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Service Training
Electric reach truck

Linde Material Handling

Series Series 115-03

R14, R14HD, R14N, R16, R16HD, R16N, R20, R20N

Edition 06/2008

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Edition 12/2007

- First issue

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- Amended hydraulic circuit annotation
- Amended circuit annotation
- Added joystick and gearbox heater circuit
- Added special tools
- Added gearbox

Edition 06/2008

- Revised drive wheel removal procedure

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Introduction

This is a guide to those responsible for the repair and maintenance of the 115-03 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 User Manual.

Due to the ever increasing higher standard of production methods, materials used, and the company policy of continuous improvement, some servicing procedures detailed in this manual may have changed. We are therefore unable to consider any claims based on the specification, illustrations and descriptions contained in this manual.

⚠ CAUTION

Working on the electrical control system without first discharging the steering capacitor can lead to damage of the CAN interface drivers.

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.

⚠ CAUTION

Connecting or disconnecting the battery with the truck switched on could cause damage to electrical components.

Before connecting or disconnecting the battery, ensure the truck is switched off, and the emergency isolator is depressed.

DO NOT FIT PARTS OTHER THAN THOSE AVAILABLE FROM THE MANUFACTURER, OR ALTER EXISTING EQUIPMENT. INCORPORATION OF PARTS OTHER THAN THOSE SUPPLIED BY THE MANUFACTURER OR ALTERATION OF EXISTING EQUIPMENT WITHOUT THE MANUFACTURER'S PERMISSION MAY MAKE THE TRUCK UNSAFE AND WILL RENDER INVALID THE MANUFACTURER'S 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.

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Structure of training document

This training document is based on the relevant seminar held at our Linde training centres or at the authorised dealer's premises and is designed to supplement it. The training document taken by itself without an accompanying seminar is not suitable for self-study.

This training document is divided into numbered sections from 0 to 10, with the content being identical in all training documents. The sections are only guided by the organisation of the spare parts list and may differ from the content . The circuit diagrams for the truck can be found in section 10 in the Appendix.

Section	Content
0	Product information
1	Motor
2	Gearbox
3	Chassis
4	Undercarriage
5	Controls
6	Electrics / Electronics
7	Hydraulics
8	Load lift system
9	Special equipment and accessories
10	Circuit diagrams

The training document is **not** organised so that it successively describes the structure of the truck but is based on a modular concept. This means that in the different sections the individual vehicle components are described as independent units one after the other. This is another reason why a course at one of our training centres is essential.

The introduction is followed by a complete contents list for the training document. This is supplemented by an index at the end of the training document.

Here we should like to inform you that a list of all special tools and measuring instruments used for this truck can be called up referred to type, including spare part number, usage and graphics, in the documentation software "Truck Expert".

Symbols used

The precautions **Danger**, **Warning**, **Caution**, **Note** und **Environment Note** in this manual are provided to indicate special hazards or unusual information requiring special identification:

⚠ DANGER

indicates hazards that may result in personal injury or death and/or substantial damage to the product.

⚠ WARNING

indicates hazards that may result in personal injury and/or substantial damage to the product.

⚠ 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.

ENVIRONMENT NOTE

The information contained herein must be observed, otherwise environmental damage may occur.

For your safety other symbols are also used. Please note the different symbols.

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0 Product information

Safety . . . 0-1
[MODULE] . . . 0-1
Service . . . 0-2
Covers and cowlings . . . 0-2
Emergency lower . . . 0-4
Emergency steering and parking brake release . . . 0-5
Securing for transportation . . . 0-7
Slinging the truck . . . 0-7
Towing procedure . . . 0-8
Jacking the truck . . . 0-9
Mast unit . . . 0-10
Service plans - standard . . . 0-12
50 h Service plan . . . 0-12
1000 h Service plan . . . 0-13
2000 h Service plan . . . 0-14
5000 h Service plan . . . 0-15
10000 h Service plan . . . 0-16
Service plans - cold store . . . 0-17
50 h Service plan (cold store) . . . 0-17
250 h Service plan (cold store 250 h to 6500 h) . . . 0-18
250 h Service plan (cold store 6750 h to 13250 h) . . . 0-19
250 h Service plan (cold store 13500 h to 19750 h) . . . 0-20
1000 h Service plan (cold store) . . . 0-21
2500 h Service plan (cold store) . . . 0-22
5000 h Service plan (cold store) . . . 0-23
Recommended lubricants . . . 0-24
Non standard torques . . . 0-25
Special tools . . . 0-28
Diagnostics . . . 0-30
Overview . . . 0-30
Canbox . . . 0-32
Software update for Canbox . . . 0-33
Traction diagnostic codes . . . 0-35
Hydraulic diagnostic codes . . . 0-37
Steering diagnostic codes . . . 0-40
Display diagnostic codes . . . 0-42
LAC - Traction diagnostic codes . . . 0-43
LAC - Hydraulic diagnostic codes . . . 0-44

https://truckmanualshub.com/

1 Motor

Traction motor 1-1

Traction motor 1-1

2 Axles

Mechanical drive axle 2-1

Drive wheel 2-1

Gearbox 2-4

3 Chassis, bodywork and fittings

Covers and panelling 3-1

Covers and panelling 3-1

Steering binnacle 3-3

Operator's console 3-4

Operator's seat 3-6

Seat assembly 3-6

Battery carrier 3-8

Battery carrier 3-8

4 Undercarriage

Electrical steering 4-1

Steering wheel potentiometer 4-1

Drive wheel position potentiometer 4-4

Steering motor 4-10

Wheels and tyres 4-12

Load wheels 4-12

Brake installation 4-14

Hydraulic braking system 4-14

Traction motor brake (standard) 4-16

Load wheel brakes 4-20

5 Controls

Drive and brake controls 5-1

Accelerator and brake pedals 5-1

Operating elements 5-5

Joysticks 5-5

https://truckmanualshub.com/

6 Electric/electronic

Battery and accessories 6-1

The battery 6-1

Battery lock sensor 6-6

Electrical control 6-7

EMC – Electromagnetic compatibility 6-7

AC Control - operating principle 6-8

Connector locations 6-10

Fuses 6-14

Emergency isolator 6-15

13 Volt power supply 6-16

Control module (LDC 61) - A2 6-17

Connector X13 6-17

Charge resistor module - A11 6-21

Electrical control - Traction 6-24

Traction power module 6-24

Direction selection switch 6-28

Parking brake 6-29

Accelerator 6-31

Brake pedal switch 6-33

Traction motor temperature sensor 6-34

Switch controlled speed reduction and 8.5 m switch 6-36

Electrical control - Hydraulics 6-37

Hydraulic power module 6-37

Valve voltage supply 6-41

Joysticks 6-43

Joystick voltage supply 6-44

Joystick operation 6-45

Hydraulic pump motor temperature sensor 6-47

Lower lock valve 6-49

Lift and lower - electrical operation 6-50

Reach - electrical operation 6-51

Sideshift - electrical operation 6-52

Tilt - electrical operation 6-53

Lift stop sensor 6-54

Reach system 6-55

https://truckmanualshub.com/

Electrical control - Steering 6-58
Steering system overview 6-58
Drive wheel position potentiometer 6-61
Steering wheel unit 6-62
Electrical control - Display 6-64
Operator's display 6-64

7 Hydraulic installation

Operating hydraulics 7-1
Change the hydraulic oil and suction filter 7-1
Valve block 7-2
Hydraulic valve block 7-2

8 Load lift system

Mast unit 8-1
Introduction 8-1
Mast removal 8-2
Mast unit dismantling 8-7
Hydraulic cylinders 8-11
Primary lift cylinder 8-11
Secondary lift cylinder 8-15
Lift cylinder bleeding 8-19
Load support 8-20
Forks 8-20

Annex

10 Circuit Diagrams

Electric diagrams 10-2
Circuit diagram (Standard) 115 802 60 14 10-2
Circuit diagram (Variable electric brake) 115 802 60 09 10-6
Coldstore joystick and gearbox heaters 10-10
Hydraulic diagrams 10-12
Hydraulic circuit 10-12

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Safety

[MODULE]

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Service

Covers and cowlings

Opening the motor cover

For ease of access to the motors and hydraulic tank, the seat unit is mounted on a pivot which enables it to be swung out from the chassis as a complete unit.

➢ Remove the securing screw (1).

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

⚠ WARNING

The motors can become very hot. Risk of scalding.

Before working on or near the motors, ensure they have cooled sufficiently.

➢ To close, swing the seat assembly back into the chassis.

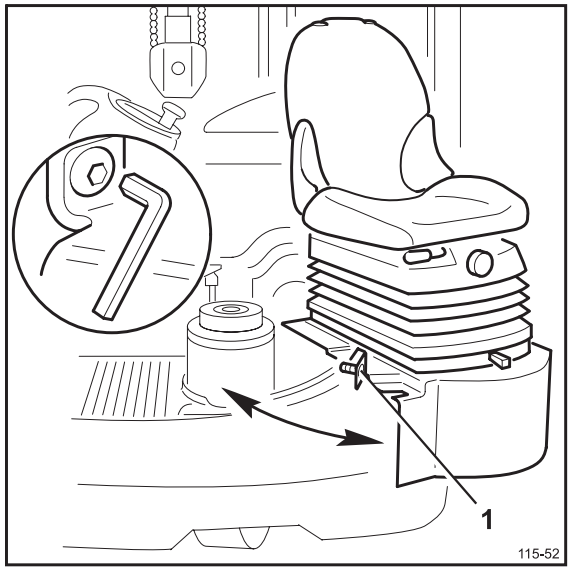
➢ Replace the securing screw (1).

➢ 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.



Removing the floorplate

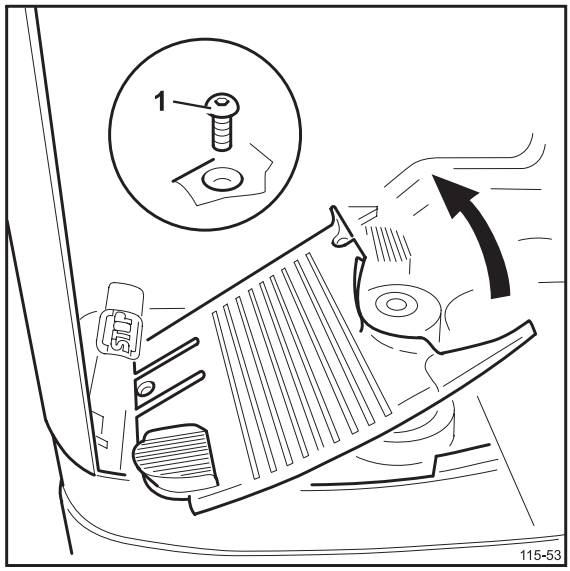
➢ Open the motor cover.

➢ Remove the two securing screws (1).

➢ Lift the floorplate from the truck.

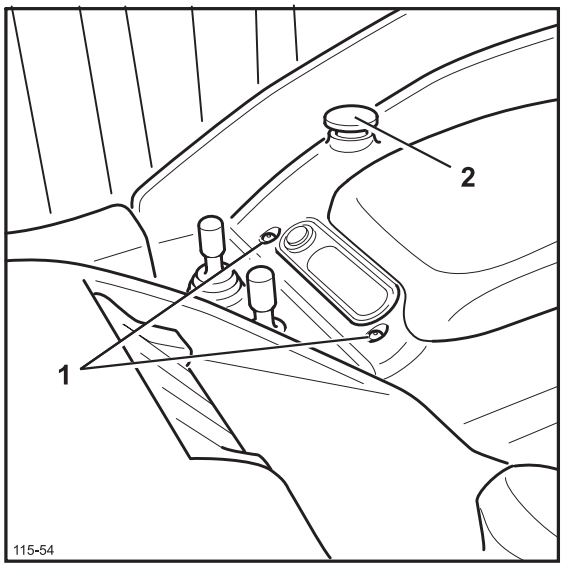
NOTE

The left foot interlock switch (if fitted) is attached to the floorplate.



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Opening the top cover



- Turn the keyswitch off.
- Unplug the battery.
- Unscrew the emergency isolator 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 isolator (2).

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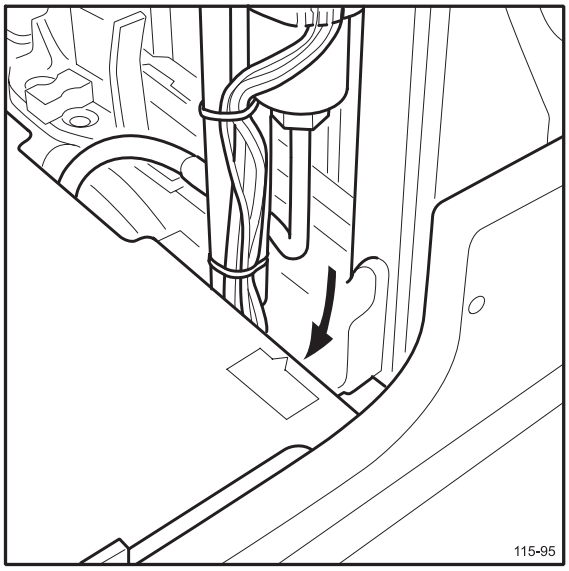
Emergency lower

In the event of power failure, the forks can lowered manually in order that the truck can be moved to a safe position.

Standard chassis

To manually lower the forks, use the emergency lower valve which is located on the hydraulic control valve. (Refer to attached label).

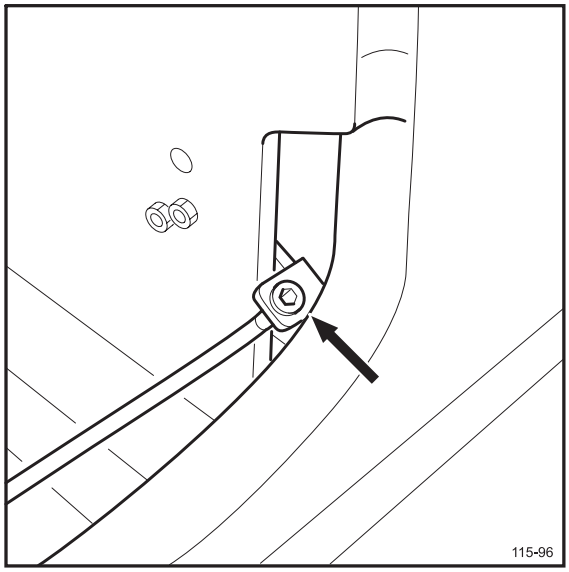
- After ensuring that no persons are in the vicinity, slowly release the valve to allow the lift carriage to be lowered.
- Ensure valve is re-tightened once the forks are lowered.



Wide chassis

On wide chassis trucks, the emergency lower valve is operated remotely.

- After ensuring that no persons are in the vicinity, slowly release the valve to allow the lift carriage to be lowered.
- Ensure valve is re-tightened once the forks are lowered.

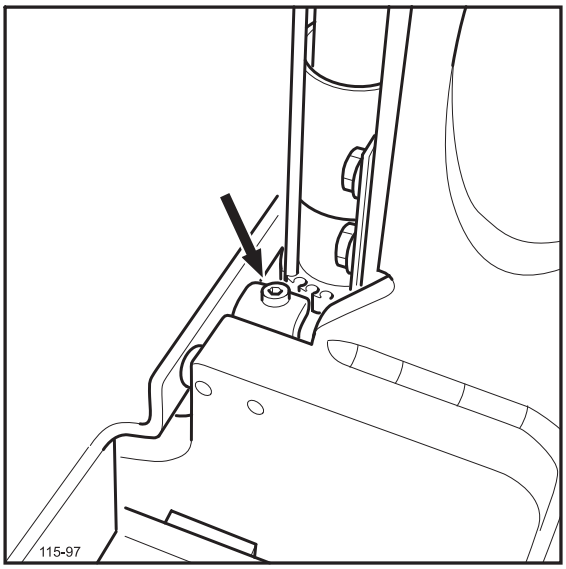


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Narrow chassis

On narrow chassis trucks, the emergency lower valve is operated remotely.

- ➢ After ensuring that no persons are in the vicinity, slowly release the valve to allow the lift carriage to be lowered.
- ➢ Ensure valve is re-tightened once the forks are lowered.



Emergency steering and parking brake release

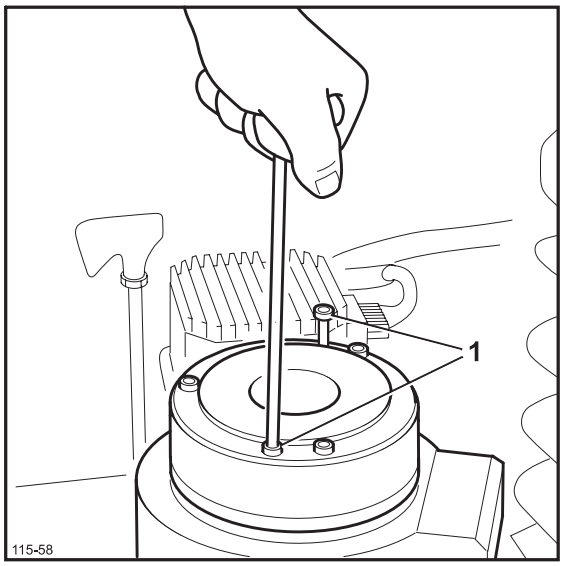
NOTE

In the unlikely event of complete electrical failure, then the parking brake will be applied and steering becomes unavailable. In order to remove the truck from an aisle the following procedure must be followed.

⚠ WARNING

When the parking brake is released, the truck is in an unbraked condition.

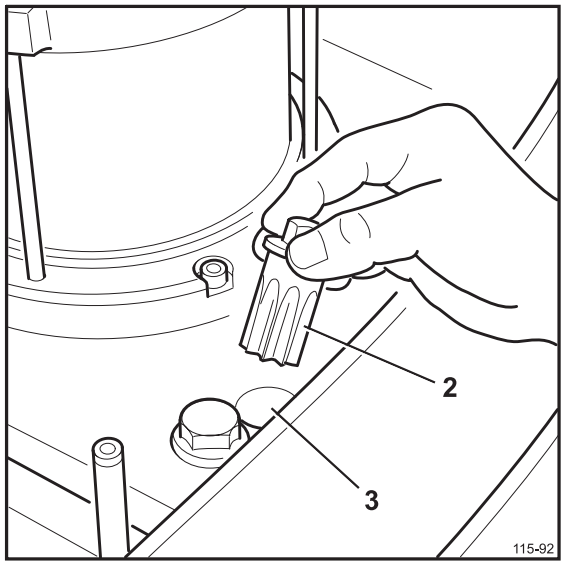
Before releasing the parking brake, ensure that the truck is either on level ground, or that chocks are available to prevent the truck from rolling away.



- ➢ Turn the keyswitch off, depress the emergency isolator and disconnect the battery.
- ➢ Open the motor cover.
- ➢ Insert two M6 x 55 mm screws (1), and tighten fully to mechanically release the parking brake.

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- Special tool (2), which engages on the gearbox toothed ring, allows the drive wheel to be turned manually using an extension bar and ratchet.



NOTE

Apply a small amount of grease to hole (3) before using special tool (2).

- Attach the towing vehicle (with sufficient tractive force) with a suitable rope or sling around the chassis.
- Using extreme caution, very slowly manoeuvre the truck from the aisle.

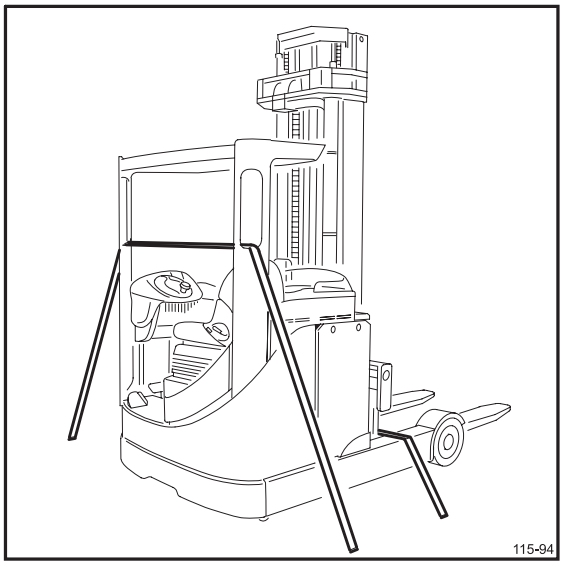
⚠ CAUTION

The above procedure should only be used in order to remove the truck from an aisle.

Once clear of the aisle, remove the load and follow the normal towing procedure.

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Securing for transportation



⚠ CAUTION

When lashing down the truck for transportation, use the points on the overhead guard and reach legs as indicated.

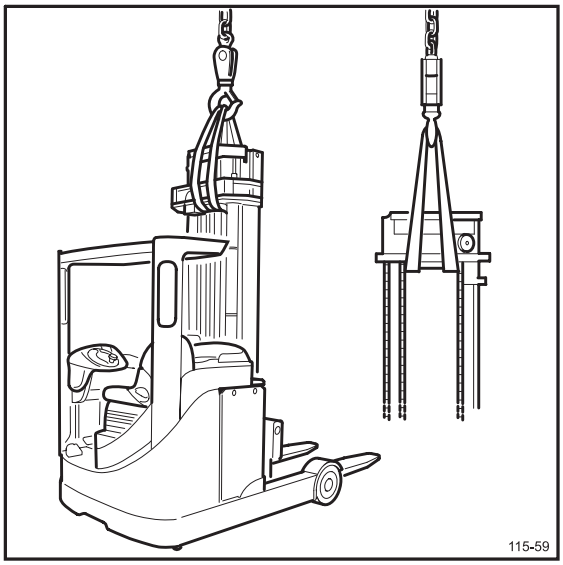
Using different lashing point to those shown could result in damage to the truck.

- ➢ Turn the keyswitch off, depress the emergency isolator and disconnect the battery.
- ➢ Chock the truck securely both front and rear.
- ➢ Lash down the truck as shown.

NOTE

Protect the straps from sharp edges on the overhead guard.

Slinging the truck



⚠ DANGER

Only use lifting equipment with sufficient lifting capacity.

Refer to truck type/capacity plate for truck and battery weights.

⚠ DANGER

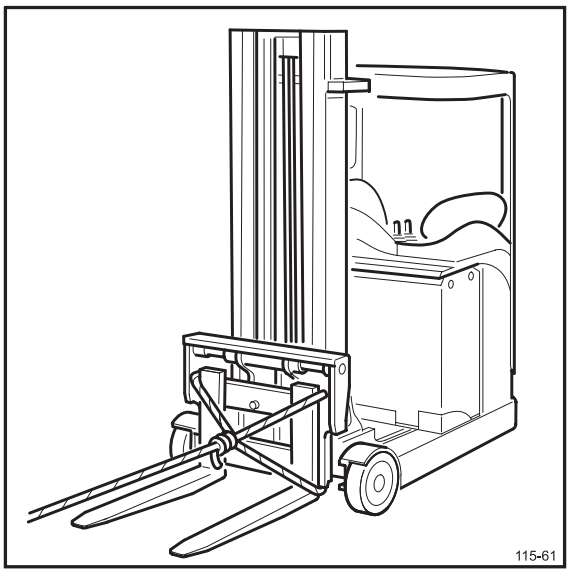
Never step under an elevated load.

When lifting the truck with a crane, ensure that no persons are within the vicinity.

- ➢ Reach the mast fully back.
- ➢ Fix two double loop slings around the mast upper cross member.
- ➢ Protect the truck parts in contact with the slings.

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Towing procedure



⚠ DANGER

With the battery disconnected and the drive wheel raised clear of the ground, only the load wheel hydraulic brakes are operative.

When towing the truck do not exceed the maximum recommended speed of 2.5 km/h.

When towing on slopes, reduce speed to an absolute minimum and keep chocks at hand.

- ➢ Reach the mast unit out and lower the load.
- ➢ Remove the load.
- ➢ Attach the towing vehicle (with sufficient tractive and braking force) with a suitable rope or chain to the fork carriage.
- ➢ Disconnect the battery plug.
- ➢ Raise the drive wheel using a suitable maintenance dolly or fork lift truck.

⚠ DANGER

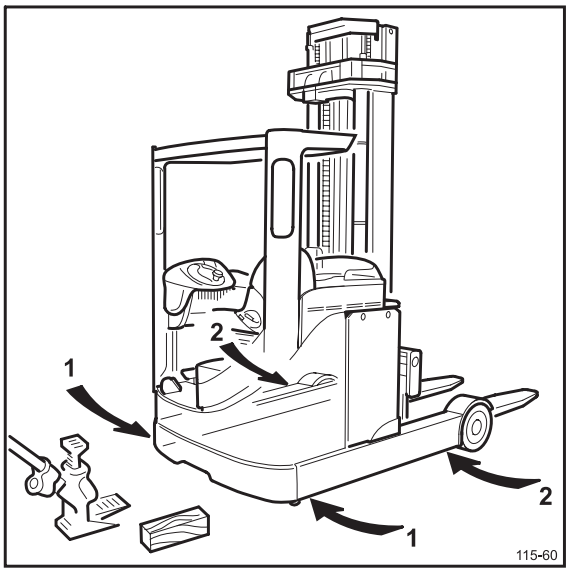
Do not raise the truck more than necessary.

Only raise the drive wheel just clear of the floor.

- ➢ One person should be on the truck being towed to operate the brakes if necessary.

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Jacking the truck



⚠ DANGER

Only use a toe jack with sufficient lifting capacity.

Refer to truck type/capacity plate for truck and battery weights.

⚠ DANGER

Never work on, or leave a raised truck unattended when supported by the jack.

Always block the raised truck securely after jacking.

Raising the drive wheel

- Turn the keyswitch off, depress the emergency isolator and disconnect the battery.
- Securely chock both load wheels.
- Position the jack under the power unit chassis.(1).
- Raise the drive wheel clear of the floor.

⚠ DANGER

Do not raise the truck more than necessary.

Only raise the wheel just clear of the floor.

- After jacking, block the truck securely.

Raising the load wheels

- Turn the keyswitch off, depress the emergency isolator and disconnect the battery.
- Position the jack under the load wheel leg.(2)
- Raise the load wheel clear of the floor.

⚠ DANGER

Do not raise the truck more than necessary.

Only raise the wheel just clear of the floor.

- After jacking, block the truck securely.

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Mast unit

Mast operation

The fork carriage rises up to the free lift height by means of the chain of the primary jack. The secondary lift jack lifts the inner mast. The inner mast is raised via the chain pulley at twice the speed. The secondary jack is fitted on the extensible middle mast.

Work on the mast and the reach frame part of the truck

⚠ DANGER

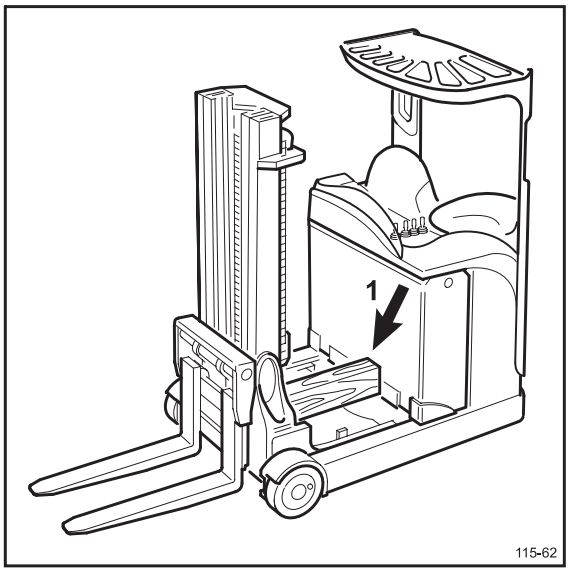
Before attempting repairs or adjustments on the reach frame, the raised fork carriage or mast, always ensure that the following safety procedures are carried out.

Securing the reach frame against reaching in or out

⚠ DANGER

Before work in front of or behind the reach frame, securing against reaching in or out is required.

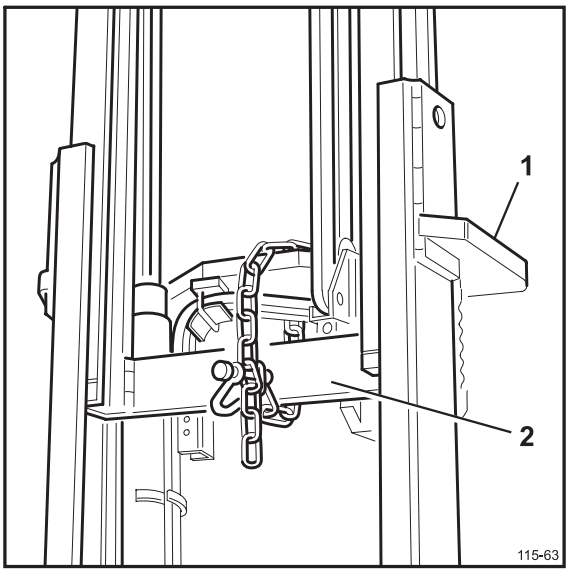
- Apply the parking brake.
- Lower the fork carriage fully.
- Reach the reach frame out.
- Insert a wood block (1) between the mast and the battery.
- Reach the frame back until it is stopped by the wood block.
- Switch off and remove the key.
- Disconnect the battery plug.



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Securing the mast

▷



- ➢ Raise the forks.
- ➢ Close the chain after passing it over the outer mast cross member (1) and under the centre mast cross member (2).
- ➢ Lower the mast until it comes into contact with the chain.
- ➢ Lower the fork carriage until it rests in the end stop.

Mast and lift carriage removal

⚠ DANGER

Removing the mast or lift carriage requires special knowledge and tools.

Mast or lift carriage removal must only be carried out by the trained personnel of your local distributor.

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Service plans - standard

50 h Service plan

At operating hours												Carried out	
First 50 hours												✓	✖
The following procedures should be carried out after the first 50 hours of operation.													
Before carrying out the procedures													
If necessary clean the truck													
Check for error codes using diagnostic software													
Reset the service interval using diagnostic software													
Undercarriage													
Check the condition and security of the wheels and tyres													
Controls													
Check all controls and their operation													
Hydraulic Installation													
Replace the hydraulic suction line filter													
Load lift system													
Lubricate the mast, lift chains and chain pulleys													
Lubricate the reach channels													
Lubricate the sideshift slider pad													
Lubricate the fork carriage													

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1000 h Service plan

At operating hours												Carried out	
1000		3000		7000		9000		11000		13000			
17000		19000										✓	✖
Depending on application, environmental conditions and driving style, the following procedures should be carried out at the intervals shown above.													
Before carrying out the procedures													
If necessary clean the truck													
Check for error codes using diagnostic software													
Reset the service interval using diagnostic software													
Motor													
Check the parking brake gap													
Chassis bodywork and fittings													
Check and lubricate the battery trolley slides and associated mechanism													
Check the condition of the side guide rollers (if fitted)													
Undercarriage													
Check the condition and security of the wheels and tyres													
Electrical/Electronic													
Check the condition of the battery and battery cables													
Check the condition and security of electrical connections and cables													
Hydraulic Installation													
Check the hydraulic hoses and pipes for damage													
Check the hydraulic fluid level													
Load lift system													
Check the lift chains for condition and security													
Lubricate the mast, lift chains and chain pulleys													
Lubricate the reach channels													
Lubricate the fork carriage													
Lubricate the sideshift slider pad													

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2000 h Service plan

At operating hours													
2000		4000		6000		8000		12000		14000		Carried out	
16000		18000										✓	✖
Depending on application, environmental conditions and driving style, the following procedures should be carried out at the intervals shown above.													
Before carrying out the procedures													
If necessary clean the truck													
Check for error codes using diagnostic software													
Reset the service interval using diagnostic software													
Motor													
Check the parking brake gap													
Chassis bodywork and fittings													
Check and lubricate the battery trolley slides and associated mechanism													
Check the condition of the side guide rollers (if fitted)													
Undercarriage													
Check the condition and security of the wheels and tyres													
Check the brake fluid level													
Check the load wheel brakes for wear													
Electrical/Electronic													
Check the condition of the battery and battery cables													
Check the condition and security of electrical connections and cables													
Hydraulic Installation													
Check the hydraulic hoses and pipes for damage													
Check the hydraulic fluid level													
Replace the hydraulic tank breather filter													
Load lift system													
Check the lift chains for condition and security													
Lubricate the mast, lift chains and chain pulleys													
Lubricate the reach channels													
Check the reach carriage rollers and adjust if necessary													
Lubricate the fork carriage													
Lubricate the sideshift slider pad													

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5000 h Service plan

At operating hours												Carried out	
5000		15000										✓	✖
Depending on application, environmental conditions and driving style, the following procedures should be carried out at the intervals shown above.													
Before carrying out the procedures													
If necessary clean the truck													
Check for error codes using diagnostic software													
Reset the service interval using diagnostic software													
Motor													
Check the parking brake gap													
Chassis bodywork and fittings													
Check and lubricate the battery trolley slides and associated mechanism													
Check the condition of the side guide rollers (if fitted)													
Undercarriage													
Check the condition and security of the wheels and tyres													
Grease the load wheel bearings													
Check the condition of the brake pipes													
Electrical/Electronic													
Check the condition of the battery and battery cables													
Check the condition and security of electrical connections and cables													
Hydraulic Installation													
Check the hydraulic hoses and pipes for damage													
Change the hydraulic fluid													
Replace the hydraulic suction line filter													
Load lift system													
Check the lift chains for condition and security													
Lubricate the mast, lift chains and chain pulleys													
Lubricate the reach channels													
Lubricate the fork carriage													
Lubricate the sideshift slider pad													

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10000 h Service plan

At operating hours												Carried out	
10000		20000										✓	✖
Depending on application, environmental conditions and driving style, the following procedures should be carried out at the intervals shown above.													
Before carrying out the procedures													
If necessary clean the truck													
Check for error codes using diagnostic software													
Reset the service interval using diagnostic software													
Motor													
Check the parking brake gap													
Chassis bodywork and fittings													
Check and lubricate the battery trolley slides and associated mechanism													
Check the condition of the side guide rollers (if fitted)													
Undercarriage													
Check the condition and security of the wheels and tyres													
Change the brake fluid (at least every 5 years)													
Check the condition of the brake pipes													
Check the load wheel brakes for wear													
Grease the load wheel bearings													
Electrical/Electronic													
Check the condition of the battery and battery cables													
Check the condition and security of electrical connections and cables													
Hydraulic Installation													
Check the hydraulic hoses and pipes for damage													
Change the hydraulic fluid													
Replace the hydraulic suction line filter													
Replace the hydraulic tank breather filter													
Load lift system													
Check the lift chains for condition and security													
Lubricate the mast, lift chains and chain pulleys													
Lubricate the reach channels													
Check the reach carriage rollers and adjust if necessary													
Lubricate the fork carriage													
Lubricate the sideshift slider pad													

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Service plans - cold store

50 h Service plan (cold store)

At operating hours												Carried out	
First 50 hours												✓	✖
The following procedures should be carried out after the first 50 hours of operation.													
Before carrying out the procedures													
If necessary clean the truck													
Check for error codes using diagnostic software													
Reset the service interval using diagnostic software													
Undercarriage													
Check the condition and security of the wheels and tyres													
Controls													
Check all controls and their operation													
Hydraulic Installation													
Replace the hydraulic suction line filter													
Load lift system													
Lubricate the mast, lift chains and chain pulleys													
Lubricate the mast rollers													
Lubricate the reach channels and reach carriage rollers													
Lubricate the sideshift slider pad													
Lubricate the fork carriage and fork carriage rollers													

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250 h Service plan (cold store 250 h to 6500 h)

At operating hours												Carried out	
250		500		750		1250		1500		1750			
2250		2750		3250		3500		3750		4250			
4500		4750		5250		5500		5750		6250			
6500												✓	✖
Depending on application, environmental conditions and driving style, the following procedures should be carried out at the intervals shown above.													
Before carrying out the procedures													
If necessary clean the truck													
Check for error codes using diagnostic software													
Reset the service interval using diagnostic software													
Motor													
Check the parking brake gap													
Chassis bodywork and fittings													
Check and lubricate the battery trolley slides and associated mechanism													
Lubricate the cabin hinges and door latch													
Check the condition of the side guide rollers (if fitted)													
Undercarriage													
Check the condition and security of the wheels and tyres													
Electrical/Electronic													
Check the condition of the battery and battery cables													
Check the condition and security of electrical connections and cables													
Hydraulic Installation													
Check the hydraulic hoses and pipes for damage													
Check the hydraulic fluid level													
Load lift system													
Check the lift chains for condition and security													
Lubricate the mast, mast rollers, lift chains and chain pulleys													
Lubricate the mast hose pulley assemblies													
Lubricate the reach channels and reach carriage rollers													
Lubricate the fork carriage and fork carriage rollers													
Lubricate the sideshift slider pad													

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250 h Service plan (cold store 6750 h to 13250 h)

At operating hours												Carried out	
6750		7250		7750		8250		8500		8750			
9250		9500		9750		10250		10500		10750			
11250		11500		11750		12250		12750		12750			
13250												✓	✖
Depending on application, environmental conditions and driving style, the following procedures should be carried out at the intervals shown above.													
Before carrying out the procedures													
If necessary clean the truck													
Check for error codes using diagnostic software													
Reset the service interval using diagnostic software													
Motor													
Check the parking brake gap													
Chassis bodywork and fittings													
Check and lubricate the battery trolley slides and associated mechanism													
Lubricate the cabin hinges and door latch													
Check the condition of the side guide rollers (if fitted)													
Undercarriage													
Check the condition and security of the wheels and tyres													
Electrical/Electronic													
Check the condition of the battery and battery cables													
Check the condition and security of electrical connections and cables													
Hydraulic Installation													
Check the hydraulic hoses and pipes for damage													
Check the hydraulic fluid level													
Load lift system													
Check the lift chains for condition and security													
Lubricate the mast, mast rollers, lift chains and chain pulleys													
Lubricate the mast hose pulley assemblies													
Lubricate the reach channels and reach carriage rollers													
Lubricate the fork carriage and fork carriage rollers													
Lubricate the sideshift slider pad													

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250 h Service plan (cold store 13500 h to 19750 h)

At operating hours												Carried out	
13500		13750		14250		14500		14750		15250			
15500		15750		16250		16500		16750		17250			
17750		18250		18500		18750		19250		19500			
19750												✓	✖
Depending on application, environmental conditions and driving style, the following procedures should be carried out at the intervals shown above.													
Before carrying out the procedures													
If necessary clean the truck													
Check for error codes using diagnostic software													
Reset the service interval using diagnostic software													
Motor													
Check the parking brake gap													
Chassis bodywork and fittings													
Check and lubricate the battery trolley slides and associated mechanism													
Lubricate the cabin hinges and door latch													
Check the condition of the side guide rollers (if fitted)													
Undercarriage													
Check the condition and security of the wheels and tyres													
Electrical/Electronic													
Check the condition of the battery and battery cables													
Check the condition and security of electrical connections and cables													
Hydraulic Installation													
Check the hydraulic hoses and pipes for damage													
Check the hydraulic fluid level													
Load lift system													
Check the lift chains for condition and security													
Lubricate the mast, mast rollers, lift chains and chain pulleys													
Lubricate the mast hose pulley assemblies													
Lubricate the reach channels and reach carriage rollers													
Lubricate the fork carriage and fork carriage rollers													
Lubricate the sideshift slider pad													

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1000 h Service plan (cold store)

At operating hours												Carried out	
1000		2000		3000		4000		6000		7000			
8000		9000		11000		12000		13000		14000			
16000		17000		18000		19000						✓	✖
Depending on application, environmental conditions and driving style, the following procedures should be carried out at the intervals shown above.													
Before carrying out the procedures													
If necessary clean the truck													
Check for error codes using diagnostic software													
Reset the service interval using diagnostic software													
Motor													
Check the parking brake gap													
Chassis bodywork and fittings													
Check and lubricate the battery trolley slides and associated mechanism													
Lubricate the cabin hinges and door latch													
Check the condition of the side guide rollers (if fitted)													
Undercarriage													
Check the condition and security of the wheels and tyres													
Check the brake fluid level													
Check the load wheel brakes for wear													
Electrical/Electronic													
Check the condition of the battery and battery cables													
Check the condition and security of electrical connections and cables													
Hydraulic Installation													
Check the hydraulic hoses and pipes for damage													
Check the hydraulic fluid level													
Replace the hydraulic tank breather filter													
Load lift system													
Check the lift chains for condition and security													
Lubricate the mast, mast rollers, lift chains and chain pulleys													
Lubricate the mast hose pulley assemblies													
Lubricate the reach channels and reach carriage rollers													
Check the reach carriage rollers and adjust if necessary													
Lubricate the fork carriage and fork carriage rollers													
Lubricate the sideshift slider pad													

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2500 h Service plan (cold store)

At operating hours												Carried out	
2500		7500		12500		17500						✓	✖
Depending on application, environmental conditions and driving style, the following procedures should be carried out at the intervals shown above.													
Before carrying out the procedures													
If necessary clean the truck													
Check for error codes using diagnostic software													
Reset the service interval using diagnostic software													
Motor													
Check the parking brake gap													
Chassis bodywork and fittings													
Check and lubricate the battery trolley slides and associated mechanism													
Lubricate the cabin hinges and door latch													
Check the condition of the side guide rollers (if fitted)													
Undercarriage													
Check the condition and security of the wheels and tyres													
Grease the load wheel bearings													
Check the condition of the brake pipes													
Electrical/Electronic													
Check the condition of the battery and battery cables													
Check the condition and security of electrical connections and cables													
Hydraulic Installation													
Check the hydraulic hoses and pipes for damage													
Change the hydraulic fluid													
Replace the hydraulic suction line filter													
Load lift system													
Check the lift chains for condition and security													
Lubricate the mast, mast rollers, lift chains and chain pulleys													
Lubricate the mast hose pulley assemblies													
Lubricate the reach channels and reach carriage rollers													
Lubricate the fork carriage and fork carriage rollers													
Lubricate the sideshift slider pad													

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5000 h Service plan (cold store)

At operating hours												Carried out	
5000		10000		15000		20000						✓	✖
Depending on application, environmental conditions and driving style, the following procedures should be carried out at the intervals shown above.													
Before carrying out the procedures													
If necessary clean the truck													
Check for error codes using diagnostic software													
Reset the service interval using diagnostic software													
Motor													
Check the parking brake gap													
Chassis bodywork and fittings													
Check and lubricate the battery trolley slides and associated mechanism													
Lubricate the cabin hinges and door latch													
Check the condition of the side guide rollers (if fitted)													
Undercarriage													
Check the condition and security of the wheels and tyres													
Change the brake fluid													
Check the load wheel brakes for wear													
Grease the load wheel bearings													
Check the condition of the brake pipes													
Electrical/Electronic													
Check the condition of the battery and battery cables													
Check the condition and security of electrical connections and cables													
Hydraulic Installation													
Check the hydraulic hoses and pipes for damage													
Change the hydraulic fluid													
Replace the hydraulic suction line filter													
Replace the hydraulic tank breather filter													
Load lift system													
Check the lift chains for condition and security													
Lubricate the mast, mast rollers, lift chains and chain pulleys													
Lubricate the mast hose pulley assemblies													
Lubricate the reach channels and reach carriage rollers													
Check the reach carriage rollers and adjust if necessary													
Lubricate the fork carriage and fork carriage rollers													
Lubricate the sideshift slider pad													

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Recommended 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 and IN - OUT)

Anti wear hydraulic oil
Grade ISO VG 22-32
Viscosity index ≥ 300
e.g Shell Tellus Arctic 32

NOTE

The above 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)

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

Steering drive gears

Multi purpose grease containing 5% Molybdenum Disulphide
Trucks manufactured prior to serial number G1X115U52000
Shell Aeroshell 17 (No longer available)
Trucks manufactured after serial number G1X115U52000
Shell Aeroshell 33MS

⚠ CAUTION

The two grease type are not compatible, and must not be mixed.

If in doubt as to the type of grease applied to the drive gears, then all traces of the existing grease must be removed before applying Aeroshell 33MS

General purpose oil

Engine Oil SAE 20W/50

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Chain Spray

STANDARD

Chain spray

COLD STORE

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.

NOTE

For any further information, we recommend that you contact your local distributor.

Non standard torques

Section 2 - Axles

APPLICATION	DESCRIPTION	TORQUE	REMARKS
Gearbox mounting plate	Hex head M20 x 60 - 12.9 Durlock	700 Nm	
Pinion gear to traction motor	M20 x 1 Slotted ring nut	55 Nm	
Drive wheel nut to gearbox	M14 Spherical nut	195 Nm	

Section 3- Chassis, bodywork and fittings

APPLICATION	DESCRIPTION	TORQUE	REMARKS
Battery carrier buffer	M5 x 15 Countersunk	4 Nm	Apply Loctite 243 or 248 Theadlocker stick

Section 4 - Undercarriage

APPLICATION	DESCRIPTION	TORQUE	REMARKS
Load wheel locknut (R 14 and R 16)	M40 Slotted Locknut	See remarks	Tighten to 50 Nm, slacken off, re-tighten to 12 Nm. Turn clockwise to nearest tab on the washer
Load wheel locknut (R 20)	M45 Slotted Locknut	See remarks	Tighten to 50 Nm, slacken off, re-tighten to 20 Nm. Turn clockwise to nearest tab on the washer
Load wheel backplate to stub axle (R14 and R 16)	M 8 x 12 - 10.9	35 Nm	Unlubricated

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APPLICATION	DESCRIPTION	TORQUE	REMARKS
Load wheel backplate to stub axle (R 20)	M 8 x 16 - -10.9	35 Nm	Unlubricated
All brake pipes	M10 x 10	10Nm	

Section 5- Controls

APPLICATION	DESCRIPTION	TORQUE	REMARKS
Clamp on brake and accelerator pedals	M6 x 30	10 Nm (Standard torque)	Apply Loctite 243 or 248 Theadlocker stick

Section 6- Electrical installation

APPLICATION	DESCRIPTION	TORQUE	REMARKS
Heavy cables to motor terminals	M8 full nut	16 Nm	
Heavy cables to motor terminal	M5 full nut	2-3 Nm	
Traction limit switch to truck fixing screws	M4 x 30 Hex head	1.5 Nm	
Traction limit switch - lever fixing screw	Part of switch	0.5 Nm	Adjusted to suit application
Traction limit switch - top actuator fixing screws	Part of switch	0.5 Nm	Not normally removed
Traction limit switch - cable gland to switch	M20 gland nut	1-2 Nm	The cable gland should be fitted and tightened onto the cable **BEFORE** the gland is tightened into the switch body.
Power module heatsink to chassis	M8 x 50/55	25-35 Nm	SEMIKRON Data sheet
Power module connections	M5 full nut	2-3 Nm	SEMIKRON Data sheet
Power module connections	M8 full nut / M8 special nut	8-10 Nm	SEMIKRON Data sheet
Contactor terminations	M8 full nut	2-3 Nm	ALBRIGHT Data sheet
Emergency isolator terminations	M8	12 Nm	REMA Data sheet
Emergency isolator terminations	M8	12 Nm	ALBRIGHT Data sheet
Emergency isolator fixings	M5	3 Nm	REMA Data sheet
Fuse assembly brass nuts	M10	19.6 Nm	

Section 7- Hydraulic installation

APPLICATION	DESCRIPTION	TORQUE	REMARKS
Lift pump to motor (BOSCH)	M10 x 100 - 10.9 Cap head	55-58 Nm	
Valve to reach frame	M8 x 20 Hex head screw	12 Nm	

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APPLICATION	DESCRIPTION	TORQUE	REMARKS
Primary to secondary cylinder pipe assembly	'28L' M36 x 2	140 Nm	
Lift cylinder bleed screws	M6 x 6 Hex head (Cap head on R 20)	10 Nm	
Hydraulic tank fixings to chassis	M8 x 16 Hex head (Plain washer A8.4)	8 Nm	Apply Loctite 243 or 248 Theadlocker stick
HOSE ASSEMBLIES			
Lift cylinder and hydraulic pump	M22 x 1.5	45-50 Nm	
Hydraulic tank	3/4'' BSP	70-80 Nm	
Bottom of lift cylinder	M36 x 2	140 Nm	
Reach cylinders	M18 x 1.5	27-32 Nm	
Additional hydraulics	3/8'' BSP	40 Nm	
HYDRAULIC VALVE FITTINGS			
Lift cylinder and hydraulic pump	M22 x 1.5	16-18 Nm	
Hydraulic tank	M27 x 2.0	60 Nm	
Reach cylinders	M16 x 1.5	39-45 Nm	
Additional hydraulics	M14 x 1.5	33-38 Nm	

Section 8 - Load lift system

APPLICATION	DESCRIPTION	TORQUE	REMARKS
Sideshift wear plate to fork carriage	M6 x 12 Hex head screw	10 Nm (Standard torque)	Apply Loctite 243 or 248 Theadlocker stick
Mast to reach carriage - bottom fixing	M20 x 80 Durlock	600 Nm	183/186 mast on R 20 1400 and 1600 mm chassis
Mast to reach carriage - pivot fixing	M12 x 25 - 10.9 Cap head	90 Nm	183/186 mast on R 20 1400 and 1600 mm chassis
Reach leg stop screws	M12 x 30 Socket head screw	50 Nm	
Eccentric roller shafts	M20 thin hex head	240 Nm	Non cold store
Eccentric roller shafts	M24 thin hex head	429 Nm	Cold store
Non-metallic bump stops to chassis	M12 x 25 thin cap head screw	40 Nm	Apply Loctite 243 or 248 Theadlocker stick
Chain anchor nut (prevailing torque to run up the thread)	M20	54 Nm Maximum	
Chain anchor nut with half nut	M20	100 Nm	
Free lift slow down screw (186/187 only)	M12 x 30 hex head	50 Nm	
Height indicator toothed belt clamp	M6 x 16 socket head screw / M6 Nyloc	2-3 Nm	

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Additional for Compact version

APPLICATION	DESCRIPTION	TORQUE	REMARKS
Tilt cylinders to mast backplate	M14 x 80 Socket head	235 Nm (Standard torque)	
Mast to mast backplate	M27 x 110 Socket head M27 x 120 Socket head M27 nut	930 Nm 930 Nm 930 Nm	
Mast pivot to reach carriage	M16 x 70 Socket head	275 Nm	
Tilt cylinder pinch bolt	M14 x 80 Socket head	46 Nm	

Additional for tough terrain version

APPLICATION	DESCRIPTION	TORQUE	REMARKS
Mast pivot to reach carriage	M12 x 30 Socket head	90 Nm	
Load wheel lock nut to stub axle	M45 Slotted Locknut	See remarks	Tighten to 50 Nm, slacken off, re-tighten to 20 Nm. Turn clockwise to nearest tab on the washer
Load wheel bolts	M14 x 24 Hexagon head spherical - 10.9	195 Nm	
Drive wheel bolts	M14 x 24 Hexagon head spherical - 10.9	195 Nm	
Bump stops - plastic	M16 x 75 Hexagon head	40 Nm	
Bump stops - metal	M16 x 75 Hexagon head	195 Nm	
Rubber compression spring mounting bracket	M12 x 35 Hexagon head	80 Nm	
Rubber compression spring centre screw	M24 x 215 Hexagon head	300 Mn	
Load wheel backplate to stub axle	M8 x 16 Hexagon head	35 Nm	

Special tools

Section 0 - Diagnostics

Description	Part Number
Can box	390 360 51 12
Truck adaptor cable	390 382 01 01
Notebook to CAN box serial cable	390 382 01 00

Section 1 - Motor

Description	Part Number
Emergency steering tool	002 941 80 16

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Section 4 - Undercarriage

Description	Part Number
Load wheel nut removal/refitting tool	
(1.4 and 1.6 tonne)	002 941 80 01
(2.0 tonne)	002 941 80 08

Section 6- Electric/electronic

Description	Part Number
AMP-SAAB Connector crimping pliers	350 509 00 30
AMP-SAAB Pin extraction tool (large pins)	350 985 30 02
AMP-SAAB Pin extraction tool (small pins)	350 985 30 02

Section 7- Hydraulic installation

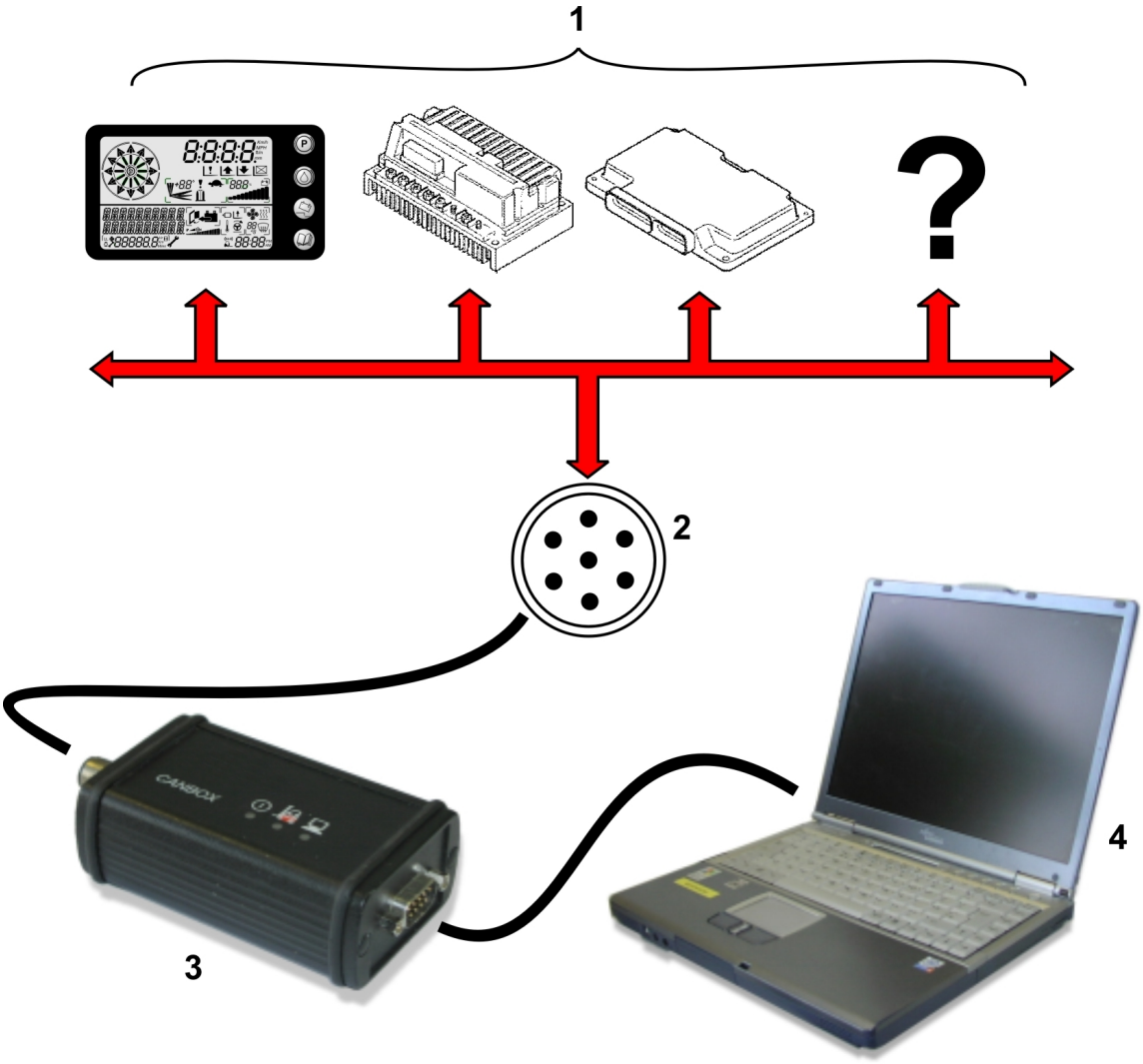
Description	Part Number
Special spanner for tank hose to hydraulic block	002 941 80 18
Return to tank hose plug	000 952 40 24

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Diagnostics

Overview

CAN bus connection



Truck fault diagnosis and parameter changes are carried out using a Notebook with a registered copy of the diagnostic software installed. Additionally, the appropriate 'ServiceBase' for the truck being diagnosed must also be installed on the Notebook.

The Notebook (4) is connected via the Canbox (3) to the truck's diagnostic port (2).

From the diagnostic port (2) there is a connection to various controllers (1) via the CAN bus.

Depending on the type of CAN box used (serial or USB), the connection to the Notebook can be made using a Sub-D plug or USB cable. Regardless of cable type, diagnostic options are identical.

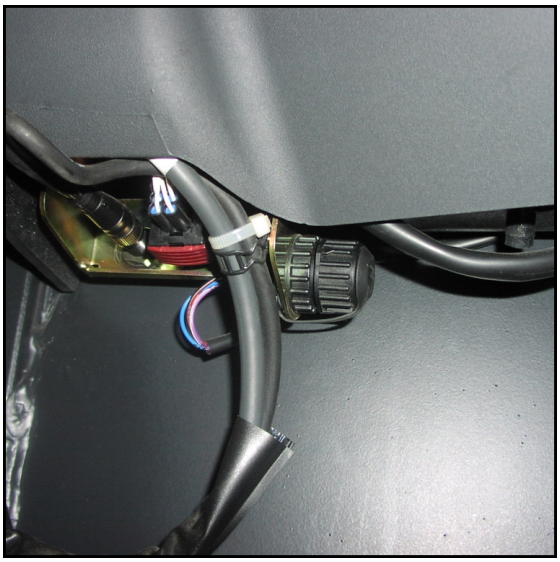
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Diagnostic connector

The diagnostic connector is beneath the steering binnacle.

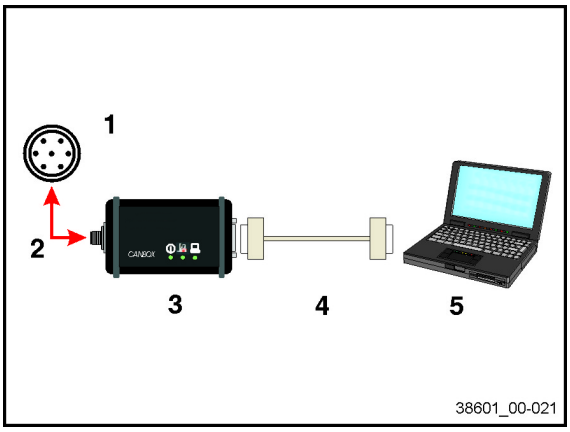
NOTE

After completing diagnostics, the cap must be screwed back on the diagnostic connector to prevent the ingress of moisture.



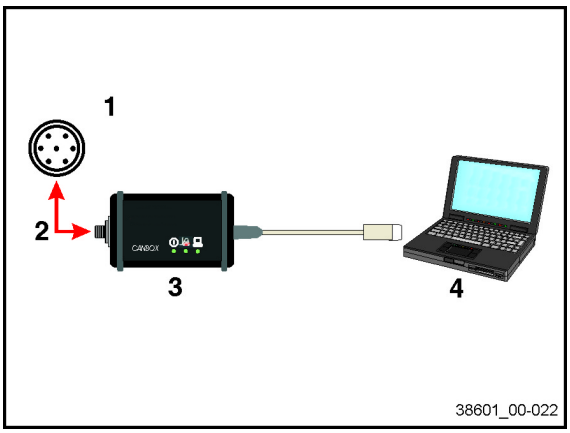
Canbox Serial - Notebook Serial

The serial interface of the notebook (5) is connected via the connecting cable (4) to the Canbox Serial (3) . The connecting cable (2) is inserted between the Canbox (3) and the truck's diagnostic connector (1) .



Canbox USB - Notebook USB

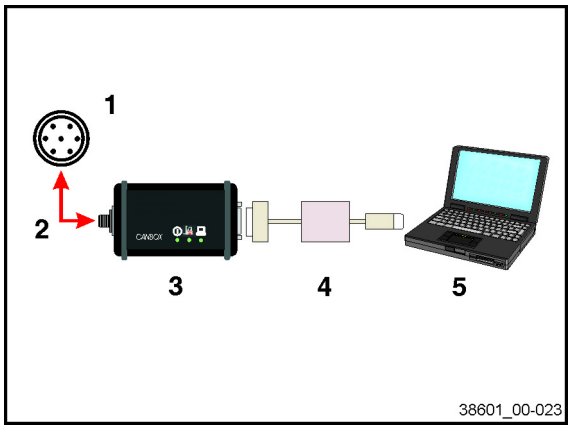
The USB interface of the notebook (4) is connected to Canbox USB (3) . The connecting cable (2) is inserted between the Canbox (3) and the truck's diagnostic connector (1) .



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Canbox Serial - Notebook USB

The USB interface of the notebook (5) is connected to the USB plug of the interface adapter (4). The Canbox Serial (3) is connected to the serial connection of the interface adapter(4). The connecting cable (2) is inserted between the Canbox (3) and the truck's diagnostic connector (1).



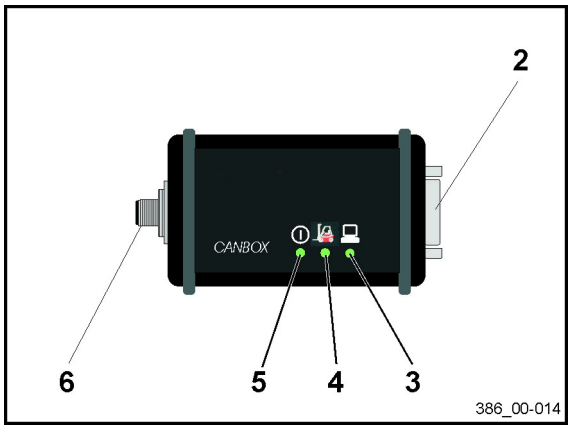
Canbox

The Canbox is required for truck diagnostics. The Canbox provides access to the individual controls of the truck via the CAN bus of the diagnostic connector.

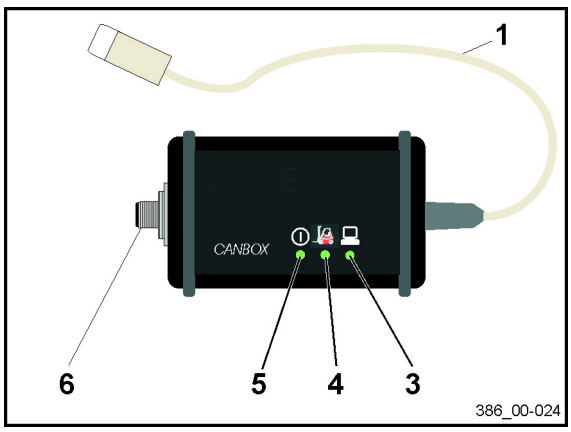
The Canbox contains a computer with relevant software that controls the communications between the diagnostic notebook and the individual controls .

The Canbox is available in two different versions:

- Serial Canbox
- USB Canbox



On its left-hand side the Canbox has a 4-pin round plug (6), which is connected to the diagnostic connector of the truck. On its right-hand side it either has a 9-pin Sub-D plug (2) or a USB cable (1), to which the diagnostic notebook is connected.



Three LEDs indicate the communication state of the Canbox:

- LED (5) lights up as soon as the Canbox is supplied with power via the diagnostic connector when the truck is switched on.
- LED (4) lights up as soon as data is transmitted from the truck to the diagnostic notebook.
- LED (3) lights up as soon as data is transmitted from the diagnostic notebook to the truck.

On the left-hand side there is a "Reset button" to restart the Canbox. The Canbox software is stored on a flash EEPROM so that software updates are possible as required.

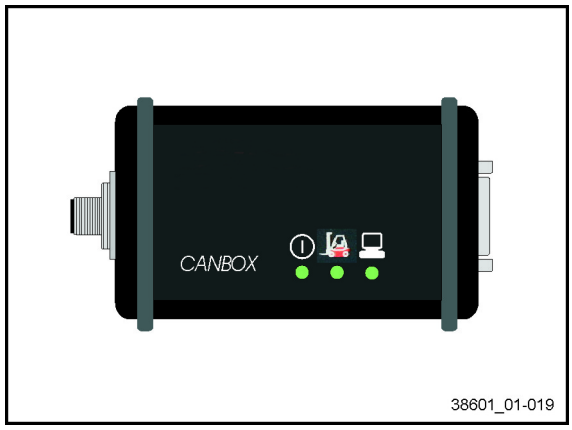
NOTE

To operate the Canbox USB the appropriate driver must be installed on the diagnostic notebook.

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A CD with the driver is included with the Canbox USB.

Software update for Canbox



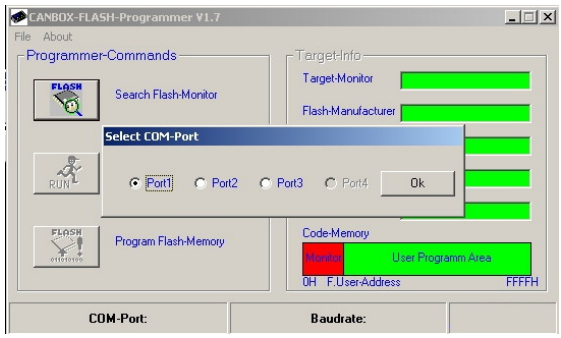
For a software update of the Canbox the Flash program "Canbox Flash Programmer" and the software for the Canbox are required. Both programs can be retrieved from the Download area on the Extranet.

The zipped file "FlashProgrammer.zip" contains the program for programming the Canbox. The software for the Canbox is named "V2_20.zip", for example.

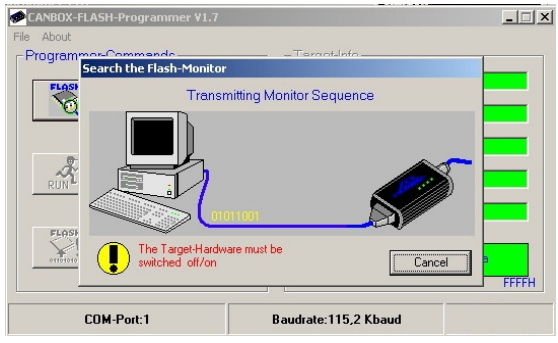
NOTE

The version number for the Flash program and the software for the Canbox may change. The version numbers e.g. V2_20.zip are just examples. The latest version is always available on the Extranet.

- Unzip zipped file "FlashProgrammer.zip" to folder C:/temp .
- Install Flash program by starting "Setup.exe".
- Unzip zipped file e.g. "V2_20.zip" to folder C:/temp .
- Move file "e.g. V2_20.bin" from "C:/temp" to folder "Canbox Flash Programmer".
- Connect Canbox to notebook and truck.
- Start Flash program.
- Select interface COM 1.



- Switch key switch of truck off and back on or press Reset button on Canbox.

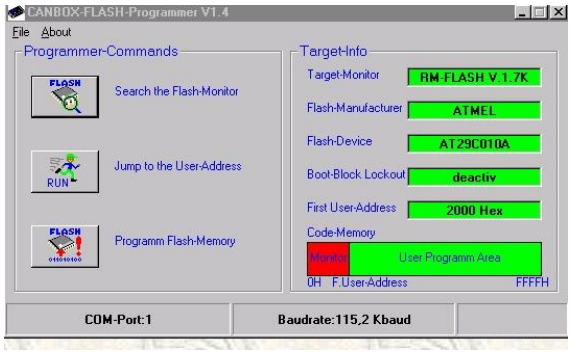


As soon as the Flash program has established the connection to the Canbox, the connection screen is closed.

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➢ Click on the Program Flash Memory button.

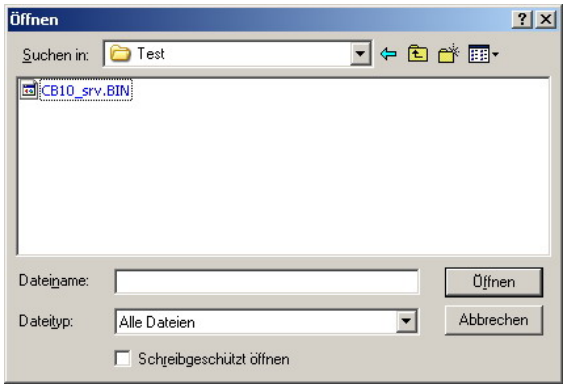
▷



➢ Select software for Canbox, e.g. "CB10_srv.BIN"

➢ Click on the Open button.

▷

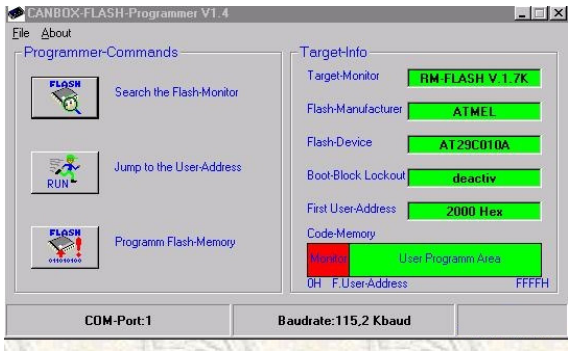


Updating of the Canbox software starts. The user is then asked whether the programming process should be checked.

➢ Confirm checking of programming process.

➢ Click on the Jump to User Address button.

▷



Programming of the Canbox has now been completed.

➢ Label Canbox with current spare part number and version number.

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Traction diagnostic codes

The codes are divided into three groups according to the effect on the truck as follows:

Information	Codes 1 to 99
Warning	Codes 100 to 199
Faults	Codes 200 to 999

Information:

Information codes represent current interlock status rather than faults. Information codes are not stored in the controller code history.

Warning:

A warning code is generated during normal operation, and does not influence the function of the truck. Warning codes are stored in the controller code history.

Fault:

A fault code will influence the function of the truck. Depending on the severity of the fault, reduced performance or shut down may result. Fault codes are stored in the controller code history.

TRACTION INFORMATION CODES	
1	Boot conditions not met
2	Accelerator in neutral position
4	Seat switch not operated
5	Left foot switch not operated
6	Battery access door open
7	Motor temperature too high
8	Parking brake applied
9	Footbrake operated
10	No Direction Selected (single pedal only)
11	Speed override input is released
12	Code Entry Keypad fitted and Learner Driver set
13	Code Entry Keypad fitted and code not entered
14	UPA Slow traction when reach extended
15	Battery Voltage dropped below 35V during Traction
16	One or both sensors monitoring the battery latches is off. One or both latch(es) has dropped
17	External battery connected. The auxiliary power cable is being used
19	At least one parameter is not taught or taught incorrectly
20	Cab is disabling traction

TRACTION WARNING CODES	
121	Brake: gap >= 0.60mm
128	Emergency isolator operated
130	Accelerator operated without seat occupied
139	Power circuit voltage <30V (battery discharged or battery impedance too high)
140	Power circuit voltage >65.5V while driving (battery impedance too high)

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TRACTION WARNING CODES	
150	Steering controller not sending CAN information.
158	The Traction MOSFETs are too hot

TRACTION FAULT CODES	
219	Code pin input incompatible (module fitted to wrong truck type)
220	Bad Configuration (360° with twin pedal)
222	Safety brake error - Jammed
223	Safety brake error - Short Circuit
224	Safety brake error - Open Circuit
225	Safety brake error - Drive Error
226	Motor Temperature error
227	MOSFET temperature error
231	Accelerator signals 1 & 2 incompatible
232	Accelerator signal 1 out of range (+-2V)
233	Accelerator pot supply over 5.5V
234	Accelerator pot supply under 4.5V
235	Invalid combination of directional lever signals
236	Steering angle error
237	Steering angle does not correspond with 180° configuration
240	Steering angle error (calibration values)
238	Power circuit voltage >65V shortly after power-up
241	Safety signal from steering is off.
242	Steering direction is incorrect
243	Safety relay contact does not close
244	Safety relay contact welded. When the relay is not activated, the voltage on it's contact is too high
245	LAC power can not reach 40V during charging
246	K1 wiring error
248	K1 contact does not close or high impedance contact
249	K1 contact welded
259	EEPROM read error. Possible corruption of Accelerator teach value
260	Enable signal via wiring from LAC is not present
261	Enable signal via CAN from LAC is not present
262	One or more CAN signals from Lift LAC not present
265	Defective Safety signal from steering (short circuit to ground) The safety signal from the steering should be cut off (24 V) during the first 3 seconds after switch on and the LDC checks it for the 1st 2s. This did not occur
270	Phase monitor error. The 3 motor phase connections are monitored by the LDC-51 where the motor torque is calculated. If this calculated torque rises above the requested torque during driving then this error is generated. This provides a basic functionality test of the LAC
299	Controller not tested. The tested code is missing from the memory of the LDC-51. This module therefore appears to be not tested
471	Safety controller has cut out the traction function because of a detected error.
481	Safety controller has slowed traction function because of a detected error.

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Hydraulic diagnostic codes

The codes are divided into three groups according to the effect on the truck as follows:

Information	Codes 1 to 99
Warning	Codes 100 to 199
Faults	Codes 200 to 999

Information:

Information codes represent current interlock status rather than faults. Information codes are not stored in the controller code history.

Warning:

A warning code is generated during normal operation, and does not influence the function of the truck. Warning codes are stored in the controller code history.

Fault:

A fault code will influence the function of the truck. Depending on the severity of the fault, reduced performance or shut down may result. Fault codes are stored in the controller code history.

HYDRAULIC INFORMATION CODES	
1	Boot condition not satisfied
2	Boot condition not satisfied. One or more joystick(s) is/are not in the neutral position after POWER ON
4	The seat switch is not operated
5	Slow signal (from CAN height)
6	Stop signal (from CAN height)
7	Excessive motor temperature - Lift speed reduction
9	Reach back inhibited. Used either for "fork park" or for a UPA version of the module, a "Reach Back Inhibit" exists when the forks are below a certain height
10	Lift inhibited (pin 102)
11	Battery discharge indicator cut-out active (lift speed affected)
12	Special interlocks apply (UPA 2 & 3)
15	Battery approaching low (torque limitation active)
16	Lift in calibrate mode
17	The reach limit(s) are not programmed, reach in calibrate mode
18	There was no valve detected during the POWER ON checks. (assume no mast and therefore no pump)
20	Battery unlatched - lift lower interlocks apply (no lower / slow lift)

HYDRAULIC WARNING CODES	
119	The calibration value for the joysticks has been corrupted
120	Lift valve open circuit.
121	Lower valve open circuit
122	Control valve open circuit
123	Select valve open circuit

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HYDRAULIC WARNING CODES	
124	5th hydraulics valve open circuit
126	6th hydraulics valve open circuit
127	Pump dump or maximum lower valve open circuit

HYDRAULIC FAULT CODES	
219	Codepin input incompatible - module fitted to wrong truck type
220	Error detected during loading of data from EEPROM Will normally be accompanied by a parameter or calibration resetting to default or calibration mode
226	The lift motor temperature sensor is giving an incorrect signal
227	The MOSFET temperature sensor is giving an incorrect signal
228	The lift MOSFETs are too hot
230	Lift/lower MOSFET short circuit
231	Reach MOSFET short circuit
232	Tilt MOSFET short circuit
233	Sideshift MOSFET short circuit
234	Vsen rail > 5.5V or < 4.5V
235	Lift/Lower valve overcurrent
236	Reach valve overcurrent
237	Tilt valve overcurrent
238	Sideshift valve overcurrent
239	Battery voltage <30V
240	The two signals from the lift joystick do not correspond
241	The two signals from the reach joystick do not correspond
242	The two signals from the tilt joystick do not correspond
243	The two signals from the sideshift joystick do not correspond
244	The two signals from the 5th hydraulic joystick do not correspond
245	The two signals from the 6th hydraulic joystick do not correspond
246	One or both of the signals from the lift joystick are outside the permitted range and the value suggests a cable fault.
247	One or both of the signals from the reach joystick are outside the permitted range and the value suggests a cable fault.
248	One or both of the signals from the tilt joystick are outside the permitted range and the value suggests a cable fault.
249	One or both of the signals from the sideshift joystick are outside the permitted range and the value suggests a cable fault.
250	One or both of the signals from the 5th hydraulic joystick are outside the permitted range and the value suggests a cable fault.
251	One or both of the signals from the 6th hydraulic joystick are outside the permitted range and the value suggests a cable fault.
252	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.
253	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.
254	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.
255	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.

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HYDRAULIC FAULT CODES	
256	One or both of the signals from the 5th hydraulic joystick are outside the permitted range and the value suggests a defective joystick or faulty connection.
257	One or both of the signals from the 6th hydraulic joystick are outside the permitted range and the value suggests a defective joystick or faulty connection.
258	5th / 6th MOSFET short circuit
259	Aux 1 / Aux 2 MOSFET short circuit
260	Enable signal via wiring from LAC is not present
261	Enable signal via CAN from LAC is not present
262	One or more CAN signals from the Lift LAC are not present
263	Invalid reach limit stored value
264	The truck has previously been turned off whilst above the reference sensor for the LHI/LPS.
265	Joystick safety check inactive due to internal safety controller error
266	Aux 1 / Aux 2 valve overcurrent
267	5th / 6th valve overcurrent
268	External current path on valve or valve open circuit.
269	Safety relay contact welded at power up
270	Safety relay contact stuck open at power up
271	Safety relay contact stuck closed at power up
272	Safety relay contact welded during use
273	Battery voltage during power up is out of range
274	Lock valve driver MOS short circuit
275	Lock valve load short circuit (over current)
276	Lock valve load open circuit no current)
299	Controller not tested The tested code is missing from the memory of the LDC-51. This module therefore appears to be not tested
470	Safety controller error - proportional valve current comparisons
471	Safety controller error - peripheral tests
472	Safety controller error - joystick comparisons
474	Safety controller error - function operation tests. valve being operated without joystick requesting
477	Safety controller error - No version number, communications failure between main and safety controllers
478	Safety controller error - lift motor RPM tests

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Steering diagnostic codes

The codes are divided into two groups according to the effect on the truck as follows:

Warning	Codes 100 to 199
Faults	Codes 200 to 999

Warning:

A warning code is generated during normal operation, and does not influence the function of the truck. Warning codes are stored in the controller code history.

Fault:

A fault code will influence the function of the truck. Depending on the severity of the fault, reduced performance or shut down may result. Fault codes are stored in the controller code history.

STEERING WARNING CODES	
100	Calibration of new device not completed, incorrect parameters from EEPROM
106	CAN message cannot be sent
112	Error in the EEPROM or incomplete saving
118	Miscellaneous, there was for example an unknown service starting
124	The input current at the output for the steering-wheel brake is too high
131	Parameter 0x33 has an invalid value

STEERING FAULT CODES	
200	Software is not suitable for the hardware version
201	Reset by PWD stop() triggered. Monitoring Watchdog triggered.
202	Stack overflow
203	Stack underflow
204	Undefined operations code
205	Protected Instruction Fault
206	Illegal Word Operand Access
207	Illegal Instruction Access
208	Illegal External Bus Access
209	Computer Link-up error
214	Raster overflow 1ms
215	Raster overflow 2ms
216	Raster overflow 4ms
217	Raster overflow 8ms
218	Raster overflow 16ms
223	Error during writing in the EEPROM
224	Error during the reading of the EEPROM
225	Check-sum error in the EEPROM
228	Error in the standardisations parameter
229	Parameter error
234	Timeout when receiving the CAN-message from the truck control unit
239	The 15V supply voltage is over/under rated (via A/D)

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240	Over/under rated voltage of the referenced 2.5V in the SNT (Via A/D)
241	Supply voltage is over rated (Battery)
246	Temperature rise at the output stage
247	Current too high at output stage
248	Offset error, phase U (L1) current sensor too high
249	The offset error for the current sensor phase W (L3) is to large
250	missing translation
251	The current sensor values when compared with the actual current are incorrect
252	Measured phase resistance is too high - phase outline motor phase
253	Measured phase resistance is too low - short-circuited
254	Comparison with inverse value
255	Alignment between the motor and sensor position not possible
256	Sensor error when starting the step-motor
257	Build-up error. Initialization time for the machine is too long
258	Machine start error
263	Motor model calculation error
264	Machine start error
265	Feedback control error
270	Wire break in the drive unit's potentiometer
271	Wire break in the steering wheel potentiometer
272	Steering wheel potentiometer overcurrent
273	Wire break in the drive unit's potentiometer
274	Drive unit potentiometer overcurrent
275	Drive unit sensor potentiometer error
276	Steering angle sensor potentiometer error
277	Drive unit potentiometer error
278	Steering angle sensor error
279	Error between what the drive unit potentiometer reads and its actual position
280	Incremental meters (HR/KR) are incorrect
281	Incorrect calibration/calibration value of the drive unit potentiometer
282	Incorrect calibration/calibration value of the steering wheel potentiometer
288	Teach in steering wheel general/timeout
289	Teach in drive unit general/timeout
294	Drive unit neutral position, Timeout when starting straightforward
295	Drive unit neutral position, Timeout when searching for the flank of the proximity sensor
296	Drive unit neutral position, unknown error

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Display diagnostic codes

The codes are divided into three groups according to the effect on the truck as follows:

Information	Codes 1 to 99
Warning	Codes 100 to 199
Faults	Codes 200 to 999

Information:

Information codes represent current interlock status rather than faults. Information codes are not stored in the controller code history.

Warning:

A warning code is generated during normal operation, and does not influence the function of the truck. Warning codes are stored in the controller code history.

Fault:

A fault code will influence the function of the truck. Depending on the severity of the fault, reduced performance or shut down may result. Fault codes are stored in the controller code history.

DISPLAY INFORMATION CODES	
1	Height Under-range
2	Height Over-range

DISPLAY WARNING CODES	
110-113	Hour meter corruption
140	Illegal brake operation count too high
190	CAN frame missing from LDC
191	CAN frame missing from LLC
192	CAN frame missing from LES

DISPLAY FAULT CODES	
223	Missing quadrature signal from height encoder
224	Fork height is below reference height for half-mast encoder
225	A reference signal was detected whilst already referenced
230	Battery voltage input was not calibrated in production test or is outside the allowable range or has been corrupted
242	Keyswitch input voltage too high (>15V)
250	A stored shelf height is corrupt

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LAC - Traction diagnostic codes

The codes are divided into three groups according to the effect on the truck as follows:

Information	Codes 1 to 99
Warning	Codes 100 to 199
Faults	Codes 200 to 999

Information:

Information codes represent current interlock status rather than faults. Information codes are not stored in the controller code history.

Warning:

A warning code is generated during normal operation, and does not influence the function of the truck. Warning codes are stored in the controller code history.

Fault:

A fault code will influence the function of the truck. Depending on the severity of the fault, reduced performance or shut down may result. Fault codes are stored in the controller code history.

LAC - TRACTION INFORMATION CODES	
1	No hardware enable input (1X17:11) for traction
2	No enable via CAN for traction
5	No PWM for traction requested
18	No PWM
40	No hardware feedback (1X17:12)
50	ECU in passive mode
51	Restricted communication with traction controller
52	Variant is not valid or not released

LAC - TRACTION WARNING CODES	
100	Faulty chip-temperature sensor (exceeds -30°C...200°C)

LAC - TRACTION FAULT CODES	
801	Offset-correction current-sensor Phase U exceeds UPPER limit
802	Offset-correction current-sensor Phase U exceeds LOWER limit
803	Offset-correction current-sensor Phase W exceeds UPPER limit
804	Offset-correction current-sensor Phase W exceeds LOWER limit
810	Speed sensor error
813	Temperature in power unit for traction > 100°C
820	Permanent driver error in power unit for traction (over current or under voltage on 13 V supply).
821	Driver error in power unit for traction (over current or under voltage on 13 V supply)
855	Battery voltage (capacitor voltage) too high
860	13V supply exceeds higher limit
861	13V supply exceeds lower limit

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LAC - Hydraulic diagnostic codes

The codes are divided into three groups according to the effect on the truck as follows:

Information	Codes 1 to 99
Warning	Codes 100 to 199
Faults	Codes 200 to 999

Information:

Information codes represent current interlock status rather than faults. Information codes are not stored in the controller code history.

Warning:

A warning code is generated during normal operation, and does not influence the function of the truck. Warning codes are stored in the controller code history.

Fault:

A fault code will influence the function of the truck. Depending on the severity of the fault, reduced performance or shut down may result. Fault codes are stored in the controller code history.

LAC - HYDRAULIC INFORMATION CODES	
1	No hardware enable input (2X37:11) for hydraulics
2	No enable via CAN for hydraulics
5	No PWM for hydraulics requested
18	No PWM
40	No hardware feedback (1X37:12)
50	ECU in passive mode
51	Restricted communication with hydraulic controller
52	Variant is not valid or not released

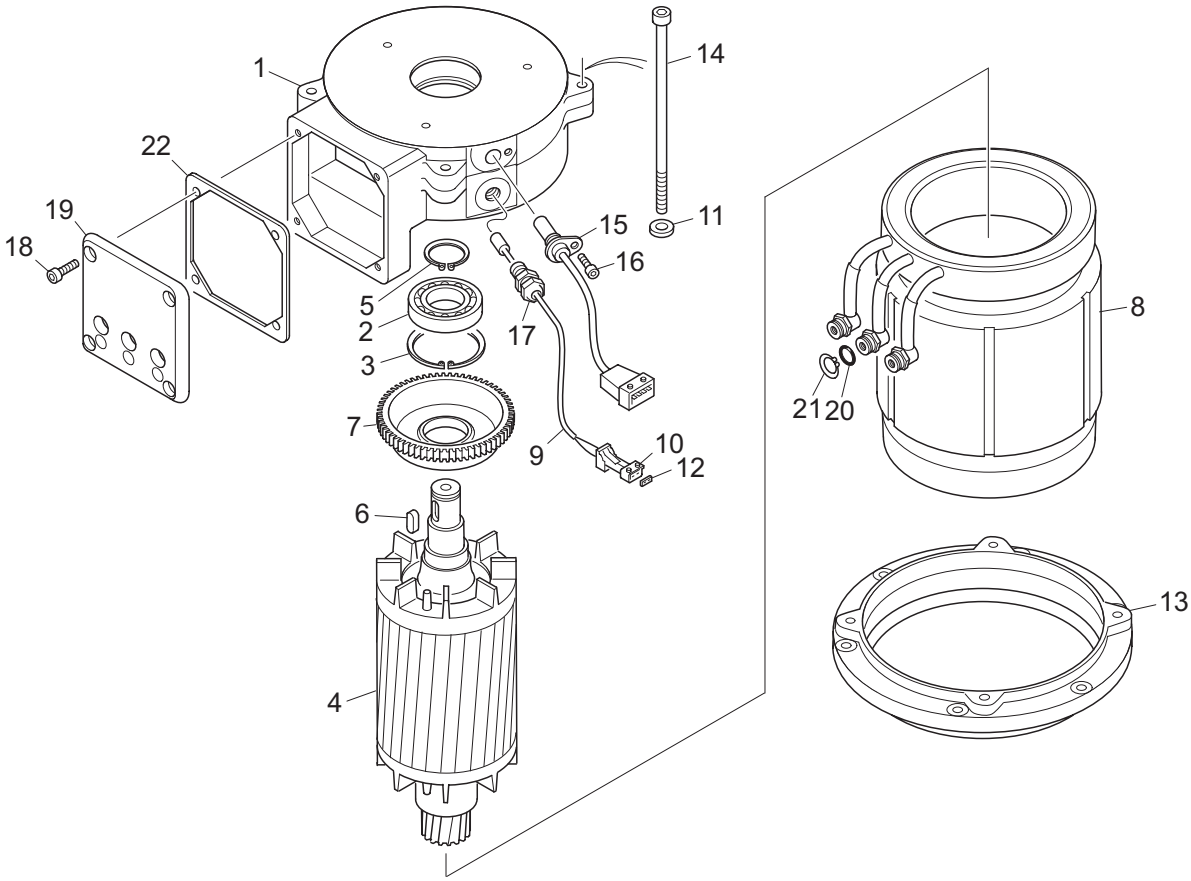
LAC - HYDRAULIC WARNING CODES	
100	Faulty chip-temperature sensor (exceeds -30°C...200°C)

LAC - HYDRAULIC FAULT CODES	
801	Offset-correction current-sensor Phase U exceeds UPPER limit
802	Offset-correction current-sensor Phase U exceeds LOWER limit
803	Offset-correction current-sensor Phase W exceeds UPPER limit
804	Offset-correction current-sensor Phase W exceeds LOWER limit
810	Speed sensor error
813	Temperature in power unit for hydraulics > 100°C
820	Permanent driver error in power unit for hydraulics (over current or under voltage on 13 V supply).
821	Driver error in power unit for hydraulics (over current or under voltage on 13 V supply)
855	Battery voltage (capacitor voltage) too high
860	13V supply exceeds higher limit
861	13V supply exceeds lower limit

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Traction motor

Traction motor



1	Bearing plate	12	Seal
2	Bearing	13	Flange
3	Circlip	14	Screw
4	Armature	15	Speed sensor
5	Circlip	16	Screw
6	Parallel key	17	Gland nut
7	Transmitter wheel	18	Screw
8	Casing	19	Terminal board
9	Temperature sensor	20	O ring
10	Connector housing	21	Circlip
11	Washer	22	Gasket

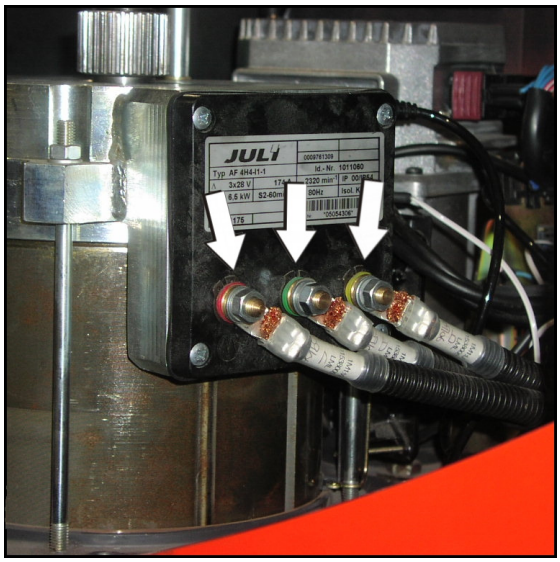
Removal

- Turn the keyswitch off, depress the emergency isolator and disconnect the battery.
- Chock the load wheels securely.
- Remove the brake drum (refer to relevant procedure), and position away from the motor.

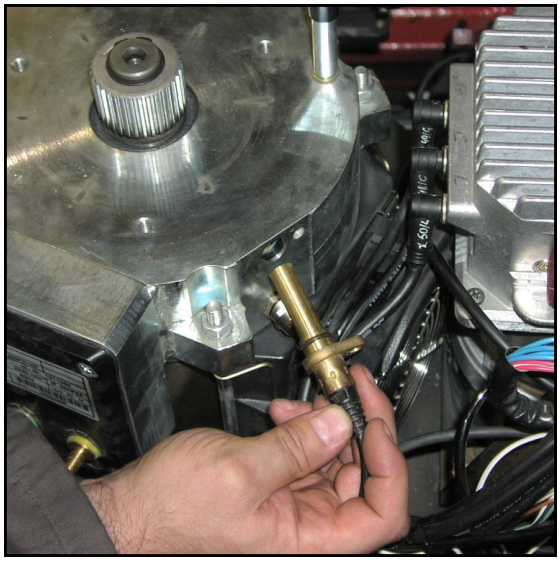
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Traction motor

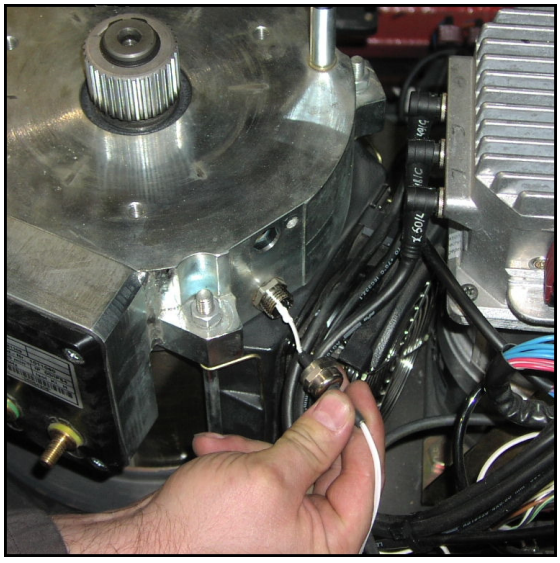
➢ Disconnect the three phase connections from the motor, noting their position for re-assembly. ▷



➢ Remove the hexagon head screw, and remove the motor speed sensor. ▷



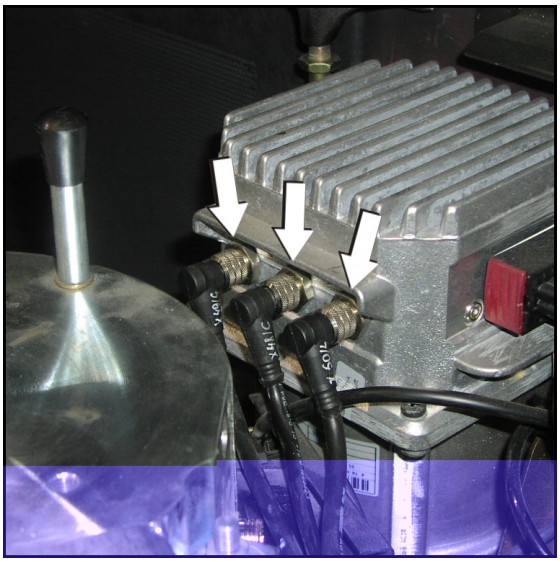
➢ Unscrew the gland nut, and remove the temperature sensor. ▷



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➢ Disconnect the steering motor three phase connections, noting their position for re-assembly.

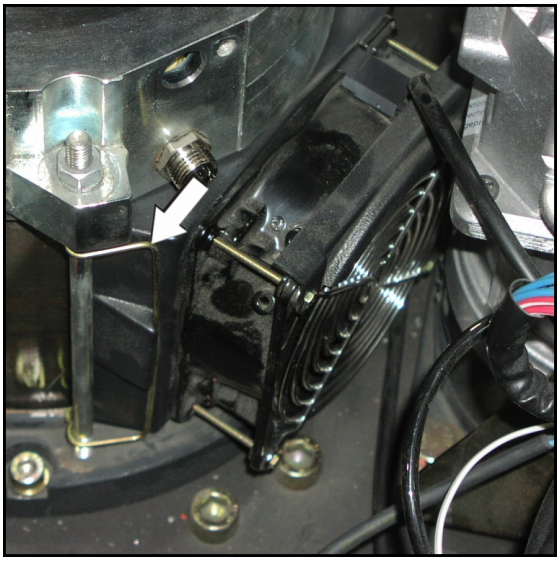
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➢ Unclip the two clips, and remove the cooling fan.

➢ To avoid damage, position all previously disconnected harnesses and the cooling fan away from the motor.

▷



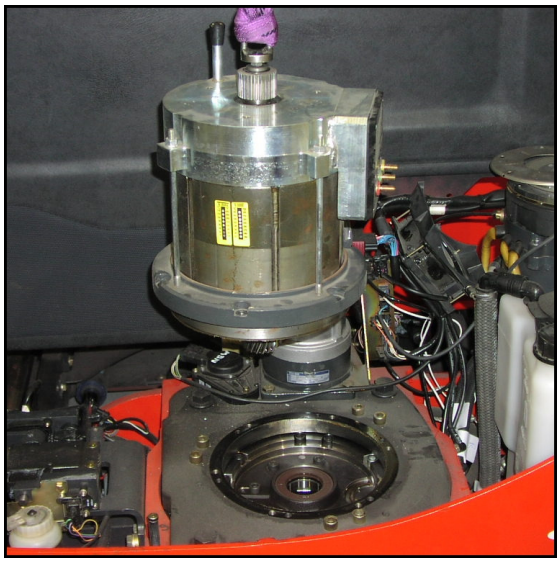
➢ Remove the six socket head screws which secure the motor to the mounting plate.

▷



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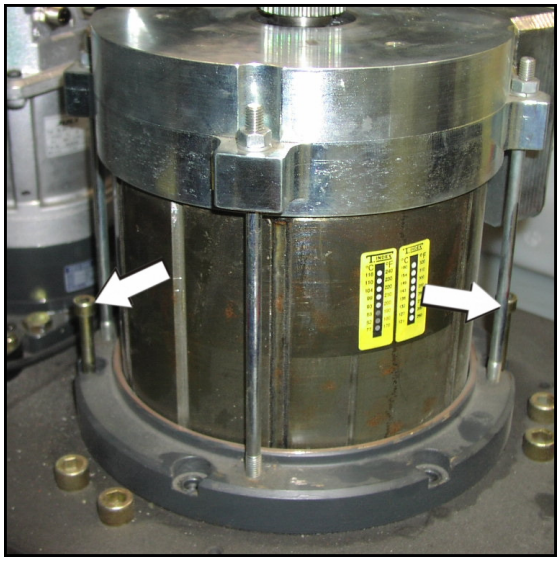
➢ Using suitable eyebolt and lifting equipment, remove the motor. ▷



Installation

To replace the traction motor, reverse the removal procedure.

To assist in alignment, two longer screws can be used when lowering the motor onto the mounting plate. ▷



Ensure that all cables are routed and connected correctly.

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Mechanical drive axle

Drive wheel

Removal

- Chock the load wheels securely.
- Raise the chassis until the drive wheel is just clear of the ground and block securely in position.
- Turn the drive wheel until the securing nuts are visible.
- Turn the keyswitch off.
- Remove the accessible wheel nuts.
- Sit on truck, turn the keyswitch on and operate the accelerator pedal until further nuts become accessible.
- Turn the keyswitch off and remove the wheel nuts.
- Repeat the procedure until all of the wheel nuts have been removed.
- Turn the drive wheel to the straight ahead position.

▷



- Remove the wheel from the hub

▷



⚠ WARNING

Manual handling risk. The wheel weighs approximately 23 kg

Take care when manoeuvring the wheel off of the studs.

Ensure hands are clear as the wheel drops.

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Mechanical drive axle

➢ Raise the rear of the chassis approximately 200 mm and block securely in position.

▷



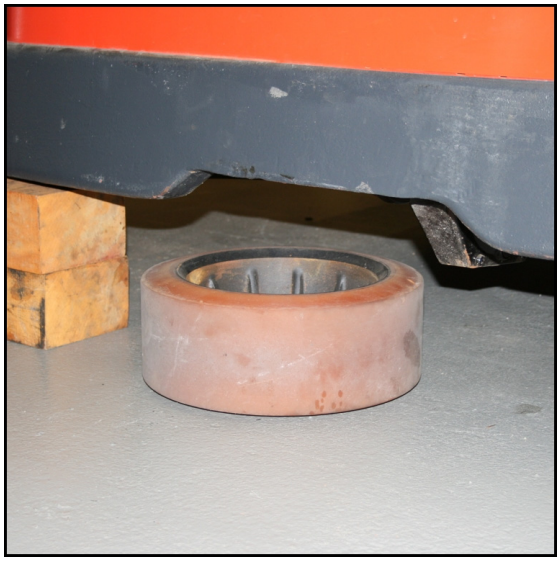
➢ Lay the wheel onto it's side.

▷



➢ Slide the wheel out from under the chassis.

▷



Replacement

➢ Chock the load wheels securely.

➢ Raise the rear of the chassis approximately 200 mm and block securely in position.

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➢ Slide the wheel under the chassis and stand it upright. ▷



➢ Position the rim of the wheel over the studs.

⚠ WARNING

Manual handling risk. The wheel weighs approximately 23 kg

Take care when lifting the wheel.

➢ Lower the chassis so that when positioned onto the hub, the drive wheel is just clear of the ground. Block securely in position.

➢ Position the wheel onto the hub.

➢ Turn the keyswitch on and turn the drive wheel until the studs are visible.

➢ Rotate the wheel on the hub to align the studs.

➢ Push the wheel onto the studs and replace the wheel nuts. ▷



Tighten the wheel nuts diametrically to 195 Nm

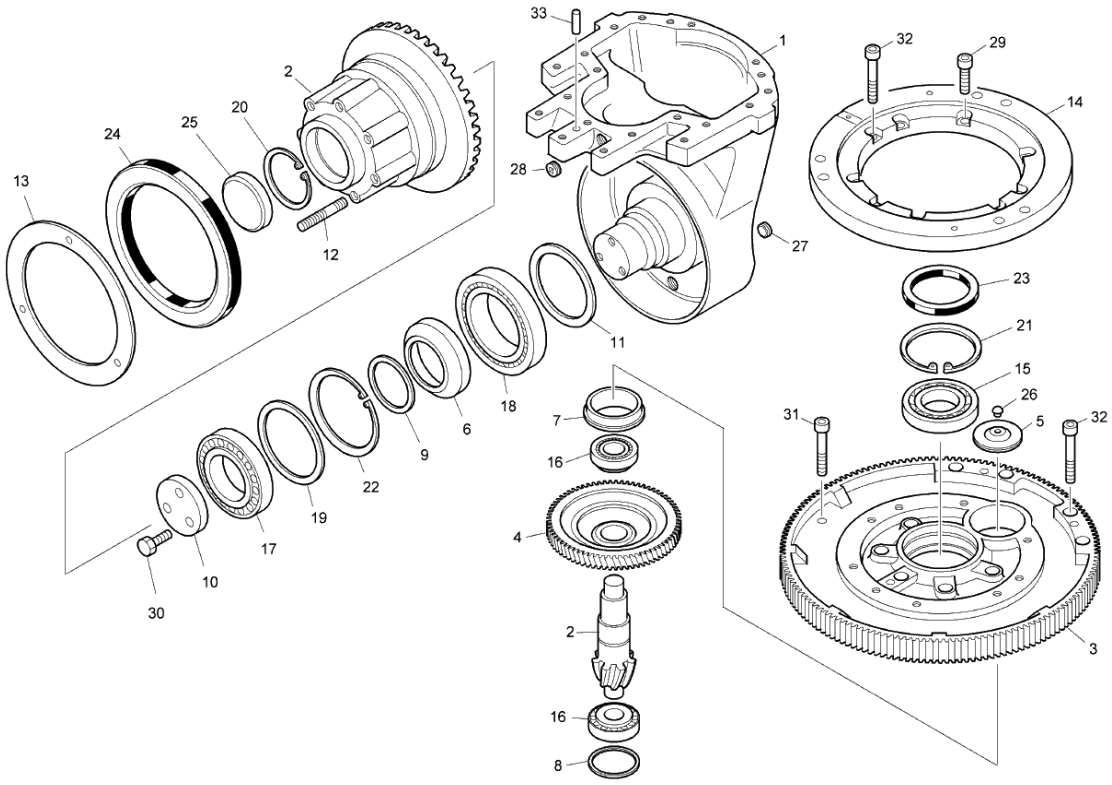
➢ After removing the drive wheel, the security of the nuts must be checked within 50 hours of operation.

NOTE

If it is found necessary to tighten the wheel nuts to the correct torque, then they must be checked again after 50 hours. Repeat the tightening procedure every 50 hours until the correct torque is consistently obtained.

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Gearbox



1	Housing	18	Tapered roller bearing
2	Pinion gear / crown wheel	19	Spacer
3	Cover	20	Circlip
4	Gear	21	Circlip
5	Air vent	22	Circlip
6	Spacer	23	Shaft seal
7	Bearing ring	24	Shaft seal
8	Shim	25	Cap
9	Shim kit	26	Adjusting screw
10	Cover	27	Magnetic drain plug
11	Spacer	28	Plug
12	Wheel stud	29	Socket head screw
13	Guard	30	Socket head screw
14	Steering bearing	31	Socket head screw
15	Deep groove ball bearing	32	Socket head screw
16	Tapered roller bearing	33	Cylindrical pin
17	Tapered roller bearing		

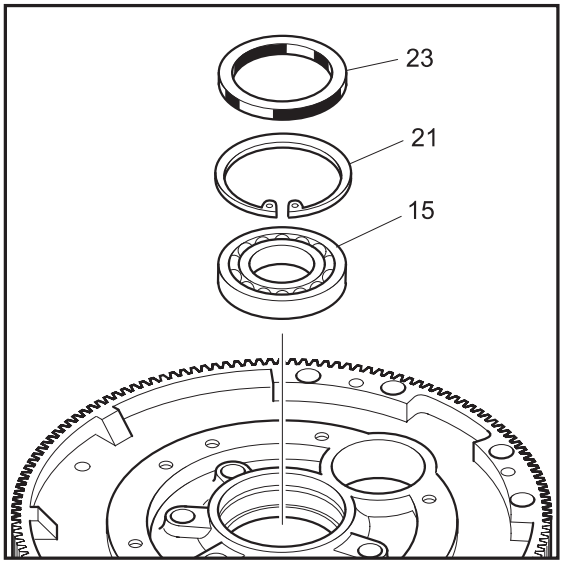
Servicing

Servicing of the gearbox is limited to :

Changing the wheel studs (12)
Changing the steering bearing (14)
Changing the pinion shaft and crown wheel seals (23) and (24)
Changing the bearing (15) and circlip (21)

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Replacing the pinion shaft seal and bearing



- Remove the shaft seal (23).
- Remove the circlip (21).
- Extract the bearing (15).
- Clean and inspect the seatings for the bearing, circlip and seal.
- Press in the new bearing.

NOTE

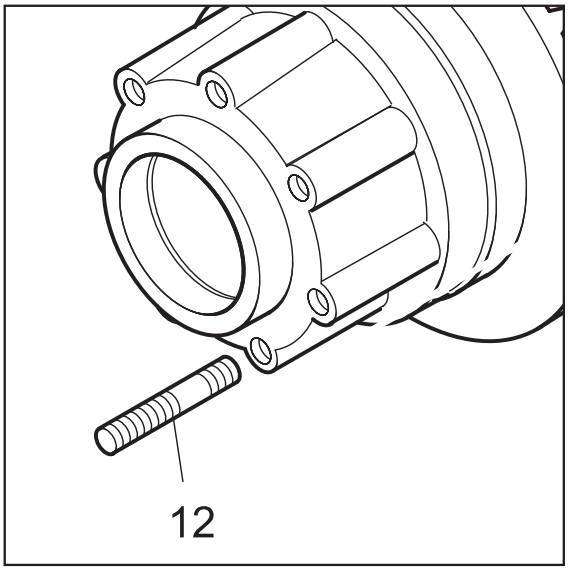
Only apply pressure to the outer ring of the bearing.

- Replace the circlip (21).
- Install a new shaft seal (23).

NOTE

To avoid damage to the shaft seal when replacing the motor, a light coating grease should be applied to the sealing and dust seal lips on the shaft seal.

Replacing the wheel studs



- Remove the damaged wheel studs.
- Clean and degrease the tapped holes in the crown wheel.
- Screw in the new studs.

NOTE

The shorter threaded end of the stud is pre-coated with thread locking compound. Do not apply additional thread locking compound to the studs.

- Tighten the studs to 35 - 40 Nm.

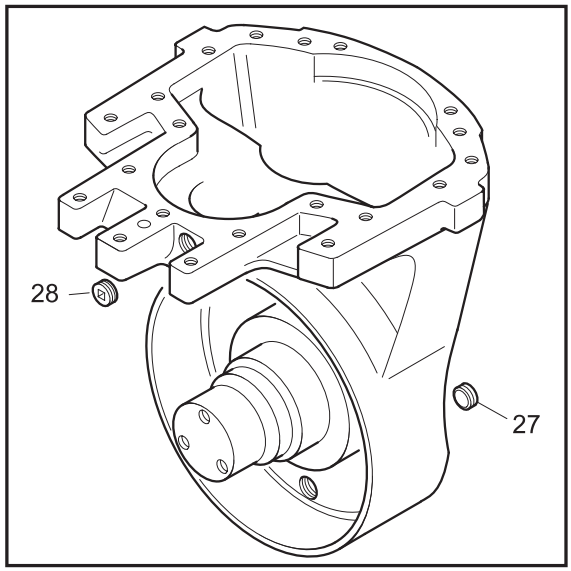
https://truckmanualshub.com/

Replacing the crown wheel seal

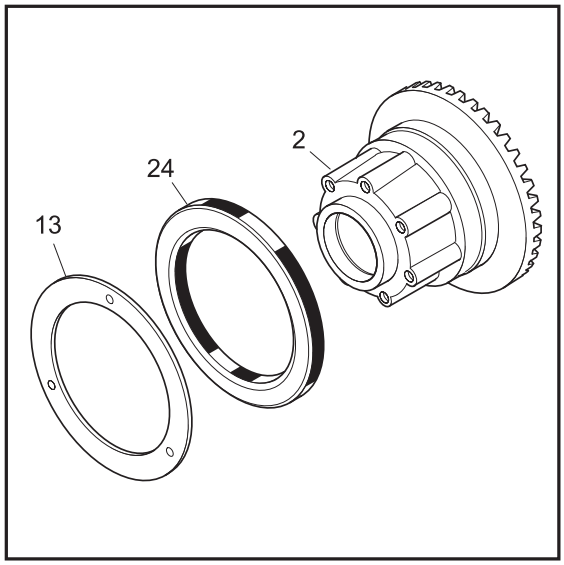
- Remove the magnetic drain plug (27), and allow the oil to drain into a suitable container.
- Degrease the thread on the drain plug hole.
- Fit a new magnetic drain plug. Torque to 35 Nm

NOTE

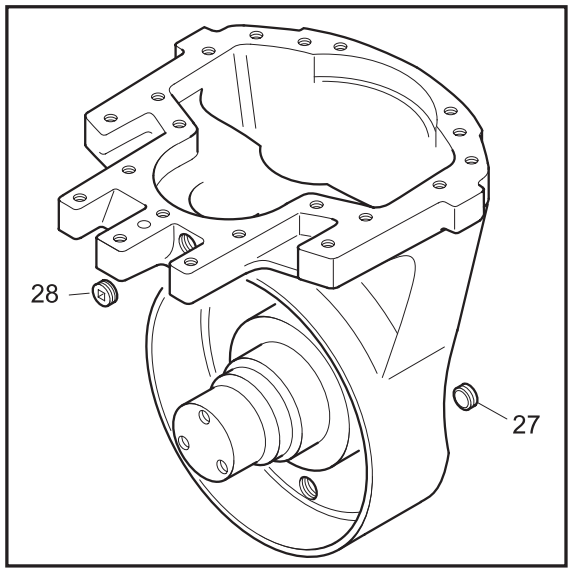
The new plug is microencapsulated self locking. Do not apply additional locking compound to the plug.



- Remove the guard (13).
- Remove the seal (24).
- Clean the seal seating in the housing and the seal running area on the crown wheel (2).
- Apply high temperature grease to the area on the crown wheel which will come in contact with the dust and sealing lips on the seal
- Press the new seal (24)into position.
- Press a new guard (13) onto the crown wheel.

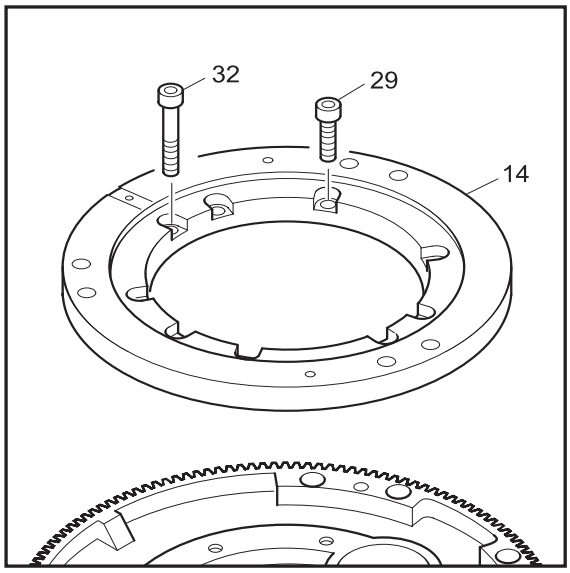


- Refill the gearbox, refer to recommended lubricants. The oil level should be to the lower edge of the filler plug (28).
- If the filler plug has been removed, it should be tightened to 35 Nm



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Replacing the steering bearing



- Remove the seven socket head screws (32).
- Remove the two socket head screws (29).
- Remove the steering bearing (14).
- Clean the area on the cover where the bearing is located.
- Degrease the screw holes.
- Press in the new bearing.
- Fit new screws (32) and (29).

NOTE

These screws are microencapsulated self locking screws. Do not apply additional thread locking compound to the screws.

- Tighten the screws diametrically to 66 Nm

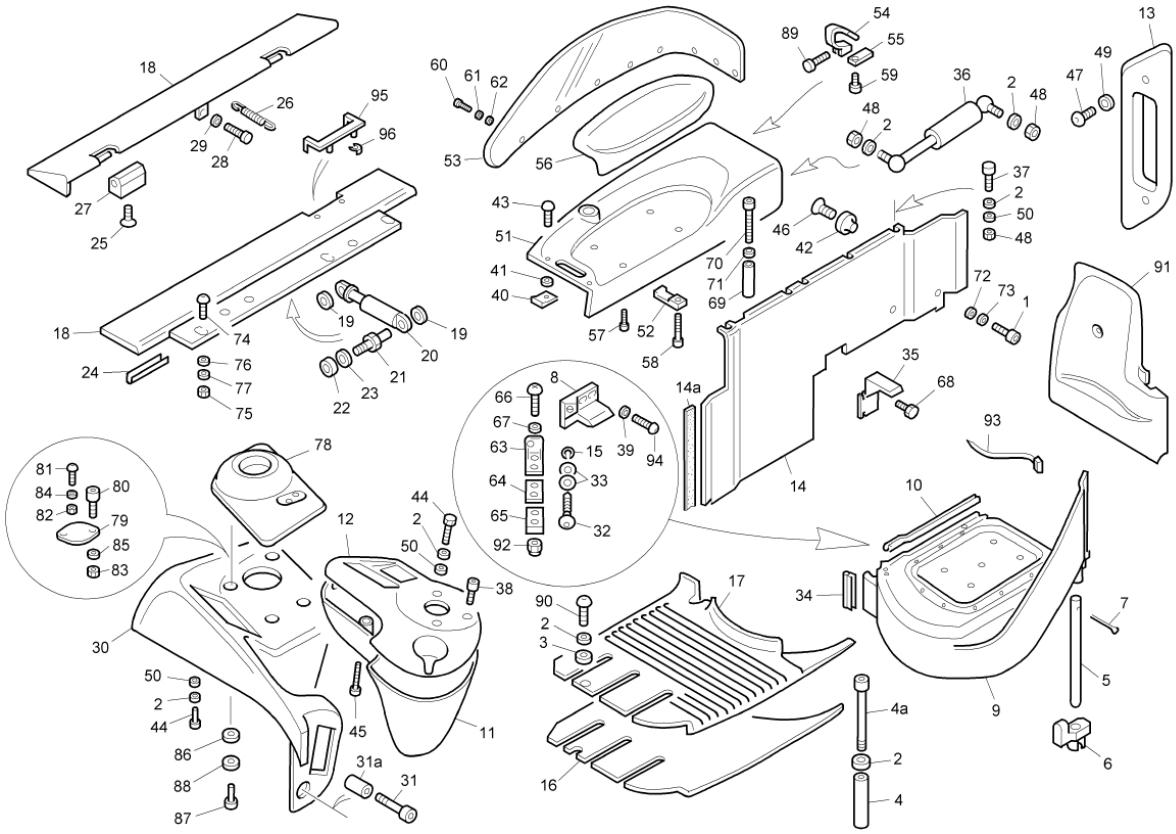
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Mechanical drive axle

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Covers and panelling

Covers and panelling



1	Button head screw
2	spring washer
3	Washer
4	Bush
4a	Socket head screw
5	Shaft
6	Support bearing
7	Pin
8	Plate
9	Seat support assembly
10	Seal
11	Steering binnacle bottom cover
12	Steering binnacle top cover
13	Headrest
14	Fabric panel
14a	Sealing strip
15	Retaining ring
16	Floor plate
17	Floor mat
18	Battery cover assembly
19	Fastener
20	Gas spring
21	Bolt
22	Hexagon nut
23	Wavy washer
24	Edge protection
25	Countersunk screw
26	Tension spring
27	Hinge block
28	Hexagon head screw
29	Hexagon nut
30	Front cover
31	Socket head screw
31a	Bush
32	Special screw
33	Washer
34	Seal
35	Bracket
36	Gas spring
37	Screw
38	Socket head screw
39	Washer
40	Nut
41	Locking disc
42	Washer
43	Special screw
44	Hexagon head screw
45	Socket head screw
46	Countersunk screw
47	Raised head screw
48	Nut
49	Washer
50	Washer
51	Cover
52	Cable clip
53	Safety screen
54	Hinge
55	Plate
56	Armrest insert
57	Screw

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Covers and panelling

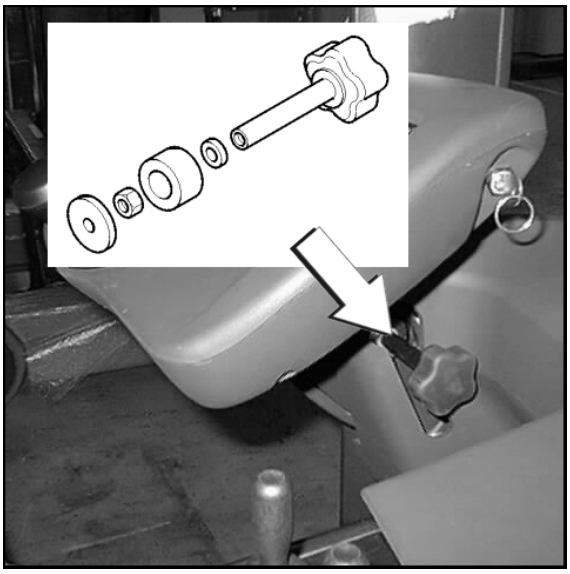
58	Screw
59	Hexagon head screw
60	Self tapping screw
61	Washer
62	Rubber washer
63	Bracket
64	Gasket
65	Plate
66	Raised head screw
67	Washer
68	Button head screw
69	Bush
70	Cap head screw
71	Washer
72	Washer
73	Washer
74	Raised head screw
75	Nut
76	Washer
77	Spring washer
78	Housing
79	Cover
80	Socket head screw
81	Button head screw
82	Hexagon nut
83	Hexagon nut
84	Washer
85	Washer
86	Washer
87	Hexagon head screw
88	Wavy washer
89	Socket head screw
90	Raised head screw
91	Cover
92	Hexagon head nut
93	Cable tie
94	Button head screw
95	Battery lid protection
96	Lock washer

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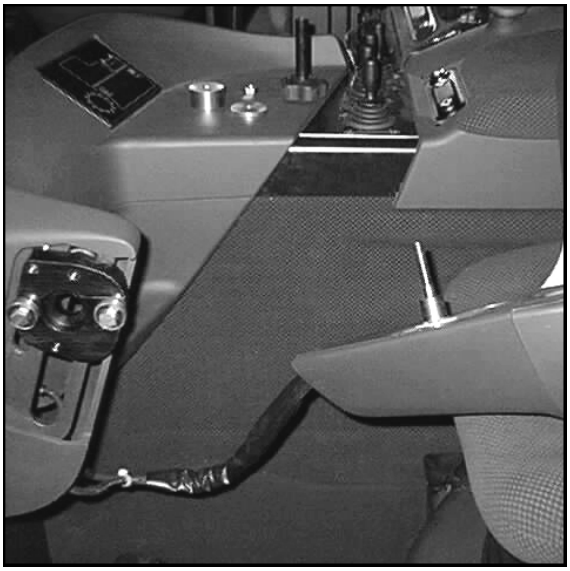
Steering binnacle

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 re-assembly. ▷



- Disconnect the harness and remove the binnacle. ▷



⚠ CAUTION

Do not allow the binnacle to hang from the harness.

Ensure the binnacle is supported.

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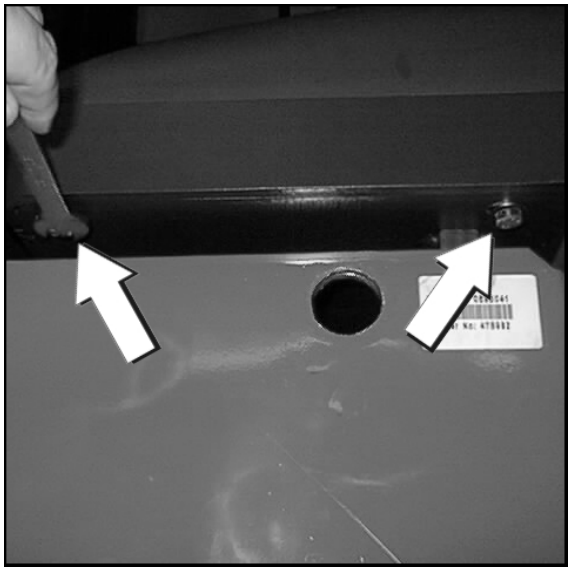
Operator's console

Removal

- Turn the keyswitch off and disconnect the battery.
- Remove the steering binnacle, refer to relevant procedure.
- Remove the console securing screw on the steering bracket. ▷



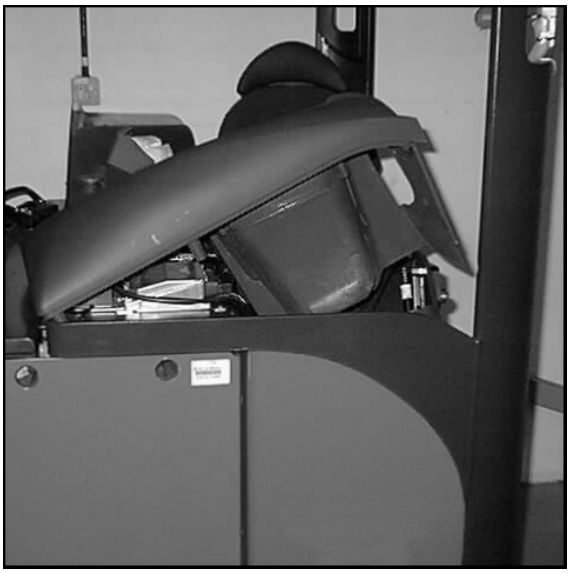
- Remove the two screws from under the control unit shelf. ▷



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➢ Disconnect the driver's display and remove the console.

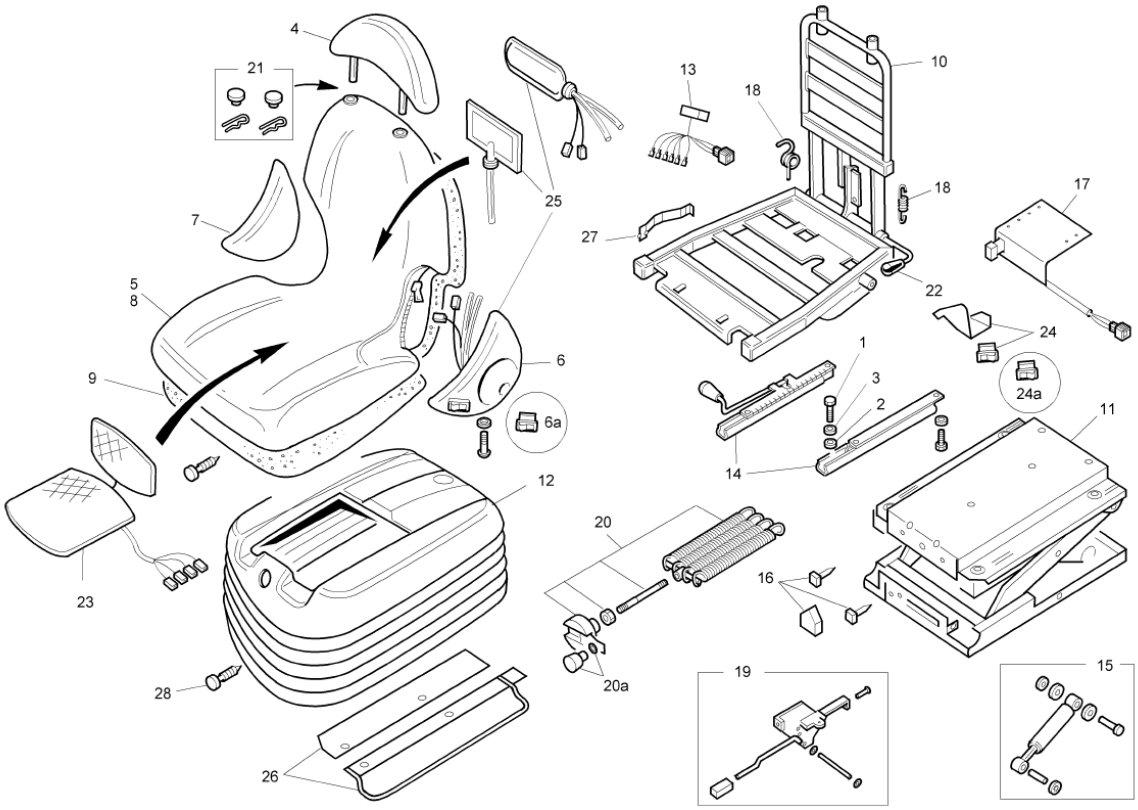
▷



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Operator's seat

Seat assembly



1	Hexagon head screw
2	Washer
3	Spring washer
4	Backrest
5	Covering assembly
6	Cover (left hand)
6a	Microswitch
7	Cover (right hand)
8	Cover assembly
9	Foam pad
10	Support assembly
11	Support assembly
12	Suspension cover
13	Microswitch
14	Guide assembly
15	Shock absorber
16	Bumper
17	Terminal assembly
18	Springs
19	Lever assembly
20	Lever assembly
20a	Weight adjuster handle kit
21	Backrest cap
22	Handle
23	Heater
24	Microswitch kit
24a	Heater microswitch
25	Support assembly
26	Retainer plate
27	Leaf spring
28	Clip

Removal

➢ Turn the keyswitch off and disconnect the battery.

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➢ Remove the securing screw. ▷

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



➢ Disconnect the seat switch. ▷

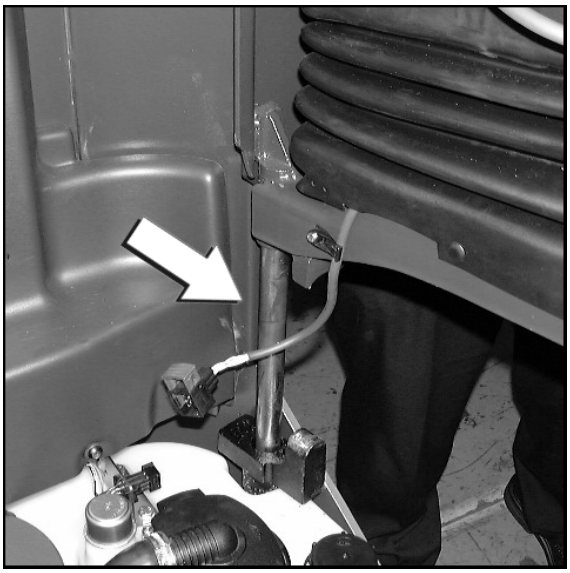


➢ Lift the seat from it's pivot, and store in a safe place. ▷

⚠ WARNING

Manual handling risk. The seat assembly is heavy.

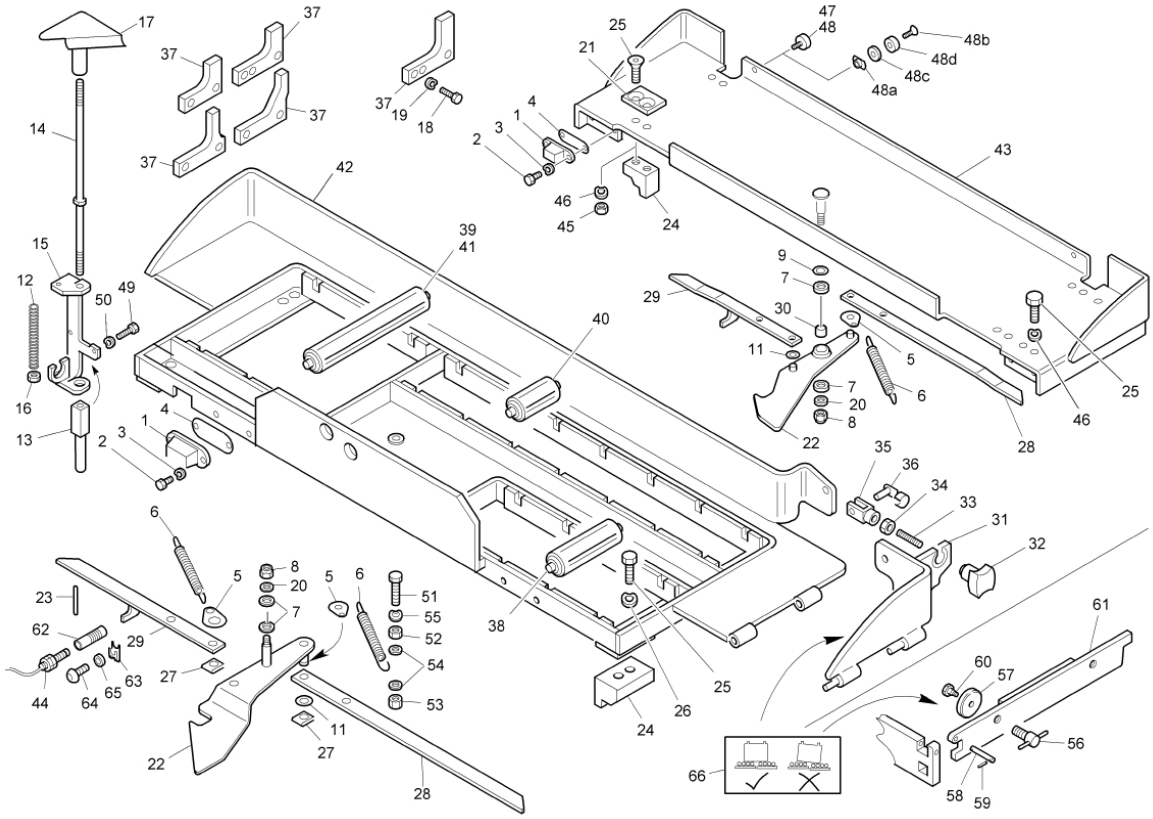
Assistance should be sought if it is to be completely removed.



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Battery carrier

Battery carrier



1	Buffer	31	Plate
2	Hexagon head screw	32	Handle
3	Wavy washer	33	Threaded pin
4	Shim	34	Hexagon nut
5	Plate	35	Clevis
6	Tension spring	36	Pin
7	Bush	37	Plate
8	Hexagon head nut	38	Support roller
9	Shim	39	Support roller
10	Shim	40	Support roller
11	Bush	41	Support roller
12	Spring	42	Battery carrier assembly
13	Rod	43	Battery carrier assembly
14	Rod assembly	44	Sensor
15	Plate assembly	45	Hexagon nut
16	Hexagon nut	46	Spring washer
17	Battery carrier release handle	48a	Special nut
18	Hexagon head screw	48b	Countersunk screw
19	Spring washer	48c	Washer
20	Washer	48d	Stop
21	Plate	49	Hexagon head screw
22	Lever assembly	50	Spring washer
23	Cotter	51	Hexagon head screw
24	Support block	52	Nut
25	Flat head screw	53	Hexagon nut
26	Spring washer	54	Washer
27	Clip	55	Spring washer
28	Rod	56	Handle
29	Rod	57	Plate
30	Bush	58	Cotter pin

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59	Slotted spring pin
60	Special bolt
61	Plate assembly
62	Guide
63	Sensor clip
64	Screw
65	Washer
66	Label

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 battery capacities. See the Spare Parts Catalogue for details.

Removal

Should the battery carrier require removal, follow the battery changing procedure.

Once the battery has been removed then the carrier can be lifted clear of the truck using suitable lifting equipment.

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.
- Replace the battery.

NOTE

Ensure the carrier sits square and firm on the reach legs before replacing the battery.

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Battery carrier

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Electrical steering

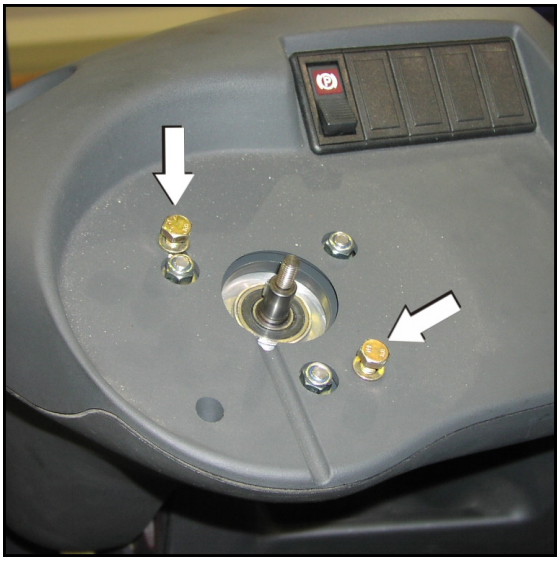
Steering wheel potentiometer

Removal

- Turn the keyswitch off, depress the emergency isolator and disconnect the battery.
- Remove the plastic cover, and remove the central nut which secures the steering wheel. ▷



- Remove the two hexagon head screws. ▷



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Electrical steering

- Remove the four screws which secure the binnacle top cover (two on top, two underneath.
- Disconnect switch and remove the top cover.

▷



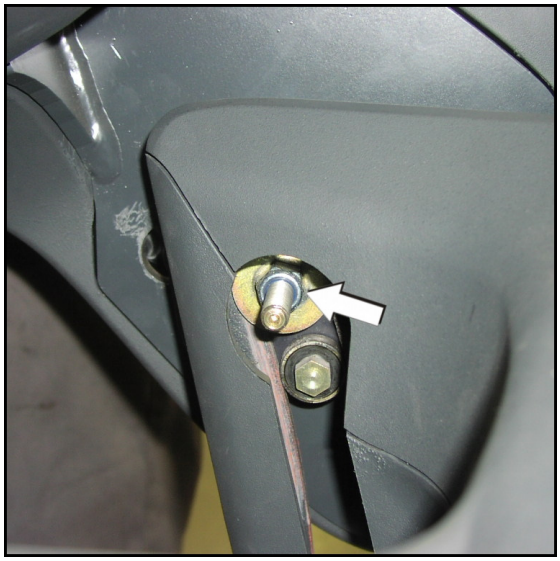
- Remove the clamping knob, washer and spacer.

▷



- Slacken off the nut sufficiently to gain access to the screw which secures the binnacle lower cover.

▷

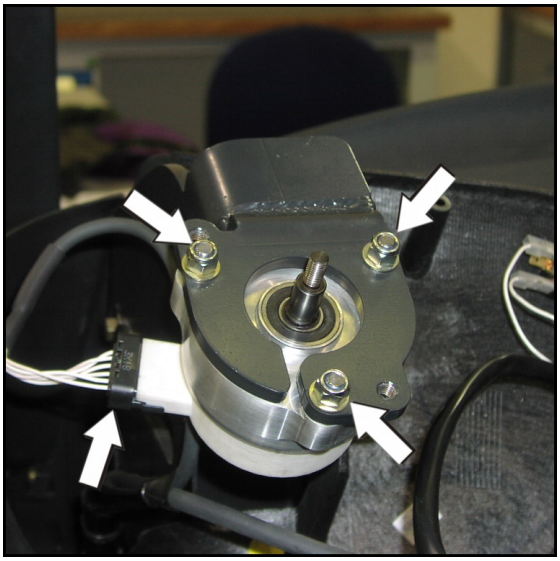


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➢ Remove the screw which secures the binnacle lower cover. ▷



➢ Remove the three nuts which secure the potentiometer, disconnect the harness and remove the potentiometer. ▷



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Drive wheel position potentiometer

Potentiometer removal

⚠ CAUTION

Separating the potentiometer from the gearbox will damage the potentiometer and could invalidate any warranty.

Before separating the potentiometer from the gearbox, ensure that the potentiometer is faulty.

To replace the complete potentiometer and gearbox assembly refer to relevant procedure.

- ➢ Chock the load wheels.
- ➢ Jack and block the truck so that the drive wheel is free to rotate.
- ➢ Position the drive wheel in the straight ahead position with the gearbox on the right hand side.

NOTE

On the tough terrain version, the gearbox is on the left hand side.

Verify that the drive wheel is in the straight ahead position using diagnostic software :

`Inputs + Outputs`
▼
`Steering`
▼
`Steering Unit`

NOTE

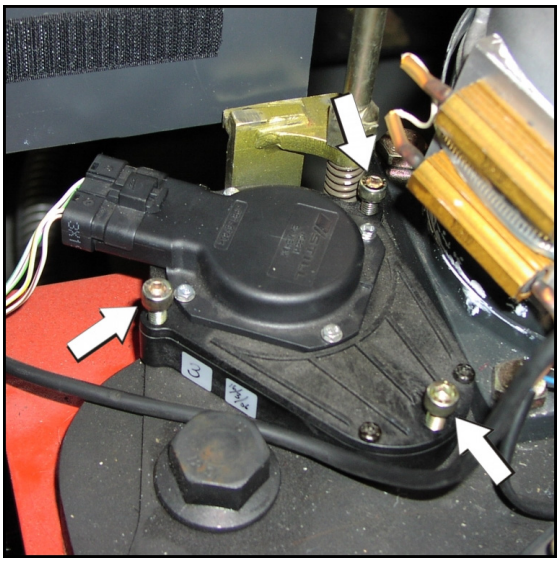
In the straight ahead position, the voltage of U1 will be ≈5.5 volts and U2 will be ≈3.2 volts.

- ➢ Turn the keyswitch off, disconnect the battery and depress the emergency isolator.
- ➢ Open the motor cover and remove the floor-plate.
- ➢ Disconnect the potentiometer connector 3X19

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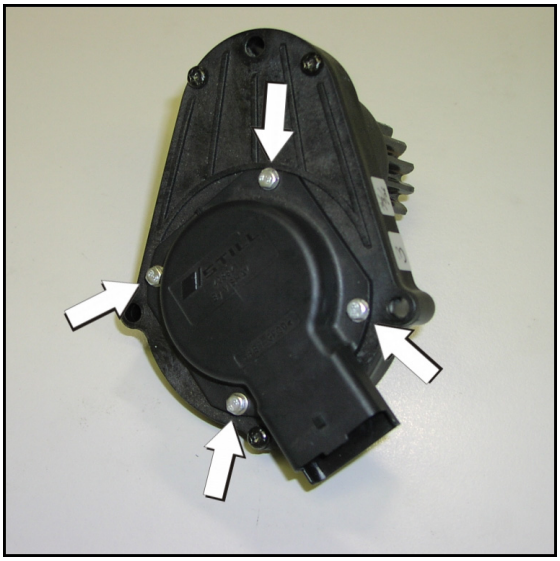
- Remove the three screws which secure the potentiometer gearbox to the drive plate.
- Remove the gearbox and potentiometer assembly.

▷



- Remove the four screws which secure the potentiometer to the gearbox.
- Separate the potentiometer from the gearbox.

▷



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Potentiometer installation

- Turn the gearbox drive pinion until the potentiometer drive shaft is in the position shown.
- Assemble the potentiometer to the gearbox, and replace the four securing screws.
- Connect potentiometer connector 3X19
- Turn the keyswitch on.
- Using diagnostic software :

Inputs + Outputs
▼
Steering
▼
Steering Unit

- Rotate the gearbox drive pinion until Channel U1 reads ≈5.5 volts. Channel U2 will be ≈3.2 volts.
- Turn the keyswitch off, disconnect the battery and depress the emergency isolator.
- Fit the potentiometer gearbox assembly to the drive plate and replace the three securing screws.

NOTE

The gearbox drive pinion may move slightly in order that the gears mesh.

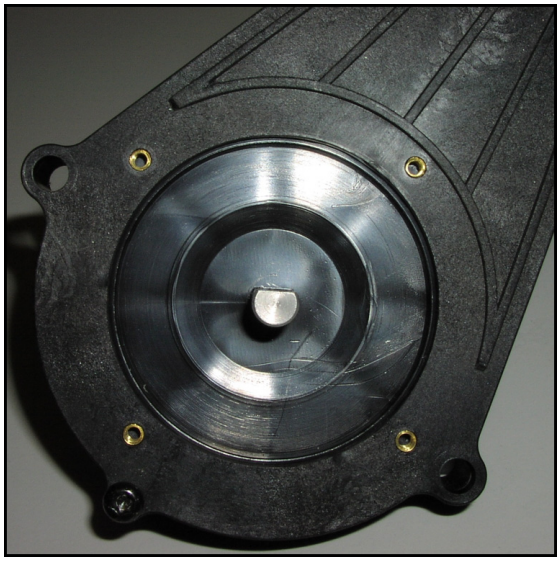
- Turn the keyswitch on.
- Calibrate the steering unit using diagnostic software:

Guided diagnostics
▼
Work order
▼
Calibrate

Potentiometer and gearbox assembly removal

- Chock the load wheels.
- Jack and block the truck so that the drive wheel is free to rotate.
- Position the drive wheel in the straight ahead position with the gearbox on the right hand side.

▷



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NOTE

On the tough terrain version, the gearbox is on the left hand side.

Verify that the drive wheel is in the straight ahead position using diagnostic software :

Inputs + Outputs
▼
Steering
▼
Steering Unit

NOTE

In the straight ahead position, the voltage of U1 will be ≈5.5 volts and U2 will be ≈3.2 volts.

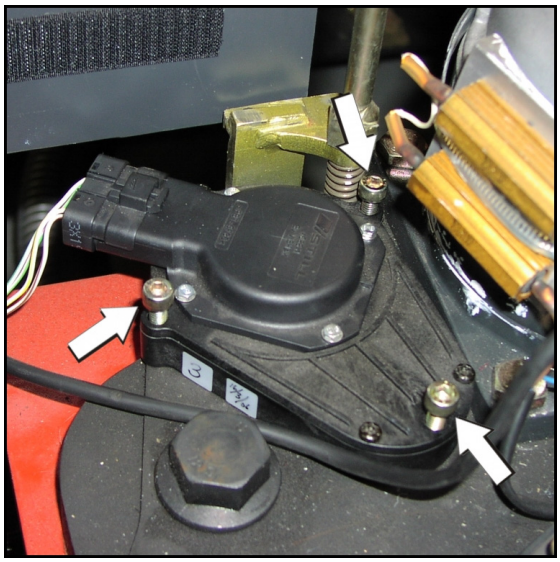
- Turn the keyswitch off, disconnect the battery and depress the emergency isolator.
- Open the motor cover and remove the floor-plate.
- Disconnect the potentiometer connector 3X19

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➢ Remove the three screws which secure the potentiometer gearbox to the drive plate.

➢ Remove the gearbox and potentiometer assembly.

▷



Potentiometer and gearbox assembly installation

Replacement potentiometer assemblies are supplied with the drive pinion taped in the straight ahead position.

▷



➢ Remove the tape, fit the potentiometer assembly to the drive plate and replace the three securing screws.**Do not rotate the gearbox drive pinion.**

NOTE

The gearbox drive pinion may move slightly in order that the gears mesh.

➢ Connect potentiometer connector 3X19

➢ Turn the keyswitch on.

➢ Calibrate the steering unit using diagnostic software:

`Guided diagnostics`
▼
`Work order`
▼
`Calibrate`

If installing a potentiometer assembly which has not been taped in position, then proceed as follows.

➢ Connect potentiometer connector 3X19

➢ Turn the keyswitch on.

➢ Using diagnostic software :

`Inputs + Outputs`
▼
`Steering`

https://truckmanualshub.com/

▼

Steering Unit

- Rotate the gearbox drive pinion until Channel U1 reads ≈5.5 volts. Channel U2 will be ≈3.2 volts.
- Turn the keyswitch off, disconnect the battery and depress the emergency isolator.
- Fit the potentiometer gearbox assembly to the drive plate and replace the three securing screws.

NOTE

The gearbox drive pinion may move slightly in order that the gears mesh.

- Turn the keyswitch on.
- Calibrate the steering unit using diagnostic software:

Guided diagnostics

▼

Work order

▼

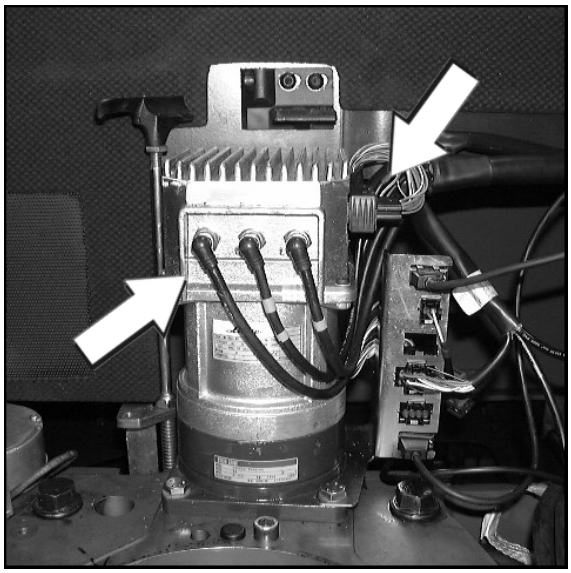
Calibrate

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Steering motor

Removal

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



- 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.

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- 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.



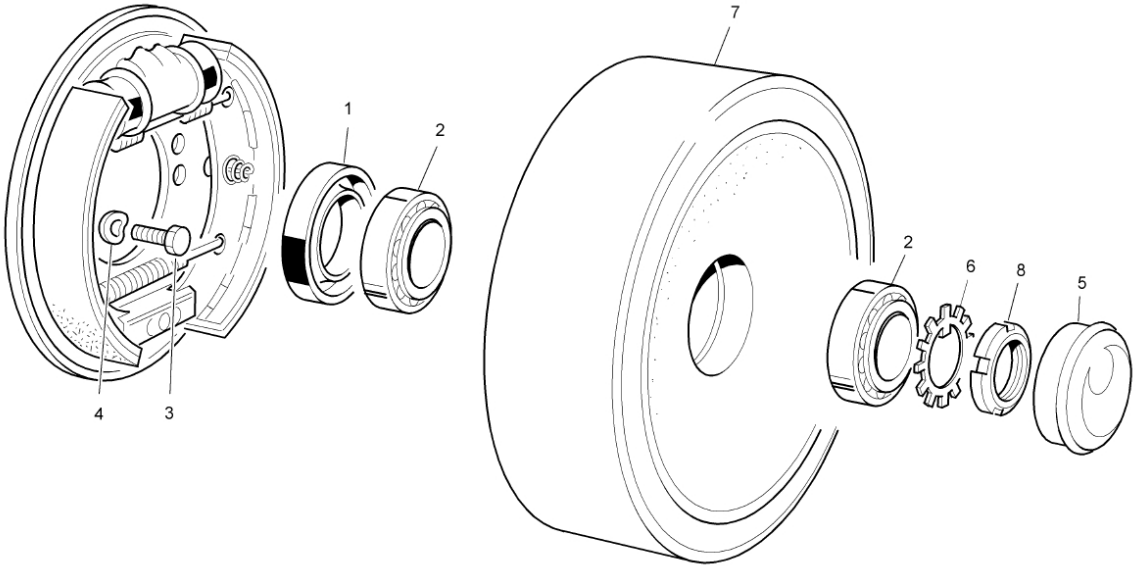
NOTE

The shaft has a keyway to locate the gear.

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Wheels and tyres

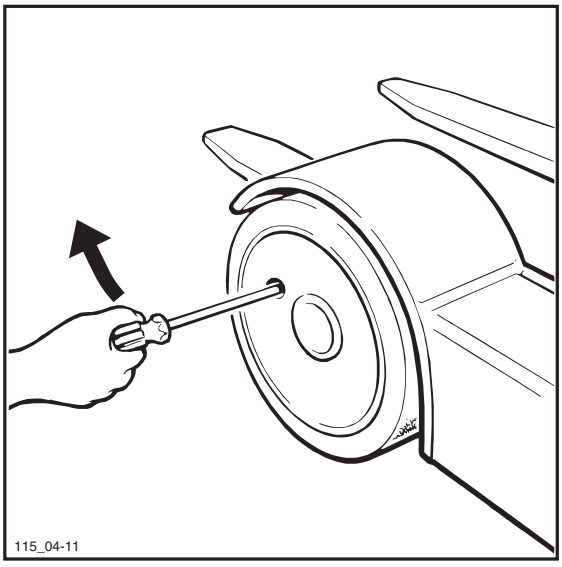
Load wheels



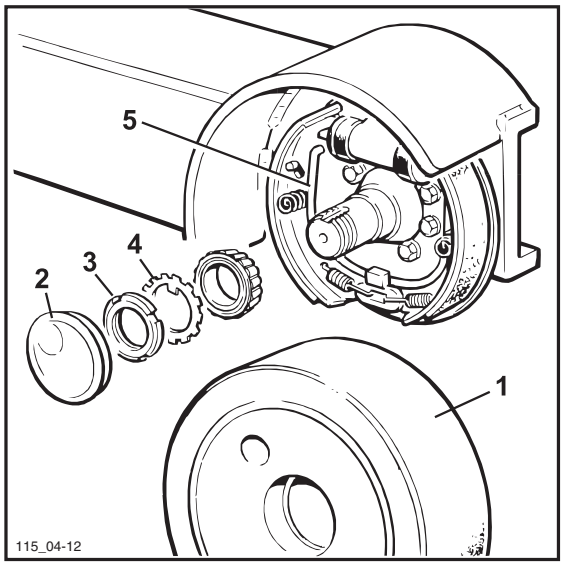
1	Seal	5	Hubcap
2	Bearing	6	Tab washer
3	Hexagon head screw	7	Wheel
4	Spring washer	8	Locknut

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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 002 941 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.



Installation

To replace the load wheel to the load wheel axle shaft, re-grease the bearings and reverse the removal procedure.

To tighten the locknut R14 and R16

- Tighten to 50 Nm, slacken off, re-tighten to 12 Nm. Turn clockwise to nearest tab on the washer.

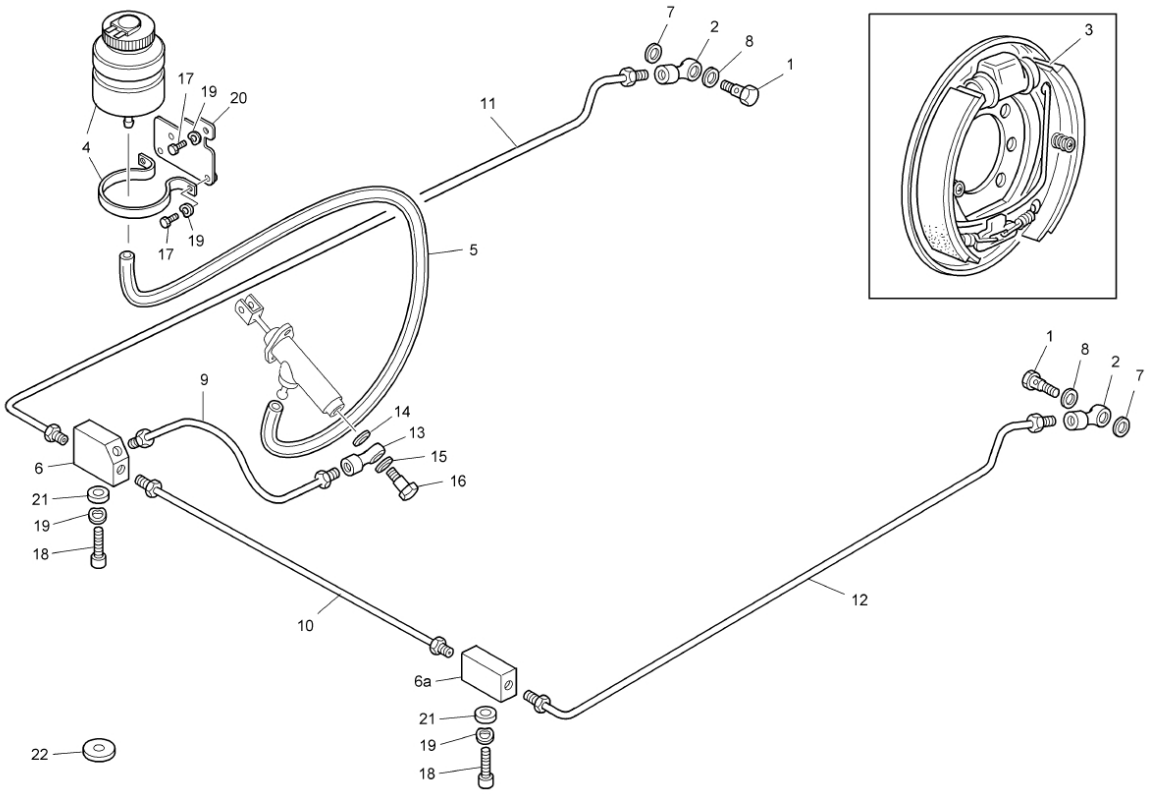
To tighten the locknut R20

- Tighten to 50 Nm, slacken off, re-tighten to 20 Nm. Turn clockwise to nearest tab on the washer.

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Brake installation

Hydraulic braking system



1	Hollow screw	12	Brake pipe assembly
2	Banjo union	13	Banjo union
3	Brake assembly	14	Seal ring
4	Reservoir	15	Seal ring
5	Flexible brake hose	16	Hollow screw
6	Adaptor	17	Hexagon head screw
6a	Brake adaptor	18	Socket head screw
7	Seal ring	19	Wavy washer
8	Seal ring	20	Bracket
9	Brake pipe assembly	21	Washer
10	Brake pipe assembly	22	Washer
11	Brake pipe assembly		

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.

Preventative maintenance

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

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- 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.

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.*

- 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.

▷

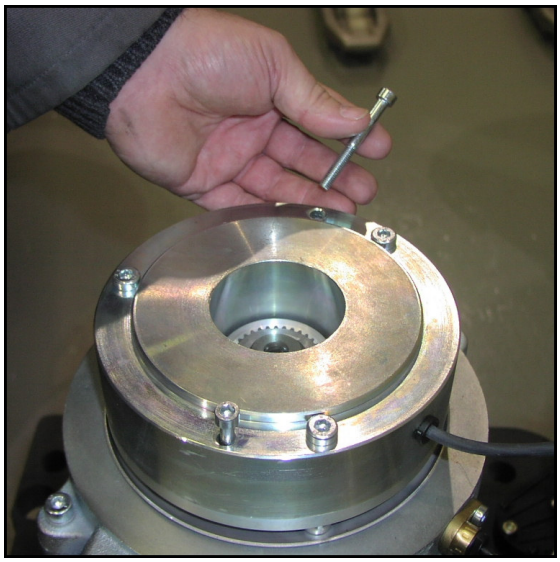


- Gently depress the brake pedal and slacken the nipple, 3/4 of a turn.
- Slowly depress brake pedal fully and lock the nipple.
- Release the brake pedal.
- Repeat procedure until fluid in the container is free of air bubbles.
- Replace dust cover.
- Repeat procedure on the left hand load wheel.

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Traction motor brake (standard)

Mechanically releasing



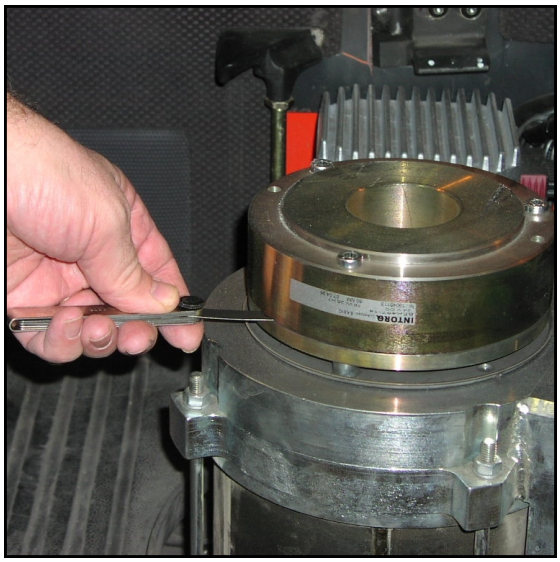
⚠ WARNING

When the parking brake is released, the truck is in an unbraked condition.

Before releasing the parking brake, ensure that the truck is either on level ground, or that chocks are available to prevent the truck from rolling away.

- ➢ Turn the keyswitch off, depress the emergency isolator and disconnect the battery.
- ➢ Open the motor cover.
- ➢ Insert two M6 x 55 mm socket head screws, and tighten fully to mechanically release the parking brake.

Checking the friction lining clearance



- ➢ Turn the keyswitch off, depress the emergency isolator and disconnect the battery.
- ➢ Open the motor cover.
- ➢ Using a feeler gauge, measure the clearance between the coil housing and pressure plate.

  Nominal clearance = 0.3 mm ±0.1 mm
  Maximum clearance = 0.7 mm

The brake gap can also be verified using diagnostic software:

Inputs + Outputs
▼
Traction
▼
Safety Brake

NOTE

The clearance cannot be adjusted. If the clearance is greater than 0.7 mm, then the friction lining must be replaced.

Checking the magnetic coil

- ➢ Turn the keyswitch off, depress the emergency isolator and disconnect the battery.
- ➢ Open the motor cover.
- ➢ Disconnect the brake coil connector 1X78.
- ➢ Using a suitable multimeter, measure the resistance between 1X78:1 and 1X78:2

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The resistance should be 7.5 Ohm ±2.5 Ohm

If the measured value is not within tolerance, then the coil must be replaced.

Checking operation

➢ Whilst applying the parking brake, check the currents and voltages at 1X78:1 and 1X78:2

	APPLYING	HOLDING
Current	≈ 3.2 Amp	≈ 1 Amp

The current can also be verified using diagnostic software:

Inputs + Outputs
▼
Traction
▼
Safety Brake

NOTE

The reduction in voltage and current takes place after approximately 1 second.

Disassembly

⚠ WARNING

When the parking brake assembly is removed, the truck is in an unbraked condition.

Before removing the parking brake, ensure that the truck is securely chocked.

➢ Turn the keyswitch off, depress the emergency isolator and disconnect the battery.

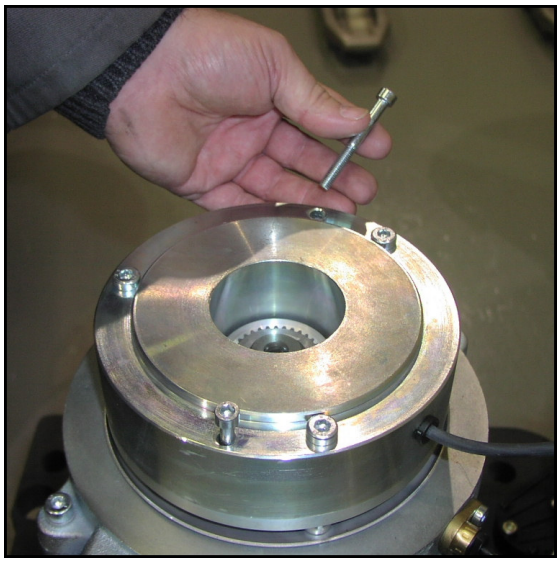
➢ Open the motor cover.

➢ Disconnect the brake coil connector 1X78.

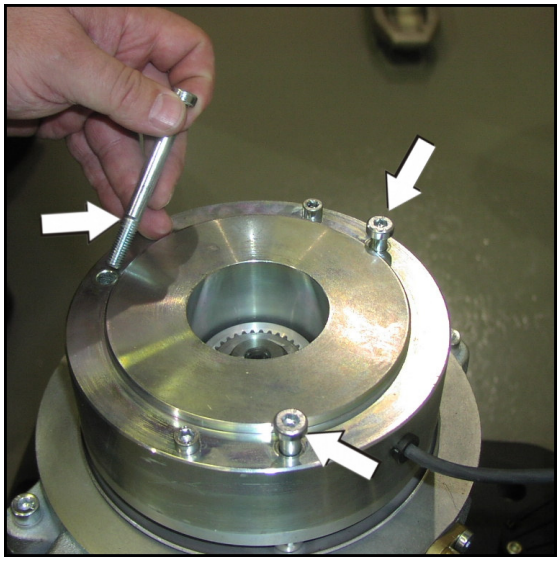
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Brake installation

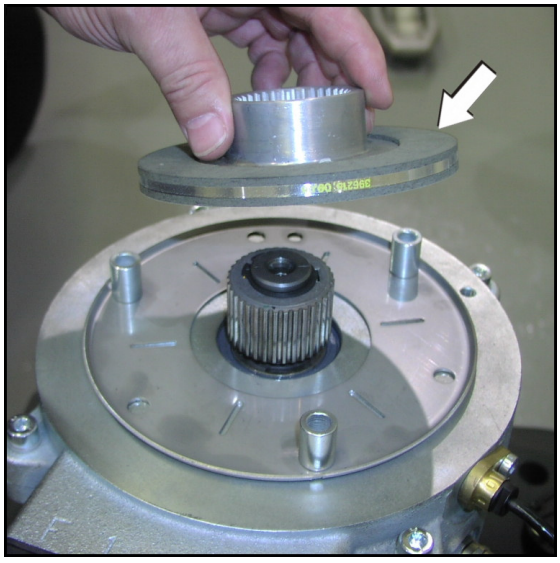
➢ Insert two M6 x 55 mm socket head screws, and tighten fully to lock the brake coil assembly for transportation. ▷



➢ Remove the three socket head screws, and remove the brake coil assembly. ▷



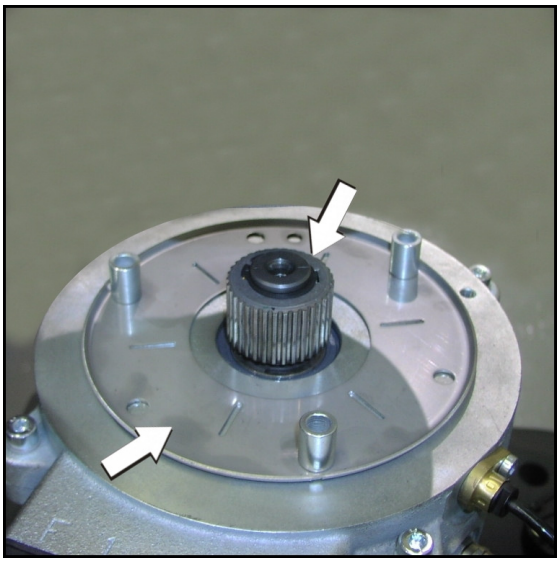
➢ Remove the friction lining. ▷



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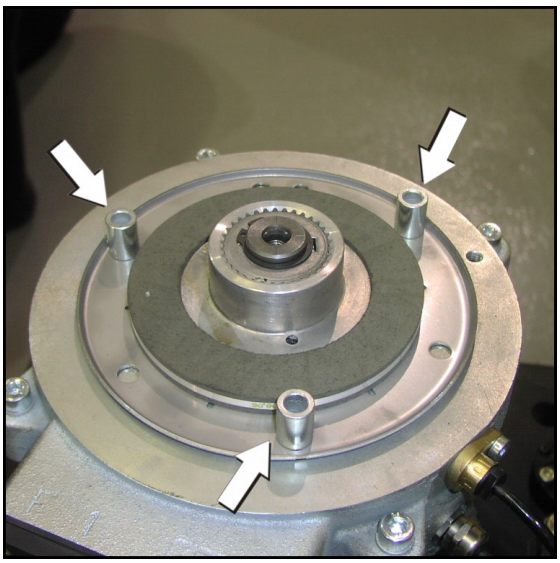
➢ Check the friction plate for wear. Clean the motor pinion, and check for wear. If necessary, the pinion can be removed using a suitable puller.

▷



Reassembly

▷



➢ To reassemble the brake assembly reverse the removal procedure.

➢ Before replacing the coil assembly, ensure that the three spacers are positioned correctly.

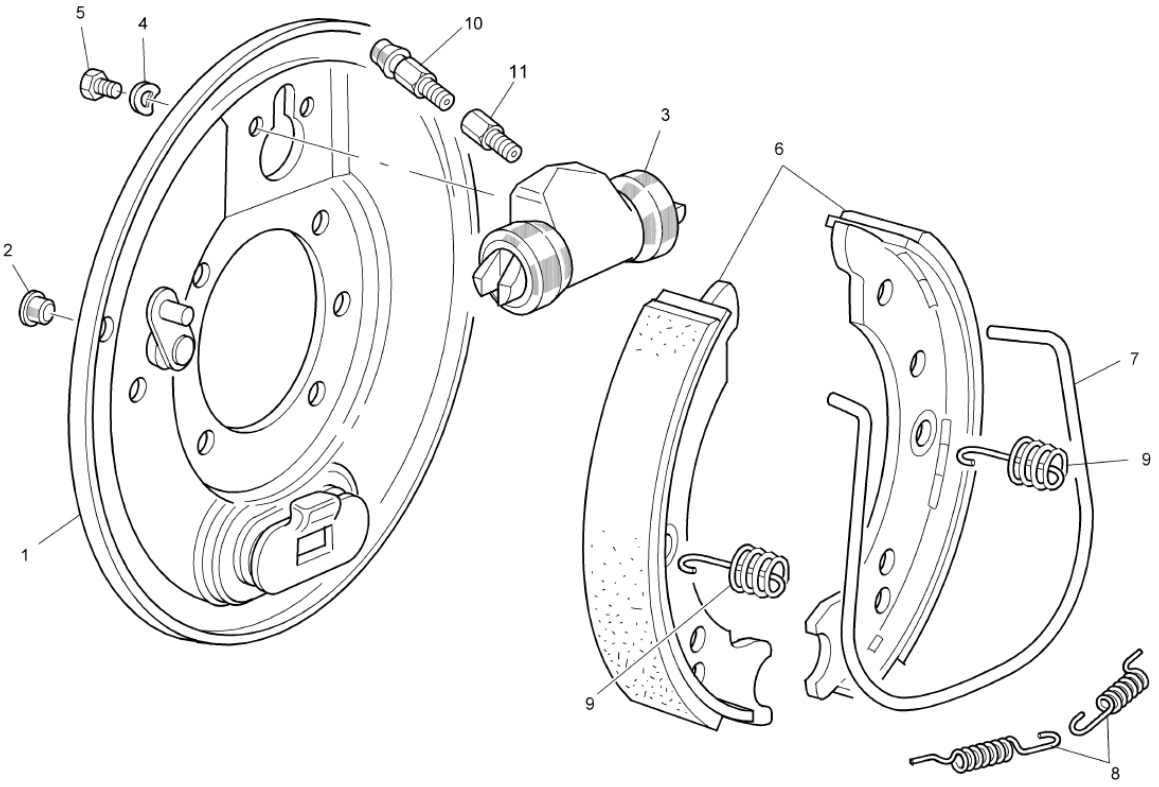
➢ After installing the coil assembly, ensure that the two M6 x 55 mm socket head transportation screws are removed.

➢ Reconnect connector 1X78

➢ Test the brake for correct operation

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Load wheel brakes



1	Back plate	7	Spring
2	Plug	8	Tension spring
3	Slave cylinder	9	Compression spring
4	Wavy washer	10	Bleed nipple
5	Hexagon head screw	11	Adaptor
6	Brake shoe		

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

Hydraulic brake fluid pressure applied to each slave 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.

Brake shoe removal

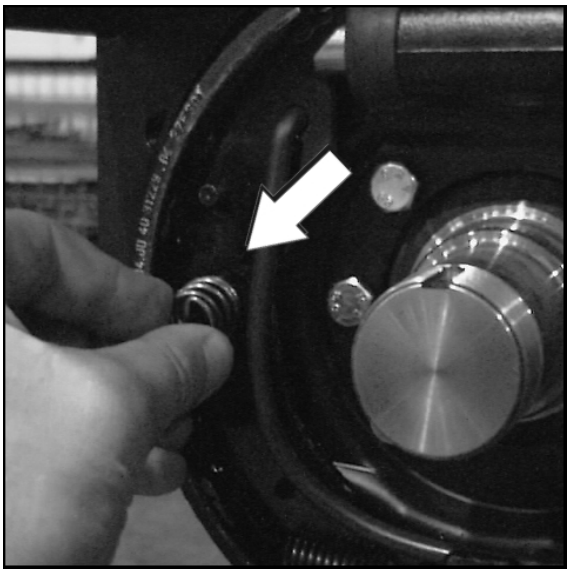
The brake shoes need little maintenance. They require only periodical inspection for damage and wear. Check the thickness of the brake linings. These should be examined every 2000 hours. Brake shoes should be replaced if the linings are worn. Minimum thickness at the most worn part 1.0 mm.

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Always replace a set of brake shoes. Use only 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 wheel securely.
- With a suitable jack or lifting equipment raise load wheel clear of the ground and securely chock under the reach legs.
- Remove the load wheel. Refer to relevant procedure.
- 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.

▷



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

▷

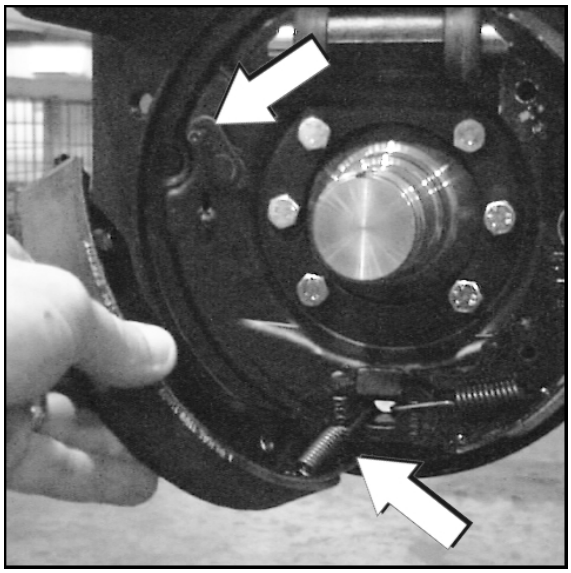


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Brake installation

- 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.

Brake shoe installation

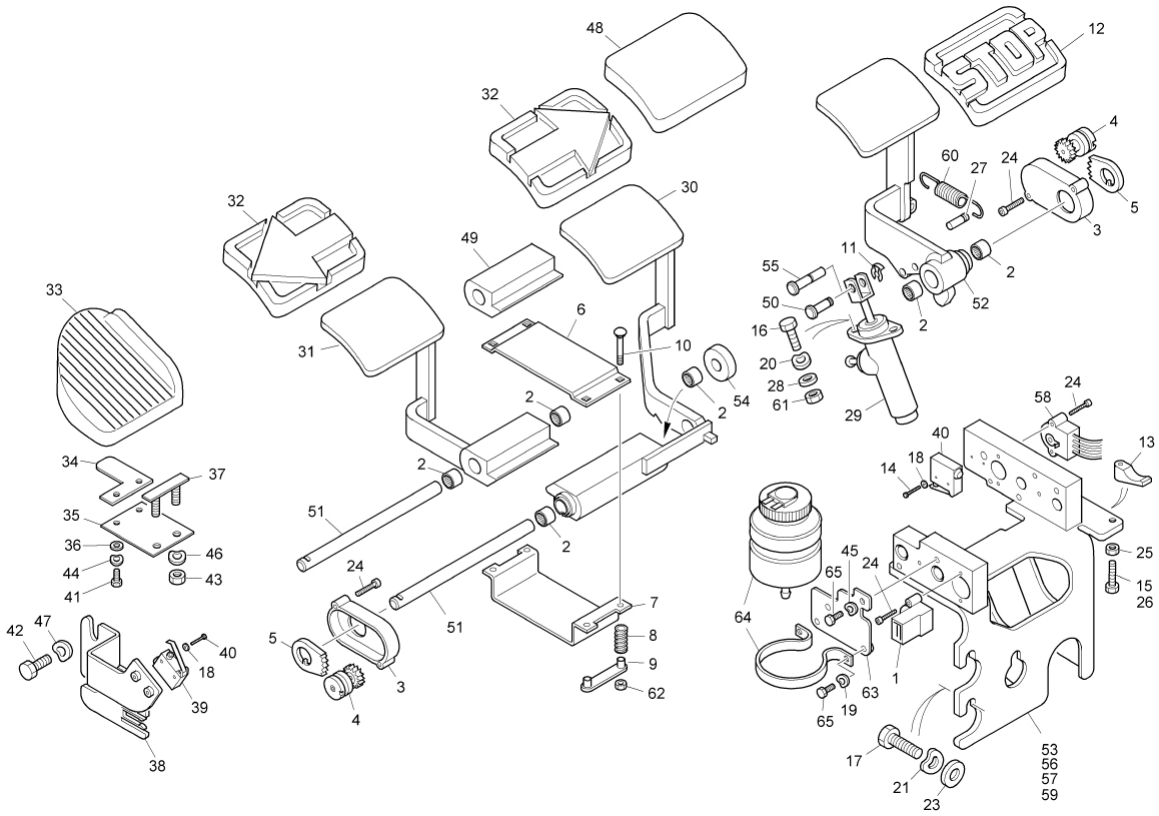
- To reassemble the brake shoes reverse the removal procedure. Ensure all springs are fitted correctly, and that the restraining wire or band is removed from the cylinder body.
- Refit load wheel. Refer to relevant procedure.

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.

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Drive and brake controls

Accelerator and brake pedals



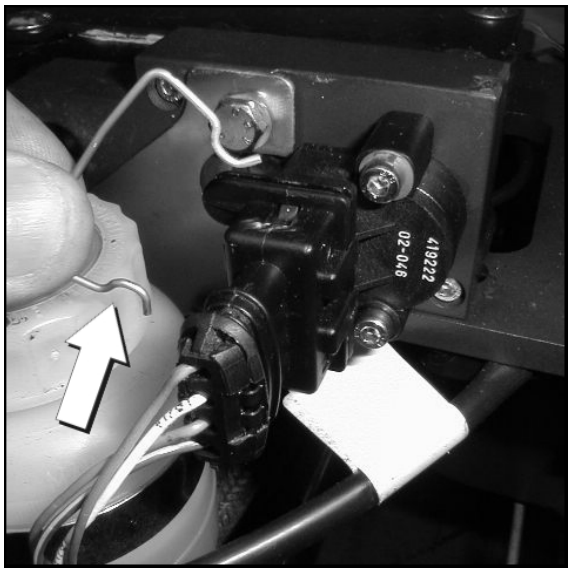
1	Potentiometer	31	Accelerator pedal assembly
2	Needle bearing	32	Accelerator pedal rubber
3	Housing	33	Left foot pedal
4	Gear	34	Spring plate
5	Gear	35	Spring
6	Bracket	36	Washer
7	Bracket	37	Retaining plate
8	Spring	38	Bracket
9	Spring guide	39	Microswitch
10	Truss head screw	40	Hexagon head screw
11	Retaining clip	41	Hexagon head screw
12	Brake pedal rubber	42	Hexagon head screw
13	Cable clip	43	Hexagon nut
14	Hexagon head screw	44	Wavy washer
15	Hexagon head screw	45	Wavy washer
16	Hexagon head screw	46	Spring washer
17	Hexagon head screw	47	Spring washer
18	Spring washer	48	Accelerator pedal rubber (single pedal)
19	Wavy washer	49	Spacer for single pedal
20	Spring washer	50	Pin
21	Spring washer	51	Shaft
22	Washer	52	Brake pedal assembly
23	Washer	53	Pedal box assembly
24	Socket head screw	54	Bush
25	Hexagon nut	55	Pin
26	Hexagon head screw	56	Pedal box assembly
27	Grooved pin	57	Pedal box assembly
28	Washer	58	Potentiometer harness
29	Brake master cylinder	59	Pedal box assembly
30	Accelerator pedal assembly	60	Spring clip

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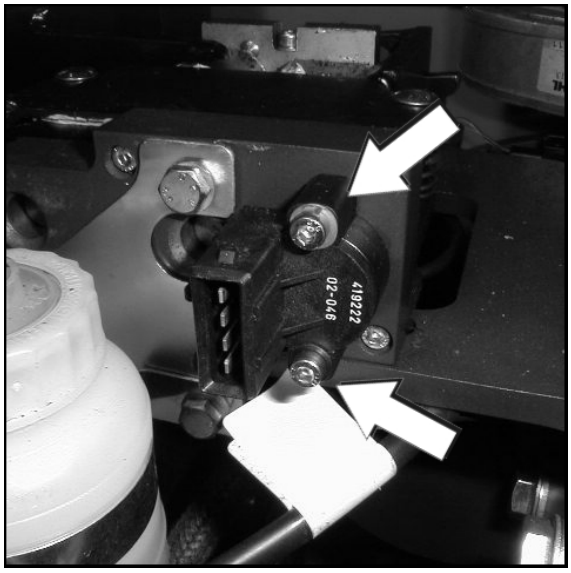
61 Hexagon nut
62 Hexagon nut
63 Bracket
64 Reservoir
65 Hexagon head screw

Accelerator unit removal

- Chock the load wheels securely, turn the keyswitch off and disconnect the battery.
- Remove the floorplate.
- Remove the securing clip, and disconnect the 4 way accelerator connector 1X10. ▷



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



Accelerator unit installation

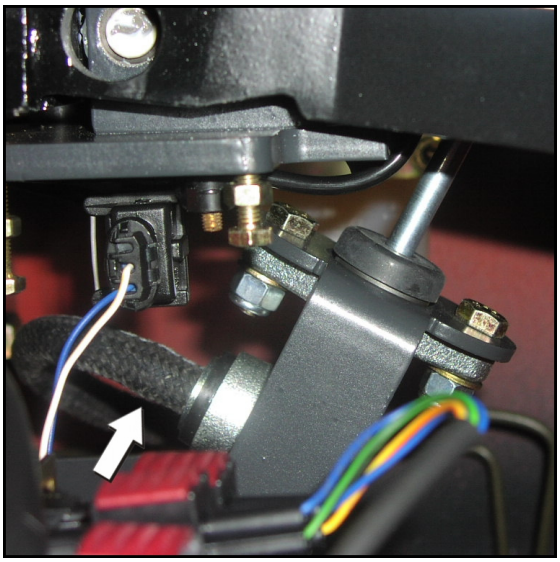
- To refit the accelerator, reverse the removal procedure. Ensure that the microswitch actuating cam locates correctly.
- After refitting, the accelerator should be calibrated using diagnostic software. Refer to relevant procedure.

Master cylinder removal

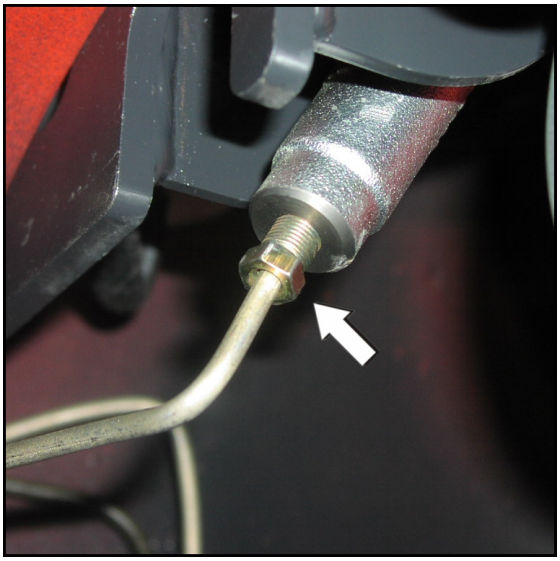
- Reach the battery out fully.
- Chock the load wheels securely, turn the keyswitch off and disconnect the battery.
- Remove the floorplate.

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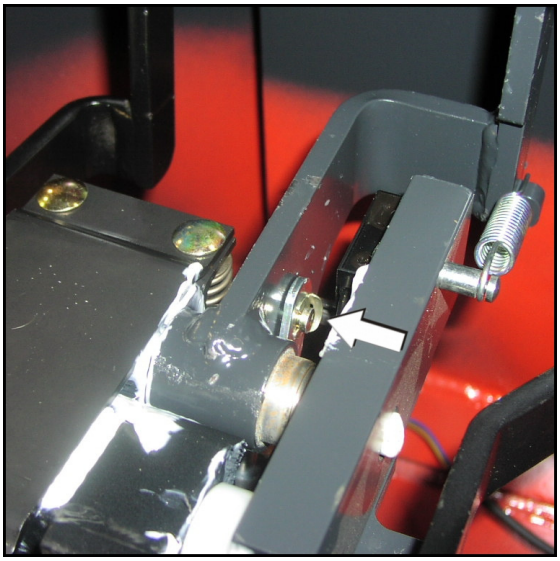
➢ Disconnect the feed pipe from the master cylinder and drain the brake fluid reservoir. ▷



➢ Disconnect brake pressure pipe. ▷



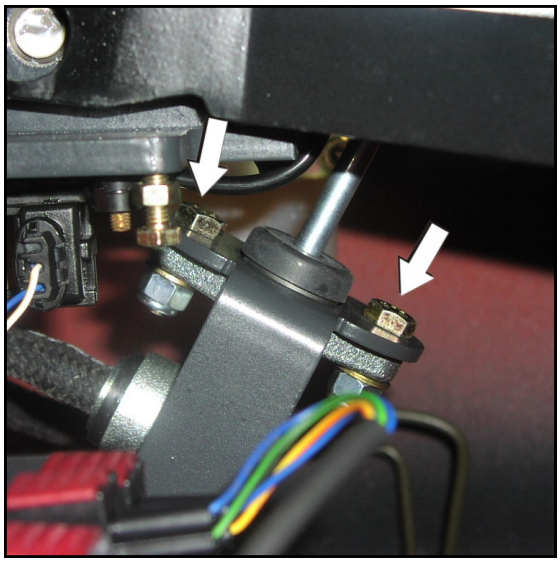
➢ Remove the split pin, depress the pedal fully, and extract the clevis pin. ▷



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➢ Remove the two screws which secure the master cylinder, noting the position of any washers for re-assembly.

▷



Master cylinder installation

To replace the master cylinder, reverse the removal procedure.

➢ When securing the master cylinder to the mounting bracket, ensure that any washers previously removed are replaced in the correct position.

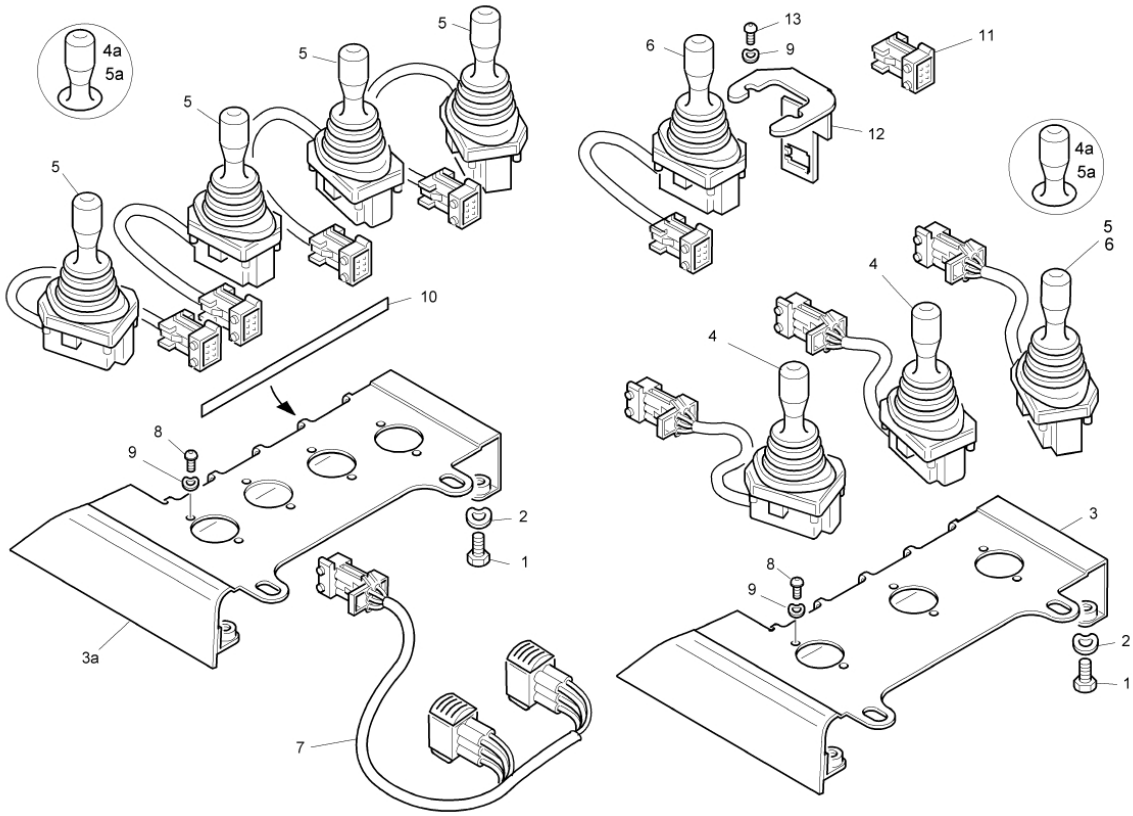
➢ Torque the pressure pipe to 10 Nm

➢ Replenish the reservoir with fresh brake fluid and bleed the brake system. Refer to relevant procedure.

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Operating elements

Joysticks



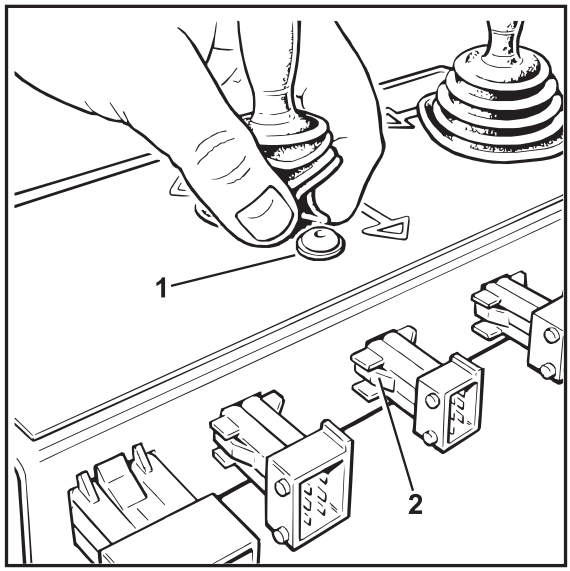
1	Hexagon head screw	8	Raised head screw
2	Spring washer	9	Wavy washer
3	Bracket assembly	10	Label
4	Joystick (dual axis)	11	Harness assembly
5	Joystick (single axis)	12	Bracket (5th Hydraulics)
6	Joystick with interlock button	13	Button head screw
7	Harness		

Removal

- Chock load wheels securely. Reach battery out. Disconnect battery and apply the hand-brake.
- Open the top covers.
- Remove the four screws securing the lever mounting bracket to the chassis.
- Disconnect the relevant lever connector.

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- 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.



Installation

- 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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Battery and accessories

The battery

Connecting the battery to an external charger

⚠ WARNING

Batteries can be hazardous when being handled and maintained. During charging, explosive hydrogen gas is released.

- Always handle, charge and maintain batteries according to the manufacturer's instructions supplied with the battery.
- Protective equipment i.e. goggles and gloves must be worn at all times when working on batteries.
- Do not expose the battery to sparks or naked flames.
- Only charge batteries is designated areas.
- Battery charging and storage areas must be well ventilated.
- Always follow the manufacturer's instructions supplied with the battery charger.

If you do not have these instructions, then please contact you local distributor.

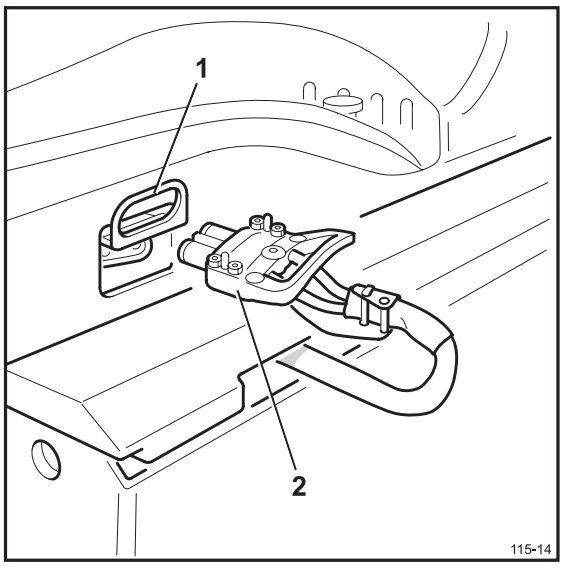
- Lower the forks.
- Turn the keyswitch off and depress the emergency isolator.

⚠ CAUTION

Connecting or disconnecting the battery with the truck switched on could cause damage to electrical components.

Before connecting or disconnecting the battery, ensure the truck is switched off, and the emergency isolator is depressed.

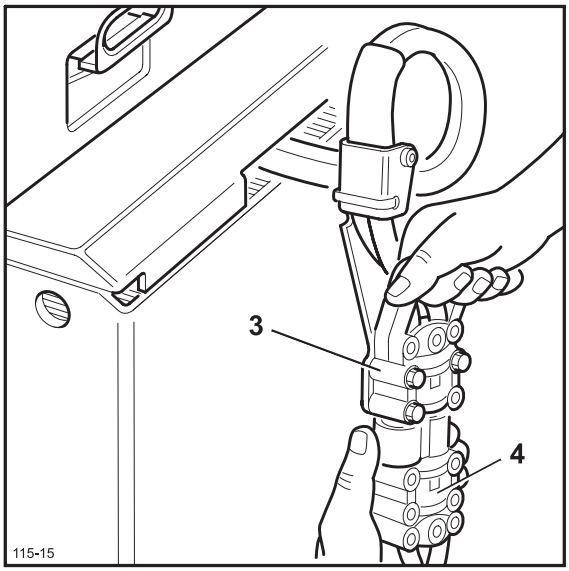
- Release the battery connector locking plate (1) and unplug the battery connector (2). ▷



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➢ Insert the charger connector (4) into the battery connector (3).

➢ Switch on the battery charger.



Reaching the battery out

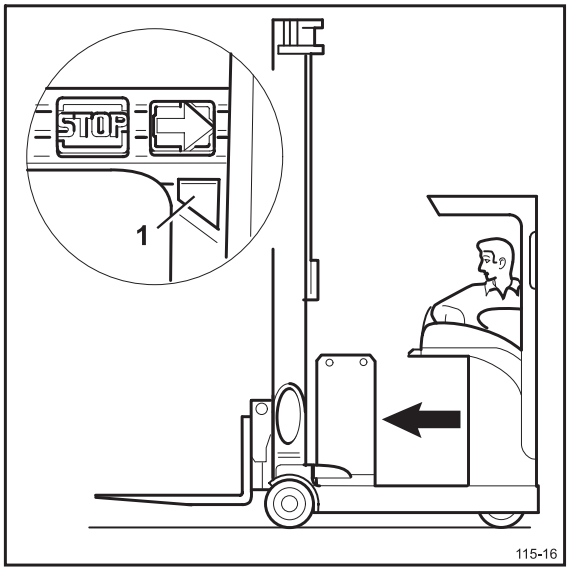
The battery must be reached out for inspection or routine maintenance.

➢ Lower the forks to just above the ground.

➢ Return the mast to the fully reached back position.

➢ Lift the battery trolley locking lever (1) and reach the battery forward. The battery unlocked warning indicator on the operator's display will illuminate.

➢ To relocate the battery, operate the reach lever to reach the battery in until the battery unlocked warning indicator on the operator's display extinguishes.



⚠ CAUTION

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

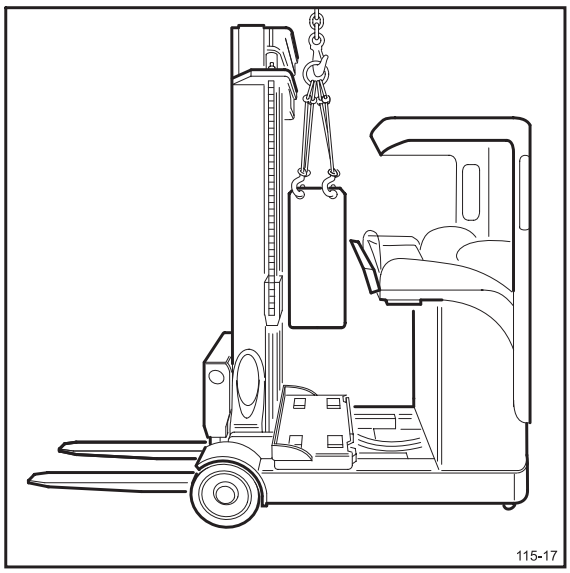
⚠ DANGER

Do not use the truck with the battery reached forward.

Changing the battery (hoist method)

⚠ DANGER

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



⚠ CAUTION

Connecting or disconnecting the battery with the truck switched on could cause damage to electrical components.

Before connecting or disconnecting the battery, ensure the truck is switched off, and the emergency isolator is depressed.

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

➢ Reach battery fully forward.

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- Apply the parking brake, 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.
- Reconnect the battery, ensuring the battery connector locking plate is engaged.
- Turn the keyswitch on and operate the reach lever to reach the battery in until the battery unlocked warning indicator on the operator'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.

Any deviations in size or weight, please contact your local representative.

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Changing the battery (roll on, roll off)

⚠ WARNING

Manual handling risk. The battery is heavy.

Take care when manoeuvring the battery from the chassis.

⚠ CAUTION

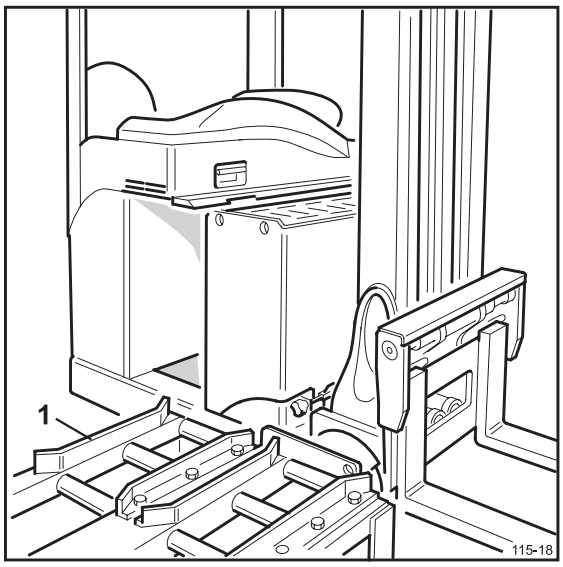
Before changing the battery, ensure that the roller stand is adjusted so that it's rollers are level with those on the truck battery trolley. Failure to do so could cause damage to the battery trolley rollers and locking mechanism.

⚠ CAUTION

Connecting or disconnecting the battery with the truck switched on could cause damage to electrical components.

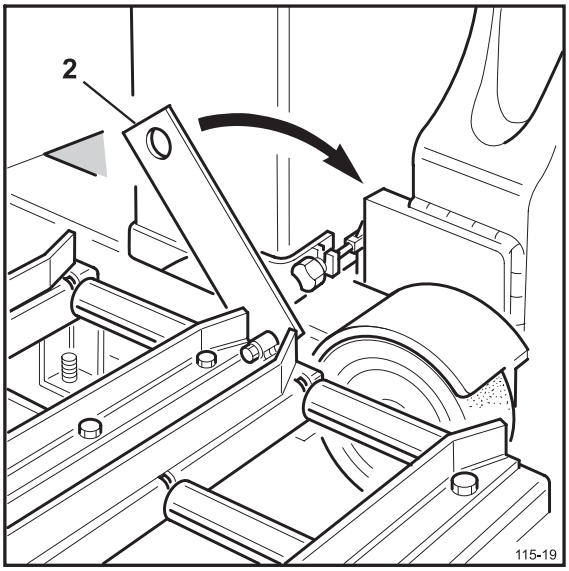
Before connecting or disconnecting the battery, ensure the truck is switched off, and the emergency isolator is depressed.

- ➢ 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.
- ➢ Apply the parking brake, turn the keyswitch off, and depress the emergency isolator.
- ➢ Release the battery connector locking plate and unplug the battery from the truck.



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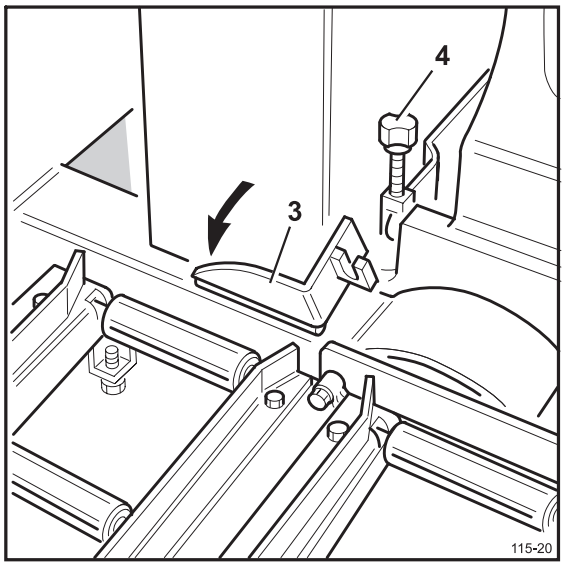
➢ Open the latch (2)on the roller stand. ▷



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.

➢ Apply the parking brake, turn the keyswitch off, and depress the emergency isolator.

➢ Disconnect the slave lead.

➢ Connect the truck battery plug, ensuring that the battery locking plate is engaged.

➢ Release the emergency isolator, switch on, and operate the reach lever to reach the battery in until the battery unlocked warning indicator on the operator'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.

Any deviations in size or weight, please contact your local representative

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Battery lock sensor

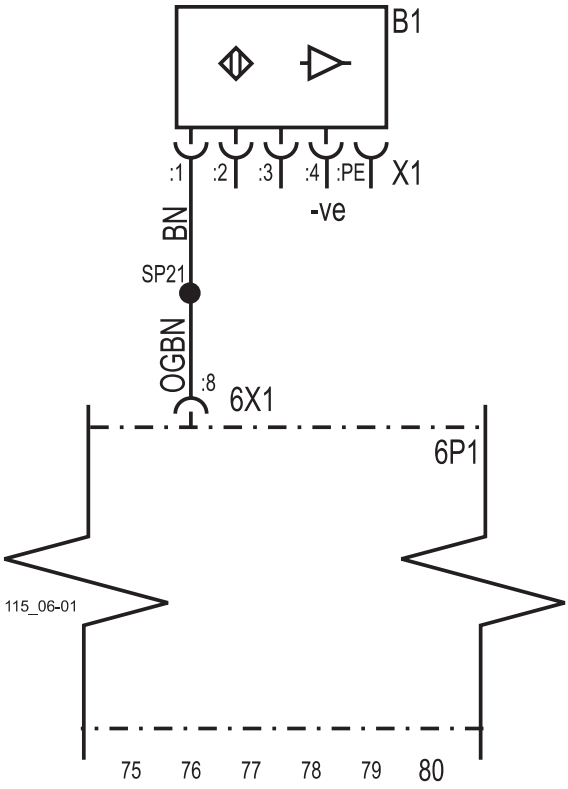
Battery lock sensor B1, which is monitored by the display via 6X1:8 will detect when the battery is unlocked.

The display will indicate when the battery is unlocked.

The status of the sensor B1 can be verified using diagnostic software:

Inputs + Outputs
▼
Display
▼
Supplies

The battery lock sensor clearance is 3.5 mm ±0.5 mm



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Electrical control

EMC – Electromagnetic compatibility

Electromagnetic compatibility (EMC) is a key quality feature of the truck.

EMC involves

- limiting the emission of electromagnetic interference to a level that ensures the troublefree operation of other equipment in the environment.
- ensuring sufficient resistance to external electromagnetic interference so as to guarantee proper operation at the planned usage location under the electromagnetic interference conditions to be expected there .

An EMC test thus firstly measures the electromagnetic interference emitted by the truck and secondly checks it for sufficient resistance to electromagnetic interference with reference to the planned usage location . A number of electrical measures are taken to ensure the electromagnetic compatibility of the truck .

⚠ CAUTION

The EMC regulations for the truck must be observed.

When replacing truck components the protective EMC components must be installed and connected again.

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AC Control - operating principle

On a typical 3 phase AC induction motor the current in the three windings is controlled by a "bridge" of six MOSFETS. By controlling when each of the six MOSFETS is on or off, it is possible to cause the current in each of the three motor windings (phases) to flow in either direction.

Motor winding phase one

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Motor winding phase two

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Motor winding phase three

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- Also, by varying the amount of time each MOSFET spends in conduction (2 and 3), it is possible to control the average voltage applied to each motor winding at any moment in time. In this way a near sinusoidal voltage (1) is applied to each winding as the motor rotor rotates.

  ▷ [File not found:
  x.eps]

- The frequency that the six MOSFETS switch on and off, is much faster than that of the AC supply seen by the motor. Typically, the traction and lift motors will see an AC frequency of 75 Hz at maximum speed, although the MOSFETS will be switched ON and OFF at 8 Khz to enable this 75 Hz to be accurately synthesised.

- High speed microprocessors are used to carry out the complex mathematical calculations required to sequence this operation in order to generate a 3 phase variable rotating magnetic field. The synthesised AC supply applied to the motor windings is therefore of variable AC frequency and voltage. The motor speed and available torque is controlled very accurately when driving and also when acting as an electric brake returning energy to the battery.

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Speed and direction control

The speed of the truck is proportional to the frequency of the supply applied to the motor. The direction of travel is dependent on the direction

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of current flow through the three motor windings relative to each other.

When the applied AC frequency is low, the average AC voltage applied to the motor windings is also low. On initial application of the accelerator the AC motor voltage and frequency will be low. As the speed of the truck increases the AC frequency and voltage increase simultaneously.

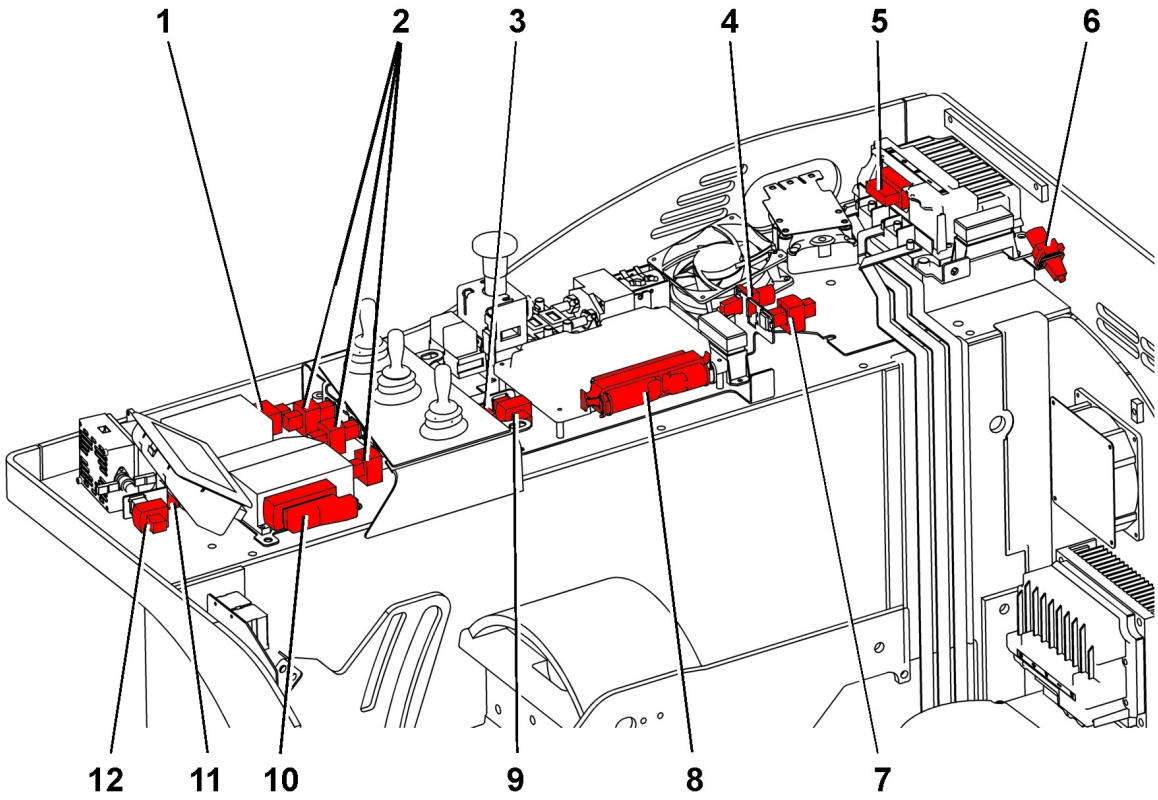
With AC induction motors as used on 115-03, maximum torque is achieved when the rotational speed of the motor is very slightly less than that determined by the AC voltage generated by the controller - the "synchronous speed". This small difference is called "slip". The controller regulates both motor voltage and frequency to ensure that the slip is maintained at optimum for efficient performance.

The controller monitors the motor current and in order to ensure that this does not become excessive will automatically override the accelerator demand and reduce the AC frequency and voltage when necessary.

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Connector locations

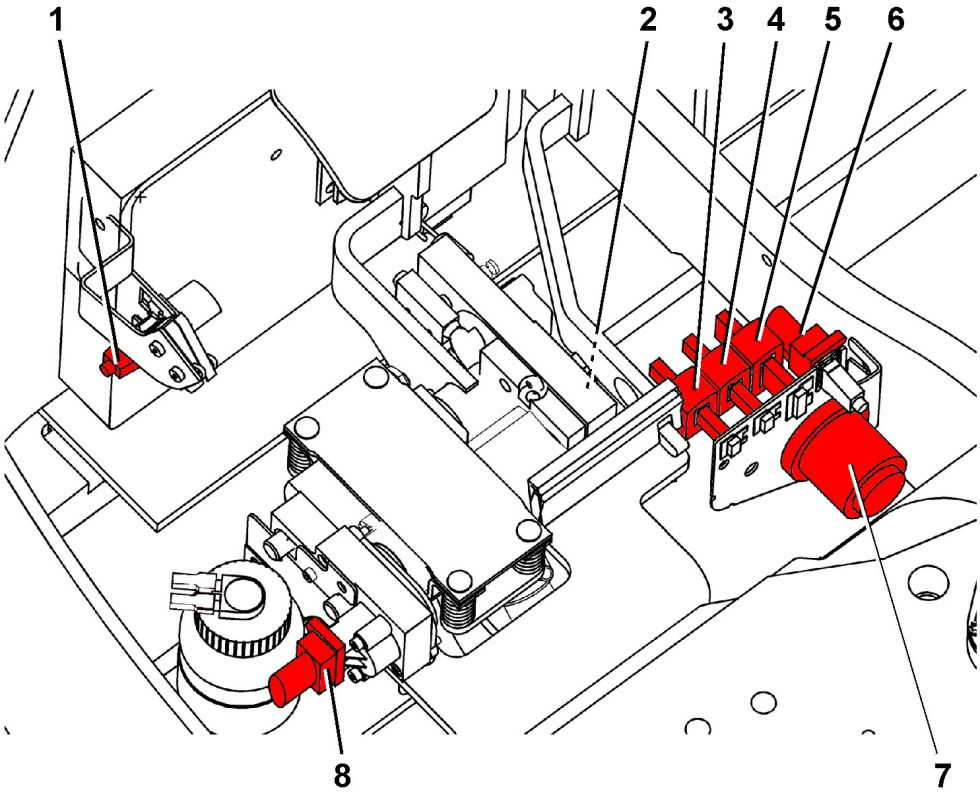
Connector locations under the top cover



Position	Connector	Duty
1	X8	DC/DC Converter
2	2X15 2X26 2X27	Joysticks
3	6x63	UPA
4	9X1	Traction module cooling fan
5	1X17	Traction power module
6	9X12	Hydraulic module cooling fan
7	1X9	Direction switch
8	X13	Control module
9	X12	Charge resistor
10	1X81	Variable brake module (option)
11	6X1	Display
12		Joystick heater (option)

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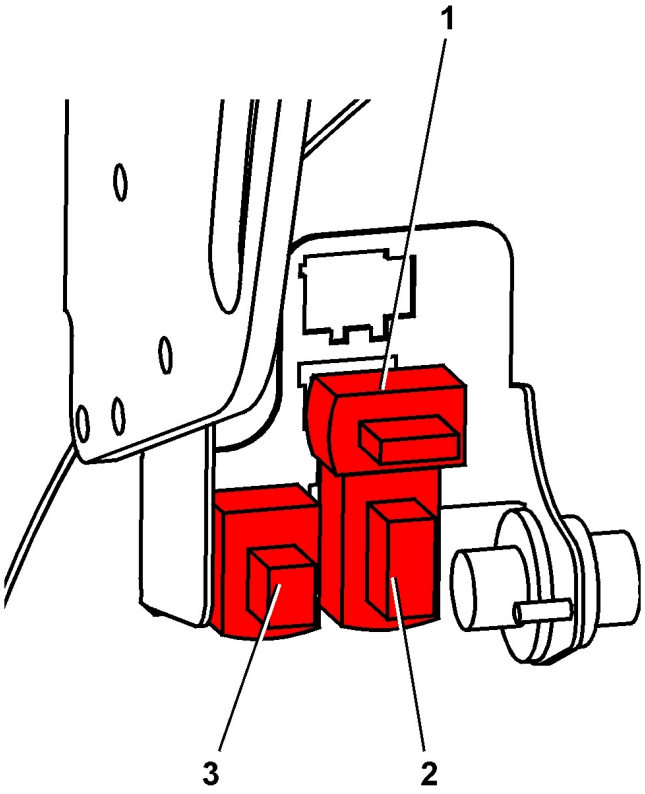
Connector locations under the floor plate



Position	Connector	Duty
1	1X38	Left foot switch
2	1X14	Footbrake
3	1X34	Travel alarm
4	4X1	Horn
5	1X80	Brake potentiometer
6		
7	2X20	Reach carriage
8	1X10	Acclerator

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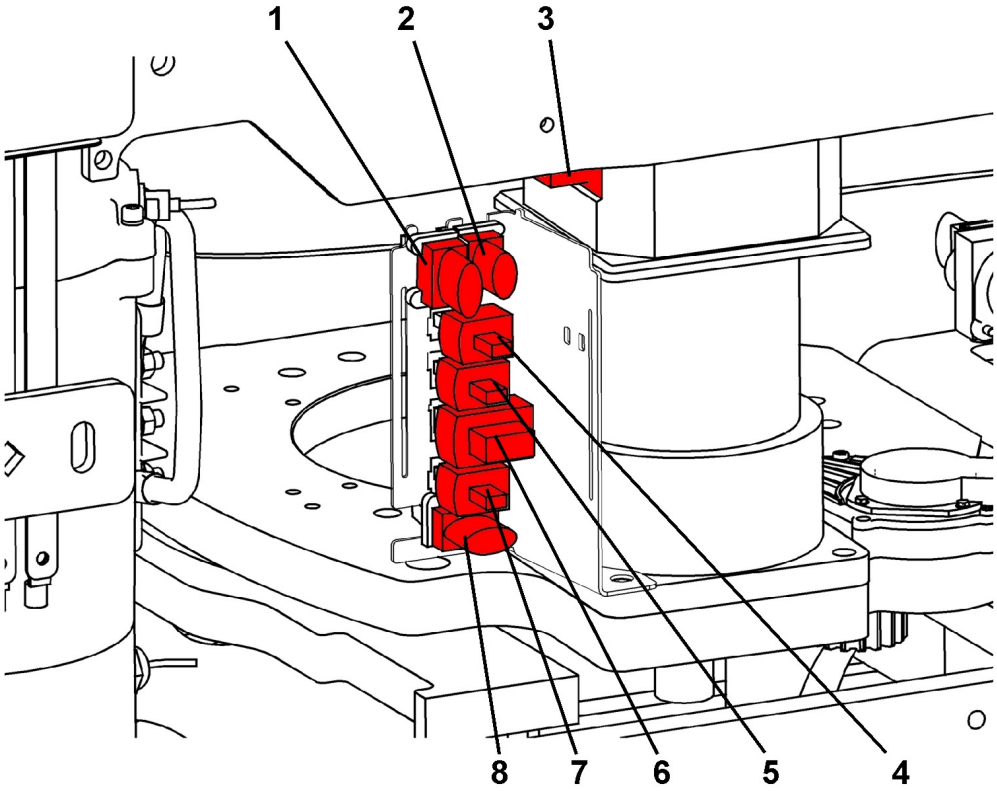
Connector locations within the steering binnacle



Position	Connector	Duty
1	5X1	Lighting supplies
2	X5	Steering binnacle
3	3X4	Steering potentiometer

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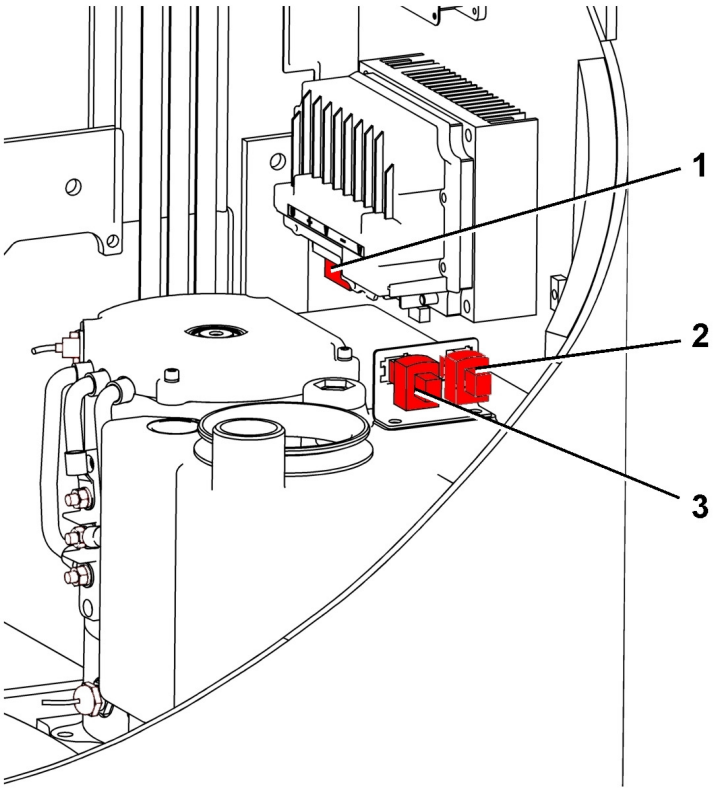
Connector locations on the steering motor bracket



Position	Connector	Duty
1	2X83	Hydraulic motor speed sensor
2	1X16	Traction motor speed sensor
3	3X1	Steering unit
4	2X7	Hydraulic motor temperature sensor
5	1X78	Electromagnetic brake
6	3X15	Steering interface
7	1X7	Traction motor temperature sensor
8	9X2	Traction motor cooling fan

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Connector locations under the motor cover



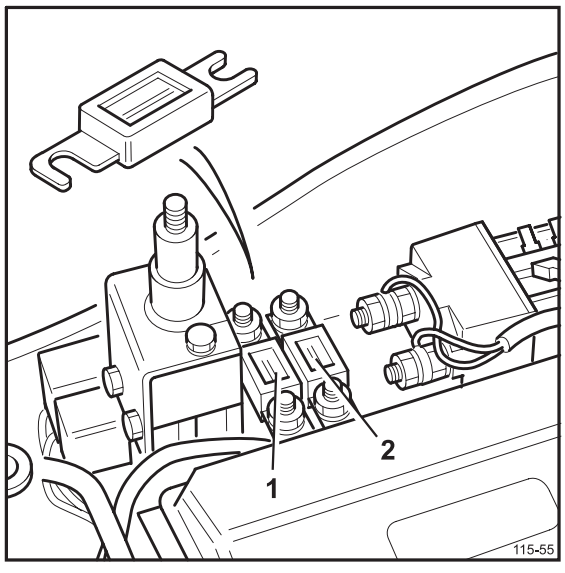
Position	Connector	Duty
1	2X37	Hydraulic power module
2	1X32	Seat
3	5X27	Lighting supplies

Fuses

Main circuit fuses

The fuses for the main circuits are:

1 3F1 50A Power steering pump motor
2 1F1 425A Main power circuits



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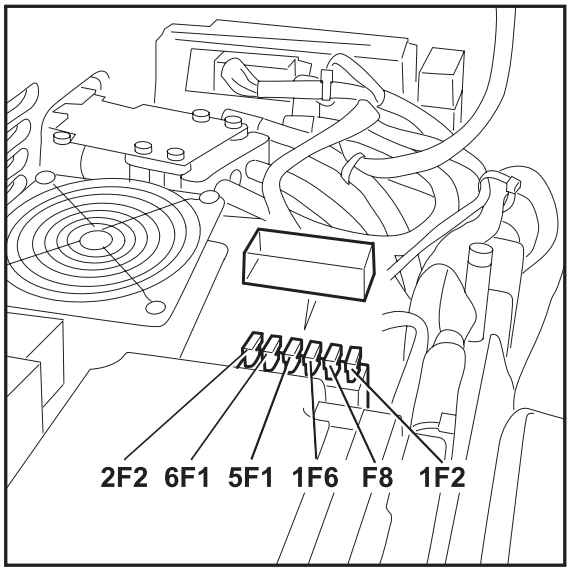
Ancillary circuit fuses

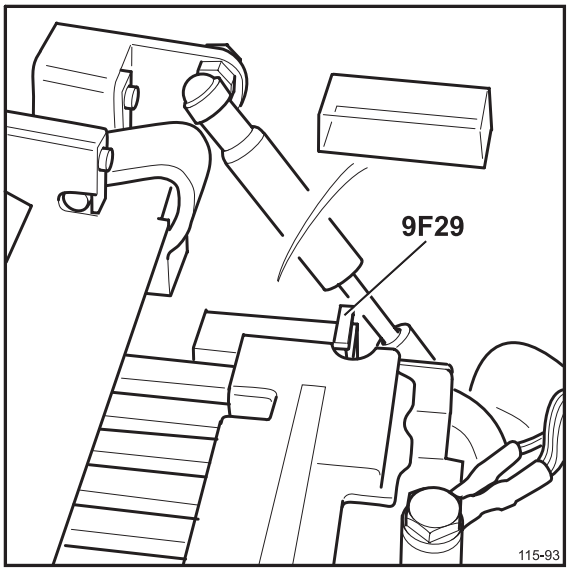
The fuses for the ancillary circuits are:

F8	5A	Truck control circuits
1F2	10A	Truck control circuits
1F6	5A	Horn
2F2	5A	Hydraulic valves
5F1	5A	Lighting
6F1	5A	Battery monitor
9F29	5A	Cooling fans

NOTE

Although these fuses are interchangeable with automotive fuses, automotive fuses MUST NOT be used. Only fuses supplied by the manufacture have sufficient voltage capability to ensure correct operation at truck voltages.





Emergency isolator

➢ When operated, the emergency isolator S2 breaks the main battery positive feeds to the hydraulic, traction and steering circuits.

⚠ CAUTION

Connecting or disconnecting the battery with the truck switched on could cause damage to electrical components.

Before connecting or disconnecting the battery, ensure the truck is switched off, and the emergency isolator is depressed.



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13 Volt power supply

➢ With the keyswitch S1 turned on, DC-DC converter U1 provides a stabilised 13 volt supply to : ▷

Motor speed sensors 1B1 and 2B8
Power modules 1A1 and 2A1
Control module A2
Operator's display 6P1
Height encoder 1B12
Reference sensor 8B5
Lift stop sensor 2B20
Reach sensors 2B18 and 2B21
Steering wheel potentiometer 3R11
Steering module 3A1
Diagnostic port 1X15
UPA connector 6X63
Lighting supply connector 5X1
Keypad (if fitted)

The output voltage of converter U1 can be verified using diagnostic software:

Inputs + Outputs
▼
Display
▼
Supplies

and

Inputs + Outputs
▼
LAC-T
▼
Voltages

and

Inputs + Outputs
▼
LAC-L
▼
Voltages

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Control module (LDC 61) - A2

The digital control module A2 employs two microprocessors. One microprocessor controls hydraulics, and also acts as the safety processor for traction. The second microprocessor controls traction, and also acts as a safety processor for hydraulics. Should an error occur, it will be instantly detected and the control system will take appropriate action. This action may be a reduction in performance, or a system shut down depending on the severity of the fault.

The control module is fitted with two close coupled connectors which are numbered as one. In total, these two connectors have 121 pins. The connector is designated X13. Part A (1) has 81 pins, Part B (2) has 40 pins. The pins are grouped according to their usage.

NOTE

The traction power module 1A1, hydraulic power module 2A1 and electronic control module A2 are interconnected by second local CAN bus (CAN 2).

Connector X13

Connector X13

PIN	TRAC/HYD	DUTY	(INPUTS + OUTPUTS)
1	Traction	Main contactor –ve coil connection	Traction > Digital In / Out
2	Both	Battery negative supply for module	
3	Traction	Main contactor +ve coil connection (Safety Relay Output)	Traction > Digital In / Out Traction > Supplies
4	Traction	Battery positive supply (Safety Relay Input)	
5		Not connected	
6	Both	13 volt supply for module	
7		Not connected	
8	Traction	Parking brake –ve connection	
9	Traction	Enable to LAC (Traction)	Traction > Digital In / Out
10		Not connected	
11	Hydraulic	CAN bus 1 Truck (CAN High)	
12	Hydraulic	CAN bus 1 Truck (CAN Low)	
13	Hydraulic	Enable to LAC (Lift)	
14		Not connected	
15	Traction		
16	Traction		

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PIN	TRAC/HYD	DUTY	(INPUTS + OUTPUTS)
17	Traction	Input: Direction lever reverse	Traction > Switches
18	Traction	Input: Motor speed sensor signal-B	
19	Traction	Potentiometer: Accelerator U1 signal	Traction > Accelerator
20	Traction	Potentiometer: Accelerator U2 signal	Traction > Accelerator
21	Traction	Potentiometer: Steering C1 signal	
22		Not connected	
23	Traction	LAC power supply voltage (battery/capacitor voltage)	Traction > Supplies
24	Traction	Traction motor phase L1	
25		Not connected	
26		Not connected	
27		Not connected	
28		Not connected	
29		Not connected	
30	Hydraulic	CAN bus 2 LAC (CAN High)	
31	Hydraulic	CAN bus 2 LAC (CAN Low)	
32		Not connected	
33	Both	Input: Seat switch	Traction > Switches
34	Traction	Input: LAC status	Traction > Digital In / Out
35	Traction	Input: Parking brake switch/button	Traction > Switches
36	Traction	Input: Direction lever forwards	Traction > Switches
37	Traction	Input: Motor speed sensor signal-A	
38		Not connected	
39		Not connected	
40		Not connected	
41		Not connected	
42	Hydraulic	LAC power supply voltage (battery/capacitor voltage)	
43	Traction	Traction motor phase L2	
44	Traction	Relay output 1	Traction > Digital In / Out
45	Traction	Relay output 2	Traction > Digital In / Out
46	Hydraulic	Not used	
47	Traction	CAN bus 1 Truck (CAN High)	
48	Traction	CAN bus 2 LAC (CAN High)	
49	Traction	Not used	
50	Both	Not used	
51	Hydraulic	Input: LAC status	
52	Traction	Input: Steering drive enable signal	Traction > Steering Inputs
53	Traction	Input: UPA Traction	
54	Traction	Input: Footbrake switch	Traction > Switches
55	Traction	Input: Left foot switch	Traction > Switches
56		Not connected	
57	Traction	Potentiometer: Steering C1 signal	
58		Not connected	
59		Not connected	
60	Hydraulic	Accelerator 5 volt supply	Traction > Accelerator

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PIN	TRAC/HYD	DUTY	(INPUTS + OUTPUTS)
61		Not connected	
62	Traction	Traction Motor Phase L3	
63	Traction	Relay output 3 (travel alarm)	Traction > Digital In / Out
64	Traction	Relay output 4 (K2 charge relay)	Traction > Digital In / Out
65	Hydraulic	Not used	
66	Traction	CAN bus Truck 1 (CAN Low)	
67	Traction	CAN bus 2 LAC (CAN Low)	
68	Traction	Not Used	
69	Both	Not Used	
70	Both	Not Used	
71		Not connected	
72	Traction	Digital: Speed override	Traction > Switches
73	Traction	Potentiometer: Brake pedal U1 (variable electric brake)	
74	Traction	Input: Direction switch neutral	Traction > Switches
75		Not connected	
76	Traction	Potentiometer: Brake pedal U2 (variable electric brake)	
77		Not connected	
78		Not connected	
79	Traction	Accelerator 0 volt supply	
80		Not connected	
81		Not connected	
82	Hydraulic	Joystick Lift/Lower Y1	
83	Hydraulic	Joystick Reach X1	Hydraulics > Reach
84	Hydraulic	Joystick Tilt X1	Hydraulics > Sideshift
85	Both	Joystick and brake pedal potentiometer 0 volt supply	
86		Not connected	
87	Hydraulic	Digital: Spare	
88	Hydraulic	Valve output – Auxiliary 2	Hydraulics > 5th Hydraulics Hydraulics > 6th Hydraulics Hydraulics > Hyd. Boot-Up
89	Hydraulic	Valve output – Tilt forward	Hydraulics > Tilt Hydraulics > Hyd. Boot-Up
90	Hydraulic	Joystick Sideshift Y1	Hydraulics > Tilt
91	Hydraulic	Joystick 5th Hydraulic Y1	Hydraulics > 5th Hydraulics
92	Hydraulic	Joystick 6th Hydraulic X1	Hydraulics > 6th Hydraulics
93	Hydraulic	Joystick and brake pedal potentiometer 5 volt supply	
94	Hydraulic	Input: UPA Lift	
95		Not connected	
96	Hydraulic	Valve output – Auxiliary 1	Hydraulics > 5th Hydraulics Hydraulics > 6th Hydraulics Hydraulics > Hyd. Boot-Up
97	Hydraulic	Valve output – Tilt back	Hydraulics > Tilt Hydraulics > Hyd. Boot-Up

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PIN	TRAC/HYD	DUTY	(INPUTS + OUTPUTS)
98	Hydraulic	Joystick Lift/Lower Y2	
99	Hydraulic	Joystick Reach X2	Hydraulics > Reach
100	Hydraulic	Joystick Tilt X2	Hydraulics > Sideshift
101	Hydraulic	Digital: Spare	
102	Hydraulic	Input: Lift enable	
103	Hydraulic	Input: Motor Speed sensor signal-A	
104	Hydraulic	Valve output – 6th Hydraulic (1)	Hydraulics > 6th Hydraulics Hydraulics > Hyd. Boot-Up
105	Hydraulic	Valve output – Sideshift right	Hydraulics > Sideshift Hydraulics > Hyd. Boot-Up
106	Hydraulic	Joystick Sideshift Y2	Hydraulics > Tilt
107	Hydraulic	Joystick 5th Hydraulic Y2	Hydraulics > 5th Hydraulics
108	Hydraulic	Joystick 6th Hydraulic X2	Hydraulics > 6th Hydraulics
109	Hydraulic	Digital: Reach sensor B	Hydraulics > Reach
110	Hydraulic	Digital: Reach sensor A	Hydraulics > Reach
111	Hydraulic	Valve output – 5th Hydraulic (2)	Hydraulics > 5th Hydraulics Hydraulics > Hyd. Boot-Up
112	Hydraulic	Valve output – Lift	Hydraulics > Hyd. Boot-Up
113	Hydraulic	Valve output – Sideshift left	Hydraulics > Sideshift Hydraulics > Hyd. Boot-Up
114	Both	Battery negative supply for module	
115		Not connected	
116	Hydraulic	Battery voltage supply (Safety relay input)	
117	Hydraulic	Valve output – Lower lock	Hydraulics > Hyd. Boot-Up
118	Hydraulic	Valve (all) +ve connections (Safety relay output)	
119	Hydraulic	Valve output – Lower (proportional)	Hydraulics > Hyd. Boot-Up
120	Hydraulic	Valve output – Reach out (proportional)	Hydraulics > Hyd. Boot-Up
121	Hydraulic	Valve output – Reach back (proportional)	Hydraulics > Hyd. Boot-Up

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Charge resistor module - A11

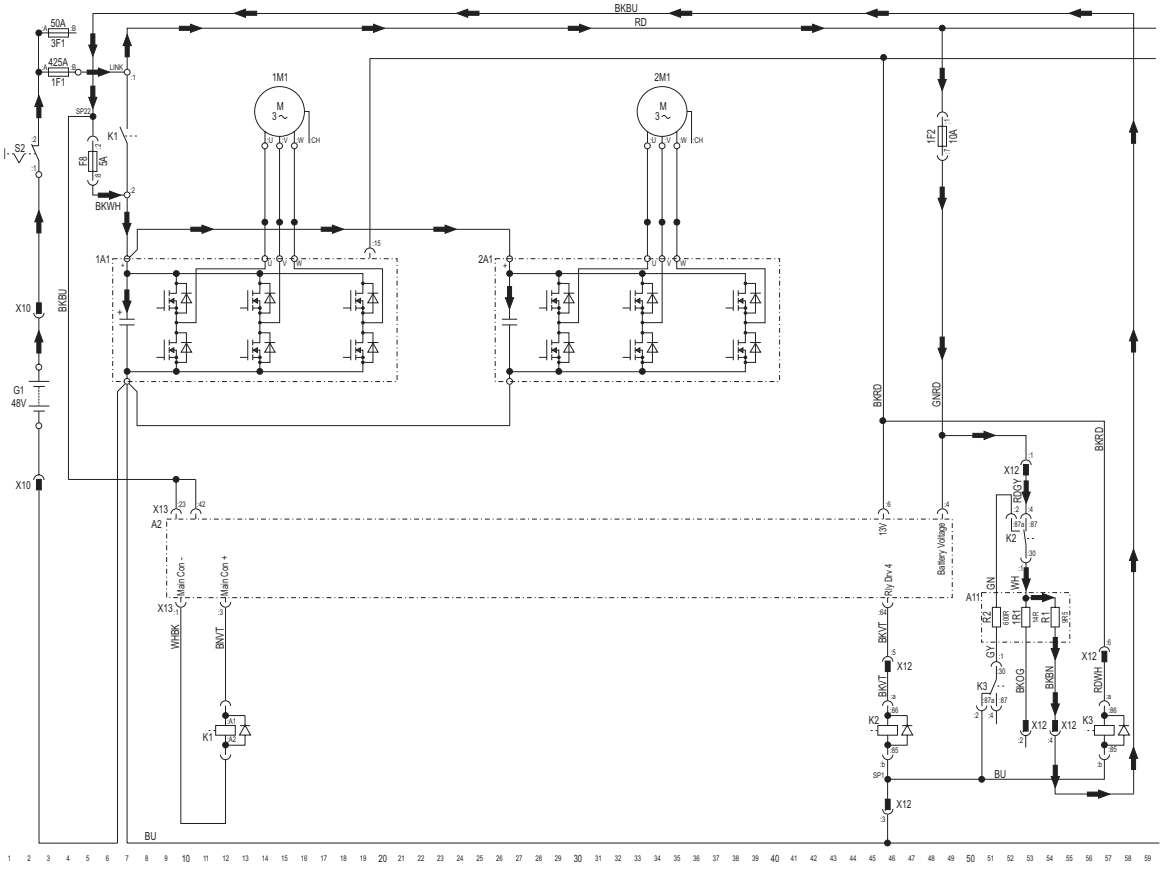
The reservoir circuit capacitors are located inside the power unit A1. In order to prevent very high current flowing across the contact tips of K1, these capacitors are pre-charged before K1 energises.

⚠ CAUTION

Before servicing the power supply or the power circuit, ensure that the reservoir circuit capacitors are discharged.

Measure between the positive and negative terminals of power module 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 re-checked before working on the system.

Switching on and charging the reservoir circuit capacitors



Pre-charging is carried out via a charging circuit using two relays K2 and K3. When the keyswitch is turned on, relay K3 is activated directly by DC converter U1. Relay K2 is activated by the electronics within control module A2. As soon as the two relays are activated, the capacitors in the power module can charge up via the charging resistor R1.

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Electrical control

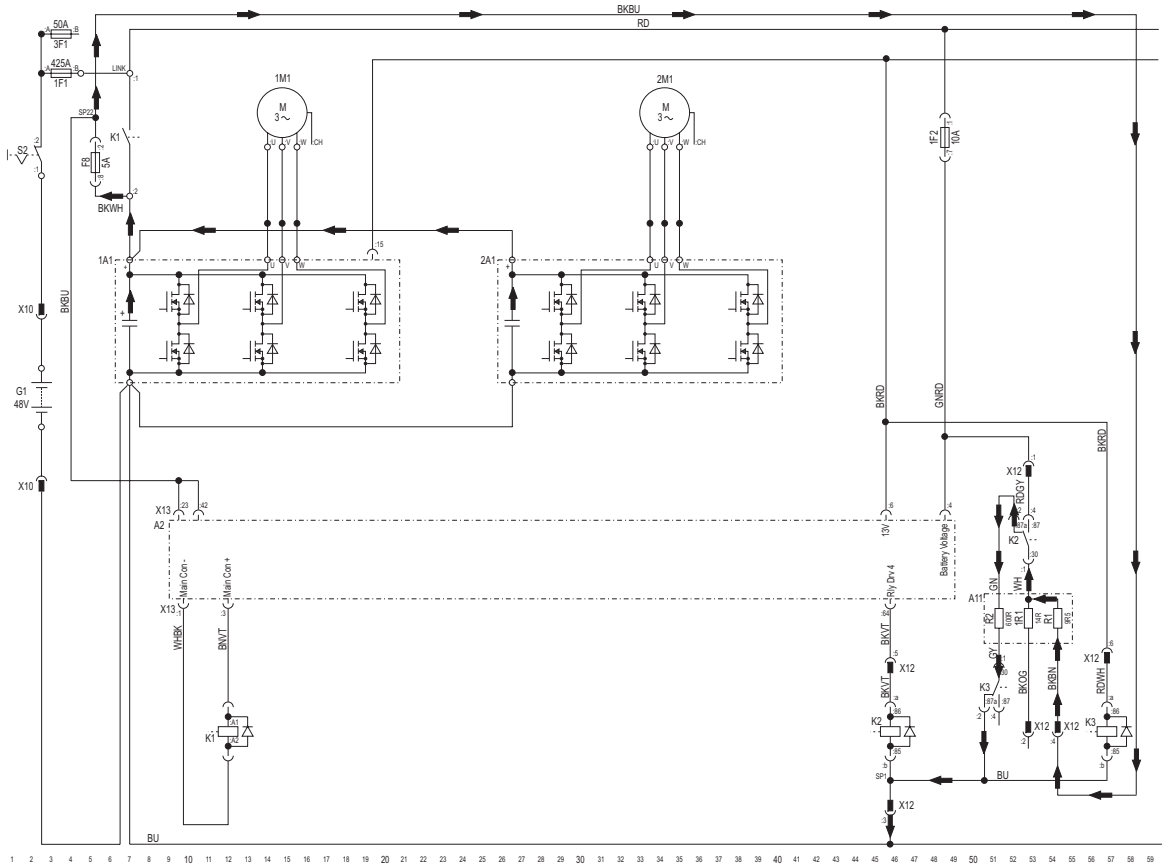
Only when the reservoir circuit capacitors are charged, can the activation of the main contactor K1 take place (monitored by an electronic circuit inside A2). Approximately five seconds after that, the relay K2 is switched off again, since the capacitors are now receiving their charging voltage via the contacts of the main contactor K1.

Should the capacitors fail to charge within approximately 2 seconds, then the control module A2 will indicate a fault in the charge circuit, and contactor K1 will not energise.

The status of contactors can be verified using diagnostic software:

Inputs + Outputs
▼
Traction
▼
Digital In / Out

Discharging the reservoir circuit capacitors



When the keyswitch is turned off, relays K2 and K3 are released, allowing the reservoir capacitors to discharge to battery negative through the closed contacts of K3, K2, R1 and R2 in series.

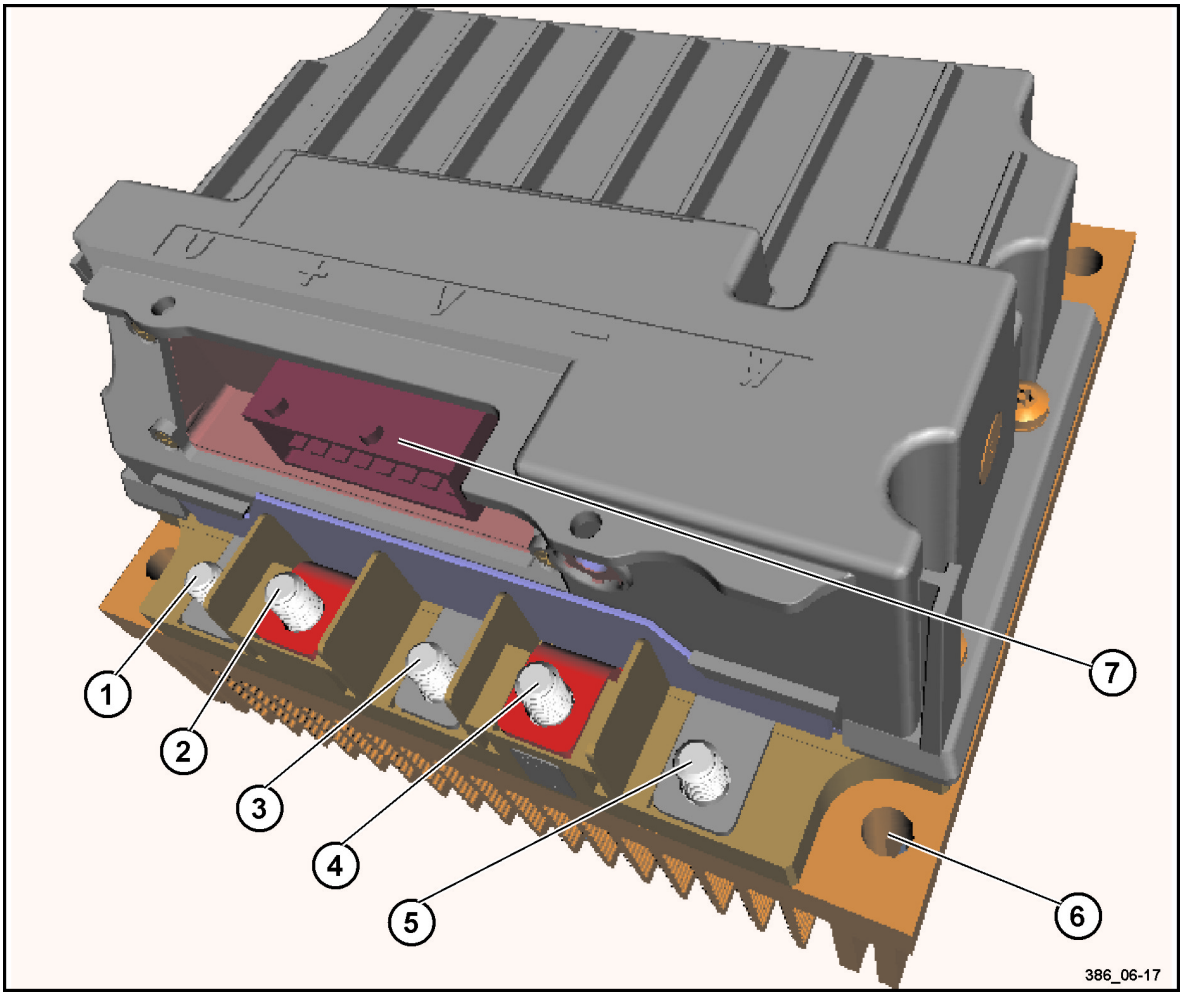
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Because the discharging circuit only operates when the truck is turned off, no monitoring of this circuit is carried out.

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Electrical control - Traction

Traction power module



1	Motor connection U1
2	Battery positive connection via line contactor K1 and positive supply to hydraulic power module
3	Motor connection V1
4	Battery negative connection and negative supply to hydraulic power module
5	Motor connection W1
6	Securing screw hole
7	Connector 1X17

⚠ CAUTION

Risk of damage due to electrostatic charge.

Do not touch the 16 way connector pins. The module is supplied with a protective cover over the connector. Always ensure this cover is in place when transporting the module.

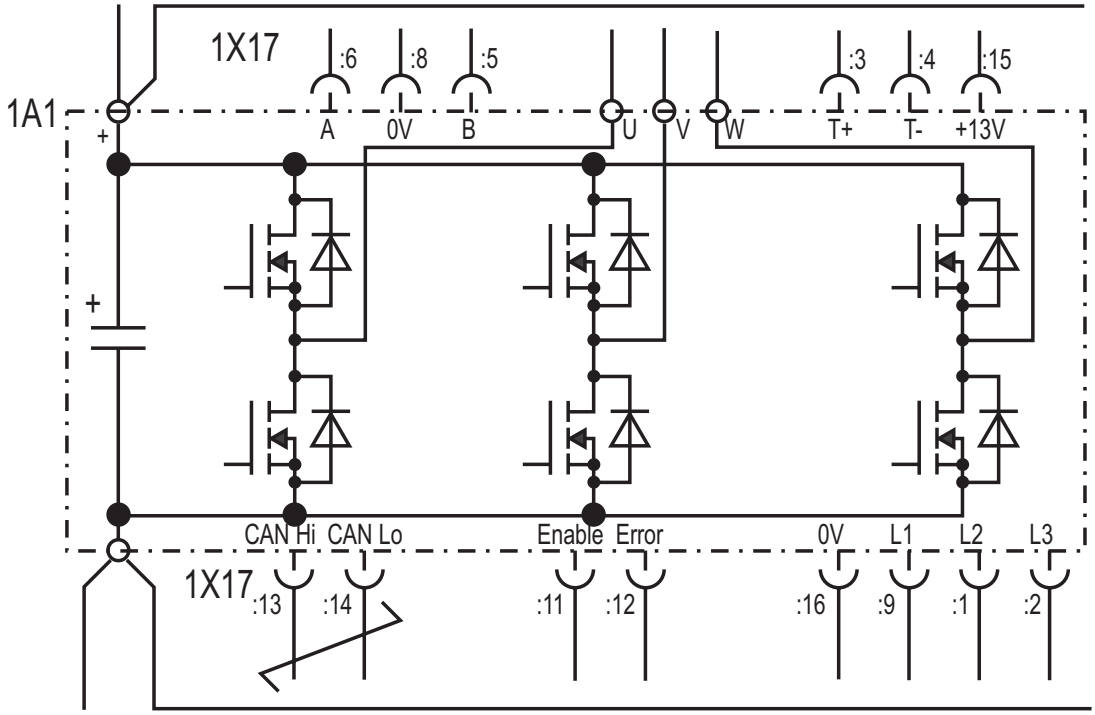
Do not attempt to open the power module as this will result in damage.

NOTE

The traction power module 1A1, hydraulic power module 2A1 and electronic control unit A2 are interconnected by a second local CAN bus (CAN 2)

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Connector 1X17 pin designations



115_06-04

6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22

:1	Phase voltage L1
:2	Phase voltage L3
:3	Motor temperature T+
:4	Motor temperature T-
:5	Motor speed sensor signal B
:6	Motor speed sensor signal A
:7	Not connected
:8	Negative supply to motor speed sensor
:9	Phase voltage L1
:10	Not connected
:11	Traction motor enable signal
:12	Traction motor error signal
:13	CAN bus Hi connection
:14	CAN bus Lo connection
:15	13 volt supply
:16	Not connected

Error signal

The module reports it's readiness for operation to the control unit A2 via the CAN bus 2. For safety reasons the power module is also connected to the control module via a separate connection (1X17:12 to X13:34). With the power module functioning correctly, a negative signal is present.

The error signal can be verified using diagnostic software.

Inputs + Outputs
▼
LAC-T
▼
Digital I/O

Enable signal

For traction to be available, an enable signal must be present at the power module 1A1. This signal is generated by the control module A2 and sent to the power module via X13:9

The status of the power module enable signal can be verified using diagnostic software :

Inputs + Outputs
▼
LAC-T
▼
Digital I/O

In order to generate this enable signal, both hard-wired inputs and internally generated signals are monitored by the control module.

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The status of these hard-wired inputs and generated signals can be verified using diagnostic software :

Inputs + Outputs
▼
Traction
▼
Switches

and

Inputs + Outputs
▼
Traction
▼
Steering inputs

Speed signals

The traction motor is fitted with a speed sensor which senses motor speed and direction of rotation. The speed sensor is connected to the power module via 1X17:6 (sensor A) and 1X17:5 (sensor B). Speed and direction information is sent from the power module to the control module via the CAN bus 2. For safety reasons speed and direction of rotation information is also sent to the control module via separate connections

Speed sensor 1B1 Channel A - X13:37
Speed sensor 1B1 Channel B - X13:18

The calculated speed can be verified using diagnostic software:

Inputs + Outputs
▼
Traction
▼
Motor control

and the actual speed sensor inputs can be verified using diagnostic software

Inputs + Outputs
▼
LAC-T
▼
Digital I/O

Phase voltage feedback

The power module uses the required speed/torque value supplied by the control module via the CAN bus 2 to generate the three phase voltage for the motor. The phase currents and voltages are sent back to the control module via the CAN bus. For safety reasons the phase voltages are also sent to the control module via separate connections.

Voltage L1 - X13:24
Voltage L2 - X13:43
Voltage L3 - X13:62

The voltages can be verified using diagnostic software:

Inputs + Outputs
▼
LAC-T
▼
Voltages

Temperature monitoring and forced ventilation

A silicon sensor embedded within the power module which changes it's resistance according to temperature allows the temperature of the MOSFETS within the power module to be monitored.

The resistance of this sensor is monitored by the control module via the local CAN bus 2. The control module transmits this information via the main CAN bus to the display 6P1.

When the temperature of the MOSFETs reach 40°C, then the 48 volt PWM speed controlled cooling fan 9M1 will begin to operate at reduced speed. Should the temperature continue to rise, then the speed of the fan will increase. At a temperature of 80°C, the fans will be running at full speed.

Power module temperature information can be verified using diagnostic software :

Inputs + Outputs
▼
LAC-T
▼
Temp

or

Inputs + Outputs
▼
Display
▼
Temperatures / Fans

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or

Inputs + Outputs
▼
Traction
▼
Temperatures

Fan operation can be tested using diagnostic software :

Error codes + Parameters
▼
Display
▼
Fan tests

Fan operation can be verified using diagnostic software :

Inputs + Outputs
▼
Display
▼
Temperatures / Fans

NOTE

If necessary, the power module will start reduce output performance at 90°C to allow the components to cool. Should the temperature reach 105°C, then the power module will stop working.

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Direction selection switch

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

On trucks fitted with a single accelerator pedal, switch 1S13 is used to select the direction of travel.

Connector 1X9

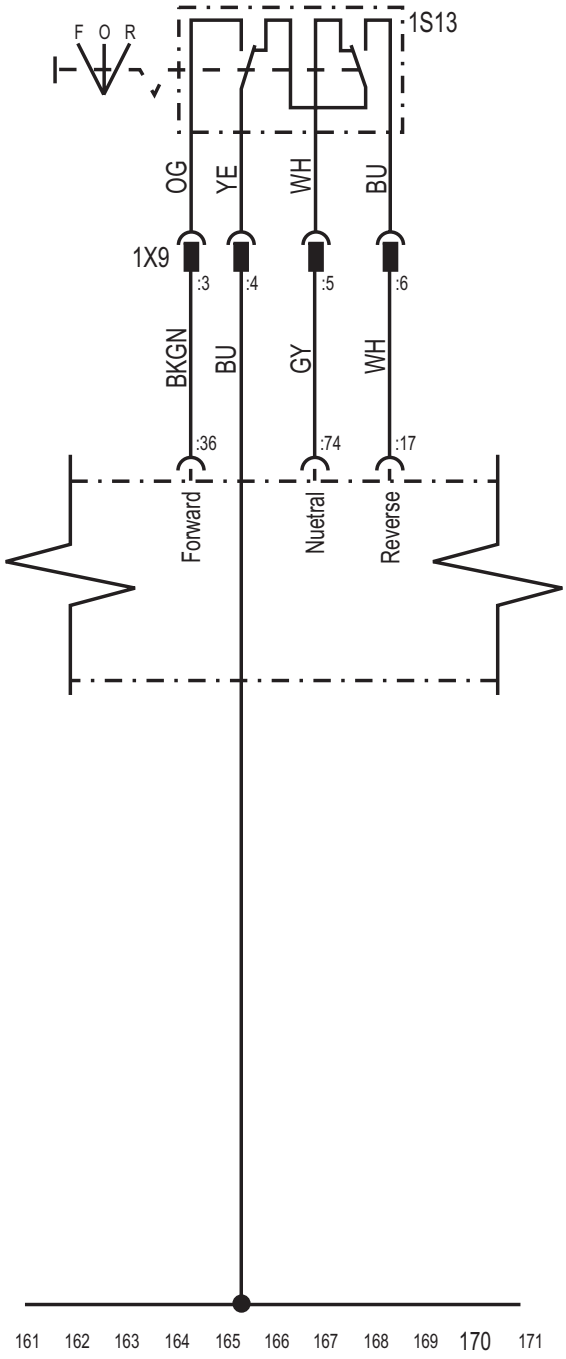
Pin	Duty
1	Horn push negative
2	+ 48 volt horn push supply
3	Forward
4	Negative
5	Neutral
6	Reverse

Operation of the switch can be verified using diagnostic software:

Inputs + Outputs
▼
Traction
▼
Switches

NOTE

On trucks fitted with twin accelerator pedals, a link plug is fitted to the left foot switch connector 1X38 located beneath the floorplate, and pins 3, 4, 5 and 6 on connector 1X9 are linked together.



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Parking brake

The parking brake is electrically controlled by the control module A2.

The parking brake is released by a single press of the momentary parking brake release switch 1S4. The brake is applied by a further single press of the momentary switch.

Operation of the parking brake switch can be verified using diagnostic software :

Inputs + Outputs
▼
Traction
▼
Switches

The brake employs a 24 volt solenoid. Using PWM, the control module reduces battery voltage to ≈24 volts (energising) and ≈8 volts (holding).

The brake solenoid Y1 is fed a battery positive supply via fuse F8 and line contactor K1. The pulsed negative is supplied via the control module connection X13:8. The parking brake switch 1S4 controls the braking function via a switched negative signal at X13:35.

Operation and status of the parking brake can be verified using diagnostic software :

Inputs + Outputs
▼
Traction
▼
Safety brake

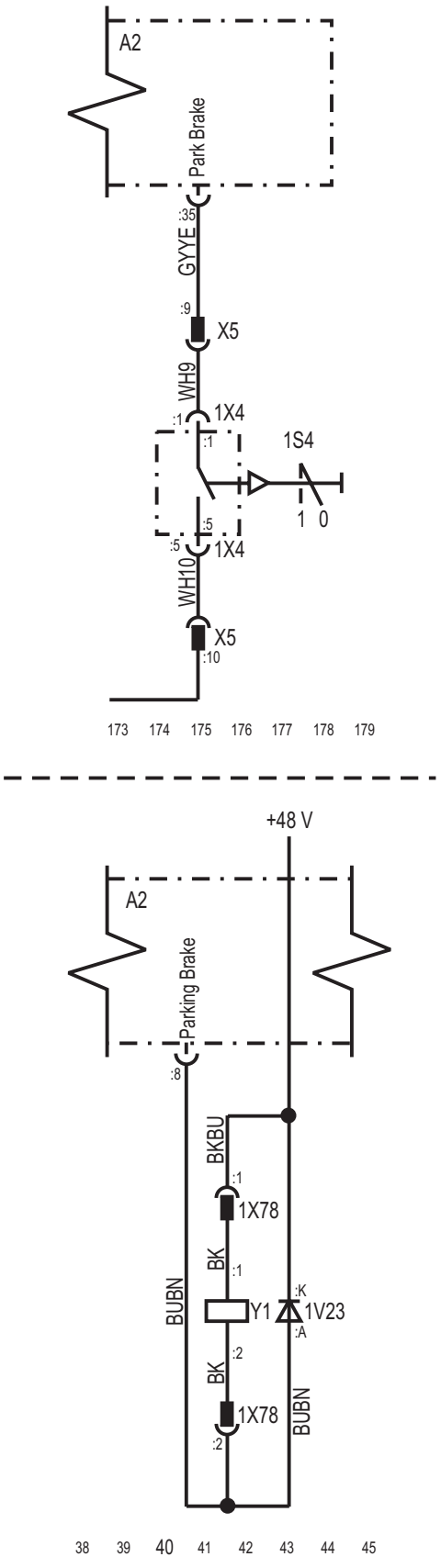
The parking brake will automatically apply under certain conditions.

If traction speed is below 2.5km/h, then, after a preset time delay, the parking brake will automatically apply when either the seat is vacated or the left foot switch opens.

If traction speed is above 2.5km/h when either the seat is vacated or the left foot switch opens, then regenerative braking will slow the truck to 2.5km/h, and then after a preset time delay the parking brake will apply.

The time delay between the seat being vacated or the left foot switch opening, and the brake applying is set using diagnostic software :

Error codes + Parameters
▼
Traction



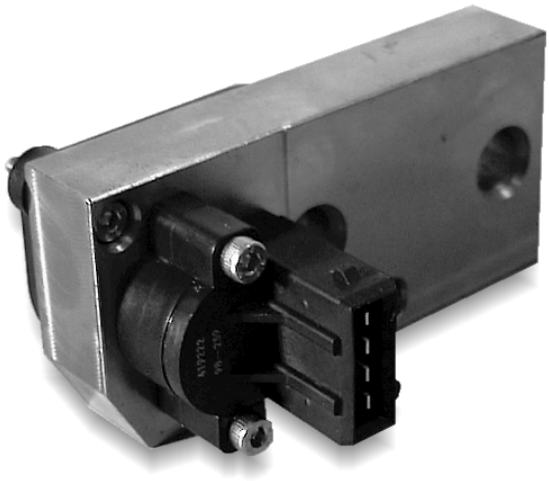
https://truckmanualshub.com/

▼

Drive Parameters

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Accelerator

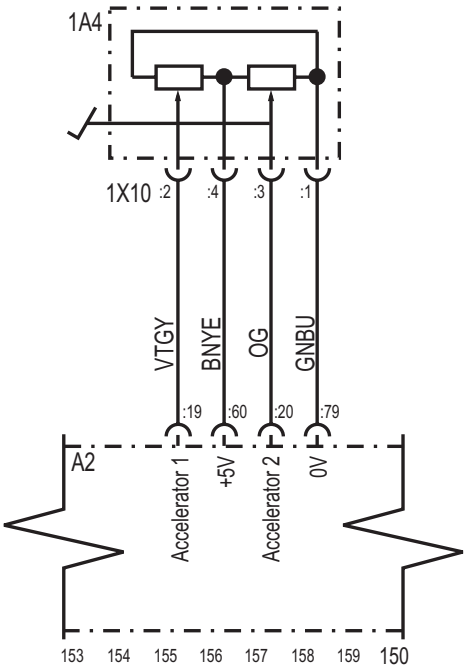


The accelerator unit is supplied with 5 V from the control module via X13:60. The output from the accelerator unit controls the speed and torque of the traction motor. For safety reasons the accelerator unit employs two wipers U1 and U2 which move in opposite directions. The output from the two wipers are sent to the control unit via connections X13:19 and X13:20

With the accelerator pedal(s) at rest, both wipers rest at the mid point on the potentiometer track, and the output of each wiper will be a nominal 2.5 volts. As the accelerator pedal is depressed, the combined output of both wipers will always be 5 V ±10%. The potentiometer includes a return spring, which ensures that the shaft is biased anticlockwise looking at the actuating lever end.

The accelerator pedal travel and the potentiometer supply can be verified using diagnostic software :

Inputs + Outputs
▼
Traction
▼
Accelerator



NOTE

There is no mechanical adjustment of the potentiometer neutral position.

	Single pedal	Dual pedal (forks trailing)	Dual pedal (forks leading)
Pedals in neutral position	2.5 Volts	2.5 Volts	2.5 Volts
Maximum demand	3.75 Volts	3.75 Volts	1.25 Volts
Maximum permissible over-travel	4.5 Volts	4.5 Volts	0.5 Volts

Calibration

If the accelerator potentiometer or control module is changed, then the accelerator will required calibrating. Calibration is carried out using diagnostic software :

➢ Raise and securely block the drive wheel.

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➢ With the accelerator in neutral position, select :

Guided Diagnostics
▼
Work Order
▼
Calibration

➢ Select Start, and follow the on screen instructions.

NOTE

If the calibrated value is outside the 2.5 ±0.3 volt tolerance, then this will be indicated.

Adjusting the accelerator stops

Using diagnostic software :

Inputs + Outputs
▼
Traction
▼
Accelerator

➢ On single pedal trucks, press the accelerator pedal fully. the Accelerator % should read 100 %. If necessary, adjust the accelerator pedal stop to achieve the correct value.

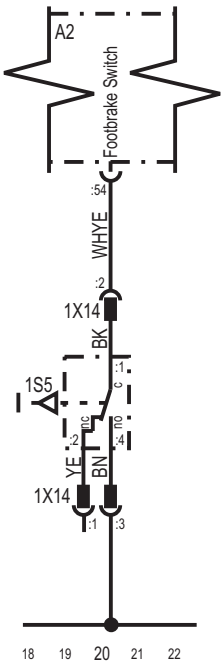
➢ On dual pedal trucks, press the forks trailing accelerator pedal fully, the Accelerator % should read -100 %. If necessary, adjust the forks trailing accelerator pedal stop to achieve the correct value. Press the forks leading accelerator pedal fully, the Accelerator % should read 100 %. If necessary, adjust the forks leading accelerator pedal stop to achieve the correct value.

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Brake pedal switch

Microswitch 1S5 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 control module A2 and is used to apply an increased level of electrical braking.



NOTE

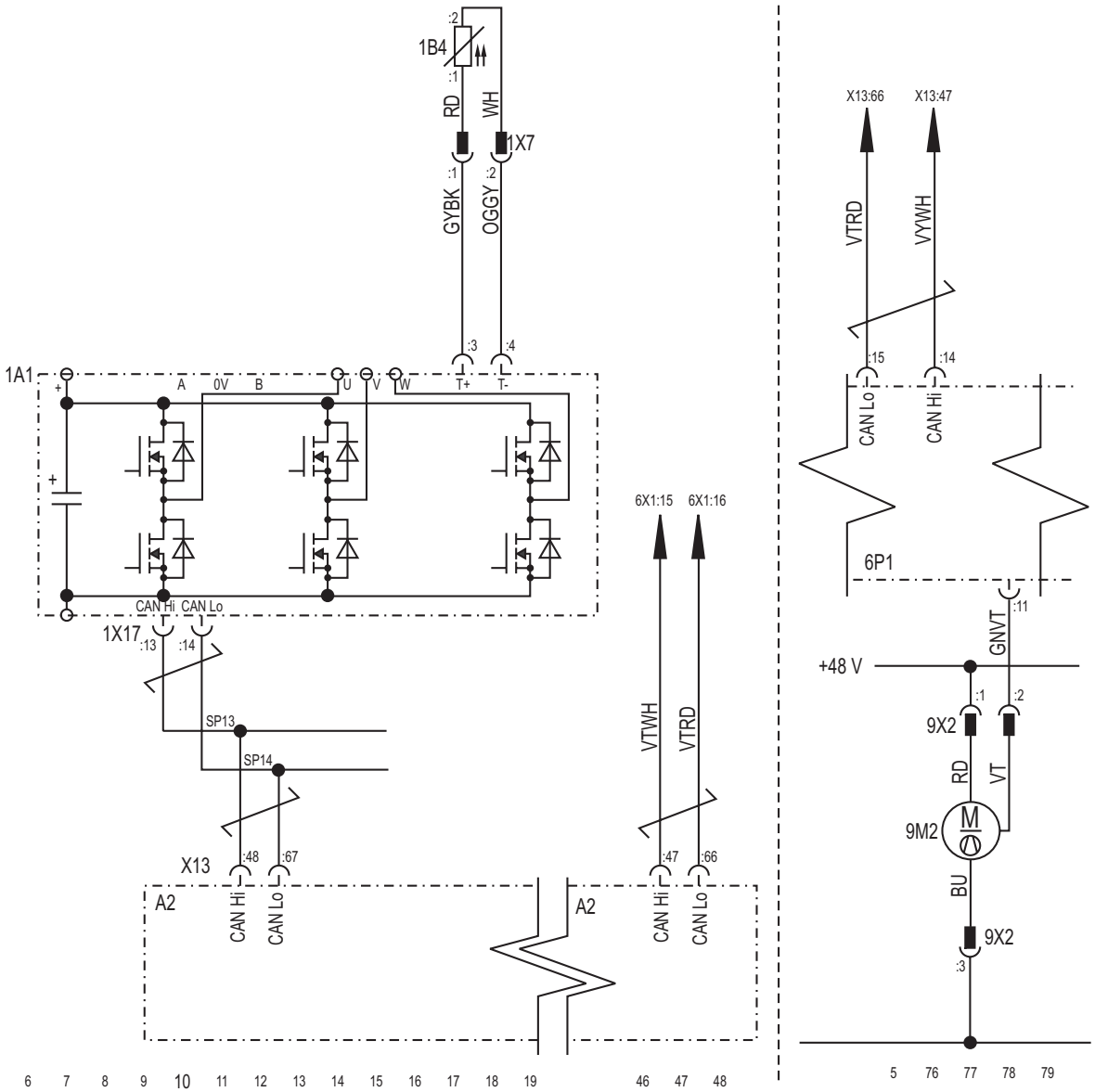
The level of electrical braking when the footbrake is applied cannot be adjusted.

The status of the brake pedal microswitch can be verified using diagnostic software:

Inputs + Outputs
▼
Traction
▼
Switches

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Traction motor temperature sensor



A sensor 1B4 embedded within the traction motor which changes it's resistance according to temperature, allows the temperature of the traction motor to be monitored.

The resistance of this internal sensor is monitored by the control module A2 via the power module 1A1 and the local CAN bus 2. The control module transmits this information via the main CAN bus to the display 6P1.

Traction motor temperature information can be verified using diagnostic software :

Inputs + Outputs
▼
Traction
▼
Temperatures

and

Inputs + Outputs
▼
Display
▼
Temperature/Fans

and

Inputs + Outputs
▼
LAC-T
▼
Temp

When the temperature of the motor reaches 60°C, then the 48 volt PWM speed controlled

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cooling fan 9M2 will begin to operate at reduced speed. Should the temperature continue to rise, then the speed of the fan will increase. At a temperature of 100°C, the fans will be running at full speed.

Fan operation can be verified using diagnostic software :

Inputs + Outputs

▼

Display

▼

Temperature/Fans

NOTE

If necessary, traction motor performance will start to reduce at 120°C to allow the components to cool. Should the temperature of the traction motor reach 140°C, then the traction motor will stop working.

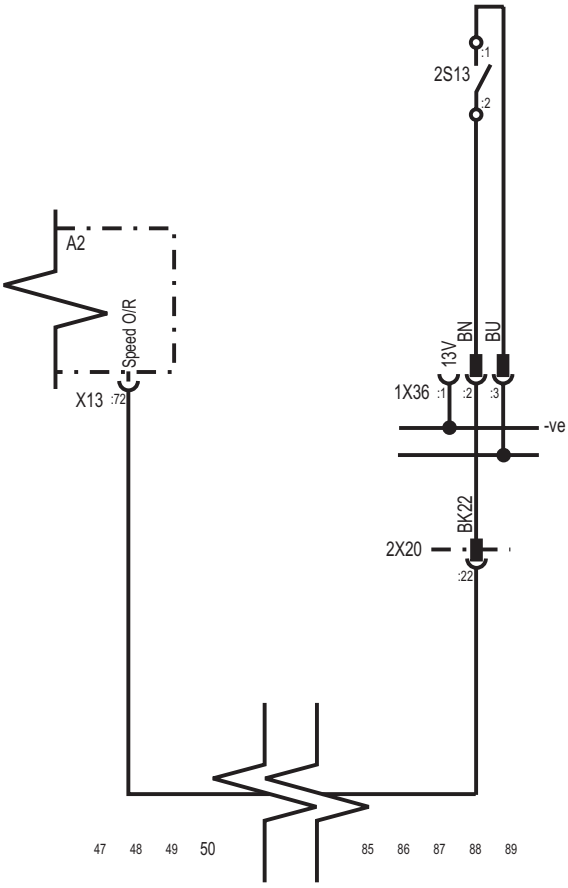
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Switch controlled speed reduction and 8.5 m switch ▷

Control module pin X13:72 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 X13:72 is routed through the reach carriage via 2X20:22 and the reach carriage cable to the base of mast connector 1X36 and via the back of mast cable to a switch 2S13 at the top of the fixed mast.

On trucks with lift heights above 8.5 metres, this switch opens when the forks are raised above 8.5 metres which 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.

Operation of the switch can be verified using diagnostic software:

`Inputs+Outputs`
▼
`Traction`
▼
`Switches`

The reduced traction speed can be adjusted using diagnostic software:

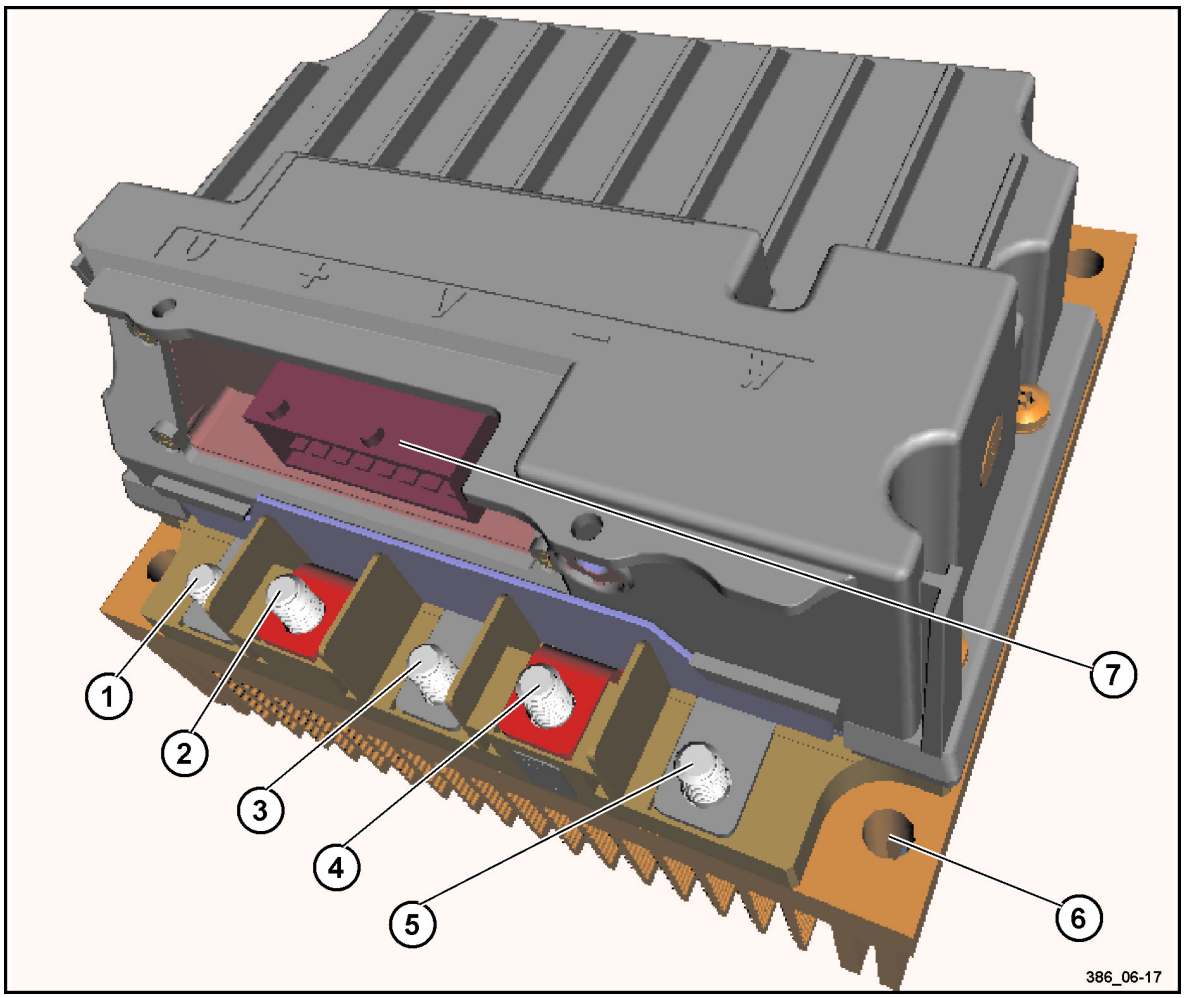
`Error codes + Parameters`
▼
`Traction`
▼
`Drive Parameters`

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

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Electrical control - Hydraulics

Hydraulic power module



1	Motor connection U1
2	Battery positive connection from the traction power module via line contactor K1
3	Motor connection V1
4	Battery negative connection from the traction power module
5	Motor connection W1
6	Securing screw hole
7	Connector 2X37

⚠ CAUTION

Risk of damage due to electrostatic charge.

Do not touch the 16 way connector pins. The module is supplied with a protective cover over the connector. Always ensure this cover is in place when transporting the module.

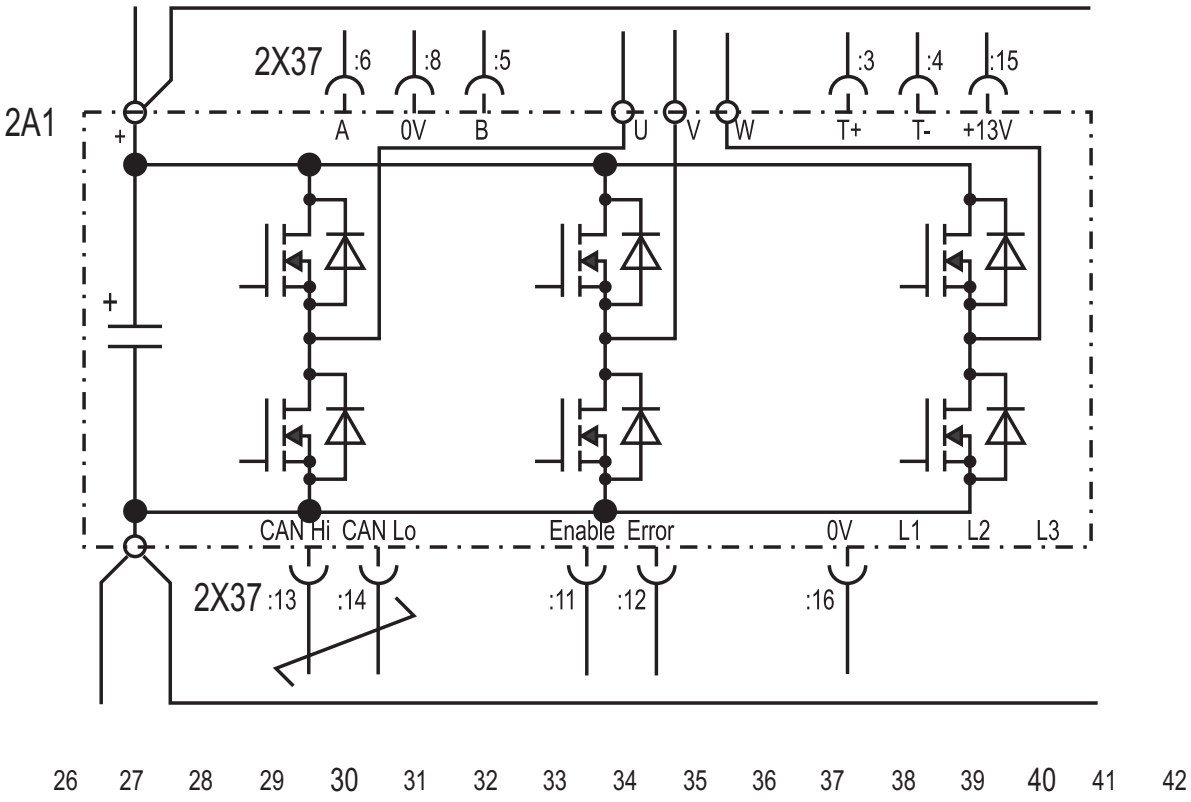
Do not attempt to open the power module as this will result in damage.

NOTE

The traction power module 1A1, hydraulic power module 2A1 and electronic control unit A2 are interconnected by a second local CAN bus (CAN 2)

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Connector 2X37 pin designations



:1	Not connected
:2	Not connected
:3	Motor temperature T+
:4	Motor temperature T-
:5	Motor speed sensor signal B
:6	Motor speed sensor signal A
:7	Not connected
:8	Negative supply to motor speed sensor
:9	Not connected
:10	Not connected
:11	Hydraulic motor enable signal
:12	Hydraulic motor error signal
:13	CAN bus Hi connection
:14	CAN bus Lo connection
:15	13 volt supply
:16	Not connected

Error signal

The module reports it's readiness for operation to the control unit A2 via the CAN bus 2. For safety reasons the power module is also connected to the control module via a separate connection (2X37:12 to X13:51). With the power module functioning correctly, a negative signal is present.

The error signal can be verified using diagnostic software.

Inputs + Outputs
▼
LAC-L
▼
Digital I/O

Enable signal

For hydraulics to be available, an enable signal must be present at the power module 1A1. This signal is generated by the control module A2 and sent to the power module via X13:13

The status of the power module enable signal can be verified using diagnostic software :

Inputs + Outputs
▼
LAC-L
▼
Digital I/O

In order to generate this enable signal, both hard-wired inputs and internally generated signals are monitored by the control module.

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The status of these hard-wired inputs and generated signals can be verified using diagnostic software :

Inputs + Outputs
▼
Hydraulics
▼
Digital In/out

Speed signals

The hydraulic motor is fitted with a speed sensor which senses motor speed. The speed sensor is connected to the power module via 2X37:6 (sensor A) and 3X37:5 (sensor B). Speed information is sent from the power module to the control module via the CAN bus 2. For safety reasons this information is also sent to the control module via a separate connection.

Speed sensor 2B8 Channel A - X13:103

Motor speed information can be verified using diagnostic software:

Inputs + Outputs
▼
Hydraulics
▼
Motor Control

and the actual speed sensor inputs can be verified using diagnostic software

Inputs + Outputs
▼
LAC-L
▼
Digital I/O

Temperature monitoring and forced ventilation

A silicon sensor embedded within the power module which changes it's resistance according to temperature allows the temperature of the MOSFETS within the power module to be monitored.

The resistance of this sensor is monitored by the control module via the local CAN bus 2. The control module transmits this information via the main CAN bus to the display 6P1.

When the temperature of the MOSFETs reach 40°C, then the 48 volt PWM speed controlled cooling fan 9M4 will begin to operate at reduced speed. Should the temperature continue to rise, then the speed of the fan will increase. At a temperature of 80°C, the fans will be running at full speed.

NOTE

Cooling fan 9M4 is also used to cool the hydraulic pump motor.

Power module temperature information can be verified using diagnostic software :

Inputs + Outputs
▼
LAC-L
▼
Temp

or

Inputs + Outputs
▼
Display
▼
Temperatures / Fans

or

Inputs + Outputs
▼
hydraulics
▼
Analogue inputs

Fan operation can be tested using diagnostic software :

Error codes + Parameters
▼
Display
▼
Fan tests

Fan operation can be verified using diagnostic software :

Inputs + Outputs
▼
Display
▼
Temperatures / Fans

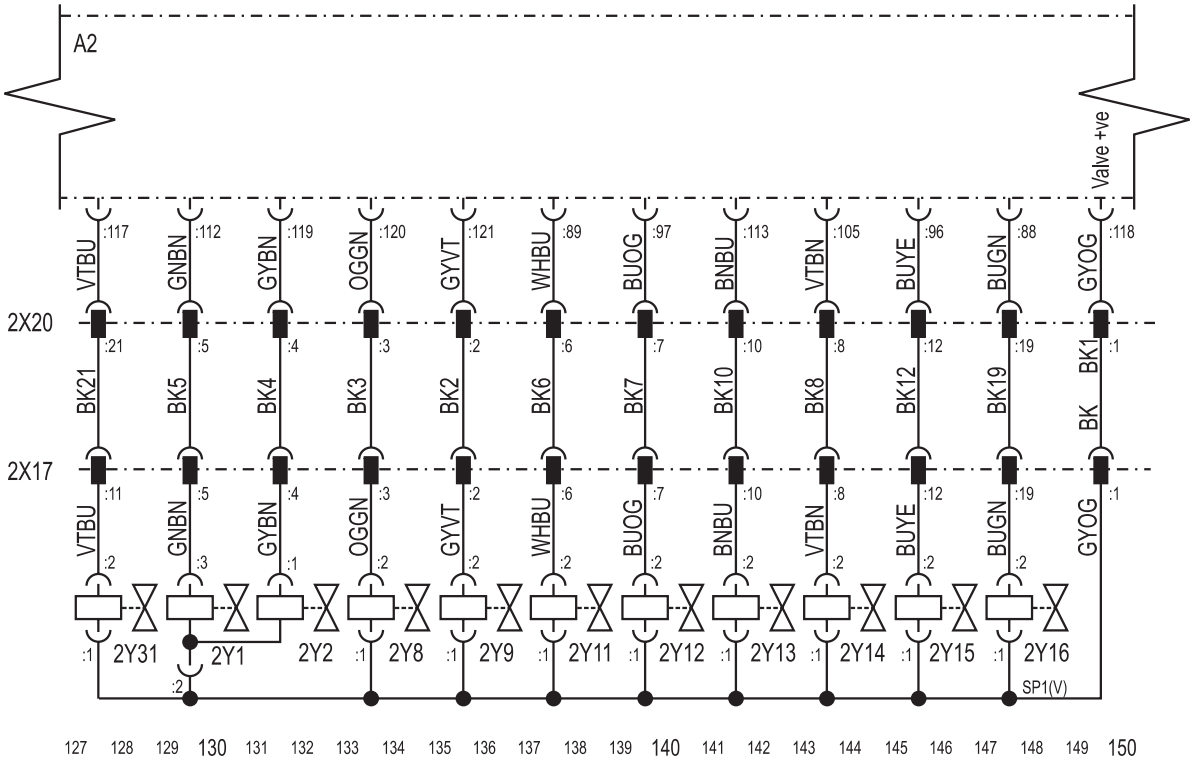
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NOTE

If necessary, the power module will start reduce output performance at 90°C to allow the components to cool. Should the temperature reach 105°C, then the power module will stop working.

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Valve voltage supply



The valve solenoids are connected to a common 48 V positive supply at X13:118 via a safety relay within the control module.

This supply can be verified using diagnostic software:

Inputs + Outputs
▼
Hydraulics
▼
Analogue Inputs

The negative coil supply to each solenoid valve is individually wired to the control module where a bank of MOSFETs switch each coil as required.

The solenoids for lower (2Y2) and reach (2Y8 and 2Y9) are proportional with the coils driven by a variable voltage. All other solenoids are energised at full voltage.

The function of the solenoids 2Y1 and 2Y2 can be verified using diagnostic software:

Inputs + Outputs
▼
Hydraulics
▼
Lift / Lower

and solenoids 2Y8 and 2Y9

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Electrical control - Hydraulics

Inputs + Outputs

▼

Hydraulics

▼

Reach

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Joysticks



Two joystick configurations are available.

Two dual axis joysticks
Four single axis joysticks

CONNECTORS

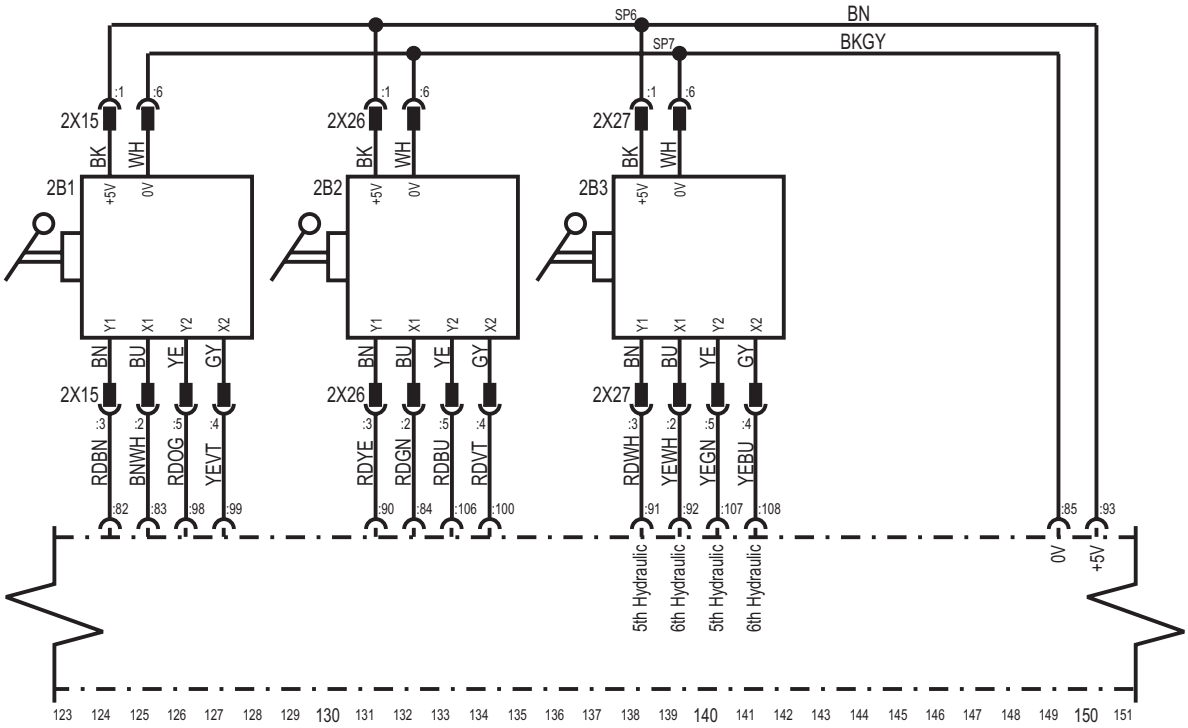
2X15 = lift and reach
2X26 = Tilt and sideshift
2X27 = 5th / 6th hydraulics

2X15, 2X26 and 2X27 pin duties

PIN	DUTY
1	+5 volt supply
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	0 volt supply

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Joystick voltage supply



A stabilised 5 V supply is generated by the control module A2. This supplies the joysticks via X13:93

This supply can be verified using diagnostic software:

Inputs + Outputs
▼
Hydraulics
▼
Analogue Inputs

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Joystick operation

For each joystick axis there are two mechanically connected potentiometers. Both potentiometers are supplied with +5 V, although with opposing polarity. The output voltage from the potentiometers is added together within the control module A2. Irrespective of potentiometer setting, a combined output voltage of 5V ±10% must be measured. If this value is not achieved, an error will be generated and the hydraulic function concerned turned off.

The operation of the lift / lower joystick can be verified using diagnostic software :

Inputs + Outputs
▼
Hydraulics
▼
Lift / Lower

The operation of the reach joystick can be verified using diagnostic software :

Inputs + Outputs
▼
Hydraulics
▼
Reach

The operation of the tilt joystick can be verified using diagnostic software :

Inputs + Outputs
▼
Hydraulics
▼
Tilt

The operation of the sideshift joystick can be verified using diagnostic software :

Inputs + Outputs
▼
Hydraulics
▼
Sideshift

Two dual axis joysticks

1	Lower	4	Reach extend
2	Lift	5	Sideshift left
3	Reach retract	6	Sideshift right

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7 Tilt back
8 Tilt forward

Function	Pot	Value	Joystick pin	Module pin	Pot	Value	Joystick pin	Module pin
Lift	Y1	Rising	2X15:3	X13:82	Y2	Falling	2X15:5	X13:98
Lower	Y1	Falling	2X15:3	X13:82	Y2	Rising	2X15:5	X13:98
Reach extend	X2	Rising	2X15:4	X13:83	X1	Falling	2X15:2	X13:99
Reach retract	X2	Falling	2X15:4	X13:83	X1	Rising	2X15:2	X13:99
Tilt forward	X1	Rising	2X26:2	X13:84	X2	Falling	2X26:4	X13:100
Tilt back	X1	Falling	2X26:2	X13:84	X2	Rising	2X26:4	X13:100
Sideshift left	Y1	Rising	2X26:3	X13:90	Y2	Falling	2X26:5	X13:106
Sideshift right	Y1	Falling	2X26:3	X13:90	Y2	Rising	2X26:5	X13:106

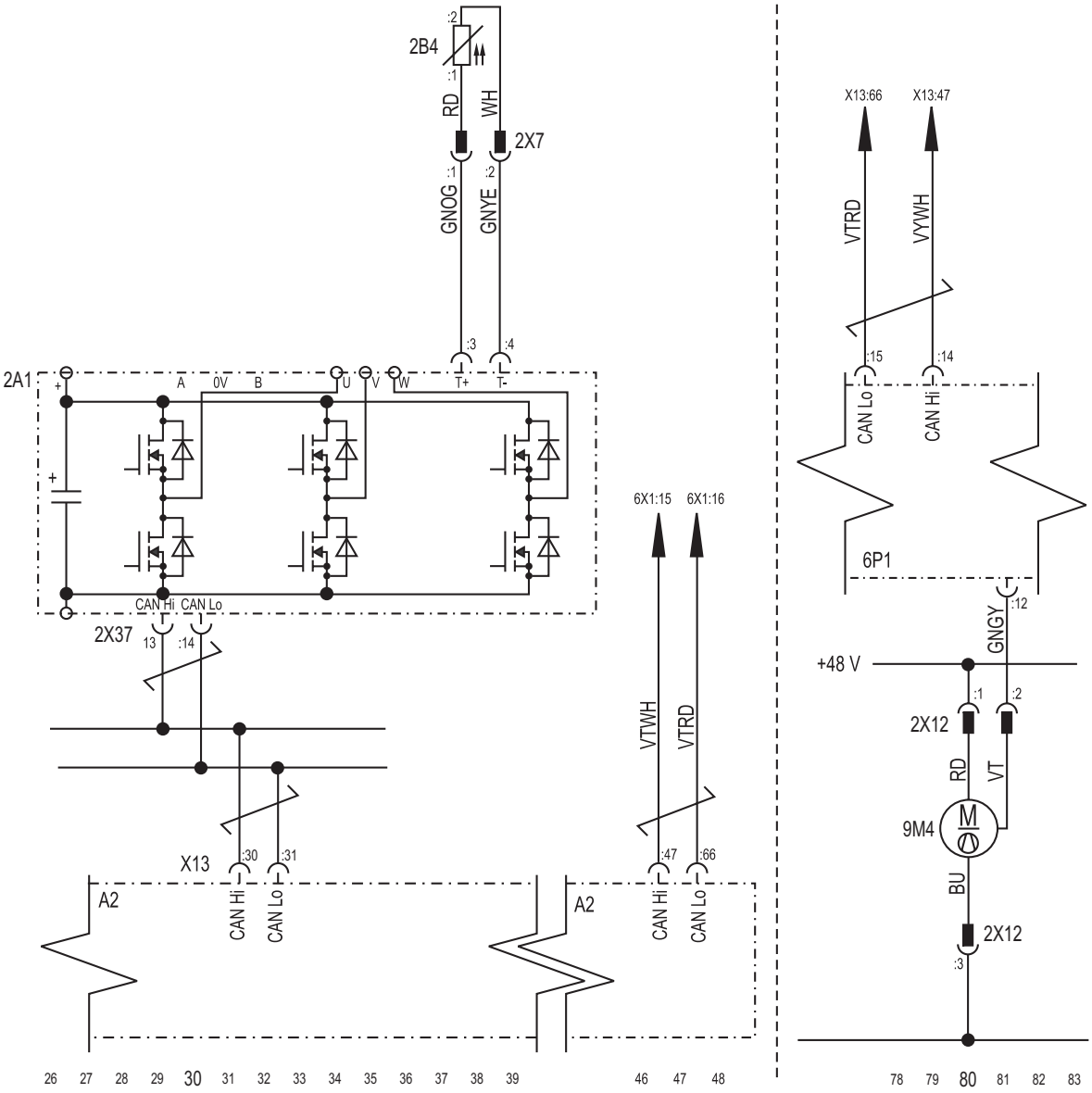
Four single axis joysticks

1 Lower
2 Lift
3 Reach extend
4 Reach retract
5 Tilt forward
6 Tilt back
7 Sideshift left
8 Sideshift right

Function	Pot	Value	Joystick pin	Module pin	Pot	Value	Joystick pin	Module pin
Lift	Y1	Rising	2X15:3	X13:82	Y2	Falling	2X15:5	X13:98
Lower	Y1	Falling	2X15:3	X13:82	Y2	Rising	2X15:5	X13:98
Reach extend	X1	Rising	2X15:2	X13:83	X2	Falling	2X15:4	X13:99
Reach retract	X1	Falling	2X15:2	X13:83	X2	Rising	2X15:4	X13:99
Tilt forward	X2	Rising	2X26:4	X13:84	X1	Falling	2X26:2	X13:100
Tilt back	X2	Falling	2X26:4	X13:84	X1	Rising	2X26:2	X13:100
Sideshift left	Y1	Rising	2X26:3	X13:90	Y2	Falling	2X26:5	X13:106
Sideshift right	Y1	Falling	2X26:3	X13:90	Y2	Rising	2X26:5	X13:106

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Hydraulic pump motor temperature sensor



A sensor 2B4 embedded within the hydraulic pump motor which changes it's resistance according to temperature, allows the temperature of the pump motor to be monitored.

The resistance of this internal sensor is monitored by the control module A2 via the power module 2A1 and the local CAN bus 2. The control module transmits this information via the main CAN bus to the display 6P1.

Hydraulic pump motor temperature information can be verified using diagnostic software :

Inputs + Outputs
▼
Hydraulics
▼
Analogue inputs

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and

Inputs + Outputs
▼
Display
▼
Temperatures/Fans

and

Inputs + Outputs
▼
LAC-L
▼
Temp

When the temperature of the motor reaches 60°C, then the 48 volt PWM speed controlled cooling fan 9M4 will begin to operate at reduced speed. Should the temperature continue to rise, then the speed of the fan will increase. At a temperature of 100°C, the fans will be running at full speed.

NOTE

Cooling fan 9M4 is also used to cool the hydraulic power module.

Fan operation can be verified using diagnostic software :

Inputs + Outputs
▼
Display
▼
Temperature / Fans

Fan operation can be tested using diagnostic software :

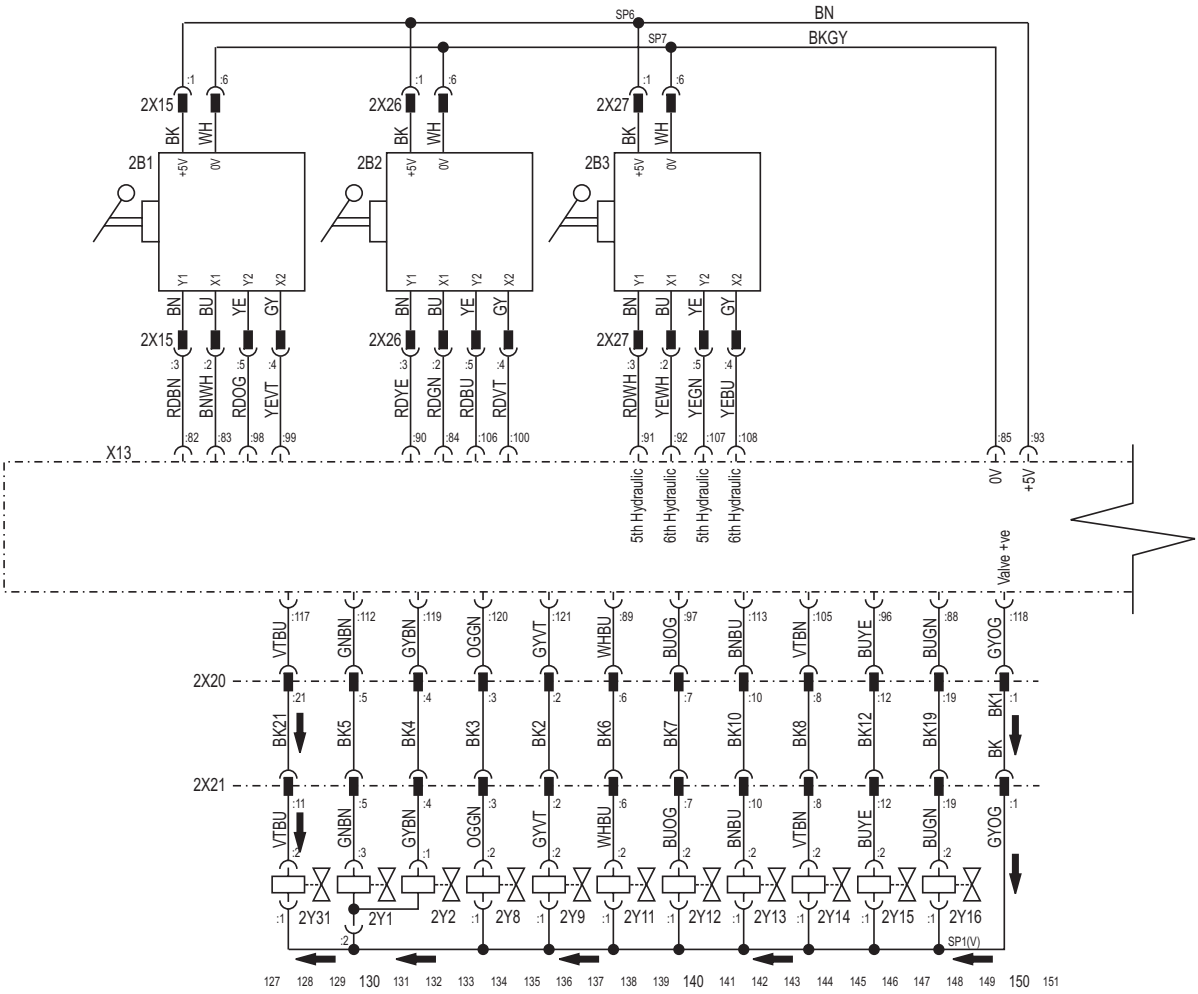
Error codes + Parameters
▼
Display
▼
Fan tests

NOTE

If necessary, pump motor performance will start to reduce at 120°C to allow the components to cool. Should the temperature of the pump motor reach 140°C, then the pump motor will stop working.

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Lower lock valve



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

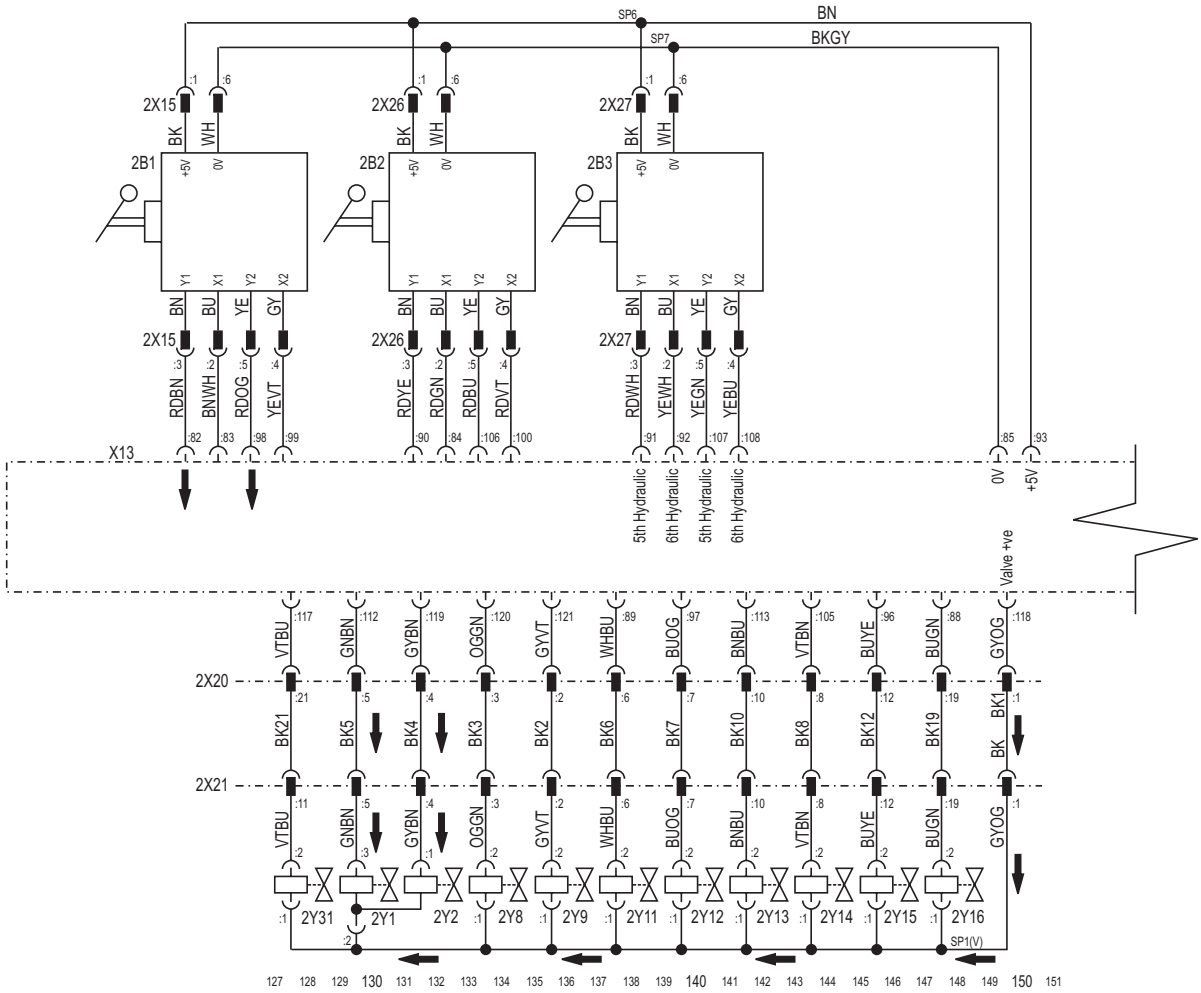
The switched solenoid 2Y31 is supplied with +48 volts at connector X13:118 via a safety relay within the control module A2. With the keyswitch on, emergency isolator released, and lower function selected, the control module A2 provides a negative at X13:117, thus opening the lower lock valve. When not in use, the negative supply is removed and the solenoid will de-energise to close the valve. After the solenoid has de-energised, the safety relay within the control module A2 will open and remove the +48 volts supply from X13:118.

Operation of the valve can be verified using diagnostic software:

Inputs + Outputs
▼
Hydraulics
▼
Lift / Lower

https://truckmanualshub.com/

Lift and lower - electrical operation



Lift

The potentiometer variable voltage to X13:82 is duplicated and inverted at X13:98 as a confirmed safety signal.

When the joystick is moved in the lift direction, battery negative is applied to X13:112, energising the switched solenoid 2Y1.

Lift speed is determined by the pump motor speed which increases progressively as the joy-stick is moved further.

Lower

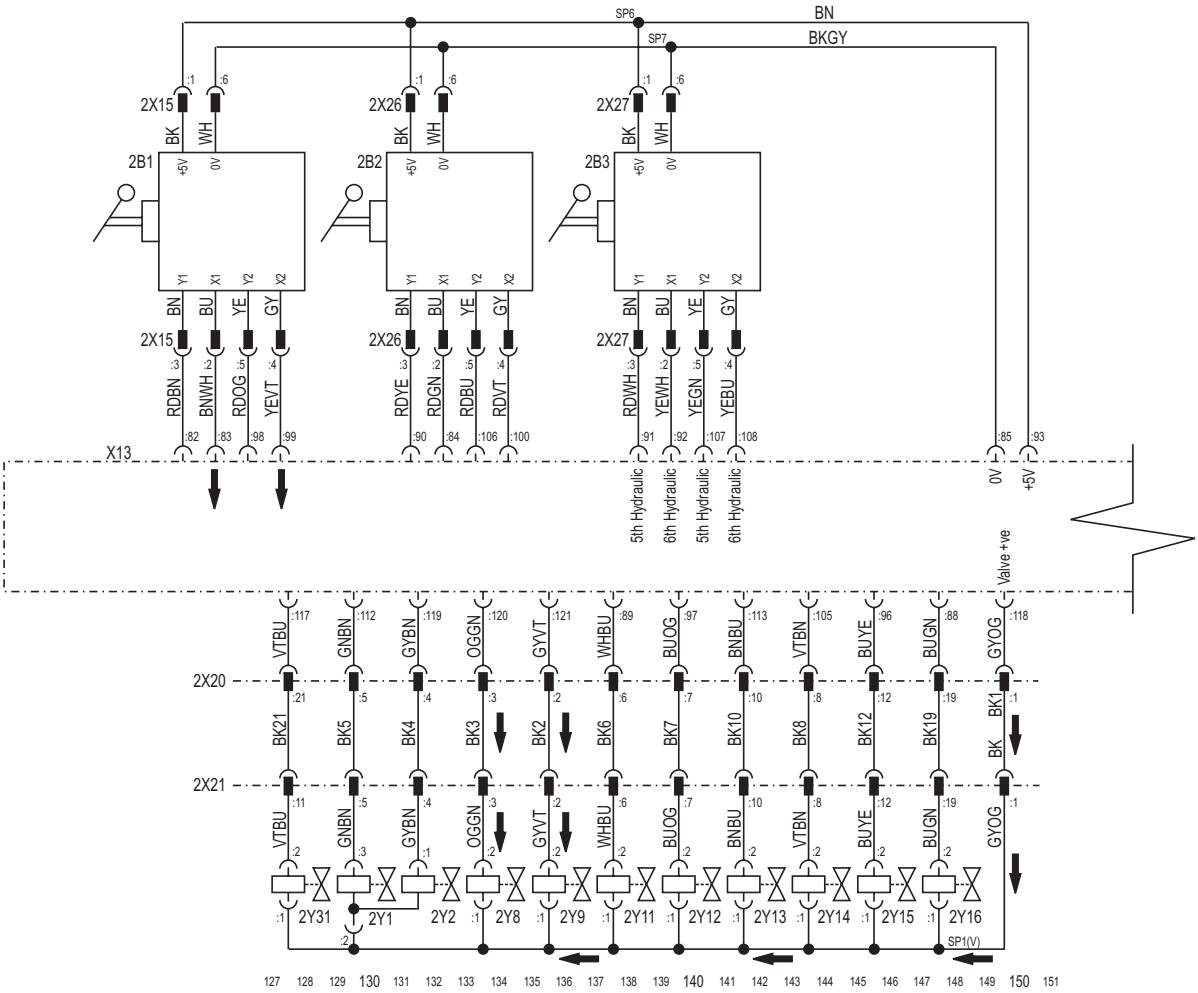
When the joystick is moved in the lower direction, battery negative is applied to X13:117, energising the switched solenoid 2Y31 (Lower lock valve).

The proportional solenoid 2Y2 is opened progres-sively by applying a variable signal to X13:119

Lower speed is determined by the position of the current-controlled solenoid 2Y2 which opens progressively as the joystick is moved further.

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Reach - electrical operation



Reach out

When the joystick is operated, the proportional solenoid 2Y8 is opened progressively by applying a variable signal to X13:120

Reach speed is determined by the position of the current-controlled solenoid 2Y8 which opens progressively as the joystick is moved further.

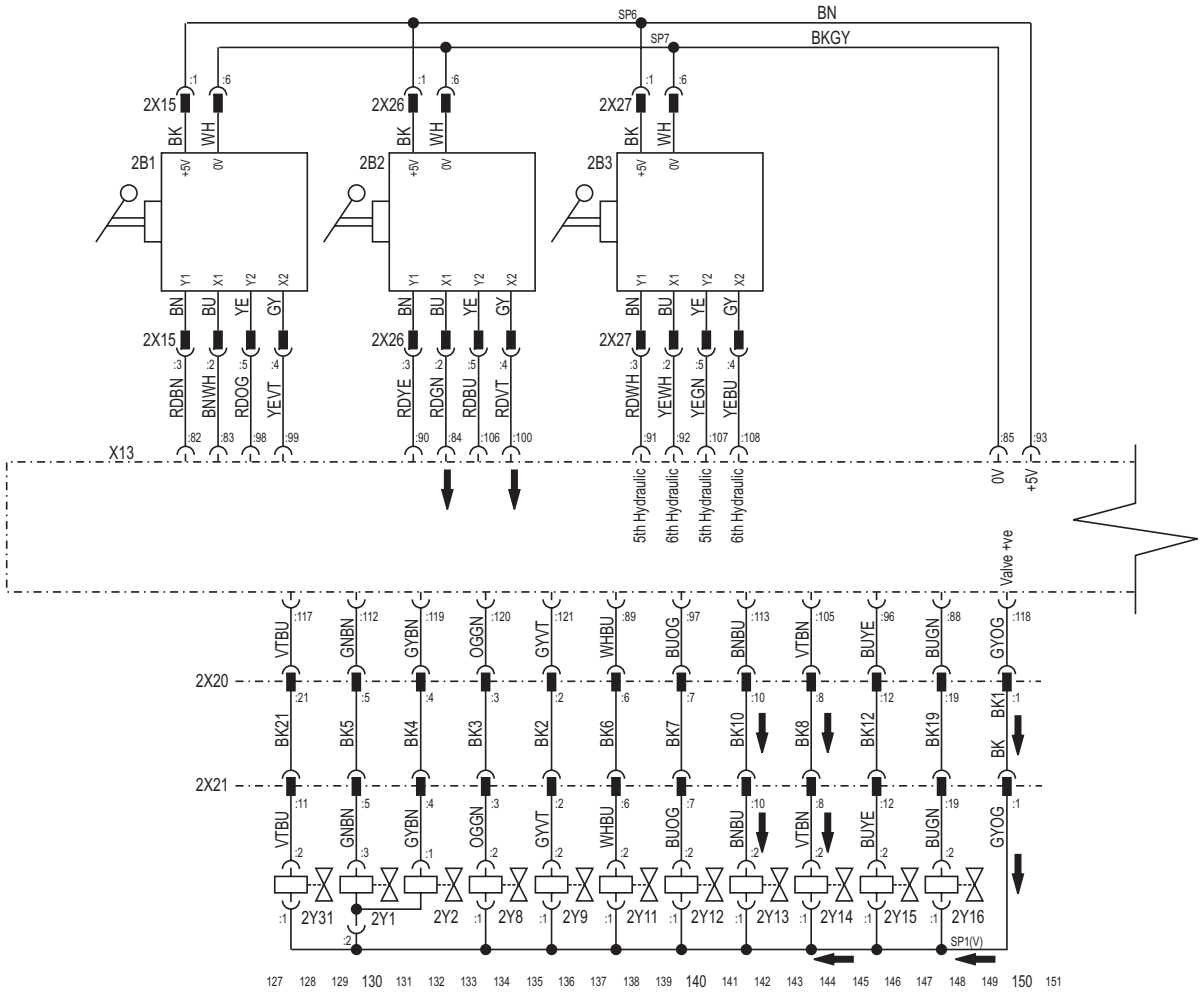
Reach back

When the joystick is operated, the proportional solenoid 2Y9 is opened progressively by applying a variable signal to X13:121

Reach speed is determined by the position of the current-controlled solenoid 2Y9 which opens progressively as the joystick is moved further.

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Sideshift - electrical operation



Sideshift right

When the joystick is moved in the sideshift right direction, battery negative is applied to X13:105, energising the switched solenoid 2Y14.

Sideshift speed is determined by the pump motor speed which increases progressively as the joy-stick is moved further.

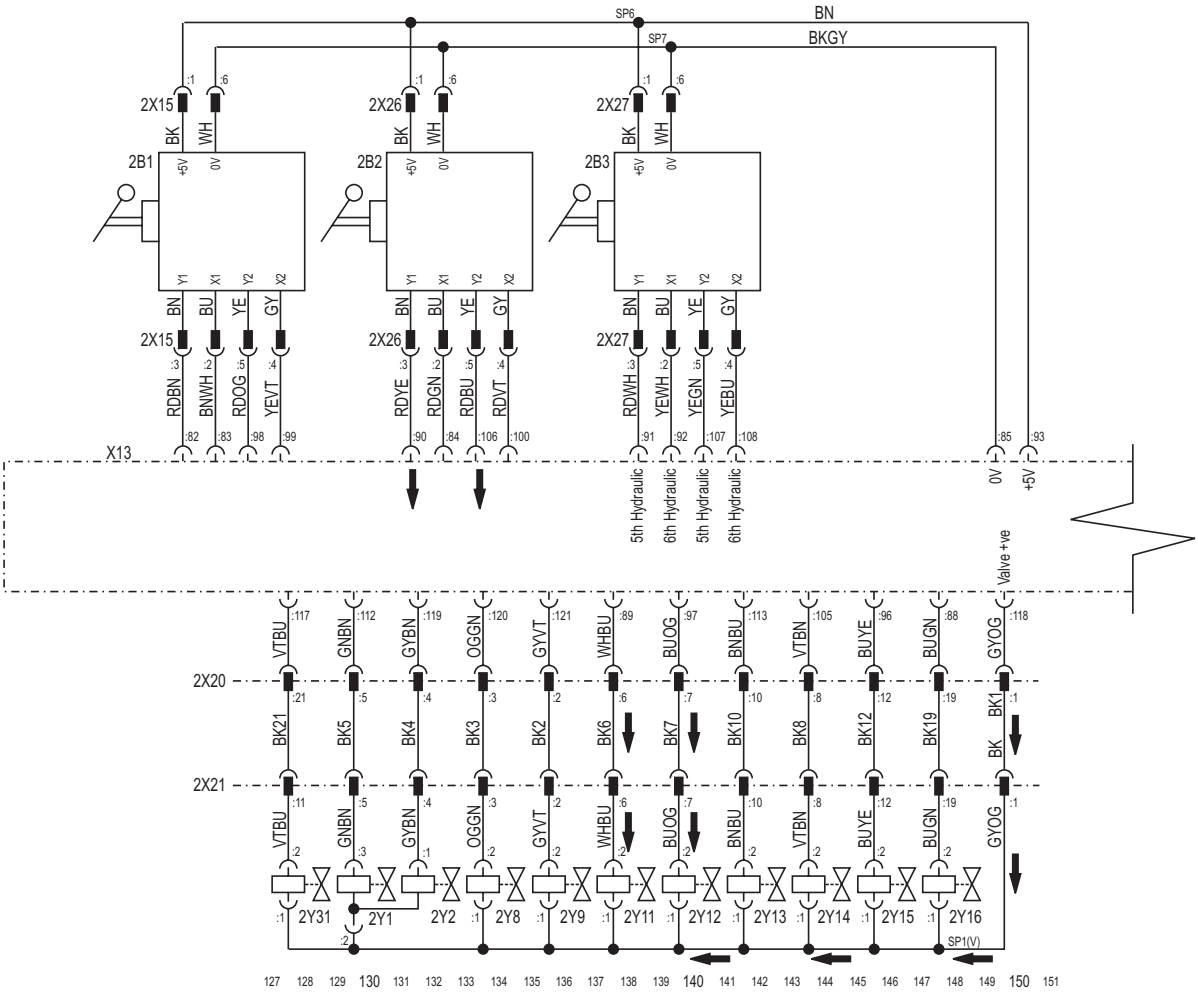
Sideshift left

When the joystick is moved in the sideshift left direction, battery negative is applied to X13:113, energising the switched solenoid 2Y13.

Sideshift speed is determined by the pump motor speed which increases progressively as the joy-stick is moved further.

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Tilt - electrical operation



Tilt back

When the joystick is moved in the tilt back direction, battery negative is applied to X13:97, energising the switched solenoid 2Y12.

Tilt speed is determined by the pump motor speed which increases progressively as the joystick is moved further.

Tilt forward

When the joystick is moved in the tilt forward direction, battery negative is applied to X13:89, energising the switched solenoid 2Y11.

Tilt speed is determined by the pump motor speed which increases progressively as the joystick is moved further.

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Lift stop sensor

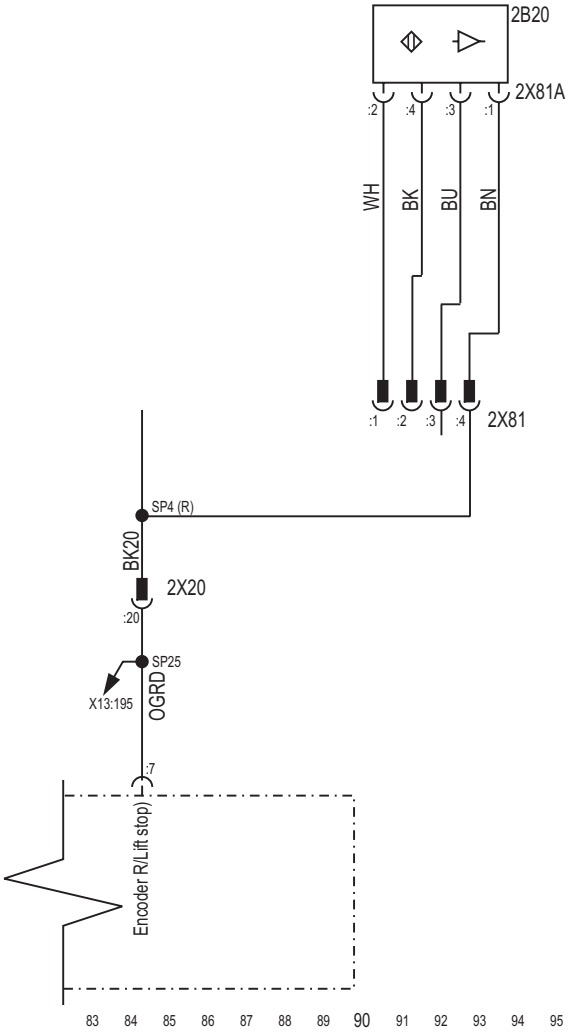
The lift stop sensor which is fitted to all trucks **NOT** fitted with a height encoder, stops lift before the mast reaches it's mechanical stop.

When activated it applies a signal to the display via 6X1:7 and control module via X13:95

To lift the forks further release the lever and re-initialise lift. Lift will resume at a reduced speed until full lift is achieved.

Operation of the lift stop sensor can be verified using diagnostic software:

Inputs + Outputs
▼
Hydraulics
▼
Lift/Lower



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Reach system

Reach slowdown sensors

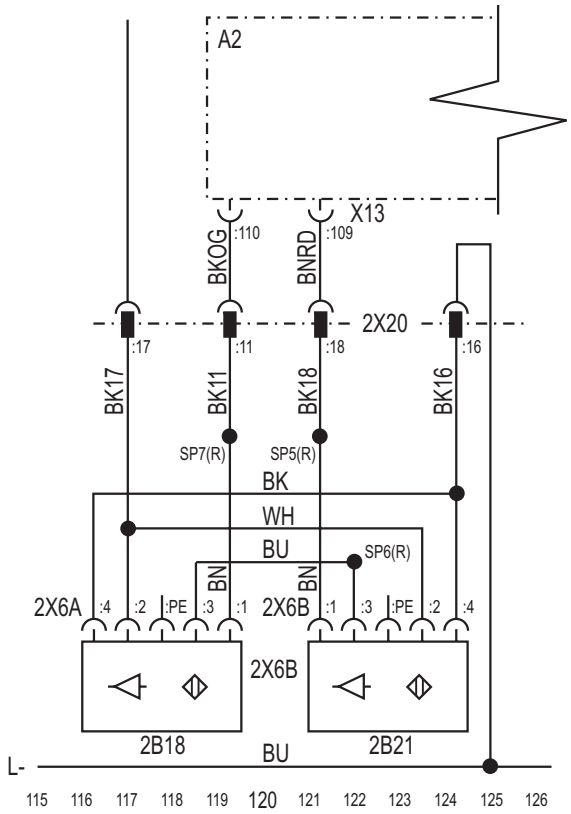
The slowdown system for reach uses a toothed strip fixed to the chassis bottom plate and two inductive sensors fixed to the reach carriage. As the reach is moved, the sensors pass the teeth and the software within the control module A2 adjusts the reach position value.

The control module A2 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.

Operation of the reach sensors can be verified using diagnostic software :

`Inputs + Outputs`
▼
`Hydraulics`
▼
`Reach`



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Reach position value

The teeth on the fixed strip are positioned such that the two sensors send signals to the control module A2 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 control module A2, to zero the position value.

Reach limits

If a new replacement control module is fitted, then reach limit(s) are not programmed and the reach automatically goes into calibrate mode. Operating the reach lever shows "**Pot Calibrate**" on the display

The reach must be reached to the **FURTHEST** mechanical limit and held. It must then be reached to the other limit and held. **Pot Calibrate** should then automatically be removed from the display and full speed reach possible with smooth rampdowns.

The reach limits can be re-programmed at any time using diagnostic software:

Guided Diagnostics
▼
Work Order
▼
Calibration

➢ Select Start, and follow the on screen instructions.

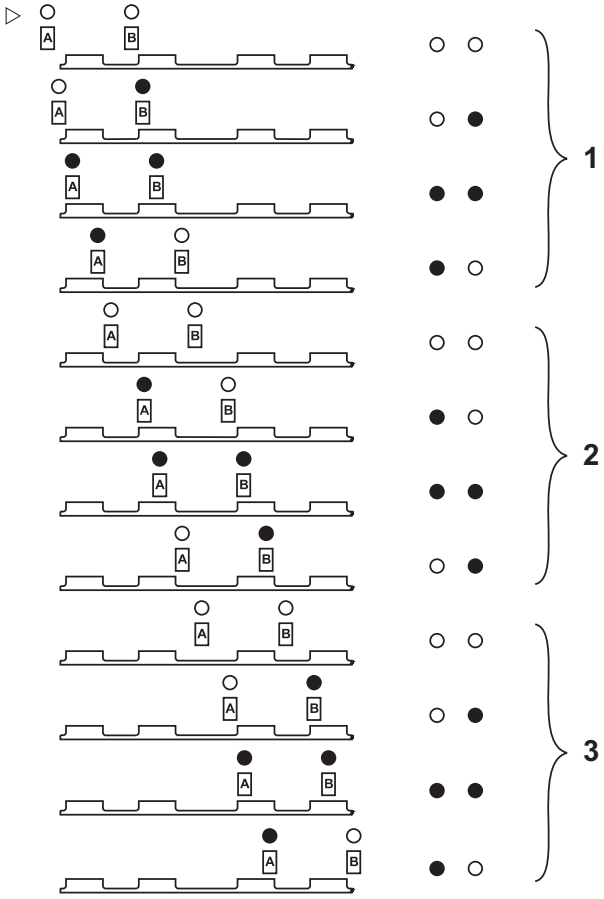
NOTE

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.

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.



Sensor A = 2B18
Sensor B = 2B21

1 Normal signal
2 Reset signal
3 Normal signal

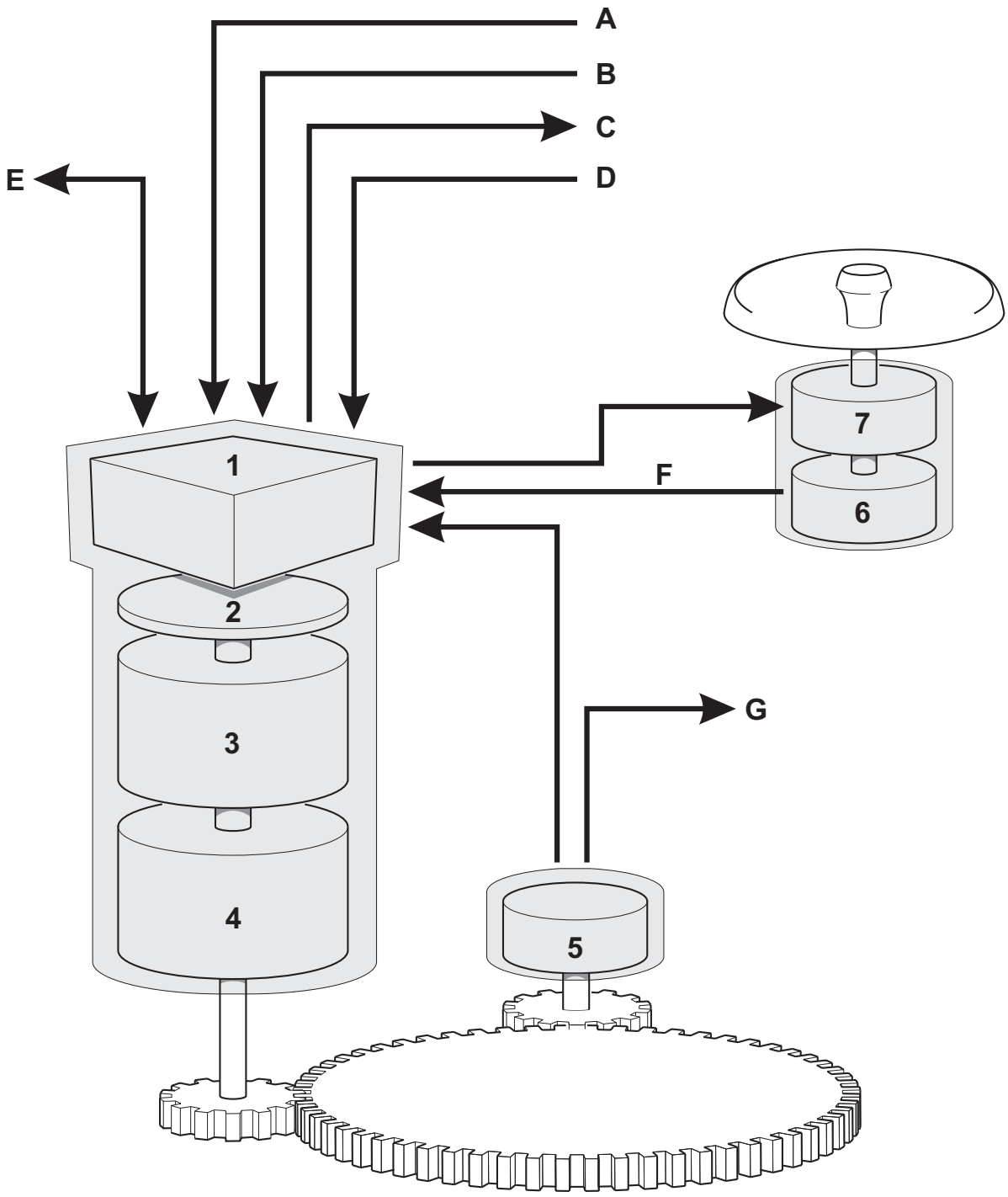
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The optimum adjustment distance is 3.5 mm ± 0.5, which will allow for some deviation. The deviation could be caused by reach channel wear or by the tolerance between the reach carriage and chassis. It is normal to experience some “run out” as the sensors travel along the strip.

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Electrical control - Steering

Steering system overview



A	+48 Volt	1	Module 3A1
B	0 Volt	2	Position encoder
C	OK signal to control module	3	Motor
D	Keyswitch ON signal	4	Gearbox
E	CANbus	5	Drive wheel position potentiometer
F	Driver demand	6	Steering wheel position potentiometer
G	To control module	7	Torque control

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The steering motor unit comprises the motor 3M1, a gearbox and also the steering controller 3A1. Only the steering wheel unit 3R11 and the drive wheel position potentiometer 3R12 are required external to the main unit.

An encoder within the main unit sends a position signal to the controller. This position signal is also sent to the operator's display via the CAN bus.

The drive wheel angle which is calculated from internal encoder signals can be verified using diagnostic software:

Inputs + Outputs
▼
Steering
▼
Steering unit

and

Inputs + Outputs
▼
Traction
▼
Steering inputs

For safety reasons the position value is confirmed by the position potentiometer 3R12 which is mounted on the drive unit plate.

This signals from the position potentiometer can be verified using diagnostic software:

Inputs + Outputs
▼
Steering
▼
Steering unit

and

Inputs + Outputs
▼
Traction
▼
Steering inputs

The steering wheel unit 3R11 comprises the position potentiometer for monitoring the position of the steering wheel, and a torque control unit which varies the amount of force that the operator is required to use to turn the steering wheel.

These signals from the steering wheel potentiometer can be verified using diagnostic software:

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Inputs + Outputs

▼

Steering

▼

Steering wheel

The steering enable signal is separately wired to the control module. This signal can be verified using diagnostic software:

Inputs + Outputs

▼

Traction

▼

Steering inputs

and

Inputs + Outputs

▼

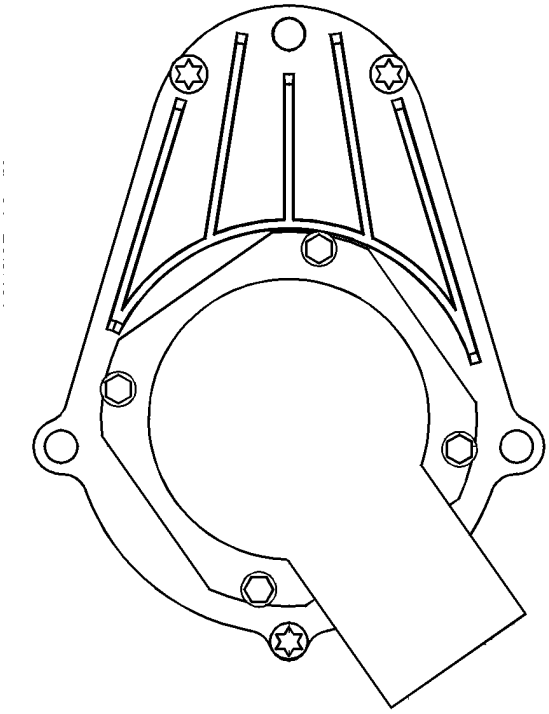
Steering

▼

Steer inputs

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Drive wheel position potentiometer ▷



The drive wheel position potentiometer is used to determine the position of the drive wheel.

The potentiometer has two channels 90° out of phase. Both channels are processed by the steering unit 3A1 and the control module A2

The output from the position potentiometer is compared with the signals from the drive unit internal encoder.

The output from the potentiometer can be verified using diagnostic software:

Inputs + Outputs
▼
Steering
▼
Steering unit

and

Inputs + Outputs
▼
Traction
▼
Steering inputs

Connector 3X19

Pin	Duty
1	Potentiometer track 1
2	-ve
3	Not connected
4	Not connected
5	+15 V
6	Potentiometer track 2

The drive wheel position potentiometer is calibrated using diagnostic software:

Guided Diagnosis
▼
Work Order
▼
Calibration

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Steering wheel unit

The steering unit located within the steering binnacle contains the steering wheel position potentiometer and a torque control device.

Connector 3X18

Pin	Duty
1	Potentiometer track 1
2	-ve
3	Torque control PWM -ve
4	Torque control 13V supply
5	Potentiometer 15V supply
6	Potentiometer track 2

Steering wheel potentiometer

The steering wheel potentiometer has two channels 90° out of phase. Both channels are processed by the steering unit.

This signals from the steering wheel potentiometer can be verified using diagnostic software:

Inputs + Outputs
▼
Steering
▼
Steering wheel

Steering wheel torque control

A torque control device provides the expected 'feel' of a power assisted steering system.

NOTE

In order to feel this effect, the operator's seat must be occupied.

Various signals from the steering module are sent via the CANbus to the display. The display calculates the required torque feedback value which is sent back to the steering module. The steering module controls the torque control device by varying the voltage using PWM.

The steering wheel torque value can be verified using diagnostic software:

Inputs + Outputs
▼
Steering

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▼

Steering wheel

There are five levels of increasing stiffness available which can be selected using diagnostic software :

Error codes + Parameters

▼

Display

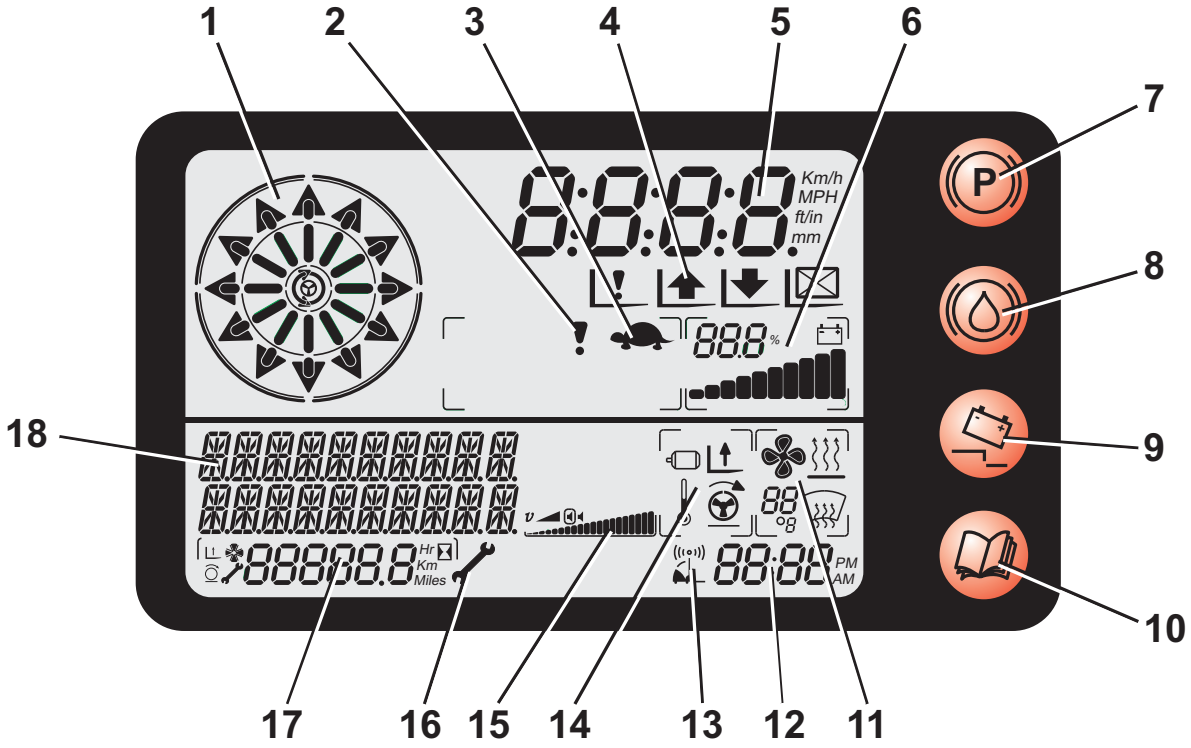
▼

Display options

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Electrical control - Display

Operator's display



1	Steering indicator	10	Service indicator
2	Interlock warning indicator	11	Cabin heater indicators (option)
3	Slow speed indicator	12	Clock
4	Fork height command indicators	13	Data Logger communication indicator (option)
5	Fork height display	14	Over temperature indicators
6	Battery discharge indicator	15	Cabin intercom volume (option)
7	Parking brake indicator	16	Service interval elapsed indicator
8	Brake fluid warning indicator	17	Hour meter
9	Battery lock warning indicator	18	Message panel

Connector 6X1

Pin	Duty
1	+13 Volt input
2	Brake fluid level sensor S3
3	+48 Volt (direct from battery)
4	Optional current sensor
5	Height encoder (A) 1B12
6	Height encoder (B) 1B12
7	Height encoder reference sensor 8B5
8	Battery lock sensor B1
9	Traction module cooling fan 9M1 (PWM)
10	External bleeper output
11	Traction motor cooling fan 9M2 (PWM)
12	Hydraulic motor and module cooling fan 9M4 (PWM)

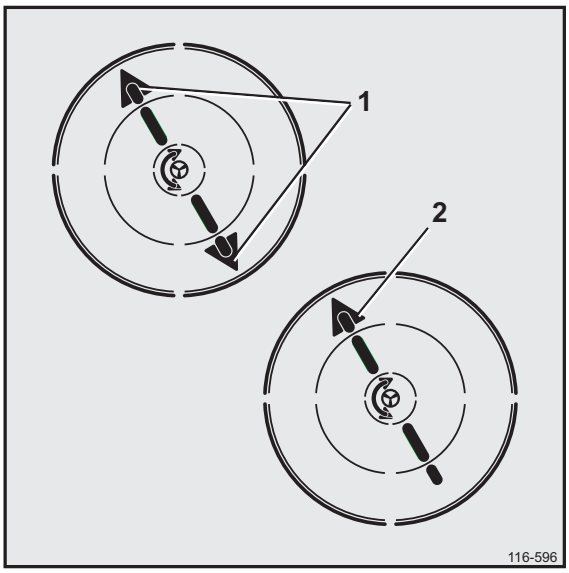
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Pin	Duty
13	UPA input (Load sensor)
14	CAN HI
15	CAN LO
16	0 Volt (direct from battery)

Steering indicator

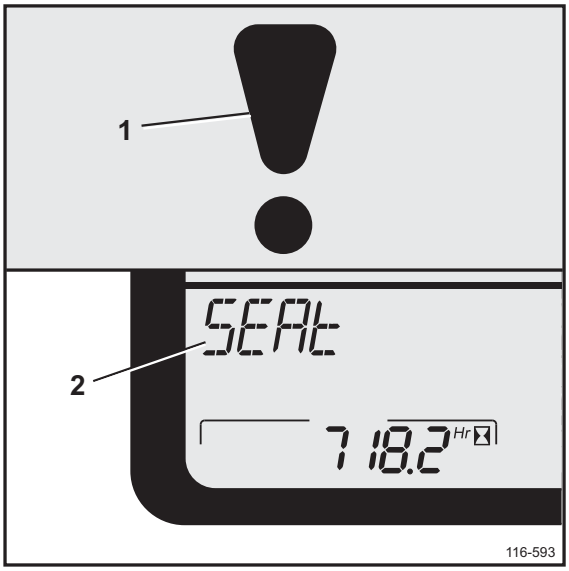
The angle of the drive wheel is sent from the steering controller to the operator's display via CAN.

This signal is processed and output to the steering indicator.



Interlock warning indicator

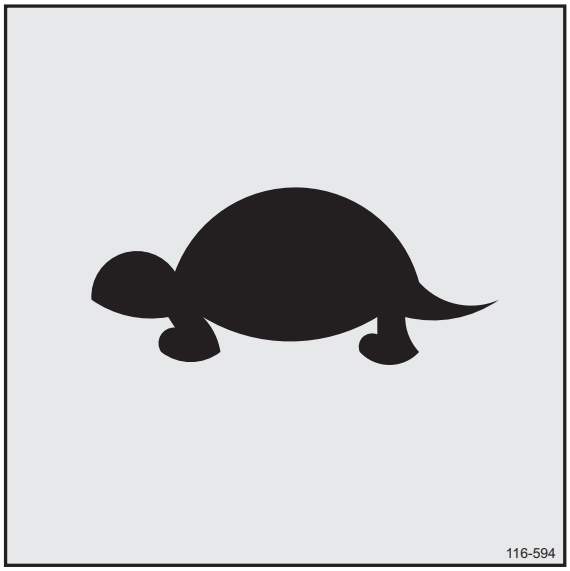
If an attempt is made to operate a function which has been interlocked out or inhibited, then the interlock warning icon (1) will be displayed. This may be accompanied by a help prompt on the message panel (2).



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Slow speed indicator

The slow speed icon will be displayed when a controller is reducing the performance of the selected function.



Lift height indicator (LHI) and Height pre-selector (LPS)

Height indicator/pre-selector options and parameters are programmed using diagnostic software:

Error Codes + Parameters
▼
Display
▼
Height Indicator Parameters

The hardwired height encoder signals are processed by the operator's display to calculate the height of the forks. The fork height is displayed in the required format.



The encoder signals and fork height can be verified using diagnostic software:

Inputs+Outputs
▼
Display
▼
LHI/LPS

This calculated height and status information is output on the CAN bus and is used by the control module to control height pre-selector functions.

Storage locations are programmed using diagnostic software:

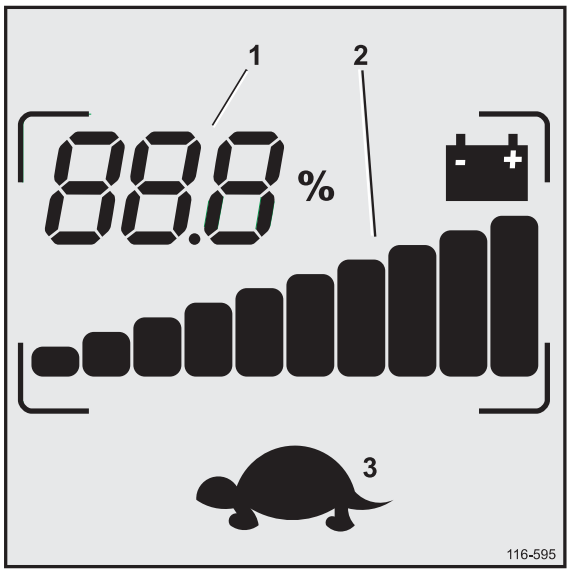
Error Codes + Parameters
▼
Display

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▼

Shelf heights

Battery discharge indicator



The battery discharge indicator comprises a bar graph of 10 segments (2) and a numerical display (1).

The bar graph (2) gives a visual representation of the battery state of charge. At full charge all 10 segments will be filled

Battery settings are programmed using diagnostic software:

Error Codes + Parameters
▼
Display
▼
Battery settings

The numerical display can show the remaining charge as a percentage of the rated capacity or the estimated remaining operating time in hours. Mode of operation is set using diagnostic software:

Error Codes + Parameters
▼
Display
▼
Battery settings

To prevent damage to the battery, the display will indicate zero percent or hours when the battery has been discharged to twenty percent of it's rated capacity. Truck performance will be reduced and the slow speed icon (3) will be displayed when the lift lever is operated.

The cut off threshold for different cell voltages is set using diagnostic software:

Error Codes + Parameters
▼
Display
▼
Battery settings

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Clock

To set the clock on trucks fitted with a keypad :

- Log on using your personal PIN.
- Within ten seconds of logging on, press and hold the 1 key for more than five seconds.

On trucks not fitted with a keypad, clock options are set using diagnostic software:

Error Codes + Parameters
▼
Display
▼
Time / Date



Data Logger communication indicator

This indicator shows when data communication is taking place.



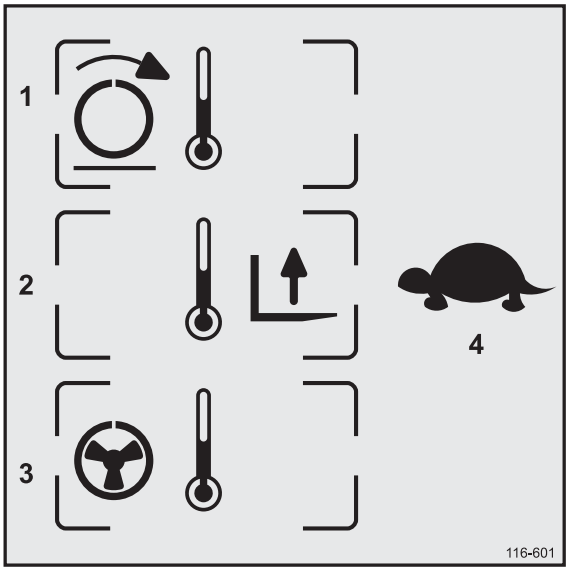
Over temperature indicators

Should prolonged overload conditions exist, then the motors or controller may become too hot. The display utilises a combination of two icons to notify the operator of this condition.

Icons (1) will flash should the traction motor or controller become to hot.
Icons (2) will flash should the hydraulic motor or controller become to hot.
Icons (3) will flash should the steering motor become to hot.

NOTE

If a motor or the controller becomes too hot, then it's performance will be reduced until it has cooled to normal operating temperature. The



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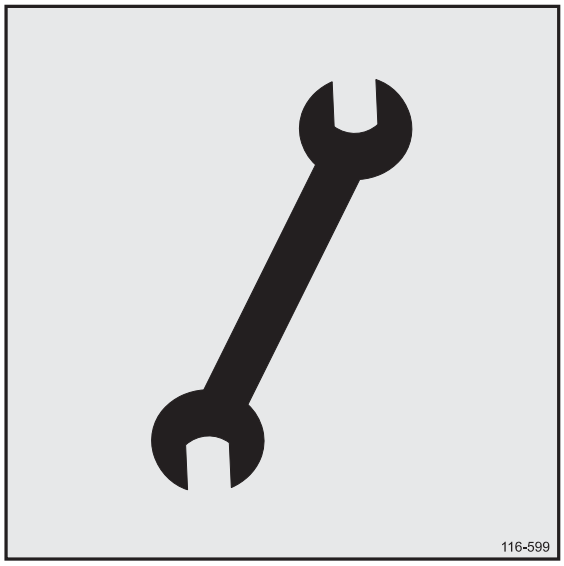
slow speed icon (4) will be displayed to notify the operator of reduced performance.

Service interval elapsed indicator

When a service is overdue, the animated service interval elapsed icon will flash for 10 seconds when the keyswitch is turned on.

Operating of the indicator and service intervals are set using diagnostic software:

Error Codes + Parameters
▼
Display
▼
Service Interval



Hour meter

There are four counters in total:

Main - Keyswitch on and seat occupied
Traction - Total time that traction has been in operation
Hydraulic - Total time that the pump motor has been in operation
Next service - time to next service

As standard, the hour meter displays operational time (keyswitch on and seat occupied) of the truck in hours (1). The animated hourglass icon will flash to indicate that the hour meter is running.

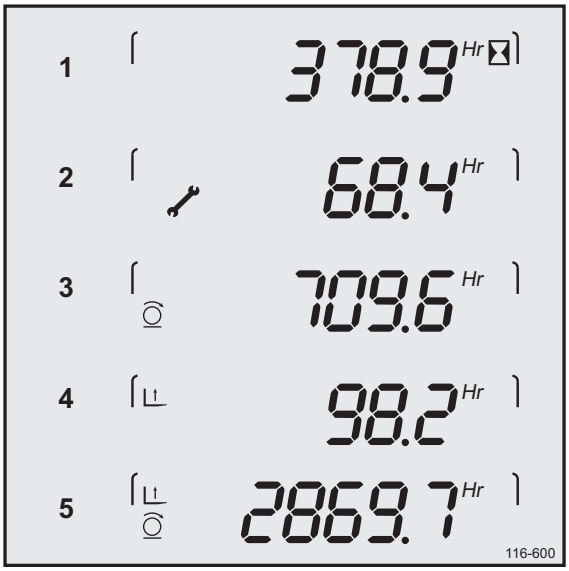
The hour meter can be configured to display alternative meter readings for a brief period when the truck is switched on using diagnostic software:

Error Codes + Parameters
▼
Display
▼
Display Options

(2) Time to next service
(3) Traction motor operational time
(4) Hydraulic motor operational time
(5) Combined traction and hydraulic motor operational time

The hour meter values can be viewed using diagnostic software:

Inputs + Outputs
▼



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Display

▼

Hour Meters

The hour meter history values can be viewed and reset using diagnostic software:

Error Codes + Parameters

▼

Display

▼

Hour Meter

Message panel

The twenty character message panel (1). conveys various information to the operator including operator help prompts and diagnostic codes.



MESSAGE	EXPLANATION	ACTION REQUIRED
No SEAT	Attempting to drive with the operator's seat unoccupied	Sit on the seat
Low battery	Battery voltage is very low	Recharge the battery immediately
Trac Boot Err	The traction system has not powered up correctly	Could Indicate a potential fault. Switch the truck off and on again. If the message is still displayed, then check fault codes.
Release Handbrake	Attempting to drive with the handbrake applied	Release the handbrake
Select Direction	Attempting to drive without first selecting a direction	Select a direction of travel
Left foot	Attempting to drive without depressing the left foot interlock pedal	Depress the left foot interlock pedal
Lift Boot Err	The lift system has not powered up correctly	Could Indicate a potential fault. Switch the truck off and on again. If the message is still displayed, then please contact your local distributor.

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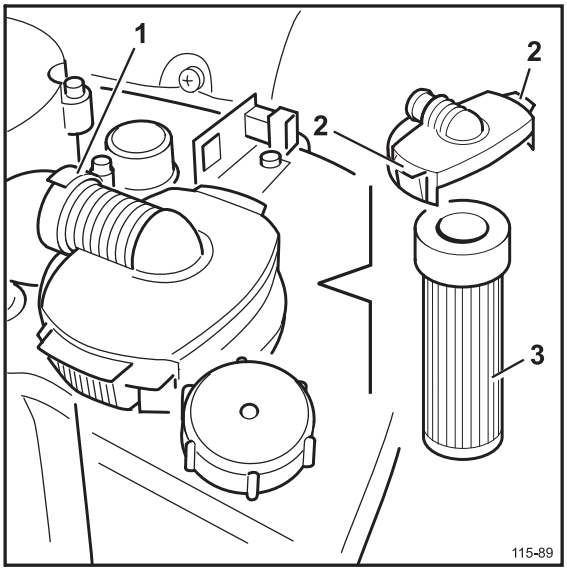
MESSAGE	EXPLANATION	ACTION REQUIRED
Joystick Err	Joystick is operated at power up	Could Indicate a potential fault. Check the joysticks are in neutral position then switch the truck off and on again. If the message is still displayed, then check fault codes.
Slow Only	A controller is reducing the perfor-mance of the requested function	No action required
No VALVE detected	No Valve is detected	Could Indicate a potential fault. Switch the truck off and on again. If the message is still displayed, then check fault codes.
Not Tested	The display is not tested and will not function properly	
Getting Hours	The hour meters are being collected from the truck (when fitting a new display)	No action required
Clock Changed	The clock has been updated due to a change in winter/summer time	No action required
Clock Setting	The Clock is in “setting mode” (requested by the operator via the keypad)	No action required
No CANbus	There are no signals being received on the CANbus	Could Indicate a potential fault. Switch the truck off and on again. If the message is still displayed, then check fault codes.
Zone	A warehouse zone is being displayed or changed via the keypad	No action required
PIN	Request entry of a PIN (Personal Identification Number) to access the truck	Enter your PIN
Display Warming Up	The temperature of the operator’s display is below 2°C and is being warmed up.	No action required NOTE: if the temperature of the display is below 2°C, then some icons including the steering indicator are not displayed. Proceed with caution until the display has warmed up and all icons are displayed.
Pot Calibrate	The reach system is being calibrated	No action required

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Operating hydraulics

Change the hydraulic oil and suction filter



⚠ WARNING

The hydraulic fluid can become very hot. Risk of scalding.

Ensure the hydraulic oil has cooled sufficiently before carrying out the following procedure.

Carry out this operation with forks in the lowered position and with the mast reached in.

- ➢ Turn the keyswitch off and depress the emergency isolator.
- ➢ Open the motor cover.
- ➢ Slacken the securing clip (1) on the outlet hose.
- ➢ Pull the outlet hose 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.
- ➢ Empty the hydraulic tank using a suitable hand-pump.
- ➢ Refill the tank to the correct level with clean hydraulic oil.

NOTE

The tank has two level marks labelled 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.

- ➢ Place a new filter element (3) into the tank and replace the filter cap.
- ➢ Prime the pump by filing the outlet hose with clean hydraulic oil.

⚠ CAUTION

Failure to prime the pump will cause it to run dry causing premature failure.

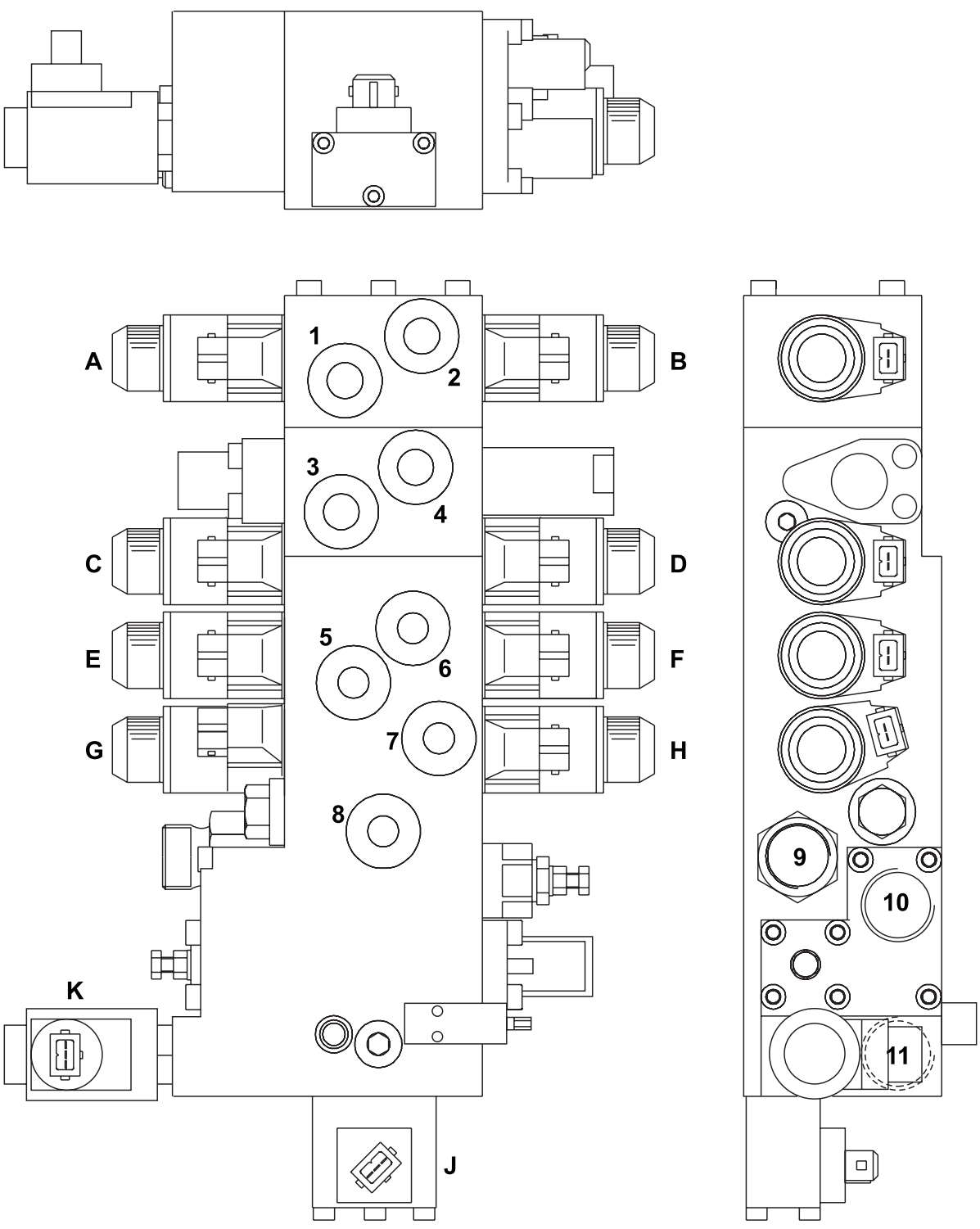
Ensure the pump is primed by filling the outlet hose with hydraulic oil prior to running.

- ➢ Replace outlet hose, ensuring clip (1) is secure.

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Valve block

Hydraulic valve block



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ELECTRICAL CONNECTIONS

ITEM	CONNEC-TOR	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	1Y11	Tilt forward
H	1Y12	Tilt back
J	2Y1/2	Lift and lower
K	2Y31	Lower lock valve

HYDRAULIC CONNECTIONS

ITEM	PORT	FUNCTION
1	B4	Auxiliary 2
2	A4	Auxiliary 1
3	B3	Reach back
4	A3	Reach forward
5	B2	Sideshift left
6	A2	Sideshift right
7	A1	Tilt forward
8	B1	Tilt back
9	T	Tank (Adaptor M27 - 3/4BSP)
10	P	Pump (Adaptor)
11	A	Lift/Lower (Adaptor)

Removal

- ➢ Reach out, centralise the sideshift, and lower the mast fully
- ➢ Turn the keyswitch off, depress the emergency isolator and disconnect the battery.
- ➢ Remove the cover to gain access to the hydraulic valve.

NOTE

Before carrying out the following procedure, ensure the valve block and surrounding area are cleaned thoroughly. Also ensure that an adequate supply of plugs is available in order that the hoses and valve ports can be plugged prevent the ingress of dirt.

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Valve block

- Using a suitable spanner, unscrew the emergency lower valve one full turn, and re-tighten.
- Disconnect all the hydraulic connections, noting their position for re-assembly, and plug to prevent the ingress of dirt.

⚠ CAUTION

To prevent the hydraulic oil draining from the tank the return to tank hose will need to be plugged. **DO NOT** clamp the hose to prevent oil leakage as this will damage the hose inner lining.

To plug the return to tank hose, only use plug Pt. No. 000 952 40 24

NOTE

Special spanner, Pt. No. 002 941 80 18 will facilitate the removal of the return to tank hose.

NOTE

On wide and narrow chassis trucks, the emergency lower valve is operated remotely by a cable, which must be disconnected before removing the valve.

- Disconnect all the electrical connections, noting their position for re-assembly, and position harnesses away from the valve block to prevent damage.
- If necessary, raise and securely block the truck in order to gain better access to the three screws located under the reach frame which secure the valve block.
- Remove the three screws and wavy washers.
- Remove the valve block, retaining the three plain washers that are located between the valve block and reach frame.

Installation

- Before replacing the valve block, ensure any leaked hydraulic oil is cleared away.
- To replace the valve block, reverse the removal procedure, ensuring that the three plain washers between the valve and the reach frame are located correctly. Use grease to prevent the washers from moving.

NOTE

To facilitate valve block replacement, three studs can be made from M8 screws which are then loosely screwed into the valve block before assembling to the reach frame. These will hold the

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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 12 Nm.

➢ Bleed the hydraulic system.

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Valve block

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Mast unit

Introduction

The standard versions of this 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:

Mast	Model	Design features
184	1.4 / 1.6 tonne standard	80mm mast channels, integral reach carriage
187	2.0 tonne standard	90mm mast channels, integral reach carriage
183	1.4 / 1.6 tonne, 1400 / 1600mm	As mast 184 but with separate reach carriage
186	2.0 tonne 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 1.4 tonne version, and 100 mm x 45 mm section for 1.6 and 2.0 tonne versions of this model.

Fork lengths from 800 mm to 1500 mm are available as a customer option.

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.

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Mast removal

- Remove the forks. Refer to relevant procedure.
- Position the truck under suitable lifting equipment.

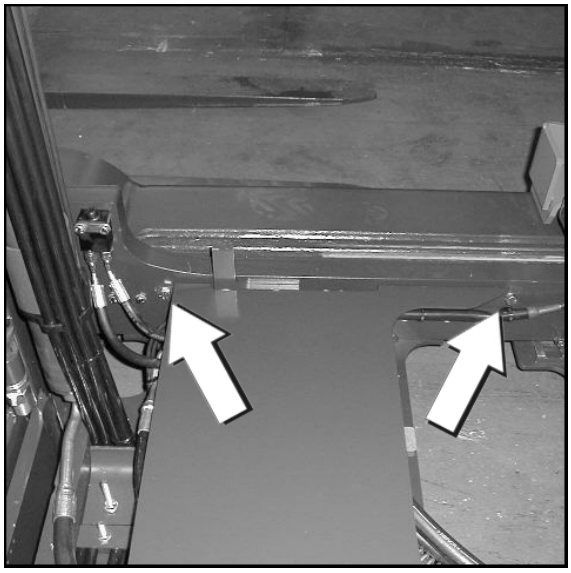
⚠ DANGER

Only use lifting equipment of suitable capacity.

Minimum capacity 3000 kg

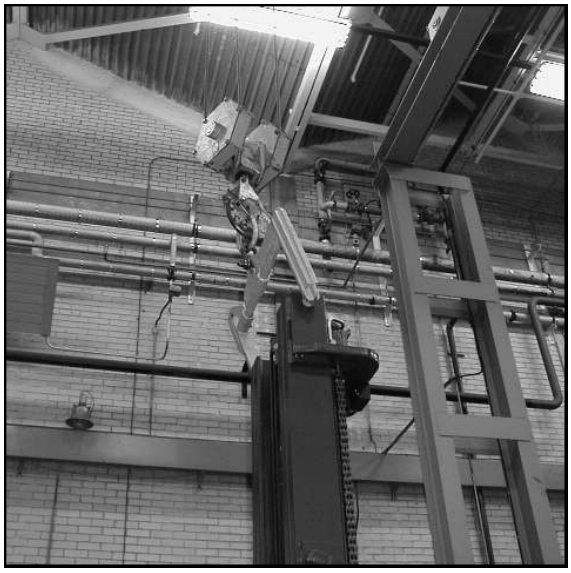
- Apply the parking brake and chock the wheels securely.
- Reach the mast fully forward. Lower the fork carriage.
- Turn the keyswitch off.
- Remove the four screws and washers which secure the hydraulic control valve cover to the reach chassis.
- Remove the cover.

▷



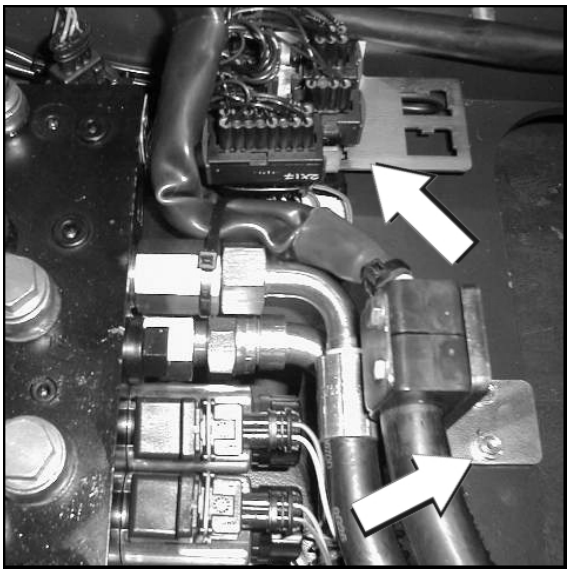
- Secure the mast assembly with the lifting equipment (and wooden blocks if necessary) to prevent it rolling forwards or backwards once the reach jack is disconnected.
- Disconnect the reach cylinder from the chassis beneath the operators footwell. It may be necessary to lift the drive end of the truck 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.

▷

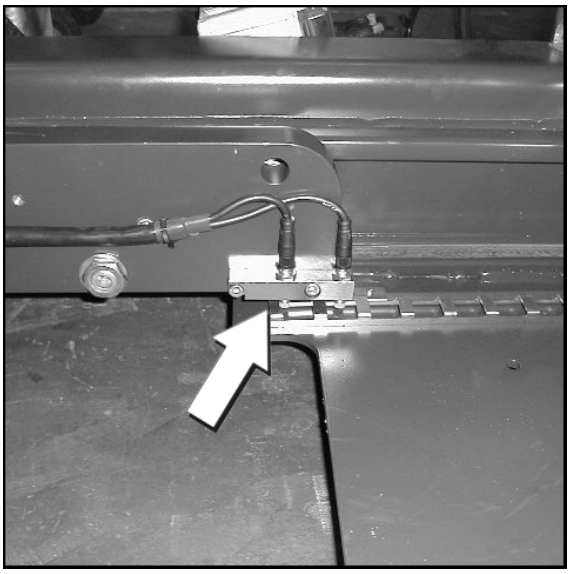


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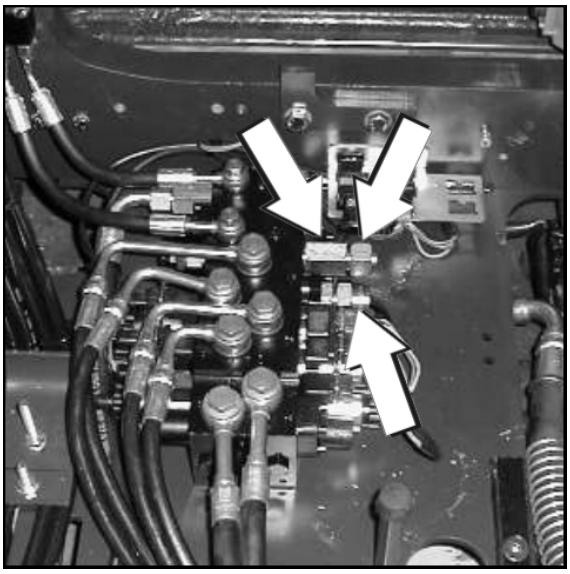
- Disconnect the hydraulic control valve wiring at the plugs/sockets, noting their positions.
- Remove the two screws securing the harness support bracket to the reach frame.



- 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.
- Plug the hose using plug Pt. No. 000 952 40 24 to prevent oil draining from the tank.



⚠ CAUTION

DO NOT clamp the hose to prevent oil leakage, as this will damage the inner lining.

Only use the plug specified.

NOTE

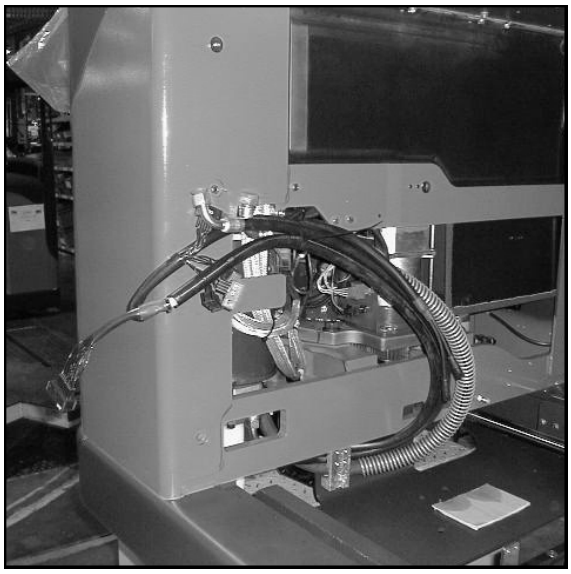
Special spanner, tool number 002 941 80 18 will facilitate removal of the return to tank hose.

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Mast unit

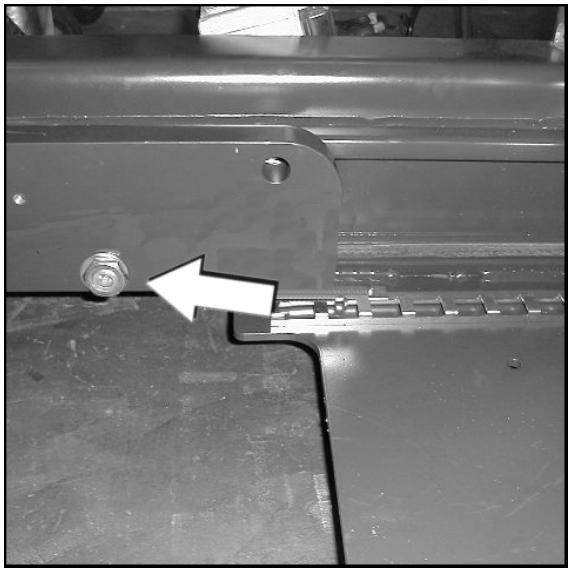
- Seal the pump to control valve hose and both hydraulic connections on the hydraulic control valve.
- Tie both hydraulic hoses back and as high as possible to further prevent oil leaking from the hydraulic tank.
- Remove cable clips as required to enable wiring harness to be tied back to the chassis free of the mast.

▷



- Undo the locking nuts and release the adjustment of the two bottom steady rollers.

▷

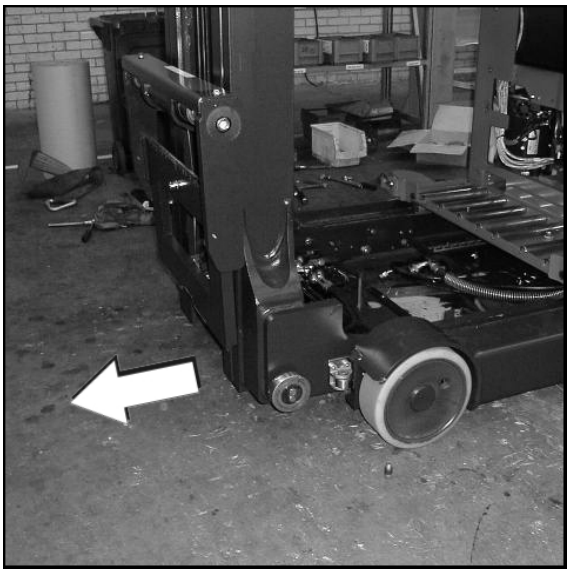


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➢ Remove the reach stop screw, washer and spacer from both reach channels. ▷



➢ Using the overhead lifting equipment carefully ease the mast assembly along the reach channels until the unit is clear of the chassis. ▷



⚠ WARNING

Never step under an elevated load.

When lifting the mast with a crane, ensure that no persons are within the vicinity.

⚠ WARNING

Manual handling risk. The mast is heavy.

Care should be taken when manoeuvring the mast out of the chassis.

Installation

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.

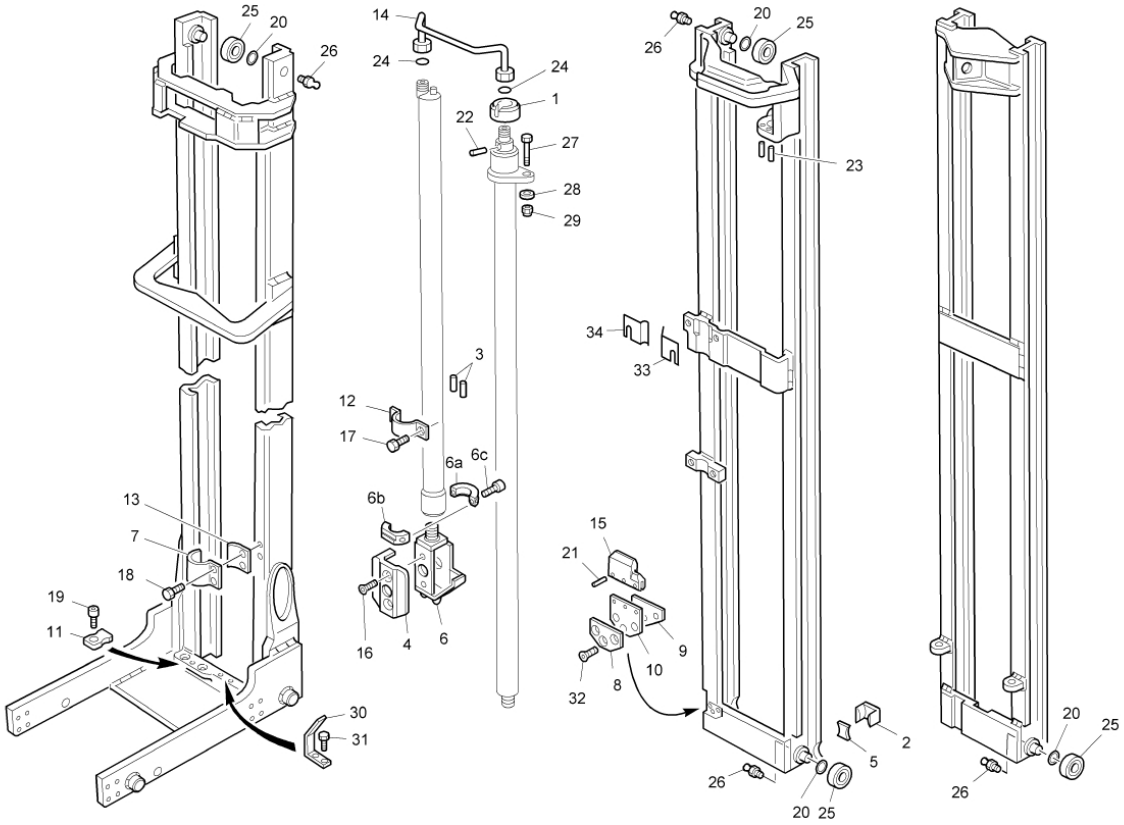
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Mast unit

- Adjust both left and right hand eccentric reach rollers. Check reach side rollers and adjust as necessary. Refer to relevant procedure.
- 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 3.5 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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Mast unit dismantling



1	Buffer
2	Pad
3	Cylindrical pin
4	Cover
5	Shim
6	Bracket assembly
6a	Clamping piece
6b	Clamping piece
6c	Socket head screw
7	Bracket
8	Plate
9	Plate
10	Plate
11	Stop
12	Clamping piece
13	Clamping piece
14	Pipe assembly
15	Block
16	Countersunk screw
17	Hexagon head screw
18	Hexagon head screw
19	Socket head screw
20	Shim
21	Dowel
22	Cotter pin
23	Dowel pin
24	O ring
25	Support roller
26	Lubrication nipple
27	Hexagon head bolt
28	Washer
29	Hexagon nut
30	PLate
31	Hexagon head screw
32	Countersunk screw
33	Retainer plate
34	Retainer plate

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 procedure will require workshop facilities which must include a suitable mast stand and lifting equipment.

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Mast unit

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.

Mast unit re-assembly

Re-assembly of the mast unit is a reversal of the dismantling procedure. Particular attention should be paid to the adjustment of the mast rollers.

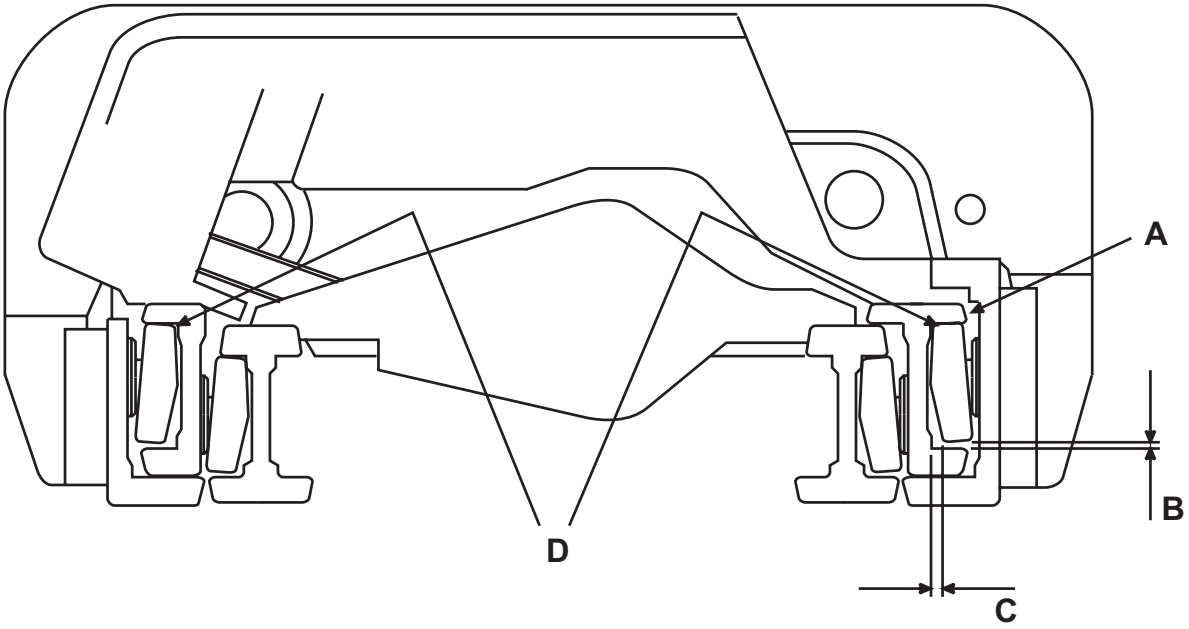
Mast support rollers are available in several “over sizes” to allow for slight tolerances within the mast channels. The part numbers for the different diameter rollers are all listed in the mast section of the 115 parts manual.

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

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have to be removed locally from the channel by careful grinding. The final finish must be smooth.

Mast roller shimming



A	Lever here
B	1.4 mm nominal clearance of non contact side
C	0.1 mm minimum clearance
D	Shim rollers equally each side to CONTACT the channel at the tightest point. Maximum clearance elsewhere must not exceed 1.0 mm IMPORTANT heavy roller contact must be avoided

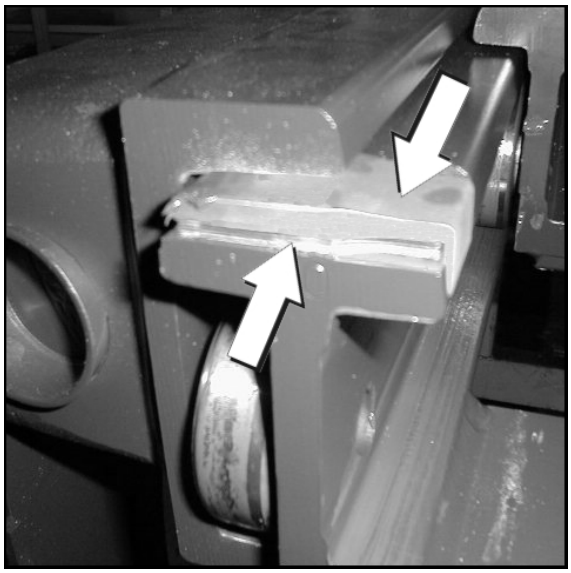
To take up side play between the mast sections fit shims (20) to the roller shafts (equally to left and right rollers to centralise the carriage/mast sections). There should be a minimum sideways clearance of 0.2 mm between the contact side of the roller and its channel throughout the whole length of 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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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.

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Hydraulic cylinders

Primary lift cylinder

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 cylinders to be removed.

NOTE

It is recommended that two qualified persons carry out the following procedure.

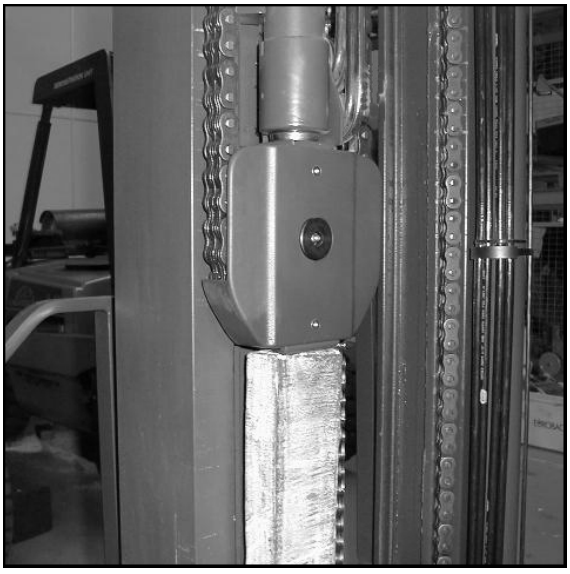
⚠ WARNING

Manual handling risk. The lift cylinder is heavy.

Care should be taken when removing the lift cylinder.

- 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.
- Chock the load wheels securely.
- Turn the keyswitch off and disconnect the battery.
- Using the lifting equipment raise and block the fork carriage to slacken the primary lift chain. Ensure that the cylinder remains fully closed.
- Place a suitable wooden support between the reach carriage and the underside of the primary lift cylinder chain pulley assembly.
- Remove the chain pulley cover.

▷

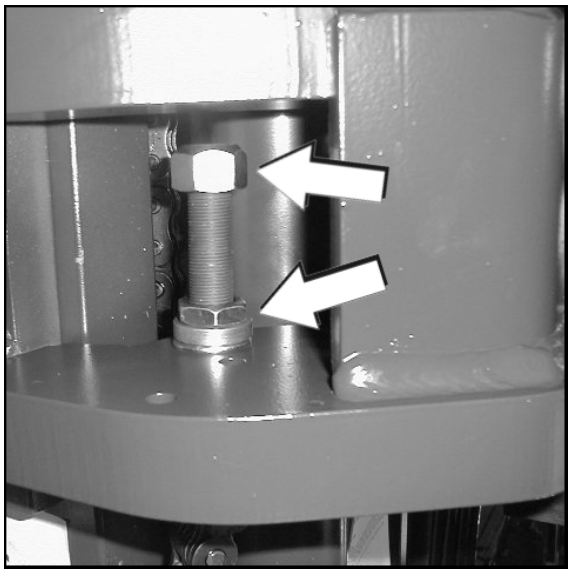


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Hydraulic cylinders

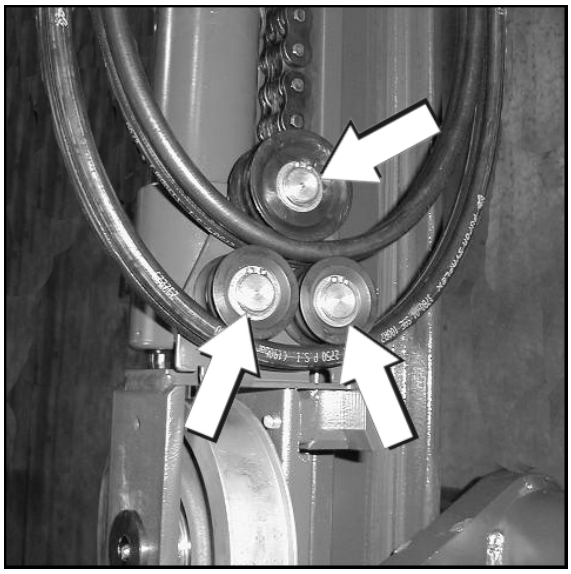
- Disconnect the primary lift chain at the top of the outer mast.
- Withdraw the chain from the pulley and stow safely.

▷



- Remove the three circlips and shims retaining the three hose pulleys. Remove hose pulleys and safely stow mast hoses away from the primary lift cylinder.
- Secure the hose pulley shafts to the lift cylinder outer cylinder with suitable cord or rope to prevent the lift cylinder extending as it is removed from the mast.

▷



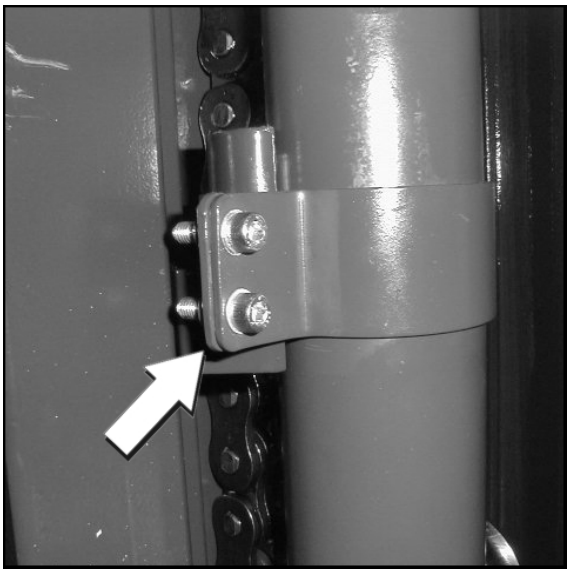
- Using a suitable mobile safety step up platform, disconnect the primary lift cylinder inlet connector using a 41 mm open end spanner. Contain any oil spillage.
- Plug the inlet hole in the cylinder and hydraulic pipe.

▷



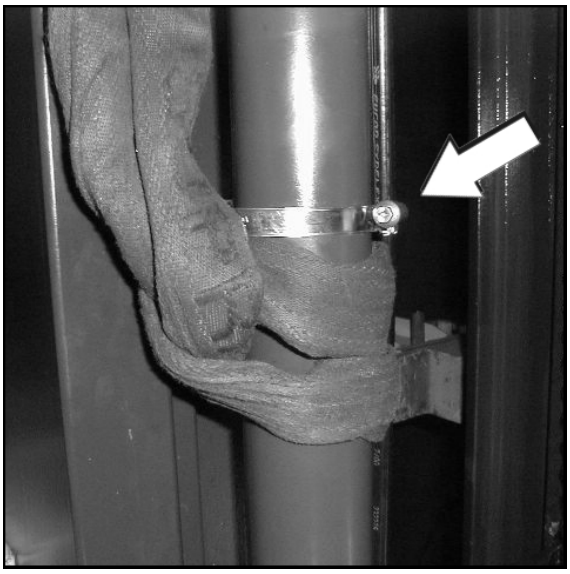
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➢ Remove the two part primary lift cylinder steady clamp. ▷



➢ Connect a suitable sling around the lift cylinder cylinder with a clip fitted around the cylinder to prevent the sling from slipping down. Connect the sling to suitable lifting equipment. ▷

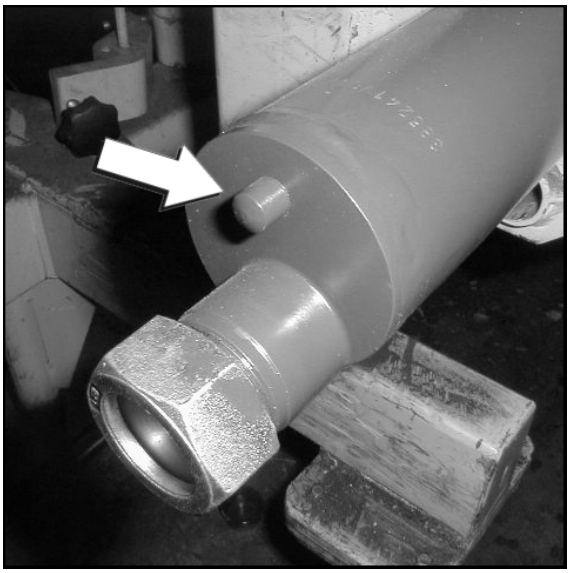
➢ Carefully remove the primary cylinder from its middle mast mounting.



Installation

➢ To replace the primary lift cylinder 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. ▷

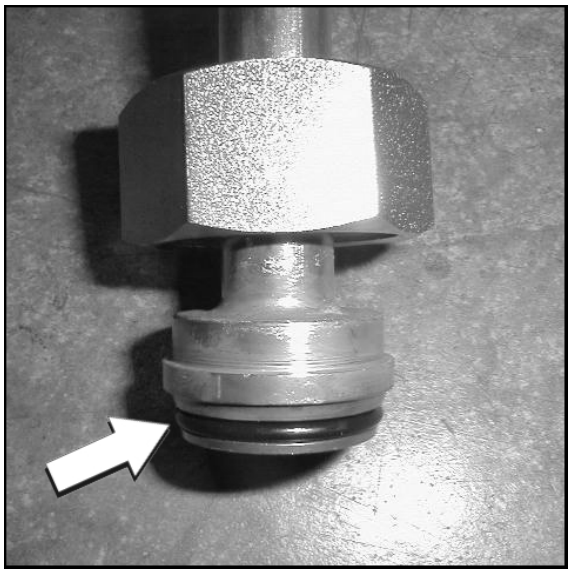


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Hydraulic cylinders

- 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.
- Bleed the hydraulic lift system. Refer to relevant procedure.

▷



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Secondary lift cylinder

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 cylinders to be removed.

NOTE

It is recommended that two qualified persons carry out the following procedure.

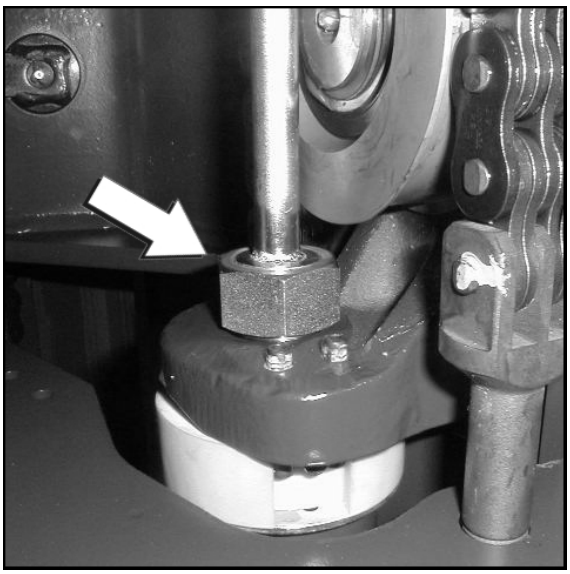
⚠ WARNING

Manual handling risk. The lift cylinder is heavy.

Care should be taken when removing the lift cylinder.

- ➢ 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.
- ➢ Chock the load wheels securely.
- ➢ Turn the keyswitch off and disconnect the battery.
- ➢ Using a suitable safety step up working platform, disconnect the secondary lift cylinder top hydraulic pipe connection using a 41 mm open end spanner. Plug hydraulic pipe and cylinder connection holes.

▷

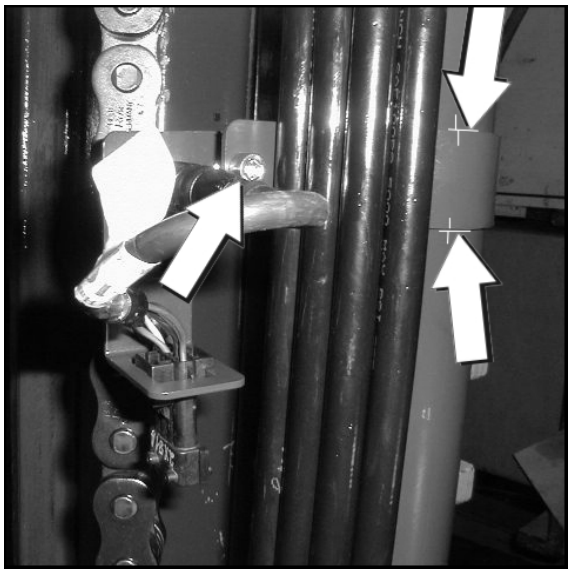


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Hydraulic cylinders

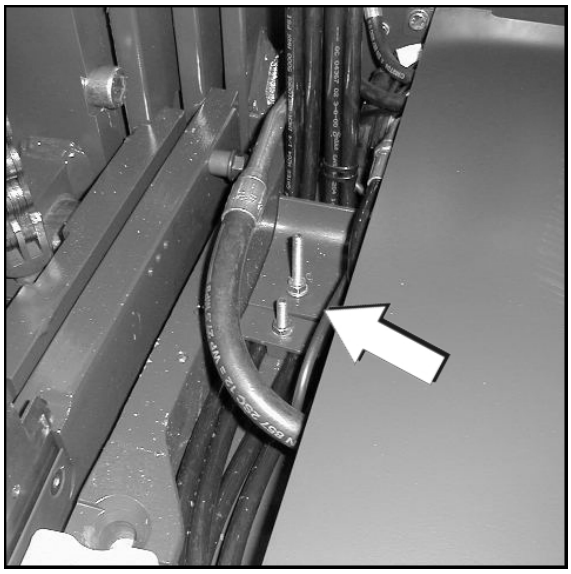
- Remove the lift stop sensor cover and disconnect the sensor.
- To assist re-assembly, mark the bracket position top and bottom on the lift cylinder.
- Unscrew the bracket clamping screw, and remove the two part bracket complete with sensor.
- Using a suitable sling around the middle and inner mast top cross member, raise the mast unit sufficient to enable the cylinder to be removed. Block the mast unit securely.

▷



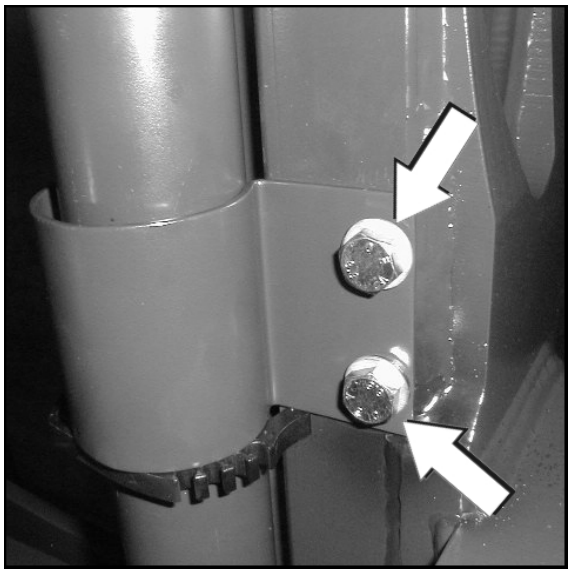
- Unclip the mast hoses from the secondary lift cylinder. Remove the bottom hose clamp/guide to enable the hoses to be safely stowed to one side.

▷



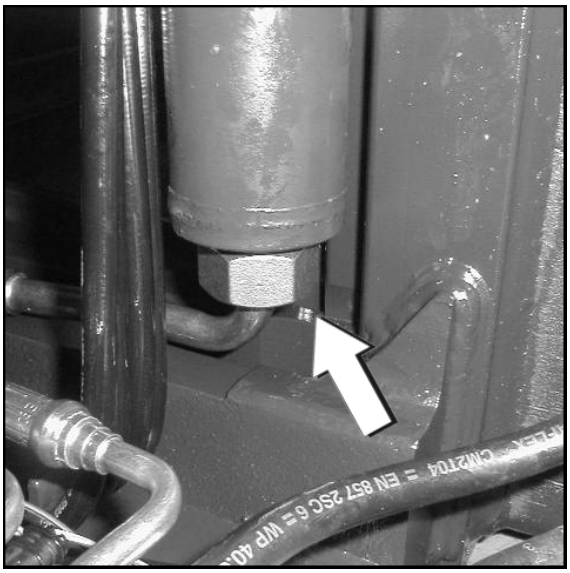
- Undo the two securing screws and remove the two part secondary lift cylinder steady bracket.
- Place a drip tray underneath the mast unit to contain any oil spillage.

▷



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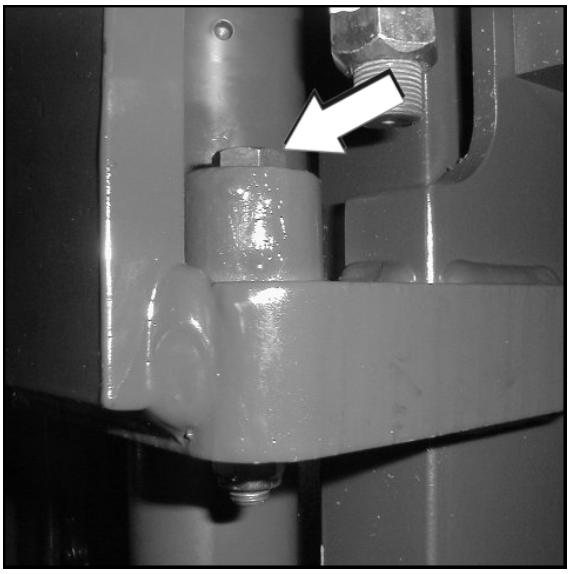
➢ Disconnect the bottom hydraulic pipe connector using a 41 mm spanner. Plug the cylinder and pipe connection holes. ▷



➢ Remove the lift cylinder top mounting bolt, washer and nut. ▷

➢ Place a suitable sling around the lift cylinder (using a hose clamp to prevent the sling from slipping up the cylinder) and connect to the lifting equipment.

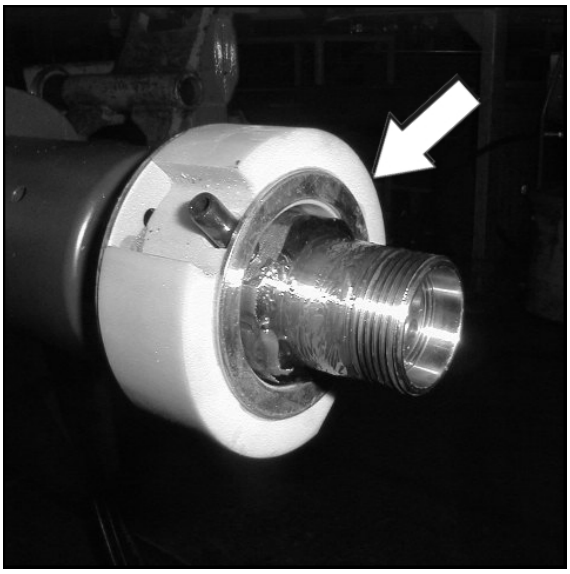
➢ Carefully raise the lift cylinder sufficient to manoeuvre it clear of the mast assembly. Take care not to lose the buffer fitted to the top of the cylinder shaft.



Installation

To replace the secondary lift cylinder, reverse the removal procedure. Take care when replacing the cylinder to ensure that it is not damaged.

➢ Ensure that the buffer is in good condition and is refitted to the top of the lift cylinder shaft. ▷

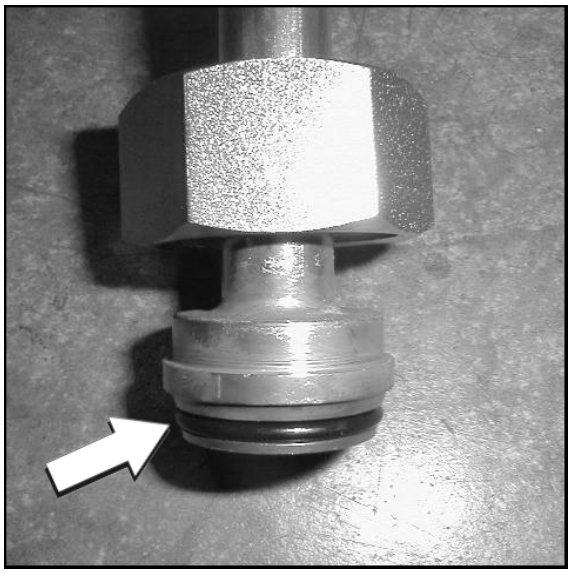


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Hydraulic cylinders

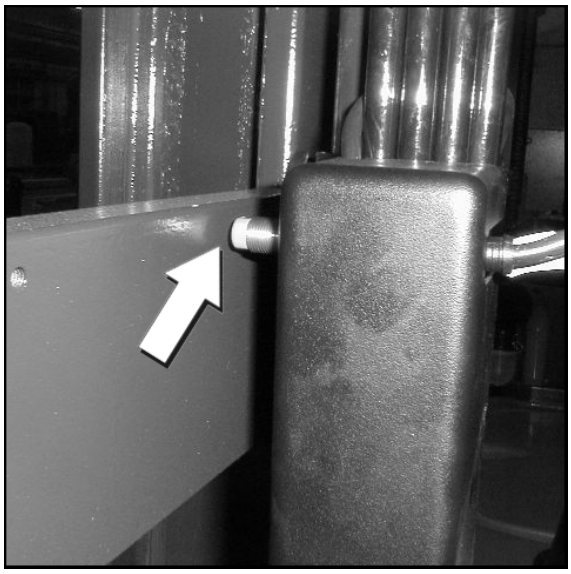
- Check the condition of the 'O' Ring and replace if necessary.
- Tighten connector of interconnecting pipe 120-150 Nm. **DO NOT** overtighten.
- Check the hydraulic oil tank level. Top up if necessary using the recommended grade of oil.

▷



- 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. Refer to relevant procedure.

▷



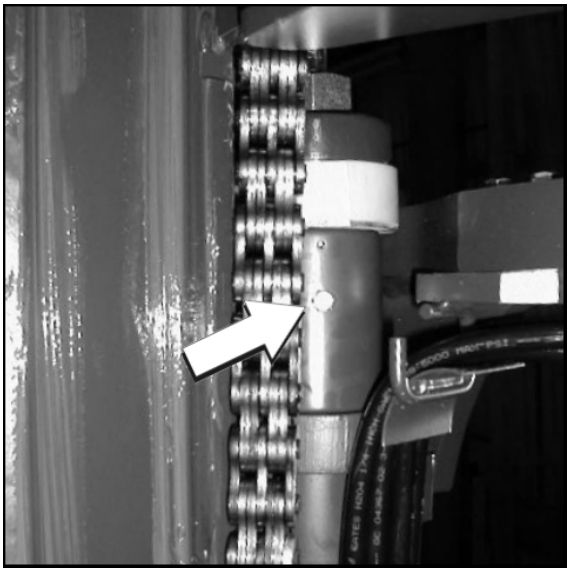
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Lift cylinder bleeding

Air should be released from the hydraulic lift system by raising the mast to full lift height a few times, if this is not the case, proceed as follows:

- To bleed the system, using a 7 mm spanner, loosen the bleed screw on the secondary lift cylinder.
- Carefully operate the lift control until all the air bubbles cease to flow from the bleed point.
- Tighten the bleed screw.
- Ensure that the fork carriage and mast unit does not ‘bounce’ after the bleeding operation is complete.
- Re-bleed the system if the mast lift operation continues to ‘bounce’.

▷



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Load support

Forks

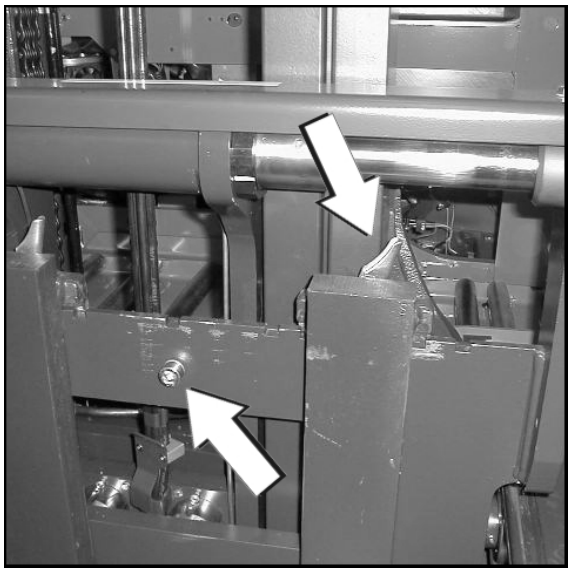
Removal

⚠ 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.

Fitting

- ➢ 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.

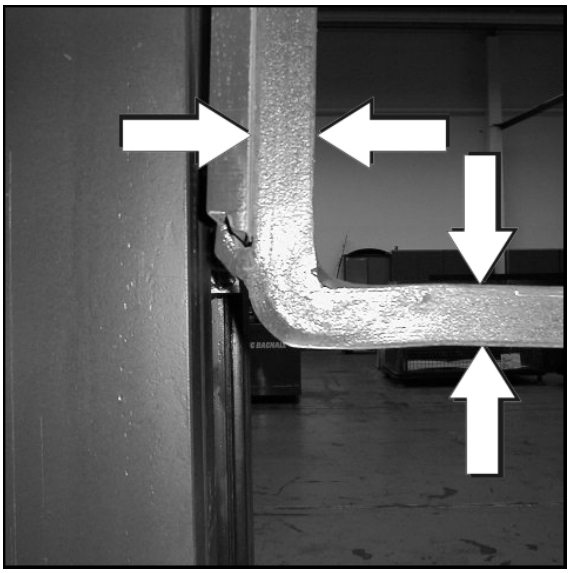
Inspection

NOTE

Before carrying out fork inspection, any rust, scale or paint should be removed from the forks.

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➢ Check the thickness of the fork arm blade at a point between the end of the taper and heel of the fork arm. ▷

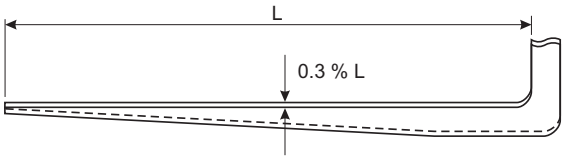


The forks should be withdrawn from service if the blade has been worn to 90% of it's original thickness.

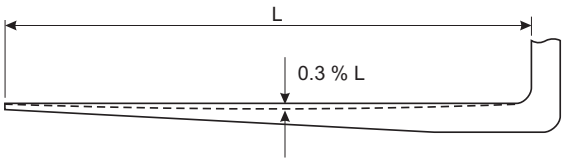
NOTE

The shank of the fork can be used as a guide to it's original thickness. It is advisable to use a wear gauge to assist in this measurement.

➢ When mounted on the fork carriage, the vertical variation between the top blade surfaces in each pair of fork arms should not at any point exceed 0.3% (3mm/metre) of the total blade length. ▷



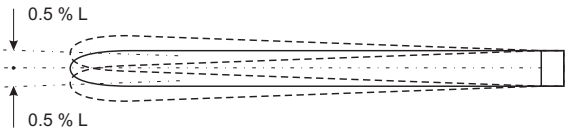
➢ The top surface of each blade should be longitudinally flat within 0.3% (3mm/metre) of the total blade length. ▷



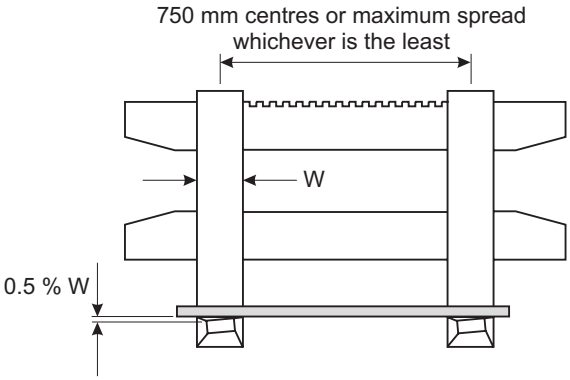
➢ The nominal blade to shank angle (a) as specified by the truck manufacturer, should not deviate by more than ± 1/2° on each fork arm. ▷



➢ The deviation from squareness to the carriage plate (toe-in or toe-out) in each blade should not exceed 0.5% (5mm/metre) of the total blade length. It is not necessary to match pairs in this respect. ▷



➢ When mounted on the carriage at 750 mm or maximum spread, whichever is the least, the twist of the upper blade surfaces should be measured by placing a straight edge across the pair of fork arms as shown. The twist should not exceed 1.5% of the blade width. ▷



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NUMBERS AND SYMBOLS

13 Volt power supply 6-16

A

AC Control
Operating principle 6-8
Accelerator 6-31
Adjust stops 6-32
Calibration 6-31
Accelerator pedals 5-1
Accelerator unit
Installation 5-2
Removal 5-2

B

Battery
Changing the battery (hoist method) . . . 6-2
Changing the battery (roll on, roll off) . . . 6-4
Connecting to a charger 6-1
Reaching the battery out 6-2
Battery carrier 3-8
Lubrication 3-9
Removal 3-9
Battery lock sensor 6-6
Brake pedal switch 6-33
Brake pedals 5-1

C

Canbox
Serial 0-32
Software update 0-33
USB 0-32
Charge resistor module - A11 6-21
Charging the reservoir circuit capacitors 6-21
Discharging the reservoir circuit capacitors 6-22
Connector locations 6-10
On the steering motor bracket 6-13
Under the floor plate 6-11
Under the motor cover 6-14
Under the top cover 6-10
Within the steering binnacle 6-12
Control module - A2 6-17
Connector X13 6-17
Connector X13 pin designations 6-17
Covers and cowlings 0-2
Opening the motor cover 0-2
Opening the top cover 0-3
Removing the floorplate 0-2
Covers and panelling 3-1

D

Danger notices
Graduation IV
Diagnostic codes
Display 0-42
Hydraulic 0-37
Traction 0-35
Diagnostics
CAN bus connection 0-30
Diagnostic connector 0-31
Overview 0-30
ServiceBase 0-30
Direction selection switch 6-28
Drive wheel 2-1
Removal 2-1
Replacement 2-2
Drive wheel position potentiometer 4-4
Potentiometer and gearbox assembly installation 4-8
Potentiometer and gearbox assembly removal 4-6
Potentiometer installation 4-6
Potentiometer removal 4-4

E

EMC – Electromagnetic compatibility 6-7
Emergency isolator - S2 6-15
Emergency lower 0-4
Emergency steering and parking brake release 0-5

F

Forks 8-20
Fitting 8-20
Inspection 8-20
Removal 8-20
Fuses 6-14
Ancillary circuits 6-15
Main circuits 6-14

https://truckmanualshub.com/

G

Gearbox 2-4
Replacing the crown wheel seal 2-6
Replacing the pinion shaft seal and bearing 2-5
Replacing the steering bearing 2-7
Replacing the wheel studs 2-5
Servicing 2-4

H

Hydraulic braking system 4-14
Bleeding 4-15
Preventative maintenance 4-14
Hydraulic controls 5-5
Hydraulic oil
Change 7-1
Hydraulic power module 6-37
Connector 2X37 pin designations 6-38
Enable signal 6-38
Error signal 6-38
Speed signals 6-39
Temperature monitoring and forced ventilation 6-39
Hydraulic pump motor
Temperature sensor 6-47
Hydraulic tank
Replace suction filter 7-1
Hydraulic valve block 7-2
Installation 7-4
Removal 7-3
Hydraulic valves
Voltage supply 6-41

I

Inspection and maintenance every 5000 hours
Change the hydraulic oil and suction filter 7-1
Introduction III

J

Jacking the truck 0-9
Raising the drive wheel 0-9
Raising the load wheels 0-9
Joysticks 6-43
Installation 5-6
Operation 6-45
Removal 5-5
Voltage supply 6-44

L

LAC - Hydraulic codes
Display 0-44
LAC - Traction codes
Display 0-43
Lift and lower - electrical operation 6-50
Lift cylinder bleeding 8-19
Lift stop sensor 6-54
Load wheel brakes 4-20
Brake shoe installation 4-22
Brake shoe removal 4-20
Load wheels 4-12
Installation 4-13
Removal 4-13
Lower lock valve 6-49
Lubricants 0-24
Brake fluid 0-25
Chain Spray 0-25
Gear oil 0-24
General purpose oil 0-24
Hydraulic oil specification 0-24
Multipurpose grease 0-24
Steering drive gears 0-24

M

Mast unit 0-10
Description of operation 0-10
Dismantling 8-7
Installation 8-5
Introduction 8-1
Re-assembly 8-8
Removal 0-11, 8-2
Roller shimming 8-9
Rubbing pads 8-10
Securing the mast 0-11
Securing the reach frame against reaching in or out 0-10
Work on the mast and the reach frame part of the truck 0-10

https://truckmanualshub.com/

Master cylinder
Installation 5-4
Removal 5-2

O

Operator's console
Removal 3-4
Operator's display 6-64
Battery discharge indicator 6-67
Clock 6-68
Data Logger communication indicator 6-68
Hour meter 6-69
Interlock warning indicator 6-65
Lift height indicator (LHI) and Height pre-selector (LPS) 6-66
Message panel 6-70
Over temperature indicators 6-68
Service interval elapsed indicator 6-69
Slow speed indicator 6-66
Steering indicator 6-65

P

Parking brake 6-29
Primary lift cylinder 8-11
Installation 8-13
Removal 8-11

R

Reach - electrical operation 6-51
Reach system 6-55
Position value 6-56
Reach limits 6-56
Sensor mechanical adjustments 6-56
Slowdown sensors 6-55

S

Seat assembly 3-6
Removal 3-6
Secondary lift cylinder 8-15
Installation 8-17
Removal 8-15
Securing for transportation 0-7
Sideshift - electrical operation 6-52
Slinging the truck 0-7
Special tools 0-28
Diagnostics 0-28
Hydraulic installation 0-29
Motor 0-28
Undercarriage 0-29
Steering
Drive wheel position potentiometer . . . 6-61
Overview 6-58
Steering binnacle
Removal 3-3
Steering codes
Display 0-40
Steering motor
Removal 4-10
Steering wheel potentiometer 4-1
Removal 4-1
Switch controlled speed reduction and 8.5 m switch 6-36
Symbols IV

T

Tilt - electrical operation 6-53
Torques
Non standard 0-25
Towing procedure 0-8
Traction motor 1-1
Installation 1-4
Removal 1-1
Temperature sensor 6-34
Traction motor brake (standard) 4-16
Checking operation 4-17
Checking the friction lining clearance . 4-16
Checking the magnetic coil 4-16
Disassembly 4-17
Mechanically releasing 4-16
Reassembly 4-19
Traction power module 6-24
Connector 1X17 pin designations 6-25
Enable signal 6-25
Error signal 6-25
Phase voltage feedback 6-26
Speed signals 6-26
Temperature monitoring and forced ventilation 6-26
Training document
Structure IV

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Service Training
Electric reach truck

Linde Material Handling

Series Series 115-03

R14, R14HD, R14N, R16, R16HD, R16N, R20, R20N

Edition 06/2008

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Annex

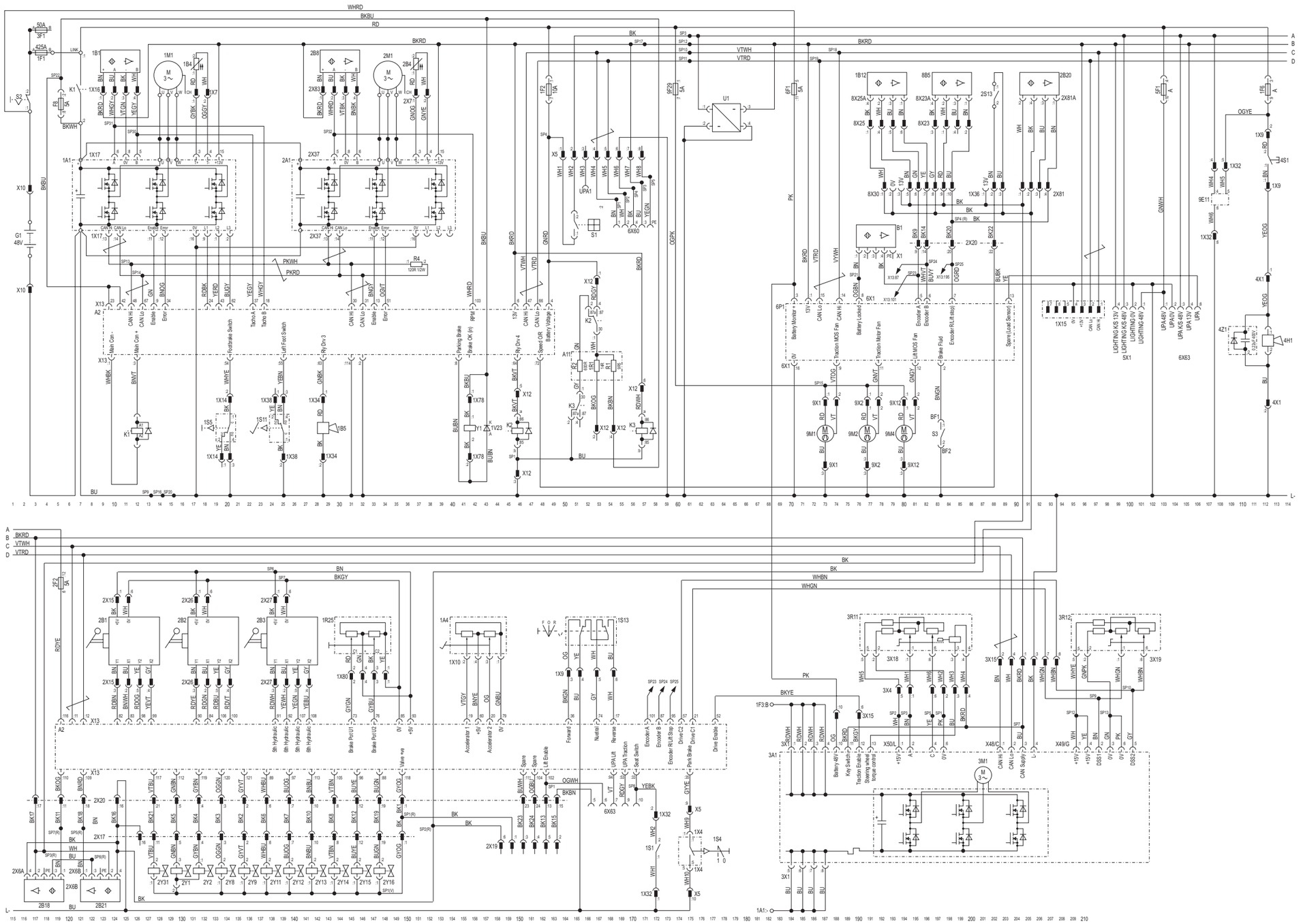
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Electric diagrams

Circuit diagram (Standard) 115 802 60 14



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Code	Explanation of function
A2	Module – Control, 9-49
	:1 - Main contactor -ve
	:3 - Main contactor +ve
	:4 - Battery voltage
	:6 - 13 volt
	:8 - Parking brake
	:9 - Enable
	:13 - Enable
	:17 - Reverse
	:18 - Tacho B
	:19 - Accelerator 1
	:20 - Accelerator 2
	:21 - Drive C1
	:30 - CAN Hi
	:31 - CAN Lo
	:33 - Seat switch
	:34 - Error
	:35 - Parking brake
	:36 - Forward
	:37 - Tacho A
	:47 - CAN Hi
	:48 - CAN Hi
	:51 - Error
	:52 - Drive enable
	:53 - UPA Traction
	:54 - Footbrake switch
	:55 - Left foot switch
	:57 - Drive C2
	:60 - +5 volt
	:63 - Relay driver 3
	:64 - Relay driver 4
	:66 - CAN Lo
	:67 - CAN Lo
	:72 - Speed Override
	:73 - Brake potentiometer U1
	:74 - Neutral
	:76 - Brake potentiometer U2
	:79 - 0 volt
	:85 - 0 volt
	:87 - Encoder B
	:91 - 5th hydraulic
	:92 - 6th hydraulic
	:93 - +5 volt
	:94 - UPA lift
	:95 - Encoder reach/lift stop

Code	Explanation of function
	:101 - Encoder A
	:102 - Lift enable
	:103 - RMP
	:104 - Spare
	:107 - 5th hydraulic
	:108 - 6th hydraulic
	:111 - Spare
	:118 - Valve +ve
A11	Module – Charge resistor, 50-55
1A1	Module – Traction power block LAC1, 6-22
	:11 - Enable
	:12 - Error
	:13 - CAN Hi
	:14 - CAN Lo
1A4	Accelerator, 155-159
2A1	Module – Hydraulic power block LAC1, 26-41
	:11 - Enable
	:12 - Error
	:13 - CAN Hi
	:14 - CAN Lo
3A1	Module – Steering, 183-210
B1	Sensor – Battery lock, 71-75
1B1	Sensor – Traction motor tachometer, 9-12
1B4	Sensor – Traction motor temperature, 17-18
1B5	Alarm – Reverse, 28-29
1B12	Sensor – Height encoder, 78-81
2B1	Joystick – Lift and reach, 123-128
2B2	Joystick – Tilt and sideshift, 130-135
2B3	Joystick – 5th and 6th hydraulics, 137-142
2B4	Sensor – Lift motor temperature, 37
2B8	Sensor – Lift motor tachometer, 29-32
2B18	Sensor – Reach out, 116-119
2B20	Sensor – Lift stop, 91-94
2B21	Sensor – Reach back, 121-124
8B5	Sensor – Reference, 78-82
9E11	Seat heater and lumber control, 108-109
F8	Fuse – Control circuit, 5
1F1	Fuse – Main circuit, 4
1F2	Fuse – Control circuit, 48-49
1F6	Fuse – Horn, 108
2F2	Fuse – Hydraulic valves, 119
3F1	Fuse – Power steering, 4
5F1	Fuse – Lighting circuit, 104
6F1	Fuse – Battery monitor, 66
9F29	Fuse – Cooling fans, 60

Code	Explanation of function
G1	Battery, 2-3
4H1	Horn, 113
K1	Contactor – Main, 7,12
K2	Relay – Charge resistor, 46,53
K3	Relay – Charge resistor, 51,57
1M1	Motor – Traction, 14-16
2M1	Motor – Hydraulic, 34-36
9M1	Motor – Traction MOS fan, 74
9M2	Motor – Traction motor fan, 78
9M4	Motor – Hydraulic MOS fan, 76
6P1	Module – display, 65-85
	:1 - 13 volt
	:2 - Brake fluid
	:3 - Battery monitor +ve
	:5 - Encoder A
	:6 - Encoder B
	:7 - Encoder reach/lift stop
	:8 - Battery locked
	:9 - Traction MOS fan
	:11 - Traction motor fan
	:12 - Hydraulic MOS fan
	:13 - Spare (load sensor)
	:14 - CAN Hi
	:15 - CAN Lo
	:16 - 0 volt
R3	Resistor – CAN bus, 8
R4	Resistor – CAN bus, 40
1R25	Resistor – Brake, 144
3R11	Potentiometer – Steering wheel, 190
3R12	Potentiometer – Steering drive, 209
6R1	Resistor – CAN bus, 69
S1	Keyswitch, 51
S2	Switch – Emergency isolator, 2-3
S3	Switch – Brake fluid level, 79
1S1	Switch – Seat, 172
1S4	Switch – Parking brake, 175
1S5	Switch – Footbrake, 20
1S11	Switch – Left foot, 25
1S13	Switch – Direction, 156-160
2S13	Switch – 8.5 metre, 89
4S1	Switch – Horn push, 113
U1	Converter – 48 V / 24 V, 60-64
1V23	Diode – Electromagnetic brake, 36
X1	Connector – Battery lock (5 way), 72-75
X5	Connector – Binnacle (10 way), 50-57, 175

Code	Explanation of function
X8	Connector – Converter (6 way), 60,64
X10	Connector – Battery, 2-3
X12	Connector – Charge resistor (6 way), 46, 53-57
X13	Connector – Control module (121 way), 10-49, 119-177
X48/C	Connector – Steering CAN bus (5 way), 203-206
X49/G	Connector – Wheel position input (8 way), 210+
X50/L	Connector – Steering wheel input (8 way), 193-198
1X4	Connector – Brake switch (8 way), 175
1X7	Connector – Traction motor temperature(2 way), 17-18
1X9	Connector – Direction/horn switch (6 way), 112, 164-169
1X10	Connector – Accelerator (4 way), 155-159
1X14	Connector – Footbrake (3 way), 19-20
1X15	Connector – Diagnostic (7 way), 93-98
1X16	Connector – Traction tachometer (4 way),9-12
1X17	Connector – Traction power block (16 way), 9-21
1X32	Connector – Seat (6 way), 108-109, 175
1X34	Connector – Travel alarm (2 way), 28-29
1X36	Connector – 8.5 metre switch (4 way), 88-90
1X38	Connector – Left foot switch (3 way), 24-25
1X78	Connector – Electromagnetic brake (2 way), 41
1X80	Connector – Brake potentiometer (4 way), 145-149
1X81	Connector – Variable electric brake module, 38-43
2X6A	Connector – Reach out sensor (5 way), 116-119
2X6B	Connector – Reach back sensor (5 way), 121-124
2X7	Connector – Hydraulic motor temperature sensor (2 way), 37-38
2X15	Connector – Lift/reach lever (6 way), 124-127
2X17	Connector – Reach carriage (16 way), 126-150
2X19	Connector – 5th/6th hydraulics UPA (6 way), 158-163
2X20	Connector – Reach carriage (24 way), 77-84, 117-163
2X26	Connector – Tilt/side shift lever (6 way), 131-134
2X27	Connector – 5th/6th hydraulics UPA (6 way), 138-141

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Electric diagrams

Code	Explanation of function
2X37	Connector – Hydraulic power block (16 way), 28-41
2X81	Connector – Lift stop/slow sensor (4 way), 91-94
2X81A	Connector – Lift stop sensor (4 way), 91-94
2X83	Connector – Lift tachometer (4 way), 28-32
3X1	Connector – Steer unit (16 way), 184-191
3X4	Connector – Steering potentiometer feed (6 way), 192-200
3X15	Connector – Steering interface (10 way), 188-210+
3X18	Connector – Steering potentiometer (10 way), 190-200
3X19	Connector – Steering drive (6 way), 209-214
4X1	Connector – Horn (2 way), 113

Code	Explanation of function
5X1	Connector – Lighting supplies (4 way), 94-97
6X1	Connector – Display (16 way), 66-85
6X60	Connector – Datalogger/keypad (5 way), 55-58
6X63	Connector – Option supplies (10 way), 99-102, 166-170
8X23	Connector – Reference sensor (4 way), 78-81
8X23A	Connector – 8B5 (4 way), 83-86
8X25	Connector – Height encoder (6 way), 83-86
8X25A	Connector – 1B12 (4 way), 78-81
8X30	Connector – Height encoder (10 way), 74-80
9X1	Connector – Traction MOS fan (2 way), 74
9X2	Connector – Traction motor fan (2 way), 77-78
9X12	Connector – Hydraulic MOS fan (2 way), 79

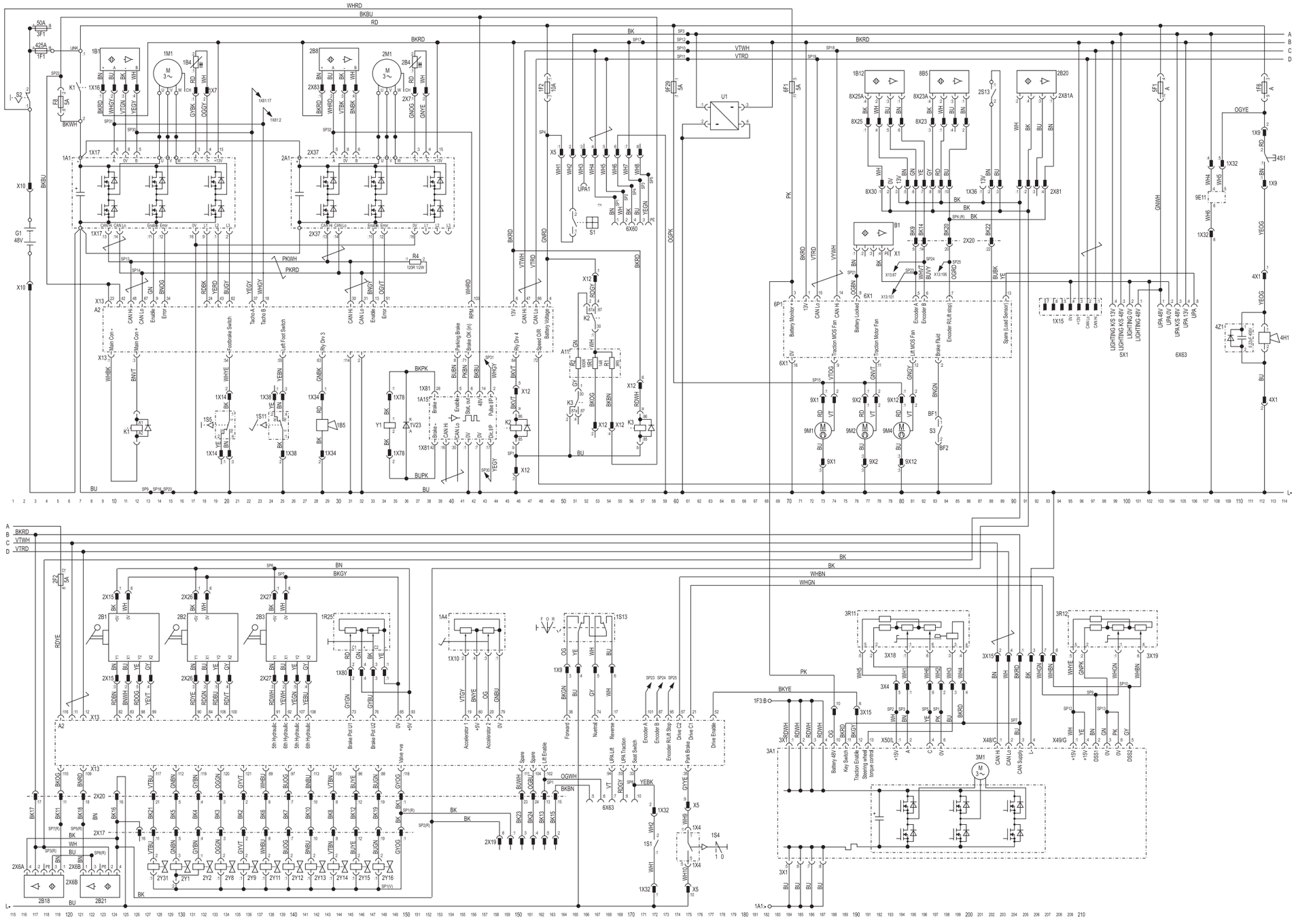
Code	Explanation of function
Y1	Solenoid – Traction motor brake, 34
2Y1	Valve – Lift, 130
2Y2	Valve – Lower, 132
2Y8	Valve – Reach out, 134
2Y9	Valve – Reach back, 136
2Y11	Valve – Tilt forward, 138
2Y12	Valve – Tilt back, 140
2Y13	Valve – Side shift left, 142
2Y14	Valve – Side shift right, 144
2Y15	Valve – Auxiliary 1, 146
2Y16	Valve – Auxiliary 2, 148
2Y31	Valve – Lock, 128
4Z1	Suppression – Horn, 109-111

Colour abbreviations	
BK	Black
BN	Brown
BU	Blue
GN	Green
GY	Grey
OG	Orange
RD	Red
VT	Violet
WH	White
YE	Yellow

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Circuit diagram (Variable electric brake) 115 802 60 09



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Code	Explanation of function
A2	Module – Control, 9-49
	:1 - Main contactor -ve
	:3 - Main contactor +ve
	:4 - Battery voltage
	:6 - 13 volt
	:8 - Parking brake
	:9 - Enable
	:13 - Enable
	:17 - Reverse
	:18 - Tacho B
	:19 - Accelerator 1
	:20 - Accelerator 2
	:21 - Drive C1
	:30 - CAN Hi
	:31 - CAN Lo
	:33 - Seat switch
	:34 - Error
	:35 - Parking brake
	:36 - Forward
	:37 - Tacho A
	:47 - CAN Hi
	:48 - CAN Hi
	:51 - Error
	:52 - Drive enable
	:53 - UPA Traction
	:54 - Footbrake switch
	:55 - Left foot switch
	:57 - Drive C2
	:60 - +5 volt
	:63 - Relay driver 3
	:64 - Relay driver 4
	:66 - CAN Lo
	:67 - CAN Lo
	:72 - Speed Override
	:73 - Brake potentiometer U1
	:74 - Neutral
	:76 - Brake potentiometer U2
	:79 - 0 volt
	:85 - 0 volt
	:87 - Encoder B
	:91 - 5th hydraulic
	:92 - 6th hydraulic
	:93 - +5 volt
	:94 - UPA lift
	:95 - Encoder reach/lift stop

Code	Explanation of function
	:101 - Encoder A
	:102 - Lift enable
	:103 - RMP
	:104 - Spare
	:107 - 5th hydraulic
	:108 - 6th hydraulic
	:111 - Spare
	:118 - Valve +ve
A11	Module – Charge resistor, 50-55
1A1	Module – Traction power block LAC1, 6-22
	:11 - Enable
	:12 - Error
	:13 - CAN Hi
	:14 - CAN Lo
1A4	Accelerator, 155-159
1A15	Module – Variable electric brake, 38-44
	:1 - 0 volt
	:2 - Pulse input
	:5 - Enable
	:6 - Status out
	:7 - 0 volt
	:14 - 48 volt
	:16 - CAN Hi
	:17 - Direction input
	:28 - Brake +
	:30 - CAN Lo
	:42 - Brake -ve
2A1	Module – Hydraulic power block LAC1, 26-41
	:11 - Enable
	:12 - Error
	:13 - CAN Hi
	:14 - CAN Lo
3A1	Module – Steering, 183-210
B1	Sensor – Battery lock, 71-75
1B1	Sensor – Traction motor tachometer, 9-12
1B4	Sensor – Traction motor temperature, 17-18
1B5	Alarm – Reverse, 28-29
1B12	Sensor – Height encoder, 78-81
2B1	Joystick – Lift and reach, 123-128
2B2	Joystick – Tilt and sideshift, 130-135
2B3	Joystick – 5th and 6th hydraulics, 137-142
2B4	Sensor – Lift motor temperature, 37
2B8	Sensor – Lift motor tachometer, 29-32
2B18	Sensor – Reach out, 116-119
2B20	Sensor – Lift stop, 91-94

Code	Explanation of function
2B21	Sensor – Reach back, 121-124
8B5	Sensor – Reference, 78-82
9E11	Seat heater and lumber control, 108-109
F8	Fuse – Control circuit, 5
1F1	Fuse – Main circuit, 4
1F2	Fuse – Control circuit, 48-49
1F6	Fuse – Horn, 108
2F2	Fuse – Hydraulic valves, 119
3F1	Fuse – Power steering, 4
5F1	Fuse – Lighting circuit, 104
6F1	Fuse – Battery monitor, 66
9F29	Fuse – Cooling fans, 60
G1	Battery, 2-3
4H1	Horn, 113
K1	Contactor – Main, 7,12
K2	Relay – Charge resistor, 46,53
K3	Relay – Charge resistor, 51,57
1M1	Motor – Traction, 14-16
2M1	Motor – Hydraulic, 34-36
9M1	Motor – Traction MOS fan, 74
9M2	Motor – Traction motor fan, 78
9M4	Motor – Hydraulic MOS fan, 76
6P1	Module – display, 65-85
	:1 - 13 volt
	:2 - Brake fluid
	:3 - Battery monitor +ve
	:5 - Encoder A
	:6 - Encoder B
	:7 - Encoder reach/lift stop
	:8 - Battery locked
	:9 - Traction MOS fan
	:11 - Traction motor fan
	:12 - Hydraulic MOS fan
	:13 - Spare (load sensor)
	:14 - CAN Hi
	:15 - CAN Lo
	:16 - 0 volt
R3	Resistor – CAN bus, 8
R4	Resistor – CAN bus, 40
1R25	Resistor – Brake, 144
3R11	Potentiometer – Steering wheel, 190
3R12	Potentiometer – Steering drive, 209
6R1	Resistor – CAN bus, 69
S1	Keyswitch, 51
S2	Switch – Emergency isolator, 2-3

Code	Explanation of function
S3	Switch – Brake fluid level, 79
1S1	Switch – Seat, 172
1S4	Switch – Parking brake, 175
1S5	Switch – Footbrake, 20
1S11	Switch – Left foot, 25
1S13	Switch – Direction, 156-160
2S13	Switch – 8.5 metre, 89
4S1	Switch – Horn push, 113
U1	Converter – 48 V / 24 V, 60-64
1V23	Diode – Electromagnetic brake, 36
X1	Connector – Battery lock (5 way), 72-75
X5	Connector – Binnacle (10 way), 50-57, 175
X8	Connector – Converter (6 way), 60,64
X10	Connector – Battery, 2-3
X12	Connector – Charge resistor (6 way), 46, 53-57
X13	Connector – Control module (121 way), 10-49, 119-177
X48/C	Connector – Steering CAN bus (5 way), 203-206
X49/G	Connector – Wheel position input (8 way), 210+
X50/L	Connector – Steering wheel input (8 way), 193-198
1X4	Connector – Brake switch (8 way), 175
1X7	Connector – Traction motor temperature(2 way), 17-18
1X9	Connector – Direction/horn switch (6 way), 112, 164-169
1X10	Connector – Accelerator (4 way), 155-159
1X14	Connector – Footbrake (3 way), 19-20
1X15	Connector – Diagnostic (7 way), 93-98
1X16	Connector – Traction tachometer (4 way),9-12
1X17	Connector – Traction power block (16 way), 9-21
1X32	Connector – Seat (6 way), 108-109, 175
1X34	Connector – Travel alarm (2 way), 28-29
1X36	Connector – 8.5 metre switch (4 way), 88-90
1X38	Connector – Left foot switch (3 way), 24-25
1X78	Connector – Electromagnetic brake (2 way), 41
1X80	Connector – Brake potentiometer (4 way), 145-149
1X81	Connector – Variable electric brake module, 38-43
2X6A	Connector – Reach out sensor (5 way), 116-119
2X6B	Connector – Reach back sensor (5 way), 121-124

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Electric diagrams

Code	Explanation of function
2X7	Connector – Hydraulic motor temperature sensor (2 way), 37-38
2X15	Connector – Lift/reach lever (6 way), 124-127
2X17	Connector – Reach carriage (16 way), 126-150
2X19	Connector – 5th/6th hydraulics UPA (6 way), 158-163
2X20	Connector – Reach carriage (24 way), 77-84, 117-163
2X26	Connector – Tilt/side shift lever (6 way), 131-134
2X27	Connector – 5th/6th hydraulics UPA (6 way), 138-141
2X37	Connector – Hydraulic power block (16 way), 28-41
2X81	Connector – Lift stop/slow sensor (4 way), 91-94
2X81A	Connector – Lift stop sensor (4 way), 91-94
2X83	Connector – Lift tachometer (4 way), 28-32

Code	Explanation of function
3X1	Connector – Steer unit (16 way), 184-191
3X4	Connector – Steering potentiometer feed (6 way), 192-200
3X15	Connector – Steering interface (10 way), 188-210+
3X18	Connector – Steering potentiometer (10 way), 190-200
3X19	Connector – Steering drive (6 way), 209-214
4X1	Connector – Horn (2 way), 113
5X1	Connector – Lighting supplies (4 way), 94-97
6X1	Connector – Display (16 way), 66-85
6X60	Connector – Datalogger/keypad (5 way), 55-58
6X63	Connector – Option supplies (10 way), 99-102, 166-170
8X23	Connector – Reference sensor (4 way), 78-81
8X23A	Connector – 8B5 (4 way), 83-86
8X25	Connector – Height encoder (6 way), 83-86

Code	Explanation of function
8X25A	Connector – 1B12 (4 way), 78-81
8X30	Connector – Height encoder (10 way), 74-80
9X1	Connector – Traction MOS fan (2 way), 74
9X2	Connector – Traction motor fan (2 way), 77-78
9X12	Connector – Hydraulic MOS fan (2 way), 79
Y1	Solenoid – Traction motor brake, 34
2Y1	Valve – Lift, 130
2Y2	Valve – Lower, 132
2Y8	Valve – Reach out, 134
2Y9	Valve – Reach back, 136
2Y11	Valve – Tilt forward, 138
2Y12	Valve – Tilt back, 140
2Y13	Valve – Side shift left, 142
2Y14	Valve – Side shift right, 144
2Y15	Valve – Auxiliary 1, 146
2Y16	Valve – Auxiliary 2, 148

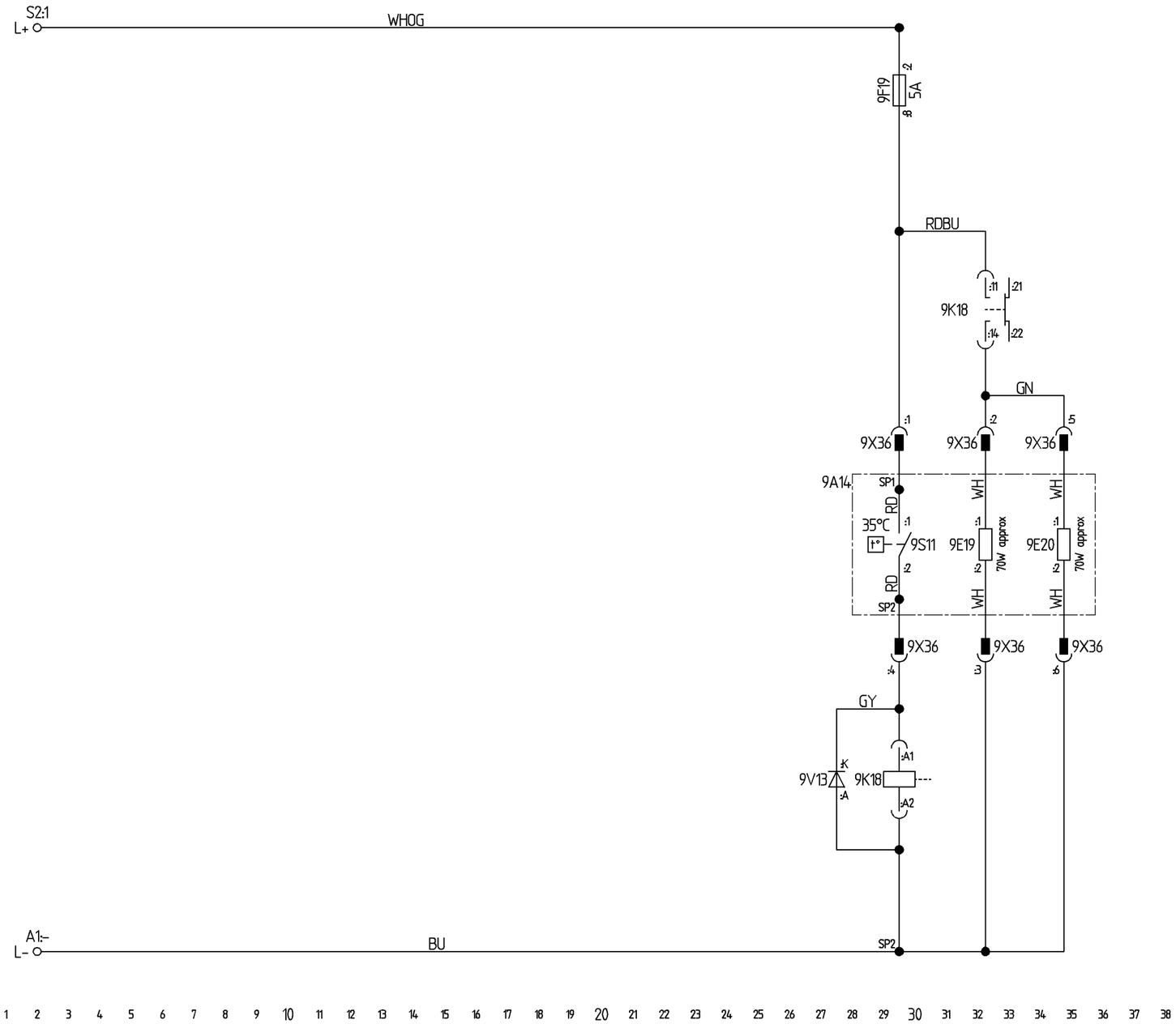
Code	Explanation of function
2Y31	Valve – Lock, 128
4Z1	Suppression – Horn, 109-111

Colour abbreviations	
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Coldstore joystick and gearbox heaters



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Joystick heater circuit keycode

Code	Explanation of function	Pos.
9A13	Assembly - joystick heater	17-26
9A14	Assembly - gearbox heater	27-36
9E18	Heater - joystick	24
9E19	Heater - gearbox	32
9E20	Heater - gearbox	34
9F18	Fuse - joystick heater	20
9F19	Fuse - gearbox heater	29
9K17	Relay - joystick heater	20-24
9K18	Relay - gearbox heater	29-33
9M13	Motor - joystick heater fan	22
9S11	Thermostat - gearbox heater	30
9S13	Thermostat - joystick	20
9S14	Thermostat - joystick heater	20
9V12	Diode - freewheel for 9K17	18
9V13	Diode - freewheel for 9K18	27
9X36	Connector - gearbox heater (6 way)	27-35
9X40	Connector - joystick heater (6 way)	20-25

NOTE

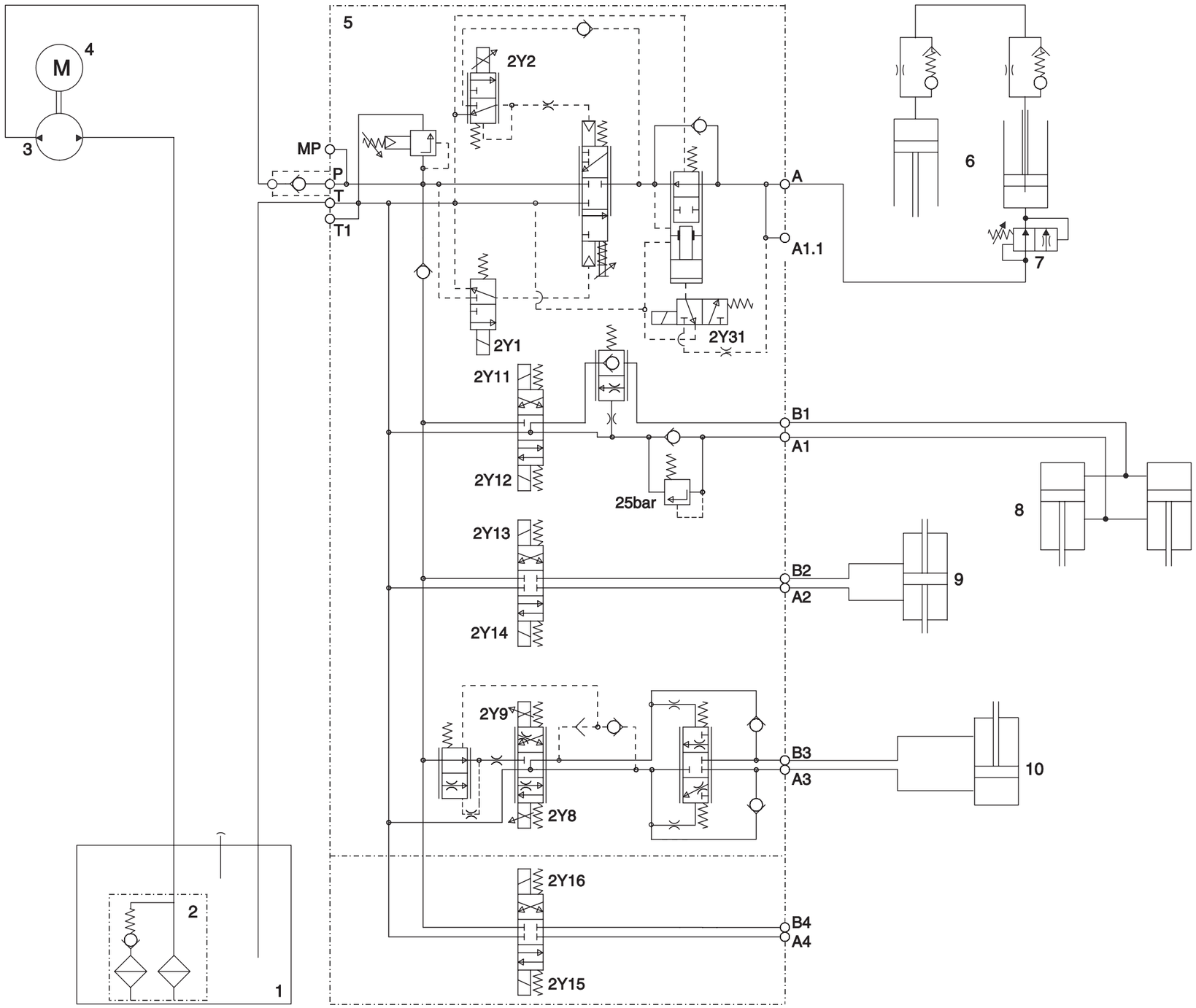
Joystick heaters fitted to in/out coldstore versions. Steering unit gearbox heaters fitted to all coldstore versions

Colour abbreviations	
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OG	Orange
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Hydraulic diagrams

Hydraulic circuit



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Keycode

1. Hydraulic tank
2. Filter
3. Hydraulic pump
4. 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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