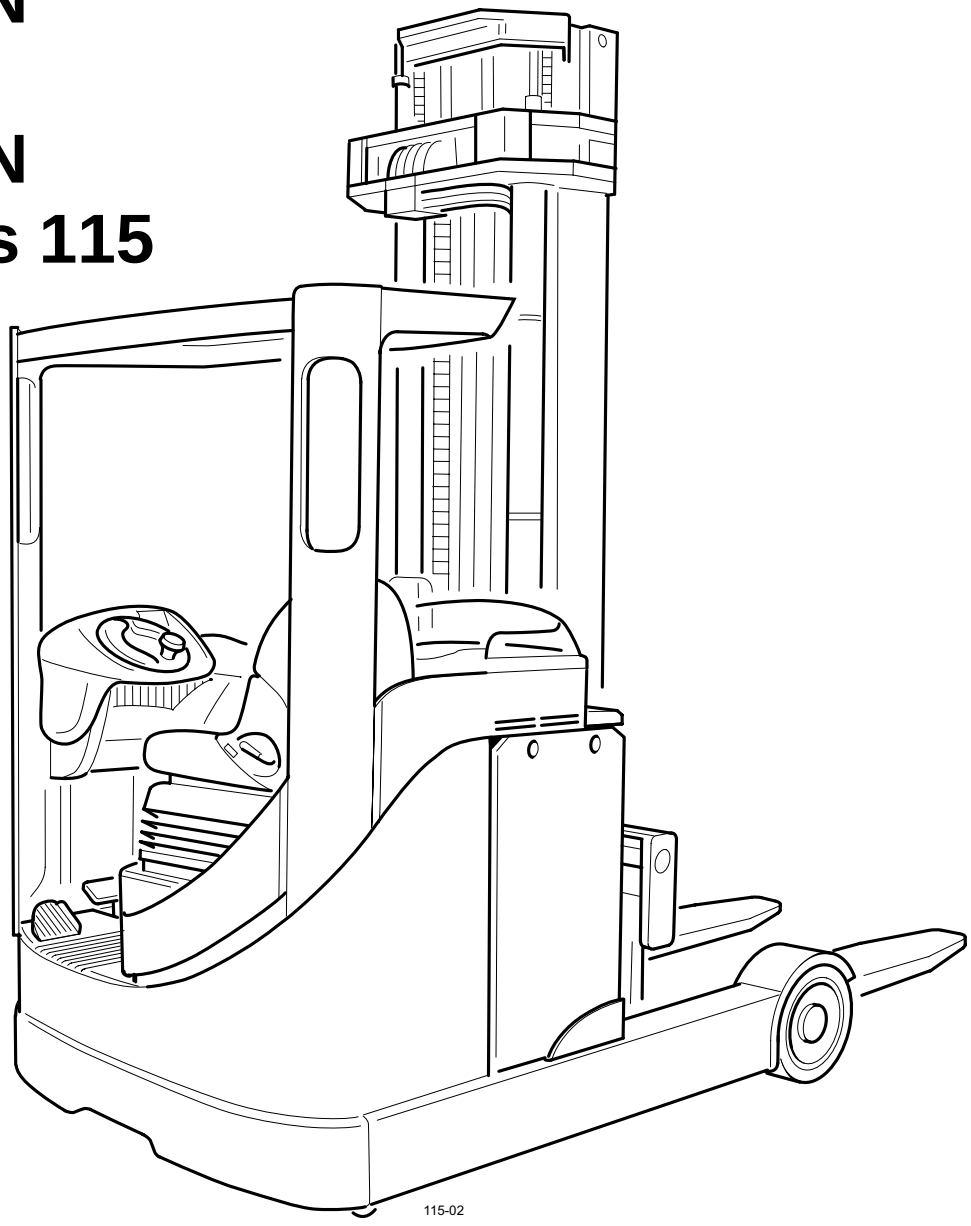
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Service Training

Linde Electric Reach Truck
R 14
R 14 HD
R 16
R 16 HD
R 16 N
R 20
R 20 N
Series 115

RP01 / Chapter 1
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INTRODUCTION

This is a guide to those responsible for the repair and maintenace of the 115 reach truck. A full inspection and maintenance procedure for up to 10000 hours, together with all necessary checks and adjustments can be found in the Operating Instructions publication 115 804 2501 GB.

The TABLE OF CONTENTS gives the various sections into which this manual is divided.

Due to the ever increasing higher standard of production methods, materials used and the company policy of continuous improvement, various servicing procedures will have changed.

DANGER: On no account should metric and imperial threads be intermixed although in some cases they might appear to fit. This is particularly important in the case of eyebolt fixings which can be seriously weakened.

CAUTION: It is imperative, that before working on the control system, that the battery is disconnected, and the steering capacitor voltage is discharged.
The steering capacitor voltage can be safely discharged by operating the horn with the battery plug DISCONNECTED. Check that the voltage between 3F1 and the main negative is less than 5V before working on the truck.
Failure to carry out this procedure can lead to damage of the CAN interface drivers. Components MUST NOT be removed or replaced with the truck live.

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CAUTION: If the battery has been disconnected, before reconnecting, ensure that the emergency isolator is depressed and the keyswitch is turned off.

DO NOT FIT PARTS OTHER THAN THOSE AVAILABLE FROM LINDE MATERIAL HANDLING (UK) LIMITED, OR ALTER EXISTING EQUIPMENT. INCORPORATION OF PARTS OTHER THAN THOSE SUPPLIED BY LINDE MATERIAL HANDLING (UK) LIMITED OR ALTERATION OF EXISTING EQUIPMENT WITHOUT THE MANUFACTURER'S PERMISSION MAY MAKE THE TRUCK UNSAFE AND WILL RENDER INVALID THE LINDE MATERIAL HANDLING (UK) LIMITED VEHICLE GUARANTEE.

When overhauling any unit, all seals, tab washers or split pins must be renewed. The unit must then be greased or filled with correct grade lubricant. See Recommended Lubricants.

Reference is made throughout the text to the front, rear, left hand side and right hand side of the truck. To avoid any confusion when ordering spare parts, it should be noted that the elevating forks are always considered to be on the rear of the truck. The left hand or right hand side is determined from the driving position facing towards the mast.

TRUCK IDENTIFICATION

The truck has a detailed Truck Identification Plate serial number which can be seen on the serial number plate. The plate is mounted on the top of the overhead guard facing the driver.

It is most important that the full serial number is quoted when ordering replacement parts, or when any reference is made to your vehicle, in any correspondence or by telephone conversation.

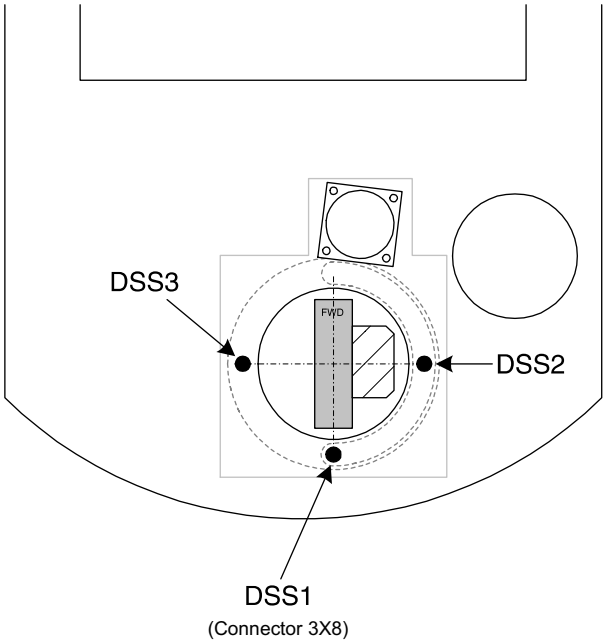
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ELECTRICAL SAFETY CHECKS

Should major electrical work or disassembly be carried out on the truck, then the following electrical safety checks MUST be carried out prior to returning the truck into service.

1)
- Depress the emergency isolator, and disconnect the battery.
- Connect a FUSED shorting link between traction LTM studs 1A1:1 and 1A1:2.
- Connect the battery, release the emergency isolator, turn the keyswitch ON, close interlocks and select a direction of travel.
- Depress the accelerator.
- Check that no function takes place and that an alarm is displayed on the driver's display.
- Turn the keyswitch OFF, depress the emergency isolator, disconnect the battery and remove the fused shorting link.

2)
- Disconnect the steering sensor connector 3X8 from DSS1.
- Reconnect the battery, release the emergency isolator and turn the keyswitch ON.
- Operate the steering from lock to lock.
- Confirm that the line contactor releases and that an alarm is displayed on the driver's display.
- Turn the keyswitch OFF, depress the emergency isolator and disconnect the battery.
- Reconnect connector 3X8.
- Reconnect the battery and return the truck to service.



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SAFETY

The warning precautions DANGER, WARNING, CAUTION and NOTE in this manual are provided to indicate special dangers or unusual information requiring special identification:

DANGER: Indicates hazards that may result in bodily injury or death and/or severe product damage.

WARNING: Indicates hazards that may result in bodily injury and/or severe product damage.

CAUTION: Indicates hazards that may result in damage to or destruction of the product.

☞ NOTE: Identifies technical information requiring special attention because the connection may not even be obvious to skilled personnel.

AVOIDING ACCIDENTS

Most accidents and injuries that occur in workshops are caused by the failure to observe some basic rules of care and safety. For this reason, in the majority of cases they can be avoided.
Anticipate potential hazards, and act with the necessary care and caution to reduce the risk to a minimum.

An alert, cautious mechanic is a safe one.

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SAFETY GUIDELINES

DANGER: Before attempting any repair work, apply the parking brake, turn the keyswitch off, disconnect the battery, and, unless the particular routine being performed requires otherwise, chock the load wheels securely front and rear.

DANGER: Before carrying out any electrical maintenance or checks, raise the drive wheel clear of the ground and securely chock the truck in position.

DANGER: Take the necessary fire precautions when working on batteries.

DANGER: Before attempting repairs or adjustments on the reach frame, the raised fork carriage or mast, always ensure that they are secured against accidental movement.

DANGER: Always ensure any lifting equipment, is of sufficient capacity, and has the relevant certification. All blocks, jacks and chains etc. are subject to regular examination and must only be used for the purpose intended.

DANGER: Use only prescribed attachment points when towing or lifting. Attach connections carefully. Check that the pins and/or bolts provided are secure before loading. Never stand close to drawbars, slings or chains that are working under load.

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WARNING: Before disconnecting hydraulic connections, ensure that there is no pressure in the system.

WARNING: Do not allow hydraulic oil under pressure, for example at a leak, to penetrate the skin. Medical aid is required if such an injury occurs.

DANGER: Never wear rings, wrist watches, jewellery, loose or dangling items of clothing such as ties, torn clothing, scarves, unbuttoned jackets or overalls with open zip fasteners that could get caught up in moving parts. Always wear approved safety clothing.

DANGER: Never carry out maintenance or servicing operations on the truck with anyone sat on the seat, unless that person is fully trained and involved in the operation being carried out.

DANGER: Never start the machine or operate an attachment from any position other than the operator's seat.

DANGER: The design of service steps or platforms used in the workshop or on site must comply with current regulations.

DANGER: Label all controls to indicate a service or repair operation is being carried out.

DANGER: Never use petrol, or diesel fuel as cleaning agents. Instead, use non-inflammable, non toxic commercial solvents.

WARNING: Protective equipment i.e. goggles and mask must be worn at all times when using compressed air.

HANDLING LUBRICANTS

Always handle lubricants safely and as specified by the manufacturer.

Only store lubricants in approved containers at specified storage locations. As they could be inflammable, do not let them come in contact with hot objects or naked flames.

Clean the area surrounding the part in question before lubrication, filter renewal or repairs in the hydraulic system.

Only use clean containers when replenishing fuels and lubricants.

Follow the manufacturer's safety and disposal instructions when using lubricants and cleaning compounds.

Avoid spilling lubricants. Remove any spillage immediately with a suitable absorbant, and dispose of as per local legislative requirements.

Always dispose of used or contaminated lubricants as specified. Follow laws and regulations.

Dispose of used parts, filters etc. as per local legislative requirements.

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1 TRACTION MOTOR AND BRAKE

CAUTION: Electrical components must not be connected or disconnected whilst the truck is live. The battery must be disconnected, failure to do so can result in failure of the modules.

1.1 TRACTION MOTOR

The traction motor is a shunt wound unit, rigidly fixed to the steer bearing plate by four screws.

Two heavy cables connect the armature to the control system, with two lighter cables connected to the shunt field. As a result the control system needs to monitor both the current flowing through the armature and shunt field.

The current sensors are mounted in and adjacent to the power module, see **SECTION 6** for further details.

The motor also incorporates a transmission brake mounted directly to the armature shaft, which is operated by either the foot brake or a solenoid brake within the same unit.

Motor temperature and brush condition are monitored, with warnings for these shown on the Linde Intelligent Display (LID).

A cooling fan is fitted which is only activated should the motor temperature exceed 40°C.

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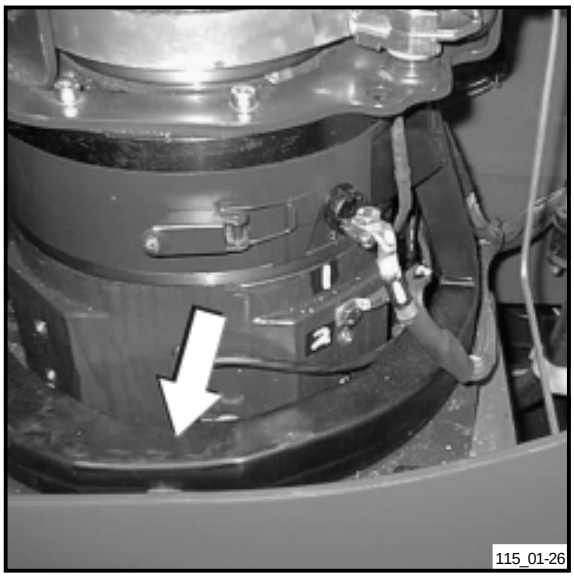
1.1.2 TRACTION MOTOR REMOVAL

WARNING: The motors can become very hot. Risk of scalding.

WARNING: Manual handling risk. The traction motor is heavy. Do not attempt to remove the motor without suitable lifting equipment.

- Turn the keyswitch off, disconnect the battery, and chock the load wheels securely.
- Remove the driver's seat, see **SECTION 3**.
- Carefully unclip, and remove the motor air cooling duct from the traction motor.
- Remove the power cables from the motor.

☞ **NOTE: To assist reassembly, the cables should be marked.**



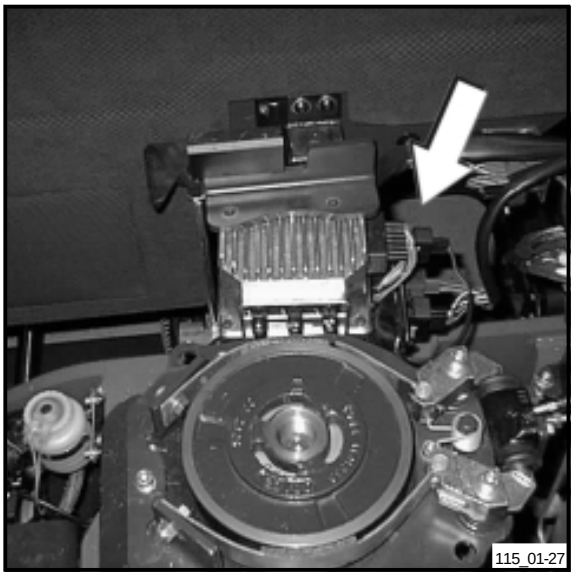
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- At the connector bracket, disconnect 1X19 (Brake solenoid) and 1X7 (Temperature and Brushwear).

- Remove the connector bracket.

☞ **NOTE: This is secured by two of the steer motor securing bolts.**

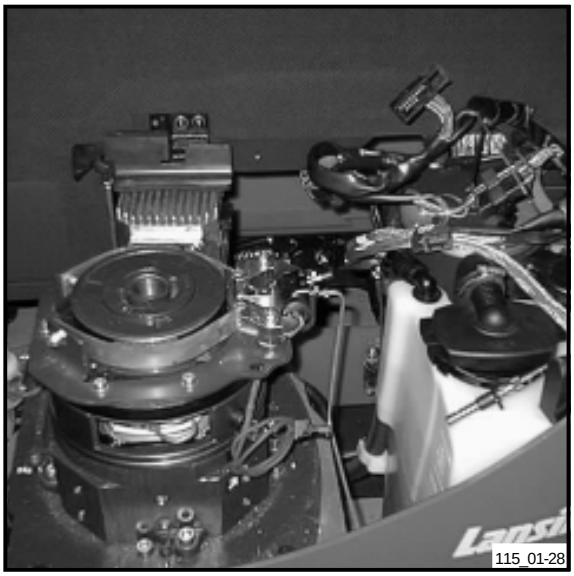
- Remove connectors 1X19 and 1X7 from the bracket and secure the harnesses to the motor to prevent damage.



- Remove the steer sensors.

☞ **NOTE: To assist reassembly, the sensors should be marked.**

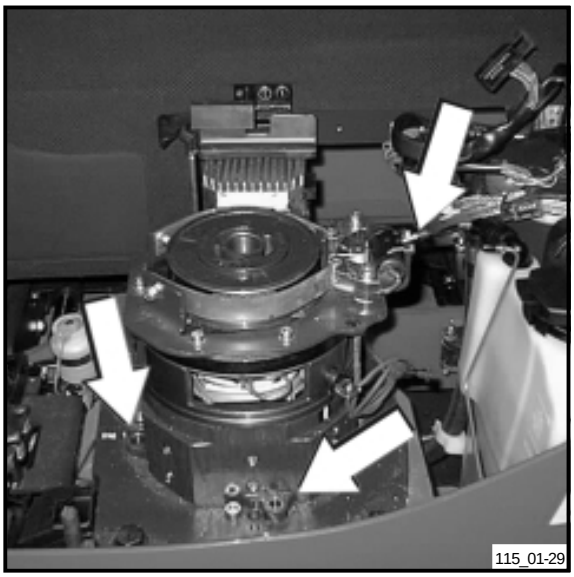
- Having removed all cables and connectors, the harness can now be moved clear and secured in position to prevent damage.



- Disconnect the footbrake pipe connection and seal to prevent contamination.

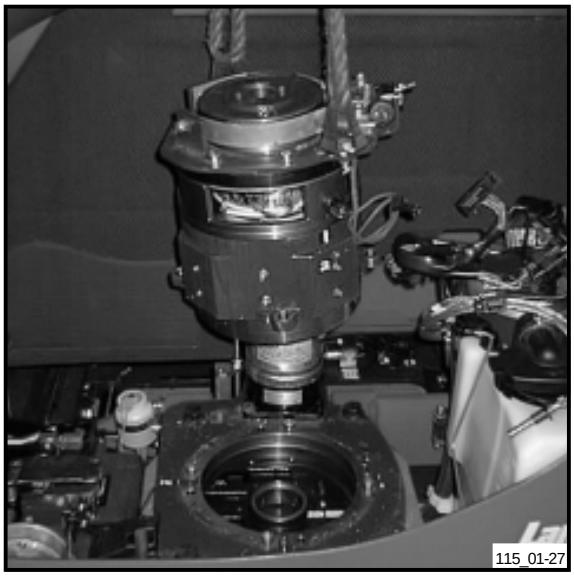
☞ **NOTE: If the motor is to be disassembled, then to aid disassembly, the footbrake shoes, support assembly and the brake drum should be removed at this point, see PARKING BRAKE DRUM REMOVAL.**

- Remove the four motor securing screws.



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- Using suitable lifting equipment, remove the motor.



1.1.2.1 TRACTION MOTOR REFITTING

- To replace the traction motor, reverse the removal procedure, ensuring all fasteners are tightened to the correct torque.

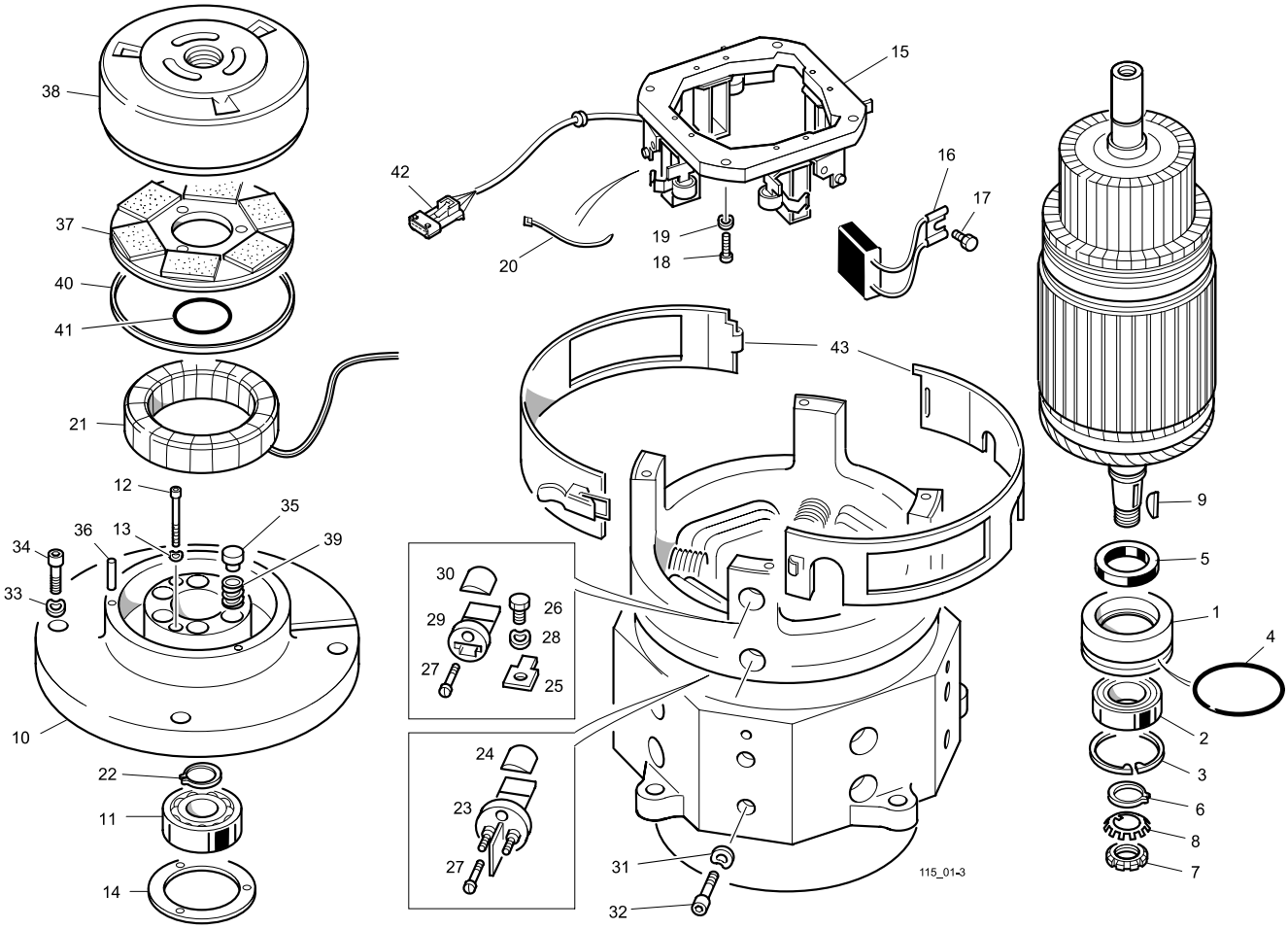
- Check steer sensors for correct adjustment.

- Bleed the brakes, see **SECTION 5.**

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Service Training

THE TRACTION MOTOR



1. Bush
2. Bearing
3. Retaining ring
4. O ring
5. Seal
6. Retaining ring
7. Slotted nut
8. Tab washer
9. Key
10. Bearing cover
11. Bearing
12. Socket head screw
13. Wave washer
14. Spacer
15. Brush holder assembly
16. Brush
17. Hexagon screw
18. Raised head screw
19. Wave washer
20. Cable tie
21. Coil
22. Retaining ring
23. Terminal
24. Bush
25. Clamping nut
26. Hexagon screw
27. Fillister head screw
28. Spring washer
29. Insulating bush
30. Clamping piece
31. Spring washer
32. Socket head screw
33. Spring washer
34. Socket head screw
35. Cap
36. Pin
37. Brake disc
38. Brake drum
39. Spring
40. Seal
41. O ring
42. Cable assembly
43. Brush cover

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1.1.3 TRACTION MOTOR DISMANTLING

- Remove brush cover (43).

- Disconnect and remove brushes (16) from the brush holder in the brush holder assembly (15).

☞ **NOTE: Ensure the brushes are marked, and returned to their original position on re-assembly.**

- Mark the bearing cover (10) and the main body to ensure correct re-assembly.

- Remove the four screws (34) and spring washers (33).

- Withdraw the armature and bearing cover (10).

- Support the bearing cover (10) on two suitable wooden blocks, remove screw (12) from the bearing cover (10) which releases spacer (14). Using a suitable hide head hammer, drive the armature from the cover-bearing (10).

⚠ **CAUTION: Ensure the drive end of the armature is protected to prevent damage.**

- Remove the four screws (18) and washers (19) and withdraw the brush holder assembly (15) from the bearing cover (10).

- It is only necessary to remove seal (5) and O ring (4) if they are damaged.

The traction motor is now dismantled.

1.1.4 TRACTION MOTOR COMPONENT INSPECTION

After the motor is dismantled, the components should be thoroughly cleaned and inspected for wear or damage. Clean components with a good grade petroleum based cleaning solvent and dry. Discard all bearings and always fit new ones.

⚠ **CAUTION: Under no circumstances must solvents be used on motors fitted to trucks as any residue can ignite when power is applied.**

Check brushes for even wear and commutation, replace if badly worn (minimum wear brush length 17 mm), pitted or burnt from overheating. Always replace a complete set of brushes, never individually. Check the brush movement is free in the holders, and the brush spring tension.

1.1.5 TRACTION MOTOR ARMATURE CHECKS

Check the armature shaft bearing journals and spline for wear. Check windings, commutator connections and bars for any signs of burning. If burned sections are evident either in the brush track or on the riser ends of the commutator bars, an open or short circuit is indicated in the armature windings.

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1.1.6 TRACTION MOTOR COMMUTATOR REFACING

The commutator may be refaced in a lathe with 00 or fine glass paper for superficial scores or pitting. Excessive pitting, scores or wear will require turning. Only light cuts of 0.13 mm and the final skim of 0.005 mm. The Mica segment insulation should then be undercut with a parallel sided cutter to a depth of 1.2 mm. After the commutator has been undercut, it should be lightly sanded with No.00 glass paper and cleaned to remove dust and dirt particles.

1.1.7 TRACTION MOTOR REASSEMBLY

To reassemble the motor reverse the dismantling procedure. Ensure all bolts and terminal connections are secure, and all O rings and tab washers are replaced. Bed in the brushes if new ones have been fitted.

☞ **NOTE: To fit the pinion gear use a press of 3 tonnes capacity. Torque the slotted nut to 55 Nm and secure with tab washer.**

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1.1.8 TRACTION MOTOR - BEDDING THE BRUSHES

When fitting new brushes the brushes should be bedded to the commutator.

New brushes should first be bedded to the commutator using fine sand paper to obtain a rough shape. A commutator stone may be used for final bedding.

- Place a sheet of fine glass paper round the commutator - rough side facing brushes.
- Position the new brushes in their holders and ensure that the brush springs are centrally located.
- Rotate the armature slowly, until the brush surface shows contact over the whole area.
- Mark the brushes and their respective holders.
- Withdraw the brushes and glass paper and remove the carbon deposit from the commutator.
- Rub the commutator with a clean rag moistened with paraffin to remove oil or grease. Replace the brushes back in their correct position.
- Run the drive motor at reduced speed.
- Apply the bedding stone close behind a brush, moving it from side to side across the commutator, using just sufficient pressure to give a steady flow of dust. Reverse direction of rotation and repeat procedure until all brushes are perfectly bedded.
- Clean out the motor, brushes and boxes thoroughly.



CAUTION: This final step is most important, as no abrasive material must be present on the brushes or commutator during normal running.

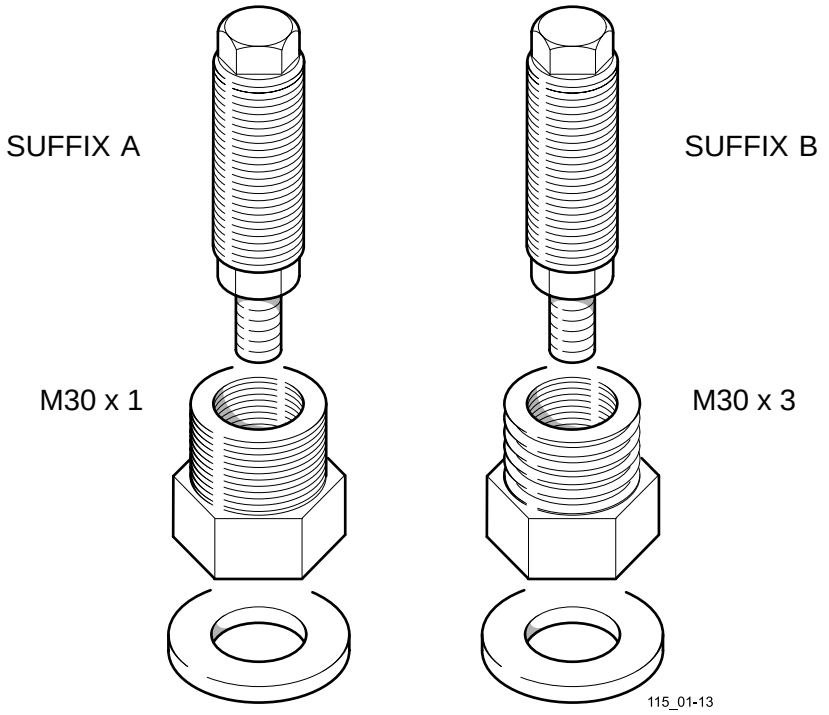
Recommended grade of bedding stone - Morganite BS24.

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1.2 PARKING BRAKE ADJUSTMENT

WARNING: The traction motor can become very hot. Risk of scalding.

By using Window 61 of the LDC diagnostics, the calculated gap between the friction plates and brake drum when the brake is released, can be ascertained. This gap should be between 0.3 mm and 0.6 mm (0.45 optimum) In order to adjust the parking brake, special tool No. 002.941.80.14 for pre production fine pitch drums, or 002.941.80.15 for later course pitch drums, and a PC with the relevant diagnostic software installed are required.



- Securely chock the drive wheel front and rear to prevent the traction motor armature from rotating.
- Connect PC to the diagnostic port.
- Screw the inner part of the tool fully into the armature shaft.



CAUTION: Do not overtighten.

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- Place the washer over the inner part of the tool.

- Screw the outer part of the tool onto the inner part, so that the hexagon section is in contact with the washer.

- Turn the keyswitch on, and access window 61 of the traction diagnostics.

☞ NOTE: The 'GAP' will display 0.00 until the first release of the brake after power on.

```
(61)
GAP :0.35mm
Ibrk:1.12A
```

- Release the parking brake. The reading should be 0.45 mm with an accepted range between 0.30 mm and 0.6 mm

- To reduce the gap, using a 32 mm spanner, turn the outer part of the tool clockwise.

☞ NOTE: Only small adjustments should be made. 1/8 turn = approx. 0.12 mm reduction.



- Apply, and release the parking brake.

- Re-check the gap using Window 61, and repeat the procedure until the correct adjustment is achieved.

☞ NOTE: Should the gap need increasing, then the tool will need to be reversed in order to pull the drum away from the friction plates. See PARKING BRAKE DRUM REMOVAL.

- Remove chocks, and test for correct operation.

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1.3 PARKING BRAKE DRUM REMOVAL

WARNING: The traction motor can become very hot. Risk of scalding.

The brake drum will need to be removed, should the friction plate need replacing.

- Turn the keyswitch off.

- Securely chock the drive wheel front and rear to prevent the traction motor armature from rotating.

☞ **NOTE: Although not necessary, removing the footbrake shoes will facilitate brake drum removal, see SECTION 5.**

- Insert an M8 x 15 mm screw into the end of the armature shaft.





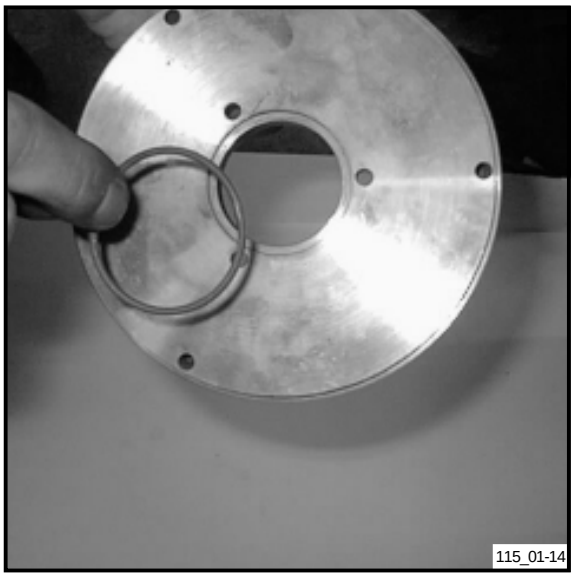
- Screw the outer part of the removal tool into the brake drum.

- To withdraw the drum from the armature shaft, screw the inner part of tool (hexagon section leading) into the outer part, using a 15 mm spanner.



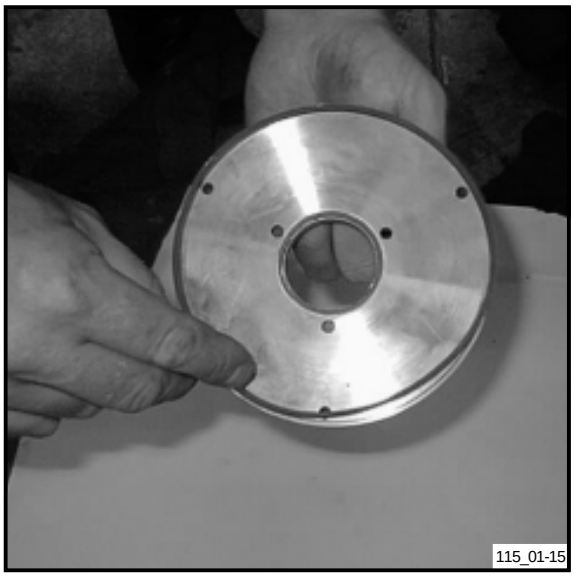
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1.4 PARKING BRAKE FRICTION PLATE SEAL RENEWAL



When replacing the friction plate, new seals should be fitted.

- Replace the inner seal.



- Replace the outer seal.

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1.5 PARKING BRAKE DRUM REPLACEMENT

- Turn the keyswitch off.

- Securely chock the drive wheel front and rear to prevent the traction motor armature from rotating.

- Slacken the footbrake shoes.

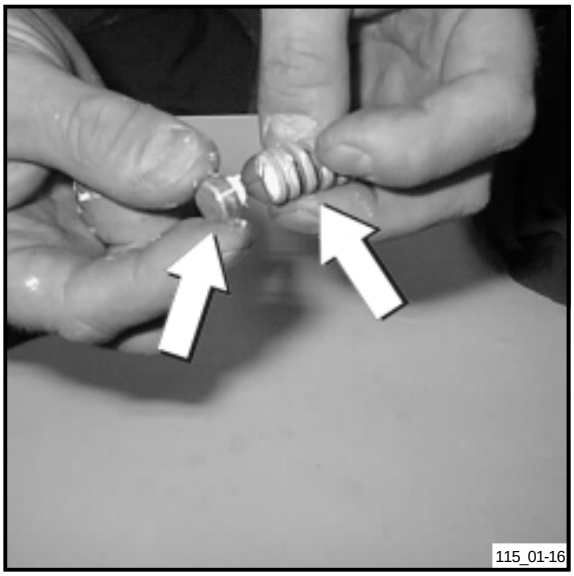
☞ **NOTE: Although not necessary, removing the footbrake shoes will facilitate brake drum replacement.**

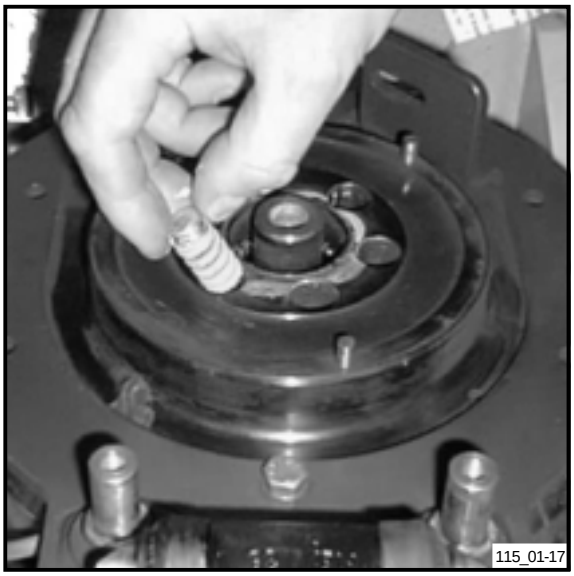
☞ **NOTE: To facilitate replacement, the seat should be removed, and the seat and left foot switches by-passed.**

CAUTION: Manual handling risk. The seat assembly is heavy. Assistance should be sought when removing the seat assembly.

- Insert the six brass wear pads into the pressure springs.

- Insert the wear pads/spring assemblies into the motor bearing cover.



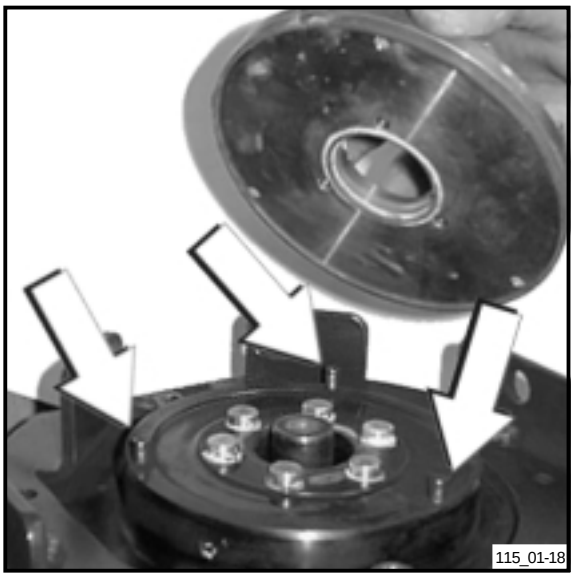


- Located the friction plate on the three dowels. Using 3 off M5 x 20 mm cap head screws, clamp the disc down fully, then back off each screw half a turn. This will give approximately 0.5 mm movement.

- Turn the keyswitch on, and operate the parking brake switch. Check for brake disc movement.

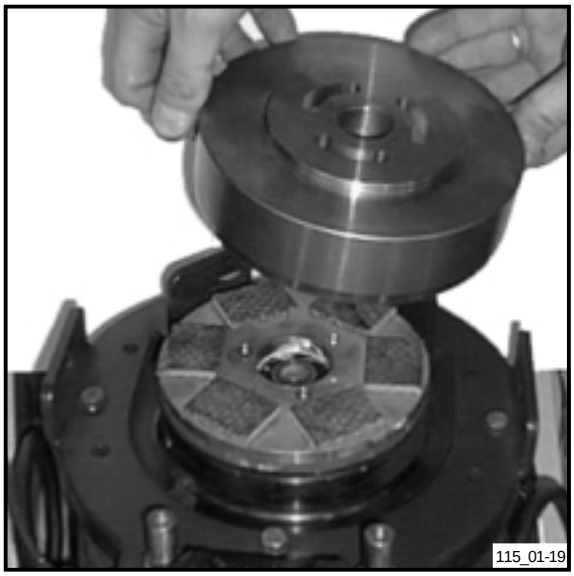
☞ **NOTE: Take care not to dislodge the two seals.**

- Turn the keyswitch off.



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- Replace the brake drum, allowing it to rest on the armature shaft.



- Screw the inner part of the tool fully into the armature shaft.

CAUTION: Do not overtighten.



- Place the washer over the inner part of the tool.

- Screw the outer part of the tool onto the inner part, so that the hexagon section is in contact with the washer.



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- Using a 32 mm spanner, draw the drum onto the armature shaft until it is almost in contact with the friction pads.

☞ **NOTE: The friction plate can be seen through the slotted holes in the drum.**

- Continue to draw the drum slowly onto the shaft, continually checking that the drum is free to rotate.

- As soon as resistance is felt, remove the 3 off M5 screws.

- Turn the keyswitch on, and access window 61 of the traction diagnostics.

☞ **NOTE: The 'GAP' will display 0.00 until the first release of the brake after power on.**

- Release the parking brake. The reading should be 0.45 mm with an accepted range between 0.30 mm and 0.6 mm

- Continue to draw the drum slowly onto the shaft until the correct adjustment is achieved.

☞ **NOTE: Only small adjustments should be made. 1/8 turn = approx. 0.12 mm reduction.**

- Apply, and release the parking brake.

- Re-check the gap using Window 61, and repeat the procedure until the correct adjustment is achieved.

☞ **NOTE: Should the gap need increasing, then the tool will need to be reversed in order to pull the drum away from the friction plates. See PARKING BRAKE DRUM REMOVAL.**

- Replace the seat.

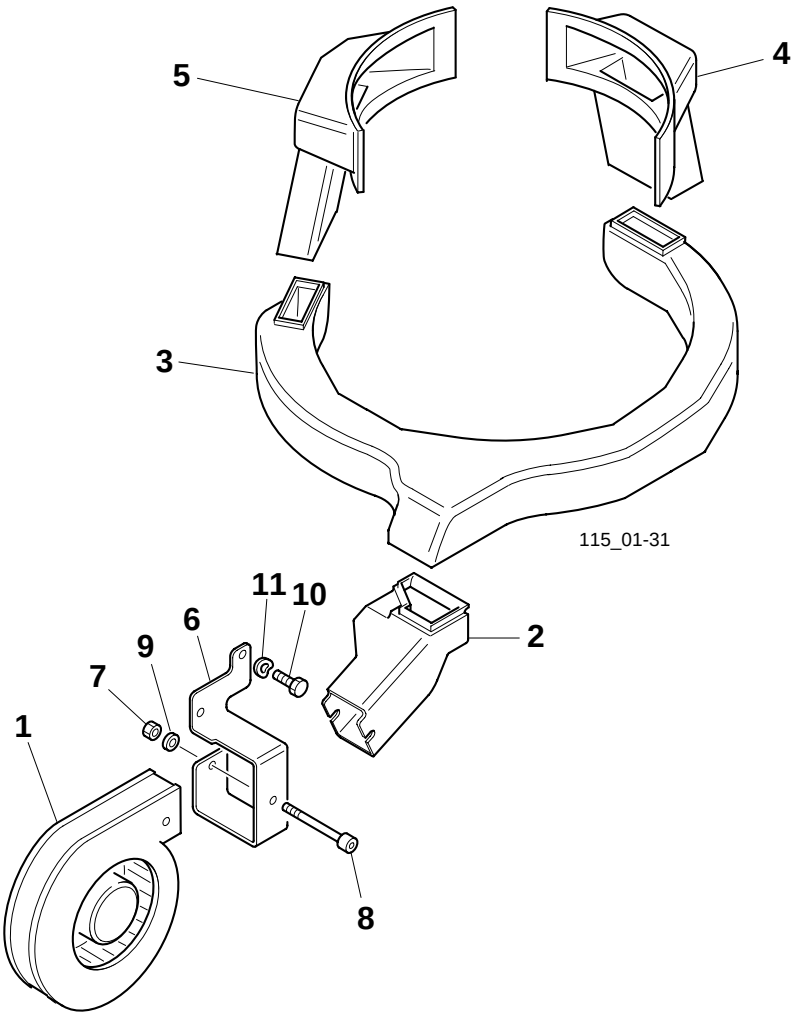
- Remove chocks, and test for correct operation.



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1.6 TRACTION MOTOR COOLING SYSTEM

The traction motor is equipped with a cooling fan assembly, which forces air through a cooling duct into the motor when cooling is required, this is activated when the motor reaches 40°C



1. Fan
2. Cooling air duct assembly
3. Cooling air duct assembly
4. Cooling air duct assembly
5. Cooling air duct assembly
6. Bracket
7. Bracket
8. Socket head screw
9. Washer
10. Hexagon head screw
11. Wavy washer

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Service Training

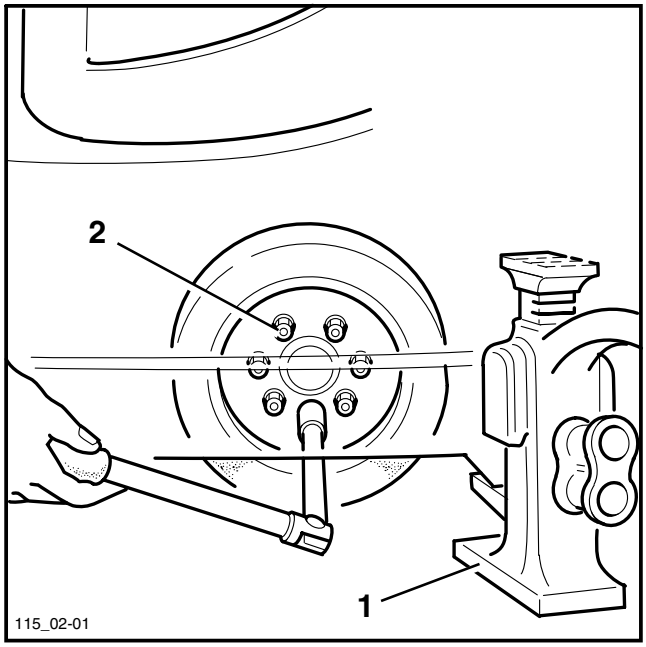
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2 TRANSMISSION

2.1 DRIVE WHEEL REMOVAL

- Apply the parking brake.
- Raise the truck at the drive end approximately 300 mm using a suitable jack (1) and chock in position.
- Turn the steering wheel full lock.
- Remove accessible wheel nuts.
- Remount the truck, release the parking brake and rotate the wheel until further wheel nuts become accessible.
- Repeat the procedure until all the wheel nuts have been removed.
- Manoeuvre the wheel off of the gearbox and from under the chassis.

WARNING: Manual handling risk. The wheel is heavy.

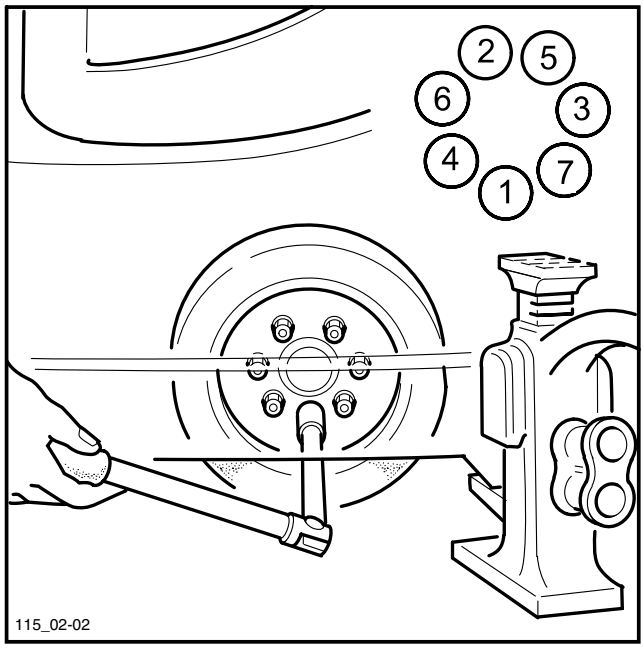


2.1.1 DRIVE WHEEL REFITTING

- To refit the drive wheel, reverse the removal procedure.

NOTE: The wheel nuts should be tightened daily after a wheel change until they are seated firmly, i.e. until the correct torque figure is consistently obtained.

For effective wheel fixing, tighten wheel nuts to 195 Nm in accordance with the sequence shown.



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2.2 GEARBOX REMOVAL

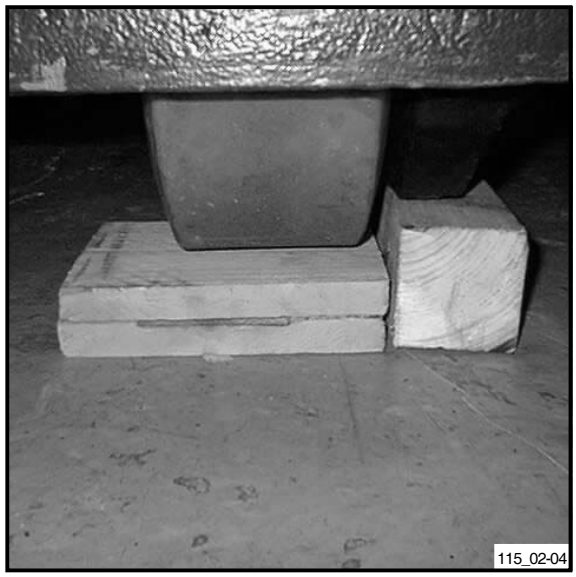
☞ **NOTE: If the gearbox is to be stripped down, it is advisable to remove the drive wheel first, see DRIVE WHEEL REMOVAL.**

- Remove the traction motor, see **SECTION 1**.
- Remove the Steer motor, see **SECTION 4**.
- Place a suitable tray beneath the gearbox, remove the gearbox drain plug and drain the gearbox oil.

WARNING: Follow the precautions for handling lubricants.

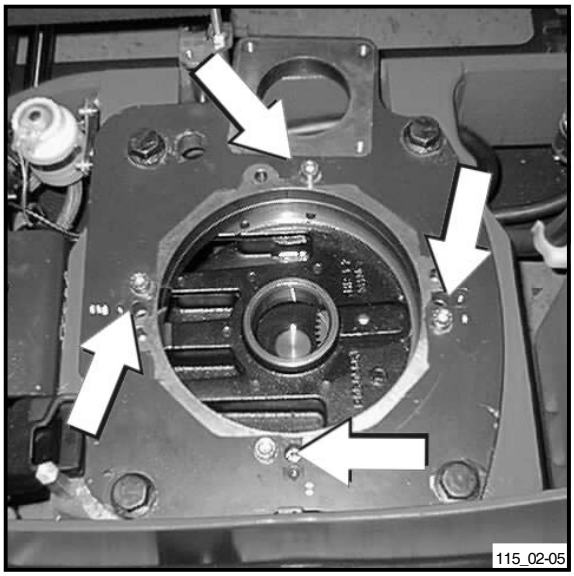


- Support the drive wheel and/or the gearbox, if the drive wheel has been removed.



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- Remove the four screws securing the gearbox.



- Using suitable lifting equipment, raise the front of the truck sufficiently to clear the gearbox and chock in position.
- The gearbox can now be manoeuvred clear of the chassis.

WARNING: Manual handling risk. The gearbox is heavy. Take care when manoeuvring the gearbox from under the chassis.

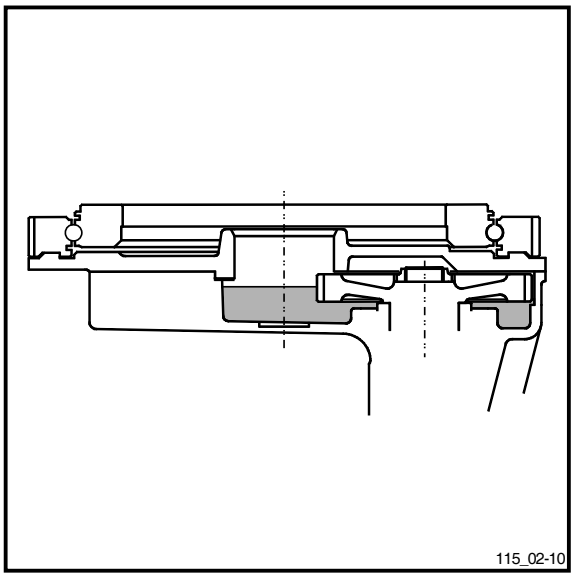
- Remove chocks and lower the chassis onto suitable blocks.



2.2.1 GEARBOX REFITTING

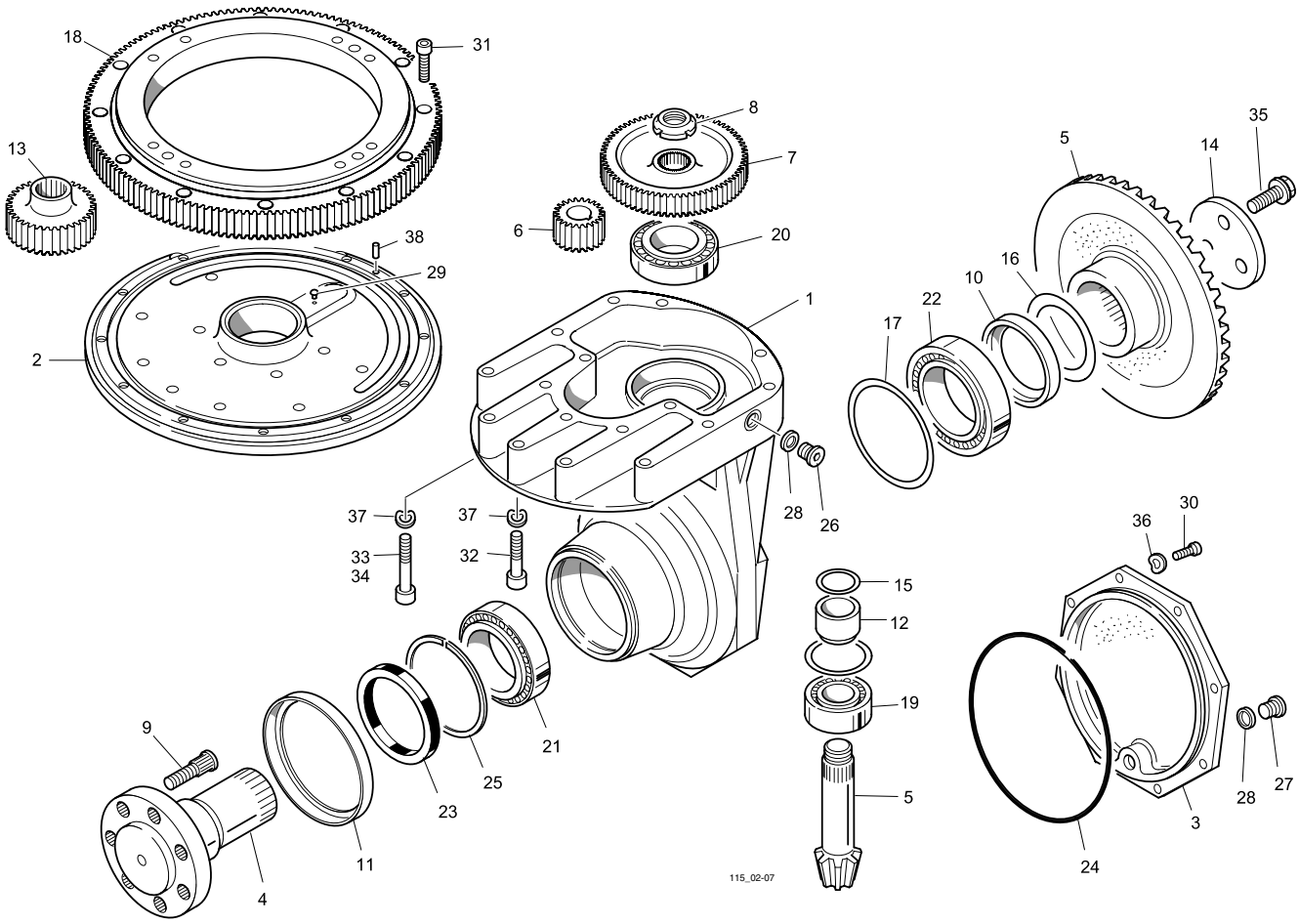
Reverse the removal procedure to replace the gearbox, but lower the chassis onto wooden blocks thick enough to allow final repositioning of the gearbox. Draw up the gearbox to the chassis using two of the securing bolts. Refit the rest of the bolts and tighten to correct torque, See **SECTION 10**.

☞ **NOTE: When the gearbox is refitted in the truck, before refitting the traction motor, the gearbox should be filled with recommended oil (see SECTION 10) to the level shown.**



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2.3 GEARBOX

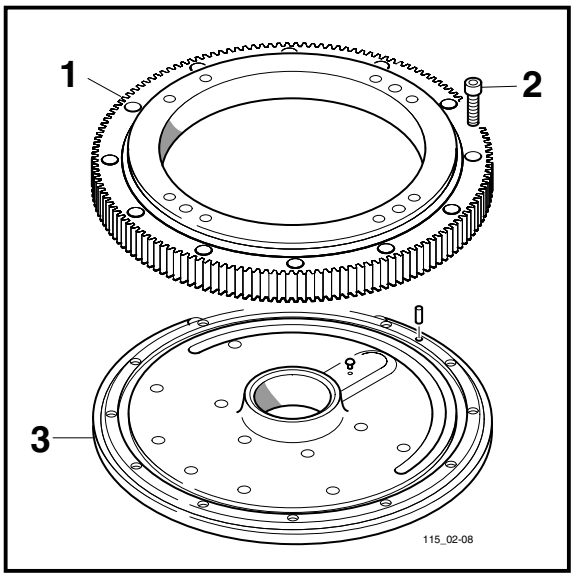


1. Housing
2. Cover
3. Cover
4. Wheel shaft
5. Pinion gear assembly
6. Pinion gear
7. Gear
8. Nut
9. Wheel bolt
10. Bush
11. Ring
12. Bush
13. Pinion gear
14. Washer
15. Shim
16. Shim
17. Shim
18. Bearing
19. Tapered roller bearing
20. Tapered roller bearing
21. Tapered roller bearing
22. Bearing
23. Seal ring
24. O ring
25. Snap ring
26. Plug
27. Plug
28. Seal
29. Vent valve
30. Socket head screw
31. Socket head screw
32. Socket head screw
33. Socket head screw
34. Socket head screw
35. Hexagon screw
36. Spring washer
37. Spring washer
38. Cylindrical pin

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2.3.1 STEER BEARING REMOVAL

- Support the gearbox securely in an upright position.
- Remove the 12 off screws (2) securing the bearing to the gearbox.
- Remove the bearing (2) from the cover (3).



2.3.1.1 STEER BEARING REFITTING

- To reassemble, reverse the removal procedure, applying Loctite 243 to the securing screws (2).

2.3.2 GEARBOX DISMANTLING

- Before dismantling the gearbox, ensure that the oil has been completely drained and that all loose dirt has been removed from the assembly.
- Remove the drive wheel, see **DRIVE WHEEL REMOVAL**.
- Remove the steer bearing, see **STEER BEARING REMOVAL**.
- Remove the cover (2) from the housing (1) after first removing securing screws (32, 33, 34) and spring washers (37).
- Remove the cover plate (3) together with 'O' ring (24) after first removing the securing screws and spring washers (30 & 36).
- Prevent pinion shaft (5) from turning and remove retaining nut (8).
- Undo the retaining screws (35) and remove together with washer (14). Carefully drive out the shaft (4) from the housing (1). Note the number of shims (16) when removed with the bush (10) and gear (5) to assist re-assembly.
- Carefully drive out the pinion shaft (5) complete with bearing (19), distance sleeve (12) and shims (15) noting their number to assist in re-assembly.
- Unless new bearings are to be fitted do not remove bearing outer shells from the housing (1).
- The gearbox components are now ready for cleaning and inspection. During re-assembly new seals and 'O' rings should be fitted.

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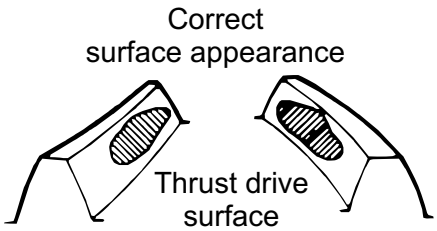
2.3.3 GEARBOX REASSEMBLY

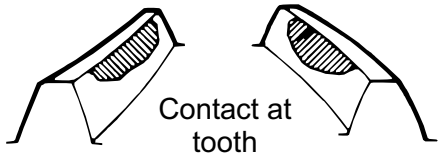
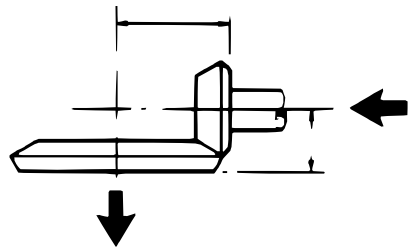
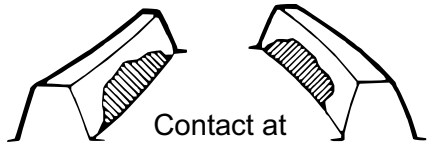
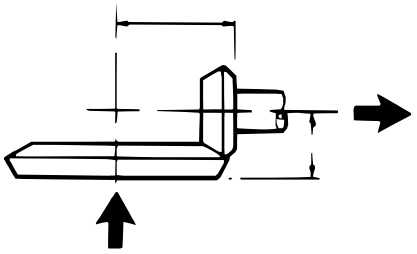
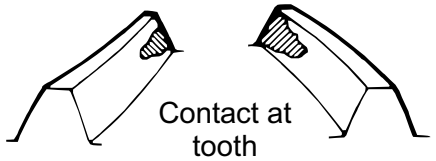
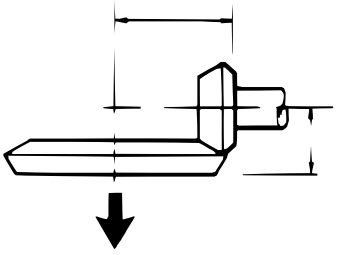
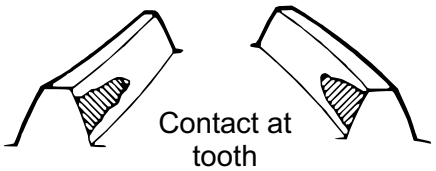
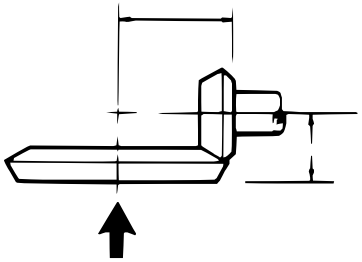
- Before assembling the gearbox ensure the housing (1) is thoroughly clean.
- Assemble to the housing (1) the outer shell of taper roller bearings (20), (19), (21) and (22).
- Assemble ring (11) to the housing (1).
- Assemble the inner race of taper roller bearing (20) to gear (7).
- Assemble the taper roller bearing inner race (19) to the pinion (5), applying Loctite 603.
- Assemble the bush (12), and shims (15) to the pinion (5).
- The assembled pinion assembly can now be mounted into housing (1).
- Assemble gear (7) to the pinion and secure with nut (8).
- Assemble taper roller bearing inner race (21) to the shaft (4) after wheel bolts (9) are securely fitted.
- Assemble the inner race of taper roller bearing (22) onto the gear (5).
- Fit snap ring (11) and oil seal (23) (apply Loctite 574 to circumference) to housing (1).
- Mount the assembled shaft (4) to the housing (1).
- Assemble bush (10) and shims (16) into the housing (1).
- Gear (5) can now be assembled to shaft (4) and secured by washer (14) and screws (35).
- Adjust the gears to obtain the correct surface tooth contact and bearing play to the main drive shaft and vertical input shaft.

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2.3.4 GEARBOX TOOTH BEARING CHECK

To check the tooth bearing, coat 2 or 3 surfaces of the crown gear with marking ink. Move marked tooth surfaces several times into mesh with the bevel pinion. The bearing pattern will be better visible if the bevel pinion is slightly braked. Compare tooth bearing with the attached 'Tooth Bearing Chart'. If correction is required proceed as shown on the chart. The gear shaft (vertical input shaft) is adjusted by shimming (15). The horizontal shaft (main drive shaft) is adjusted by the thickness of the shimming (16).



Tooth contacts at crown wheel Wrong surface appearance Concave flank Convex flank	To obtain correct surface appearnace, adjust the gears in the direction of the arrows.
	
	
	
	

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The optimum backlash setting is marked on the crown gear. Measure backlash 0.25-0.30mm on bevel gear by locking spur gear shaft. Adjust backlash by positioning hub bevel gear assembly on splined end of wheel shaft by means of the shims (16).

Proceed with final assembly, check backlash, bearing clearances and gear tooth engagement.

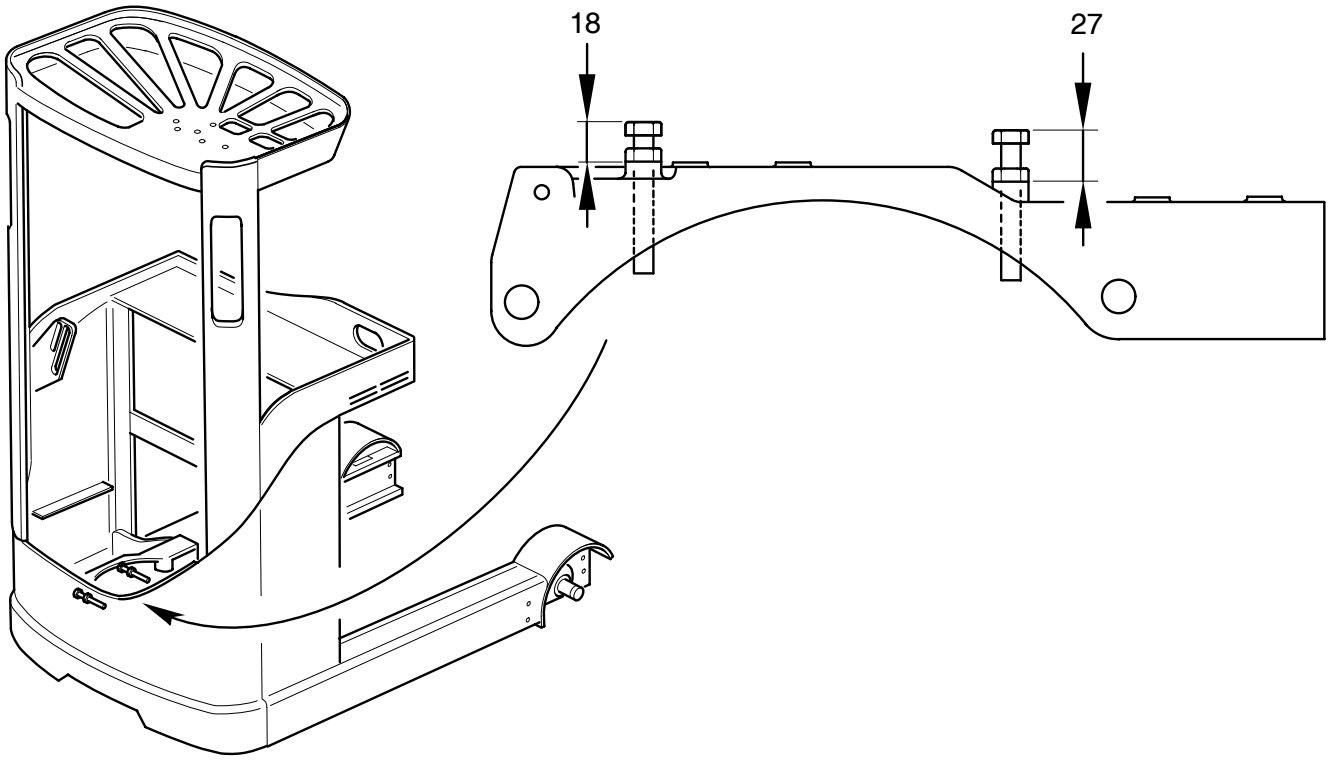
- Apply Loctite 243, and tighten nut (8) . Torque to 176 Nm
- Apply Loctite 243, and tighten screws (35). Torque to 130 Nm.
- Assemble the plate (3) and O-ring (24) to the housing (1) and secure with screws (30) and spring washers (36). Ensure drain plug (27) and seal (28) is positioned at bottom of the gearbox.
- Test gearbox for smooth, free running operation.
- Clean face surfaces of housing (1) and cover (2) and seal with Loctite 574.
- Tighten the securing screws (32, 33, 34) diametrically to the correct torque.
- Replace the steer bearing, see **STEER BEARING REFITTING**.
- The gearbox is now ready for assembly to the truck and test, see GEARBOX REFITTING.

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2.4 SETTING THE STEERING STOP BOLTS

Should the steering stop bolts need to be adjusted, then the correct setting is shown below.

☞ **NOTE: On trucks manufactured before to serial number G1X115M00216, 120mm long screws were fitted. These must be replaced with new 80 mm screws prior to setting.**



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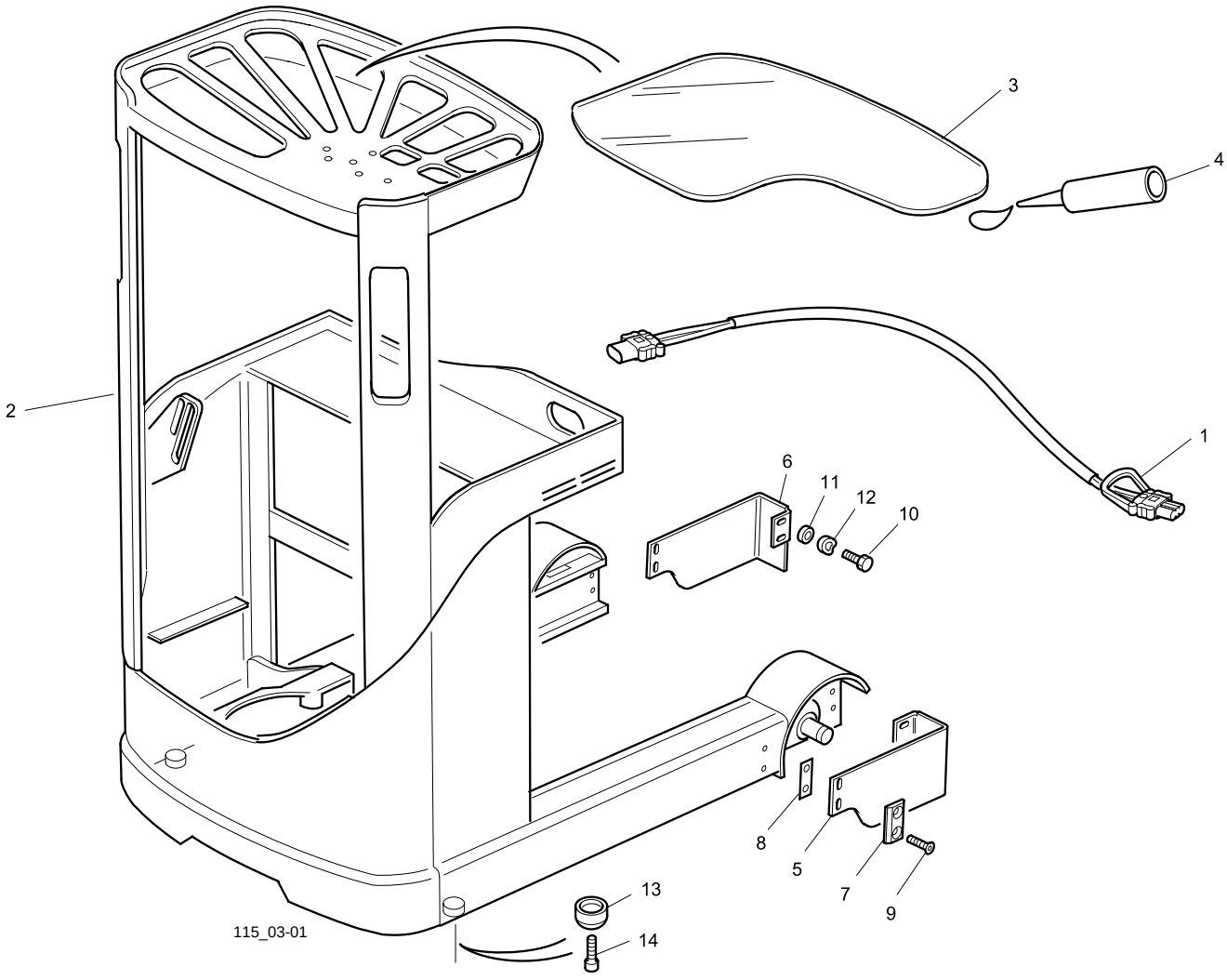
https://truckmanualshub.com/

3 CHASSIS AND BODYWORK

CAUTION: Electrical components must not be connected or disconnected whilst the truck is live. The battery must be disconnected, failure to do so can result in failure of the modules.

3.1 CHASSIS

The chassis has been designed to achieve maximum strength and rigidity. The rear lower chassis consists of a steel casting giving a low centre of gravity for stability and excellent residual capacities at high lift. The operator's compartment, motors, and electronics, are protected within the rugged structure, with easy accessibility for maintenance



1. Cable assembly
2. Chassis
3. Panel
4. Adhesive
5. Right hand cover
6. Left hand cover
7. Plate
8. Shim
9. Countersunk screw
10. Hexagon screw
11. Washer
12. Spring washer
13. Stop
14. Socket head screw

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3.2 SEAT

3.2.1 SEAT ADJUSTMENT

- To move the seat forward or back, lift lever (5) and while sat on the seat slide to the required position and release the lever (5) to lock into the nearest notch.

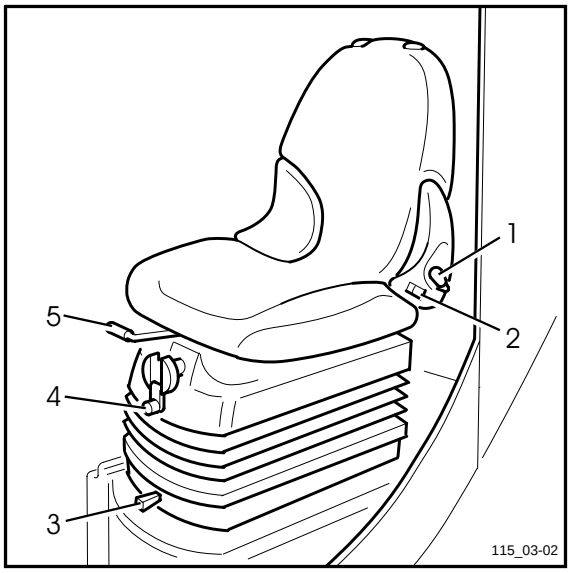
- The handwheel (4) is for suspension tension and height adjustment. Rotate the handwheel clockwise to raise the tension. Rotate the handwheel anticlockwise to lower the tension.

- Lever (3) is used to set the height of the seat when unoccupied. Move the lever right to raise the seat unoccupied position. Move the lever left to lower the unoccupied position.

☞ **NOTE: This adjustment must be made whilst sat on the seat.**

- Button (2) is used to adjust lumber support.

- Lever (1) must be lifted to alter the rake of the seat back. The rake can be adjusted to three positions.

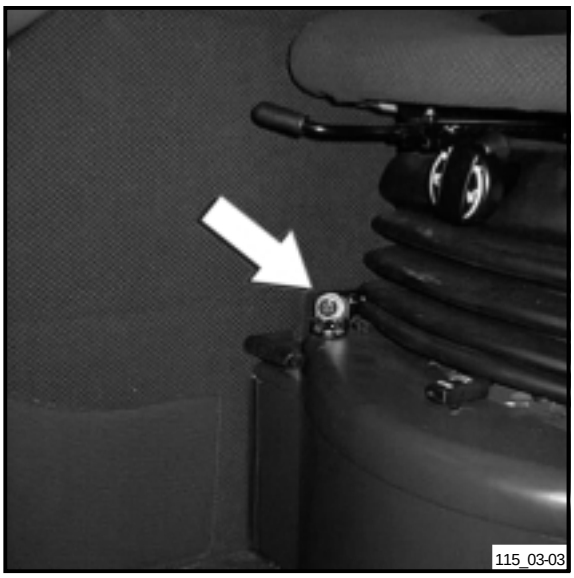


3.2.2 SEAT REMOVAL

- Turn the keyswitch off and disconnect the battery.

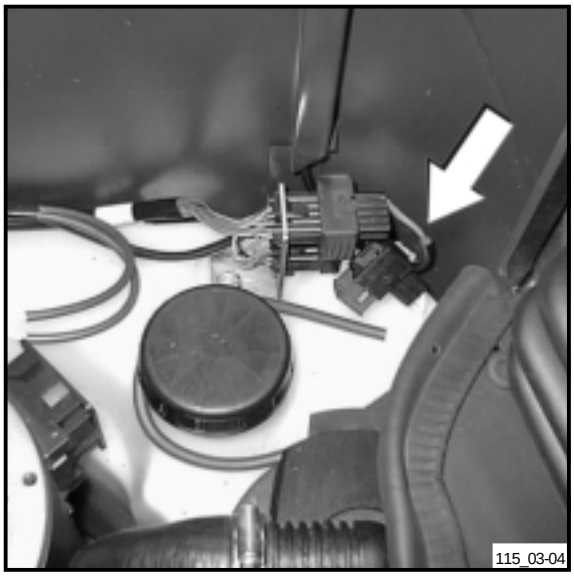
- Remove the securing screw.

- Swing the seat assembly out from the chassis, until it locates in the open position.

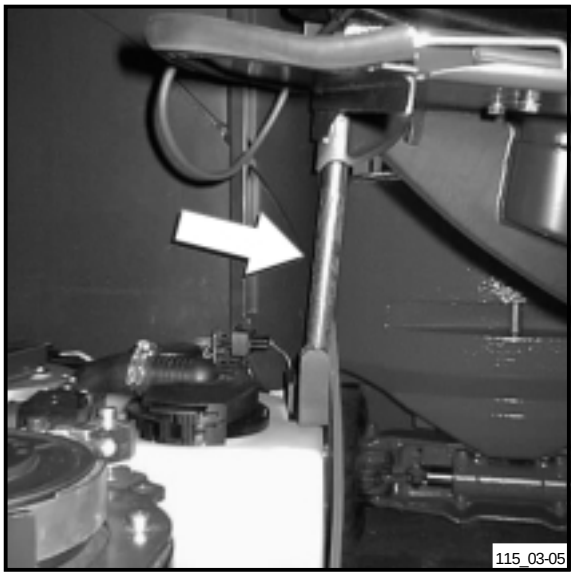


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- Disconnect the seat switch.



- Lift the seat from it's pivot, and store in a safe place.

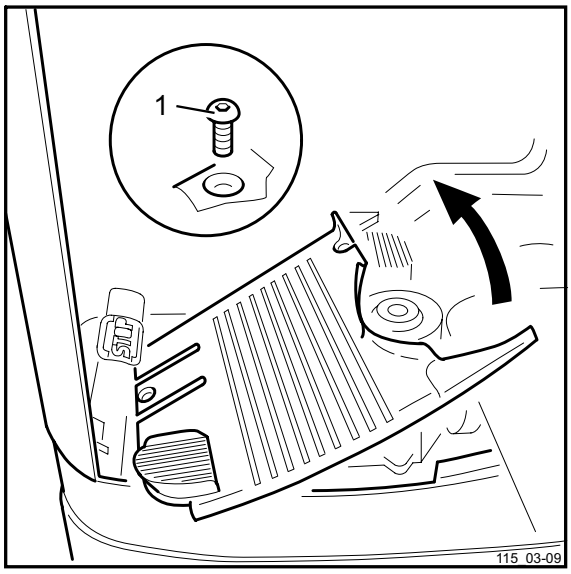


WARNING: Manual handling risk. The seat assembly is heavy. Assistance should be sought if it is to be completely removed.

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3.3 FLOORPLATE REMOVAL

- Turn the keyswitch off and disconnect the battery.
- Open or remove the seat assembly.
- Remove the rubber floorplate mat.
- Remove the two securing screws (1), and lift the floorplate clear.

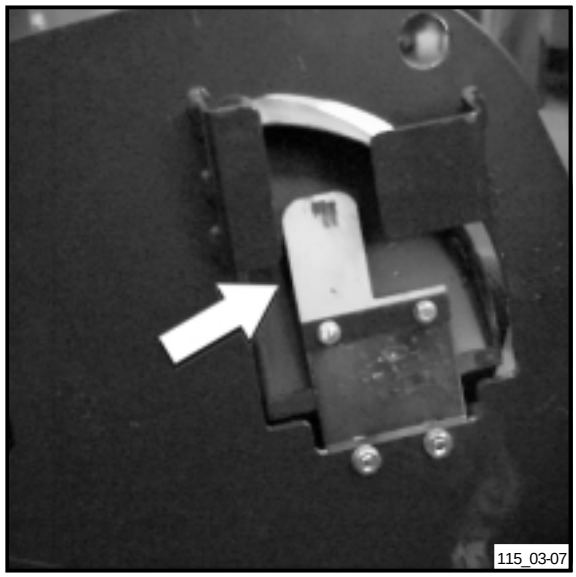


3.3.1 FLOORPLATE REFITTING

- To refit the floorplate, reverse the removal procedure.

☞ **NOTE: On single pedal trucks, ensure that the left foot microswitch actuator engages correctly.**

DANGER: Before tightening the mounting screws, ensure that none of the footpedals foul on the floorplate.

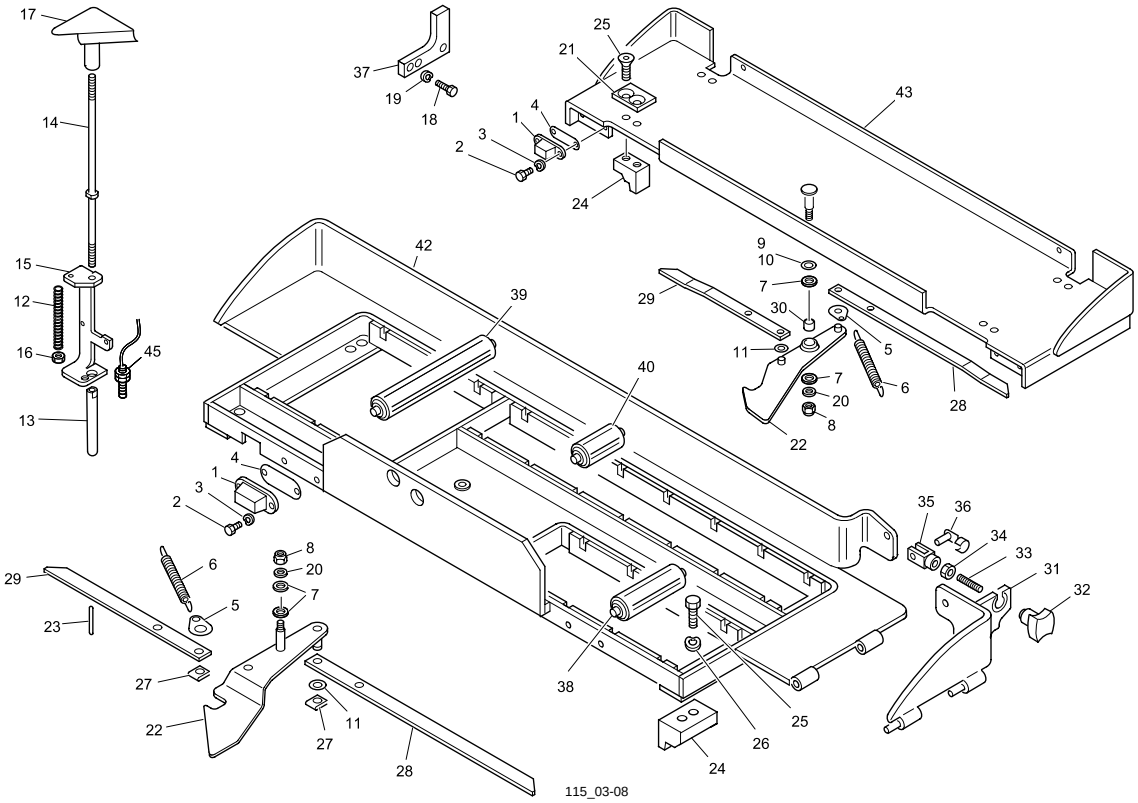


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3.4 BATTERY CARRIER

Two types of battery carrier are available. Each type of battery carrier is mounted across the top of the chassis legs and located on two guides each side. The battery carrier in each case is released by lifting lever (14), which disengages the locking mechanism lever (22). This allows the battery carrier to be drawn out by the reach out operation, and allow the battery to be lifted or rolled clear.

☞ **NOTE: There are combinations of the above detailed plates and angles, which are fitted to the reach carriage to suit various chassis widths and amp hour capacities. See the Spare Parts List publication for details.**



1. Buffer
2. Hexagon screw
3. Wavy washer
4. Shim
5. Plate
6. Tension spring
7. Thrust washer
8. Hexagon nut
9. Shim
10. Shim
11. Thrust washer
12. Spring
13. Pin
14. Rod
15. Bracket
16. Hexagon nut
17. Handle
18. Hexagon screw
19. Spring washer
20. Washer
21. Plate
22. Lever assembly
23. Spring cotter
24. Support
25. Screw
26. Spring washer
27. Locking disc
28. Rod
29. Rod
30. Bush
31. Plate
32. Handle
33. Stud
34. Hexagon nut
35. Clevis
36. Pin
37. Plate
38. Support collar
39. Support roller
40. Support roller
41. Support roller
42. Support assembly
43. Support assembly
44. Washer
45. Harness assembly

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3.4.1 BATTERY CARRIER REMOVAL

Should the battery carrier require removal, follow the battery changing procedure, see **BATTERY CHANGING**. Once the battery has been removed then the carrier can be lifted clear of the truck. If no suitable lifting equipment is available, then it is recommended that two persons are used to lift the battery carrier from the truck's reach legs.

3.4.2 BATTERY CARRIER LUBRICATION

To ensure correct operation of the battery carrier locking mechanism, and smooth reaching in and out of the carrier assembly, its is essential that the sliding surfaces are lubricated regularly. The following procedure be carried out at least every 1000 hours. Under certain conditions it may be necessary to lubricate the carrier more frequently.

- Remove the battery and battery carrier.

- Clean, inspect and lubricate the locking mechanism on the underside of the carrier assembly paying particular attention to the lever. Check that the release lever on the truck operates correctly and apply grease to the latching pin at the bottom of handle.

- Apply grease to the four guides and to their mating surfaces on the reach legs. Refit the battery carrier.

- Lubricate the battery carrier rollers if fitted.

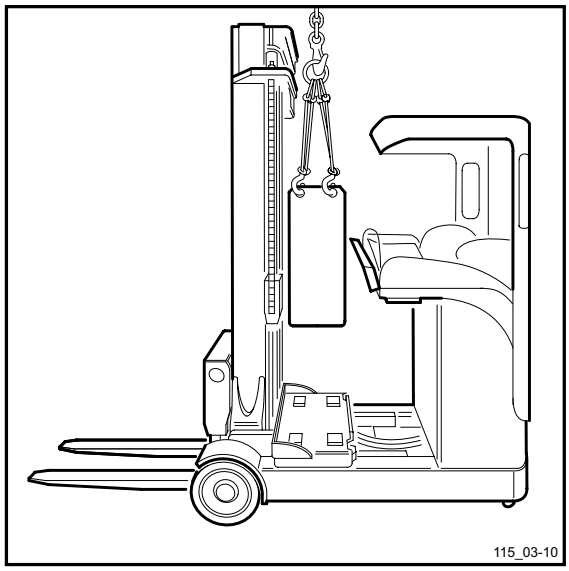
3.3.3 BATTERY CARRIER REPLACEMENT

Battery carrier replacement is a reversal of the battery carrier removal procedure. Ensure the carrier sits square and firm on the reach legs before replacing the battery.

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3.5 BATTERY CHANGING (HOIST METHOD)

DANGER: When lifting the battery with a crane, ensure that no persons are within the vicinity. Never step under a elevated load.



Use lifting equipment of sufficient capacity for the weight of the battery. (See Battery Plate).

- Reach battery fully forward.
- Turn the keyswitch off, and depress the emergency isolator
- Release the battery connector locking plate and unplug the battery from the truck.
- Connect the lifting equipment to the battery and lift the battery up and outwards from the truck. Ensure the battery does not hit the mast or power unit chassis.

WARNING: Manual handling risk. The battery is heavy. Take care when manoeuvring the battery from the chassis.

- Reverse the procedure to fit the battery.

CAUTION: Before reconnecting the battery, ensure the keyswitch is turned off and the emergency isolator is depressed.

- Reconnect the battery, ensuring the battery connector locking plate is engaged.
- Release the emergency isolator, turn the keyswitch on and operate the reach lever to reach the battery in until the battery unlocked warning indicator on the driver's display extinguishes.

CAUTION: Ensure that the battery cables are not twisted when reaching the battery back.

NOTE: The battery cable is designed to minimise the free cable projecting beyond the battery face.
In order to maintain this condition it is necessary to replace the battery so that the face adjacent to the cable route and negative terminal is nearest to the truck bulkhead.

With some batteries the positive terminal is also on the same face as the cable route.

CAUTION: It is essential that the battery is correctly seated on the battery trolley before reaching back and locking into position.

DANGER: The replacement battery MUST be identical in size and weight to the standard battery.

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3.6 BATTERY CHANGING (ROLL ON, ROLL OFF)

WARNING: Manual handling risk. The battery is heavy. Take care when manoeuvring battery on and off the roller stand.

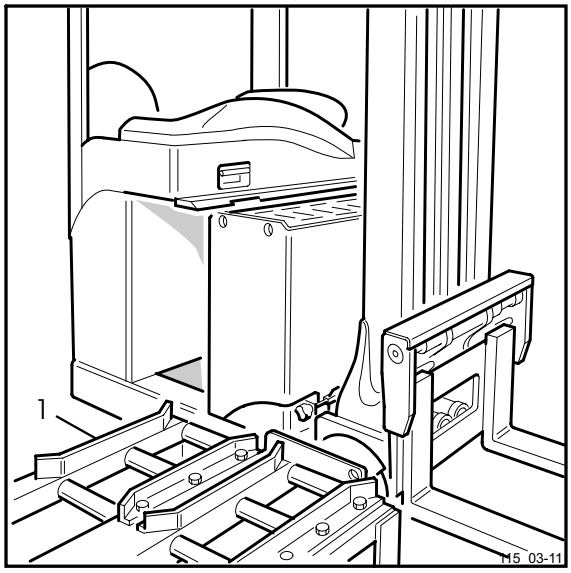
CAUTION: Before reconnecting the battery, ensure the keyswitch is turned off and the emergency isolator is depressed.

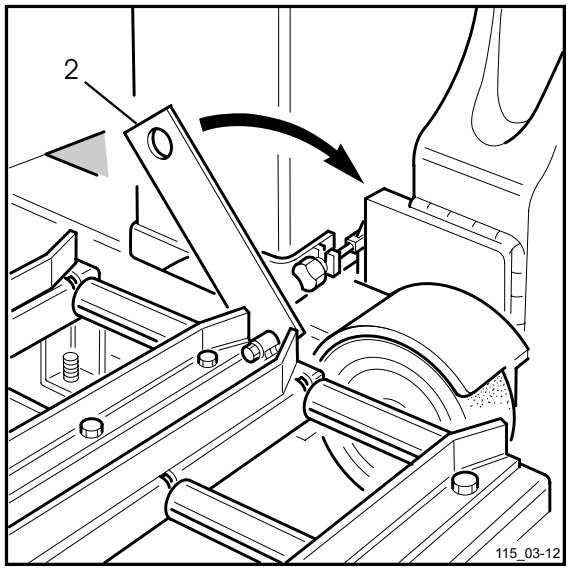
CAUTION: Before changing the battery, ensure that the roller stand is adjusted so that it's rollers are level with, or slightly above those on the truck battery trolley. Failure to do so could cause damage to the battery trolley locking mechanism.

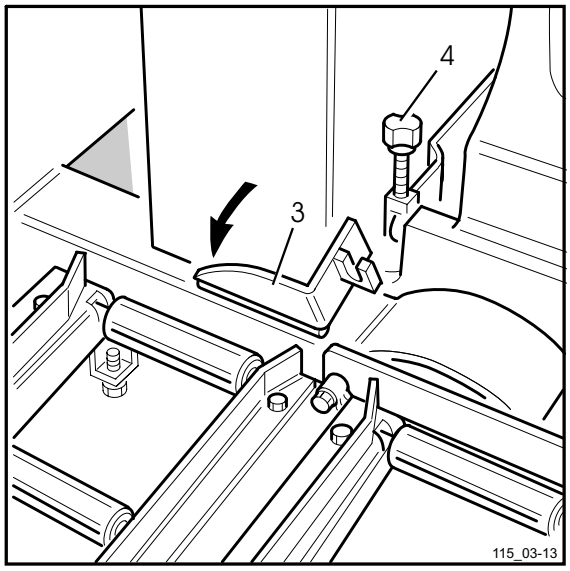
- Drive the truck up to the battery roller stand (1).
- Reach the battery forward, manoeuvre the truck until the battery is aligned with the vacant track on the roller stand.
- Switch off, depress the emergency isolator, release the battery connector locking plate and disconnect the battery lead.
- Open the latch (2) on the roller stand.

☞ **NOTE: The latch hinges over to secure one battery alternately.**

- Undo the securing latch clamp (4) and release the battery securing latch (3) on the truck battery trolley.
- Push the battery from the truck onto the roller stand. Hinge the securing latch (2) over to retain the battery.
- Connect a slave lead between the charged battery and truck battery plug.
- Release the emergency isolator, switch on and manoeuvre the truck to align the truck battery trolley with the charged battery.
- Push the charged battery onto the truck trolley and secure with the securing latch (3), ensuring clamp (4) is tightened.
- Turn keyswitch off, and depress the emergency isolator.
- Disconnect the slave lead.







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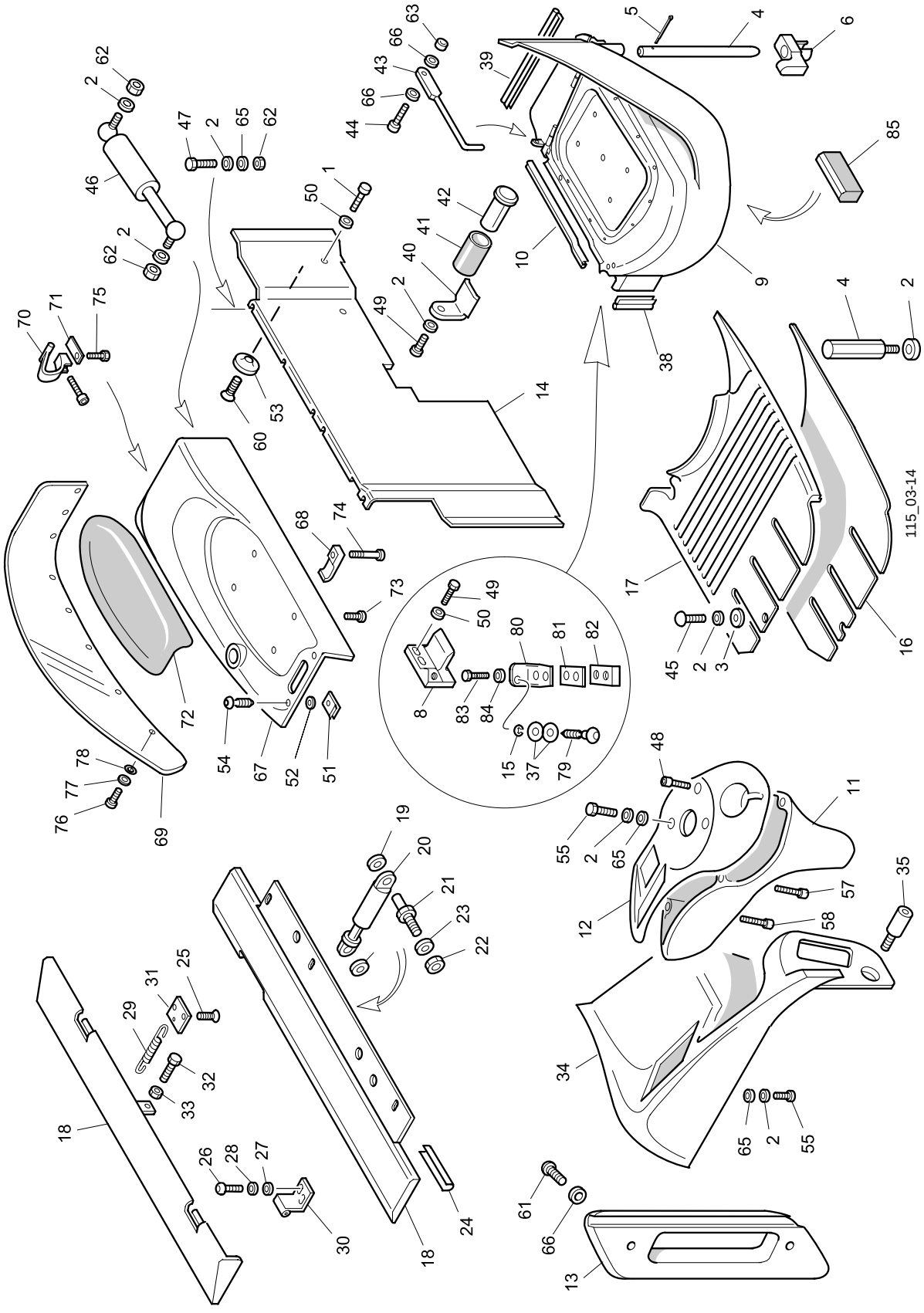
- Connect the truck battery plug, ensuring that the battery locking plate is engaged.
- Release the emergency isolator, turn the keyswitch on and operate the reach lever to reach the battery in until the battery unlocked warning indicator on the driver's display extinguishes.

CAUTION: Ensure that the battery cables are not twisted when reaching the battery back.

DANGER: The replacement battery MUST be identical in size and weight to the standard battery.

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3.7 COVERS AND PANELLING

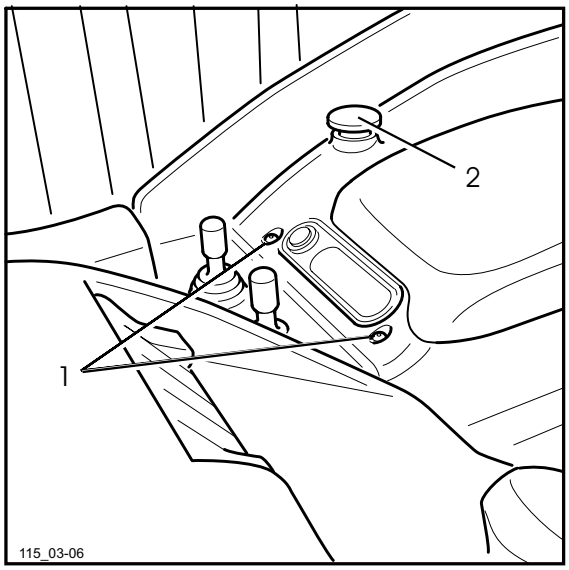


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1. Screw
2. Spring washer
3. Washer
4. Pillar
5. Shaft
6. Support
7. Pin
8. Plate
9. Seat support
10. Seal
11. Bottom cover
12. Top cover
13. Headrest
14. Cover
15. Locking disc
16. Floorplate
17. Floor mat
18. Battery cover
19. Fastening
20. Gas spring
21. Bolt
22. Hexagon nut
23. Wavy washer
24. Edge protection
25. Countersunk screw
26. Raised head screw
27. Washer
28. Wavy washer
29. Tension spring
30. Hinge
31. Plate
32. Hexagon screw
33. Hexagon nut
34. Cover
35. Socket head screw
36. Screw
37. Washer
38. Seal
39. Seal
40. Bracket
41. Sleeve
42. Shaft
43. Strut
44. Button head screw
45. Raised head screw
46. Gas spring
47. Screw
48. Socket head screw
49. Raised head screw
50. Washer
51. Nut
52. Locking disc
53. Washer
54. Screw
55. Hexagon screw
56. Socket head screw
57. Socket head screw
58. Socket head screw
59. Socket head screw
60. Countersunk screw
61. Raised head screw
62. Nut
63. Hexagon nut
64. Washer
65. Washer
66. Washer
67. Cover
68. Cable clip
69. Screen
70. Hinge
71. Plate
72. Armrest
73. Screw
74. Screw
75. Screw
76. Screw
77. Washer
78. Rubber washer
79. Screw
80. Bracket
81. Gasket
82. Plate
83. Raised head screw
84. Washer
85. Support

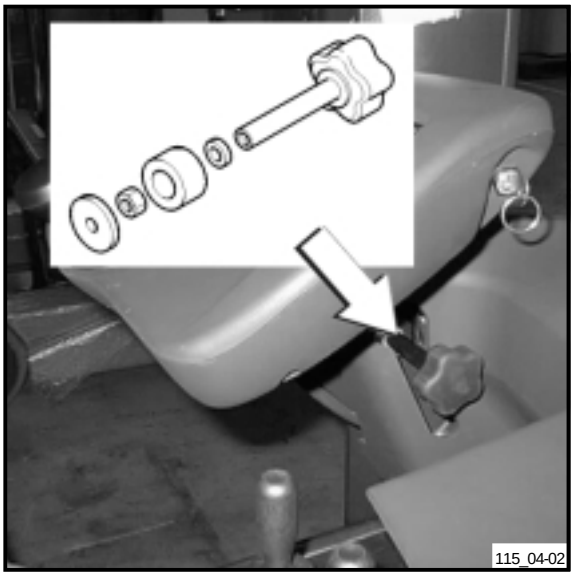
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3.8 TOP COVER, OPENING

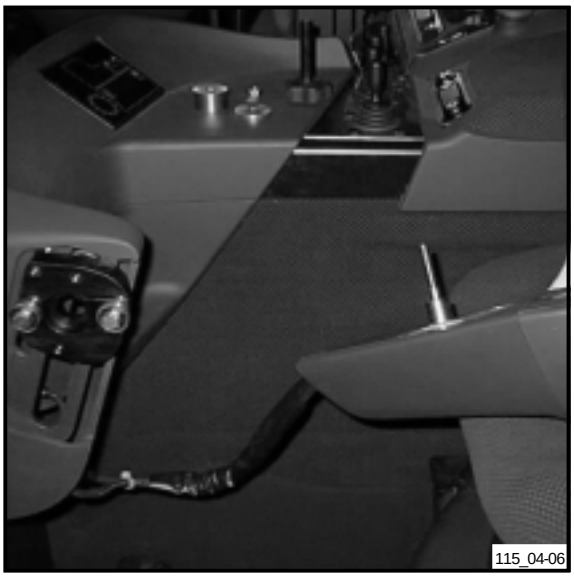


- Turn the keyswitch off and disconnect the battery.
- Unscrew the emergency stop button knob (2).
- Undo the two socket head screws in the cover (1). Open the cover fully.
- Reverse the procedure to close the cover.
- Replace the emergency stop button (2).

3.9 BINNACLE REMOVAL



- Turn the keyswitch off and disconnect the battery.
- Unscrew and remove the binnacle adjusting knob.
- Extract the locking mechanism components, noting their order on the shaft for reassembly.



- Disconnect the harness and remove the binnacle.

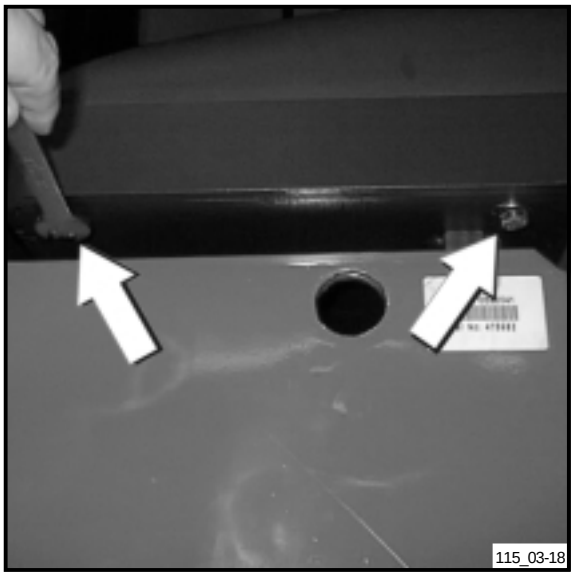
CAUTION : Ensure the binnacle is supported. Do not allow the binnacle to hang from the harness.

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3.10 CONSOL REMOVAL



- Turn the keyswitch off and disconnect the battery.
- Remove the steering binnacle, see **BINNACLE REMOVAL**.
- Remove the consol securing screw on the steering bracket.



- Remove the two screws from under the control unit shelf.



- Disconnect the driver's display and remove the consol.

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3.11 SERIAL NUMBER FORMAT

The composition of the truck serial number is as follows:-

XX XXXX X XXXXX

- XX — Production site
- XXXX — Currently not used
- X — Family type number
- XXXXX — Year (See table)
- Sequential number

Year	0	1	2	3	4	5	6	7	8	9
199x	A	B	C	D	E	F	G	H	J	K
200x	L	M	N	P	R	S	T	U	W	Z

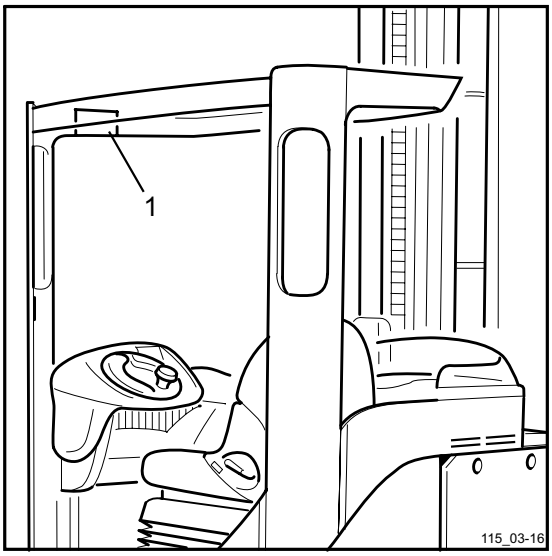
3.11.1 SERIAL NUMBER EXAMPLE

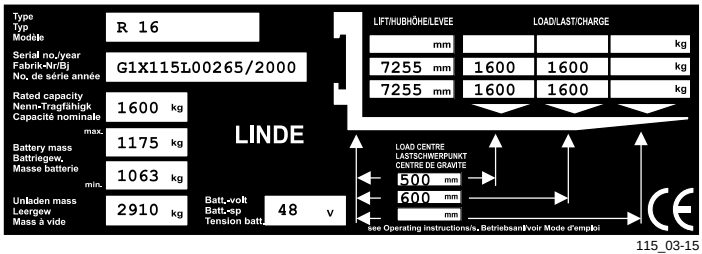
G1 X115 L 00386

- G1 — Production site - Linde Material Handling (UK) Ltd.
- X115 — Currently not used
- L — Family type (115)
- 00386 — Year (2000)
- Sequential number

☞ **NOTE: When ordering spare parts, the truck serial number is normally required to ensure the correct replacement part is supplied.**

1. Capacity plate and Truck serial number





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4 STEERING AND LOADWHEELS

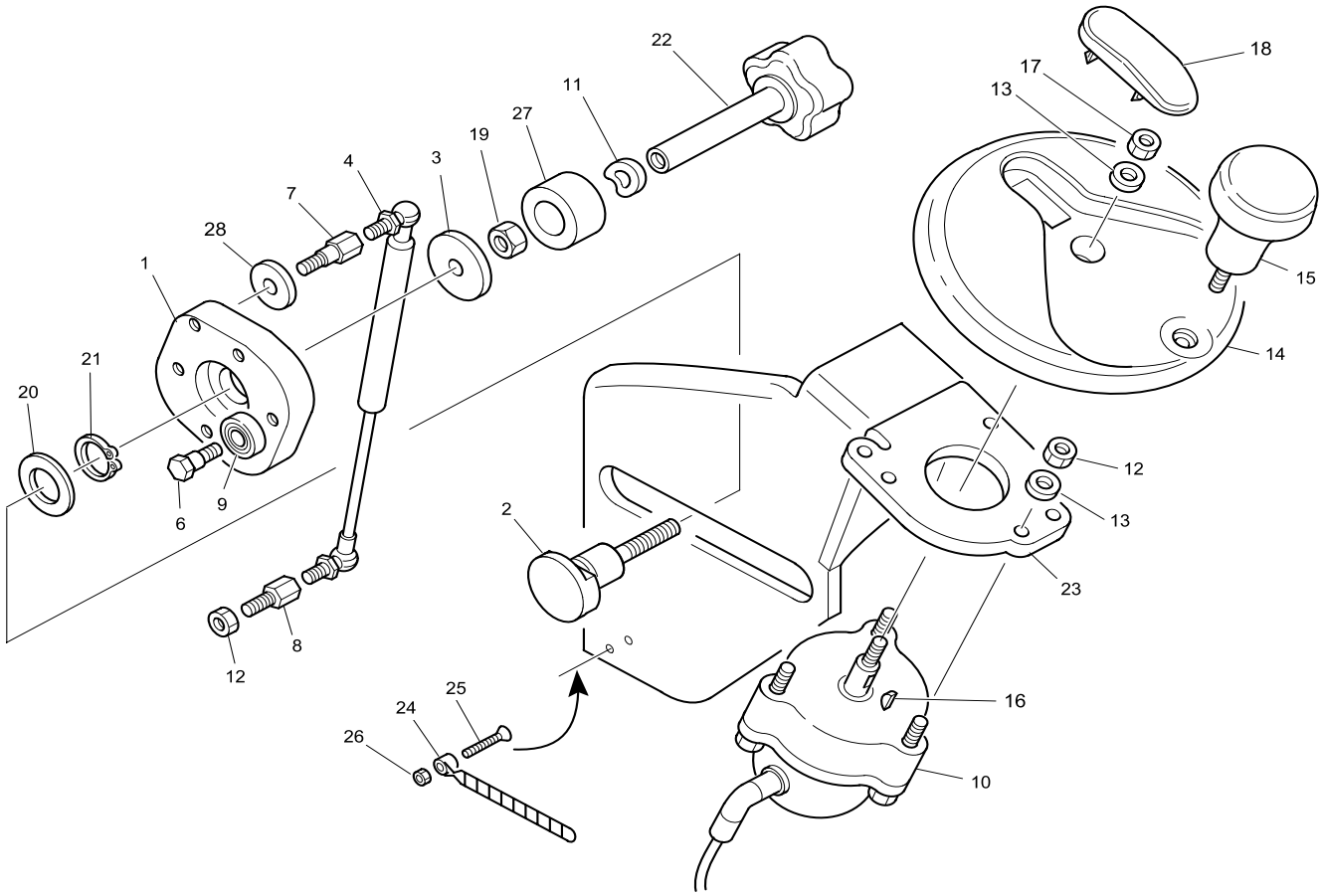
CAUTION: Always disconnect the battery connector and ensure the steering controller capacitors are discharged by pressing the horn button prior to working on the system.

CAUTION: Components must not be connected or disconnected whilst the truck is live. The battery must be disconnected, failure to do so can result in failure of the modules

4.1 STEERING

See **SECTION 6** for electrical operation details.

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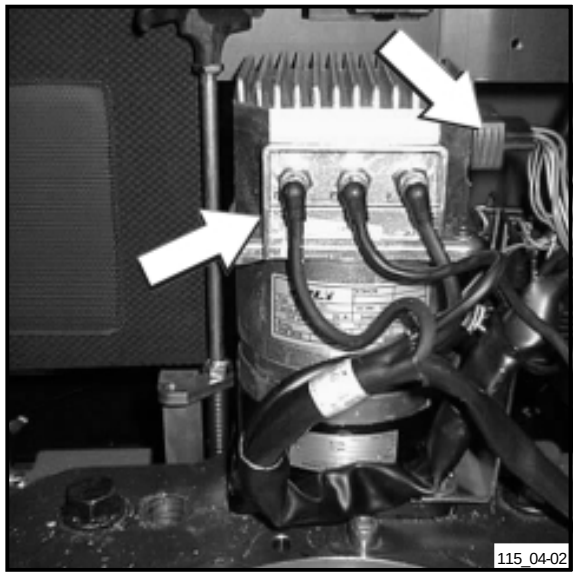


1. Plate
2. Pin
3. Washer
4. Gas spring
5. Washer
6. Bolt
7. Bolt
8. Bolt
9. Bearing
10. Steering module
11. Spring washer
12. Hexagon nut
13. Washer
14. Steering wheel
15. Handle
16. Woodruff key
17. Hexagon nut
18. Cover
19. Hexagon nut
20. Washer
21. Circlip
22. Clamping piece
23. Plate
24. Cable tie
25. Countersunk screw
26. Nut
27. Housing
28. Washer

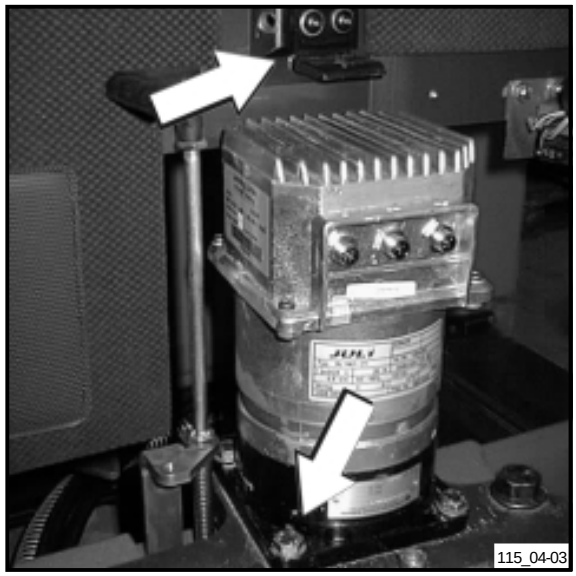
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4.2 STEER MOTOR REMOVAL

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- Turn the keyswitch off and disconnect the battery.
- Remove all electrical connections to the motor, noting their position for reassembly.



- Remove the seat assembly support bracket.
- Remove the four steer motor securing screws and withdraw the motor.



- If fitting a new or exchange unit, the pinion gear will need to be removed. Support the unit in a vice and remove the locking nut from the shaft.
- Using a suitable puller, extract the pinion gear from the shaft.

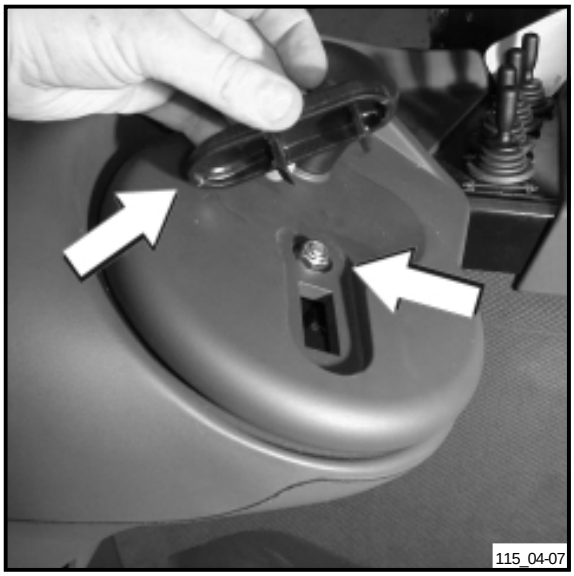
☞ **NOTE: The shaft has a keyway to locate the gear.**

4.2.1 STEER MOTOR REFITTING

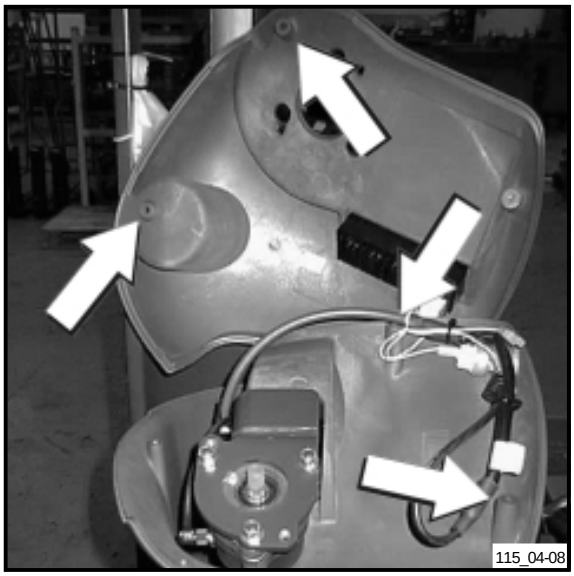
To refit the steer motor, reverse the removal procedure. No setting up is required.

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4.3 STEERING ENCODER REMOVAL



- Turn the keyswitch off and disconnect the battery.
- Remove the plastic cover, and release the central securing nut.
- Remove the steering wheel and woodruff key.



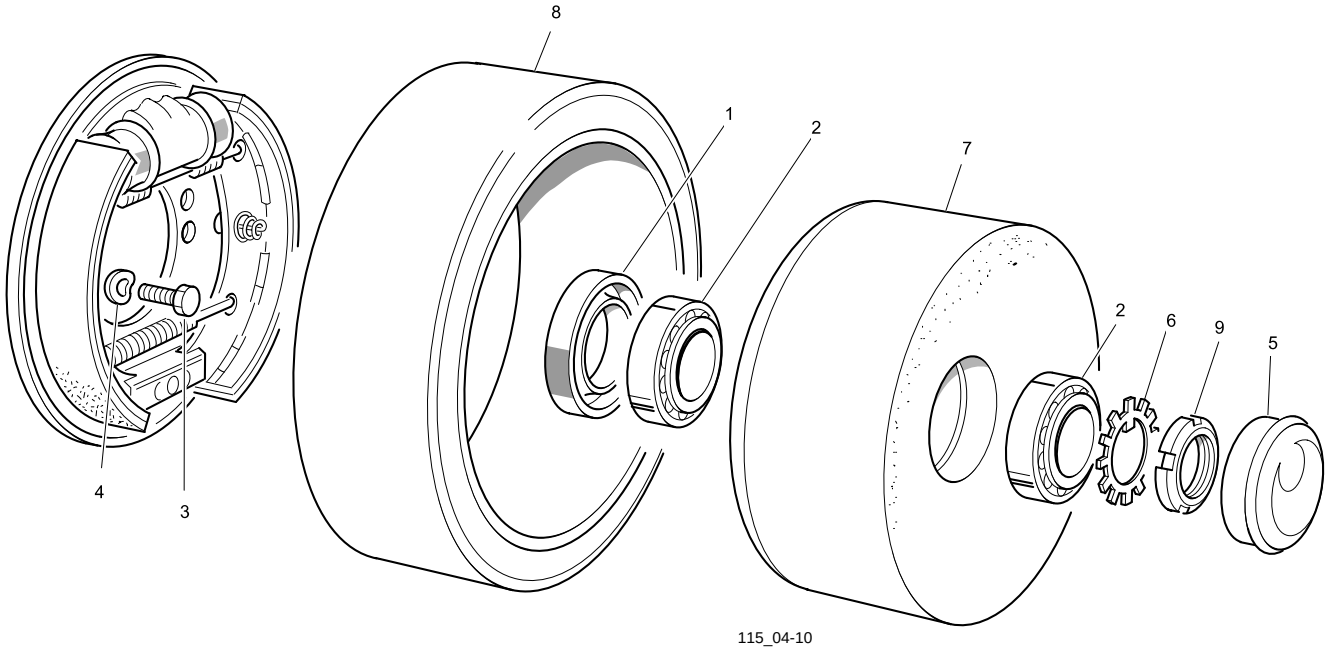
- Remove the four securing screws (two on top, two underneath), and remove the binnacle top cover.
- Remove the binnacle lower cover securing screw.



- Remove the three encoder securing nuts, disconnect harness and remove the encoder.

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4.4 LOAD WHEEL



1. Seal
2. Bearing
3. Hexagon screw
4. Spring washer
5. Hubcap
6. Tab washer
7. Wheel
8. Tyre
9. Nut

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4.4.1 LOAD WHEEL REMOVAL

- Apply handbrake, turn keyswitch OFF, disconnect battery.

- Securely chock the opposite load wheel and drive wheel.

- Raise the load wheel to be removed clear of the ground.
- Rotate the wheel to position access hole as shown, and lower the load wheel.

- Using a suitable lever through access hole and applying force to spring (5), lever the brake shoe away from the drum.

- Raise and rotate the load wheel to position access hole for remaining brake shoe.

- Lower the load wheel and repeat procedure for the second brake shoe.

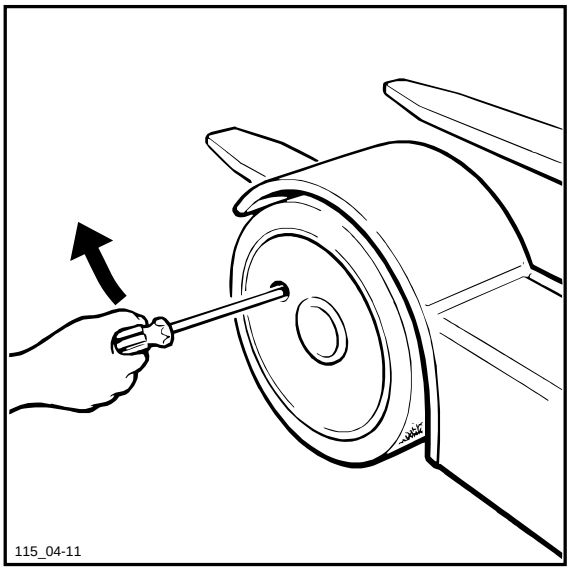
- Raise the load wheel.

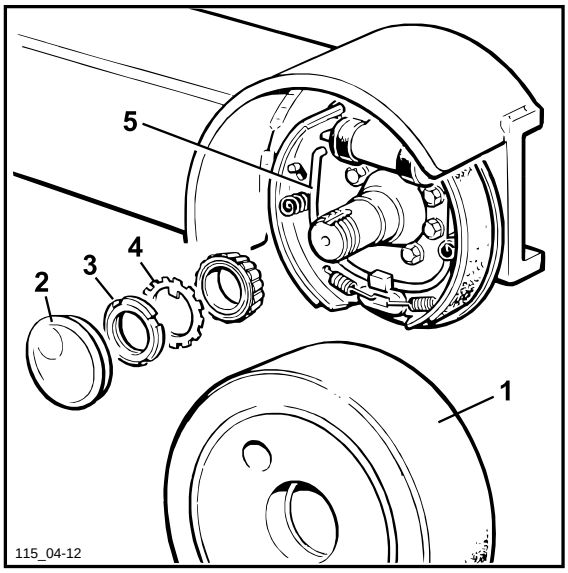
- Remove the dust cap (2) with a screwdriver.

- Release tab on lock washer (4).

- Remove slotted ring nut (3). Tool number 000 941 80 01 can be used for this operation on the 1.4 and 1.6 tonne model, tool number 002 941 80 08 on the 2.0 tonne.

- Withdraw the load wheel, lock washer and bearing inner races from the load wheel axle shaft.





4.4.2 LOAD WHEEL REFTTING

To replace the load wheel to the load wheel axle shaft, re-grease the bearings and reverse the removal procedure. See **SECTION 10** for slotted nut tightening procedure.

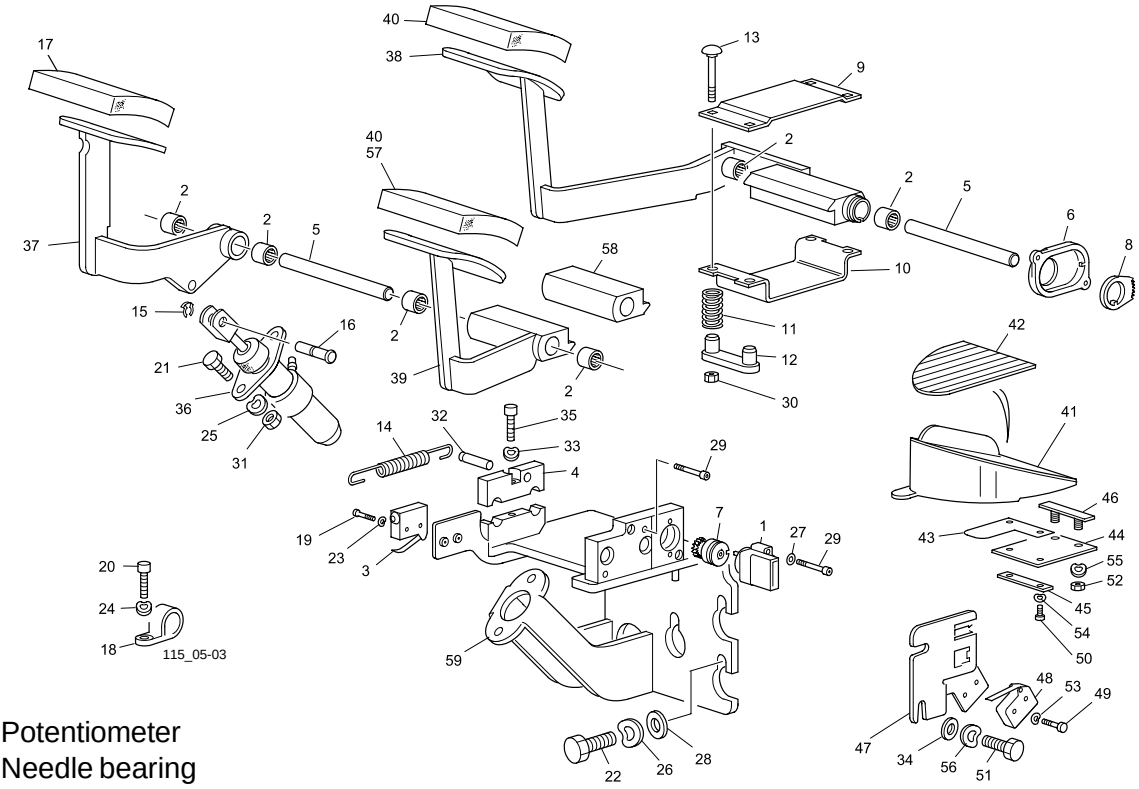
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5 CONTROLS

CAUTION: Electrical components must not be connected or disconnected whilst the truck is live. The battery must be disconnected, failure to do so can result in failure of the modules.

5.1 ACCELERATOR AND BRAKE PEDALS

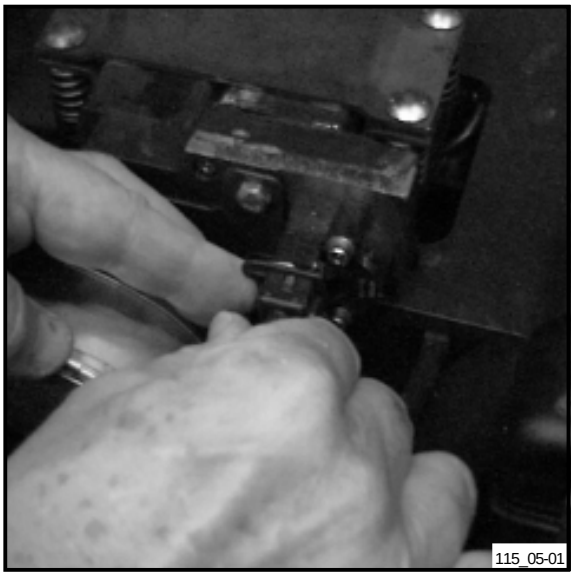


1. Potentiometer
2. Needle bearing
3. Limit switch
4. Bearing block
5. Rod
6. Gasket
7. Pinion gear
8. Gear
9. Bracket
10. Bracket
11. Spring
12. Guide
13. Bolt
14. Tension spring
15. Retaining clip
16. Pin
17. Pedal rubber
18. Cable clip
19. Hexagon screw
20. Socket head screw
21. Hexagon head screw
22. Hexagon screw
23. Wavy washer
24. Wavy washer
25. Spring washer
26. Spring washer
27. Washer
28. Washer
29. Socket head screw
30. Hexagon nut
31. Hexagon nut
32. Pin
33. Washer
34. Washer
35. Socket head screw
36. Master cylinder
37. Brake pedal
38. Right accelerator pedal
39. Left accelerator pedal
40. Pedal rubber
41. Pedal
42. Pedal rubber
43. Spring plate
44. Spring
45. Retainer ring
46. Retainer ring
47. Bracket
48. Limit switch
49. Hexagon screw
50. Hexagon screw
51. Hexagon screw
52. Hexagon nut
53. Wavy washer
54. Wavy washer
55. Wavy washer
56. Spring washer
57. Pedal rubber
58. Spacer
59. Pedal box assembly

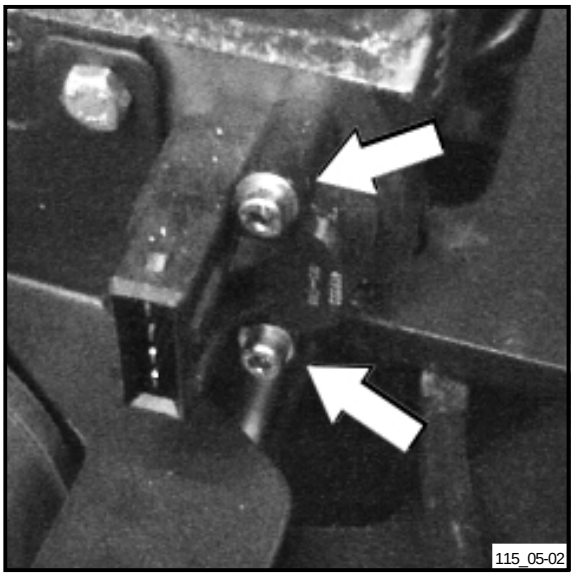
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5.1.1 ACCELERATOR UNIT REMOVAL

- Remove the floorplate
- Disconnect the 4 way accelerator connector 1X10.



- Remove the two cap head screws securing the accelerator unit.



5.1.2 ACCELERATOR UNIT REFITTING

To refit the accelerator, reverse the removal procedure. Ensure that the microswitch actuating cam locates correctly.

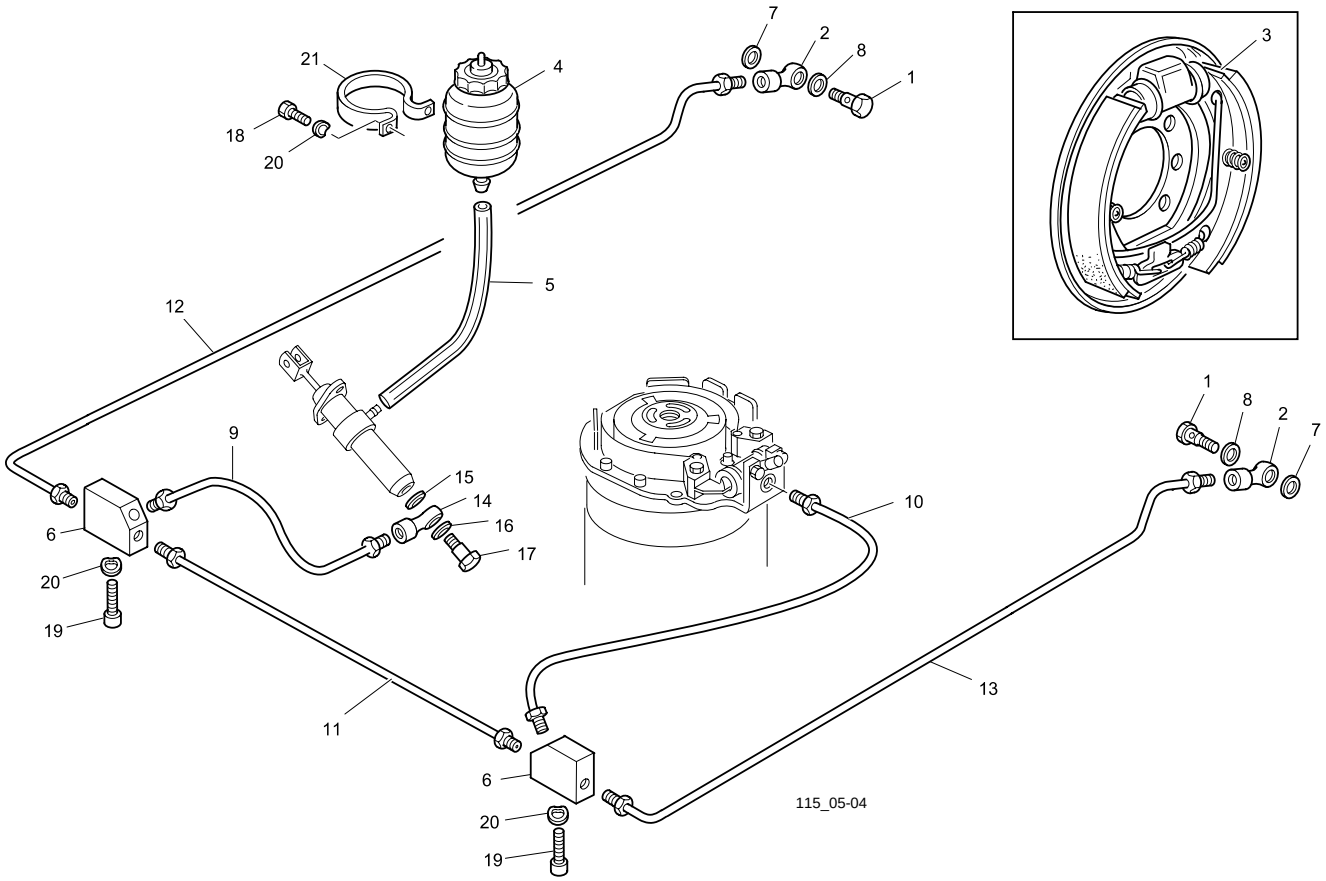
After refitting, ensure the accelerator is adjusted correctly, refer to **SECTION 6**.

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5.2 HYDRAULIC BRAKING SYSTEM

The hydraulic braking system is operated by the footbrake pedal and is used to supplement the regenerative braking and provide an emergency brake. The footbrake is directly coupled to the brake master cylinder, which is self replenished from an external supply reservoir.

The footbrake operates a single self adjusting leading brake shoe assembly on each of the load wheels and also a brake connected to top of the traction motor armature shaft.



1. Hollow screw
2. Banjo union
3. Brake assembly
4. Reservoir
5. Pipe
6. Adaptor
7. Seal
8. Seal
9. Pipe assembly
10. Pipe assembly
11. Pipe assembly
12. Pipe assembly
13. Pipe assembly
14. Banjo union
15. Seal
16. Seal
17. Hollow screw
18. Hexagon head screw
19. Socket head screw
20. Wavy washer
21. Bracket

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5.2.1 HYDRAULIC BRAKES - PREVENTATIVE MAINTENANCE

To ensure the brakes operate with maximum efficiency, the following notes should be observed:-

- Check the hydraulic fluid level in the master cylinder every 2000 hours. Under normal circumstances, topping up should only be required after considerable use. A rapid fall in the fluid level indicates either a leak in the system or overfilling of the cylinder. **THE FLUID LEVEL SHOULD BE KEPT TOPPED UP TO THE MAX MARK ON THE RESERVOIR, DO NOT OVERFILL.**

- Check that the filler cap orifice is not blocked.

- Check the brake shoes periodically for wear.

- If any part of the system is uncoupled, the system must be “bled”.

- There is a brake fluid low level warning indicator on the driver's display. If this indicator should illuminate, the truck brake reservoir must be topped up immediately and the system checked for leaks.

5.2.2 MASTER CYLINDER REMOVAL

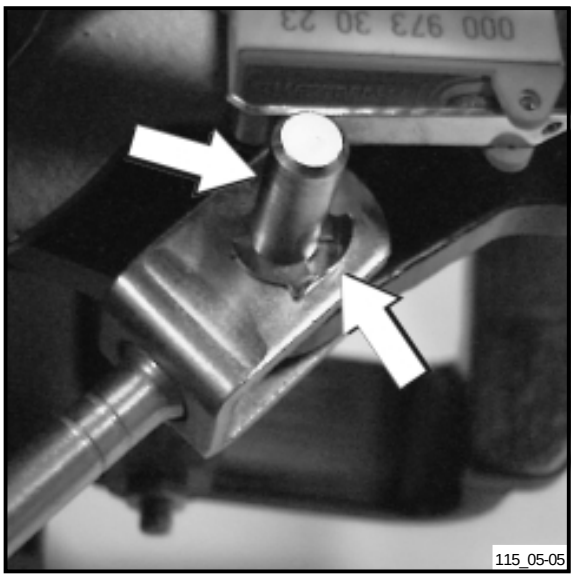
- Chock load wheels securely, turn keyswitch OFF and disconnect the battery.

- Remove the floorplate.

- Disconnect the feed pipe from the master cylinder and drain the brake fluid reservoir.

- Disconnect brake pressure pipe.

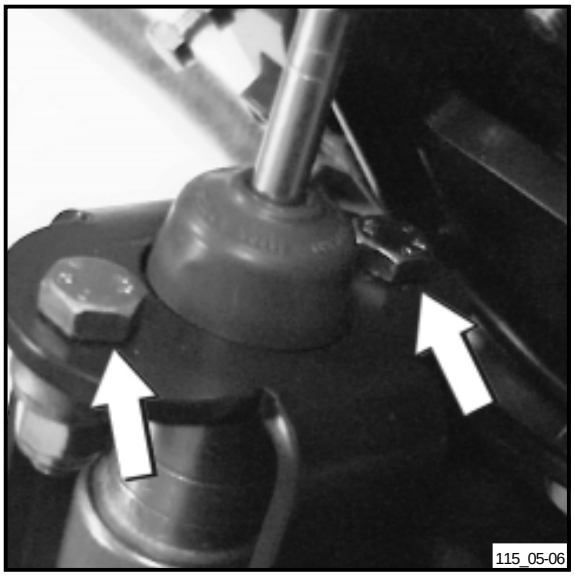
- Remove the retaining clip, and extract the clevis pin.



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- Remove the two screws, nuts and spring washers securing the master cylinder.

- Remove the master cylinder.



5.2.3 MASTER CYLINDER REFITTING

- To replace the master cylinder, reverse the removal procedure.

- Torque pressure pipe connector to 10 Nm.

- Replenish the reservoir with fresh brake fluid and bleed the brake system.

☞ **NOTE: When replacing the clevis pin, ensure that the microswitch actuating lever is located correctly.**



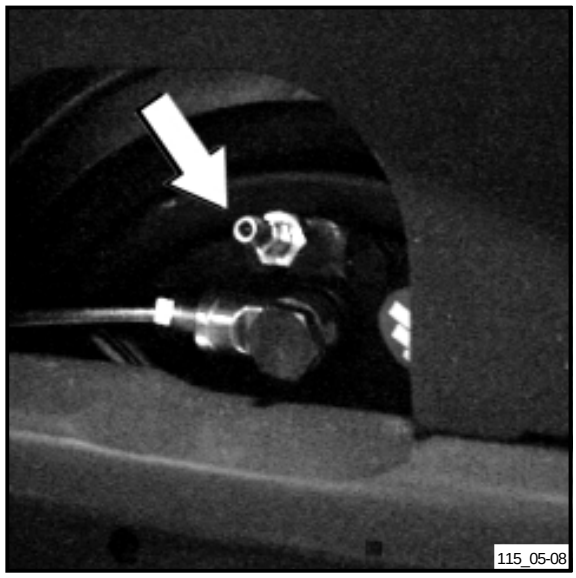
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5.3 BRAKE BLEEDING

☞ **NOTE: While bleeding the brakes, keep reservoir topped up as necessary with correct grade of brake fluid. DO NOT use old brake fluid which has been bled from the system.**

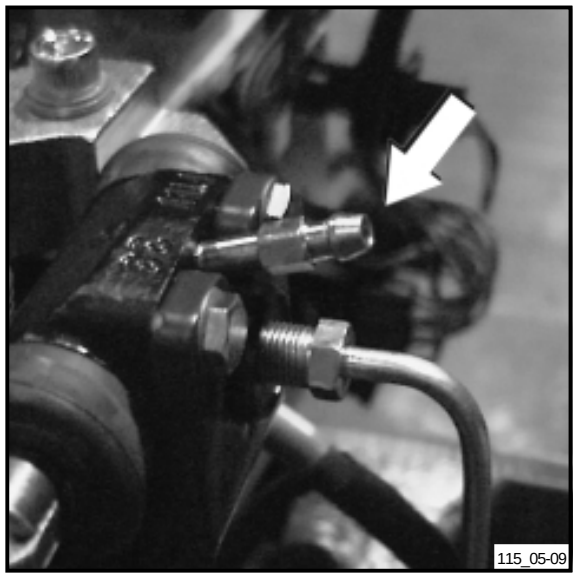
LOAD WHEEL BRAKES

- Apply handbrake, turn keyswitch OFF, disconnect battery and chock wheels. Ensure all brake pipe connections are secure.
- Remove dust cover from bleed nipple on the right hand load wheel backplate and connect a length of 5 mm bore rubber tube. Immerse other end in a small quantity of clean brake fluid in a glass container.
- Gently depress the brake pedal and slacken the nipple, 3/4 of a turn.
- Slowly depress brake pedal fully and lock the nipple.
- Release the brake pedal.
- Repeat procedure until fluid in the container is free of air bubbles.
- Replace dust cover.
- Repeat procedure on the left hand load wheel.



TRACTION MOTOR BRAKE

- Open the motor cover and bleed the drive unit brake cylinder at nipple. Carry out the bleeding procedure as for load wheel brakes.
- Check brake operation and top up reservoir if necessary.



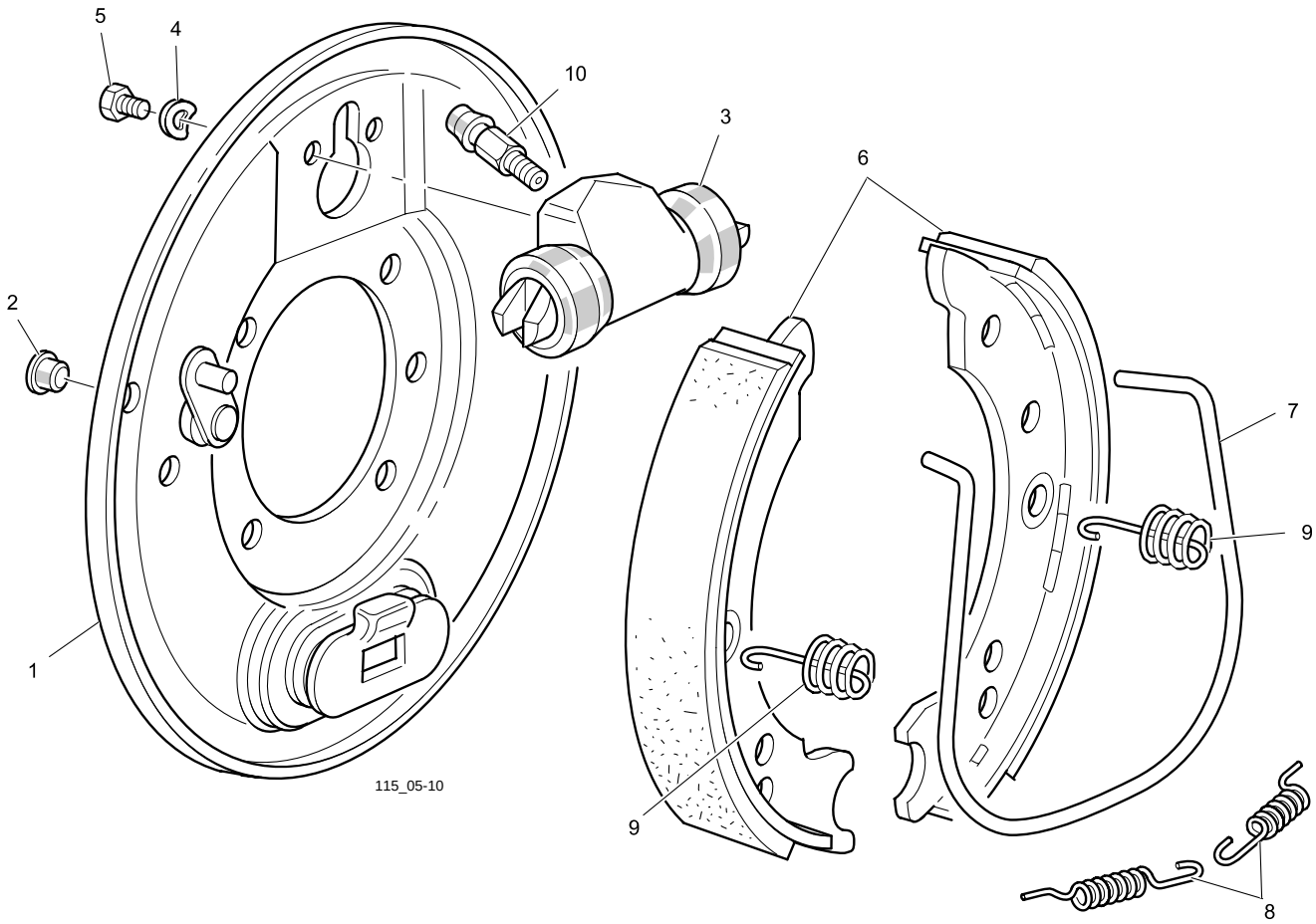
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5.4 LOAD WHEEL BRAKES

Each load wheel brake has a wheel cylinder mounted to the top of the brake backplate secure by two M6 x 16 screws and M6 spring washers.

Hydraulic brake fluid pressure applied to each wheel cylinder expands the brake shoes onto the load wheel brake drum. Each brake shoe pivots from the fixed anchor, thus the leading brake shoe is applied to the brake drum in the direction of rotation and the trailing brake shoe against the direction of rotation.

As a result the braking action is approximately the same in both directions of travel.



1. Back plate
2. Plug
3. Slave cylinder
4. Wavy washer
5. Hexagon screw
6. Brake shoe
7. Spring
8. Tension spring
9. Spring
10. Bleed nipple

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5.4.1 LOAD WHEEL BRAKE CYLINDERS

The wheel cylinder is operated by the hydraulic brake fluid pressure transmitted by the application of the driver's foot to the brake pedal, thus expanding the brake shoes by the wheel cylinder pistons.

5.4.2 LOAD WHEEL BRAKE CYLINDER MAINTENANCE

The wheel cylinders and pipe connections should be checked for leaks in accordance with the periodical service in the operating instructions routine maintenance.

5.4.3 LOAD WHEEL BRAKE CYLINDER REPAIR INSTRUCTIONS

Repair of individual wheel cylinder items is not recommended. In the event of leaks or damage, replace the wheel cylinders complete and bleed the braking system.

5.5 LOAD WHEEL BRAKE SHOES

5.5.1 LOAD WHEEL BRAKE SHOES MAINTENANCE AND INSPECTION

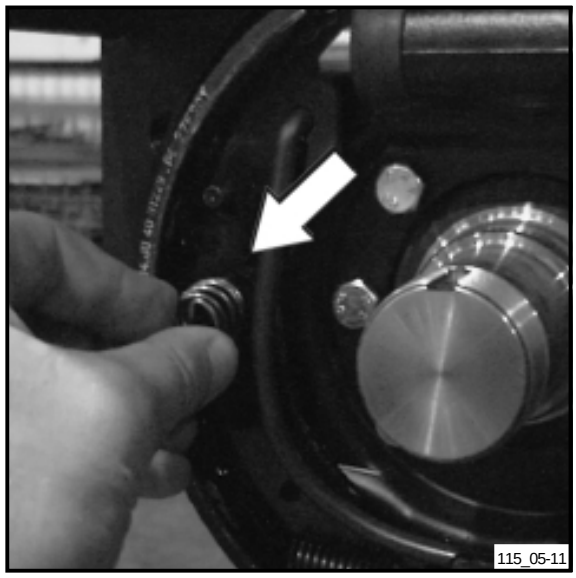
The brake shoes need little maintenance. They require only periodical inspection for damage and wear. Check the thickness of the brake linings. These should be examined every 2000 hours. Brake shoes should be replaced if the linings are worn to the following:-
Bonded Brake Linings: Minimum thickness at the most worn part 1.0 mm.

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5.5.2 LOAD WHEEL BRAKE SHOE REMOVAL

Always replace a set of brake shoes. Use only Lansing Linde Ltd. genuine spare parts in all servicing and repair operations, otherwise the vehicle guarantee will be void.

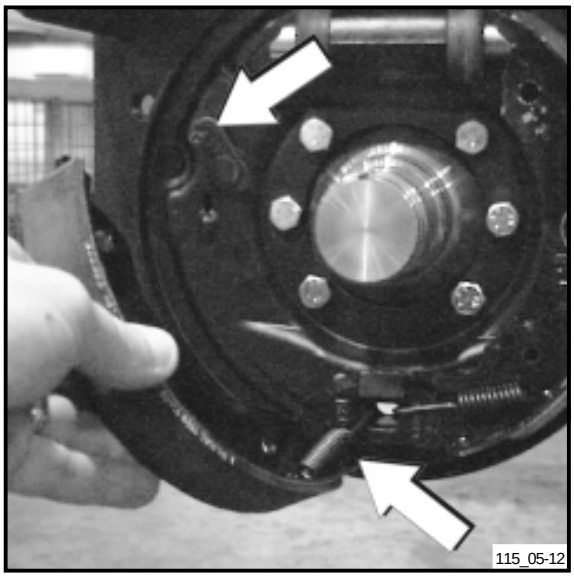
- Apply the handbrake, turn keyswitch OFF, disconnect the battery, chock the drive wheels securely.
- With a suitable jack or lifting equipment raise load wheel clear of the ground and securely chock under the chassis.
- Remove the load wheel. See **SECTION 4**.
- Take careful note of the positions of the shoes and their springs.
- Remove the retaining spring from each shoe by pushing in and turning through 180°. Carefully store for reuse.



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- Using a suitable lever, prise one side of the return spring from the brake shoe and remove.



- Pull brake shoe outwards and release from self adjusting mechanism and slave cylinder slots. Unhook the tension spring and remove shoe. Repeat procedure for other shoe
- Prevent inadvertent ejection of the pistons by restraining them with soft wire, or an elastic band, around the slave cylinder body. Take care not to damage the rubber boots.
- Remove all dust and dirt from the backplate.

The brake shoes should be renewed if the linings are contaminated with lubricants or hydraulic fluid irrespective of the state of wear.

Check for signs of leakage from the wheel cylinders. Inspect the boots, also examine metal brake pipes for wear, damage or corrosion and pull-off springs for damage or overstretching and replace as necessary. Do not attempt to remove the adjusters from the backplate, if faulty a new backplate will be required.

Other than hydraulic parts, metal to metal contact points should be lightly coated with a high melting point grease that is shoe tips, the areas where the shoe platform seats against backplate, the wheel cylinder abutment slots.

DO NOT allow grease to contaminate the shoe linings, rubber parts and the friction surface of the brake drum.

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5.5.3 LOAD WHEEL BRAKE SHOE - FITTING

- To reassemble the brake shoes reverse the removal procedure. Ensure all springs are fitted correctly, and that the restraining wire or band is removed from the cylinder body.

- Refit load wheel. See **SECTION 4**.

To ensure balanced brake performance, it is necessary to replace the shoes on both load wheel brake assemblies. Repeat above procedure on the other load wheel brake assembly. Bed in the brakes.

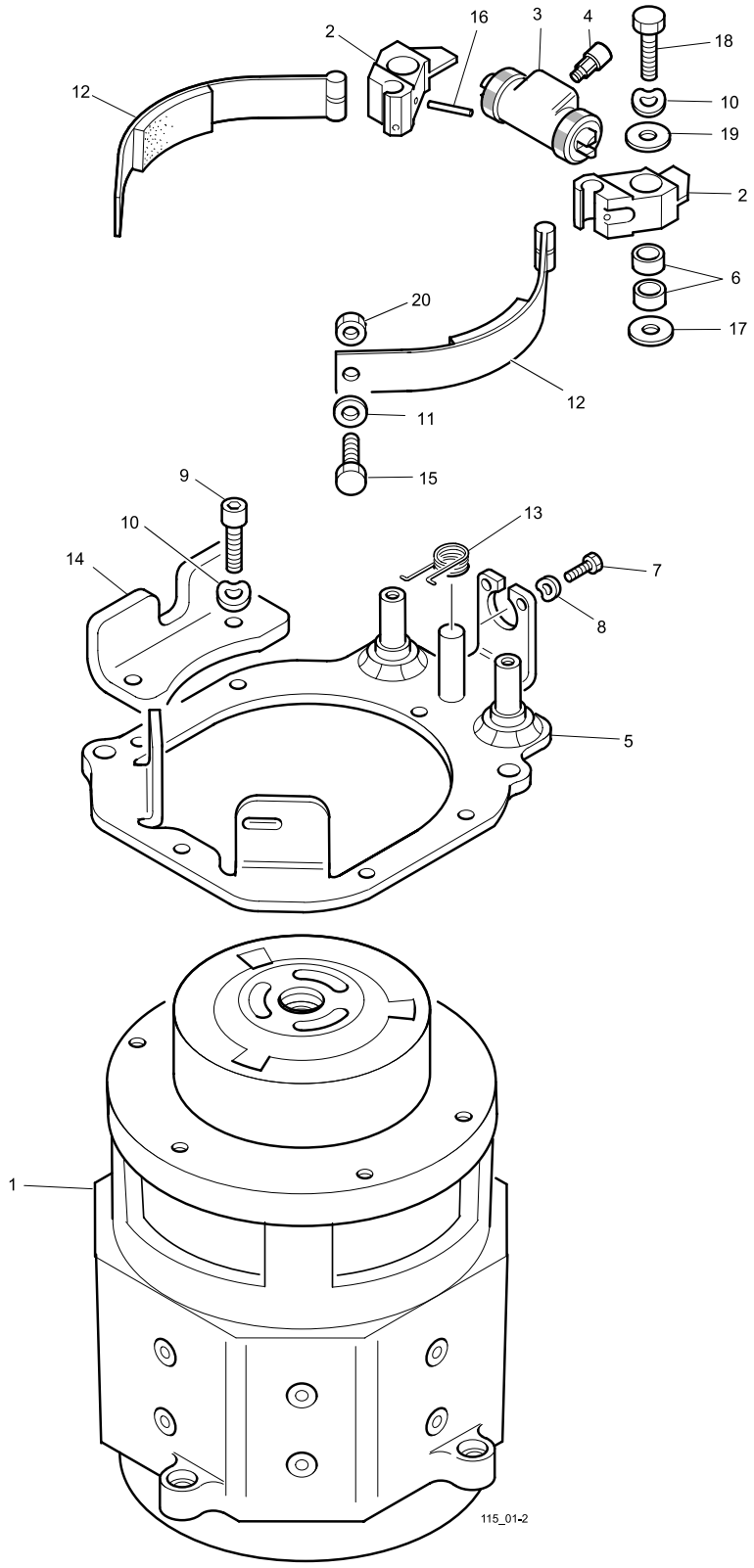
5.6 LOAD WHEEL BRAKE DRUMS

If the brake drum is found to be scored during periodical maintenance, new drums must be fitted.

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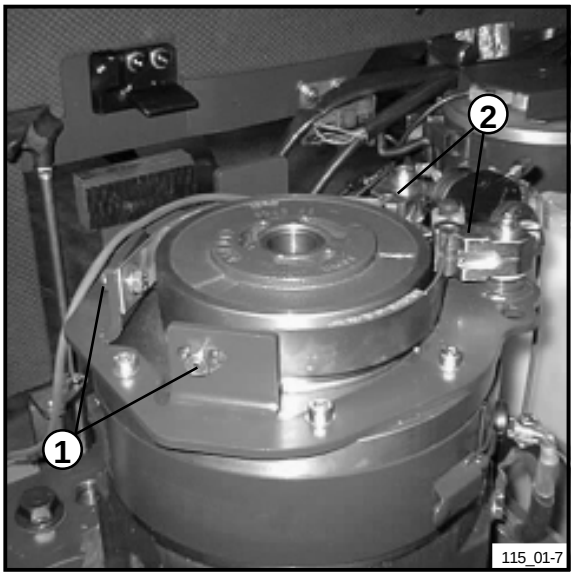
5.7 FOOTBRAKE ASSEMBLY

1. Traction motor
2. Lever
3. Brake cylinder
4. Air vent screw
5. Support assembly
6. Bush
7. Hexagon screw
8. Wave washer
9. Socket head screw
10. Spring washer
11. Washer
12. Brake shoe
13. Return spring
14. Plate
15. Hexagon screw
16. Cotter pin
17. Thrust washer
18. Hexagon screw
19. Washer
20. Hexagon nut



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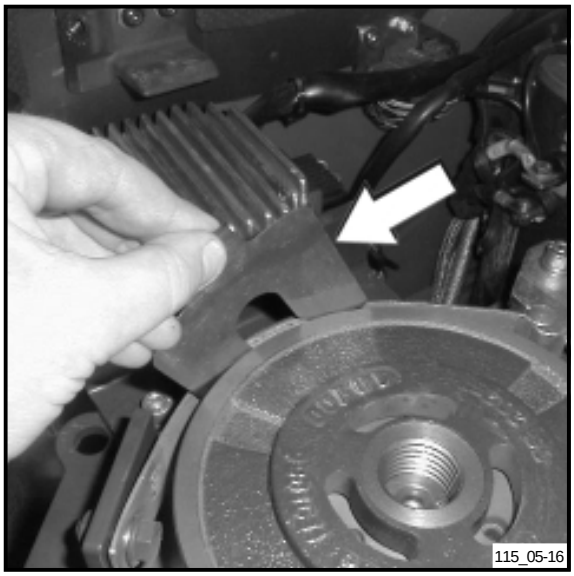
5.7.1 FOOTBRAKE SHOE REMOVAL



- Turn the keyswitch off.
- Remove the two screws, nuts and washers (1).
- Remove the two brake shoes from the levers (2).
- To replace the brake shoes, reverse the removal procedure and adjust the brake shoes.

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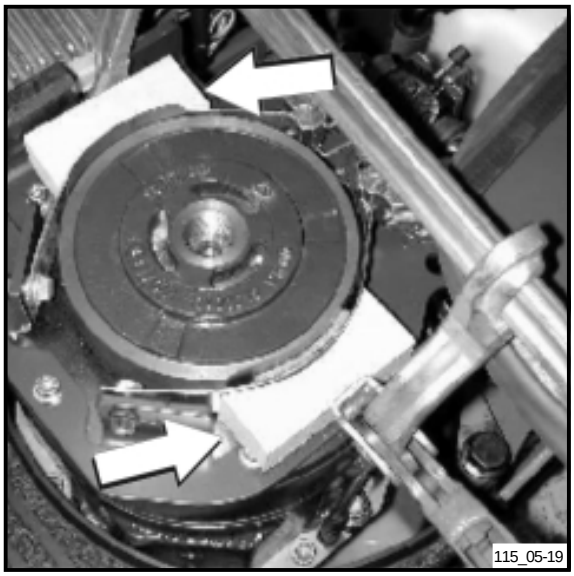
5.7.2 FOOTBRAKE SHOE ADJUSTMENT



- Set both brake pads so they are touching the drum and tighten the Durlok nuts to 37Nm.
- Pump the brake pedal hard five times.

☞ **NOTE: The previous two steps are only necessary if fitting new shoes.**

- Slacken the Durlok nuts and insert a 0.37mm shim Pt. No. 002.914.65.28 between each of the shoes and drum.

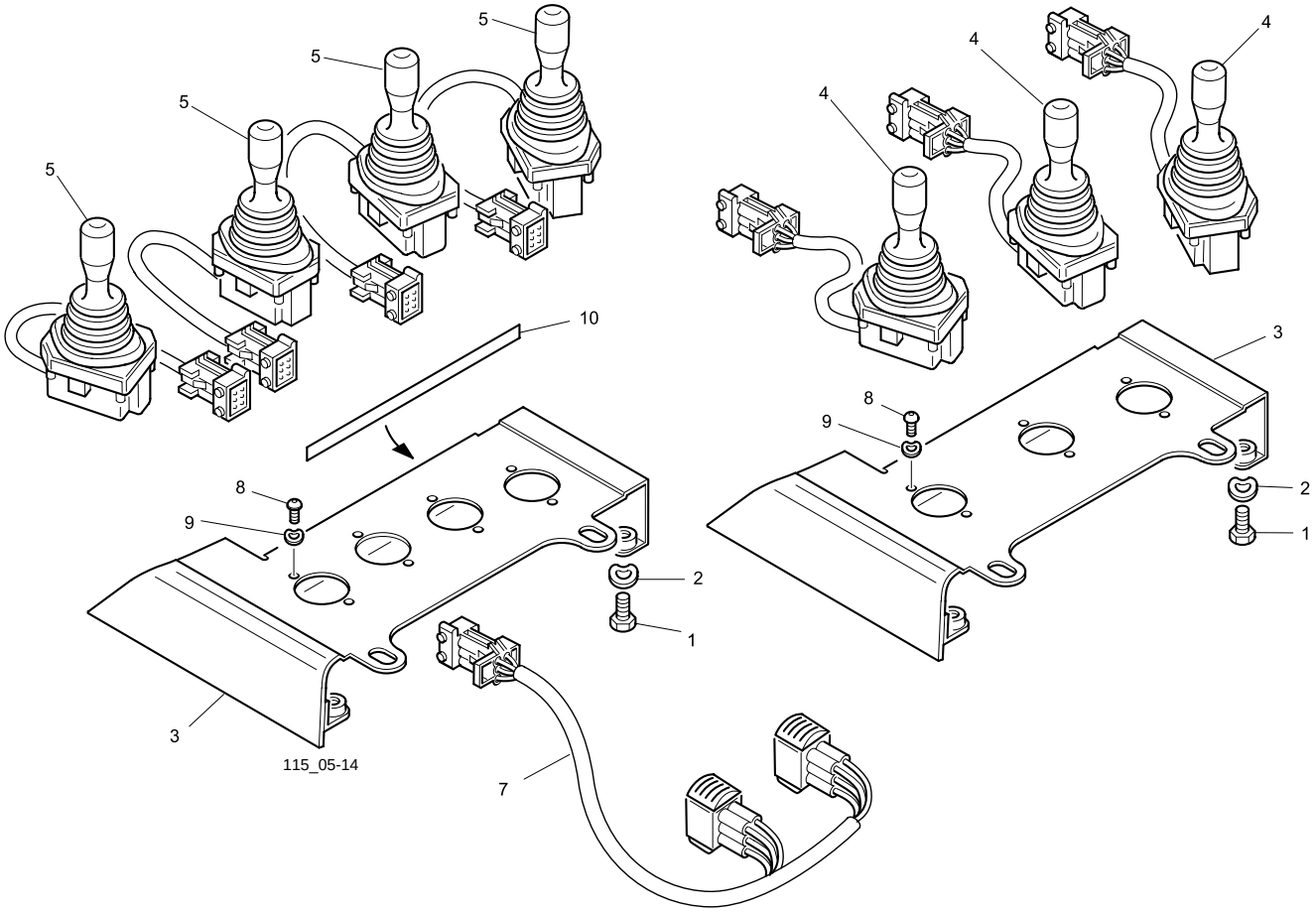


- Press the shoes against the drum and clamp in position using blocks, Pt. No.115.527.18.00 and tighten the Durlok nuts to 37Nm.

☞ **NOTE: It is important that when tightening the screws that the appropriate side of the nut/bolt is rotated to ensure the shoe does not loosen on the shim.**

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5.8 HYDRAULIC CONTROLS



1. Hexagon head screw
2. Spring washer
3. Bracket (3 position)
4. Control lever (dual axis)
5. Control lever (single axis)
6. Control lever with button (clamp)
7. Harness assembly
8. Screw
9. Wavy washer
10. Label
11. Housing

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5.8.1 HYDRAULIC CONTROL LEVER REMOVAL

- Chock load wheels securely. Reach battery out. Disconnect battery and apply the handbrake.
- Open the top covers.

- Remove the four screws securing the lever mounting bracket to the chassis.

- Disconnect the relevant lever connector.

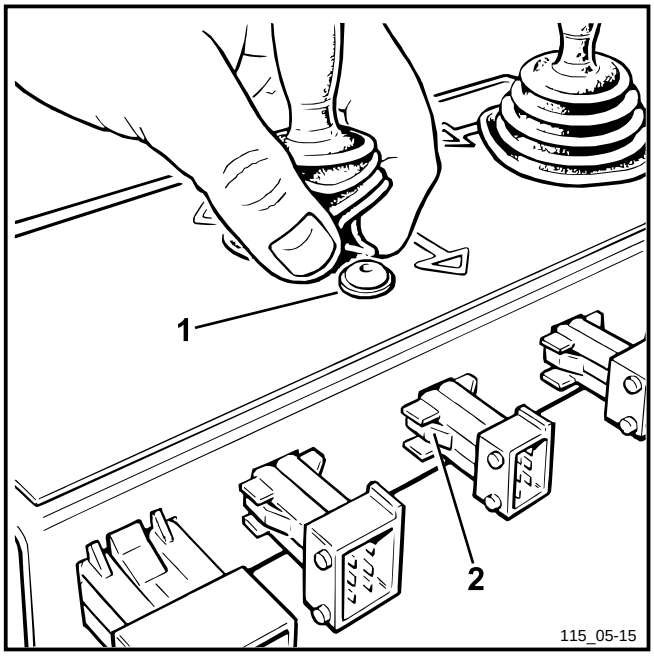
- Push in the two tabs (2) on the connector body and remove from the bracket.

- Pull rubber boot back and remove the two lever securing screws (1).

- Squeeze the rubber boot and carefully push the lever assembly back through the hole in the mounting bracket, taking care not to damage the rubber boot.

5.8.2 HYDRAULIC CONTROL LEVER REFITTING

To refit the lever assembly, reverse the removal procedure, taking care not to damage the rubber boot when refitting the lever. Ensure rubber boot is located correctly before securing the lever to the mounting bracket.



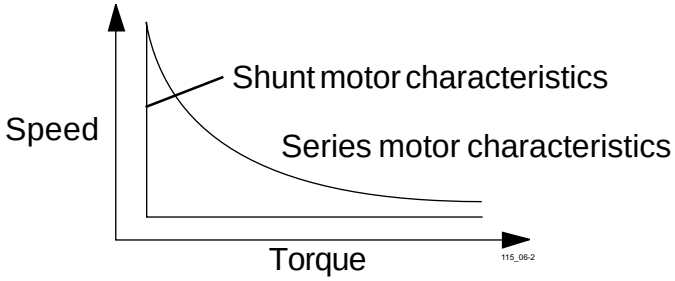
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Service Training

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6 ELECTRICAL CONTROL

CAUTION: It is imperative, that before working on the control system, that the battery is disconnected, and the steering capacitor voltage is discharged.
The steering capacitor voltage can be safely discharged by operating the horn with the battery plug DISCONNECTED. Check that the voltage between 3F1 and the main negative is less than 5V before working on the truck.
Failure to carry out this procedure can lead to damage of the CAN interface drivers. Components MUST NOT be removed or replaced with the truck live.

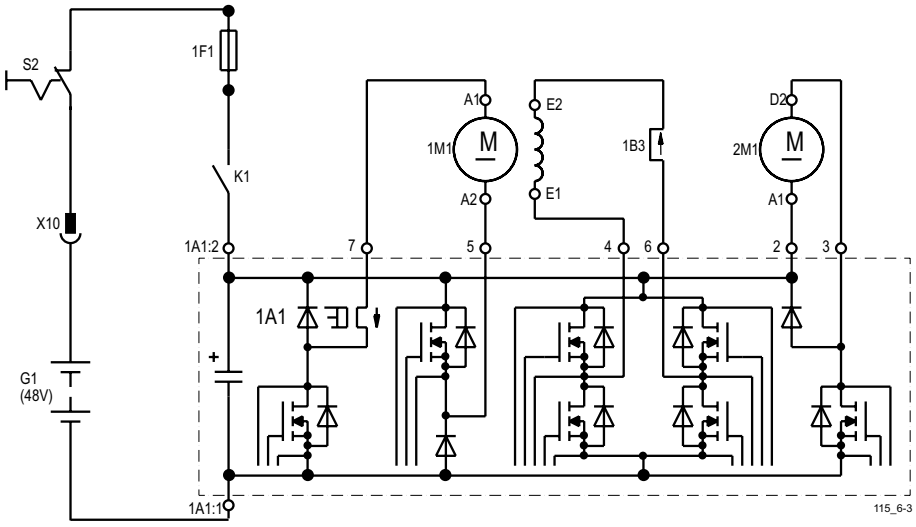


6.1 CONTROL SYSTEM FOR LDC TRACTION DRIVE UNIT

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The reversing field separately excited (shunt wound) motor together with the 16kHz LDC controller provides smooth precise control of drive and regenerative electric braking.
This motor configuration permits higher travel speeds to be maintained when laden as well as improved performance on moderate gradients.
The computer based controller provides smooth automatic regenerative electrical braking when the accelerator pedal is released and brings the truck to a complete stop. When the opposite direction is selected whilst travelling the transition between directions is seamless with again all electrical braking returning energy to the battery. Because regenerative electrical braking returns current at battery voltage good levels of braking can be achieved for moderate motor currents. This ensures a cool running drive motor, minimises use of the mechanical brakes and increases the work available per battery charge.

6.1.1 OPERATING PRINCIPLE



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6.1.1.1 SPEED & DIRECTION CONTROL

In general terms the speed of the truck is proportional to the average voltage applied to the motor armature, and inversely proportional to the current flowing through the motor field. The direction of travel is dependent on the direction of current flow through the motor field relative to the motor armature.

6.1.1.2 FIELD CONTROL

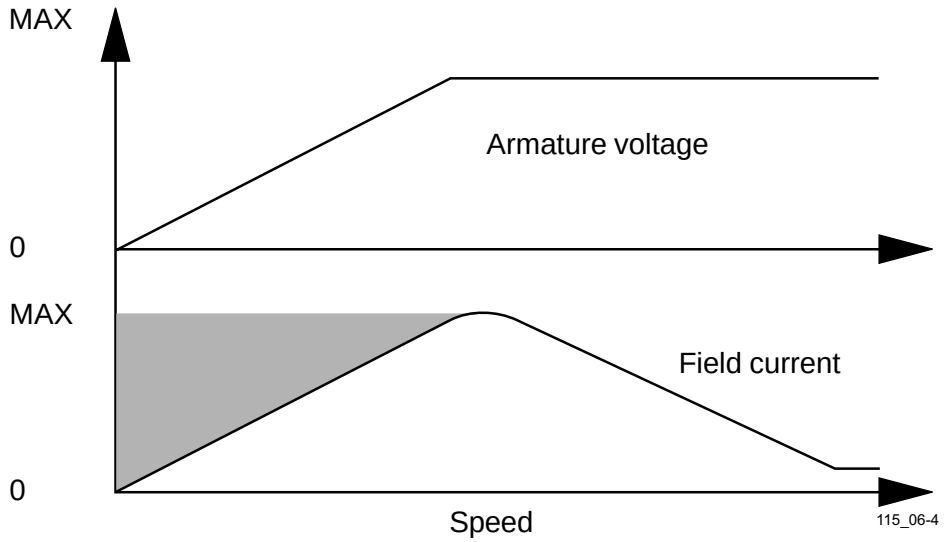
A bridge of 4 mosfets within the power module control the direction and magnitude of the traction motor field current. When the truck is at rest the field is alternatively pulsed in one direction then the other to ensure that no significant remnant magnetism is induced into the yoke of the motor.

6.1.1.3 ARMATURE CONTROL

Two banks of mosfets within the power module are in series with the positive and negative ends of the motor armature connections. Under normal driving, one would be in full conduction and the other pulsed to vary the average voltage applied to the armature in accordance with driver demand and load conditions imposed. At maximum speed both armature mosfet banks are in full conduction and the field current will be at minimum level.

On initial depression of the accelerator, the field current and armature voltage will both progressively increase from zero, and will achieve maximum levels at about a third of maximum truck speed. Further depression of the accelerator will result in the field current weakening, and the truck will continue to accelerate to maximum speed.

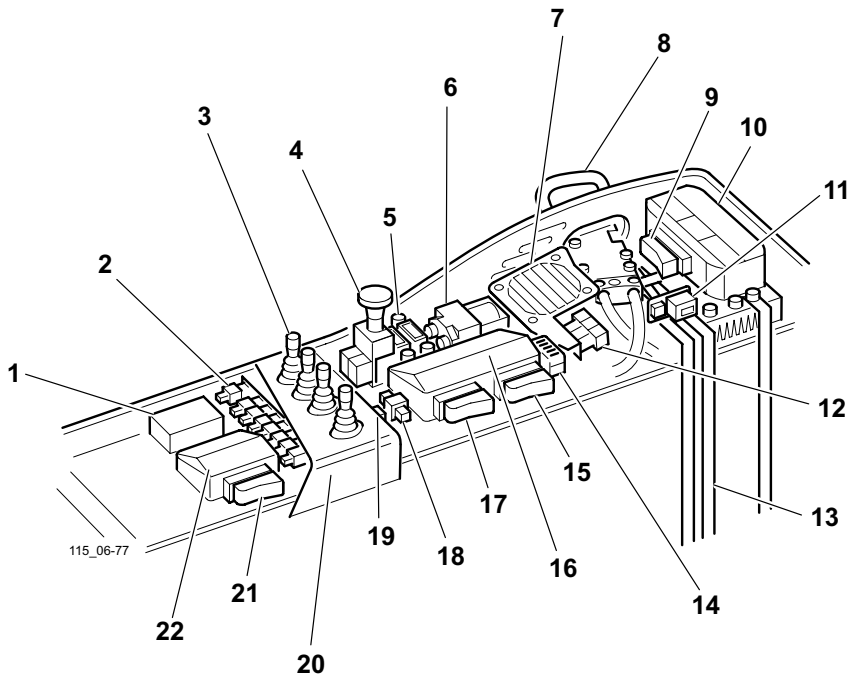
The controller monitors the armature current, and in order to ensure that this does not become excessive, will automatically override the accelerator demand and increase the field current to reduce truck speed and thus armature current as required. Under slow speed conditions when high torque is also required, for example when climbing a gradient, the field current will also be increased automatically into the shaded area of the graph.



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6.1.2 ELECTRICAL COMPONENTS (UNDER THE TOP COVER)

1.	DC/DC converter 48/24 volt	U1
	Connector 6 way DC/DC converter U1	X8
2.	UPA and hydrualic control lever connectors	6X63, 2X27, 2X26X, 2X26Y 2X26, 2X15X, 2X15Y, 2X15
3.	Hydraulic control levers	
4.	Safety isolator	S2
5.	Power steering fuse	3F1
	Traction & hydraulic fuse	1F1
6.	Main contactor	K1
7.	Control unit cooling fan	9M1
8.	Battery connector	X10
9.	Connector 29 way traction (power unit) 1A1	1X13
10.	Power module	1A1
11.	Current sensor	1B3
	Connector	1X6
12.	Direction switch connector (single pedal)	1X9
	Safety isolator microswitch connector	X3
	MOSFET cooling fan connector	9X1
13.	'Bus bars' link between power module and motors	
14.	Control current fuses	
15.	Connector 29 way traction module 1A2	1X11
16.	LDC controller	1A2
17.	Connector 29 way traction module 1A2	1X12
18.	Charge resistor assembly connector	X12
19.	Connector 10 UPA supplies	6X63
20.	Charge resistor assembly (under bracket)	
21.	Connector 42 way lift module 2A2	2X1
22.	LLC controller	2A2

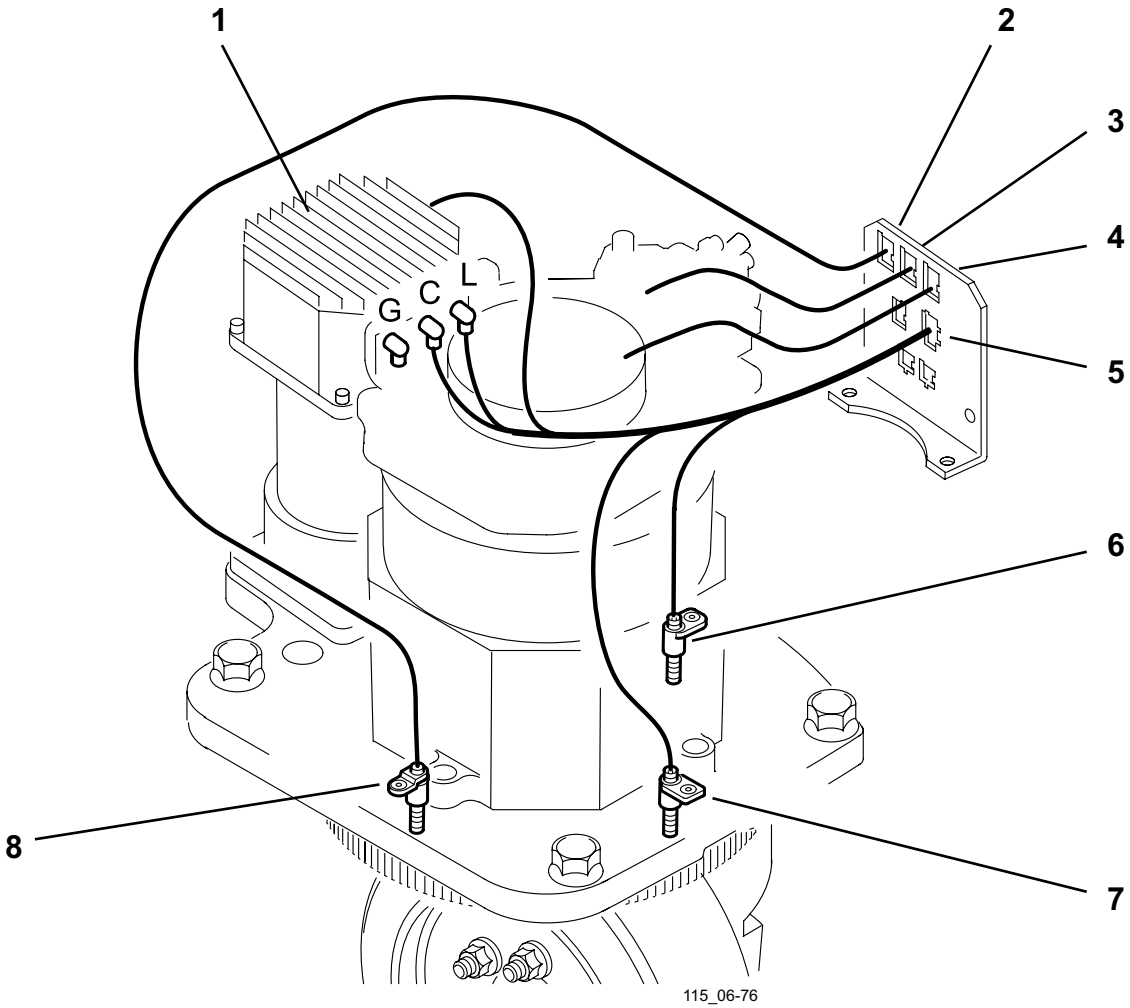


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6.1.2.1 ELECTRICAL COMPONENTS (MOTOR COMPARTMENT)

The drive unit assembly is fitted to the truck as a sub assembly and includes a bracket that supports 6 connectors. A separate wiring harness is used for the electric steering system and this connects to the main truck wiring at the steering interface connector 3X15.

		Connector	Component
1.	Electrical steering unit		3M1
2.	360° steering sensor	3X10	3B4
3.	Traction sensors	1X7	6B1, 6B1A
4.	Parking brake solenoid	1X19	1K13
5.	Steering system interface	3X15	
6.	DSS2		
7.	DSS1		
8.	DSS3		

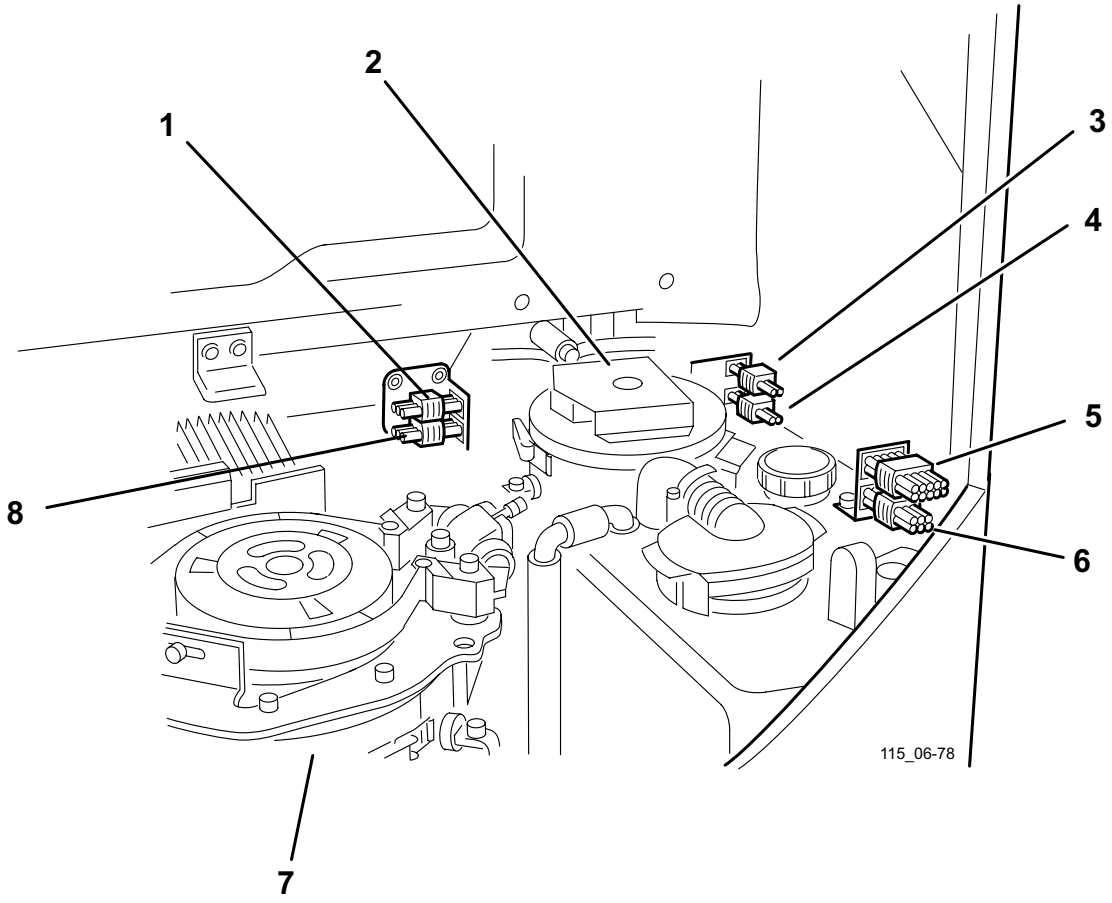


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6.1.2.2 ELECTRICAL COMPONENTS (PUMP MOTOR & HYDRAULIC TANK AREA)

The connectors for the pump motor cooling fans are mounted to a bracket attached to the pump motor brush cover band. Mounted above the hydraulic tank are connectors to provide function for the drivers seat and the optional lighting distribution connector.

		Connector	Component
1.	Hydraulic pump motor sensors	2X7	6B3, 6B3A
2.	Hydraulic pump motor		2M1
3.	Hydraulic pump fan 2	9X28b	9M3B
4.	Hydraulic pump fan 1	9X28a	9M3A
5.	Lighting distribution	5X27	1S1
6.	Seat switch connector	1X32	
7.	Traction motor		1M1
8.	Hydraulic pump motor speed sensor	2X83	2B8

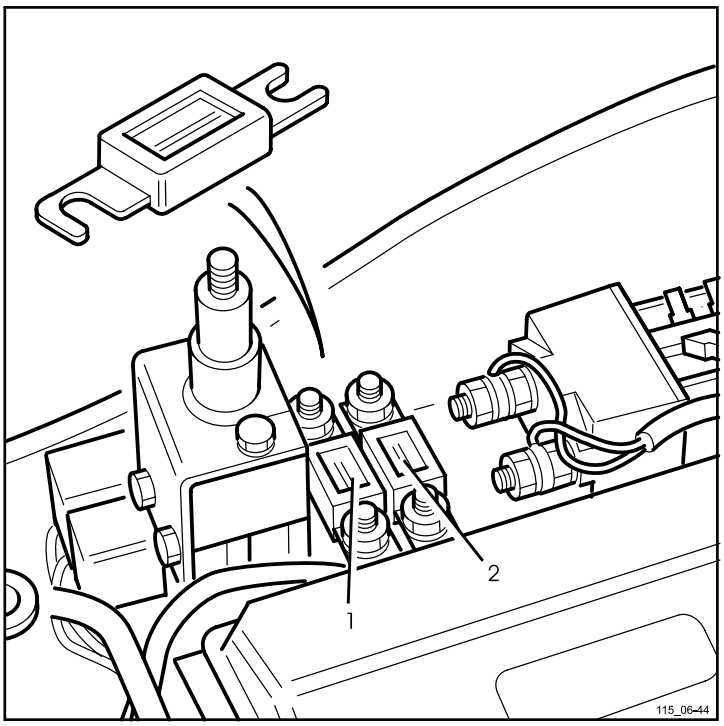


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6.1.3 FUSES - CONTROL CURRENT

Power circuit fuses are situated within the control unit enclosure and are to DIN 43560 form B.

1. Steering fuse 3F1 is rated at 50 A
2. Main battery fuse 1F1 is rated at 330 A



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6.1.3.1 FUSES - ANCILLARY CIRCUITS

Small fuses are to DIN 72581 outline.

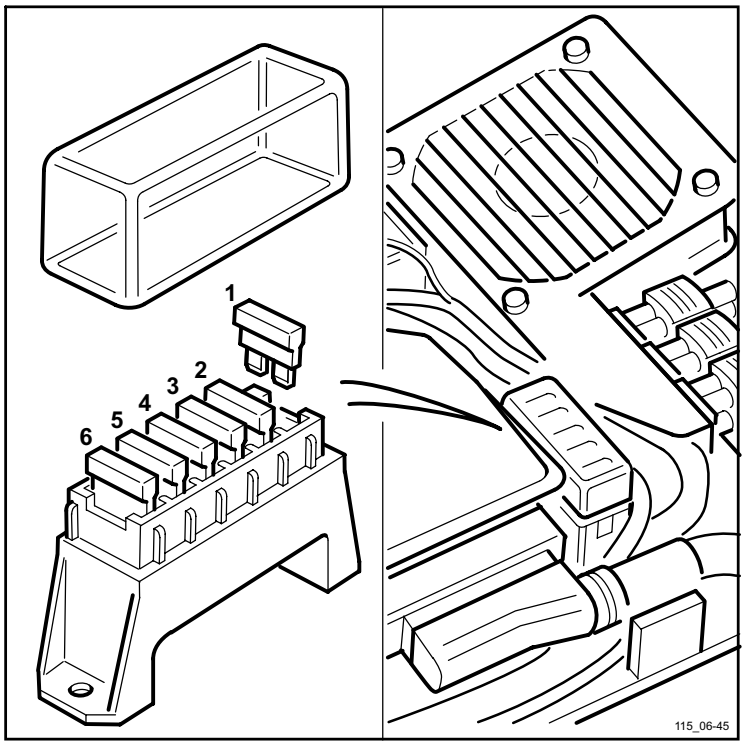
These battery voltage fuses within the control unit enclosure are a special sand filled type and rated at a nominal 80 volts.

☞ **NOTE: Although these fuses are interchangeable with automotive fuses, automotive fuses MUST NOT be used. Only genuine Linde fuses have sufficient voltage capability to ensure correct operation at truck voltages.**

6.1.3.2 FUSE DUTIES AND POSITIONS - ANCILLARY CIRCUITS

1. 1F2 5A Key switch, traction and steering control circuits.
2. 1F4 5A 24 volt output from DC-DC converter.
3. 1F6 5A Heated seat & horn supplies
4. 6F1 5A BDI monitoring voltage.
5. 1F8 5A Parking brake release & Pre-charge Resistor.
6. 5F1 5A Lighting supplies

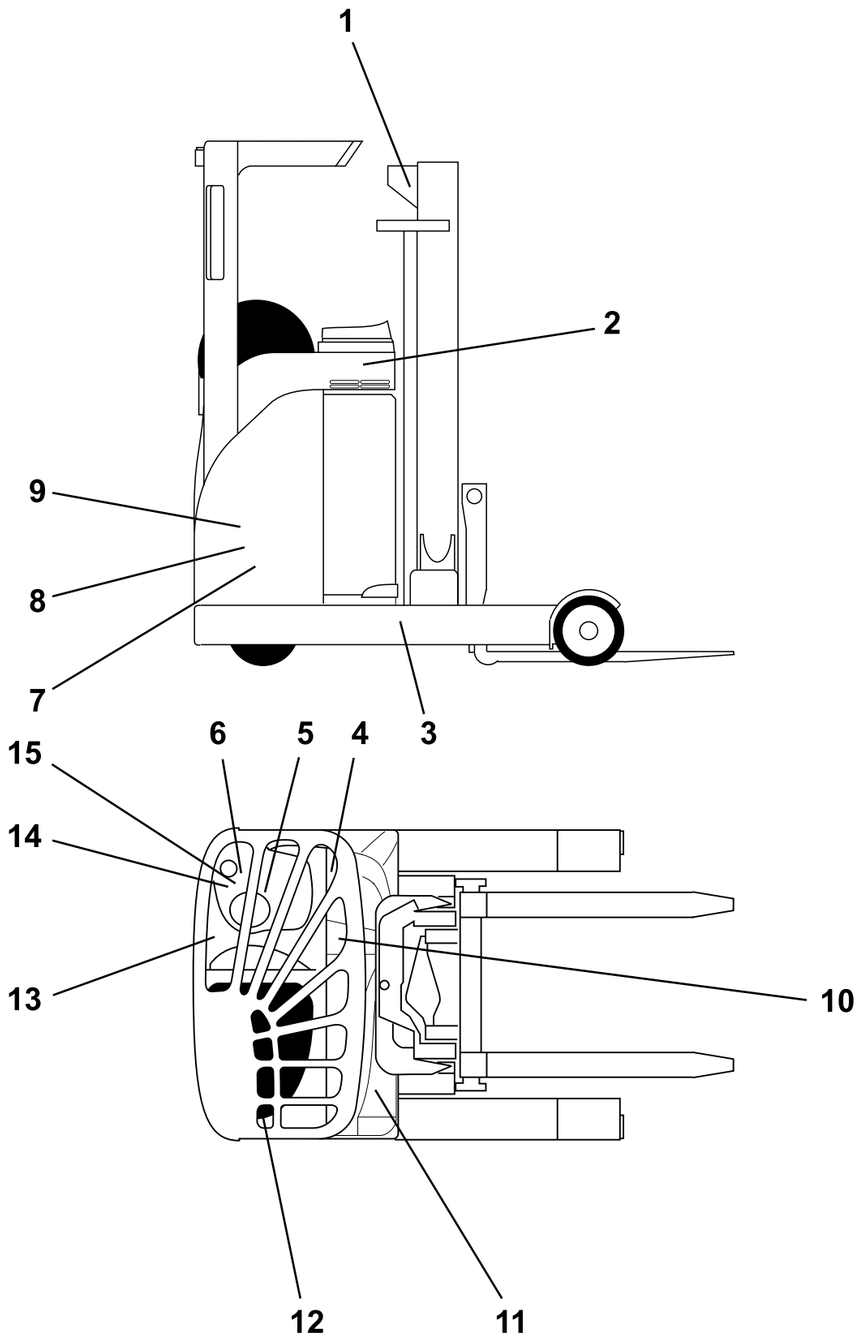
☞ **NOTE: All control fuses are rated at 80V**



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DESIGNATION	ITEM	POSITION ON TRUCK	TYPE	POLES	DUTY
1X10	13	Under the floorplate	JPT	4	Acclerator
1X11	11	On the shelf	SAAB	29	Traction Module
1X12	11	On the shelf	SAAB	29	Traction Module
1X13	11	On the shelf	SAAB	29	MOSFET block
1X14	13	Under the floorplate	JPT	3	Footbrake switch
1X15	11	On the shelf	SAAB	4	Diagnostics
1X19	7	On drive unit	SAAB	2	Brake soleniod
1X32	12	Behind/under the seat	SAAB	6	Seat
1X34	13	Under the floorplate	SAAB	2	Travel alarm (Option)
1X36	3	Base of mast	SAAB	4	8.5 m Traction slow switch
1X38	13	Under the floorplate	JPT	3	Left foot switch
1X4	14	Inside the steering binnacle	SWITCH	8	Handbrake switch
1X7	7	On drive unit	SAAB	4	Traction brush and temp.
1X9	2	On shelf heatsink bracket	SAAB	6	Direction switch/Horn push
2X1	11	On the shelf	SAAB	42	Lift Module
2X15	10	On shelf - lever bracket	SAAB	6	Lift/Reach lever
2X15X	10	On shelf - lever bracket	SAAB	6	Reach lever
2X15Y	10	On shelf - lever bracket	SAAB	6	Lift lever
2X17	3	Base of mast	SAAB	16	Valve block
2X19	3	Base of mast	SAAB	6	6th Hyd./UPA connector
2X20	13	Under the floorplate	SAAB	24	Reach carriage cable
2X26	10	On shelf - lever bracket	SAAB	6	Tilt/sideshift lever
2X26X	10	On shelf - lever bracket	SAAB	6	Sideshift lever
2X26Y	10	On shelf - lever bracket	SAAB	6	Tilt lever
2X27	10	On shelf - lever bracket	SAAB	6	5/6th Hyd. lever
2X6A	4	On reach sensor	ESCHA	4	Reach out sensor
2X6B	4	On reach sensor	ESCHA	4	Reach out sensor
2X7	8	Adjacent to lift motor	SAAB	4	Lift brush and temp.
2X81	3	Base of mast	SAAB	4	Lift stop sensor
2X83	8	Adjacent to lift motor	SAAB	4	Lift tachometer
3X1	15	Part of the steering unit	SAAB	16	Steering supplies
3X15	7	On drive unit	SAAB	10	Steering system interface
3X4	5	Under the steering unit	BUS	8	Steering encoder & feedback
3X4A	14	Inside the steering binnacle	BUS	8	Steering encoder & feedback
3X8	7	On drive unit	SAAB	4	90ˆ sensor
3X9	7	On drive unit	SAAB	4	180ˆ sensor
4X1	13	Under the floorplate	SAAB	2	Horn
5S1	14	Inside the steering binnacle	SWITCH	8	Working light switch 5S1
5S2	14	Inside the steering binnacle	SWITCH	8	Working light switch 5S2
5X1	6	Behind steering column	SAAB	4	Lighting supplies
5X1A	6	Behind steering column	SAAB	4	Lighting supplies + CCTV
5X27	12	Behind/under the seat	SAAB	10	Lights (Option)
5X4	5	Under the steering unit	SAAB	4	To lighting switches
6X1	11	On the shelf	SAAB	16	Driver's display
6X60	14	Inside the steering binnacle	SAAB	6	Keyswitch/keypad/Data Logger
6X65	1	Top of fixed mast	SAAB	2	Heater supply/height encoder
8X23	1	Top of fixed mast	SAAB	4	Reference sensor (Option)
8X25	1	Top of fixed mast	SAAB	6	Height encoder (Option)
8X30	3	Base of mast	SAAB	10	Mast cable - height encoder
9X1A	2	On shelf heatsink bracket	SAAB	2	MOSFET fan A
9X1B	2	On shelf heatsink bracket	SAAB	2	MOSFET fan B
9X2	7	On drive unit	SAAB	2	Traction fan
9X28A	9	On the lift motor	SAAB	2	Lift motor fan A (on motor)
9X28B	9	On the lift motor	SAAB	2	Lift motor fan B (on motor)
Convertor CCTV	13	Under the floorplate	SAAB	6	Converter CCTV
Convertor UPA	13	Under the floorplate	SAAB	6	Converter UPA
Faston (x2)	14	Inside the steering binnacle	FASTON	1	Keyswitch
Faston (x2)	13	Under the floorplate	FASTON	1	Brake fluid reservoir
Faston (x2)	11	On the shelf	FASTON	1	Line contactor coil
Fuses	11	On the shelf	Fuse box	12	Fuse holder
G/X49	15	Part of the steering unit	ESCHA	8	Steering 90ˆ/180ˆ sensor input
L/x50	15	Part of the steering unit	ESCHA	8	Steering encoder input
M10 ring (x2)	11	On the shelf	RING	1	Line contactor contacts
M8 ring (x1)	11	On the shelf	RING	1	Battery Positive direct
X1	13	Under the floorplate	SAAB	4	Battery lock sensor
X12	11	On the shelf	SAAB	6	Charge restistor
X3	2	On shelf heatsink bracket	SAAB	2	Isolator aux switch
X48	15	Part of the steering unit	ESCHA	4	Steering CAN interface
X5	5	Under the steering unit	SAAB	10	Keyswitch/keypad/Data Logger
X8	10	On shelf - lever bracket	SAAB	6	DC/DC converter connector

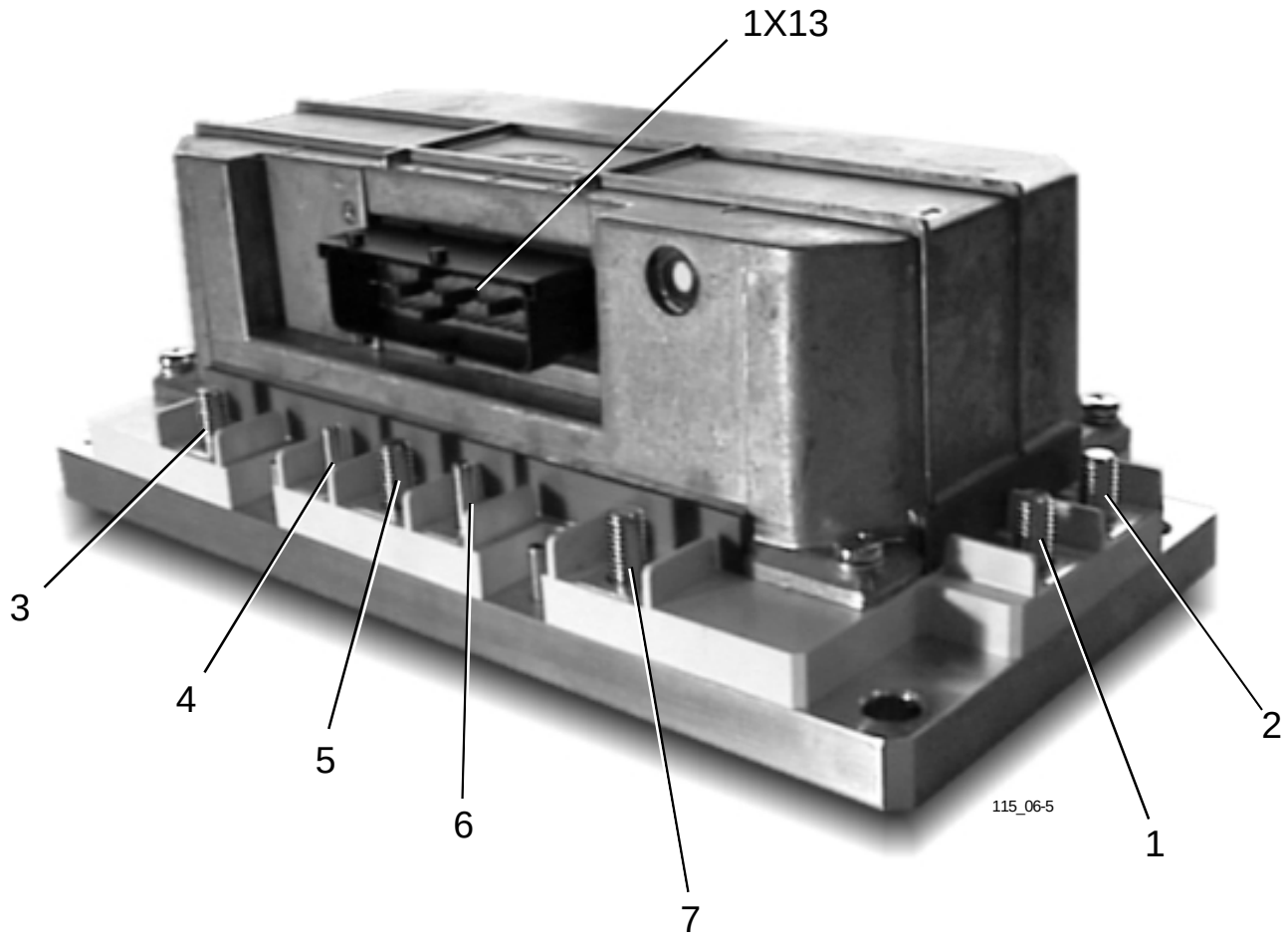
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6.1.4 POWER UNIT CONNECTIONS

The power module, which includes all power components for traction and pump motors, is connected by a cable between 1X13 and 1X12. A further 29 way connector 1X11 on the LDC controller receives all other traction signals from the truck, and links to the LLC controller, diagnostic connector, and display via the CAN bus.



MAIN CIRCUIT CONNECTIONS

1 Negative connection for the power unit (source for the power transistors)
2 Positive connection for the power unit via line contactor fuse/isolator/motor A1
3 Drain connection for the power transistor for pump motor D2
4 Field winding connection E1 for the traction motor
5 Armature connection A2 for the raction motor
6 Field winding connection E2 for the traction motor
7 Armature connection A1 for the traction motor

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6.1.4.1 1X13 PIN CONNECTIONS

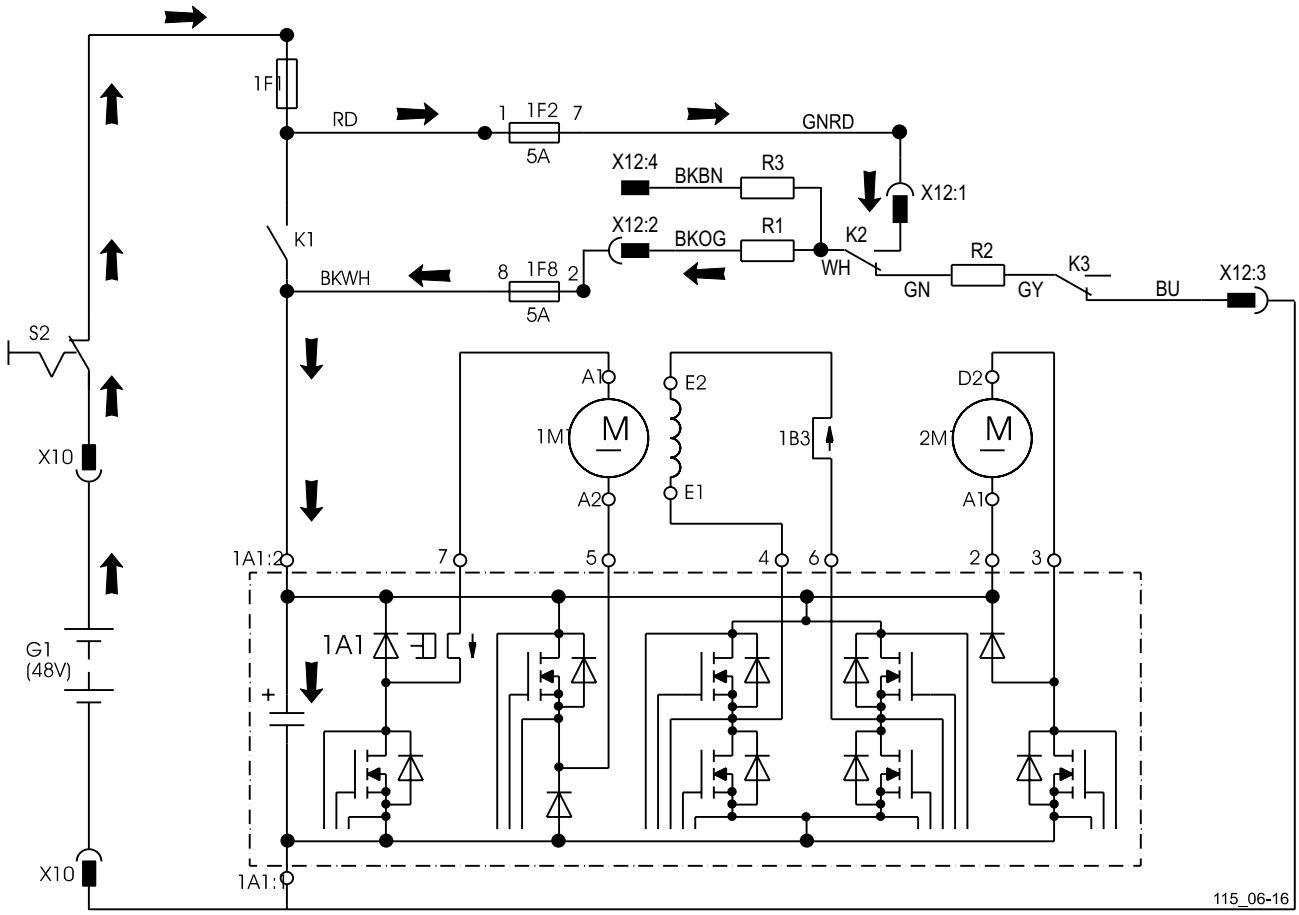
Pin	Colour	Duty
1	GYVT	Pump motor MOSFET gate
2	BNGY	Pump motor MOSFET source
3	Not used	
4	Not used	
5	Not used	
6	RDYE	Current sensor - signal
7	BURD	Current sensor 0V
8	Not used	
9	Not used	
10	Not used	
11	BKWH	Field MOSFETs D HI
12	BKWH	Traction MOSFET HI gate
13	BKBU	Traction MOSFET LO source
14	GYYE	Traction MOSFET HI source
15	BNYE	Traction MOSFET LO drain
16	YE	Temperature sensor traction
17	VT	Temperature sensor pump motor
18	Not used	
19	GYBN	Pump motor MOSFET source
20	BKGY	Traction MOSFET LO gate.
21	BKBN	Field MOSFET 1 gate HI
22	BKYE	Field MOSFET 3 gate LO
23	Not used	
24	Not used	
25	OG	Traction Error signal
26	RDOG	Pump motor error signal
27	Not used	
28	BKRD	24 Volt
29	BU	Negative

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6.1.5 INTERMEDIATE CIRCUIT CAPACITORS, SWITCHING ON AND CHARGING

The intermediate circuit capacitors are located inside the main traction/hydraulic power unit 1A1. In order to prevent very high current flowing across the contact tips of K1, capacitors are pre-charged before K1 energises.

This pre-charging is carried out via a charging circuit using two relays K2 and K3. When the keyswitch is turned on, the relay K3 is activated directly by voltage transformer U1. The relay K2 is directly activated by the drive electronics within 1A2. As soon as the two relays are activated, the capacitors in the power unit can charge up via the charging resistor R1.
Only when the intermediate circuit capacitors are charged can the activation of the main contactor K1 take place (monitored by an electronic circuit inside 1A2). Approximately five seconds after that, the relay K2 is switched off again, since the capacitors are now receiving their charging voltage via the contacts of the main current contactor K1.

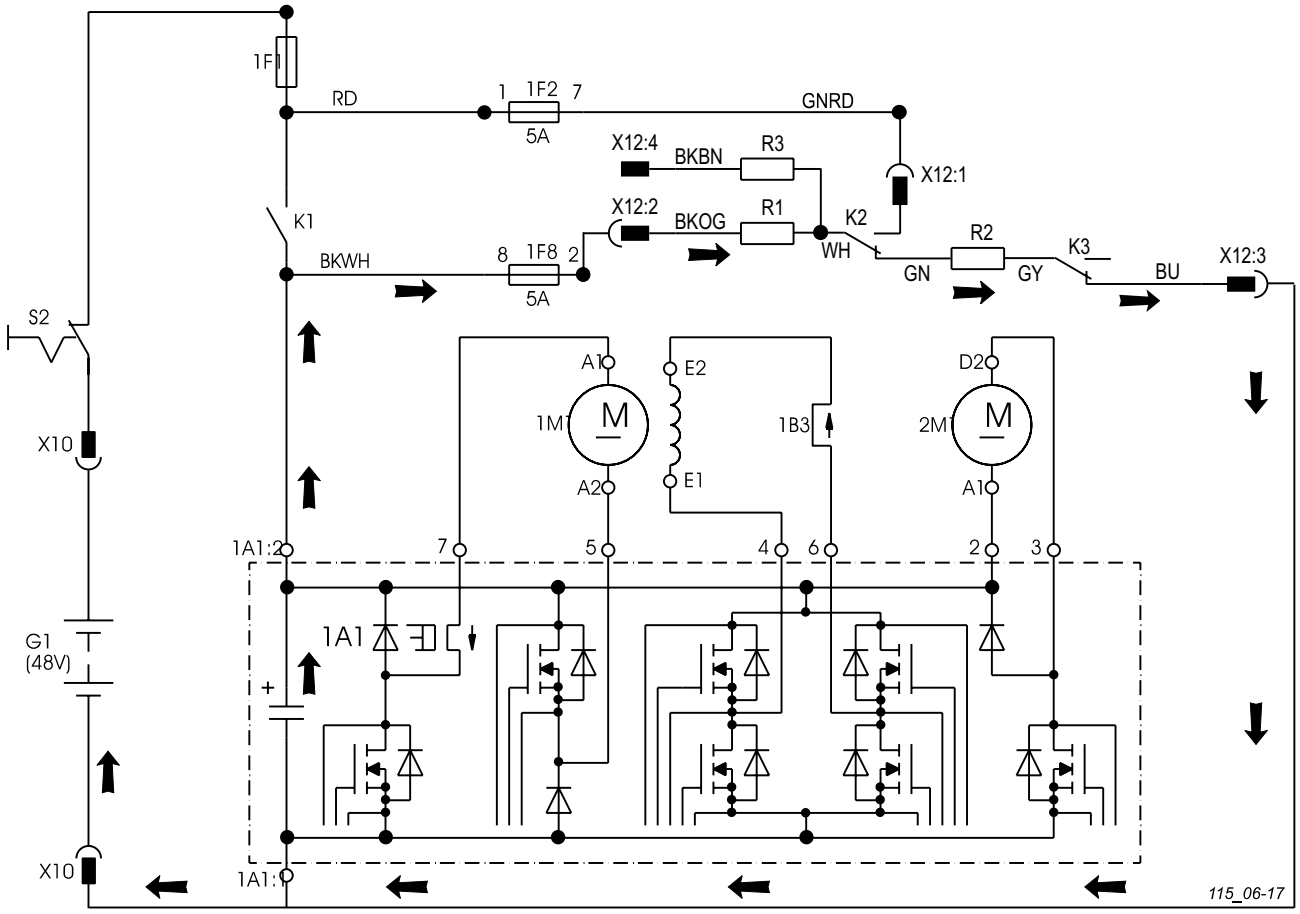


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6.1.5.1 INTERMEDIATE CIRCUIT CAPACITORS, DISCHARGING

As soon as the keyswitch is turned off, relays K2 and K3 are released, allowing the intermediate capacitors to discharge through K3, K2 and R2 to battery negative.

CAUTION: When servicing the power supply or the power circuit, ensure that the intermediate circuit capacitors are discharged. Measure between terminal 1 and 2 of power block 1A1. The voltage must be under five volts. If the capacitors remain charged at battery voltage for more than 30 seconds after the truck is switched off, then the charging circuit is probably defective. Wait about fifteen minutes until the capacitors have discharged via the power supply. The voltage should be rechecked before working on the system.



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6.1.5.2 K1 MAIN CONTACTOR

Contactor coil characteristics:

Resistance (20°C)	54 ohms
Coil pull in voltage	28 - 32 volts
Coil hold in voltage	18 volts
Coil drop out voltage	4 - 10 volts
Coil suppression	Free wheel diode only. No series resistor.

A single pole normally open contactor with a magnetic arc extinguishing system is employed. After the large capacitors within the power block are charged by the charge resistor circuit, this contactor is initially energised at battery voltage but is then held closed at a reduced coil voltage. The reduced coil voltage is achieved by pulsing the switching FET within the traction control module. 1K1 must be closed for traction and hydraulic functions to operate. Power steering is not routed via 1K1.

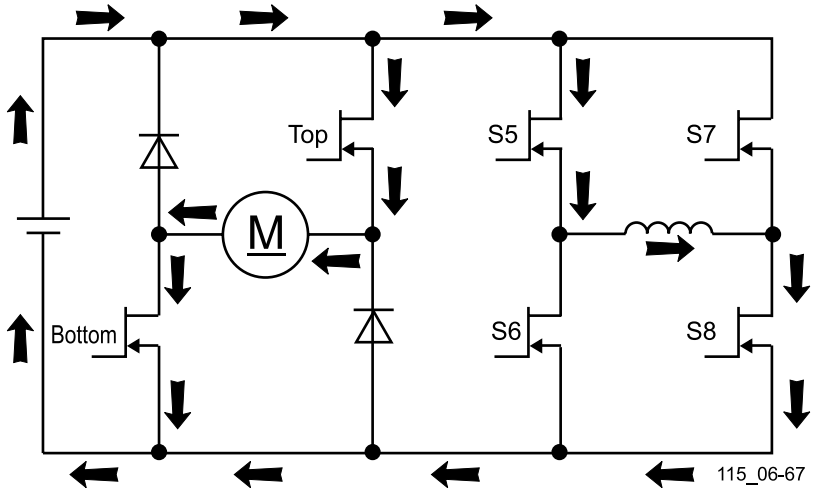


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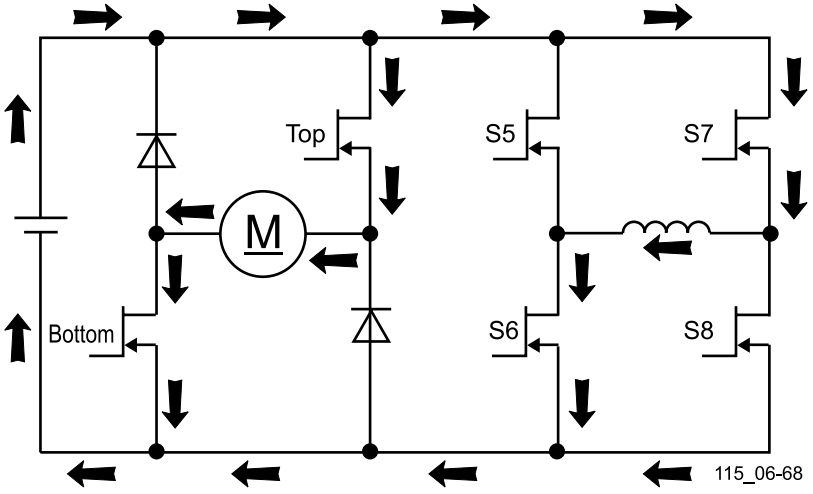
6.1.5.3 FORWARD DIRECTION OF TRAVEL

When driving forwards, the top transistor of the power unit 1A1 is switched on. The field winding of the traction motor is excited via the clock pulse (16 Khz) of the field transistors S5 and S8 in the power unit. At the same time, the bottom transistor of the power unit is given a clock pulse.



6.1.5.4 REVERSE DIRECTION OF TRAVEL

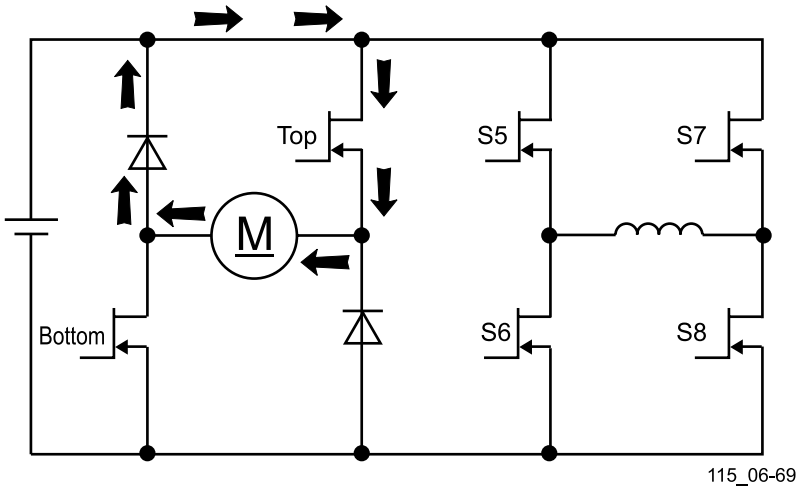
When driving backwards, the top transistor of the power unit 1A1 is switched on. The field winding of the traction motor is excited via the clock pulse (16 Khz) of the field transistors S6 and S7 in the power unit. At the same time, the bottom transistor of the power unit is given a clock pulse.



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6.1.5.5 FREEWHEEL CIRCUIT

When the bottom FET is turned off, the armature current will freewheel through the top FET and diode.



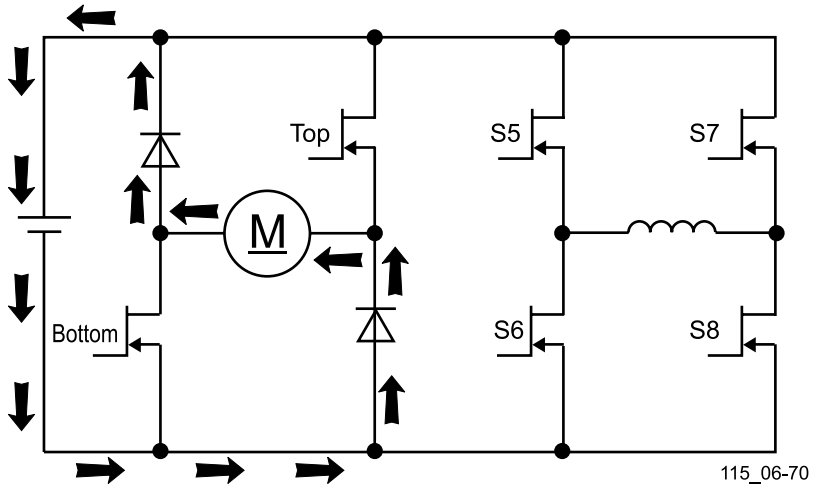
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6.1.5.6 REGENERATIVE ELECTRICAL BRAKING *(USEFUL CURRENT BRAKING)*

RELEASE OF ACCELERATOR

When the accelerator is released, the controller automatically configures into a braking mode, to slow the truck and return energy to the battery. The motor field current will be reversed, and the armature top MOSFET turned off at the point of releasing the accelerator pedal. The armature bottom MOSFET will be initially turned on, causing an increasing self generating circulating current to flow through the armature, the bottom diode and the bottom MOSFET.

When this current has reached a predetermined threshold, the bottom MOSFET will be turned off and the circulating current will then flow via the top diode into the battery returning energy. The current will decay and the bottom MOSFET will be turned on again. This process will continue automatically until the truck has come to rest and the armature no longer generates. The level of electrical braking is preset but can be changed within window 72 (Ilbc) of the LDC diagnostics.



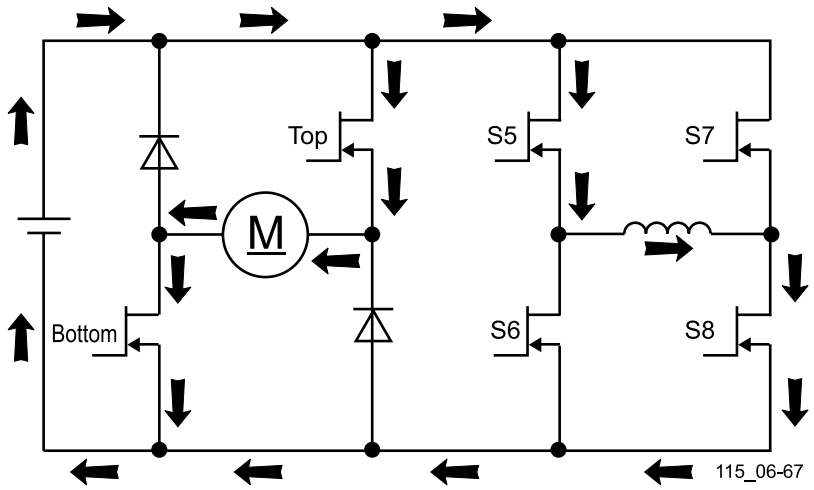
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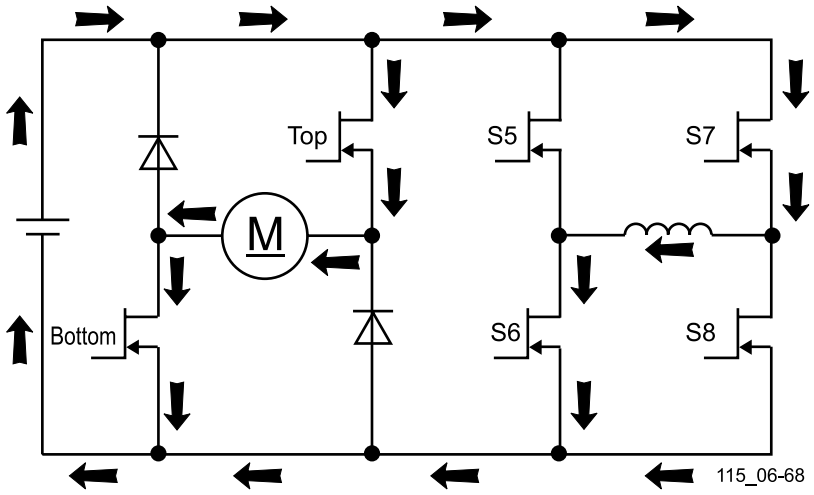
6.1.5.7 ELECTRICAL BRAKING - SELECTING OPPOSITE DIRECTION OF TRAVEL.

This process is similar to releasing the accelerator pedal with two differences:-

· When the truck is nearly to a stop the top MOSFET is turned on and the truck drives in the reverse direction. This method of slowing by regeneration and driving away by armature chopping ensures a seamless transition between braking and drive.

· The level of electric braking when the reverse pedal is selected can be controlled by accelerator pedal depression. Its maximum level is set in window 72 (Ibrk) of the LDC diagnostics.



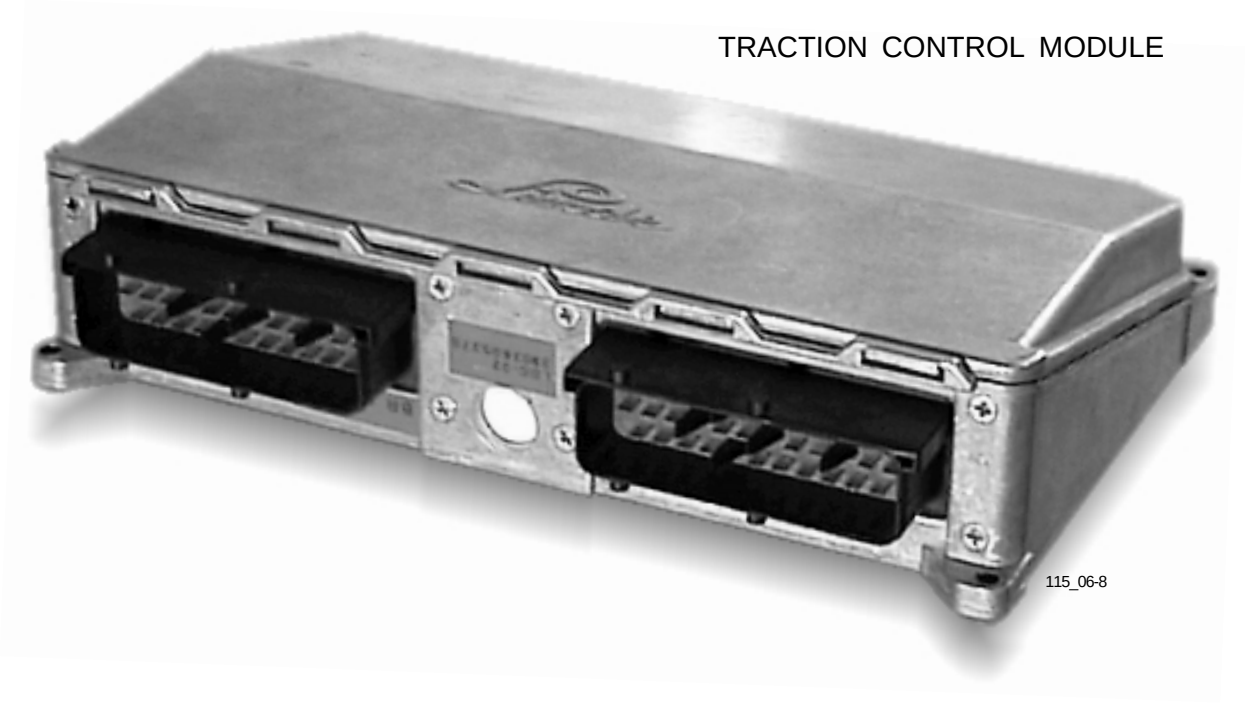


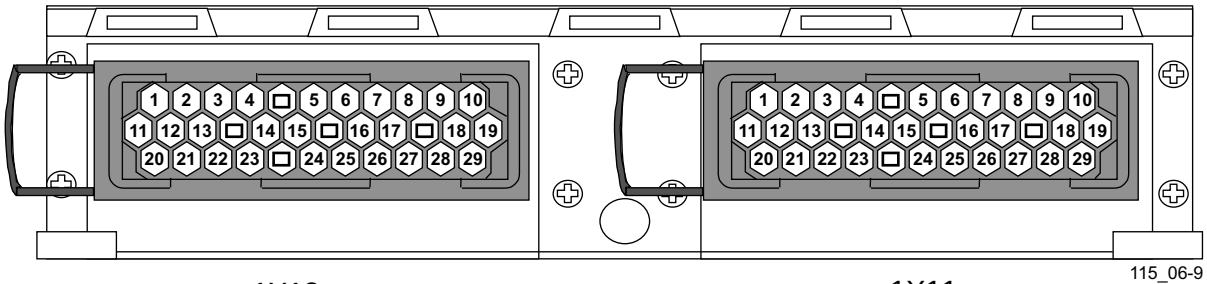
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6.1.6 CONTROL CIRCUIT

DRIVE ELECTRONICS 1A2

TRACTION CONTROL MODULE





1X12 1X11

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6.1.6.1 1X11, 29 WAY CONNECTOR

PIN	COLOUR	DUTY
1	RDOG	UPA Input to 6X63:9
2	GNRD	Battery + from fuse 1F2
3		Spare 24V relay output
4		Spare 24V relay output
5	GNRD	Travel alarm +24v
6	BKVT	Relay K2 coil +
7	GN	Isolator S2 aux switch. Negative when closed.
8	GY	Neutral direction selection input (Single pedal switch)
9	BK	Forward direction selection input. (Single pedal switch)
10	WH	Reverse direction selection input (Single pedal switch)
11	GYYE	Hand brake switch
12	RDVT	+15v to accelerator
13	BKRD	+24 input to module
14	BNVT	Line contactor K1 coil +
15	WHBK	Line contactor K1 coil -
16	YEBN	Negative enable from seat switch and left foot switch.
17		Spare analogue input
18	RD	Accelerator input 1
19	OG	Accelerator input 2
20	VTWH	CAN HI
21	VTRD	CAN LO
22		Steering check sensor 1 (DSS1)
23		Steering check sensor 2 (DSS2)
24	WHYE	Foot brake switch 1S5 input. Negative enable.
25	BUOG	Parking brake solenoid 1K13 driver. Coil negative.
26	BUBK	Speed override input. Tied to negative by 8.5 metre switch 2S13.
27	BUGN	Accelerator negative supply.
28	BKGY	Drive enable from steering system. Tied to negative when steering OK.
29	BU	Battery negative supply to module.

6.1.6.2 1X12, 29 WAY CONNECTOR

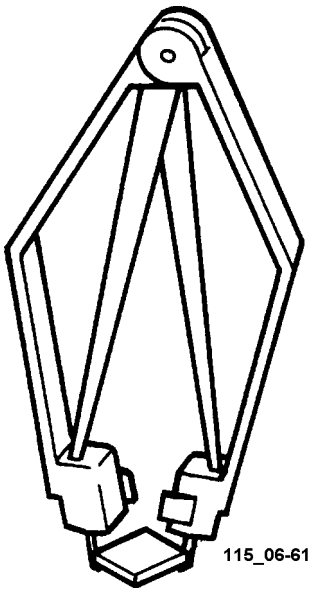
PIN	COLOUR	DUTY
1	GYVT	Pump motor MOSFET gate
2	BNGY	Pump motor MOSFET source
3		not used (ISO-K for production test)
4		not used (ISO-L for production test)
5		not used
6	RDYE	Current sensor - signal
7	BURD	Current sensor 0V
8		not used
9		not used (UPA RPM sensor A)
10		not used (UPA RPM sensor B)
11	BKWH	Field MOSFETs D HI
12	BKWH	Traction MOSFET HI gate
13	BKBU	Traction MOSFET LO source
14	GYYE	Traction MOSFET HI source
15	BNYE	Traction MOSFET LO drain
16	YE	Temperature sensor - traction motor
17	VT	Temperature sensor - pump motor
18		not used
19	GYBN	Pump motor MOSFET source
20	BKGY	Traction MOSFET LO gate.
21	BKBN	Field MOSFET 1 gate HI
22	BKYE	Field MOSFET 3 gate LO
23		not used
24		not used
25	OG	Traction Error signal
26	RDOG	Pump motor error signal
27		not used
28	BKRD	24 volt
29	BU	Negative

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6.1.7 PROGRAM MEMORY REPLACEMENT

The program memory is located in an EPROM (PLCC housing) which is placed in a socket on the circuit board in the LDC controller. A special extraction tool is required to remove the EPROM.

EXTRACTION TOOL



Should a replacement of the program memory prove necessary in the event of a software update, there are several requirements for the replacement which must be borne in mind in all cases:

- The replacement should only be carried out by staff who are experienced in working with electrical components.
- The truck's driving axle must be jacked up prior to the replacement.
- Clean working procedures must be observed.
- Under no circumstances must dust be allowed to get into the control electronics.
- Remove the battery plug.

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Procedure:

- Remove the control unit from the truck.
- Remove the cover of the control unit.
- Using one of the hooks on the extraction tool, and without using force, carefully lift one corner of the EPROM (2) a little way out of the socket (1).
- Now place both the hooks on the extraction tool under the EPROM and lift the EPROM out of the socket by pressing them together.

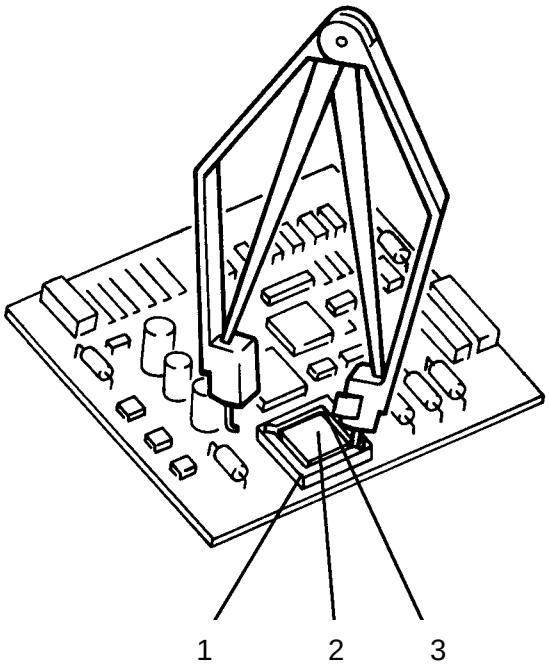
☞ NOTE: If no extraction tool is available, the EPROM can also be prised out of the socket with a precision screwdriver.

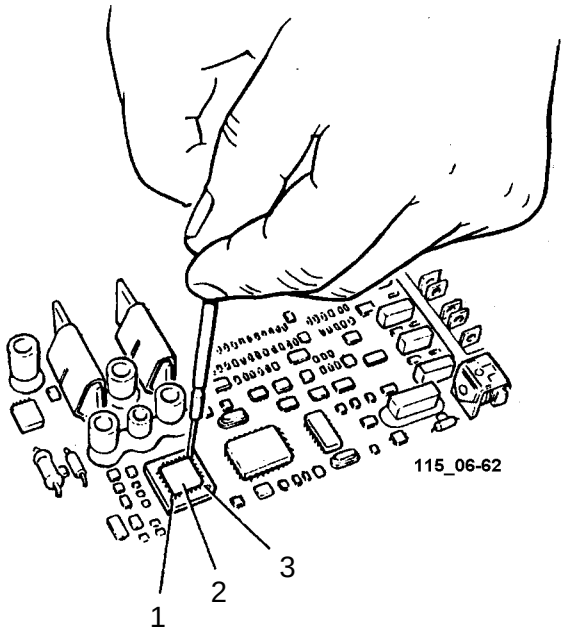
- Place the new EPROM level on the socket with the writing or sticker facing upward. In so doing, pay attention to the correct positioning of the coded nose (3).
- With steady pressure, but without using force, press the EPROM into the socket without tilting it.

⚠ CAUTION: Failure to replace the EPROM properly could destroy the control electronics.

- Close the control housing.

- Check the function of the control system in the truck.



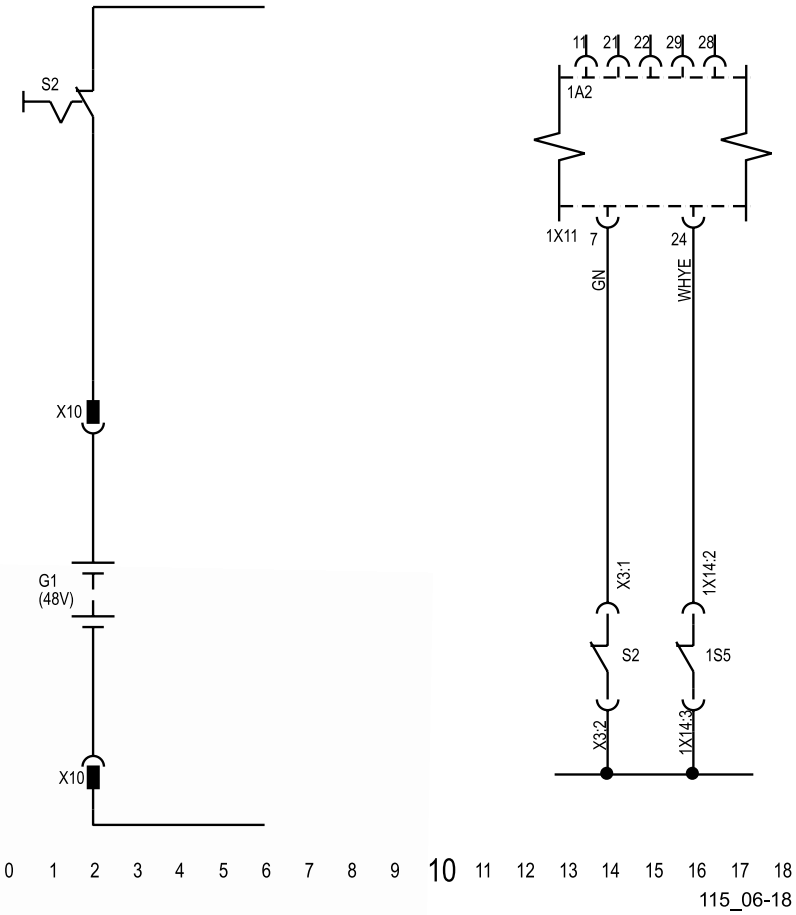


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6.1.8 EMERGENCY OFF MICROSWITCH

The emergency isolator S2, when operated, breaks the main battery positive feeds to the truck motion generating circuits. An auxiliary switch is built into the emergency isolator. This switch signals the traction control module that the isolator is being operated before its main contacts open. This signal is used to cause the traction motor field to reduce such that the traction system will not generate when the main battery supply is disconnected by the main contacts of the isolator.

COLOUR ABBREVIATIONS	
BK = BLACK	GN = GREEN
BN = BROWN	BU = BLUE
OG = ORANGE	VT = VIOLET
YE = YELLOW	GY = GREY
RD = RED	WH = WHITE



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EMERGENCY ISOLATOR S2

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X3

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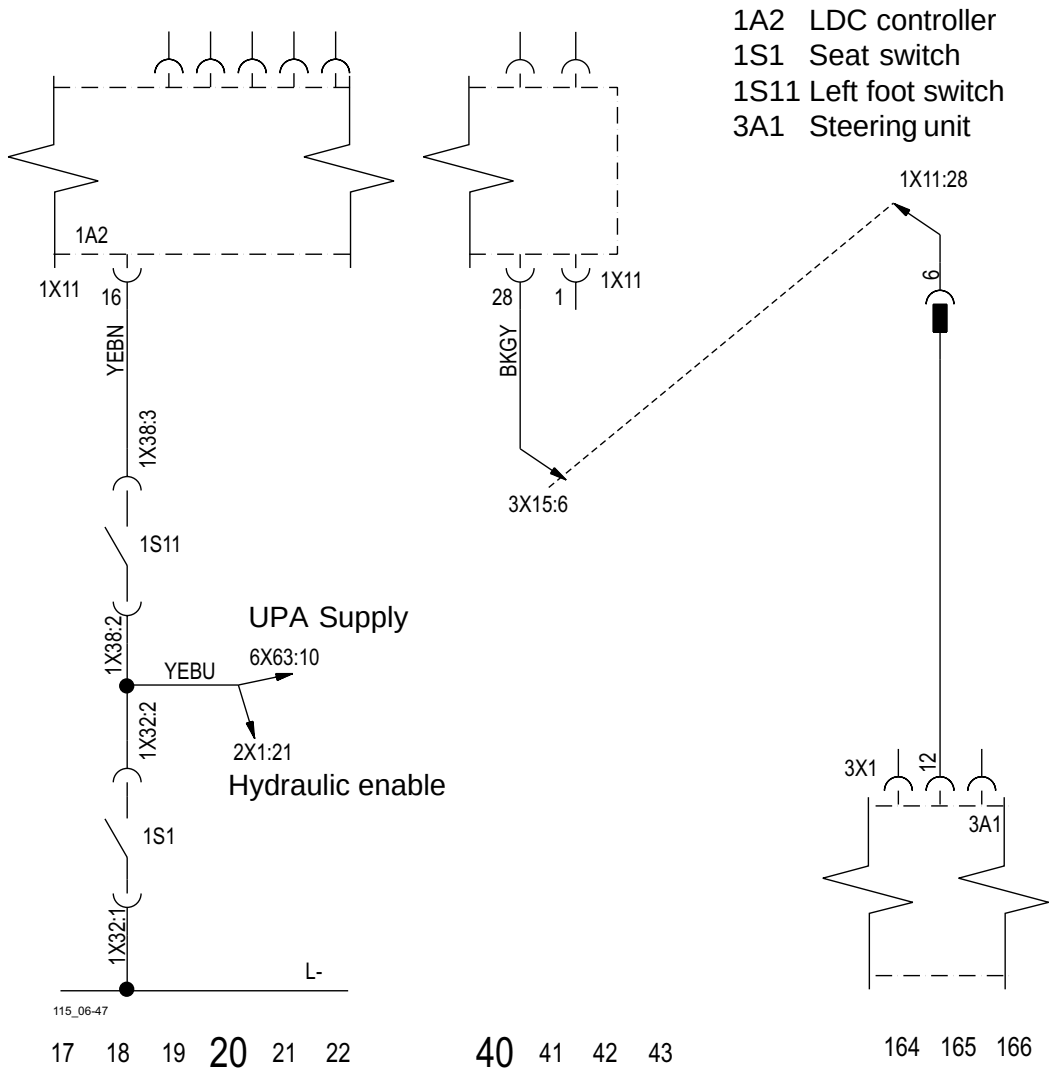
6.1.9 TRACTION ENABLE SIGNAL

Traction is only available when:- the seat switch is closed, the left foot switch (if fitted) is operated and the steering enable circuit is activated.

The operator MUST press the left foot switch (if fitted) continually if traction is required. The switch is fitted to stop the driver from operating the truck with his leg outside the protective cage of the truck.

☞ NOTE: Left foot switches are not fitted to trucks with twin pedal systems or trucks with cabs.

The steering system provides a separately wired enable signal to the traction controller.



OPERATION

With the seat switch 1S1 closed, LLC controller 2X1:21 and UPA supplies 6X63:10 are enabled. When the foot switch (if fitted) is operated (closed) a negative traction enable signal is present at 1X11:16. For traction enable, a signal from the steering unit 3A1 is also required, if the internal steering check confirms the system is fully operational, a negative traction enable signal is present at 1X11:28.

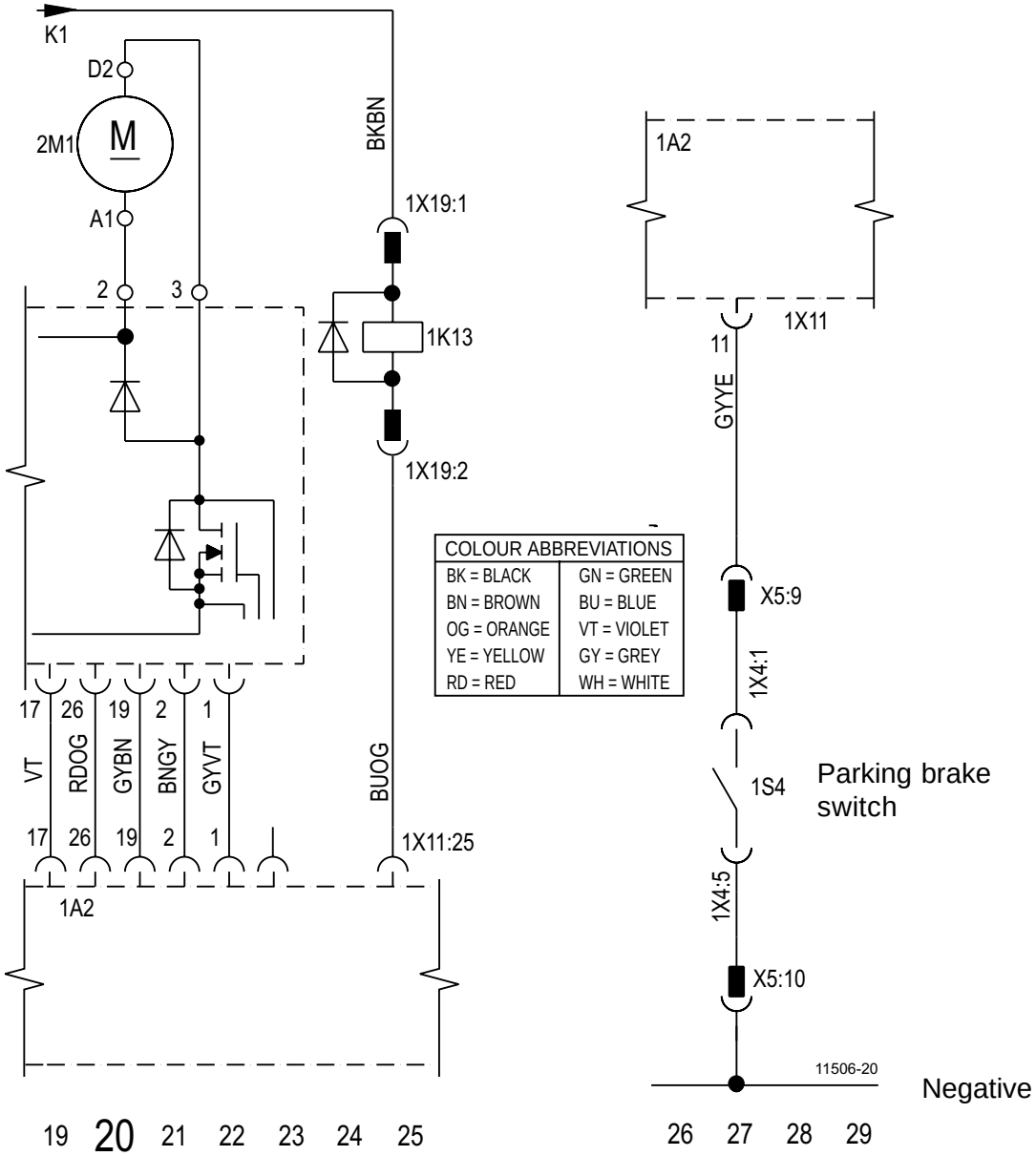
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6.1.10 PARKING BRAKE SWITCH 1S4

The parking brake is electrically controlled from the traction control module.

The parking brake can be released by a single press of the momentary parking brake release switch 1S4. The brake may then be applied by the driver by a further single press of the momentary switch.

1K13 is the braking solenoid which is fed positive from the key switch circuit/K1 line contactor, the negative switching circuit is supplied via the LDC controller connection 1X11:25. The parking brake switch 1S4 controls the braking function via a switched negative signal 1X11:11.



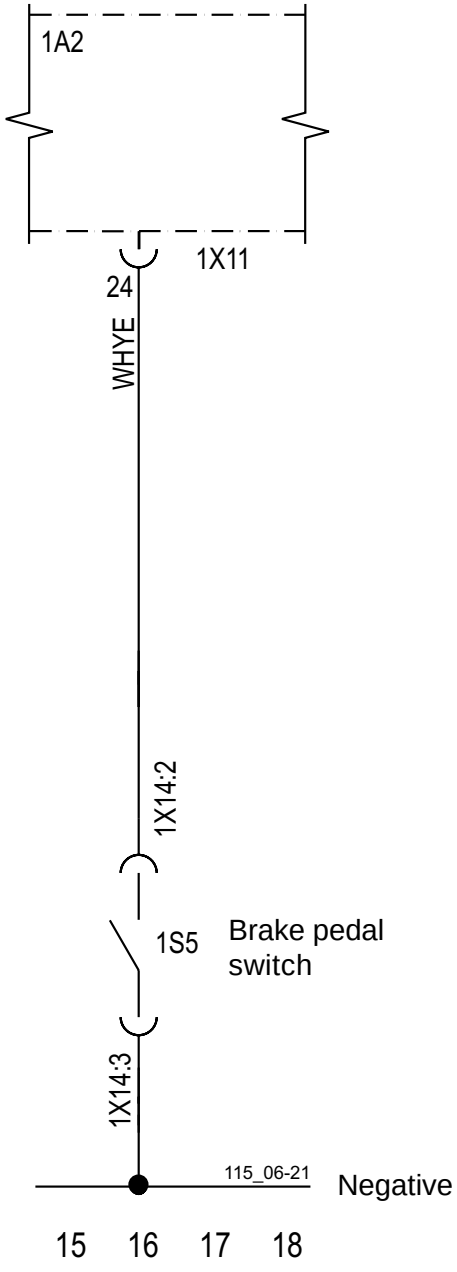
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6.1.11 BRAKE PEDAL SWITCH 1S5

This microswitch is located at the brake pedal, and is closed when the pedal is released. When the brake pedal is depressed the microswitch opens. The brake pedal signal is routed to the traction control module. It is used to select an increased fixed level of electric braking. It is also used in conjunction with the diagnostic equipment to program some aspects of the controller.

The operation of this switch can be checked in Window 4 of LDC diagnostic windows.

COLOUR ABBREVIATIONS	
BK = BLACK	GN = GREEN
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OG = ORANGE	VT = VIOLET
YE = YELLOW	GY = GREY
RD = RED	WH = WHITE

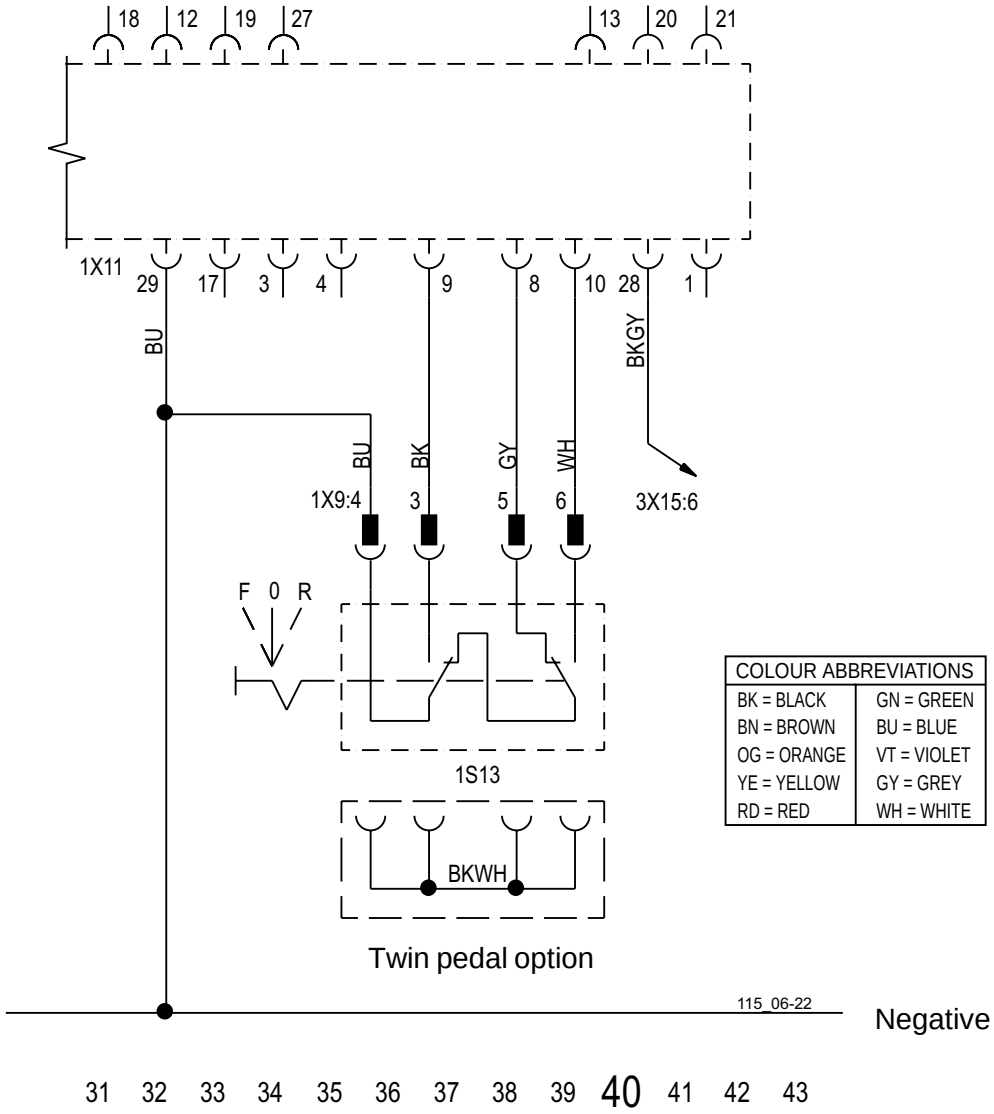


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6.1.12 DIRECTION OF TRAVEL SWITCH (1S13), SINGLE PEDAL OPERATION

This truck model is available with either an automotive configuration, with one accelerator pedal and a manually operated direction selection switch, or DUAL accelerator pedals situated either side of a centrally mounted brake pedal.

On trucks with DUAL accelerator pedals a link plug is fitted to the left foot switch connector 1X38 beneath the floor plate.



COLOUR ABBREVIATIONS	
BK = BLACK	GN = GREEN
BN = BROWN	BU = BLUE
OG = ORANGE	VT = VIOLET
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RD = RED	WH = WHITE

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6.1.13 POWER UNIT TEMPERATURE MONITORING

Silicon sensors, embedded within the power module, change their resistance according to temperature. The resistance of these sensors is monitored by the LDC controller. The controller will reduce output performance at high temperatures to allow the components to cool.
The temperature of the controllers is transmitted via CAN bus to the other controllers.

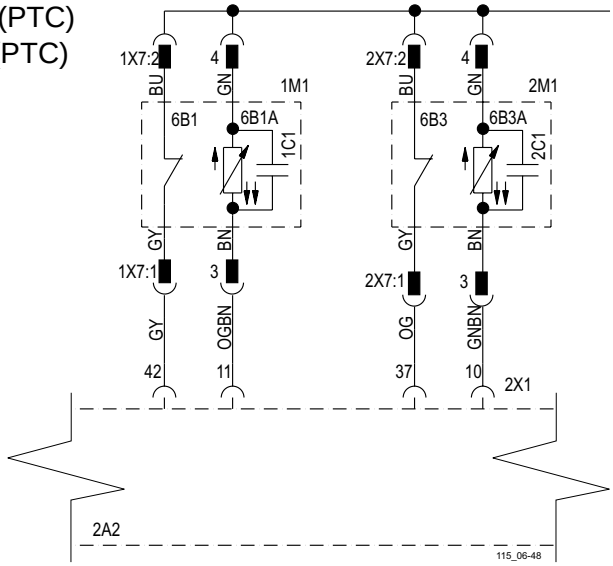
6.1.13.1 TRACTION & HYDRAULIC MOTORS TEMPERATURE SIGNAL

Silicon sensors attached to the brush assembly within the traction and hydraulic motors, change their resistance according to temperature. The resistance of these sensors is monitored by the LLC controller via CAN bus. The controller will operate cooling blowers or reduce motor performance as required to protect the components of the truck.

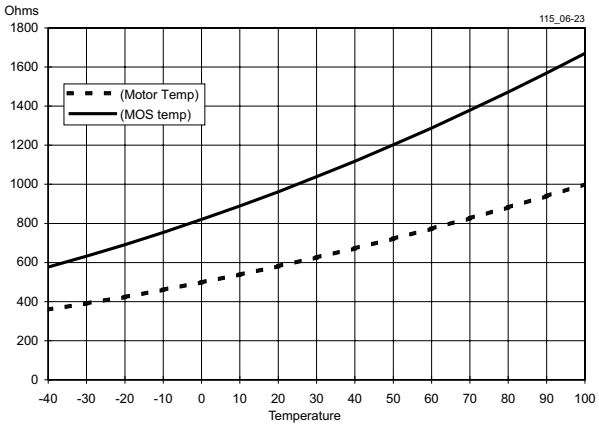
☞ NOTE: The traction motor temperature sensor & brake wear unit is connected to the LLC controller 2A2.

6B1A Traction motor temperature sensor (PTC)
6B3A Pump motor temperature sensor (PTC)
2A2 LLC controller

PTC = Positive temperature coefficient



119 120 121 122 123 124 125 126 127 128 129 130

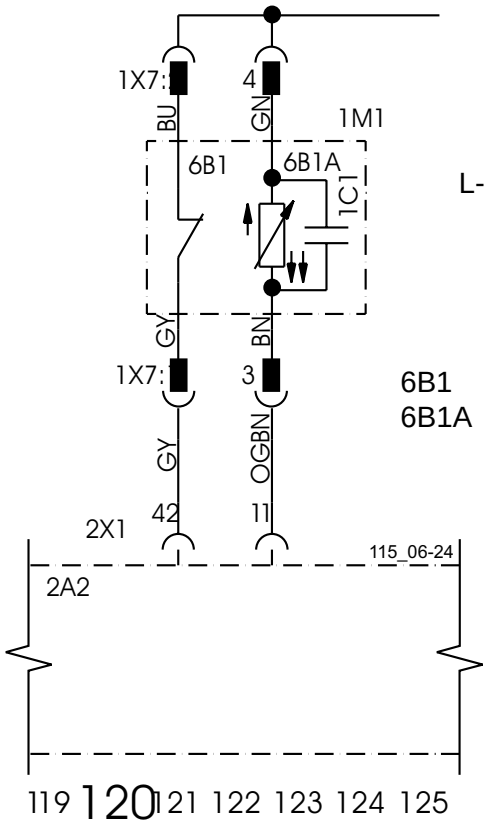


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6.1.14 BRUSH WEAR SWITCH

Switch 6B1 normally closed, will open if the brushes are worn, illuminating a warning light on the driver's display. Temperature sensor 6B1A sends via CAN bus information to the display module which in turn controls traction motor cooling fan operation.

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BK = BLACK	GN = GREEN
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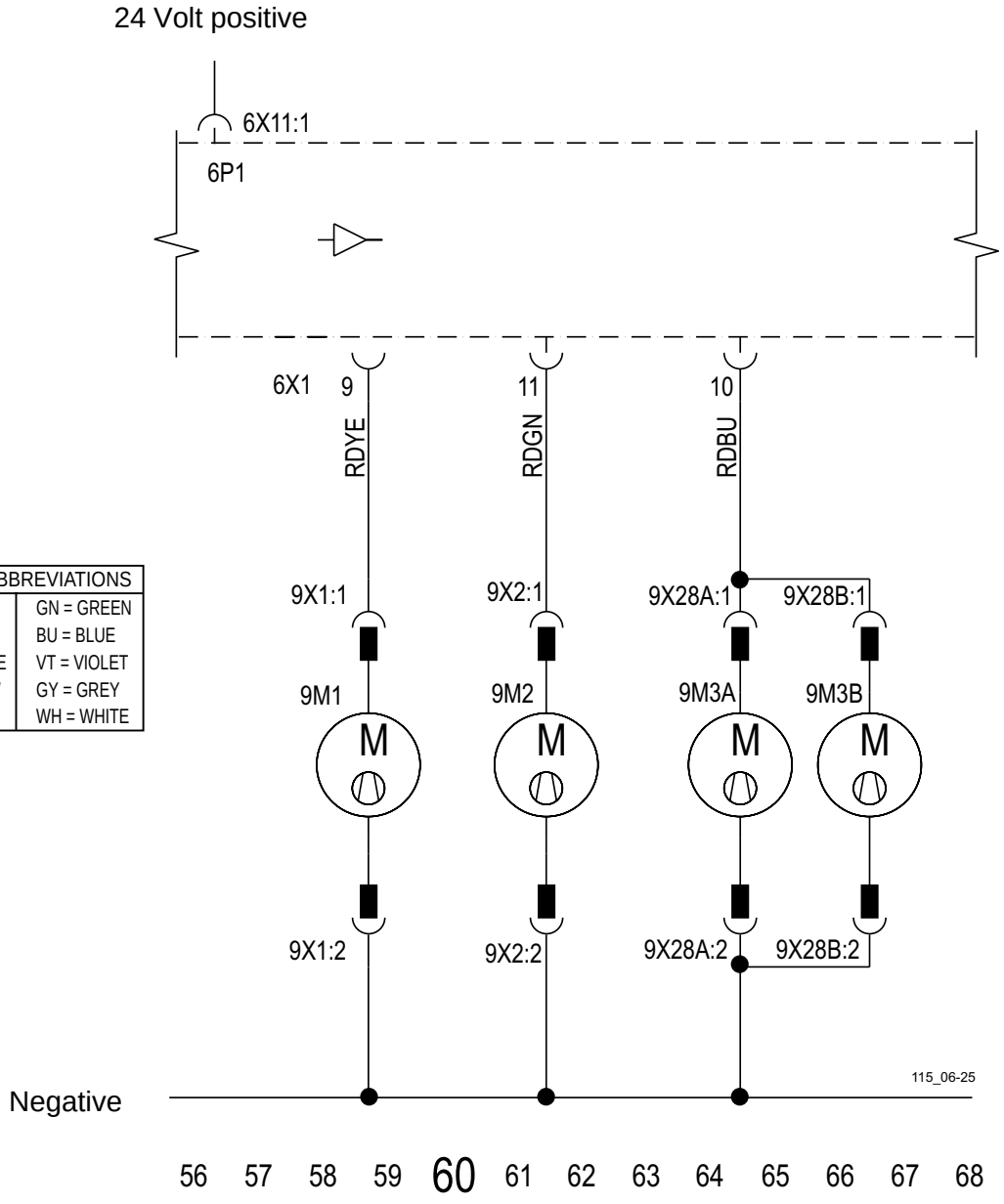
6B1 Brushwear
6B1A Temperature sensor (PTC)

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6.1.15 COOLING SYSTEM

24 volt DC brushless blowers, all with long life bearings are used for cooling the drive motors and electrical controller. One 18 watt radial blower 9M2 cools the traction motor, one high performance axial blower 9M1 cool the drive controllers and two axial blowers 9M3A & B cool the hydraulic pump motor.

9M1 Heatsink cooling
9M2 Traction motor cooling
9M3 Hydraulic motor cooling



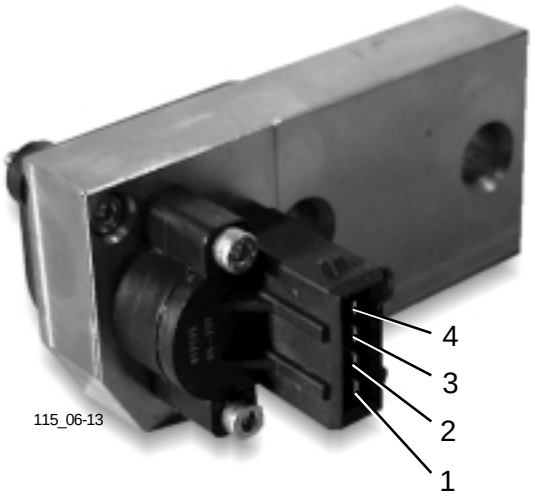
COLOUR ABBREVIATIONS	
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BN = BROWN	BU = BLUE
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Fans 9M1 (Control unit cooling fan), 9M2 (Traction motor cooling fan), and 9M3a & b (pump motor cooling fans) operate individually at 100% speed when the power unit / motor temperature of the item to be cooled reaches 40°C.

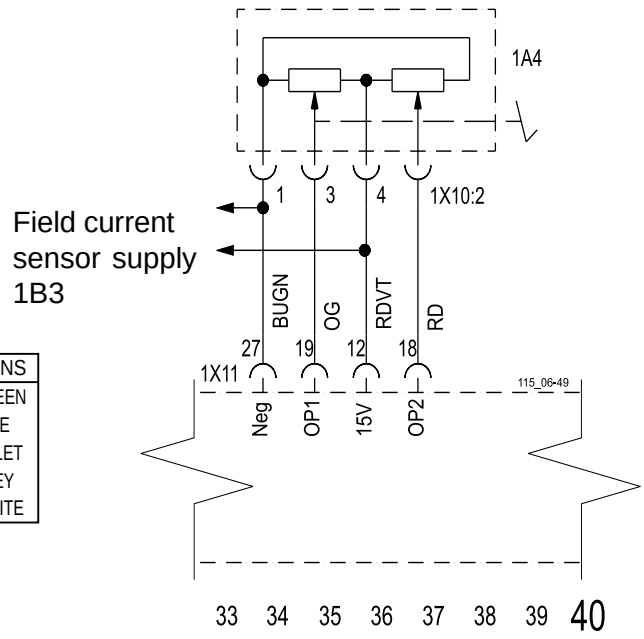
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6.1.16 ACCELERATOR

The accelerator has two internal potentiometers, a guide potentiometer and a monitoring potentiometer. The two potentiometers are supplied with 15 volts, but with opposite polarity. This has the effect that the mathematically added output signal to the processor must always be 15 volts between the two wipers OP1 and OP2 . If there is a fault in the accelerator potentiometers or in the supply voltage (i.e. a break in the cable) the signal between the two wiper points changes and the LDC controller recognises a fault. The output voltage on wiper OP2 of the guide potentiometer controls the direction of the rotation and speed of the drive motors. The output voltage on wiper OP1 of the monitoring potentiometer serves as a checking signal to confirm the guide potentiometer is functioning correctly.



Pin	Colour	Duty
1	BUGN	Accelerator negative
2	RD	Potentiometer OP2
3	OG	Potentiometer OP1
4	RDVT	Accelerator +15 volt supply.



COLOUR ABBREVIATIONS	
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6.1.16.1 ACCELERATOR ELECTROMECHANICAL CHARACTERISTICS

	SINGLE PEDAL	DUAL PEDAL FORWARD	DUAL PEDAL REVERSE
Maximum demand	11.25v	11.25v	3.75v
Maximum permissable overtravel	13.5v	13.5v	1.5v

Voltages exceeding the overtravel limit will result in an error being detected by the LDC module.

The stabilised supply to the accelerator is 15v

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6.1.16.2 ACCELERATOR CALIBRATION AND SETTING UP

☞ NOTE: In order to adjust the accelerator, a laptop PC with the relevant software and CAN bus connection must be used.

- Raise and securely block the drive wheel.

- Turn on truck and run diagnostic program.

- With accelerator pedal(s) in neutral select Window 8 of the LDC controller.

- With the hand brake applied, depress the foot brake. Diagnostic should indicate OK (if pot voltage within 0.9v of mid point).

- Press ENTER, centre position is now calibrated.

- Release Foot brake pedal.

- Press forward pedal fully. Adjust pedal stop screw stop so that “u1c” in diagnostic window is 11.5 - 11.6. Lock pedal stop screw in position with lock nut.

- Press reverse pedal fully. Adjust pedal stop screw stop so that “u1c” in diagnostic window is 3.4 - 3.5v. Lock pedal stop screw in position with lock nut.

- Calibration is complete.

In order to achieve correct traction operation the accelerator pedal stops must be set and operating voltages measured using the Diagnostic equipment.

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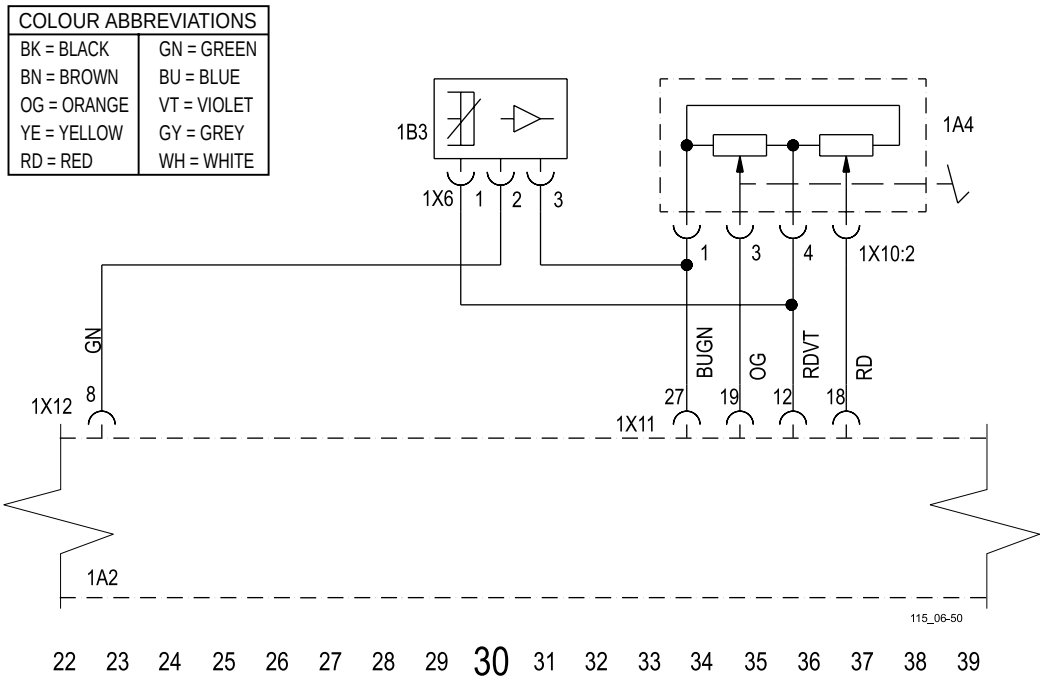
6.1.17 DIRECTION OF TRAVEL SWITCH (1S13), SINGLE PEDAL OPERATION

This model can be fitted with either single or dual accelerator pedals.

With the single pedal configuration a separate left foot switch is positioned on the floor plate, which must remain depressed at all times for traction to be available. This is to ensure that the operator is dissuaded from driving with the left foot outside the boundary of the truck. Traction is not available if the left foot switch is not operated.
On trucks with DUAL accelerator pedals, a link plug is fitted to the left foot switch connector 1X38 beneath the floor plate.

6.1.18 TRACTION MOTOR SPEED CONTROL

The speed of the traction motor is regulated by controlling the armature voltage and field current. To allow accurate control of the field and hence motor speed, a remote current sensor is mounted adjacent to the power module and monitors the drive motor field current.



The current sensor is powered from the traction stabilised 15 volt supply. The output from the current sensor will be half of this supply voltage when no field current is flowing. This output voltage will rise or fall, depending on the travel direction selected, by 1.25V for each 10 amps of field current.

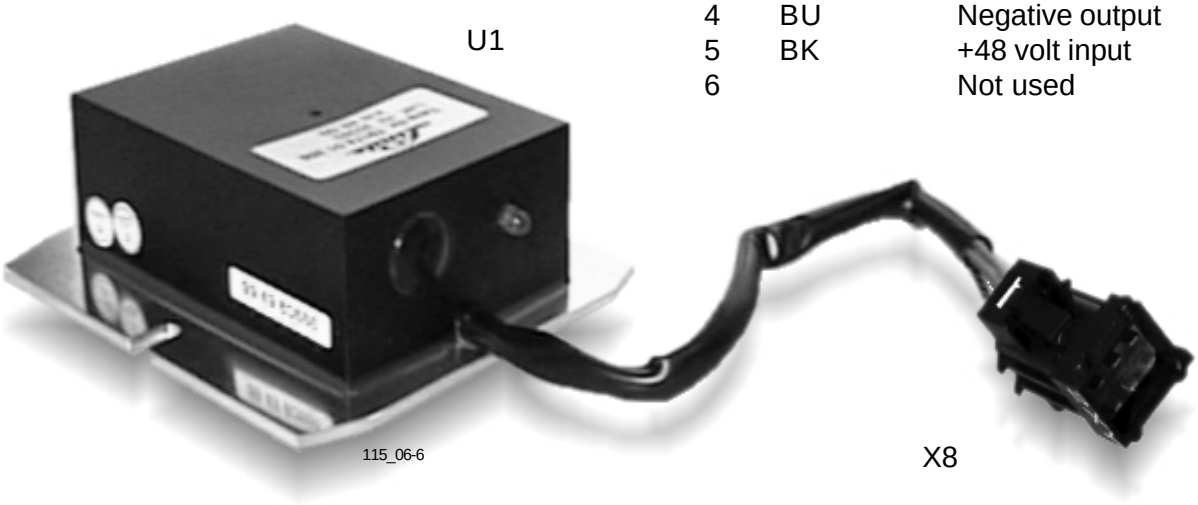
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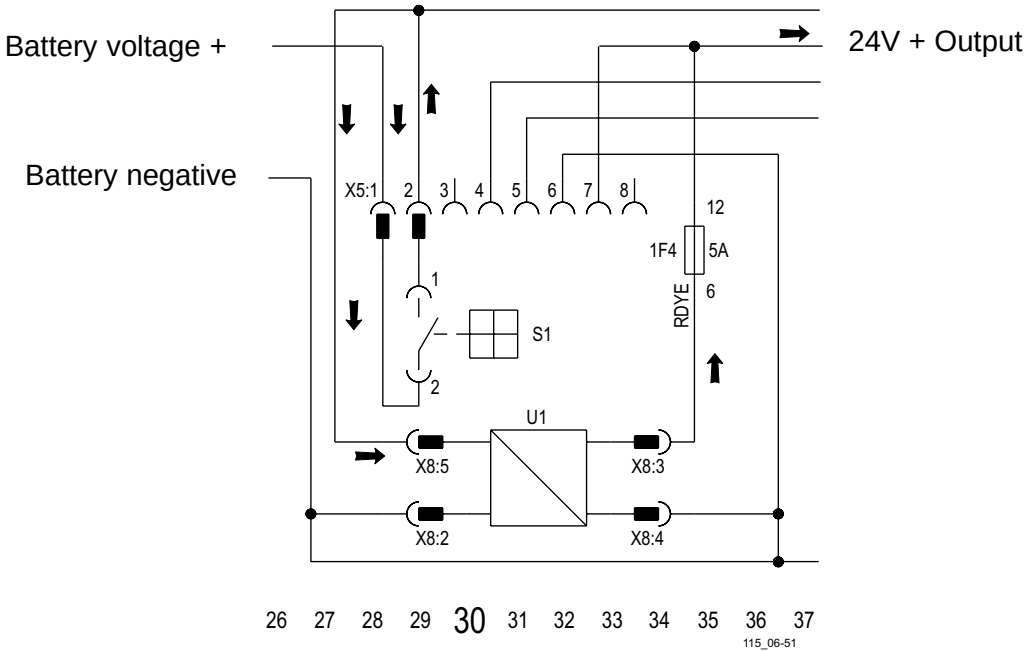
6.1.19 POWER SUPPLY

A DC-DC converter provides a stabilised 24 volt supply, which is used to power the control electronics for traction, hydraulic and steering, as well as the trucks cooling fans. The converter has an 75 watt output capability.

CONNECTOR X8

Pin	Colour	Duty
1		Not used
2	BU	Battery negative input
3	RDYE	+24 V output
4	BU	Negative output
5	BK	+48 volt input
6		Not used





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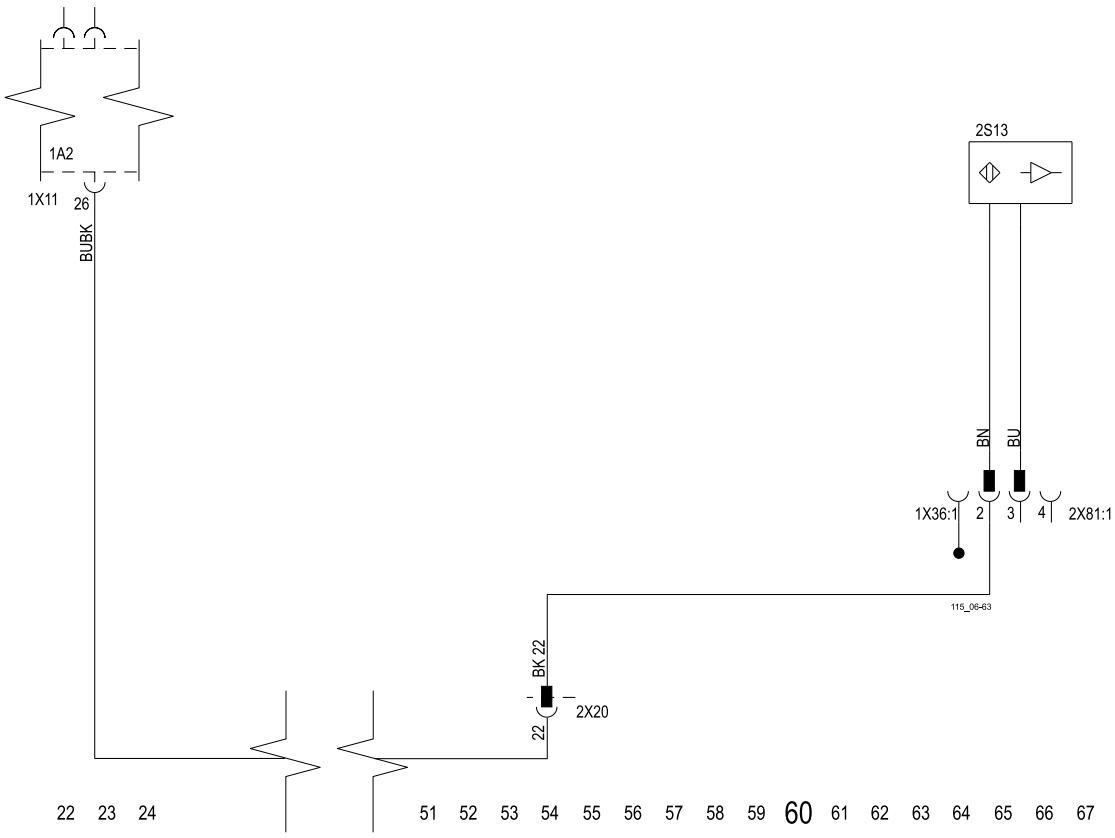
6.1.20 SWITCH CONTROLLED SPEED REDUCTION & HEIGHT SENSOR 8.5M

Traction control module pin 1X11:26 (BUBK) is associated with speed reduction. When this pin is connected to negative, normal maximum speed can be achieved. When this pin is open circuit, traction performance will be limited to a much reduced speed. Pin 1X11:26 is routed through the reach carriage via 2X20:22 and the reach carriage cable to the base of mast connector 8X30:7 and via the back of mast cable to a connector at the top of the fixed mast 1X36. On trucks with lift heights above 8.5 metres, a switch 2S13 is fitted which opens when the forks are raised above 8.5 metres. This causes traction performance to be reduced.

☞ NOTE: If the mast is lowered whilst driving and the switch closes, normal traction speed will not be restored until the accelerator pedal is released and reapplied.

This reduced speed can be adjusted in LDC controller Window 7 (Vred)

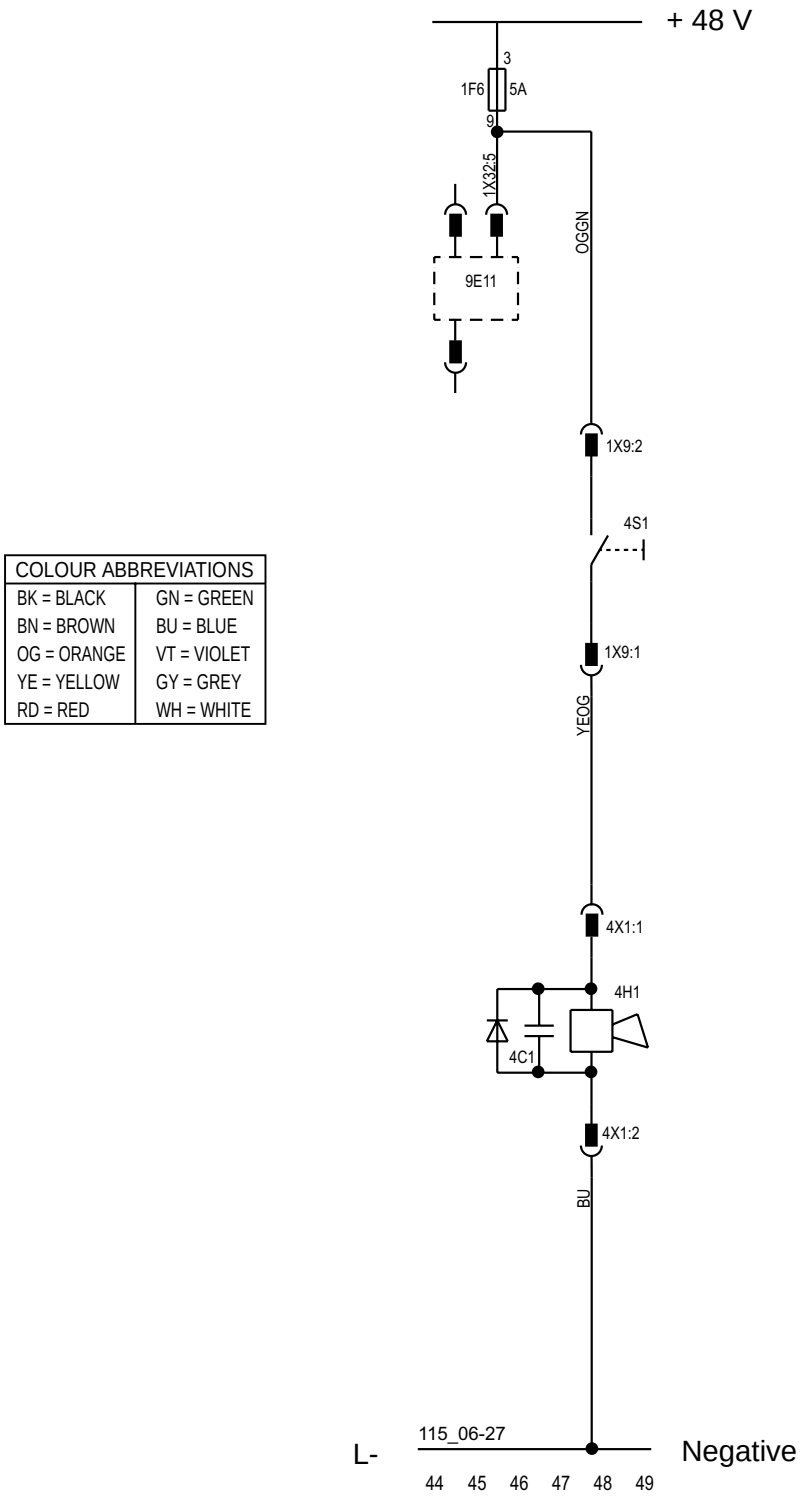
On trucks with lift heights not exceeding 8.5 metres the mast height switch is replaced by a wire link at the top of fixed mast connector 1X36.



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6.1.21 HORN OPERATION

The horn circuit is powered direct from the emergency isolator 1S2. The horn push 4S1 is located next to the joysticks. Pressing 4S1 provides +48v to the hom 4H1 via fuse 1F6.



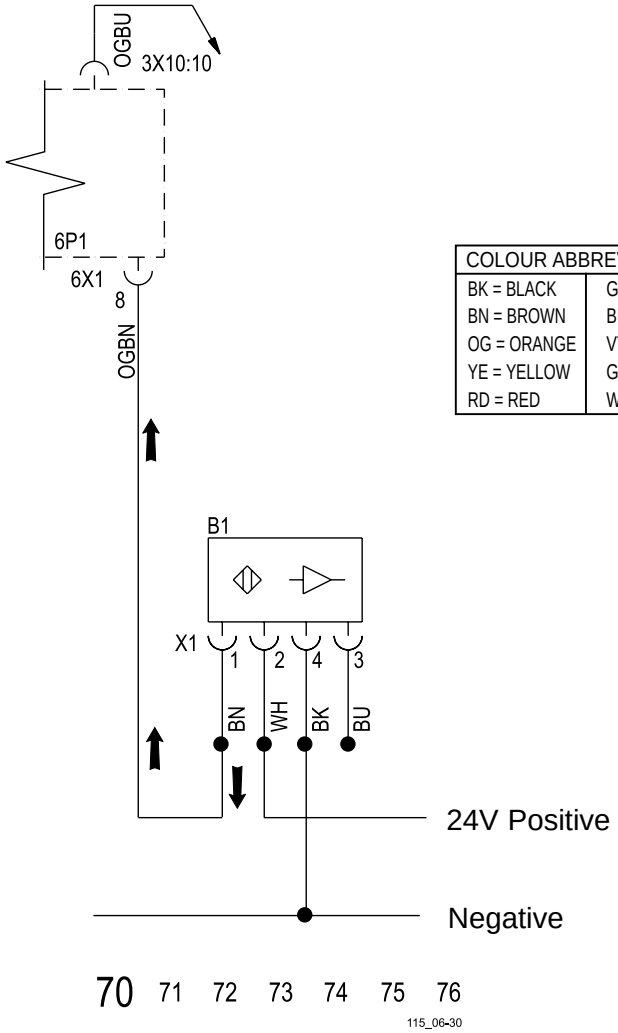
COLOUR ABBREVIATIONS	
BK = BLACK	GN = GREEN
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OG = ORANGE	VT = VIOLET
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RD = RED	WH = WHITE

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6.1.22 BATTERY LOCK SENSOR

A battery lock sensor B1 is fitted to ensure the battery box is securely locked in position. If the battery is not locked in position, the battery unlocked warning light is illuminated on the driver's display.

The battery lock sensor B1 is powered by a 24V supply from the DC/DC converter. A negative switch output signal is sent to the display via 6X1:8.



COLOUR ABBREVIATIONS	
BK = BLACK	GN = GREEN
BN = BROWN	BU = BLUE
OG = ORANGE	VT = VIOLET
YE = YELLOW	GY = GREY
RD = RED	WH = WHITE

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6.2 LOAD CONTROL (LLC)

CAUTION: It is imperative, that before working on the control system, that the battery is disconnected, and the steering capacitor voltage is discharged.
The steering capacitor voltage can be safely discharged by operating the horn with the battery plug DISCONNECTED. Check that the voltage between 3F1 and the main negative is less than 5V before working on the truck.
Failure to carry out this procedure can lead to damage of the CAN interface drivers. Components MUST NOT be removed or replaced with the truck live.

The 115 control valve uses a technique know as 'fly by wire' where all control of the valve is achieved using electrical signals - there are no mechanical linkages as in previous systems.

The LLC controlled valve, located at the base of the mast, controls all hydraulic functions.

6.2.1 LLC SAFETY FEATURES

The controller has a dual input control system. There are two independent microprocessors that read the inputs, and only if both inputs are equal, will an output be generated. This guarantees, that if there is a fault in the LLC controller, no output will be generated. A safety relay inside the controller can also interrupt the power supply to the valves.

The main processor (uC1) is responsible for the control of all functions - taking inputs and driving the outputs to the pump and valves. The second "safety" processor (uC2) has no control responsibility but takes the same inputs and in addition monitors and checks the outputs of uC1. It sends it's interpretation of these signals to uC1 where they are compared, checked and any actions taken. The outputs from the controller are also interlocked by uC2 (independent of uC1's action). If uC2 detects any errors in the output circuitry it will disable the appropriate function(s).

6.2.2 LLC FAULT DETECTION

Extensive diagnostic checks are used to provide quick fault diagnostics. Over 95 different error codes inform of faults either in external sensors, valves, wiring or internal module components.

When a fault exists, the minimum amount of functions will be shut down in order to keep the truck working safely. For example an error on a joystick will results in that function being disabled but all others operating normally. Lower is maintained whenever possible and only in situations where safety is compromised, will the entire hydraulic system be shut down.

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6.2.3 PUMP CONTROL

In order to achieve accurate hydraulic control, the joystick input and hydraulic pump speed are monitored constantly.

The pump speed is monitored by an inductive sensor 2B8 - generating a square wave of varying frequency (0-800Hz for 0-3500rpm). The signal is compared with the required rpm in the controller and the drive to the pump motor modified accordingly.

This method is used for lift and reach control and results in much improved "feel" of the joystick.

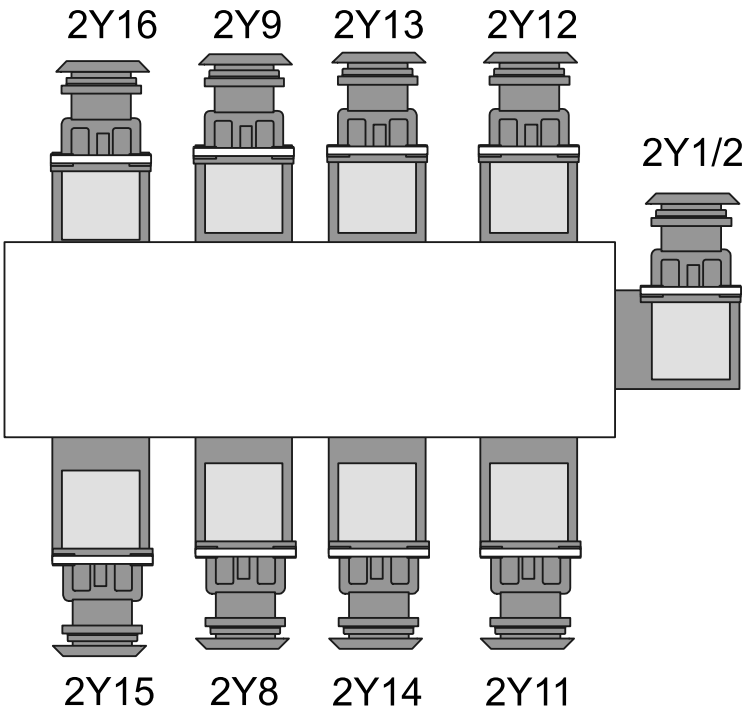
6.2.4 VALVE CONTROL

The valve currents of the main truck functions (lift, lower, reach tilt and sideshift) are monitored and used for a variety of purposes. Firstly the current is used to detects faults in the valve circuits. Short circuits and open circuits of the valve coils are detected as well as module output circuit faults.

Secondly for the proportional valves (lower and reach), the measured current is used in controlling the current in the valve and hence valve opening. The controller continuously maintains the required current and fixed ripple current in the valve. Ripple current is required to overcome hysteresis effects of the valve spool.

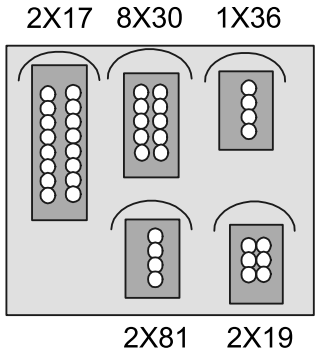
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6.2.5 VALVE BLOCK



VALVE BLOCK CONNECTIONS

Connector	Function
2Y1/2	Lift/lower
2Y8	Reach out
2Y9	Reach back
2Y11	Tilt forward
2Y12	Tilt back
2Y13	Sideshift left
2Y14	Sideshift right
2Y15	Auxiliary valve 1
2Y16	Auxiliary valve 2



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Connector	Function
1X36	4 way 8.5m reference sensor
2X17	16 way valve block
2X19	6 way auxillary 2 UPA hydraulic
2X81	4 way lift stop/slow sensor
8X30	10 way mast cable

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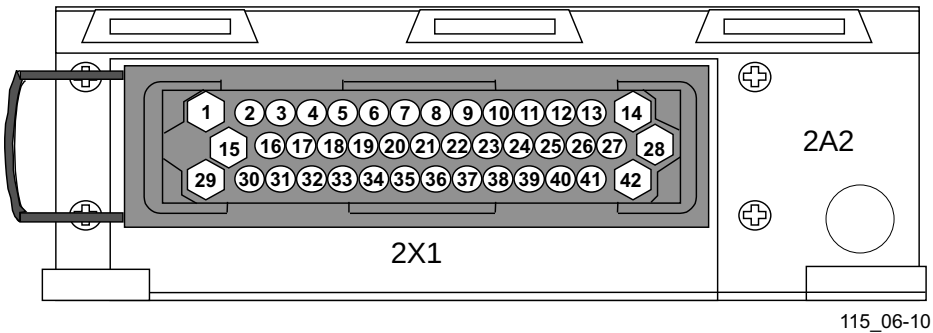
6.2.6 LLC CONTROL

6.2.6.1 CONTROL CIRCUIT

All hydraulic functions have their oil flow directed by an electrically controlled valve block mounted at the base of the mast. Proportional valves are used for controlling the oil flow during lowering and reaching. All other valves are ON/OFF and the function speed is achieved by accurate control of the pump motor speed using the motor RPM sensor 2B8.

The hydraulic system is controlled by the LLC controller, which employs two microprocessors; One is used for precise control of the valves and pump speed whilst the other constantly monitors inputs, outputs so that should an error occurs it is instantly recognised and the system safely shut down. Also for safety, all control joysticks have duplicate complimentary signals which independently input to the digital control module: again, errors are instantly recognised and action taken.





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6.2.6.2 2X1 PIN DESIGNATIONS

Pin	Colour	Duty
1	BK	Battery positive from key switch.
2	WHBU	Valve driver, Tilt forward. 2Y11
3	BUOG	Valve driver, Tilt back. 2Y12
4	VTBN	Valve driver, Side shift right. 2Y14
5	BNBU	Valve driver, Side shift left. 2Y13
6	BUGN	Valve driver, Auxillary 2. 2Y16
7	VT	UPA input - Routed to 6X63:7
8	YEBU	Control lever / Joystick 3 signal for function X2. Auxillary
9	RDWH	Control lever / Joystick 3 signal for function Y1. Auxillary
10	GNBU	Pump motor temperature sensor.
11	OGBN	Traction motor temperature sensor.
12	BN	+15V supply to control levers.
13	BKRD	+24V supply to LLC
14	BUWH	Valve driver, open collector. UPA rotate.
15	GYOG	Positive supply to solenoid valves via safety relay within LLC.
16	OGGN	Valve driver, Reach out. 2Y8
17	GYVT	Valve driver, Reach back. 2Y9
18	OGGN	Control lever / Joystick 3 signal for function X1. Auxillary
19	YEGN	Control lever / Joystick 3 signal for function Y2. Auxillary
20	BUYE	Valve driver, Auxillary 1. 2X15
21	YEBU	Seat switch input. Closed to neg to enable
22	BKOG	Reach out sensor. 2B18
23	OGWH	Lift STOP input. Linked to negative to enable lift.
24	RDGN	Control lever / Joystick 2 signal for function X1 Sideshift
25	RDVT	Control lever / Joystick 2 signal for function X2 Sideshift
26	RDBU	Control lever / Joystick 2 signal for function Y2 tilt
27	BKGY	Negative supply to lift control levers.
28	OGBU	Valve driver, UPA clamp..
29	BU	Battery negative supply to LLC
30	GNBN	Valve driver, Lift 2Y1
31	GYBN	Valve driver, Lower 2Y2
32	RDOG	Control lever / Joystick 1 signal for function Y2 Lift
33	YEVT	Control lever / Joystick 1 signal for function X2 Reach
34	VTWH	CAN HI
35	VTRD	CAN LO
36	OGBK	Speed sensor 2B8 pump motor
37	OG	Hydraulic motor brushwear detection. Closed to neg when OK
38	YEVT	Reach back sensor. 2B21
39	RDBN	Control lever / Joystick 1 signal for function Y1 Lift
40	BNWH	Control lever / Joystick 1 signal for function X1 Reach
41	RDYE	Control lever / Joystick 2 signal for function Y1 Tilt.
42	GY	Traction motor 1M1 brushwear. Closed to neg. if OK.

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6.2.7 HYDRAULIC CIRCUIT MOSFET ON

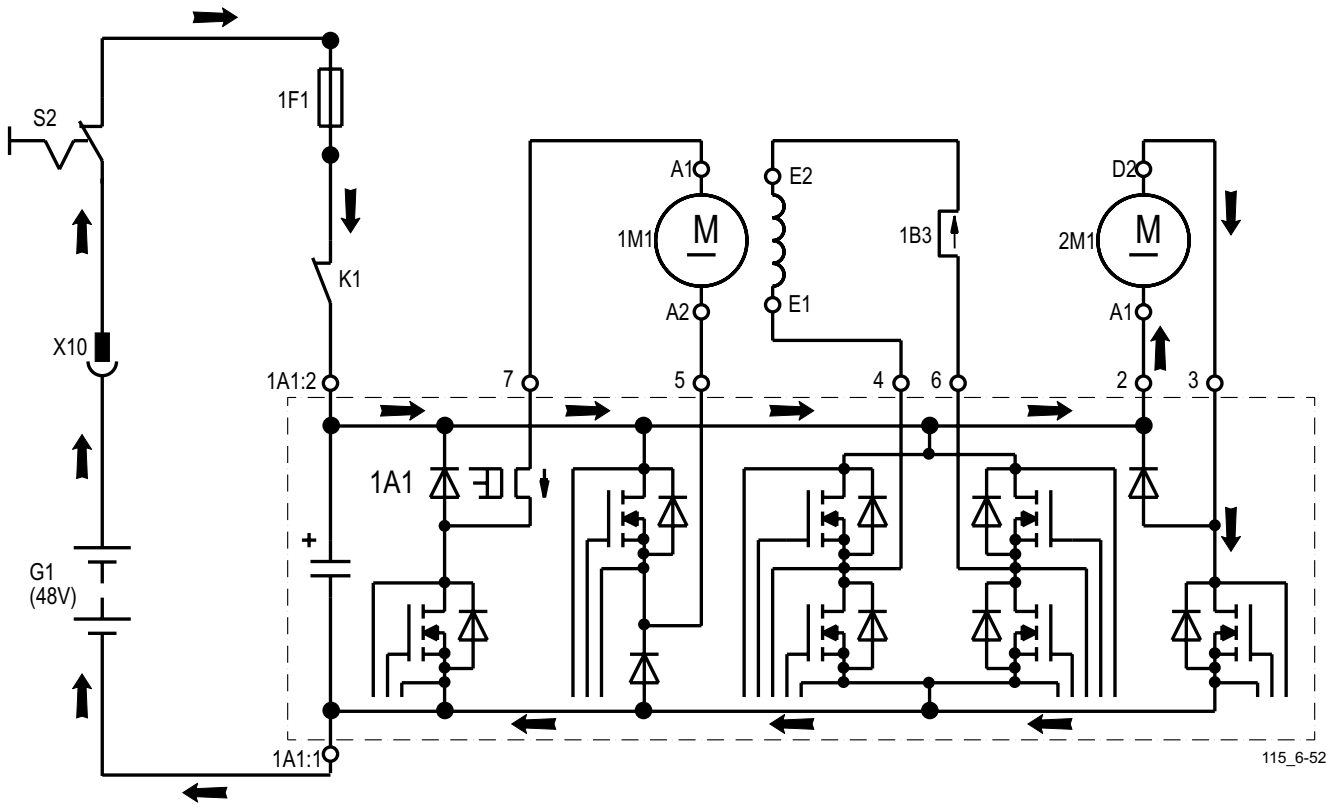
Hydraulic lever operated

MOSFET switched on

Battery providing motor current

With battery isolator and truck interlocks made, K1 closed and a hydraulic joystick lever moved (except in mast lower direction), the power MOSFET in 1A1 will be switched on and off at high speed. The ratio of On to Off time will determine the speed of the hydraulic pump motor.

The power module includes freewheel diodes which conduct current when the MOSFET is in a non conducting state, and an analogue temperature sensor, that progressively reduces power to the motor should the temperature exceed 90°C.



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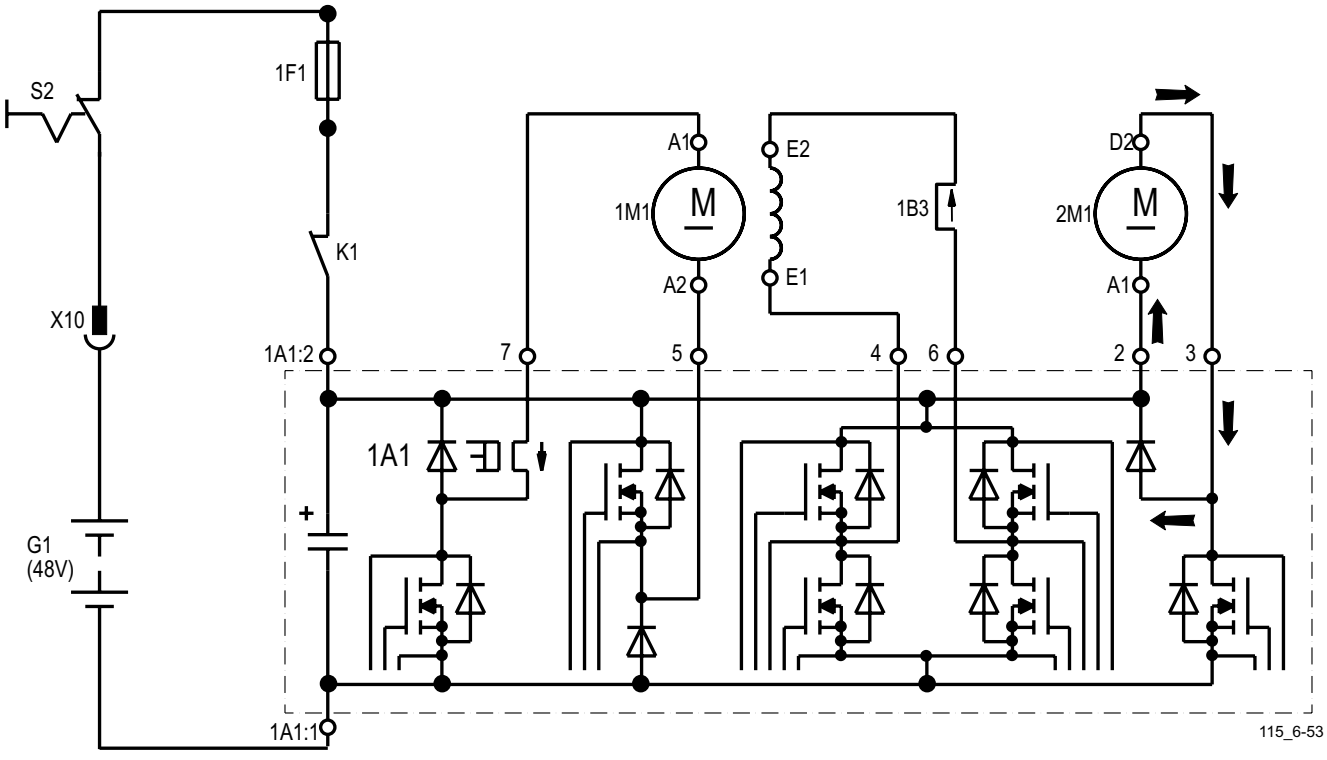
6.2.7.1 HYDRAULIC CIRCUIT MOSFET OFF (FREEWHEEL CIRCUIT)

Hydraulic lever operated

MOSFET switched off

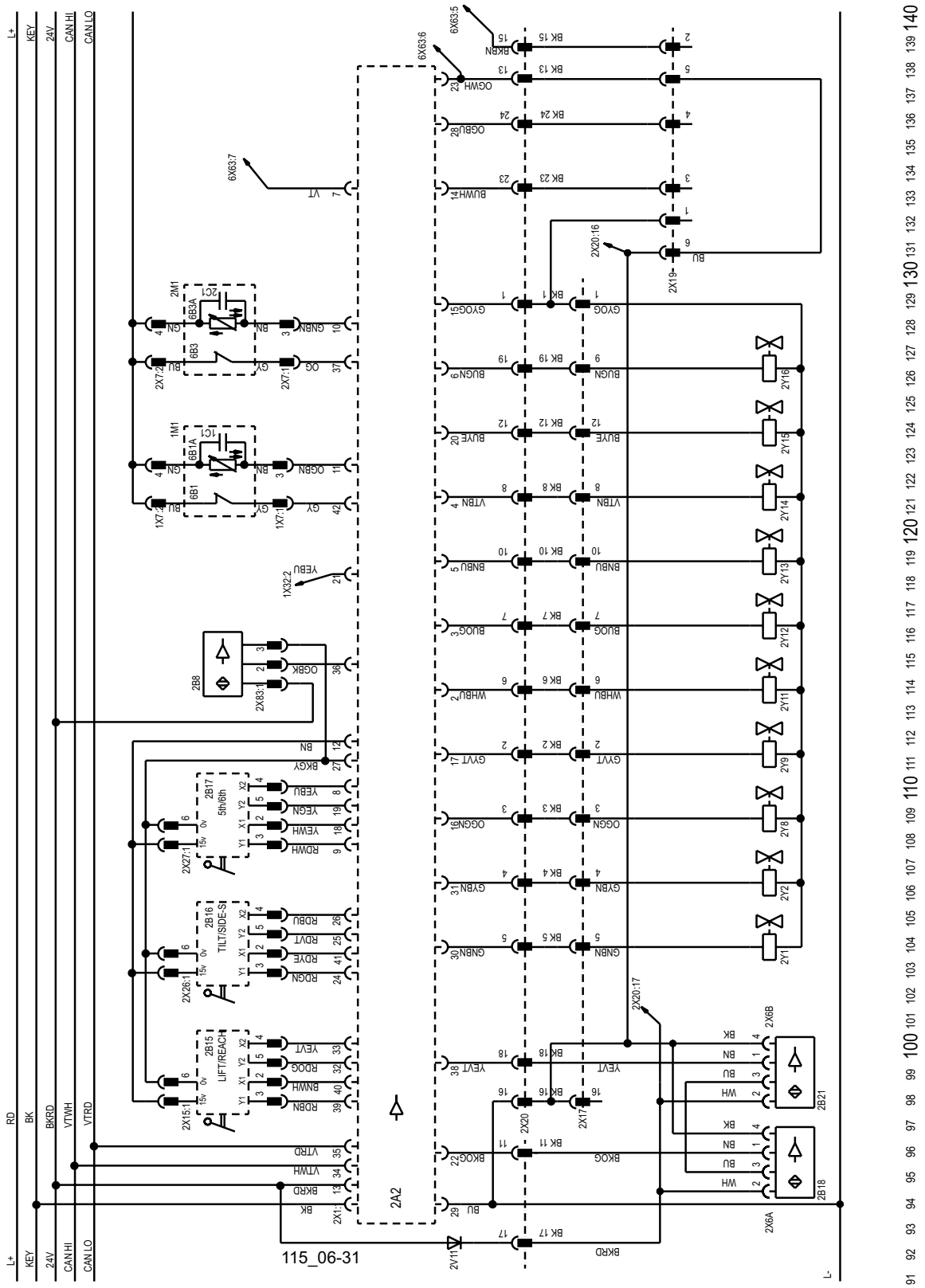
Established motor current freewheeling through diode

Every time the motor current is switched off, collapsing magnetic field in the motor can induce high voltages. These are 'freewheeled' through the motor circuit by a diode on the power unit 1A1, to protect other circuits.



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6.2.7.2 HYDRAULIC ELECTRICAL CIRCUIT



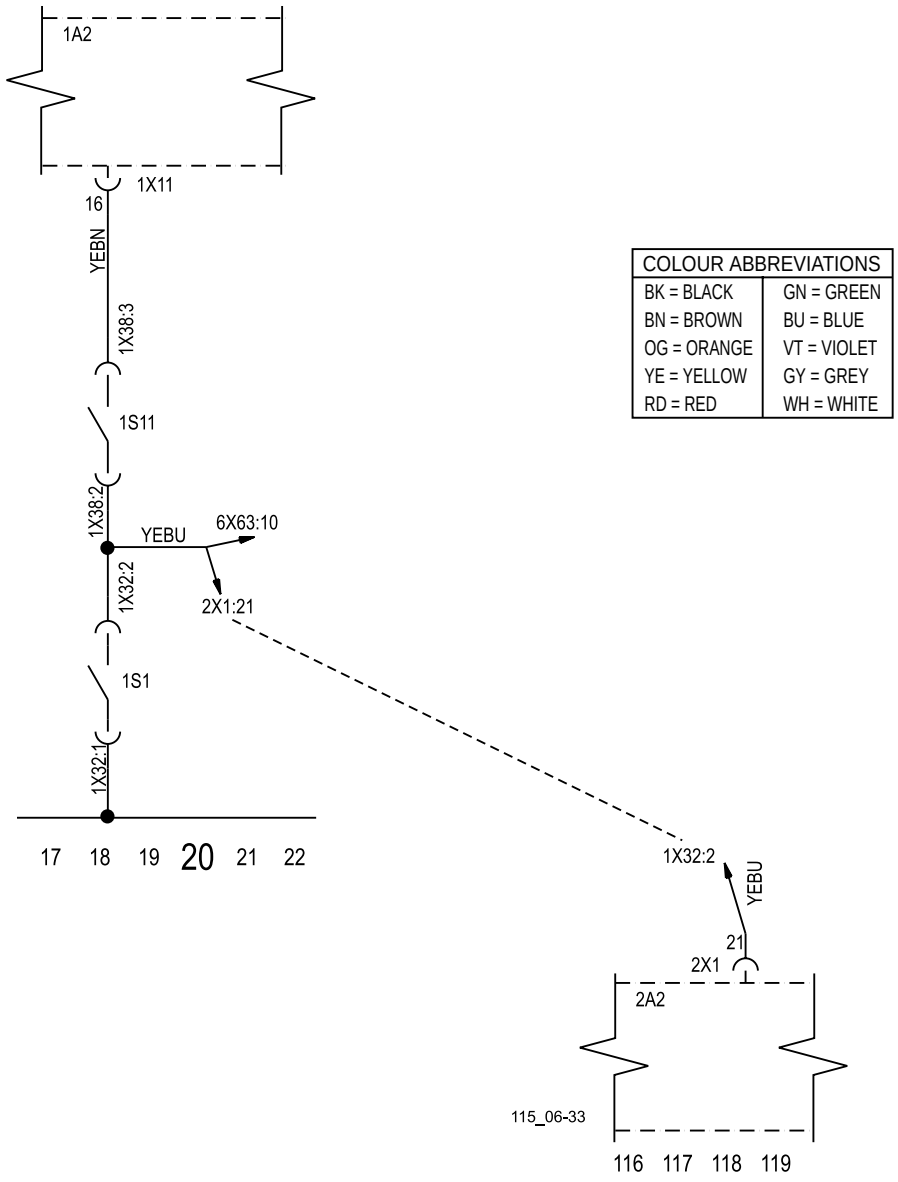
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6.2.8 HYDRAULIC ENABLE SIGNAL

Hydraulic functions are inhibited until the truck key switch S1 is turned ON and the seat switch 1S1 is closed.

6.2.8.1 HYDRAULIC RELEASE SIGNAL

The release signal at 2X1:21is controlled by the seat switch 1S1. The operation of the working hydraulics is only active when the seat switch is closed. The signal can be confirmed within window 4 of the LLC Diagnostic Window.



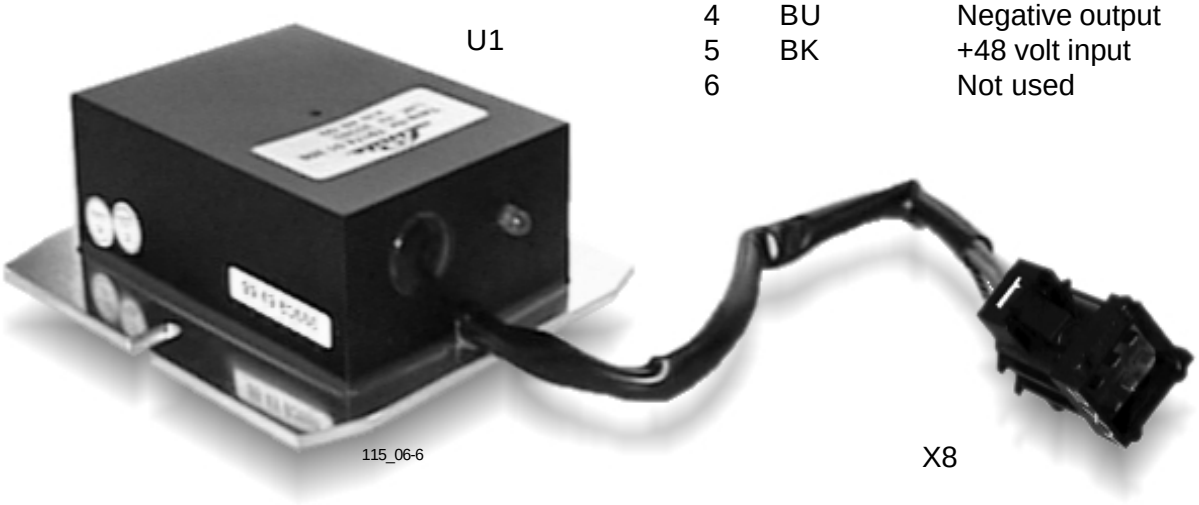
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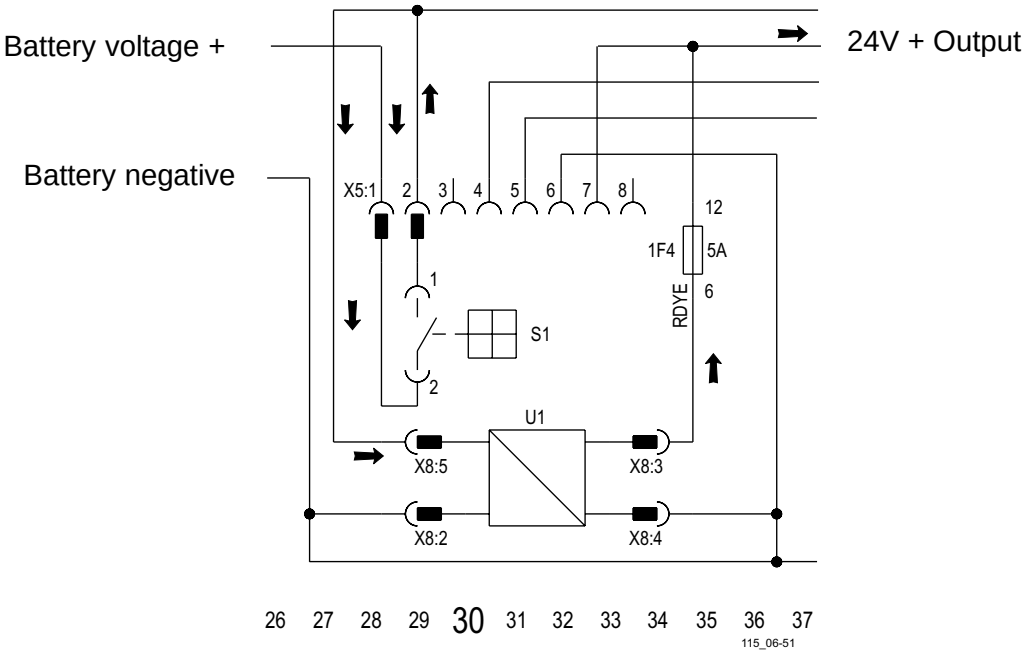
6.2.9 HYDRAULIC POWER SUPPLY

A DC-DC converter provides a stabilised 24 volt supply, which is used to power the control electronics for traction, hydraulic and steering, as well as the trucks cooling fans. The converter has an 75 watt output capability.

CONNECTOR X8

Pin	Colour	Duty
1		Not used
2	BU	Battery negative input
3	RDYE	+24 V output
4	BU	Negative output
5	BK	+48 volt input
6		Not used





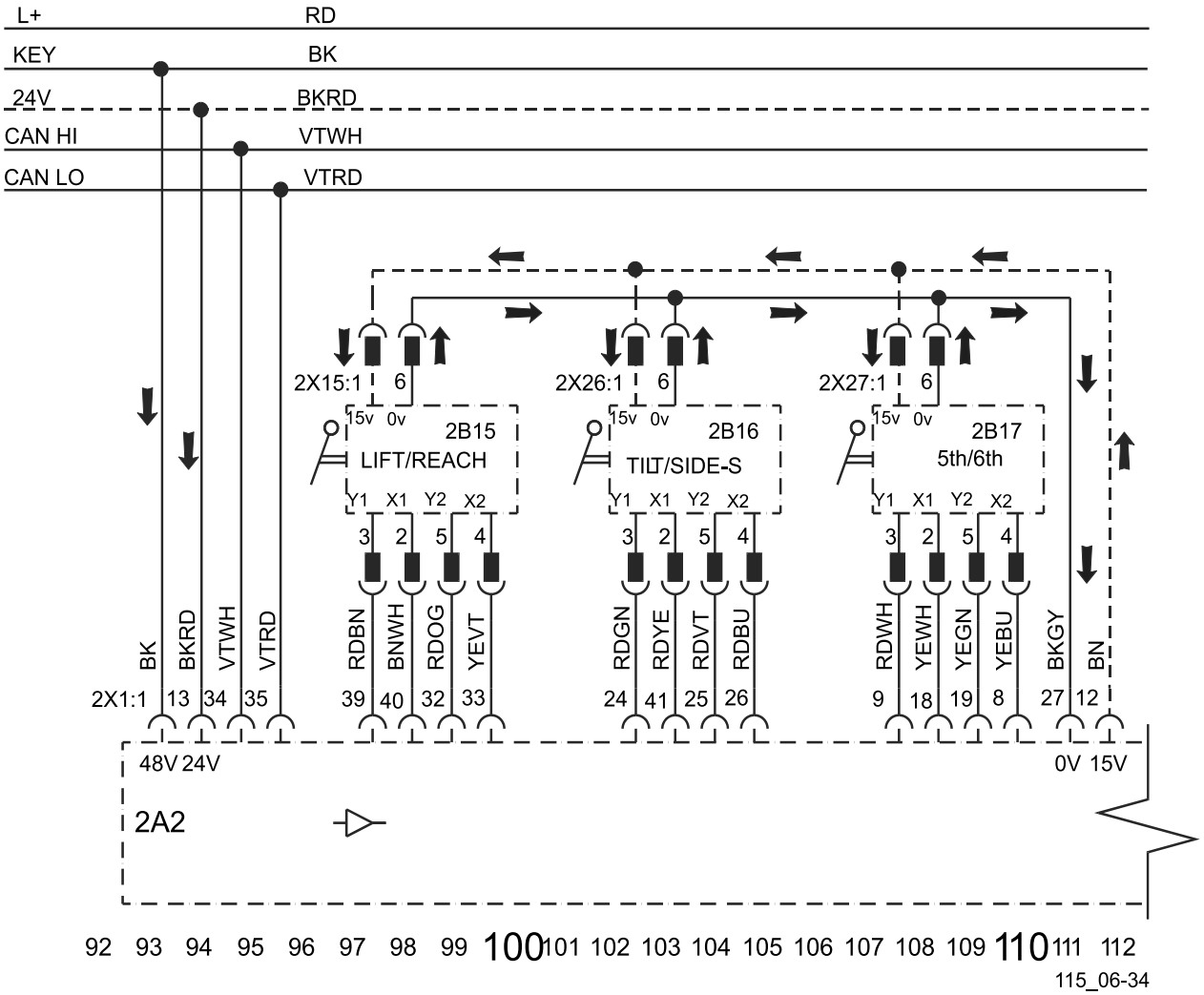
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6.2.10 HYDRAULIC CONTROL CIRCUIT

6.2.10.1 LLC VOLTAGE SUPPLY

The voltage supply for the LLC controller is provided via the converter U1. The output voltage of 24 volts from the converter is applied via the fuse 1F2 to the connection 2X1:13 of 2A2 the LLC controller. In addition, the LLC controller is supplied with the battery voltage via connection 2X1:1 of 2A1 on the LLC controller.

As soon as the voltage is present, a stabilised supply voltage of 15 volts is generated by the LLC controller which supplies the hydraulic control joysticks. The battery voltage and the stabilised voltage can be checked in window 6 of the LLC Diagnostic Software.



115_06-34

COLOUR ABBREVIATIONS	
BK = BLACK	GN = GREEN
BN = BROWN	BU = BLUE
OG = ORANGE	VT = VIOLET
YE = YELLOW	GY = GREY
RD = RED	WH = WHITE

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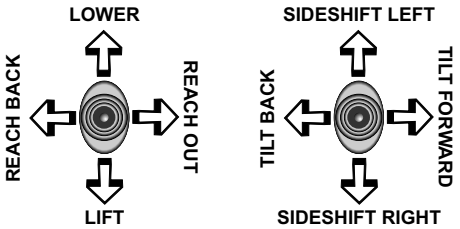
6.2.11 JOYSTICKS

In standard form two dual axis joystick levers provide precise control of lift/lower, reach out/back, tilt forward/back and side shift. The left joystick being for lift and reach functions. When additional hydraulic functions are required, third or fourth single axis joysticks can be fitted.

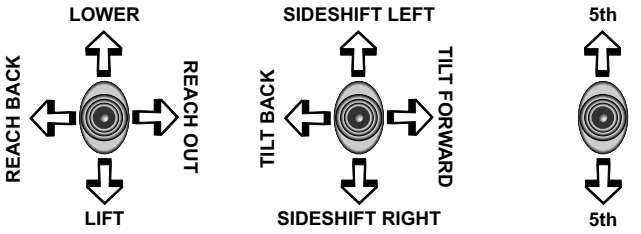
Both single axis and dual axis joysticks are available and many lever configurations are possible. Up to 4 single axis joysticks can be mounted. For special clamp applications the single axis joystick is available with a mechanical interlock which requires the lever to be depressed to enable lever control movement to be carried out.

Dual axis joystick

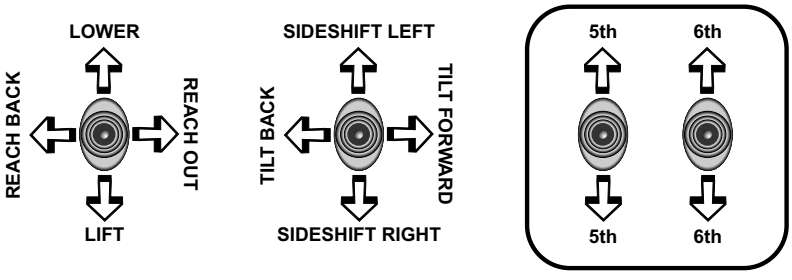
Standard



Plus 5th

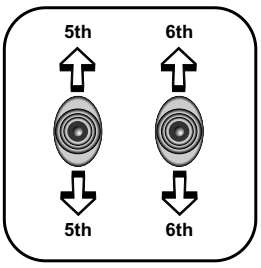


Plus 5th & 6th



115_06-35

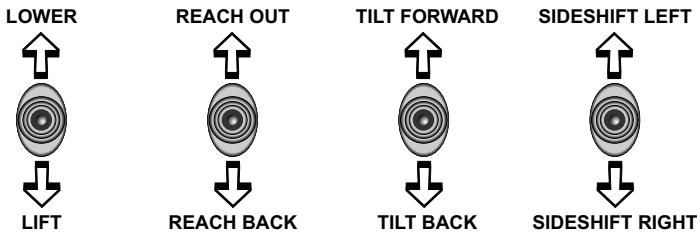
Joysticks shown in a box (right) are mounted in a separate enclosure on the truck as there is insufficient space in the normal joystick area.



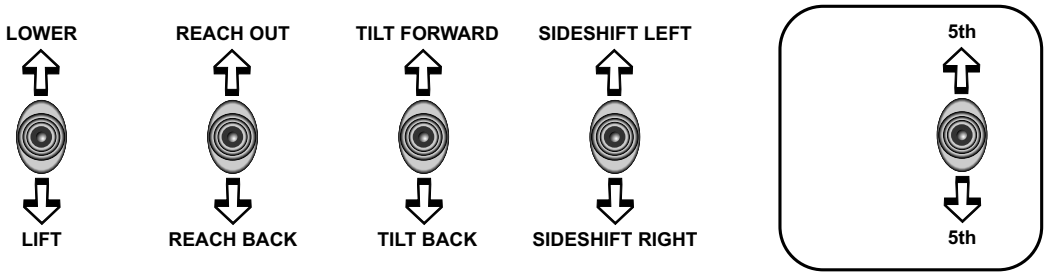
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Single axis joystick

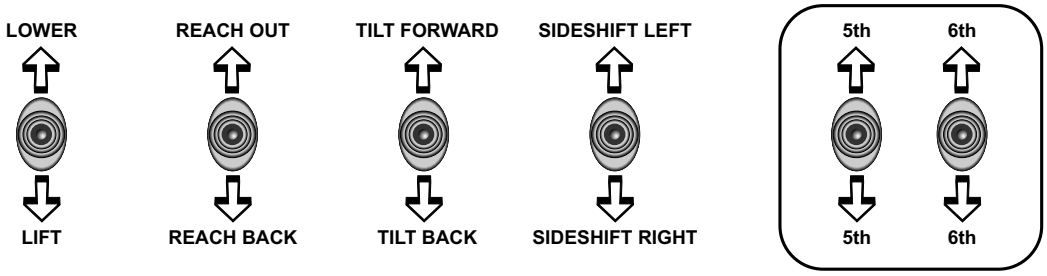
Standard



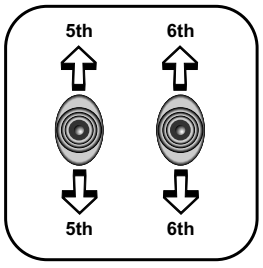
Plus 5th



Plus 5th & 6th

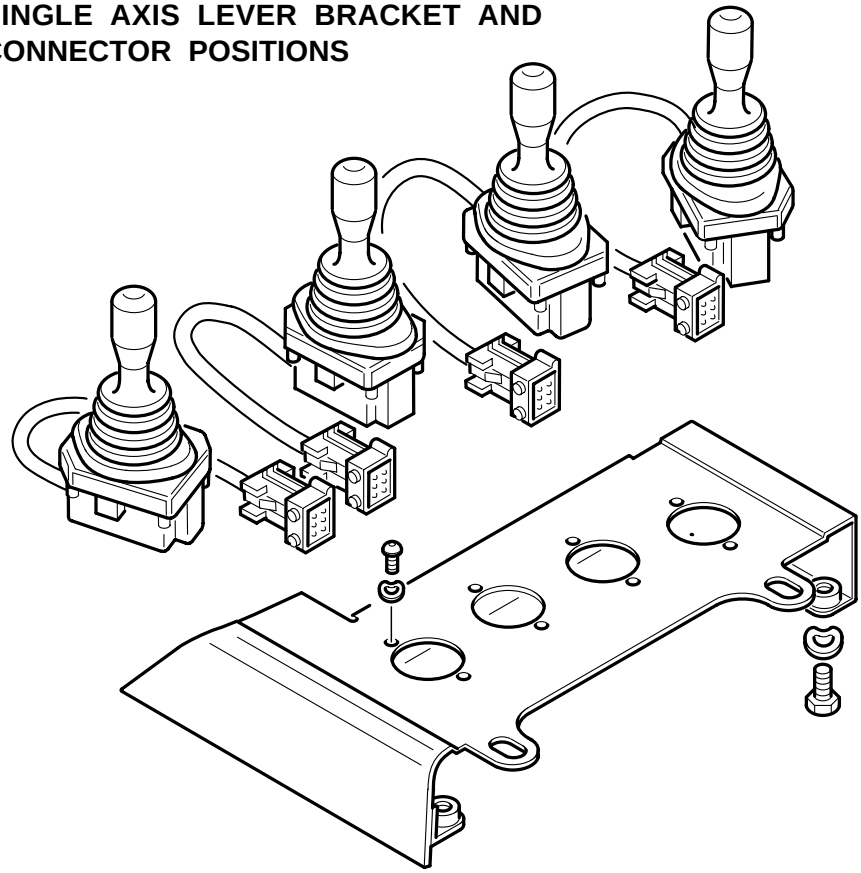


Joysticks shown in a box (right) are mounted in a separate enclosure on the truck as there is insufficient space in the normal joystick area.

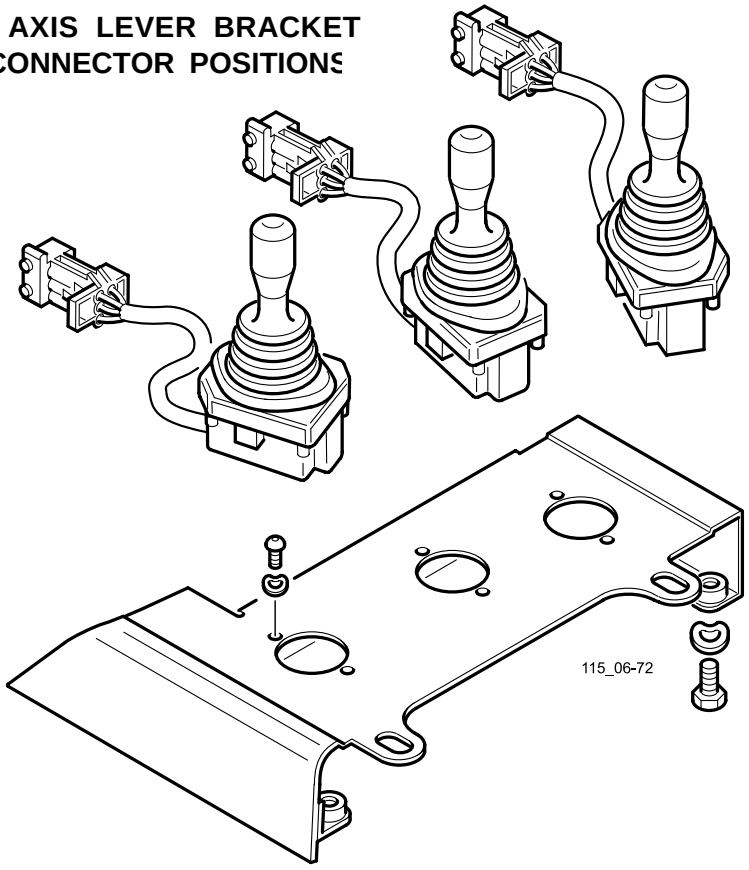


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6.2.11.1 SINGLE AXIS LEVER BRACKET AND CONNECTOR POSITIONS



6.2.11.2 DUAL AXIS LEVER BRACKET AND CONNECTOR POSITIONS



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6.2.11.3 JOYSTICK

In the standard form two hydraulic joysticks are fitted to control the hydraulic functions on the 115. Integrated into the two joysticks are four potentiometers. Two guide potentiometers and two monitoring potentiometers. One guide potentiometer and one monitoring potentiometer are mechanically connected to the X axis, and the other two potentiometers are connected to the Y axis. Both potentiometers are supplied with +15volts, although with opposing polarity . The two slider output voltages are added together inside the control unit (2A2) . Irrespective of the potentiometer setting, a combined output voltage of 15 volts must measured. If the value is not achieved ,due to a cable break for example, an error message appears and the hydraulic function concerned turned off.

Connector
2X15 = Lift /Reach Lever.
2X26 = Tilt/Side Shift lever.
2X27 = 5th /6th Hydraulics. (Auxiliary 1 and 2)

Plug Allocation 2X15, 2X26, 2X27

:1 Supply voltage 15 volts positive.
:2 Signal guide potentiometer ,X-axis.
:3 Signal guide potentiometer, Y-axis.
:4 signal monitoring potentiometer, X-axis
:5 Signal monitoring potentiometer, Y axis
:6 Battery Negative.


115_06-12

No adjustment is possible in the joystick circuit, as the alignment of the system is carried out in the control unit. Calibration of the joysticks can be carried out within window 8 of the **LLC Diagnostic software.**

☞ NOTE: When a new joystick is fitted ,it must be calibrated using window (window 8 and 81 **of the LLC Diagnostic Software.)**

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6.2.12 JOYSTICK OPERATION LIFT / LOWER

6.2.12.1 LIFT / LOWER OPERATION

One axis of the combined joystick provides lift/lower control. Note Two single axis joysticks can replace the single two axis joystick as an option.

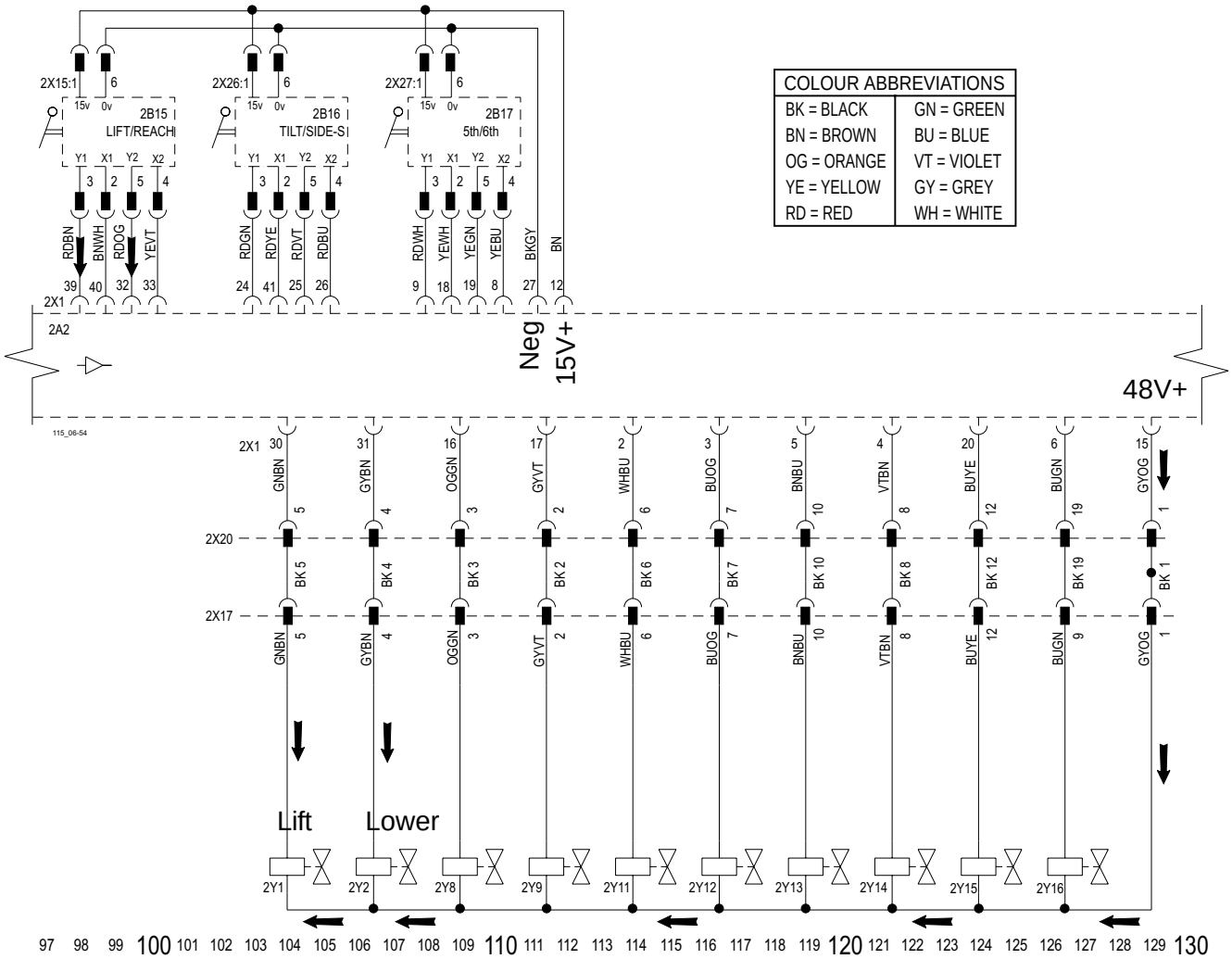
6.2.12.2 LIFT

The potentiometer variable to 2X1:39 is duplicated and inverted at 2X1:32, as a confirmed safety signal. As the potentiometer is moved in the lift direction, the single acting lift solenoid valve 2Y1 is opened via a negative signal from 2X1:30, the pump motor speed increases progressively as the lever is moved further.

6.2.12.3 LOWER

As the lever is moved in the lower direction, the proportional valve 2Y2 is opened progressively with a variable current negative from 2X1:31, to allow the control of oil flow from the lift jack back to tank.

Operation of the valves and joysticks can be checked in window 61 of the LLC diagnostic system



COLOUR ABBREVIATIONS	
BK = BLACK	GN = GREEN
BN = BROWN	BU = BLUE
OG = ORANGE	VT = VIOLET
YE = YELLOW	GY = GREY
RD = RED	WH = WHITE

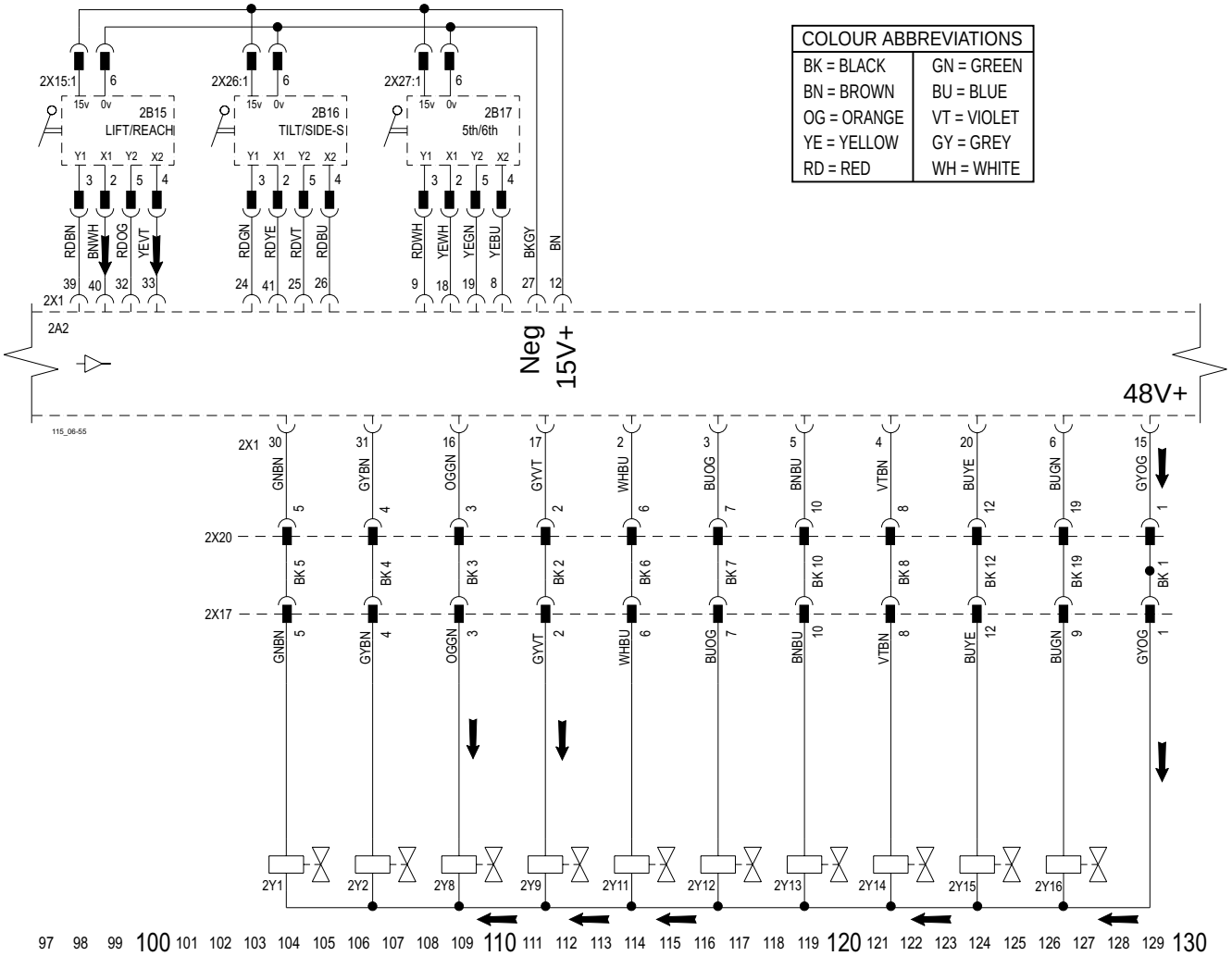
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6.2.12.4 JOYSTICK OPERATION REACH OUT/REACH BACK

Controlled by the second axis on the lift joystick assembly, movement of the reach potentiometer in either direction, inputs the variable voltage at 2X1:40 and 2X1:33. This controls either the reach out proportional valve 2Y8 or the reach back proportional valve 2Y9, with a variable negative from 2X1:16 or 2X1:17 respectively. Reach slowdown is controlled by two sensors 2B18 (reach out slowdown) and 2B21 (reach back slowdown). The sensors are activated by a rail which runs down the reach frame. When the sensors are triggered, the hydraulic pump motor power is reduced slowing reach operation. A short time later the respective function valve is closed.

The proportional valves are supplied with +48 volts via a safety relay inside the hydraulic control module 2A2 at connector 2XI:15. The current-controlled proportional valves are activated with a pulsating direct current of up to 320 mA. The greater the activation current, the greater the opening angle of the proportional valve.

Operation of the valves and joysticks can be checked in window 62 of the LLC diagnostic system.

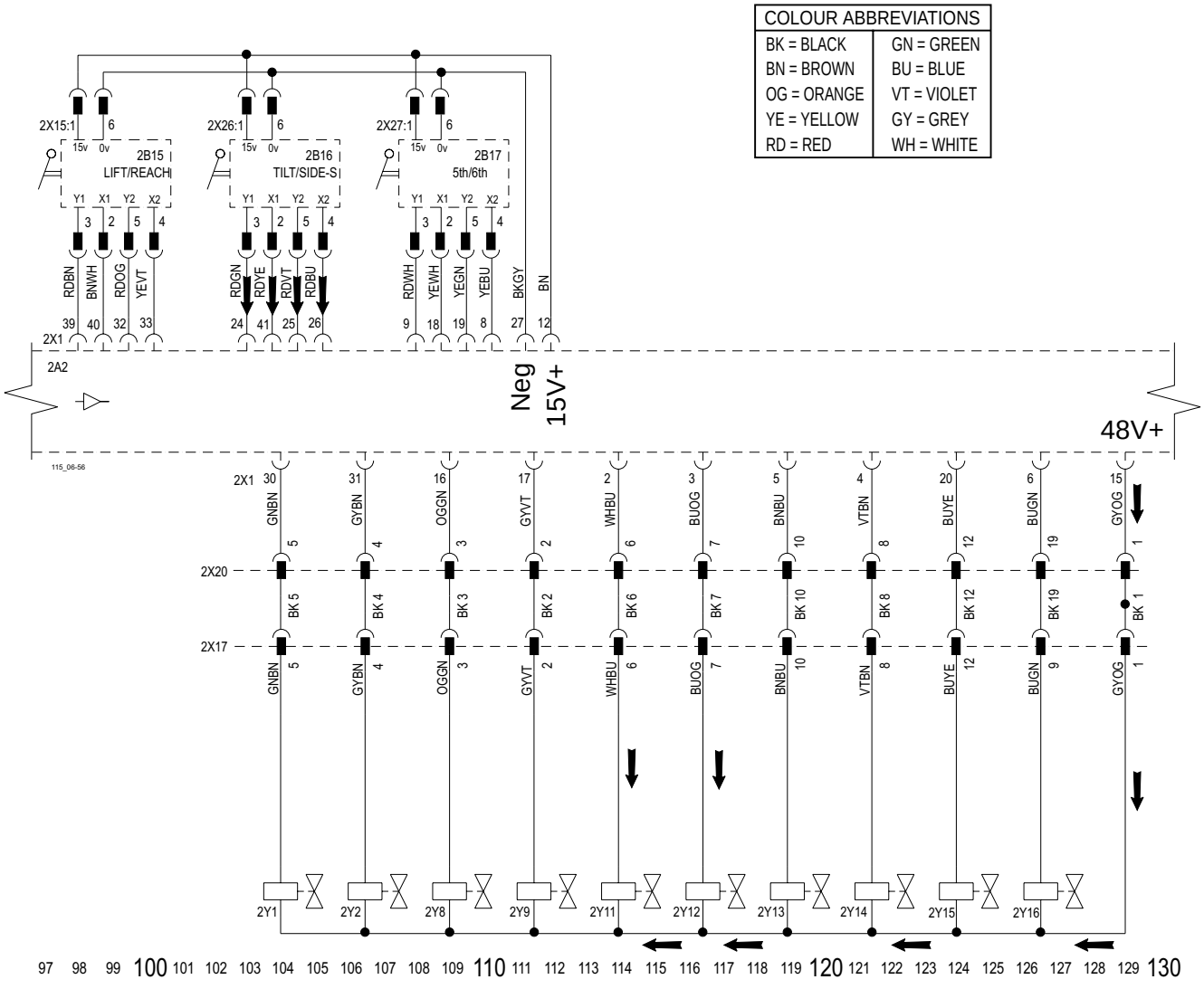


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6.2.12.5 JOYSTICK OPERATION TILT / SIDESHIFT

Joystick 2B16 controls tilt and sideshift operations. Selecting tilt forward or backward provides variable voltages to 2X1:41 and 2X1: 26. The LLC controller then provides a negative for either solenoid valve 2Y11 or 2Y12 from 2X1:2 or 2X1:3. At the same time the speed of the hydraulic pump motor controls operation speed. Side shift potentiometer operation provides variable voltages to 2X1:24, and 2X1:25. The module then provides a negative for either solenoid valve 2Y13 or 2Y14 from 2X1:5 or 2X1:4. At the same time the speed of the hydraulic pump motor controls operational speed.

Operation of the valves and joysticks can be checked in windows 63 and 64 of the LLC diagnostic system.

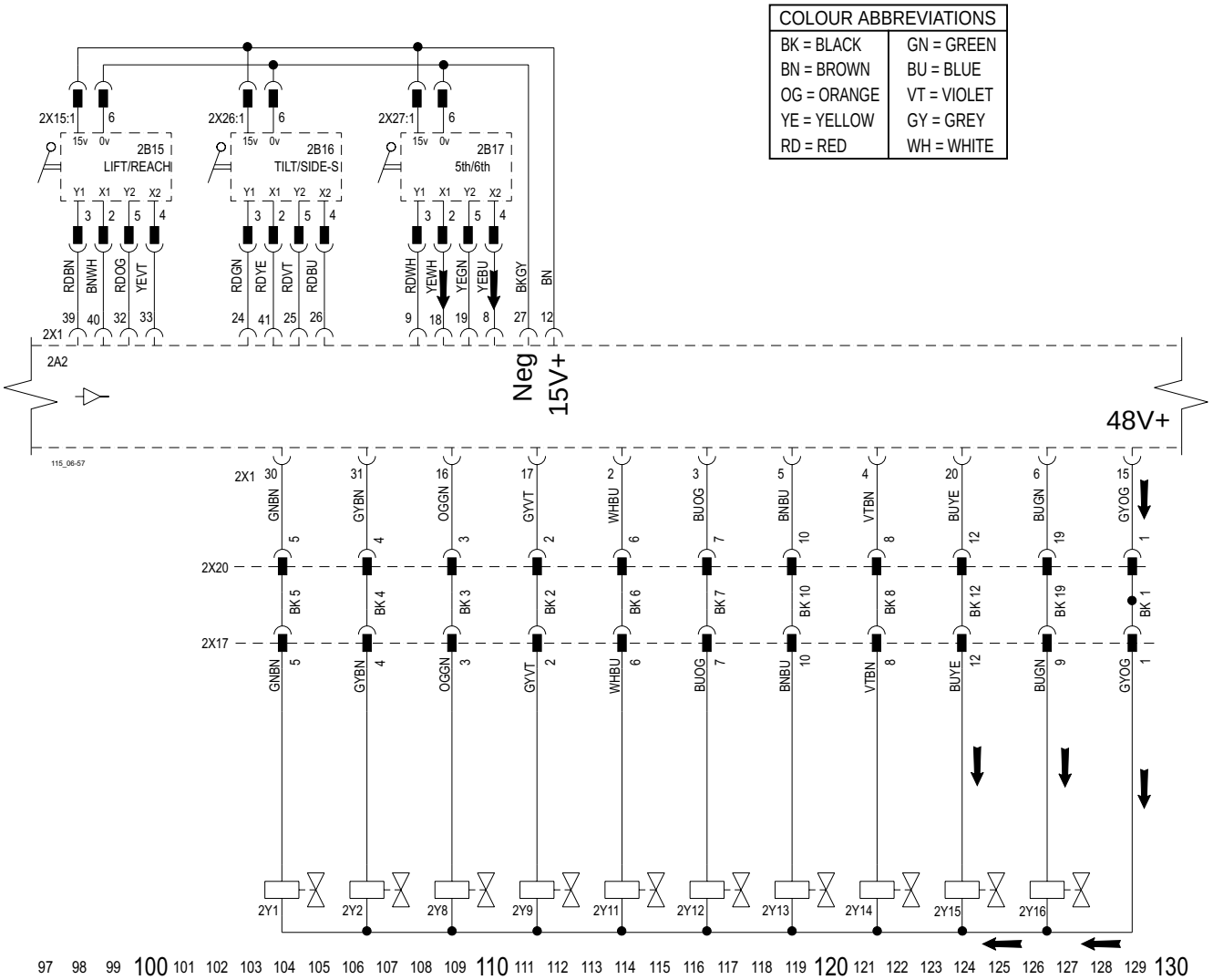


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6.2.12.6 JOYSTICK OPERATION FOR AUXILIARY 1 AND 2 FUNCTIONS

Auxiliary 1 and 2. Joystick 2B17 controls Auxiliary functions. Selecting Auxiliary 1 or 2 provides variable voltages to 2X1:18 and 2X1:8. The module then provides a negative for either solenoid valve 2Y15 or 2Y16 from 2X1:20 or 2X16. At the same time the speed of the hydraulic pump motor controls operation speed.

Operation of the valves and joysticks can be checked in windows 65 and 66 of the LLC diagnostic system.



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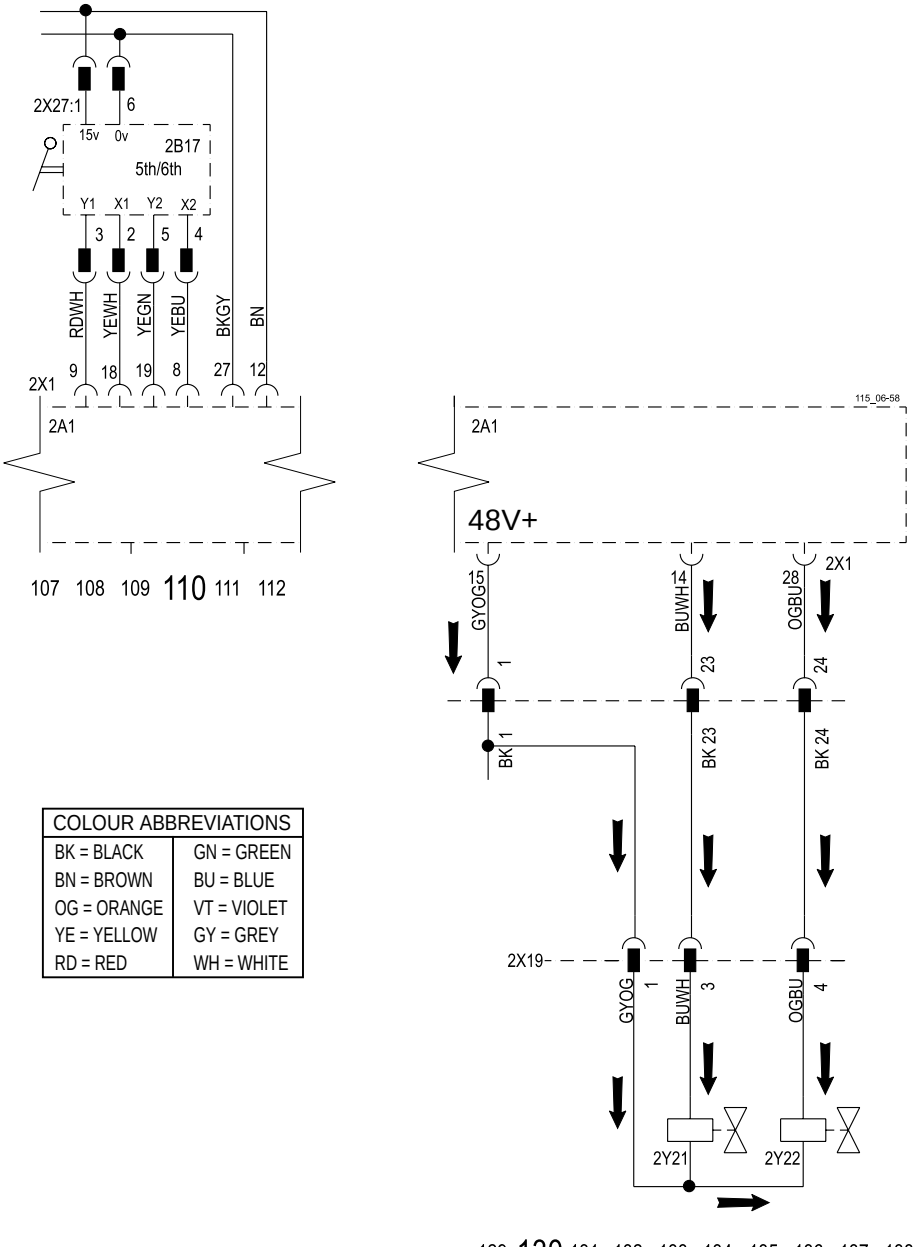
6.2.12.7 UPA JOYSTICK OPERATION FOR CLAMP ROTATE

CLAMP ROTATE FUNCTIONS 1 & 2

Joystick 2B17 controls clamp functions. Selecting Clamp option 1 or 2 provides variable voltages to 2X1:9 and 2X1:19. The module then provides a negative for either solenoid valve 2Y21 or 2Y22 from 2X1:14 or 2X1:22 At the same time the speed of the hydraulic motor controls operation speed.

5th and 6th inputs and outputs can be viewed in the following windows of the LLC diagnostic system.

Window 51: 5th and 6th hydraulic valve outputs and configuration detection at powerup.
Window 65: 5th hydraulic joystick inputs and motor outputs
Window 66: 6th hydraulic joystick inputs and motor outputs



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BN = BROWN	BU = BLUE
OG = ORANGE	VT = VIOLET
YE = YELLOW	GY = GREY
RD = RED	WH = WHITE

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6.6.13 REACH SLOWDOWNS

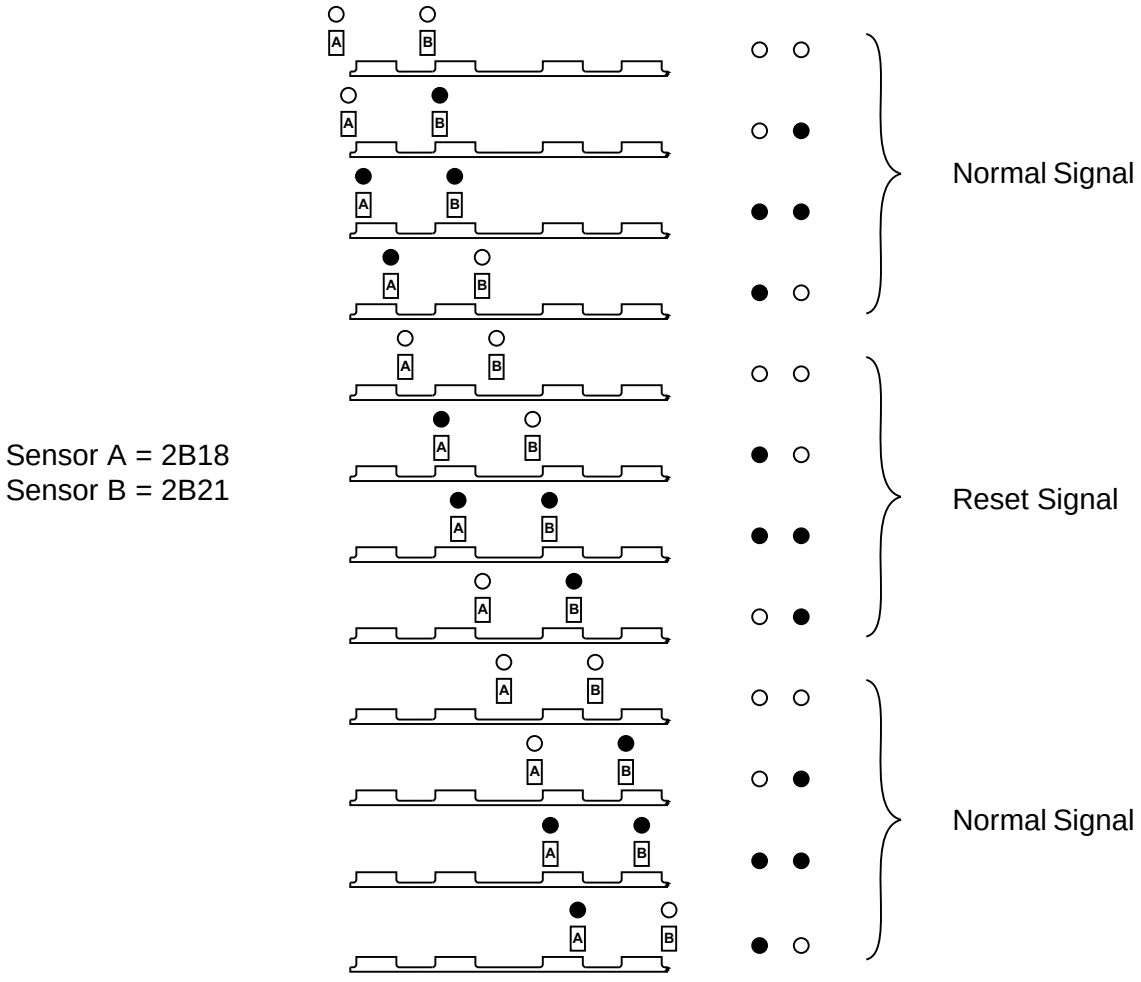
The slowdown system for reach uses a toothed strip fixed to the chassis bottom plate and two inductive sensors fixed to the reach carriage. As the reach is moved, the sensors pass the teeth and the software within the LLC controller adjusts the reach position value.

The LLC controller will detect a reset signal at the centre of reach travel, and zero the position value. At either end of reach travel, the hydraulic pump motor power is reduced slowing reach operation. A short time later the respective reach function valve is closed.

The reach position value is stored at power off, and reinstated at next switch on. This ensures the position is always known and slowdowns are always present. If the position cannot be loaded at switch on, then reach is permanently slow until a reset signal is received.

6.6.13.1 REACH POSITION VALUE

The teeth on the fixed strip are positioned such that the two sensors send signals to the LLC controller in a fixed sequence. At the centre of reach travel, a wider gap in the teeth spacing changes this sequence. This change is used by the LLC controller, to zero the position value.



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6.6.13.2 REACH LIMITS

On a new truck, or if a new hydraulic module is fitted, the reach limit(s) are not programmed and the reach automatically goes into calibrate mode. Operating the reach lever shows “r-CaL“ on the display

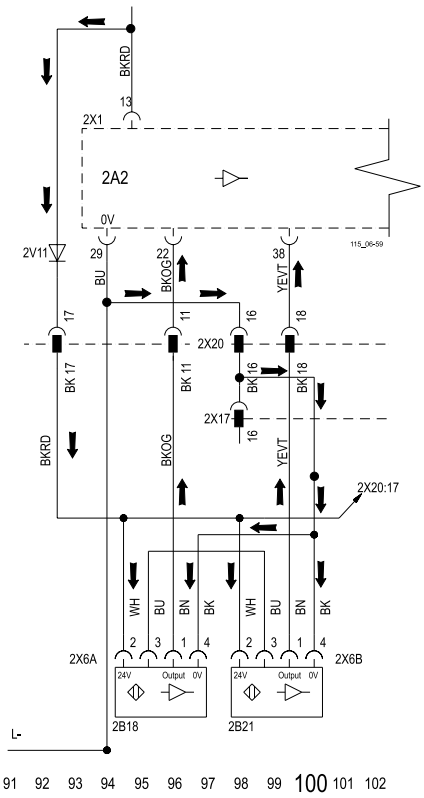
The reach must be reached to the FURTHEST mechanical limit and held until the power stops. It must then be reached to the other limit and held until the power stops. "r-CaL“ should then automatically be removed from the display and full speed reach possible with smooth rampdowns. This procedure can be repeated using diagnostic software at any time.

☞ **NOTE: If reach position is in the back half of reach, the limits should be set in the order Out - Back, otherwise, if reach position is in the out half of reach, the limits should be set in the order Back - Out. This always ensures that the position is referenced in the centre before the limit is calibrated.**

6.6.13.3 REACH SENSOR MECHANICAL ADJUSTMENTS

The reach strip is fixed to the chassis floor and there are no mechanical adjustments possible. The mounting position has been chosen carefully to match the truck dimensions, reach stroke and battery capacity.
The sensors are mounted in a block that again has no adjustments. The sensors themselves however can be adjusted up and down within the mounting block by screwing them in and out.
The optimum adjustment distance is 3.5 mm ± 0.5, which will allow for some deviation. The deviation could be caused by reach channel wear or by the tolerance between the reach carriage and chassis. It is normal to experience some “run out” as the sensors travel along the strip.

6.2.13.4 REACH SENSOR OPERATION



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6.2.14 HYDRAULIC SPEED SENSOR 2B8

The rpm of the pump motor is measured and adjusted in operation in accordance with the load. Speed sensor 2B8 is fitted to the top of the pump motor for this purpose. The speed sensor is supplied with 24 volts direct from U1 the DC to DC converter. As soon as the pump motor rotates, a toothed gear connected externally to the top of the hydraulic pump motor armature passes in front of the sensor face 2B8, turning the sensor on and off as it passes. (0v to 24 volts). The frequency of the output signal thereby alters with the motor rpm sensor.

6.2.14.1 HYDRAULIC SPEED SENSOR FUNCTION TEST

The signal of the speed sensor can be tested in window 6, n2M1 of the LLC Diagnostic Software.)
In addition the following tests are possible.
Using suitable test equipment i.e. Linde test / breakout box

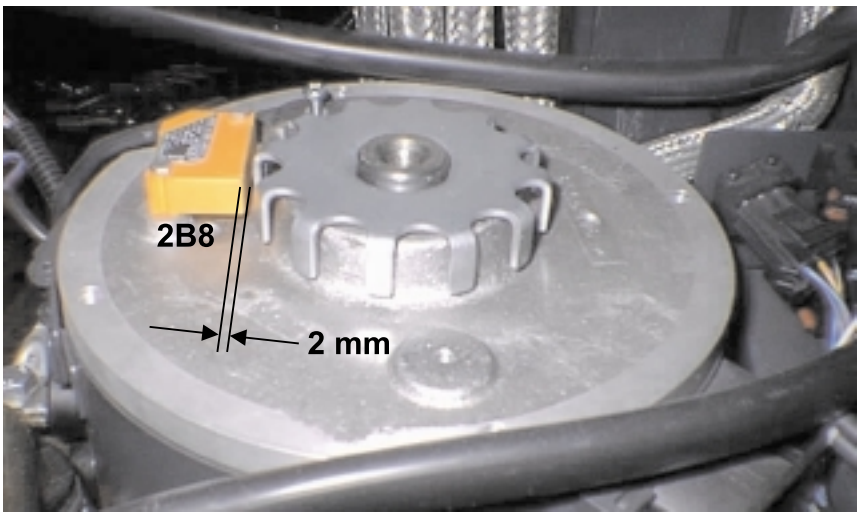
Connect a voltmeter between 2X83:1 negative and 2X81:3 24 volts positive the supply voltage must be 24 volts. If not check U1 voltage converter and 1F2 5 amp fuse and 1F4 5 amp voltage converter output fuse.

6.2.14.2 HYDRAULIC SPEED SENSOR OUTPUT SIGNAL.

- Connect a voltmeter to 2X1:27 negative and 2X1:36.
- Turn on the keyswitch
- Activate the steering. As soon as the pump motor rotates, the output signal must be 7.5V.

6.2.14.3 HYDRAULIC SPEED SENSOR SETTING 2B8

There should be a distance of 2 mm from the speed sensor 2B8 and the toothed gear that rotates in front of it.

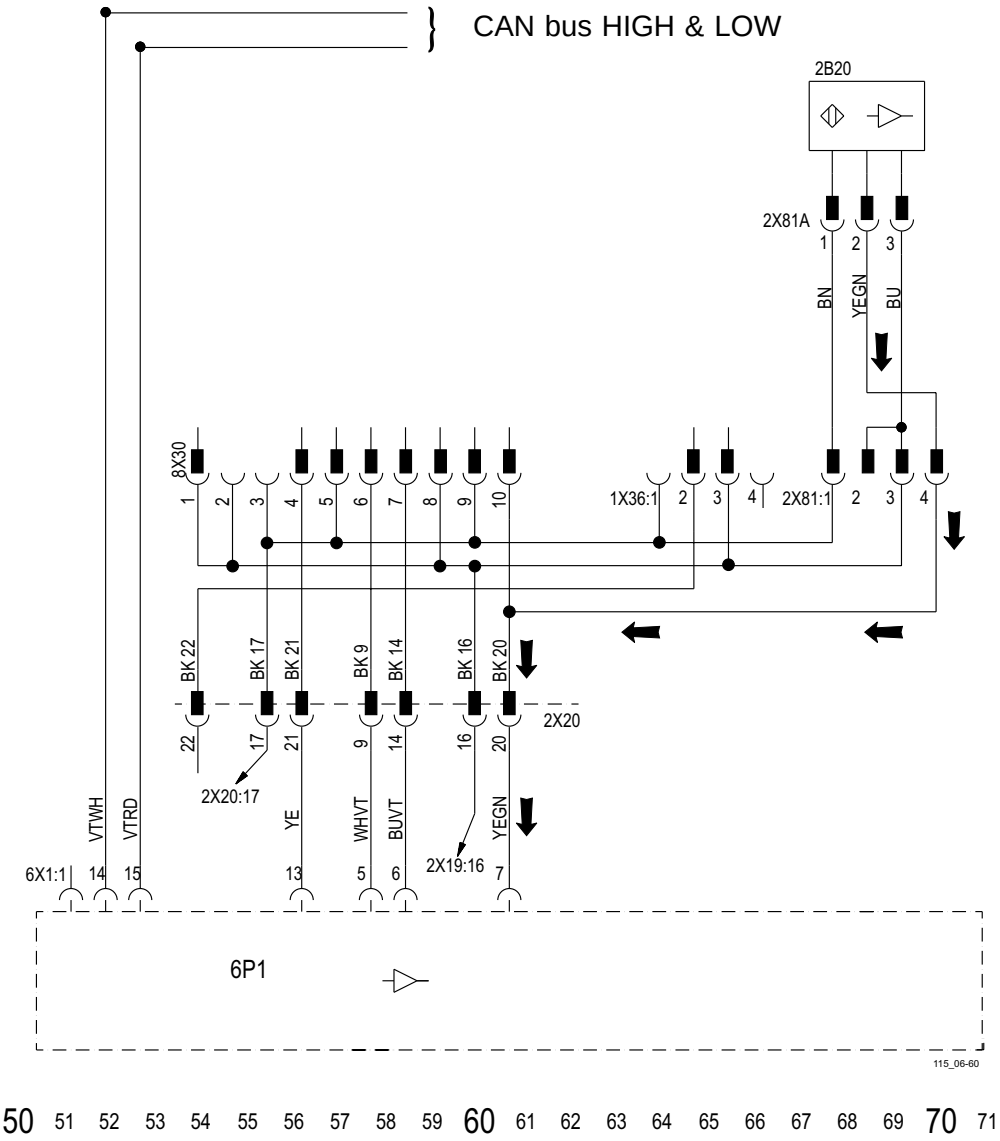


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6.2.15 LIFT STOP SENSOR

Sensor 2B20 stops lift before the mast reaches it's mechanical stop. When activated it applies a signal to 6X11:7. To lift the forks further, release the lever and re initialise lift, it will lift at a reduced speed until full lift is achieved.



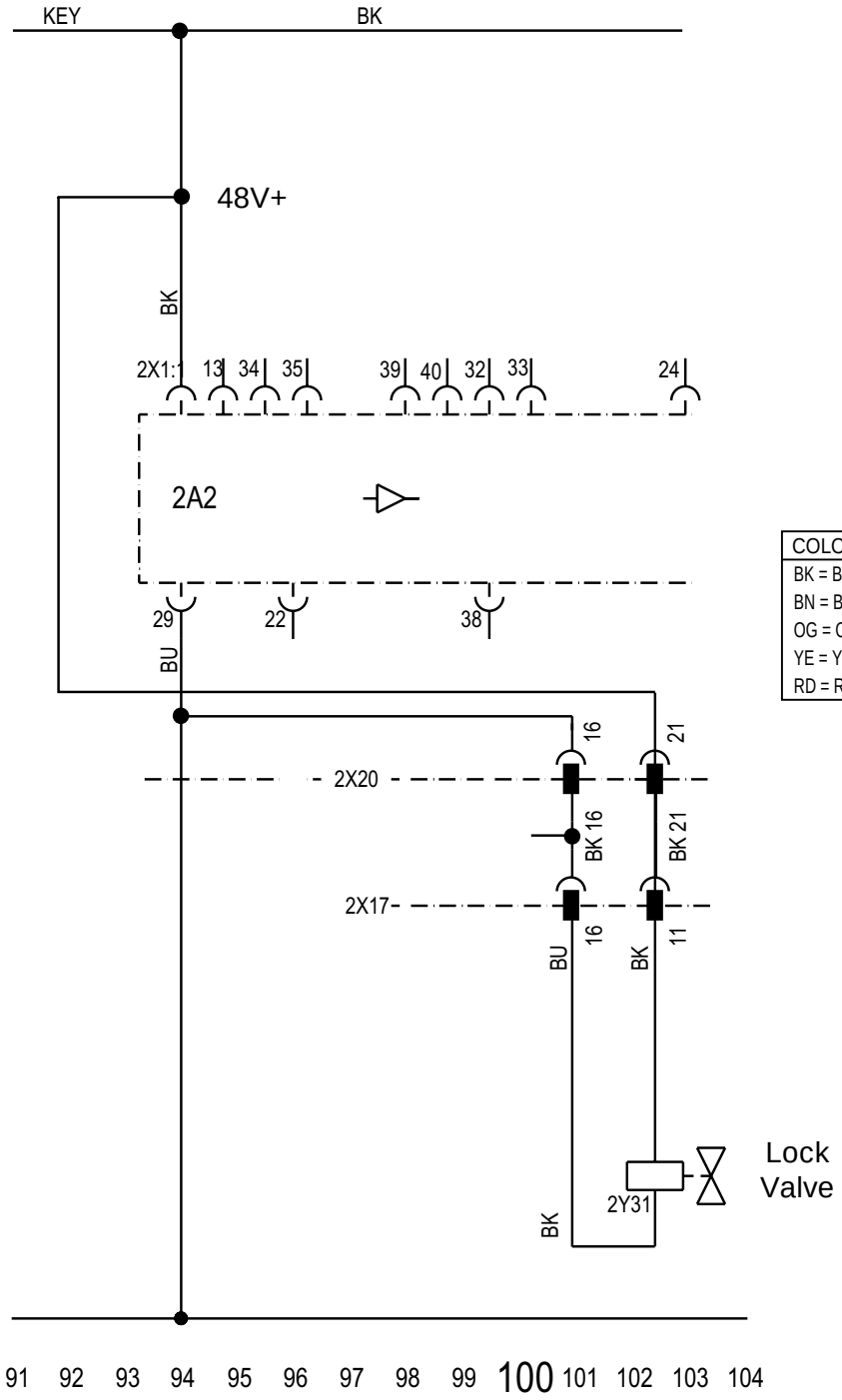
50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71

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6.2.16 LOCK VALVE OPERATION - 2Y31

The lock valve serves as a safety backup should a fault develop within the main lower valve 2Y2.

With the keyswitch on and the emergency isolator released, the valve is supplied with +48 volts, thus opening the valve.

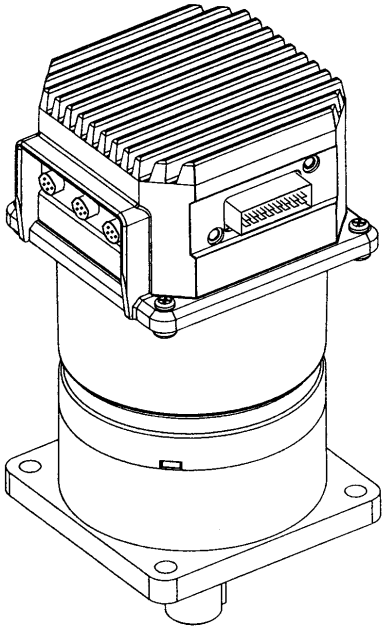


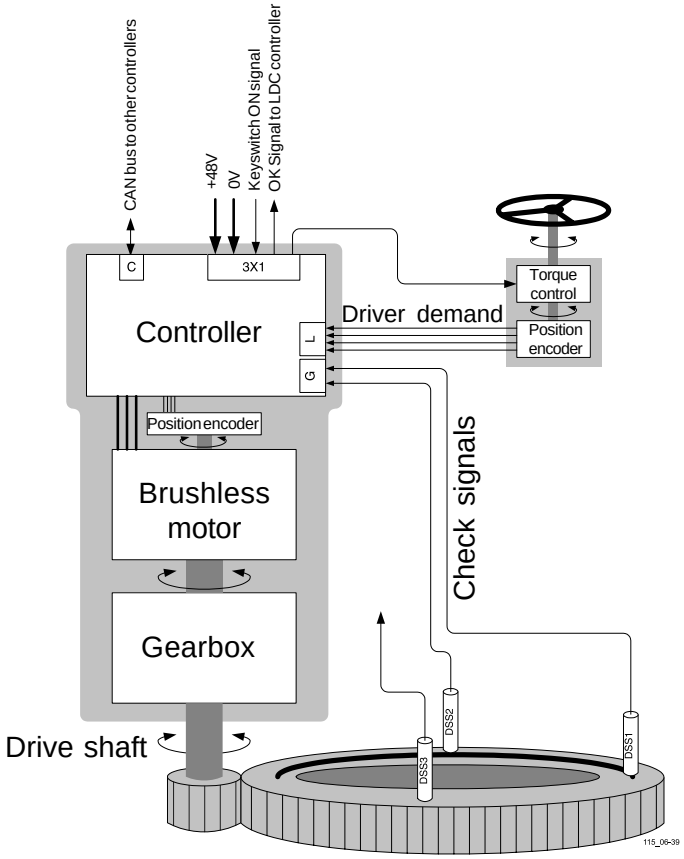
COLOUR ABBREVIATIONS	
BK = BLACK	GN = GREEN
BN = BROWN	BU = BLUE
OG = ORANGE	VT = VIOLET
YE = YELLOW	GY = GREY
RD = RED	WH = WHITE

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6.3 STEERING SYSTEM (LES)

CAUTION: It is imperative, that before working on the control system, that the battery is disconnected, and the steering capacitor voltage is discharged.
The steering capacitor voltage can be safely discharged by operating the horn with the battery plug DISCONNECTED. Check that the voltage between 3F1 and the main negative is less than 5V before working on the truck.
Failure to carry out this procedure can lead to damage of the CAN interface drivers. Components MUST NOT be removed or replaced with the truck live.





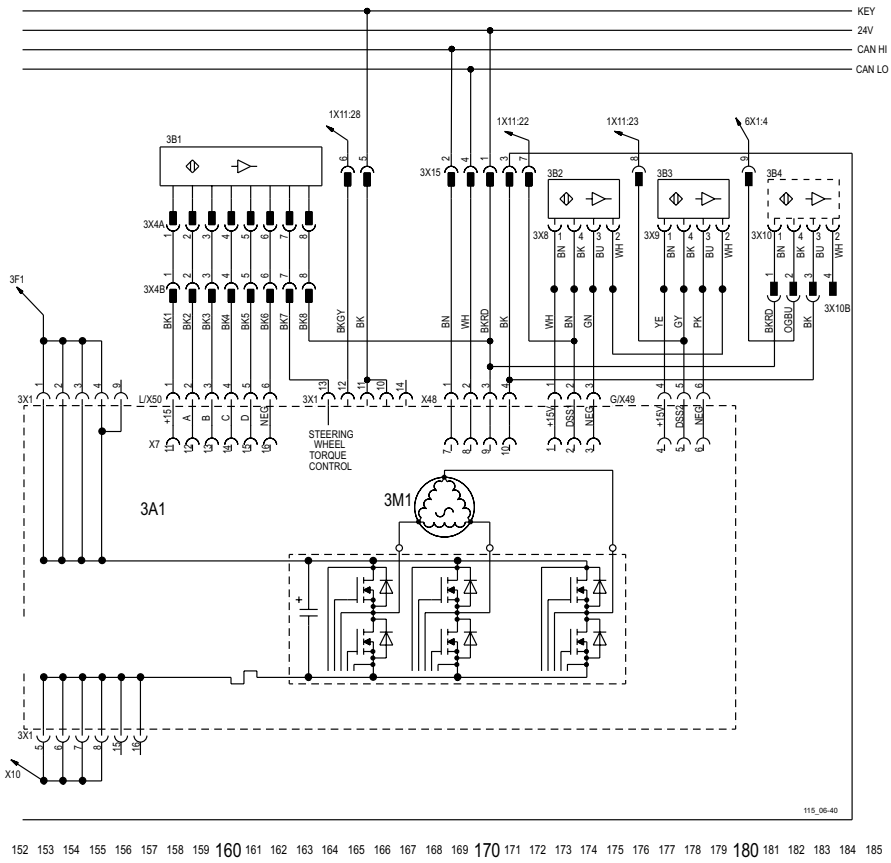
An electrically powered steering system is used. The single unit comprises The motor, gearbox and also the controller. Only a steering wheel unit and two safety sensors are required external to the main unit. The steering system is “fly by wire”.
Within the main unit, the motor uses brushless technology and a digital position encoder provides an accurate position to the controller. This position is also sent via CAN to the driver display for the steering indicator. The position value is confirmed for safety purposes by monitoring two of the safety sensors (DSS1 and DSS2) which detect a semicircular cutout in the gear ring attached to the main drive unit. The third safety sensor (DSS3) is monitored by the driver display for an additional level of safety.
The steering wheel unit contains two parts. The wheel position is monitored by a digital encoder providing two sets of output signals and a brake unit allows the steering controller to vary the force that the driver must apply. This gives the driver a similar feel to previous power assisted systems.
The steering system provides a separately wired enable signal to the LDC controller to ensure that traction is not permitted unless the steering system is fully operational.
The steering system also communicates with other truck controllers via CAN. For example, steering status, drive wheel position information and diagnostic information are all passed via CAN.

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6.3.1 LES CIRCUIT DIAGRAM

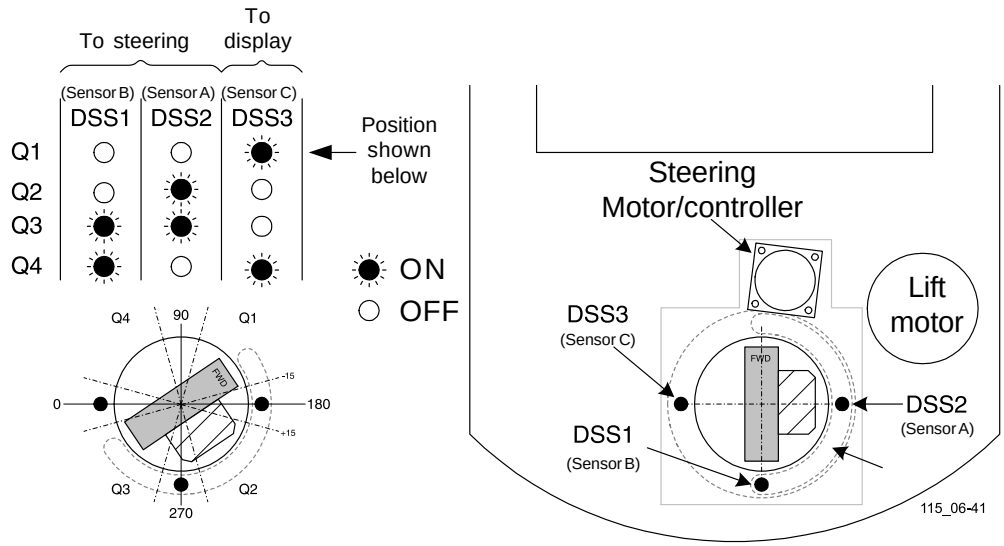
3B1 Steering wheel encoder
3B2 Steering sensor 90°
3B3 Steering sensor 180°
3B4 Steering sensor 360°
3A1 LES controller
3M1 Power steering motor

COLOUR ABBREVIATIONS	
BK = BLACK	GN = GREEN
BN = BROWN	BU = BLUE
OG = ORANGE	VT = VIOLET
YE = YELLOW	GY = GREY
RD = RED	WH = WHITE



6.3.2 STEERING SAFETY SENSORS

There are three inductive sensors that monitor the angle of the drive wheel. Two of these sensors (DSS1 and DSS2) are used by the steering controller to check against the absolute calculated angle that is used for the steering indicator.



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On passing through each sensor, the calculated angle is compared with the absolute values 0°,90°,180° and 270° (with 360° steering only)

The comparison will result in one of two actions…

- If the difference is less or equal to 15° then the calculated angle is corrected without notification.

- If the difference is greater than 15° then the safety output of the steering is released and the truck will be stopped by the parking brake. A message will appear on the display instructing the driver to turn the steering through a complete revolution (or lock to lock) in order to re-calibrate. Upon successful calibration, the steering controller will activate the safety output and drive may recommence.

Conversely if a sensor has not changed at 30° past it's intended operating point then the truck will also be halted for re-calibration.

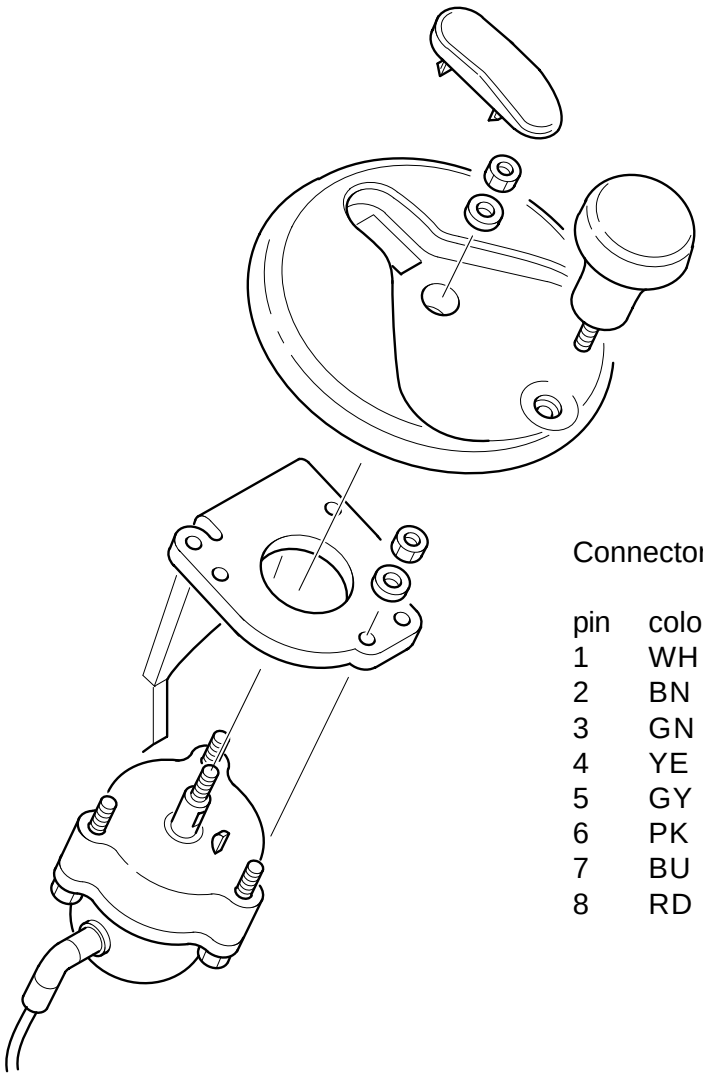
Sensor DSS3 is an additional safety sensor that connects to the driver display. The display will compare the state of this sensor against DSS2 - the two should be complementary since they are opposite each other on the drive unit. It is these sensors that are used to decide which direction to drive in 360° mode and so it is very important that the correct angle is detected.

	DSS1 (Sensor B)	DSS2 (Sensor A)	DSS3 (Sensor C)
180° steering	Changes state at straight ahead. ON when wheel turns clockwise from straight ahead.	ON at either steering limit	OFF at either steering limit. NOT USED for 180ˆ steering.
360° steering	Quadrant check	Quadrant check OFF when steering is in reversed half, ON in normal half. Used to define selected traction direction.	Safety check of DSS2

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6.3.3 STEERING WHEEL UNIT

The device contains an encoder and torque control device



Connector 3X4 Pinout

pin	colour	description
1	WH	Encoder +15 v supply
2	BN	Encoder signal A
3	GN	Encoder signal B
4	YE	Encoder signal C
5	GY	Encoder signal D
6	PK	Encoder 0V supply
7	BU	Torque control signal -
8	RD	Torque control supply +24v

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6.3.4 STEERING FORCE FEEDBACK

A torque control device provides the expected “feel” of a power assisted steering system. This “feel” is present by default on previous models because of the hydraulic power assisted steering but not on the 115 because of it’s “fly by wire” control.

Various signals from the steering controller are sent via CAN to the display which then calculates the force. The force is then sent back to the steering from where the feedback device is controlled by varying the voltage to it via PWM.

There are 5 setting of increasing “stiffness” available

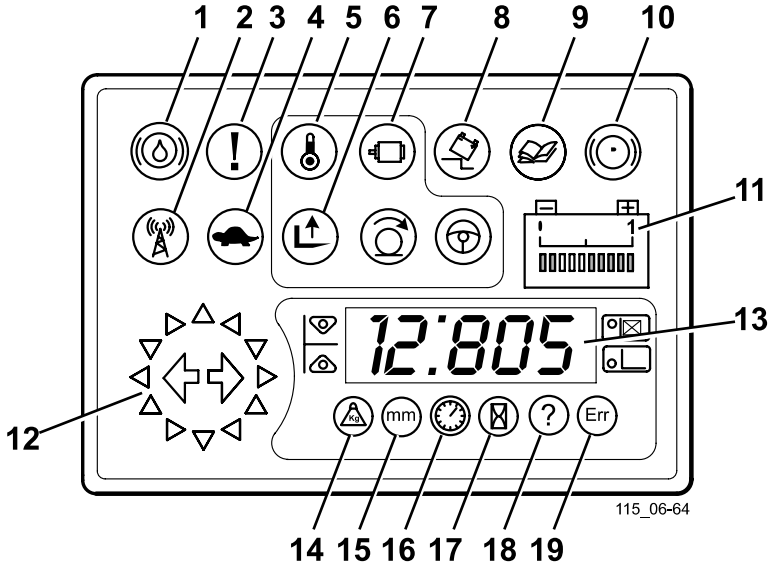
The following voltages are expected across pins 7 and 8 of 3X4

This adjustment is available in Window 7 LID (STFF)

	STIFFNESS SETTING				
	1 PWM/V	2 PWM/V	3 PWM/V	4 PWM/V	5 PWM/V
Idle	0/0	7/1.7	15/3.6	22/5.3	30/7.2
reducing to .. when wheel is turned	0/0	3/0.7	5/1.2	7/1.7	10/2.4
but then increasing to… as driving speed increases	0/0	5/1.2	10/2.4	15/3.6	20/4.8
and increasing to … at 180° limits	50/12.0/	50/12.0	50/12.0	50/12.0	50/12.0
and increasing to … When steering wheel is operated too quickly	40/9.6	45/10.8	50/12.0	55/13.2	60/14.4
and increasing to … when drive wheel is difficult to move (ground effect)	30/7.2	35/8.4	40/9.6	45/10.8	50/12.0

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6.4 DRIVER'S DISPLAY (LID)



A new display provides all information to the driver.

- Hour meter
- Battery condition (BDI)
- Steering angle indicator
- Fork Height display (LHI)
- Warning indications

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It also controls the following truck functions

- Cooling fans
- Steering wheel force feedback via CAN bus

Pin Connections 6X1 (LID)

Pin	Colour	Duty
1	BKRD	+24V input
2	BURD	Brake fluid sensor input S3
3	OG	+48V input (direct from battery)
4	OGBU	Spare UPA input to 6X63:8
5	WHVT	Height encoder pulse A 1B12
6	BUVT	Height encoder pulse B 1B12
7	YEGN	Height encoder reference sensor 8B5
8	OGBN	Battery lock sensor B1
9	RDYE	Output to cooling fan for power block (control unit) 9M1
10	RDBU	Output to cooling fans for pump motor 9M3a and b
11	RDGN	Output to cooling fan for traction motor 9M2
12	GN	Output that is not used at present.
13	YE	Input from fork load sensor UPA.
14	VTWH	CAN HI
15	VTRD	CAN LO
16	BU	0V supply (direct from battery)

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6.4.1 DISPLAY INDICATORS

ITEM	INDICATOR	FUNCTION
1.	Brake Fluid Level	**ON** when the brake fluid needs topping up.
2.	Transmitter Range	**ON** when a data logger with radio comms is fitted and the truck is within transmitting range of a base station.
3.	Interlock Warning	**ON** when any controller has a function locked out or inhibited for any reason. It is sometimes accompanied by a help code on the MPD.
4.	Slow Speed	**ON** when any controller is limiting the speed of it's active function(s).
5.	Temperature Warning	**ON** when any motor or power controller is too hot. It is always accompanied by a motor (or function) indicator to show which device is overheating.
6.	Motor Identification (3)	**ON** when either a brush wear or temperature warning exists and indicated the motor (or controller) at fault. (Lift - Traction - Steering)
7.	Brush wear Warning	**ON** when a motor's brush wear sensor operates. It is always accompanied by a motor indicator to show which motor is at fault.
8.	Battery Unlocked	**ON** when the battery is not locked firmly into place.
9.	Service Warning	**FLASHING FAST (250 ms on/250 ms off)** when a fault exists within one of the controllers that is causing drastic loss of function. OR CAN data missing at display **ON** when the hour meters indicate that a service interval is approaching or has passed. (NSWI is active) See hour meter section. **FLASHING SLOW (500 ms on/500 ms off)** when brake abuse has occurred.
10.	Parking Brake	**ON** when the parking brake is applied. **FLASHING** if brake is released but the calculated brake wear is excessive (>= 0.6 gap)
11.	Battery Discharge	Shows the remaining charge in the battery. The battery cutout will occur when only the bottom red bar is flashing.
12.	Steering and direction Indicator	Shows the position of the drive wheel. In 180° mode, opposite indicators rotate together and the inside direction indicators show the selected direction. In 360° mode, a single indicator rotates showing both angle and direction. The direction indicators are not used in this mode.
13.	Multi Purpose Display (MPD),	Used for a variety of purposes. Mode indicators (items 14 - 19) will illuminate to qualify the information displayed.

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6.4.2 MODE INDICATORS & HEIGHT COMMANDS



The information being displayed is the weight of the load on the forks. This is a UPA feature of the Lift controller.



The information being displayed is the fork height. The command indicators at the left and right of the MPD are also used for certain modes of height display. See Height Indicator section.



The information being displayed is the time of day. This is only available when the data logger is fitted.



The information being displayed is the main hour meter. This is displayed for 10 seconds after power on.



The information being displayed is a help message or code. It reveals to the driver why the function he is attempting to operate will not work by displaying Seat or H.Br etc. It reflects only standard interlocks - not fault conditions.



The information being displayed is an error code. This is reserved for testing only.

6.4.3 DISPLAY FUNCTIONS

6.4.3.1 HOUR METERS

There are 4 hour meters.

Total The main hour meter displayed on the MPD at power on. This is the equivalent of the traditional hour meter and counts up when the keyswitch is on.

Traction This meter gives the total time that the traction has been in operation either driving or braking.

Lift This meter gives the total time that the pump motor has been in operation.

Next Service This meter is different from the other 3 in that it counts down to 0 from a pre programmed service interval time. When it reaches 0 the service light illuminates and remains on until the service engineer resets it with his diagnostic equipment. The meter will only be reset if it is within 10 hours of it's next service thus allowing the engineer to service at his/her convenience but not too early. The intervals are programmed using LID window 74 (NSWP).

An auto-configure facility will ensure that a new display fitted to a customer's truck will adopt the hour meter values of it's presumably broken predecessor, however, if other modules are replaced at the same time then this feature may not function and the new display's meters will start from 0.. The 3 main hour meters cannot otherwise be reset.

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6.4.4 HELP PROMPTS

A series of prompts may appear on the MPD if a function is being interlocked. These prompts only appear as a function is being operated and only cover the basic interlocks of the truck. The prompts will appear in the selected language, which can be changed in Window 7 (LID)

Seat	The seat switch is not operated
H,br	The handbrake is applied
f,br	The foot brake pedal is operated
No	A UPA interlock is inhibiting the function
Stop	The lift stop input is active
VaLVe	There was no valve detected at power up
Joy	One or more joysticks are operated at power up
L,booT	The Lift controller failed it’s power on self test or the battery is flat
T,booT	The Traction controller failed it’s power on self test
L,FooT	On single pedal trucks, the left foot switch not operated

6.4.5 FAN CONTROL

All cooling fans are temperature controlled in order to reduce the ambient noise to the driver.

All temperatures arrive at the display on the CAN bus. Once switched on, the fan(s) will only stop when the temperature reduces significantly. Thresholds are set in a diagnostic window.

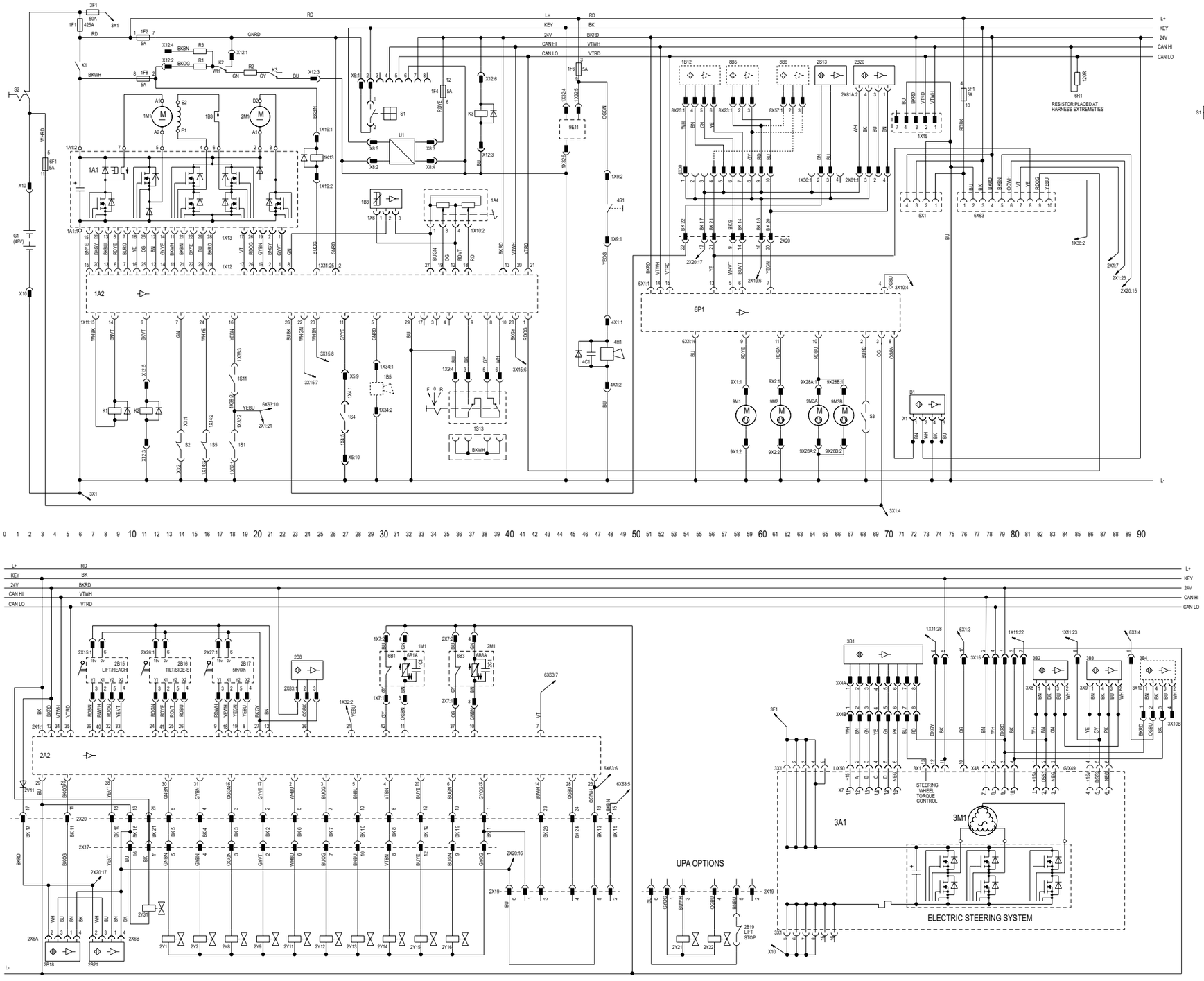
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1A1	Power module	5-23
1A2	Traction control module (LDC)	7-42
1A4	Accelerator assembly	30-35
2A2	Hydraulic control module	93-138
3A1	Steer motor control module (LLC)	152-180
B1	Battery lock sensor	72-74
1B3	Current sensor	17, 29-32
1B5	Travel alarm 24V (option)	29-30
1B12	Height encoder (option)	55-57
2B8	Speed sensor 2M1	114-117
2B15	Dual axis joystick (Lift/Reach)	97-101
2B16	Dual axis joystick (Tilt/Shift)	102-106
2B17	Dual axis joystick (5th/6th)	107-111
2B18	Sensor (Reach Out}	95-97
2B19	Sensor (Lift Stop UPA)	149
2B20	Sensor (Lift stop/slow)	67-70
2B21	Sensor (Reach Back)	98-101
3B1	Steer wheel unit	158-164
3B2	Steer sensor 90°	172-175
3B3	Steer sensor 180°	177-179
3B4	Steer sensor 360° (option)	181-184
6B1	Temperature/Brushwear sensor (1M1)	121-124
6B3	Temperature/Brushwear sensor (2M1)	126-130
8B5	Lift stop sensor of ref. sensor (option)	58-60
8B6	Load sensor (UPA)	62-64
1C1	Capacitor traction motor sensor	124
2C1	Capacitor lift motor sensor	129
4C1	Suppression Capacitor (Horn)	47
9E11	Seat Heater (optional)	44-46
1F1	Traction motor fuse	6
1F2	Control Circuit fuse	11-12
1F4	Control Circuit fuse	35
1F6	Horn/seat heater fuse	46
1F8	Control module fuse	11-12
3F1	Steer motor fuse	7-8
5F1	Lighting fuse	76
6F1	Driver's display fuse	3
G1	Battery – 48 volt	2
4H1	Horn	48
K1	Main line contactor	6, 8-10
K2	Relay charge resistor assembly	11-12, 21
K3	Relay charge resistor assembly	17, 38
1K13	Solenoid EM park brake	25
1M1	Traction motor	12-14
2M1	Hydraulic pump motor	20-22
3M1	Power steering motor	167-170
9M1	Fan (control unit heatsink)	59
9M2	Fan (traction motor)	61-62
9M3a & b	Fans (pump motor)	64-67
6P1	Driver's display	50-71
R1	Resistor charge	15
R2	Resistor charge\discharge	23
6R1	Resistor can bus terminator	85
S1	Keyswitch	31
S2	Emergency isolator	2, 14
S3	Brake Fluid Level switch	68
1S1	Seat switch	18
1S4	Parking brake switch	27
1S5	Footbrake switch	16
1S11	Left Foot switch	18
1S13	Direction switch (single pedal)	34-40
2S13	8.5m lift slowdown sensor	65-67
4S1	Horn switch	48
U1	Converter	31-33
2V11	Routing diode	93
X1	Connector 4 way battery lock sensor	72-74
X3	Connector 2 way isolator aux switch	14
X5	Connector 10 way binnacle	28-34
X8	Connector 6 way converter	30,34
X10	Connector 2 way battery	2
X12	Connector 6 way charge resistor	11,13,22,25,38
X48	Connector 4 way steer can bus	169-171
X49	Connector 8 way steer wheel pos. inputs	173-179
X50	Connector 8 way steer wheel inputs	158-162
1X4	Connector 8 way parking brake switch	27
1X6	Connector 4 way current sensor	29-31
1X7	Connector 4 way 1M1 motor sensors	121-123
1X9	Connector 6 way horn/direction switch	36-39,48
1X10	Connector 4 way accelerator	31-34
1X11	Connector 29 way traction module	7-42
1X12	Connector 29 way traction module	7-23
1X13	Connector 29 way traction module	7-23
1X14	Connector 3 way footbrake switch	16
1X15	Connector 7 way diagnostic	70-74
1X19	Connector 2 way parking brake solenoid	25
1X32	Connector 6 way seat pan	18,44-46
1X34	Connector 2 way travel alarm	29-30
1X36	Connector 4 way 8.5 ref. sensor	64-67
1X38	Connector 3 way left foot switch	18
2X1	Connector 42 way lift module	94-138
2X6	Connector 4 way reach position sensors	95-100
2X7	Connector 4 way 2M1 motor sensors	127-129
2X15	Connector 6 way lift/reach lever	98-100
2X17	Connector 16 way valve block	98-129
2X19	Connector 4 way 6th/UPA hydraulic	131-150
2X20	Connector 24 way reach cable	57-63/93-139
2X26	Connector 6 way tilt/shift lever	103-106
2X27	Connector 6 way 5th/6h lever	108-110
2X81	Connector 4 way 2B20 sensor	68-70
2X81A	Connector 4 way lift stop/slow sensor	68-69
2X83	Connector 4 way 2M1 speed sensor	114-116
3X1	Connector 16 way steer supplies	153-157,164-167
3X4	Connector 8 way steer encoder/torque control	158-164
3X8	Connector 4 way steer sensor 3B2	173-175
3X9	Connector 4 way steer sensor 3B3	177-179
3X10	Connector 4 way steer sensor 3B4	181-184
3X15	Connector 10 way steer interlocks	165-176
4X1	Connector 2 way horn	48
5X1	Connector 4 way lighting supplies	71-74
6X1	Connector 16 way driver's display	50-71
6X63	Connector 10 way UPA supplies	76-83
8X23	Connector 4 way ref. sensor	63-65
8X25	Connector 6 way height encoder	59-61
8X30	Connector 10 way mast cable	55-63
8X57	Connector 4 way load sensor UPA	66-67
9X1	Connector 2 way MOSFET cooling fan	61-62
9X2	Connector 2 way 1M1 cooling fan	61-62
9X28	Connector 2 way 2M1 cooling fans	64-67
2Y1	Valve lift	104
2Y2	Valve lower	106-107
2Y8	Valve reach out	109
2Y9	Valve reach back	111-112
2Y11	Valve tilt forward	114
2Y12	Valve tilt back	116-117
2Y13	Valve sideshift left	119
2Y14	Valve sideshift right	121-122
2Y15	Valve aux1	124
2Y16	Valve aux2	126-127
2Y21	Valve rotate	145
2Y22	Valve clamp	147
2Y31	Lock valve	102-103

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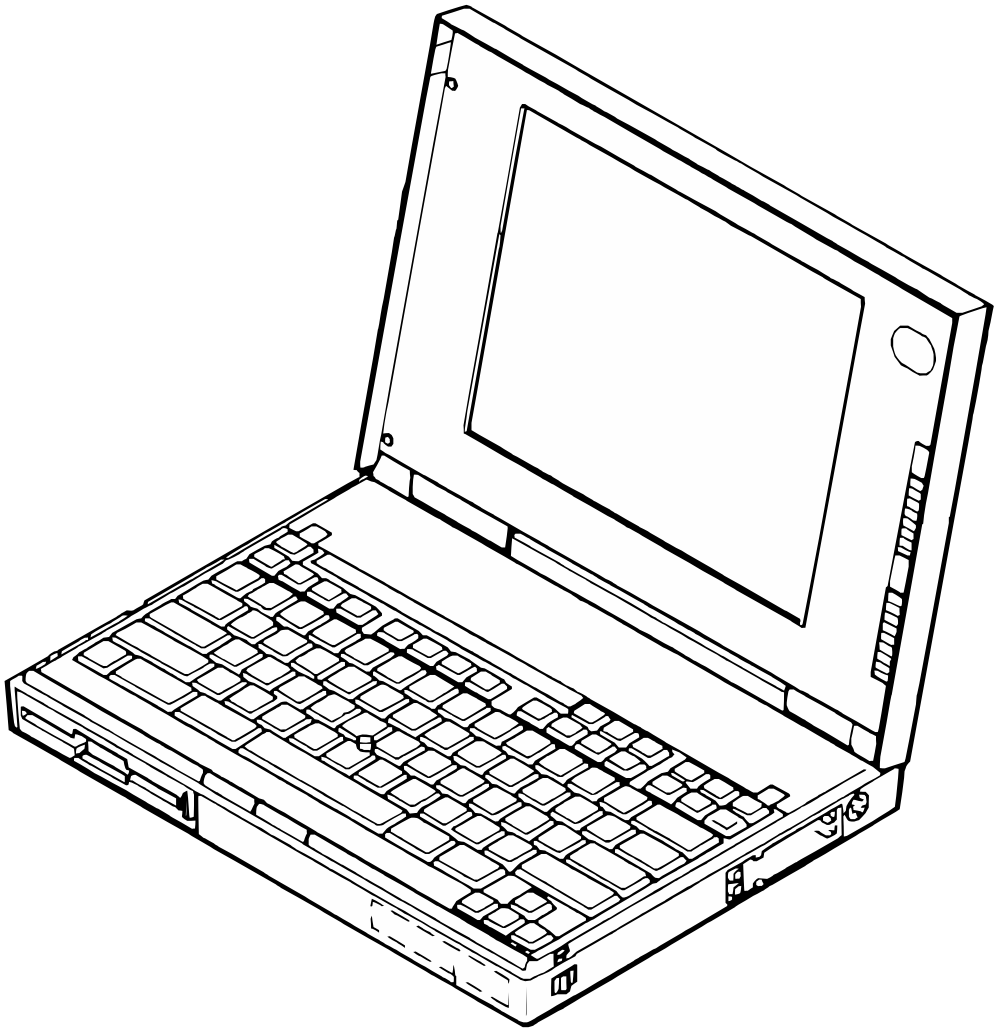


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Service Training

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DIAGNOSTICS



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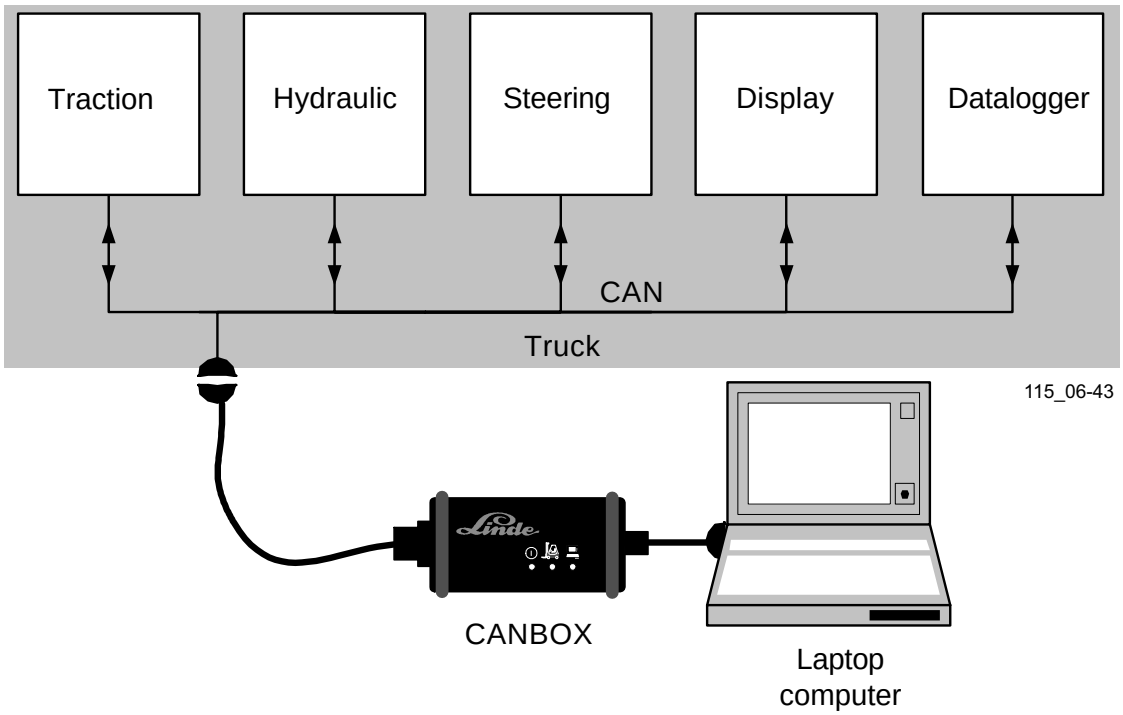
6.5 DIAGNOSTIC CONCEPT

NOTE: The Linde diagnosis tool **cannot** be used with the 115. **Only Laptop diagnostics are supported.**

The diagnostic system uses the Linde diagnostic program for a laptop. The laptop however, now connects to the truck using an interface cable / adaptor (CANBOX).

The diagnostic equipment connects to a single connector 1X15 under the steering binnacle. This diagnostic connector is an interface to the CAN bus and from here, all controllers can be diagnosed.

Each controller provides it's own diagnostics using windows 1 – 8 (and sub windows) in the normal format.



- Turn off the truck
- Connect up the CANBOX
- Run the diagnostic program
- Turn on the truck - the traction controller is always selected first.

New windows 9, 91…99 are used to select the controller that the engineer wishes to diagnose.

9 To display a summary of controllers
91 To select the Traction controller
92 To select the Lift / Hydraulic controller
93 To select the Steering controller
94 To select the Display
95 To select Data Logger (option)

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When a different controller is requested there is a 1-2 second delay after which window 1 of the new controller is selected and the appropriate help file is loaded. Master mode is unlocked at this stage if appropriate.

If no communication can be established with the selected controller, CANBOX will display the following message

```
LINDE CANBOX
Vers: 1.0
Type: CBX32R00
NO DATA
```

CANBOX adds one special feature to the normal diagnostics. Window 0 (zero) monitors the CAN bus for available controllers. During the monitoring process, a series of **...** are displayed after which the controller codes are listed.

```
LDC32V10     LLC32V11
LID32V10     LHD32V10
```

If more than 8 controllers are found then the **>** symbol appears in the bottom right corner and a further press of the **0** key will list the remaining (up to 12 total).

Pressing the **0** key once more will return CANBOX to it's normal mode of operation.

The controller codes are made up as follows:-

LDC the acronym for the controller (see below)
32 the type number for the controller (always 32 for the 115)
V10 the software version number (version 1.0)

The 115 has the following possible controllers:-

LDC	Linde DC Control	(Traction)
LLC	Linde Load Control	(Lift / hydraulics)
LES	Linde Electric Steering	
LID	Linde Intelligent Display	(Driver's main display)
LHD	Linde High level Display	(Slave Display on overhead guard)
LDL	Linde Data Logger	
LDE	Linde Data Entry	(optional keypad)
LCE	Linde Code Entry	(optional keypad / code entry)

6.5.1 HELP FILES

Certain files are required to be installed on your laptop to provide help for each controller's windows (these appear in the lower half of the diagnostic screen). Help files will be provided on the install disks for Linde diagnostics but If any help is missing then it can be obtained by emailing a request to ***nick.greenwood@lansinglinde.co.uk***. Please state the language required (English, German or French).The appropriate files will be supplied by return email as a self installing EXE file. The diagnostic software also includes help files, which will also be displayed.

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6.5.2 TRUCK ONBOARD DIAGNOSTICS (TOD)

Because primary diagnostics are only available by using a laptop computer, a much reduced diagnostic scheme has been provided and is available via the truck display. It does not require any additional tools.

To place the truck in a special mode (TOD mode) the controls must be operated with the seat switch open, in the sequences below with each operation lasting about ½ second. The timing of the lever operation must be exactly right or the TOD mode will not be set.

Confirmation of entering the mode is given by the display **—1—** where 1 is the selected mode. The seat may be occupied once more and the controls used to toggle through the items.

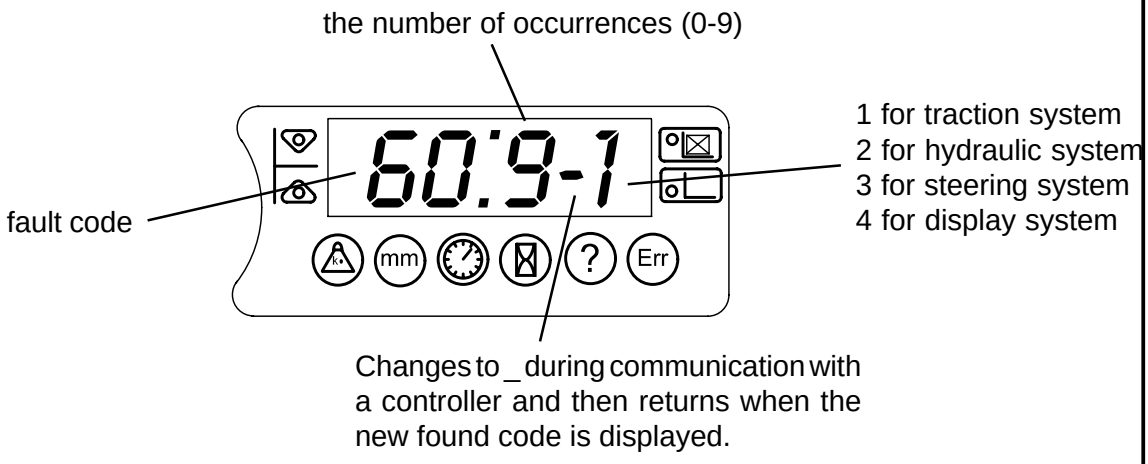
To **change** TOD modes, vacate the seat and enter the sequence for the new mode.

To **exit** the TOD mode, vacate the seat and operate lower lever twice. The display will return to normal and the truck may be driven once again.

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TOD MODE 1 Display error histories (window 3) of all controllers.	Entered by… LOWER - LOWER - LIFT - LOWER - LOWER or BRAKE - BRAKE - ACCEL - BRAKE - BRAKE

Each controller is searched in turn and the error history displayed on the display. Operate the LIFT or ACCEL to step through error codes.

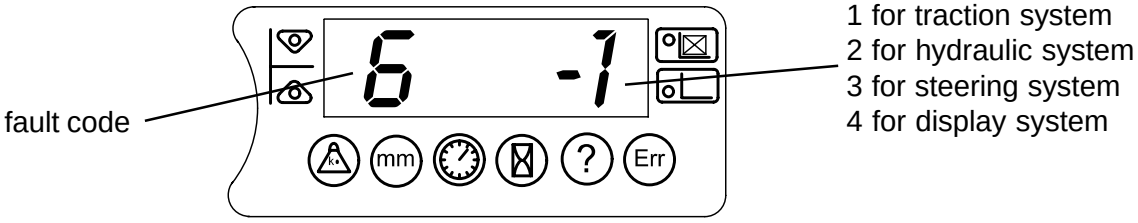


Controllers are searched in order and there is a small delay as each new controller is accessed. At the end of the last controller, the sequence is repeated.

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TOD MODE 2 Display current errors (window 2) of all controllers.	Entered by… LOWER - LOWER - LIFT - LIFT - LOWER - LOWER or BRAKE - BRAKE - ACCEL - ACCEL - BRAKE - BRAKE

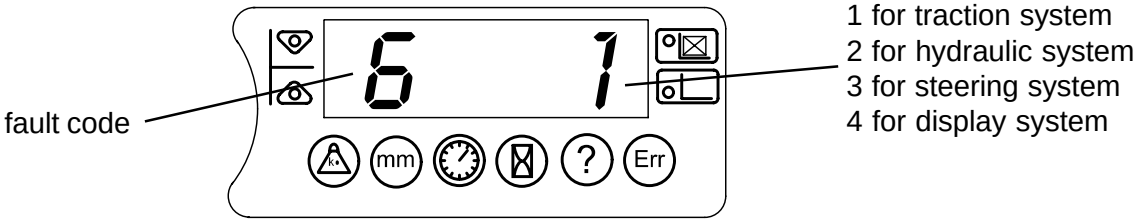
Each controller is searched in turn and the error history displayed on the display. Operate the LIFT or ACCEL to step through error codes.



Controllers are searched in order and there is a small delay as each new controller is accessed. At the end of the last controller, the sequence is repeated.

TOD MODE 3 Display Error codes during normal truck operation.	Entered by… LOWER - LOWER - LIFT - LIFT - LIFT - LOWER - LOWER or BRAKE - BRAKE - ACCEL - ACCEL - ACCEL - BRAKE - BRAKE

This mode is different to the previous two in that truck operation is completely normal but any error codes will appear on the display as they occur.



The “Err” mode indicator (red) illuminates to indicate error display.
If two error occur at the same time then they are displayed in the above priority (i.e. Traction overrides all others)

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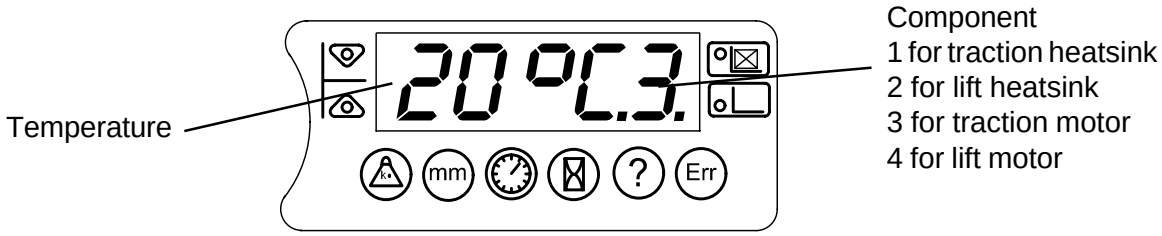
TOD MODE 4 Display Temperatures and fan statuses.	Entered by… LOWER - LOWER - LIFT (x4) - LOWER - LOWER or BRAKE - BRAKE - ACCEL (x4) - BRAKE - BRAKE

This mode allows the temperatures of the power module and Lift and Traction motors to be displayed during normal truck operation.

The fan for the displayed component

.8. = off

.8. = 100% Speed

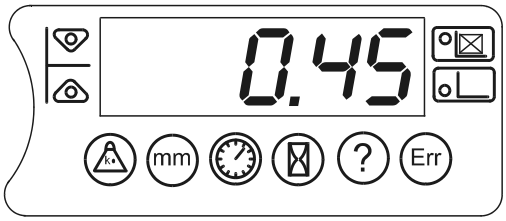


Only the component with the highest temperature is displayed. If the temperatures of several components are close then the display will flicker between them

TOD MODE 5 Display parking brake gap/condition	Entered by… LOWER - LOWER - LIFT (x5) - LOWER - LOWER or BRAKE - BRAKE - ACCEL (x5) - BRAKE - BRAKE

This mode allows the calculated parking brake gap to be viewed (mm). The brake must be released for the first time before a value is displayed. The value will be updated on every subsequent release.

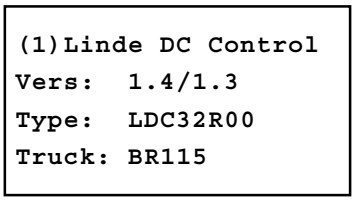
If there is a brake error, then one of the following error messages will br shown.



GAP .6	Brake gap exceeds 0.6 mm (The brake must be adjusted)
GAP.7	Brake gap exceeds 0.7 mm (The brake must be adjusted)
GAP .2	The brake gap is less than 0.2 mm (The brake must be adjusted)
br. St	Brake mechanism is stuck and cannot operate
br. Sc	Brake coil is short circuit or there is a wiring fault
br. oc	Brake coil is open circuit or there is a wiring fault
du. Sc	Brake drive circuit is faulty and the brake is always released. The main contactor (K1) will be released so the brake is applied.

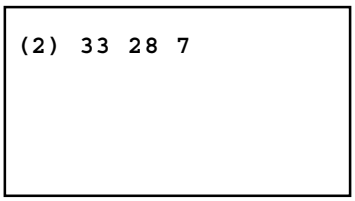
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6.5.3 LDC DIAGNOSTIC WINDOWS



Home Page

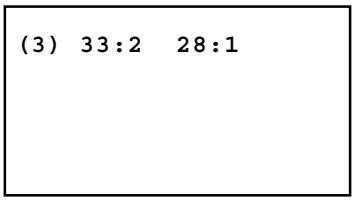
Shows controller's details
Vers: Version numbers of the main and safety software
Type: Reference for the required help file name
Truck: Truck range



Current Faults/information

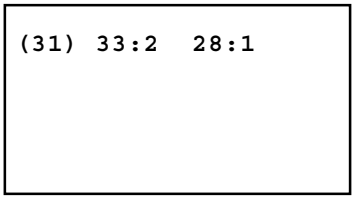
Active faults and information on controller

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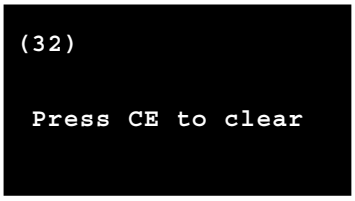
Fault History

Shows the faults that have been logged. This window may be cleared at Diagnostic level by pressing CE or DEL but codes remain in window 31 with the confirmation symbol '/' (eg 33.2/)



Fault History (total)

As window 3 but total level. Even if 3 is cleared, the faults remain here. Window 3 information can also be cleared from this window using CE or DEL



Clear entire Fault History (Master)

Clears all faults from windows 3 and 31, by pressing CE or DEL.

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```
(4)
1S13:010    1S4:00
1S1 :1      2S13:00
1S5 :1      STOK:1
```

Digital Inputs

Shows the states of digital inputs to the controller. An active state is represented by a ‘1’ and an inactive state ‘0’.

1S13: Directional lever signals
111: 2-pedal truck
100: 1-pedal truck with forwards selected
010: 1-pedal truck with neutral selected
001: 1-pedal truck with reverse selected
other: Incorrect signal combinations

1S1: Seat switch signal

1S4: Handbrake switch signal
<input state><brake state>

1S5: Foot brake switch signal

2S13: Speed override signal (8.5 m)
<input state><interlock state>

STOK: Steering OK signal

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```
(41) MSC
DSS1:000    ANG:     0
DSS2:000    ERR:     0
DSS3:  0    DIR: <<--
```

Steering Angle / sensors

DSS1 State of steering sensor DSS1
M = via wiring to main controller,
S = via wiring to Safety Controller,
C = via CAN bus from steering controller
All M,S and C signal should be the same with a small time delay acceptable when changing state.

DSS2 State of steering sensor DSS2 (as DSS1)

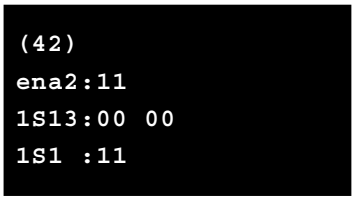
DSS3 State of steering sensor DSS3. This sensor is only fitted and displayed when 360° steering is selected and it arrives only via CAN from the driver display.

ANG The steering angle from the steering controller

ERR If the ANG and DSS sensors do not agree then an error number will result here. This error will generate an Error code 36 in the error history windows. Refer to steering section for a more detailed description.

DIR The direction of rotation of the steering wheel
<<— for anticlockwise
—>> for clockwise
—— for no rotation

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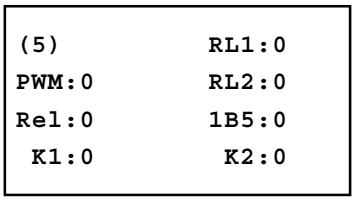
Safety Controller Inputs (Master)

ena2: ab / safety controller enable signal
(0: No enable, 1: Enable)
a: Captured directly by function controller and
b: Captured by safety controller and transmitted serially

1S13: ab cd / directional switch signals
(0: Contact closed, 1: Contact open)
Forward signal ...
a: Captured directly by function controller
b: Captured by safety controller and transmitted serially
Reverse signal ...
c: Captured directly by function controller
d: Captured by safety controller and transmitted serially

1S1: ab / Seat switch signal
(0: Contact closed, 1: Contact open)
a: Captured directly by function controller
b: Captured by safety controller and transmitted serially

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Digital Outputs

Shows the states of digital outputs.
0: Output OFF
1: Output ON

PWM Enable demand by power electronics drive
Rel Safety relay drive
K1 Line contactor drive
RL1 Relay output 1 (for UPA)
RL2 Relay output 2 (for UPA)
1B5 Travel Alarm output
K2 Charging relay drive

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```
(51) ENA  ERR  STA
PMW:  0
Rel:  0          0
K1:   0    0     0
```

Additional information on outputs **(Master)**

This window displays additional information on the outputs:

ENA: Enable demand of function controller
ERR: Error feedback of drive circuit
STA: Feedback of power stage output signal to function controller

PWM: Enable demand of power electronics drive

Rel: Safety relay drive (ENA)
Status feedback (STA: function controller, safety controller)

K1: Set clock ratio for drive contactor (ENA) in 1/1000
Error feedback of drive circuit (ERR)
Measured clock ratio of power stage output (STA) in 1/1000

```
(6)
u+:14.17V ur :19.8V
u1: 8.23V uc1:10.0V
u2: 7.13V
```

Non-motor related analogue outputs

This window shows analogue inputs not referring to either

u+ Accelerator potentiometer supply voltage (about 15 V) in [V]
u1 Accelerator potentiometer signal 1 in [V]
u2 Accelerator potentiometer Signal 2 in [V]
ur Battery voltage in [V] measured at contact output of safety relay
uc1 Intermediate circuit voltage power module in [V]

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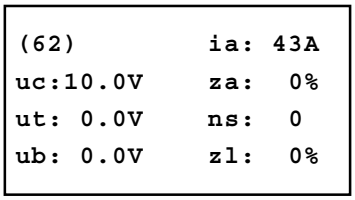
```
(61)
GAP :0.35mm
Ibrk:1.12A
```

Parking brake measurements

GAP calculated gap between the friction plate and the brake disk. The nominal setting is 0.45mm and the accepted range is 0.3 - 0.6 mm. this will display 0.00 until the first release of the brake after power on.

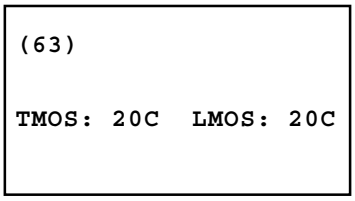
Ibrk Current flowing in the brake coil. This is approx 3A during brake release, decreasing to 1A for holding the brake in the released state.

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Analogue inputs related to motor

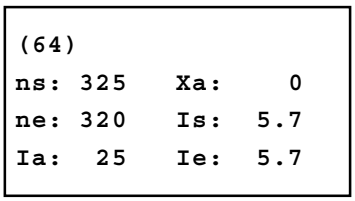
uc	Intermediate circuit voltage in [V]
ut	Source voltage of top transistor in [V]
ub	Drain voltage of bottom transistor in [V]
ia	Armature current in [A]
za	Armature PWM (bottom transistor) in [%]
ns	Set speed in [rpm]
zl	PWM of lift transistor in [%]



MOSFET Temperatures

TMOS	Temperature of traction MOSFETs in °C (at power electronics)
LMOS	Temperature of lift MOSFETs in °C (at power electronics)

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Motor Control

ns	requested speed from Accelerator demand (RPM)
ne	Calculated speed of the motor (RPM)
Ia	Measured armature current (A)
Xa	Armature PWM (%)
Is	requested Field current in Amps (± for direction)
Ie	measured Field current in Amps (± for direction)



Analogue inputs of both processors (Master)

On this window the analogue signals of both processors can be compared for a given input.
The top value is the signal captured directly by the function controller at the port pin.
The bottom value is the signal captured by the safety controller and transmitted serially to the function controller.

u+: Potentiometer supply voltage in [V]

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```
(66)          uc: 10.1V
                :  0.0V
v+: 7.7V
  : 7.7V
```

Analogue inputs of both processors (Master)

On this window the analogue signals of both processors can be compared for a given input.
The top value is the signal captured directly by the function controller at the port pin.
The bottom value is the signal captured by the safety controller and transmitted serially to the function controller.

v1: Guidance potentiometer signal in [V] (without radiometric or teach-in correction)
uc2: Intermediate circuit voltage of Power Module in [V]

```
(7)   Vmax: 12.5km/h
      Vred:  2.5km/h
      Valm:  0.5Km/h
      Talm:  0
```

General truck parameters

Vmax: Max. Set speed in [km/h] (with max. accelerator)
Adjustment range: 5.0 km/h to Vlim (see Window 74)
Adjustment step: 0.2 km/h
Factory setting: 12.5 km/h

Vred: Speed applied when speed override input is released (2S13, 8.5m).
Adjustable 0.5km/h-12.5km/h.
Factory setting: 2.5 km/h

Valm: Speed in [km/h] at which the travel alarm sounds
Adjustable 0.5 - 20.0 km/h in steps of 0.5 km/h
Factory setting: 0.5 km/h

Talm: Type of Alarm
0: No alarm
1: Forwards and Reverse (Continuous bleep)
2: Reversing only (Continuous bleep)
3: Forwards only (Continuous bleep)
4: Forwards and reverse (Intermittent bleep)
5: Reversing only (Intermittent bleep)
6: Forwards only (Intermittent bleep)
Factory setting: 1

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```
(71)
   Default (7):1

  (Default = <CE>)
```

Set truck parameters to default values

If window 7 parameters are already at their default values then “Default (7):1” is displayed
otherwise “Default (7):0” is displayed
Press the DEL key to reset to defaults.

```
(72)
Ilbc: 130A  Bdly: 1
Ibrk: 200A  Bopt: 0
Accl:  4
```

☞ NOTE: These parameters can only be viewed at diagnostic level but can be changed at MASTER level.

Driving Characteristics

Ilbc Armature current generated during braking by releasing accelerator pedal (LBC)
Adjustment range: 0 A (coasting) to 250 A
Adjustment step: 10 A
Factory setting: 130 A

Ibrk Armature current generated during full braking by selecting opposite direction or operating the brake pedal.
Adjustment range: 250 A to 300 A
Adjustment step: 10 A
Factory setting: 250 A

Accl Acceleration / Economy Setting
1 Low Acceleration, High Economy
4 factory setting
5 High Acceleration, Low Economy

Bopt Sets the level of braking if during driving the seat is vacated of the left foot released (single pedal).
0 = normal fixed 130A (Ilbc default value)
1 = use Ibrk (up to 300A)

Bdly The delay between leaving the seat or left foot switch and the parking brake applying. It is programmable between 1s and 30s, the default being 1s. THIS DOES NOT AFFECT THE STANDARD SEAT DELAY.


```
(73)
Default  (7) :1
Default  (72):1
   (Default=<CE>)
```

Set ALL parameters to default values

If window 7 parameters are already at their default values then “Default (7):1” is displayed
otherwise “Default (7):0” is displayed
If window 72 parameters are already at their default values then “Default (72):1” is displayed
otherwise “Default (72):0” is displayed
Press the DEL key to reset everything to defaults.

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```
(74)
Vlim:  12.5km/h
```

Fixed special version parameters

This window contains the fixed special version parameters, which are only displayed and can not be altered.
Vlim: upper limit of adjustment range of max. set speed (see Window 7)
Factory setting: 12.5 km/h

```
(8)
uld: 8.2V OK
ulm: 7.8V Stored
ulc: 7.8V
```

Teach in of pedal zero position

On this window the accelerator potentiometer can be set to the pedal zero position with “teaching”.
The required teach-in conditions (“OK” is displayed):
1) Handbrake operated
2) Brake pedal operated
3) Accelerator pedal not operated
The teach-in is performed by pressing the ENTER key.
A successful teach-in is acknowledged by the brief display of “stored”.
The displayed data has the following meaning:

u1d:	Guidance potentiometer signal (radiometric) without teach-in correction
u1m:	Value of ‘u1d’ stored at last teach-in as teach-in parameter
u1c:	Guidance potentiometer signal with teach-in correction (correction with consideration of calibration parameter ‘u1m’)

NOTE: The accelerator can be calibrated when the input voltage (u1d) is 7.5V ± 0.9V

If the voltage is outside this range then the potentiometer on the accelerator assembly must be mechanically adjusted.

Also if the accelerator is calibrated close to the limits then spurious error codes (77,87,88) could be generated. This is because the calibration value is only used by the main processor and in this case there will be a large difference between the inputs to the main and safety processors which causes the problem.

The remedy is to ensure the accelerator is mechanically adjusted closer to the 7.5V value before performing the calibration.

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6.5.3.1 LDC FAULT CODES

If the Traction function is cutting out regularly then before turning off the keyswitch, window 2 should be used to display the error number and then the following table used to try and diagnose the fault.

If an intermittent fault is reported then the stored error numbers in diagnostic windows 3 or 31 should be noted down and the following table used to diagnose the fault.

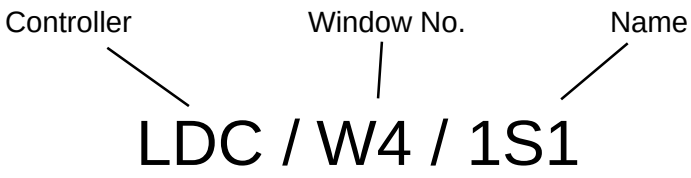
If a diagnosis is not forthcoming then before reporting any problems make sure the error numbers can be quoted on the service report.

An error number displayed in windows 3 or 31 should not be taken as a genuine fault unless the truck is reported to be misbehaving. The numbers may be quoted on service reports but no components should be changed unless a proven fault exists.

☞ NOTE: Numbers 1-19 are only present in window 2 and represent active interlocks rather than faults.

The following Mnemonics have been used to denote diagnostic window contents.

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LDC fault code 1

Description:	Power-up conditions not all met (accelerator zero position signals)
Result:	Creep speed
Fault condition:	Voltage at 1X11:18 is not equal to Vm where Vm = half the Voltage at 1X11:12 LDC / W6 / u1 is not equal to half LDC / W6 / u+ d
Possible cause:	Traction potentiometer operated or setting is incorrect or fault in path 1X11:18 - 1X10:2 - 1A4 (pot signal) or fault in path 1X11:12 - 1X10:4 - 1A4 (+15V) or fault in path 1X11:27 - 1X10:1 - 1A4 (0V) or 24V power supply for electronics too low (1X11:13) or fault in path 1X11:12 - 1X6:1 - 1B3

LDC fault code 2

Description:	Accelerator pedal is at zero position (it is not operated)
Result:	
Fault condition:	7V < 1X11:18 < 8V 7V < LDC / W6 / u1 < 8V
Possible cause:	Traction potentiometer at zero position or setting is incorrect or fault in path 1X11:18 - 1X10:2 - 1A4 (pot signal) or fault in path 1X11:12 - 1X10:4 - 1A4 (+15V) or fault in path 1X11:27 - 1X10:1 - 1A4 (0V)

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LDC fault code 4

Description:	Seat switch not operated. (for single pedal trucks, the left foot switch must also be operated)
Result:	Only braking is enabled
Fault condition:	1X11:16 is not equal to 0V ± 2V LDC / W4 / 1S1 is not equal to 1
Possible cause:	Seat switch is open. The seat is empty or for single pedal truck the left foot switch is open or fault in path 1X11:16 - 1X38:3 - 1S11 - 1X38:2 - 1X32:2 - 1S1 - 1X32:1 - 0V

LDC fault code 7

Description:	The sensor in the traction motor is indicating excessive temperature.
Result:	Reduced speed
Fault condition:	2X1:11 > 3.61V LLC / W6 / t1M1> 160°C LID / W62 / tTM > 160°C
Possible cause:	Traction motor is too hot or faulty connection 2X1:11 - 1X7:3 - 6B1 - 1X7:4 - 0V

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LDC fault code 8

Description:	Parking brake is applied
Result:	Reduced Current limit means that truck will generally not drive against brake but is suitable for hill starts
Fault condition:	LDC / W4 / 1S4 is not equal to 01 or 11 Brake symbol on display is illuminated 1X11:11 is not equal to 0 ± 2V when brake switch operated LDC / W4 / 1S4 is not equal to 1X when brake switch operated (where X doesn't matter)
Possible cause:	Parking brake is not released or Parking brake has a fault (refer to error codes 21 - 25) or fault in path 1X11:11 - X5:9 - 1S4 - X5:10 - 0V

LDC fault code 9

Description:	Service brake operated
Result:	
Fault condition:	LDC / W4 / 1S5 is not equal to 1 1X11:24 is not equal to 0V ±2V
Possible cause:	Service brake switch open or setting is incorrect or fault in path 1X11:24 - 1X14:2 - 1S5 - 1X14:3 - 0V

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LDC fault code 10

Description:	No Direction Selected (single pedal only)
Result:	
Fault condition:	LDC / W42 / 1S13 = 00 00 LDC / W4 / 1S13 is not equal to 100 or 001 when direction switch operated.
Possible cause:	No direction selected when accelerator is operated or fault in path 1X11:9 - 1X9:3 - 1S13 - 1X9:4 - 0V or fault in path 1X11:10 - 1X9:6 - 1S13 - 1X9:4 - 0V or fault in path 1X11:8 - 1X9:5 - 1S13 - 1X9:4 - 0V

LDC fault code 11

Description:	Speed override input is released
Result:	The speed is reduced to “Vred” in window 7 of traction diagnostics. It is used for various UPAs
Fault condition:	1X11:26 is not equal to 0V ± 2V LDC / W4 / 2S13 is not equal to 10
Possible cause:	The forks are above 8.5m or the shorting link in 1X36 is missing or fault in path 1X11:26 - 2X20:22 - 1X36:2 - 2S13 - 1X36:3 - 2X20:16 - 0V

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LDC fault code 12

Description:	Learner Driver A Driver Code Entry Keypad is fitted and the driver currently logged on has been set as a “Learner”.
Result:	Traction speed is reduced to 60% (7.5Km/h)
Fault condition:	not measurable
Possible cause:	The driver is actually a “learner” or he / she has been incorrectly set as a “learner”

LDC fault code 13

Description:	Truck Immobilised A Driver Code Entry Keypad is fitted and no driver is currently logged on. Truck functions are therefore inhibited (except steering).
Result:	Main contactor does not activate
Fault condition:	not measurable
Possible cause:	The main contactor (K1) is released and no functions are operational.

LDC fault code 19

Description:	At least one parameter is not taught or taught incorrectly
Result:	
Fault condition:	LDC / W8 / u1m = ??
Possible cause:	The accelerator neutral voltage has not been taught properly

LDC fault code 20

Description:	Truck Type Error
Result:	
Fault condition:	not measurable
Possible cause:	360° steering has been configured on a twin pedal truck. This combination is not allowed.

LDC fault code 21

Description:	Safety brake error - Gap
Result:	
Fault condition:	LDC / W61 / GAP > 0.60mm TOD5 = “GAP .6” or “GAP.7”
Possible cause:	The calculated gap of the safety brake exceeds the maximum 0.6mm. The brake should be readjusted.

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LDC fault code 22

Description:	Safety brake error - Jammed
Result:	Brake does not release
Fault condition:	TOD5 = “br.St”
Possible cause:	The brake disk does not move when energised. The adjustment is incorrect or the mechanism is stuck.

LDC fault code 23

Description:	Safety brake error - Short Circuit
Result:	Brake does not release
Fault condition:	TOD5 = “br.Sc”
Possible cause:	There is too much current flowing in the brake coil. The brake coil is faulty or fault in path 1X11:25 - 1X19:2 - 1K13 (shorted to another connection)

LDC fault code 24

Description:	Safety brake error - Open Circuit
Result:	Brake does not release
Fault condition:	TOD5 = “br.oc”
Possible cause:	There is no current flowing in the brake coil or fault in path 1X11:25 - 1X19:2 - 1K13 - 1X19:1 - 1F8 - K1

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LDC fault code 25

Description:	Safety brake error - Drive Error
Result:	Main contactor is deactivated
Fault condition:	TOD5 = “dv.Sc”
Possible cause:	The drive circuit in the control module is defective - the brake is energised when it should not be. The module is faulty

LDC fault code 27

Description:	Power Circuit voltage >70V
Result:	PWM cut-off
Fault condition:	1A1:2 > 60V LID / W63 / V48C > 60
Possible cause:	Incorrect battery (80V) or fault in path 1X12:11 - 1X13:11 or fault in path 1A1:2 - K1 - 1F1 - S2

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LDC fault code 28

Description: Emergency stop switch operated
Result:
Fault condition: 1X11:7 is not equal to 0V ± 2v
Possible cause: Emergency stop switch open or setting is incorrect or fault in path 1X11:7 - X3:1 - S2 - X3:2 - 0V (isolator aux switch)

LDC fault code 29

Description: Emergency stop switch operated while driving
Result:
Fault condition: 1X11:7 is not equal to 0V ± 2v
Possible cause: Emergency stop switch open or setting is incorrect
or fault in path 1X11:7 - X3:1 - S2 - X3:2 - 0V (isolator aux switch)
or fault in path 1X13:4 - 1X12:4 (1A1 current sensor)
or fault in path 1X13:3 - 1X12:3 (1A1 current sensor 0V)

LDC fault code 30

Description: Accelerator operated, seat switch not operated
Result:
Fault condition: 1X11:16 is not equal to 0V ± 2V
LDC / W4 / 1S1 is not equal to 1
Possible cause: Seat switch / left foot switch open
or fault in path 1X11:16 - 1X38:3 - 1S11 - 1X38:2 - 1X32:2 - 1S1 - 1X32:1 - 0V
or traction potentiometer setting is incorrect
or fault in path 1X11:18 - 1X10:2 - 1A4 (pot signal)
or fault in path 1X11:12 - 1X10:4 - 1A4 (+15V)
or fault in path 1X11:27 - 1X10:1 - 1A4 (0V)

LDC fault code 31

Description: Accelerator control potentiometer and monitoring potentiometer signals incompatible
Result: LBC braking only
Fault condition: $V_{1X11:18} + V_{1X11:19}$ is not equal to 15 ± 1V
LDC / W6 / u1 + u2 is not equal to 15 ± 1V
Possible cause: Traction potentiometer setting is incorrect
or fault in path 1X11:18 - 1X10:2 - 1A4 (pot signal 1)
or fault in path 1X11:19 - 1X10:3 - 1A4 (pot signal 2)
or fault in path 1X11:12 - 1X10:4 - 1A4 (+15V)
or fault in path 1X11:27 - 1X10:1 - 1A4 (0V)

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LDC fault code 32

Description:	Accelerator control potentiometer signal not within set limits
Result:	LBC braking only
Fault condition:	1X11:18 > 13V or < 1.5V
	LDC / W6 / u1 > 13V or <1.5V
Possible cause:	Traction potentiometer setting is incorrect
	or fault in path 1X11:18 - 1X10:2 - 1A4 (pot signal)
	or fault in path 1X11:12 - 1X10:4 - 1A4 (+15V)
	or fault in path 1X11:27 - 1X10:1 - 1A4 (0V)

LDC fault code 33

Description:	15V power supply too high
Result:	PWM cut-off
Fault condition:	1X11:12 > 17.5V
	LDC / W6 / u+ > 17.5V
Possible cause:	24V power supply for electronics too high (1X11:13)
	or fault in path 1X11:12 - 1X10:4 - 1A4 (1A4 +15V)
	or fault in path 1X11:12 - 1X6:1 - 1B3 (1B3 +15V)
	or fault in path 1X11:27 - 1X10:1 - 1A4 (1A4 0V)
	or fault in path 1X11:27 - 1X6:3 - 1B3 (1B3 0V)
	or fault in path 1X12:3 - 1X13:3 (0V)

LDC fault code 34

Description:	15V power supply too low
Result:	PWM cut-off
Fault condition:	1X11:12 < 11.3V
	LDC / W6 / u+ < 11.3V
Possible cause:	24V power supply for electronics too low (1X11:13)
	or fault in path 1X11:12 - 1X10:4 - 1A4 (1A4 +15V)
	or fault in path 1X11:12 - 1X6:1 - 1B3 (1B3 +15V)
	or fault in path 1X11:27 - 1X10:1 - 1A4 (1A4 0V)
	or fault in path 1X11:27 - 1X6:3 - 1B3 (1B3 0V)
	or fault in path 1X12:3 - 1X13:3 (0V)

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LDC fault code 35

Description: Invalid combination of directional lever signals
Result: LBC braking only
Fault condition: LDC / W4 / 1S13 is not equal to 010 or 100 or 001 or 111
Two-pedal truck:
1X11:8 and 1X11:9 and 1X11:10 = 0V ± 2V
Single-pedal truck:
1X11:8 = 0V, 1X11:9 is not equal to 0V, 1X11:10 is not equal to 0V (Neutral)
or 1X11:8 is not equal to 0V, 1X11:9 = 0V, 1X11:10 is not equal to 0V (Forward)
or 1X11:8 is not equal to 0V, 1X11:9 is not equal to 0V, 1X11:10 = 0V (Reverse)
Possible cause: Two-pedal truck:
fault in path 1X11:8 - 1X9:5 - coded plug
or fault in path 1X11:9 - 1X9:3 - coded plug
or fault in path 1X11:10 - 1X9:6 - coded plug
or fault in path coded plug - 1X9:4 - 0V
Single-pedal truck:
fault in path 1X11:8 - 1X9:5 - 1S13
or fault in path 1X11:9 - 1X9:3 - 1S13
or fault in path 1X11:10 - 1X9:6 - 1S13
or fault in path coded plug - 1X9:4 - 0V

LDC fault code 36

Description: Steer angle signal error
Result: The Steering indicator will blank out because there is a possible error with the angle from the steering controller.
Fault condition: LDC / W41 / ERR is not equal to 0 (see below for detail)

ERR=1:	DSS1 changed when angle is not equal to 0±15° or ±180°±15°
ERR=2:	DSS2 changed when angle is not equal to 90±15° or -90°±15°
ERR=9:	DSS1 & DSS2 (& DSS3 for 360°) do not agree with angle in range -75° <> -15°
ERR=10:	DSS1 & DSS2 (& DSS3 for 360°) do not agree with angle in range +75° <> +15°
ERR=11:	DSS1 & DSS2 (& DSS3 for 360°) do not agree with angle in range +105° <> +165°
ERR=12:	DSS1 & DSS2 (& DSS3 for 360°) do not agree with angle in range -105° <> -165°
ERR=13:	DSS1 error [M] is not equal to [S] or [M] is not equal to [C]
ERR=15:	DSS2 error [M] is not equal to [S]
ERR=16:	DSS2 error [M] is not equal to [C]

Possible cause: Angle from steering controller does not agree with check sensors DSS1 / DSS2 / DSS3
The steering controller has lost it's angle. It must be taught again by turning through one of the DSS sensors and then turning off and on using the keyswitch or one of the check sensors is defective
or fault in path 1X11:22 - 3X15:7 - 3X8:4 - 3B2 (DSS1)
or fault in path 1X11:23 - 3X15:8 - 3X9:4 - 3B3 (DSS2)
or for 360° steering only, fault in path 6X1:4 - 3X15:9 - 3X10B:2 - 3X10:4 - 3B4 (DSS3)

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LDC fault code 38

Description:	Power circuit voltage >60V shortly after power-up
Result:	PWM cut-off, main contactor opened and safety relay opened.
Fault condition:	1X11:2 > 60V or 1F1 > 60V LDC / W6 / ur > 60.0V
Possible cause:	Incorrect battery (80V ?) or fault in path 1X11:2 - 1F2 - 1F1 - S2 - X10 - G1 or fault in path 1X11:14 - K1 - 1X11:15 or fault in path 1X11:29 - 0V

LDC fault code 39

Description:	Power circuit voltage <35V (battery discharged or battery impedance too high)
Result:	
Fault condition:	1X12:11 < 26V LDC / W62 / uc < 35.0V
Possible cause:	Battery discharged or defective or fault in path 1X12:11 - 1X13:11 - 1A1 or fault in path 1X11:2 - 1F2 - 1F1 - S2 - X10 - G1

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LDC fault code 40

Description:	Power circuit voltage >65.5V while driving (battery impedance too high)
Result:	
Fault condition:	1X12:11 > 65.5V during driving (regen) LDC / W62 / uc > 65.5V during driving (regen)
Possible cause:	Battery defective or fault in path 1X12:11 - 1X13:11 - 1A1

LDC fault code 41

Description:	Safety signal from steering is off.
Result:	Main contactor is opened and safety brake applied.
Fault condition:	1X11:28 is not equal to 0V ± 2V LDC / W4 / STOK is not equal to 1
Possible cause:	Steering Fault - refer to steering diagnostic section or fault in path 1X11:28 - 3X15:6 - 3X1:12 - 3A1

LDC fault code 42

Description:	Safety relay drive and feedback signals incompatible
Result:	Creep speed
Fault condition:	not measurable
Possible cause:	Fault in path 1X11:29 - 0V or fault in 24V power supply for electronics (1X11:13)

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LDC fault code 43

Description:	Safety relay contact does not close. When the relay is activated, the voltage on it's contact is too low .
Result:	Creep speed
Fault condition:	LDC / W5 / Rel = 1 and 1X11:14 (or K1 coil+) is much less that battery voltage
Possible cause:	Fault in path 1X11:14 - K1 - 1X11:15 or fault in path 1X11:2 - 1F2 - 1F1 - S2 - X10 - G1

LDC fault code 44

Description:	Safety relay contact sticks. When the relay is not activated, the voltage on it's contact is too high
Result:	Creep speed
Fault condition:	With the keyswitch OFF, the voltage at 1X11:14 is approximately battery voltage.
Possible cause:	Fault in path 1X11:14 - K1 - 1X11:15

LDC fault code 45

Description:	Power circuit voltage can not reach 40V during charging
Result:	Main contactor does not close
Fault condition:	Voltage difference (1X11:14 <> 1X12:11) > 8V When this fault occurs, the charge relay is switched off so the voltages on the above contacts are no longer meaningful.
Possible cause:	Battery discharged or defective or fault in path 1F1 - 1F2 - X12:1 - K2 or fault in path K2 - K3 - R1 - X12:2 - 1F8 - 1A1:2 - 1A1:1 - 0V or fault in path 1X11:6 - X12:5 - K2 - X12:3 - 0V or fault in path 1X12:11 - 1X13:11 or fault in path 1X11:14 - K1 - 1X11:15 or fault in path 1X11:2 - 1F2 - 1F1 - S2 - X10 - G1

LDC fault code 46

Description:	Line contactor drive circuit signals an error (short?)
Result:	PWM cut-off
Fault condition:	LDC/ W51 / K1 = xxx 1 xxx. Where xxx can be anything
Possible cause:	Fault in path 1X11:14 - K1 - 1X11:15 or fault in path 1X11:29 - 0V or fault in 24V power supply for electronics (1X11:13)

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LDC fault code 47

Description:	Line contactor drive and feedback signals incompatible.
Result:	PWM cut-off
Fault condition:	LDC/ W51 / K1 = xxx 1 yyy. Where xxx and yyy vary more than 20% between each other
Possible cause:	fault in path 1X11:14 - K1 - 1X11:15 or fault in path 1X11:29 - 0V or fault in 24V power supply for electronics (1X11:13)

LDC fault code 48

Description:	Line contactor contact does not close or high impedance contact Power circuit voltage varies more than 5V from the voltage at the main positive side for more than 1s.
Result:	Creep speed
Fault condition:	Voltage difference (1X11:14 <> 1X12:11) > 5V
Possible cause:	Fault in path S2 - 1F1 - K1 - 1A1:2 or fault in path 1X12:11 - 1X13:11 - 1A1 - 1A1:1 - 0V or fault in path 1X11:14 - K1 - 1X11:15 or fault in path 1X11:2 - 1F2 - 1F1

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LDC fault code 49

Description:	Line contactor contact sticks or is shorted During the charging phase of the capacitors, the power circuit voltage is too high and cannot be discharged.
Result:	PWM cut-off and main contactor not enabled
Fault condition:	With the keyswitch OFF, the voltage at 1X12:11 (or 1A1:2) is approximately battery voltage.
Possible cause:	Line contactor or charging relay (K2) sticks or fault in path 1X11:6 - X12:5 - K2:86 - K2:85 - X12:3 - 0V or fault in path 1X11:14 - K1 - 1X11:15 (contactor) or fault in path 1X12:11 - 1X13:11 - 1A1 (cap voltage) or fault in path 1X12:22 - 1X13:22 (Field 1) or fault in path 1X12:21 - 1X13:21 (Field 2) or fault in path 1X12:13 - 1X13:13 (0V PWM)

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LDC fault code 50

Description:	Traction motor temperature sensor error The traction motor temperature sensor is giving a signal outside the usual operating range.
Result:	Creep speed
Fault condition:	LDC / W6 / t2M1 > 250°C or < -50°C LLC / W6 / t2M1 > 250°C or < -50°C An open circuit sensor will always show 300°C
Possible cause:	Faulty connection 2X1:11 - 1X7:3 - SENSOR - 1X7:4 - 0V or Faulty temperature sensor in motor. With 1X7 disconnected, on fixed connector (motor side) 1X7:3 - 1X7:4 =600 Ohm at 20°C increasing to 1700 Ohm at 200°C

LDC fault code 52

Description:	Voltage V_{DS} is too low of switched off top transistor when high current is flowing from power unit 1A1.
Result:	PWM cut-off and main contactor opened and safety relay opened
Fault condition:	1X12:14 > 5V when braking
Possible cause:	Fault in path 1X12:14 - 1X13:14 (voltage at top transistor) or fault in path 1X12:12 - 1X13:12 (armature PWM top transistor) or fault in path 1X12:13 - 1X13:13 (0V PWM) or faulty power block

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LDC fault code 53

Description:	Voltage V_{DS} is too high at the switched on top transistor on the power unit 1A1.
Result:	low speed
Fault condition:	When truck is stationary, the voltage at 1X12:14 is significant lower than the battery voltage
Possible cause:	Fault in path 1X12:14 - 1X13:14 (voltage at top transistor) or fault in path 1X12:12 - 1X13:12 (armature PWM top transistor) or fault in path 1X12:13 - 1X13:13 (0V PWM) or faulty power block

LDC fault code 54

Description:	Voltage V_{DS} of bottom transistor on power unit is too low when current is flowing.
Result:	PWM cut-off and main contactor opened and safety relay opened
Fault condition:	1X12:15 is approximately 0V when driving
Possible cause:	Fault in path 1X12:15 - 1X13:15 (voltage at bottom transistor) or fault in path 1X12:20 - 1X13:20 (armature PWM bottom transistor) or fault in path 1X12:13 - 1X13:13 (0V PWM) or faulty power block

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LDC fault code 55

Description:	Voltage V_{DS} of the bottom transistor of power module is too high for set PWM
Result:	Low speed
Fault condition:	LDC / W62 / ub > (100% - za) x uc
Possible cause:	Fault in path 1X12:15 - 1X13:15 (voltage at bottom transistor) or fault in path 1X12:20 - 1X13:20 (armature PWM bottom transistor) or fault in path 1X12:13 - 1X13:13 (0V PWM) or faulty power block

LDC fault code 56

Description:	Fault signal of traction power electronics drive circuit
Result:	PWM cut-off
Fault condition:	not measurable
Possible cause:	Fault in path 1X12:25 - 1X13:25 or fault in path 1A1:2 - 1A1:1 (motor circuit, power electronics) or faulty power block

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LDC fault code 57

Description:	The Traction MOSFET temperature sensor is giving an incorrect signal
Result:	low speed
Fault condition:	Voltage on 1X12:16 ranges from 0.9V to 5.08V over the range -50°C to 200°C. The voltage at 1X12:16 is outside these limits. The voltage at 20°C should be 2.41V LDC / W63 / TMOS > 200°C or < -50°C An open circuit sensor will always show 300°C
Possible cause:	Faulty connection 1X12:16 - 1X13:16 or Faulty temperature sensor in power block.

LDC fault code 58

Description:	The Traction MOSFETs are too hot
Result:	Creep speed
Fault condition:	Voltage on 1X12:16 > 3.61V LDC / W63 / TMOS > 90°C
Possible cause:	You are working too hard or fault in path 1X12:16 - 1X13:16 or the power block heatsink unit fan (9M1) is malfunctioning or there is a fault with either the power block or the pump motor.

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LDC fault code 59

Description:	Field Current Sensor Defect. The signal from the current sensor is not within the expected range (5-30A)
Result:	PWM cut-off and main contactor opened and safety relay opened.
Fault condition:	LDC / W64 / Ie < 2* or > 35* *Note: At standstill current oscillates ±5A and during use is +ve for one direction and –ve for the other. The limits stated above are the absolute values (i.e. without the + or – sign).
Possible cause:	Fault in path 1X12:8 – 1X6:2 (signal) or fault in path 1X11:27 – 1X6:3 (0V) or fault in path 1X11:12 – 1X6:1 (+15V) or Sensor 1B3 installed incorrectly (reversed) or Sensor 1B3 faulty.

LDC fault code 65

Description:	Defective Safety signal from steering The safety signal from steering should be off (24V) during the 1st 3 seconds after switch on. This was not the case on this occasion.
Result:	Creep speed
Fault condition:	not measurable
Possible cause:	The signal must be open during the 1st two seconds after power is applied. There is a short between 1X11:28 and 0V or the steering controller is defective (short between 3X1:12 and 3X1:5 with 3X1 removed)

LDC fault code 66

Description:	Hydraulic error signal in 1A1
Result:	No hydraulic PWM enable signal from 1A1
Fault condition:	not measurable
Possible cause:	Fault in path 1X12:26 - 1X13:26 or fault in path 1A1:2 - 1A1:3 (motor circuit, power electronics) or faulty power block

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The following error codes indicate a possible fault within the traction control module. These codes can accompany one of the error codes already explained previously - in this case these codes should be ignored and the previously explained one used as the primary fault.

If the truck has loss of function because of these then the module should be replaced.

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LDC fault code 71

Description: The safety processor has cut out the traction function
Result:
Fault condition: not measurable
Possible cause: Can result from other fault codes
Possible Fault within control module.

LDC fault code 72

Description: Accelerator potentiometer
The signal output by the main processor and that measured by the safety processor are not compatible.
Result: Slow traction.
Fault condition: LDC / W66 / v1 : x.xV
z.zV
x.xV is not equal to z.zV
Possible cause: Possible Fault within control module.

LDC fault code 73

Description: Motor Excitation (Field)
The signal output by the main processor and that measured by the safety processor are not compatible.
Result: Slow traction.
Fault condition: Not measurable
Possible cause: Possible Fault within control module.

LDC fault code 74

Description: Digital inputs
The signal measured by the main processor and that measured by the safety processor are not compatible.
Result: Slow traction.
Fault condition: Not measurable
Possible cause: Possible Fault within control module.

LDC fault code 75

Description: Processor Communication
There has been a break in communication between the main and safety processors.
Result: Slow traction.
Fault condition: Not measurable
Possible cause: Possible Fault within control module.

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LDC fault code 77

Description:	"Checkup" / Motor Model (Main Processor) The output signals to the motor do not correspond to the measured currents from the motor.
Result:	No Traction
Fault condition:	Not measurable
Possible cause:	Can result from other fault codes Motor circuit fault or Motor fault or accelerator neutral position needs resetting see note with Window 8 or Possible Fault within control module.

LDC fault code 80

Description:	Processor Communication An unexplained error code was received from the safety processor.
Result:	Main contactor release
Fault condition:	Not measurable
Possible cause:	Possible fault within control module.

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LDC fault code 81

Description:	Safety Relay During the initial operation of the output, the circuit is tested but on this occasion a fault has been found
Result:	Main Contactor Release
Fault condition:	Not measurable
Possible cause:	Possible Fault within control module.

LDC fault code 82

Description:	Main Contactor During the initial operation of the output, the circuit is tested but on this occasion a fault has been found
Result:	Main Contactor Release
Fault condition:	Not measurable
Possible cause:	Possible Fault within control module.

LDC fault code 83

Description:	PWM Drive During the initial operation of the output, the circuit is tested but on this occasion a fault has been found
Result:	Main Contactor Release
Fault condition:	Not measurable
Possible cause:	Possible Fault within control module.

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LDC fault codes 87 and 88

Description:	“Checkup” / Motor Model (Safety Processor) The output signals to the motor do not correspond to the measured currents from the motor. One code for each direction.
Result:	Main Contactor Release
Fault condition:	Not measurable
Possible cause:	Can result from other fault codes Motor circuit fault or Motor fault or accelerator neutral position needs resetting see note with Window 8 or Possible Fault within control module.

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6.5.3.2 TRACTION MODULE CHANGE HISTORY

Version	Pt. No.	Date
1.0/1.0	**(390.360.53.75)**	06.00
1.1/1.0	**(390.360.53.75)**	08.00
1.2/1.1	**(390.360.53.75)**	10.00
1.3/(1.2/1.3)	**(390.360.58.19)**	10.00
1.4/1.3	**(390.360.58.60)**	08.02

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TRACTION (LDC) DIAGNOSTIC WINDOW CHART (Software version 1.4 / 1.3)

```
(1)Linde DC Control
Vers:  1.4/1.3
Type:  LDC32R00
Truck: BR115
```

```
(2) 33 28 7
```

```
(3) 33:2  28:1
```

```
(4)
1S13:010   1S4:00
1S1 :1     2S13:00
1S5 :1     STOK:1
```

```
(5)          RL1:0
PWM:0        RL2:0
Rel:0        1B5:0
 K1:0         K2:0
```

```
(6)
u+:14.17V ur :19.8V
u1: 8.23V uc1:10.0V
u2: 7.13V
```

```
(7)  Vmax: 12.5km/h
     Vred:  5.0km/h
     Valm:  0.5Km/h
     Talm:  0
```

```
(8)
uld: 8.2V OK
ulm: 7.8V Stored
ulc: 7.8V
```

```
(31) 33:2  28:1
```

```
(41) MSC
DSS1:000   ANG:    0
DSS2:000   ERR:    0
DSS3:  0   DIR: <<--
```

```
(51) ENA  ERR  STA
PMW:  0
Rel:  0         0
K1:   0    0    0
```

```
(61)
GAP :0.35mm
Ibrk:1.12A
```

```
(71)
   Default (7):1

  (Default = <CE>)
```

```
(32)

 Press CE to clear
```

```
(42)
ena2:11
1S13:00 00
1S1 :11
```

```
(62)         ia: 43A
uc:10.0V     za:  0%
ut: 0.0V     ns:  0
ub: 0.0V     zl:  0%
```

```
(72)
Ilbc: 130A  Bdly: 1
Ibrk: 250A  Bopt: 0
Accl:  4
```

```
(63)

TMOS: 20C  LMOS: 20C
```

```
(73)
Default  (7) :1
Default  (72):1
   (Default=<CE>)
```

```
(64)
ns: 325   Xa:    0
ne: 320   Is:  5.7
Ia:  25   Ie:  5.7
```

```
(74)
Vlim:  12.5km/h
```

```
(65)
u+: 14.1V
  : 14.1V
```

```
(66)        uc: 10.1V
              :  0.0V
v+: 7.7V
  : 7.7V
```

```
(31) 33:2  28:1
```

= Standard Windows (Diagnostic access)

```
(32)

 Press CE to clear
```

= Protected Windows (Master access)

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6.5.4 LLC DIAGNOSTIC WINDOWS

```
(1)Linde Load CTRL
Vers:  1.5/1.1
Type:  LLC32R00
Truck: BR115/00
```

Home Page

Shows controller's details
Vers: Version numbers of the main and safety software
Type: Reference for the required help file name
Truck: Truck range and UPA version of the software (/00)

```
(11)
SW-ID:  121814261061
  UC1:   V 1.5 UPA#0
  UC2:   V 1.1 UPA#0
```

Software identification

Shows the controller's software build in more detail
SW-ID: A unique number that identifies the software - even if the version number is not changed, this number will be different to any other.
UC1: Version number of the main processor software, plus the UPA version.
UC2: Version number of the safety processor software, plus the UPA version.
NOTE: The UPA versions in this window allow the compatibility between UC1 and UC2 to be comfirmed.

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```
(2) 33 28 7
```

Current Faults/information

Active faults and information on controller

```
(3) 33:2  28:1
```

Fault History

Shows the faults that have been logged. This window may be cleared at Diagnostic level by pressing CE or DEL but codes remain in window 31 with the confirmation symbol '/' (eg 33.2/)

```
(31) 33:2  28:1
```

Fault History (total)

As window 3 but total level. Even if 3 is cleared, the faults remain here.
Window 3 information can also be cleared from this window using CE or DEL

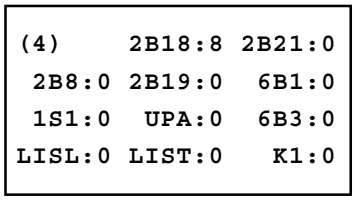
```
(32)

 Press CE to clear
```

Clear entire Fault History (Master)

Clears all faults from windows 3 and 31, by pressing CE or DEL.

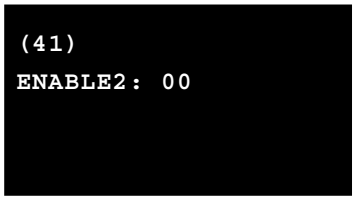
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Digital Inputs

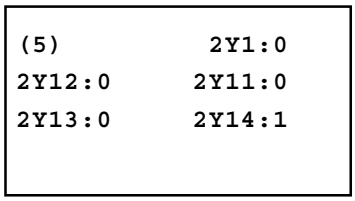
Shows the states of digital inputs to the controller. An active state is represented by a ‘1’ and an inactive state ‘0’.

2B21	Reach sensor B	**2B18**	Reach sensor A
LISL	Lift Slow (encoder)	**LIST**	Lift Stop (encoder) Sensor 2B20
1S1	Seat switch	**2B8**	Lift rpm sensor
6B1	Traction Brush	**6B2**	Lift Brush
2B19	Enable Lift (pin 23) (If fitted)	**UPA**	UPA input
K1	State of main contactor, 1= Energised 0=released		



Safety Processor Inputs

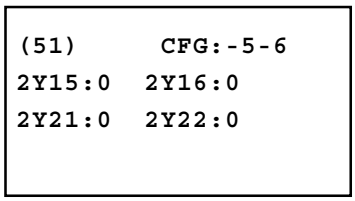
ENABLE2=safety relay enable uC1/uC2



Digital Outputs (Lift, tilt and sideshift valves)

Shows the states of digital outputs from the controller. An active state is represented by a ‘1’ and an inactive state ‘0’.

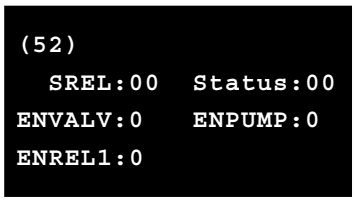
2Y1	Lift value
2Y11	Tilt forward value
2Y12	Tilt back value
2Y13	Sideshift left value
2Y14	Sideshift right value



Digital Outputs (5th and 6th hydraulics)

Shows the states of digital outputs from the controller. An active state is represented by a ‘1’ and an inactive state ‘0’.

CFG	detected functions
2Y15	5th (1) (or Aux1) value
2Y16	5th (2) (or Aux2) value
2Y21	6th (1) value
2Y22	6th (2) value

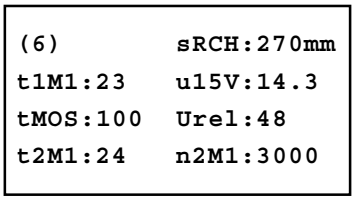


Safety Processor Outputs

SREL	safety relay Drive uC1/uC2
Status	safety relay drive status uC1/uC2
ENVALV	valve enable
ENPWM	pump enable
ENREL1	Open Clamp enable

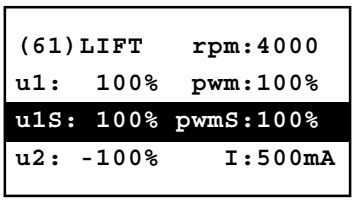
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Analogue Inputs

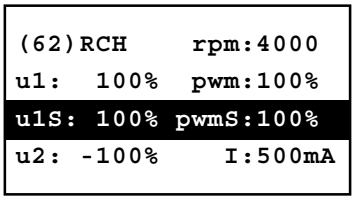
sRCH	reach position (mm)		
t1M1	Trac motor temp	**u15V**	Joystick Supply
tMOS	Lift MOS Temp.	**Urel**	Vbatt (at relay)
t2M1	Lift Motor temp.	**n2M1**	Motor Speed



Analogue Inputs/Outputs - Lift / Lower

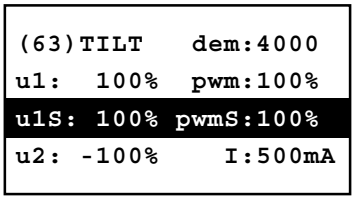
rpm: pump speed requested
u1: Joystick signal to uC1
pwm: output to pump % V_{BATT}
u1S: Joystick signal to uC2
pwmS: pump output seen by uC2
u2: Joystick signal to uC1
I: Current in valves 2Y1 and 2Y2

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Analogue Inputs/Outputs -Reach

rpm: pump speed requested
u1: Joystick signal to uC1
pwm: output to pump % V_{BATT}
u1S: Joystick signal to uC2
pwmS: pump output seen by uC2
u2: Joystick signal to uC1
I: Current in valves 2Y8 and 2Y9



Analogue Inputs/Outputs -Tilt

dem: pump duty requested
u1: Joystick signal to uC1
pwm: output to pump % V_{BATT}
u1S: Joystick signal to uC2
pwmS: pump output seen by uC2
u2: Joystick signal to uC1
I: Current in valves 2Y11 and 2Y12

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```
(64)SHIFT  dem:4000
u1:  100%  pwm:100%
u1S: 100% pwmS:100%
u2: -100%     I:500mA
```

Analogue Inputs/Outputs - Sideshift

dem: pump duty requested
u1: Joystick signal to uC1
pwm: output to pump % V_{BATT}
u1S: Joystick signal to uC2
pwmS: pump output seen by uC2
u2: Joystick signal to uC1
I: Current in valves 2Y13 and 2Y14

```
(65)5TH    dem:4000
u1:  100%  pwm:100%
u1S: 100% pwmS:100%
u2: -100%     I:500mA
```

Analogue Inputs/Outputs -5th Hydraulics

dem: pump duty requested
u1: Joystick signal to uC1
pwm: output to pump % V_{BATT}
u1S: Joystick signal to uC2
pwmS: pump output seen by uC2
u2: Joystick signal to uC1
I: Current in valves 2Y15 and 2Y16

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```
(66)6TH    dem:4000
u1:  100%  pwm:100%
u1S: 100% pwmS:100%
u2: -100%     I:500mA
```

Analogue Inputs/Outputs -6th Hydraulics

dem: pump duty requested
u1: Joystick signal to uC1
pwm: output to pump % V_{BATT}
u1S: Joystick signal to uC2
pwmS: pump output seen by uC2
u2: Joystick signal to uC1
I: Current in valves 2Y21 and 2Y22

```
(7)
LOWR:100%  LIFT:100%
RCH-:100%  RCH+:100%
```

Function Speeds - Lift, Lower & Reach

Allows speeds and options to be adjusted

LOWR	Lower speed	adjustable **0%-100%**
LIFT	Lift speed	adjustable **50%-100%**
RCH-	reach back speed	adjustable **50%-100%**
RCH+	reach out speed	adjustable **50%-100%**

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```
(71)
TLT-:100%  TLT+:100%
           SHFT:100%
```

Function Speeds - Tilt & Sideshift

Allows overall speed to be restricted 0-100% of default speed. Each direction can be set independently (not sideshift).
0%-100%

```
(72)
HY5-:100%  HY5+:100%
HY6-:100%  HY6+:100%
```

Function Speeds - 5th & 6th

Allows overall speed to be restricted 0-100% of default speed. Each direction can be set independently. **0%-100%**

```
(73)
ST-H: 10.000m
SL-H:  3.500m
SL-W:  0.000m
```

Encoder Settings for lift

All parameters in this window are only available when an encoder is fitted and enabled in the display diagnostics. When no encoder is fitted, “N/A” is displayed.

ST_H Allows the height to be programmed for the soft stop at full lift. Should be set to full lift height - 130mm

SL_H & **SL_W**
Allows a slow area to be defined. This feature is for UPA use and is disabled by SL_W = 0.

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```
(74)
          SLFT: 3
RSLO: 3   SLWR: 3
RSLB: 3   SRCH: 3
```

Smoothness

Allows the smoothness of lift, lower and reach to be adjusted. Affects ramp up and down of each function.

SLFT Smoothness of Lift (1-5)
SLWR Smoothness of Lower (1-5)
SRCH Smoothness of Reach (1-5)
RSLO Smoothness of Reach Out at limit (1-5)*
RSLB Smoothness of Reach Back at limit (1-5)*
* sets the speed at the end of ramp down at the mechanical limit and hence the abruptness of the end of function. 1=very smooth.

```
(75)
UPSL: 3%    LIMW: 50
DNSL: 8%
RAMP: 0.300m
```

LPS parameters

Allows the operation of LPS to be fine tuned

UPSL final speed of lift at stop point (min. speed)
DNSL final speed of lower at stop point (min. speed)
RAMP length of ramp down (250-500mm)
LIMW Sets the width in mm of reach limit for signals output to CANbus (used for UPAs)

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```
(76)
LBDI:  1
OPTR:  1
OPTK:  1
```

Configuration & Options

Allows basic operating characteristics and options to be configured.

LBDI How the lift reacts to the BDI cutout signal
- 1 = Slow Lift [default]
- 0 = No Lift

OPTR selects the type of reach slowdown system
- 1 = New system - reset in centre [default]
- 0 = Old system - reset at back limit

OPTK Allows the new LLC to be used with older LDC's.
- 1 = K1 interlock active - will work only with new LDC
- 0 = K1 interlock disabled - will work with old and new LDC's but errors could be stored if used with a "Driver code Entry" system.

```
(77)
Reset to defaults
<CE> to reset
```

Reset to defaults

Sets windows 7-76 to default values by pressing CE or DEL

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```
(8)      RAW   CAL
Lift :   1.0  -1.7
Reach:   0.3   3.0
```

Joystick Calibration

3 windows for the calibration of the 6 joystick inputs.

This should be used to cancel out any small joystick signals that are due to tolerance of the joysticks. It is NOT intended to be used to rectify faulty joysticks that fail to return to their neutral position.

Calibrating will only ensure that there is an equal "dead time" for each direction of the joystick and will therefore give optimum feel.

```
(81)     RAW   CAL
Tilt :   1.0   2.8
Shift:   2.2   0.2
```

The RAW value is the uncalibrated input from the joystick in % operation.
The CAL value is the calibrated input from the joystick in % operation.

Ensure the joystick is in the neutral position. This is most easily done by releasing the lever from full operation then press ENTER to calibrate the values

```
(82)     RAW   CAL
5th  :   9.5    8.0**
6th  :  -2.3   -9.8
```

** symbol means that the RAW value is outside the warning level of 7.5% but may still be calibrated

!! symbol means that the RAW value is outside the acceptance level of 15% and may not be calibrated

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```
(83)
sRCH: -> OutLim
 460  ->    0
```

Teaching of reach out Limit

sRCH is the current position
OutLim is the stored limit

1. Reach out to mechanical limit
2. Press ENTER
3. The limit is stored

From V1.3 there is an alternative layout for this window if OPTR in window 76 is set to 1

```
(83)
sRCH:  110
 Out:  240
Back: -310
```

Teaching of reach out and Back Limits

sRCH	the current position
Out	the stored out limit
Back	the stored back limit

1. Reach from Back limit to Out mechanical limit
2. Press ENTER
3. The limit is stored (…Stored is displayed next to Out value)
4. Return to Back mechanical limit
5. Press ENTER
6. The limit is stored (…Stored is displayed next to back value)

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6.5.4.1 LLC FAULT CODES

If the hydraulic function is cutting out regularly then before turning off the keyswitch, window 2 should be used to display the error number and then the following table used to try and diagnose the fault.

If an intermittent fault is reported then the stored error numbers in diagnostic windows 3 or 31 should be noted down and the following table used to diagnose the fault.

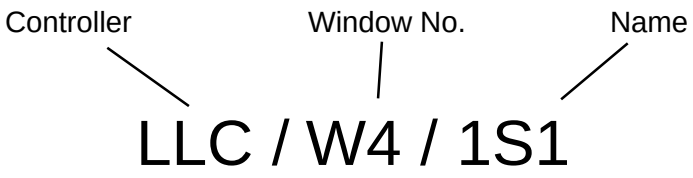
If a diagnosis is not forthcoming then before reporting any problems make sure the error numbers can be quoted on the service report.

An error number displayed in windows 3 or 31 should not be taken as a genuine fault unless the truck is reported to be misbehaving. The numbers may be quoted on service reports but no components should be changed unless a proven fault exists.

☞ NOTE: Numbers 1-19 are only present in window 2 and represent active interlocks rather than faults.

The following Mnemonics have been used to denote diagnostic window contents.

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LLC fault code 1

Description: After switching on the keyswitch, POWER ON checks the control unit for correct external signals and functioning. The following items are checked
- the neutral positions of the joysticks
- the safety relay circuit
- the battery voltage
- communication with the safety processor
- Valve output circuits

If POWER ON recognises any faults, these will be specified in more detail by a second fault number.
If this code appears on it's own then the reason is an incorrect battery voltage.

Result: No Hydraulic functions

Fault condition: see fault No. 2

Possible cause: see fault No. 2

LLC fault code 2

Description: One or more joystick(s) is/are not in the neutral position after POWER ON

Result: No hydraulic functions until levers are all in neutral.

Fault condition: For the following Vm = (V2X1:12 /2)
2X1:39 or 2X1:32 is not equal to Vm ± 0.15V
LLC / W61 / U1is not equal to0±15%
2X1:40 or 2X1:33 is not equal to Vm ± 0.15V
LLC / W62 / U1is not equal to0±15%
2X1:41 or 2X1:26 is not equal to Vm ± 0.15V
LLC / W63 / U1is not equal to0±15%
2X1:24 or 2X1:25 is not equal to Vm ± 0.15V
LLC / W64 / U1is not equal to0±15%
2X1:9 or 2X1:19 is not equal to Vm ± 0.15V
LLC / W65 / U1is not equal to0±15%
2X1:18 or 2X1:8 is not equal to Vm ± 0.15V
LLC / W66 / U1is not equal to0±15%

Possible cause: One or more joystick(s) is/are stuck in the operated condition possibly due to a mechanical malfunction.
Or faulty connection 2X1:39 - 2X15:3 or 2X1:32 - 2X15:5
Or faulty connection 2X1:40 - 2X15:2 or 2X1:33 - 2X15:4
Or faulty connection 2X1:24 - 2X26:3 or 2X1:25 - 2X26:5
Or faulty connection 2X1:41 - 2X26:2 or 2X1:26 - 2X26:4
Or faulty connection 2X1:9 - 2X27:3 or 2X1:19 - 2X27:5
Or faulty connection 2X1:18 - 2X27:2 or 2X1:8 - 2X27:4

LLC fault code 4

Description: The seat switch is not operated

Result: Only lower is permitted

Fault condition: 2X1:21 is not equal to 0V
LLC / W4 / 1S1 is not equal to 1

Possible cause: The seat is not occupied
or the seat switch is malfunctioning or the seat suspension is adjusted too hard for the weight of the driver
or the seat is unplugged
or faulty connection 2X1:21 - 1X32:2 or 1X32:1 to 0V

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LLC fault code 5

Description:	The lift slow input is operated. This is a UPA condition. A slow lift condition.
Result:	Reduced speed lift
Fault condition:	LLC / W4 / LISL is not equal to 0
Possible cause:	Encoder is fitted and height is > LLC / W73 / SL-H and < LLC / W73 / (SL-H + SL-W). SL-W = 0 will disable this feature.

LLC fault code 6

Description:	lift stop feature is active The lift is stopped when a momentary signal is received on the lift stop input. On re-application of the lift lever, lift will continue at slow speed. A momentary signal during lower will reset this feature.
Result:	Slow lift
Fault condition:	LLC / W4 / LIST is not equal to 0 **SEE NOTE*
Possible cause:	The mast is lifted to it's full height and the stop feature has operated. **Encoder Not Fitted**: The sensor 8B5 located on the mast is adjusted incorrectly and is detecting other metallic objects. It should only detect the bottom mast cross member. Or there is a short circuit between the connection 6X1:7 and 0V **Encoder Fitted**: height is > LLC / W73 / ST-H *NOTE: On versions lower than V1.3, this code and input signal will only appear whilst the stop sensor is operated. On V1.3 and above the code will remain until the feature is reset.*

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LLC fault code 7

Description:	The sensor in the lift motor is indicating excessive temperature.
Result:	Reduced speed
Fault condition:	2X1:10 > 3.61V LLC / W6 / t2M1> 130°C LID / W62 / tLM > 130°C
Possible cause:	Lift motor is too hot or faulty connection 2X1:10 - 2X7:3 - 6B3 - 2X7:4 - 0V

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LLC fault code 8

Description:	The reach position is calculated by sensors detecting a “ladder strip” mounted to the chassis base plate. During operation, as the position nears the mechanical limit, the reach speed is progressively reduced to a very slow speed. This code means that this final slow speed has been reached.
Result:	Slow speed reach
Fault condition:	not measurable
Possible cause:	Reach out is being operated at the reach out limit Or Reach back is being operated at the reach back limit Or an incorrect reach out limit has been set in LLC / W83 / OutLim (Out) Or an incorrect reach back limit has been set in LLC / W83 / BackLim (for new Reach system only - see window 7 in previous section) Or The reach “ladder strip” is positioned too far towards the mast giving too long a reach back slowdown (for old Reach system only - see window 7 in previous section).

LLC fault code 9

Description:	For a UPA version of the module 390.360.61.12, a “Reach Back Inhibit” exists when the forks are below a certain height
Result:	No reach back
Fault condition:	2X1:7 is not equal to 0V±2V LLC / W4 / UPA is not equal to 1
Possible cause:	The forks are too low to allow reach back or faulty connection 2X1:7 - 6X63:7 - 6X63:5 - 2X20:15 - 2X19:2 - Height Switch - 2X19:6 - 2X20:16 - 0V

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LLC fault code 10

Description:	The lift enable signal to the module is missing. This could be because a UPA interlock has disabled lift.
Result:	
Fault condition:	2X1:23 is not equal to 0V ±2V LLC / W4 / 2B19 is not equal to 1
Possible cause:	The interlock is valid or faulty connection 2X1:23 - 2X20:13 - 2X19:5 **- Link** - 2X19:6 - 2X20:16 - 0V

LLC fault code 11

Description:	Battery is fully discharged and lift speed has been reduced (or Stopped if LLC / W7 / LBDI = 0)
Result:	
Fault condition:	Display shows flat battery LID / W63 / CAP = 0%
Possible cause:	Battery is empty

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LLC fault code 12

Description: UPA module 390.360.61.13 (Cage interlocks)
The Special function of this module are selected.
No lift unless reached back. Lift and lower are always slow and no other functions are possible - except reach back.
UPA module 390.360.61.15 (KOOI Lift interlock)
The Special function of this module is selected. No lift unless reached back.

Result:

Fault condition: Voltage on 2X1:7 is not equal to 0V ± 2V
LLC / W4 / UPA is not equal to 1

Possible cause: Cage Interlocks
The signal is valid for the UPA or faulty connection 2X1:7 - 6X63:7 - D2 - K1:5 - K1:1 - 6X63:2 - 0V
KOOI
The signal is valid for the UPA or faulty connection 2X1:7 - 6X63:7 - 6X63:5 - 2X20:15 - 2X19:2 - height Switch - 2X19:6 - 2X20:16 - 0V

LLC fault code 13

Description: The main contactor is not energised and so the lift motor cannot run.

Result: Lower only possible

Fault condition: Main contactor released (visible)
LDC / W5 / K1 is not equal to 1

Possible cause: A Driver Code Entry system is fitted and no Driver is logged on
or a fault exists in the LDC (Traction) controller which has resulted in the main contactor being released - refer to LDC section
or a LLC control module with a Version > V1.0 has been fitted to a truck which has an LDC control module <V1.1. Either a new traction module should be fitted or parameter LLC / W76 /OPTK should be set to 0.
Note: If LLC / W76 / OPTK = 0 then error codes could be stored when a “Driver Code Entry” system is fitted. In this case a new LDC should be fitted and LLC / W76 / OPTK set to 1.

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LLC fault code 17

Description: When a new hydraulic module is fitted, the reach limit(s) are not programmed and the reach automatically goes into calibrate mode.

Result:

Fault condition: Operating the reach lever shows “r-CaL“on the display
LLC / W83 / OutLim (or Out) = -1
or LLC / W83 / Back = -1

Possible cause: V1.3 The reach must be fully reached back and then out until the mechanical out limit is reached. Hold the lever until “r-CaL“ is removed from the display. On earlier trucks the software version prior to 1.1, the reach out limit must be programmed from LLC window 83 by pressing ENTER at the out limit.
>= V1.3 The reach must be reached to the furthest mechanical limit and held until the power stops. It must then be reached to the other limit and held until the power stops. r-CaL“ should then automatically be removed from the display and full speed reach possible with smooth rampdowns. This procedure can be repeated using LLC / W83 at any time.
i.e. if reach position is in the back half of reach, the limits should be set in the order Out - Back, otherwise, if reach position is in the out half of reach, the limits should be set in the order Back - Out. This always ensures that the position is referenced in the centre before the limit is calibrated.

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LLC fault code 18

Description: There was no valve detected during the POWER ON checks.
No current was measured from any valve during POWER ON tests. Either this is intended due to there being no mast fitted or the mast connections are unplugged or there is a connection fault

Result: No Hydraulic functions.

Fault condition: Not measurable

Possible cause: Mast / reach unplugged at 2X20 under floor plate or 2X17 in reach carriage.
Or
Faulty connection 2X1:15 - 2X20:1 - 2X17:1

LLC fault code 19

Description: The calibration value in the module for the joysticks has been corrupted and default values are applied.

Result:

Fault condition: Not measurable

Possible cause: Continue using as normal
or if joysticks feel strange, use windows 8, 81 and 82 to re-calibrate.

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LLC fault code 20

Description: Lift valve open circuit.
No current was measured whilst valve was energised. When a valve is controlled there must be greater that 130mA flowing in it.

Result:

Fault condition: With 2X1 disconnected from module, on loose connector…
2X1:15 - 2X1:30 is not equal to 78 Ohm ± 5 Ohm

Possible cause: Faulty connection 2X1:30 - 2X20:5 - 2X17:5 - 2Y1
or Faulty connection 2X1:15 - 2X20:1 - 2X17:1 - 2Y1

LLC fault code 21

Description: Lower valve open circuit
No current was measured whilst valve was energised. When a valve is controlled there must be greater that 130mA flowing in it.

Result:

Fault condition: With 2X1 disconnected from module, on loose connector…
2X1:15 - 2X1:31 is not equal to 27 Ohm ± 5 Ohm

Possible cause: Faulty connection 2X1:31 - 2X20:4 - 2X17:4 - 2Y2
or Faulty connection 2X1:15 - 2X20:1 - 2X17:1 - 2Y2

LLC fault code 22

Description: Reach valve open circuit
No current was measured whilst valve was energised. When a valve is controlled there must be greater that 130mA flowing in it.

Result:

Fault condition: With 2X1 disconnected from module, on loose connector…
2X1:15 - 2X1:16 is not equal to 27 Ohm ± 5 Ohm
or 2X1:15 - 2X1:17 is not equal to 27 Ohm ± 5 Ohm

Possible cause: Faulty connection 2X1:16 - 2X20:3 - 2X17:3 - 2Y8 (Reach Out)
or Faulty connection 2X1:17 - 2X20:2 - 2X17:2 - 2Y9 (Reach Back)
or Faulty connection 2X1:15 - 2X20:1 - 2X17:1 - 2Y8 or 2Y9

LLC fault code 23

Description: Tilt valve open circuit
No current was measured whilst valve was energised. When a valve is controlled there must be greater that 130mA flowing in it.

Result:

Fault condition: With 2X1 disconnected from module, on loose connector…
2X1:15 - 2X1:2 is not equal to 68 Ohm ± 5 Ohm
or 2X1:15 - 2X1:3 is not equal to 68 Ohm ± 5 Ohm

Possible cause: Faulty connection 2X1:2 - 2X20:6 - 2X17:6 - 2Y11 (Tilt Forwards)
or Faulty connection 2X1:3 - 2X20:7 - 2X17:7 - 2Y12 (Tilt Back)
or Faulty connection 2X1:15 - 2X20:1 - 2X17:1 - 2Y11 or 2Y12

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LLC fault code 24

Description: Shift valve open circuit (or Rotate / Clamp)
No current was measured whilst valve was energised. When a valve is controlled there must be greater that 130mA flowing in it.
Result:
Fault condition: With 2X1 disconnected from module, on loose connector…
2X1:15 - 2X1:4 is not equal to 68 Ohm ± 5 Ohm
or 2X1:15 - 2X1:5 is not equal to 68 Ohm ± 5 Ohm
Possible cause: Faulty connection 2X1:5 - 2X20:10 - 2X17:10 - 2Y13 (Shift Left)
or Faulty connection 2X1:4 - 2X20:8 - 2X17:8 - 2Y14 (Shift Right)
or Faulty connection 2X1:15 - 2X20:1 - 2X17:1 - 2Y13 or 2Y14

LLC fault code 25

Description: Current calibration
An internal calibration value for the valve control is invalid so default values are in use
Result: Possible slight reduction in Lower or Reach speeds
Fault condition: Not measurable
Possible cause: Unknown reason for corruption.
Or Incorrect testing at Supplier
If slow speeds are causing a problem, the module should be replaced and returned to supplier for re-testing.

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LLC fault code 26

Description: The Lift Motor temperature sensor is giving an incorrect signal
Result: Slow Lift
Fault condition: LLC / W6 / t2M1 > 250°C or < -50°C
An open circuit sensor will always show 300°C
Possible cause: Faulty connection 2X1:10 - 2X7:3 - SENSOR - 2X7:4 - 0V
or Faulty temperature sensor in motor. With 2X7 disconnected, on fixed connector (motor side)…
2X7:3 - 2X7:4 =600 Ohm at 20°C increasing to 1700 Ohm at 200°C

LLC fault code 27

Description: The MOSFET temperature sensor is giving an incorrect signal
Result: Slow Lift
Fault condition: Voltage on 1X12:17 ranges from 0.9V to 5.08V over the range -50°C to 200°C. The voltage at 1X12:17 is outside these limits. The voltage at 20°C should be 2.41V
LLC / W6 / tMOS > 200°C or < -50°C
LDC / W63 / LMOS > 200°C or < -50°C
An open circuit sensor will always show 300°C
Possible cause: Faulty connection 1X12:17 - 1X13:17
or Faulty temperature sensor in power block.

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LLC fault code 28

Description:	The Lift MOSFETs are too hot
Result:	Pump output is reduced gradually to 0 over the range 90° to 120°. Lift function Slows down
Fault condition:	Voltage on 1X12:17 > 3.61V LLC / W6 / tMOS > 90°C LDC / W62 / LMOS > 90°C
Possible cause:	You are working too hard or fault in path 1X12:16 - 1X13:16 or the power block heatsink unit fan (9M1) is malfunctioning or there is a fault with either the power block or the pump motor.

LLC fault code 30

Description:	Lift or Lower valve drive short circuit There was current measured in the lift or lower valve when it was not operated.
Result:	No Hydraulic functions
Fault condition:	with the lift lever at neutral a voltage exists across either 2X1:15 - 2X1:30 or 2X1:15 - 2X1:31
Possible cause:	If the fault is persistent, the control module should be replaced.

LLC fault code 31

Description:	Reach valve drive short circuit There was current measured in the reach valve when it was not operated.
Result:	No Hydraulic functions
Fault condition:	with the reach lever at neutral a voltage exists across either 2X1:15 - 2X1:16 or 2X1:15 - 2X1:17
Possible cause:	If the fault is persistent, the control module should be replaced.

LLC fault code 32

Description:	Tilt valve drive short circuit There was current measured in the tilt valve when it was not operated.
Result:	No Hydraulic functions
Fault condition:	with the tilt lever at neutral a voltage exists across either 2X1:15 - 2X1:2 or 2X1:15 - 2X1:3
Possible cause:	If the fault is persistent, the control module should be replaced.

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LLC fault code 33

Description:	Sideshift valve drive short circuit There was current measured in the sideshift valve when it was not operated.
Result:	No Hydraulic functions
Fault condition:	with the sideshift lever at neutral a voltage exists across either 2X1:15 - 2X1:4 or 2X1:15 - 2X1:5
Possible cause:	If the fault is persistent, the control module should be replaced.

LLC fault code 34

Description:	The 15V supply to the joysticks is either too high or too low. Either the module is defective or there is an external influence on the voltage.
Result:	No Hydraulic functions
Fault condition:	Voltage on 2X1:12 is not equal to 14.3V ± 3V (11.3V to 17.5V)
Possible cause:	Defective Joystick or short circuit from 2X1:12 to somewhere else or defective module

LLC fault code 35

Description:	Lift/Lower valve overcurrent There was too much current measured in the valve during operation. The maximum current allowed is 1A.
Result:	No Lift or Lower
Fault condition:	not measurable
Possible cause:	the valve coil is short circuit or short circuit between 2X1:30 and another supply (24V or 48V) or short circuit between 2X1:31 and another supply (24V or 48V)

LLC fault code 36

Description:	Reach Valve overcurrent There was too much current measured in the valve during operation. The maximum current allowed is 1A.
Result:	No Reach
Fault condition:	not measurable
Possible cause:	the valve coil is short circuit or short circuit between 2X1:16 and another supply (24V or 48V) or short circuit between 2X1:17 and another supply (24V or 48V)

LLC fault code 37

Description:	Tilt valve overcurrent There was too much current measured in the valve during operation. The maximum current allowed is 1A.
Result:	No Tilt
Fault condition:	not measurable
Possible cause:	the valve coil is short circuit or short circuit between 2X1:2 and another supply (24V or 48V) or short circuit between 2X1:3 and another supply (24V or 48V)

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LLC fault code 38

Description:	Sideshift Valve overcurrent There was too much current measured in the valve during operation. The maximum current allowed is 1A.
Result:	No Sideshift
Fault condition:	not measurable
Possible cause:	the valve coil is short circuit or short circuit between 2X1:4 and another supply (24V or 48V) or short circuit between 2X1:5 and another supply (24V or 48V)

LLC fault code 39

Description:	The battery voltage is either too low or too high The battery is either over discharged or the wrong battery is fitted.
Result:	Truck will not start (see fault 1) or truck ceases to operate if discharged during use.
Fault condition:	2X1:1 <33V or >60V LID / W63 / V48C < 33 or > 60
Possible cause:	The battery is over discharged or the battery is the wrong voltage or the module is faulty

LLC fault code 40

Description:	The two signals from the lift joystick do not correspond to the same degree of operation (they do not match each other)
Result:	No Lift or Lower
Fault condition:	The voltage difference between 2X1:39 and half the potentiometer supply is not the same as the voltage difference between 2X1:32 and half the potentiometer supply (±0.3V). LLC / W61 / U1= -U2 (± 10%) or -U1=U2 (± 10%)
Possible cause:	Defect in the joystick or faulty connection 2X1:39 - 2X15:3 or faulty connection 2X1:32- 2X15:5 or short circuit between either of the above and another connection.

LLC fault code 41

Description:	The two signals from the reach joystick do not correspond to the same degree of operation (they do not match each other)
Result:	No Reach
Fault condition:	The voltage difference between 2X1:40 and half the potentiometer supply is not the same as the voltage difference between 2X1:33 and half the potentiometer supply (±0.3V). LLC / W62 / U1= -U2 (± 10%) or -U1=U2 (± 10%)
Possible cause:	Defect in the joystick or faulty connection 2X1:40 - 2X15:2 or faulty connection 2X1:33- 2X15:4 or short circuit between either of the above and another connection.

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LLC fault code 42

Description:	The two signals from the tilt joystick do not correspond to the same degree of operation (they do not match each other)
Result:	No tilt
Fault condition:	The voltage difference between 2X1:41 and half the potentiometer supply is not the same as the voltage difference between 2X1:26 and half the potentiometer supply (±0.3V). LLC / W63 / U1= -U2 (± 10%) or -U1=U2 (± 10%)
Possible cause:	Defect in the joystick or faulty connection 2X1:41 - 2X15:2 or faulty connection 2X1:26- 2X15:4 or short circuit between either of the above and another connection.

LLC fault code 43

Description:	The two signals from the sideshift joystick do not correspond to the same degree of operation (they do not match each other)
Result:	No sideshift
Fault condition:	The voltage difference between 2X1:24 and half the potentiometer supply is not the same as the voltage difference between 2X1:25 and half the potentiometer supply (±0.3V). LLC / W64 / U1= -U2 (± 10%) or -U1=U2 (± 10%)
Possible cause:	Defect in the joystick or faulty connection 2X1:24 - 2X15:3 or faulty connection 2X1:25- 2X15:5 or short circuit between either of the above and another connection.

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LLC fault code 44

Description:	The two signals from the 5th hydraulic function joystick do not correspond to the same degree of operation (they do not match each other)
Result:	No 5th hydraulics
Fault condition:	The voltage difference between 2X1:9 and half the potentiometer supply is not the same as the voltage difference between 2X1:19 and half the potentiometer supply (±0.3V). LLC / W65 / U1= -U2 (± 10%) or -U1=U2 (± 10%)
Possible cause:	Defect in the joystick or faulty connection 2X1:9 - 2X15:3 or faulty connection 2X1:19- 2X15:5 or short circuit between either of the above and another connection.

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LLC fault code 45

Description:	The two signals from the 6th hydraulic function joystick do not correspond to the same degree of operation (they do not match each other)
Result:	No 6th hydraulics
Fault condition:	The voltage difference between 2X1:8 and half the potentiometer supply is not the same as the voltage difference between 2X1:18 and half the potentiometer supply (±0.3V). LLC / W66 / U1= -U2 (± 10%) or -U1=U2 (± 10%)
Possible cause:	Defect in the joystick or faulty connection 2X1:18 - 2X15:2 or faulty connection 2X1:8- 2X15:4 or short circuit between either of the above and another connection.

LLC fault code 46

Description:	One or both of the signals from the lift joystick are outside the permitted range and the value suggests a cable fault.
Result:	No Lift or Lower
Fault condition:	Voltage at 2X1:39 <1.3V or >12.8V LLC / W61 / U1 < -150% or >+150% Voltage at 2X1:32 <1.3V or >12.8V LLC / W61 / U2 < -150% or >+150%
Possible cause:	Defect in the joystick or faulty connection 2X1:12 - 2X15:1 or faulty connection 2X1:27- 2X15:6 or short circuit between 2X1:39 and another connection or short circuit between 2X1:32 and another connection

LLC fault code 47

Description:	One or both of the signals from the reach joystick are outside the permitted range and the value suggests a cable fault.
Result:	No reach
Fault condition:	Voltage at 2X1:40 <1.3V or >12.8V LLC / W62 / U1 < -150% or >+150% Voltage at 2X1:33 <1.3V or >12.8V LLC / W62 / U2 < -150% or >+150%
Possible cause:	Defect in the joystick or faulty connection 2X1:12 - 2X15:1 or faulty connection 2X1:27- 2X15:6 or short circuit between 2X1:40 and another connection or short circuit between 2X1:33 and another connection

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LLC fault code 48

Description:	One or both of the signals from the tilt joystick are outside the permitted range and the value suggests a cable fault.
Result:	No tilt
Fault condition:	Voltage at 2X1:41 <1.3V or >12.8V LLC / W63 / U1 < -150% or >+150% Voltage at 2X1:26 <1.3V or >12.8V LLC / W63 / U2 < -150% or >+150%
Possible cause:	Defect in the joystick or faulty connection 2X1:12 - 2X26:1 or faulty connection 2X1:27- 2X26:6 or short circuit between 2X1:41 and another connection or short circuit between 2X1:26 and another connection

LLC fault code 49

Description:	One or both of the signals from the sideshift joystick are outside the permitted range and the value suggests a cable fault.
Result:	No sideshift
Fault condition:	Voltage at 2X1:24 <1.3V or >12.8V LLC / W64 / U1 < -150% or >+150% Voltage at 2X1:25 <1.3V or >12.8V LLC / W64 / U2 < -150% or >+150%
Possible cause:	Defect in the joystick or faulty connection 2X1:12 - 2X26:1 or faulty connection 2X1:27- 2X26:6 or short circuit between 2X1:24 and another connection or short circuit between 2X1:25 and another connection

LLC fault code 50

Description:	One or both of the signals from the 5th hydraulic function joystick are outside the permitted range and the value suggests a cable fault.
Result:	No 5th hydraulics
Fault condition:	Voltage at 2X1:9 <1.3V or >12.8V LLC / W65 / U1 < -150% or >+150% Voltage at 2X1:19 <1.3V or >12.8V LLC / W65 / U2 < -150% or >+150%
Possible cause:	Defect in the joystick or faulty connection 2X1:12 - 2X27:1 or faulty connection 2X1:27- 2X27:6 or short circuit between 2X1:9 and another connection or short circuit between 2X1:19 and another connection

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LLC fault code 51

Description:	One or both of the signals from the 6th hydraulic function joystick are outside the permitted range and the value suggests a cable fault.
Result:	No 6th hydraulics
Fault condition:	Voltage at 2X1:18 <1.3V or >12.8V LLC / W66 / U1 < -150% or >+150% Voltage at 2X1:8 <1.3V or >12.8V LLC / W66 / U2 < -150% or >+150%
Possible cause:	Defect in the joystick or faulty connection 2X1:12 - 2X27:1 or faulty connection 2X1:27- 2X27:6 or short circuit between 2X1:18 and another connection or short circuit between 2X1:8 and another connection

LLC fault code 52

Description:	One or both of the signals from the lift joystick are outside the permitted range and the value suggests a defective joystick or faulty connection.
Result:	No Lift or Lower
Fault condition:	Voltage at 2X1:39 <2.3V or >12V LLC / W61 / U1 < -125% or >+125% Voltage at 2X1:32 <2.3V or >12V LLC / W61 / U2 < -125% or >+125%
Possible cause:	Defect in the joystick. Operating force is or has been excessive resulting in damage to the joystick. or short circuit between 2X1:39 and another connection or short circuit between 2X1:32 and another connection

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LLC fault code 53

Description:	One or both of the signals from the reach joystick are outside the permitted range and the value suggests a defective joystick or faulty connection.
Result:	No reach
Fault condition:	Voltage at 2X1:40 <2.3V or >12V LLC / W62 / U1 < -125% or >+125% Voltage at 2X1:33 <2.3V or >12V LLC / W62 / U2 < -125% or >+125%
Possible cause:	Defect in the joystick. Operating force is or has been excessive resulting in damage to the joystick. or short circuit between 2X1:40 and another connection or short circuit between 2X1:33 and another connection

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LLC fault code 54

Description: One or both of the signals from the tilt joystick are outside the permitted range and the value suggests a defective joystick or faulty connection.
Result: No tilt
Fault condition: Voltage at 2X1:41 <2.3V or >12V
LLC / W63 / U1 < -125% or >+125%
Voltage at 2X1:26 <2.3V or >12V
LLC / W63 / U2 < -125% or >+125%
Possible cause: Defect in the joystick. Operating force is or has been excessive resulting in damage to the joystick.
or short circuit between 2X1:41 and another connection
or short circuit between 2X1:26 and another connection

LLC fault code 55

Description: One or both of the signals from the sideshift joystick are outside the permitted range and the value suggests a defective joystick or faulty connection.
Result: No sideshift
Fault condition: Voltage at 2X1:24 <2.3V or >12V
LLC / W64 / U1 < -125% or >+125%
Voltage at 2X1:25 <2.3V or >12V
LLC / W64 / U2 < -125% or >+125%
Possible cause: Defect in the joystick. Operating force is or has been excessive resulting in damage to the joystick.
or short circuit between 2X1:24 and another connection
or short circuit between 2X1:25 and another connection

LLC fault code 56

Description: One or both of the signals from the 5th hydraulic function joystick are outside the permitted range and the value suggests a defective joystick or faulty connection.
Result: No 5th hydraulics
Fault condition: Voltage at 2X1:9 <2.3V or >12V
LLC / W65 / U1 < -125% or >+125%
Voltage at 2X1:19 <2.3V or >12V
LLC / W65 / U2 < -125% or >+125%
Possible cause: Defect in the joystick. Operating force is or has been excessive resulting in damage to the joystick.
or short circuit between 2X1:9 and another connection
or short circuit between 2X1:19 and another connection

LLC fault code 57

Description: One or both of the signals from the 6th hydraulic function joystick are outside the permitted range and the value suggests a defective joystick or faulty connection.
Result: No 6th hydraulics
Fault condition: Voltage at 2X1:18 <2.3V or >12V
LLC / W66 / U1 < -125% or >+125%
Voltage at 2X1:8 <2.3V or >12V
LLC / W66 / U2 < -125% or >+125%
Possible cause: Defect in the joystick. Operating force is or has been excessive resulting in damage to the joystick.
or short circuit between 2X1:18 and another connection
or short circuit between 2X1:8 and another connection

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LLC fault code 59

Description:	Aux valve drive short circuit There was current measured in the Aux1 or Aux2 valves when 5th or 6th were not operated.
Result:	No Hydraulic functions
Fault condition:	with the 5th / 6th lever(s) at neutral a voltage exists across either 2X1:15 - 2X1:20 or 2X1:15 - 2X1:6 LLC / W51 / CFG = “!5!6”
Possible cause:	If the fault is persistent, the control module should be replaced.

LLC fault code 60

Description:	5th or 6th valve drive short circuit There was current measured in the 5th or 6th valves when 5th or 6th were not operated.
Result:	No Hydraulic functions
Fault condition:	with the 5th / 6th lever(s) at neutral a voltage exists across either 2X1:15 - 2X1:14 or 2X1:15 - 2X1:28 LLC / W51 / CFG = “!5!6”
Possible cause:	If the fault is persistent, the control module should be replaced.

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LLC fault code 61

Description:	With moderate power applied to the pump motor, there was no signal from sensor 2B8
Result:	Operation of all functions continue but “open loop” control is applied resulting in loss of controllability at very low speeds. This code can appear if the LLC is requesting the pump to turn but nothing happens. Because this request is sent via CAN to the LDC which in turn controls the Power Unit which in turn controls the motor, a fault in any one of these devices will cause the motor to not turn and the error code will be generated.
Fault condition:	LLC / W6 / n2M1= 0 whilst pump motor is running or at high pump speed. LDC / W62 / zl > 0 and motor not turning. This is the signal from the LLC received by the LDC
Possible cause:	Faulty connection 2X1:36 - 2X83:2 or Voltage at 2X83:1 is not equal to 24V ± 5V or Voltage at 2X83:3 is not equal to 0V ± 1V or sensor 2B8 on top of the pump motor is incorrectly adjusted or defective. Sensor gap should be 2-3mm. Smaller gaps will result in loss of signal at higher speeds. Ensure that n2M1 reads 4000 rpm ±100 at full lift speed in free lift area. or LLC / W76 / OPTK is set to 0 and a hydraulic function has been operated whilst “logged off” (Drive Code Entry only) or Module 1A1 is defective (power block) or Module 1A2 is defective (LDC) or 2M1 (or cable) is defective

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LLC fault code 62

Description:	There could be a problem with one of the reach sensors 2B18 or 2B21. The sensors should count the bars on the “ladder strip” and the signals on the sensors should alternate. The controller detected several signals from one sensor without any from the other
Result:	normal operation (information only)
Fault condition:	LLC / W4 / 2B18, 2B21 should switch alternately 0,0 - 1,0 - 1,1 - 0,1 - 0,0 etc. LLC / W6 / sRCH will count up and down correctly as the reach is moved. The count will not be so uniform around the reset position.
Possible cause:	Defective sensor 2B18 or 2B21 or incorrect sensor adjustment (should be 3.5mm) or damaged segment in “ladder strip” or metal object interfering with sensor

LLC fault code 63

Description:	The stored reach out limit value is outside the allowed range. LLC V1.3 was introduced with a new reach position system to improve slowdown accuracy, ease limit calibration and correct possible position drift. There are therefore 2 explanations for this code.
Result:	
Fault condition:	(for LLC < V1.3) LLC / W83 / Outlim <300 or >1000 (for LLC >= V1.3 and LLC / W7 / OPTR = 1) LLC / W83 / Out <100 or >1000 LLC / W83 / Back > -100 or <-1000
Possible cause:	Reprogram using Window LLC / W83

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LLC fault code 64

Description:	The truck has previously been turned off whilst above the reference sensor for the LHI/LPS. This interlock is to prevent full speed operation into lift limit.
Result:	Slow Lift
Fault condition:	not measurable
Possible cause:	The forks must be returned below the sensor to restore full speed operation.

LLC fault code 66

Description:	Aux valve overcurrent There was too much current measured in the valve during operation. The maximum current allowed is 1A.
Result:	No 5th or 6th
Fault condition:	not measurable
Possible cause:	the valve coil is short circuit or short circuit between 2X1:20 and another supply (24V or 48V) or short circuit between 2X1:6 and another supply (24V or 48V)

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LLC fault code 67

Description: 5th / 6th valve overcurrent
There was too much current measured in the valve during operation. The maximum current allowed is 1A.
Result: No 5th or 6th
Fault condition: not measurable
Possible cause: the valve coil is short circuit
or short circuit between 2X1:14 and another supply (24V or 48V)
or short circuit between 2X1:28 and another supply (24V or 48V)

LLC fault code 68

Description: During the POWER ON tests, each valve is operated in quick succession and the current measured. This is to check that there are no short circuits between any valve and 0V resulting in the valve being energised without the LLC knowing. If a short circuit or low impedance exists in this manner then no current will be measured in the LLC.
One or more (but not all*) of the valves does not have current measured.
* If all valves have no measured current then code 18 is generated instead to indicate that no valve is detected. This prevent error codes being stored during production.
Result: No hydraulic functions will operate.
Fault condition: not measurable
Possible cause:

<10 Ohm between 2X1:30 and 0V	or >1 Ohm 2X1:30 - 2Y1
<10 Ohm between 2X1:31 and 0V	or >1 Ohm 2X1:31 - 2Y2
<10 Ohm between 2X1:16 and 0V	or >1 Ohm 2X1:16 - 2Y8
<10 Ohm between 2X1:17 and 0V	or >1 Ohm 2X1:17 - 2Y9
<10 Ohm between 2X1:2 and 0V	or >1 Ohm 2X1:2 - 2Y11
<10 Ohm between 2X1:3 and 0V	or >1 Ohm 2X1:3 - 2Y12
<10 Ohm between 2X1:4 and 0V	or >1 Ohm 2X1:4 - 2Y13
<10 Ohm between 2X1:5 and 0V	or >1 Ohm 2X1:5 - 2Y14

The LLC module could also be faulty if all the above checks are OK

LLC fault code 69

Description: The safety relay failed a test. This can be for one of several reasons
1. During the POWER ON test the relay drive circuit did not operate correctly
2. During the POWER ON test there was a voltage >5V measured on 2X1:15 before the relay was energised.
3. During normal operation of the hydraulics, the relay remains energised and battery voltage appears on 2X1:15. When all joysticks are released, the relay will be de-energised after 5 seconds. If the voltage at 2X1:15 remains high then the code is generated

Result: No hydraulic functions will operate.
Fault condition: POWER ON tests are not measurable
Voltage at 2X1:15 > 24V with joysticks released for 5 seconds or more.
Possible cause: The relay or drive circuit inside the module is defective
or a short circuit exists between 2X1:15 and another connection
or there is excessive noise pickup on 2X1:15 (It is normal to measure up to approx. 15V on this connection during traction).

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The following error codes indicate a possible fault within the lift control module. These code can accompany one of the error code already explained above - in this case these codes should be ignored and the previously explained one used as the primary fault.

If the truck has loss of function because of these then the module should be replaced.

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LLC fault code 72

Description: Joystick Inputs
The signal measured by the safety processor and the main processor are not compatible.
Result: The function related to the faulty signal will operate.
Fault condition: LLC / W61 / U1 and U1S are different or
LLC / W62 / U1 and U1S are different or
LLC / W63 / U1 and U1S are different or
LLC / W64 / U1 and U1S are different or
LLC / W65 / U1 and U1S are different or
LLC / W66 / U1 and U1S are different
A '!' is displayed next to the U1 signal in windows 61-66. For the function at fault look in the respective window 61-66.
Possible cause: Possible fault within control module.

LLC fault code 73

Description: Valve Outputs
The signal output by the main processor and that measured by the safety processor are not compatible.
Result: The function related to the faulty signal will not operate.
Fault condition: A '!' is displayed next to the U1 signal in windows 61-66. For the function at fault look in the respective window 61-66.
Possible cause: Possible fault within control module.

LLC fault code 74

Description: Other Outputs
The signal output by the main processor and that measured by the safety processor are not compatible.
Result: Loss of all functions
Fault condition: not measurable
Possible cause: Possible fault within control module.

LLC fault code 75

Description: Processor Communication
There has been a total loss of communication between the main and safety processors.
Result: Loss of all functions
Fault condition: not measurable
Possible cause: Possible fault within control module.

LLC fault code 76

Description: 15V supply for Joysticks
The 15V supply measured by the safety processor and the main processor are not compatible.
Result: Loss of all functions
Fault condition: not measurable
Possible cause: Possible fault within control module.

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LLC fault code 77

Description: Processor Communication
There has been a break in communication between the main and safety processors.
Result: Loss of all functions
Fault condition: not measurable
Possible cause: Possible fault within control module.

LLC fault code 79

Description: The safety processor has powered up in Factory test mode. This is only possible by applying a predetermined voltage pattern on the joystick inputs that is very difficult to reproduce on a truck but just in case the required condition has been found, normal operation is disabled
Result: Loss of all functions
Fault condition: not measurable
Possible cause: Joysticks are all operated at the same time to their extreme limits or
Unknown - Try switching off and on again

LLC fault code 81

Description: During the initial operation of the safety relay, the circuit is tested but on this occasion a fault has been found
Result:
Fault condition: not measurable
Possible cause: Joysticks are all operated at the same time to their extreme limits or
Unknown - Try switching off and on again

LLC fault code 82

Description: During the initial operation of each valve output, the circuit is tested but on this occasion a fault has been found
Result:
Fault condition: not measurable
Possible cause: Joysticks are all operated at the same time to their extreme limits or
Unknown - Try switching off and on again

LLC fault code 84

Description: The safety processor during its monitoring of the inputs and outputs of the control module has found an error. Generally speaking, an output has occurred without an input request.
Result:
Fault condition: not measurable
Possible cause: Joysticks are all operated at the same time to their extreme limits or
Unknown - Try switching off and on again

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6.5.4.2 LIFT MODULE CHANGE HISTORY

Version	Pt. No.	Date
1.0/1.0	**(390.360.53.68)**	06.00
1.1/1.1	**(390.360.61.08)**	08.00
1.2/1.1	**(390.360.61.08)**	10.00
1.3/1.1	**(390.360.61.10)**	11.01
1.4/1.1	**(390.360.61.28)**	08.02
1.5/1.1	**(390.360.61.33)**	05.03

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HYDRAULIC (LLC) DIAGNOSTIC WINDOW CHART (Software version 1.5 / 1.1)

```
(1)Linde Load CTRL
Vers:  1.5/1.1
Type:  LLC32R00
Truck: BR115/00
```

```
(2) 33 28 7
```

```
(3) 33:2  28:1
```

```
(4)     2B18:8 2B21:0
 2B8:0 2B19:0   6B1:0
 1S1:0   UPA:0   6B3:0
LISL:0 LIST:0    K1:0
```

```
(5)          2Y1:0
2Y12:0       2Y11:0
2Y13:0       2Y14:1
```

```
(6)        sRCH:270mm
t1M1:23    u15V:14.3
tMOS:100   Urel:48
t2M1:24    n2M1:3000
```

```
(7)
LOWR:100%  LIFT:100%
RCH-:100%  RCH+:100%
```

```
(8)      RAW    CAL
Lift :   1.0   -1.7
Reach:   0.3    3.0
```

```
(11)
SW-ID:  121814261061
  UC1:   V 1.5 UPA#0
  UC2:   V 1.1 UPA#0
```

```
(31) 33:2  28:1
```

```
(41)
ENABLE2: 00
```

```
(51)      CFG:-5-6
2Y15:0  2Y16:0
2Y21:0  2Y22:0
```

```
(61)LIFT    rpm:4000
u1:   100%  pwm:100%
u1S: 100% pwmS:100%
u2: -100%     I:500mA
```

```
(71)
TLT-:100%  TLT+:100%
           SHFT:100%
```

```
(81)     RAW    CAL
Tilt :   1.0    2.8
Shift:   2.2    0.2
```

```
(32)

 Press CE to clear
```

```
(52)
  SREL:00   Status:00
ENVALV:0    ENPUMP:0
ENREL1:0
```

```
(62)RCH     rpm:4000
u1:   100%  pwm:100%
u1S: 100% pwmS:100%
u2: -100%     I:500mA
```

```
(72)
HY5-:100%  HY5+:100%
HY6-:100%  HY6+:100%
```

```
(82)     RAW    CAL
5th  :   9.5    8.0**
6th  :  -2.3   -9.8
```

```
(63)TILT    dem:4000
u1:   100%  pwm:100%
u1S: 100% pwmS:100%
u2: -100%     I:500mA
```

```
(73)
ST-H: 10.000m
SL-H:  3.500m
SL-W:  0.000m
```

```
(83)
sRCH: -> OutLim
 460  ->    0
```

or, if OTPR in
Window 76 is set to 1

```
(64)SHIFT   dem:4000
u1:   100%  pwm:100%
u1S: 100% pwmS:100%
u2: -100%     I:500mA
```

```
(74)
           SLFT: 3
RSLO: 3    SLWR: 3
RSLB: 3    SRCH: 3
```

```
(83)
sRCH:  110
 Out:  240
Back: -310
```

```
(65)5TH     dem:4000
u1:   100%  pwm:100%
u1S: 100% pwmS:100%
u2: -100%     I:500mA
```

```
(75)
UPSL: 3%   LIMW:50
DNSL: 8%
RAMP: 0.300m
```

```
(66)6TH     dem:4000
u1:   100%  pwm:100%
u1S: 100% pwmS:100%
u2: -100%     I:500mA
```

```
(76)
LBDI:  1
OPTR:  1
OPTK:  1
```

```
(11)

SW-ID:  XXXXXXXXXXX
```

```
(77)
Reset to defaults
<CE> to reset
```

```
(2) 33 28 7
```

= Standard Windows (Diagnostic access)

```
(66)6TH     dem:4000
u1:   100%  pwm:100%
u1S: 100% pwmS:100%
u2: -100%     I:500mA
```

= Limited diagnostic access
(Highlighted area does not appear in standard software)

```
(32)

 Press CE to clear
```

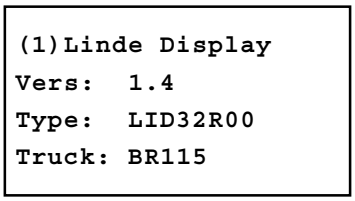
= Protected Windows (Master access)

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Service Training

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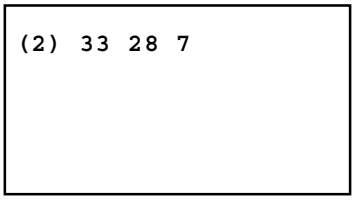
6.5.5 LID DIAGNOSTIC WINDOWS



Home Page

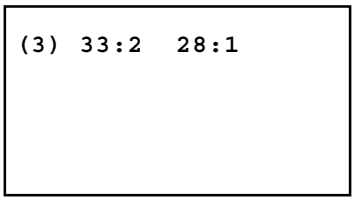
Shows controller's details

Vers:	Version numbers of the main and safety software
Type:	Reference for the required help file name
Truck:	Truck range



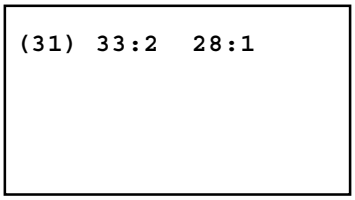
Current Faults/information

Active faults and information on controller



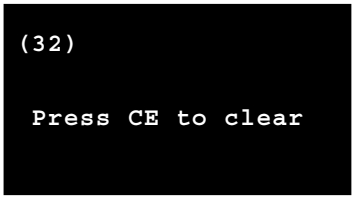
Fault History

Shows the faults that have been logged. This window may be cleared at Diagnostic level by pressing CE or DEL but codes remain in window 31 with the confirmation symbol '/' (eg 33.2/)



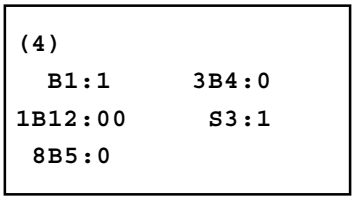
Fault History (total)

As window 3 but total level. Even if Window 3 is cleared, the faults remain here.
Window 3 information can also be cleared from this window using CE or DEL



Clear entire Fault History (Master)

Clears all faults from windows 3 and 31, by pressing CE or DEL.



Digital Inputs

Shows the states of digital inputs to the controller. An active state is represented by a '1' and an inactive state '0'.

B1	Battery locked sensor
1B12	Height Encoder signals (B & A) (Optional)
8B5	Height Encoder reference sensor (Optional)
3B4	DSS3 steering sensor (360° steering)
S1	Brake fluid

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```
(5)
9M1 :    0%
9M2 :  100%
9M3 :  100%
```

Fan Outputs

Fans are controlled depending on MOS and motor temperatures. They are either off, or fully on. 0% = fan off, 100% = fan on

9M1 - heatsink fan
9M2 - traction motor fan
9M3 - pump motor fan

```
(6)
FKHT: 12805
1B12:00    8B5:0
ZONE:0    LEVL:0
```

LHI / LPS

FKHT	current height of forks in mm
1B12	encoder input signals (B & A) as window 4
8B5	encoder reference as window 4
ZONE	active zone selected via keypad.
LEVL	active height selected via keypad (0=manual).

```
(61) NSRV:     8.2
     TOTL:    41.8
     TRAC:     3.4
     LIFT:     1.9
```

Hour Meters

NSRV:	time to next service (counts down)
TOTL:	total time elapsed (truck has been in service)
TRAC:	time traction has been running
LIFT:	time pump motor has been running

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If a NEW display is fitted, then all of these values in Window 61 are loaded into the new display. If however, a display is taken from another truck, then the values displayed will be for the truck from which the display was taken.

from V1.3 onwards

If OPTH in Window 74 is set to either 4 or 5, then the TRAC and LIFT parameters in Window 61 will be replaced by a single TRAC/LIFT parameter, which displays the combined (traction OR lift running) hours from the time this option is selected.

Notes on NSRV

NSRV counts down from the preset service interval (Window 74 NSWP) to zero. If Window 7 NSWI is set to 1, then when NSRV reaches zero, the service due indicator will illuminate. NSRV will continue counting negative indicating how overdue the service is.

The initial service period is always 50.0 hours.

On completing a service, NSWP is reset to the preset service interval (Window 74 NSWP) by pressing <ENTER> followed by <DEL> to confirm.

Up to V1.3

The service can be performed early and the meters reset so long as NSRV is less than 10.0 hours.

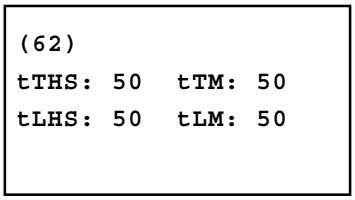
from V1.4 onwards

The service can be performed early and the meters reset so long as at least 80% of the service interval has passed. i.e. when NSRV is less than the following values.

Interval	Reset allowed at	
50	10	Initial service interval
250	50	Service intervals programmed by NSWP
500	100	Service intervals programmed by NSWP
750	150	Service intervals programmed by NSWP
1000	200	Service intervals programmed by NSWP

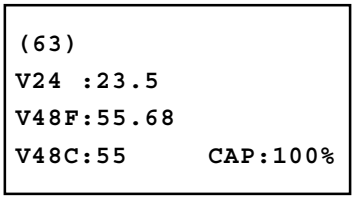
This change in V1.4 allows trucks to be service more conveniently when long distance travel is required.

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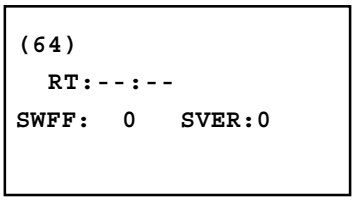
Temperatures

tTHS: traction power unit temperature
tLHS: hydraulic power unit temperature
tTM: traction motor temperature
tLM: pump motor temperature



Voltages

V24 measured voltage of 24V converter
V48F accurate measurement of Battery
V48C approximate measurement of battery
CAP calculated capacity of battery

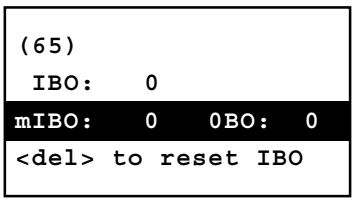


Miscellaneous CAN I/O

RT If a datalogger is fitted then this is the received time that will be displayed as HH:MM. If no data logger is fitted then it shows - -:- -.

SWFF The force feedback applied to the steering wheel as PWM. 100 therefore represents 24V. The value depends on a number of system variables combined, see separate description in steering section.

SVER: *from V1.3 onwards*
Indicates the version of steering controller. Controllers from software version 113/111 will indicate 1 here and use a different calculation for the steering force feedback.This parameter is to help diagnose any problems.



Illegal Brake Operations (IBO)

If the parking brake is used to stop the truck from speed by the driver, the IBO and mIBO counters in this window will be incremented. This will be the case if either the parking brake switch or keyswitch or isolator are operated.
When IBO reaches the IBOT threshold in window 74, the service light on the display will illuminate and remain illuminated until IBO is reset in this window.
factory settings for IBOT: Up to V1.3 = 20, From V1.4 = 0 (OFF)
Pressing DEL in this window will reset IBO and extinguish the service light but mIBO (master IBO) will remain unchanged. mIBO therefore records the total number of such illegal operations.
If the parking brake (emergency brake) is operated by the control system due to a detected fault then the OBO counter is incremented. There is no action taken on this counter, it is just for information. Adding OBO and mIBO gives the total number of brake operations.

NOTE: mIBO and OBO are only visible in Master diagnostics.

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(66)	NSRV:	- 0.1
	TOTL:	-.-
	TRAC:	-.-
	LIFT:	-.-

Reset Hour Meters
(available from display V1.2 onwards)
The Hour meters in Window 61 and on the main display can be reset ONCE ONLY in this window by pressing DEL followed by ENTER to confirm.

During reset the hour meter values are moved from window 61 to this window and the window 61 values are reset

V1.2
All values are reset to 0 except NSRV which is reset to the next service interval.

From V1.3
The hour meter values in window 61 are copied to this window (66) before being reset to predefined values set in window 75. This window therefore keeps a record of the previous hour meter values. Before reset, the window's contents show no hour meters. After the reset is done, window 75 and any further resets are disabled.



Before pressing DEL in this window ensure that the values in window 75 are those required because there is only one chance to perform this action.
NSRV is automatically calculated to the next service interval depending on the reset value of TOTL.

If hour meter option 4 or 5 has been set in window 74 then TRAC is replaced with TRAC/LIFT and LIFT is not displayed.

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(7)		CAB?:	0
DFMD:	1	NSWI:	0
LANG:	0	STMD:	0
DCPT:	0	STFF:	3

General display options

DFMD: Display mode
(You can force one of the following onto the display)
0 = automatic
1 = height indicator
2 = Time
3 = hour meter
4 = loadweight
5 = Warning
6 = error codes (TOD mode 3)
default mode is 0 - “automatic”

LANG: Language for help prompts
V1.0… 0 = English 1 = German 2 = French 3 = Italian
V1.1… 0 = Off 1 = English 2 = German 3 = French 4 = Italian
V1.3… 0 = Off 1 = English 2 = German 3 = French 4 = Italian 5 = Spanish
default setting is English

DCPT: Hour meter display option
0=hours/tenths 1=hours only

CAB?: Select whether a cold store cab is fitted. When a cab is fitted, the heatsink fan runs all the time to ensure fresh air is drawn into the cab.
0=No Cab 1=Cab fitted

NSWI Enables the Next Service warning to the driver. The NSRV counter continues to operate even when the warning is disabled
0=Disabled 1=Enabled

STMD Option for the type of steering indicator
0=Standard 1=Enhanced

STFF Steering wheel force feedback (stiffness)
1 = light, 2 = lighter 3 = default, 4 = heavier, 5 = heavy
NOTE: With the seat unoccupied, the steering wheel will always be free (no torque). The setting here will be used only when the seat is occupied.

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(71)			
HIMD:	1	tLEV:	5s
TYPE:	0	RFHT:	3500
SDIF:	150	MMPP:	4

Height Indicator Parameters

HIMD: Mode.
0 = no height indicator fitted
1 = display absolute height
2 = display shelf mode *
3= LPS mode *

TYPE: Sets the type of encoder fitted
0 = operates above free lift only
1 = operates over full height range

SDIF: The distance in mm of the stack height above the de-stack height (programmed shelf height).

RFHT: The height at which the reference switch operates

MMPP: mm per pulse of the height encoder

tLEV For LPS, sets the delay time allowed between selecting a shelf level and operating the lift/lower lever. After this time the selection will be cancelled.

* NOTE: Before selecting modes 2 or 3, at least one shelf level must be programmed, otherwise the selection will be overridden.

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```
(72)
COFF:1.94V
CAP:  400
ALRM:   0
```

Battery Settings

TYPE The type of battery fitted ***(Up to V1.2 only)***
0=Standard Lead Acid
1=CSM
2=Standard GEL
3=Sonnenschein GEL

COFF The battery cut-out threshold ***(From V1.3 onwards)***
This replaces the TYPE parameter.
2.05V Maximum setting
2.01V Gel (Sonnensschein) / Champion GMB
1.96V Gel - various makes
1.94V Lead-Acid - Standard
1.83V Minimum setting

CAP The capacity of the battery in Ampere-Hours
This is used in the BDI calculations when there are long periods of Traction or Lifting without any rest periods. It should have minimal affect on the 115 but should match the battery for best accuracy.

ALRM Sets the optional low battery audible alarm ***(From V1.3 onwards)***
0 =None
1 = At 75% discharge bleep slowly
2 = At 75% discharge bleep annoyingly
3 = At 80% discharge bleep slowly
4 = At 80% discharge bleep annoyingly
5 = At 75% discharge bleep slowly and then at 80% discharge bleep annoyingly

Note: The battery cut-out interlock will occur 5

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```
(73)
ZONE:1
LEVL:1
HGHT:12000
```

Adjust / set shelf levels

ZONE: Select which zone to adjust

LEVL: Select which shelf height to adjust

HGHT: adjust shelf height. "——" indicates that the end of the programmed levels is reached.
↑ or ↓ keys will set the height to a minimum of 10mm above the previous shelf height and then allow adjustment up to 10mm below the next height. (keep keys pressed for faster scrolling)
ENTER will store the chosen height.
DEL will erase all programmed height from the displayed height to the end of the current zone.

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```
(74)
IBOT:    0    CDEN:   0
NSWP:1000h    DCLK:   1
OPTH     0    ROPT:   0
```

IBOT Adjusts the number of Illegal brake operations before the service light will illuminate. Setting IBOT to 0 will disable the service light illumination altogether but the IBO counters will still function.
Factory setting 20 (before V1.4), 0 (1.4 and thereafter)

NSWP Sets the service interval for the truck. This value is used to reset NSRV hour meter when a service is done. It can be adjusted 250, 500, 750 & 1000.

OPTH: Sets the optional hour meter configurations. ***(Available from V1.3 onwards)***

0: Seat hours [10s] (Factory Setting)

1: Seat hours [10s] ⟶ Trac hours [5s]

2: Seat hours [10s] ⟶ Trac hours [5s] ⟶Lift hours [5s]

3: Seat hours [10s] ⟶ Trac hours [5s] ⟶Lift hours [5s] ⟶Hours to Next Service [5s]

4: Trac/Lift hours [10s]

5: Seat hours [10s] ⟶ Trac/Lift hours [5s]

6: Seat hours [10s] ⟶ Hours to Next Service [5s]

If OPTH is set to either 4 or 5, then the traction and lift meters will be replaced by a single meter (traction OR lift running) which counts the combined hours. This new combined meter value is added to the original traction meter value. Setting OPTH to either 4 or 5 will affect the display of Window 61.

CDEN: Code Entry Configuration ***(Available from V1.3 onwards)***

0: There is no code entry system fitted to the truck. The display will turn on without the code entry system.

1: A code entry system has been detected and this parameter configured automatically. The display will not turn on unless the correct code is entered.

If no code entry system exists (maybe because the display has been taken from another truck), this parameter should be set to 0 and the display reset by disconnecting and reconnecting the battery.

DCLK: Display the Clock ***(Available from V1.3 onwards)***

0: Do not display the clock. Select this if you do not like the clock being displayed.

1: display the Clock (Factory setting). The clock is only available when a datalogger is fitted.

ROPT: Radio Indicator Option ***(Available from V1.4 onwards)***

Allows the function of the Radio Indicator to be defined. This indicator is used with a datalogger which has a radio connection with a base station within the warehouse. It will otherwise remain OFF. The indicator will show that the truck is within range of the base station and that the truck is communicating. The lower the setting, the less irritating the indicator will be.

0: Disabled - Off all the time (factory setting) (off)
1: “In Range” Off when in seat (steady)
2: “In Range” Off when truck moving (steady)
3: “In Range” Change state only when stationary (steady)
4: “In Range” Change state on-the-fly (steady)
5: “In Range” + “Communicating” Change state on-the-fly (flashing)

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```
(75)
R_MN:  1090h
R_TR:   410h
R_LI:   280h
```

Hour Meter Reset values
(available from display V1.3 onwards)

R_MN is the reset value for the TOTL hour meter (seat)
R_TR is the reset value for the TRAC hour meter
R_LI is the reset value for the LIFT hour meter

The Hour meters in Window 61 and on the main display can be reset ONCE ONLY in window 66 by pressing DEL. This window allows the reset values to be defined.
Each value is adjustable 0-5000 hours and it is the user's responsibility to choose sensible values i.e. R_TR and R_LI should be less than R_MN
NSRV is automatically calculated to the next service interval depending on the reset value of TOTL.
When a reset has already been performed on the display each parameter in this window is shown as "-.-" and cannot be changed.
If hour meter option 4 or 5 has been set in window 74 then R_TR is copied into TRAC/LIFT and R_LI does nothing.

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```
(8)
ZONE:1
LEVL:1
HGHT:12000     12422
```

Teach in shelf levels

ZONE: Indicates the selected zone
LEVL: Indicates the selected level
HGHT: Indicates programmed shelf height in mm for the selected zone and level.
"——" indicates that the end of the programmed levels is reached.

Using the ↑ or ↓ keys, select correct zone and level
Raise the forks to the desired shelf height (the current fork height is displayed on the right hand side of the window.
Press **ENTER** to set the programmed shelf height to the current fork height.
Press **DEL** to erase all programmed shelf heights above the displayed height in the current zone.

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6.5.5.1 LID FAULT CODES

If the traction function is cutting out regularly then before turning off the keyswitch, window 2 should be used to display the error number and then the following table used to try and diagnose the fault.

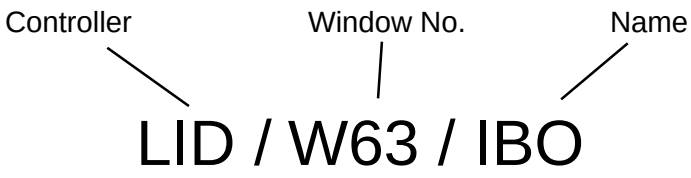
If an intermittent fault is reported then the stored error numbers in diagnostic windows 3 or 31 should be noted down and the following table used to diagnose the fault.

If a diagnosis is not forthcoming then before reporting any problems make sure the error numbers can be quoted on the service report.

An error number displayed in windows 3 or 31 should not be taken as a genuine fault unless the truck is reported to be misbehaving. The numbers may be quoted on service reports but no components should be changed unless a proven fault exists.

☞ NOTE: Numbers 1-19 are only present in window 2 and represent active interlocks rather than faults.

The following Mnemonics have been used to denote diagnostic window contents.



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LID fault code 1

Description: The pulse count from the height encoder has counted below 0
Result:
Fault condition: Display 1:—-
Possible cause: The fork height has gone below 0.
The reference sensor (8B5) is defective
or is not adjusted correctly
or fault in path 6X1:7 - 2X20:20 - 8X30:10 - 8X23:2 - 8B5

LID fault code 2

Description: The pulse count from the height encoder has counted above 15m
Result:
Fault condition: Display 9:—-
Possible cause: The fork height has gone above the maximum working range

LID fault code 23

Description: Encoder signal
The signals from the height encoder do not operate in the correct order. This should only be classed as a fault if the height is not being displayed correctly i.e. miscounting.
Result:
Fault condition: Not measurable
Possible cause: Fault in path 6X1:5 - 2X20:9 - 8X30:6 - 8X25:5 - 1B12
or fault in path 6X1:6 - 2X20:14 - 8X30:7 - 8X25:6 - 1B12
or faulty height encoder

LID fault code 24

Description: Height below reference (for encoder operating above full free lift)
Result:
Fault condition: Not measurable
Possible cause: The reference sensor (8B5) was not detected as the forks were lowered through the reference height.

LID fault code 30

Description: BDI calibration
Result:
Fault condition: LID / W63 / V48F is not equal to voltage on 6X1:3
Possible cause: An internal calibration value is missing or has been corrupted. The display must be replaced.

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LID fault code 40

Description: IBO count too high
Result:
Fault condition: LID / W65 / IBO > LID / W74 / IBOT
Possible cause: The number of illegal brake operations is over the internal limit. This must be reset by a Linde service person.

LID fault codes 70-99

Description: Internal error on display
Result:
Fault condition: not measurable
Possible cause: The display must be replaced.

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6.5.5.2 DISPLAY CHANGE HISTORY

Version	Pt. No.	Date
1.0	**(115.360.51.00)**	06.00
1.1	**(115.360.51.02)**	08.00
1.2	**(115.360.51.03)**	10.00
1.3	**(115.360.51.06)**	12.00
1.4	**(115.360.51.08)**	07.01
1.4	**(115.360.51.09)**	08.01
1.4	**(115.360.51.09)**	03.02

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DISPLAY (LID) DIAGNOSTIC WINDOW CHART (Software version 1.4)

```
(1)Linde Display
Vers:  1.4
Type:  LID32R00
Truck: BR115
```

```
(2) 33 28 7
```

```
(3) 33:2  28:1
```

```
(4)
  B1:1     3B4:0
 1B12:00    S3:1
  8B5:0
```

```
(5)
9M1 :    0%
9M2 :  100%
9M3 :  100%
```

```
(6)
FKHT: 12805
1B12:00    8B5:0
ZONE:0    LEVL:0
```

```
(7)         CAB?:  0
DFMD:  1    NSWI:  0
LANG:  0    STMD:  0
DCPT:  0    STFF:  3
```

```
(8)
ZONE:1
LEVL:1
HGHT:12000    12422
```

```
(31) 33:2  28:1
```

```
(61) NSRV:     8.2
     TOTL:    41.8
     TRAC:     3.4
     LIFT:     1.9
```

```
(71)
HIMD: 1   tLEV:   5s
TYPE: 0   RFHT: 3500
SDIF: 150 MMPP:    4
```

```
(32)

 Press CE to clear
```

```
(62)
tTHS: 50  tTM: 50
tLHS: 50  tLM: 50
```

```
(72)
COFF:1.94V
CAP:  400
ALRM:   0
```

```
(63)
V24 :23.5
V48F:55.68
V48C:55     CAP:100%
```

```
(73)
ZONE:1
LEVL:1
HGHT:12000
```

```
(64)
  RT:--:--
SWFF:  0   SVER:0
```

```
(74)
IBOT:   0   CDEN:  0
NSWP:1000h  DCLK:  1
OPTH    0   ROPT:  0
```

```
(65)
 IBO:   0
mIBO:   0   0BO:  0
<del> to reset IBO
```

```
(75)
R_MN:  1090h
R_TR:   410h
R_LI:   280h
```

```
(66)     NSRV: - 0.1
         TOTL:   -.-
         TRAC:   -.-
         LIFT:   -.-
```

```
(2) 33 28 7
```

= Standard Windows (Diagnostic access)

```
(66)6TH    dem:4000
u1:  100%  pwm:100%
u1S: 100% pwmS:100%
u2: -100%    I:500mA
```

= Limited diagnostic access
(Highlighted area does not appear in standard software)

```
(32)

 Press CE to clear
```

= Protected Windows (Master access)

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Service Training

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6.5.6 LES DIAGNOSTIC WINDOWS

This section assumes your CANbox is version 1.3 or higher

```
(1) Linde Elec Steer
Vers:   440/406
Type:   LES32V440
Truck:  BR115
```

Home Page

Shows controller's details

Vers: Version numbers of the main and safety software
Due to a problem in the CANbox, the new steering version 440/406 will display as 154/150 (256 should be added to versions in the 150 range, in order to determine the correct version.

Type: Reference for the required help file name

Truck: Truck range

```
(2) 18   33
```

Current Faults/information

Active faults and information on controller

NOTE: On steering versions 113 and before, a code may not be visible in this window even when the steering is not working. In this case use window 21 to determine the fault.

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```
(21)  sav.flags=0000
DR:0  ER:0  LG:0  MD:0
TP:0  OI:0  --:0  IN:0
EI:0  DI:0  PS:0  EL:0
```

Current Faults
Active faults and interlocks on controller
sav.flags Shows the Hexadecimal fault code that has been used up to now. This code should be quoted on all reporting of steering errors.

The following parameters show the individual bit states within the above error code. 0=OK, 1=ERROR

DR: DSS Read Error. [Error code 53]
Internal error in the steering controller or A DSS sensor signal is not correct. The connections and depth of the sensor should be checked.

ER: Encoder Read Error. [Error code 54]
The signals from the wheel encoder are not correct. This can be viewed in window 4. The connections should be checked and if the problem persists, the wheel encoder assembly should be replaced.

LG: Motor Encoder / DSS Logic Error. [Error code 55]
A DSS sensor is faulty or The internal motor encoder is faulty

MD: Motor Model Error. [Error code 65]
The measured motor current does not correspond with the applied voltage. This could be because another error has shut the steering down. In this case ignore this signal or Internal error in the steering controller

TP: Temperature Error [Error code 34]
The temperature of the steering controller is too high

OI: Over Current [Error code 33]
There is or has been too much current on the motor

—: As LG on new steering controllers from V410/406 [Error code 56]

IN: Internal Error [Error code 95]

EI: Encoder Current [Error code 49/50]
The current measured in the supply to the steering wheel encoder is wrong. The encoder is faulty or there is a wiring fault or a connector is not locked in properly or the steering controller is defective

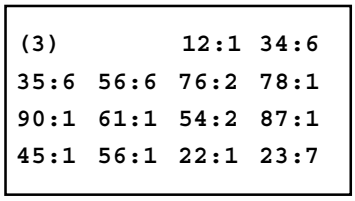
DI: DSS sensor Current [Error code 51/52]
The current measured in the supply to the DSS sensors is wrong. One or both DSS sensors is faulty or there is a wiring fault or a connector is not locked in properly or the steering controller is defective.

PS: Power Supply Error
The battery is too low or too high [Error code 21/20]
or the steering controller is defective [Error code 18/19]

EL: EEPROM Load [Error code 146/147]
Parameters could not be loaded properly from the internal memory. The steering controller is defective

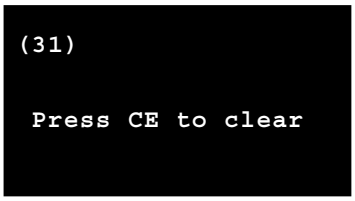
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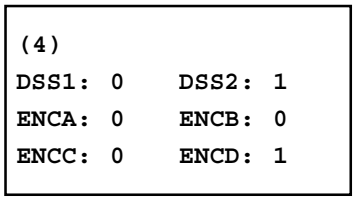
Fault History

Shows the faults that have been logged. This window may be cleared in window 31



Clear entire Fault History (Master)

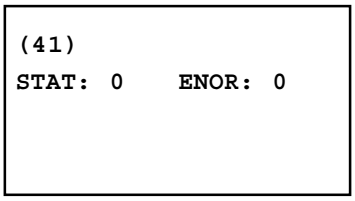
Clears all faults from windows 3.



Digital Inputs

Shows the states of digital inputs to the controller. An active state is represented by a ‘1’ and an inactive state ‘0’.

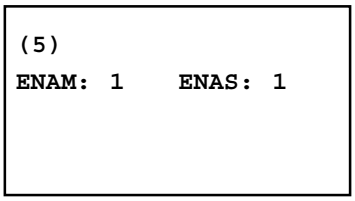
DSS1 state of DSS1 sensor
DSS2 state of DSS2 sensor
ENCA state of Wheel Encoder A
ENCB state of Wheel Encoder B
ENCC state of Wheel Encoder C
ENCD state of Wheel Encoder D



CAN Inputs

Shows the states of digital inputs to the controller. An active state is represented by a ‘1’ and an inactive state ‘0’.

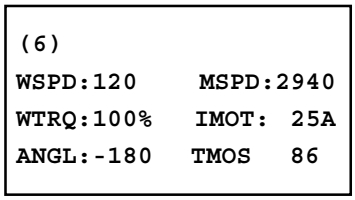
STAT Truck Stationary (Input from CAN)
ENOR Enable output override (Input from CAN)



Enables

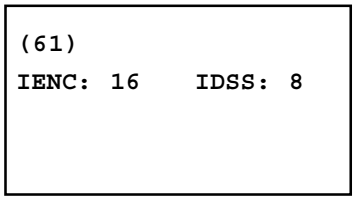
ENAM Safety output from main controller
ENAS Safety output from safety controller

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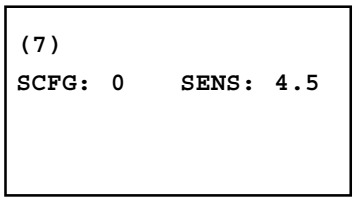
Analogue I/O

WSPD Wheel speed in RPM
MSPD Motor Speed in RPM
WTRQ Wheel Torque in %
IMOT Motor Current in Amps
ANGL Wheel angle in degrees
TMOS Temperature of MOS in °C (always indicates 86 for temperatures less than 86°C)



Sensor Currents

IENC Current in Wheel Encoder
IDSS Current in DSS sensors (combined)



Steering Configuration

CFG Configuration 0=180° / 1=360°
SENS Sensitivity adjustable 3.5…6.5 turns lock-lock (180°) (default 5.5).
Value less than 3.5 are nor recommended as they make the truck difficult to drive. A “!” symbol will appear if a value in this range is chosen

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```
(71)
Reset  Linde  Params
to  Defaults  =  <DEL>
```

Parameter reset to default

Pressing <DEL> will reset all internal Linde parameters to their default values. This ensure that the steering controller to set up to work with other controllers on the 115.

CAUTION:The default settings guarantee correct operation of the steering unit on the 115. Under no circumstances should these parameters be adjusted unless by direct instructions from Linde Material Handling (UK) Ltd.

```
(8)
DELTA  now  =  0
DELTA  Max  =  0
```

Steering Wheel Encoder Check

This window allows the steering wheel encoder to be checked for correct function. The 4 signals should follow a predefined pattern as the wheel is turned but on some early units, this was not the case.

Instructions...

Turn the wheel at moderate speed Clockwise and anti-clockwise observing the 2 values in this window

DELTA now: Shows current error value (can go up and down as wheel is turned)

DELTA Max: Shows maximum error value reached during this test (since entering window 8)

If DELTA Max reaches a value in excess of 10 then the steering wheel encoder could be defective and should be replaced.

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6.5.6.1 LES FAULT CODES

If the traction or steering function is cutting out regularly then before turning off the keyswitch, the diagnostics should be used to display the error number and then the following table used to try and diagnose the fault.

If an intermittent fault is reported then the stored error numbers in diagnostic windows 3 or 31 should be noted down and the following table used to diagnose the fault.

If a diagnosis is not forthcoming then before reporting any problems make sure the error numbers can be quoted on the service report.

An error number displayed in windows 3 or 31 should not be taken as a genuine fault unless the truck is reported to be misbehaving. The numbers may be quoted on service reports but no components should be changed unless a proven fault exists.

Numbers 1-19 are only present in window 2 and represent active interlocks rather than faults.

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LES fault code 2

Description:	Means nothing. Debug code erroneously left in
Sav.flags:	
Result:	
Fault condition:	None
Possible cause:	None

LES fault code 18

Description:	Under/Over of 15V supply
Sav.flags:	0400
Result:	Steering Shut-down
Fault condition:	3X8:1 or 3X9:1 <13V or >18V
Possible cause:	DSS sensor over-current fault (check for error code 52) or Wheel encoder over-current fault (check for error code 50) or fault in path G/X49:1 - 3X8:1 - 3B2 (DSS1 supply shorted to other) or fault in path G/X49:4 - 3X9:1 - 3B3 (DSS2 supply shorted to other) or fault in path L/X50:1 - 3X4B:1 - 3X4A:1 - 3B1 (wheel encoder supply shorted to other) or internal steering fault

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LES fault code 19

Description:	Under/Over Voltage of 2.5V Reference
Sav.flags:	0400
Result:	Steering Shut-down
Fault condition:	Not measurable
Possible cause:	internal steering fault

LES fault code 20

Description:	Over Voltage of Battery supply
Sav.flags:	0400
Result:	Steering Shut-down
Fault condition:	3X1:10 > 70V
Possible cause:	Incorrect Battery

LES fault code 21

Description:	Under Voltage of Battery supply
Sav.flags:	0400
Result:	Steering Shut-down
Fault condition:	3X1:10 < 18V
Possible cause:	Faulty battery or fault in path X10 - S2 - 3F1 - 3X1:1,2,3,4 …(+ve power supply) or fault in path X10 - 6F1 - 3X1:10 …(+ve electronics supply) or fault in path X10 - 3X1:5,6,7,8 …(0V)

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LES fault code 33

Description:	over-current power-unit The saturation voltage of the MOSFETs is too high.
Sav.flags:	0020
Result:	Steering Shut-down
Fault condition:	Not measurable
Possible cause:	internal steering fault with controller or motor

LES fault code 34

Description:	Over-temperature
Sav.flags:	0010
Result:	Steering Shut-down
Fault condition:	Temperature of Heatsink >100°C LES / W6 / TMOS > 100
Possible cause:	Motor compartment is too hot and/or steering has been operated too long whilst truck not moving (i.e. high current) Wait for cooling.

LES fault code 35

Description:	Offset current sensor out of range
Sav.flags:	
Result:	
Fault condition:	Not measurable
Possible cause:	internal steering fault

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LES fault code 49

Description:	Wire broken Steering wheel sensor
Sav.flags:	0100
Result:	Steering Shut-down
Fault condition:	current in supply line of the steering wheel encoder is too low LES / W61 / IENC < 12 mA
Possible cause:	fault in path L/X50:1 - 3X4B:1 - 3X4A:1 - 3B1 …(+ve supply open circuit) or fault in path L/X50:6 - 3X4B:6 - 3X4A:6 - 3B1 …(-ve supply open circuit) or 3B1 (steering wheel encoder faulty) or internal steering fault

LES fault code 50

Description:	Over-current Steering wheel sensor
Sav.flags:	0100
Result:	Steering Shut-down
Fault condition:	current in supply line of the steering wheel encoder is too high LES / W61 / IENC > 42 mA
Possible cause:	fault in path L/X50:1 - 3X4B:1 - 3X4A:1 - 3B1 (+ve supply shorted to other) or 3B1 (steering wheel encoder faulty) or internal steering fault

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LES fault code 51

Description:	Wire broken Motor position (DSS) sensor
Sav.flags:	0200
Result:	Steering Shut-down
Fault condition:	current in supply line of the DSS sensors is too low LES / W61 / IDSS < 2 mA
Possible cause:	fault in path G/X49:1 - 3X8:1 - 3B2 …(DSS1 +ve supply open circuit) or fault in path G/X49:4 - 3X9:1 - 3B3 …(DSS2 +ve supply open circuit) or 3B2 (DSS1) faulty or 3B3 (DSS2) faulty or internal steering fault

LES fault code 52

Description:	Over-current Motor position (DSS) sensor
Sav.flags:	0200
Result:	Steering Shut-down
Fault condition:	current in supply line of the DSS sensors is too high LES / W61 / IDSS > 40 mA* * increased to 50 mA in version 115
Possible cause:	fault in path G/X49:1 - 3X8:1 - 3B2 …(DSS1 +ve supply shorted to other) or fault in path G/X49:4 - 3X9:1 - 3B3 …(DSS2 +ve supply shorted to other) or 3B2 (DSS1) faulty or 3B3 (DSS2) faulty or internal steering fault

LES fault code 53

Description:	DSS sensor(s) (safety processor) Main processor signal is not equal to the safety processor signal
Sav.flags:	0001
Result:	Steering Shut-down
Fault condition:	not measurable
Possible cause:	internal steering fault Update software to at least 113/111

LES fault code 54

Description:	Steering wheel sensor check The A&B signals counted by the main processor do not agree with the C&D signals counted by the safety processor.
Sav.flags:	0002
Result:	Steering Shut-down
Fault condition:	LES / W4 / ENCA,B,C,D all toggle when wheel is turned slowly. If one or more are static then the encoder or wiring is faulty.
Possible cause:	Fault in path L/X50:2 - 3X4B:2 - 3X4A:2 - 3B1 …(signal A open or shorted) or Fault in path L/X50:3 - 3X4B:3 - 3X4A:3 - 3B1 …(signal B open or shorted) or Fault in path L/X50:4 - 3X4B:4 - 3X4A:4 - 3B1 …(signal C open or shorted) or Fault in path L/X50:5 - 3X4B:5 - 3X4A:5 - 3B1 …(signal D open or shorted) or 3B1 (steering wheel encoder faulty) or internal steering fault

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LES fault code 55

Description: Motor position sensor (safety processor) various checks…
- Motor Encoder: The A&B signals counted by the main processor do not agree with the C&D signals counted by the safety processor.
- The DSS sensor signals does not correspond with the calculated angle.
- The gearbox has tuned more than 95° but the DSS sensor(s) did not detect this
- Maximum motor RPM exceeded

Sav.flags: 0004

Result: Steering Shut-down

Fault condition: LDC / W41 / DSS1 does not change at ANG= 0°±5° or ANG=180°±5° or changes when angle is outside these values.
LDC / W41 / DSS2 does not change at ANG= 90°±5° or ANG=-90°±5° or changes when angle is outside these values.
NOTE: to check wiring and sensor operation, a sensor can be removed and placed near metal to observe the signal change. This however only checks the sensor operation and not the correct depth setting.

Possible cause: fault in path G/X49:2 - 3X8:4 - 3B2 (DSS1 signal open circuit or shorted) or fault in path G/X49:5 - 3X9:4 - 3B3 (DSS2 signal open circuit or shorted) or foreign metallic matter in gearbox turntable causing false signals on DSS1 or 2.
Remove DSS1 and turn by hand whilst looking down through hole, removing anything that shouldn't be there. or 3B2 (DSS1) faulty or incorrect setting or 3B3 (DSS2) faulty or incorrect setting The sensor should be 1mm from the gearbox turntable at the bottom of the sensor hole which means the distance from sensor tip to underside of the fixing tab should be 56mm ± 0.2mmand the depth of the hole should be 57mm nominal.
Other signals are not measurable. or internal steering fault or Mechanical/ Electrical failure of the internal motor position sensor

LES fault code 56

Description: As 55 but on new steering controller V410/406

Sav.flags: 0040

Result: Steering Shut-down

Fault condition:

Possible cause:

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LES fault code 63

Description:	Only on steering controllers V440/406 onwards. An illegal state has been detected on the steering wheel encoder. NOTE: If version 440/406 is used on an old truck with steering wheel encoder 002 965 50 00 then this error will be produced sporadically. To overcome this either fit a new encoder unit 115 360 51 05 or run the steering updater program V4.00 which will allow the encoder type to be selected.
Sav.flags:	8000
Result:	Steering Shut-down
Fault condition:	Not measurable
Possible cause:	Fault in path L/X50:2 –3X4A:2 - 3B1 (signal A open or shorted) Or Fault in path L/X50:3 - 3X4A:3 - 3B1 (signal B open or shorted) Or Fault in path L/X50:4 - 3X4A:4 - 3B1 (signal C open or shorted) Or Fault in path L/X50:5 - 3X4A:5 - 3B1 (signal D open or shorted) Or 3B1 (steering wheel encoder faulty) Or internal steering fault

LES fault code 65

Description:	Model calculation (safety processor) The controller compares Motor voltage and current against an internal “model”. In this case, the voltage does not correspond with measured current so there is an error with the motor or controller.
Sav.flags:	0008
Result:	Steering Shut-down
Fault condition:	Not measurable
Possible cause:	Another fault exists and because it has turned off the motor, this error has occurred. In this case this error should be ignored. or internal steering fault if code exists on it’s own.

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LES fault code 66

Description:	position controller (not yet active !)
Sav.flags:	
Result:	
Fault condition:	
Possible cause:	

LES fault code 70

Description:	Start-up Error: Can’t start up processor communication or Offset-adjustment of current-sensors takes too much time
Sav.flags:	1000
Result:	Steering does not start
Fault condition:	Not measurable
Possible cause:	internal steering fault

LES fault code 71

Description:	error in motor-initialisation no zero-pulse. The first falling edge of signal B after the rising edge of signal C of the motor-position-encoder wasn’t recognised
Sav.flags:	1000
Result:	Steering does not start
Fault condition:	Not measurable
Possible cause:	internal steering fault

LES fault code 72

Description:	Restore position <>Wheel position. The position restored from EEPROM during start up doesn’t match the actual motor encoder position or position wasn’t stored correctly during last power down.
Sav.flags:	
Result:	None (only warning)
Fault condition:	Not measurable
Possible cause:	Not a fault. This code appear regularly and should be ignored

LES fault code 73

Description:	restore position <> DSS position The position restored from EEPROM during start up doesn’t match the first estimated motor encoder position.
Sav.flags:	
Result:	None (only warning)
Fault condition:	Not measurable
Possible cause:	Not a fault. The motor encoder has significantly moved in the switched off state

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LES fault code 75

Description:	Only on steering controllers V440/406 onwards. Not enough motor torque
Sav.flags:	
Result:	Steering Shut down
Fault condition:	No movement of the steering motor is detected when the steering is operated. This error can be generated only when the truck is moving faster than 0.3km/h (7cm/s). If the truck speed is slower than this then no fault is generated as the drive wheel could be jammed in a hole or rough ground.
Possible cause:	Steering pinion or turntable jammed Or Steering motor or gearbox jammed Or Steering internal fault with motor encoder

LES fault codes 81 to 147

Steering fault codes 81 to 147 represent internal module faults where the fault condition is not measurable. Try switching off, and on again. If the fault persists, replace the steering unit.

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6.5.6.2 STEERING CONTROLLER CHANGE HISTORY

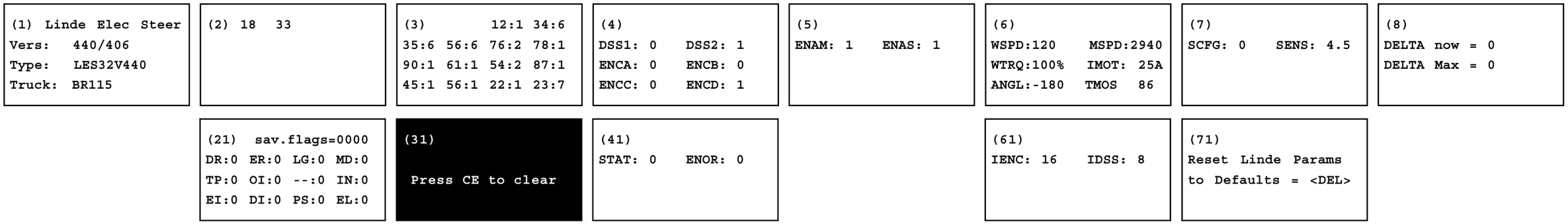
Version	Date
107/107	06.00
108/107	06.00
113/111	02.01
116/111	06.01
410/406 *	07.01
Encoder	16.01
417/406 *	04.02
418/406 *	08.02
No change	12.02
440/406*	05.03

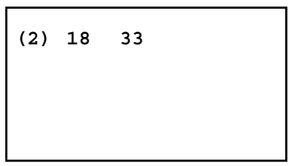
* For CANbox version 1.3 and below, these versions report incorrectly as (real number - 256)

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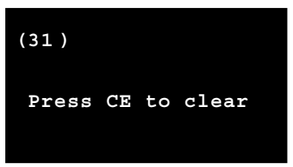
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STEERING (LES) DIAGNOSTIC WINDOW CHART (Software version 440/406)





= Standard Windows (Diagnostic access)



= Protected Windows (Master access)

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Service Training

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7 HYDRAULIC SYSTEM

CAUTION: Electrical components must not be connected or disconnected whilst the truck is live. The battery must be disconnected, failure to do so can result in failure of the modules.

7.1 HYDRAULIC OVERVIEW

WARNING: The hydraulic fluid and motors can become very hot. Risk of scalding.

WARNING: The hydraulic system operates at very high pressures, do not allow hydraulic oil under pressure, for example at a leak, to penetrate the skin. Medical aid is required if such an injury occurs.

All mast functions have their oil flow directed by an electrically controlled valve block mounted at the base of the mast. Proportional valves are used for controlling the oil flow during reaching and lowering. All other valves are ON/OFF and the function speed is achieved by control of the pump motor speed which is under closed loop control via an impulse sensor which monitors armature rotation. The hydraulic pump motor power circuit and hydraulic valves are continuously monitored and controlled by the LLC controller. This controller uses twin microprocessors so that should an error occur, it is instantly identified and the system shut down.

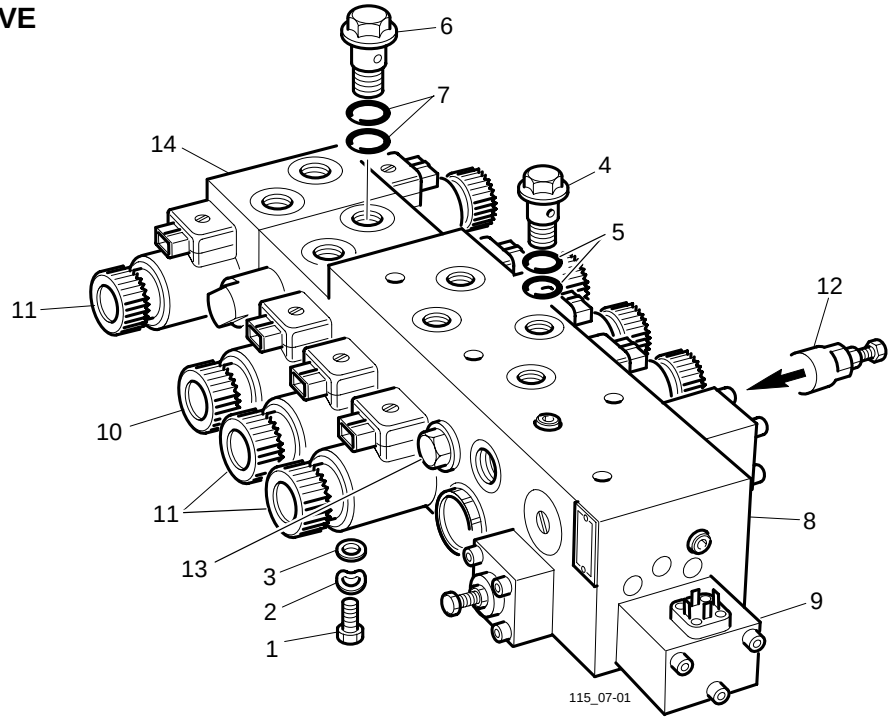
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Power is supplied by a gear pump connected directly to a 48 volt, 230 amp pump motor, developing 9kw at 2900 rpm, located under the driver's seat cover. The pump motor incorporates an over temperature sensor designed to reduce performance should the motor temperature get too high.

Any maintenance or overhaul to any part of the hydraulic system should be carried out with care and attention paid to keeping the system clean and dirt free.

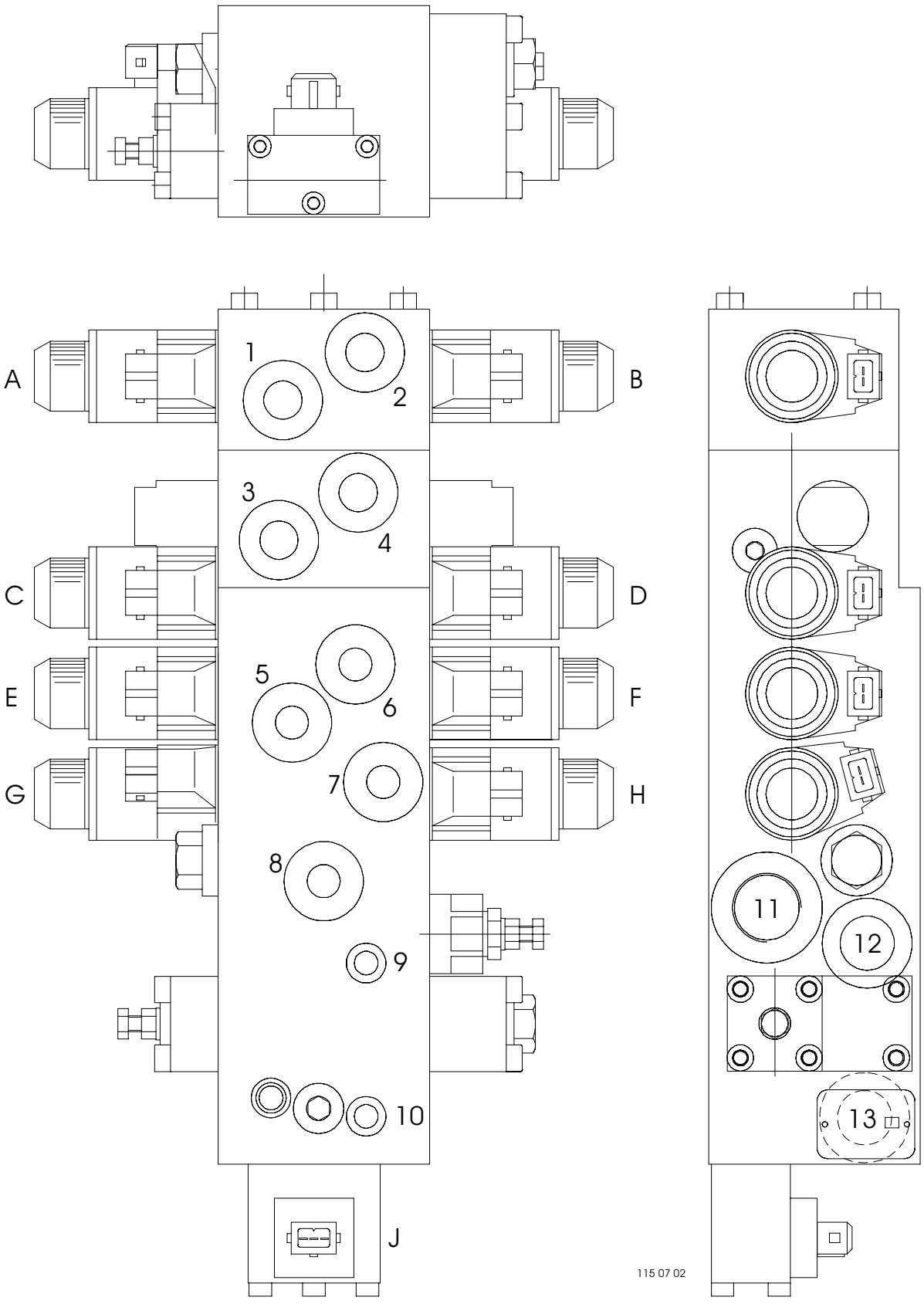
HYDRAULIC CONTROL VALVE

1. Hex head screw
2. Spring washer
3. Washer
4. Hollow screw
5. O ring
6. Hollow screw
7. O ring
8. Control valve
9. Lift/lower contactor
10. Contactor
11. Contactor
12. Pressure relief valve
13. Valve insert
14. Auxiliary unit



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7.2 HYDRAULIC CONTROL VALVE CONNECTIONS



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HYDRAULIC CONTROL VALVE CONNECTIONS - KEYCODE

ELECTRICAL CONNECTIONS

Item	Connector	Function
A	2Y15	Auxiliary 1
B	2Y16	Auxiliary 2
C	2Y8	Reach out
D	2Y9	Reach back
E	2Y14	Sideshift right
F	2Y13	Sideshift left
G	2Y11	Tilt forward
H	2Y12	Tilt back
J	2Y1/2	Lift and lower

HYDRAULIC CONNECTIONS

Item	Port	Function	Torque
1	B4	Auxiliary 2	Torque to 39-45Nm
2	A4	Auxiliary 1	Torque to 39-45Nm
3	B3	Reach back	Torque to 39-45Nm
4	A3	Reach forward	Torque to 39-45Nm
5	B2	Sideshift left	Torque to 33-38Nm
6	A2	Sideshift right	Torque to 33-38Nm
7	A1	Tilt forward	Torque to 33-38Nm
8	B1	Tilt back	Torque to 33-38Nm
9	T1	Emergency lower valve	Torque to 16-18Nm
10	A1.1	Emergency lower valve	Torque to 16-18Nm
11	T	Tank (Adaptor M27-¾BSP)	
12	P	Pump (Adaptor)	
13	A	Lift/lower (Adaptor)	

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7.3 HYDRAULIC CONTROL BLOCK REMOVAL

WARNING: The hydraulic fluid can become very hot. Risk of scalding.

WARNING: Do not allow hydraulic oil under pressure, for example at a leak, to penetrate the skin. Medical aid is required if such an injury occurs.

- Reach out, centralise the sideshift, and lower the mast fully.
- Apply the parking brake, turn the keyswitch OFF and disconnect the battery.
- Remove all hydraulic connections to the block, noting their position for reassembly. Ensure ends are sealed to prevent ingess of dirt etc.

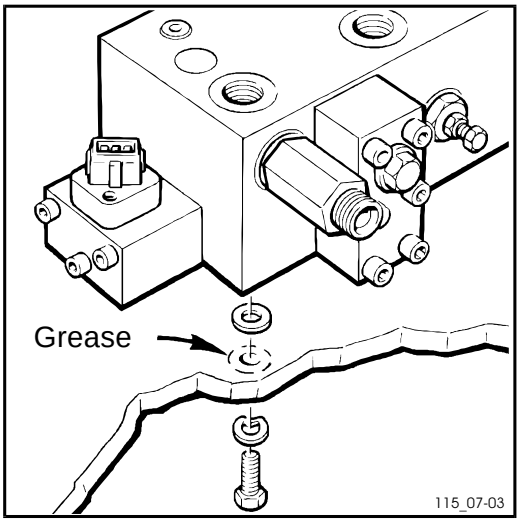
CAUTION: To prevent the hydraulic oil draining from the tank, the return to tank hose will need to be plugged using plug Pt. No. 000 952 40 24. Before removing the hose, ensure this plug is available. DO NOT clamp the hose to prevent oil leakage, as this will damage the inner lining.

☞ **NOTE: Special spanner, tool number J 43975 will facilitate removal of the return to tank hose.**

- Remove all electrical connections to the block, noting their position for reassembly.
- If necessary, jack and securely block the truck in order to gain better access to the three valve block securing screws located under the reach frame.
- Remove the three securing screws and wavy washers.
- Remove the valve block, retaining the three plain washers located between the valve block and the reach frame for reassembly, and place in a clean area prior to carrying out any servicing.

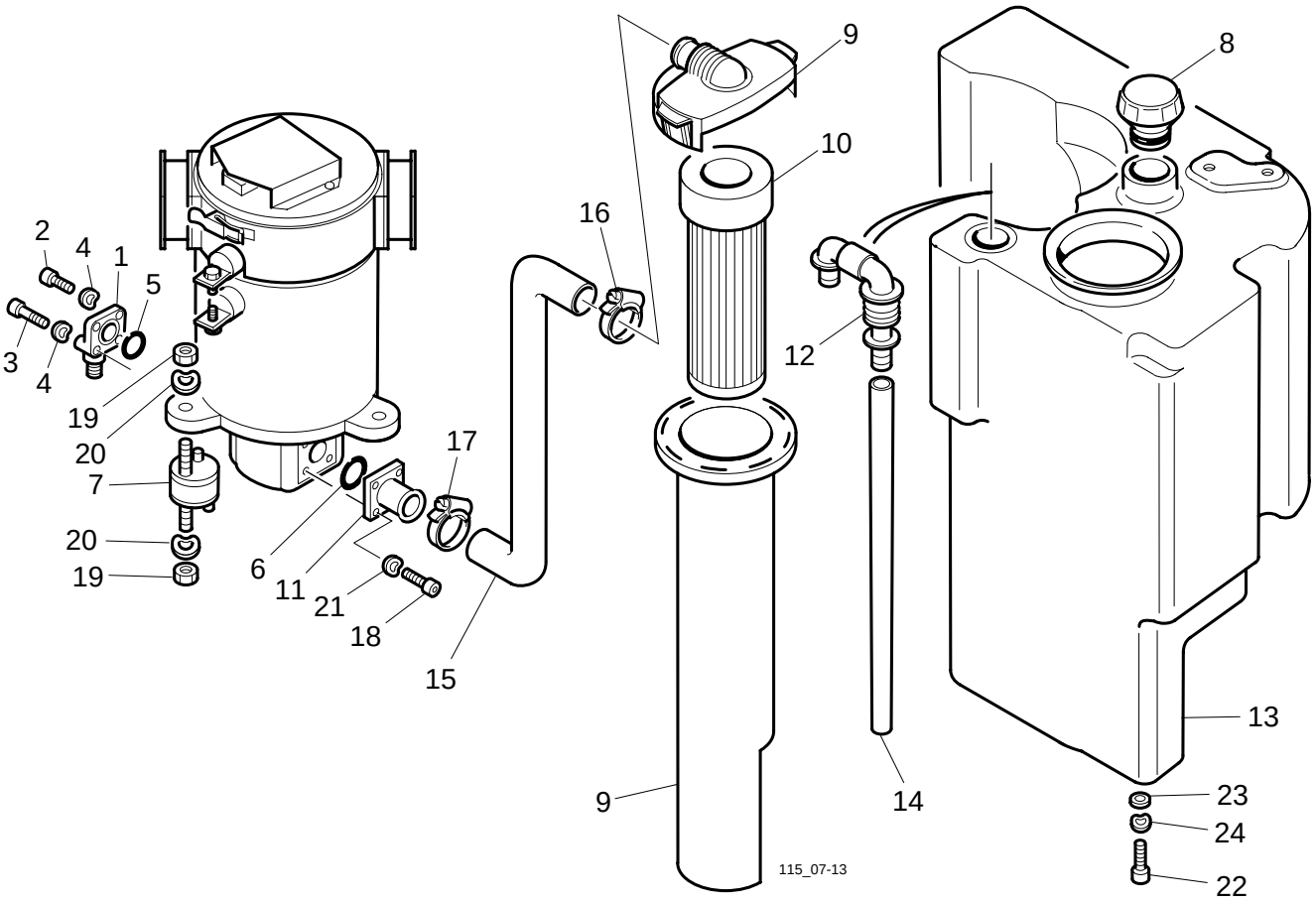
7.3.1 HYDRAULIC CONTROL VALVE RE-FITTING

To refit the control valve, reverse the removal procedure, ensuring that the three plain washer between the valve block and the reach frame are correctly located. Use grease to prevent the washers from moving. To facilitate reassembly, three studs can be made from M8 screws, which are then loosly screwed into the valve block before assembling to the reach frame. These will hold the plain washers in place, and can be removed one at a time and replaced with the correct screw and wavy washer. Torque valve block securing screws to 12Nm.



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7.4 HYDRAULIC UNIT AND TANK



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1. Screw joint
2. Socket head screw
3. Socket head screw
4. Wavy washer
5. O ring
6. O ring
7. Rubber/steel mounting
8. Air vent filter
9. Oil filter
10. Filter element
11. Connecting piece
12. Adaptor
13. Hydraulic tank
14. Pipe
15. Hose
16. Clip
17. Hose clip
18. Socket head screw
19. Hexagon nut
20. Spring washer

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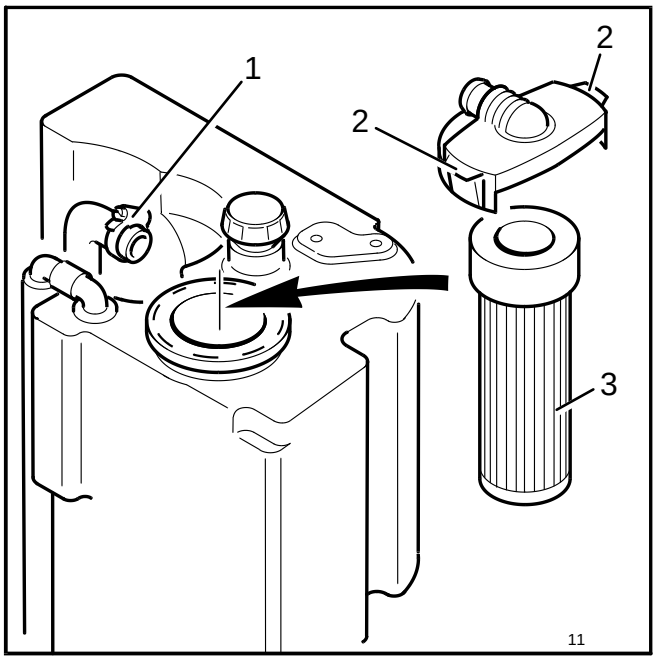
7.4.1 HYDRAULIC TANK FILTER RENEWAL

WARNING: The hydraulic fluid and motors can become very hot. Risk of scalding.

WARNING: Do not allow hydraulic oil under pressure, for example at a leak, to penetrate the skin. Medical aid is required if such an injury occurs.

- Open the motor cover.
- Slacken the securing clip (1) on the outlet pipe
- Pull pipe from the filter assembly.
- Release and remove the filter cap by squeezing the two tabs (2).
- Lift the filter (3) from the tank. Allow to drain and discard.
- Place a new filter element (3) into the tank and replace the filter cap.
- Replace outlet pipe, ensuring clip (1) is secure.

CAUTION: The hydraulic pump operates by suction due to the outlet flow from the tank being located higher than the pump. It will be necessary to prime the pump by filling the suction hose with hydraulic oil prior to running. Failure to do this will cause the pump to run dry and result in premature pump failure.



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7.5 HYDRAULIC FLUID CHANGING

WARNING: The hydraulic fluid and motors can become very hot. Risk of scalding.

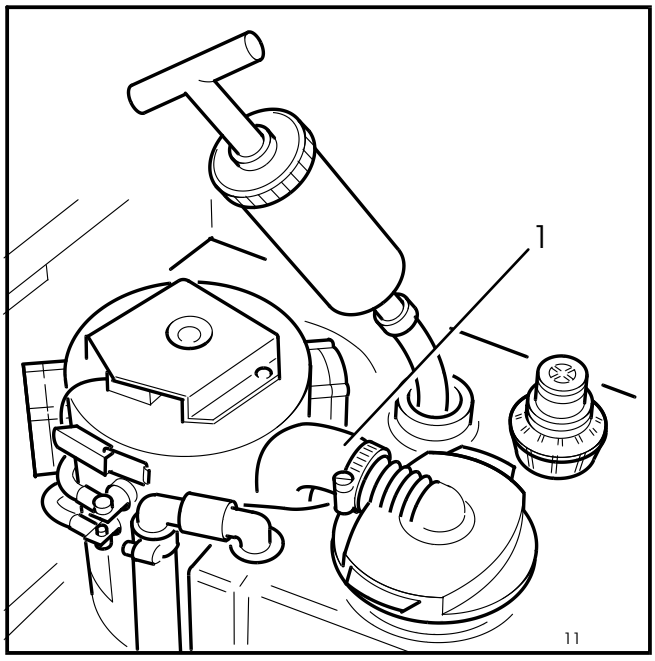
WARNING: Do not allow hydraulic oil under pressure, for example at a leak, to penetrate the skin. Medical aid is required if such an injury occurs.

- Carry out this operation with forks in the lowered position and with the mast reached in.
- Open the motor cover.
- Remove the breather/filler cap.
- Empty reservoir using a suitable handpump.
- Replenish the tank to the correct level with clean oil, and prime the pumps by pouring oil into the outlet hose when disconnected from the tank fine filter (1)

☞ **NOTE: The tank has two level marks labeled 184 and 187. These labels refer to the mast type fitted on the truck. The mast type can be determined from the mast serial number which is stamped on the mast.**

CAUTION: Check correct hydraulic operation after refilling the system.

CAUTION: The hydraulic pump operates by suction due to the outlet flow from the tank being located higher than the pump. It will be necessary to prime the pump by filling the suction hose with hydraulic oil prior to running. Failure to do this will cause the pump to run dry and result in premature pump failure.



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7.6 HYDRAULIC PUMP AND MOTOR REMOVAL

WARNING: The hydraulic fluid and motors can become very hot. Risk of scalding.

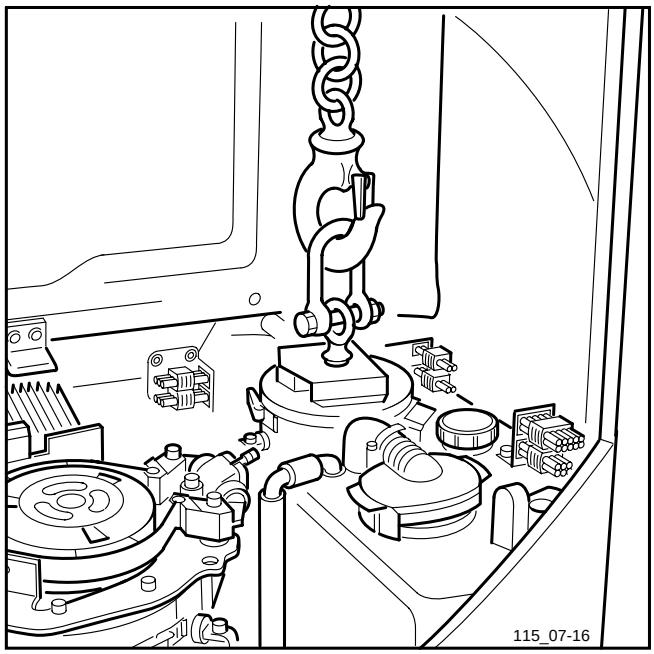
WARNING: Do not allow hydraulic oil under pressure, for example at a leak, to penetrate the skin. Medical aid is required if such an injury occurs.

- Apply the parking brake. Reach the battery fully forward.
- Turn keyswitch OFF, disconnect battery, chock load wheels securely.
- Open the motor cover.

☞ **NOTE: To facilitate pump motor removal, the seat can be completely removed. To remove the seat assembly completely, disconnect the seat wiring, and lift the assembly from the pivot.**

WARNING: Manual handling risk. The seat assembly is heavy. Assistance should be sought if it is to be completely removed.

- Disconnect the two cooling fan leads at the connector support bracket.



- Disconnect the speed sensor and brushwear/temperature sensor leads at the connector support bracket, and remove the connectors from the bracket.
- Disconnect the main motor cables, noting their position for reassembly.
- Disconnect both hydraulic connections at the pump and plug pump and hoses to prevent ingress of dirt.
- Remove the three hexagon head screws which secure the pump motor to its rubber mountings.
- Using an eyebolt attached to the armature, and suitable lifting equipment, manoeuvre the pump and motor assembly from the chassis, ensuring that any cables and electrical leads do not become caught.

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WARNING: Manual handling risk. The pump motor is heavy, do not attempt to remove the motor without the correct lifting equipment.

7.6.1 HYDRAULIC PUMP AND MOTOR RE-FITTING

- To re-fit the pump and motor into the chassis, reverse the removal procedure.



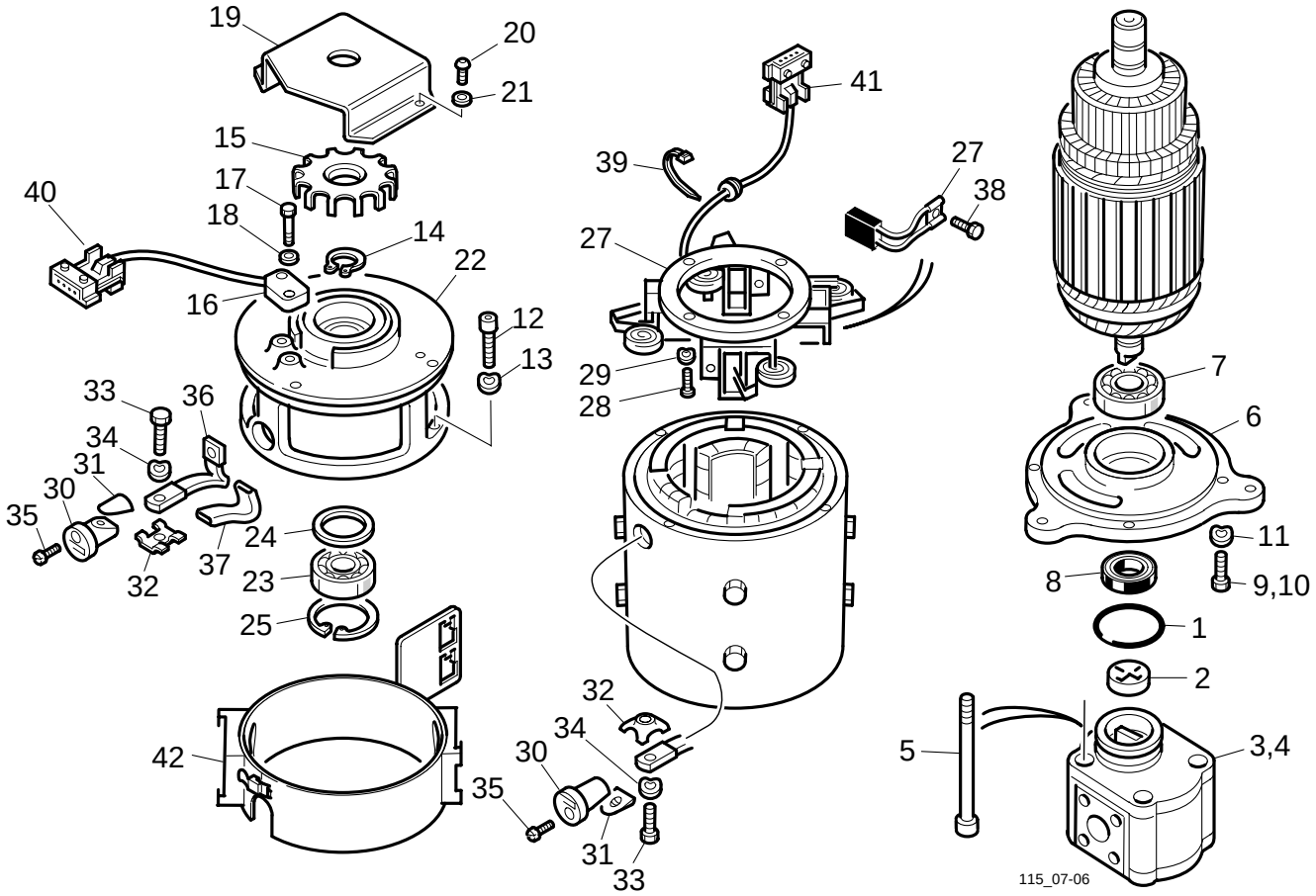
WARNING: Manual handling risk. The pump motor is heavy, do not attempt to replace the motor without the correct lifting equipment.



CAUTION: The pump operates by suction, due to the outlet flow from the hydraulic tank being located higher than the pump. Therefore, it will be necessary to prime the power steering pump by dismantling the suction hose at the tank end, and pouring clean hydraulic into the suction hose.
Failure to do this will cause the pump to run dry and resulting in premature pump failure.

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LIFT PUMP AND MOTOR ASSEMBLY



1. O ring
2. Coupling
3. Gear pump
4. Seal kit
5. Socket head screw
6. Bearing cover
7. Grooved ballbearing
8. Shaft seal ring
9. Hexagon head screw
10. Socket head screw
11. Wavy washer
12. Socket head screw
13. Wavy washer
14. Retaining ring
15. Pole operating contact member
16. Sensor assembly
17. Hexagon head screw
18. Wavy washer
19. Cover
20. Screw
21. Wavy washer
22. Bearing cover
23. Bearing
24. Belleville cup
25. Retaining ring
26. Brush holder assembly
27. Carbon brush
28. Screw
29. Wavy washer
30. Insulating bush
31. Bush
32. Clamping nut
33. Hexagon head screw
34. Spring washer
35. Screw
36. Connecting bridge
37. Insulator
38. Screw
39. Cable tie
40. Tab housing
41. Tab housing
42. Brush cover

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7.6.2 HYDRAULIC PUMP MOTOR DISMANTLING

With the lift pump motor removed from its truck mounting and the pump removed from the motor, the following procedure is a guideline to the lift pump motor dismantling.

- Remove the brush cover band (42) complete with cooling fans.
- Remove screw (20), wavy washer (21) and cover (19).
- Remove sensor assembly (16).
- Using a suitable extractor, remove the toothed sensor disc (15).
- Remove the four brushes (27) from the brush holder assembly (26), using a suitable hook to lift the brush spring.
- Disconnect each brush wire connection and remove the brushes (27) from the lift pump motor. Note the brush position in each brush holder for re-assembly to the same position.
- Remove circlip (14) from the armature.
- Disconnect the field link from brush cage.
- Mark the commutator end bearing cover (22) and drive end bearing cover (6) and main casing to ensure correct re-assembly.
- Remove the four screws (12).
- Using a suitable hide head hammer, drive the armature together with the bearing cover (22) from the motor casing, bearing cover (6) and seal ring (8).
- Using a suitable extractor withdraw bearing (7) from the armature drive end.
- Support armature and bearing cover (22) on two wooden blocks. Using a suitable hide head hammer, drive the bearing cover assembly (22) from the armature.
- Remove the circlip (25) from the bearing cover (22) and carefully drive out bearing (23).
- Remove screws (28) and withdraw brush holder assembly (27) from bearing cover (22).
- It is only necessary to remove seal ring (9) and ‘O’ ring (1) if they are damaged.
- The lift pump motor is dismantled and ready for visual inspection

7.6.3 HYDRAULIC MOTOR COMPONENT INSPECTION

After the motor is dismantled, the components should be thoroughly cleaned and inspected for wear or damage. Clean components with a good grade petroleum based cleaning solvent and dry. Discard all bearings all bearings and re-fit new always.



CAUTION: Under no circumstances must solvents be used on motors fitted to trucks as any residue can ignite when power is applied.

Check brushes for even wear and commutation, replace if badly worn (minimum wear 17mm), pitted or burnt from overheating. Always replace a complete set of brushes, never individually. Check the brush movement is free in the holders, and the brush spring tension.

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7.6.4 HYDRAULIC MOTOR ARMATURE CHECKS

Check the armature shaft bearing journals for wear. Check windings, commutator connections and bars for any signs of burning. If burned sections are evident either in the brush track or on the riser ends of the commutator bars, an open or short circuit is indicated in the armature windings.

7.6.5 HYDRAULIC MOTOR COMMUTATOR REFACING

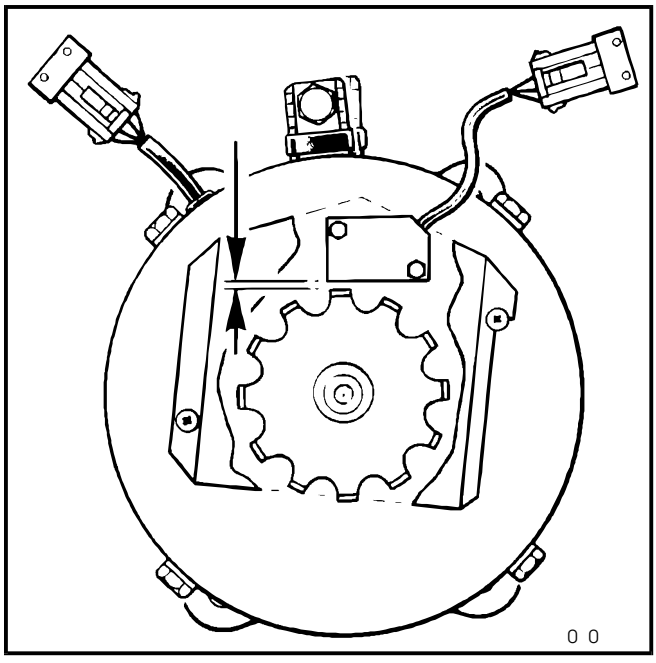
The commutator may be refaced in a lathe with 00 or fine glass paper for superficial scores or pitting. Excessive pitting, scores or wear will require turning to a minimum diameter 78mm. Only light cuts of 0.13mm and the final skim of 0.005mm. The Mica segment insulation should then be undercut with a parallel sided cutter to a depth of 1mm. After the commutator has been undercut, it should be lightly sanded with No.00 glass paper and cleaned to remove dust and dirt particles.

7.6.6 HYDRAULIC MOTOR RE-ASSEMBLY

To re-assemble the motor reverse the dismantling procedure. Ensure all bolts and terminal connections are secure. Bed in the brushes if new ones have been fitted.

Pump to motor securing bolts torque to 47Nm ±4Nm

After refitting the speed sensor thoothed disk, the sensor should be set with a gap of 2.0mm ±0.2mm between the sensor and the toothed disk.



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7.6.7 HYDRAULIC MOTOR BRUSH BEDDING

When fitting new brushes or after adjustment of the neutral position the brushes should be bedded to the commutator.

New brushes should first be bedded to the commutator using fine sand paper to obtain a rough shape. A commutator stone may be used for final bedding.

- Place a sheet of fine glass paper round the commutator - rough side facing brushes.
- Position the new brushes in their holders and ensure that the brush springs are centrally located.
- Rotate the armature slowly, until the brush surface shows contact over the whole area.
- Mark the brushes and their respective holders.
- Withdraw the brushes and glass paper and remove the carbon deposit from the commutator.
- Rub the commutator with a clean rag moistened with paraffin to remove oil or grease. Replace the brushes back in their correct position.
- Run the drive motor at reduced speed.
- Apply the bedding stone close behind a brush, moving it from side to side across the commutator, using just sufficient pressure to give a steady flow of dust. Reverse direction of rotation and repeat procedure until all brushes are perfectly bedded.
- Clean out the motor, brushes and boxes thoroughly.



CAUTION: This final step is most important, as no abrasive material must be present on the brushes or commutator during normal running.

Recommended grade of bedding stone - Morganite BS24.

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7.7 HYDRAULIC PUMP

7.7.1 HYDRAULIC PUMP - INTRODUCTION

These unit comprises an end cover, a body housing a dual element gear set, bushes and a mounting flange bolted together with through bolts. The gear set comprises a dual element arrangement with phased teeth to give low pressure amplitude and hence low overall system noise. The gear sets are separated by a balance plate and the gear journals are supported in plain bearings within pressure balanced bushes to give high volumetric and mechanical efficiency.

7.7.2 HYDRAULIC PUMP ROUTINE MAINTENANCE

No maintenance is necessary other than periodic checks for tightness of the mounting bolts and port fittings plus visual examination for oil leaks. The unit should be kept externally clean, especially in the area of the shaft seal as dirt can accelerate seal wear and cause leakage.

The unit must be operated on clean hydraulic fluid and the system manufacturer's directions for periodic renewal of filters must be adhered to. A fluid cleanliness level of ISO4406 17/14 or better is recommended to give maximum life.

7.7.3 HYDRAULIC PUMP DIRECTION OF ROTATION

The direction of rotation is indicated by the word ROTATE and an arrow etched on the body adjacent to the driveshaft. The reference code defines the pump size and mounting details, the first letter after the pump size also denotes the direction of rotation, A = anticlockwise, C = clockwise. Rotation is always specified as viewed on the driveshaft.

For identification the inlet port is also arrowed and marked INLET.

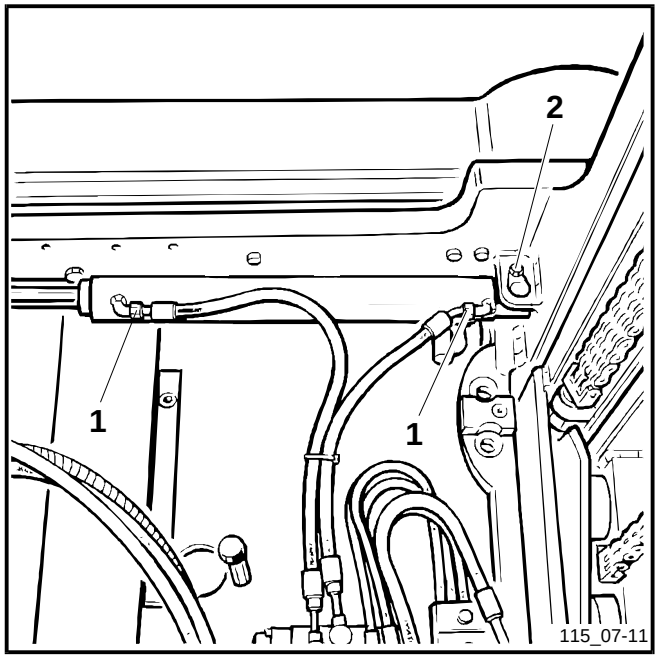
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7.8 REACH CYLINDER REMOVAL

WARNING: The hydraulic fluid can become very hot. Risk of scalding.

WARNING: Do not allow hydraulic oil under pressure, for example at a leak, to penetrate the skin. Medical aid is required if such an injury occurs.

- Apply handbrake. Chock load wheels.
- Reach the carriage and battery fully forward.
- Turn keyswitch OFF.
- Jack the chassis at the steer end clear of the ground and block securely in order to gain access to the front reach cylinder anchor.
- Disconnect the front end reach cylinder anchor by removing the screw, spring washer and anchor pin.
- Turn keyswitch ON and retract the reach cylinder fully.
- Turn keyswitch OFF, disconnect the battery and disconnect both hydraulic hose connections (1). Plug hoses and ports to prevent loss of oil and to stop the ingress of dirt.
- Disconnect the rear end reach cylinder anchor (2) by removing the screw, spring washer and anchor pin.
- Withdraw the reach cylinder from the chassis.

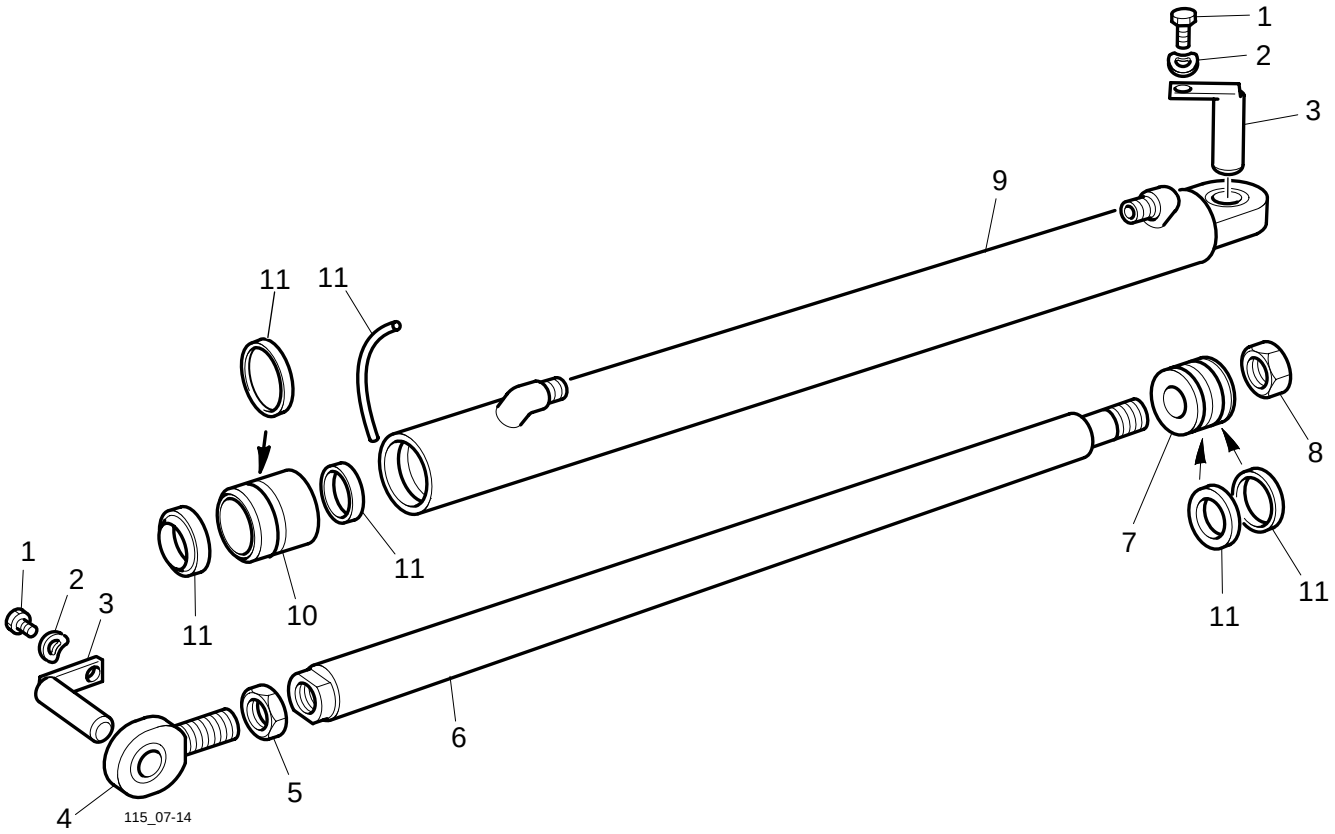


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7.9 REACH CYLINDER RE-FITTING

- To replace the reach cylinder, reverse the removal procedure.
- When the hoses are reconnected, replace the battery plug, turn the keyswitch ON, and use the reach lever to carefully extend the reach shaft forward until the rod end bearing is aligned to the front securing point on the chassis.

7.9.1 REACH CYLINDER



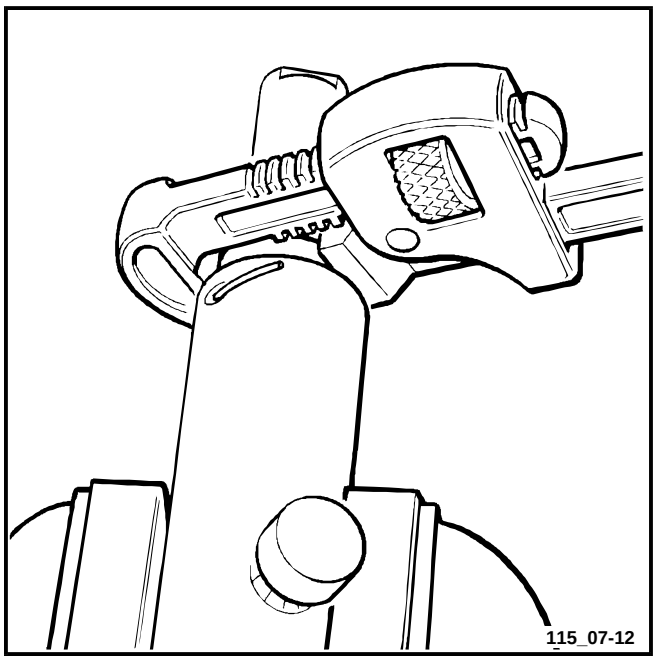
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1. Hexagon head screw
2. Spring washer
3. Pin
4. Rod end
5. Hexagon nut
6. Shaft
7. Guide
8. Hexagon nut
9. Cylinder
10. Guide
11. Seal kit

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7.9.2 REACH CYLINDER DISMANTLING

- Place the cylinder in a soft jaw vice.
- Measure the effective length of the rod end (4) to assist in re-assembly.
- Release locknut (5) and remove the rod end (4).
- Remove silicone sealant from the locking wire aperture.
- Using a 'C' spanner or suitable grips, turn the guide (10) anticlockwise to extract the locking wire.
- With the locking wire removed, extract the guide (10) from the cylinder (9).



CAUTION: It is recommended, that unless absolutely necessary, the shaft (6) is NOT removed from the cylinder (9). Removing the shaft completely could damage the locking wire groove in the cylinder and render the unit unservicable.

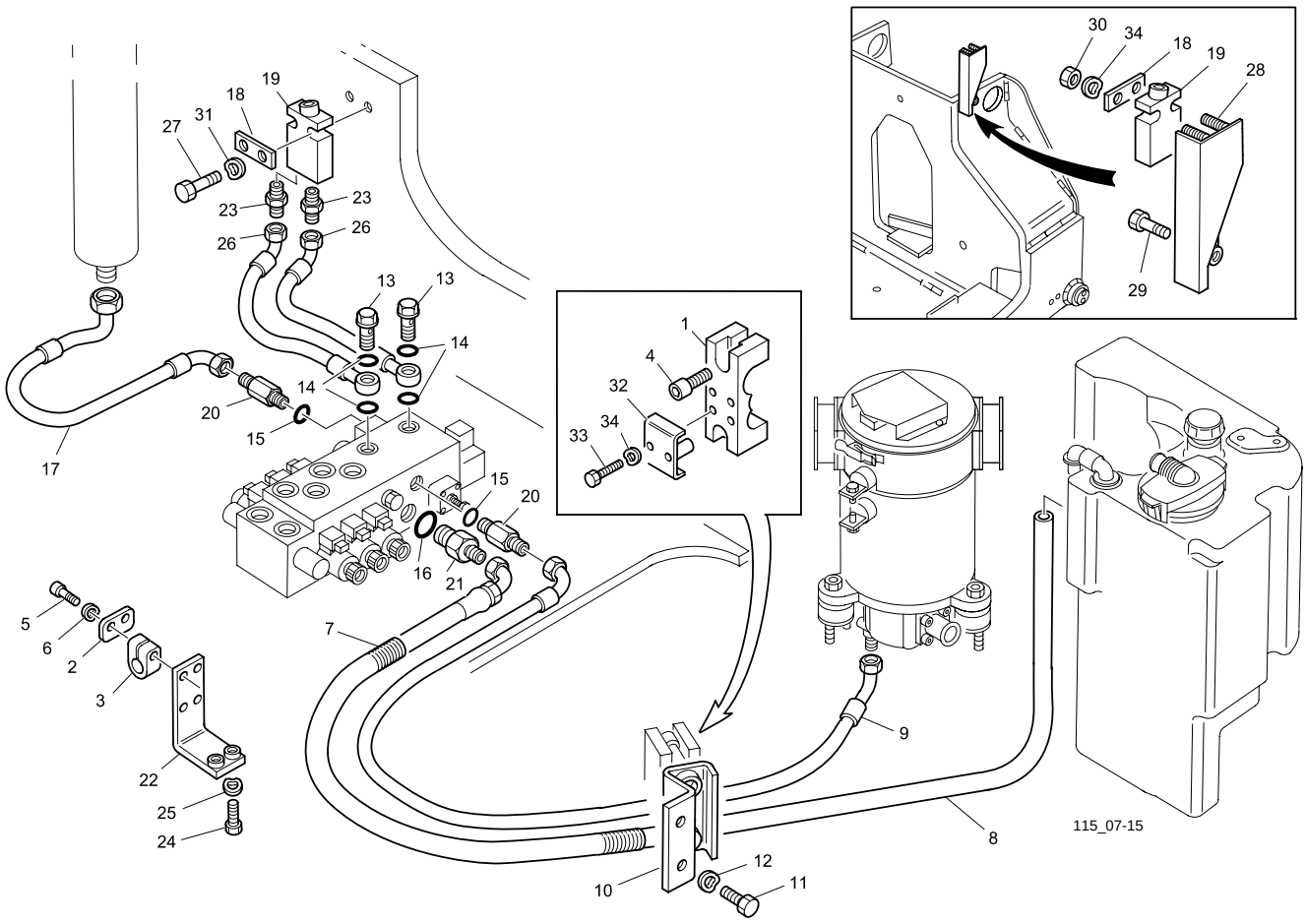
- Remove all seals etc. from the guide (10).

7.9.3 REACH CYLINDER REASSEMBLY

- To re-assemble the reach cylinder, reverse the dismantling procedure, using new seals and locking wire from the seal kit.
- To refit the locking wire, align the hole in the guide (10) locking wire groove with the locking wire aperture in the cylinder (9). Insert the bent end of the locking wire into the hole, and using a 'C' spanner or suitable grips, turn the guide (10) clockwise to draw the wire into place. Reseal aperture with silicone sealant.

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7.10 TILT AND LIFT CYLINDER HOSES

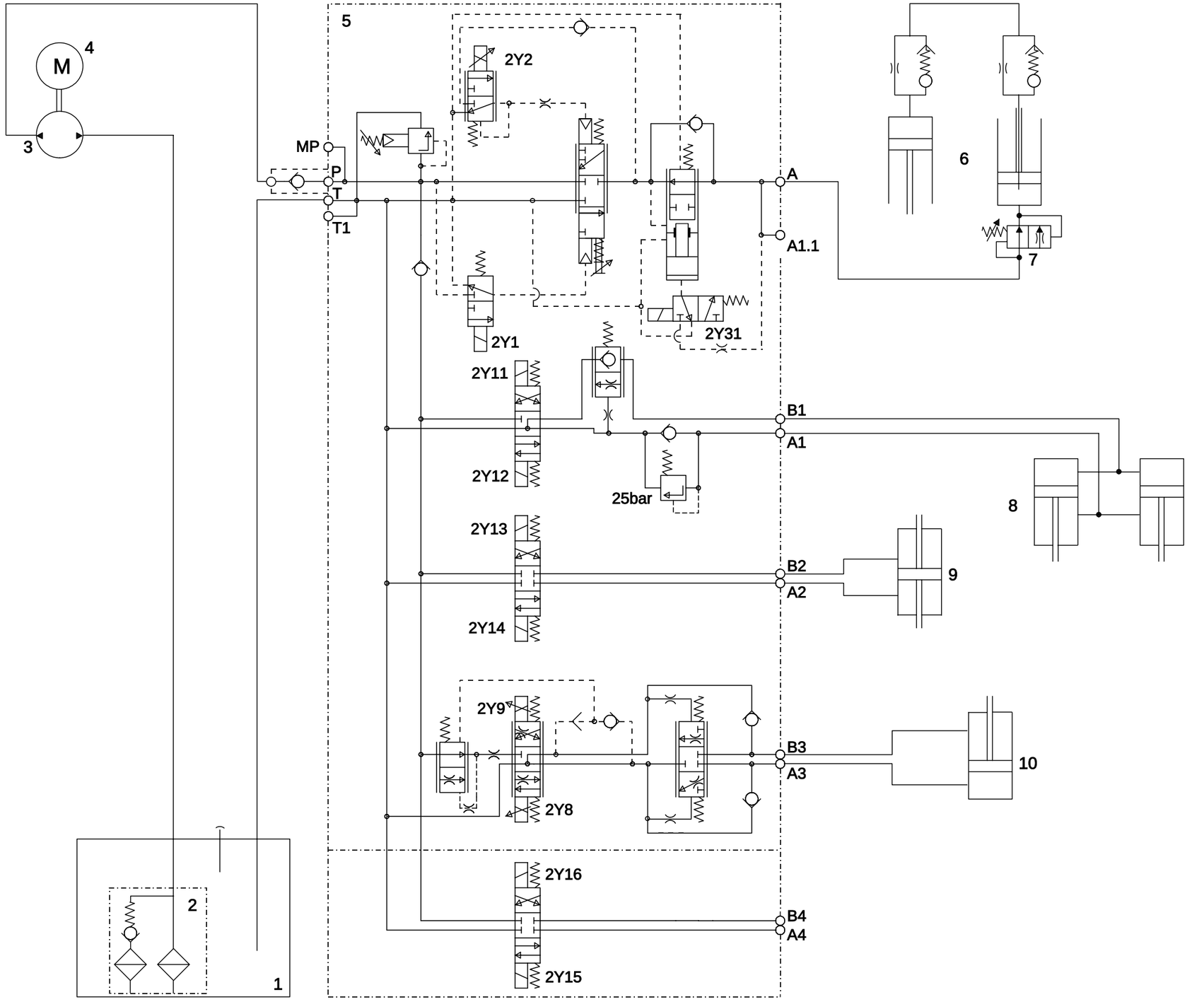


1. Hose clamp
2. Guard
3. Cable clamp
4. Socket head screw
5. Hexagon head screw
6. Wavy washer
7. Spring
8. Hose assembly
9. Hose assembly
10. Bracket
11. Heaxagon head screw
12. Spring washer
13. Hollow screw
14. O ring
15. O ring
16. O ring
17. Hose assembly
18. Clamping piece
19. Valve block
20. Adaptor
21. Adaptor
22. Bracket
23. Adaptor
24. Hexagon head screw
25. Spring washer
26. Hose assembly
27. Hexagon head screw
28. Bracket
29. Hexagon head screw
30. Nut
31. Spring washer
32. Guide
33. Hexagon head screw
34. Wavy washer
35. Hexagon head screw

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HYDRAULIC CIRCUIT DIAGRAM

1. Hydraulic tank
2. Filter
3. Main Hydraulic Pump
4. Main Pump Motor
5. Hydraulic Control Valve
6. Lift Cylinders
7. Lift Cylinder Flow Control Valve
8. Tilt Cylinders
9. Sideshift Cylinder
10. Reach Cylinder



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8 MAST UNIT AND ATTACHMENTS



WARNING: The hydraulic fluid can become very hot. Risk of scalding.



WARNING: Do not allow hydraulic oil under pressure, for example at a leak, to penetrate the skin. Medical aid is required if such an injury occurs.

8.1 INTRODUCTION

The R14, R16 and R20 versions of the 115 model are all fitted with triplex mast units of open centre design. The mast and reach carriage on the standard versions of this model forms an integral unit, The reach carriage and outer mast being a welded assembly. On wide chassis versions of the truck the mast assembly is mounted on a separate reach carriage. The reach carriage and mast assembly are supported on 4 steel guide rollers. The rollers incorporating ball bearings run two on each side within the reach channels formed in the main truck chassis.

The different mast assemblies are currently fitted as follows:

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Mast	Truck	Design features.
184	R14/R16 STD.	80mm mast channels, integral reach carriage
187	R20 STD.	90mm mast channels, integral reach carriage.
183	R14/R16 1400/1600mm	As mast 184 but with separate reach carriage.
186	R20 1440/1600mm	As mast 187 but with separate reach carriage

The masts are designed to provide trouble free operation with minimum maintenance. Angled guide rollers run within the mast channels for smooth operation. These rollers can be adjusted using various thickness shims should the mast require overhaul.

Two lift jacks are used to raise the fork carriage and extend the triplex mast via wide link lift chains. An inverted primary jack extends to raise the fork carriage by hydraulic oil pressure via the control valve and secondary lift jack. When the primary jack has fully extended, oil pressure at the base of the secondary lift jack increases and smoothly raises the triplex mast.

The fork carriage assembly is built to FEM standards. This model is fitted with an integrated sideshifting, tilting carriage as standard.

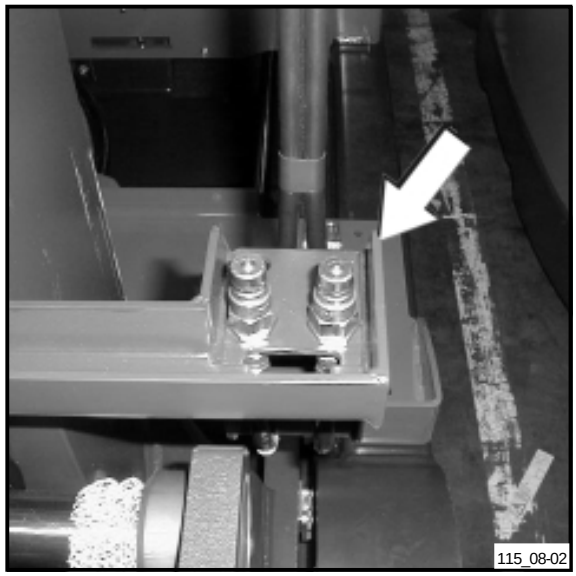
Two tilt jacks are fitted to the lift carriage assembly, these operate via the control valve and mast hoses to tilt the fork carriage 2° forward and 4° back from the vertical position. The tilt jack rams contact the fork carriage via a slide arrangement which forms the lower rubbing pad of the sideshift assembly.

A single sideshift jack is mounted on top of the lift carriage and operates between the lift carriage and fork carriage plates. This double acting ram operates from the control valve via the second pair of mast hoses to provide 160 mm of sideways movement of the fork carriage, 80mm either side of centre.

The elevating forks are 80mm x 40 mm section for R14 and 100 mm x 45 mm section for R16 and R20 versions of the 115 model. Fork lengths from 800 mm to 1500 mm are available as a customer option.

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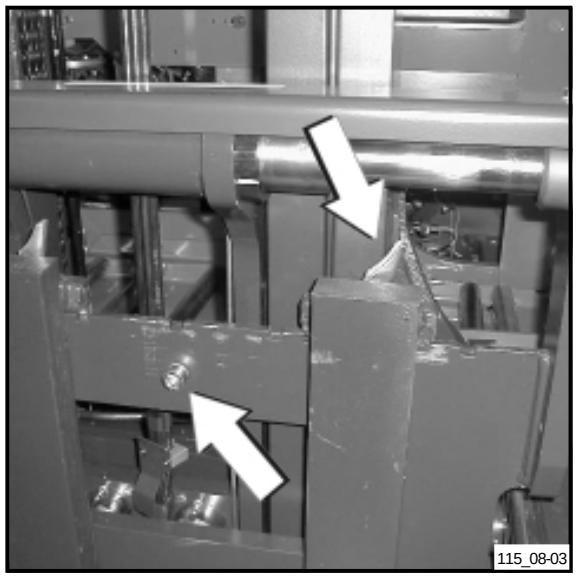


Additional hydraulic services can be fitted as an option if required. These require hydraulic hose reels to be attached to the outside of the mast to supply oil to the optional attachment.

8.2 FORKS REMOVAL

WARNING: Manual handling risk. The forks are heavy. Care should be taken when removing the forks.

- Apply parking brake
- Reach the mast fully forward and lower the forks to approximately 150 mm from the ground.
- Remove the fork carriage centre stop bolt.
- Release the fork latch and slide fork to centre of carriage.
- Carefully lower the fork onto suitable wooden blocks placed toe and heel, until it detaches from the top of the carriage plate.
- Release the parking brake and drive truck slowly away from the fork, first ensuring that it is clear of the fork carriage.



- Repeat procedure for the other fork.

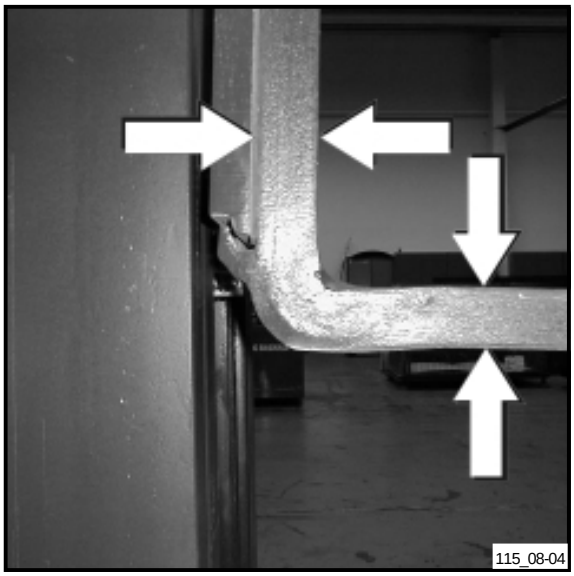
☞ NOTE: It will assist with sliding the forks along the carriage, to lightly grease its top and bottom faces.

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8.2.1 FORKS REFITTING

- Drive the truck to the fork and place it centrally to the fork carriage.
- Drive slowly forward until the fork is attached to the centre of the carriage.
- Apply parking brake, raise the fork carriage slowly with the fork located on the carriage.
- Ensure that it secure before sliding it along the carriage.
- Repeat the operation for the other fork and fit the centre stop bolt.

8.2.2 FORKS INSPECTION

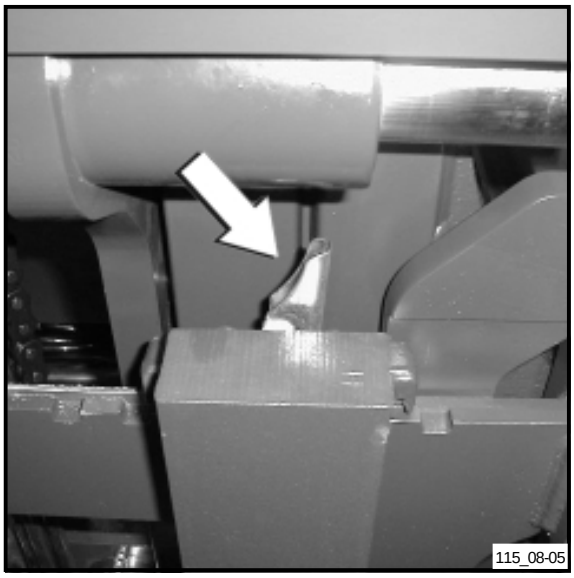


Remove rust, scale and paint from the forks and examine them for wear. All forks should be withdrawn from service when the blade near the heel has been worn to 90% of its original thickness.

☞ **NOTE: the vertical section of the fork is a guide to its original thickness.**

Check fork stops for proper seating and for any signs of damage which would render them unfit for further service.

8.2.3 FORK LATCHES



Lubricate the fork latch mechanism with oil. Manipulate a few times to ensure oil penetration.

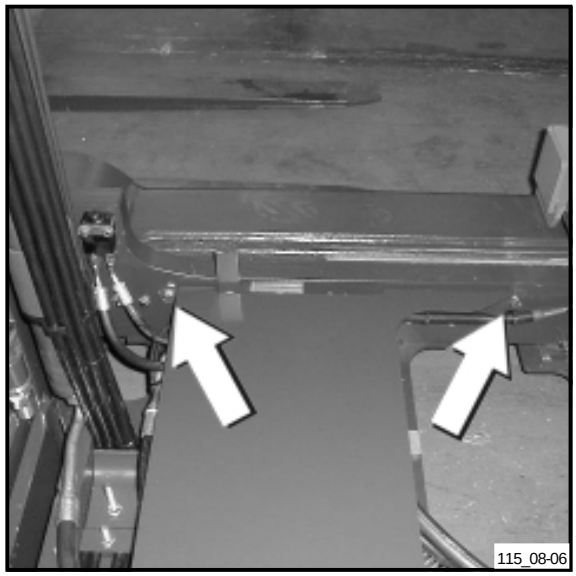
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8.3 MAST UNIT REMOVAL

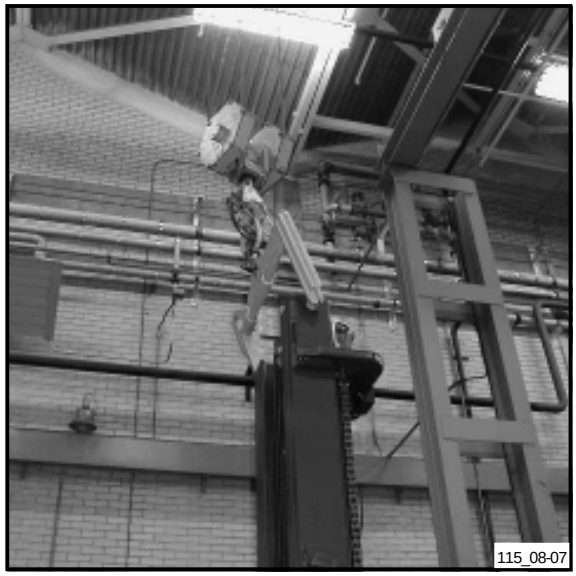
- Remove the elevating forks, see **ELEVATING FORKS REMOVAL.**
- Position the truck under suitable lifting equipment (to support the weight of approximately 3000 kg).

DANGER: Use lifting equipment of suitable capacity.

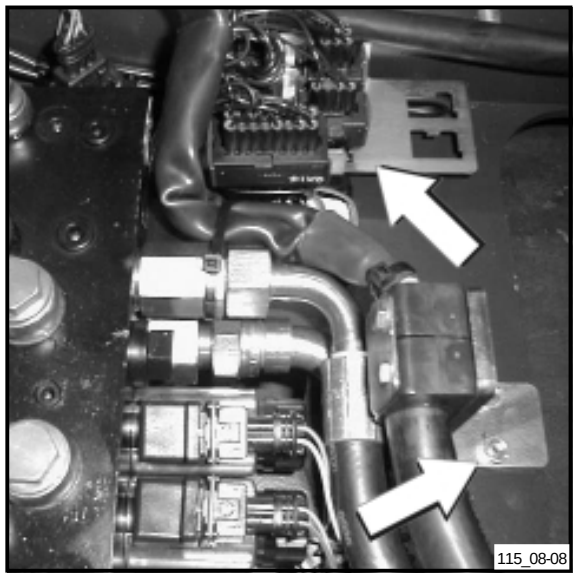
- Apply the parking brake and chock the wheels securely.
- Reach the mast fully forward. Lower the fork carriage. Turn OFF the key switch.
- Remove the four screws and washers securing the hydraulic control valve cover to the reach chassis. Remove the cover.



- Secure the mast assembly with the lifting equipment (and wooden blocks if necessary) to prevent it rolling forwards or backwards once the reach jack is disconnected.
- Disconnect the reach jack from the chassis beneath the operators footwell. It may be necessary to lift the drive end of the truck to enable the securing screw and pivot pin to be removed.
- With the key switch ON and the seat switch closed carefully operate the REACH BACK control. This will close the reach jack so that it is contained within the reach frame during the mast removal operation.
- Turn key switch OFF and disconnect the battery.

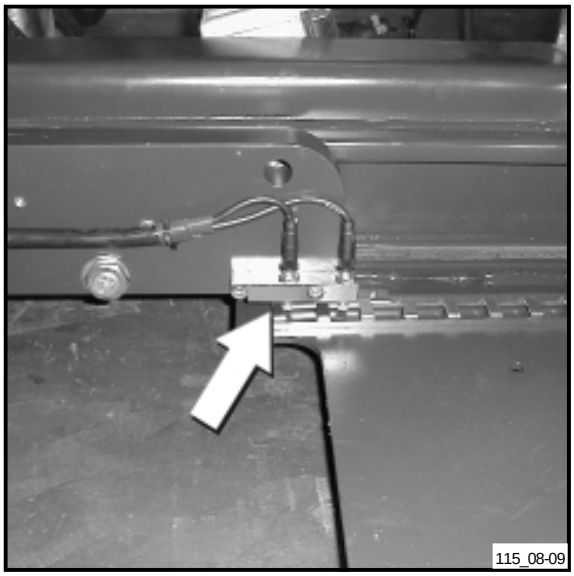


- Disconnect the hydraulic control valve wiring at the plugs/sockets, noting their positions.
- Remove the two screws securing the harness support bracket to the reach frame.

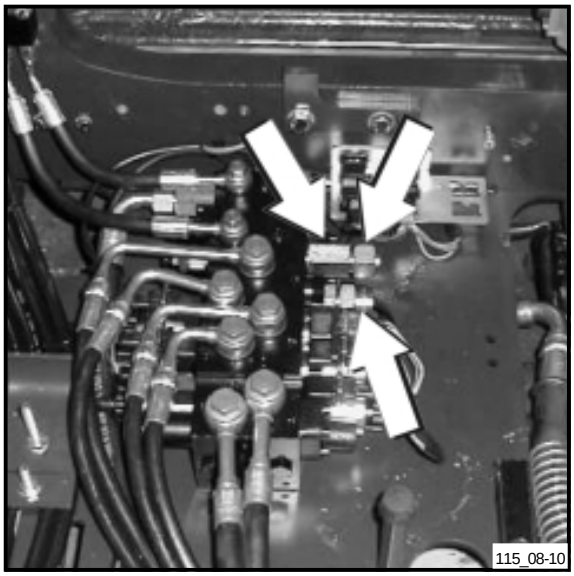


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- Remove the reach sensor block from the reach frame.



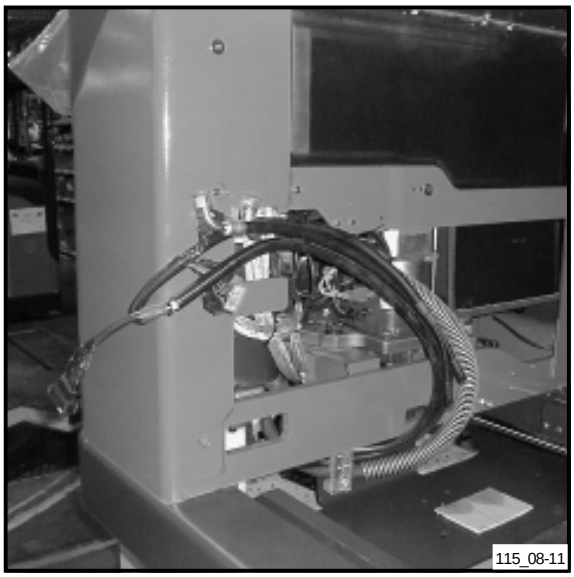
- Place a suitable oil drip tray underneath the reach chassis.
- Carefully release the pump to control valve hose. A small loss of hydraulic fluid is to be expected as there may still be pressure trapped in this hose.
- Carefully disconnect the return to tank hose from the hydraulic control valve.



CAUTION: To prevent the hydraulic oil draining from the tank, the return to tank hose will need to be plugged using plug Pt. No. 000 952 40 24. Before removing the hose, ensure this plug is available. DO NOT clamp the hose to prevent oil leakage, as this will damage the inner lining.

☞ **NOTE: Special spanner, tool number J 43975 will facilitate removal of the return to tank hose.**

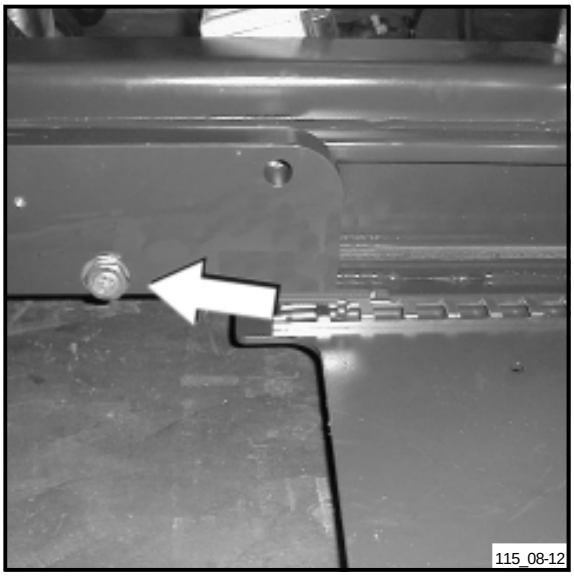
- Seal the pump to control valve hose and both hydraulic connections on the hydraulic control valve.



- Tie both hydraulic hoses back and as high as possible to further prevent oil leaking from the hydraulic tank.
- Remove cable clips as required to enable wiring harness to be tied back to the chassis free of the mast.

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- Undo their locking nuts and release the adjustment of the two bottom steady rollers.



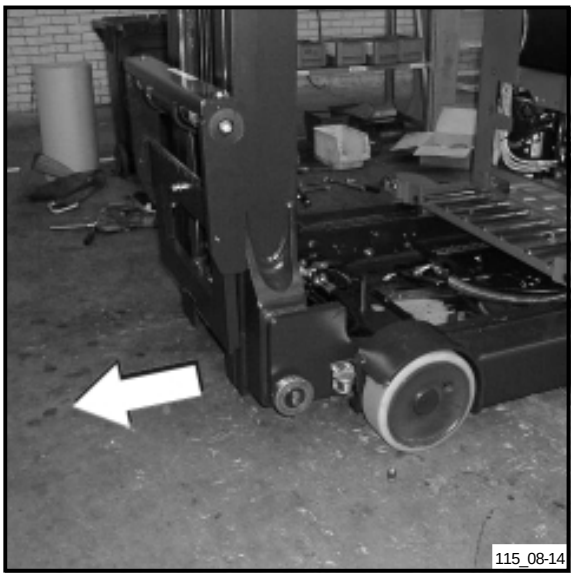
- Remove the reach out stop cap head screw, washer and spacer from both reach channels



- Using the overhead lifting equipment carefully ease the mast assembly along the reach channels until the unit is clear of the chassis.

DANGER: When lifting the mast with a crane, ensure that no persons are within the vicinity. Never step under an elevated load.

WARNING: Manual handling risk. The mast is heavy. Care should be taken when manoeuvring the mast out of the chassis.



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8.4 MAST UNIT REFITTING

- Refitting the mast unit to the truck chassis is a reversal of the removal process paying particular attention to the following points:

- With the mast unit back in the truck chassis, still secured by the overhead lifting equipment. Refit both reach out stops and fully tighten the cap head screws.

- With the hydraulic hoses and the wiring harness reconnected. Connect the battery and turn the key switch ON.

- With the aid of a qualified assistant carefully operate REACH OUT while manoeuvring the reach jack shaft into position to enable the rear pivot pin to be inserted.

- Refit and secure reach jack pivot pin securing screw and washer.

- Turn the key switch OFF.

- Disconnect the overhead lifting equipment and move it clear of the mast unit.

- Adjust both left and right hand eccentric reach rollers. Check reach side rollers and adjust as necessary. See **REACH ROLLER ADJUSTMENT**.

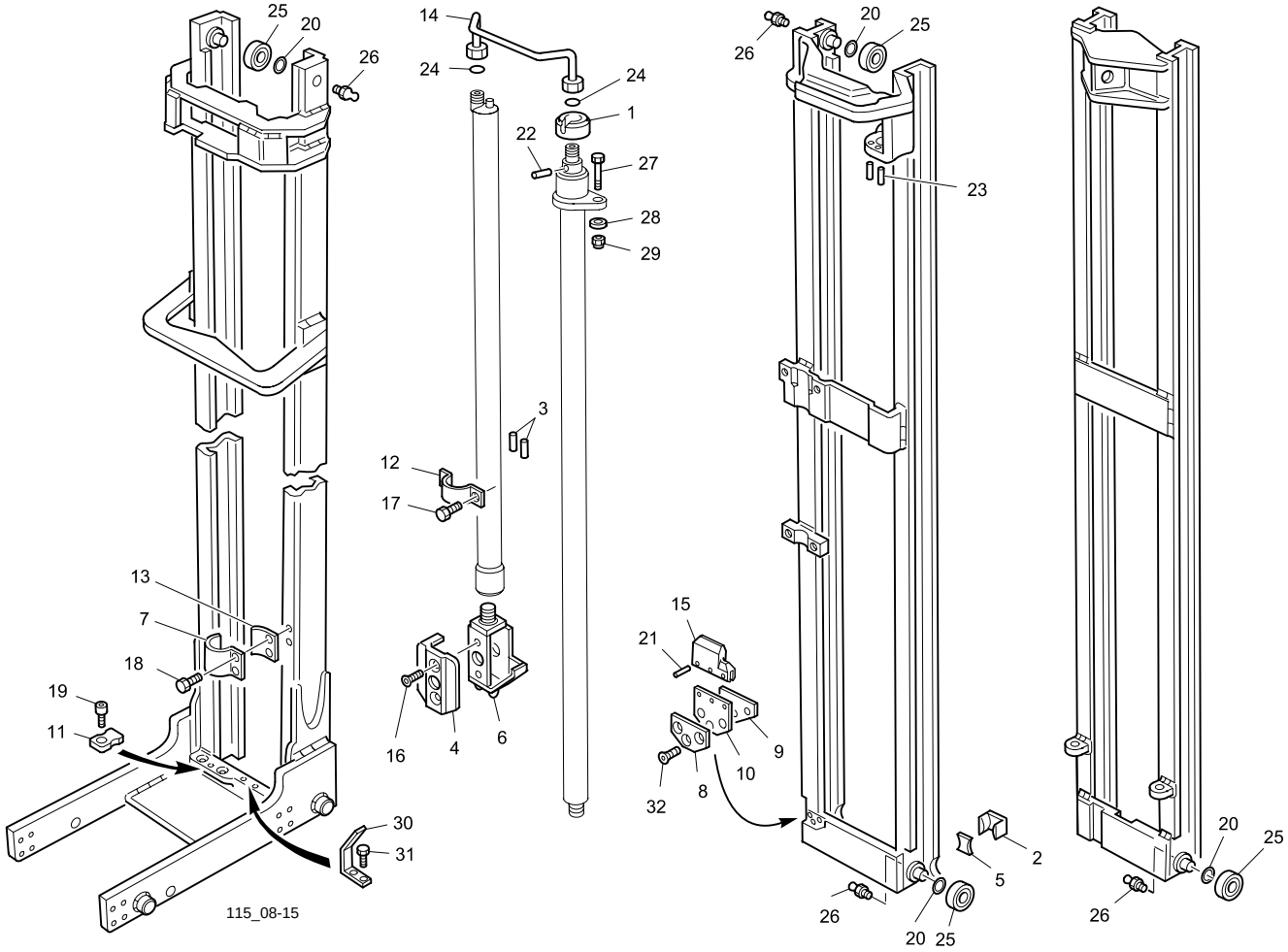
- Refit the reach sensor block to the reach chassis. Adjust the sensor to operating strip distance, if necessary, to achieve an air gap of approximately 3 mm.

- Refit the elevating forks and test mast and reach unit for correct operation.

- Refit the control valve cover plate after first ensuring that all necessary cable ties have been replaced to ensure the security of the hydraulic hoses and wiring harness..

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Service Training



1. Buffer
2. Pad
3. Pin
4. Cover
5. Shim
6. Bracket
7. Bracket
8. Plate
9. Plate
10. Plate
11. Buffer
12. Clamp
13. Clamp
14. Pipe assembly
15. Guide
16. Countersunk screw
17. Hexagon screw
18. Hexagon screw
19. Socket. head screw
20. Shim
21. Pin
22. Cotter pin
23. Cotter pin
24. ‘O’ ring
25. Support roller
26. Grease nipple
27. Hexagon screw
28. Washer
29. Hexagon nut
30. Plate
31. Hexagon screw
32. Countersunk screw

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8.5 MAST UNIT DISMANTLING

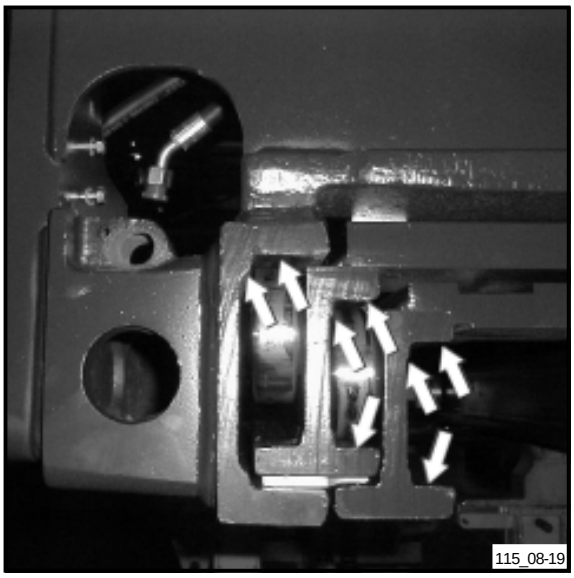
The previous illustration shows an exploded view of a type 187 mast assembly. Dismantling/assembling of other mast types used on this model are identical. The only differences being of minor components. The triplex mast unit dismantling operation for inspection will require workshop facilities which must include a suitable mast stand and lifting equipment. With the tilting sideshift unit removed, see **TILTING SIDESHIFT REMOVAL**, the primary lift jack removed, see **PRIMARY LIFT JACK REMOVAL, AND** the secondary lift jacks removed, see **SECONDARY LIFT JACK REMOVAL**, the mast unit can then be cleaned, inspected and then reassembled.

With the mast unit removed from the truck and with tilting sideshift unit, primary and secondary lift jacks, lift chains and sideshift and tilt hoses removed, proceed as follows.

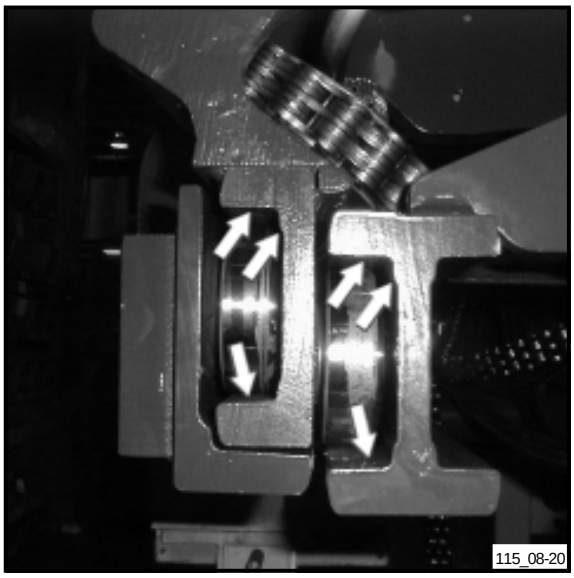
- Carefully extend the inner mast as far as it will go out of the bottom of the middle mast section. This will expose the inner mast bottom support rollers (25).
- Remove the bottom rollers together with any shims fitted (20) noting their positions if they are to be used again.
- At this point the inner mast top rollers can also be removed from the middle mast section together with their shims.
- Using suitable lifting equipment remove the inner mast section out through the top of the mast assembly by carefully manoeuvring it over the roller shafts.
- Repeat the procedure for the middle mast section to separate it from the outer mast assembly. In addition remove the rubbing pads (2) and shims (5) from either side of the bottom of the middle mast section.
- Cleaning and inspection of the mast components can now be carried out.

It may not be necessary to remove each mast section. Inspection of the mast channel can be carried out by extending the mast to permit visual examination. DO NOT extend the mast sections too far as they will separate. Ensure that there is no excessive scoring on the channel face in which the support rollers run. Scores which cannot be removed or are in excess of 0.5 mm deep will require that the mast section is replaced.

View from bottom



View from top



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8.5.1 MAST UNIT REASSEMBLY

Re-assembly of the mast unit is a reversal of the dismantling procedure. Particular attention however, should be paid to the adjustment of the mast rollers.

8.6 MAST ROLLER SIZING

Mast support rollers are available in several “over sizes” to allow for slight tolerances within the mast channels. The part numbers for the different diameter rollers are all listed in the mast section of the 115 parts manual, or on the following chart

183 AND 184 MAST / CARRIAGE ROLLERS

	Standard		Cold store	
Diameter	**Pt. No.**	**Stamped**	**Pt. No.**	**Stamped**
80.9/80.8	000.924.95.04	04	000.924.95.08	08
81.2/81.1	000.924.95.05	05	000.924.95.09	09
81.5/81.4	000.924.95.06	06	000.924.95.10	10

186 AND 187 MAST / CARRIAGE ROLLERS

	Standard		Cold store	
Diameter	**Pt. No.**	**Stamped**	**Pt. No.**	**Stamped**
89.9/89.8	000.924.95.75	01	000.924.95.97	04
90.2/90.1	000.924.95.76	02	000.924.95.98	05
90.5/90.4	000.924.95.77	03	000.924.95.99	16

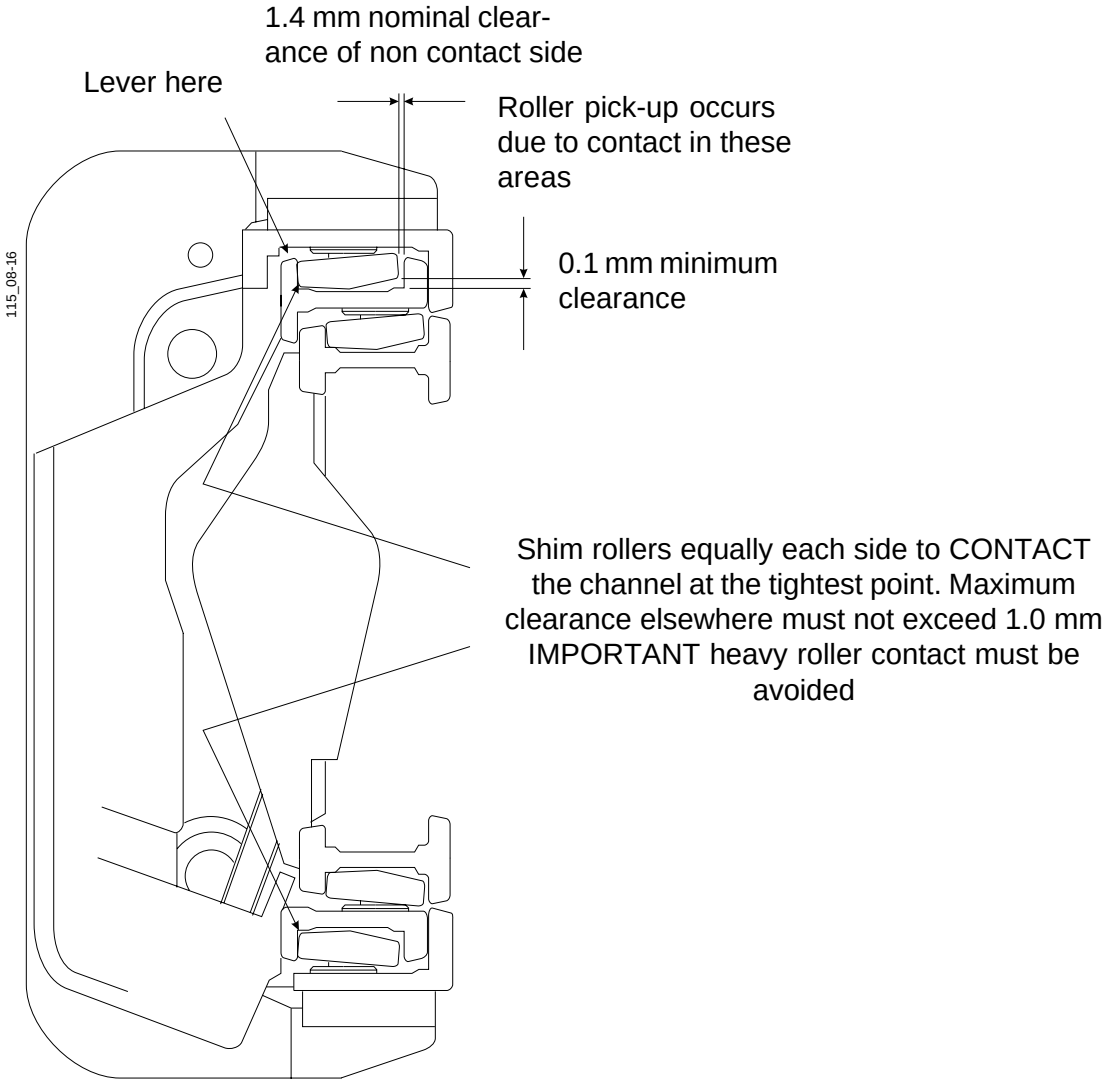
Ensure that when fitted, each roller has a radial clearance in its channel, throughout the whole working length of the mast, of between 0.1 mm to 0.5 mm This clearance is essential to prevent roller “pick up” on its non-contact face and resultant damage to the roller and its channel. To achieve correct roller sizing any tight spots may have to be removed locally from the channel by careful grinding. The final finish must be smooth.

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8.6.1 MAST ROLLER SHIMMING

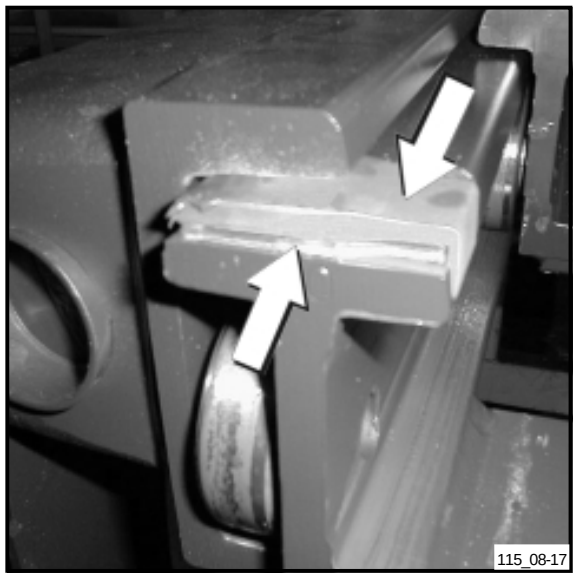
To take up side play between the mast sections fit shims (20) to the roller shafts (equally to left and right rollers to centralise the carriage/mast sections). There should be a minimum sideways clearance of 0.2 mm between the contact side of the roller and its channel throughout the whole length of the mast. A small lever should be inserted to help check for free play, but do not use excessive force. The maximum side clearance should be less than 1.0 mm When correctly shimmed the rollers must be checked to ensure that there is 1.4 mm nominal clearance on the non-contact face between the channel and the roller. This clearance must not be less than 0.2 mm at any point throughout the whole length of the channel, failure to achieve this will result in radial “pick up” of the roller and damage to the non contact side of the channel. Any tight spots in the channel can be locally relieved by careful grinding but the final finish must be smooth.



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8.7 MAST RUBBING PADS

Two rubbing pads are fitted one each side at the lower end of the middle mast.. Various thickness shims are available to enable adjustment to be carried out between the lower end of the middle mast and the outer mast channels. Place shims between the pad and the middle mast to remove excessive free play between the middle and outer mast sections. The free play should not exceed 0.1 mm-0.4 mm, do not shim too tight.



☞ **NOTE: For this adjustment or replacement to be carried out on a mast unit which has not been removed from the truck and stripped for inspection the lift chains will need to be disconnected. This will permit the middle mast section to be lowered sufficient to access the rubbing pads.**

☞ **NOTE: See SECTION 10 for type of lubricants and periods of application.**

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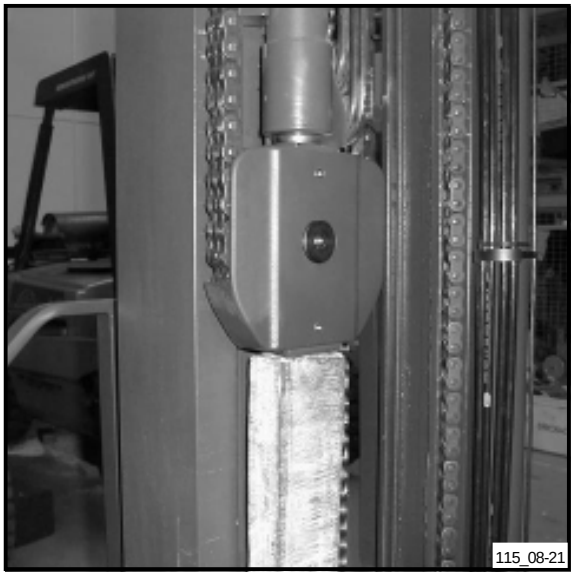
8.8 PRIMARY LIFT JACK REMOVAL

The following procedures apply to trucks with a lift height of up to 7.6 metres. All trucks with a lift height in excess of this will require the mast unit to be removed from the truck chassis to enable the primary and secondary lift jacks to be removed.

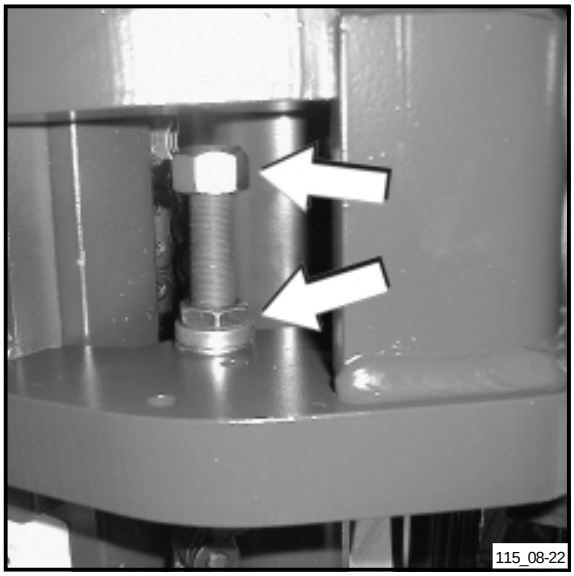
☞ **NOTE: It is recommended that two qualified persons carry out the following procedure.**

WARNING: Manual handling risk. The lift jack is heavy. Care should be taken when removing the lift jack.

- Park the truck under suitable lifting equipment (safe working load 1000 kg) with the mast unit reached fully out and the elevating forks fully lowered. Switch OFF the key switch and disconnect the battery.
- Raise (WITH THE LIFTING EQUIPMENT) and block the fork carriage to slacken the primary lift chain. Ensure that the jack remains fully closed.
- Place a suitable wooden support between the reach carriage and the underside of the primary lift jack chain pulley assembly.

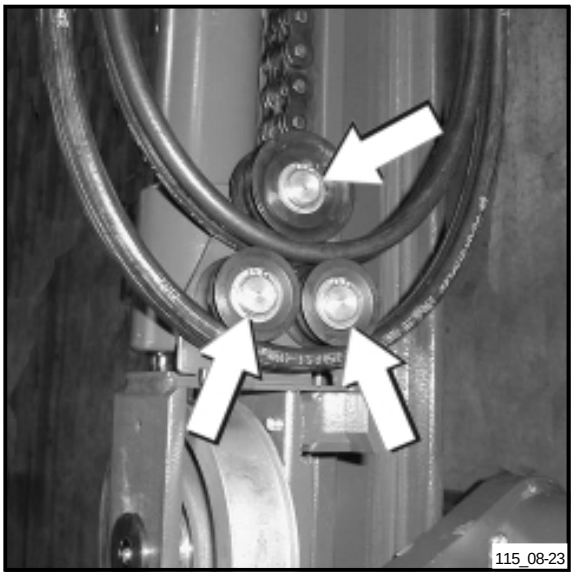

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- Remove the chain pulley cover.
- Disconnect the primary lift chain at the top of the outer mast.
- Withdraw the chain from the pulley and stow safely.


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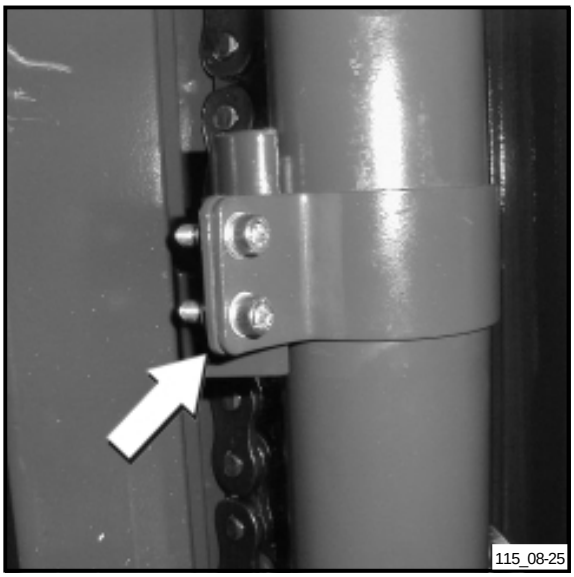
- Remove the three circlips and shims retaining the three hose pulleys. Remove hose pulleys and safely stow mast hoses away from the primary lift jack.
- Secure the hose pulley shafts to the lift jack outer cylinder with suitable cord or rope to prevent the lift jack extending as it is removed from the mast.



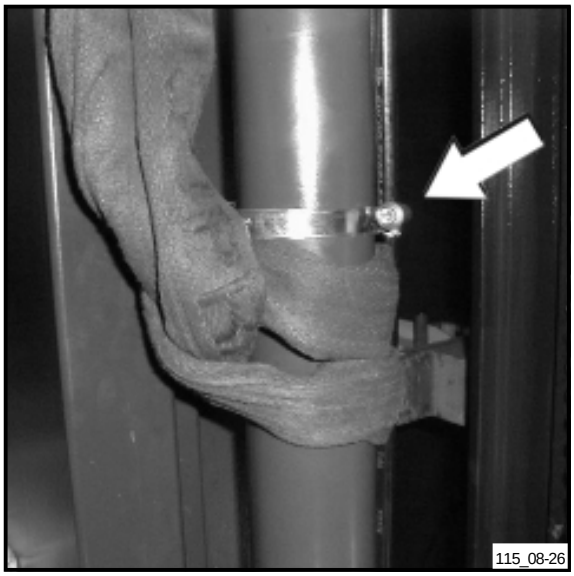
- Using a suitable mobile safety step up platform, disconnect the primary lift jack inlet connector using a 41 mm open end spanner. Contain any oil spillage. Plug the inlet hole in the jack and hydraulic pipe.



- Remove the two part primary lift jack steady clamp.

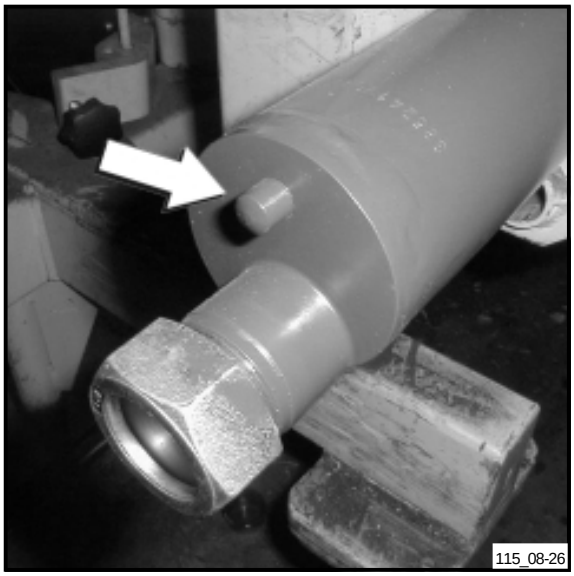


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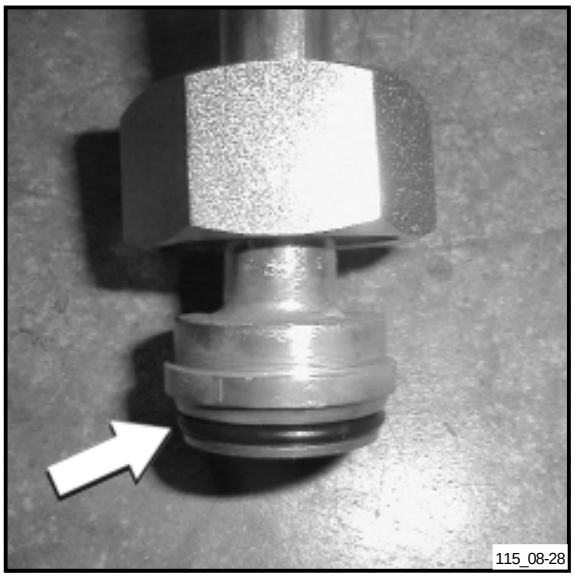


- Connect a suitable sling around the lift jack cylinder with a clip fitted around the cylinder to prevent the sling from slipping down. Connect the sling to suitable lifting equipment.
- Carefully remove the primary jack from its middle mast mounting.

8.8.1 PRIMARY LIFT JACK REPLACEMENT



- To replace the primary lift jack reverse the removal procedure
- Ensure that the dowel peg on the inlet end of the cylinder locates in its mating hole in the middle mast assembly.



- Check condition of the ‘O’ ring and replace if necessary.
- Tighten the inlet connector to a torque of 120 -150 Nm. DO NOT overtighten.
- Check the hydraulic oil tank level. Top up if necessary using the recommended grade of oil, see **SECTION 10**.
- Bleed the hydraulic lift system. See **LIFT JACK BLEEDING**.

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8.9 SECONDARY LIFT JACK REMOVAL

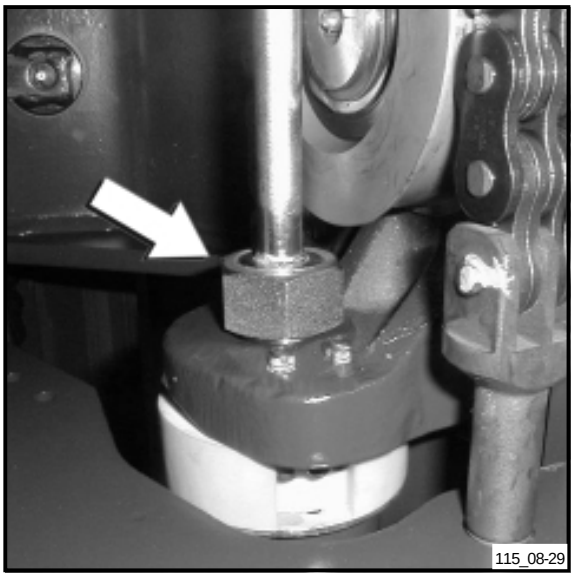
The following procedures apply to trucks with a lift height of up to 7.6 metres. All trucks with a lift height in excess of this will require the mast unit to be removed from the truck chassis to enable the primary and secondary lift jacks to be removed.

☞ **NOTE: It is recommended that two qualified persons carry out the following procedure.**

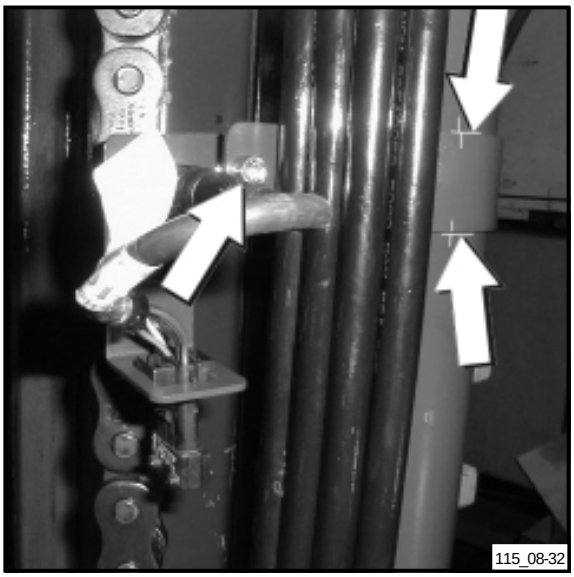
WARNING: Manual handling risk. The lift jack is heavy. Care should be taken when removing the lift jack.

- Park the truck under suitable lifting equipment (safe working load 1000 kg) with the mast reached fully out and elevating forks fully lowered. Chock the load wheels, switch OFF the key switch and disconnect the battery.

- Using a suitable safety step up working platform, disconnect the secondary lift jack top hydraulic pipe connection using a 41 mm open end spanner. Plug hydraulic pipe and jack connection holes.

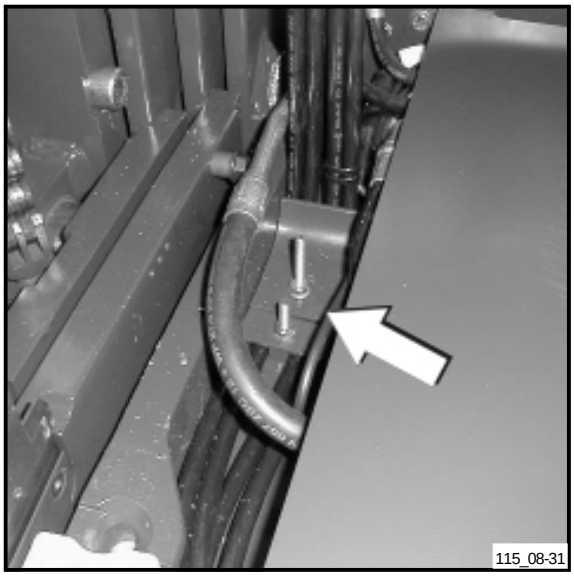


- Remove the lift stop sensor cover and disconnect the sensor.
- To assist reassembly, mark the bracket position top and bottom on the lift jack.
- Unscrew the bracket clamping screw, and remove the two part bracket complete with sensor.

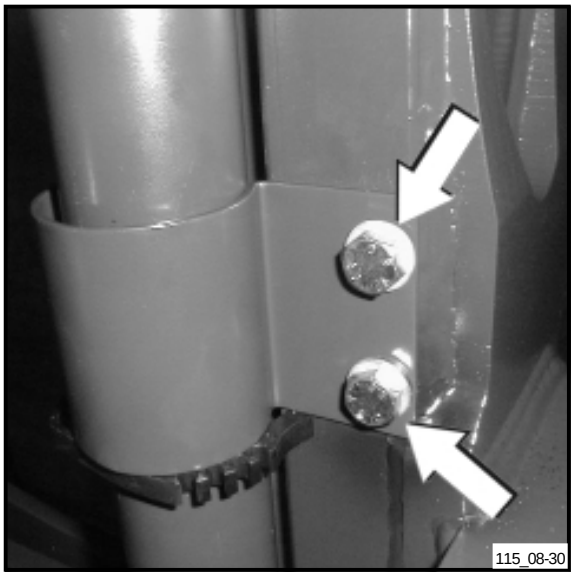


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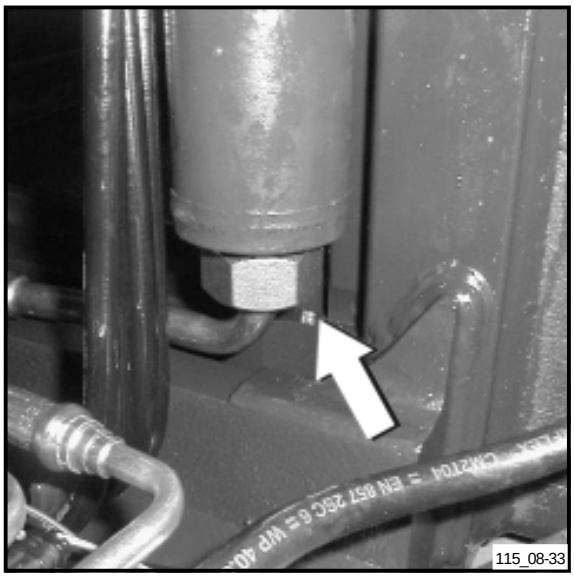
- Using a suitable sling around the middle and inner mast top cross member, raise the mast unit sufficient to enable the jack to be removed. Block the mast unit securely.
- Unclip the mast hoses from the secondary lift cylinder. Remove the bottom hose clamp/guide to enable the hoses to be safely stowed to one side.



- Undo the two securing screws and remove the two part secondary lift jack steady bracket.

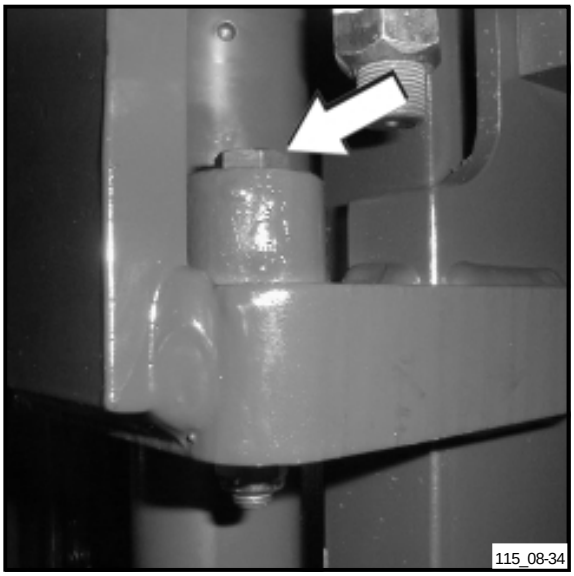


- Place a drip tray underneath the mast unit to contain any oil spillage.
- Disconnect the bottom hydraulic pipe connector using a 41 mm spanner. Plug the jack and pipe connection holes.



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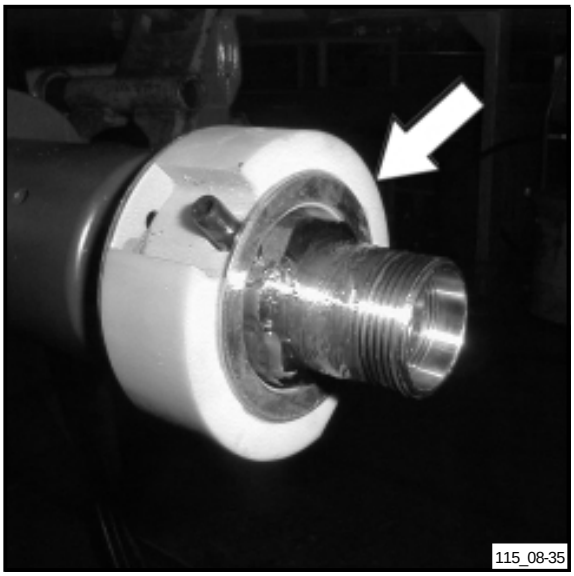
- Remove the lift jack top mounting bolt, washer and nut.
- Place a suitable sling around the lift jack (using a hose clamp to prevent the sling from slipping up the cylinder) and connect to the lifting equipment
- Carefully raise the lift jack sufficient to manoeuvre it clear of the mast assembly. Take care not to lose the buffer fitted to the top of the jack shaft.



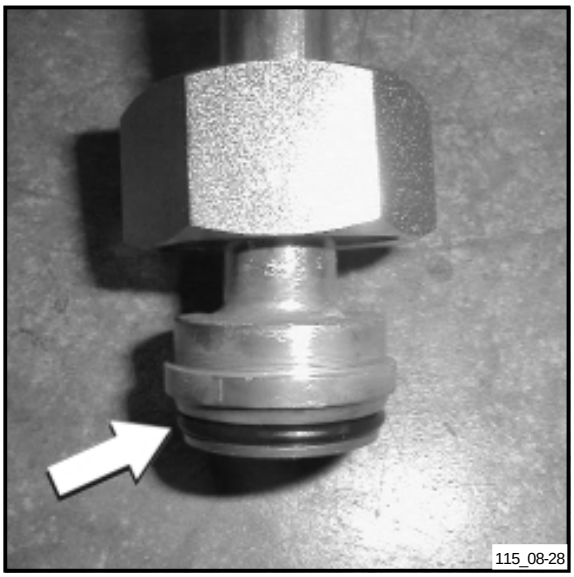
8.9.1 SECONDARY LIFT JACK REFITTING

To replace the secondary lift jack, reverse the removal procedure.

- Take care when replacing the jack into the mast unit otherwise damage to the jack can occur.
- Ensure that the buffer is in good condition and is refitted to the top of the lift jack shaft.

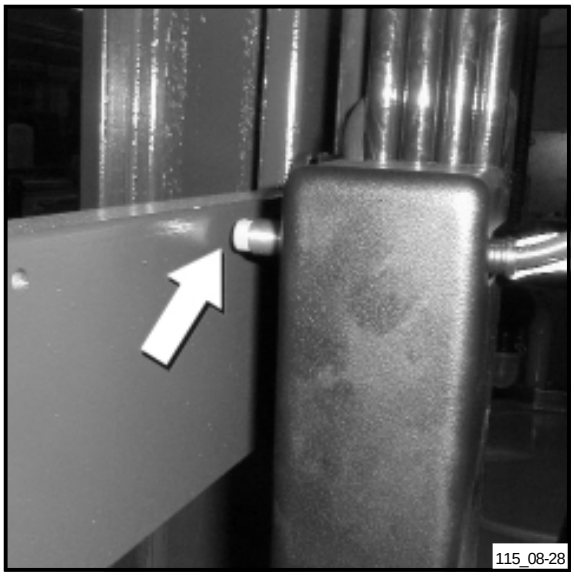


- Check the condition of the ‘O’ Ring and replace if necessary.



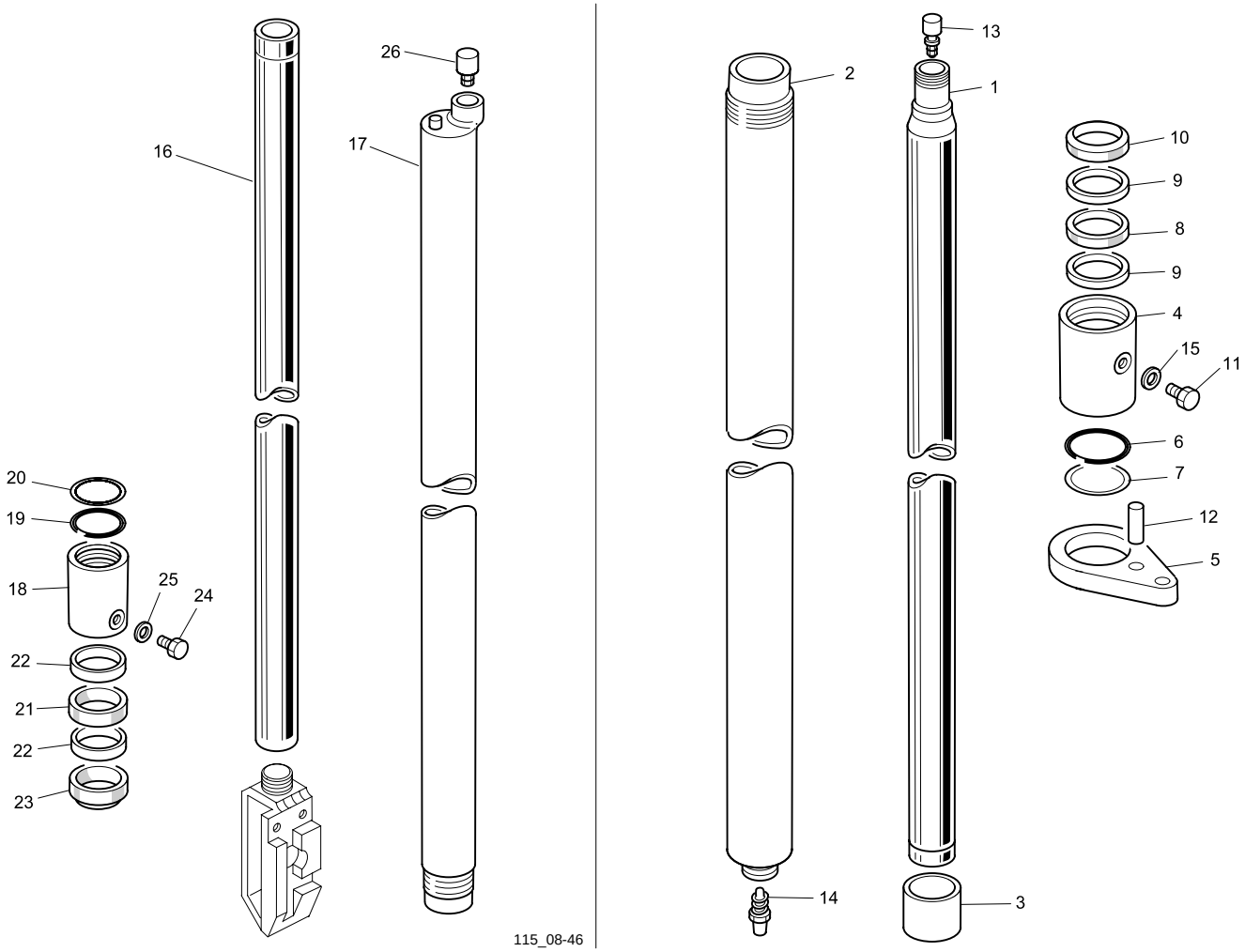
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- Tighten connector of interconnecting pipe 120-150 Nm. DO NOT overtighten.
- Check the hydraulic oil tank level. Top up if necessary using the recommended grade of oil, see **SECTION 10**.
- Raise the mast fully and check the lift stop sensor operation, the clearance between the sensor and middle mast cross member should be 3 ±1mm. The sensor should operate 60 mm (187 mast) or 80 mm (184 mast) from full mast extension.
- Bleed the hydraulic lift system, see **LIFT JACK BLEEDING**.



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8.10 PRIMARY AND SECONDARY LIFT JACK DISMANTLING



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1. Piston
2. Cylinder
3. Spacer
4. Housing - seal
5. Support plate
6. O ring
7. Anti extrusion ring
8. Grooved ring
9. Bearing strip
10. Wiper seal
11. Screw
12. Spring cotter
13. Valve
14. Flow control valve
15. Seal ring
16. Piston
17. Cylinder
18. Seal
19. O ring
20. Support ring
21. Grooved ring
22. Bearing strip
23. Wiper seal
24. Screw
25. Seal
26. Check valve

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- The lift jack cylinder should be placed in a soft jawed vice.

- Remove the burst check valve (13) or (26) using a peg spanner.

- On the primary lift jack remove the chain pulley and bracket assembly. This is extracted from the piston (16) by means of a sharp tap with a copper/hide hammer and turning anticlockwise.

- On a secondary lift jack, tap the locking dowel down to permit housing (4) to be removed. Remove the locating spirol pin from shaft (1) top end.

- Remove the housing (18). A chain wrench may be needed in this operation.

- Withdraw the piston (15) and seal housing (17) from cylinder (16).

- Slide the seal housing (17) from the piston (15).

- Renew the wiper seal (9), bearing strip (8), seal (7), 'O' ring (5) and anti extrusion ring (6) in the secondary jack.

- Replace the same components listed in the primary lift jack.

8.10.1 PRIMARY AND SECONDARY LIFT JACK REASSEMBLY

- To reassemble the primary and secondary lift jack, reverse the dismantling procedure.

- On the secondary lift jack, ensure the spacer (3) is refitted prior to assembling the piston (1) to cylinder (2).

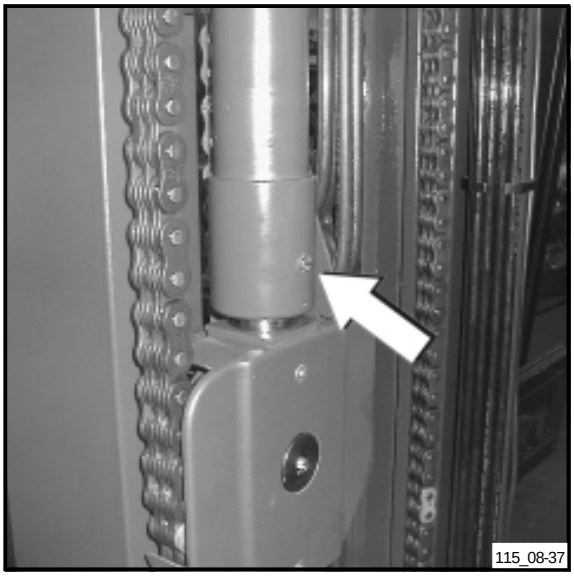
- Assemble the seal housing (4) or (18) to the cylinder (2) or (17), using Loctite 242 evenly applied around the cylinder threads and tighten to a torque of 160-180 Nm.

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8.11 LIFT JACK BLEEDING

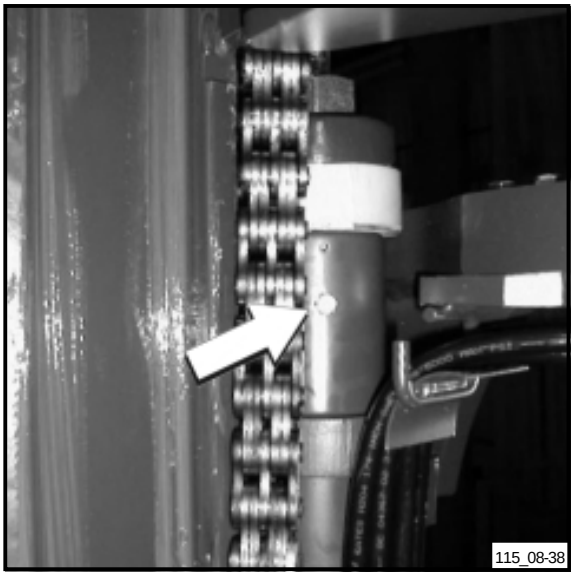
- Air should be released from the hydraulic lift system by raising the mast to full lift height a few times, otherwise proceed as follows:

- To bleed the primary lift jack, loosen the screw with an 7 mm spanner. Carefully operate the lift control until all the air bubbles cease to flow from the bleed point. Tighten the bleed screw'.



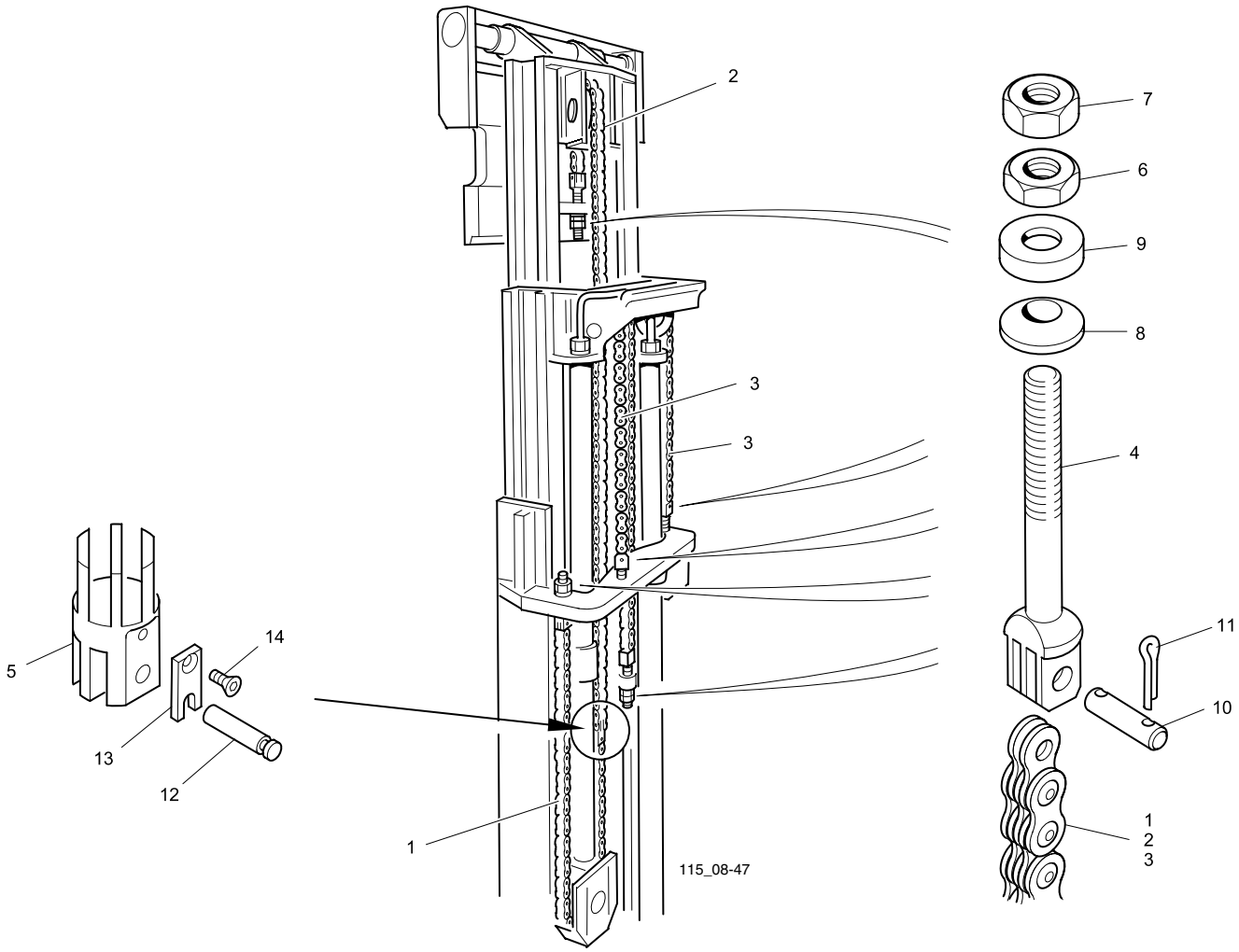
- Repeat the procedure to the bleed screw on the secondary lift jack.

- Ensure that the fork carriage and mast unit does not 'bounce' after the bleeding operation is complete. Re-bleed the lift jacks to clear the air from the system if the mast lift operation continues to 'bounce'.



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8.12 CHAINS



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1. Chain
2. Chain
3. Chain
4. Chain anchor
5. Chain link
6. Hexagon nut
7. Hexagon nut
8. Ball washer
9. Taper socket
10. Rivet pin
11. Cotter pin
12. Pin
13. Plate
14. Countersunk screw

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8.12.1 CHAIN INSPECTION

WARNING: The examination of lift chains should only be carried out by certified personnel who have received the relevant training. DO NOT make an assessment of chain condition unless you have been certified to do so.

8.12.2 CHAIN SERVICE LIFE

Hostile and Aggressive Environments

Irrespective of the results of the inspection, chains and anchor pins should be replaced after a period not exceeding 4000 operating hours or two years, whichever is the shorter. Industrial trucks operating in the following examples of arduous environments may fall into this category:-
The competent person shall make a judgement based on the operating conditions and then decide if replacement is necessary on a case by case basis.

i) Marine environments
ii) Corrosive chemical environments
iii) Metal manufacturing or processing
iv) Cement/aggregate processing or where abrasive particulates are present
v) Brine processes

☞ **NOTE: This list is not exhaustive.**

Cold Store Conditions

Irrespective of the results of the inspection, chains and anchor pins should be replaced after a period not exceeding 6000 hours or three years, whichever is the shorter.

8.12.3 CHAIN REPLACEMENT AND SHORTENING

- Under no circumstances are chains to be lengthened by joining together (this action would invalidate the chain certification).

- It is not recommended but should a chain require shortening, it is essential that the truck manufacturer/ supplier be consulted.

- Where a mast is fitted with pairs of chains, they must be replaced together and adjusted to have equal tension in each chain.

- Only fit replacement chains, chain anchors, anchor pins and integral anchors as specified and approved by the truck manufacturer/supplier.

- In all circumstances new anchor pins/end connecting links with new split pins must be used when replacing chain(s).

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8.13 CHAIN ADJUSTMENT

It is most important in all lift systems, that upright jacks can expand fully against the internal mechanical stops, thereby containing relief pressure at maximum lift and not allowing pressure to be transmitted to the lift chains.

If chains are adjusted too short, restricting the final movement of the jack, relief pressure at maximum lift would be transmitted to the chains and mast, resulting in possible over stressing and damage. In this condition the jack would have a tendency to 'bow'.

If chains are adjusted too slack, damage can result through unrestricted movement and shock loading. The maximum lift height would be decreased.

Lift systems using inverted jacks rely on correct chain adjustment to ensure the upright jack can fully expand.

When satisfied that the chains are in a serviceable condition, follow this procedure:-

Park truck on LEVEL ground with parking brake on, chock wheels. Turn off keyswitch and disconnect battery.

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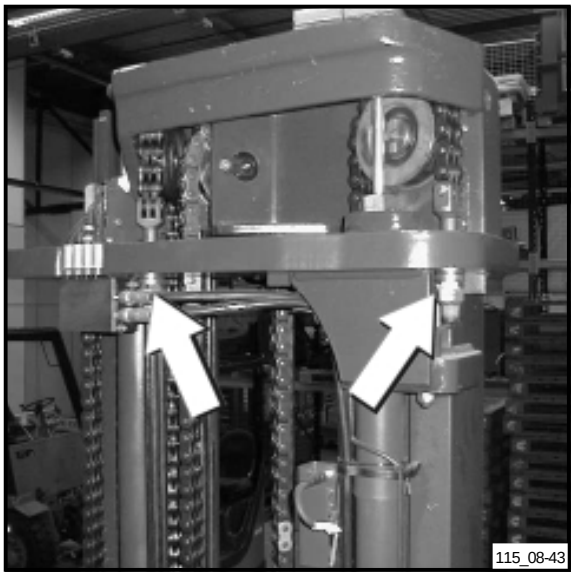
8.13.1 CHAIN ASSOCIATED EQUIPMENT CHECK

Check pulleys and bearings for wear with chain load off the pulley. Check they run true and that enough side clearance exists between the pulley flanges and the chain pins.

Check fork carriage chain tension.

8.13.2 MAST CHAIN ADJUSTMENT

- With the mast vertical, secure the lift/lower lever in the 'lower' position.
- Pull on each chain to ensure both jacks are fully closed.
- Adjust the chain anchors so that all mast sections are level at the top.
- Tighten the mast lift chain anchor locknuts after adjustment is complete. THIS IS MOST IMPORTANT.

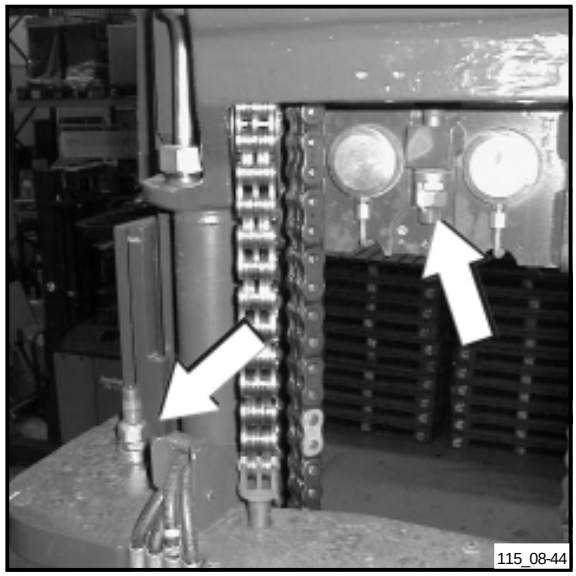


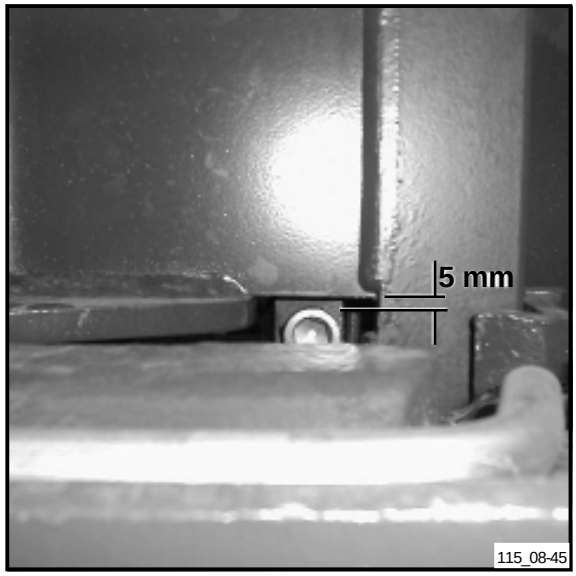
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8.13.3 CARRIAGE CHAIN ADJUSTMENT

- Raise the fork carriage sufficiently to enable the distance between the fork carriage stop bolt and the inner mast crossmember to be measured.

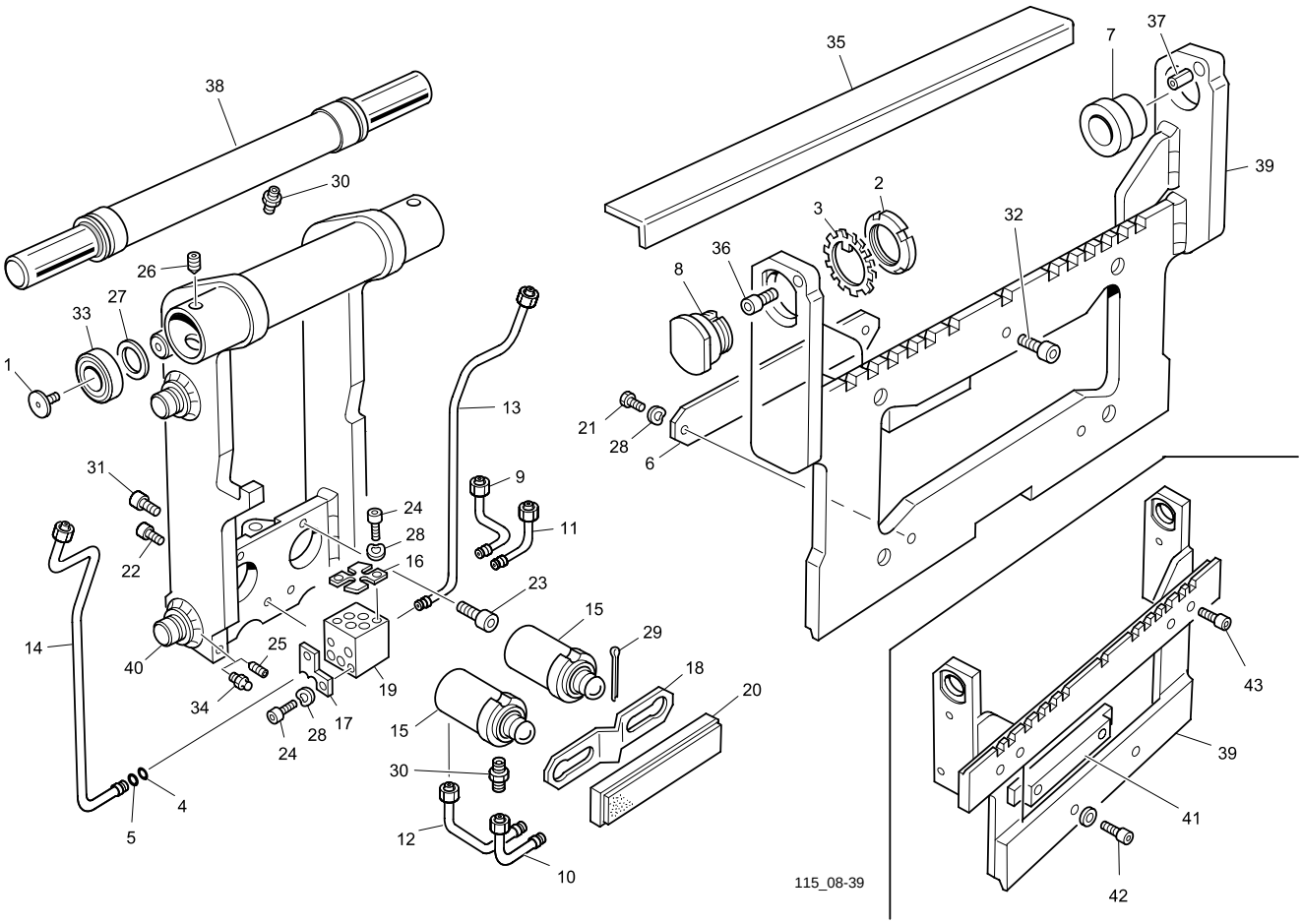
- Adjust the fork carriage lift chain anchors so as to give a 5 mm clearance between the fork carriage stop bolt and the inner mast crossmember. Tighten all locknuts.





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8.14 TILTING SIDESHIFT ASSEMBLY (187 MAST)



1. Screw plug
2. Nut.
3. Tab washer
4. Support ring
5. 'O' Ring
6. Plate
7. Bush
8. Threaded bush
9. Pipe assembly
10. Pipe assembly
11. Pipe assembly
12. Pipe assembly
13. Pipe assembly
14. Pipe assembly
15. Tilt jack assembly
16. Plate
17. Plate
18. Retaining spring
19. Connecting block
20. Wear strip
21. Hexagon screw
22. Socket head screw
23. Socket head screw
24. Socket head screw
25. Threaded pin
26. Threaded pin
27. Shim
28. Wave washer
29. Cotter pin
30. Adaptor
31. Stop bolt
32. Socket head screw
33. Support roller
34. Lubrication nipple
35. Cover
36. Socket head screw
37. Pin
38. Sideshift jack assembly
39. Fork carriage assembly
40. Support assembly
41. Spacer
42. Socket head screw
43. Socket head screw

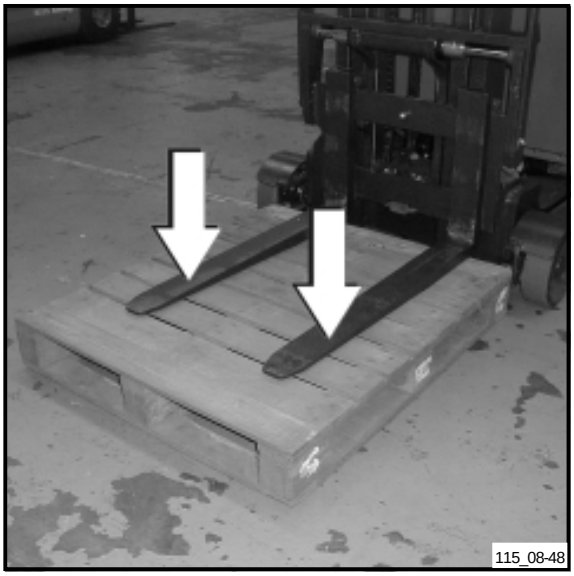
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The tilting sideshift unit comprises two main steel welded assemblies, these are the support assembly (40) which operates within the inner mast on rollers (33) and the fork carriage plate (39) which pivots on the reach jack assembly (38). Two tilt jacks (15) are mounted at the base of the support assembly and are designed to fully tilt the fork carriage 4° back and 2° forward of vertical. The standard sideshift unit has a 160 mm movement, 80mm each side of central and is designed to operate between the reach legs on a wide chassis model. Five different height load backrests are available to suit customer requirements, these are 1050 (mm), 1200, 1350, 1500 and 1800. See **LOAD BACKREST.**

WARNING: Under no circumstances should any work be carried out on the tilting sideshift unit in the raised position unless it is suitably blocked into position and the hydraulic oil pressure is released from the hoses.

8.14.1 TILTING SIDESHIFT UNIT REMOVAL (187 MAST)

- Park the truck under suitable lifting equipment to raise the inner mast. Reach the mast unit fully out. Chock the load wheels securely.
- Apply parking brake, turn the keyswitch OFF, disconnect battery.
- Place a drip tray under the mast unit to catch surplus oil.
- Using a suitable sling raise the fork carriage sufficient to enable access to the tilt and sideshift hose connections.
- Remove the stop bolt (31) from the support assembly
- Remove tilt and sideshift hoses from connector block (19). Stow the hoses safely out of the way.
- Lower the forks onto a pallet, and secure with a suitable ‘G’ clamp, strap or counterweight where arrowed.
- Remove the chain anchor pin from the support assembly anchor point and stow chain safely.
- Reconnect the battery, turn ON the keyswitch and carefully raise the mast unit sufficient to enable the tilting sideshift unit to be removed.
- Carefully drive the truck away from the tilting sideshift assembly. Lower the mast unit fully, switch OFF the keyswitch, disconnect the battery.



8.14.2 TILTING SIDESHIFT UNIT REFITTING (187 MAST)

- To replace the tilting sideshift unit, reverse the removal procedure.
- Ensure that shims (27) and rollers (33) are replaced in their “as removed” condition.
- Ensure that stop bolt (31) is fitted and secured after the unit has been refitted to the mast assembly.

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8.14.3 TILTING SIDESHIFT UNIT DISMANTLING 187 MAST

With the tilt jacks fully retracted, the elevating forks and the load backrest removed, lay the tilting sideshift on two suitable wooden blocks with the fork carriage at the top under suitable lifting equipment.

- Attach the lifting equipment securely around the fork carriage (39).
- Open the tab on tab washer (3). Undo the ring nut (2). This will allow threaded bush (8) to be removed.
- Using the lifting equipment carefully manoeuvre the fork carriage off the sideshift jack and separate it from the support assembly (40).
- Disconnect both steel hydraulic pipes (13) and (14) from the underside of the reach jack. Remove two hydraulic unions (30) from the reach cylinder.
- Remove two securing screws (26) and withdraw reach jack from the support assembly.
- Disconnect four steel pipes (9, 10, 11 and 12) from the tilt jacks (15) and connecting block (19).
- Remove split pin (29) which secures the wear strip (20) to the tilt jacks via spring plate (18).
- Remove four hydraulic unions (30) from the tilt jack cylinders. The tilt jacks can now be withdrawn from the support assembly.
- Undo two screws (22) to remove connecting block (19) from the support assembly.
- Remove support rollers (33) and shims (27) from the support assembly. Check each roller for excessive wear, damage or scores on the circumference. Check also for excessive bearing wear. Replace the support roller if not serviceable.

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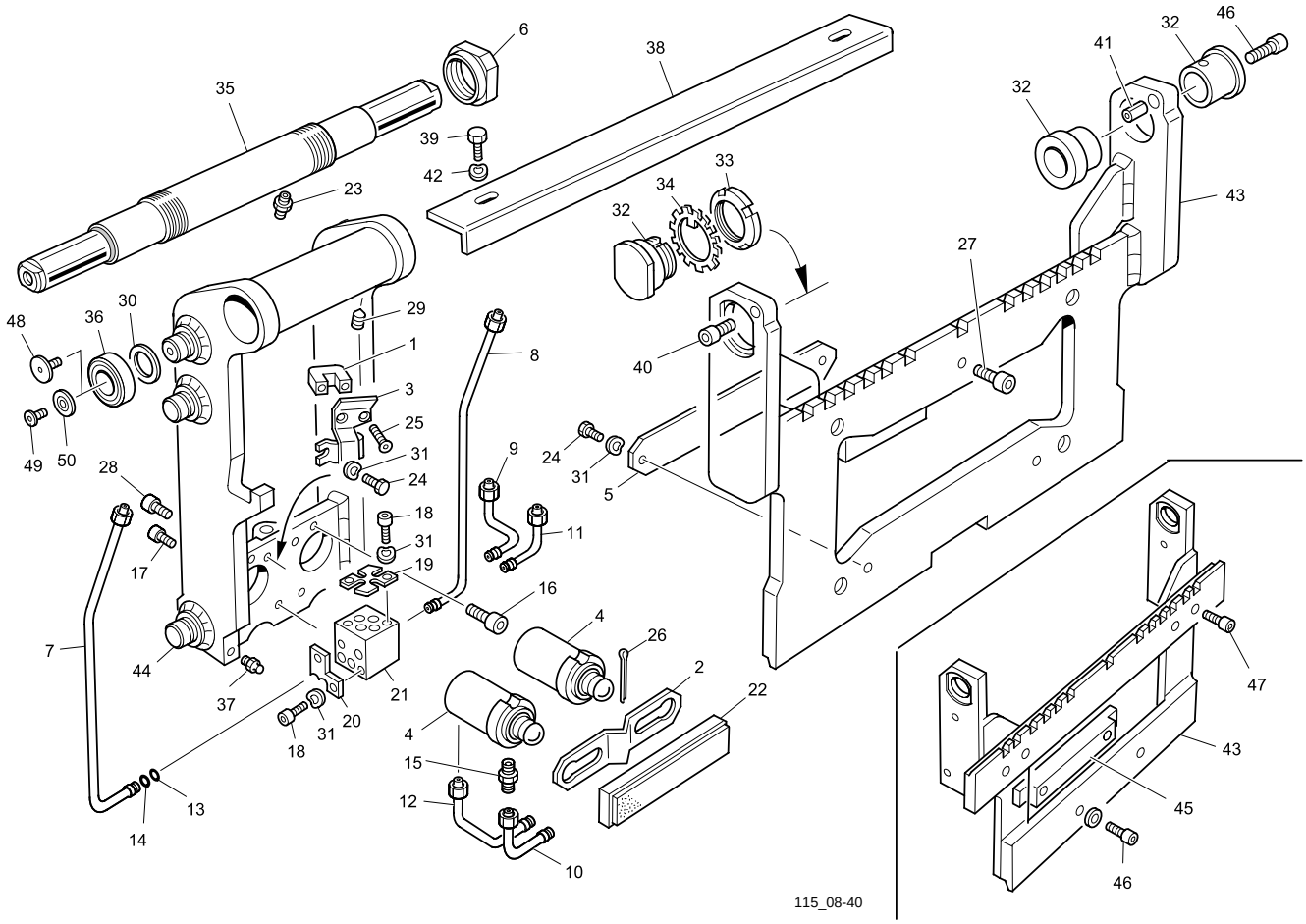
8.14.4 TILTING SIDESHIFT REASSEMBLY 187 MAST

Reassembly of the tilting sideshift unit is a reversal of the dismantling procedure, however particular attention should be paid to the following points.

- Fit the support rollers (33) to the support assembly (40), using the same number of shims (27) removed during dismantling. If new support rollers are fitted then shimming will be carried out as the tilting sideshift unit is reassembled with the mast unit.
- Inspect the wear strip (20) and spring plate (18) for serviceability, replace if required. Secure the assembly with a new split pin (29).
- When refitting hydraulic steel pipes to the connecting block (19) new ‘O’ rings must be used.
- Refit stop bolt (32) after tilting sideshift unit is fitted to the mast.

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8.15 TILTING SIDESHIFT ASSEMBLY (184 MAST)



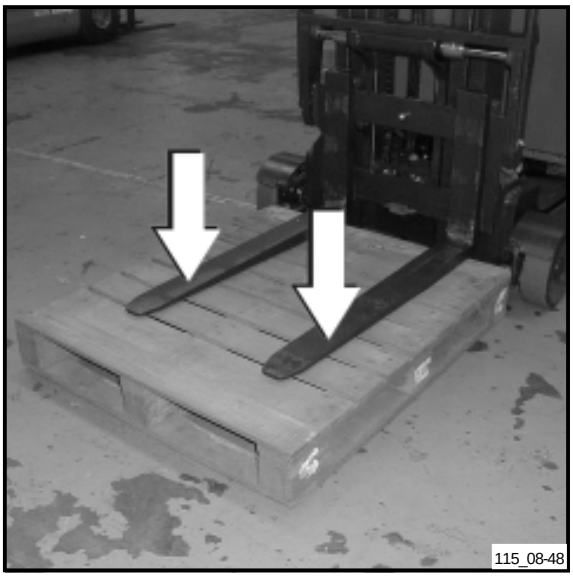
1. Clamp
2. Spring plate
3. Bracket
4. Tilt jack
5. Plate
6. Nut
7.. Pipe assembly
8. Pipe assembly
9. Pipe assembly
10. Pipe assembly
11. Pipe assembly
12. Pipe assembly
13. Support ring
14. Socket head screw
15. Adaptor
16. Socket head screw
17. Socket head screw
18. Socket head screw
19. Plate
20. Plate
21. Connecting block
22. Wear strip
23. Adaptor
24. Hexagon screw
25. Countersunk screw
26. Cotter pin
27. Socket head screw
28. Socket head screw
29. Grub screw
30. Shim
31. Wave washer
32. Bush
33. Nut
34. Tab washer
35. Sideshift jack
36. Support roller
37. Lubrication nipple
38. Cover
39. Hexagon screw
40. Socket head screw
41. Roll pin
42. Washer
43. Fork carriage assembly
44. Support assembly
45. Spacer
46. Socket head screw
47. Socket head screw
48. Screw plug
49. Collar
50. Washer

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The tilting sideshift unit comprises two main steel welded assemblies, these are the support assembly (44) which operates within the inner mast on rollers (36) and the fork carriage plate (43) which pivots on the reach jack assembly (35). Two tilt jacks (4) are mounted at the base of the support assembly and are designed to fully tilt the fork carriage 4° back and 2° forward of vertical. The standard sideshift unit has a 160 mm movement, 80 mm each side of central and is designed to operate between the reach legs on a wide chassis model. Five different height load backrests are available to suit customer requirements, these are 1050 (mm), 1200, 1350, 1500 and 1800. See **LOAD BACKREST.**

WARNING: Under no circumstances should any work be carried out on the tilting sideshift unit in the raised position unless it is suitably blocked into position and the hydraulic oil pressure is released from the hoses.

8.15.1 TILTING SIDESHIFT UNIT REMOVAL (184 MAST)



- Park the truck under suitable lifting equipment to raise the inner mast. Reach the mast unit fully out. Chock the load wheels securely.
- Apply parking brake, turn the keyswitch OFF, disconnect battery.
- Place a drip tray under the mast unit to catch surplus oil.
- Using a suitable sling raise the fork carriage sufficient to enable access to the tilt and sideshift hose connections.
- Remove the stop bolt (28) from the support assembly
- Remove tilt and sideshift hoses from connector block (21) and clamp (1). Stow the hoses safely out of the way.
- Lower the forks onto a pallet, and secure with a suitable ‘G’ clamp, strap or counterweight where arrowed.
- Remove the chain anchor pin from the support assembly anchor point and stow chain safely.
- Reconnect the battery, turn ON the keyswitch and carefully raise the mast unit sufficient to enable the tilting sideshift unit to be removed.
- Carefully drive the truck away from the tilting sideshift assembly. Lower the mast unit fully, switch OFF the keyswitch, disconnect the battery.

8.15.2 TILTING SIDESHIFT UNIT-REPLACEMENT (184 MAST)

- To replace the tilting sideshift unit, reverse the removal procedure.
- Ensure that shims (30) and rollers (36) are replaced in their “as removed” condition.
- Ensure that stop bolt (28) is fitted and secured after the unit has been refitted to the mast assembly.

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8.15.3 TILTING SIDESHIFT UNIT DISMANTLING (184 MAST)

With the tilt jacks fully retracted, the elevating forks and the load backrest removed, lay the tilting sideshift on two suitable wooden blocks with the fork carriage at the top under suitable lifting equipment.

- Attach the lifting equipment securely around the fork carriage (43).
- Open the tab on tab washer (34). Unscrew the ring nut (33). This will allow threaded bush (32) to be removed.
- Using the lifting equipment carefully manoeuvre the fork carriage off the sideshift jack and separate it from the support assembly (44).
- Disconnect both steel hydraulic pipes (7) and (8) from the underside of the reach jack. Remove two hydraulic unions (23) from the reach cylinder (35).
- Unscrew either of the nuts (6) and withdraw the sideshift jack assembly from the support assembly.
- Disconnect four steel pipes (9, 10, 11 and 12) from the tilt jacks (4) and connecting block (21).
- Unscrew the two securing screws (24) and remove bracket (3) and washers (31).
- Remove split pin (26) which secures the wear strip (22) to the tilt jacks via spring plate (2).
- Remove four hydraulic unions (15) from the tilt jack cylinders. The tilt jacks can now be withdrawn from the support assembly.
- Undo two screws (17) to remove connecting block (21) from the support assembly.
- Remove support rollers (36) and shims (30) from the support assembly. Check each roller for excessive wear, damage or scores on the circumference. Check also for excessive bearing wear. Replace the support roller if not serviceable.

8.15.4 TILTING SIDESHIFT REASSEMBLY (184 MAST)

Reassembly of the tilting sideshift unit is a reversal of the dismantling procedure, however particular attention should be paid to the following points.

- Fit the support rollers (36) to the support assembly (43), using the same number of shims (30) removed during dismantling. If new support rollers are fitted then shimming will be carried out as the tilting sideshift unit is reassembled with the mast unit.
- Inspect the wear strip (22) and spring plate (2) for serviceability, replace if required. Secure the assembly with a new split pin (26).
- When refitting hydraulic steel pipes to the connecting block (21) new ‘O’ rings must be used.
- Refit stop bolt (28) after tilting sideshift unit is fitted to the mast.

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8.16 TILT JACK DISMANTLING

With the tilt jack removed from the Tilting sideshift unit proceed as follows:

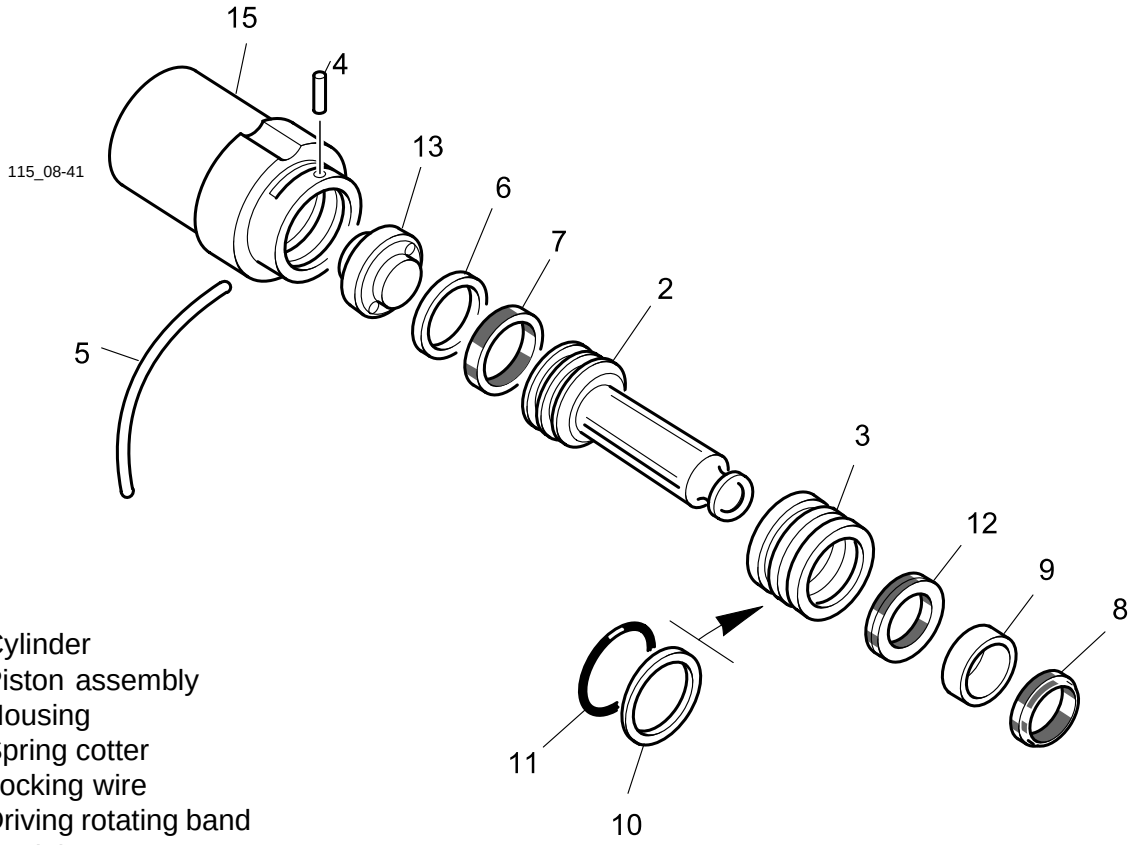
- Secure the jack assembly in a soft jawed vice. DO NOT OVERTIGHTEN.
- Remove locking wire (5) and withdraw housing (3) together with piston and shaft assembly (2) from the cylinder (1).
- Remove all seals from piston (2) and housing (3).
- Inspect the condition of all components and replace as necessary.

8.16.1 TILT JACK REASSEMBLY

- Reassembly of the tilt jack is a reversal of the removal procedure.

- Ensure that all seals and ‘O’ Rings are replaced using seal kit 113 446 97 00.

- Ensure that spacer (13) is in place before the piston (2) is refitted to cylinder (1).



1. Cylinder
2. Piston assembly
3. Housing
4. Spring cotter
5. Locking wire
6. Driving rotating band
7. Seal ring
8. Wiper ring
9. Driving rotating band
10. Support ring
11. ‘O’ ring
12. Grooved ring
13. Spacer

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8.17 SIDESHIFT JACK DISMANTLING

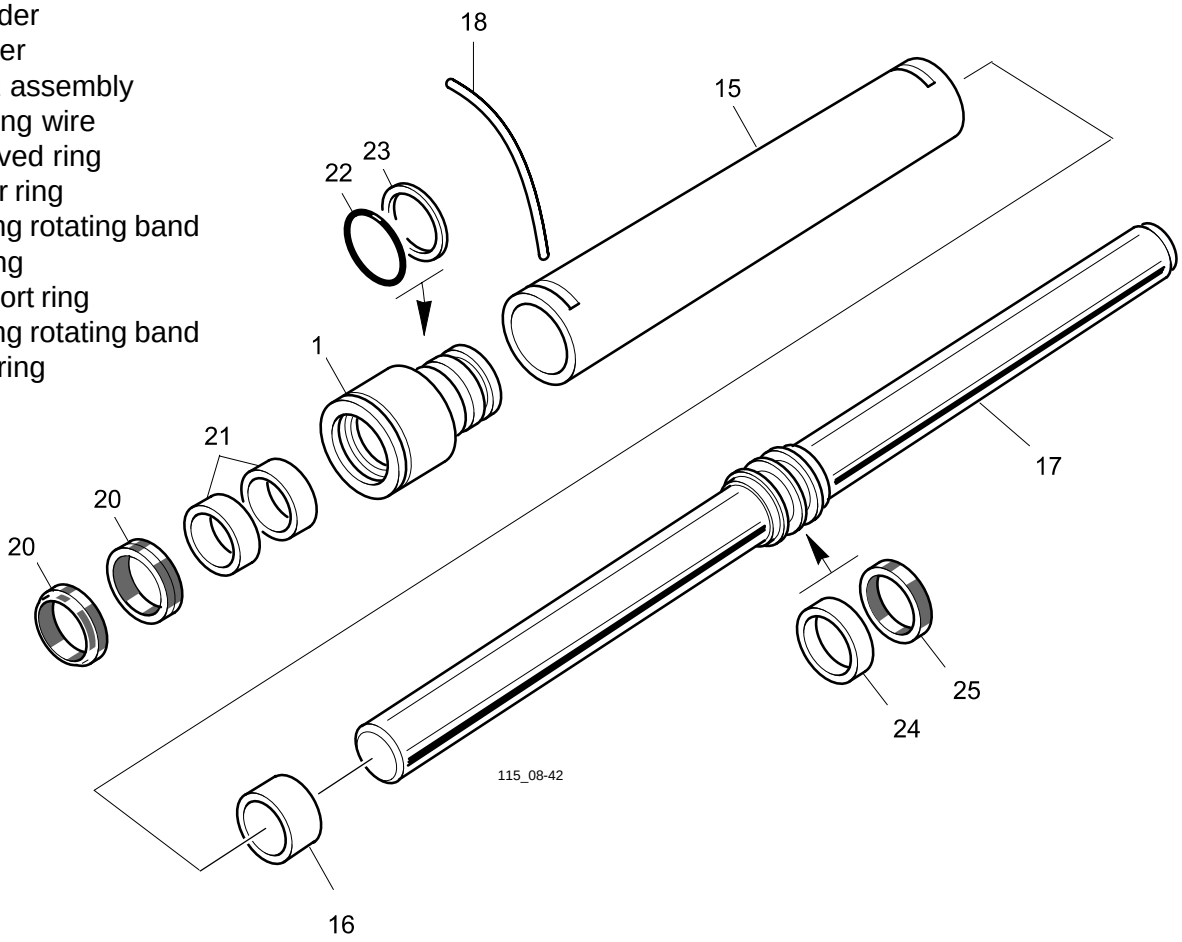
With the sideshift jack removed from the tilting sideshift unit proceed as follows:

- Secure the jack in a soft jawed vice. DO NOT OVERTIGHTEN.
- Remove the locking wire (18) from both ends of the cylinder (15).
- Withdraw the shaft and piston assembly (17) from the cylinder bringing with it one of the seal housings (14)
- Remove the remaining seal housing (14) from the cylinder (15).
- Inspect the condition of all components.

8.17.1 SIDESHIFT JACK REASSEMBLY

- Reassembly of the sideshift jack is a reversal of the dismantling procedure.
- Ensure that ALL seals and 'O' rings are replaced by using seal kit no. 186 440 50 01

14. Housing
15. Cylinder
16. Spacer
17. Shaft assembly
18. Locking wire
19. Grooved ring
20. Wiper ring
21. Driving rotating band
22. 'O' ring
23. Support ring
24. Driving rotating band
25. Seal ring



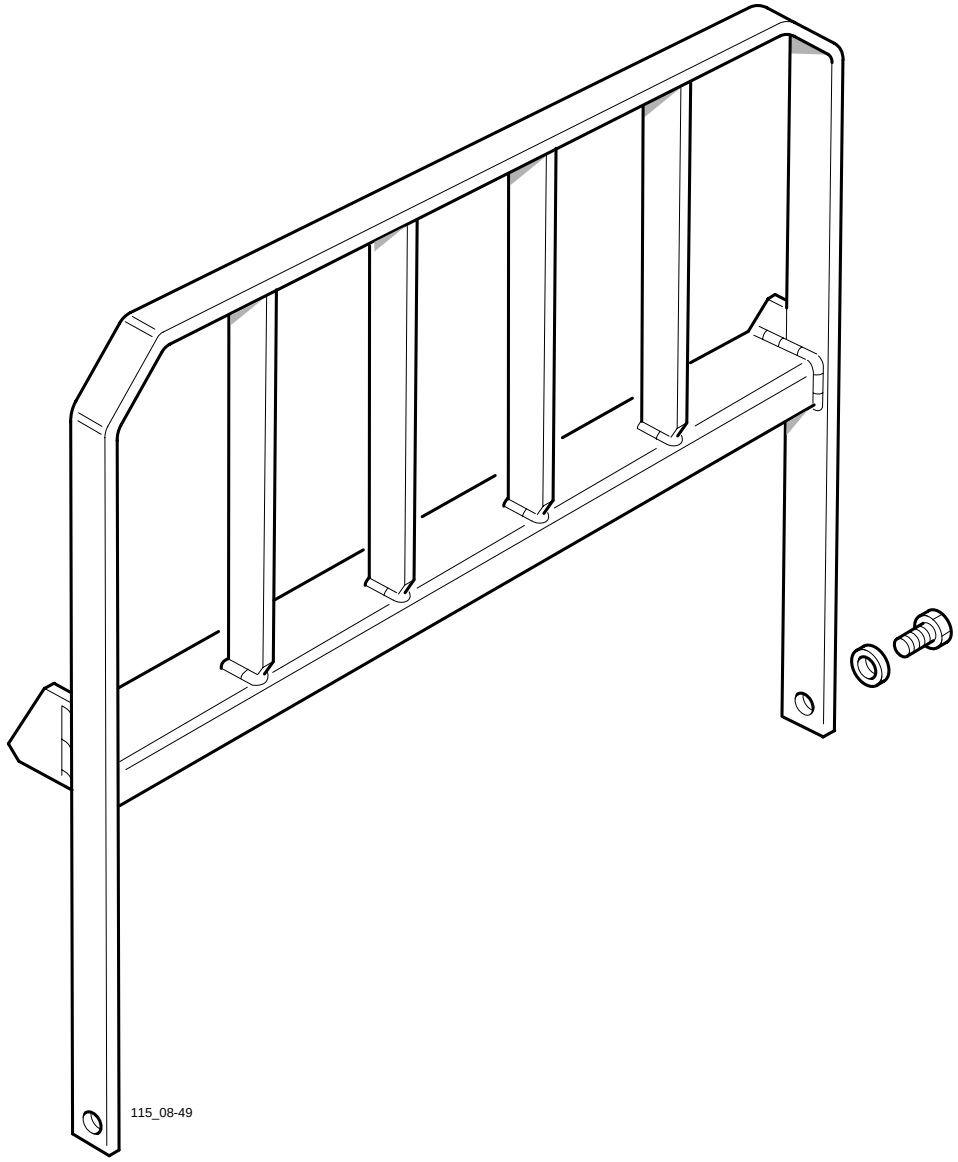
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8.18 LOAD BACKREST

The 115 reach truck family of R 14/R 16 and R 20 trucks can all be supplied with a load backrest fitted to the fork carriage assembly.

There are five optional load backrest heights available. Measuring from the top of the elevating forks to the top of the load backrest they are:

1055 mm, 1200 mm, 1350 mm, 1500 mm and 1800 mm Part numbers of each load backrest option can be found in the Spare Pars Catalogue.



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8.19 MAST SERIAL NUMBER

The 115 family models are equipped with either Type 184 or Type 187 triple mast assemblies
Each mast is stamped with its serial number (which is not the same as the serial number allocated to the truck chassis) in one of two positions on the left hand channel of the outer mast frame in characters of 8mm.



☞ **NOTE: When ordering spare parts for the mast assembly always quote the mast serial number in addition to the truck type and serial number to ensure that the correct replacement part is supplied.**

8.19.1 MAST SERIAL NUMBER FORMAT

The composition of the mast serial number is as follows:-

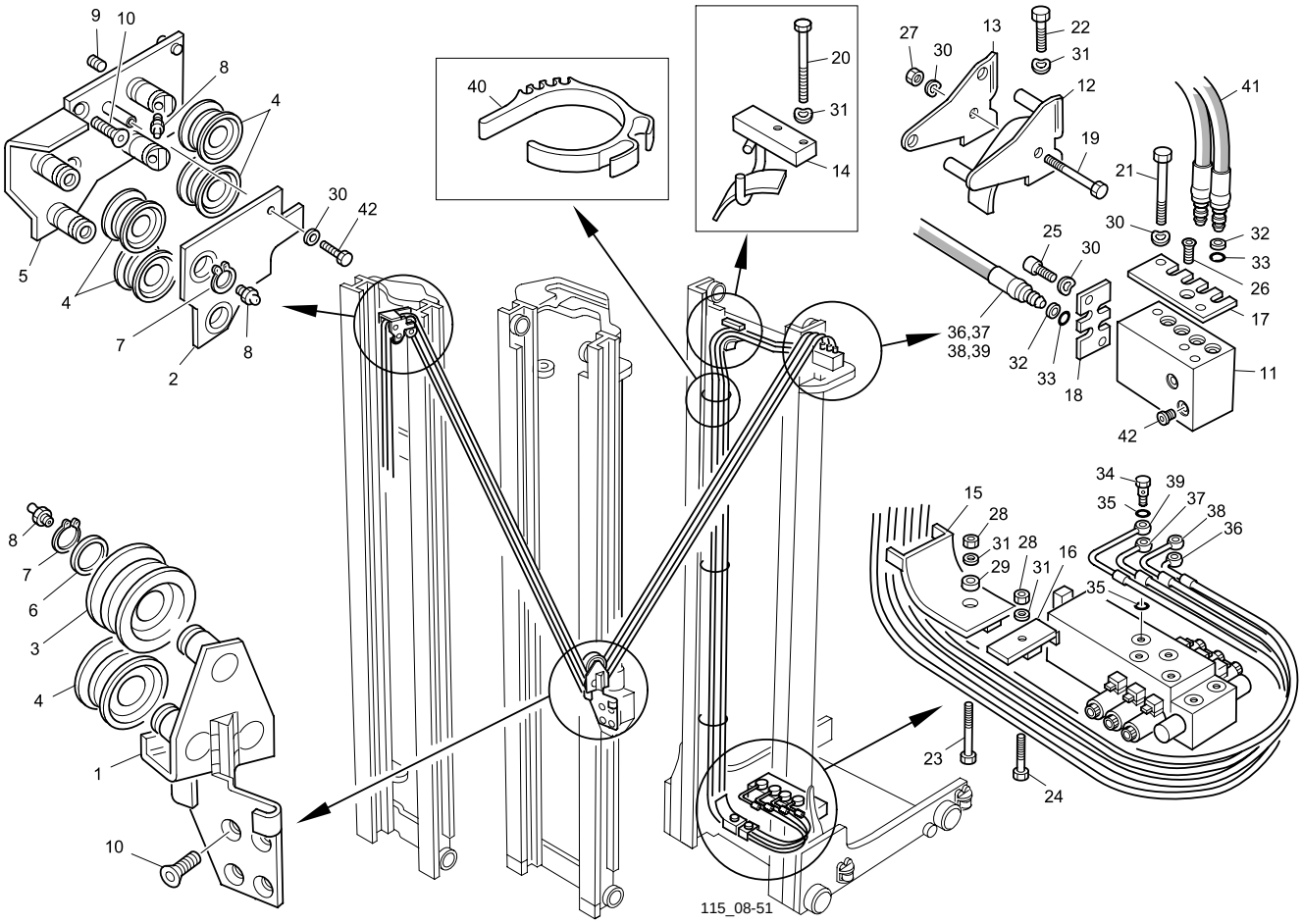
XXX XXX X XXXXX XX
- XX — Abbreviation of the lift height
- XXXXX — Serial number
- X — Year produced
- XXX — Mast type
- XXX — Manufacturing plant

8.19.2 MAST SERIAL NUMBER EXAMPLE

G1X 184 L00028 66
- 66 — The lift height >6.6 m <6.7 m
- 00028 — The mast serial number.
- L — The year it was manufactured (K = 1999 L = 2000. Etc.)
- 184 — The mast type number.
- G1X — The manufacturer. (G1 = Basingstoke.)

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8.20 MAST HYDRAULIC HOSES



1. Bracket assembly
2. Cover assembly
3. Pulley
4. Pulley
5. Bracket
6. Shim
7. Retaining ring
8. Lubrication nipple
9. Threaded pin
10. Countersunk screw
11. Block
12. Bracket
13. Bracket
14. Guide
15. Clamp
16. Clamp
17. Clamp plate
18. Clamp plate
19. Hexagon screw
20. Hexagon screw
21. Hexagon screw
22. Hexagon screw
23. Hexagon screw
25. Socket head screw
26. Countersunk screw
27. Nut
28. Hexagon nut
29. Washer
30. Washer
31. Spring washer
32. Support ring
33. ‘O’ ring
34. Union bolt
35. ‘O’ ring
36. Hose assembly
37. Hose assembly
38. Hose assembly
39. Hose assembly
40. Hose assembly
41. Hose assembly
42. Plug

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Both the 184 and 187 mast have two pairs of twin bonded flexible hoses running over the mast, supplying hydraulic oil under pressure to the tilt and sideshift jacks. The hoses are kept under tension at all stages of lift and lowering of the mast through a series of pulleys connected to the lift jacks and mast sections.

Each hose is connected from the hydraulic control valve to either the reach jack or the tilt jacks and is made up of two sections. The first (static) section is from the hydraulic control valve, mounted in the reach carriage, up the mast to connect to a 4 way junction block (11) mounted on top of the outer mast. This section is clipped to the secondary lift jack cylinder and clamped at the base (15) and the top cross member (14) of the outer mast.

The second (reeving) section of the hoses connects the 4 way junction block (11) at the top of the outer mast to and from the reach and tilt jacks via the mast pulleys and a similar 4 way junction block mounted inside the tilting sideshift unit.

The four hoses are made up of two double (Siamese) sections which are kept separate by each having a dedicated set of pulleys on both of the pulley assemblies. This prevents the hose pairs chaffing together as they pass over the pulleys since they would both be travelling through a different radius as they change direction and therefore different speeds.

8.20.1 HOSE REPLACEMENT

Should the hoses become damaged in any way it will be necessary to replace one or both pairs of hoses. To ensure that the hoses are under tension at all times the length of hose fitted to each mast is critical. Hoses stretch during service so using the original hose as a pattern is not recommended. The correct Lansing Linde part number of the hose can easily be found in SECTION 8 of the 115 Spare Parts Catalogue once the mast type and closed height have been established. The mast type can be found stamped onto the front face of the outer mast channel as part of the mast serial number, see **MAST SERIAL NUMBER.** The closed height can easily be found by measuring from the highest part of the outer mast unit down to ground level **(not the top of the forks)**

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8.20.2 MAST HOSES REMOVAL

- Raise the fork carriage 1 metre from the ground either using the hydraulics or overhead lifting equipment. Secure in this position with suitable wooden blocks.

- Lower the fork carriage down onto the blocks.

- Close the primary lift jack using overhead lifting equipment and slings, secure the lift jack in this position with suitable wooden block between jack head and the reach carriage.

- Place a drip tray under the tilting sideshift unit.

- With the tension now relieved from the hydraulic hoses they can now be disconnected from the connecting block in the tilting sideshift unit, allow the surplus oil to drain into the drip tray.

- With the aid of a suitable step up safety platform disconnect the hoses from the mast connecting block (11) by removing clamp plate (17).

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- Remove the side cover (2) from the top hose pulley assembly to enable the hoses to be passed over the pulleys.

- Remove the circlip (7) and shim (6) from both lower pulleys (4) on the primary lift jack bracket (1) .Remove hoses from the mast by first sliding the lower set off together with the pulleys (4).

8.20.3 MAST HOSES REFITTING

Refitting either or both pairs of mast hoses is a reversal of the removal procedure

- If original hoses are being refitted inspect and replace, if necessary, the 'O' Ring seals (33) and support rings (32) on the hose connectors.

- With both sets of hoses fitted and connected, carefully release the primary lift jack shaft and allow it to extend slowly under its own weight.

- Re- connect the battery, turn keyswitch ON and carefully operate the lift control until the fork carriage starts to rise off the supporting wooden blocks.

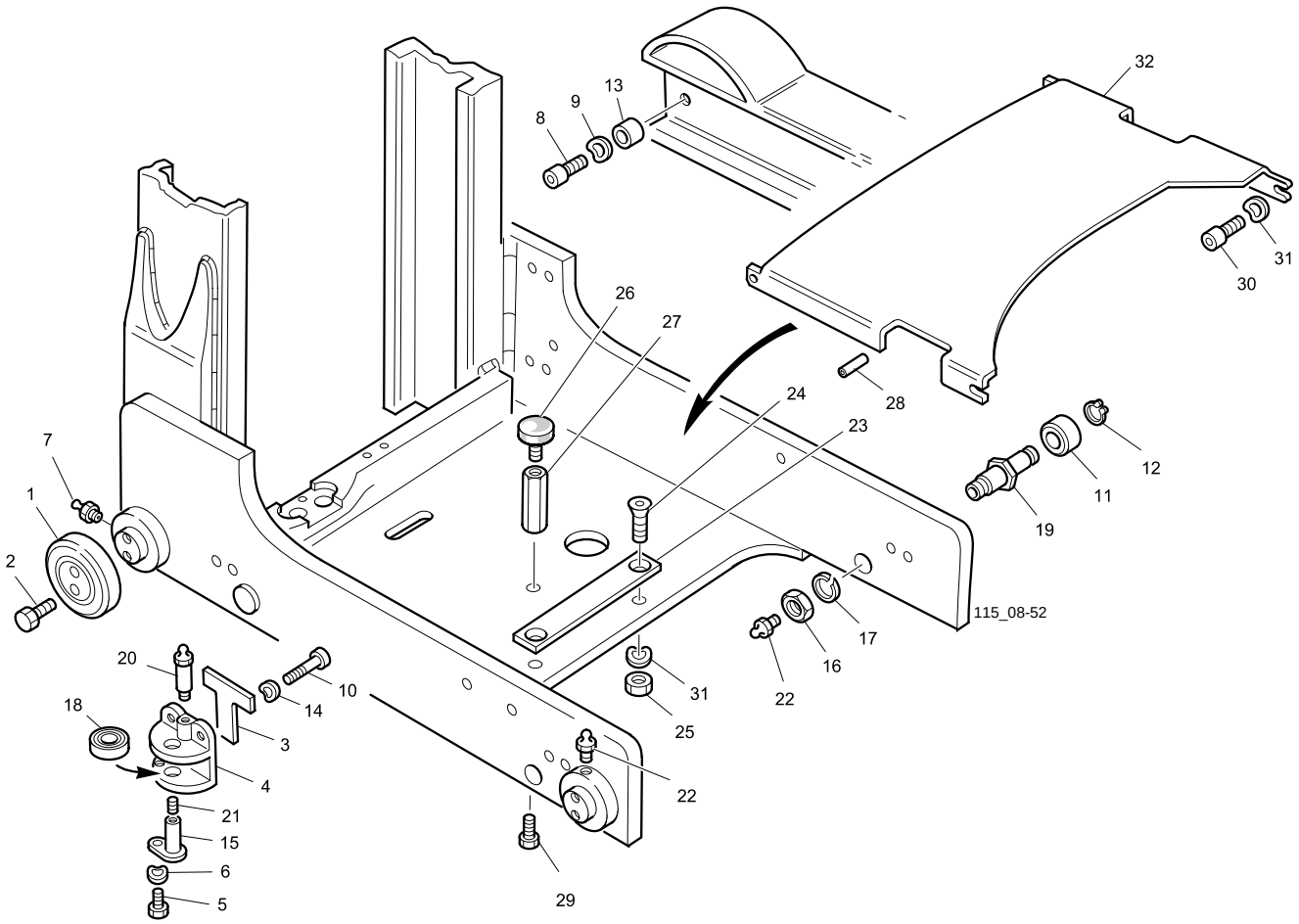
- Remove the supporting wooden block from beneath the fork carriage and test lift, tilt and sideshift for correct operation.

- Alternately raise the carriage with the overhead lifting equipment, remove the wooden block supporting the carriage. Lower the carriage to the ground and disconnect from the lifting equipment.

- Test for correct operation of the lift, tilt and sideshift functions.

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8.21 REACH FRAME



1. Support roller
2. Hexagon screw
3. Shim
4. Bracket
5. Hexagon screw
6. Lubrication nipple
7. Lubrication nipple
8. Socket head screw
9. Spring washer
10. Hexagon screw
11. Bearing
12. Retaining ring
13. Spacer
14. Spring washer
15. Shaft
16. Hexagon nut
17. Spring washer
18. Support roller
19. Shaft
20. Lubrication nipple
21. Threaded pin
22. Lubrication nipple
23. Strip
24. Countersunk screw
25. Hexagon nut
26. Buffer
27. Pillar
28. Spring cotter
29. Hexagon screw
30. Socket head screw
31. Spring washer
32. Cover

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The reach frame on the standard version of the 115 range of reach trucks is formed as an integral part of the mast assembly. The mast and reach frame assembly is supported by 4 steel guide rollers with integral bearings. These rollers run in hardened steel reach channels welded into the truck chassis. 4 side rollers are fitted adjacent to each guide roller assembly, these can be adjusted with the aid of shims to remove any side play between the reach frame and the reach channels. A further pair of rollers is fitted, one either side of the rear end of the reach frame. These can be adjusted to take out any movement up and down between the rear guide rollers and the reach channels.

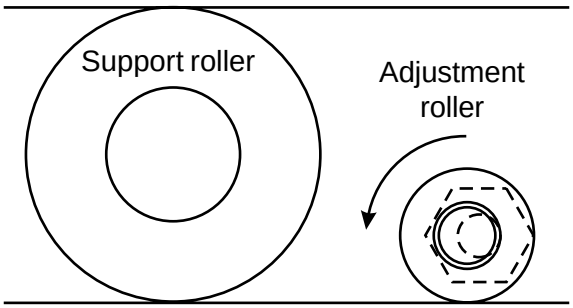
8.22 REACH FRAME ADJUSTMENT

The main support rollers (1) are non adjustable and the assembly is designed so that a maximum clearance exists between the roller and the guide channel of 1.4 mm. Clearance in excess of this figure on the front (fork carriage end) reach support rollers must be eliminated as this will result in fore and aft movement in the mast assembly when laden in the raised condition. The reach channels on this model are hardened steel, with correct maintenance and lubrication they should last the lifetime of the truck without the need for any further attention. Any clearance greater than 1.4 mm between the support rollers and the reach channels should be reduced by replacing the rollers. The reach rollers can only be replaced with the mast removed from the truck chassis. See **MAST UNIT REMOVAL**

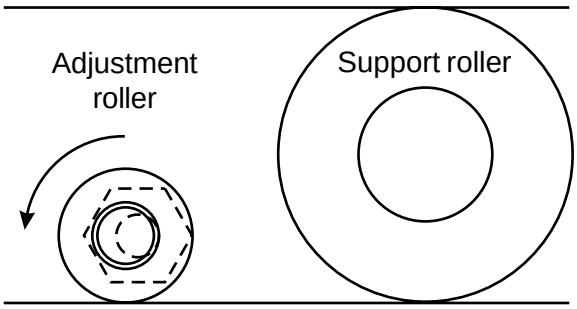
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Clearance between the rear support rollers and the reach channels can be eliminated by adjustment to the eccentric roller assemblies.

- Remove the cover plate (32) by taking out screws (30) and washers (31).
- Carefully measure the clearance between the rear support rollers and reach channels throughout their working area. Make a note of the position with the least clearance.
- Position the reach carriage so that the rear support rollers are in the above position.
- Slacken the locknut (16) and with an open end spanner between the reach channels and the reach frame, turn the eccentric shaft (19) ANTI-CLOCKWISE until there is no free play between either the support roller (1) and the top reach channel track or the adjusting roller (11) and the bottom reach channel track. DO NOT OVER TIGHTEN. Tighten the locknut (16) to a torque of 200 Nm, while still holding the eccentric shaft (19) with the spanner.
- Test the truck for correct operation of the reach mechanism.
- Replace cover plate (32).



Right hand side when viewed from the driver's seat



Left hand side when viewed from the driver's seat

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8.23 REACH SIDE ROLLERS ADJUSTMENT

Both the front and rear side rollers can be adjusted with the mast unit fitted to the truck.

- Remove the cover plate (32) by taking out screws (30) and washers (31).

- Carefully measure the clearance between both the front and rear side rollers and their working tracks of the reach channels. Make a note of the position of the tightest point (if any).

- Position the reach frame so that the side rollers are at their tightest point in the reach channel.

- Free play between the reach channels and the side rollers (18) can be removed by inserting shims (3) between the reach frame and the roller mounting bracket (4).

- To insert shims release screws (10) securing the side roller bracket. Working between the reach channel and the reach frame open up the gap between the carriage and the roller mounting bracket (4) with the aid of a long screwdriver or similar tool. Insert sufficient shims to remove half the measured free play.

- Repeat the process for the opposite side roller(s) thus ensuring that the reach frame remains centrally located in the reach channels.

- Test the truck for correct operation of the reach mechanism.

- Replace cover plate (32).

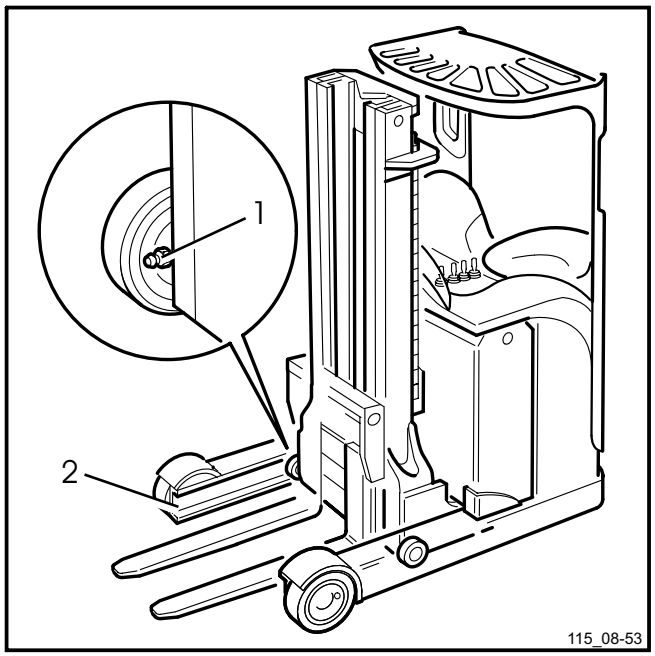
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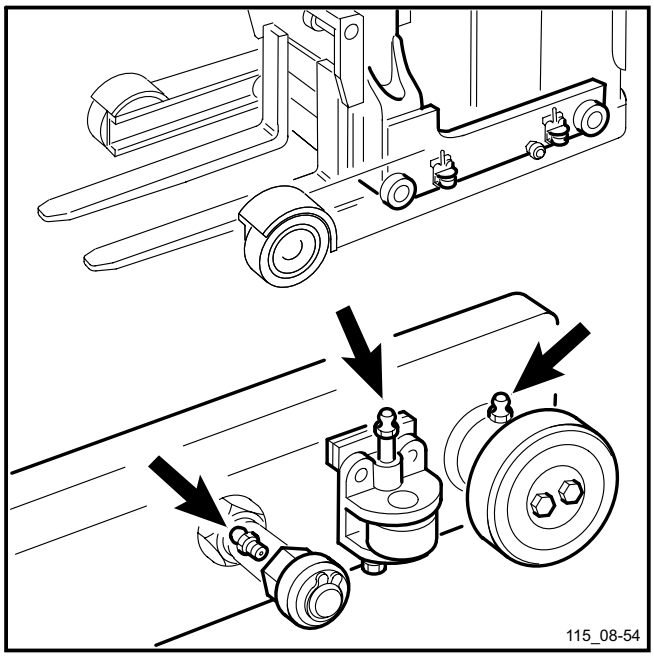
8.24 REACH FRAME ROLLER LUBRICATION

The standard (or ambient) versions of the 115 reach truck range are normally supplied with lubrication nipples (7) fitted to the front main support rollers (1) of the reach mechanism. These should be lubricated every 1000 hours (250 hours for cold store trucks) All other reach rollers are fitted with “sealed for life” bearings and normally require no additional lubrication other than that provided externally by lubricating the reach channels every 1000 hours.

Cold store trucks, to cope with their extreme working conditions, are fitted with lubrication nipples to all reach rollers which should receive attention every 250 hours.

For trucks used in other arduous conditions it is possible to retrofit lubrication points to all reach rollers by fitting the necessary greasable components (shafts and mounting brackets etc.) The parts are all listed in SECTION 3 of the 115 Spare Parts Catalogue. However this can only be carried out with the mast removed from the truck chassis. See **MAST UNIT REMOVAL.**





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8.25 MAST UNIT OPTIONAL VERSIONS TYPES 183 AND 186

Although the standard versions of the type 115 reach truck family are fitted with either type 184 or 187 mast assemblies, on the wide chassis versions (1400 mm and 1600 mm) of the R 14/R16 and R20 trucks the mast designation changes to 183 and 186. The only major difference between the two versions of both types is that on wide chassis trucks the mast and reach carriage are separate items. All the component parts of each mast version are identical, that is, parts for 183 and 184 masts are the same, so are parts for 186 and 187 masts.

8.25.1 REACH CARRIAGE ROLLERS (183 AND 186)

Adjustment and replacement of reach roller can be carried out in the same way as for types 184 and 187 masts with integral reach frame.

The procedure to remove the mast to gain access for changing the reach rollers is a little more involved when dealing with either a 183 or 186 mast so this is separately explained in the following section.

8.25.2 MAST REMOVAL (183 AND 186)

The mast assembly on wide version trucks can be removed complete with its reach carriage still attached if, for example, the reason for removal is to attend to a reach roller/channel problem. In this case follow the mast removal procedure for type 184/187 mast units at the front of this section of the manual.

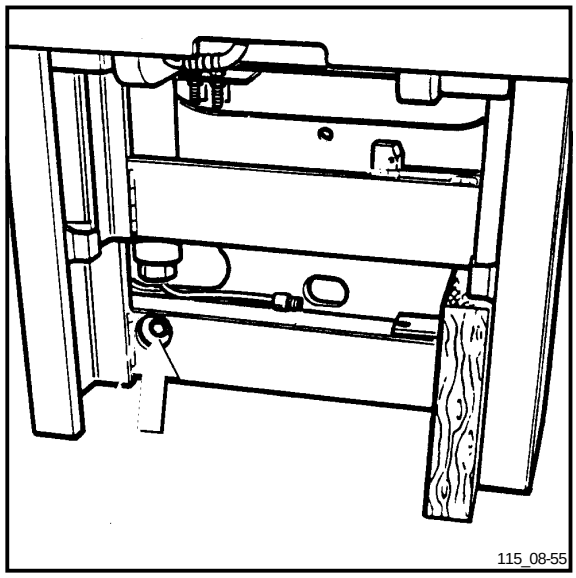
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DANGER: When lifting the mast with a crane, ensure that no persons are within the vicinity. Never step under an elevated load.

WARNING: Manual handling risk. The mast is heavy. Care should be taken when manoeuvring the mast.

To remove the mast unit only, leaving the reach carriage still attached to the truck chassis proceed as follows:

- Position the truck underneath suitable lifting equipment (to support the weight of approximately 3000 kg.)
- Apply the parking brake and chock the wheels securely.
- Reach the mast unit fully forward. Lower the fork carriage, remove the forks. Turn the key switch OFF, disconnect the battery.
- Remove the control valve cover plate from the reach carriage to gain access to the hydraulic hose connections.
- Connect a suitable sling to the top of the inner and middle mast sections with the overhead lifting equipment. Raise the masts sufficient to access the 2 fixing bolts at the base of the mast. Securely block the mast sections in this position and remove both M 20 x 70 mm bolts.



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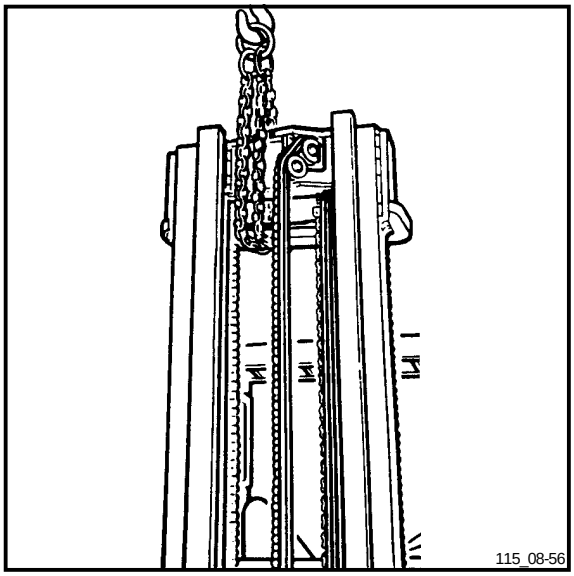
- Lower the mast sections fully and secure the base of the mast to the reach carriage, using a suitable clamp/ heavy duty strap to prevent mast from tilting back when the overhead lifting equipment is released.

- Reposition the sling to enable the complete mast assembly to be raised by the overhead lifting equipment. Take the weight of the mast unit.

- Remove the clamp/strap securing the mast to the reach carriage.

- Place a large drip tray underneath the reach carriage assembly to catch any hydraulic oil spillage from the hoses when being disconnected.

- Carefully disconnect, at the control valve end, the hydraulic hoses connecting the tilt, sideshift and main lift cylinders, noting their positions for refitting. A small loss of hydraulic fluid is to be expected as the system remains pressurised for some time after use.



- Seal the hose ends and the control valve outlets to prevent further oil spillage. Feed the disconnected hoses through the front opening of the reach carriage and secure them to the mast unit.

- Remove The four M 12 x 25 mm mast pivot mounting cap head screws from each side of the reach carriage.

- Using two M8 x 50 mm hexagon head extraction screws withdraw both mast pivots. Note any shims between the Pivot and the mast unit for reassembly.

- Using the lifting equipment carefully manoeuvre the mast unit from the reach carriage support.

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8.25.3 MAST REFITTING (183 AND 186)



DANGER: When lifting the mast with a crane, ensure that no persons are within the vicinity. Never step under an elevated load.



WARNING: Manual handling risk. The mast is heavy. Care should be taken when manoeuvring the mast.

- This operation should be carried out on a level surface under suitable lifting equipment to support approximately 3000 kg.

- Ensure that the reach carriage is fully reached OUT. Apply the parking brake, turn the keyswitch OFF, disconnect the battery and chock the load wheels securely.

- Using suitable lifting equipment and slings mount the mast unit to the reach carriage.

- Align the mast unit and reach carriage pivot holes. Refit any shims previously removed between the mast and the pivots.

- Using two M12 x 100 mm bolts to assist in guidance when fitting the mast pivots. Tap the mast pivots in.

- Fit two of the M12 x 25 mm cap head screws to the mast pivot. Remove the two long guidance bolts and replace with the other two M12 x 25 cap head screws.

- Repeat the operation on the other side. Tighten all 8 cap head screws.

- Secure the base of the mast to the reach carriage to prevent the mast from tilting when the overhead lifting equipment is released.

- Lower the mast unit and reposition the slings to enable the inner and middle mast sections to be raised.

- Raise and securely block the inner and middle mast sections. Fit the two M20 x 70 mm mast fixing hexagon head screws and shims previously removed to the reach carriage.

- Lower the mast unit. Remove the clamp/strap securing the mast to the reach carriage. Disconnect the lifting equipment from the mast.

- Connect the hydraulic hoses supplying the lift, tilt and sideshift cylinders.

- Fit the forks to the fork carriage.

- Bleed the primary and secondary lift jacks and test the truck for satisfactory operation.

- Refit the hydraulic control valve cover to the reach carriage.

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9 OPTIONS AND ACCESSORIES

CAUTION: Electrical components must not be connected or disconnected whilst the truck is live. The battery must be disconnected, failure to do so can result in failure of the modules.

9.1 COLD STORE CABIN

For operating trucks in a cold store environment a cold store cabin is available.

This double glassed cabin provides the driver with the following comforts:-

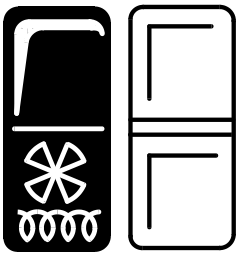
1) Thermostatically controlled cabin heater with temperature adjustment.
2) Two way voice intercom to ensure the driver is aware of, and can have voice contact with others in the warehouse.
3) Heated glass - This is necessary should the truck be driven out of the cold store to an ambient environment. Pre-heating the screens stops instant frosting that would otherwise take place the moment the screens hit ambient damp air.
4) Interior lighting with ON/OFF switch.
5) External lighting with ON/OFF switch.

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The control switches for these functions are mounted in the cabin roof.

The electrical aspects of features (1) to (3) are interfaced to their respective control switches by a microprocessor control module.

9.1.1 CABIN INTERIOR TEMPERATURE CONTROL.



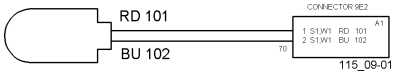
The truck cab is fitted with a heater comprising one 1200W and one 500W element along with a fan. For automatic control purposes, the temperature in the cab is sensed with a silicon sensor 9E2, which monitors the air inlet to the cabin heater.

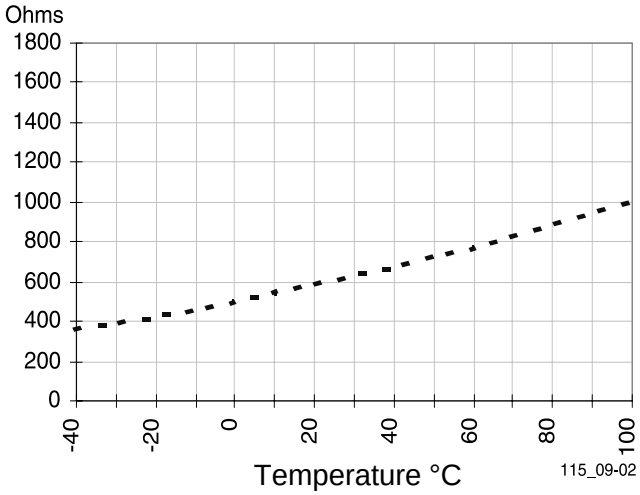
The driver controls the heater unit via a three position master switch (the three positions being OFF, ON and BOOST), and the current state of the heater is indicated to the driver by a set of three lamps, one internal to the master heater switch, along with two separate lamps, one being an indicator for the 1200W element (heater stage one) and the other for the 500W element (heater stage two). With this switch in the OFF position, the two heater elements, the fan and the three lamps are all off. With this switch in the ON position, the fan runs continuously, the lamp internal to the switch is lit, and the 1200W element alone is controlled according to cabin temperature, with the heater stage one lamp being switched on and off in sympathy with this 1200W element.

With the master heater switch in the BOOST position, the fan again runs continuously and the switch's lamp is permanently lit, but in this case the 1200W and 500W heater elements are brought in and out as a pair, with both heater stage one and two lamps being switched on and off simultaneously in sympathy with the two elements.

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TEMPERATURE SENSOR CHARACTERISTICS





9.1.1.1 CABIN TEMPERATURE SETTING/CONFIGURATION

The temperature Up/Down rocker switch will change the desired cab internal temperature in the range 5-30°C in 2°C steps, with the temperature thus set being indicated by flashes of the lamp within the heater control switch. One flash of the bulb in the heater On/Off switch indicates one 2°C increment, i.e. one flash for 5°C, two flashes for 7°C etc., with the flash rate of 4 flashes per second.

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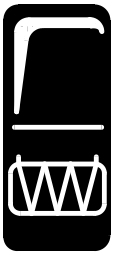
9.1.2 CABIN SPEAKER VOLUME CONTROL

The driver will operate the Volume Up/Down rocker switch only to change the cab internal speaker volume, or hold down the PTT (press to talk) switch down simultaneously to adjust the external volume. The volume control is adjustable in 25 increments.

The Push-to-talk switch is conveniently mounted in the truck Binnacle and enables outgoing speech whilst muting incoming speech when depressed.

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9.1.3 CABIN GLASS HEATER TIMER



The Glass heater timer trigger switch initiates the glass heater for a preset time. The timer action is re-triggerable, i.e. every time the trigger switch is pressed, the timer is reset to its preset value and starts to count down from there, regardless of its current value.

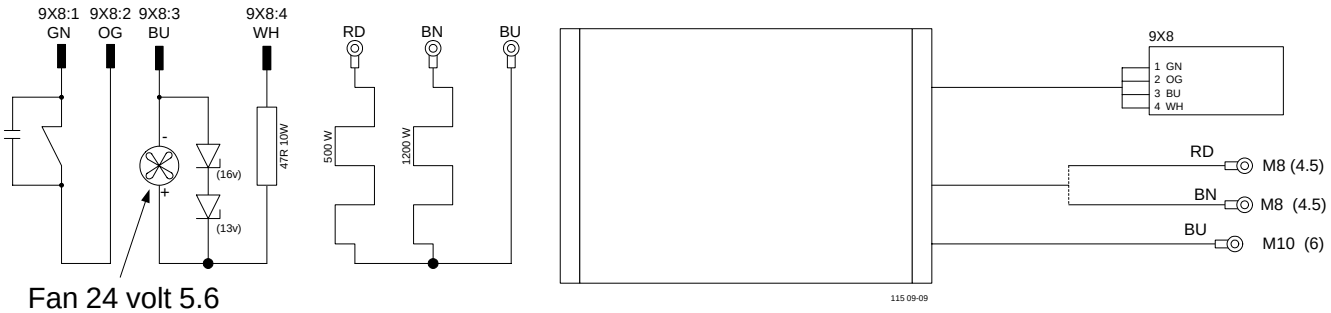
9.1.3.1 CABIN GLASS HEATER TIMER SETTING/CONFIGURATION

The preset time can be set in the range 5-25 minutes in 2-minute increments (i.e. 12 steps) by operating the temperature Up/Down buttons with the glass timer trigger switch held in simultaneously. The trigger switch bulb indicates the time set, by flashing once for each two-minute set and has a flash rate of 4 flashes per second. It then pauses for a two second interval before progressing to the next 2-minute increment/ decrement.
The selected time value is memorised when the trigger and up/down switches are all released.

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9.1.4 CABIN HEATER UNIT

This is positioned against the door hinge vertical pillar. Air is drawn from the top of the cabin, past the silicon sensor, and exhausted via a manifold to provide warm air to various parts of the cabin. Should the air flow be reduced for any reason resulting in increased temperature rise, a thermal trip will open causing the heater contactors to remove the supply to the heating elements. After clearing the obstruction, the trip can be reset by depressing it using a small blunt instrument via the small access hole in the GRP cover in front of the driver.



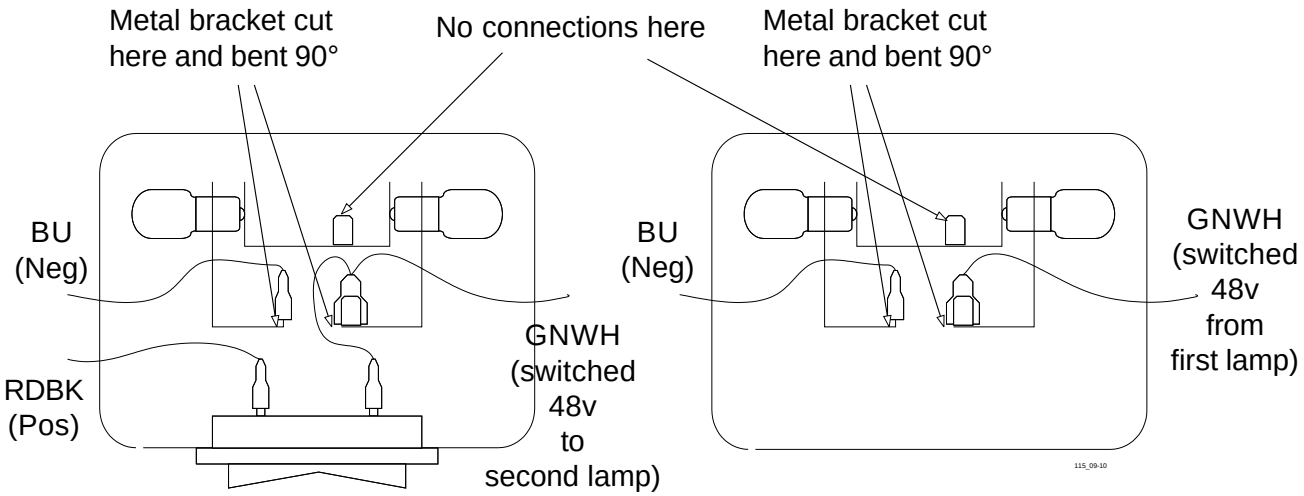
Fan 24 volt 5.6 Watt

The two contactors that control the heater elements 9K1 and 9K2 plus the contactor used to control the heated glazing 9K3 are situated behind the heater in the door hinge vertical pillar in a standard cabin. In a Drive In Racking cabin these contactors are located at the top of the door catch side vertical pillar, behind the drivers head.

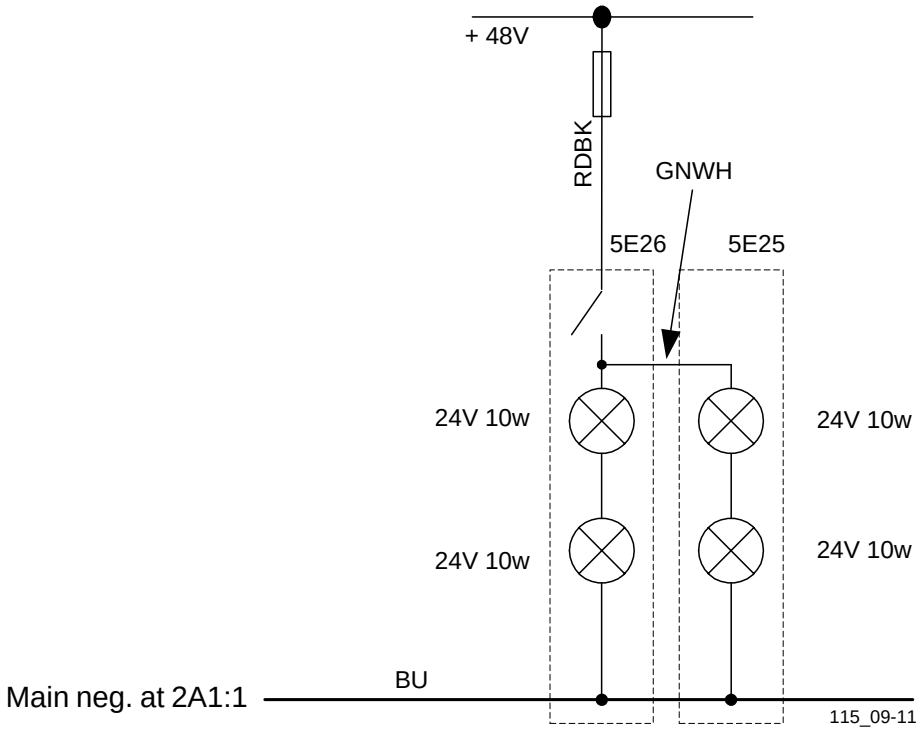
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9.1.5 CABIN INTERIOR LIGHTS

The standard cabin has two lamp fittings each containing two 24V 10 watt festoon lamps which are connected in series within the lamp. The two lamp units are connected in parallel and controlled by one rocker switch on the lamp unit above the cabin door. The drive in racking variant of the cabin has one interior light unit.



☞ **NOTE: This method of wiring the interior lamps ensures that in the event of failure to open circuit, no other bulb will be damaged and that the remaining lamp assembly will continue to illuminate.**



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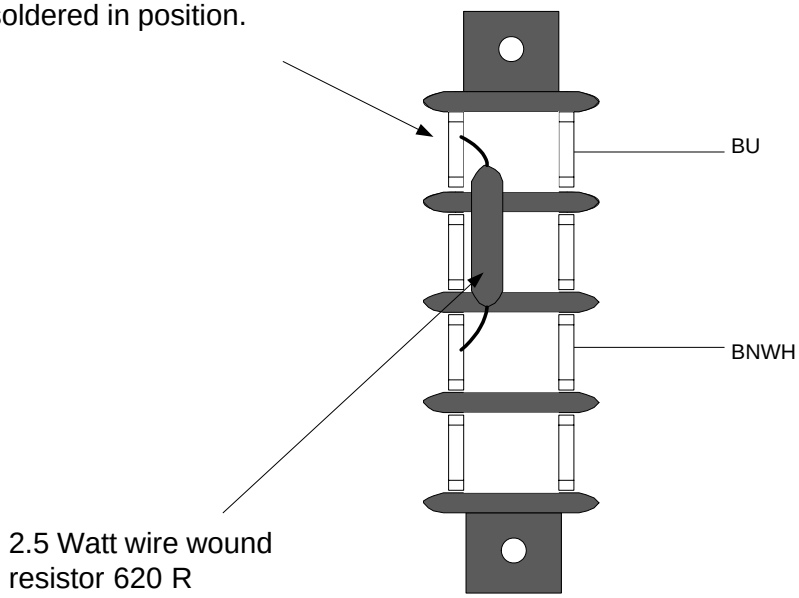
9.1.6 CABIN EXTERIOR LIGHTING



This uses 48 volt lamps with Quartz Halogen bulbs and is controlled by a switch in the cabin roof.

The series resistor for the pilot lamp for the exterior lighting control switch is mounted on a terminal block situated behind the heater unit.

Exposed resistor wires leads are insulated with PTFE sleeving. Resistor wires to be passed through tab hole, folder back and soldered in position.



2.5 Watt wire wound resistor 620 R

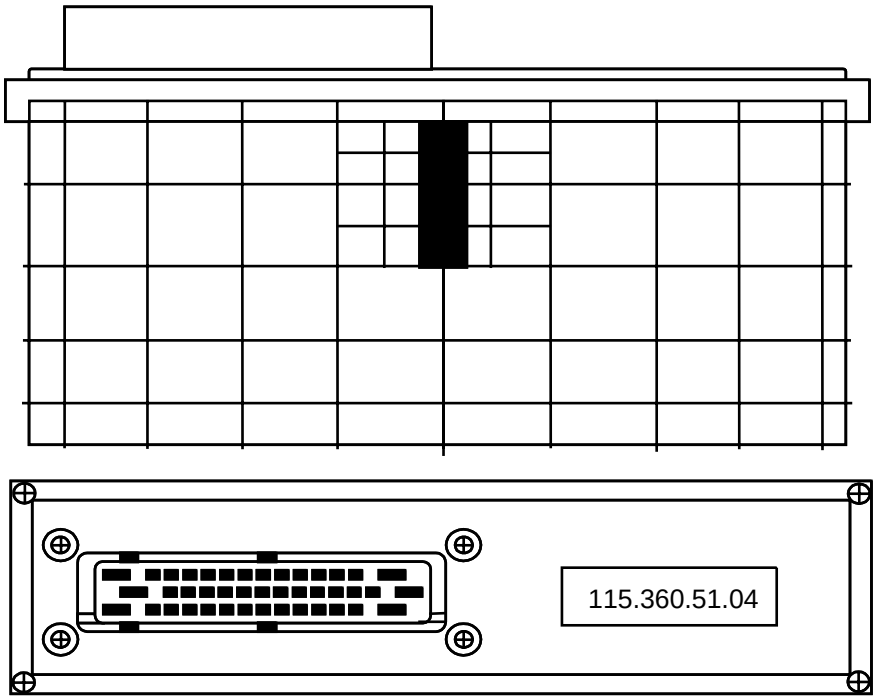
9.1.7 CABIN LOUDSPEAKERS AND MICROPHONE

Located within the cabin roof is the interior loudspeaker and interior Electret microphone.
A similar loudspeaker and microphone are mounted within the cab door and are directed outside the cabin into the warehouse.

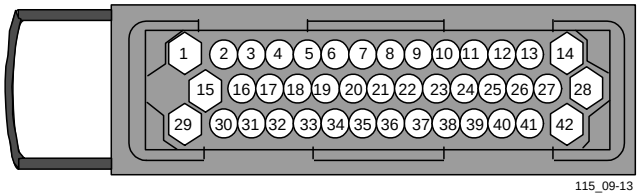
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9.1.8 CABIN CONTROL MODULE 4A1

The cab control module is situated within the cabin roof .



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115_09-13

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9.1.8.1 CABIN CONTROL MODULE PIN DUTIES

1	RDGN	Battery positive +48 volt supply to the module.
2		Linked within module to pin 1
3	OG	Driver for glass heater contactor 9K3. Negative when 9K3 energised. +48 when 9K3 off.
4		Linked within module to pin 1
5	RDWH	Driver for stage 1 heater contactor 9K1. Negative when 9K1 energised. +48 when 9K1 off.
6		Linked within module to pin 1
7	RDBU	Driver for stage 2 heater contactor 9K2. Negative when 9K2 energised. +48 when off.
8	RDOG	Driver for heater blower motor. Negative when energised. +48 when off.
9		Not used
10	GNYE	Door loudspeaker HI
11	GNOG	Door loudspeaker LO (negative)
12	GNVT	Cab roof (inside) loudspeaker HI
13	GNGY	Cab roof (inside) loudspeaker LO (negative)
14		Not used
15	BKOG	Door switch. Closed to negative when door closed. (+ 12V when open)
16	WH	Heated glass switch lamp. +24 V when lamp in switch is lit. (+48 if bulb open circuit)
17	GY	Heater stage 1 Lamp driver. +24 V when lamp in switch is lit. (+48 if bulb open circuit)
18	VTWH	CAN bus HI
19	BU	CAN bus neg.
20	BKBU	Temperature UP control. Closed to neg. when switch depressed. (+ 12V when open)
21	BKWH	Temperature DOWN control. Closed to neg. when switch depressed. (+ 12V when open)
22	BKGY	Heater stage 2 from switch. Negative when switch closed. (+ 12V when open)
23	YE	Closed to neg. by PTT switch to enable outgoing speech from cab. (+ 12V when open)
24	BKBN	Seat switch. +1.2V when seat switch closed. (48 when open. 12V if disconnected)
25		Not used
26	RD	Cab roof (inside) microphone HI (approx. 2v)
27	RD	Door (outside) microphone HI (approx. 2v)
28		Not used
29	BU	Battery negative
30	RDBN	Heater stage 2 Lamp driver. +24 V when lamp lit. (+48 if bulb open circuit)
31	RDVT	Heater stage 3 Lamp driver. +24 V when lamp lit. (+48 if bulb open circuit)
32	VTRD	CAN bus LO
33	GN	Heated Glass trigger switch. Negative when depressed. (+12v when open)
34	BKBU	Volume UP control. Closed to neg when vol up switch depressed. (+12v when open)
35	BKGN	Volume DOWN control. Closed to neg when switch depressed. (+12v when open)
36	BKYE	Heater stage 1 from switch. Negative when switch closed. (+12v when open)
37	BKVT	Temperature sensor HI (approx. 2.5 v depending on temperature)
38		Not used
39		Not used
40	BK	Cab roof (inside) microphone LO (negative)
41	BK	Door (outside) microphone LO (negative)
42	GNBU	Truck CHASSIS (Not negative!)

☞ **NOTE: The Cab Control Module and cabin wiring include provision for future enhancement of facilities by inclusion of the CAN digital interface.**

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9.1.9 CABIN FUSES

The cabin heater and heater glass supplies are routed through a unique 50 amp fuse mounted at the bottom of the cabin door hinge vertical pillar. This Power fuse is to DIN 43560 form B.

Small fuses are to DIN 72581

These battery voltage fuses are within the truck control unit enclosure and are a special sand filled type and rated at a nominal 80 volts. Automotive type fuses must NOT be used as they have inadequate voltage rating.

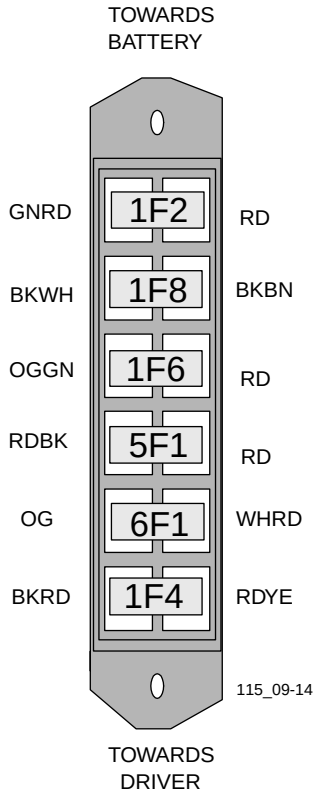
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9.1.9.1 CABIN FUSE DUTIES AND POSITIONS

Designation	Rating	Supplies
1F2	5A/80V	Key switch, Cabin & truck control circuits.
1F4	5A/80V	24 volt output from DC-DC converter.
1F6	5A/80V	Heated seat & horn supplies
6F1	5A/80V	BDI monitoring voltage.
1F8	5A/80V	Parking brake release & Pre-charge Resistor.
5F1	5A/80V	Cabin exterior lighting supplies

POSITION OF 80 VOLT FUSES IN CONTROL UNIT FUSE HOLDER.

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CABIN CIRCUIT

CODE	DESCRIPTION	LOCATION
4A1	Module, intercom and heated glass timer	58-64
4B1	Microphone (inside cab)	40
4B2	Microphone (outside cab)	40
9E1	Heater thermal trip	19
9E2	Heater air inlet temperature sensor	54-56
5E5	Working lamp 48V 35W	13
5E6	Working lamp 48V 35W rear	14-15
5E10	Rotating beacon 24V 36W	18-20
5E24	Working lamp 48V 35W	16
5E25	Rear interior lamp 2 x 24V 10W	11-12
%e26	Front interior lamp 2 x 24V 10W	10
5E27	Heater status lamp	41-43
9F2	Fuse, main cab 80A	7-8
4H3	Speaker, inside cab	43
4H4	Speaker, outside cab	43
9K1	Contactor, cab heater 1	26-27,30-32
9K2	Contactor, cab heater 2	28,34-35
9K3	Contactor, heated glass	23-24,36-38
N	Ground (chassis) connection	48
4R1	Heater, main cab	26-30
4R2	Heater, glass	22
4R3	Heater, glass	23-24
4R4	Heater, glass	25
5R10	Resistor, rotating beacon	21
5R12	Resistor, warning lamp ballast	17-18
4S8	Switch, press to talk	32-33
4S11	Switch, intercom volume	34-36
5S7	Switch, working lamp	12-16
9S2	Switch, heater master	44-48
9S3	Switch, cab door	53-54
9S4	Switch, cabin temperature control	37-40
9S7	Switch, heated glass timer	49-52
9V1	Diode, routing	34
9V2	Diode, routing	37
X5	Connector, 10 way binnacle	3-4
4X10	Connector, 2 way inside cab microphone	43
4X11	Connector, 2 way cab door mic/speaker	43,46
4X12	Connector, 42 way control module	58-59
4X13	Connector, 4 way press to talk	33
6X63	Connector, 10 way UPA	3-4
9X8	Connector, 4 way heater controls	17,21

NOTES

Resistor 5R10 is not required for alternative XENON beacon.

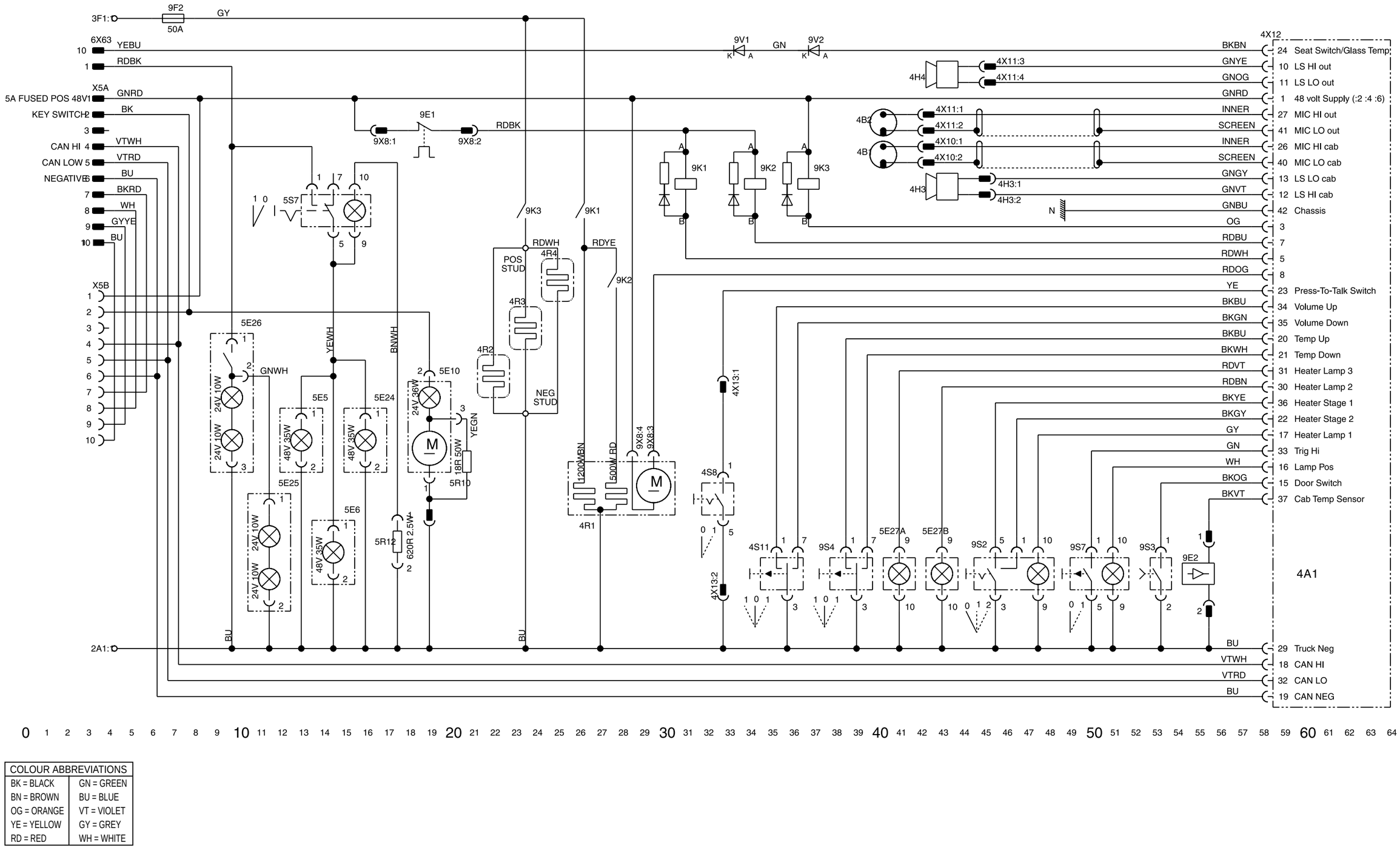
Intercom and cab heater is turned off when the door switch is open.

Module pin 24 on interim module is used for seat switch input - if grounded then 'driver seated' and 'cab temperature' is adjustable. I input is not grounded then cab temperature defaults to 5 °C.

5E25 interior lamp is not fitted to drive-in-racking cab.

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CABIN CIRCUIT DIAGRAM



0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64

COLOUR ABBREVIATIONS	
BK = BLACK	GN = GREEN
BN = BROWN	BU = BLUE
OG = ORANGE	VT = VIOLET
YE = YELLOW	GY = GREY
RD = RED	WH = WHITE

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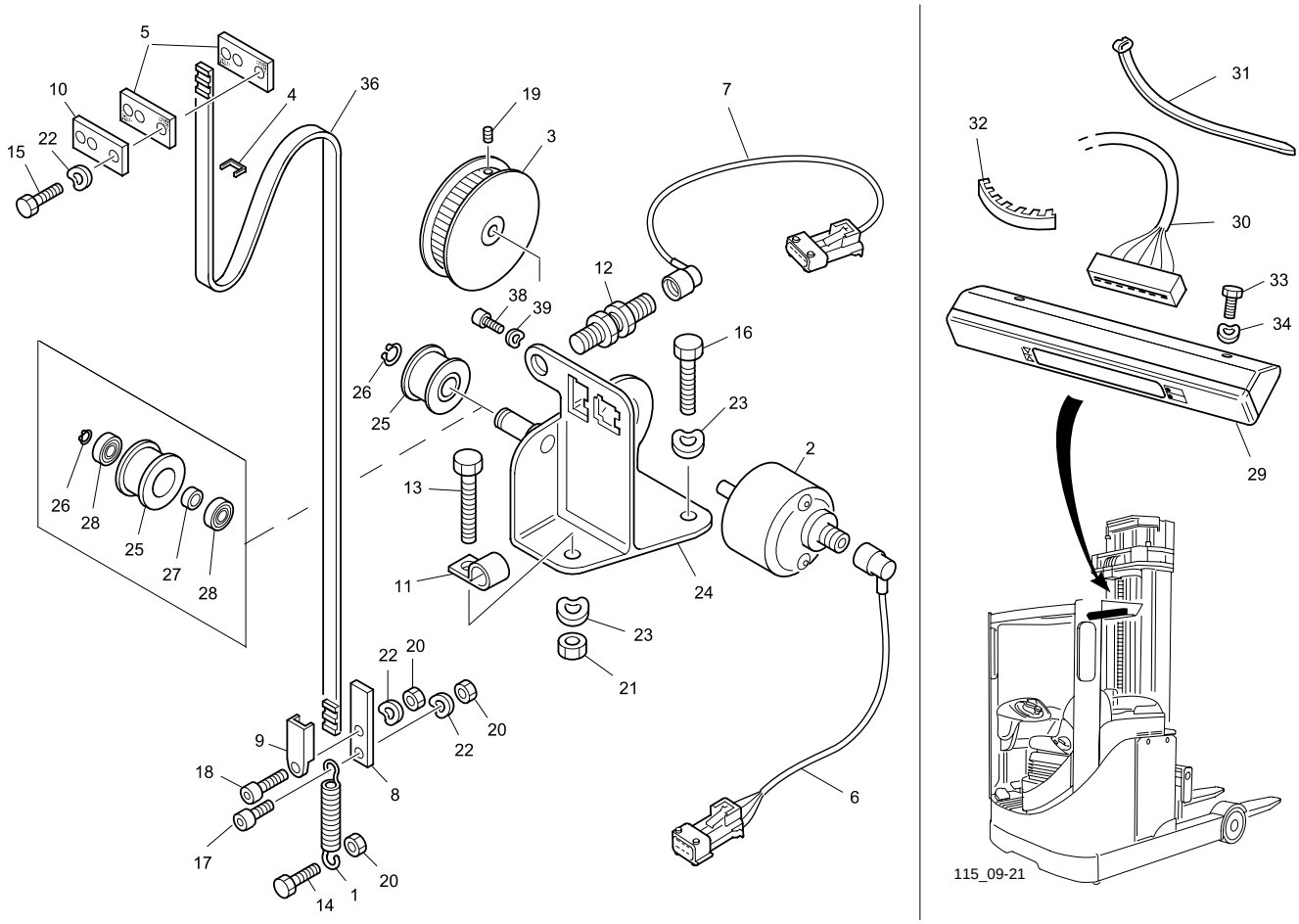
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9.2 HEIGHT PRESELECTION (LPS) AND LIFT HEIGHT INDICATOR (LHI)

9.2.1 LPS SYSTEM OVERVIEW

Based on LHI display system. With LPS configured, the display will show LHI in shelf mode. When a shelf is selected via the keypad, The display enters LPS mode showing the level and flashing the “mm” indicator during lift/lower. On releasing the lever, the display returns to LHI mode.



1. Tension spring
2. Shaft
3. Pulley
4. Clamp
5. Rubber strip
6. Harness assembly
7. Harness assembly
8. Plate
9. Clamping piece
10. Plate
11. Clip
12. Sensor
13. Hexagon head screw
14. Hexagon head screw
15. Hexagon head screw
16. Hexagon head screw
17. Socket head screw
18. Socket head screw
19. Threaded pin
20. Hexagon nut
21. Nut
22. Wavy washer
23. Bracket
24. Bracket
25. Roller
26. Retaining ring
27. Ring
28. Ball bearing
29. Indicator unit
30. Harness assembly
31. Cable tie
32. Edge protection
33. Hexagon screw
34. Spring washer
35. Harness assembly
36. Toothed belt

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9.2.2 LPS PARAMETER WINDOWS

LID WINDOWS

```
(4)
  B1:1      3B4:0
 1B12:00     S3:1
  8B5:0
```

Digital Inputs

Shows the states of digital inputs to the controller. An active state is represented by a ‘1’ and an inactive state ‘0’.

1B12	Height Encoder signals (B & A)
8B5	Height Encoder reference sensor

```
(6)
FKHT: 12805
1B12:00    8B5:0
ZONE:0    LEVL:0
```

LHI / LPS

FKHT	current height of forks in mm
1B12	encoder input signals (B & A) as window 4
8B5	encoder reference as window 4
ZONE	active zone selected via keypad.
LEVL	active height selected via keypad (0=manual).

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```
(71)
HIMD: 1   tLEV:   5s
TYPE: 0   RFHT: 3500
SDIF: 150 MMPP:    4
```

Height Indicator Parameters

HIMD: Mode.
- 0 = no height indicator fitted
- 1 = display absolute height
- 2 = display shelf mode
- 3= LPS mode

TYPE: Sets the type of encoder fitted
- 0 = operates above free lift only
- 1 = operates over full height range

SDIF: The distance in mm of the stack height above the de-stack height (programmed shelf height).

RFHT: The height at which the reference switch operates

MMPP: mm per pulse of the height encoder

tLEV For LPS, sets the delay time allowed between selecting a shelf level and operating the lift/lower lever. After this time the selection will be cancelled.

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```
(73)
ZONE:1
LEVL:1
HGHT:12000
```

Adjust / set shelf levels

ZONE: Select which zone to adjust
LEVL: Select which shelf height to adjust
HGHT: adjust shelf height. "——" indicates that the end of the programmed levels is reached.
↑ or ↓ keys will set the height to a minimum of 10mm above the previous shelf height and then allow adjustment up to 10mm below the next height. (keep keys pressed for faster scrolling)
ENTER will store the chosen height.
DEL will erase all programmed height from the displayed height to the end of the current zone.

```
(8)
ZONE:1
LEVL:1
HGHT:12000     12422
```

Teach in shelf levels

ZONE: Indicates the selected zone
LEVL: Indicates the selected level
HGHT: Indicates programmed shelf height in mm for the selected zone and level.
"——" indicates that the end of the programmed levels is reached.

Using the ↑ or ↓ keys, select correct zone and level
Raise the forks to the desired shelf height (the current fork height is displayed on the right hand side of the window.
Press **ENTER** to set the programmed shelf height to the current fork height.
Press **DEL** to erase all programmed shelf heights above the displayed height in the current zone.

LLC WINDOWS

```
(75)
UPSL: 3%   LIMW:50
DNSL: 8%
RAMP: 0.300m
```

LPS parameters

Allows the operation of LPS to be fine tuned

UPSL final speed of lift at stop point (min. speed)
DNSL final speed of lower at stop point (min. speed)
RAMP length of ramp down (250-500mm)
LIMW Sets the width in mm of reach limit for signals output to CANbus (used for UPAs)

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9.2.3 LPS - SETTING THE REFERENCE HEIGHT

Set LID Window 71 HIMD to 1 — Height Mode = encoder with absolute height readout (2 and 3 are not available until reference height is programmed and at least one shelf is programmed)

Operate the tilt such that the forks are level.

Lift forks to the end of free lift then continue very slowly until the LHI just references - release the lever immediately.

Measure the height to the top surface of the forks from the ground.

Set LID Window 71 RFHT to — the distance measured above.

9.2.4 LPS - CONFIGURING

Set	LID	Window 71	HIMD	To set operating mode to one of the following…. 0 = No LHI or LPS (no encoder fitted) 1 = LHI in absolute (mm) display mode 2 = LHI in shelf display mode 3 = LPS in shelf display mode ☞ **NOTE: Until some shelf levels are programmed, modes 2 and 3 will not be available**
Set	LID	Window 71	TYPE	To set the type of encoder… 0 = Count from end of free lift 1 = Count from floor
Set	LID	Window 71	tLEV	For LPS to set the delay from selecting a shelf to operating the lift/lower lever. After this delay, the selection will be cancelled.
Set	LID	Window 71	MMPP	DO NOT change this - it sets how many mm/pulse the encoder gives and should always be set to 4.

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9.2.5 LPS - PROGRAMMING SHELF LEVELS USING LAPTOP COMPUTER

2 METHODS ARE AVAILABLE

Method 1 (direct height entry) - Using LID Window 73

1. Press [Enter] to select ZONE
2. Select the zone for the new shelf
3. Press [Enter] to select LEVL. The HGHT will display the existing setting for the selected level. "——" will be displayed for "end of list" i.e. no level programmed.
4. Use the [↑] and [↓] keys to select the desired height
5. Press [Enter] to store
6. go back to step 1 to enter another level. The next level can be programmed from (this level + 10mm)

Method 2 (teaching height) - Using LID Window 8

1. Press [Enter] to select ZONE
2. Select the zone for the new shelf
3. Press [Enter] to select LEVL. The HGHT will display the existing setting for the selected level. "——" will be displayed for "end of list" i.e. no level programmed.
4. Lift or lower the forks to the desired shelf level and then press either the [↑] or [↓] keys to program it. The current fork height is displayed in the bottom-right corner of the screen.
5. Press [Enter] to store
6. go back to step 1 to enter another level. The next level can be programmed from (this level + 10mm)

9.2.6 LPS - DELETING SHELF LEVELS

Using LID Window 73

1. Press [Enter] to select ZONE
2. Select the zone for the new shelf
3. Press [Enter] to select LEVL. The HGHT will display the existing setting for the selected level.
4. Press the [Delete] key to delete the level and "——" will be displayed to show the deleted shelf.

WARNING: All shelves after this shelf will also be deleted. This shelf therefore becomes the "end of list"

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9.2.7 LPS - SETTING THE STACK - DESTACK DISTANCE

Set LID Window 71 SDIF to — the desired difference between stack and destack. It is adjustable 0 to 500mm in 1mm steps.

9.2.8 LPS - ADJUSTING OPERATIONAL CHARACTERISTICS

Set LLC Window 75 RAMP — To adjust the total ramp down distance. The speed is progressively ramped from full speed as the forks approach the target shelf. This is programmable from 250mm to 800mm in 50mm steps.

Set LLC Window 75 UPSL — To set the final speed of lift at the target shelf. The default value of 3% has been found to be the optimum value. Higher values will give a quicker operation but at the risk of overshooting the target.

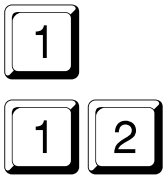
Set LLC Window 75 DNSL — To set the final speed of lower at the target shelf. The default value of 3% has been found to be the optimum value. Higher values will give a quicker operation but at the risk of overshooting the target.

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9.2.9 LPS OPERATION

9.2.9.1 LPS SHELF SELECTION (DESTACK)

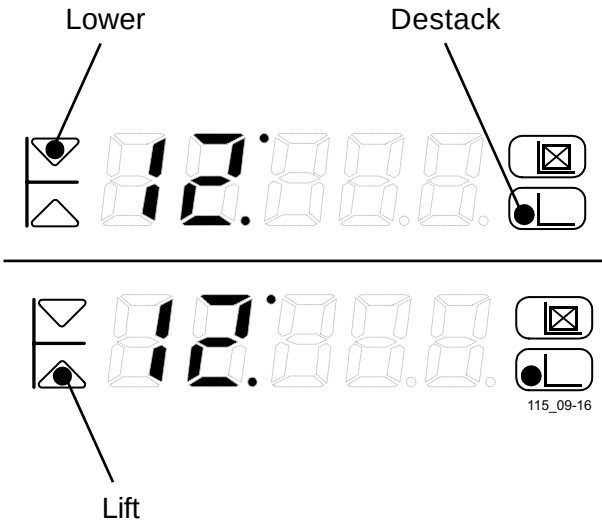
1



etc.

Enter the desired level (1 to 25). Buttons must be pressed within 0.5 seconds for levels > 9

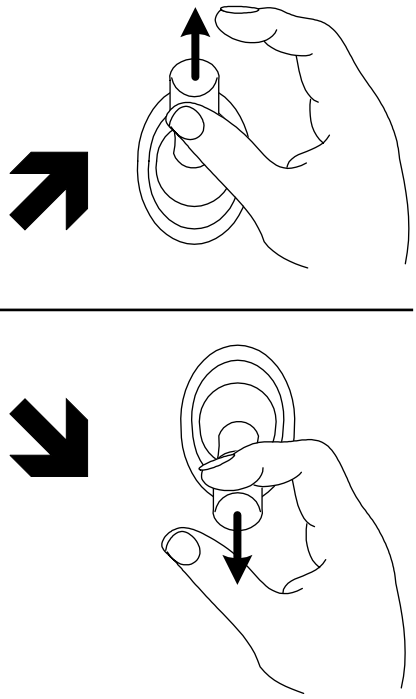
2



Display shows selected level

A long bleep is sounded when the selected level is not available (i.e. not programmed)

3



Operate the lift or lower within 5 seconds* according to the displayed instruction.

mm The 'mm' mode indicator will flash to indicate automatic mode

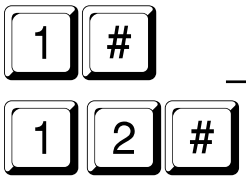
* The delay is programmable between 2 and 10 seconds. (LID Window 71, tLEV)

☞ **NOTE: If the truck is switched on when the forks are above the reference height then slow lift will only be possible. To restore full speed operation the forks must be lowered below the reference height.**
To prevent this happening, always lower the forks to the ground before turning the truck off.

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9.2.9.2 LPS SHELF SELECTION (STACK)

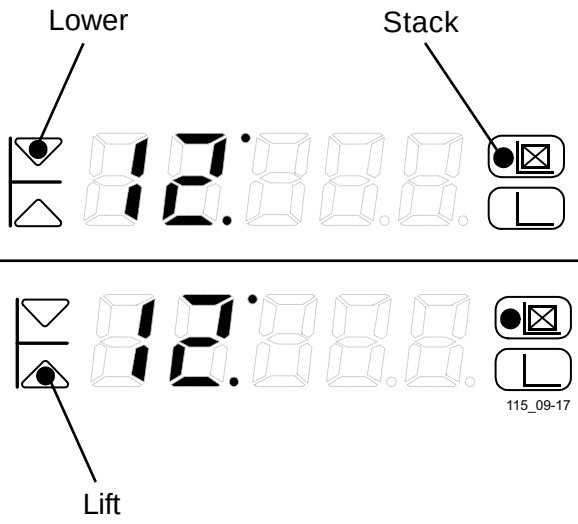
1



etc.

Enter the desired level (1 to 25) followed by the # key.
Buttons must be pressed within 0.5 seconds for levels > 9

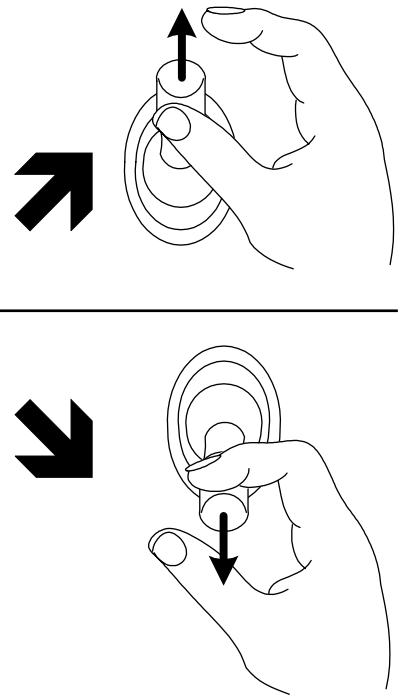
2



Display shows selected level

A long bleep is sounded when the selected level is not available (i.e. not programmed)

3



Operate the lift or lower within 5 seconds* according to the displayed instruction.

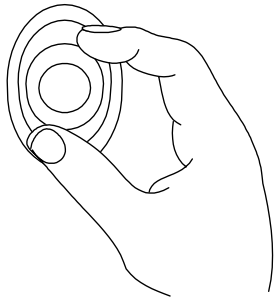
mm The 'mm' mode indicator will flash to indicate automatic mode

* The delay is programmable between 2 and 10 seconds. (LID Window 71, tLEV)

☞ **NOTE: If the truck is switched on when the forks are above the reference height then slow lift will only be possible. To restore full speed operation the forks must be lowered below the reference height.**
To prevent this happening, always lower the forks to the ground before turning the truck off.

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9.2.9.3 LPS - CANCEL SHELF SELECTION / OPERATION


115_09-18

If lifting or lowering - release the lever
or
Don't operate lift / lower lever within 5 seconds*
or
Operate and release immediately

* The delay is programmable between 2 and 10 seconds. (LID Window 71, tLEV)

9.2.9.4 LPS - VIEW AN A ZONE



Press the # key



115_09-19

The display briefly shows the current zone.

☞ **NOTE: Zone 1 is always selected if the battery is disconnected/reconnected. Otherwise a zone selection is preserved - even if the keys-witch is turned off.**

9.2.9.5 LPS - SELECTING A ZONE



Press the # key followed by the desired zone number (1 to 4). Buttons must be pressed within 0.5 seconds)



115_09-20

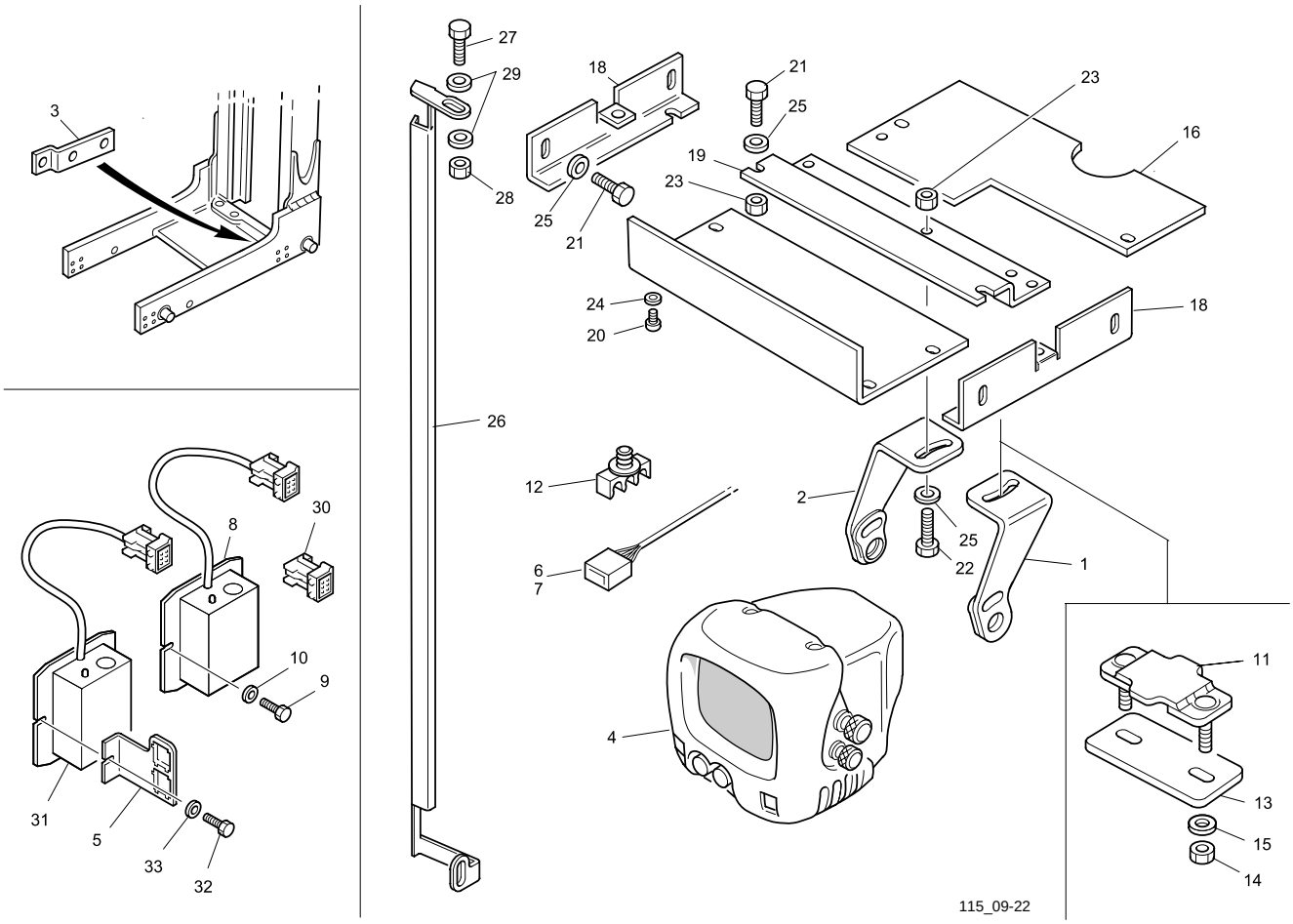
The display briefly shows the selection.

☞ **NOTE: Zone 1 is always selected if the battery is disconnected/reconnected. Otherwise a zone selection is preserved - even if the keys-witch is turned off.**

☞ **NOTE: If the truck is switched on when the forks are above the reference height then slow lift will only be possible. To restore full speed operation the forks must be lowered below the reference height.**
To prevent this happening, always lower the forks to the ground before turning the truck off.

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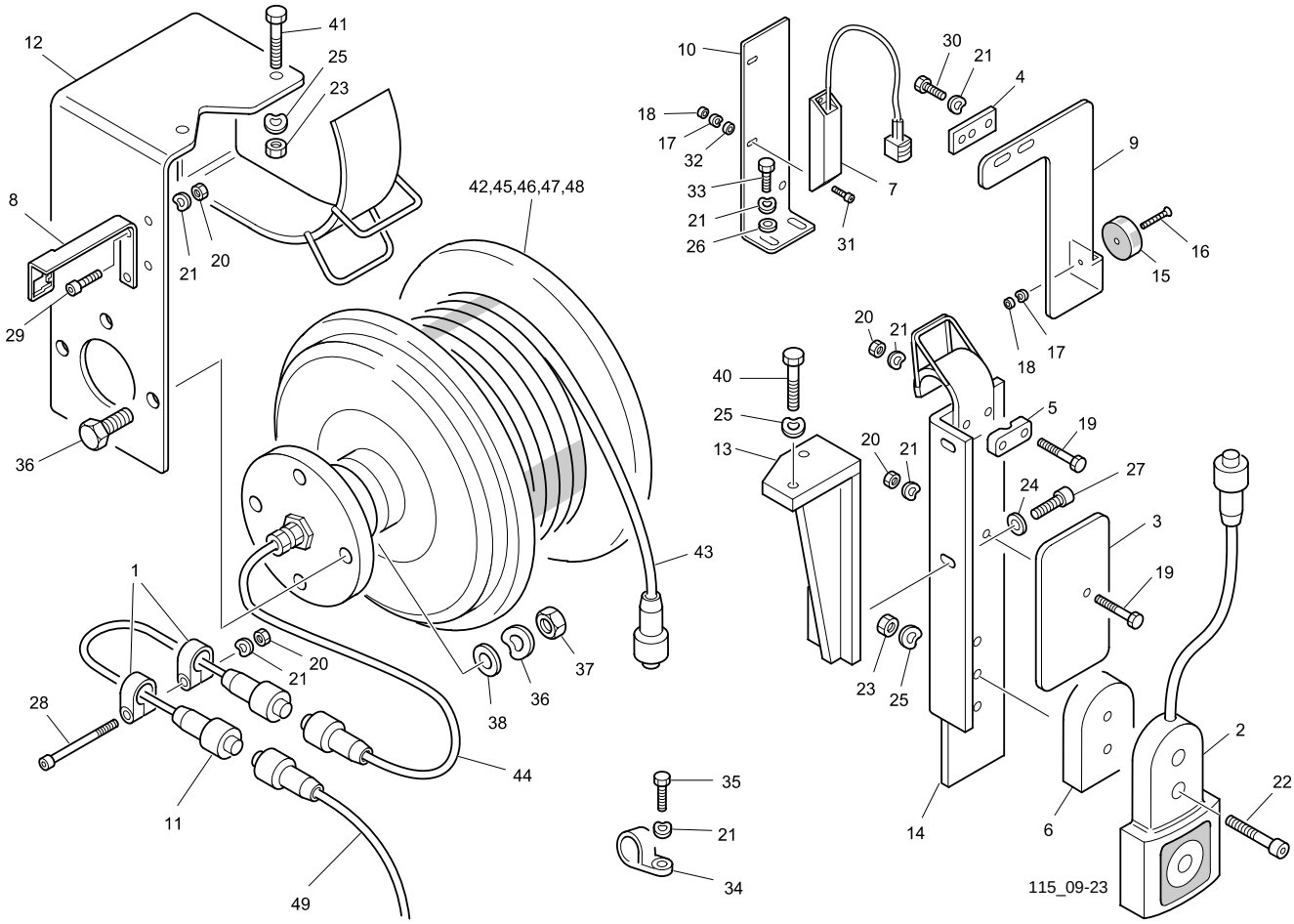
9.3 CLOSED CIRCUIT TELEVISION



1. Bracket
2. Bracket
3. Bracket
4. Monitor
5. Bracket
6. Harness assembly
7. Harness assmbly
8. Transformer
9. Socket head screw
10. Spring washer
11. Bracket
12. Clip
13. Plate
14. Hexagon nut
15. Washer
16. Cover *
17. Cover *
18. Plate *
19. Plate *
20. Raised head screw *
21. Hexagon head screw *
22. Hexagon head screw *
23. Hexagon nut *
24. Washer *
25. Washer *
26. Cover
27. Hexagon head screw
28. Hexagon nut
29. Washer
30. Connector plug
31. Transformer **
32. Socket head screw **
33. Spring washer **

* With cabin
* Cold store protected

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1. Cable clamp
2. Camera
3. Cover
4. Plate
5. Cable clamp
6. Spacer
7. Harness assembly
8. Bracket
9. Bracket
10. Bracket
11. Harness assembly
12. Bracket
13. Bracket
14. Bracket
15. Magnet
16. Countersunk screw
17. Washer
18. Hexagon nut
19. Hexagon screw
20. Hexagon nut
21. Wavy washer
22. Socket head screw
23. Nut
24. Washer
25. Spring washer
26. Washer
27. Socket head screw
28. Socket head screw
29. Socket head screw
30. Hexagon screw
31. Socket head screw
32. Washer
33. Hexagon screw
34. Clip
35. Hexagon screw
36. Hexagon screw
37. Hexagon nut
38. Washer
39. Spring washer
40. Hexagon screw
41. Hexagon screw
42. Cable reel assmbly
43. Harness assembly
44. Harness assembly
45. Brush gear
49. Harness

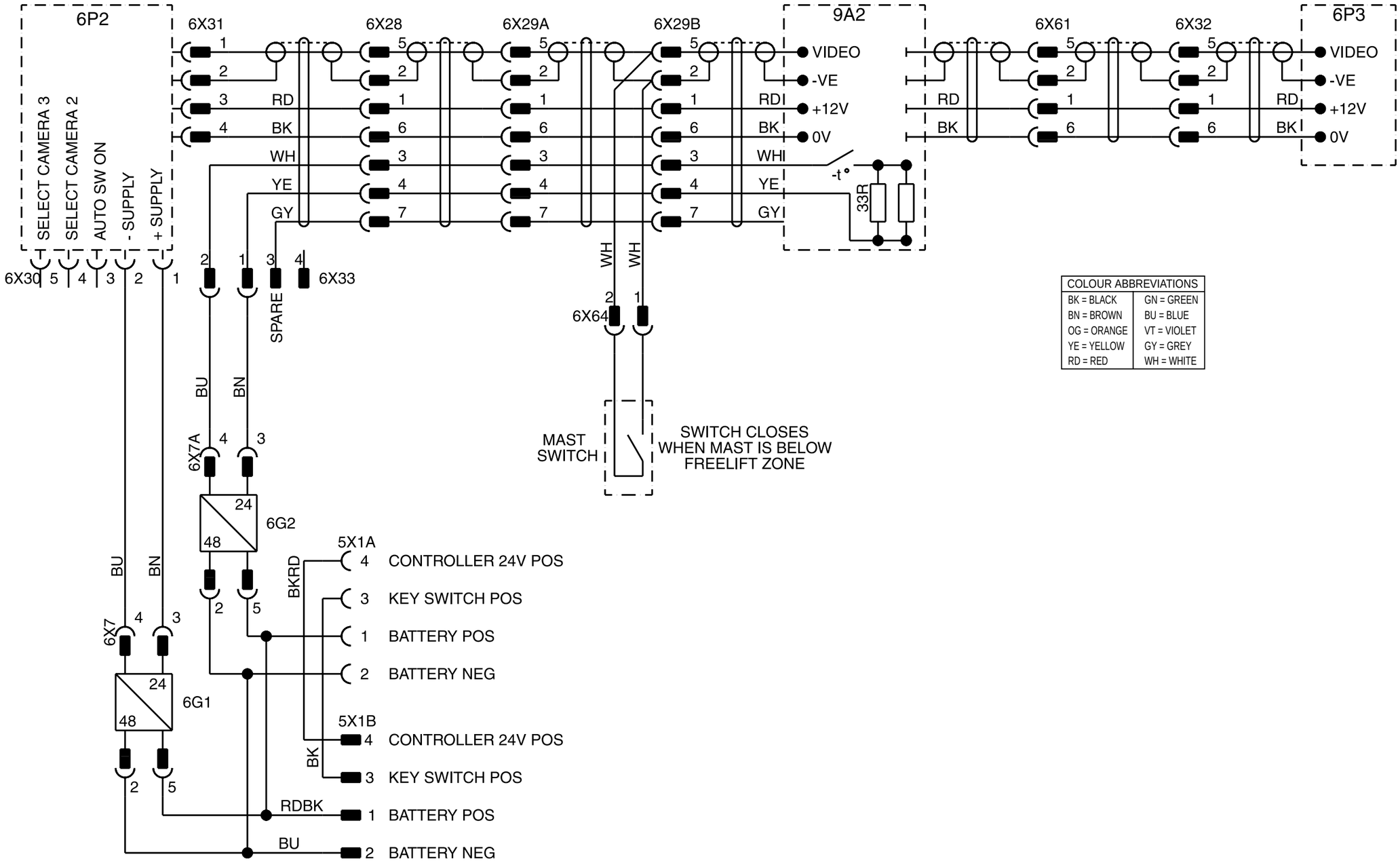
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9.3.1 CLOSED CIRCUIT TELEVISION - CIRCUIT DIAGRAM

9A2	Cable reel
6G1	Converter 48/24V
6G2	Converter 48/24V
6P1	Monitor
5X1	4 way lighting connectors
6X7	6 way converter connectors
6X28	7 way connector - base of mast
6X29	7 way connector - mast to reel
6X30	3 way connector - monitor supply
6X31	4 way connector - monitor video
6X32	7 way connector - video camera
6X33	4 way onnector - heater supply
6X61	7 way connector - cabin reel

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CCTV CIRCUIT DIAGRAM



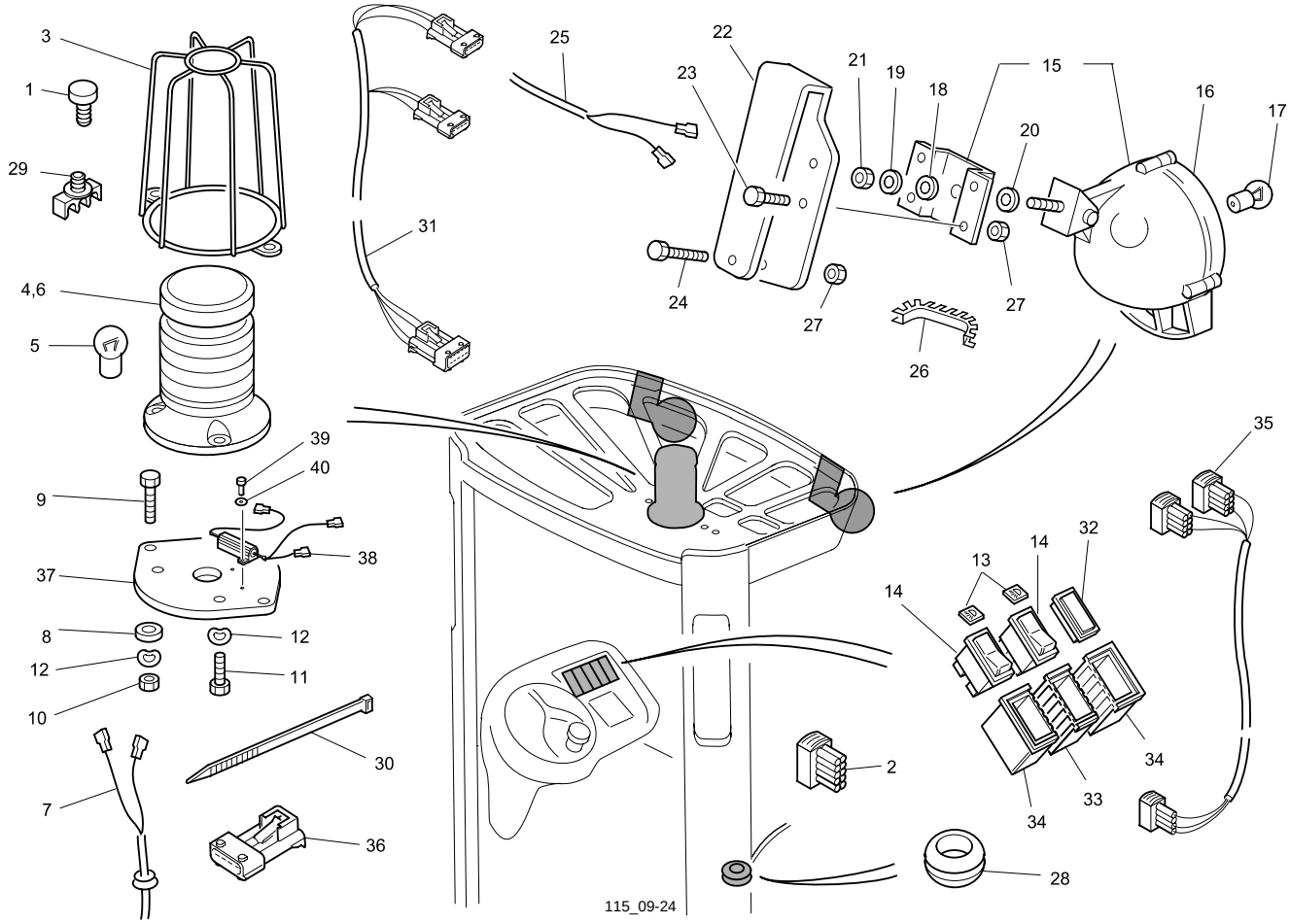
COLOUR ABBREVIATIONS	
BK = BLACK	GN = GREEN
BN = BROWN	BU = BLUE
OG = ORANGE	VT = VIOLET
YE = YELLOW	GY = GREY
RD = RED	WH = WHITE

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Service Training

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9.4 LIGHTING



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1. Stopper
2. Plug housing
3. Guard
4. Beacon
5. Bulb
6. Lens
7. Harness assembly
8. Washer
9. Hexagon screw
10. Hexagon nut
11. Hexagon screw
12. Wavy washer
13. Symbol insert
14. Toggle switch
15. Spot light
16. Headlight insert
17. Bulb
18. Washer
19. Spring washer
20. Washer
21. Hexagon nut
22. Bracket
23. Hexagon screw
24. Hexagon screw
25. Harness assembly
26. Protection strip
27. Hexagon nut
28. Grommet
29. Clip
30. Cable tie
31. Harness assembly
32. Switch blank
33. Switch holder
34. Switch holder
35. Harness
36. Connector
37. Plate
38. Harness
39. Screw
40. Wavy washer

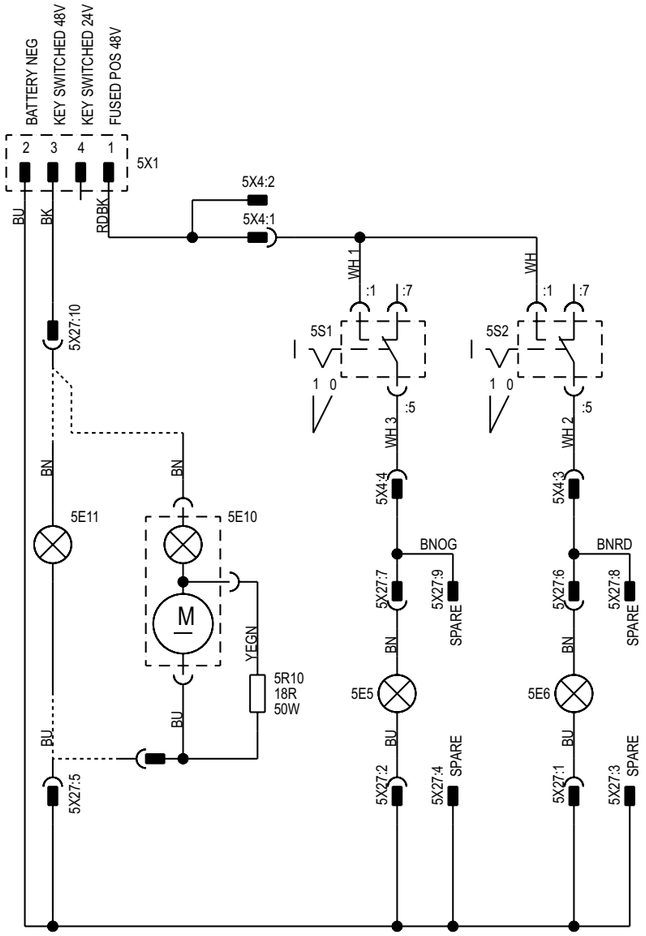
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9.4.1 LIGHTING CIRCUIT

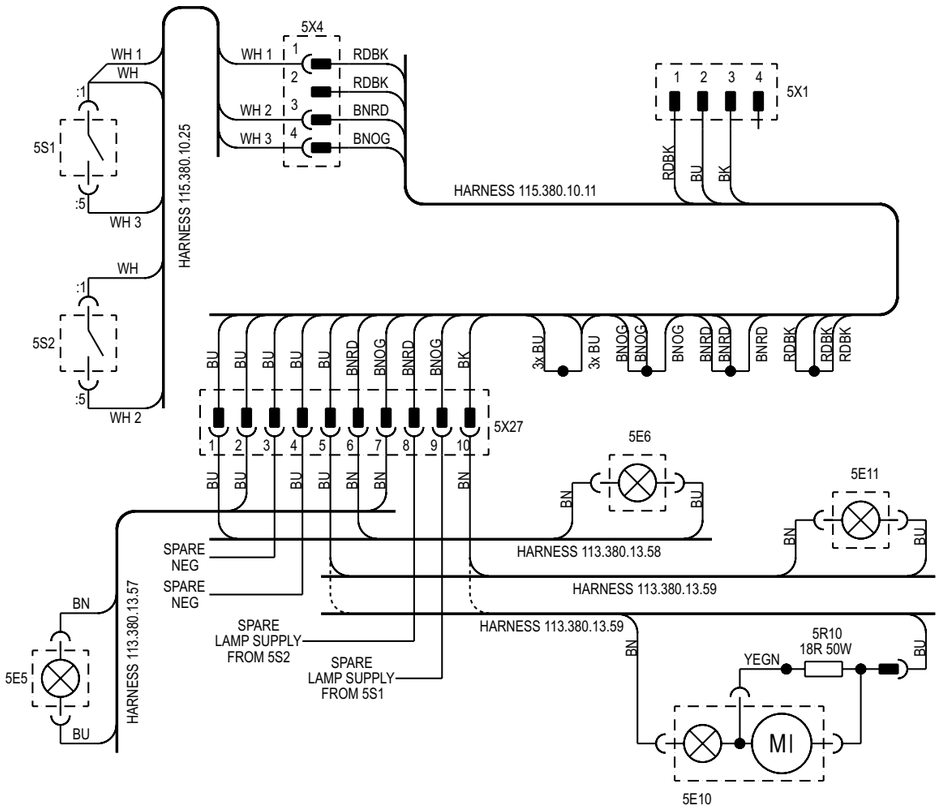
5E5	Working lamp (left hand) 48V 36W
5E6	Working lamp (right hand) 48V 36W
5E10	Beacon (rotating) 24V 36W
5E11	Beacon (flashing) Xenon
5R10	Ballast resistor (rotating beacon)
5S1	Working lamp switch (left hand)
5S2	Working lamp switch (right hand)
5X1	4 way connector - lighting supplies
5X4	4 way connector - binnacle
5X27	10 way connector - lighting options

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LIGHTING CIRCUIT DIAGRAM

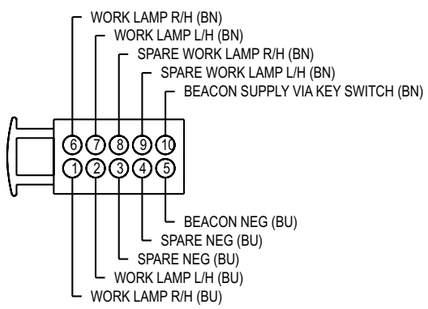


CIRCUIT DIAGRAM



WIRING DIAGRAM

COLOUR ABBREVIATIONS	
BK = BLACK	GN = GREEN
BN = BROWN	BU = BLUE
OG = ORANGE	VT = VIOLET
YE = YELLOW	GY = GREY
RD = RED	WH = WHITE



VIEW ON WIRE ENTRY SIDE OF 5X27
(RECEPTACLE HOUSING)

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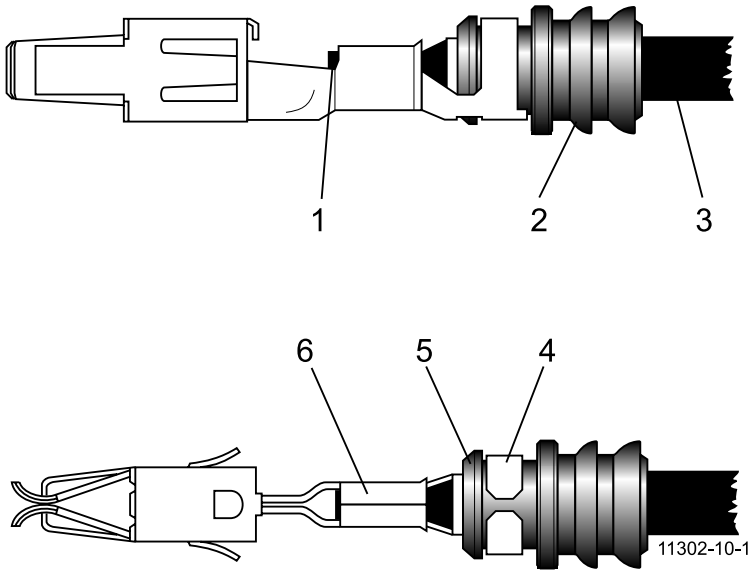
10 MISCELANEOUS

10.1 AMP-SAAB CONNECTORS

The majority of the pin connectors fitted on the 115 are of the type AMP-SAAB. These pin connectors are watertight, each pin having it's own seal with the connections locking together mechanically.
The following description will help to explain how to crimp the pins.

- Push the single seal (2) into the correct position over the insulated wire (Ensure that the shrouded end (5) is in the correct position on the insulated wire)
- With the aid of a pair wire strippers remove 5 mm the insulation, taking care not to demage the inner wire.
- The insulation of the wire must protrude 1 mm from the seal (2).
- Place the wire (3) with the seal (2) into the connector pin (1) as illustrated below.
- With the crimping pliers Part No. 350 509 0030 first crimp the connector pin onto the seal (2) in the area marked (4)
- Secondly the conector pin should be crimped in the area marked (6)
- Press the connector pin with attached wire fully into the plug housing.

☞ **NOTE: To remove the connector pin there is a special extraction tool Part No. 350 985 3002 available. For the smaller connector pins there is also an extraction tool Part No. 350 985 3001 available.**



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10.2 STANDARD TORQUES

	SIZE	TORQUE Nm						
		Grade 4.6	Grade 4.8	Grade 5.8 22H/45H	Grade 6.8	Grade 8.8	Grade 10.9	Grade 12.9
STANDARD THREAD	M4	1	1.3	1.7	2	2.7	3.8	4.6
	M5	2.1	2.7	3.4	4.1	5.5	8	9.5
	M6	3.6	4.7	5.9	7.1	9.5	13	16
	M8	8.5	11	14	17	23	32	39
	M10	17	23	29	34	46	64	77
	M12	30	40	50	60	80	110	135
	M14	47	62	78	94	125	180	215
	M16	73	100	122	146	195	275	330
	M20	145	192	240	289	385	540	650
	M24	250	330	410	495	660	930	1110
	M30	510	675	840	1000	1350	1850	2250
	M36	880	1170	1470	1760	2350	3300	3900
FINE THREAD	M8x1	9.5	12	16	19	25	35	42
	M10x1	20	26	32	39	52	72	95
	M10x1.25	18	24	30	37	49	68	82
	M12x1.25	33	44	55	66	88	125	150
	M12x1.5	31	41	52	62	83	115	140
	M14x1.5	52	70	87	105	140	195	235
	M16x1.5	79	105	130	157	210	295	350
	M18x1.5	115	150	190	230	305	425	510
	M20x1.5	160	210	265	320	425	600	720
	M22x1.5	215	285	355	425	570	800	960
	M24x2	270	360	450	540	720	1000	1200
	M27x2	395	525	655	785	1050	1500	1800
	M30x2	540	725	905	1085	1450	2050	2500
	M36x3	930	1250	1560	1870	2500	3500	4100

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10.3 NON STANDARD TORQUES

Section 1

Pinion gear to traction motor	1 off M20 Slotted ring nut	55Nm

Section 2

Drive wheel nuts	7 off M14 Spherical seat nut	195Nm

Section 4

Load wheel locknut	(R14/R16) 1 off M40 Slotted nut	See Note 1
	(R20) 1 off M45 Slotted nut	See Note 2

NOTE 1 Tighten to 50Nm, slacken off retighten to 12Nm and turn clockwise to nearest tab on washer.

NOTE 2 Tighten to 50Nm, slacken off retighten to 20Nm and turn clockwise to nearest tab on washer.

Section 5

Footbrake shoes adjustment		37 Nm
All brake pipes	M10 x 1mm	10Nm

Section 6

Heatsink to chassis	M10 x 30 cap head	30 ±5Nm
Compact module connections	M8 full nut	9 ±1Nm
Heavy cables to motor terminals	M8 full nut	16Nm

Section7

Lift pump to motor	M10 x 100 Cap head (Grade 12.9)	55-58 Nm
Valve to reach frame	M8 x 20 Hex head	12Nm

Section 8

Mast to reach carriage bottom fixing (Type 183 & 186)	M20 x 80 Durlok hex head	600Nm
Mast to reach carriage pivot fixing (Type 183 & 186)	M12 x 25 cap head (Grade 10.9)	90Nm

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10.4 SPECIAL TOOLS, SEALANTS AND COMPOUNDS

Section 1

Traction motor brush bedding stone	Morganite BS24
Parking brake adjustment tool (Fine thread)	002.941.80.14 (Early trucks)
Parking brake adjustment tool (Coarse thread)	002.941.80.15 (approx G1X115L00032 on)
1 off M8 x 20 hex head	037.752.50.75
1 off washer 44 mm o/d, 23 mm i/d	036.650.20.65
Emergency steering tool	002.941.80.16
Emergency brake release screws (3 off M5 x 20 mm cap head)	9.045.316.102

Section 2

Gearbox pinion bearing	Loctite 603
Gearbox input pinion locknut	Loctite 243
Gearbox output shaft snap ring	Loctie 574
Gearbox output gear securing screws	Loctite 243
Gearbox top plate to housing	Loctite 574
Steer bearing securing screws	Loctite 243

Section 4

Load wheel nut removal/refitting tool	(1.4 & 1.6)	002 941 80 01
	(2.0)	002 941 80 08

Section 5

Footbrake shoe adjustment shims	002.914.65.28
Footbrake shoe clamping blocks	115.527.18.00

Secton 6

AMP-SABB Connector crimping pliers	350 509 00 30
AMP-SABB Pin extraction tool (large pins)	350 985 30 02
AMP-SABB Pin extraction tool (Small pins)	350 985 30 02
CAN box	390.360.51.12
Serial cable	390.382.01.00
Truck adaptor cable	390.382.01.01

Section 7

Special spanner for tank hose to hydraulic block	002 941 80 18
Return to tank hose plug	000 952 40 24
Lift brush bedding stone	Morganite BS24

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10.5 RECOMMEND LUBRICANTS

Hydraulic oil

STANDARD
Hydraulic oil grade HLP to DIN 51524 part 2
Viscosity ISO VG 46., Cloud point lower than -10°C when tested to IP 216.82
COLD STORE (STAY IN)
Anti wear hydraulic oil
Grade ISO VG 22-32
Viscosity index > 300
e.g Shell Tellus Arctic 32
COLD STORE (IN - OUT)
Anti wear hydraulic oil
Grade ISO VG 22-32
Viscosity index > 300
e.g Shell Tellus Arctic 32

☞ **NOTE: The above cold store specification is a high Viscosity Index oil, which allows the use of hydraulics in ambient temperatures between -30°C and +40°C (Oil temperatures between -30°C and +80°C)**

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☞ **NOTE: The above oil recommendations are approximate values. In case of doubt we recommend contacting your local Linde representative.**

Multipurpose grease

STANDARD
Lithium-based grease to DIN51825, KP2K-20

COLD STORE
Low temperature clay based grease

Gear oil
Use only oil of classification SHC, e.g. Mobil SHC 75w/90

General purpose oil
Engine Oil SAE 20W/50

Chain Spray

STANDARD
Linde chain spray
COLD STORE
Linde cold store chain spray

Brake fluid
Original ATE brake fluid to DOT3, type “S”, classification to FMVSS 116 or SAE J 1703 issue 1980 and ISO 4925.

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