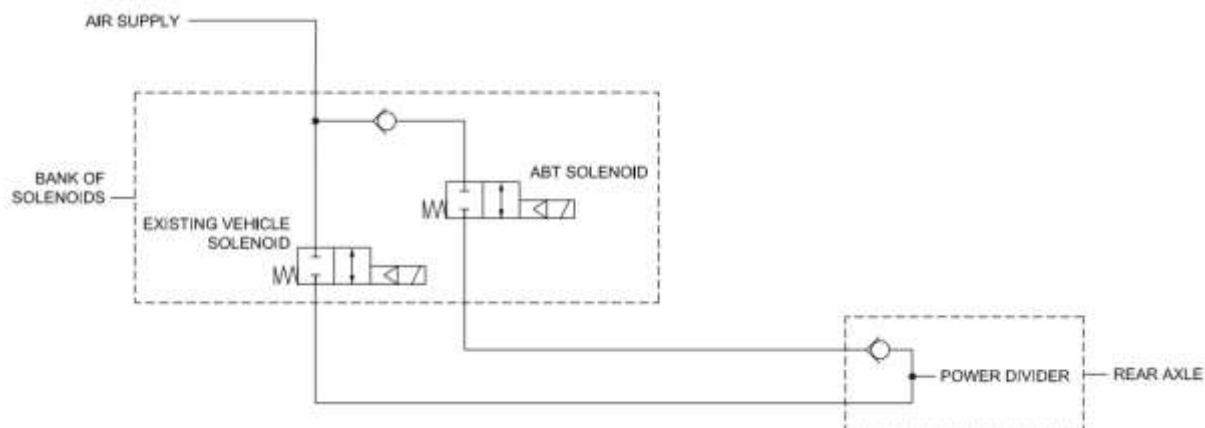


Figure 29: ABT™ Failsafe Pneumatic Schematic.

5. Connect the supplied parts as per the pneumatic schematic.
6. Connect power and earth to the solenoid as per electrical installation section 12.

14. Pre-Service Inspection

1. Top up all reservoirs with the specified fluids.
 - a. Use ABT™ cooling fluid for the brake. 800ml approx. required.

IMPORTANT:
Only ABT™ cooling fluid should be used in the brake assemblies.

- b. Use ATF Dexron III for the ABT™ Failsafe Emergency pump reservoir.

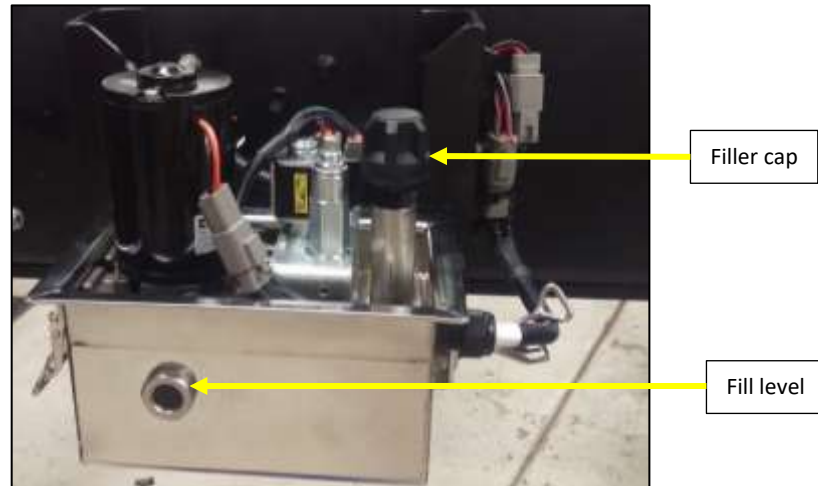


Figure 30: ABT™ Failsafe Emergency brake pump enclosure with lid removed.

2. Ensure the battery is in good condition – this is critical to ensure correct programming of the control unit.
3. Reconnect the vehicle battery to power the vehicle and ABT™ Failsafe Emergency system.
4. Bleed the ABT™ Failsafe Emergency brake system:
 - a. Twist and release the red E-stop button on the control unit.
 - b. If the control system detects air in the system on first release, it will enter bleed mode – this is indicated by the brake status light flashing green – system pressure will be limited to 100 psi.
 - c. With the E-stop released, thoroughly bleed the brake system by opening and closing the driveline brake system bleed nipples until the fluid runs through clearly with no air bubbles. Ensure the pump reservoir is topped up regularly during the procedure.

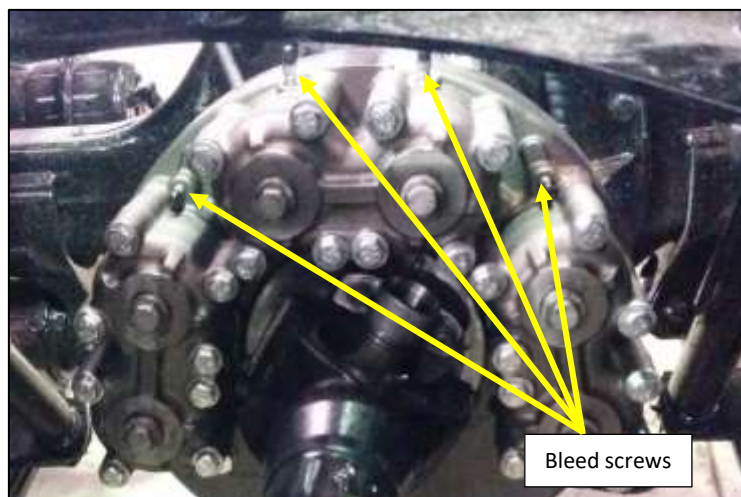


Figure 31: Failsafe Emergency brake bleed screws.

- d. Once the system is bled, while the E-stop is still released, remove the retractor bolts.

NOTE:

The Retractor Bolts should be retained in the vehicle.

5. Once the retractor bolts are removed, apply and then release the driveline brake again – if the system has been sufficiently bled then the brake status light should be solid green with the brake released.
6. Ensure the diff rotates freely when the ABT™ Failsafe Emergency brake is released.
7. Attach 5 x taper plugs to the spring covers, leaving one of the upper-most holes for the pad wear indicator. Use Loctite Silver Grade Anti-seize on the threads of the taper plugs to assist with future removal. Torque to 10Nm.
8. Silicone may be used to fill the socket head of the taper plugs to prevent dirt ingress.
9. Attach 1 x pad wear indicator plunger to the EMMA™ piston inside the remaining hole in the spring cover. Torque to 15Nm.
10. Attach the pad wear indicator plug to the spring cover over the pad wear indicator plungers. Ensure it is threaded all the way onto the spring cover. Torque to 15Nm.
11. Attach the fibre washer and cap. Torque to 10Nm.

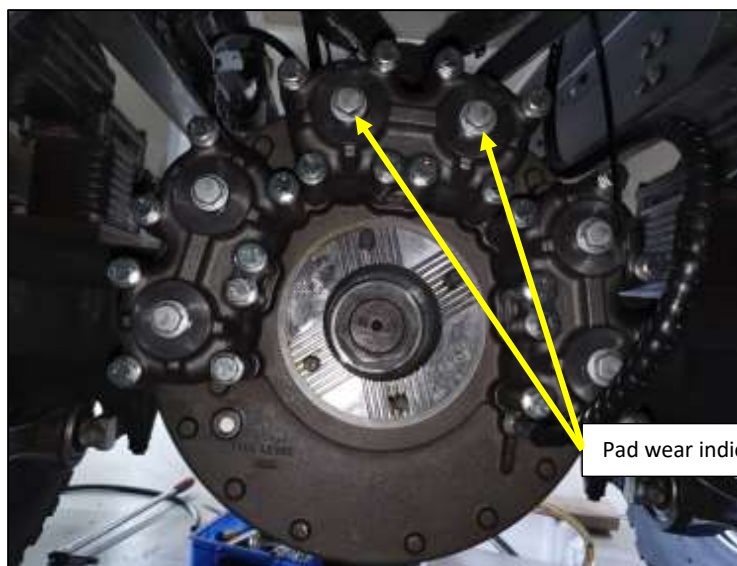


Figure 32: Brake assembly attached to rear-rear diff centre.

12. Affix the ABT™ Failsafe caution label and ABT™ Failsafe Emergency warning label to the inside top corner of the windshield on the driver's side.



Figure 33: Failsafe Emergency labels.



Figure 34: Failsafe Emergency labels on windshield.

13. Complete a vehicle pre-start check.

15. Control System Setup

1. Ensure the battery is fully charged and in good working condition.
2. Activate all connected interlocks and check function:
 - a. To activate the door interlock – open and close a vehicle door.
 - b. To activate the seat belt interlock – connect and disconnect the driver's seatbelt.
 - c. To activate the stall interlock – switch the ignition off, wait for 5 seconds, then start the engine, run for 10 seconds and then switch the engine off again.
 - d. The corresponding warning light on the control unit should display when each interlock is activated (note: interlock warning lights are only displayed when ignition is on).
3. Set the HSI speed threshold:
 - a. After releasing the brake for the first time the green HSI light will begin flashing – this indicates the HSI speed threshold needs to be set.
 - b. The HSI system overrides the door, stall and seatbelt interlocks when the vehicle is travelling at speeds above the HSI threshold – this is designed to reduce the possibility of unintended brake application at high speeds.
 - c. Start the engine, release the brakes and accelerate the vehicle up to the desired HSI threshold speed (ABT recommends 40 km/h).
 - d. While maintaining this speed, press and hold the grey button on the control unit for 3 seconds – the control unit will beep twice to confirm the speed has been accepted.
 - e. If HSI is not required, simply complete the above procedure with the vehicle is stationary.

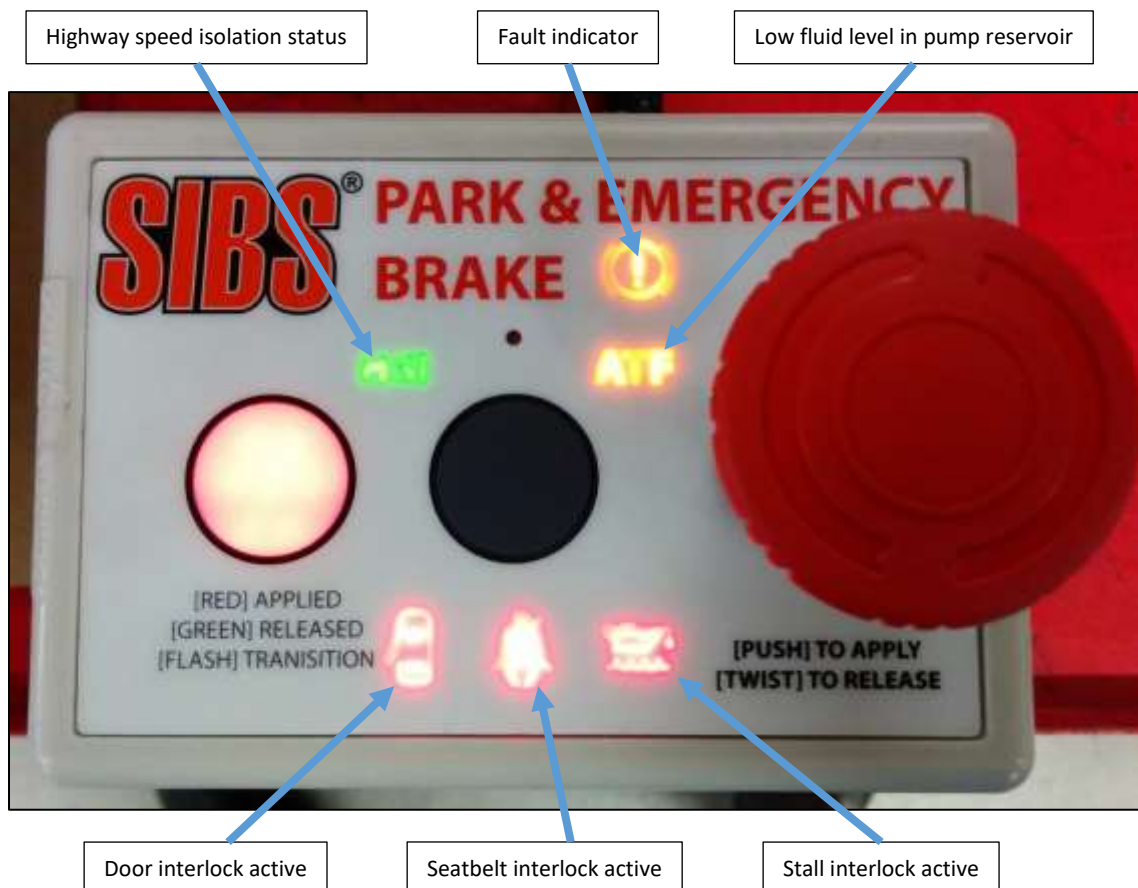


Figure 35: ABT™ Failsafe Emergency control unit warning lights

16. Service Schedule

The following table shows the recommended service intervals for ABT™ Failsafe Emergency brake systems fitted to vehicles being operated in a harsh mining environment. ABT™ recommends each site undertake a review of the service intervals and adjust to suit their specific conditions.

	Frequency
Pre-Start Check	Daily
Minor Service	Monthly or every 5,000 km or every 100 hours (whichever occurs first)
Major Service	When driveline brake pad wear reaches minimum (as indicated by the pad wear indicator)

The pre-start check involves a quick check of the fluid levels and confirms proper brake system operation.

The minor service involves a general system inspection and replacement of the ABT™ cooling fluid in the brake.

The major service involves a system inspection and replacement of any worn components to ensure continued reliable operation of the ABT™ Failsafe braking system.

17. Pre-Start Check

1. Check ABT™ Failsafe Emergency brake pump reservoir level. If low, top up with ATF Dexron III and check system for leaks.

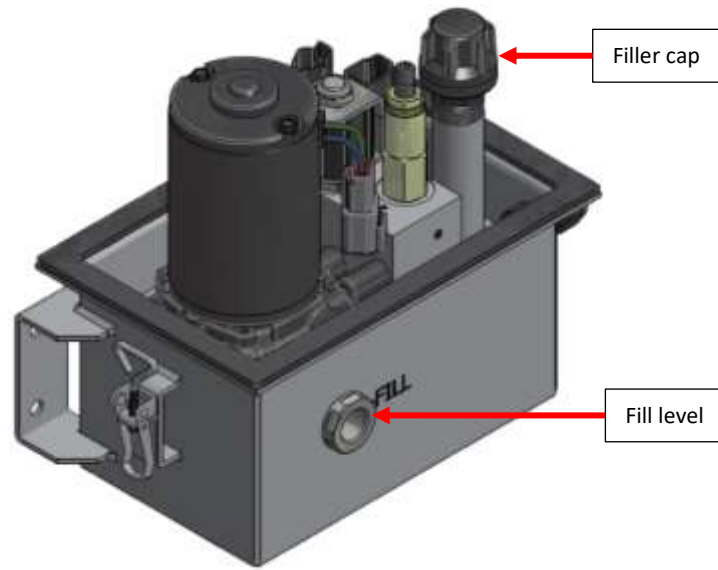


Figure 36: ABT™ Failsafe pump enclosure with lid removed.

2. With the doors closed, engine running, and driver's seat belt connected, press the E-Stop button:
 - a. The brake status light on the ABT™ Failsafe Emergency control unit should be solid red.
 - b. The park brake should be applied.
3. Twist and release the E-Stop button:
 - a. The brake status light should flash red momentarily and then change to solid green.
 - b. The park brake should now be released.
4. Check the Failsafe EM brake applies when (*Note: optional interlock connections c, d and e if connected*):
 - a. The E-Stop is pressed.
 - b. The ignition is switched to the 'ACC' position.
 - c. The door is opened (door ajar warning light should display on control unit).
 - d. The driver seatbelt is released (seatbelt warning light should display on control unit).
 - e. The engine is stalled (low oil pressure warning light should display on control unit).
5. Carry out Failsafe EM brake performance test:
 - a. Ensure the test is carried out on a level surface, with no obstructions in front of the vehicle.
 - b. With engine running at normal operating temperature
 - Apply ABT™ Failsafe Emergency brake
 - Depress clutch
 - Engage third gear low range
 - Do not press footbrake
 - Do not rev engine (engine should be idling as normal)

- Slowly release clutch
 - Allow the engine rpm to slowly reduce until either the engine stalls or the vehicle rolls forward
 - Vehicle must stall without the vehicle driving through the brake
- c. If the vehicle is equipped with an automatic gearbox:
- Engage drive on the gear selector
 - Slowly drive the vehicle (5 – 10 km/h)
 - Apply ABT™ Failsafe Emergency brake
 - The vehicle must stop within 5 metres or 3 seconds
6. If the vehicle drives through the brake a Major Service must be performed.

IMPORTANT:
The Pre-Start check does not replace visual inspection of the pad wear indicators.

18. Minor Service

1. Check brake unit for leaks:
2. Check the fluid level in the ABT™ Failsafe Emergency pump reservoir. Top up if necessary.
3. Check ABT™ Failsafe Emergency pump for leaks:
 - a. Engine running
 - b. Twist and release the E-stop button to release the Failsafe Emergency brake
 - c. Release the brake for 30 seconds
 - d. The alarm should remain silent and the pump should not recharge
4. Check hydraulic lines for cracks or damage.
5. Check the breather hose for kinks, cracks or damage.
6. Check the expansion chamber filler breather cap is clear.
7. Check all electrical connectors and wiring for damage or corrosion.
8. Ensure the vehicle battery is in good working order.
9. Check brake pad wear:
 - a. Apply the ABT™ Failsafe Emergency driveline brake.
 - b. Remove the protective cap on the pad wear indicator (found on the spring cover).
 - c. The plunger should project out from the gland fitting.
 - d. The distance the plunger projects shows the remaining brake pad wear available. (New pads = 2mm approx.).

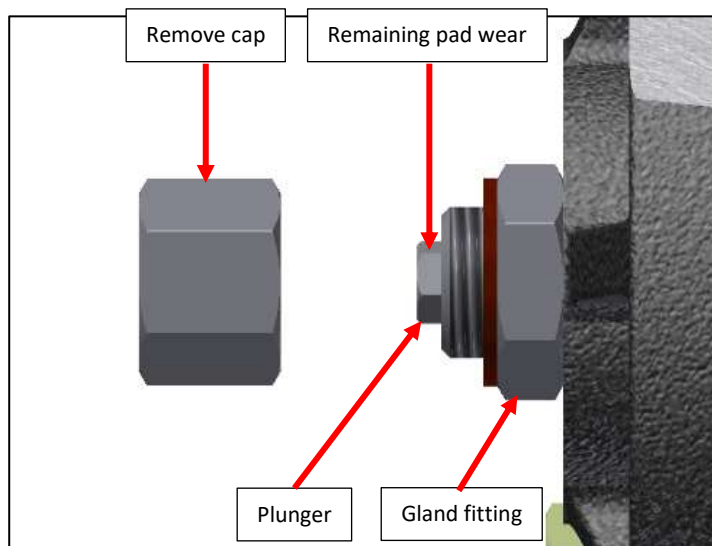


Figure 37: Brake pad wear indicator schematic.

- e. Check the inside of the protective cap for signs of grease or other contaminants and clean if necessary.

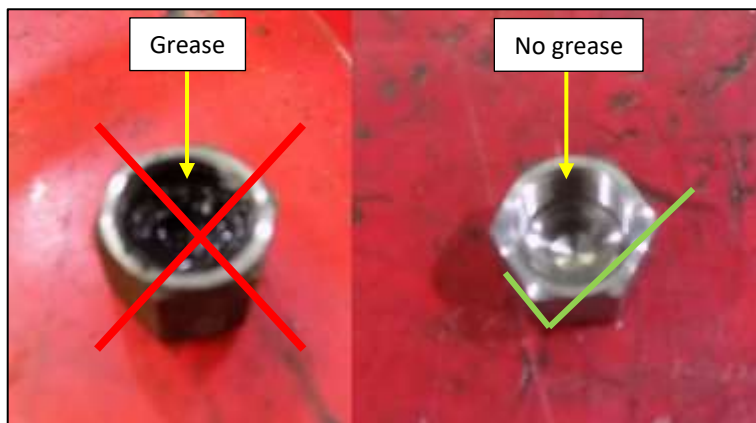


Figure 38: Check for grease in cap.

- f. Check inside the pad wear indicator gland around the top of the plunger for signs of grease or other contaminants and clean if necessary.

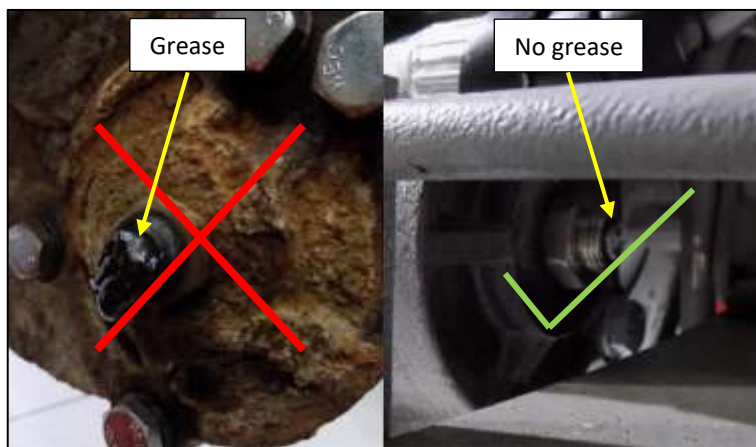


Figure 39: Check for grease around gland and plunger.

IMPORTANT:



A major service must be carried out if there are any signs of grease wash-out due to contamination from water or ATF.

- g. Ensure the inside of the cap and around the top of the plunger are thoroughly clean and dry.
h. Refit the fibre sealing washer.

NOTE:

ABT part 31-4025 Dowty Seal (metal ring with rubber insert) is available as an alternative sealing washer.

- i. Refit the protective cap.

- j. Centralise the washer as the cap is tightened by hand.

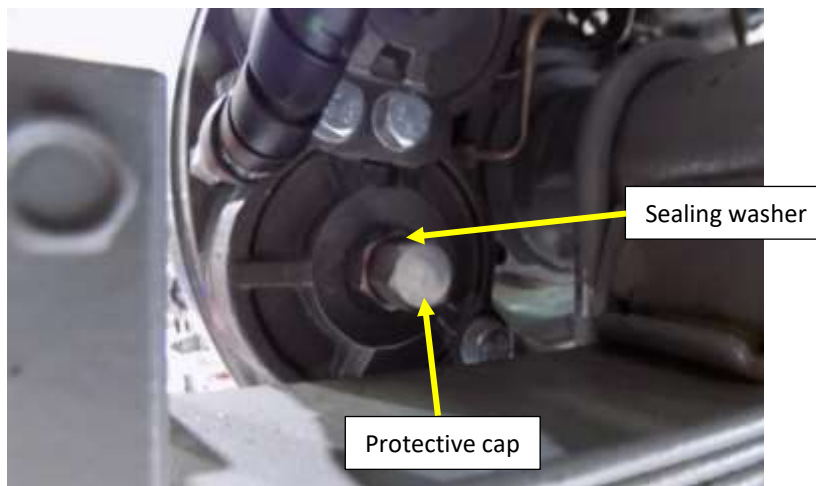


Figure 40: Pad wear indicator.

- k. Torque the cap to 10 Nm. Do not overtighten as the washer will get damaged.
10. If the brake pads have worn beyond the wear limit, then a major service must be completed.
11. Remove 5x tapered plugs, recoat each one with anti-seize and refit them. Silicone should be placed in the hex socket to aid future removal.
12. Drain and discard the ABT™ cooling fluid from the driveline brake.
- a. At least 600 ml of ABT™ cooling fluid should be found in the brake. Check for leaks if this amount is not found.
- b. The cooling fluid should drain freely from the brake. If it comes out in a “glug, glug” fashion ensure there is no blockage in the breather line.
- c. Dispose of used ABT™ cooling fluid responsibly in accordance with regulatory and environmental legislation.
13. Refit the drain plug with a new sealing washer.
14. Refill the brake up to the level plug (fill to spill). Approximately 800 ml of ABT™ cooling fluid is required.

IMPORTANT:

Only ABT™ cooling fluid should be used in the brake assemblies.

15. Conduct a “vehicle pre-start check”.

19. Major Service

WARNING:

Always wear a respirator when working around brakes or brake lining dust. Always wear eye and hand protection.

1. Check ABT™ Failsafe Emergency driveline brake systems for leaks.
2. If leaks are present replace damaged seals where necessary during the major service (section 24).
3. Repair/replace damaged parts where necessary during the major service.
4. Test the EMMA springs and pistons (section 20).
5. Disassemble the brake (section 21).
6. Perform a rotor service (section 22).
7. Perform a pad change, seal change and housing service (section 23).
8. If the springs need to be replaced, perform a replacement now (section 24).
9. Assemble the brake (section 25).
10. Conduct a “vehicle pre-start check”.

20. EMMA Piston Test Procedure

1. Remove the 5x tapered plugs and 1x pad wear indicator from the spring cover. Refer to exploded view for more details.
2. Operate the brake to check for fluid or grease washout. Any substances being ejected from the holes indicates a failed EMMA piston seal which will need to be replaced.
3. Fit 6x retractor bolts into the spring cover and tighten hand tight.
4. Loosen the retractor bolts until there is approximately 2mm gap to the spring cover.
5. A short test is required to check the integrity of the springs in the ABT™ Failsafe Emergency brake. Assistance is required for this test.
6. While the ABT™ Failsafe Emergency brake is applying/releasing observe the movement of the retractor bolts.
7. The 6x retractor bolts should move in and out simultaneously.
8. If the retractor bolts move simultaneously then the spring integrity check is complete.
9. If the retractor bolts appear to be moving unevenly then check the following:
 - a. While the brake is releasing (the pump is running) one or more bolts moves quickly out at the beginning of the pump cycle and is then followed by the remaining retractor bolts moving slowly as the pump cycle continues and then finishes.
 - b. While the brake is applying (fluid dumping back to reservoir) the slow-moving bolt/bolts from the previous test move back into the spring cover first and are then followed by the remaining bolt/bolts.
10. If the retractor bolts behave as explained in step 9 then the spring covers must be removed to visually check the springs.
11. With the brake released retighten the retractor bolts.

21. Service Disassembly Procedure

1. Remove the 5x tapered plugs and 1x pad wear indicator from the spring cover. Refer to exploded view for more details.
2. Fit 6x retractor bolts into the spring cover and torque to 130 Nm. Alternatively, while the system is active retract the pistons and wind in the retractor bolts in. Use greased, hardened flat washers under the bolt heads to assist.
3. Drain and discard the ABT™ cooling fluid from the brake.
 - a. At least 600 mL of ABT™ cooling fluid should be found in the brake. Check for leaks if this amount is not found.
 - b. The ABT™ cooling fluid should drain freely from the brake. If it comes out in a “glug, glug” fashion ensure there is no blockage in the ABT™ Failsafe breather line.
 - c. Dispose of used ABT™ cooling fluid responsibly in accordance with regulatory and environmental legislation.
4. Remove the drive shaft from the ABT™ yoke.
5. Disconnect the driveline brake hydraulic line from the brake.
6. Undo to pinion nut and remove from the pinion shaft.
7. Remove and discard the remaining 20x housing bolts.
8. Carefully separate the inner and outer housings until there is a slight gap between them.
9. Carefully rotate the outer assembly by 180° so the spring covers are located at the bottom of the assembly. The outer housing, rotor, yoke and outer pads should remain as one assembly.
10. With the aid of a trolley jack or similar, remove the outer assembly completely. Care must be taken as the outer assembly is heavy.
11. Sit the outer housing assembly, yoke and rotor on a clean bench.



Figure 41: Outer housing assembly

22. Rotor Replacement Procedure

1. Disassemble the outer housing according to section 21.
2. Remove the yoke and rotor from the assembly. Clean the rotor.
3. Inspect the rotor and yoke splines for wear.
4. Check for movement between the rotor and yoke. If there is excessive movement between the splines of the mating components the rotor should be replaced.
5. Inspect the rotor friction surface. If there are signs of scouring covering more than 50% of the surface the rotor should be replaced.

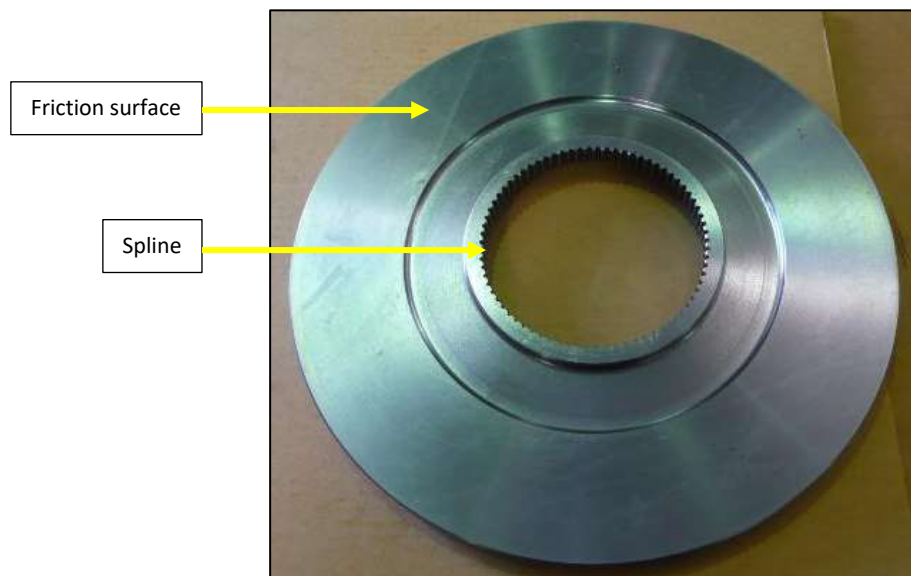


Figure 42: Rotor.

6. Measure the thickness of the friction surface using a micrometre at four evenly spaced position around the rotor. If thickness is below 14.0 mm the rotor should be replaced.

23. Pad Change, Seal Change and Housing Inspection

WARNING:

Always wear a respirator when working around brakes or brake lining dust. Always wear eye and hand protection.

1. Disassemble the outer housing according to section 21.
2. Remove and discard the inner and outer brake pad mounting hardware (bolts, washers, springs and brackets).
3. Remove and discard the inner and outer brake pads.
4. Inspect the diff pinion seal. Replace if showing any signs of damage or leaking.
5. If the seal is to be replaced, inspect the pinion bearings and replace if necessary
6. Remove the housing O-ring from the inner housing and discard.
7. Clean the inner housing and inspect for damage or wear.
8. Install a new O-ring onto the inner housing.
9. Install the inner brake pads in the inner housing ensuring correct orientation.
 - a. Apply Loctite 222 to the first 5 threads of the brake pad mounting bolts with countersunk head.
 - b. Torque 3x bolts to 8 Nm.
 - c. Check pads for looseness.

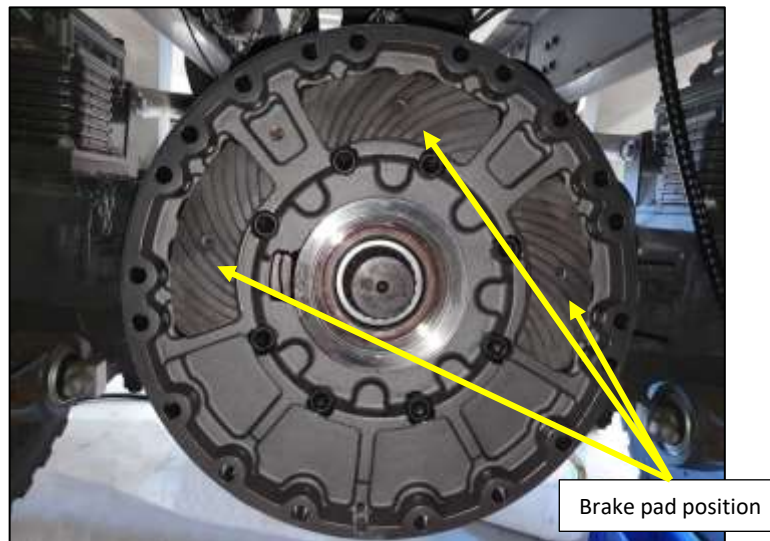


Figure 43: Brake pad position

10. Remove the cassette seal from the outer housing and discard.
11. Clean the outer housing and inspect for damage or wear.
12. If the springs or EMMA piston seals need to be replaced, do so now (section 24,25).
13. Install a new cassette seal into the outer housing.
14. Install the outer brake pads, brackets, springs and bolts in the outer housing ensuring correct orientation.
 - a. Apply Loctite 222 to the first 5 threads of the brake pad spring bracket cap head mounting bolts.
 - b. Torque 6x bolts to 5 Nm
 - c. Attach 6x brake pad retaining springs.

15. Install a new v-seal onto the yoke.
16. Install the outer housing assembly onto the yoke.
17. Install the rotor onto the yoke spline ensuring correct orientation.
18. Inspect all fittings for damage or corrosion and replace if necessary.

24. Spring Replacement Procedure

1. Disassemble the outer housing according to section 21.
2. Remove the 24x spring cover bolts and discard.
3. Loosen the 6x retractor bolts progressively and in sequence no more than 3x full turns at a time until completely removed. Retain the retractor bolts for later use.
4. Remove the spring cover.
5. Clean mating surfaces and ensure they are free of any signs of liquid gasket.
6. Remove the disc springs and inspect each one for signs of excessive wear or cracking. If there are any cracked springs, then all 96x springs must be replaced.
7. If there are no cracked springs clean all thoroughly.
8. Perform an EMMA piston seals replacement now. (Section 25).
9. Lubricate all disc springs with a high-pressure grease (Castrol LMM recommended) and reinstall on the park/emergency pistons. There are 16x springs per piston stacked 2 in parallel.

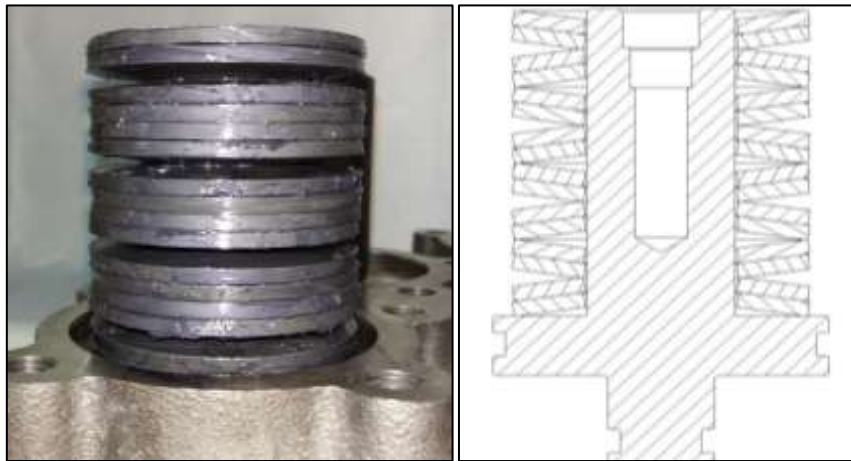


Figure 44: Disc springs installed on Failsafe Emergency brake piston.

10. Apply a 1 mm thick continuous bead of Loctite 515 to 3x spring covers and refit spring covers to the housing.
11. Install 24x spring cover bolts and washers finger tight.
12. Reinstall the retractor bolts and torque to 130 Nm. Use greased, hardened flat washers under the bolt heads to assist.
13. Install and torque all spring cover bolts progressively and in sequence (one full turn at a time) to ensure that the spring cover does not distort or crack, torque to 120 Nm. Ensure each bolt is torqued twice.

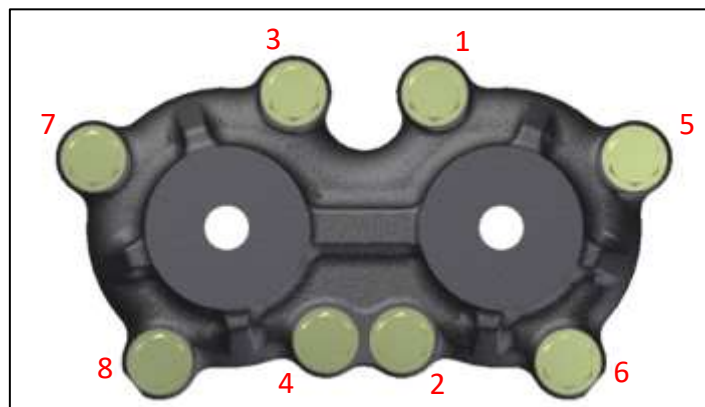


Figure 45: Spring cover bolt torque sequence.

25. EMMA Piston and Piston Seal Replacement Procedure

1. Follow steps 1-7 in section 24 to remove piston cover and springs.
2. Remove the pistons from the bore. A slide hammer may assist with removal.
3. Remove the piston O-ring seals and backup rings.
4. Clean the pistons with parts cleaner.
5. Inspect the pistons for damage, if there are signs of pitting and corrosion in the O-ring grooves the pistons should be replaced.
6. Apply a light smear of silicone grease to the pistons where the O-ring is seated (Parker Super O Lube recommended).
7. Attach the piston seals to the pistons. Ensure the O-rings and back-up washers are installed in the correct position and not twisted.

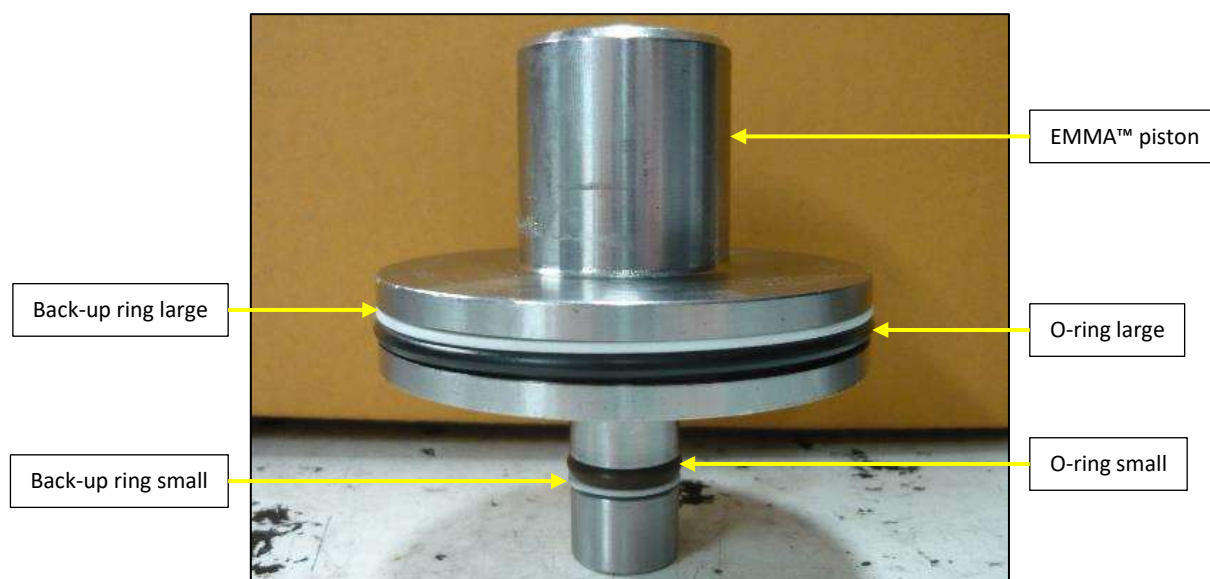


Figure 46: EMMA piston with seals installed.

8. Clean the exposed areas of the Failsafe Emergency pistons in cases where the pistons have not been removed.
9. Ensure the piston seals avoid contamination during cleaning process.
10. Clean the outer housing and spring cover. Inspect both for damage.
11. Wipe the piston bores dry and apply a small amount of silicone grease in the piston bore.
12. Install any pistons that were previously removed.
13. Follow steps 9-13 in section 24 to reassemble piston springs and spring covers.

26. Service Assembly and Bleed Procedure

1. Using a suitable lifting apparatus fit the ABT™ Failsafe Emergency brake unit over the pinion shaft.
2. Hold the brake rotor to prevent it from detaching from the yoke during assembly.
3. Lift outer assembly and align the yoke with the pinion shaft with the EMMA™ spring covers positioned towards the bottom of the brake.
4. Once the brake is held by the pinion shaft, rotate the outer housing until the EMMA™ spring covers are positioned towards the top of the brake.
5. Remove any rotor retaining devices once the inner and outer housings are as close to each other as possible.
6. Fit the 20x M14 bolts and torque to 158 Nm in a star sequence. Ensure each bolt is torqued twice.
7. Attach the pinion shaft nut. Torque to correct Volvo/Meritor specifications, 2000 – 2200Nm.
8. Knock over locking tab on pinion nut.
9. Ensure the diff rotates freely when the ABT™ Failsafe Emergency brake is released.
10. Assemble the drive shaft onto the ABT™ yoke. Torque fasteners as per universal joint manufacturer's instructions.
11. Fill the cavity behind the V-lip seal with a high temperature bearing grease (Castrol LMX recommended) via the grease nipple located on the yoke. Do not over-grease the V-lip cavity.
12. Remove the 6x retractor bolts from the spring cover.
13. Fit the pad wear indicator to one of the uppermost pistons:
 - a. Screw the pad wear indicator plunger into the piston thread and torque to 15 Nm.
 - b. Apply Loctite 222 to the gland fitting on the thread that attaches to the spring cover only.
 - c. Fit the gland fitting over the piston and screw this into the spring cover. Torque to 15Nm.
 - d. Fit the stainless-steel protective cap and fibre washer to the gland fitting.

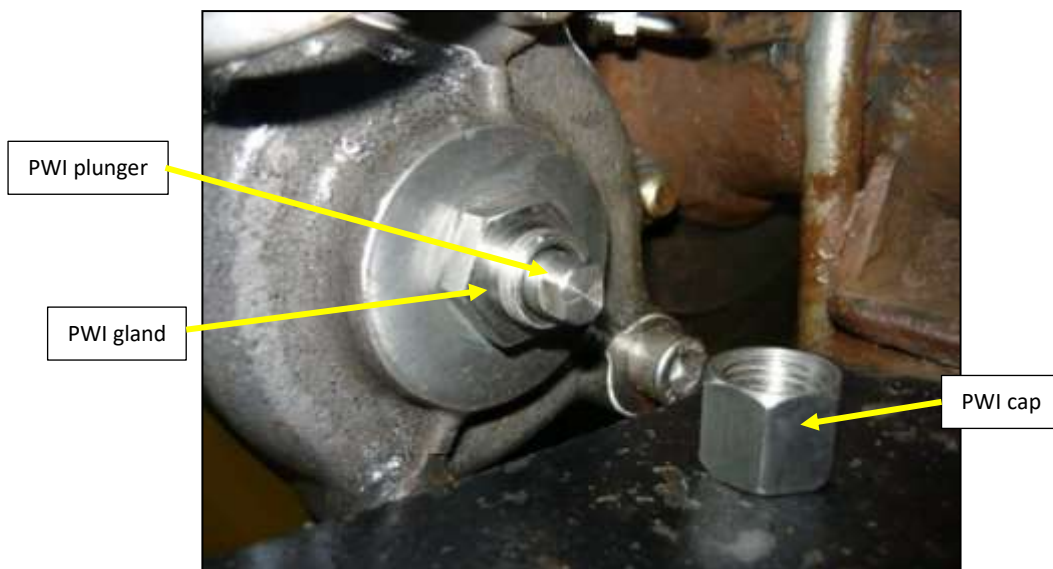


Figure 47: Pad wear indicator install in spring cover.

- e. Fit 5x supplied tapered plugs to seal the remaining holes in the spring cover. Use an anti-seize or a low strength thread locker on the threads to prevent the plugs seizing in the spring cover. The hex sockets may be filled with silicone or similar, to aid future removal.
14. Remove the ABT™ cooling fluid fill plug.

15. Fill the ABT™ Failsafe brake unit with new ABT™ cooling fluid and refit the fill plug with a new copper washer. Approximately 800ml of ABT™ cooling fluid is required.
16. Check the differential oil level and top up if necessary.
17. Inspect all the driveline brake hydraulic hoses and replace as required.
18. Replace all breather hoses.
19. Flush the pump reservoir with new ATF Dexron III and then fill to level window.
20. Prime the ABT™ Failsafe pump by running intermittently (no more than 10 seconds at a time) until full hydraulic pressure is reached and the motor stops running automatically.
 - a. To run the pump and release the EMMA™ brake, twist the red pushbutton on the control unit clockwise.
 - b. To release hydraulic pressure and engage the EMMA™ brake, press the red operator pushbutton.
 - c. While performing this priming process, ensure the EMMA™ reservoir is constantly topped up to prevent the pump from running dry.
21. Bleed the driveline brake system
22. Check that there are no leaks from the system.

26. Troubleshooting

1. Problem
 - a. Possible cause
 - i. Solution
2. Fault light on control unit flashing.
 - a. 2x flashes then rest – low battery fault (below 22V)
 - i. Charge vehicle battery
 - ii. Fault will self-clear when battery voltage is above 22V
 - b. 3x flashes then rest – control unit PCB too hot
 - i. Remove any sources of heat that could be causing the control unit to overheat
 - ii. Fault will self-clear when the PCB temperature drops below a certain level.
 - c. 4x flashes then rest – Failsafe Emergency brake took too long to release – operation aborted.
 - i. Check pump reservoir level is not too low. If low check system for leaks.
 - ii. Possible air in system causing slow release. Bleed Failsafe Emergency brake system.
 - iii. Pump motor has is too hot and has lost effectiveness – allow to cool to ambient.
 - iv. Cycle ignition to clear the fault from the control unit.
 - d. 5x flashes then rest – pump relay fault
 - i. Ensure wiring is not causing a short or open circuit to pump relay.
 - ii. Check pump relay for correct function – replace if required.
 - iii. Cycle ignition to clear the fault from the control unit.
 - e. 6x flashes then rest – dump valve fault
 - i. Ensure wiring is not causing a short or open circuit to dump valve.
 - ii. Check dump valve for correct function – replace if required.
 - iii. Cycle ignition to clear the fault from the control unit.
 - f. 7x flashes then rest – diff lock solenoid fault
 - i. Check vehicle diff lock is functioning correctly.
 - ii. Check wiring connections to diff lock switch.
 - iii. Check ABT™ Failsafe Emergency brake diff lock relay.
 - iv. Cycle ignition to clear the fault from the control unit.
 - g. 8x flashes then rest – pressure sensor fault
 - i. Ensure wiring is not causing a short or open circuit to pressure sensor.
 - ii. Check pressure sensor for correct function – replace if required.
 - iii. Cycle ignition to clear the fault from the control unit.

3. ATF warning light on control unit on.
 - a. Vehicle parked on steep incline causing sensor to read incorrect fluid level.
 - i. Park vehicle on flat surface and check ATF warning light if off.
 - b. Low fluid level in ABT™ Failsafe Emergency brake pump reservoir.
 - i. Top up reservoir with ATF Dexron III and check system for leaks.
4. Brake status LED is solid green and control unit is not responding.
 - a. Control unit is in 'Failsafe version 3' mode.
 - i. Conduct a master reset of the control unit by holding the manual release button and cycling the E-stop button 3 times within 5 seconds. All lights on the control unit will flash once to confirm reset was successful and all settings have been cleared.
5. Brake drag/brake not fully releasing after operation.
 - a. Control unit may have learned the incorrect release pressure (retractor bolts left in place during initial set-up).
 - i. Perform a master reset of the control unit.
 - b. EMMA™ piston seals bypassing or seals contaminated & swollen preventing them from retracting.
 - i. Inspect brake for ATF leakage around rear of spring cover.
 - ii. Strip brake and inspect components. Replace seals as required.
 - c. Insufficient hydraulic pressure to release EMMA™ brake.
 - i. Place vehicle on hoist if required and release EMMA™ brake.
 - ii. Carryout pressure check in EMMA™ circuit should be 1900psi approx. If pressure is insufficient change pressure switch. If pressure still low, EMMA™ pump may be at fault.
 - iii. Strip brake & inspect.
6. Brake not releasing/partially releasing after operation (brake status light flashes green or red)
 - a. The return gallery in the pump manifold may be blocked and is holding residual low pressure in the line.
 - i. Carefully open one of the EMMA™ hydraulic hose fittings to release any pressure. If pressure is released continue to step ii.

WARNING:

The hydraulic hose contains fluid under pressure. Ensure adequate precautions are taken when opening the hydraulic fitting.

- ii. Remove the orifice plug (18-9037) from the manifold block and clean.
7. ABT™ Failsafe Emergency brake applies unexpectedly.
 - a. Faulty wiring causing intermittent loss of continuity.
 - i. Inspect/test 24-volt ignition switched & 24-volt constant supply. Ensure all connections are clean, secure and free of corrosion.
 - ii. Check door switches.
 - iii. Check seatbelt switches.
 - iv. Check oil-pressure switches.

8. ABT™ Failsafe Emergency brake is poor. Brake not holding on inclines.
 - a. Brake pads and/or rotor worn.
 - i. Check pad wear indicators. If pads below wear limit conduct a major service.
9. ABT™ Failsafe Emergency brake slow to apply
 - a. Brake pads worn.
 - i. Check pad wear indicators. If pads below wear limit conduct a major service.
 - b. ABT™ Failsafe Emergency relief valve set too high.
 - i. Adjust to desired application speed by loosening locknut and turning adjusting screw out. Adjust ½ turn at a time & test.
10. ABT™ Failsafe Emergency pump runs intermittently during service (brake status light flashes red and beeps occasionally).
 - a. Minor leak in Failsafe Emergency brake system
 - i. Check all hydraulic hoses and connections for signs of leaking ATF.
 - ii. Strip brake and check Failsafe Emergency brake piston seals and bores. Replace as required.
11. Pump does not run (ABT™ Failsafe Emergency brake does not release).
 - a. Check interlocks are not preventing brake release
 - i. Close all doors, fasten driver's seatbelt, start vehicle engine.
 - b. Loss of power to ABT™ Failsafe Emergency control unit (indicated by lack of brake status LED).
 - i. Check all fuses. If blown identify cause and repair.
 - c. Loss of power to ABT™ Failsafe Emergency brake pump.
 - i. Check all fuses. If blown identify cause and repair.
 - ii. Check function of relay mounted at vehicle battery. Replace if required.
 - iii. Check for continuity of wiring from battery to pump motor and relay to control unit.
 - d. Faulty pump motor.
 - i. Replace pump motor.