STILL

Workshop literature

Electric forklift truck

RX20-15 - 20, RX60-16 - 20





CE

6209 6210 6211 6212 6213 6214
6215 6216 6217 6311 6313 6315

first in intralogistics

50638042201 EN - 10/2017

Edition 2017/10

- **Version 5**
- Various corrections and alignment with the specified standards for workshop manuals
- Chapter 50 - "Operating devices", "accelerator, generation 2" integrated
- Chapter 56 - "Travel direction selector and indicator module, generation 2" integrated

Edition 2014/08

- **Version 4**
- Various corrections and enhancements
- Chapter 00 — "Product overview" revised
- Chapter 01 — "Harnesses and hoists" added
- Chapter 42 — "Steering system" restructured
- Chapter 50 — "Operating devices" revised; "joystick 4Plus" added
- Chapter 60 — "Insulation testing on the drive battery" revised
- Chapter 60 — "Temperature monitoring" revised
- Chapter 69 — "2014 discharge indicator" added
- Chapter 71 — "Accumulator " added
- Chapter 81 — "Lift masts" completely revised
- Chapter 84 — "Fork carriage" completely revised

Edition 2013/06

- **Version 3**
- Various corrections and enhancements
- Integration of type carrier 6209 (RX20-14).
- Chapter 22 - "Mechanical drive axle", chapter has been restructured and drive axle AE18-07 has been added.
- Chapter 42 - "Steering axle", curve switch has been revised.
- Chapter 49 - "Brake system", chapter has been restructured and brake adjustment for drive axle AE18-07 has been added.
- Chapter 60 - "Insulation testing" has been revised
- Chapter 60 - "Power cables" have been added
- Chapter 64 - "MCU2" has been integrated
- Chapter 69 "Maintenance guidelines for attachment connectors" has been added

Edition 2011/12

- **Version 2**
- Various corrections and enhancements
- Introduction rearranged.
- Chapter 00 — maintenance and diagnostics added.
- Chapter 42 — CSC revised.
- Chapter 49 — electric parking brake revised.
- Chapter 60 — insulation testing and intermediate circuit summarised.

Edition 2010/10

- **Version 1**
- This workshop manual combines the truck series RX20-15 - 20 and RX60-16 - 20.
- All chapters have been revised.
- Facelift integration, Step 1 and 2

Information about the documentation

This workshop manual contains all the information required to assist a competent person with all work, repairs and maintenance on this truck. For the purposes of clarity and completeness, some components have been deliberately excluded from this workshop manual and described in their own specific documentation. Changes may be made at short notice and at any time, and are communicated via service information documents.

The documentation comprises operating instructions, additional workshop manuals, special documentation and circuit diagrams.

Operating instructions

- Original operating instructions for the truck
- FleetManager™ 4.x

Workshop manuals

- Display elements - display
- FleetManager™

Special documentation

- Error list
- Overview of truck software
- Overview of consumables
- STILL Flasher
- FEM 4.004 test log book
- Service information documents

Circuit diagrams

- See Steds-Navigator

Specialist

A qualified person is defined as a service engineer or a person who fulfils the following requirements:

- A completed vocational qualification that demonstrably proves their professional expertise. This proof should consist of a vocational qualification or a similar document.
- Professional experience indicating that the qualified person has gained practical experience of industrial trucks over a proven period during their career During this time, this person has become familiar with a wide range of symptoms that require checks to be carried out, such as based on the results of a hazard assessment or a daily inspection
- Recent professional involvement in the field of the industrial truck test in question and an appropriate further qualification are essential. The qualified person must have experience of carrying out the test in question or of carrying out similar tests. Moreover, this person must be aware of the latest technological developments regarding the industrial truck to be tested and the risk being assessed

Symbols Used

The signal terms **Danger**, **Warning**, **Caution**, **Note** and **Environmental note** are used in this document as hazard warnings or for unusual information that requires special identification:

⚠ DANGER

means that failure to comply involves risk to life and/or major damage to property can occur.

⚠ WARNING

means that failure to comply involves risk of serious injury and/or major damage to property can occur.

⚠ CAUTION

means that failure to comply involves risk of material damage or destruction.

NOTE

means that particular attention is drawn to the interrelationship between technical factors that may not be evident even to a specialist.

ENVIRONMENT NOTE

The instructions listed here must be strictly observed in order to prevent damage to the environment.

Additional signs and symbols are used to illustrate the hazard warnings. These are printed to the left of the hazard warnings.

Changes and retrofitting

Warnings before making changes to the truck

If the truck is used for work not listed in the guidelines or truck-specific original operating instructions and has to be converted or retrofitted accordingly, you should be aware of the following:

- Any structural modification can affect the handling and stability of the truck, and can result in accidents.
- Without authorisation from STILL, no changes that affect the stability, the load capacity and the safety systems may be carried out.
- Operation of the truck without an overhead guard at a lift height of over 1800 mm is prohibited.
- It is prohibited to install and use restraint systems that are not approved by STILL.
- It is prohibited to drill holes in the overhead guard or to perform welding on it.
- When carrying out welding on other parts of the truck, it is essential that the battery and all connections to the electronic controls are disconnected.
- **Only for electric forklift trucks:** It is prohibited to drill holes in the area of the driver's seat into the battery hood because hydrogen can enter through the bores into the driver's cab.

CE conformity

With the CE declaration of conformity, STILL confirms that the truck complies with the standards and regulations valid at the time of marketing. The CE conformity mark is shown on the nameplate and indicates compliance with the above regulations.

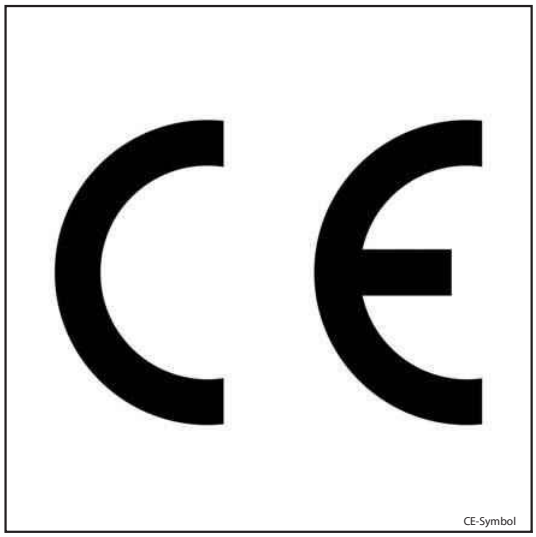
A subsequent structural change or addition to the truck can compromise safety, thus invalidating the CE declaration of conformity. In this case, a new CE declaration of conformity is essential for the structural changes. The company that was instructed by the truck operating company to carry out the change is responsible for issuing a new CE declaration of conformity.

The contractor of the operating company must also fulfil the following prerequisites:

- Construction documents, test documents and assembly instructions associated with the change must be archived and remain accessible at all times.
- Check that the capacity rating plate, decal information, hazard warnings and the operating instructions are consistent with regard to the changes and modify if necessary.

The change must be processed by a design office that specialises in the area of industrial trucks. The change must be planned, checked and implemented in accordance with the standards and directives valid at the time.

▷



CE-Symbol

Working with spare parts

Warning regarding non-original parts

Original parts, attachments and accessories are specially designed for this truck. We specifically draw your attention to the fact that parts, attachments and accessories supplied by other companies have not been tested and approved by STILL.

⚠ CAUTION

Installation and/or use of such products may therefore have a negative impact on the design features of the truck and thus impair active and/or passive driving safety.

We recommend that you obtain approval from the manufacturer and, if necessary, from the relevant regulatory authorities before installing such parts. STILL accepts no liability for any damage caused by the use of non-original parts and accessories without approval.

Working with electronic controls

It is not generally permitted to open controls. STILL's liability and the warranty are no longer applicable once the seal has been damaged.

In exceptional cases, personnel authorised by STILL are allowed to open the controls.

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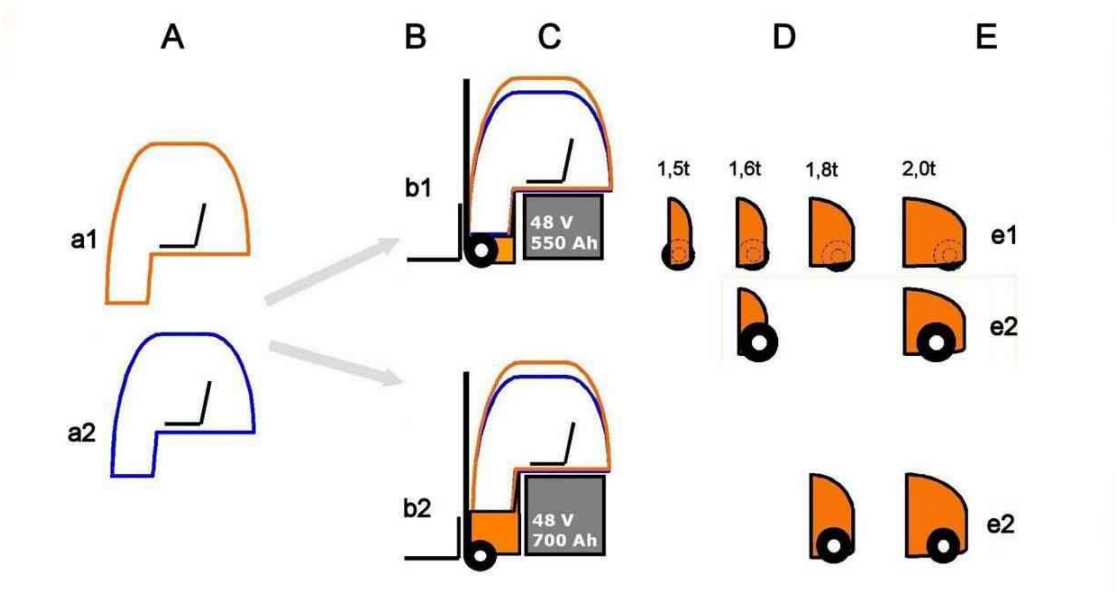
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Foreword

Product overview for the RX20



Overhead guard
A Overhead guard
a1 Standard overhead guard
a2 Container overhead guard (variant)

Chassis
B Chassis
b1 Lower chassis
b2 Higher chassis

Battery
C Battery sizes

Counterweight
D Load lifting classes

Steering axle
E Steering axle
e1 3-wheel, fifth-wheel
e2 4-wheel, swing axle

Product program

Type designation	Version				Type carrier
	Chassis	Battery	Counterweight	Steering axle	
RX20 - 14	Low	48 V / 550 Ah	1.4 t	3-wheel	6209
RX20 - 15	Low	48 V / 550 Ah	1.5 t	3-wheel	6210
RX20 - 16	Low	48 V / 550 Ah	1.6 t	3-wheel	6211
RX20 - 16	Low	48 V / 550 Ah	1.6 t	4-wheel	6212
RX20 - 18	Low	48 V / 550 Ah	1.8 t	3-wheel	6213
RX20 - 18	High	48 V / 700 Ah	1.8 t	4-wheel	6214
RX20 - 20	Low	48 V / 550 Ah	2.0 t	3-wheel	6215
RX20 - 20	Low	48 V / 550 Ah	2.0 t	4-wheel	6216
RX20 - 20	High	48 V / 700 Ah	2.0 t	4-wheel	6217

New features from 2013 - 2014

These trucks are being replaced from calendar week 35 onwards by the RX20 Facelift 2014.

Improved properties:

- Enhanced discharge indicator and consumption display

New components:

- Joystick 4Plus
- Push-up roof panel
- Metal brand emblem
- Lighting on top of the overhead guard
- Diagnostic connector (Group connector) in the front structure

New features from 2012

- New truck type RX20-14 (6209)

New components:

- Generation 2 MCU
- Drive axle AE18-07

New features from 2009 - Facelift Step1 and Step2

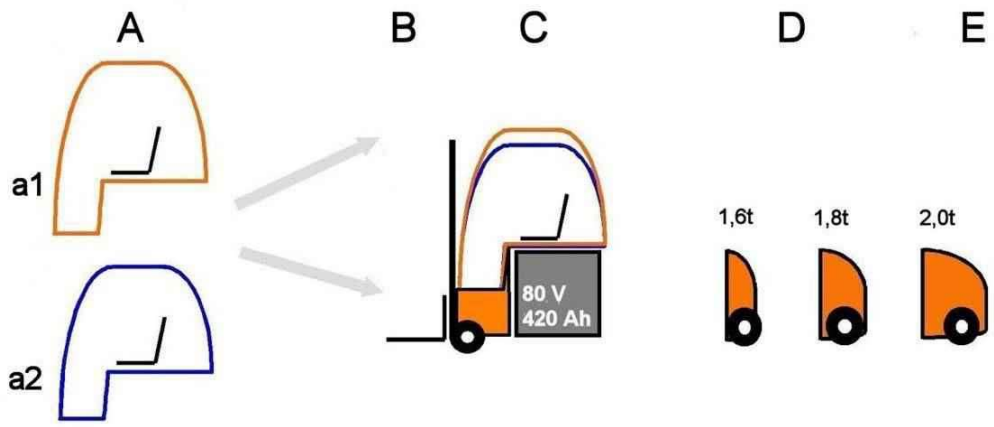
Improved properties:

- Ergonomic driver's workstation
- Drive mode Blue-Q

New components:

- Generation 2 mini-lever
- Generation 2 display and operating unit
- Electric parking brake
- Load measurement
- Mast vertical position
- Hydraulics blocking function in accordance with EN ISO 3691-1

Product overview for the RX60-16 - 20



Overhead guard
A Overhead guard
a1 Standard roof
a2 Container roof (variant)

Chassis
B Higher chassis

Battery
C Battery sizes

Counterweight
D Load lifting classes

Steering axle
E 4-wheel, swing axle

Product program

Type designation	Version				Type carrier
	Chassis	Battery	Counterweight	Steering axle	
RX60 - 16	High	80 V / 420 Ah	1.6 t	4-wheel	6311
RX60 - 18	High	80 V / 420 Ah	1.8 t	4-wheel	6313
RX60 - 20	High	80 V / 420 Ah	2.0 t	4-wheel	6315

New features from 2013 - 2014

Improved properties:

- Enhanced discharge indicator and consumption display

New components:

- Joystick 4Plus
- Push-up roof panel
- Metal brand emblem
- Lighting on top of the overhead guard
- Diagnostic connector (Group connector) in the front structure

New features from 2012

New components:

- Generation 2 MCU
- Drive axle AE18-07

New features from 2009 - Facelift Step1 and Step2

Improved properties:

- Ergonomic driver's workstation
- Drive mode Blue-Q

New components:

- Generation 2 mini-lever
- Generation 2 display and operating unit
- Electric parking brake
- Load measurement
- Mast vertical position
- Hydraulics blocking function in accordance with EN ISO 3691-1

Safety information

Parking the truck so it is secured for service work

⚠ DANGER

Risk of fatal injury if the truck rolls away.

– The truck must not be parked on a slope.

– If necessary, use wedges to prevent the truck from rolling away.

⚠ DANGER

There is a risk of fatal injury caused by lowering fork carriages and lift masts!

– Before servicing, fully lower the unladen fork carriage.

⚠ WARNING

Changes in the centre of gravity caused by attachments can lead to additional hazards.

If attachments are fitted, retract the working cylinders.

If necessary remove the attachment before performing service work.

– Apply the parking brake.

– Lower the unladen fork carriage to the ground.

– Tilt the lift mast forwards until the tips of the fork arms rest on the ground.

– If attachments (variant) are fitted, retract the unladen working cylinders; if necessary, remove the attachment.

– Turn the key switch to OFF.

– If necessary, disconnect the battery male connector or the starter battery.

Working on the electrical system

Working with the converters

⚠ DANGER

Due to the internal energy storage system in converters and control units, there may be dangerously high voltages at the electrical connections in the event of a fault, even after the battery male connector has been disconnected.

Do not touch live contact points such as the positive and negative connections of the power control units!

Before working on electrical power connections, always check the voltage between all contact points and between the contact points and the truck chassis using a suitable measuring device (capable of measuring up to 1000 V/DC).

Discharge the intermediate circuit.

Jacking up the front of the truck

General

⚠ DANGER

Risk of accident

When jacking up the forklift truck, always secure it with appropriate means (wedges, wooden blocks) to prevent rolling or tipping.

The forklift truck has to be jacked up for various maintenance tasks.

Always comply with the following:

- Use only jacks with an adequate load capacity
- Only jack up the forklift truck on a level surface
- Secure the forklift truck against rolling and dropping.

⚠ WARNING

Risk of injury!

Apply the parking brake and disconnect the battery male connector before jacking up the forklift truck.

⚠ WARNING

Risk of injury!

Jack up the forklift truck to such a height that shoes cannot be caught by turning wheels.

Jacking up

- Park the truck securely on level ground.
- Turn the key switch OFF.
- Apply the parking brake.
- Remove the forks or push them together in the middle.
- Lift the fork carriage so that the hydraulic jack can be placed on the outer mast.
- Jack up the truck until the wheels are no longer in contact with the ground.
- Insert supporting blocks under the chassis on both sides.
- Carefully lower the hydraulic jack until the truck rests securely on the support blocks.

▷



Jacking up the rear of the truck

General

⚠ DANGER

Risk of accident!

When jacking up the truck, always secure it with appropriate means (wedges, wooden blocks) to prevent rolling or tipping.

The truck has to be jacked up for various maintenance tasks.

Always comply with the following:

- Use only jacks with an adequate load capacity.
- Jack up the truck only on a level surface
- Secure the truck against rolling and dropping.

⚠ WARNING

Risk of injury!

Apply the parking brake and disconnect the battery male connector before jacking up the truck.

⚠ CAUTION

Risk of damage to the battery door!

Do not place jacks or square timbers under the battery door.

Open the battery door and snap into place before jacking up the truck.

Jacking up with swing axle

– Park the truck on a level surface.
– Turn the key switch OFF.
– Apply the parking brake.
– Open the battery door and snap into place.
– Place the hydraulic jack on a square timber at the designated position (1) at the counterweight.
– Jack up the truck until the wheels are no longer in contact with the ground.
– Place square timbers on both sides at the designated position (2) under the counterweight.
– Carefully lower the truck until it rests securely on the timbers.



Jacking up with steering turntable

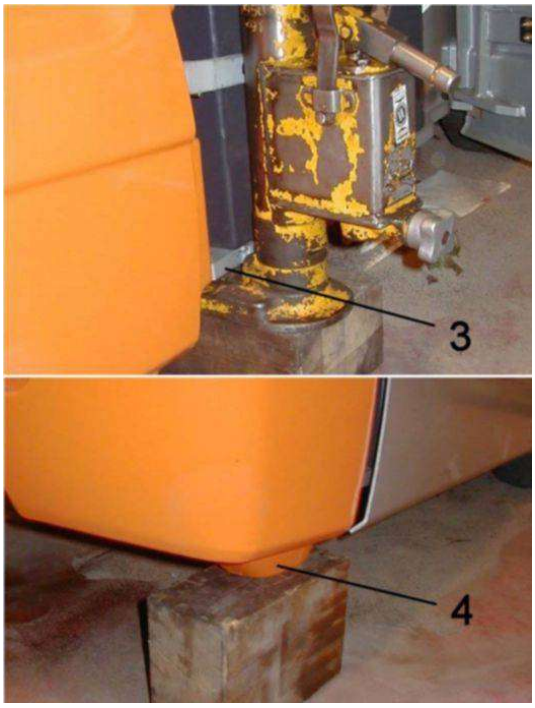
– Park the truck on a level surface.
– Turn the key switch OFF.
– Apply the parking brake.

– Open the battery door and snap into place.

Right side of the truck:

– Place the hydraulic jack on a square timber at the designated position (3) at the chassis.
– Jack up the truck until the square timber fits under the chassis at the designated position (2).
– Place the square timber at the designated position (4) under the counterweight.
– Carefully lower the jack until the truck is resting on the square timber.

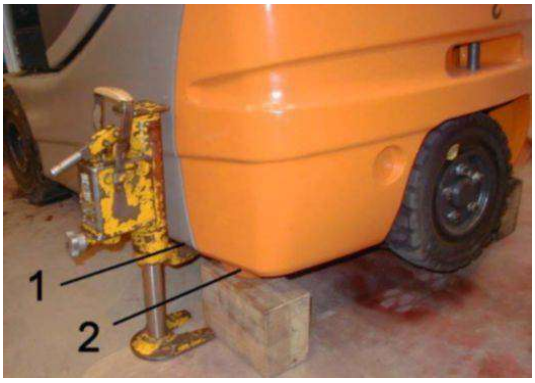
▷



Left side of the truck:

– Place the jack at the designated position (1) at the chassis
– Jack up the truck until the wheel is no longer in contact with the ground.
– Place the square timber at the designated position (2) under the counterweight.
– Carefully lower the truck until it rests securely on the timbers.

▷



Securing the fork carriage

General

⚠ DANGER

Risk of accident!

When working at the front of the truck, always secure the fork carriage to prevent it dropping.

⚠ DANGER

Risk of accident!

Use only chains with adequate lifting capacity to secure the particular lift mast.

⚠ CAUTION

Potential damage to the ceiling!

Note the maximum lift height of the particular lift mast.

Securing the tele list mast

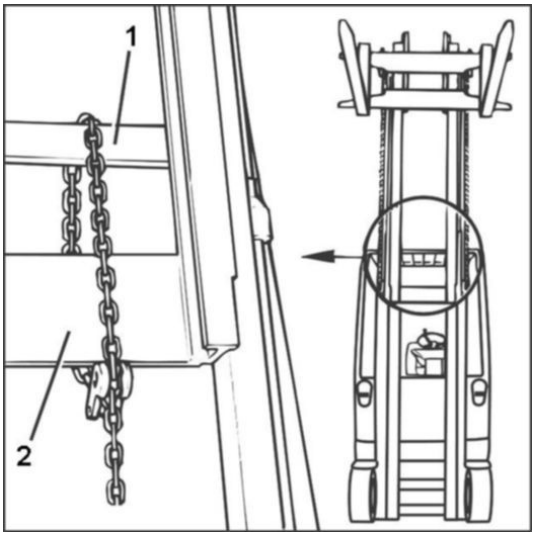
– Extend the lift mast.

– Route the chain along the cross traverse of the outer mast (1) and connect it underneath the cross traverse of the inside mast (2).

– Lower inside mast until it strikes the chain.

NOTE

Extend the lift mast to slacken the chain.



Securing the Hi-Lo lift mast

– Extend the lift mast.

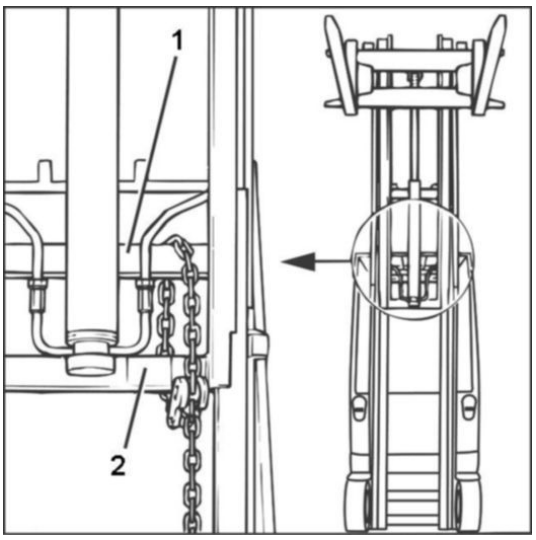
– Route the chain along the cross traverse of the outer mast (1) and connect it underneath the cross traverse of the inside mast (2).

– Lower lift mast until it sttrikes the chain.

– Lower fork carriage down to the stop.

NOTE

Extend the lift mast to slacken the chain.

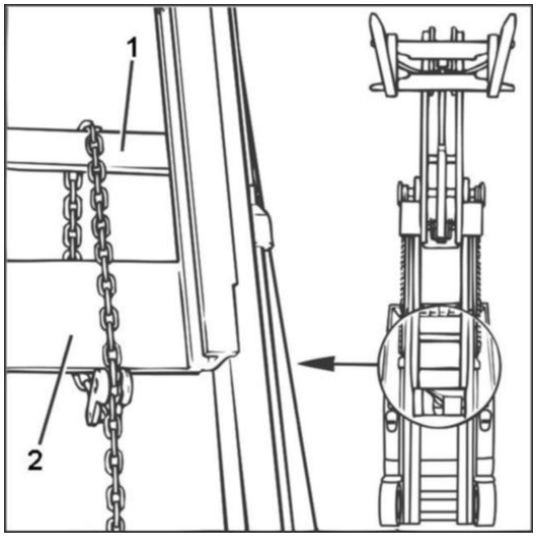


Securing the triple lift mast

- Extend the lift mast.
- Route the chain along the cross traverse of the outer mast (1) and connect it underneath the cross traverse of the middle mast (2).
- Lower lift mast until it sttrikes the chain.
- Lower fork carriage down to the stop.

NOTE

Extend the lift mast to slacken the chain.



Maintenance

Maintenance instructions

Maintenance work must be carried out in accordance with the following maintenance intervals. The intervals are designed for standard use. Depending on the application conditions of the truck, shorter maintenance intervals can be set, on agreement with the operating company.

These factors may call for shorter maintenance intervals:

- Contaminated, poor quality roads
- Dusty or salty air
- High air humidity
- Extremely high or low ambient temperatures, or extreme changes in temperature
- Multi-shift operation with a high duty cycle
- Specific national regulations for the truck or individual components

For maintenance tasks, only use original spare parts, and only use consumables that have been prescribed in the overview of consumables.

Maintenance — 1000 hours/annually

At operating hours													Carried out	
1000		2000		4000		5000		7000		8000				
10000		11000		13000		14000							✓	✖
Chassis, bodywork and fittings														
Check chassis for cracks														
Check overhead guard/cab and panes of glass for damage														
Check controls, switches and joints for damage, and apply grease and oil														
Check driver's seat for correct function and for damage														
Check driver restraint system for correct function and for damage, and clean.														
Check the signal horn														
Variant: Check the dual-pedal variant for damage and correct function, and lubricate														
Tyres and wheels														
Check tyres for wear and check the air pressure if necessary														
Check wheels for damage and check the tightening torques														
Power unit														
Drive axle: Check mounting, check for leaks, and clean cooling fins														
Drive wheel unit and multi-disc brake: Check the oil level														
Change the gearbox oil (once after the first 1000 hours)														
Steering														
Check steering system for correct function and for leaks														
Check that the steering wheel is firmly attached and check the turning handle for damage														
Steering axle: Check that it is firmly attached, check for leaks, and apply grease														
Check steering stop														
Brake														
Check all mechanical brake parts for condition and correct function														
Carry out brake test														
Variant: Check the electric parking brake variant for damage and correct function														
Variant: Electric parking brake: Check the relubrication device														
Electrical system														
Check all power cable connections														
Check main contactor contacts														
Test switches, transmitters and sensors for correct function														
Check lighting and indicator lights														
Battery and accessories														
Check the lead-acid battery for damage and check the acid density; observe the manufacturer's maintenance instructions														
Variant: Lead-acid battery with electrolyte circulation: Replace the non-return valve														
Variant: Lithium-ion battery: Observe the manufacturer's maintenance instructions														
Check the appliance plug and truck harness for damage														
Check the battery male connector and battery harness for damage														
Battery compartment														
Check that the battery door, and the sensor if necessary, is working correctly and check for damage.														
Check the battery lock for damage.														
Variant: Hydraulic battery carrier: Check all moving parts for wear, and oil or lubricate. Observe the special maintenance schedule														

At operating hours												Carried out	
1000		2000		4000		5000		7000		8000			
10000		11000		13000		14000						✓	✖
Variant: Hydraulic battery carrier: Check the oil level and check for leaks													
Hydraulics													
Check hydraulic system for condition, correct function and leaks													
Check the hydraulics blocking function (ISO valve)													
Check oil level													
Lift mast													
Check mast bearings for damage, and lubricate. Check the tightening torque													
Check mast profiles for damage and wear, and lubricate													
Check load chains for damage and wear, adjust and lubricate													
Check lift cylinders and connections for damage and leaks													
Check guide pulleys for damage and wear													
Check support rollers and chain rollers for damage and wear													
Check the play between the fork carriage stop and run-out barrier													
Check tilt cylinders and connections for damage and leaks													
Check fork carriage for damage and wear													
Check fork arm interlock for damage and correct function													
Check fork arms for wear and deformation													
Check that there is a safety screw on the fork carriage or on the attachment													
Special equipment													
Check the condition of the antistatic belt or antistatic electrode.													
Check heating system for damage; observe manufacturer's maintenance instructions													
Check attachments for wear and damage; observe manufacturer's maintenance instructions													
Check trailer coupling for wear and damage; observe manufacturer's maintenance instructions													
General													
Read out error numbers and delete list													
Reset maintenance interval													
Check labelling for completeness													
Test drive the truck													

Maintenance - 3000 hours/every two years

At operating hours													Carried out	
3000		6000		9000		12000		15000					✓	✖
Note														
Perform all 1000-hour maintenance work														
Power unit														
Drive wheel unit and multi-disc brake: Change the gearbox oil														
Replace the bleeder screws on the drive wheel units														
Brake														
Variant: Electric parking brake: Replace the actuation push button														
Hydraulics														
Renew the hydraulic oil														
Replace the return line filter and breather filter														
Variant: Replace the high-pressure filter														
For RX60-50 LSP600 (6330) only: Replace the accumulator														

Tool

Measuring instruments and testing equipment

Diagnostics

Description	Part number
USB service box, package group with wires	50983605401
USB service box	50983605400
BT service box, package group with wires and USB stick	50983605406
BT service box	50983605403
STILL Bluetooth USB stick	50983605405
Adaptor cable, service box on truck, diagnostic connector, 7-pin, 4 pins assigned	0171381
Adaptor cable, service box on truck, diagnostic connector, 7-pin, 6 pins assigned, 50 cm	3903820104
Adaptor cable, service box on truck, diagnostic connector, 7-pin, 6 pins assigned, 200 cm	3903820105
Adaptor cable, service box on truck, diagnostic connector, 4-pin	0625028

Measuring devices

Description	Part number
STILL multimeter including measurement leads	0009418737
Current probe	0156300
Temperature sensor, 20...320 C	0156299
Hydraulics test box	0147530
Hydraulics digital test box	0009416002
Accumulator test fitting	0009418044
Spring force meter with up to 200 N	
Refractometer Testing of reduction agent DEF, coolant G12+, anti-freeze, battery acid	

Measuring adaptor

Description	Part number
Adaptor cable, SAAB, 42-pin	8426527
Adaptor cable, variable from 2-pin to 25-pin	0172204
Adaptor cable, SAAB, 16-pin	0172201
Adaptor cable, SAAB, 2-4-6-10-pin	0172202
Measuring adaptor, mark II, 2-4-6-8-pin	0149862
Adaptor cable, mark II - JPT, 4-pin, male connector	0157647
Adaptor cable, mark II - JPT, 4-pin, female connector	0157648

Measuring equipment

Description	Part number
Replacement MetraHit measuring lines, pair of red and black	
Measuring tips, pair of red and black	0143426
Crocodile clips, pair of red and black	0143427
Measurement wires, pair of red and black	0143425

Tools

Description	Part number
AMP crimping tool	0144087
Ejector box	0172412
Crimping tool for wire cross-sections of 10...95 mm^2	0009418107

Harnesses and hoists, 1.0 t - 3.5 t

Hoists

Description	Part number
Hydraulic jack, load capacity 5000 kg	0161527
Ratchet hoist, 800 kg	Hahn&Kolb 77158080

Harness

Description	Part number
Round sling 1000 kg, L= 1 m (purple)	Hahn&Kolb 77200710
Round sling 1000 kg, L= 2 m (purple)	Hahn&Kolb 77200910
Round sling, 2000 kg, L = 2 m (green)	Hahn&Kolb 77200920
Safety chains up to 2000 kg	0155297
Truck hook, single, up to 2000 kg	Hahn&Kolb 77185020
Shackle	Hahn&Kolb 77174210
Lifting eye bolt M6	0148154
Lifting eye bolt M8	0148155
Lifting eye bolt M10	0148156
Lifting eye bolt M12	0148157
Adjustable screw clamp	0156303

Pads

Description	Part number
Supporting block, 250x180x120	0146466
Supporting block, 250x180x38	0009315501
Supporting block, 250x180x58	0009315502
Wheel chock, braking wedge	0144267

Standardised tightening torques for standard-pitch threads and fine-pitch threads

Standard Threads

Tightening torque [Nm]							
Thread	Grade 4.6	Grade 4.8	Grade 5.8	Grade 6.8	Class 8.8	Grade 10.9	Grade 12.9
M4	1	1.3	1.7	2	2.7	3.8	4.6
M5	2.1	2.7	3.4	4.1	5.5	8	9.5
M6	3.6	4.7	5.9	7.1	9.5	13	16
M8	8.5	11	14	17	23	32	39
M10	17	23	29	34	46	64	77
M12	30	40	50	60	80	110	135
M14	47	62	78	94	125	180	215
M16	73	100	122	146	195	275	330
M20	145	192	240	289	385	540	650
M24	250	330	410	495	660	930	1110
M30	510	675	840	1000	1350	1850	2250
M36	880	1170	1470	1760	2350	3300	3900

Fine threads

Tightening torque [Nm]							
Thread	Grade 4.6	Grade 4.8	Grade 5.8	Grade 6.8	Class 8.8	Grade 10.9	Grade 12.9
M8x1	9.5	12	16	19	25	35	42
M10x1	20	26	32	39	52	72	95
M10x1.25	18	24	30	37	49	68	82
M12x1.25	33	44	55	66	88	125	150
M12x1.5	31	41	52	62	83	115	140
M14x1.5	52	70	87	105	140	195	235
M16x1.5	79	105	130	157	210	295	350
M18x1.5	115	150	190	230	305	425	510
M20x1.5	160	210	265	320	425	600	720
M22x1.5	215	285	355	425	570	800	960
M24x1	270	360	450	540	720	1000	1200
M27x1	395	525	655	785	1050	1500	1800
M30x2	540	725	905	1085	1450	2050	2500
M36x3	930	1250	1560	1870	2500	3500	4100

Standardised tightening torques for hose fittings

The basis for these tables is works standard WN 14031 "Tightening torques for union nuts and threaded ends".

Light series

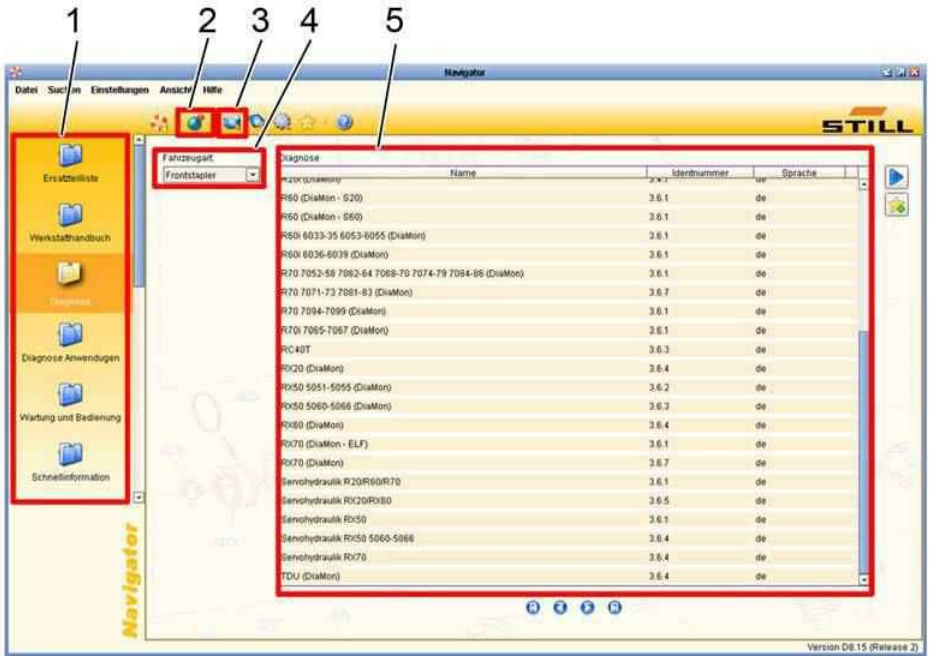
Pipe diameter/series	Nominal diameter (DN)	Thread	Wrench size (SW)	M_A [Nm]
8-L	6	M14 x 1.5	17	12
10-L	8	M16 x 1.5	19	20
12-L	10	M18 x 1.5	22	28
15-L	12	M22 x 1.5	27	50
18-L	16	M26 x 1.5	32	75
22-L	19	M30 x 1.5	36	105
28-L	25	M36 x 1.5	41	150

Heavy series

Pipe diameter/series	Nominal diameter (DN)	Thread	Wrench size (SW)	M_A [Nm]
10-S	6	M18 x 1.5	22	32
12-S	8	M20 x 1.5	24	45
14-S	10	M22 x 1.5	27	58
16-S	12	M24 x 1.5	30	70
20-S	16	M30 x 1.5	36	120
25-S	19	M36 x 1.5	46	170
30-S	25	M42 x 1.5	50	230

Introduction to DiaMon

STEDS-Navigator



STEDS-Navigator homepage

1 Document category
2 Document language
3 Document search by type carrier
4 Document search by truck series
5 Document selection

- Start the notebook and double-click the icon on the desktop. ▷



- The STEDS-Navigator opens with the home-page (see above).
- If necessary, change the document language (2). We recommend that you select English as the second language.
- Select the required document category (1).
- Select the required truck series (4).
- In the document selection (5), select and launch the required document by double clicking.

It is also possible to search for documents directly via the "Document search by type carrier" option. ▷



- Click the document search by type carrier option (3).
- Enter the required type carrier and confirm by pressing Start.

All documents relevant for the type carrier in question are listed and can be opened by double clicking.

Diagnostics service box

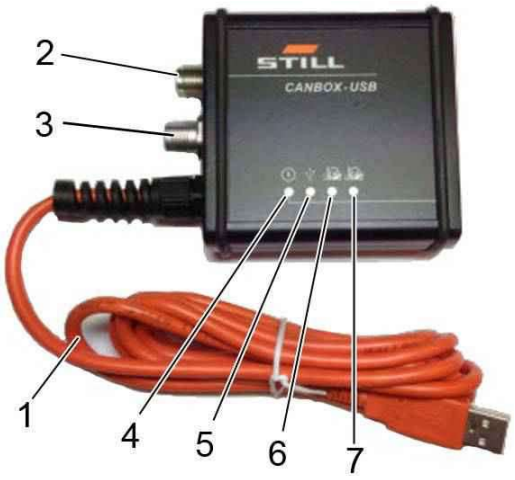
Service box , BT



1	USB cable: the service box must be loaded with the current software. The USB cable will be omitted in later versions
2	Connection for the adaptor cable, 7-pin, 4 pins assigned
3	Connection for the adaptor cable, 7-pin, 6 pins assigned
4	The LED lights up once the service box is supplied with voltage via the diagnostic connector when the truck is switched on
5	The LED indicates the status between the notebook and the service box
6	The LED indicates the status between the service box (CAN 1) and the truck
7	The LED indicates the status between the service box (CAN 2) and the truck
8	The LED indicates the Bluetooth status
9	Antenna
10	STILL Bluetooth USB stick

If all LEDs (3,4,5,6) are flashing, the service box is in programming mode. In this case, the service box must be reset.

Service box, USB



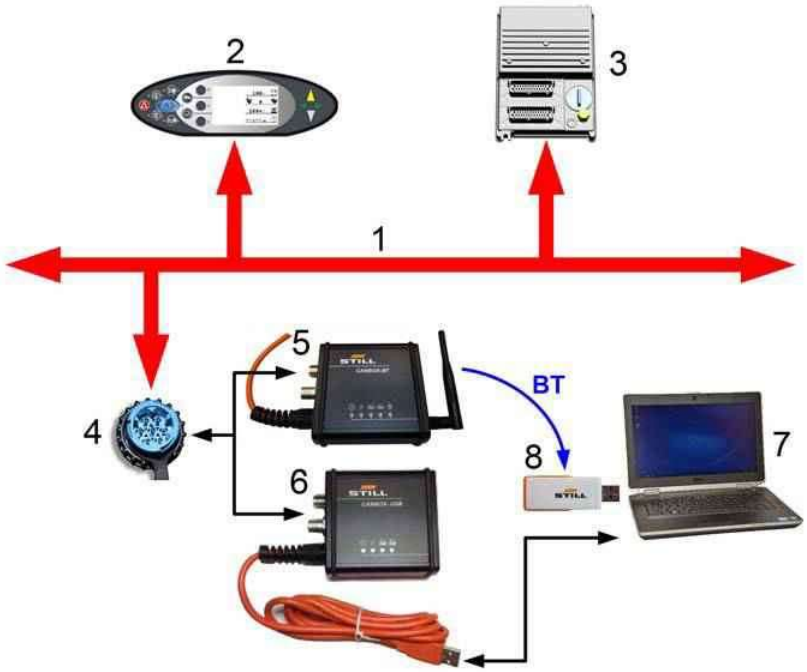
1	USB cable: the service box is connected to the notebook
2	Connection for the adaptor cable, 7-pin, 4 pins assigned
3	Connection for the adaptor cable, 7-pin, 6 pins assigned
4	The LED lights up once the service box is supplied with voltage via the diagnostic connector when the truck is switched on
5	The LED indicates the status between the notebook and the service box
6	The LED indicates the status between the service box (CAN 1) and the truck
7	The LED indicates the status between the service box (CAN 2) and the truck

If all LEDs (3,4,5,6) are flashing, the service box is in programming mode. In this case, the service box must be reset.

Resetting the service box

Switching the truck off and on again will trigger a reset of the service box. Switching the truck off interrupts the CAN bus power supply.

Diagnostic set-up



1	Truck CAN bus (red)	5	CAN box, BT
2	Display and operating unit (ABE)	6	CAN box, USB
3	Truck control unit	7	Notebook
4	Diagnostic connector	8	STILL Bluetooth USB stick

The notebook is connected to the diagnostic connector on the truck via a CAN box.

The "red" truck CAN bus connects the diagnostic connector to the display and operating unit and the truck control unit.

Depending on the type of CAN box used, the connection to the notebook can be made using a USB cable or via Bluetooth. In either case, the diagnostic options are always identical.

Connection, notebook with CAN box, BT

The notebook is connected to the CAN box via Bluetooth.

The CAN box is connected to the diagnostic connector on the truck via the adaptor cable.

NOTE

The STILL Bluetooth USB stick must be used for the Bluethooth connection.



1	Diagnostic connector, 7-pin
2	Adaptor cable for diagnostic connector, 7-pin
3	CAN box, BT
4	STILL Bluetooth USB stick
5	Notebook

Connection, notebook with CAN box, USB

The notebook is connected directly to the CAN box via the connecting line.

The CAN box is connected to the diagnostic connector on the truck via the adaptor cable.

NOTE

In the medium term the CAN box, USB will be replaced by the CAN box, BT.



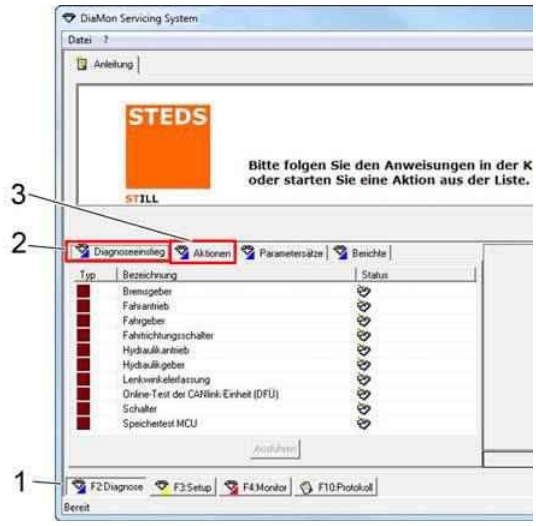
1 Diagnostic connector, 7-pin
2 Adaptor cable for diagnostic connector, 7-pin
3 CAN box, USB
5 Notebook

Starting DiaMon

DiaMon starts a guided diagnostics process that can be used to individually select and carry out different diagnostic sequences and actions. The user is guided by the program at all times. The relevant specifications stipulated must always be followed!

- Safely park the truck; see the chapter entitled "Parking the truck so it is secured for service work"
- Jack up the truck on the drive side; see the chapter entitled "Safety information"
- Turn the key switch to ON.
- Open the notebook and start STEDS-Navigator; see the chapter entitled "STEDS-Navigator"
- Connect the notebook to the truck; see the chapter entitled "Overview of diagnostic tools"
- Select the required diagnostics in STEDS-Navigator and double click to start.

It may take some time to establish the connection with the truck and to launch the diagnostics.



1 F2: Diagnosis
2 Diagnosis Start Points
3 Jobs

Working with DiaMon

Reading out access codes

All trucks are assigned a unique `SERVICE` access code ex works. This access code is created via a random generator in the truck control unit (MCU, TCU).

The `Fleet manager` access code is set to an invalid value ex works. The service engineer can adjust the access code if required.

– Connect the notebook to the truck and start the truck diagnostics, see the chapter entitled "Introduction to DiaMon":

`F3: Setup`
▼
`Truck`
▼
`Access code`
▼
`General`

▷



Service access code

– Read out the 4-digit numeric access code in the "Service" field and change if necessary.

– Save the modified access code to the truck by pressing `^F5: Save` or the enter key ↵.

Fleet manager access code

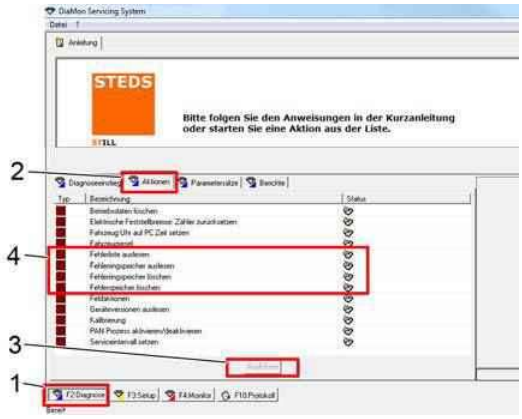
– Enter a 4-digit numeric access code in the "Fleet manager" field.

– Save the access code to the truck by pressing `^F5: Save` or the enter key ↵.

Reading out and clearing the error list

– Connect the notebook to the truck and start the truck diagnostics, see the chapter entitled "Introduction to DiaMon":

F2: Diagnosis
▼
Jobs
▼
Select action (4)
▼
Execute



1 F2: Diagnosis
2 Jobs
3 Execute

Error lists
4 Read error list
4 Clear error list
4 Read error ring buffer

Read error list

Various types of error lists are available for selection:

1 Active errors

Lists all errors that are currently active

2 Errors since the last reset

Lists all errors that have occurred since the truck was switched on.

3 All stored errors

Lists all errors that have occurred since the error list was last cleared

The relevant error list is then displayed, depending on the type of error list selected. All errors from all control units are displayed in this list. It is not possible to select individual controllers.

Clear error list

The error list for all controllers will be deleted. It is not possible to select individual controllers.

Read error ring buffer

The option to read out the error ring buffer depends on the software version installed in the truck. More information about this can be found in the "Truck software overview" document

- Error ring buffer: general

  The latest 256 errors from the truck control unit (MCU, TCU are displayed (error group A).

- Error ring buffer: converter

  The latest 256 errors from the converter are displayed (error groups D and E).

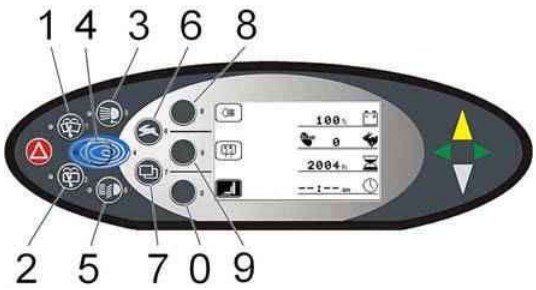
For more information, see chapter "60 - Error ring buffer"

Working using the ABE

Read error list

– Switch on the truck and wait until the standard screen appears in the display.

– Press buttons 6 and 7 simultaneously.



– The display will change to the password screen. Enter the password for the service level and confirm by pressing button 9. Determine the unique password; see the chapter entitled "Reading out access codes".



– Once the password has been successfully entered, the display will switch to the CONFIGURATION menu.

– Press button 6 or 7 until ERROR LIST is displayed in a framed field. Confirm the entry by pressing button 9.



– The display changes to the ERROR LIST MODE menu.

– Press button 6 or 7 until SERVICE is displayed in a framed field. Confirm the entry by pressing button 9.

– The display changes to the ERROR LIST menu.



Device	
A .... Z, a ... z	Selection of the relevant controller. For device IDs, see the chapter entitled "Overview of controllers"
*	**Recommendation:** Errors for all controllers are displayed.
Type	
1	The active errors are displayed
2	All errors that have occurred since the last error reset are displayed
3	All stored errors are displayed

– The framed field DEVICE is activated. Use button 6 or 7 to make the selection and confirm by pressing button 9.

– The framed field TYPE is activated. Make a selection and confirm in this field too.

– The START display is activated. Press button 9 to start generating the error list.



It may take some time to read out the error list. When the process is underway, the flashing characters `? ?? ??` are displayed. When the process is complete. the latest error in the list is displayed.

`X 00 00` indicates that the error list is empty.
`X - - - -` indicates an error with the process to read out the error list. X stands for the device ID.

– Press button 6 to scroll up the error list. It is only possible to scroll one step at a time.

▷



As soon as an error is repeated, this signals that the start of the error list has been reached. All errors in this error list have been displayed.

– Press button 7 to scroll back down the list

As soon as an error is repeated, this signals that the end of the error list has been reached. All errors in this error list have been displayed.

– Press button 0 to jump back to the `TYPE` and `DEVICE` display fields.

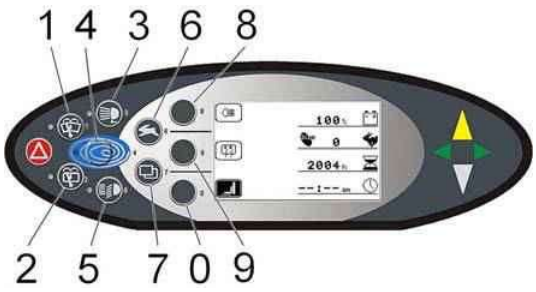
– Press button 8 to jump back to the `CONFIG-URATION` menu.

Clearing error lists

– Switch on the truck and wait until the standard screen appears in the display.

– Press buttons [6] and [7] simultaneously.

▷



– The display will change to the password screen. Enter the password for the service level and confirm by pressing button [9]. Determine the unique password; see the chapter entitled "Reading out access codes".

▷



– Once the password has been successfully entered, the display will switch to the CONFIGURATION menu.

– Press button [6] or [7] until ERROR RESET is displayed in a framed field. Confirm the entry by pressing button [9].

– The display changes to the ERROR RESET menu.

▷



Device	
A .... Z, a ... z	Selection of the relevant controller. For device IDs, see the chapter entitled "Overview of controllers"
*	**Recommendation:** Error lists for all controllers are cleared.

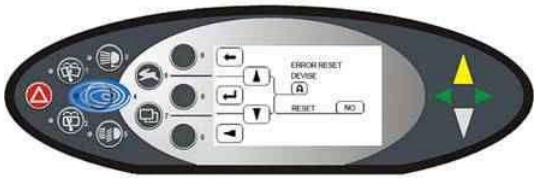
– The framed field DEVICE is activated. Use button [6] or [7] to make the selection and confirm by pressing button [9].

– The framed field RESET is activated.

– Use button [6] or [7] to select either YES or NO and confirm by pressing button [9].

– The selected error list is then cleared.

▷



It may take some time to clear the list. The text PLEASE WAIT is displayed to indicate that the process is underway.

If the clearing process fails, the flashing message ERROR is displayed.

–

– Press button [0] to jump back to the RESET and DEVICE display fields.

NOTE

Resetting automatically activates the option NO *in the framed* RESET *field. The error list is not cleared.*

– Press button 8 to jump back to the CONFIG-URATION menu.

Traction motor

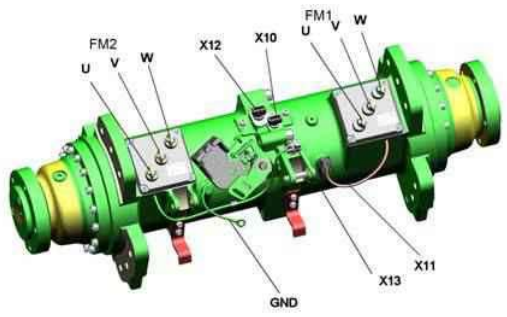
General technical data

Traction motor	6210 - 6217	6311, 6313, 6315
Manufacturer		
Designation	AF-104-K1	AF-104-I4
Operating voltage	48 V	80 V
Motor type	4-pin AC motor with cage rotor	
Connection	Star	Star
Design voltage (nominal)	3 x 28 V	3 x 48 V
Design current (nominal)	128 A	87 A
Design speed (nominal)	2000 rpm	2645 rpm
Maximum speed	4076 rpm at 16 km/h	5075 rpm at 20 km/h
Design output (nominal)	2 x 4.5 kW	2 x 5.5 kW
Mode of operation (nominal)	S2 (60 min)	S2 (60 min)
Protection type	IP 54	IP 54
Insulation class	F	F
Weight	Approx. 56 kg / motor	Approx. 65 kg / motor
Cooling	Surface / convection	
Temperature sensor	KTY84 - 130	KTY84 - 130
Rev sensor	Pin sensor	Pin sensor

Electrical connections

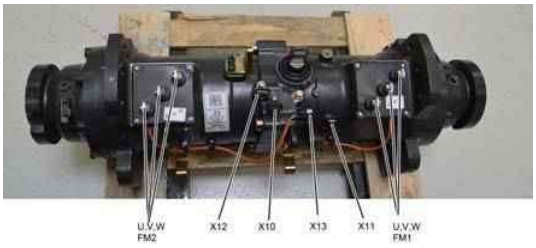
AE18-05

Plug	Designation
1M2	**Traction motor, left (FM2)**
U, V, W	1U07 converter, left
X12	Rev sensor, left
X13	Temperature sensor, left
1M1	**Traction motor, right (FM1)**
U, V, W	1U06 converter, right
X10	Rev sensor, right
X11	Temperature sensor, right



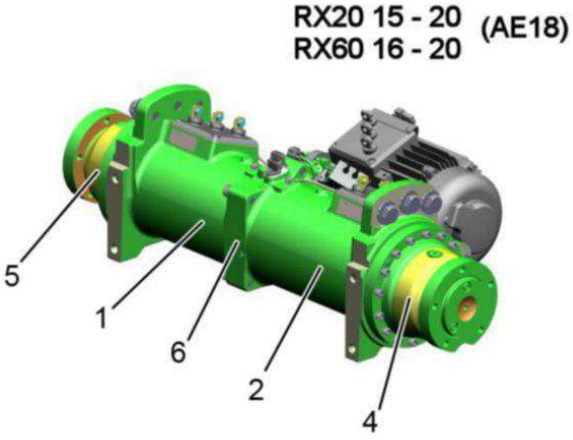
AE18-07

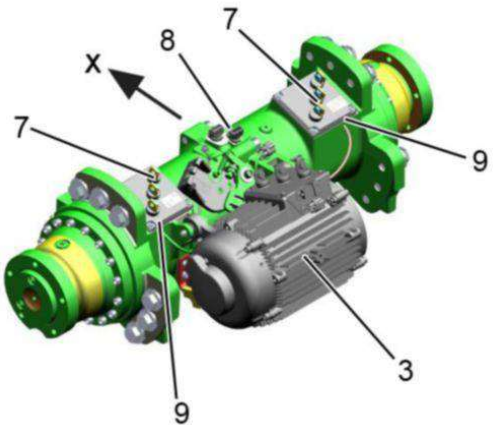
Plug	Designation
1M2	**Traction motor, left (FM2)**
U, V, W	1U07 converter, left
X12	Rev sensor, left
X13	Temperature sensor, left
1M1	**Traction motor, right (FM1)**
U, V, W	1U06 converter, right
X10	Rev sensor, right
X11	Temperature sensor, right



Traction drive

General





X	Travel direction
1	Right-hand traction motor (FM1)
2	Left-hand traction motor (FM2)
3	Pump motor
4	Left drive wheel
5	Right drive wheel
6	Multi-disc brake
7	Motor connections
8	Speed sensors
9	Temperature sensors

Both traction motors are fully integrated into the drive axle. The drive axle also holds the pump motor.

The traction motors are connected via the motor housing. A wet-running multi-disc brake is located between the motors.

On each side there is a drive wheel unit outside the traction motors.

The motor connections U, V, W are fed upwards out of the motors as screw connections.

The speed sensors are inserted in the axle from the outside, sealed with an O-ring and secured with a screw.

The temperature sensors are embedded into the stator winding. The plugs are led out of the motors.

Traction motor

The traction motors are three-phase AC asynchronous motors that are equipped with short-circuit cage rotors.

Aluminium conductors are fused into the grooving of the rotor core and connected at the ends with short-circuit rings. The conductors with the short-circuit rings form the cage rotor and hold the rotor core together.

The stator consists of the 4-pole stator core and the stator windings, which are pressed into the motor housing as a unit.

The applied voltage is induced in the rotor bars by the stator winding and causes a current to flow in the rotor. The resultant rotor current and the rotating field acting on the stator generate the torque.

Method of operation

The motors are each controlled by a converter. The speed is changed by changing the frequency and voltage of the applied AC voltage.

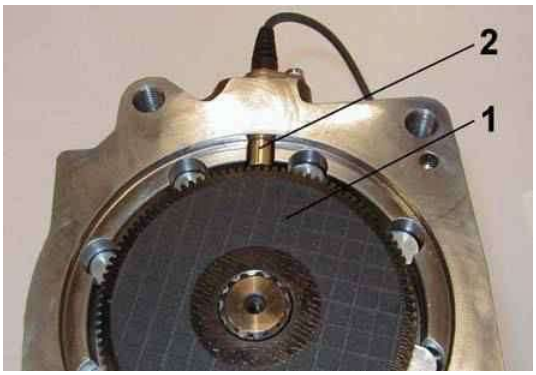
In the motor, each of the three phases is distributed to four poles in the stator, thereby generating the rotating field. The motors are operated in a star circuit and supplied with pulsating voltage by the converters.

The motors are controlled using pulse width modulation at a frequency of approx 16 kHz.

Sensors

Pin sensor

General



Each traction motor has a two-track pin sensor (2) as a rev sensor, which is fitted from above into the axle and scans the front-end gearing of the brake disc (1).

The rev sensor is sealed with an O-ring and fixed in the motor housing by a screw.

The speed sensors have a 10 V supply from the respective converter. The speed signals (A and B) are connected to the Supply Unit (SU). The sensor signals are forwarded by the SU to the relevant converter and the Main Control Unit (MCU).

The evaluation takes place in the converters, whilst monitoring occurs in the MCU.

Technical data

Model: Pin sensor

106 pulses per revolution

Phase shift: 90° ± 45°

Temperature range: -30 °C to +150 °C

Supply voltage: 10 V to 12 V, depending on the converter type (LAC/SAC)

Undo the electrical

4-pin JPT plug X10, FM1 (right)			
Red	X10/1	X151/7	Supply
Blue	X10/2	X44/24	Signal A
Black	X10/3	X151/8	GND
White	X10/4	X44/23	Signal B

4-pin JPT plug X12, FM2 (left)			
Red	X12/1	X152/7	Supply
Blue	X12/2	X44/36	Signal A
Black	X12/3	X152/8	GND
White	X12/4	X44/37	Signal B

Testing

- Insert the mark II test adapter into plug connector X10 or X12
- Use a digital multimeter with integrated duty cycle (e.g. Metra Hit 16L)
- Connecting the digital multimeter:

  Adapter Pin 4 - Plus
  Adapter Pin 3 - Minus
- Then connect the digital multimeter:

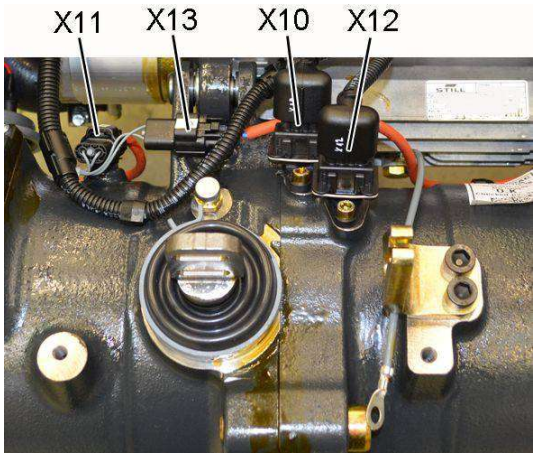
  Adapter Pin 2 - Plus
  Adapter Pin 3 - Minus
- Turn on key switch S1
- Measuring range: duty cycle "V~Hz%"
- At full speed, the duty cycle should be **40% - 60% (ideally 50%)**.

Behaviour in the event of a fault

If the sensor is not sending signals to the converter, the traction motor is operating in creep mode (creep speed).



AE18-05



AE18-07

Temperature sensor KTY84

General

Each traction motor is monitored by a temperature sensor.

The watertight temperature sensors are embedded in the stator winding and are led out of the motors through a removable terminal board.

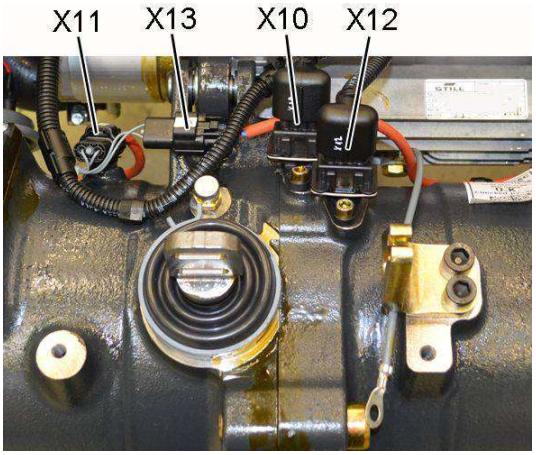
The signals are evaluated in the inverters.

Technical data

Type: KTY84-130.

Power supply: approx. 1.7 mA

Undo the electrical



3-pin mark II plug X11, FM1 (right)			
Red	X11/1	X151/3	Temp-MCT+
Blue	X11/3	X151/4	Temp-MCT-

3-pin mark II plug X13, FM2 (left)			
Red	X13/1	X152/3	Temp-MCT+
Blue	X13/3	X154/4	Temp-MCT-

⚠ CAUTION

An improperly conducted insulation test can destroy the temperature sensor.

Before the insulation testing, jumper the temperature sensor connections.

Testing

– Insert test adapter into plug connector X11 or X13

– Compare the resistance value to the table

Reference values for temperature measurement

Temperature (°C)	Resistance (Ω)
-40	355
-30	386
-20	419
-10	455
0	493
10	533
20	576
25	598
30	621
40	668
50	718
60	769
70	824
80	880
90	939
100	1000

Temperature (°C)	Resistance (Ω)
110	1063
120	1129
130	1197
140	1268
150	1340
160	1415
170	1493
180	1572
190	1654
200	1739
210	1825
220	1914

Changing the temperature sensor

A defective sensor can be exchanged with the aid of a repair kit containing a temperature sensor and two-component balancing mastic.

- Knead both components (yellow and blue) of the mastic together until the mass has a uniform green colour
- Continue kneading the green mass for at least 2 minutes until it is noticeably warm
- Unscrew the terminal board with the main power connections
- Press the sensor against the side of the winding using the balancing mastic

NOTE

Make sure that no mastic gets between the sensor and winding, as otherwise the temperature measurement will be incorrect.

- The balancing mastic is fully cured after approx. 2.5 hours

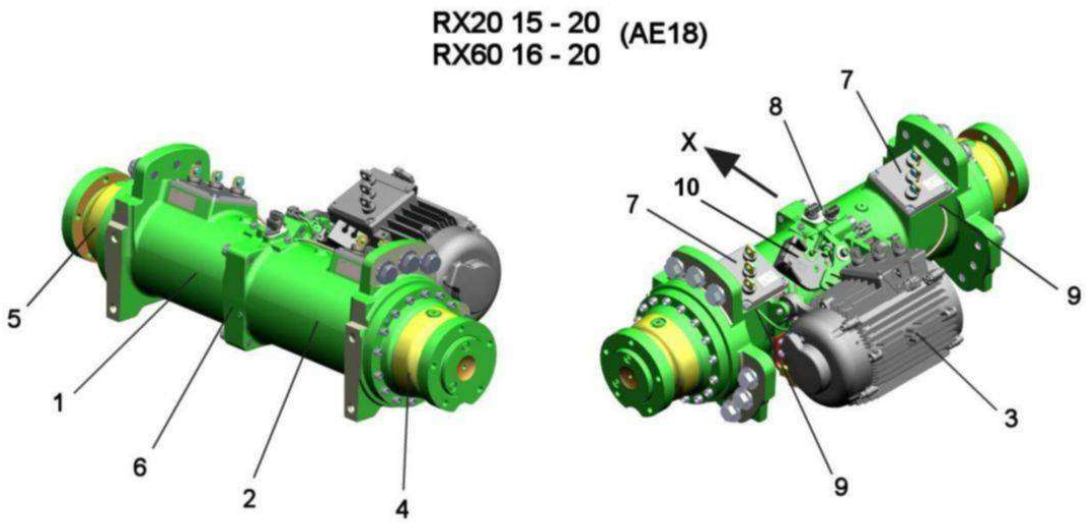
Drive axle AE18-05

General technical data

Drive axle	6210 - 6217 6311, 6313, 6315
Manufacturer	Linde, Juli
Designation	AE18 - 05AC
Weight	170 kg
Connecting elements and tightening torques	
Wheel nuts, per wheel	5 x spherical collar bolts Tightening torque: 210 Nm
Drive axle – chassis screw joint, per side	6 x hexagon head screws M20 x 40 DIN 933, quality 8.8 Tightening torque: 385 Nm
Traction motor screw joint, right/left	4 x socket head screw M16 x 50 DIN 912, Quality 10.9 Tightening torque: 195 Nm
Drive wheel unit screw joint, per side	16 x socket head screw M10 x 50 DIN 912, Quality 10.9 Tightening torque: 64 Nm
Screw plugs – drive wheel unit oil filling	M18 x 1.5 Tightening torque: 70 Nm
Screw plugs – drive wheel unit oil drain	M10 x 1 Tightening torque: 20 Nm
Screw plugs – drive wheel unit oil-level check	M10 x 1 Tightening torque: 20 Nm
Screw plugs – service brake oil filling	M10 x 1 Tightening torque: 18 Nm
Screw plugs – service brake oil drain	M10 x 1 Tightening torque: 18 Nm
Screw plugs – service brake oil-level check	M10 x 1 Tightening torque: 18 Nm
Mast bearings, per side	1 x screw M16 x 45, ISO 4017 1 x screw M16 x 110 - 10.9 A2C, ISO 4017 2 x lock washer Tightening torque: 275 Nm
Consumables	
Gearbox, drive wheel unit	SAE 80W-90, API GL4 + 5 0.3 litres per side
Service brake	Shell Donax TX 0.15 litres

Drive axle

General



X	Travel direction	6	Multi-disc brake
1	Right-hand traction motor (FM1)	7	Motor connections
2	Left-hand traction motor (FM2)	8	Speed sensors
3	Pump unit	9	Temperature sensors
4	Left drive wheel	10	Brake actuator
5	Right drive wheel		

Both traction motors are fully integrated into the drive axle.

The traction motors are connected via the motor housing. A wet-running multi-disc brake is located between the motors.

On each side there is a drive wheel unit outside the traction motors.

The drive axle also acts as a holding fixture for the pump unit. The pump unit is connected to the drive axle at the top via two bearing bolts in round bearing sockets. The pump unit is supported below on two support bearings with spring elements.

Drive axle removal and installation

Removal



NOTE

- *Removal of the individual units is described in detail in the corresponding chapters.*
- *The pump motor can remain in the truck during removal of the drive axle.*
- *Discharge the gearbox oil and brake oil at an early stage so that the oil has time to drain off.*

– Park the vehicle safely.

– Apply the parking brake.

– Drain the gearbox oil if necessary.

– Disconnect battery plug.

– Release the wheel bolts, but do not unscrew completely

– Jack up the front of the truck, see chapter "Safety instructions"

– Remove the lift mast, see chapter "Lift mast - installation / removal"

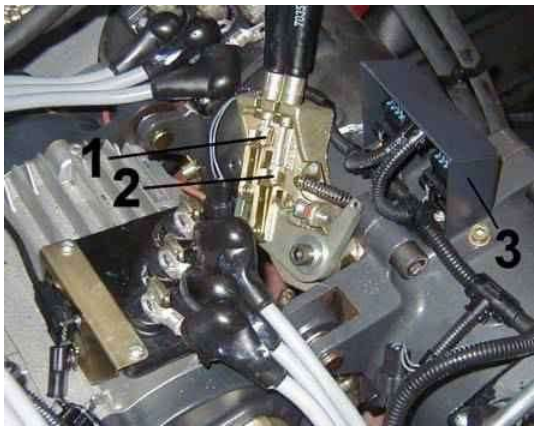
– Remove the wheel bolts and take off the drive wheels

– Release parking brake

– Remove floorplate.

– For high chassis: Remove the cover sheet on the front structure

– Remove the brake control covering

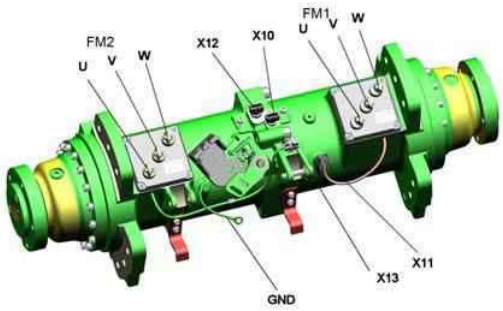


– Remove the ES bolts from parking brake (1) and service brake (2) and detach the cables; mark beforehand if necessary

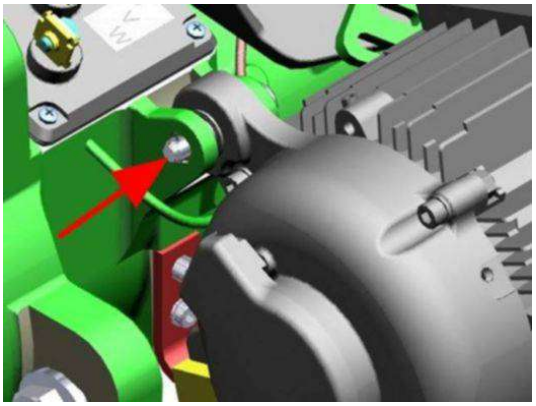
– The recuperating spring pulls the brake control to the zero position and is not unhooked

– Remove the guard plate for the speed sensors (3)

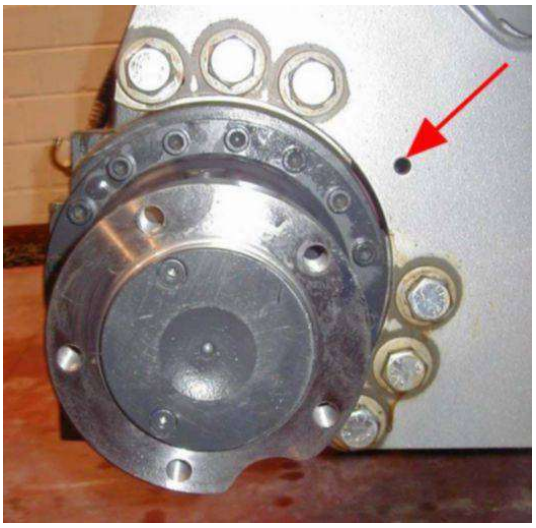
- Disconnect sensor connectors X10, X11 and X12, X13 from the traction motors; mark beforehand if necessary
- Unscrew the GND earthing cable from the pump motor
- Unscrew the power cable from the traction motors; mark beforehand if necessary



- Remove the retaining split pins from the fastening bolts of the pump motor
- Use a suitable belt to attach the pump motor to the brake pedal; use a knob to hold in position



- Remove the fastening bolts from the motor mounts; push the bolts out of the bores if necessary
- Position a pallet truck with timbers beneath the drive axle
- Raise the forklift truck until the timbers are in contact with the drive axle
- On both sides, remove the six mounting screws of the drive axle



– Lower the drive axle and pull from beneath the truck
– Retain and reuse the support bearings' spring elements



Installation

NOTE

- *Installation of the individual units is described in detail in the corresponding chapters.*
- *Check screw quality and tightening torques.*
- *Note the quality and quantity of gearbox oil, brake oil*

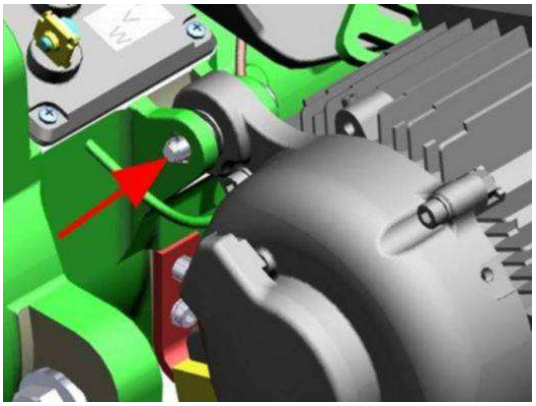
– Place the spring elements on the support bearings



– Insert the drive axle into the truck and align with the chassis and pump motor
– Insert all screws on both sides between the chassis and drive axle, and the fastening bolts for the pump motor



– Secure the fastening bolts of the pump motor with retaining split pins
– Remove the securing belt from the pump motor
– Protect the mounting screws against corrosion and tighten on both sides

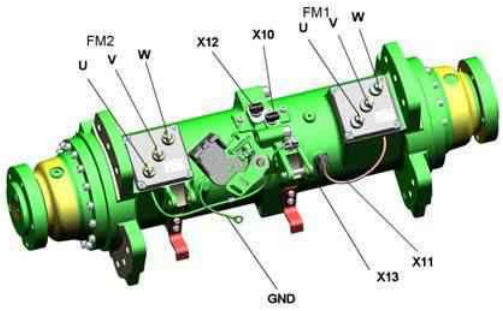


– Screw the power cables onto the traction motors and assemble the clean splash guard rims

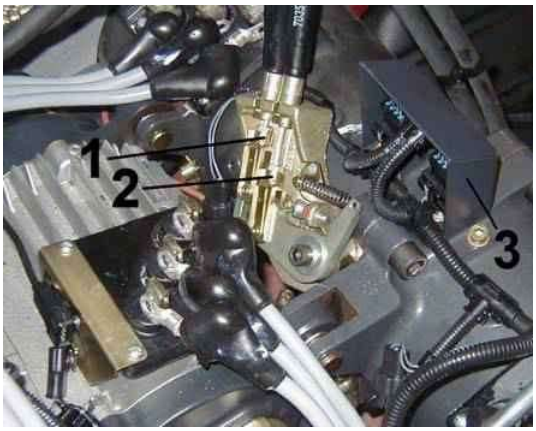
⚠ CAUTION

Traction motors defective due to water

To guarantee the protection type of the traction motors, the splash guard rims must be pulled correctly over the power cables.



– Attach sensor connectors X10, X11 and X12, X13 to the traction motor
– Screw the GND earthing cable onto the pump motor
– Screw on the guard plate (3) for the speed sensors
– Attach the brake cables and assemble the ES bolts of the parking brake (1) and the service brake (2)
– Check the brake settings; see the chapter entitled "Brake system"
– Fit the covering on the brake control
– For high chassis: Fit the cover sheet on the front structure
– Install the drive wheels and tighten the wheel bolts
– Fill with gearbox oil; see the chapter entitled "Removal/installation of the drive wheel unit"
– Attach the lift mast, see chapter "Lift mast - installation / removal"
– Refit floor plate.
– Apply the parking brake.
– Lower the truck.
– Tightening check
– Connect the battery plug



– Carry out a function check on all traction and hydraulic functions

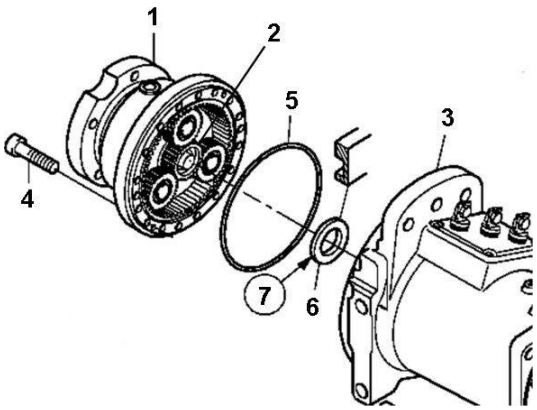
Wheel drive

General

The drive wheel units (1) are structurally identical units. The drive wheel units are screwed directly onto the axle housing (3) with socket head screws (4).

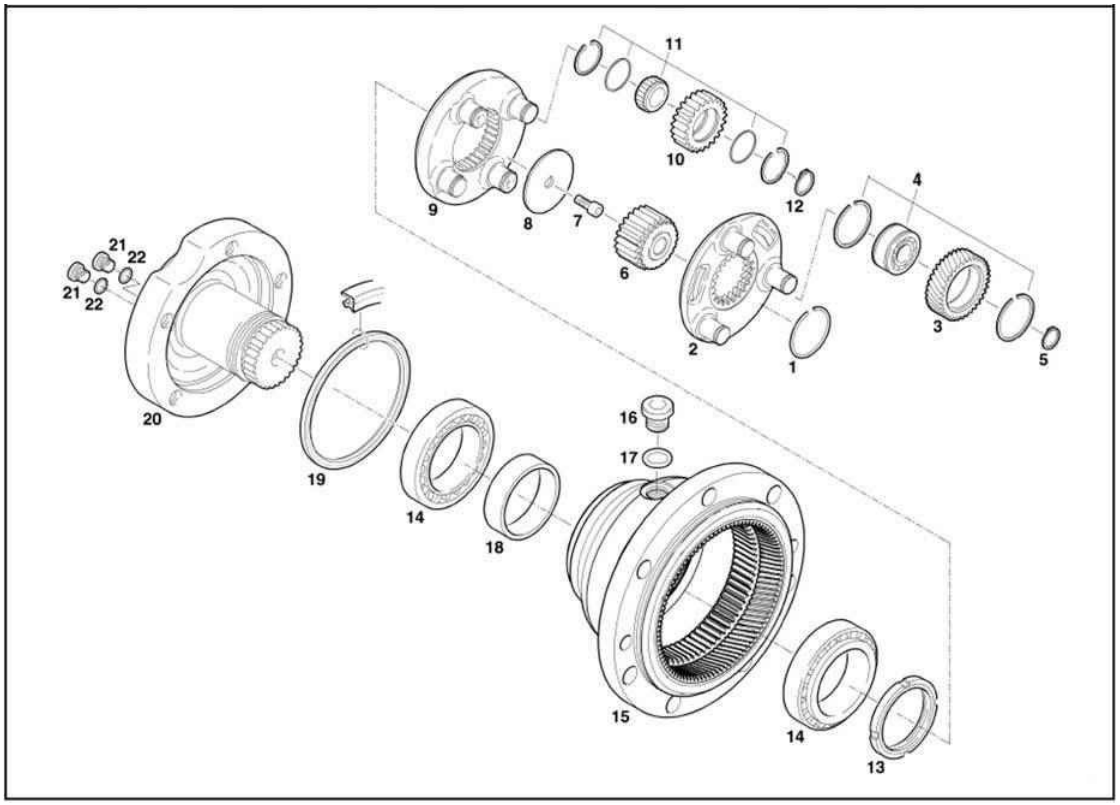
NOTE

- *The changing of shaft seals (6) at the wheel hubs is the only repair work that is permissible.*
- *The wheel gear can only be repaired using a special tool and the corresponding tensioning device.*
- *If the wheel bearings are defective, the complete drive wheel unit must be changed.*



1	Drive wheel unit
2	Planetary transmission
3	Axle housing AE18
4	Socket head screw
5	O-ring
6	Shaft seal
7	Loctite

Function



1	Snap ring	12	Locking ring
2	Planet gear carrier	13	Slotted nut
3	Planet gear	14	Tapered roller bearing
4	Angular roller bearing	15	Housing
5	Locking ring	16	Screw plug
6	Sun gear	17	O-ring
7	Socket head screw	18	Spacer ring
8	Washer	19	Shaft seal
9	Planet gear carrier	20	Wheel shaft
10	Planet gear	21	Screw plug
11	Cylindrical roller bearing	22	O-ring

The drive wheel unit consists of a housing (15) with a reduction gearbox and a wheel shaft (20). The wheel shaft is held in the housing by slotted nut (13). The location of tapered roller bearings (14) is determined by spacer ring (18) on the wheel shaft. For precise adjustment, the spacer rings are available in different sizes.

The reduction gearbox is a two-stage planetary transmission:

- Stage 1 consists of the planet gear carrier (2) and three planet gears (3). The planet gears are driven by the shaft stub in the traction motor and move the planet gear carrier too.
- Stage 2 consists of the planet gear carrier (9) and four planet gears (10).

- The sun gear (6) sits in the gearing of the planet gear carrier (2) and drives the four planet gears (10) of stage 2. The planet gears also move the planet gear carrier (9).
- The planet gear carrier (9) drives the wheel shaft (20) via the gearing.

Removal/installation of the drive wheel unit

Tool tip

For simple installation and removal of the drive wheel units, a conventional trolley jack from your local building supplies store is suitable. The U-profile is welded onto the hydraulic jack.

Profile parameter sets

- 140 x 60 x 60



For installation of the drive wheel unit, there are two stud bolts that are to be screwed into the traction motor housing to help as a guide.

- Screw M10 x 100
- Saw off the screw head



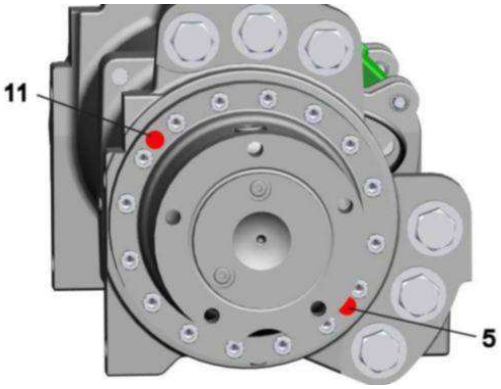
Removal

– Park the truck safely on level ground
– Apply the parking brake
– Disconnect the battery male connector
– Place a collection container for the gearbox oil under the drive wheel unit
– Drain the gearbox oil



– Loosen the wheel bolts, do not unscrew completely
– Jack up the front of the truck; see the chapter entitled "Safety information"
– Release the parking brake
– Remove the wheel bolts and remove the wheel

– If necessary, use two M10 screws to push off the drive wheel unit To do so, screw the screws into the threaded holes provided (5 o'clock and 11 o'clock position)



ENVIRONMENT NOTE

Dispose of any remaining oil that escapes in an environmentally friendly manner.

– Remove the drive wheel unit with planetary transmission

– Insert a new shaft seal

NOTE

- *The lips of the shaft seal must point towards the outside of the axle*
- *Check that the spring is properly seated*
- *Lightly oil the shaft seal*

Installation

NOTE

- *Check tightening torques and screw quality*
- *Check the quality and quantity of the gearbox oil*
- *For values, see "General technical data" in the chapter entitled "Drive axle"*

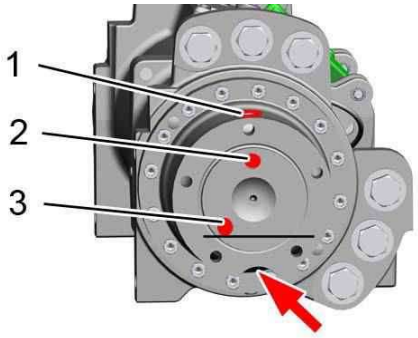
– Place new O-ring in the groove

– Fit the drive wheel unit to the traction motor housing. The oil filling opening (1) must face upwards. To aid assembly, screw two guide pins into the traction motor housing.



– Screw the drive wheel unit to the traction motor housing, tightening the screws diagonally

– Fill with gearbox oil via the oil filling opening (1) until the oil flows out of the inspection opening (3) ▷



NOTE

- *The oil level check is to be carried out when the truck is on level ground.*
- *Turn the wheel so that one of the two inspection openings is at 12 o'clock (2). The other inspection opening (3) is then automatically at the height of the maximum oil level.*
- *When filling, always undo the top checking screw so that air can escape.*

– Attach the wheel and tighten the wheel bolts

– Lower the truck.

– Check tightening torques

– Connect the battery male connector

– Function check

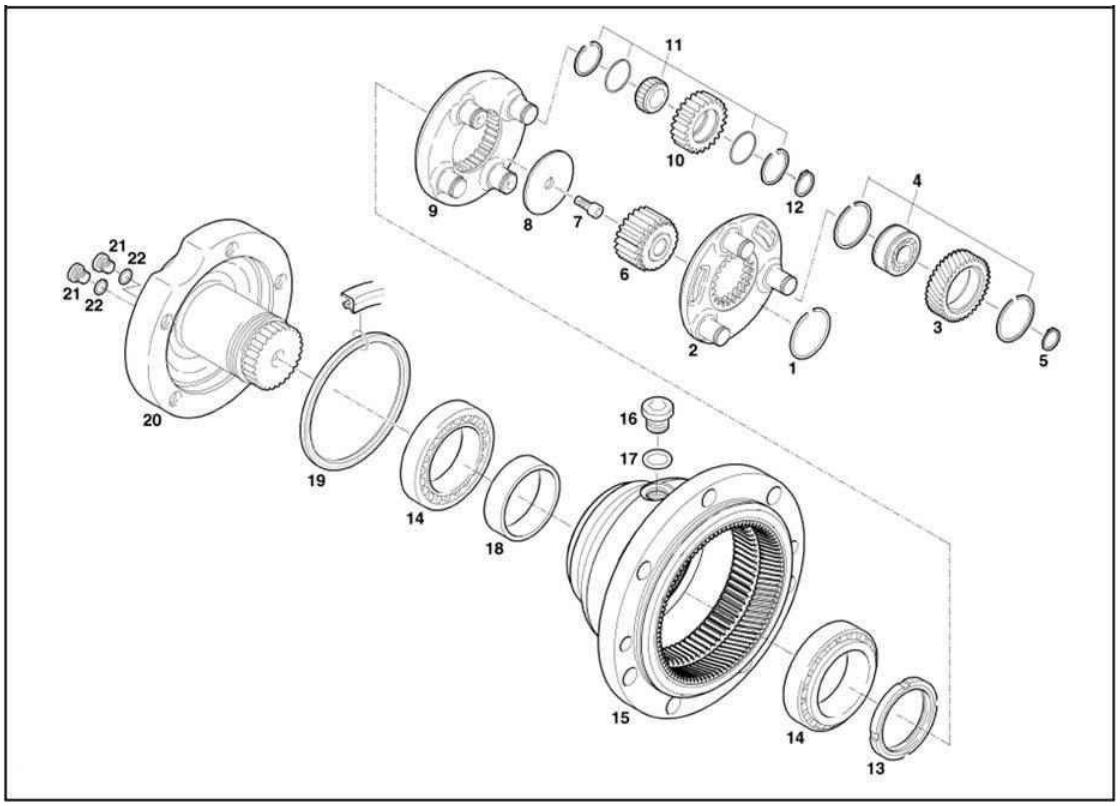
Repairing the drive wheel unit

Preparation

The following tools are necessary to disassemble the drive wheel unit:

- Vice
- Slotted nut spanner (order no. 161538)
- Brass pin
- Loctite

Changing the shaft seal



1	Snap ring	12	Locking ring
2	Planet gear carrier	13	Slotted nut
3	Planet gear	14	Tapered roller bearing
4	Angular roller bearing	15	Housing
5	Locking ring	16	Screw plug
6	Sun gear	17	O-ring
7	Socket head screw	18	Spacer ring
8	Washer	19	Shaft seal
9	Planet gear carrier	20	Wheel shaft
10	Planet gear	21	Screw plug
11	Cylindrical roller bearing	22	O-ring

– Fix the wheel shaft of the drive wheel unit in the vice.

– Pull planet gear carrier (2) with planetary gear set (4) and sun gear (6) out of housing (15).

– Unscrew socket head screw (7), washer (8) remains in planet gear carrier (9).

– Pull planet gear carrier (9) with planetary gear set (11) out of housing (15).

– Unscrew slotted nut (13) from wheel shaft (20).

NOTE

The slotted nut is secured with Loctite.

– Using a brass pin and hammer, carefully tap the front end of the wheel shaft to release the bearing halves of tapered roller bearings (14) from one another.
– Pull the wheel shaft out of the housing.
– Insert a new shaft seal (19).

NOTE

- *The lips of the shaft seal point towards the outside of the axle.*
- *Check that the spring is properly seated.*
- *Lightly oil the shaft seal.*

– Lightly oil both roller cages.
– Insert the wheel shaft into the housing.
– Attach the roller cage of the internal bearing to the wheel shaft.
– Secure slotted nut (13) with Loctite and screw tightly onto wheel shaft (20).

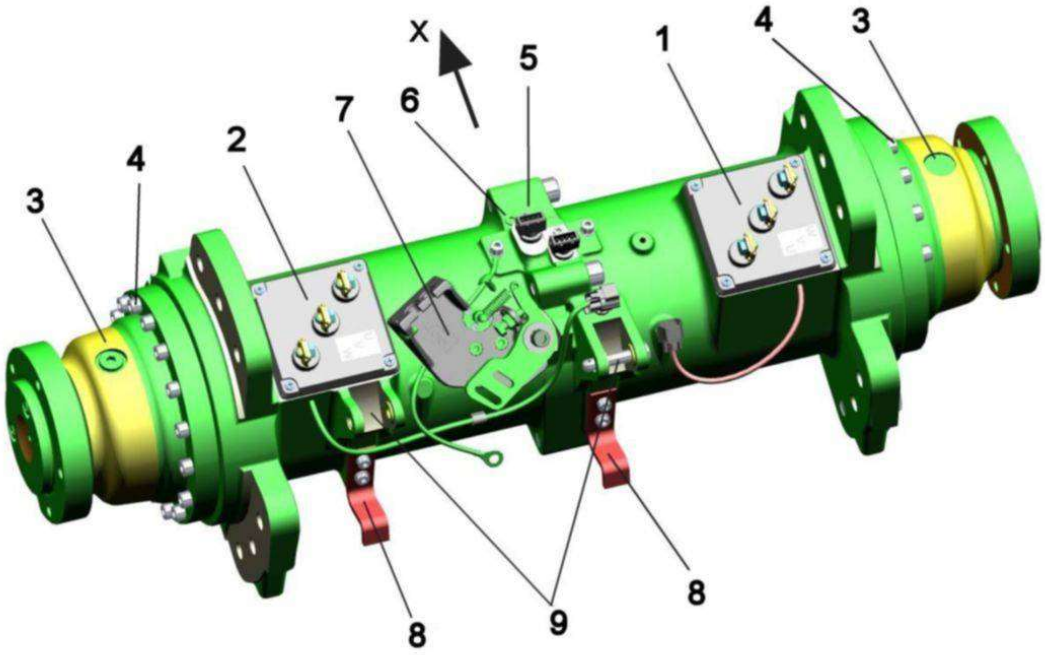
NOTE

While tightening the slotted nut, rotate the wheel shaft so that the bearing halves are evenly seated.

– Insert planet gear carrier (9) with planetary gear set (11) into housing (15).
– Insert washer (8) and screw in socket head screw (7) tightly.
– Insert planet gear carrier (2) with planetary gear set (4) and sun gear (6) into housing (15).

Traction motor

General



1	Right-hand traction motor (FM1)	6	Brake oil filler plugs
2	Left-hand traction motor (FM2)	7	Brake actuator
3	Wheel drive	8	Pump motor bearing pins
4	Drive wheel unit fixing screws	9	Pump motor support bearings
5	Multi-disc brake		

The two traction motors are almost identical to each other in mirror image and, together with the drive wheel units, form the drive axle.

The multi-disc brake is located centrally between the traction motors. The drive wheel units are on the left and right-hand sides.

To change a traction motor, the entire drive axle must be removed from the truck and dismantled.

Removal

NOTE

- *Removal of the individual units is described in detail in the corresponding chapters.*
- *The pump motor can remain in the truck during removal of the drive axle.*
- *Discharge the gear lubricant oil and brake oil at an early stage so that the oil has time to drain off.*

– Park the vehicle safely.

- Apply the parking brake.
- Draining the gear lubricant oil
- Disconnect battery plug.
- Remove the lift mast
- Release the wheel bolts, but do not unscrew completely
- Remove the lift mast, see chapter "Lift mast - installation / removal"
- Jack up the front of the truck, see chapter "Safety instructions"
- Remove the wheel bolts and take off the drive wheels
- Release parking brake
- Remove the drive axle; see the chapter entitled "Removing/installing the drive axle"
- Retain and reuse the support bearings' spring elements
- Before disassembling the left-hand traction motor, the brake control must be removed: to do so, release the two socket head screws

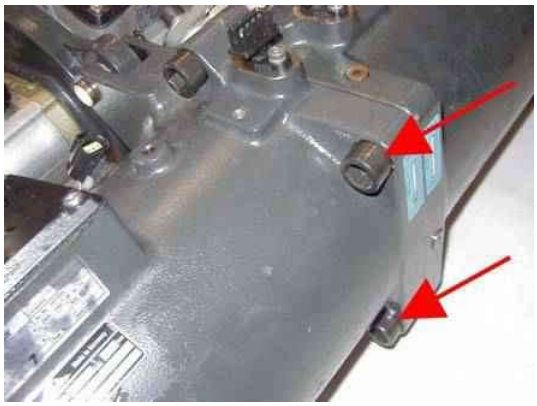
⚠ WARNING

Once the connecting screws have been removed, the drive axle splits into two parts.

Prevent the halves of the axles from rolling away

- To separate the traction motors, release the four M16 connecting screws

▷



NOTE

Screw the lower mast bearing screw on the right-hand side back in again to act as a torque damper when releasing the connecting screws.

- Remove the individual parts of the multi-disc brake and put them aside

– Unscrew the drive wheel unit from the traction motor housing ▷



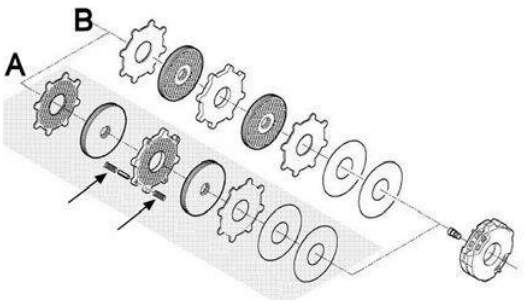
Installation

NOTE

- *Installation of the individual assemblies is described in detail in the corresponding chapters.*
- *Check tightening torques and screw quality.*
- *Check gear lubricant oil and brake oil quality*
- *For values, see "General technical data" in the chapter entitled "Drive axle"*

– Screw the drive wheel unit onto the traction motor housing

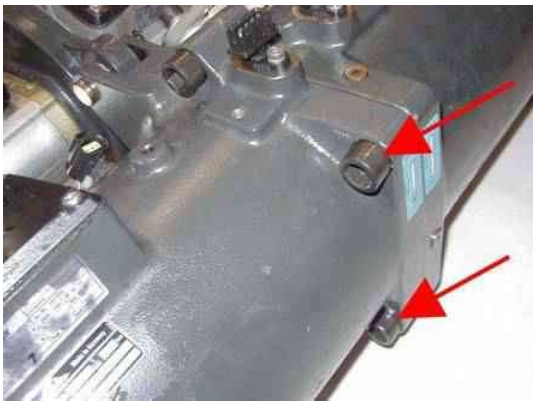
– Insert the brake disc packages into the drive axle in the order of installation ▷



– Insert the O-ring between both halves of the axle

– Join the halves of the axle in such a way that the guide pins slot into the guide holes

– Tighten the four connecting screws ▷



– To assemble the left-hand traction motor, screw on the brake control using two socket head screws

– Place the spring elements on the support bearings

– Install the drive axle; see the chapter entitled "Removing/installing the drive axle"

– Fill both drive wheels with gear lubricant oil

– Fill the multi-disc brake with brake oil

– Attach the drive wheels

– Attach the lift mast, see chapter "Lift mast - installation / removal"

– Lower the truck.

– Connect the battery plug

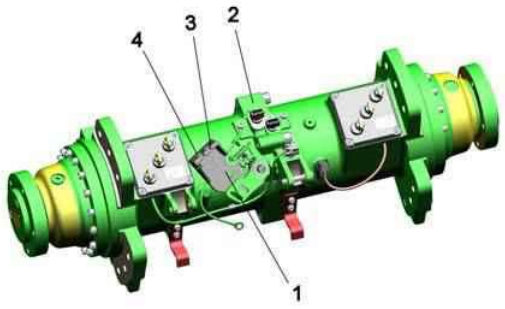
– Check the traction drive for correct operation

Service brake AE18-05

Function

The wet-running multi-disc brake (2) is positioned centrally between the traction motors.

The joint brake control (1) of the parking brake (4) and the service brake (3) is located on top of the left traction motor.



Disc pack AE18-05

The disc pack consists of two brake discs that are separated by discs.

The shim rings necessary to set the clearance of the brake are located between the pressure plate and the first disc.

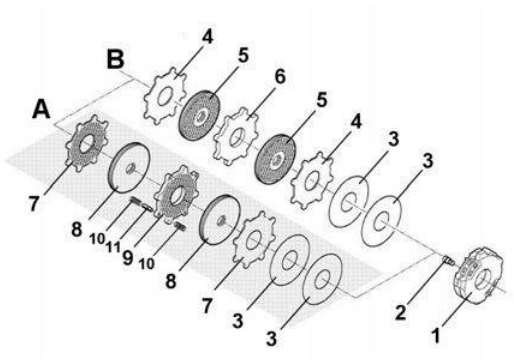
There are two variations of the armature stack.

Variant A has been in series production since August 2005:

- Two outer laminas with sintered brake lining on one side (7)
- A middle lamina with sintered brake lining on both sides (9)
- Two brake discs without brake lining (8)
- Compression springs (10) ensure that there is an equal distance between the discs when the brake is not actuated

Variant B was in series production until August 2005 and was replaced by variant A:

- Two thin laminas without brake lining (4)
- One thick lamina without brake lining (6)
- Two brake discs with sintered brake lining on both sides (5)
- No compression springs



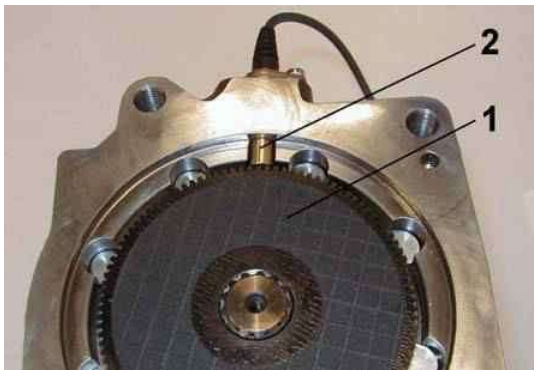
Variation A

1	Pressure plate
2	Fit bolt
3	Shim ring
7	Lamina, one-sided brake lining
8	Brake disc
9	Lamina, double-sided brake lining
10	Compression spring
11	Guide pin

Variation B

1	Pressure plate
2	Fit bolt
3	Shim ring
4	Lamina (thin)
5	Brake disc
6	Lamina (thick)

The brake discs have gearing on the facing side (1) and serve as the trigger wheel for the rev sensors (2) of the traction motors.



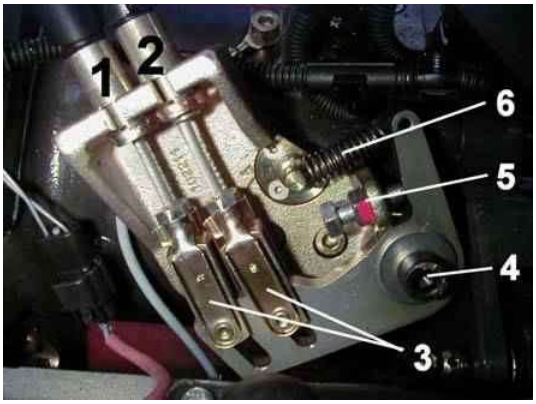
Brake actuator AE18-05

In the brake control, the brake cables are connected to the service brake (2) and the parking brake (1) using ES bolts (3).

The pressure plate of the brake is actuated via an eccentric (4) and the discs and brake discs are pressed together.

The return spring (6) returns the brake control to its initial position when the brake is not actuated. In this case, the lever must rest on the adjustment screw (5).

The adjusting screw of the actuation unit must not be adjusted.



1 Parking brake
2 Service brake
3 ES bolts
4 Eccentric
5 Setscrew
6 Return spring

Removing/installing the service brake

Removal

NOTE

- *Removal of the individual units is described in detail in the corresponding chapters.*
- *The pump motor can remain in the truck during removal of the drive axle.*
- *Discharge the gear lubricant oil at an early stage so that the oil has time to drain off.*

– Park the vehicle safely.

– Apply the parking brake.

– Draining the gear lubricant oil

– Disconnect battery plug.

– Release the drive wheel ball-seat nuts, but do not unscrew completely

– Remove the lift mast, see chapter "Lift mast - installation / removal"

– Jack up the front of the truck, see chapter "Safety instructions"

– Remove ball-seat nuts, remove drive wheels

– Remove the drive axle; see the chapter entitled "Removing/installing the drive axle"

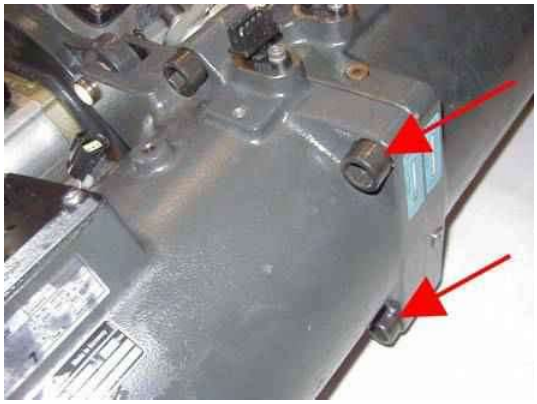
– Retain and reuse the support bearings' spring elements

⚠ WARNING

Once the connecting screws have been removed, the drive axle splits into two parts.

Prevent the halves of the axles from rolling away

– To separate the traction motors, release the four M16 connecting screws ▷



NOTE

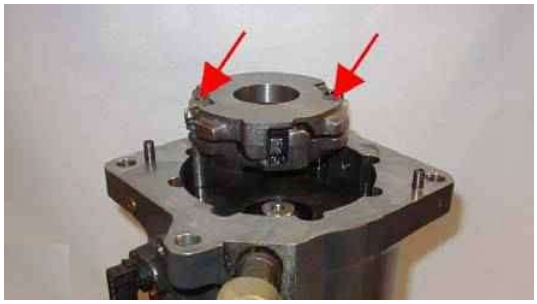
Screw the lower mast bearing screw on the right-hand side back in again to act as a torque damper when releasing the connecting screws.

– The brake discs and laminas of the right and left halves of the axle are exposed and can be removed

– On the left half of the axle, release the two cylinder screws on the brake control and remove the brake control ▷



– Release the two cylinder screws on the pressure plate and remove the pressure plate ▷



Setting the clearance

The clearance must be checked after the following operations:

- Installation of new brake spare parts
  - Brake discs
  - Discs
  - Thrust piece
- Installation of a new traction motor

The clearance is set using the shim ring. The clearance and the shim ring depth can be determined as follows:

– Measure the depth on both clean, empty traction motor housings using a slide gauge or a depth gauge

– To establish the depth of the left half of the axle, two measurements are required: **measurement A_1** and **measurement A_2**



– Adding both measurements from the left half of the axle gives **measurement A**

$A_1 + A_2 = A$

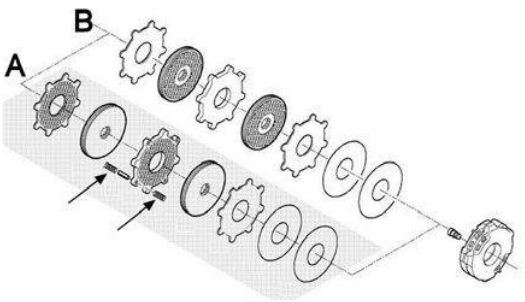
– The depth of the right half of the axle gives **measurement B**

– To establish the total depth of both halves of the axle, add both measurements together

A + B = C



– Pile up the complete armature stack and weigh down with approx. 6 kg



NOTE

For measuring the variation A armature stack, pile them up without springs.

– The height of the loaded armature stack measured with the sliding gauge gives **measurement D**

From these measurements, it is possible to determine the shim ring depth:

C – D – clearance $0.8^{+0.2}$ = shim ring depth

Installation

NOTE

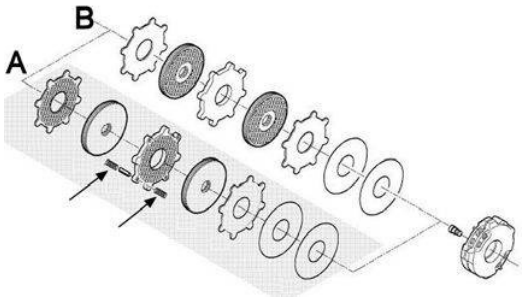
- *Installation of the individual assemblies is described in detail in the corresponding chapters.*
- *Check tightening torques and screw quality.*
- *Check gear lubricant oil and brake oil quality*
- *For values, see "General technical data" in the chapter entitled "Drive axle"*

– Mounting the pressure plate

– Screw the brake control onto the left half of the axle using two cylinder screws ▷



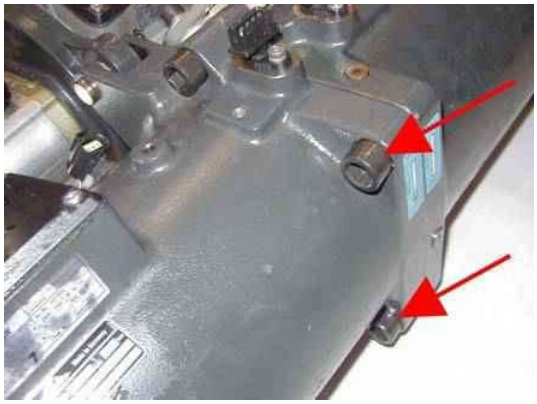
– Mount the brake discs and laminas, checking the variation and sequence ▷



NOTE

Mount armature stack variation A with springs.

– Insert the O-ring between both halves of the axle
– Join the halves of the axle in such a way that the guide pins slot into the guide holes
– Tighten the four connecting screws ▷
– Place the spring elements on the support bearings
– Install the drive axle
– Fill both drive wheels with gear lubricant oil
– Fill the multi-disc brake with brake oil
– Attach the wheels
– Attach the lift mast
– Lower the truck.
– Connect the battery plug
– Check the service brake and traction drive for correct operation



Drive axle AE18-07

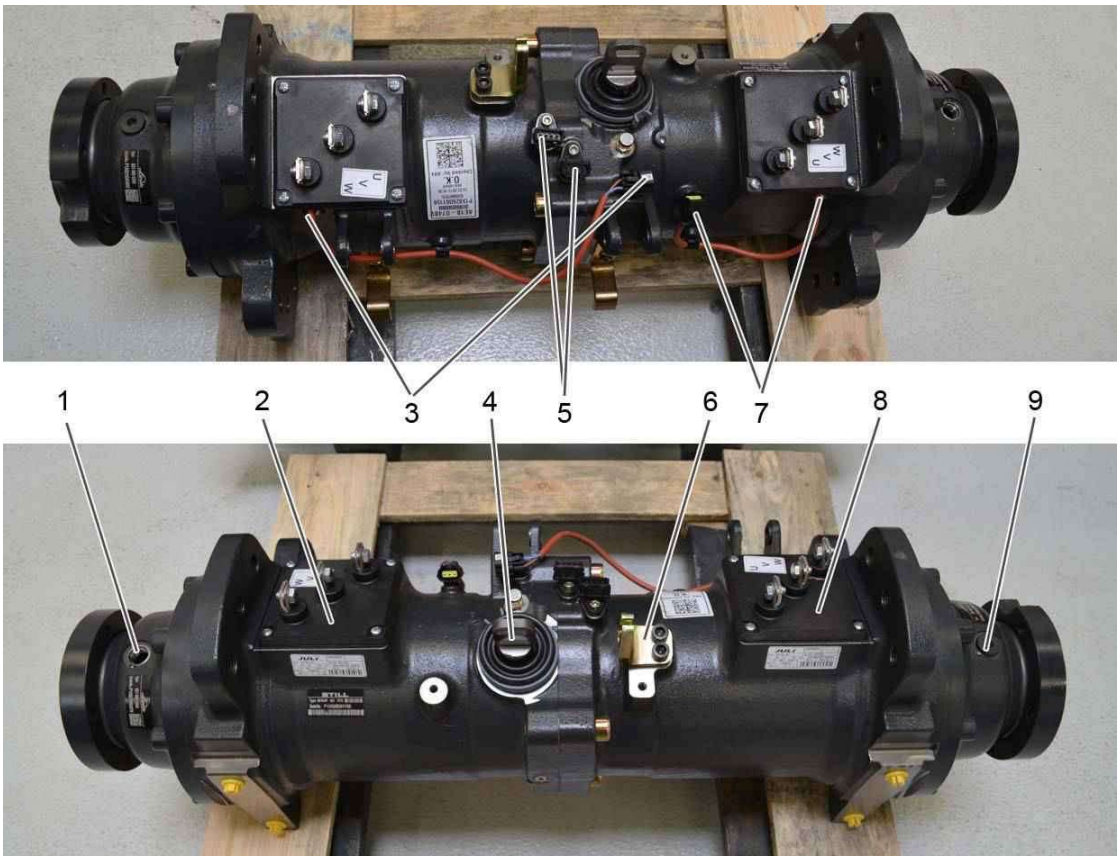
General technical data

Drive axle		6209 - 6217	6311, 6313, 6315
Designation		AE18 - 07	
Manufacturer		Linde, Juli	
Total weight	[kg]	170.5	
Permissible axle load	[kg]	4870	
Axle load for track width of 990 mm	[kg]	5430	
Maximum speed	[km/h]	16	20
Tyres (alternative)		18 x 7-8 (200/50–10)	
Dynamic tyre radius	[mm]	211 (229)	
Track width	[mm]	990 (942)	
Driving torque	[Nm]	2200	3100
Maximum wheel speed	[rpm]	201	251
Gear ratio		20.8	
Oil content per gearbox	[l]	0.3	
Gearbox oil		SAE 80W-90 API-GL4	
Oil change interval		Once at 1000 hours, then every 3000 hours	

Brake		6209 - 6217	6311, 6313, 6315
Static braking torque	[Nm]	4500	
With force F1	[N]	2270	
Dynamic braking torque	[Nm]	According to characteristic curve	
With force F2	[N]	According to characteristic curve	
Oil content	[l]	0.2	
Brake oil		Shell Spirax S4 ATF HDX	
Oil change interval			

Tightening torques and connecting elements			
Wheel nuts, per wheel	[Nm]	210	5 x spherical collar bolts
Screw joint between drive axle and chassis, per side	[Nm]	385	6 x hexagon head screw M20 x 40-8.8, DIN 933
Screw joint in traction motors, central	[Nm]	275	4 x socket head screw M16 x 60-10.9, DIN 912
Screw joint in drive wheel unit, per side	[Nm]	275	7 x socket head screw M16 x 50-10.9, DIN 912
Slotted nut on drive wheel unit	[Nm]	650^{20}	
Oil filler on drive wheel unit	[Nm]	70	M18 x 1.5
Oil drain on drive wheel unit	[Nm]	20	M10 x 1
Oil level check on drive wheel unit	[Nm]	20	M10 x 1
Oil filler on service brake	[Nm]	20	M10 x 1
Oil drain on service brake	[Nm]	20	M10 x 1
Oil level check on service brake	[Nm]	20	M10 x 1
Mast bearing, on each side	[Nm]	275	1 x screw M16 x 45, ISO 4017 1 x screw M16 x 110-10.9 A2C, ISO 4017 2 x lock washers

Drive axle AE18-07



1	Right drive wheel unit	6	Counter bearing
2	Right traction motor	7	Temperature sensor X11
3	Temperature sensor X13	8	Left traction motor
4	Brake actuator	9	Left drive wheel unit
5	Speed sensors		

NOTE

The images of the drive axle differ somewhat from the installed component in the truck! The deviations in the images only relate to the external contours. The technical descriptions correspond precisely to the installed component.

The drive axle consists of the two traction motors (2) and (8) (three-phase AC asynchronous motors) with the flange-mounted two-stage drive wheel units (1) and (9).

Between the traction motors, there is an integrated multi-disc brake that serves as the service brake and parking brake.

The two traction motors are connected to the output modules via the terminal boards. The speed and direction of rotation of the traction motors is reported back to the power module by a speed sensor on each electric motor. Two

temperature sensors (3) and (7) monitor the temperature in the coil ends.

Drive direction

In the drive direction of the axle, the traction motor connecting boxes are facing upwards. The right traction motor contains the actuating lever of the brake.

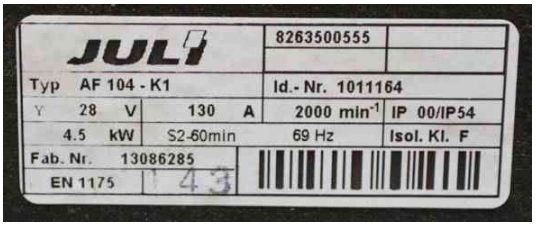
Axle identification plates

The identification plate for the axle is located on the front of the right traction motor.



Traction motor identification plate

The identification plate for the traction motors is located on the respective connection box.



Removing the drive wheel unit

- Park the truck safely on level ground.
- Apply the parking brake.
- Disconnect the battery male connector.
- Loosen the wheel bolts; do not unscrew them completely.
- Jack up the front of the truck; see the chapter entitled "Safety information".
- Release the parking brake.
- Remove the wheel bolts and remove the wheel.

NOTE

Secure the drive axle not mounted in the truck with a suitable device to prevent it from turning.

- Place a suitable collection container (> 1 l) under the oil drain opening.
- Unscrew the oil filler plug and oil drain plug.

ENVIRONMENT NOTE

Dispose of drained oil in accordance with regulations.

- Loosen and unscrew 7 screws from the drive wheel unit. The upper screw acts as a guide; do not unscrew it completely.
- Remove the two plugs from the threaded holes located opposite.
- Screw 2 M14 screws (e. g. screws from the drive wheel unit) into the threads. This will separate the drive wheel unit from the motor housing.
- Pull the drive wheel unit out of the motor housing.



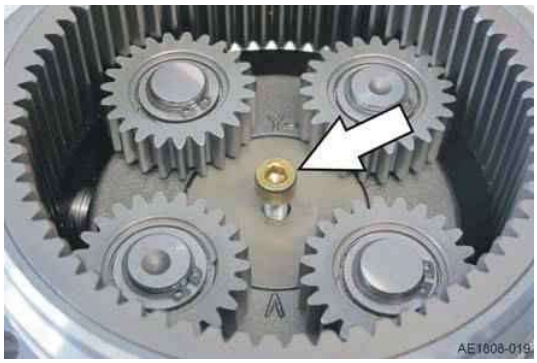
Changing the shaft seal on the drive wheel unit

Disassembling the planetary transmission

- Lift the first planetary gear set out of the annular gear.



- Loosen and unscrew the mounting screw from the second planetary gear set.



– Pull the second planetary gear set out of the housing.



– Secure the drive wheel unit on a suitable fixture.
– Warm the slotted nut to release the Loctite.

⚠ WARNING

The hot slotted nut can cause burns.
Wear suitable protective gloves.



– Loosen the slotted nut using a slotted nut spanner and torque multiplier.
– Remove the slotted nut.



– Support the drive wheel unit in order to press the wheel shaft out downwards.
– Press out the wheel shaft.



– Drill a hole in the shaft seal, cut the thread and then pull it out using ejector rod WM109.



Assembling the planetary transmission

– Coat the inside of the new shaft seal between the sealing lip and the dust lip with lithium soap grease. Fill the space to a maximum of 50%.

NOTE

The grease must not be added to the spring chamber.

– Position the shaft seal on insertion tool WM455.
– Apply Loctite 243 to the outside of the shaft seal.



– Position the shaft seal on the wheel shaft with insertion tool WM455.
– Attach insertion tool WM455 to the wheel shaft using three wheel screws.



NOTE

The shaft seal is fitted in the wheel shaft by tightening the wheel screws. Tighten the wheel screws alternately to prevent the shaft seal from canting.

– Remove the wheel screws and insertion tool from the wheel shaft.
– Remove Loctite residues from the slotted nut and the thread of the wheel shaft. Use brake cleaner if necessary.
– Position the drive wheel unit on the wheel shaft.
– Insert the spacer ring.
– Insert the tapered roller bearing.
– Coat the thread of the slotted nut with Loctite 270. Screw in the slotted nut and tighten by hand.



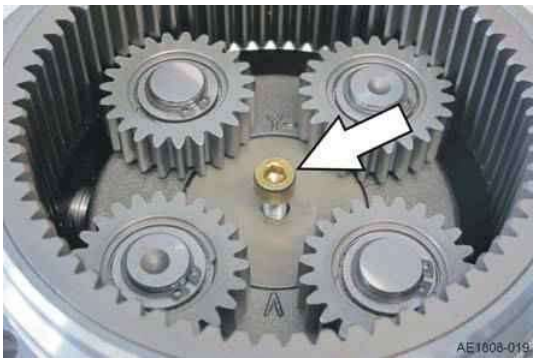
– Secure the drive wheel unit on a suitable fixture and tighten the slotted nut using the slotted nut spanner and torque multiplier to a tightening torque of 650 $^{+20}$ Nm.
– Turn the drive wheel unit by 10 revolutions and retighten the slotted nut to a tightening torque of 650 $^{+20}$ Nm.



– Insert the second planetary gear set.



– Coat the second planetary gear set mounting screw with Loctite 270; screw in and tighten the mounting screw to a tightening torque of 23 Nm.



– Insert the first planetary gear set into the housing.



Refitting the drive wheel unit

NOTE

- *Observe tightening torques and screw qualities*
- *Observe gearbox oil quality and quantities*
- *See "general technical data" for values.*

– Oil and fit a new O-ring (1).

– Attach the drive wheel unit with filler plug (2) facing upwards and screw in the 7 mounting screws (3) on the drive wheel unit.

– Tighten the mounting screws crosswise.

– See the section on "Filling with oil" for instructions on filling with gearbox oil.

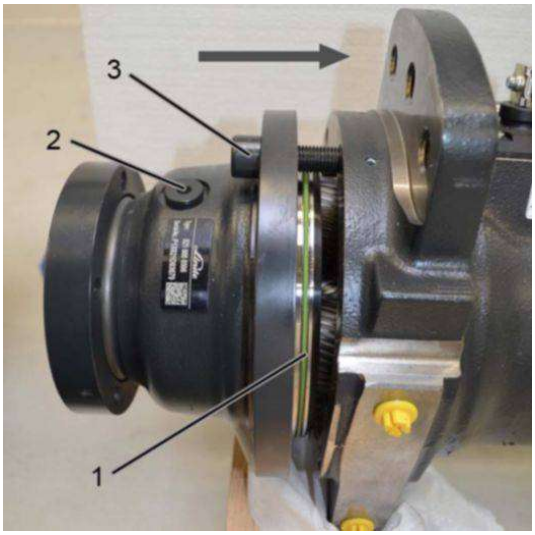
– Attach the wheel and tighten the wheel bolts

– Lower the truck.

– Check tightening torques

– Connect the battery male connector

– Perform a function check.



Traction motor - Removing the rotor

The drive axle can remain in place when extracting the rotor from the traction motor. When replacing the rear shaft seal, it is easier to remove the drive axle completely.

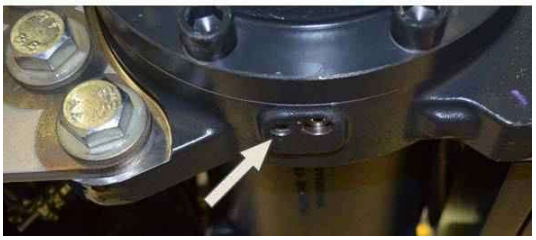
When the rotor is pulled out, brake oil runs into the traction motor. You must therefore either completely drain the brake oil beforehand, place the drive axle on a slight slope or jack up the truck on one side. A height difference of 5...10 cm is sufficient.

– Drain the gearbox oil; drain the brake oil if necessary.

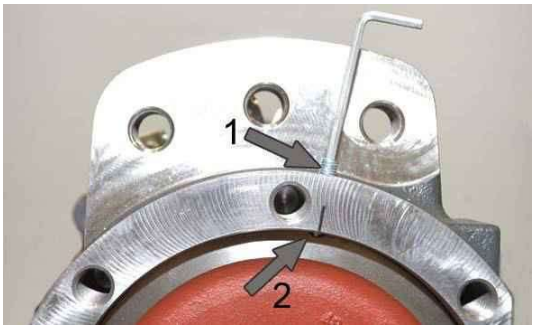
– Remove the drive wheel unit, see the chapter entitled "Removing the drive wheel unit".

– The locking screws of the rotor are positioned opposite one another and are accessible even in the installed position.
– In order to access the M8x16 locking screws (2) underneath, the threaded pins M8x8 (1) must be removed. The screws are positioned opposite one another (180°).

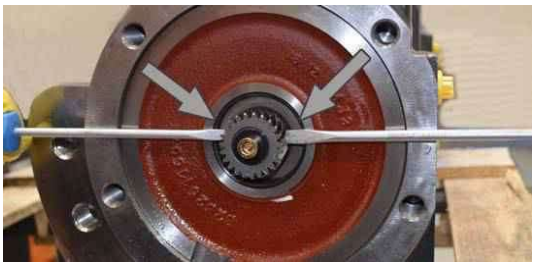




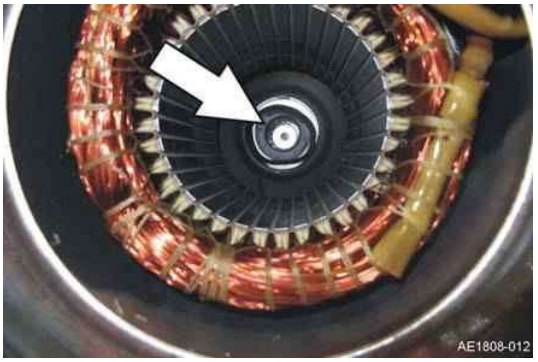
– For the bearing shield installation, mark the position of the rotation lock on the motor housing. (may differ from the illustration)
– Turn the locking screws (2) back into the housing.



– Slide 2 screwdrivers (≥ 1.2 x 8 mm) behind the pinion and carefully extract the rotor.



– Remove the washer and 2 shaft washers from the motor housing.



– If necessary, unscrew the pinion gear from the rotor shaft (M8x20), so that the rotor can be placed upright for any subsequent work.



Traction motor - Replacing the bearing and shaft seal

Disassembly

– Pull the rear bearing out of the rotor shaft using a 2-claw extractor.

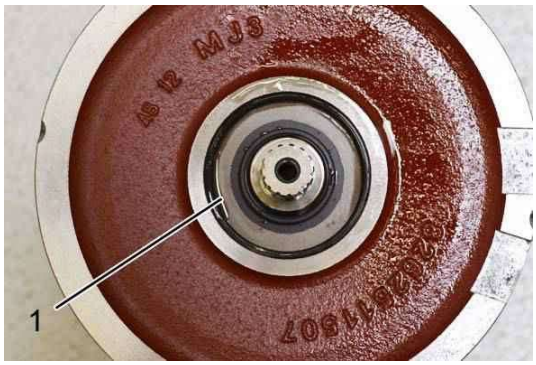


NOTE

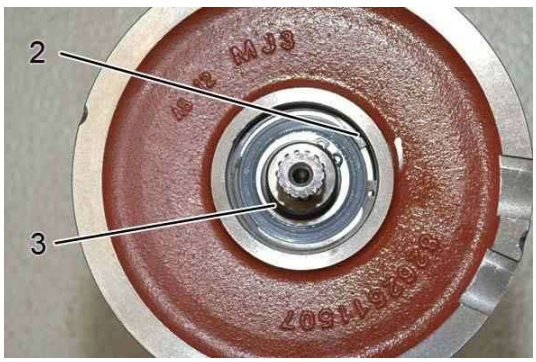
The bearing will be damaged as it is pulled out over the outer ring. Use a new bearing.

– Remove the shaft seal (1) from the bearing flange. Use a screwdriver to lever out the shaft seal or cut a thread in the shaft seal and then pull it out.

– If necessary, remove the drilling chips.



– Remove the inner retaining ring (3) and outer retaining ring (2).



– Pull the rotor shaft out from the bearing flange or press it out. ▷



– Knock the front bearing out of the bearing flange. ▷



NOTE

The bearing will be damaged as it is knocked out over the inner ring. Use a new bearing.

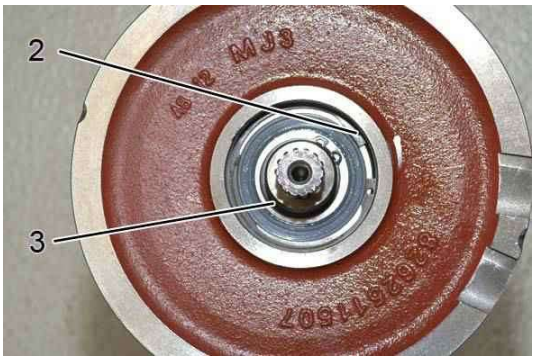
Assembly

– Press the new bearing into the bearing flange. Press the bearing in over the bearing outer ring, otherwise the bearing will be damaged. ▷

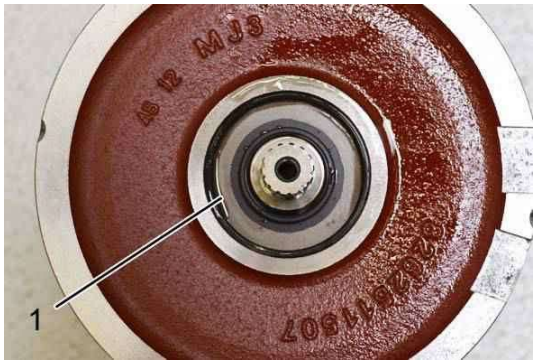


– Position the bearing flange with the bearing on the rotor shaft and press on the bearing using assembly sleeve WM451. Press the bearing in over the bearing inner ring, otherwise the bearing will be damaged.

– Fit the inner retaining ring (3) and outer retaining ring (2). ▷



– Wet the surface of the shaft with brake oil. Press the new shaft seal (1) into the bearing flange.

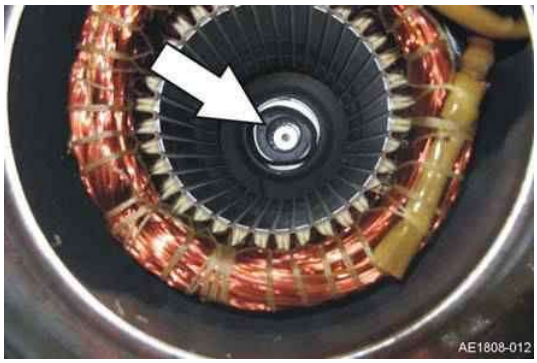


– Press on the front bearing using assembly sleeve WM451. Press the bearing in over the bearing inner ring, otherwise the bearing will be damaged.



Traction motor - Installing the rotor

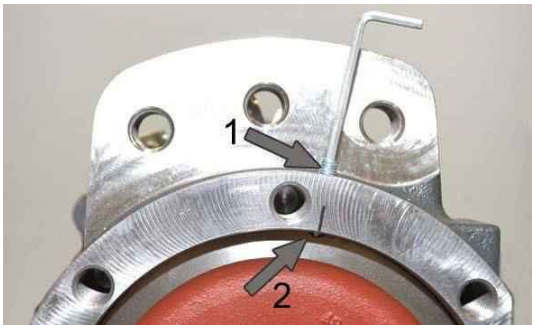
– First, insert the washer and then the shaft washers (2 pieces) into the motor housing.
– For the bearing shield installation, mark the position of the rotation lock on the motor housing.



– Insert a new seal on the bearing flange. Insert the rotor into the motor housing.



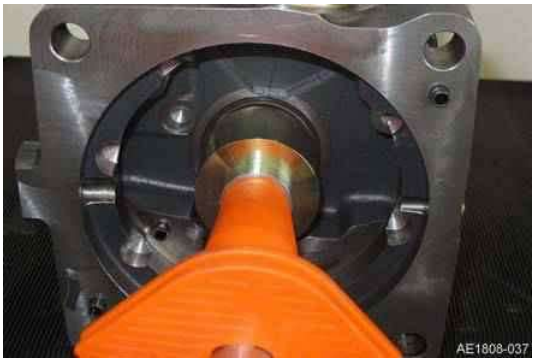
– Place the bearing flange on the axle casing in such a way that the position of the rotation lock aligns with the notch on the bearing flange. (may differ from the illustration)
– Push the bearing flange into the housing.
– Screw in the M8x16 threaded pin (2) (rotation lock) and tighten.
– Screw in the M8x8 threaded pin (1) (cover) and tighten.



NOTE

Fully screw in the M8x16 threaded pin(2). This prevents the bearing shield from turning.

– Wet the surface of the shaft with brake oil.
– Install the shaft seal with handle WM170 and universal sleeve WM449.
– If necessary, screw the pinion onto the rotor shaft (M8x20).
– See the section on "Refitting the drive wheel unit" for information on refitting the drive wheel unit.



Service brake AE18-07

Function

The wet-running multi-disc brake is positioned centrally between the traction motors.

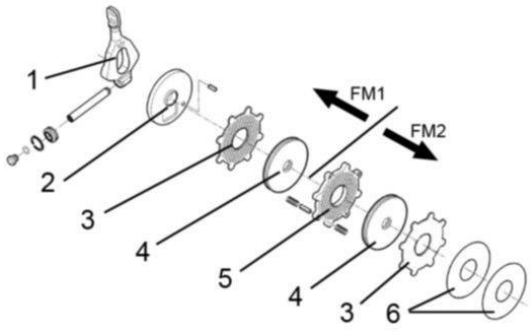
The brake actuator shared by the service brake and handbrake is located on top of the traction motor housing.



Disc pack AE18-07

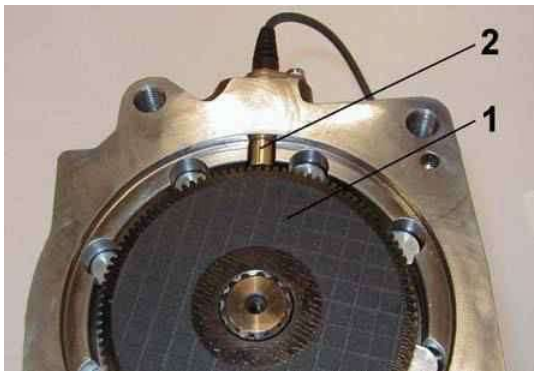
The disc pack consists of two brake discs that are separated by discs.

The shim rings are used to adjust the brake clearance.



1 Brake actuator
2 Pressure plate
3 Disc, one-sided brake lining
4 Brake disc
5 Disc, double-sided brake lining
6 Shim ring

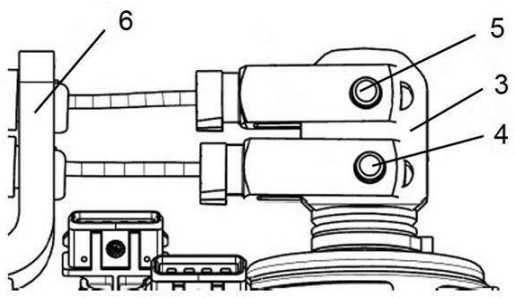
The brake discs have gearing on the facing side (1) and serve as the trigger wheel for the rev sensors (2) of the traction motors.



Brake actuator AE18-07

The brake cables of the service brake (4) and handbrake (5) are attached in the abutment (6) and secured with locking plates.

The brake cables in the brake lever (3) are attached and secured using s-bolts.



3 Brake lever
4 Service brake
5 Handbrake
6 Abutment

Dismantling the brake

The entire drive axle must be removed from the truck in order to carry out this repair.

Draining the oil

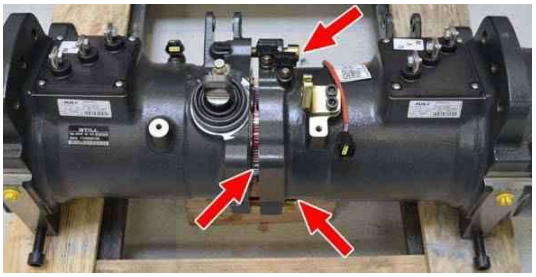
– Place a suitable collection container (> 0.5 l) under the oil drain opening.
– Unscrew the oil drain plug.

ENVIRONMENT NOTE

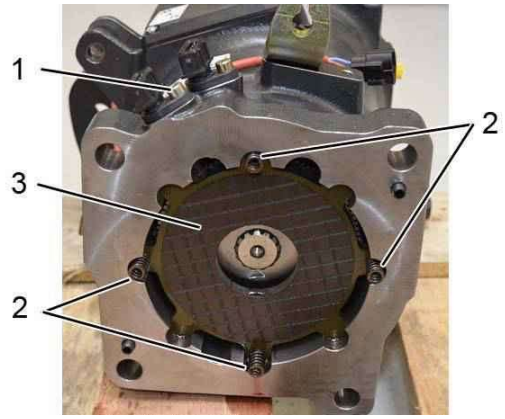
Dispose of drained oil in accordance with regulations.

Disconnecting the traction motors

– Secure the axle to prevent it from turning and loosen and unscrew the 4 screws.
– Remove plug X13 on the left side of the housing.
– Loosen and pull apart the housing halves with a suitable tool.
– 2 brake discs fall out immediately.
– Remove any remaining brake oil.

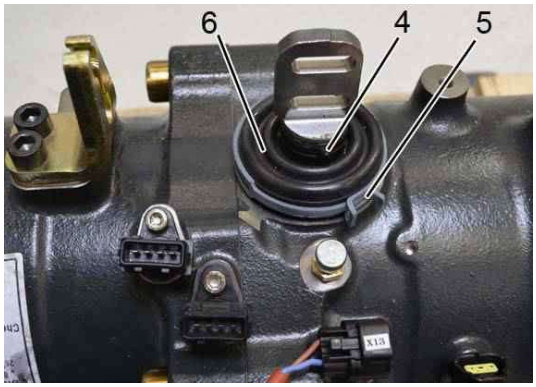


– The rev sensor (1) can remain in the axle.
– Remove the pressure plate (3) and two further brake discs. Place the compression springs (2) to one side.

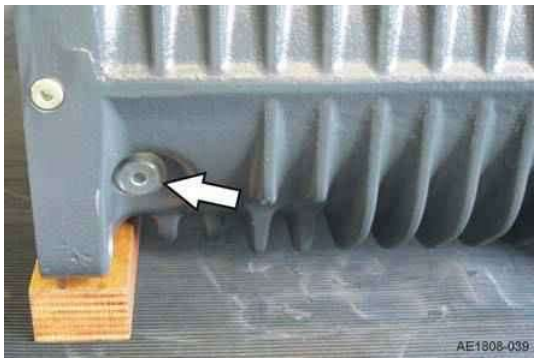


Removing the brake lever

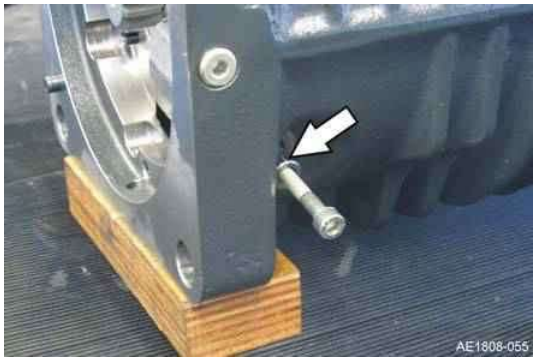
– Remove the retaining ring (4) using the installation tool.
– Carefully remove the cable tie (5). Do not damage the dust protection cover in the process; replace it if necessary.
– Remove the dust protection cover (6).



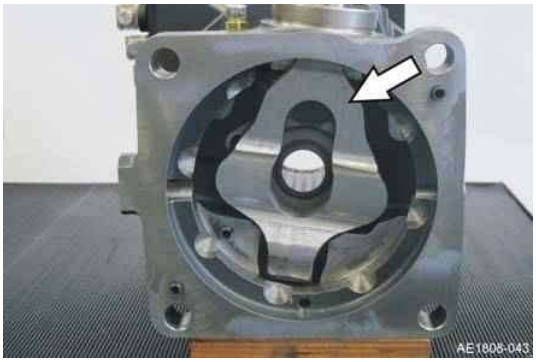
– Loosen and remove the screw plug.



– Pull out the brake lever axle with a M6x80 screw. If necessary, use ejector rod WM109.



– Remove the brake lever. ▷



– Take out the shaft seal. ▷



Assembling the brake

NOTE

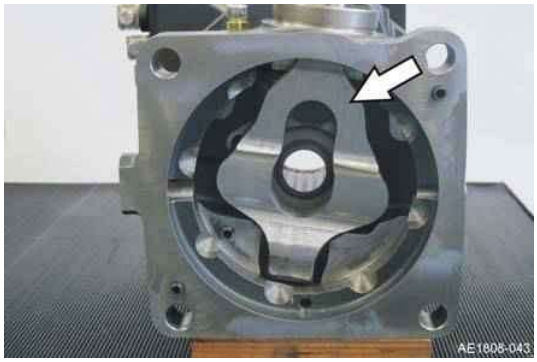
- *Observe tightening torques and screw qualities*
- *Observe gearbox oil quality and quantities*
- *See "general technical data" for values.*

Installing the brake lever

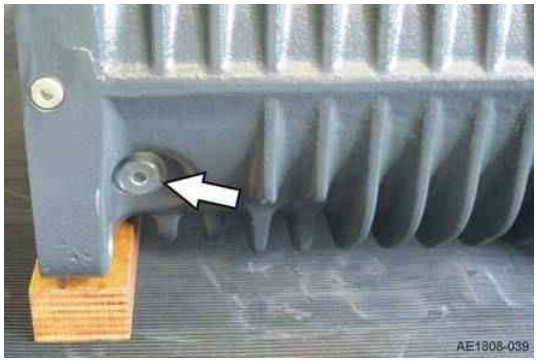
– Insert the shaft seal. ▷



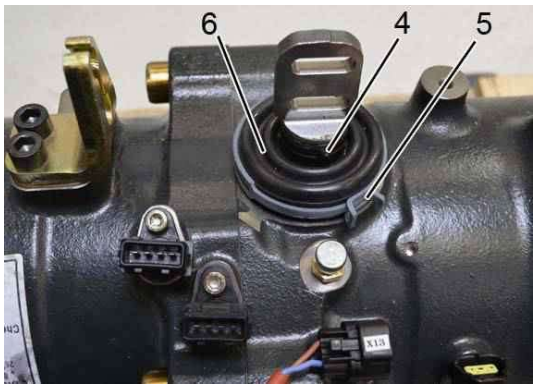
– Install the brake lever.



– Screw in and tighten the screw plug.



– Check the dust protection cover (6) for damage and replace it if necessary.
– Secure the dust protection cover using retaining ring (5) and cable tie (5).



Inspecting the brake lift play

When replacing the brake discs, the brake lift play must be inspected and, if necessary, adjusted.

– Place the right traction motor upright.

– Insert the pressure plate into the right traction motor. Make sure that the guide pin engages in the bore.
– Remove the compression springs from the middle brake disc support.
– Insert the brake package into the traction motor in the correct order.



– Load the brake package with a weight of 6 kg.
– Determine the height of the brake package above the housing edge.



– Determine the depth of the brake chamber in the left traction motor housing.

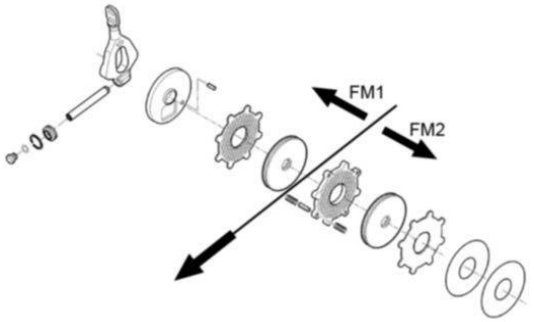
The difference between the depth and height measurements can be max. $0.8^{+0.2}$ mm.

– If necessary, insert shim rings on the left.

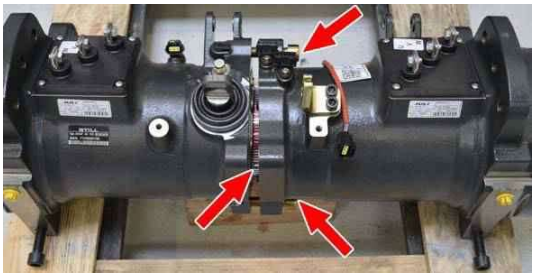


Assembling the traction motors

– Attach the compression springs to the brake disc support.
– Insert the pressure plate into the right traction motor. Make sure that the guide pin engages in the bore.
– Insert the brake package into the traction motor in the order shown. Ensure that all compression springs are positioned and aligned correctly. If necessary, secure the brake package with a suitable cord or wire to prevent it falling out.
– Oil the new O-ring and insert into the right traction motor housing.



– Position the traction motors opposite one another. Use suitable devices to align.
– Screw the traction motors together with four screws. Tighten the screws crosswise.
– Insert the speed sensor. Insert the screw and tighten to a tightening torque of 9.5 Nm.



Checking the oil level, changing the oil

NOTE

- *Observe tightening torques and screw qualities*
- *Observe oil quality and quantities of oil*
- *For the values, see the chapter entitled "General technical data"*
- *Do not reuse drained gearbox oil and brake oil. Dispose of oil in an environmentally friendly manner*

Changing the gearbox oil

– Warm up the drive wheel unit

– Park the truck so that the drive axle is horizontal

– Switch off the truck

– Remove the drive wheel

– Clean the area around the oil filler plug, the checking screw and the oil drain plug

– Place a suitable container beneath the wheel gear

– Unscrew the oil filler plug (1) from the drive wheel unit

– Unscrew the oil drain plug (2) from the drive wheel unit

– Collect the gearbox oil in the container

– Clean, screw in and tighten the oil drain plug

⚠ CAUTION

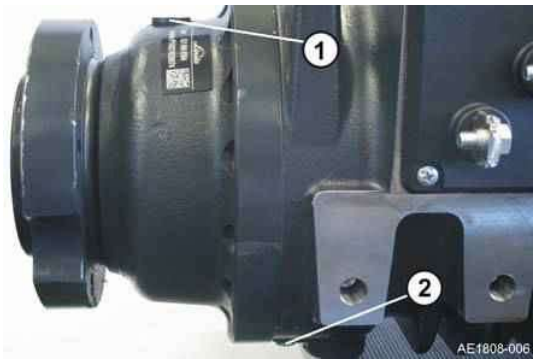
If the oil volume is too great, it can damage the shaft seal of the rotor shaft.

Pay close attention to the exact oil volumes on the left-hand and right-hand side.

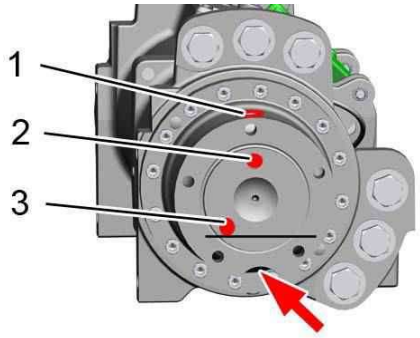
– Unscrew the checking screw (3)

– Turn the wheel so that one of the two inspection openings is at 12 o'clock (2). The other inspection opening (3) is then automatically at the height of the maximum oil level

– Measure the gearbox oil into a measuring cup



– Add the gearbox oil via the oil filling opening (1) until the oil flows out of the inspection opening ▷



NOTE

- *The oil level check must be performed when the truck is on level ground*
- *When filling, always undo the upper checking screw (2) so that air can escape*

– Screw in and tighten the oil filler plug (1).

– Clean, screw in and tighten the oil filler plug and the checking screw

– Fit the drive wheel

Checking the oil level

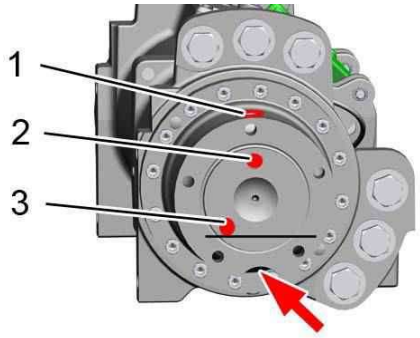
NOTE

Before checking the oil level, the truck must be switched off and left for approximately five minutes so that the gearbox oil can drain out of the planet gears.

– Switch off the truck Wait for approximately five minutes

– Remove the drive wheel

– Unscrew the checking screw (2) ▷



The oil level must reach the thread of the checking screw opening.

– Top up the gearbox oil if necessary

NOTE

Drain any excess oil into a collection container via the checking screw.

– Check the oil level again

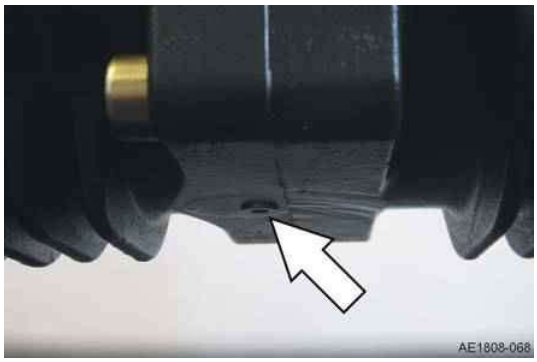
– Clean, screw in and tighten the oil filler plug

– Clean, screw in and tighten the checking screw

– Fit the drive wheel

Filling with brake oil

– Screw in the drain plug with magnetic plug and tighten. ▷



– Push back the dust protection cover. ▷

⚠ CAUTION

If the oil filling quantity is too great, it can damage the shaft seal of the rotor shaft.

Make sure you use the exact oil filling quantity for the brake.

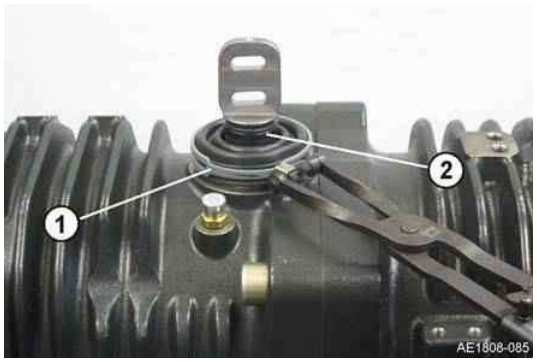


– Measure out the brake oil into a measuring cup and pour in through the brake lever opening.

– Move the cover back so it is correctly seated.

– Assemble the retaining ring (1) using the installation tool. Note the position. Check that it is correctly seated. ▷

– Assemble the cable tie (2). Check that it is correctly seated.



Chassis

Battery door

Removal

– Apply parking brake

– Battery door open

– Separate lock, loosen nut and remove screw ▷



⚠ WARNING

The lever by the frame is under spring tension. It shoots towards the frame when released. Fingers can get caught!

Firmly grip the lever with the fingers when separating the lock.

– Place jack under the battery door ▷

– Using the jack slowly lift the battery door and unhook

– Place battery door on available pallet



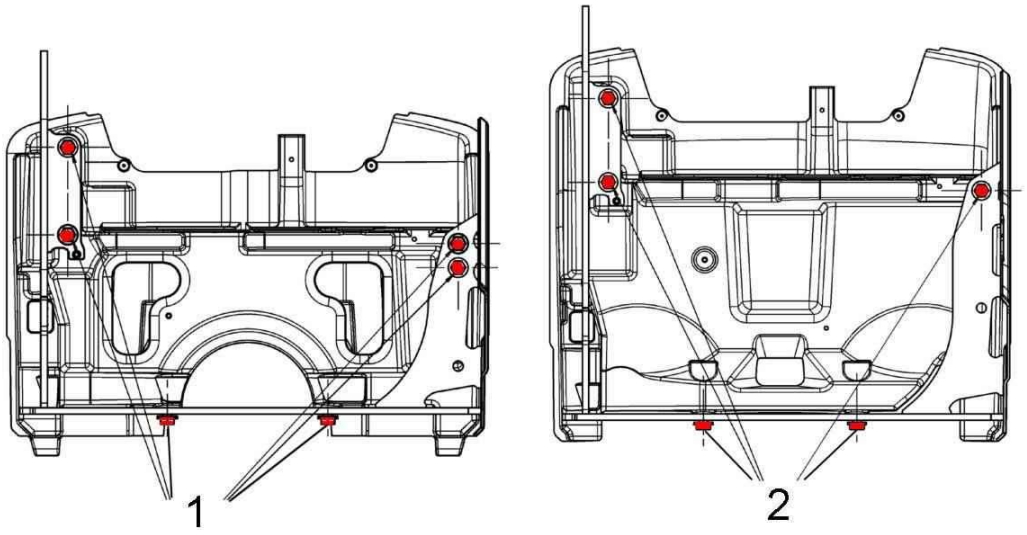
Installation

– Hook on battery door

– Connect lock

Counterweight

Counterweight



The counterweight is a massive cast component that differs according to type carrier, dependent on the load-bearing capacity, chassis and steering axle.

The counterweight is attached to the chassis with mounting screws. The number, arrangement and tightening torques of the mounting screws are dependent on the type carrier, see the table.

Mounting element:

- Hexagon head screw
  M20x70-10.9-A2C, ISO 4017
- Washer
  20-FST-A2C, DIN 6796

Type carrier	Chassis	Mounting screws		
		Position	Number of pieces	Tightening torque
6214, 6217 6311 - 6315	Low	1	6	540 Nm
6210 - 6213 6215 - 6316	High	2	5	540 Nm

Overhead guard

Overhead guard

Construction - truck design

The overhead guard is an independent unit that is connected to the chassis and the counterweight via three bearings.

At the front, the overhead guard is supported on the chassis on two bearings (1, 2), and at the rear it is supported in the counterweight on one bearing (3) on the bearing flange (4).

Depending on the truck type and chassis height, the bearing flange (4) is either an individual part or a component of the counterweight.

The bearings consist of spring elements that protect the overhead guard against vibrations.

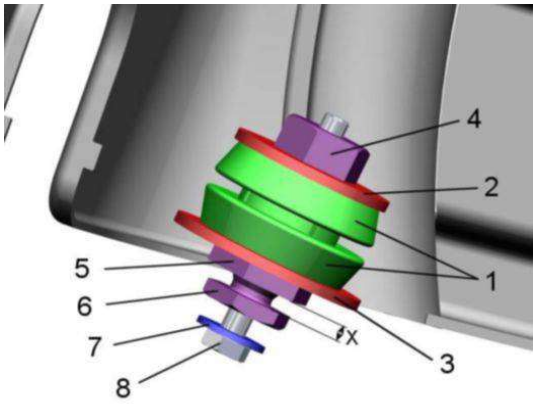


1 Right-hand overhead guard bearing
2 Left-hand overhead guard bearing
3 Rear overhead guard bearing
4 Bearing flange

Front overhead guard bearings

The front bearings consist of two spring elements (1) that are connected via washers and threaded bushes.

- Assemble the spring elements at a 90° rotation to each other.
- The spring elements in the overhead guard are pre-loaded with the threaded bushes (4, 5).
- Twisting the threaded bush (6) changes the size of the gap between the overhead guard and the chassis, as well as the gap between the overhead guard and the trademark emblem. The bearings should be pre-assembled with a setting dimension (X).



1 Spring element
2 Washer
3 Washer
4 Threaded bush
5 Threaded bush
6 Threaded bush
7 Lock washer
8 Tighten the screw
X Setting standard

Position			Values
1, 4, 5	Pre-load of the spring elements	Threaded bushes	100 Nm
7, 8	Connection between overhead guard and chassis	Hexagon head screw M10 x 90, 8.8 Lock washer	46 Nm
6	Gap, setting dimension X	Threaded bush	6 mm

Front overhead guard bearings

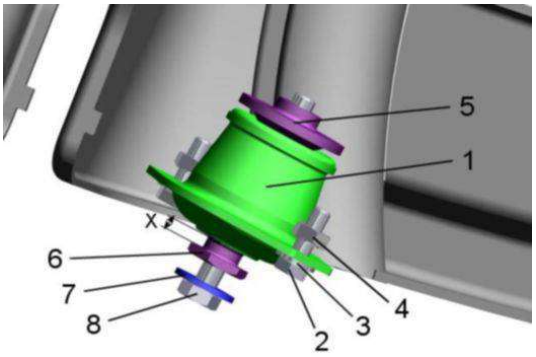
NOTE

This bearing was fitted until April 2007.

- *Only type carriers 6210 - 6217, 6311, 6313, 6315*

The front bearings (1) are pre-assembled units with a built-in spring element. The bearings are connected to the overhead guard via two screws (2-4).

Twisting the threaded bush (6) changes the size of the gap between the overhead guard and the chassis, as well as the gap between the overhead guard and the trademark emblem. The bearings should be pre-assembled with a setting dimension (X).



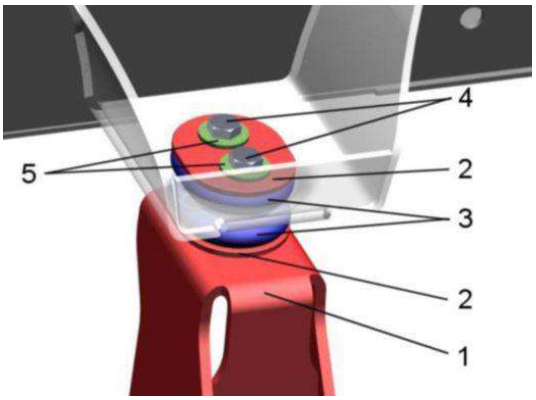
1 Bearing
2 Undo fixing screws
3 Washer
4 Nut
5 Knurled nut
6 Threaded bush
7 Lock washer
8 Tighten the screw
X Setting standard

Position			Values
7, 8	Connection between overhead guard and chassis	Hexagon head screw M10 x 90, 8.8 Lock washer	46 Nm
6	Gap, setting dimension X	Threaded bush	6 mm

Rear overhead guard bearing

The rear bearing consists of two spring elements (3) that are loosely connected by bushes.

Above and below the spring elements there are spacer washers (2). The spring elements are pre-loaded by the overhead guard screws (4).



1 Bearing flange
2 Spacing washer
3 Spring element
4 Tighten the screw
5 Lock washer

Position			Values
7, 8	Connection between overhead guard and chassis	Hexagon head screw M10 x 65, 8.8 Lock washer	46 Nm

Removing the overhead guard

Preparation

Removal of the overhead guard varies according to truck type and equipment version.

Significant differences are indicated in the removal instructions.

For trucks with cabs:

- Completely remove the cab doors and side parts
- Remove the roof window
- Remove the heater

Removal

– Tilt the lift mast fully forward

– Removing the battery

Only for high chassis:

– The drive wheels do not need to be disassembled, as overhead guard bearings can be accessed freely

– Prevent the truck from rolling away using chocks

– Remove the panelling between the chassis and the overhead guard at the front right and left

Only for low chassis:

– The drive wheels must be disassembled, as overhead guard bearings **cannot** be accessed freely

– Release ball-seat nuts

– Jack up the front of the truck; see the chapter entitled "Safety instructions". The drive wheels should only be a few millimetres above the ground

– Remove ball-seat nuts and take out the drive wheels

The following procedure applies to all chassis:

– Remove floor plate.

– Release parking brake

– Remove trademark emblem, loosening the left and right side screws but not unscrewing them completely

– **Variation:** Disconnect plug X57 from the light strip

– Remove the covering of the electronics

– Detach the electrical connection between the overhead guard and the counterweight

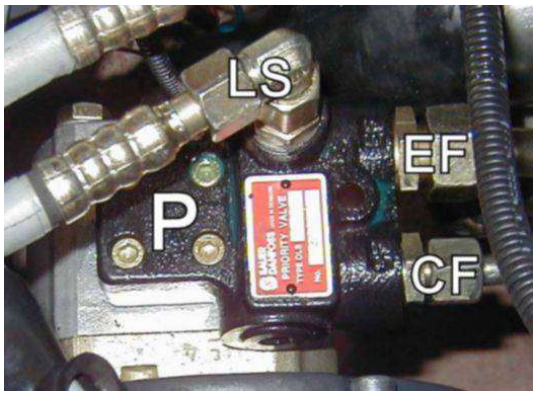
The number and location of the plug connections vary according to the truck type and equipment version. The control wiring harness (1) to the supply unit is the standard design, and the roof wiring harness (2) is a variant.



– Detach plug X41 on the supply unit
– **Variation:** Detach the connections from the roof wiring harness

  Heater XS6 and XS7
  Plug X63, X65, X66, X67
  Voltage converter wiring harness

– Detach hoses LS and CF on the priority valve; mark beforehand if necessary



– Disconnect the return line of the steering unit (1) at the return line filter
– Disconnect the connection between the steering hoses L and R (2) and the steering cylinders



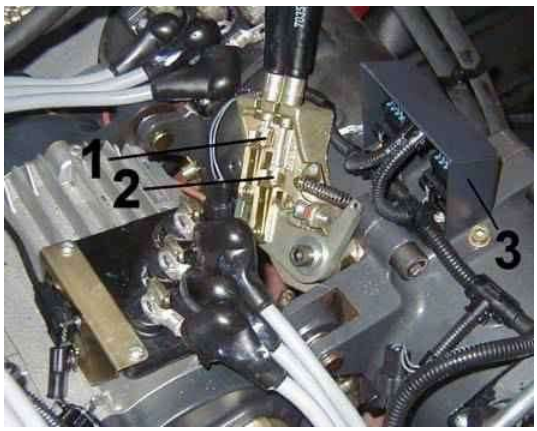
– Tie up the five loose hoses to the steering column ▷



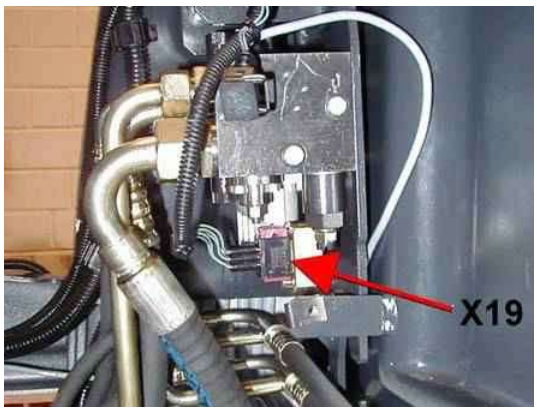
– Disassemble the hose guide from the solenoid valve on the overhead guard ▷



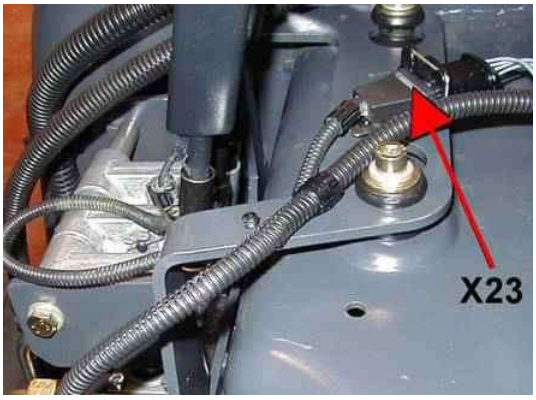
– **6210-17, 6311,13,15:** Remove the cover on the brake actuation ▷
– Remove the ES bolts from the parking brake (1) and service brake (2) and detach the cables; mark beforehand if necessary
– Remove the panelling from the front of the directional control valve block
– Release the panelling on the top of the directional control valve block



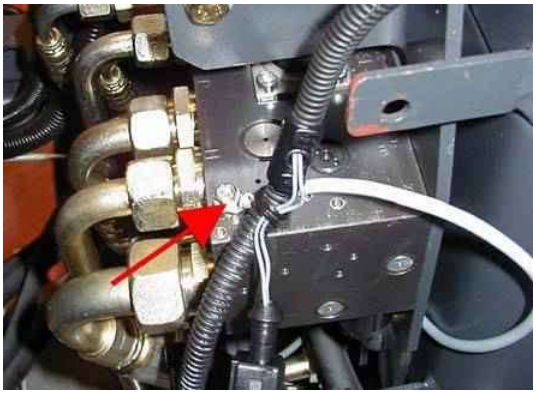
– Detach plug X19 of the hydraulic sensor on the directional control valve block ▷



– Detach plug X23 from the lift lever on the directional control valve block



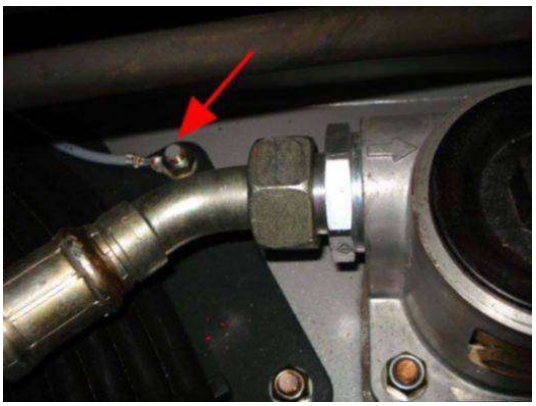
– Detach the earthing cable at the directional control valve block
– **Servo hydraulics variant:** Disconnect all the plugs 2Y1 to 2Y11 and 2B5 on the directional control valve block



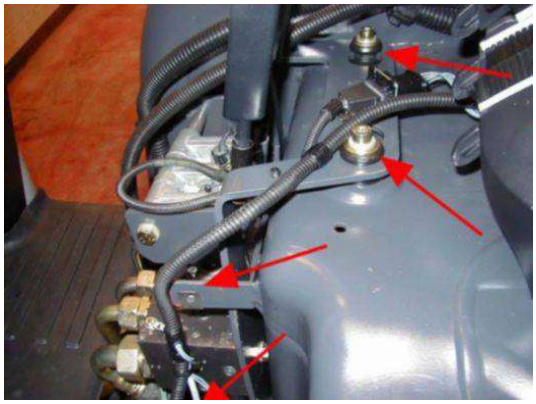
– **6210-17, 6311,13,15:** Disconnect the earth wires to the chassis and directional control valve block at the front right of the overhead guard



– **6321–30:** Disconnect the earth wires to the directional control valve block on the hydraulic tank



– Detach the directional control valve block holder from the overhead guard ▷



– From below, loosen the central screw (M8x90) of the left and right front overhead guard bearings ▷

NOTE

Do not change the setting of the threaded bushes (see arrow in picture). The overhead guard height changes according to the screw-in depth.



– Release the two screws on the rear overhead guard bearing ▷



– Secure the overhead guard with a lifting sling and a crane or truck ▷



⚠ CAUTION

The overhead guard may slip sideways

Check the fastening and position of the lifting sling

– Unscrew all four screws on the overhead guard bearings

⚠ CAUTION

Beware of damage!

Work slowly and carefully, with an assistant if possible

The solenoid valve must not remain hanging on the overhead guard

Check the height of the ceiling

– Carefully lift the overhead guard to a sufficient height and remove it ▷



– Position the overhead guard with the rear bearing on a suitable pallet stack ▷



Installing the overhead guard

Preparation

Installing the overhead guard varies according to truck type and equipment version.

Significant differences are indicated in the removal instructions.

The overhead guard is ready, placed separately on a stack of pallets ▷



Only assemble cab parts once the overhead guard has been screwed onto the chassis:

- Cab doors and side parts
- Roof window
- Heater

Installation

– Secure the overhead guard with a lifting sling and a crane or truck ▷



⚠ CAUTION

The overhead guard may slip sideways

Check the fastening and position of the lifting sling

– Position the overhead guard above the chassis and lower it carefully ▷



⚠ CAUTION

Beware of damage!

Work slowly and carefully, with an assistant if possible

The solenoid valve must not remain hanging on the overhead guard

Check the height of the ceiling

– Place the overhead guard on the front bearing points and attach it to the chassis using screws and conical spring washers ▷



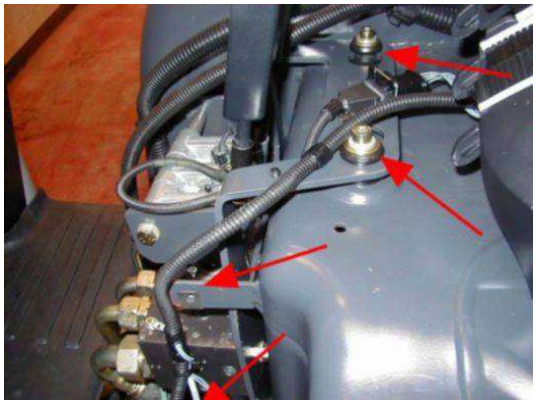
– Position the lower spacer plate on the counterweight ▷

– Place the overhead guard on the rear bearing points and secure screws and lock washer to the counterweight

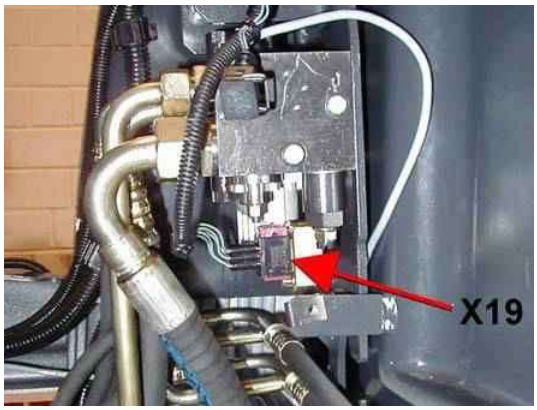
– Remove the lifting sling



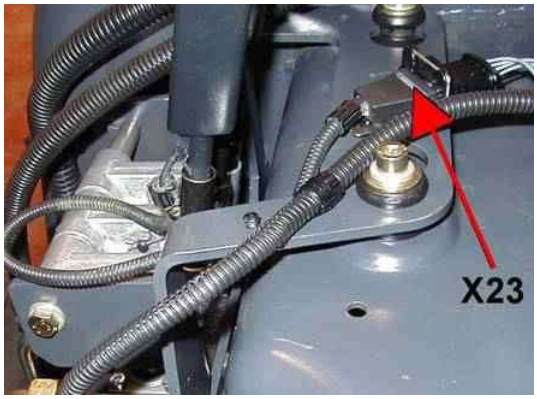
– Screw the directional control valve block holder onto the overhead guard ▷



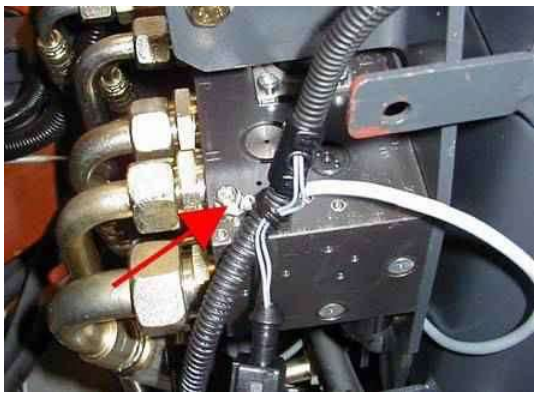
– Connect plug X19 of the hydraulic sensor on the directional control valve block ▷



– Connect plug X23 from the lift lever on the directional control valve block ▷



– Connect the earthing cable on the directional control valve block ▷
– **Servo hydraulics variant:** Connect all the plugs 2Y1 to 2Y11 and 2B5 on the directional control valve block



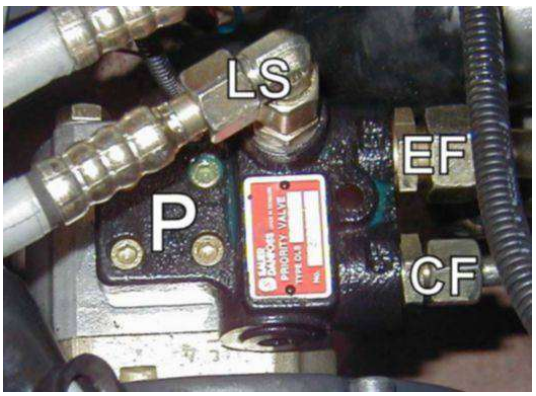
– **6210–17, 6311, 13, 15:** Connect the earth wires to the chassis and directional control valve block at the front right of the overhead guard ▷



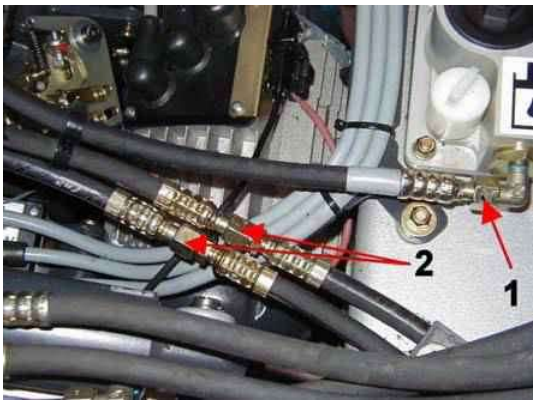
– **6321–30:** Connect the earth wires to the directional control valve block on the hydraulic tank ▷



– Connect hoses LS and CF on the priority valve ▷



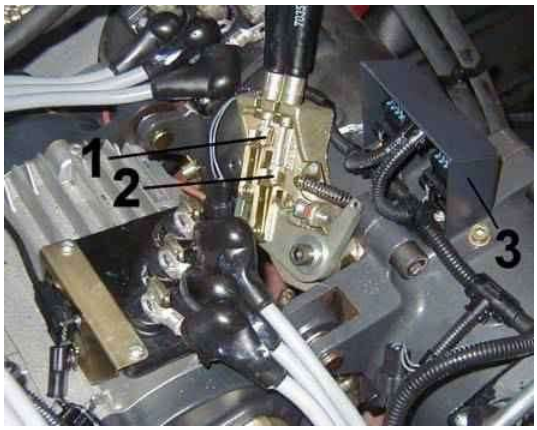
– Connect the return line of the steering unit (1) to the return line filter ▷
– Connect the steering hoses L and R of the steering cylinders (2)



– Fit the hose guide from the solenoid valve on the overhead guard



– Attach the brake cable and assemble the ES bolts of the parking brake (1) and the service brake (2)
– Check the brake settings; see the chapter entitled "Brake system"
– **6210–17, 6311, 13, 15:** Fit the cover on the brake actuation
– Apply the parking brake.
– Install the panelling on the front of the directional control valve block
– Install the panelling on the top of the directional control valve block
– Attach the electrical connection between the overhead guard and the counterweight



The number and location of the plug connections vary according to the truck type and equipment version. The control wiring harness (1) to the supply unit is the standard design, and the roof wiring harness (2) is a variant.



– Connect plug X41 on the supply unit
– **Variation:** Attach the connections from the roof wiring harness

  Heater XS6 and XS7
  Plug X63, X65, X66, X67
  Voltage converter wiring harness

– Install and tighten the covering for the electronics
– Install the trademark emblem
– **Variation:** Connect plug X57 from the light strip
– Check the gap between the overhead guard and the chassis; adjust if necessary
– Check the gap between the overhead guard and the trademark emblem; adjust if necessary
– Tighten all the screws on the overhead guard bearings, check the tightening torques

Only for high chassis:

– Remove the panelling between the chassis and the overhead guard at the front right and left

Only for low chassis:

– Install the drive wheels and tighten the ball-seat nuts

– Lower the truck.

– Tighten the spherical collar nuts; for tightening torques, see Technical data in the chapter entitled "Drive axle"

The following procedure applies to all chassis:

– Battery reconnection

– Refit floor plate.

– Bleed the steering

– Functional test

Checking and adjusting the gap

– Check that the gap between the **overhead guard and chassis** is parallel.

– Release the left front bearing screw

– Adjust the gap by turning the threaded bush in the left front bearing

Type carrier	Gap
6210 - 17	12.5 ± 2 mm
6311, 13, 15	
6321 - 25	15 ± 2 mm
6327 - 30	

▷



– Check that the gap between the **overhead guard and trademark emblem** is parallel

– Release the right front bearing screw

– Adjust the gap by turning the threaded bush in the right front bearing

– Tighten all the screws on the overhead guard bearings, check the tightening torques

▷



Hydraulic steering

General technical data

Steering unit		
Manufacturer		Sauer Danfoss
Designation		OSPF 50 LS EL 1, 50G5128
Delivery rate per rotation	[cm^3]	50
Pressure relief valve	[bar]	135–140 bar
Shock valve	[bar]	200 - 220
Steering pressure		
Connections P and EF	[bar]	250
Connections CF and LS	[bar]	140 - 145

Hydraulic connections		
Connections P, T, LS, R and L		
Tightening torque	[Nm]	

Transmission ratio of steering turntable	
Steering wheel revolution, stop to stop	Min. 5.00
Transmission ratio of swing axle	
Steering wheel revolution, stop to stop	Min. 4.25

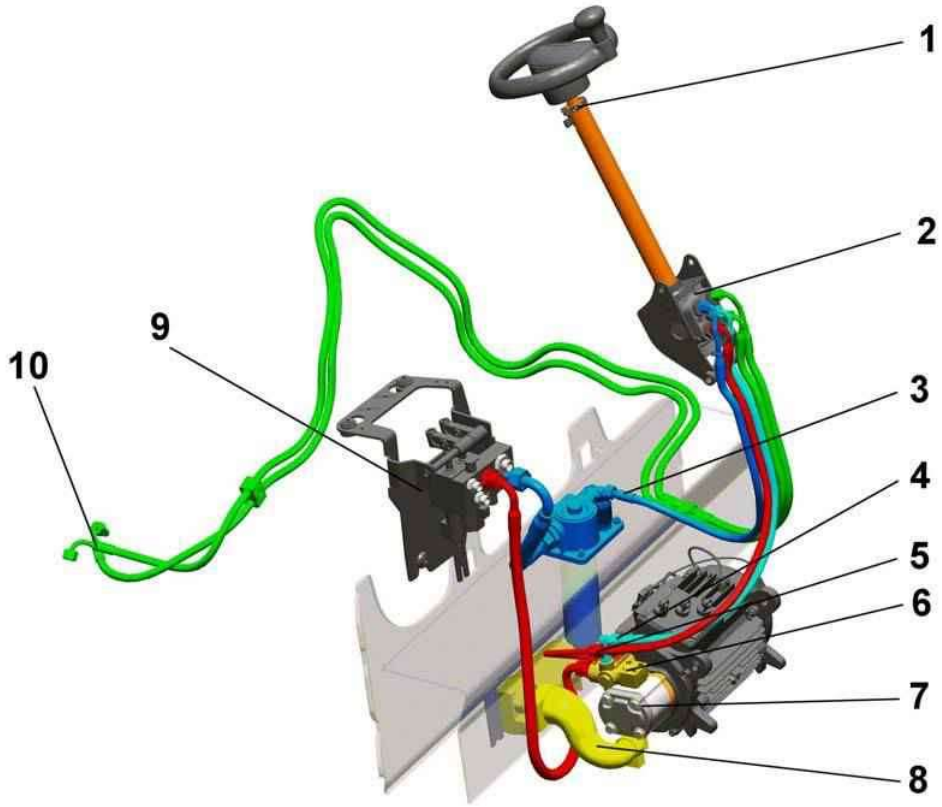
Diaphragm pressure switch	
Switching range	1.5 ± 0.2 bar
The diaphragm pressure switch is no longer evaluated in trucks with MCU 2 and software version 2.06 and is not fitted in these trucks	

Priority valve		
Manufacturer		Sauer Danfoss
Designation		OLSP 80
Charging pressure	[bar]	7
Load signal		Dynamic

Tightening torques			
Pump P	[Nm]	9^{+1}	4 x DIN 912, M6 x 35, 8.8 socket head screws
Steering CF	[Nm]	70^{+10}	GE10-PL
Directional control valve EF	[Nm]	90^{+10}	GE18-PLR
Load Sensing LS	[Nm]	35^{+5}	GE10-LR-E

Steering system

Function



1	Steering angle sensors	6	Priority valve
2	Steering unit	7	Hydraulic pump
3	Return line	8	Induction hose
4	LS signal line	9	Directional control valve block
5	Pressure line	10	Steering cylinder connection

The steering system is equipped with power steering that works according to the LS principle. It affects the steering cylinder on the steering axle.

"LS system"
"Load Sensing System"
Load Sensing System

A steering unit is flange-mounted to the lower end of the steering column. It comprises a distributor valve and a metering pump.

Upon actuating the steering wheel, an oil volume is allocated to the steering system by the metering pump, which is proportional to the amount by which the steering wheel is turned. The distributor valve guides this oil volume to the desired side of the steering cylinder.

The oil volume for the steering is directed as a priority to the steering unit by the priority valve in all operating statuses.

If the working hydraulics are not actuated, the pump speed for steering is proportional to the rotational speed at the steering wheel (dynamic steering). For slow steering wheel movements, the hydraulic pump runs at a basic speed. Fast steering wheel movements result in an increase in the speed. The rotational speed of the steering wheel is ascertained via the steering angle sensor (3B01).

With diaphragm pressure switch (until 10/2012)

The pump motor is activated when the diaphragm pressure switch (6S3) is opened. The hydraulic pump runs at a basic speed.

Without diaphragm pressure switch (since 10/2012)

Without the diaphragm pressure switch, the pump motor always runs at > 0.1 km/h. A journey of three minutes without a steering movement produces an error.

Steering angle detection for two-motor drive

For trucks equipped with two traction motors in the drive axle, controlled driving is enabled via the steering angle actual value.

Using the steering angle actual value, the truck control unit (MCU) calculates the optimum number of revolutions for the traction motors. The truck control unit constantly monitors all influences and generates errors messages in the event of faulty or implausible values.

The steering angle actual value is calculated from the following three influences:

- Speed actual values via the speed sensors in the traction motors
- Steering angle detection via the steering angle sensor 3B01 on the steering column
- Status of the cornering switches 3B28 and 3B29 on the steering axle

Steering angle detection for single-motor drive

For trucks with one traction motor in the drive axle, no steering angle actual value is required for controlled driving.

Optionally, these trucks can be equipped with steering angle detection for the "curve speed control" variant. CSC is a component of the comfort package (assistance system).

Steering — error detection

Error	Cause	Remedy
Self-steering, difficult steering		
► When the hydraulic pump is in operation, the steering actuates automatically. ► The hydraulic connections P, T, L, R are connected.	► Mechanical fault in the steering unit. ► Assembly fault between steering unit and steering axle.	Disconnect the steering unit from the steering column and check for mechanical damage: ► Without the steering unit, you must be able to turn the steering column very easily (<10 Nm). ► Check the steering unit for contamination, clean the valves. ► Assemble the steering unit free from distortion. ► Change the oil as required.
► The steering is tight (> 10 Nm) ► The hydraulic connections P, T, L, R are disconnected.		
► Only in electric forklift trucks ► Insufficient pump speed	► Steering angle sensor defective	► Check the steering angle sensor on the steering column

Error	Cause	Remedy
Hard spots		
► Steering overhaul ► Pivoting problems when starting to steer	► Air in the LS line. ► Dirt in the hydraulic oil causes faulty oil flow in the priority valve. ► No volume flow rate from P to CF.	► Clean the priority valve - even better, change it. ► Bleed the LS line at the priority valve. ► Pressure measurement at the priority valve at P and LS. If there is no standby pressure or pressure differential between P and LS, change the priority valve. ► Check the hydraulic oil for contamination and change as required.

Steering unit

General

The steering unit is secured to the steering column flange via four mounting screws.

The following valves are fitted in the steering unit.

- Pressure relief valve
- Shock valve

  The shock valve has a damping function that prevents major pressure fluctuations being transmitted from the hydraulic system to the steering.

NOTE

The values set by the manufacturer must not be changed.

Removal

NOTE

Hydraulic oil may escape when loosening the hydraulic connections.

– Remove the steering column panelling.

– Remove the parking brake panelling on the left-hand side.

– Disconnect the plug contacts at the key switch.

– Protect the bottom plate from oil by using a cleaning cloth.

6210-17, 6311,13,15: Preparation for swivelling the steering column backwards:

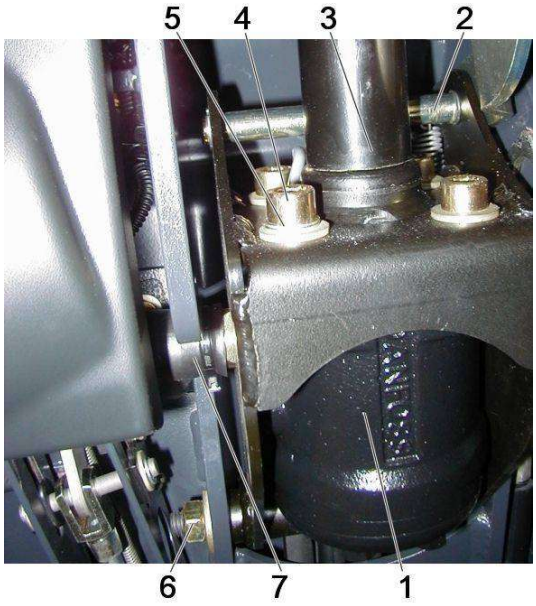
– Remove the steering wheel.

or:

– Remove the battery from the truck.

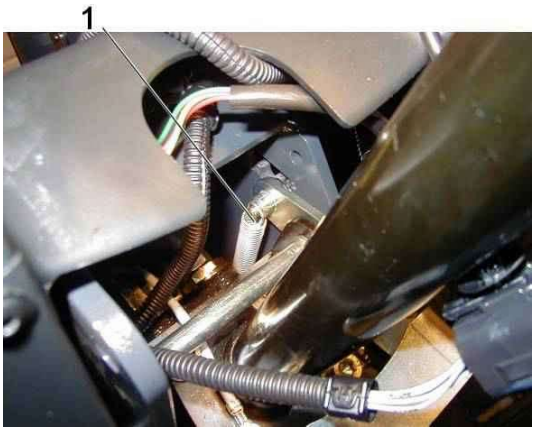
– Remove the driver's seat.

The following procedure applies to all trucks:

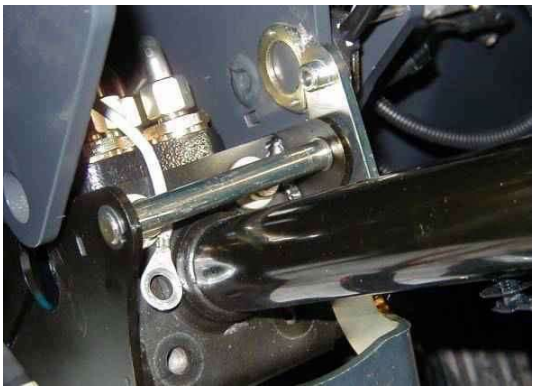


1 Steering unit
2 Steering column adjustment
3 Steering column
4 Undo the fixing screws
5 Earth wire
6 Bearing axle
7 Diaphragm pressure switch

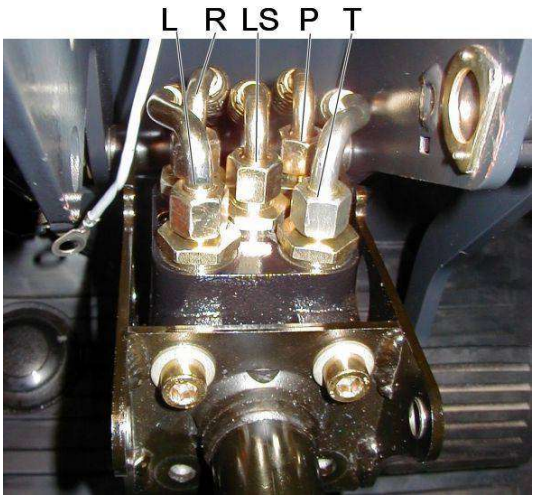
– Remove the steering column adjustment spring and securing bolt (1).
– Unscrew the earth cable from one of the mounting screws.



– Unhook the steering column adjustment and tip back.
– Remove the diaphragm pressure switch, see the chapter entitled "Diaphragm pressure switch"

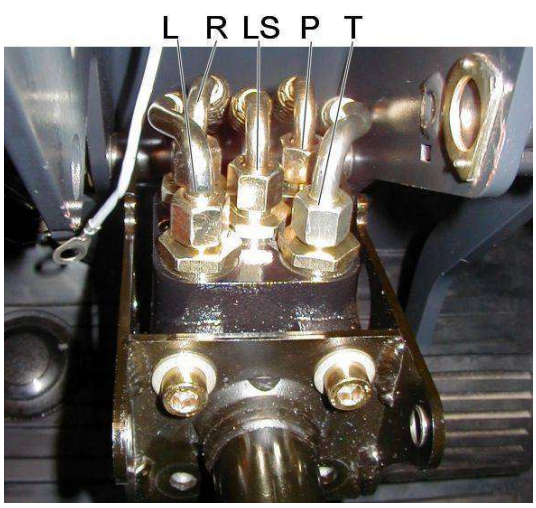


– Unscrew all hydraulic connections and protect them from contamination using sealing plugs; mark if necessary.
– Remove the steering column adjustment from the mount.
– Loosen the four M10 mounting screws and take out the steering unit from below.

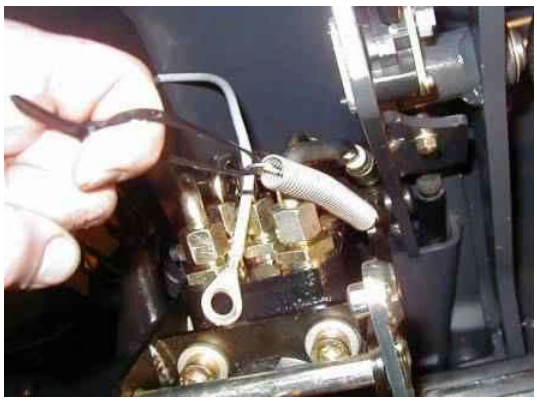


Installation

- Tightly screw the steering unit onto the steering column using the two front mounting screws.
- Connect all hydraulic connections.
- Insert the steering column adjustment into the mount.
- Swivel the steering column upwards and hook on the steering column adjustment.



- Fit the steering column adjustment spring and securing bolt.



NOTE

Using a cable tie makes it easier to fit the tension spring.

- Tightly screw in the two rear mounting screws with the earth wire.
- Install the diaphragm pressure switch, see the chapter entitled "Diaphragm pressure switch".

6210-17, 6311,13,15:

- Attach the steering wheel.

or:

- Install the driver's seat.
- Install the battery in the truck.

The following procedure applies to all trucks:

- Connect the plug contacts at the key switch.
- Attach the panelling.
- Clean the bottom plate as necessary; remove any oil.
- Carry out a functional test, steering from stop to stop several times.

6S3 diaphragm pressure switch

NOTE

The diaphragm pressure switch is no longer evaluated in trucks with MCU 2 and software version 2.06 and is not fitted in these trucks.

Service address	With 6S3	Without 6S3	Description
0E1	03	1B	Activation and mode of the dynamic steer support
0E8	00	01	Steering switch not fitted
0EF	00	20	Steering stop moment cut-off threshold

General

The diaphragm pressure switch is screwed to the steering unit.

Pressure is built up in the steering unit by turning the steering wheel. Once a specific pressure has been reached, the pressure switch opens and the pump motor starts up.

For the switching range of the diaphragm pressure switch, see chapter "General technical data".



NOTE

The switching range is set at the factory and must not be changed.

Removal

- Remove the steering column panelling
- Unscrew the parking brake panelling on the left-hand side
- Disconnect the plug contacts at the key switch
- Open the protective cap's cable ties and remove the protective cap
- Disconnect the plug contacts at the diaphragm pressure switch
- Unscrew the diaphragm pressure switch using a long SW24 socket



NOTE

Hydraulic oil can escape when unscrewing the diaphragm pressure switch.

Installation

- Screw on the diaphragm pressure switch using a long SW24 socket
- Connect the plug contacts at the diaphragm pressure switch
- Pull over the protective cap and secure with cable ties
- Connect the plug contacts at the key switch
- Screw on the steering column panelling

– Screw on the parking brake panelling on the left-hand side
– Carry out a functional test, steering from stop to stop several times

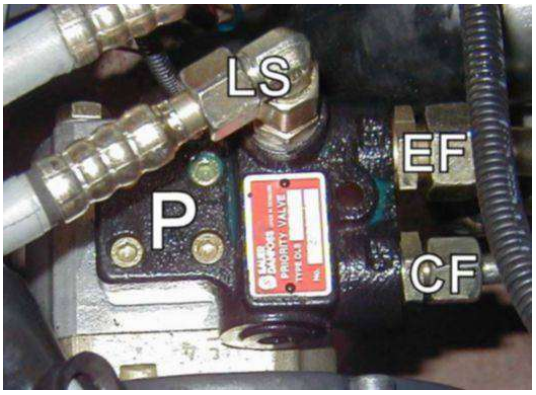
Priority valve

General

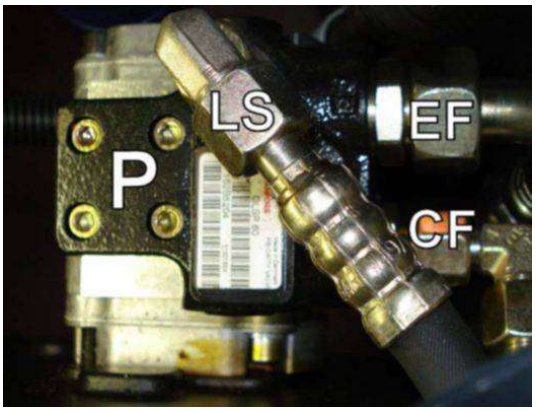
The priority valve is screwed directly onto the hydraulic pump.

The valve is a hydraulic control unit and ensures that oil is supplied to the steering as a priority in all operating conditions.

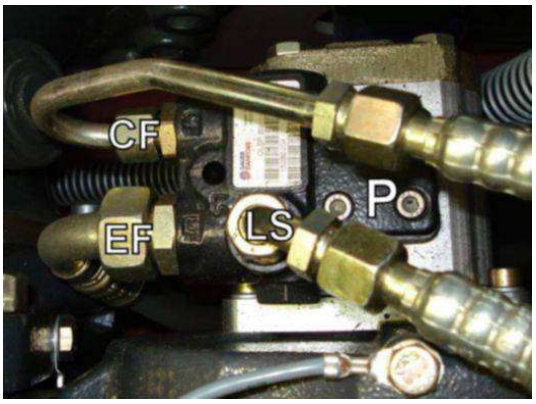
RX20, RX60-16-20 ▷



RX60-25-35 ▷



RX60-40-50 ▷



Error detection

Error	Cause	Remedy
► Steering sticks. ► Steering overhaul ► Pivoting problems when starting to steer.	► The slider in the priority valve is prevented from moving in the housing due to dirt particles	► Clean the priority valve - or even better, change it

Disassembly for cleaning

NOTE

Note the screw qualities and tightening torques.

– Remove the priority valve
– Release the screw plugs
– Remove the pre-loading spring
– Remove the slider
– Clean all parts.
– Check the sealing rings of the screw plugs
– Insert the slider
– Insert the pre-loading spring
– Screw in the screw plugs

Steering wheel with steering column

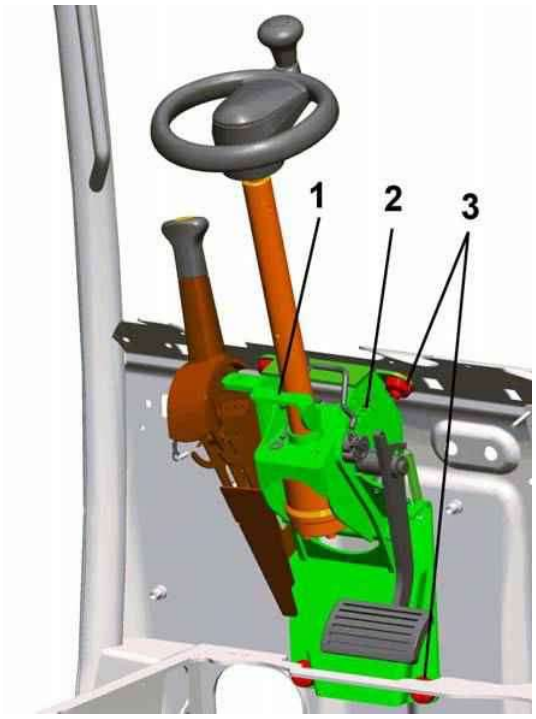
Steering column

General

The steering column is screwed to the front structure via the steering column support with four rubber bearings.

The inclination of the steering column can be adjusted in four different locking positions within a 10° range.

The brake actuation components—parking brake lever and brake pedal—are mounted on the steering column support.



1 Steering column adjustment
2 Four locking positions
3 Rubber mounts

Removal

NOTE

Hydraulic oil may escape when loosening the hydraulic connections.

– Remove the steering column panelling
– Remove the parking brake panelling on the left-hand side
– Disconnect the plug contacts at the key switch
– Protect the floorplate against oil by using a cleaning cloth

6210-17, 6311, 13, 15: Preparation for swivelling the steering column backwards:

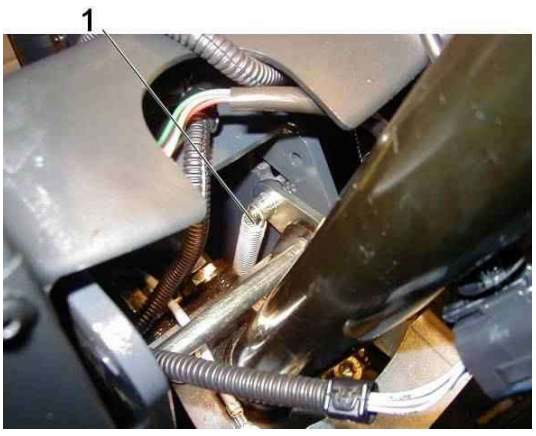
– Remove the steering wheel

or:

– Remove the battery from the truck
– Removing the driver seat

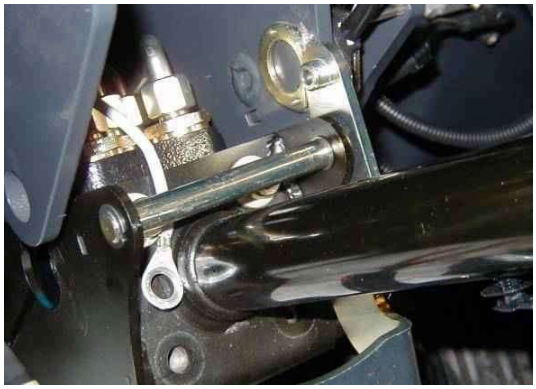
The following procedure applies to all trucks:

– Remove the steering column adjustment spring and securing bolt (1)
– Unscrew the earth cable from one of the fixing screws



– Unhook the steering column adjustment and tip back
– Remove the diaphragm pressure switch, see the chapter entitled "Diaphragm pressure switch"
– Remove the steering unit; see the chapter entitled "Steering unit"
– Remove the ES bolts of the service brake on the front structure
– Release the locknut for setting the brake cable
– Push the brake cable forwards
– Release the nut (SW19) on the bearing axle and remove the bearing axle on the right-hand side

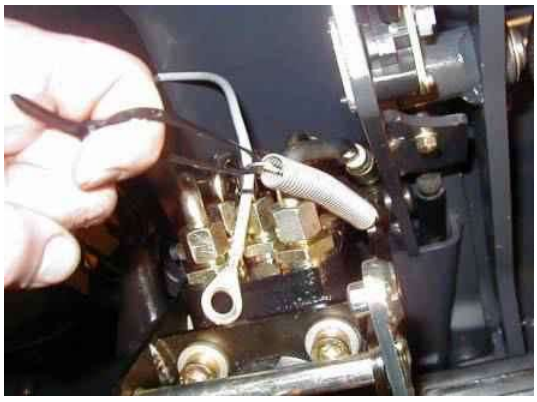
▷



Installation

– Insert the steering column with bearing axle into the front structure from the right-hand side
– Screw on the bearing axle with nut (SW19)
– Screw on the locknut for setting the brake cable
– Fit the ES bolts of the service brake on the front structure
– Install the steering unit; see the chapter entitled "Steering unit"
– Insert the steering column adjustment into the mount
– Move the steering column upwards and hook on the steering column adjustment
– Fit the steering column adjustment spring and securing bolt

▷



NOTE

Using a cable tie makes it easier to fit the tension spring.

– Tightly screw in the two rear fixing screws with the earthing cable
– Install the diaphragm pressure switch, see the chapter entitled "Diaphragm pressure switch"

6210-17, 6311,13,15:

– Attach the steering wheel

or:

– Driver's seat reconnection
– Install the battery in the truck

The following procedure applies to all trucks:

– Connect the plug contacts at the key switch
– Install the panelling
– Clean the bottom plate as necessary; remove any oil
– Carry out a functional test, steering from stop to stop several times

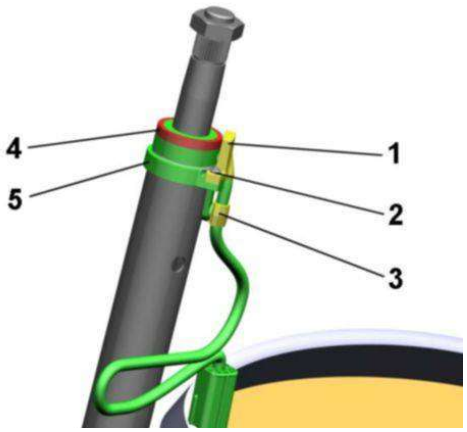
Steering angle sensor 3B01

General

The steering angle sensor is fitted below the steering wheel on the steering column and comprises a two-track pulse generator and a magnetic pole wheel. When steering is actuated, the sensor delivers positive voltage pulses.

The pole wheel (4) is firmly connected to the moving steering column. The pole wheel is fixed with Loctite and secured in place with a grub screw.

The sensor (1) is set in its position in relation to the pole wheel via two screws on the clamping ring (5). To ensure its vertical position on the steering column, the clamping ring is clipped to the steering column using a cable clip (3).



1 Steering angle sensor
2 Mounting screws
3 Cable clip
4 Magnetic pole wheel
5 Clamping ring

Technical data

Pulse generator	
Supply voltage	9–13 V
Current draw	<10 mA
Sensing distance	≤ 0.5 mm
Temperature range	-40°C to 85°C
Protection type	IP 64

Undo the electrical

6-pin mark II plug		
3B01/1 (br)	X46/38	12 V
3B01/2 (S1)	X46/36	Track A signal
3B01/3 (bl)	X46/23	GND_S
3B01/4 (S2)	X46/35	Track B signal

Error message

In the event of implausible or missing values, the truck control unit (MCU) generates error numbers.

The truck then only travels in emergency mode at 2 km/h.

The driver sees the error STEERING in the display.

Functional test

- Connect the multimeter between GND-S and track A or track B
- The displayed voltage must jump between 0.05 and 11 V during slow steering.
- Fast steering results in an average DC of approx. 5.6 V between GND_S and track A or GND_S and track B.

Alternatively, the steering angle display ADJUST can be activated in the display.

Setting

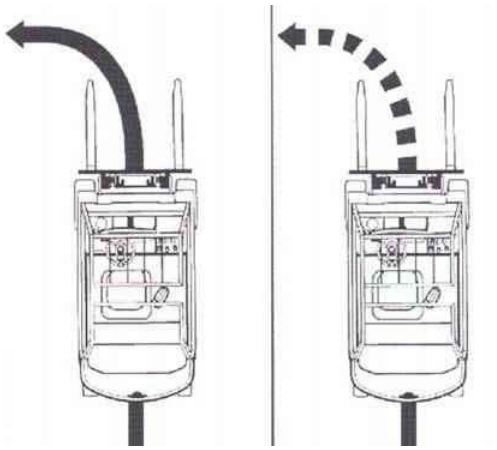
The sensor surface should rest gently on the paper at the magnet ring.

Steering angle-dependent handling performance — CSC

General

In order to optimise drive comfort and operational safety, trucks are fitted with Curve Speed Control (CSC). This function ensures that the driving speed is reduced when steering. The effect becomes more powerful at higher speeds and is triggered when steering is actuated.

Depending on the truck type, CSC is either standard equipment or a variant of the assistance system.



⚠ DANGER

Danger of truck tipping over!

The driving speed must generally be adjusted in such a way that the CSC is not used.

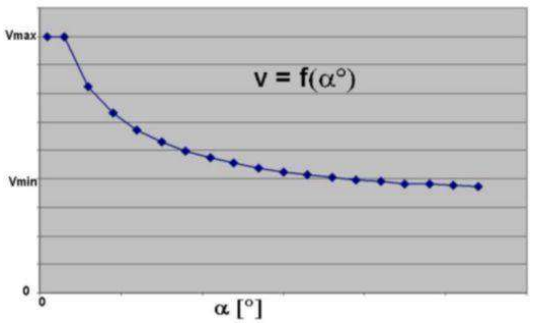
When installed as standard equipment, CSC must not be deactivated!

Equipment	5060 - 66	6209 - 17	6311 - 13 - 15	6321 - 25 6361 - 64 6345 - 56	6327 - 29 6367 - 69	6330
Traction motor rev sensor	Series	Series	Series	Series	Series	Series
Steering angle sensor 3B01	Series	Series	Series	Series	Series	Series
Curve switch 3B28, 3B29	Series	Series	Series	Only for CSC	Only for CSC	Not available
Wiring with plug X29	Not available	Series	Series	Series until week 22/2010, then omitted		

Function

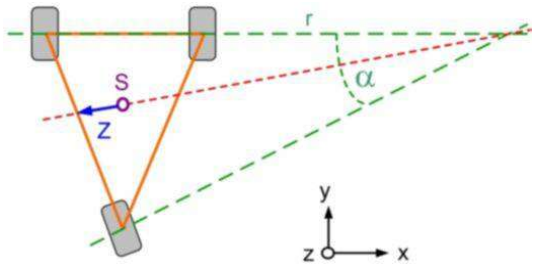
During operation, the speed is limited according to the steering angle. This behaviour follows characteristic curves that are individually calculated for each truck. Due to the different cornering behaviour, different characteristic curves are used for forwards and reverse travel.

If the driving speed is too high when cornering, the drive is decelerated to the permissible speed for the current steering angle. When driving in a straight line, the maximum speed is enabled again.



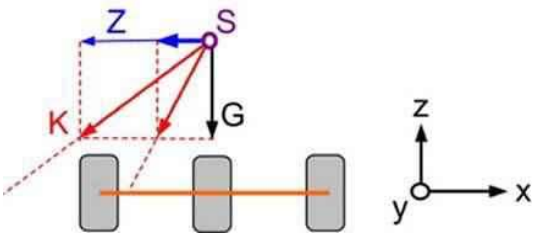
V Speed [km/h]
α Steering angle [°]

The geometry of the truck is used as a basis upon which the characteristic curve is calculated. For this procedure, a secure stability triangle is used, in the middle of which lies the centre of gravity of the truck. All of the forces exerted on the truck continuously affect its centre of gravity.



S	Truck centre of gravity
α	Steering angle
R	Curve radius
G	Weight of truck
Z	Centrifugal force
K	Resulting force vector

When cornering, a centrifugal force (Z) is produced, which influences the centre of gravity. The greater the speed and the steering angle, the greater the centrifugal force. The resulting force vector (K) is generated from the weight and the centrifugal force.



To calculate the maximum speed, it is assumed that that the truck tips over as soon as the power vector (K) attacking at the centre of gravity (S) of the truck is directed at a point outside of the stability triangle.

CSC — functional test

Components

NOTE

The CSC is an assistance system that is installed as standard. It must not be deactivated.

The steering angle is recorded and calculated via the following components:

- Curve switch 3B28 and 3B29 at the steering axle:

  Steering angle monitoring
- Steering angle sensor 3B01 at the steering column:

  Steering angle detection
- Rev sensors for the traction motors
- Accelerator
- Brake sensor
- Engine torque, calculated via the traction converters

Behaviour after switching on

The steering angle is detected by steering angle sensor 3B01 and the rev sensors. In addition, the

calculated steering angle is monitored using the two curve switches 3B28 and 3B29.

The current cornering manoeuvre can be assessed by means of the two speed signals from the traction motors. The actuation of the varying engine speeds is calculated from the brake sensor, accelerator, engine torque and current engine speed, as well as using the truck statuses. As a result of this procedure, CSC does not need to be calibrated.

Functional test

– Park the truck on even ground.
– Jack up the truck at the front, ensuring that the drive wheels are not touching the ground.
– Key switch ON
– Show the steering angle and speed in the ABE display.
– Connect the notebook to the truck and start the truck diagnostics:

```
F4: Monitor
▼
Drive unit
▼
Engine speed
```

NOTE

When the truck is jacked up, the torques of the traction motors do not match the values in actual use, as the controller cannot correctly calculate the steering angle. A trick can be used that enables the controller to still display the steering angle:

– Maximum speed of the traction motors must not exceed 5 km/h (<1290 rpm).
– Move the steering wheel from the left steering stop to the right steering stop and return the steering wheel back into the centre position.

This will cause the system to initialise once. From now on, the current steering angles will be shown in the display. The following tables can be used to check the values.

CSC values for RX20

Forward travel			Reverse travel		
Steering angle [°]	Speed [km/h]	Speed [rpm]	Steering angle [°]	Speed [km/h]	Speed [rpm]
0	(18.00)	4640	0	(16.20)	4176
3	18.00	4640	3	16.20	4176
6	14.50	3738	6	13.05	3364
12	11.40	2939	12	10.26	2645
18	10.00	2578	18	9.00	2320
24	9.10	2346	24	8.19	2111
30	8.50	2191	30	7.65	1972
36	8.10	2088	36	7.29	1879
42	7.80	2011	42	7.02	1810
48	7.67	1977	48	6.90	1779
54	7.44	1918	54	6.70	1727
60	7.03	1812	60	6.33	1632
66	6.49	1673	66	5.84	1506
72	5.93	1529	72	5.34	1377
78	5.45	1405	78	4.91	1266
84	5.12	1320	84	4.61	1188
90	5.00	1289	90	4.50	1160

CSC values for RX60

Forward travel			Reverse travel		
Steering angle [°]	Speed [km/h]	Speed [rpm]	Steering angle [°]	Speed [km/h]	Speed [rpm]
0	(20.00)	5156	0	(18.00)	4640
3	20.00	5156	3	18.00	4640
6	13.60	3506	6	12.24	3156
12	10.70	2759	12	9.63	2483
18	9.40	2423	18	8.46	2181
24	8.60	2217	24	7.74	1995
30	8.00	2062	30	7.20	1856
36	7.60	1959	36	6.84	1763
42	7.40	1908	42	6.66	1717
48	7.27	1874	48	6.54	1686
54	7.08	1825	54	6.37	1642
60	6.73	1735	60	60.6	1562
66	6.27	1616	66	56.4	1454
72	5.79	1493	72	5.21	1343
78	5.38	1387	78	4.84	1248
84	5.10	1315	84	4.59	1183
90	5.00	1289	90	4.50	1160

Steering turntable

General technical data
Fifth wheel

Steering axle	6210, 6211, 6213, 6215
Manufacturer	Linde
Designation	LA 340
Weight	
Steering angle	90°
Steering angle limit	Not adjustable
	From centre position, 7 teeth to both the right and left
Push rods - lift from right to left	103.7 mm
Tightening torques	
Wheel nuts, per wheel	5 x spherical collar nut A14-10 Tightening torque: 195 Nm
Wheel hub, per side	1 x hexagon nut M14 x 1.5, DIN 980 Tightening torque: 145 Nm Secured with Loctite No. 243
Mounting of steering box / counterweight	3 x hexagon head screw M16 x 80, 8.8, DIN 931 Tightening torque: 195 Nm Secured with Loctite No. 243
Pivot bearing adjustment screw	1 x hexagon head screw M16 x 50, 10.9, DIN 933, quality Equalisation of axial clearance using shim rings Tightening torque: 195 Nm Secured with Loctite No. 243
Cylinder pipe	Tightening torque: 145 Nm Secured with Loctite No. 243
Lubricant	
Mounts in the steering box	Lithium soap grease DIN 51825 - KP2K-30
Greasing during operation	Maintenance free
Greasing during assembly	Fill the mounts until fresh grease escapes

Fifth wheel

General

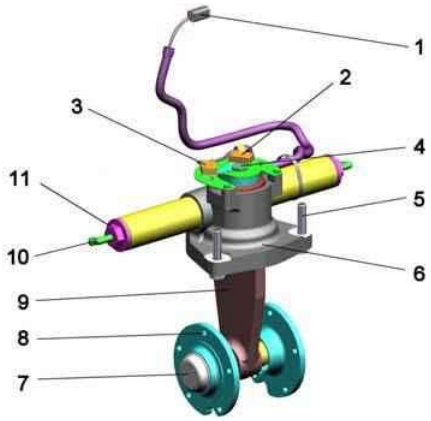
The steering axle in the steering turntable version is bolted with the steering box (6) from below to the counterweight using three mounting screws (5).

The steering cylinder pipes (11) are screwed to the left and right in the steering box. The steering cylinders' pistons actuate on a rack that performs a turning movement via the gearing in the axle casing (9).

The axle casing is fitted at the top of the housing (1) on tapered roller bearings. The axle casing is connected to the steering box via the pivot bearing adjustment screw (4). At the same time—and with the help of shim rings—the axial clearance of the pivot bearing is adjusted.

The wheel hubs (8) are placed and bolted onto both sides of the axle of the axle casing. The wheel hub nut is covered by the hubcap (7).

The curve switches fitted to the top of the housing (2, 3) calculate the steering angle actual value and switch at a defined steering angle.



1	Plug X29
2	3B28 right curve switch
3	3B29 left curve switch
4	Pivot bearing adjustment screw
5	Undo the fixing screws
6	Steering box
7	Hubcap
8	Wheel hub
9	Axle body
10	Make hydraulic connection
11	Cylinder pipe

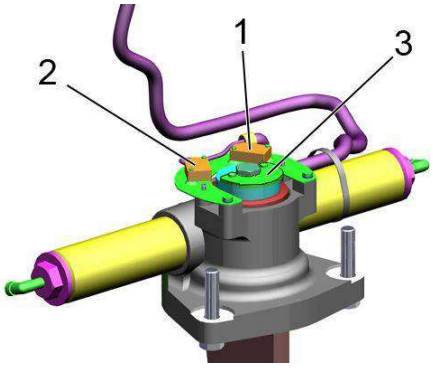
Curve switch

General

The curve switches are inductive proximity switches that react to the proximity of iron.

At a defined steering angle, curve switch 3B29 switches in left-hand curves, and curve switch 3B28 switches in right-hand curves.

Curve switches 3B28 (1) and 3B29 (2) are screwed to the steering turntable via a retaining plate. The cam disc (3) serves as a transmitter.



Technical data

RX20		
Switching range	-40° to -20°	+20° to +40°
Voltage jump	From 0 V to 11 V	
Max. steering angle of steering turntable	-70°	+70°

Electrical connections

Curve switch for left-hand curves			
3B29 (brown)	X29/1	X44/12	12 V
3B29 (black)	X29/2	X44/10	Signal
3B29 (blue)	X29/3	X44/41	GND-L

Curve switch for right-hand curves			
3B28 (brown)	X29/4	X44/13	12 V
3B28 (black)	X29/5	X44/27	Signal
3B28 (blue)	X29/6	X44/42	GND-L

Error message

In the event of implausible or missing values, the truck control unit (MCU) generates error numbers.

This does not restrict the handling characteristics.

Removing/installing the fifth wheel

Preparation

Assembly tools:

- Guide bolt, headless screw M16 x 100
- Wooden plank, ideal size 190 x 30 x 820

Plug X29 for the curve switch is located in the counterweight. In order to be able to lead the cable out downwards, the battery must be removed.

Removal

– Actuate the parking brake.

– Prevent the truck from rolling away using chocks at the front wheels.

– Remove the battery.

– Loosen the sheet metal cover.

– Disconnect connection assembly X29 of the curve switch.

– Lead the cable out downwards.

– Place the steering in full lock to the left.

– Loosen the wheel nuts.

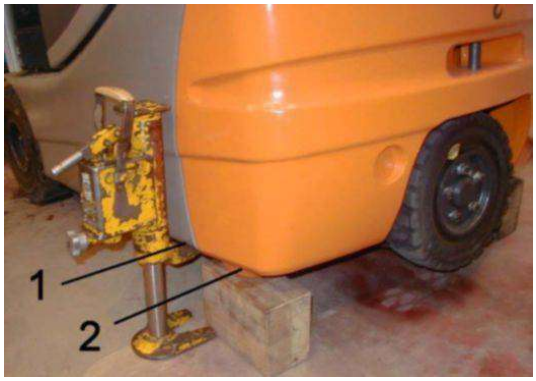
– Place the steering in full lock to the right.

– Loosen the wheel nuts.

– Jack up the truck on the right-hand side at the chassis when the battery door is open. ▷



– Place a supporting block under the counterweight.
– Jack up the truck on the left-hand side at the chassis. Place a supporting block under the counterweight. ▷



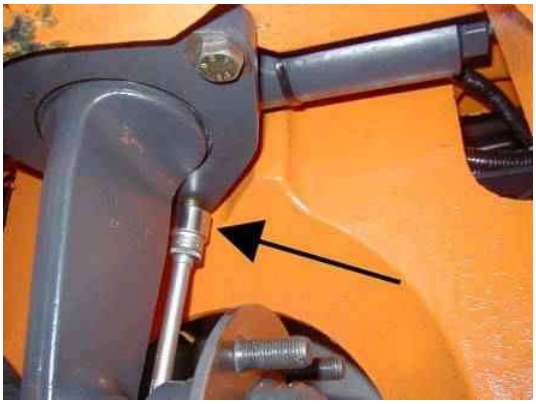
– Remove the wheels. ▷
– Return the steering to the neutral position.
– Loosen the hydraulic connections on the left-hand side and right-hand side of the steering cylinders.



ENVIRONMENT NOTE

If the hydraulic connections are opened, hydraulic oil may escape.

– First loosen the front screw. Insert the guide bolt.



NOTE

The screws are secured with pourable plastics.

– Place the wooden plank at an angle under the steering turntable and prevent it from rolling away with a wheel.
– Loosen the two front screws.



– Allow the steering turntable to slide slowly downwards over the wooden plank.



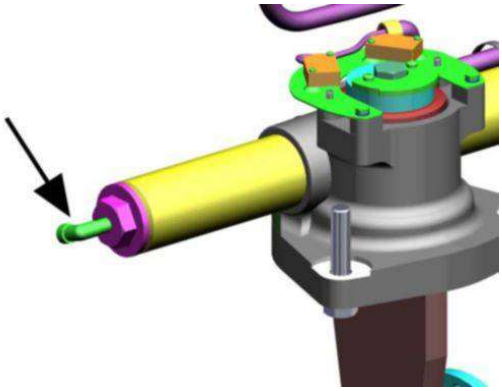
Installation

NOTE

- *Observe the screw quality and the tightening torques*
- *Observe the quality of pourable plastics*
- *For values, see "General technical data" in the chapter entitled "Steering axle"*

– Push the steering turntable upwards over the wooden plank. Use the guide bolt in the front thread as an aid to assembly.
– Clean the screws of grease. Secure the screws using pourable plastics.

– Screw in the hydraulic connections on the right-hand side and left-hand side of the steering cylinder. Follow the assembly instructions. ▷



Screw in the screw joints up to the blue coating. Then screw the screw joints into position using a minimum of three to a maximum of four revolutions. Do not unscrew the screw joints.

– Mount the wheels.
– Lower the truck.
– Tighten the wheel nuts.
– Guide the cable for plug X29 upwards into the counterweight.
– Connect plug X29.
– Fit the sheet metal cover.
– Install the battery in the truck.

Bleed the steering

– Warm up the truck.
– Then steer fully from stop to stop at least five times.

Swing axle

General technical data, swing axle

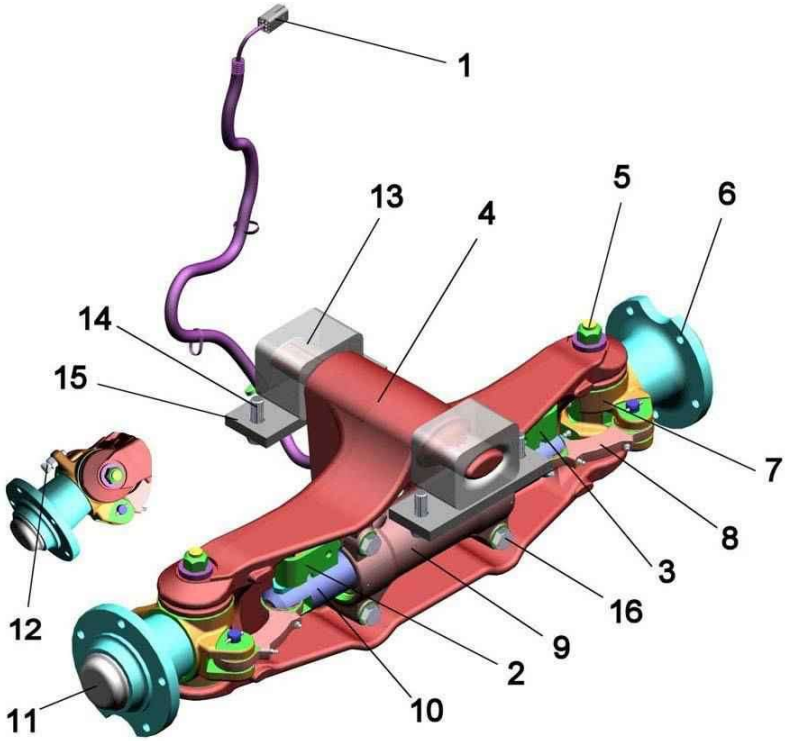
Steering axle	Swing axle
Manufacturer	DANA
Designation	LA 301
Weight	approx. 80 kg
Steering angle	80 - 82°
Steering angle limit	DIN 933, M12 x 40-8.8 stop screw

Tightening torques and connecting elements			
Wheel nuts, per wheel	[Nm]	195	5 x spherical collar nuts A14-10
Screw joint between steering axle and counterweight	[Nm]	195	2 x DIN 933, M16 x 50-8.8 hexagon head screws 2 x lock washers VSK 16
Wheel hub, per side	[Nm]	145	1 x DIN 980, M14 x 1.5 hexagon nut
Steering cylinder	[Nm]	210	4 x DIN 960, M16 x 1.5 x 100-8.8 hexagon head screws
Steering pivot pin			M18 x 1.5 hexagon nut Only insert oiled parts
	[Nm]	290	2200 - 3000 kg
	[Nm]	310	3500 kg
Press-in forces			
Bolts – tie rod on the cylinder side	[kN]	1 - 21	Treated with MoS_2
Bolts – tie rod on the axle stub side	[kN]	4 - 38	Treated with MoS_2
Axle stub — steering pivot pin	[kN]	60	Oiled

Maintenance	
Greasing	1000 operating hours
Greasing during operation	
All joints	Fill with grease until a small amount of fresh grease escapes
Greasing during assembly	
Wheel bearing, rotary shaft seal of wheel bearing Axle stub bearing	Fill with grease
Wheel hub, axle stubs, tie rod	Grease all bearings until a small amount of fresh grease escapes
Lubricant	
Axle stub bearing, spherical bearing	Aralub 4320
Wheel bearing, rotary shaft seal of wheel bearing	Lithium soap grease DIN 51825 — KP2K-30

Swing axle

General



Steering axle

4	Axle casing
5	Steering pivot pin
6	Wheel hub
7	Axle stub
8	Tie rod
9	Steering cylinder
10	Piston rod
11	Hubcap
12	Stop screw
13	Buffer element
14	Mounting screws
15	Joining plate
16	Steering cylinder mounting

Curve switch for CSC

1	Plug X29
2	3B28 right curve switch
3	3B29 left curve switch

The steering axle in the swing axle version is inserted into the counterweight with two buffer elements (13) and secured with joining plates (15) and mounting screws (14).

The steering cylinder (9) is screwed into the axle casing (4) via four mounting screws (16).

The axle stubs (7) are fitted on both sides in tapered roller bearings and secured with steering pivot pins (5).

The wheel hubs (6) are placed and bolted onto the axle stubs on both sides. The wheel hub nuts (11) are covered by hubcaps.

The steering cylinder's piston rod (10) causes a turning movement in the axle stubs via the tie rods (8). The steering angle is limited by the stop screws (12) at the axle stub.

Curve switch for CSC for two-motor drive

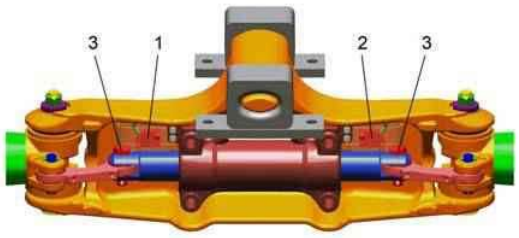
The curve switches fitted to the left and right on the steering cylinder (2, 3) serve to calculate the steering angle actual value and switch at a defined steering angle. The equipment depends on the truck type; see the chapter entitled "Steering system".

Swing axle curve switch

General

Curve switches are inductive proximity switches that respond to the proximity of iron. At a defined steering angle, curve switch 3B29 switches in left-hand curves, and curve switch 3B28 switches in right-hand curves.

Curve switches 3B28 (1) and 3B29 (2) are bolted on to the left and right-hand side of the steering axle respectively via angle plates. The connecting pin (3) between the steering cylinder and steering axle acts as a transmitter.



Technical data

RX20, RX60-16-20		
Switching range	-40° to -20°	+20° to +40°
Voltage jump	From 0 V to 11 V	
Max. steering angle	–90°	+90°

RX60-25-35, RX60-40-50		
Switching range	-20° to -12°	+12° to +20°
Voltage jump	From 11 V to 0 V	
Max. steering angle of swing axle	-70°	+70°

Electrical connections

Curve switch for left-hand curves			
3B29 (brown)	X29/1	X44/12	12 V
3B29 (black)	X29/2	X44/10	Signal
3B29 (blue)	X29/3	X44/41	GND-L

Curve switch for right-hand curves			
3B28 (brown)	X29/4	X44/13	12 V
3B28 (black)	X29/5	X44/27	Signal
3B28 (blue)	X29/6	X44/42	GND-L

Error message

If values are implausible or missing, the truck control unit (MCU) generates error numbers.

This does not restrict the handling characteristics.

Removing/installing the swing axle

Preparation

The battery may need to be removed, depending on the type of truck and equipment.

Plug X29 for the cornering switch is located in the counterweight. The cable must be led out downwards.

Removal

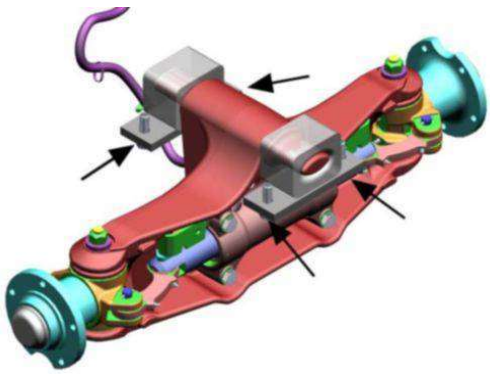
- Operating the parking brake
- Prevent the truck from rolling away using chocks at the front wheels
- Removing the battery
- Release the sheet metal cover
- Disconnect plug connector X29 of the cornering switch
- Lead the cable out downwards
- Release the wheel nuts on both sides
- Jack up the truck on the right-hand side when the battery door is open ▷
- Place square timbers under the counterweight
- Jack up the truck on the left-hand side at the chassis and place square timbers under the counterweight
- Remove the wheels
- Loosen the hydraulic connections on the left and right of the steering cylinder



ENVIRONMENT NOTE

Hydraulic oil may escape when loosening the hydraulic connections.

- Position a forklift truck under the steering axle and raise it to the stop
- Unscrew the four M16 axle bearing screws and remove the joining plates ▷



– The steering axle is retained by the forklift truck ▷



– Lower the steering axle, carefully tilt it forwards and remove it sideways from the truck ▷



Installation

NOTE

- *Check screw quality and tightening torques*
- *Check the quality of pourable plastics*
- *For values, see "General technical data" in the chapter entitled "Steering axle"*

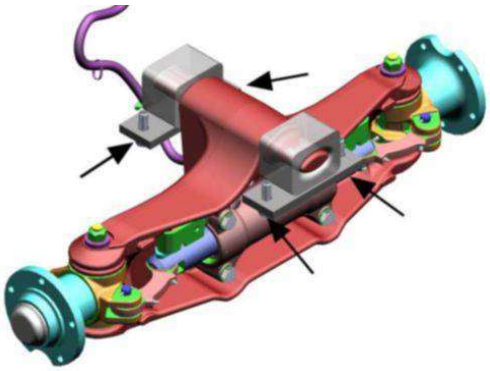
– Position the steering axle under the truck from the side

– Lift the steering axle, taking care to keep it in a straight position ▷



– Insert the buffer element, lightly greased with multi-purpose oil in the bearing shells in the counterweight

– Screw in the joining plates using two M16 axle bearing screws with spring lock washer for each one ▷



– Screw in the hydraulic connections on the right and left of the steering cylinder; follow the assembly instructions

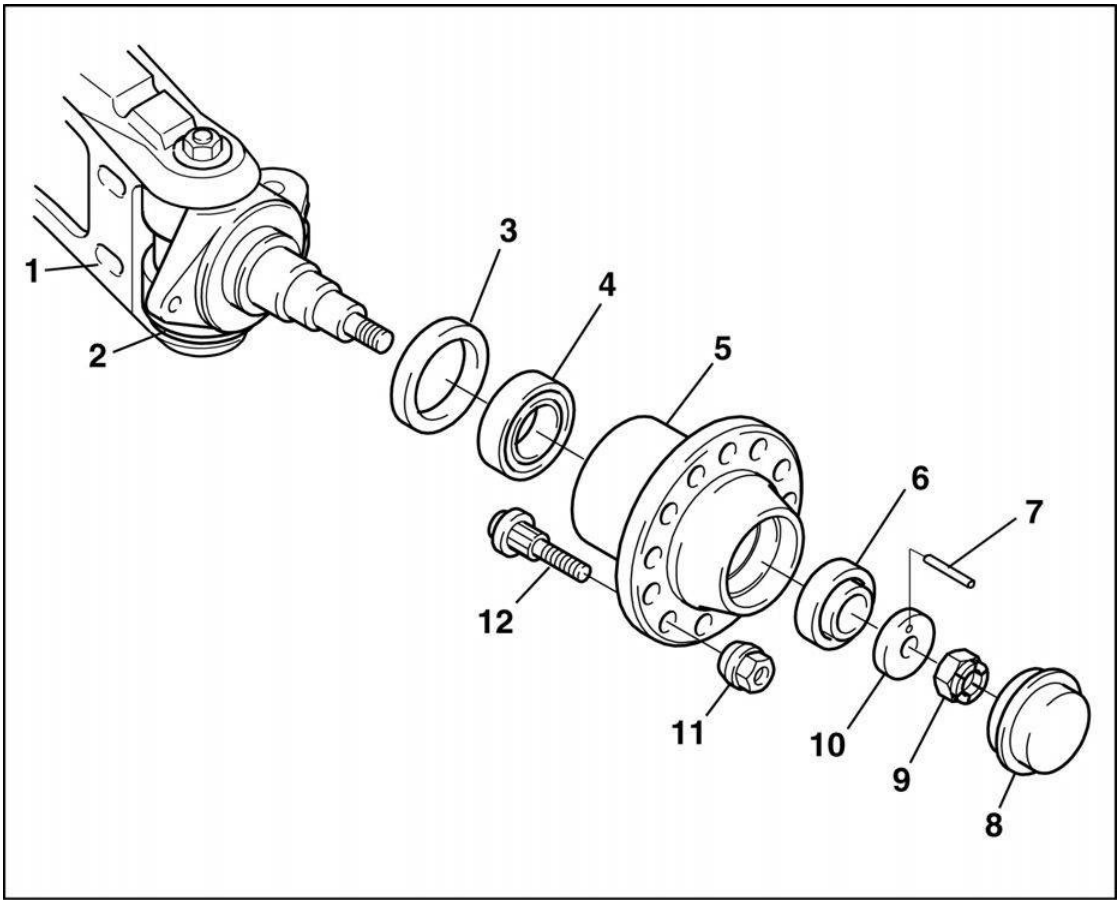
Screw in the screw joints up to the blue coating and then put them into position using at least 3 or a maximum of 4 rotations. Do not unscrew the screw joints.

– Fit the wheels

– Lower the truck.

- Tighten the wheel nuts
- Lead the cable for plug X29 upwards into the counterweight
- Connect plug X29
- Fit the sheet metal cover
- Install the battery in the truck
- Carry out a functional test, steering from stop to stop several times

Wheel hub



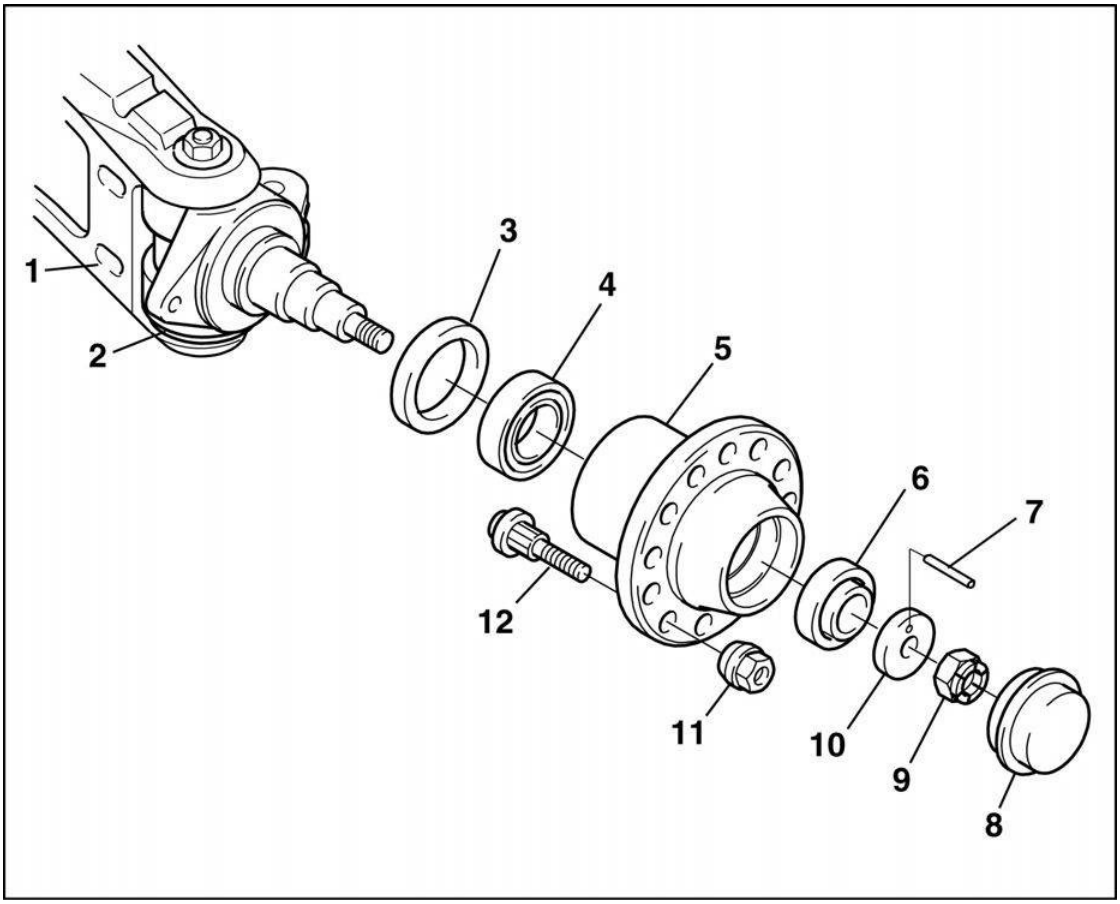
1	Axle casing	7	Slotted spring pin
2	Axle stub	8	Dust cap
3	Radial seal ring	9	Nut
4	Tapered roller bearing	10	Washer
5	Wheel hub	11	Wheel nut
6	Tapered roller bearing	12	Wheel bolt

Dismantling the wheel hub

- Apply the parking brake.
- Prevent the truck from rolling away using chocks at the front wheels.

- Loosen the wheel nuts (11).
- Jack up the truck at the counterweight.
- Remove the wheel.
- Take off the dust cap (8).
- Unscrew the nut (9) and remove along with washer (10), making sure that the slotted spring pin (7) is properly seated while doing so.
- Take off the wheel hub (5).
- Take off the radial seal ring (3).
- Remove tapered roller bearings (4, 6) from the wheel hub.
- If necessary, drive out the outer rings of the tapered roller bearings.

Reassembling the wheel hub



NOTE

- *Check the quality of screws and lubricant, as well as the correct tightening torques.*
- *Values vary according to axle type; see "General technical data" in the chapter entitled "Steering axle".*

– Carefully grease the sealing lips of the radial seal ring.

– Pack the tapered roller bearing between the inner ring and the cage with grease.

– Pack the bearing chamber with grease at the points indicated (x).

– Press in the outer rings of the tapered roller bearings.

– Insert the tapered roller bearings (4, 6) into the wheel hub.

– Fit the radial seal ring (3).

– Attach the wheel hub (5).

– Insert the washer (10) into the slotted spring pin (7) and attach the nut (9).

⚠ CAUTION

Installing the washer in the incorrect position and attaching a nut that has already been used will cause damage to the steering axle.

– The self-securing nut must not be reused. It must always be changed.

– The washer should be installed with the chamfered edge facing the axle.

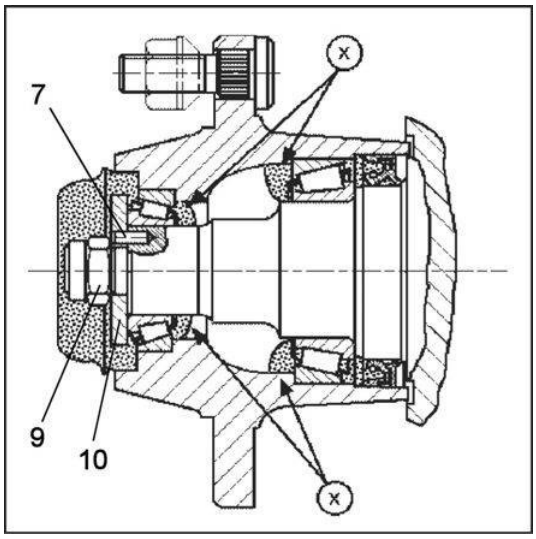
– Tighten the nut (9) by continuously turning the wheel hub.

– Fit the dust cap (8).

– Fit the wheel.

– Lower truck.

– Tighten the wheel nuts (11).



Steering angle

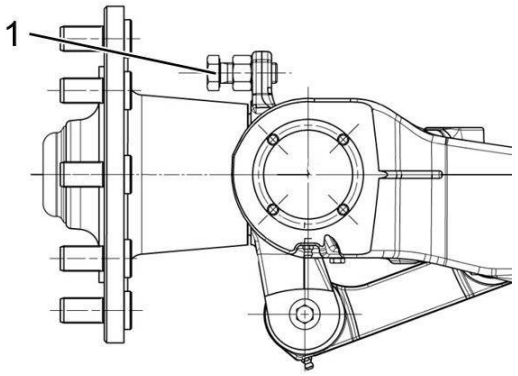
Checking the steering angle

The steering angle must be 80°–82°.

For easier measuring, a supplementary angle can be used. This angle must be 98°–100°.

Setting the steering angle

The steering angle is limited by a stop screw (1) on each side.



⚠ CAUTION

The steering cylinder can be damaged.

It is important to ensure that the steering angle is clearly limited by the stop screws. The stop must not take place in the steering cylinder.

- Set the left and right steering angles to 80°–82° using the stop screws (1)
- Check the opposite angle
- Check for clearance at the points of constriction
- Check that the steering wheel stop does not take place in the steering cylinder

Tie rod

Removing the tie rod

NOTE

A press is required to install the tie rod. For this reason, the steering axle should be completely removed beforehand; see the chapter entitled "Removing and installing the steering axle".

– Remove the steering axle; see the chapter entitled "Removing and installing the steering axle"

– Knock out the slotted spring pins (4)

– Press out the bolts (3)

Installing the tie rod

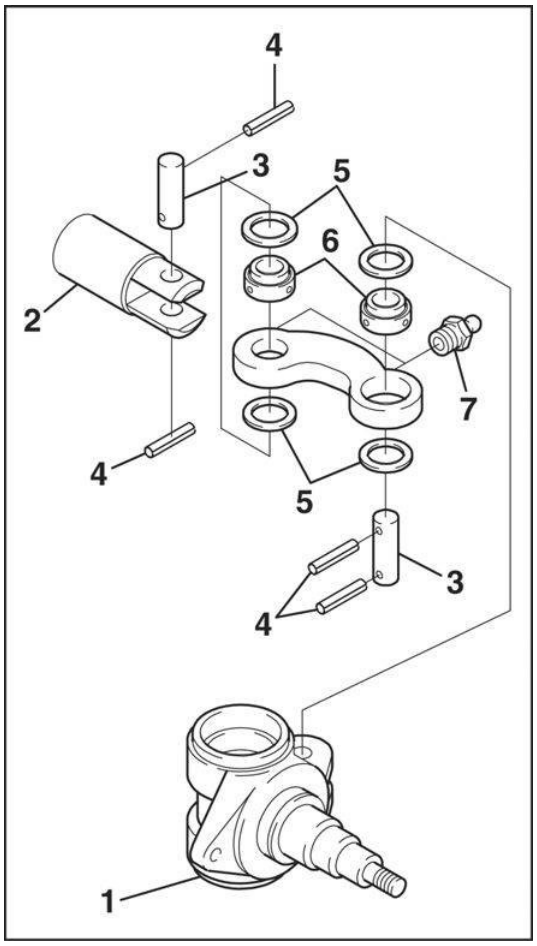
NOTE

- *Observe the press-in force of the bolts.*
- *Values vary according to type of axle; see "General technical data" in the chapter entitled "Steering axle".*

– Lubricate and press-in the bolts (3)

– Tap in the slotted spring pins (4)

– Install the steering axle; see the chapter entitled "Removing and installing the steering axle"



1 Axle stub
2 Steering cylinder piston rod
3 Bolts
4 Slotted spring pin
5 Sealing ring
6 Spherical bearing
7 Conical lubricating nipple

Axle stub

Dismantling the axle stub

NOTE

A press is required to remove the axle stub. For this reason, the steering axle should be completely removed beforehand; see the chapter entitled "Removing and installing the steering axle".

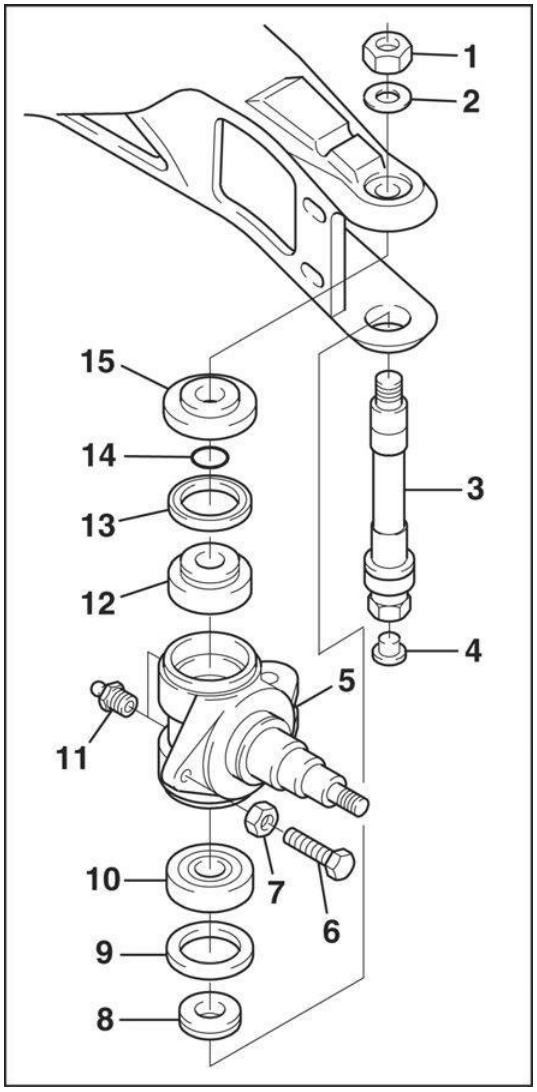
– Drive out the pin between the tie rod and the axle stub
– Slacken the hexagon nut (1)
– Take out the washer (2)
– Drive the steering pivot pin (3) out downwards
– Take the axle stub (5) off the axle
– Take the spacer washers, O-ring, wiper rings and tapered roller bearings (8 - 15) off the axle stub

Reassembling the axle stub

NOTE

- *Check the quality of screws and lubricant, as well as the correct tightening torques.*
- *Values vary according to type of axle; see "General technical data" in the chapter entitled "Steering axle".*

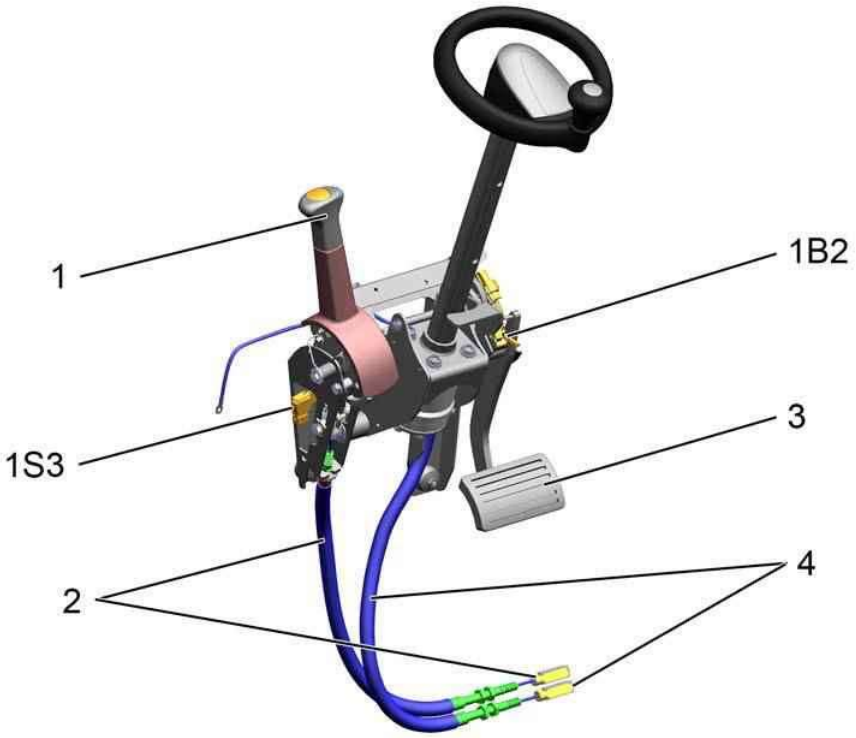
– Grease both tapered roller bearings (10, 12) well and insert them
– Carefully grease the sealing lips of the wiper rings (9, 13)
– Insert the wiper rings (9, 13), both spacer washers (8, 15) and the O-ring (14)
– Insert the axle stub (5) into the axle
– Lightly oil the steering pivot pin (3) and insert it from below
– Fit the washer (2)
– Fit and tighten the new hexagon nut (1)
– Drive in the pin between the tie rod and the axle stub, and secure it with slotted spring pins



1	Hexagon nut
2	Washer
3	Steering pivot pin
4	Sealing plug
5	Axle stub
6	Stop screw
7	Nut
8	Spacing washer
9	Wiper ring
10	Tapered roller bearing
11	Lubricating nipple
12	Tapered roller bearing
13	Wiper ring
14	O-ring
15	Spacing washer

Drive and brake actuation

Brake actuation



1	Handbrake lever	**Switches, transmitters**	
2	Brake cable pull, handbrake	1S3	Handbrake switch
3	Brake pedal	1B2	Brake sensor
4	Brake cable pull, service brake		

The multi-disc brake on the drive axle is activated via two independent actuation elements:

- Handbrake lever

  The hand brake lever effects the brake actuation of the multi-disc brake via the brake cable pull (2)
- Brake pedal

  The brake pedal effects the brake actuation of the multi-disc brake via the brake cable pull (4)

Brake cable changer AE18-05

Removal

– Park the truck safely and secure the truck against rolling away.
– Disconnect battery plug.
– Remove floorplate.
– Remove the panelling on the right-hand side of the front structure

The position of the brake cable depends on the equipment on the truck.

Equipment until June 2007

– Remove the ES bolt (1) from the brake cable in the front structure
– Disconnect the brake pedal return spring (2)



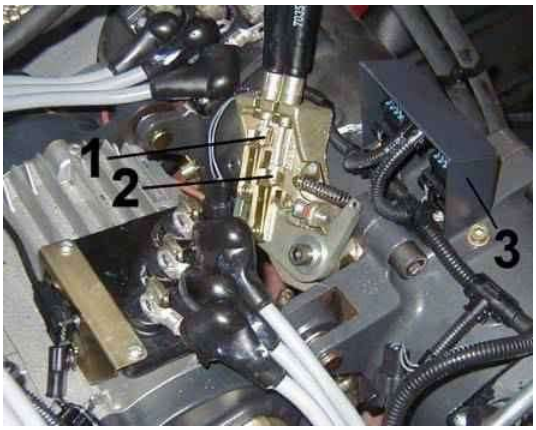
Equipment as of June 2007

– Remove the ES bolt (1) from the brake cable in the front structure
– Disconnect the brake pedal return spring (2)
– Loosen the adjustment nut on the brake cable in the front structure and disconnect the brake cable



Brake lever AE18-05:

– Remove the brake control cover (3) on the drive axle
– Remove the ES bolt from the brake cable (2) on the drive axle
– Remove the securing clips from the brake cable
– Disconnect the brake cable and pull out and down



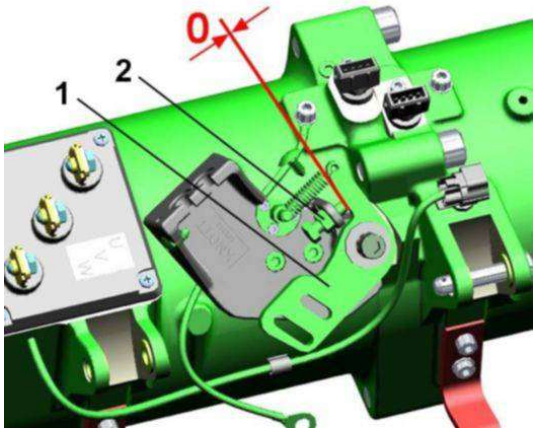
Installation

– Connect the brake cable to the drive axle

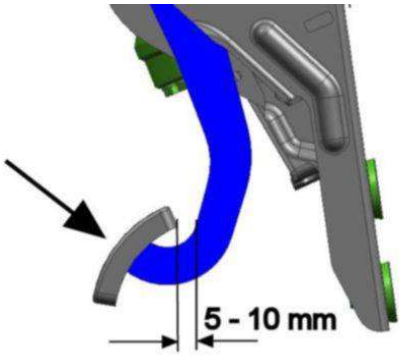
- Fit the brake cable securing clips
- Fit the ES bolt
- Connect the brake cable in the front structure
- Fit the ES bolt
- Connect the brake pedal return spring
- Adjust the brake cable at the adjustment nut
- Fit the brake lever covering to the drive axle
- Fit the panelling in the front structure
- Insert the floorplate
- Connect the battery plug
- Check the service brake for correct operation

Setting the brake cable

If the service brake is not actuated, the brake lever (1) must rest on the adjustment screw (2). The gap between the brake lever and adjustment screw is **0 mm**.



Adjust the brake cable in such a way that there is an actuation distance of **5–10 mm** at the pedal, without the brake lever coming away from the adjustment screw.



NOTE

The presetting of the adjustment screw at the brake lever must not be adjusted.

Brake cable changer AE18-07

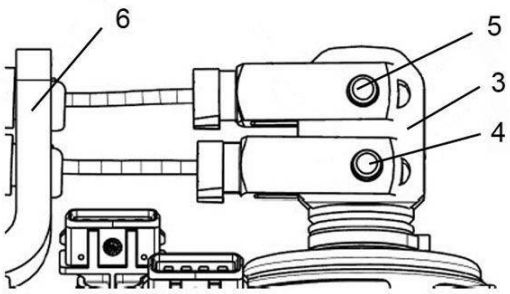
Removal

- Park the truck safely and secure the truck against rolling away.
- Disconnect the battery male connector.
- Remove the bottom plate

– Remove the panelling on the right-hand side of the front structure.
– Remove and detach the s-bolt (1).
– Detach the brake pedal return spring (2).
– Loosen the adjustment nut on the brake cable in the front structure and disconnect the brake cable.



– Remove the brake actuation assembly.
– Remove the s-bolt (4) and detach from the brake lever (3).
– Loosen the adjustment nuts and detach the brake cable from the abutment (6).



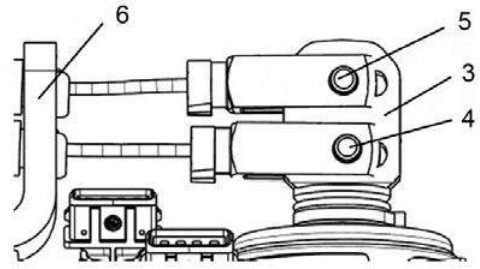
Installation

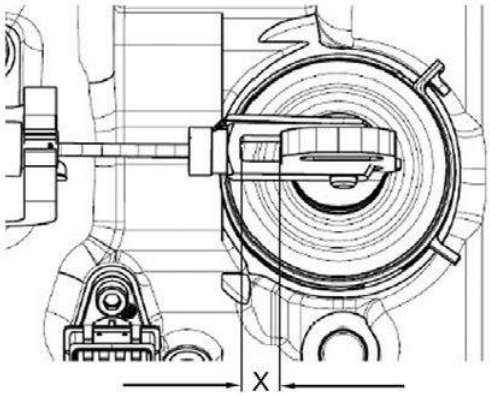
– Connect the brake cable to the drive axle.
– Fit the brake cable securing clips.
– Fit the s-bolt.
– Connect the brake cable in the front structure.
– Fit the s-bolt.
– Adjust the brake cable at the adjustment nut.
– Fit the brake lever cover to the drive axle.
– Fit the panelling in the front structure.
– Insert the bottom plate.
– Connect the battery male connector.
– Check the service brake for correct operation.

Setting the brake cable

When the service brake is not actuated, the brake cable must be adjusted so that a distance of X remains between the fork clevis and the brake lever on the axle.

Setting dimension	Value
X	19 mm





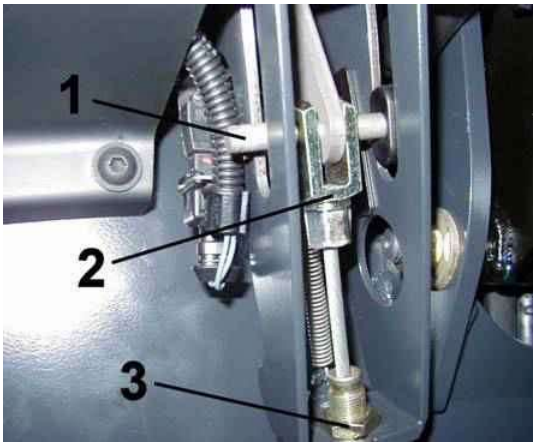
3 Brake lever
4 Service brake cable
5 Parking brake cable
6 Abutment
X Setting dimension

Handbrake cable changer

Removal

- Secure the truck against rolling away
- Disconnect battery plug.
- Remove floorplate.
- Remove the panelling on the left-hand side of the front structure
- Remove the covering from the brake lever on the drive axle

– Loosen the brake cable fastening in the front structure
– Remove the retaining ring and drive out the bolt (1) laterally from the fork clevis (2).
– Loosen the adjustment nut (3) at the brake cable and disconnect the brake cable



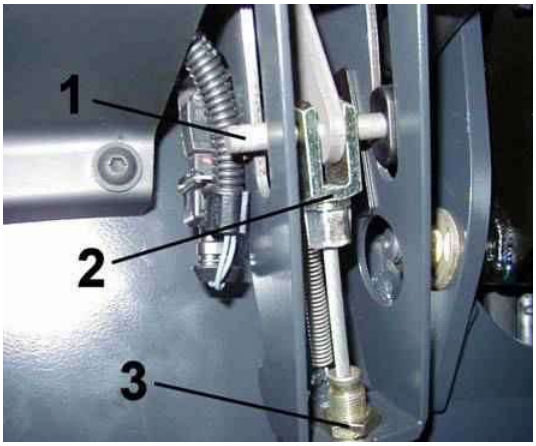
NOTE

The s-bolt on the handbrake cable can only be removed if the s-bolt on the service brake cable has been removed beforehand.

– Remove the s-bolt on the service brake cable at the drive axle.
– Remove the s-bolt on the handbrake cable at the drive axle.
– Remove the securing clips from the brake cable
– Disconnect the brake cables and pull out from below

Installation

– Connect the brake cable and gently screw in the adjustment nut (3) at the brake cable
– Drive the bolt (1) laterally into the fork clevis (2) and secure with the retaining ring.
– Attach the handbrake cable to the actuation unit at the drive axle and secure using an s-bolt.
– Attach the service brake cable to the actuation unit at the drive axle and secure using an s-bolt.
– Fit the brake lever covering to the drive axle
– Adjust the brake cable.
– Fit the panelling in the front structure
– Insert the floorplate
– Connect the battery plug
– Test the handbrake function.



Actuating force of the handbrake

Adjustment

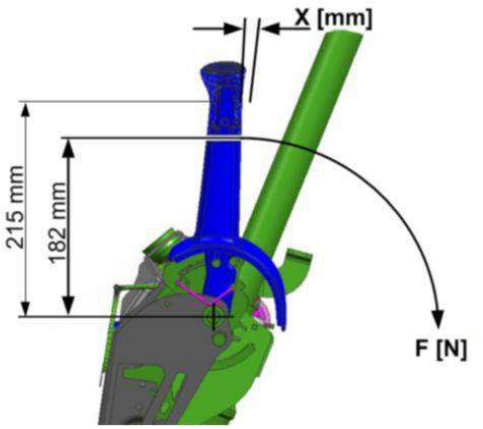
Truck	Drive axle	X [mm]	Force F [N] at 215 mm	Force F [N] at 182 mm
RX20-14-20, RX60-16-20	AE18-05	8	85 ±8	91 to 110

RX20-14-20, RX60-16-20	AE18-07	8	130 ±5	148 to 159
RX20-14-20 Facelift 2014	AE18-09	8	130 ±5	148 to 159
RX60-25-35	EC35	5	105 ±8	115 to 133
RX60-40-50	EC50	5	105 ±8	115 to 133
RX70-16-20	AD20E-02	8	100 ±8	109 to 128
RX70-22-35	8.20	4	125 ±8	138 to 157
RX70-40-50	EC50I	5	105 ±8	115 to 133

The handbrake lever must have a free travel of at least **X** without the brake lever detaching from the stop screw. There is then no noticeable tension in the cable. See the chapter entitled "Changing the brake cable for the handbrake".

Adjust the handbrake cable to set the specified actuating force.

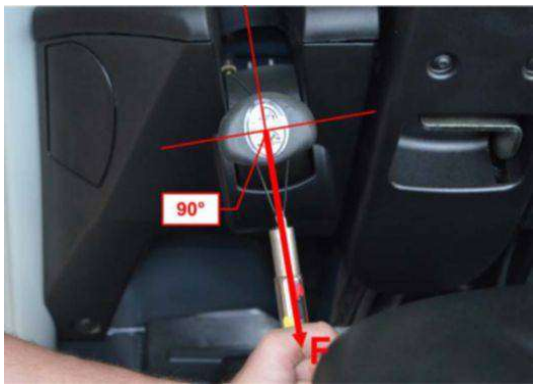
The maximum actuating force is set at approx. $^{2}/_{3}$ to $^{3}/_{4}$ of the actuation distance and then decreases again.



– Attach the spring force meter to the handbrake lever using a cable tie. Lay the cable tie into the groove beneath the movable handle.



– Actuate the handbrake lever using the spring force meter.



NOTE

The direction of movement must be observed in order for the actuating force to be displayed correctly. See the diagrams.

– Read off the maximum actuating force while actuating the lever.
– To increase the actuating force, adjust the lock nuts in the direction of the brake lever.
– To reduce the actuating force, adjust the lock nuts in the opposite direction.

NOTE

The cable tie prevents the handbrake from engaging during the test.

Parking brake switch 1S3

General

The parking brake switch 1S3 is located on the left-hand side in the front structure, behind the parking brake lever.

The parking brake switch is an NO contact, i.e. when it is not actuated it is open (normally open), whereas when it is actuated it is closed.

The switch is closed when the parking brake is not actuated. The traction drive is activated.



If the parking brake is actuated, the switch is open. The traction drive is switched off.



The parking brake switch is set by loosening the screws and moving the support.

⚠ WARNING

If the parking brake is only slightly engaged, the truck will roll as the electrical brake that keeps the truck in place is not functioning.

If the truck is parked on a ramp, the parking brake must be securely engaged

Electrical connections

The parking brake switch 1S3 is connected directly to the truck central control.

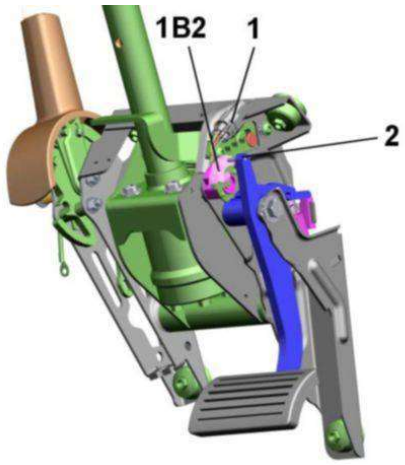
2-pin JPTimer 1S3		
1S3/1	X46/3	Handbrake
1S3/2	X46/17	GND-S handbrake

Brake sensor

Brake sensor 1B2

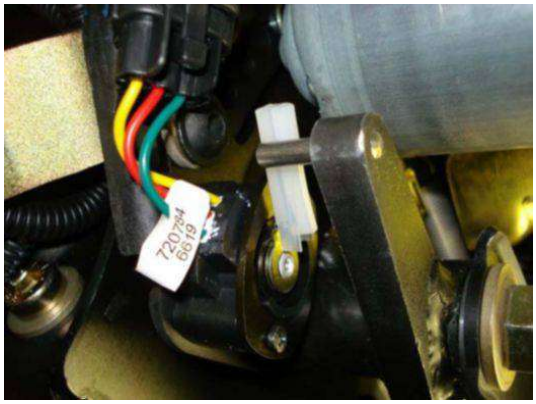
The brake sensor 1B2 is tightly screwed to the right side part of the operating unit and connected to the truck control unit (MCU) via the plug (1).

The brake sensor is a potentiometer that is adjusted by a tappet (2) on the brake pedal.



Electrical connections

3-pin mark II plug 1B2			
1B2/1	Yellow	X46/41	+12 Volt-S
1B2/2	Red	X46/13	Signal
1B2/3	Green	X46/27	GND-S



Setting

When the brake pedal is in the inactive position, the brake sensor must be adjusted so that the output signal is within the valid value range.

Truck	Ideal value	Value range
RX20	1.3 V	1.0–1.6 V
RX60	1.3 V	1.0–1.6 V

Calibration

A calibration must always take place after the brake sensor has been replaced.

– Connect the notebook to the truck and start the truck diagnostics:

```
Action
▼
Calibration
▼
0.  Sensors
```

Once calibration is complete, error messages may be displayed.

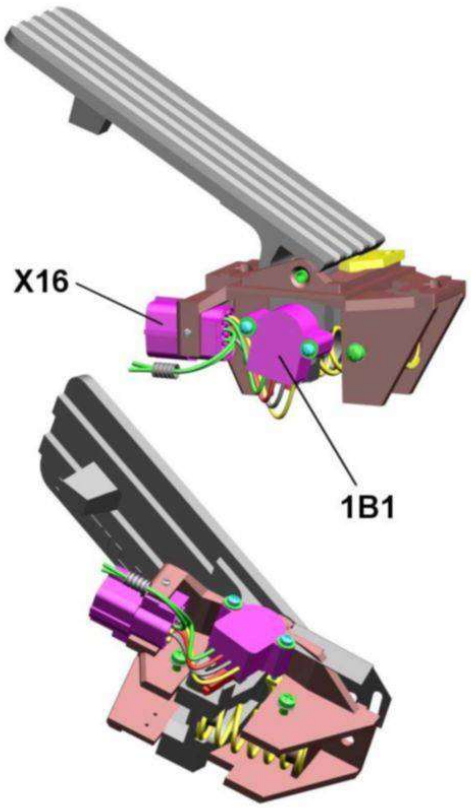
Accelerator — single-pedal

Accelerator

The accelerator comprises the accelerator pedal and a double-action potentiometer 1B1.

The accelerator pedal is fitted on a permanently greased, sealed shaft in the housing and is held in place at the lower end in its inactive position by a compression spring.

Driving speed is regulated by potentiometer 1B1 when the accelerator pedal is pressed.



Removing the accelerator

– Remove floor plate.
– Disconnect plug X16 from the accelerator
– Loosen the polystop nuts
– Remove the accelerator from the floorplate from below.

Configuration

The configuration must be parameterised again for all retrofitting and conversions related to the accelerator and drive direction.

This affects the following components:

- Single pedal
- Double pedal
- Joystick, tip switch, mini-lever
- Lift lever
- Direction indicator module

Parameterisation takes place using the truck diagnostics in the notebook.

Calibration

Calibration must always take place after the accelerator has been changed.

– Connect the notebook to the truck and start the truck diagnostics:

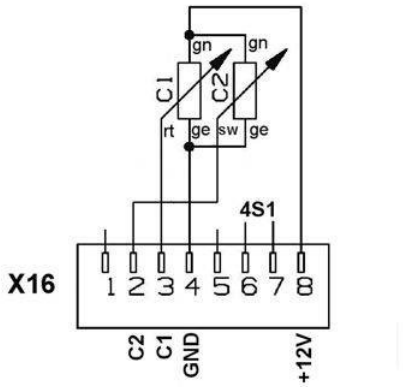
```
Job
▼
Calibration
▼
1.  Accelerator
```

Once calibration is complete, error messages may be displayed.

Possible causes:

- Operating error
- Timeout during calibration
- Value of accelerator's inactive position is outside the valid range
- Voltage increase does not lie within the valid range

Electrical connections



8-pin Mark II plug X16			
X16/1	Free		
X16/2	1B1 - C2/sw	Black	Signal C2
X16/3	1B1 - C1/rt	Red	Signal C1
X16/4	1B1 - C1/C2/ge	Yellow	GND accelerator
X16/5	Free		(Horn button)
X16/6	Free		(Horn button)
X16/7	Free		
X16/8	1B1 - C1/C2/gn	Green	12 Volt accelerator

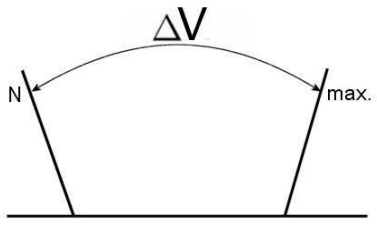
Testing

Checking	Measuring points	Measured values [Volt]	Correction
Supply voltage	X16/4 - X16/8	11.05 - 12.05	
C1 accelerator not actuated	X16/4 - X16/3	5.5 - 6.5	Correction by turning the potentiometer.
C2 accelerator not actuated	X16/4 - X16/2	5.5 - 6.5	Correction by turning the potentiometer.
C1 accelerator fully actuated	X16/4 - X16/3	8.2 - 11.0	Correction by turning the support.
C2 accelerator fully actuated	X16/4 - X16/2	1.0 - 3.8	Correction by turning the support.
GND breakdown detection		11.5	
VCC breakdown detection		0.5	

Voltage increase

The difference in voltage between the transmitter's inactive position (N) and maximum actuation (max) is designated as the potentiometer voltage increase.

At maximum actuation, the voltage must be at least **2 Volt** (up to maximum **5.4 Volt**) higher than in the neutral position (N).



Errors	
Voltage increase too small	The maximum speed is not achieved
Voltage increase too large	No problem for the evaluation ► The maximum speed is reached but not exceeded. ► The end range of the voltage increase is ignored by the controller (dead travel)
Voltage increase significantly too large	Detection of breakdown with corresponding error message

Accelerator pedal, generation 2

Function

The accelerator pedal consists of two plastic parts, the pedal and the base, which are connected to each other by an axle. The accelerator pedal is attached to the bottom plate via two screws.

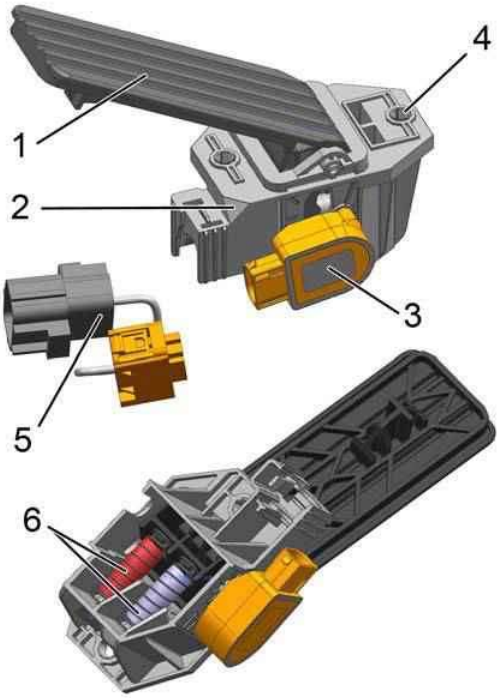
Two compression springs hold the pedal in its inactive position. The compression springs contain different-coloured foam. The colour of the foam provides information on the production batch of the springs. For safety reasons, the pedal should never be equipped with two springs from the same product batch. In addition, the foam also reduces noise made by the springs. The foam has large pores so that it does not become saturated with water.

The accelerator is a contactless inductive sensor.

NOTE

The accelerator pedal will be included in the current series from CW31/2017. As the wiring harness has not been modified, an adapter cable is required.

- *Adapter cable without signal horn cable*
- *Adapter cable with signal horn cable*



1 Pedal
2 Basis
3 Sensor 1B1
4 Fastening bushes
5 Adapter cable without signal horn cable
6 Springs with foam

Technical data

Plug	6-pin MQS (AMP)
Supply voltage	12 V ± 8%

Protection class	IP64
Temperature range	-40° to +65°C

Parameterising

The configuration must be parameterised again for all retrofitting and conversions related to the accelerator and drive direction.

The following components are affected:

- Single pedal
- Dual pedal
- Joystick, fingertip and mini-lever
- Hand lever
- Turn indicator module for the drive direction

Parameterisation is performed using the truck diagnostics in the notebook.

Calibration

Calibration must always take place after the accelerator has been replaced.

– Connect the notebook to the truck. Start the truck diagnostics:

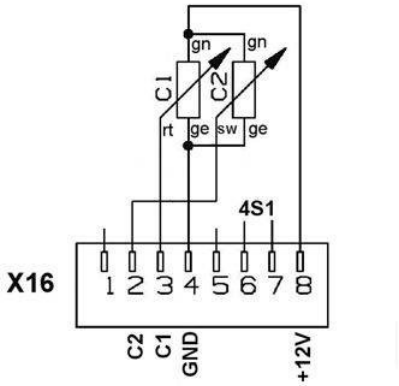
```
Action
  ▼
Calibration
  ▼
1.  Accelerator
```

Once calibration is complete, error messages may be displayed.

Possible causes:

- Operating error
- Timeout during calibration
- Value of the transmitter's inactive position is outside the valid range
- Voltage increase is not within the valid range

Electrical connections

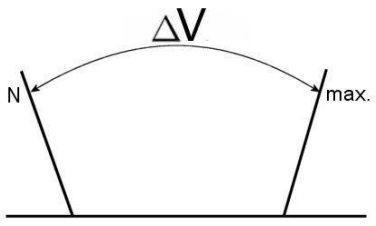


Sensor	MQS plug	Mark II plug	
1B1 - GND	Pin 1	X16/4	GND accelerator
Unassigned	Pin 2	X16/1	Unassigned
Unassigned	Pin 3	X16/7	Unassigned
1B1 - signal A	Pin 4	X16/2	Channel 2
1B1 - VCC	Pin 5	X16/8	12 V accelerator
1B1 - signal B	Pin 6	X16/3	Channel 1
Unassigned		X16/5	Horn button (variant)
Unassigned		X16/6	Horn button (variant)

Check

Check	Measuring points	Measured values [Volt]	Correction
Supply voltage	X16/4 - X16/8	11.05 - 12.05	The sensor is adjusted for the accelerator pedal by the manufacturer. It is not possible to perform a subsequent adjustment. In the event of a fault, the entire accelerator pedal must be replaced.
C1 accelerator not actuated	X16/4 - X16/3	5.5 - 6.5	
C2 accelerator not actuated	X16/4 - X16/2	5.5 - 6.5	
C1 accelerator fully actuated	X16/4 - X16/3	8.2 - 11.0	
C2 accelerator fully actuated	X16/4 - X16/2	1.0 - 3.8	
GND breakdown detection		11.5	
VCC breakdown detection		0.5	

Voltage increase



The difference in voltage between the transmitter's inactive position (N) and maximum actuation (max) is referred to as the potentiometer voltage increase.

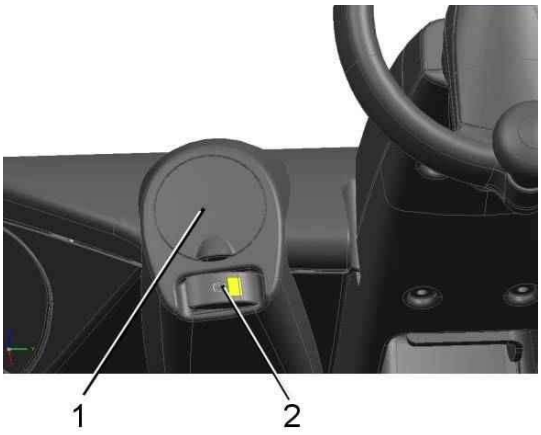
At maximum actuation, the voltage must be at least **2.0 V** and up to a maximum of **5.4 V** higher than in the neutral position (N).

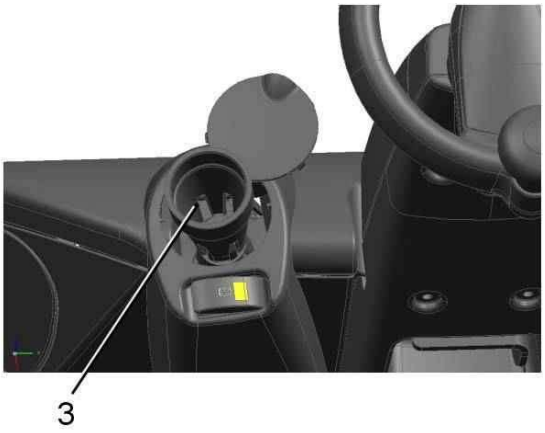
Errors	
Voltage increase too small	The maximum speed is not reached
Voltage increase too large	No problem for the evaluation ► The maximum speed is reached but not exceeded. ► The end range of the voltage increase is ignored by the controller (dead travel)
Voltage increase significantly too large	Detection of breakdown with corresponding error message

Electric parking brake

Electric parking brake

General





1 Cover
2 Actuation push button with LED
3 Hand wheel

The electric parking brake is available as a variant for the following trucks:

Type carrier	Available from
6209 - 6217	12/2009
6311, 6313, 6315	12/2009
6321 - 6325, 6361 - 6364	12/2009
6326 - 6330, 6367 - 6369	12/2009

NOTE

It is not recommended to retrofit the electric parking brake because it takes a lot of effort.

Key functions

The electric parking brake applies the mechanical brake to the axle, via a brake cable. It prevents the brake from releasing again when the truck is switched off.

The brake can be released and applied by actuating the push button. All of the necessary approvals, e.g. seat switch and switch lock, are required for releasing the brake. The parking brake also offers automatic assistance and comfort features, which apply the brake automatically and release it again in certain situations.

Why an electric parking brake?

- The driver's inattentiveness can be compensated for by the automatic brake function.
- Improved work flow, especially during order picking.
- Automatic actuation of the electric parking brake in defined operating statuses (parking assistant).
- Automatic release of the electric parking brake when setting off.
- The driver can press the actuation button as an alternative method of actuation.
- Good integration into the overall safety and comfort concept
- Standard components for all trucks.
- No unintentional, abrupt braking.
- More accurate detection of the brake condition.
- Low energy consumption.

Function

Operating mode

The function of the electric parking brake is dependent on the parameterised operating mode. Parameterising takes place using the truck diagnostics. The function of the electric parking brake cannot be derived from the operating mode designation.

⚠ CAUTION

The secure operating status of the electric parking brake is dependent on the parameterised operating mode and drive mode.

- The electric parking brake must only be operated in the "automatic applying/releasing" mode.
- All drive programs must be set in the "speed-controlled drive mode".
- The StVZO option must not be adjusted.

Mode:

- Automatic applying/releasing

  Only this mode is permitted for operation by the customer!
- Automatic applying/releasing with button

  This mode is only permitted for test operation by a service engineer.
- Applying and releasing with button only

  This mode is only permitted for test operation by a service engineer.

Automatic applying/releasing	
Automatic releasing	If all the approvals required to drive the truck are present, the brake is released when the accelerator is actuated. **Exception**: If it is absolutely necessary to release the brake via the button, see below.
Releasing the brake via the button	If the brake has been applied via the button, it must also be released on this occasion via the button. Afterwards, automatic releasing is active again.
	Every time the electrical system is switched on via the switch lock or emergency off, the brake must be released once via the button. Afterwards, automatic releasing is active again.
Automatic applying	If the truck is at a standstill, the brake is applied after a set period of time, depending on the operating situation.
Applying the brake via the button	Pressing the button applies the brake if the truck is at a standstill.
	Pressing the button has the same effect as releasing the accelerator. This procedure can be parameterised. **Example**: In speed-controlled handling performance mode, the drive brakes the truck with the dynamics of the set drive programme.
	The request is saved while the truck is travelling unpowered. The brake is applied as soon as the truck comes to a standstill. **Example**: After the emergency off switch has been actuated

Emergency operation via the hand wheel

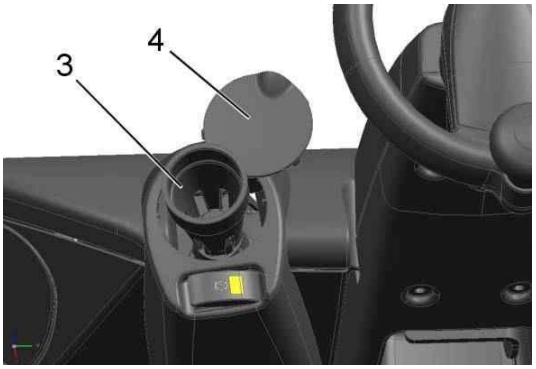
In emergency operation or during transport without a battery, the electric parking brake can be operated manually via the hand wheel.

⚠ WARNING

Risk of injury from the moving parts in the electric parking brake.

The electric parking brake must be operated via the hand wheel only when in a voltage-free state.

- Turn the key switch OFF. The display and operating unit must be switched off.
- Open cover (4), take hand wheel (3) and place it upside-down on the tappet. ▷
- Press the hand wheel down against the spring force and turn.
- To apply the parking brake, turn the hand wheel clockwise until the force is considerably increased and the truck is held securely. The required effort is not great.
- To release the brake from the applied position, turn a maximum of 5 revolutions in an anti-clockwise direction, or until the limit position switch is activated. The hand wheel can then be turned smoothly. Do not release the hand wheel to the stop, as this will trigger the central lubrication device.



Order picking mode

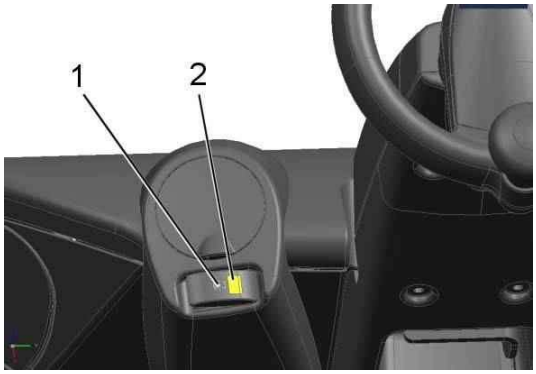
Order picking mode is always active as standard. This mode reduces the mechanical stress on the electric parking brake and therefore extends its service life.

If the truck is left switched on or is at a standstill for a prolonged period of time on level ground, the electric parking brake is applied with reduced power.

If the truck is on a slope or the enabling of the switch lock or emergency off switch fails, please apply the electric parking brake fully.

LED status

The behaviour of the LED indicates the current operating status of the parking brake. The LED illuminates with a steady light, flashes or does not light up.



LED	Parking brake status.
LED illuminates with a steady light	► Parking brake is applied correctly
LED does not light up	► Parking brake is released. The truck is ready for operation.
	► Undefined parking brake status after being restarted ► The controller cannot detect the parking brake status after the restart Actuating the button causes the parking brake to release until the limit position switch is activated — reference position
LED flashes	► Operating error caused by the driver ► Error status with error code and message in the display ► The electric parking brake has not registered correctly in the truck parameters

Cause and effect

When restarting the truck

Switch lock	LED	Brake status	Display	Comment
Seat switch actuated				
ON (V engine running, alternator engaged)	OFF	Undefined	► After actuating the accelerator: `Release the parking brake`	► Reference drive: The parking brake releases after the button is pressed
ON (V engine running, alternator engaged)	Lights up	Applied	► After actuating the accelerator: `Release the parking brake`	► Reference drive: The parking brake releases after the button is pressed **Note**: Obsolete software version 0.32
Seat switch actuated, parking brake has been released via the hand wheel				
ON (V engine running, alternator engaged)	Flashing	Released	`Apply the parking brake`	► Parking brake was released to the limit position switch ► Truck is ready for operation ► LED goes out immediately after start-up

Switch lock	LED	Brake status	Display	Comment
ON after seat switch turned actuated (V engine running, alternator engaged)	Flashing	Released	`Apply the parking brake`	▸ Start V engine ▸ Parking brake was released to the limit position switch ▸ Truck is ready for operation ▸ LED goes out immediately after start-up
ON (V engine running, alternator engaged)	OFF	Undefined	Short flare-up: `parking brake active`	▸ Parking brake was only released slightly ▸ Reference drive: The parking brake releases after the button is pressed

Automatic applying/releasing

The electric parking brake can only be automatically released if it was previously automatically applied.

If the electric parking brake was actuated via the push button, it can also only be released via the push button.

Automatic applying	
▸ Truck is at a standstill ▸ Key switch ON ▸ Seat switch actuated ▸ Accelerator not actuated	▸ The parking brake is applied after a parameterised time period ▸ LED lights up with a steady light
▸ Truck is at a standstill ▸ Key switch ON ▸ Seat switch not actuated	▸ The parking brake is applied after a parameterised time period ▸ LED lights up with a steady light
▸ Stopped on a slope ▸ Seat switch actuated ▸ Accelerator not actuated	▸ The truck does not roll downhill and the setpoint value of 0 km/h is maintained via the traction motor ▸ The parking brake is applied after a parameterised time period ▸ LED lights up with a steady light
▸ Key switch OFF	▸ The parking brake is applied immediately ▸ LED is lit constantly until the electrical system switches off after a time delay

Automatic releasing	
▸ Truck is at a standstill ▸ Key switch ON ▸ Seat switch actuated ▸ Single pedal: drive direction selected, accelerator actuated ▸ Dual pedal: accelerator actuated	▸ Parking brake releases audibly ▸ LED goes out

Emergency off switch

Behaviour upon emergency off	
► Truck is driving ► Emergency off switch actuated	► Truck rolls to a stop ► The parking brake is applied as soon as the setpoint value 0 km/h is reached
► Release emergency off switch	► Situation as if restarted ► Release the parking brake via the push button

Design and system description

Format

The electric parking brake consists of a drive unit (3) that is integrated into the console (5) of the operating unit (steering column, brake pedal).

The drive unit consists of an electric motor, a spindle drive and an incremental transducer. The spindle drive consists of a ball bearing-mounted spindle nut and a trapezoidal spindle. The tension rod (6) is pin-jointed with the trapezoidal spindle.

The electric motor turns the spindle drive, which moves the tension rod in both directions. The brake cable (9) is hooked onto the tension rod.

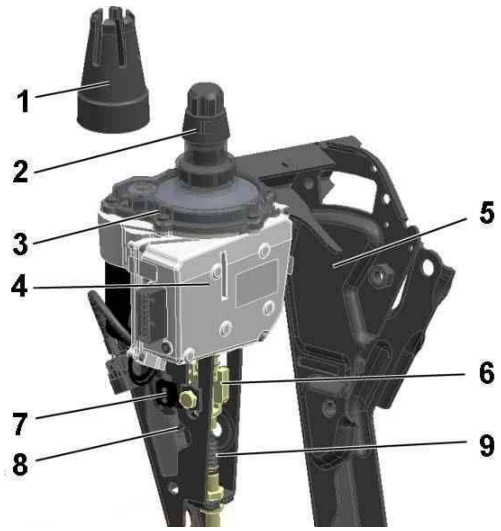
The incremental transducer sends pulses to the controller once the electric motor is turning.

The electronic control (4) provides safety monitoring and, depending on the parameterising, automatic actuation of the parking brake.

The limit position switch (7) is used to reference the zero position.

The central lubrication device (8) lubricates the spindle drive with a small amount of grease after a specific number of cycles. The central lubrication device is driven by the controller and is actuated by the tension rod. During this process, the tension rod moves a few millimetres beyond the normal zero position and thus actuates the lever for the central lubrication device.

The central lubrication device can also be actuated manually via the hand wheel (1). This should not take place unless necessary, as the grease supply will otherwise be used up too quickly.



1 Hand wheel
2 Tappet for hand wheel
3 Drive unit
4 Controller
5 Console
6 Tension rod
7 Limit position switch
8 Central lubrication device
9 Brake cable

Software version

The described functions of the electric parking brake are dependent on the software version. Where possible, an up-to-date software flash package must be loaded; see chapter entitled "Software compatibility".

NOTE

The StVZO (German Road Traffic Licensing Regulations) and the torque-regulated handling performance options are not supported in trucks with an electric parking brake.

Controller ELF

The controller consists of a control processor SR and a monitoring processor UR. The control processor processes the incoming data and activates the power module. The monitoring processor tests the incoming data for plausibility and monitors the motor movements. Both processors can block the activation of power in the event of a fatal error.

The controller ELF determines when the brake is released or applied, and engages with the drive unit via the CAN bus in order to brake the drive to a standstill or to initialize the drive before releasing the brake at the holding torque (smooth start-up). The controller ELF also analyses CAN data from the truck control unit and detects the respective operating situation. The data analysed by the controller includes the actual speed and the actual torque of the drive unit.

Maintenance instructions

NOTE

- *The maintenance intervals relate to the operating hours of the truck.*
- *The operating hours of the electric parking brake are counted separately and are the specifications used for the maintenance of the central lubrication device.*

1000 operating hours

Visual inspection		
All movable components	Visible wear	► If necessary, replace components
Brake cable	Visible wear	► If necessary, replace brake cable
Central lubrication device	Strong contamination that impairs function	► Clean the central lubrication device; replace if necessary
Lubrication hose and upper part of the grease cartridge	Abnormalities such as large air bubbles or discolouration of the grease	► Replace the central lubrication device
Rack rail position		See the chapter entitled "Central lubrication device"
Reading out values via the diagnostics		
Reading out the error memory	For error codes, see error list	► If necessary, perform the measures according to the error list
Read out the increments	Check the repeatability of the values	► Carry out calibration ► Adjust brake cable if necessary ► Adjust limit position switch if necessary
Number of times the parking brake is applied	100,000 actuations	► If limit values are exceeded, the components must be replaced.
Number of actuations of the actuation push button	Value can be read out via the diagnostics from mid-2013 onwards. **Limit value:** 5 years	
Number of relubrications	Value can be read out via the diagnostics from mid-2013 onwards. **Limit value:** 20,000 operating hours of parking brake	See the chapter entitled "Central lubrication device"

Five-year maintenance

Function	Values	Measures
All maintenance steps for the 1000 and 2000 operating hour maintenance intervals must be carried out.		
Actuation push button	**Limit value:** 5 years	Replace actuation push button

Checking the brake

Following maintenance work or during the course of the regular security checks in accordance with FEM 4.004, a brake test must be carried out on the electric parking brake. This can be performed in two different ways:

- Check the holding power of the parking brake at the maximum permissible gradient for this truck. If there is not a slope with a corresponding gradient on-site, tests must be carried out on a gradient of at least 15%.
- Brake the truck during travel using the parking brake and measure the braking distance.

The two test methods are described below.

NOTE

The permitted braking distances are summarised in the FEM 4.004 test log book.

Checking the holding power at the maximum permissible gradient

– Pick up the maximum permissible load for the truck.

NOTE

If the maximum permissible load for the truck cannot be picked up because such a load is not available where you are, the greatest load usually carried at the respective place of use should be used. This must then be noted in the test report.

– Drive up the gradient with the load facing forwards.

– Stop the truck on the gradient without using the service brake.

– Shut down the truck with the key switch.

– Wait until the display has turned off. If the parking brake was able to hold the truck during this period and it did not roll back, the holding power is sufficient.

NOTE

The brake retardation attainable is the maximum drivable gradient in %.

Braking the truck using the electric parking brake

– Carry out the brake test in both drive directions. When testing in the opposite direction to the

load (drive direction backwards), pick up the maximum permissible load, if possible.

⚠ CAUTION

Risk of the load slipping during the brake test.

- Carry out the brake test in the opposite direction to the load only.
- Always carry out the brake test in the load-side direction **without** a load.

⚠ CAUTION

Risk of the load slipping during the brake test.

Before carrying out the brake test, secure the load with suitable devices so that it cannot slip or fall down.

NOTE

If the maximum permissible load for the truck cannot be picked up because such a load is not available where you are, the greatest load usually carried at the respective place of use should be used. This must then be noted in the test report.

To ensure that the electric parking brake is applied whilst the truck is still moving and not once it has already come to a halt, the truck first needs to be put in "service mode".

- Switch to service mode via the display on the operating unit. To do this, change the following parameters:

Service address	Value	Description
A 00 103	02	Hydraulics block when no weight is detected on the seat (standard value)
	00	Hydraulics block when no weight is detected on the seat cancelled (service mode)
A 00 1E8	01	Display error list (standard value)
	00	Do not display error list (service mode)

- Reset the truck.

⚠ CAUTION

Risk of injury! An intact electric parking brake brakes the truck very hard.

- During the brake test, **always** fasten the seat belt and hold on tightly.
- Secure any loose objects in the driver's cab or remove them completely.

- Accelerate the truck.
- While travelling, actuate the switch for the electric parking brake. Depending on the condition of the parking brake, the truck will brake hard.

NOTE

When applying the electric parking brake, the accelerator must be pressed down and held. Failure to do so would also cause the electric service brake to be applied, which would falsify the test result.

⚠ CAUTION

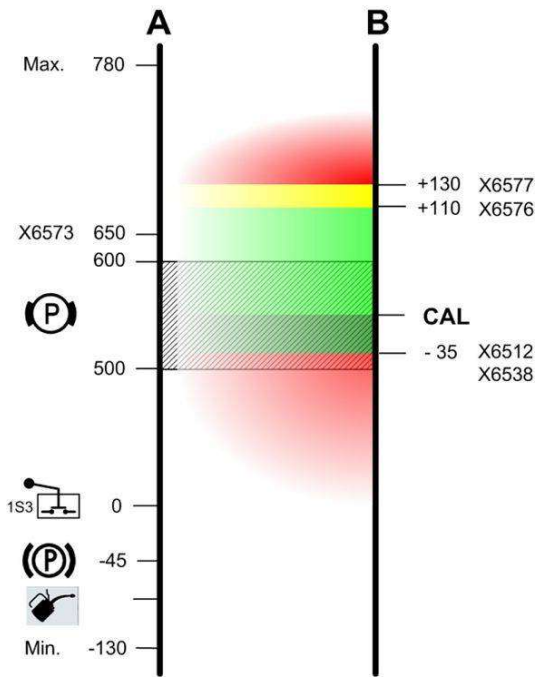
Due to the above-mentioned change made to the parameters, the truck is **not** safe for operation. The truck may **not** be given to the customer in this condition!

- Once the brake test on the electric parking brake has been completed, both parameters must be changed back to their original status (standard value). Failure to do so would cause the hydraulics blocking function in accordance with ISO to be cancelled.
- Only after this has been done may the truck be given back to the customer.

Calibration and functional test

Increments

(A) Absolute limit values	
780	Maximum value: Until the zero position is detected after switching on
650	"Calibration error" error threshold
500 to 600	Standard range for calibration value
0	Zero position Switching point of limit position switch 1S3
Approx. -45	"Brake released" inactive position
-90 to -130	Central lubrication device provides a portion of grease
-130	Minimum value: Lower stop
(B) Limit values relative to the calibration value	
CAL + 130	"Cable break" error threshold
CAL + 110	"Cable break" warning threshold
+ 110 until CAL	"Brake fully actuated "tolerance range
CAL	"Brake fully actuated" calibration value
CAL until -35	"Brake fully actuated "tolerance range
CAL -35	"Brake not applied" error threshold



Calibration

After work has been performed on the electric parking brake (drive unit, central lubrication device, brake cable, limit position switch), calibration must always be carried out.

⚠ WARNING

Risk of fingers being crushed upon actuation of the electric parking brake!

- Do not touch the brake cable during calibration.
- Before carrying out adjustment work on the brake cable, the battery male connector must always be disconnected.

- Connect the battery male connector.
- Connect the notebook to the truck and start the truck diagnostics:
- Start calibration.

```
Actions
▼
Calibration
▼
9. Electric parking brake
```

Calibration is carried out automatically, during which the electric parking brake is applied and released several times.

- Reset the truck after every calibration.
- Read out increments.

```
F4: Monitor
▼
Electric parking brake
▼
Increments
```

Values	
550	Calibration value to be aimed for (middle of the standard range)
>> 550	Shorten brake cable
<< 550	Extend brake cable
50	Corresponds to 2 revolutions of the adjustment nut (2 revolutions ≙ 46.3 increments)

- Function test

The calibration must be carried out anew after each time the brake cable is adjusted.

Error during calibration

The calibration may fail and abort with an error message. This is commonly attributed to the following two instances:

- The increments are not within the valid range for calibration values.

  Standard range for calibration value

  "Calibration error" error threshold
- The repeatability of the travel is so different that calibration is implausible:

  Limit position switches are incorrectly adjusted or faulty.

  Too much play in the brake cable suspension (screw, nut, wear strips)

NOTE

At low temperatures, the calibration requires several cycles until a static value is set.

Function test

⚠ WARNING

Risk of fingers being crushed upon actuation of the electric parking brake!

– During the function check, the brake cable must not be touched.

– Before carrying out adjustment work on the brake cable, the battery male connector must always be disconnected.

– Connect the battery male connector.

– Connect the notebook to the truck and start the truck diagnostics:

F4: Monitor

▼

Electric parking brake

▼

Increments

– Apply and release the electric parking brake.

– While doing so, read out the values in the "applied" and "released" positions in the "increments" field.

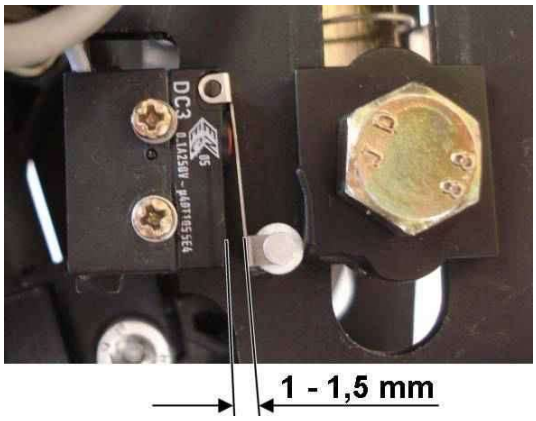
– Repeat this process 3 times.

If the values in the three processes deviate from each other considerably, the limit position switch has been incorrectly adjusted or is faulty; see the chapter entitled "Limit position switch"

If the values are the same in each of the processes, please check the following:

– Disconnect the battery male connector.
– Jack up the front of the truck.
– Release the electric parking brake using the hand wheel until the limit position switch is securely actuated. (After the click, the switch has a further 50% of remaining free travel); see the chapter entitled "Limit position switch"

After releasing the electric parking brake, the front wheels must be able to be easily turned by hand. The brake lever on the axle must lie against the stop screw; see the chapter entitled "Changing the brake cable".



Changing the parking brake cable

Removal

⚠ WARNING

Risk of fingers being crushed by automatic actuation of the electric parking brake!

It is essential that the electric parking brake power supply is disconnected.

– Park the truck safely and secure the truck against rolling away.
– Disconnect the battery male connector.
– Release the parking brake fully using the hand wheel.
– Remove the panelling in the area of the electric parking brake.
– Loosen the brake cable mounting in the front structure.

– Remove the screw and the wear strips (1), disconnect the brake cable from the tension rod (2), loosen the nut or locking ring (3) and unhook the brake cable.
– Remove the bottom plate.
– Release the brake cable from the brake lever on the drive axle.
– Detach the brake cable from the counter bearing and pull it downwards and out.

Installation

– Attach the brake cable to the counter bearing on the drive axle.
– Connect the brake cable to the brake lever and guide upwards to the parking brake.
– Connect the brake cable to the tension rod (2) and install the screw with the wear strips (1). Secure with a nut or locking ring (3).

NOTE

Only brake cables with washers (X) may be used.

⚠ CAUTION

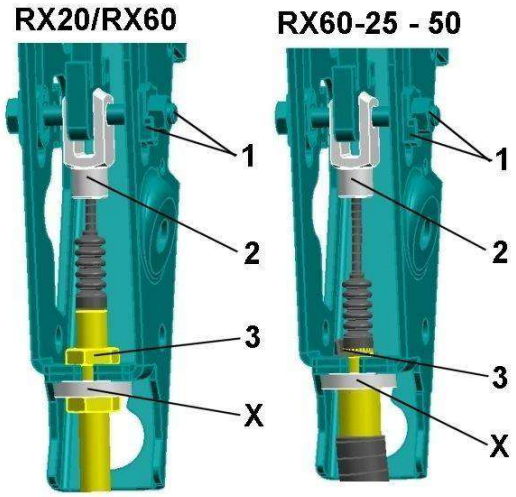
The console must not be deformed.

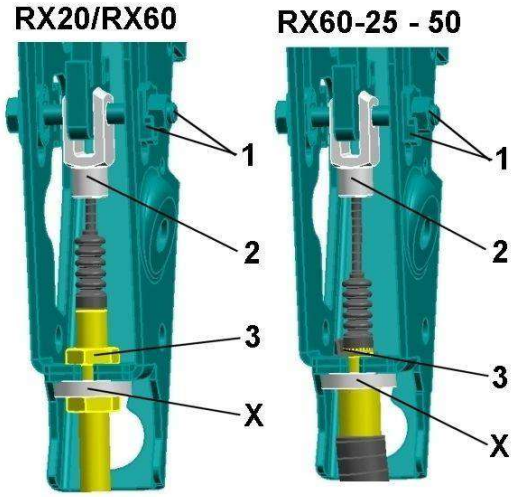
Tighten self-locking nuts to the extent that 0.1–0.5 mm of play remains between the nut and the wear strip.

– Fit the brake cable mounting to the front structure.
– Adjust the brake cable at the adjustment nut; see the chapter entitled "Adjusting the brake cable".
– Insert the bottom plate.
– Connect the battery male connector.
– Carry out calibration and functional test; see the chapter entitled "Calibration"
– Attach the panelling in the area of the electric parking brake.

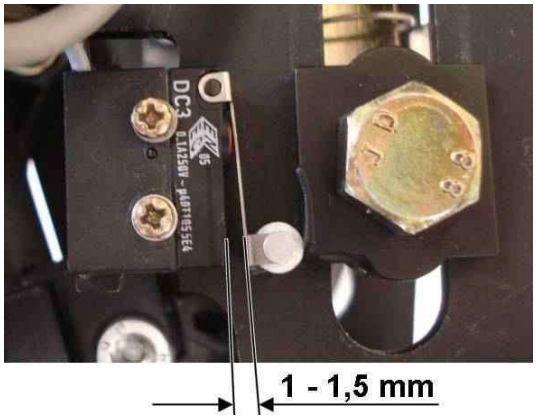
Adjusting the brake cable

– Remove the panelling in the area of the electric parking brake.
– Remove the bottom plate.





– Release the electric parking brake using the hand wheel until the limit position switch is securely actuated. (After the click, the switch has a further 50% of remaining free travel); see the chapter entitled "Limit position switch"
– Adjust the brake cable using the adjustment nut so that there is no slack in the brake cable.

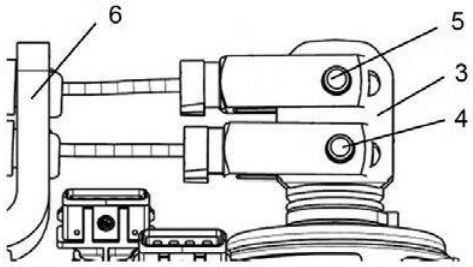


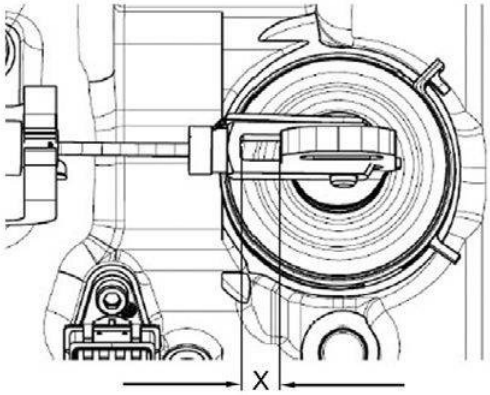
RX20, RX60-16-20: Configuring the AE18-07, AE18-09

Dimension X = 15.7 mm

The values indicated are binding. As necessary, the rope must be adjusted so that it is not as tight.

– Carry out calibration and functional test; see the chapter entitled "Calibration"

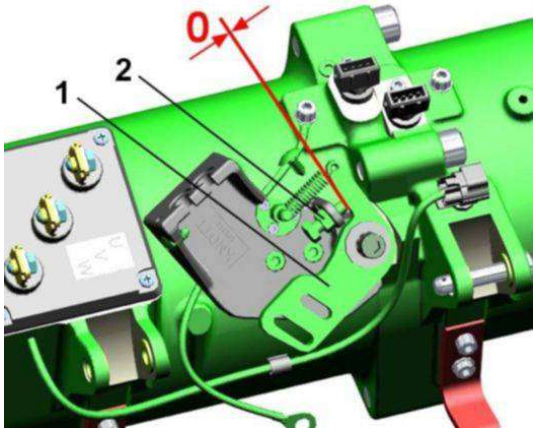




RX20, RX60-16-20: Configuring the AE18-05

If the service brake is not actuated, the brake lever must rest on the adjustment screw. The gap between the brake lever and the adjustment screw is **0 mm**.

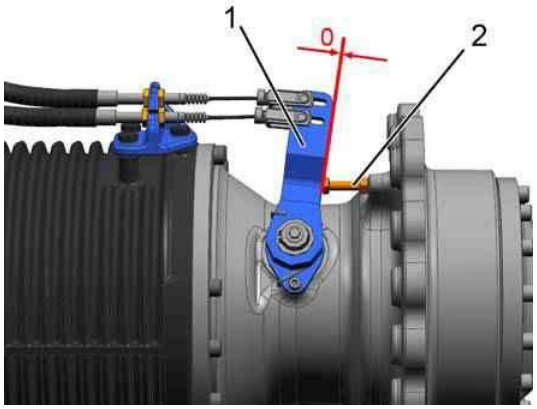
– Carry out calibration and functional test; see the chapter entitled "Calibration"



RX60-25-35, RX60-40-50: Configuring the EC35, EC50

If the service brake is not actuated, the brake lever must rest on the adjustment screw. The gap between the brake lever and the adjustment screw is **0 mm**.

– Carry out calibration and functional test; see the chapter entitled "Calibration"



Limit position switch

Position

⚠ WARNING

Risk of fingers being crushed upon automatic actuation of the electric parking brake!

It is essential that the electric parking brake power supply is disconnected.

The limit position is activated by the wear strip. In this position, the electric parking brake is released.

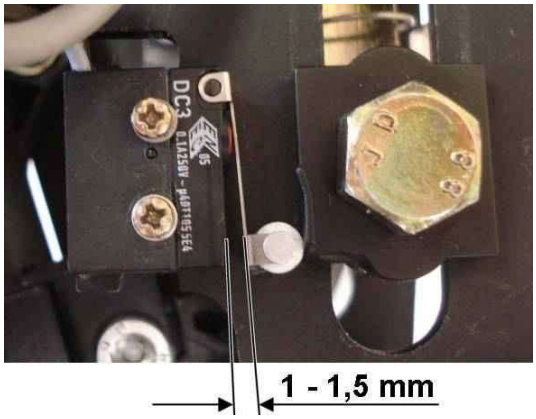
The limit position switch has just activated. A click is audible.

After the click, the wear strip continues to move another 2 mm. A 2-mm movement corresponds to one revolution of the hand wheel.



The limit position switch can only be activated safely in this position. There must subsequently be a distance of 1–1.5 mm between the switch and the actuating lever.

▷



Installation

– Park the truck safely and secure the truck against rolling away.

– Disconnect the battery male connector.

– The limit position switch is screwed to the console with two M2 screws and nuts.

⚠ CAUTION

Defective or faulty limit position switches due to deformed housing!

When screwing in, please use a very low tightening torque.

– Move the limit position switch to the right within the play and gently tighten the nuts. **Tightening torque:** 0.13±0.02 Nm.

– Secure nuts/thread with pourable plastics.

NOTE

Since 12/2011, a threaded plate has replaced the nuts.

– Carry out calibration and functional test; see the chapter entitled "Calibration"

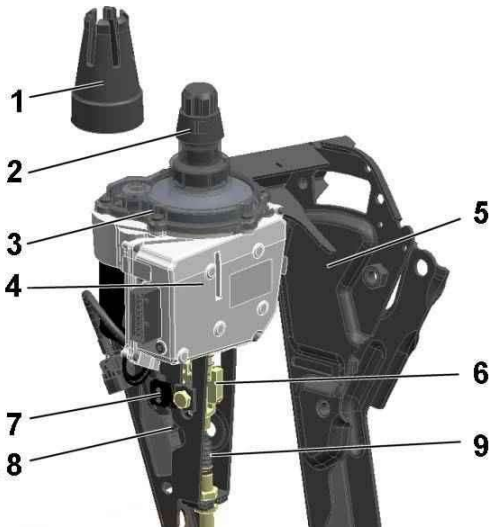
Drive unit
Installation and removal

NOTE

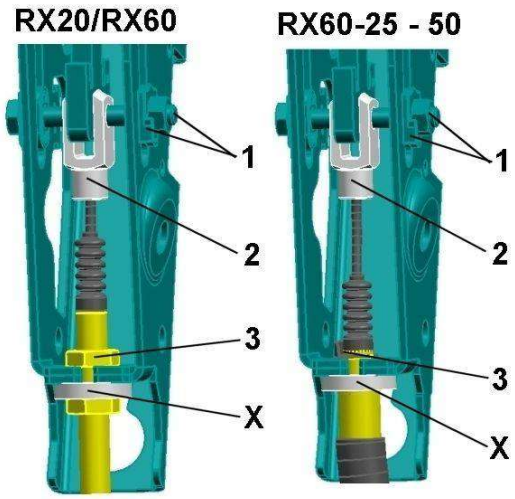
In the event of an error, the drive unit must not be repaired. In the event of an error, the drive unit must be replaced together with the actuation push button and the limit position switch.

Removal

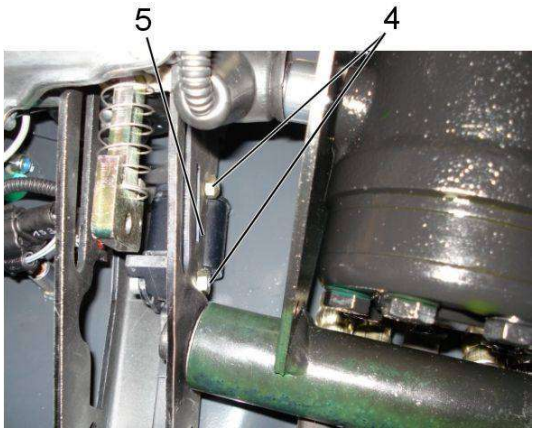
- Park the truck safely and secure the truck against rolling away.
- Disconnect the battery male connector.
- Release the parking brake fully using the hand wheel.
- Remove the panelling in the area of the electric parking brake.
- Remove the steering column panelling and move the steering column to its forwardmost position.
- Disconnect the SAAB plug X506 from the control unit of the electric parking brake.
- Remove the screw and the wear strips (1), disconnect the brake cable from the tension rod (2), loosen the nuts or locking ring (3) and unhook the brake cable.



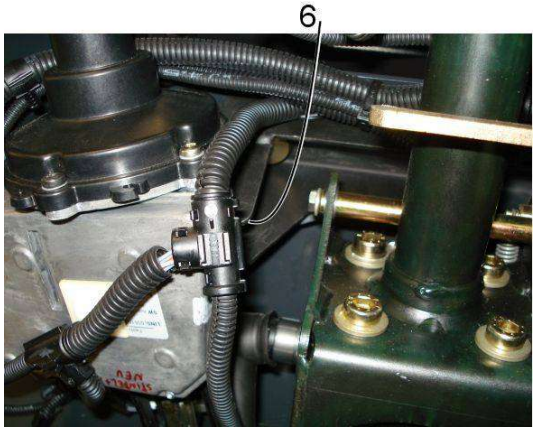
1	Hand wheel
2	Tappet for hand wheel
3	Drive unit
4	Controller
5	Console
6	Tension rod
7	Limit position switch
8	Central lubrication device
9	Brake cable



– Loosen the mounting screws (4) on the central lubrication device. ▷
– Remove the central lubrication device (5) from the recess in the console.



– Unscrew the mounting screw (6) from the drive unit (M8 hexagon head screw). ▷
– Lift up the drive unit together with the central lubrication device approx. 2.5 cm and then remove towards the rear of the console.



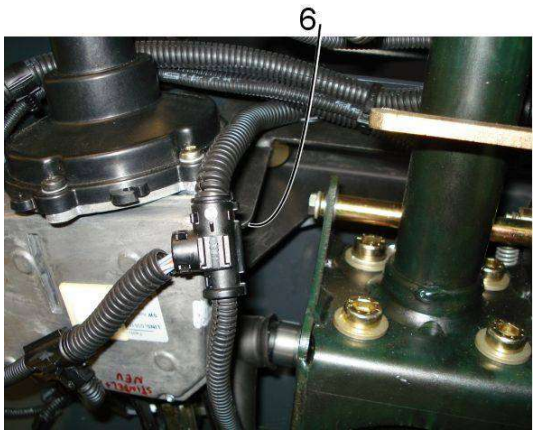
Installation

– The drive unit is installed in the console slot on the right-hand side together with the central lubrication device and is held in place by the M8 screw with a conical spring washer.

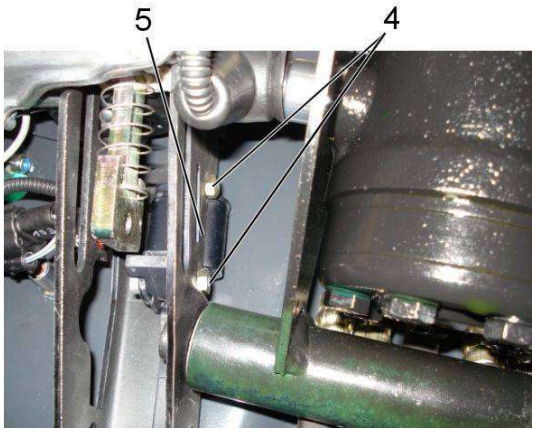
NOTE

It is important that the drive unit housing is fitted accurately because only in this way can the power be transmitted.

– The drive unit housing must rest securely on the console crosspiece.
– Screw in the drive unit mounting screw (6) (M8 hexagon head screw, 20 Nm). ▷



– Insert the central lubrication device (5) into the recess in the console.
– Screw the mounting screws (4) tightly into the central lubrication device.

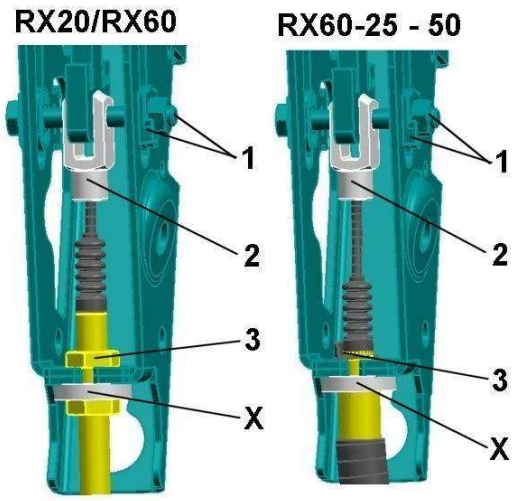


⚠ CAUTION

Observe the installation position of the tension rod in order to ensure correct function.

The wider crosspiece of the tension rod must point forwards (in the drive direction).

– Connect the brake cable to the tension rod (2) and install the screw with the wear strips (1). Secure with a nut or locking ring (3).



NOTE

Only brake cables with washers (X) may be used.

⚠ CAUTION

The console must not be deformed.

Tighten self-locking nuts to the extent that 0.1–0.5 mm of play remains between the nut and the wear strip.

– Connect the X506 SAAB plug to the control unit for the electric parking brake.
– Attach the steering column panelling.
– Check the brake cable setting; see the chapter entitled "Changing the brake cable".
– Connect the battery male connector.
– Carry out calibration and functional test; see the chapter entitled "Calibration"
– Attach the panelling in the area of the electric parking brake.

Central lubrication device Installation and removal

Servicing the central lubrication device

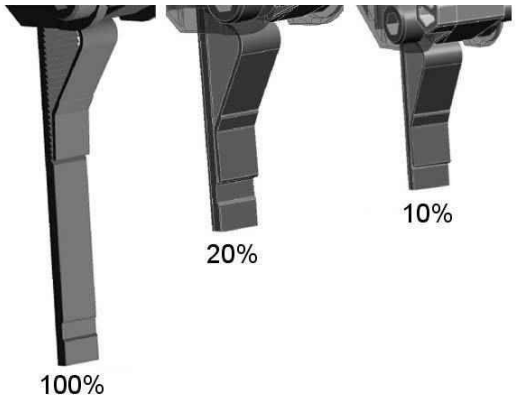
NOTE

The operating hours of the electric parking brake are counted separately and are the specifications used for the maintenance of the central lubrication device.

After carrying out repairs, the operating hours of the electric parking brake must be reset. If

this cannot be achieved via the diagnostics, the operating hours must be recorded in such a way that they cannot be lost.

The central lubrication device functions like a simple grease gun that is triggered by the drive unit mechanism. The position of the rack rail indicates the current grease supply. The grease supply is designed for approx. 20,000 parking brake operating hours and approx. 30 relubrications with normal use and correct function. With each relubrication, the rack rail retracts 1.2 mm.



Function	Values	Measures
Check position of the rack rail	100%	Status when new
	20% mark	The distance from the "new condition" to the 20% mark is approx. 32 mm, i.e. approx. 27 portions of grease.
	10% mark	Change the central lubrication device
Check the plausibility of the position	Low parking brake operating hours and it is clear that the rack rail has been retracted significantly.	Change the central lubrication device and reset the operating hours; record the operating hours in such a way that they cannot be lost
	High parking brake operating hours and it is clear that the rack rail has not been retracted very far.	

Removal

The central lubrication system can be removed only if the drive unit has been removed.

- Park the truck safely and secure the truck against rolling away.
- Disconnect the battery male connector.
- Remove the drive unit, see the chapter entitled "Drive unit".
- Disconnect the screw joint (2) between the grease gun and the lubrication hose.

Installation

- Screw the grease gun tightly into the lubrication hose.
- Install the drive unit, see the chapter entitled "Drive unit".



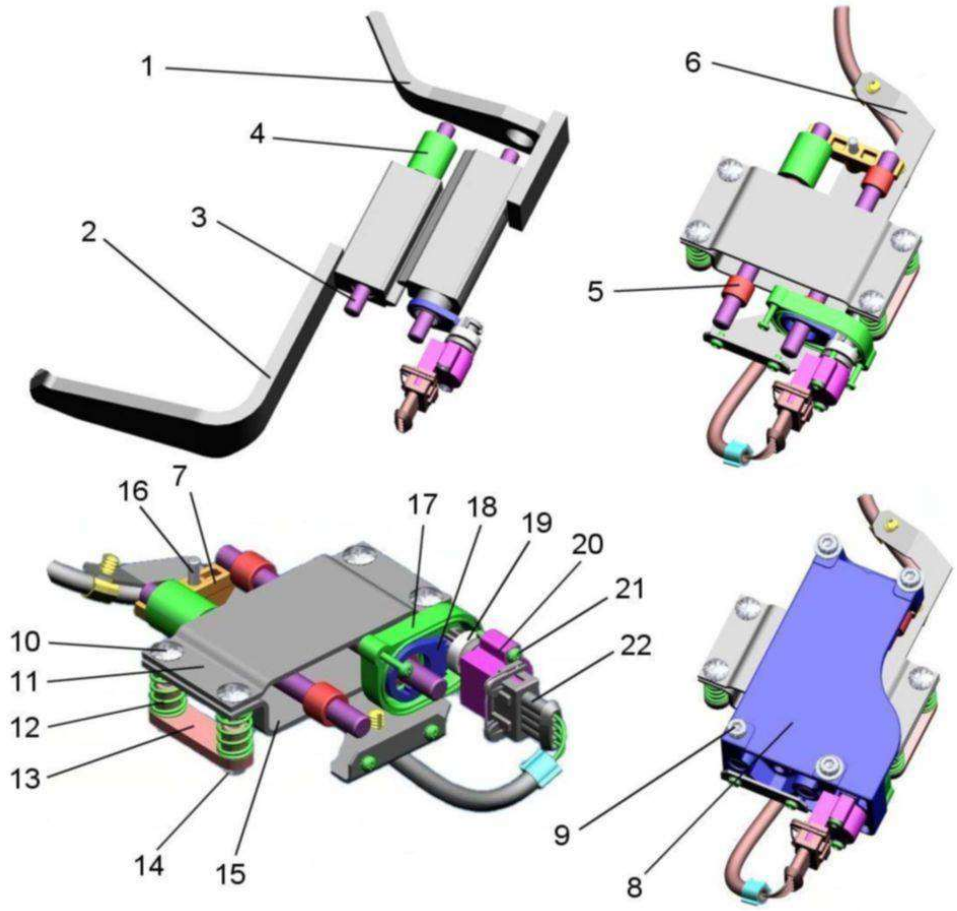
1 Central lubrication device
2 Grease gun screw joint — lubrication hose
3 Lubrication hose

- Check the brake cable setting; see the chapter entitled "Changing the brake cable".
- Attach the panelling in the area of the electric parking brake.
- Connect the battery male connector.
- Reset the operating hours and record in such a way that they cannot be lost.
- Carry out calibration and functional test; see the chapter entitled "Calibration"

Dual pedal

Accelerator - dual pedal, generation 2

Accelerator

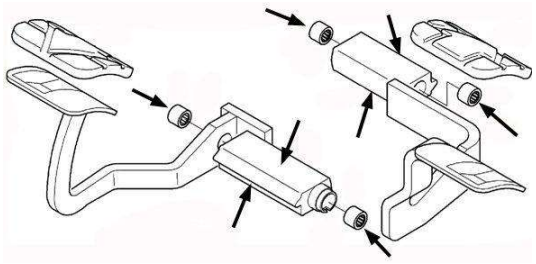


1	Pedal, forwards	12	Compression spring
2	Pedal, backwards	13	Guide
3	Rod	14	Hexagon nut
4	Bush	15	Bracket, lower
5	Needle-roller bearing	16	Hexagon head screw, 10 Nm, Loctite
6	Bearing block	17	Protective cap
7	Plate	18	Pinion
8	Bearing block	19	Pinion gear
9	Socket head screw, 18.5 Nm	20	Potentiometer
10	Coach bolt	21	Pan head screw, 2.5 Nm
11	Bracket, upper	22	Wiring harness

The accelerator comprises two mechanically connected accelerator pedals that move in opposite directions. When the accelerator pedal is pressed, the double-action potentiometer 1B1 regulates the driving speed.

Follow the instructions specified below when assembling the complete unit:

– Pre-assemble the pedals (1, 2) using bearing needle rollers (5).
– Apply lubricant evenly to all bearings of the pedals (1, 2). See "Maintenance".
– Feed the pedals through the bottom plate from above
– Fit all individual parts from below
– Screw socket head screws (9) in tightly using a **tightening torque of 18.5 Nm**
– Screw on the pan head screws (21) and secure with locking varnish using a **tightening torque of 2.5 Nm**
– Tighten the compression spring (12) to a pre-load measurement of 22 mm
– Screw on the hexagon head screw (16) and secure with Loctite using a **tightening torque of 10 Nm**



Maintenance

– Lubricate the pedals evenly at the points indicated.

Lubricant: high-pressure grease

Configuration

The configuration must be parameterised again for all retrofitting and conversions related to the accelerator and drive direction.

The following components are affected:

- Single pedal
- Double pedal
- Joystick, tip switch, mini-lever
- Hand lever
- Direction indicator module

Parameterisation takes place using the truck diagnostics in the notebook.

Calibration

Calibration must always take place after the accelerator has been changed.

– Connect the notebook to the truck. Start the truck diagnostics:

Job
▼
Calibration
▼
1. Accelerator

Once calibration is complete, error messages may be displayed.

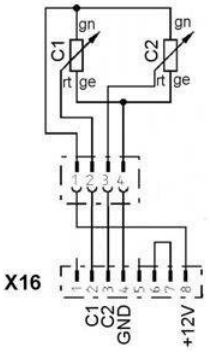
Possible causes:

- Operating error
- Timeout during calibration
- Value of accelerator's inactive position is outside the valid range
- Voltage increase does not lie within the valid range

From software flash package V1.07 onwards, the valid range for calibration can be increased by a parameter change. Parameterising takes place using the display operating unit.

Address	Value	Comment
A 00 050	26	Calibration 2 (from flash package V107 series, 06/2010)
	25	Calibration 1 (until 06/2010)

Electrical connections



8-pin Mark II plug X16				
X16/1		Free		
X16/2	X16/2	1B1 - C1		Signal C1
X16/3	X16/3	1B1 - C2		Signal C2
X16/4	X16/4	1B1 - C1/C2		GND accelerator
X16/5		Free		(Horn button)
X16/6		Free		(Horn button)
X16/8	X16/1	1B1 - C1/C2		12 V accelerator

Testing

Measured values for calibration 1 (up to 06/2010)			
Checking	Measuring points	Measured values [Volt]	Correction
Supply voltage	X16/4 - X16/8	11.05 - 12.05	
C1 accelerator not actuated	X16/4 - X16/3	5.5 - 6.5	Correction by turning the potentiometer.

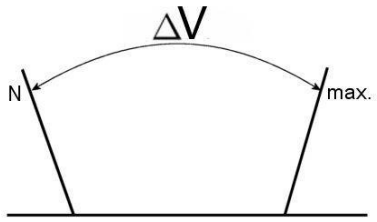
Measured values for calibration 1 (up to 06/2010)			
Checking	**Measuring points**	**Measured values [Volt]**	**Correction**
C2 accelerator not actuated	X16/4 - X16/2	5.5 - 6.5	Correction by turning the potentiometer.
C1 accelerator fully actuated, forwards	X16/4 - X16/3	1.0 - 3.8	Correction by turning the support
C2 accelerator fully actuated, forwards	X16/4 - X16/2	8.2 - 11.0	Correction by turning the support
C1 accelerator fully actuated, reverse	X16/4 - X16/3	8.2 - 11.0	Correction by turning the support
C2 accelerator fully actuated, reverse	X16/4 - X16/2	1.0 - 3.8	Correction by turning the support
GND breakdown detection		11.5	
VCC breakdown detection		0.5	

Measured values for calibration 2 (from flash package V107 series, 06/2010)			
Checking	**Measuring points**	**Measured values [Volt]**	**Correction**
Supply voltage	X16/4 - X16/8	11.05 - 12.05	
C1 accelerator not actuated	X16/4 - X16/3	4.45 - 7.0	Correction by turning the potentiometer.
C2 accelerator not actuated	X16/4 - X16/2	4.45 - 7.0	Correction by turning the potentiometer.
C1 accelerator fully actuated, forwards	X16/4 - X16/3	1.0 - 3.8	Correction by turning the support
C2 accelerator fully actuated, forwards	X16/4 - X16/2	8.2 - 11.0	Correction by turning the support
C1 accelerator fully actuated, reverse	X16/4 - X16/3	7.2 - 11.0	Correction by turning the support
C2 accelerator fully actuated, reverse	X16/4 - X16/2	1.0 - 4.5	Correction by turning the support
GND breakdown detection		11.5	
VCC breakdown detection		0.5	

Voltage increase

The difference in voltage between the transmitter's inactive position (N) and maximum actuation (max) is designated as the potentiometer voltage increase.

At maximum actuation, the voltage must be at least **2.0 V** and up to a maximum of **5.4 V** higher than in the neutral position (N).



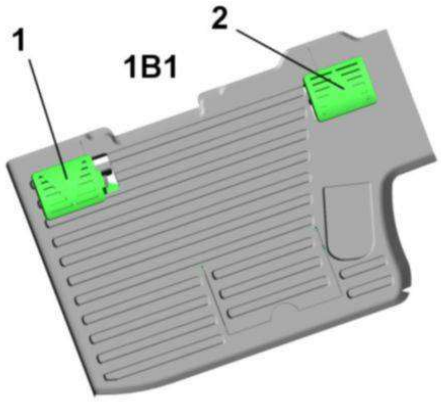
Errors	
Voltage increase too small	The maximum speed is not achieved
Voltage increase too large	No problem for the evaluation ► The maximum speed is reached but not exceeded. ► The controller ignores the end range of the voltage increase (dead travel)
Voltage increase significantly too large	Detection of breakdown with corresponding error message

Accelerator – dual pedal 1st generation

Floorplate

The dual-pedal bottom plate is equipped with the accelerator 1B1 and a dual-pedal unit for forwards (2) and backwards (1). The horn button 4S1 is located in the lift lever in this variant.

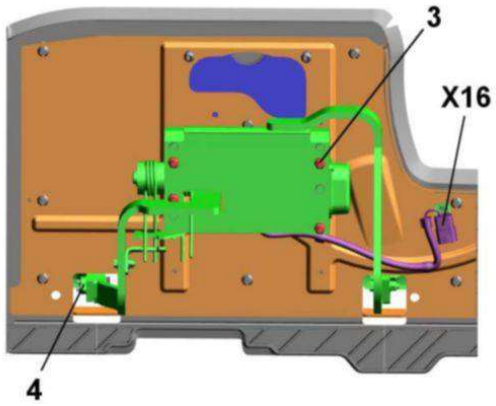
The size of the bottom plate depends on the truck equipment. For trucks equipped with a heating system, the bottom plate is shortened on the right-hand side in the area around the hydraulics.



1	Backward
2	Forward
1B1	Accelerator

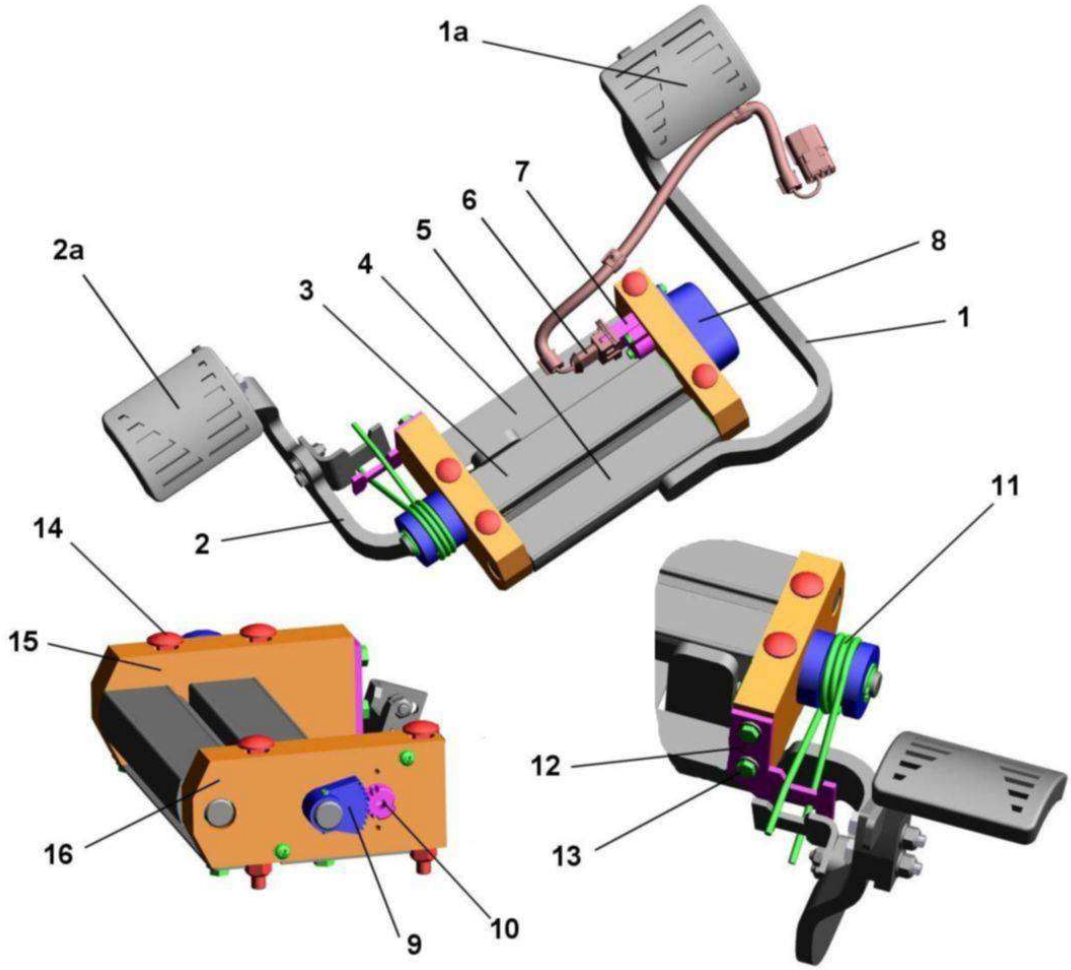
The dual-pedal unit is screwed to the bottom plate via four coach bolts (3). Only the accelerator pedals are fed through the bottom plate.

Pedal travel is restricted by stop plates that are screwed to the pedals.



Dual pedal

Accelerator



1	Pedal, forwards	8	Covering
1a	Step plate, forwards	9	Gear segment
2	Pedal, backwards	10	Pinion gear
2a	Step plate, backwards	11	Leg spring
3	Cam, backwards	12	Spring holder
4	Cover plate	13	Hexagon head bolt
5	Cam, forwards	14	Coach bolt
6	Wiring harness	15	Bearing block
7	Potentiometer	16	Bearing block

The accelerator comprises two mechanically connected accelerator pedals that move in opposite directions. Actuating the accelerator pedals regulates the driving speed via the double action potentiometer 1B1.

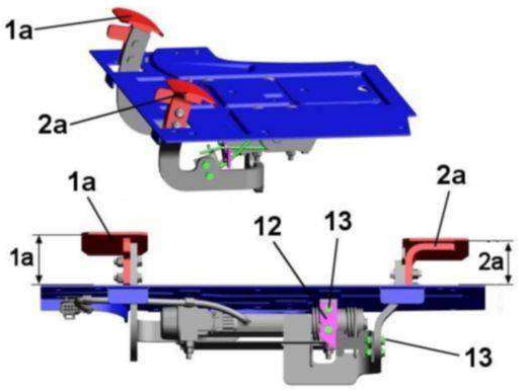
The following instructions should be followed when assembling the complete unit:

– Pre-assemble all individual parts without the step plates (1a, 2a)

– Bolt the complete unit to the bottom plate from below, guiding the pedals through the bottom plate and tightly screwing on the bearing

blocks (15, 16) from above using coach bolts (14)

– Fit the step plates (1a, 2a)
– Apply lubricant evenly to all bearings of the pedals
– Screw in the coach bolts (14) to 20 Nm
– Screw the pan head screws to the potentiometer to 2.5 Nm and secure with retaining compound
– Position the pedals in the zero position by moving the spring holder (12)
– Screw the hexagon head screws (13) to 8.3 Nm and secure with retaining compound



Configuration

The configuration must be parameterised again for all retrofitting and conversions related to the accelerator and drive direction.

This affects the following components:

- Single pedal
- Double pedal
- Joystick, tip switch, mini-lever
- Lift lever
- Direction indicator module

Parameterisation takes place using the truck diagnostics in the notebook.

Calibration

Calibration must always take place after the accelerator has been changed.

– Connect the notebook to the truck and start the truck diagnostics:

```
Job
▼
Calibration
▼
1.  Accelerator
```

Once calibration is complete, error messages may be displayed.

Possible causes:

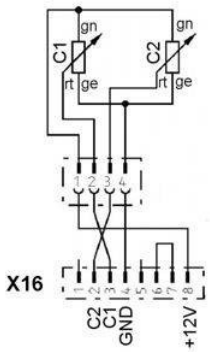
- Operating error
- Timeout during calibration
- Value of accelerator's inactive position is outside the valid range
- Voltage increase does not lie within the valid range

Dual pedal

From software flash package V107 onwards, the valid range for calibration can be increased by a parameter change. Parameterising takes place using the display operating unit.

Address	Value	Comment
A 00 050	26	Calibration 2 (from flash package V107 series, 06/2010)
	25	Calibration 1 (until 06/2010)

Electrical connections ▷



8-pin Mark II plug X16				
X16/1		Free		
X16/2	X16/3	1B1 - C2		Signal C2
X16/3	X16/2	1B1 - C1		Signal C1
X16/4	X16/4	1B1 - C1/C2		GND accelerator
X16/5		Free		(Horn button)
X16/6		Free		(Horn button)
X16/8	X16/1	1B1 - C1/C2		12 Volt accelerator

Testing

Measured values for calibration 1			
Checking	Measuring points	Measured values [Volt]	Correction
Supply voltage	X16/4 - X16/8	11.05 - 12.05	
C1 accelerator not actuated	X16/4 - X16/3	5.5 - 6.5	Correction by turning the potentiometer.
C2 accelerator not actuated	X16/4 - X16/2	5.5 - 6.5	Correction by turning the potentiometer.
C1 accelerator fully actuated, forwards	X16/4 - X16/3	1.0 - 3.8	Correction by turning the support
C2 accelerator fully actuated, forwards	X16/4 - X16/2	8.2 - 11.0	Correction by turning the support
C1 accelerator fully actuated, reverse	X16/4 - X16/3	8.2 - 11.0	Correction by turning the support
C2 accelerator fully actuated, reverse	X16/4 - X16/2	1.0 - 3.8	Correction by turning the support

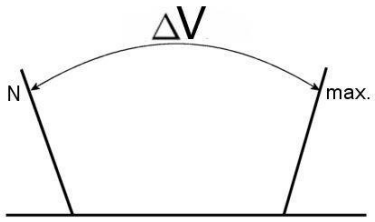
Measured values for calibration 1			
Checking	**Measuring points**	**Measured values [Volt]**	**Correction**
GND breakdown detection		11.5	
VCC breakdown detection		0.5	

Measured values for calibration 2 (from flash package V107 series, 06/2010)			
Checking	**Measuring points**	**Measured values [Volt]**	**Correction**
Supply voltage	X16/4 - X16/8	11.05 - 12.05	
C1 accelerator not actuated	X16/4 - X16/3	4.45 - 7.0	Correction by turning the potentiometer.
C2 accelerator not actuated	X16/4 - X16/2	4.45 - 7.0	Correction by turning the potentiometer.
C1 accelerator fully actuated, forwards	X16/4 - X16/3	1.0 - 3.8	Correction by turning the support
C2 accelerator fully actuated, forwards	X16/4 - X16/2	8.2 - 11.0	Correction by turning the support
C1 accelerator fully actuated, reverse	X16/4 - X16/3	7.2 - 11.0	Correction by turning the support
C2 accelerator fully actuated, reverse	X16/4 - X16/2	1.0 - 4.5	Correction by turning the support
GND breakdown detection		11.5	
VCC breakdown detection		0.5	

Voltage increase

The difference in voltage between the transmitter's inactive position (N) and maximum actuation (max) is designated as the potentiometer voltage increase.

At maximum actuation, the voltage must be at least **2 Volt** (up to maximum **5.4 Volt**) higher than in the neutral position (N).



Errors	
Voltage increase too small	The maximum speed is not achieved
Voltage increase too large	No problem for the evaluation ► The maximum speed is reached but not exceeded. ► The end range of the voltage increase is ignored by the controller (dead travel)
Voltage increase significantly too large	Detection of breakdown with corresponding error message

Operating devices

Hand lever

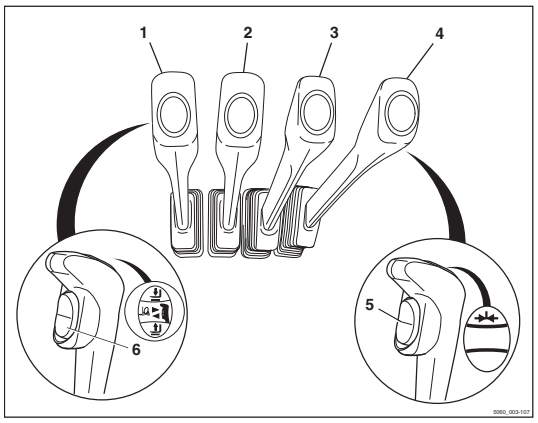
Operation

The individual hydraulic functions are operated via the hand levers. Each hydraulic function has a separate operating lever.

Like the directional control valve block, the truck is provided with three or four operating levers according to the hydraulic equipment of the truck.

- "Lift/lower" operating lever (1)
- "Tilt" operating lever(2)
- "Auxiliary hydraulics 1" operating lever(3)
- "Auxiliary hydraulics 2" operating lever(4)

Depending on the truck equipment, the drive direction switch (6) or horn button is integrated into the lift lever.



1 "Lift/lower" operating lever
2 "Tilt" operating lever
3 "Auxiliary hydraulics 1" operating lever
4 "Auxiliary hydraulics 2" operating lever
5 "5th function" function switch
6 Drive direction switch or horn button

Repairs

In the event of repairs, individual operating levers can be changed. For spare parts see the truck spare parts list.

Parameterising

The configuration must be parameterised again for all retrofitting and conversions related to the accelerator and drive direction. Parameterising takes place using the truck diagnostics in the notebook.

This affects the following components:

- Single pedal
- Double pedal
- Joystick, tip switch, mini-lever
- Lift lever
- Direction indicator module

A truck restart must always be carried out after parameterising. Calibration can only be carried out once these processes have been completed.

Calibration

Calibration must always take place after the hydraulic sensor has been changed.

– Connect the notebook to the truck and start the truck diagnostics:

Action
▼
Calibration

▼

```
0.  Sensors
```

Once calibration is complete, error messages may be displayed.

Joystick 4Plus

General

The Joystick 4Plus is an operating device that is built into the armrest of the driver's seat. The Joystick 4Plus controls various functions that the driver can activate using his right hand.

As the Joystick 4Plus does not have a turn indicator button, the turn indicator module for the drive direction must always be installed in line with the German road traffic licensing regulations on lighting.

The Joystick 4Plus is available in two variants — with and without an emergency off switch.



1 Emergency off switch
2 Housing
3 Joystick
4 Turn indicator module for the drive direction

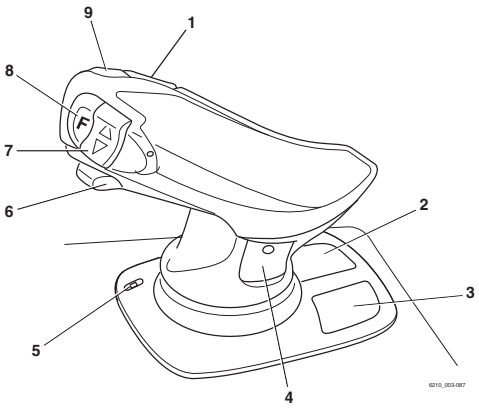
Functions

Shift key F

- The shift key can be assigned different functions during the parameterising process
- For example: the 3rd auxiliary hydraulics or 5th hydraulic function

Repairs

In the event of repairs, the entire Joystick 4Plus must be replaced. For spare parts, refer to the truck spare parts catalogue.



1 Horizontal rocker button for the 3rd hydraulic function
2 Symbols for the basic hydraulic functions
3 Symbols for the 5th hydraulic function and the clamp locking mechanism
4 Symbols for the 3rd and 4th hydraulic functions
5 LED for the clamp locking mechanism
6 Slider for the 4th hydraulic function
7 Drive direction
8 Shift key "F"
9 Signal horn button

Technical data

CAN bus	CAN open as standard; integrated into the red CAN bus
Sensors	1 Hall sensor per axle
Software	Device detection "I"
Protection class	IP 65
Temperature range	-30°C - +85°C

Electrical connections

6-pin mark II plug X71	
X71/1	12 V or 24 V
X71/2	Truck GND
X71/3	CAN r H
X71/4	CAN r L
X71/5	Emergency off 7S2/1

X71/6	Emergency off 7S2/2
Earth wire at the seat or CPP seat	

Parameterising

The configuration must be parameterised again for all retrofit and conversion work related to the accelerator, drive direction lighting and lighting in line with the German road traffic licensing regulations. Parameterising is performed using the truck diagnostics in the notebook.

This affects the following components:

- Single pedal
- Dual pedal
- Joystick, fingertip switch and mini-lever
- Lift lever
- Turn indicator module for the drive direction

A truck restart must always be performed after parameterising.

Calibration

Calibration is not necessary.

Axle assignment - Joystick 4Plus

General

The individual functions are assigned to the axles and buttons at the factory. The allocation in each case can be read from the "Decal information for actuation".

Depending on the operating device, parameterising allows for a number of different axle assignments and variants.

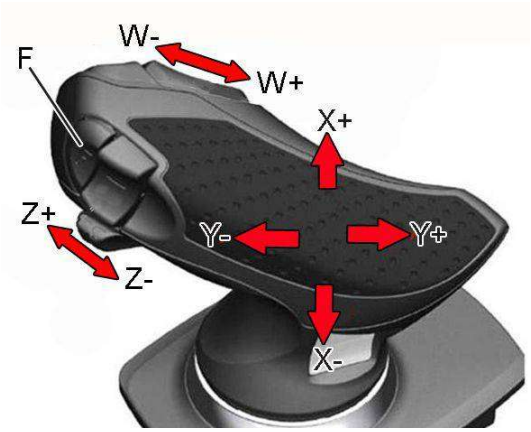
As soon as the axle assignment and consequently the operation have been changed, the "Decal information for actuation" must be modified. Current variants of the decal information can be ordered as spare parts.

NOTE

As soon as the operation has been changed, the "Decal information for actuation" must be modified.

Joystick 4Plus

Axle	Standard
X +	Lower
X -	Lift
Y +	Auxiliary hydraulics 1
Y -	Auxiliary hydraulics 1
Z +	Auxiliary hydraulics 2
Z -	Auxiliary hydraulics 2
W +	Tilt backward
W -	Tilt forward
Axle	**Variant**
X +	Tilt forward
X -	Tilt backward
Y +	Lift
Y -	Lower
Z +	Auxiliary hydraulics 1
Z -	Auxiliary hydraulics 1
W +	Auxiliary hydraulics 2
W -	Auxiliary hydraulics 2



Generation 2 mini-lever

General

NOTE

The second-generation mini-lever replaces the first-generation mini-lever.

The generation 2 mini-lever is an operating device built into the armrest of the driver's seat. The generation 2 mini-lever controls various operations that can be activated by the driver's right hand.

Depending on the hydraulic equipment and customer preference, there are different mini-lever variants that can be installed in the truck.

The customer can choose from three mini-lever variants:

- Each variant is available both with and without an emergency off switch
- Mini-lever, 2 lever

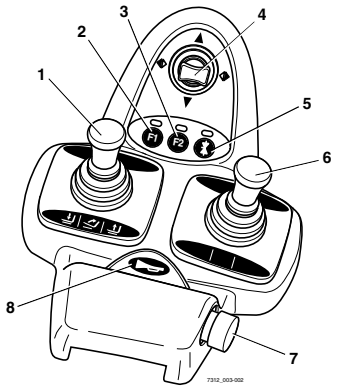
  Left: central lever for lifting, lowering, tilting

  Right: cross lever for the auxiliary hydraulic functions
- Mini-lever, 3 lever

  Left: central lever for lifting, lowering, tilting

  Right: two single levers for the auxiliary hydraulic functions replace the cross lever
- Mini-lever, 4 lever

  Four single levers replace the central lever on the left and the cross lever on the right.



Mini-lever, 2 lever with emergency off

1	Central lever for lifting and tilting
2	F1 button
3	F2 button
4	Drive direction preselection and turn indicator
5	Function key for 5th hydraulic function
6	Cross lever, auxiliary hydraulics
7	Emergency off switch
8	Horn button

Freely programmable keys

F1 and F2 button

- The F keys can be assigned different functions during parameterising
- Example: additional electrical installation, switching the spotlight

Ensure that the operation of additional electrical installations is not activated twice. If the operation of an additional electrical installation has been parameterised to one of the function keys, it must be deactivated in the display-operating unit.

Function key

- The function key actuates the 5th hydraulic function or the 3rd auxiliary hydraulics

Repairs

Mini-levers can be repaired by replacing defective components. Only those components that

are available in the spare parts catalogue for the truck may be replaced. For a detailed description, see Service Information 512015017.

Technical data

CAN bus	CAN open as standard; integrated in the red CAN bus
Sensors	One dual potentiometer per axle
Software	Device detection "I"
Protection class	IP 65
Temperature range	-30°C to +85°C

Electrical connections

6-pin Mark II plug X71	
X71/1	12 V or 24 V
X71/2	GND
X71/3	CAN r H
X71/4	CAN r L
X71/5	Emergency off 7S2/1
X71/6	Emergency off 7S2/2
Earth wire on the driver's seat or CPP driver's seat	

Parameterising

The configuration must be parameterised again for all retrofit and conversion work related to the accelerator, drive direction and lighting in line with the German road traffic licensing regulations. Parameterisation is performed using the truck diagnostics in the notebook.

The following components are affected:

- Single pedal
- Dual pedal
- Joystick, fingertip, mini-lever
- Hand lever
- Drive direction turn indicator module

A truck restart must always be carried out after parameterising.

Calibration

Calibration is not required after replacing a complete component.

The mini-lever must be re-calibrated following any repairs.

– Connect the notebook to the truck. Start the "servo hydraulics" diagnostics:

```
Action
▼
B - mini-lever, gen. 2
calibration
▼
Execute
```

Generation 2 mini-lever Actuation

Single mini-lever

The left joystick (1) is a 360° lever which can be used for operating both axes at the same time. The left joystick is used to operate the basic functions of the lift mast.

Operation of 1st and 2nd hydraulic function:

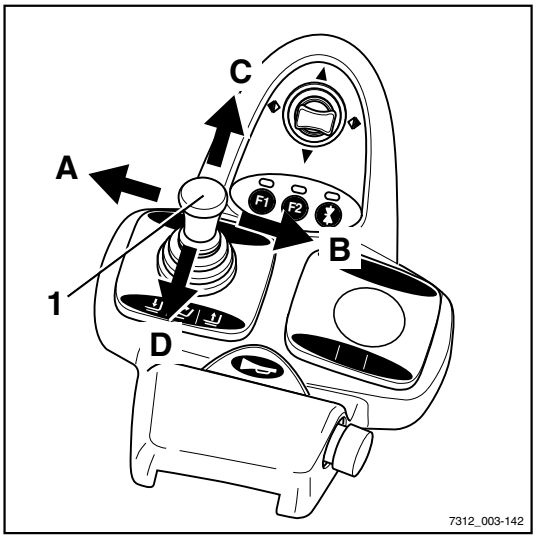
- To lift fork carriage:

  Move the left joystick in the direction of the arrow (B).
- To lower fork carriage:

  Move the left joystick in the direction of the arrow (A).
- To tilt the lift mast forwards:

  Move the left joystick in the direction of the arrow (C).
- To tilt the lift mast backwards:

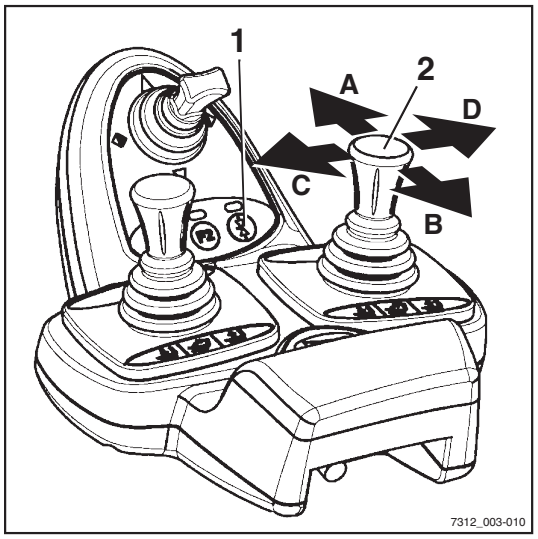
  Move the left joystick in the direction of the arrow (D).



1	Left joystick
A	Lowering
B	Lifting
C	Tilt forwards
D	Tilt backwards

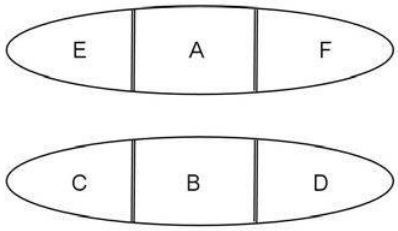
Duplicate mini-lever

In addition to the left joystick, a second joystick is available on the right. The right joystick (2) is a cross lever which can be used for operating in two axes, one axis at a time. The right joystick is used to operate attachments, depending on the equipment. The 5th hydraulic function can be activated using function key (1).



1 Right joystick

The pictograms show all functions that can be operated with the right joystick and the function key for the 5th hydraulic function.



Operation of 3rd and 4th hydraulic function:

- (A): Move the right joystick in the direction of arrow (A).
- (B): Move the right joystick in the direction of arrow (B).
- (C): Move the right joystick in the direction of arrow (C).
- (D): Move the right joystick in the direction of arrow (D).

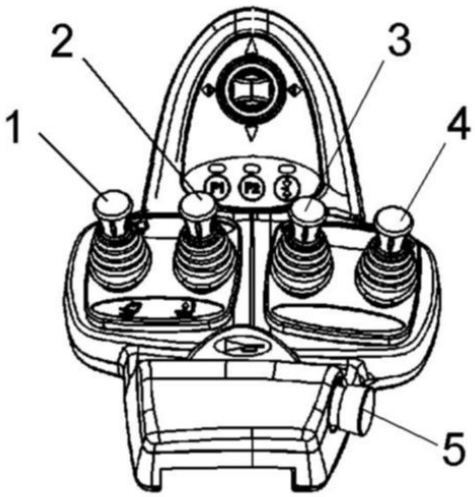
Operation of 5th hydraulic function:

- (E): Actuate the function key and move the right joystick in the direction of arrow (A).
- (F): Actuate the function key and move the right joystick in the direction of arrow (B).

Four-way mini-lever

The four levers (1-4) can only be moved forwards and backwards in one axis.

The emergency stop switch is a variant



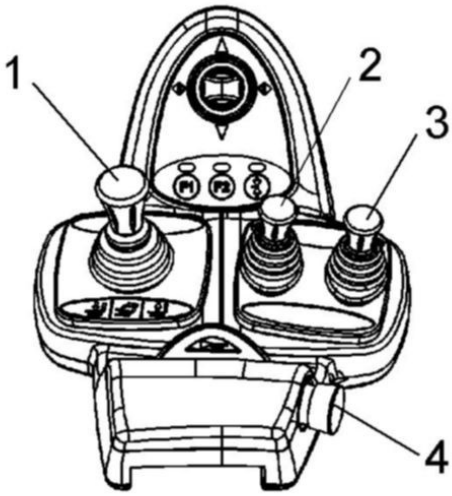
1 Lift - lower
2 Tilt
3 Auxiliary hydraulics 1
4 Auxiliary hydraulics 4
5 Emergency stop switch

Duplicate/four-way mini-lever

The left joystick (1) is a 360° lever which can be used for operating both axes at the same time. As standard, the left joystick operates the lift mast.

The two right levers (2, 3) can only be moved forwards and backwards in one axis.

The emergency stop switch is a variant



1 Left joystick
2 Auxiliary hydraulics 1
3 Auxiliary hydraulics 2
4 Emergency stop switch

Axle assignment - the mini-lever

General

The individual functions are assigned to the axles and buttons at the factory. The allocation in each

case can be read from the "Decal information for actuation".

Depending on the operating device, parameterising allows for a number of different axle assignments and variants.

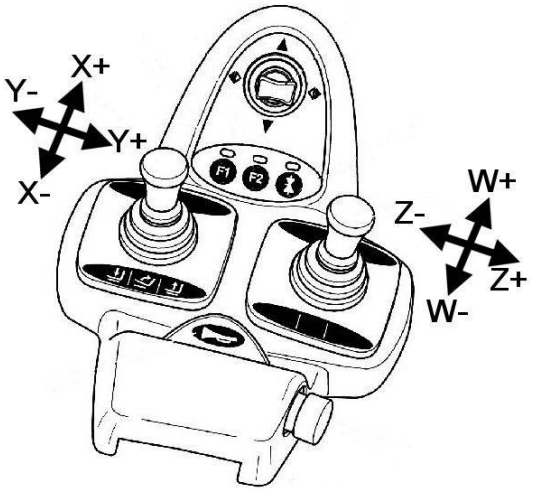
As soon as the axle assignment and consequently the operation have been changed, the "Decal information for actuation" must be modified. Current variants of the decal information can be ordered as spare parts.

NOTE

As soon as the operation has been changed, the "Decal information for actuation" must be modified.

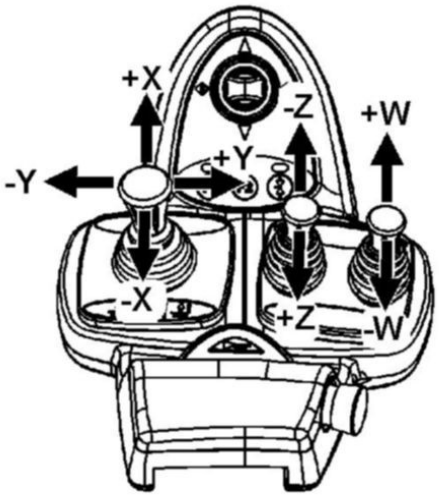
Mini-lever, 2 lever

Left-hand lever	Central lever
Y +	Lift
Y -	Lower
X -	Tilt backward
X +	Tilt forward
Right-hand lever	**Cross lever**
Z +	Auxiliary hydraulics 1
Z -	Auxiliary hydraulics 1
W -	Auxiliary hydraulics 2
W +	Auxiliary hydraulics 2



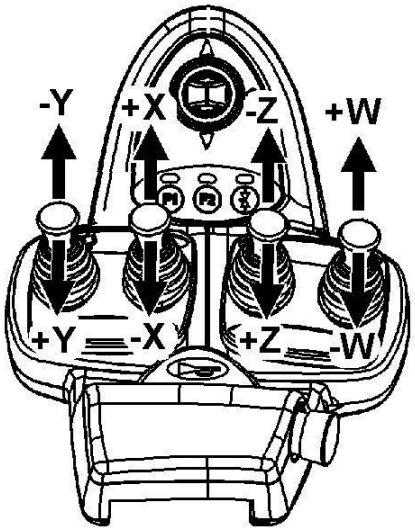
Mini-lever, 3 lever

Left-hand lever	Central lever
Y +	Lift
Y -	Lower
X -	Tilt backward
X +	Tilt forward
Z lever	**Single lever**
Z +	Auxiliary hydraulics 1
Z -	Auxiliary hydraulics 1
W lever	**Single lever**
W -	Auxiliary hydraulics 2
W +	Auxiliary hydraulics 2



Mini-lever, 4 lever

Y lever	Single lever
Y +	Lift
Y -	Lower
X lever	**Single lever**
X -	Tilt backward
X +	Tilt forward
Z lever	**Single lever**
Z +	Auxiliary hydraulics 1
Z -	Auxiliary hydraulics 1
W lever	**Single lever**
W -	Auxiliary hydraulics 2
W +	Auxiliary hydraulics 2



Tip switch

General

The fingertip switch is an operating device built into the armrest of the driver's seat. The fingertip switch controls various operations that the driver can activate using his right hand.

Freely programmable keys

F1 and F2 button

- The F keys can be assigned different functions during parameterising
- For example: additional electrical equipment, spotlight on/off

Ensure that the operation of additional electrical installations is not activated twice. If the operation of an additional electrical installation has been parameterised on one of the function keys, this key must be deactivated in the display and operating unit.

Function key

- The function key operates the 5th hydraulic function and the 3rd auxiliary hydraulics

Repairs

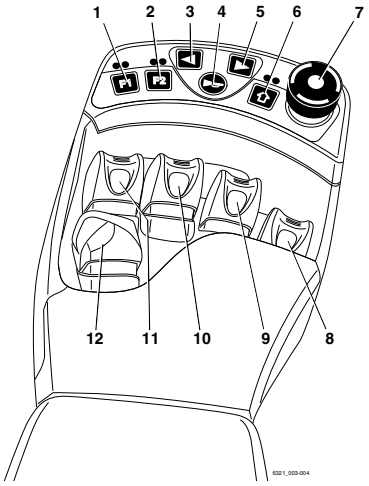
In the event of repairs, the entire fingertip console must be changed. Individual parts are not available.

Technical data

CAN bus	CAN open as standard; integrated in the red CAN bus
Sensors	
Software	Device detection "I"
Protection class	IP 55
Temperature range	-30°C - +85°C

Undo the electrical

6-pin mark II plug X71	
X71/1	24 V
X71/2	Truck GND
X71/3	CAN r H
X71/4	CAN r L
X71/5	Emergency stop 7S2/1
X71/6	Emergency stop 7S2/2
Earth wire at the seat	



1 F1 button
2 F2 button
3 Left turn indicator button
4 Signal horn button
5 Right turn indicator button
6 Function key for 5th hydraulic function
7 Emergency off switch
8 Auxiliary hydraulics 1 operating lever
9 Auxiliary hydraulics 2 operating lever
10 Pull the tilt operating lever
12 Travel direction switch
11 Lift-lower operating lever

Parameterising

The configuration must be parameterised again for all retrofit and conversion work related to the accelerator, drive direction lighting and lighting in line with the German road traffic licensing regulations. Parameterising is performed using the truck diagnostics in the notebook.

This affects the following components:

- Single pedal
- Double pedal
- Joystick, tip switch, mini-lever
- Lift lever
- Direction indicator module

A truck restart must always be carried out after parameterising.

Calibration

Calibration is not necessary.

Axle assignment - fingertip switch

General

The individual functions are assigned to the axles and buttons at the factory. The allocation in each case can be read from the "Decal information for actuation".

Depending on the operating device, parameterising allows for a number of different axle assignments and variants.

As soon as the axle assignment and consequently the operation have been changed, the "Decal information for actuation" must be modified. Current variants of the decal information can be ordered as spare parts.

NOTE

As soon as the operation has been changed, the "Decal information for actuation" must be modified.

Fingertip switch

Axle	Standard
X +	Lift
X -	Lower
Y +	Tilt backward
Y -	Tilt forward
W +	Auxiliary hydraulics 1
W -	Auxiliary hydraulics 1
Z +	Auxiliary hydraulics 2
Z -	Auxiliary hydraulics 2



Joystick

General

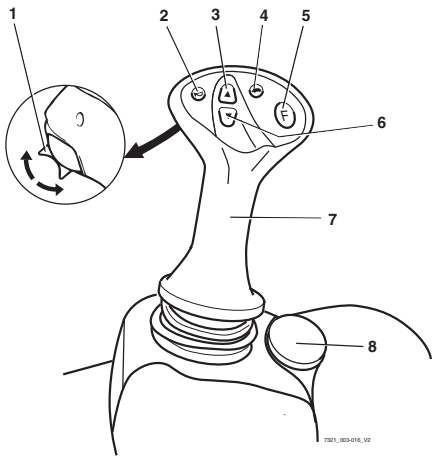
The joystick is an operating device built into the armrest of the driver's seat.

The joystick controls various operations that can be activated by the driver's right hand.

- Rocker (1)
- Horn button (2)
- Drive direction switch (3, 6)
- Precision control (zoom) (4)
- (5)Function button
- Forwards/backwards (7, 8)
- Left/right (9, 10)

The joystick also contains the following electrical components:

- Built-in evaluation electronics
- CAN bus controller
- Emergency stop switch 7S2



1	Rocker
2	Horn button
3	Forwards travel direction switch
4	Precision control (zoom)
5	Function button
6	Backwards travel direction switch
7	Lift: pull joystick back
8	Lower: push joystick forward
9	Auxiliary hydraulics: push joystick to the left
10	Auxiliary hydraulics: push joystick to the right
11	Emergency stop switch 7S2

Repairs

In the event of repairs, the entire joystick must be changed. Individual parts are not available.

Technical data

CAN open as standard

Integrated into the red peripheral CAN bus

Software: truck recognition "I"

Protection class: IP 55

Temperature range: -30°C - +85°C

Undo the electrical

6-pin Mark II plug X71	
X71/1	24 Volt
X71/2	GND truck
X71/3	CAN r H
X71/4	CAN r L
X71/5	Emergency off 7S2/1
X71/6	Emergency off 7S2/2
Earth wire at the seat or CPP seat	

Configuration

The configuration must be parameterised again for all retrofitting and conversions related to the accelerator and drive direction. Parameterising takes place using the truck diagnostics in the notebook.

This affects the following components:

- Single pedal
- Double pedal
- Joystick, tip switch, mini-lever
- Lift lever
- Direction indicator module

A truck restart must always be carried out after parameterising. Calibration can only be carried out once these processes have been completed.

Calibration

The joystick can be calibrated if necessary.

– Connect the notebook to the truck and start the servo hydraulics diagnostics:

Action
▼
Joystick calibration
▼
Execute

Joystick operation

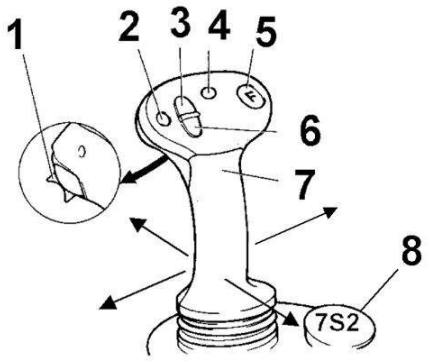
Operating functions

The joystick is used to operate all hydraulic functions and the auxiliary hydraulics for attachments.

NOTE

The joystick operating functions are only active when the driver is seated, i.e. when the seat contact switch is activated.

Various hydraulic functions can be freely assigned to the individual operating functions of the joystick using parameters.



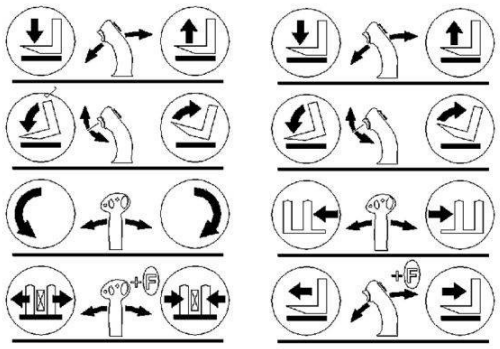
1 Rocker
2 Horn button
3 Forwards travel direction switch
4 Precision control (zoom)
5 Function button
6 Backwards travel direction switch
7 Joystick directions of movement
8 Emergency stop switch 7S2

The allocation in each case can be read from the "Decal information for operation" on the valve cover.

NOTE

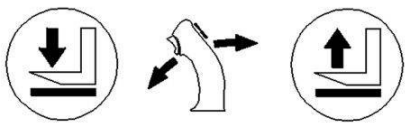
If changes are made to the assignment of the hydraulic functions, the "Decal information for operation" must be modified. The decal information labels can be ordered as spare parts.

Activating the precision control button (zoom) at the same time reduces the working speed of all consumers by half.

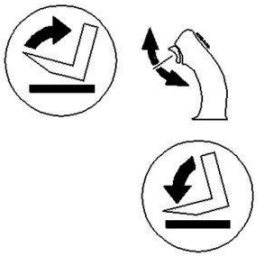


Standard functions and default settings

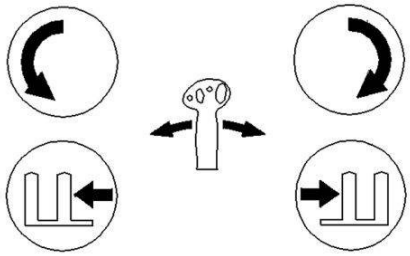
"Forwards/backwards" standard functions: Lower/lift lift mast.



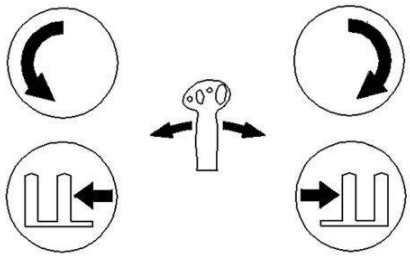
"Rocker" standard functions: Tilt lift mast forwards/backwards



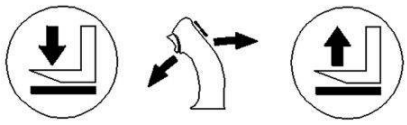
"Left/right" default setting: Operation of swivel device, roller clamp or sideshift, according to choice.



"Simultaneously function key F and left/right" default setting: Operation of fork positioner or bale clamp, according to choice.



"Simultaneously function key F and forwards/backwards" default setting: Operation of fork extension or shovel.



NOTE

Other settings can be configured using the diagnostics in the notebook.

Generation 1 mini-lever

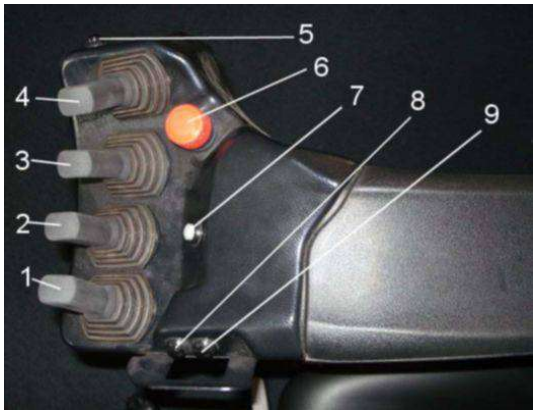
Operation

The mini-lever is an operating device built into the armrest of the driver's seat.

The mini-lever controls various operations that can be activated by the driver's right hand.

- Lift-lower operating lever (1)
- Tilt operating lever (2)
- Operating lever for auxiliary hydraulics 1 or 3rd hydraulic function (3)
- Operating lever for auxiliary hydraulics 2 or 4th hydraulic function (4)
- Button for auxiliary hydraulics 3 or 5th hydraulic function (5)
- Signal horn button (7)
- Travel direction switch (8, 9)
- Emergency stop switch (6)

The mini-lever is always provided with four operating levers, regardless of the hydraulic equipment of the truck.



1 Lift-lower operating lever
2 Pull the tilt operating lever
3 Auxiliary hydraulics 1 operating lever
4 Auxiliary hydraulics 2 operating lever
5 Auxiliary hydraulics 3 button
6 Emergency stop switch
7 Signal horn button
8 Direction switch, forwards
9 Direction switch, backwards

The assignment of the input channels and axles for hydraulic operation is configured using the truck diagnostics in the notebook.

Repairs

In the event of repairs, all the switches and push buttons can be changed separately. Individual spare parts are available for the mini-lever; see the truck spare parts list.

Technical data

CAN open as standard

Integrated into the red peripheral CAN bus

Software: truck recognition "I"

Protection class: IP 55

Temperature range: -30°C - +85°C

Undo the electrical

6-pin Mark II plug X71		
X71/1	24 Volt	X70/3
X71/2	Truck GND	X70/4
X71/3	CAN r H	X70/1
X71/4	CAN r L	X70/2
X71/5	Emergency stop 7S2/1	X71/3
X71/6	Emergency stop 7S2/2	X71/4
Earth wire to seat CPP mounting		



X18 Driver's seat connection
X71 Joystick

Configuration

The configuration must be parameterised again for all retrofitting and conversions related to the accelerator, drive direction and hydraulic controls.

This affects the following components:

- Single pedal
- Double pedal
- Joystick, tip switch, mini-lever
- Lift lever
- Direction indicator module

Parameterisation takes place using the truck diagnostics in the notebook.

Calibration

Calibration is not necessary.

Axle assignment - Joystick, mini-lever 1

General

The individual functions are assigned to the axles and buttons at the factory. The allocation in each case can be read from the "Decal information for actuation".

Parameterising allows for a number of different axle assignments and variants. When performing parameterisation, it is important to note that the variants depend on whether the "joystick" or "mini-lever" operating devices are fitted.

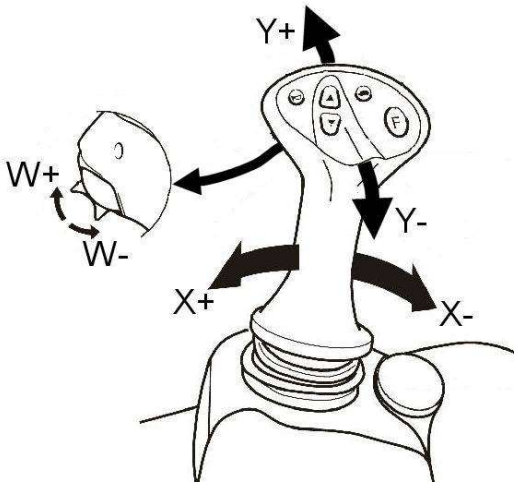
As soon as the axle assignment and consequently the means of operation have been changed, the "Decal information for actuation" must be modified. Current variants of the decal information can be ordered as spare parts.

NOTE

As soon as the means of operation has been changed, the "Decal information for actuation" must be modified.

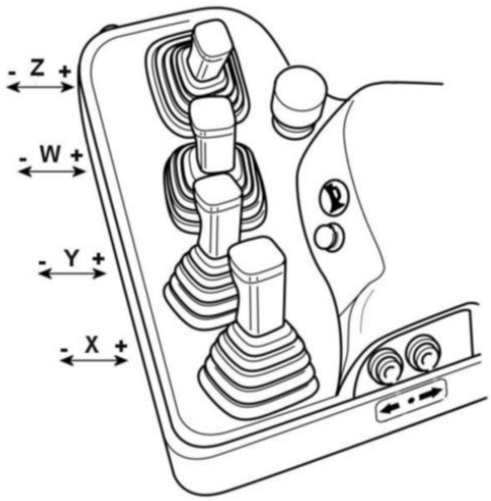
Joystick

Axle	Standard	Variant
X +	Auxiliary 1	Lift
X -	Auxiliary 1	Lower
Y +	Lower	Tilt forward
Y -	Lift	Tilt backward
W +	Tilt backward	Auxiliary 1
W -	Tilt forward	Auxiliary 1



Generation 1 mini-lever

Axle	Standard
X +	Lift
X -	Lower
Y +	Tilt backward
Y -	Tilt forward
W +	Auxiliary hydraulics 1
W -	Auxiliary hydraulics 1
Z +	Auxiliary hydraulics 2
Z -	Auxiliary hydraulics 2



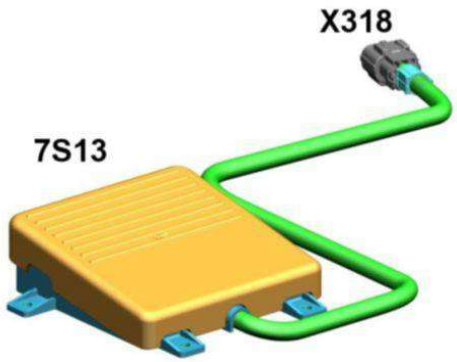
Switch

Dead man switch 7S13

General

As a variation, the single-pedal floorplate can be equipped with a dead man switch. The dead man switch is secured to the floorplate from below by four screws.

If the dead man switch is not actuated, the traction drive is turned off.



Undo the electrical

The dead man switch is connected to the truck central control (MCU) via the Option Board A22.

X318 - X31/2 - X47/35 (7S13)
X318 - X31/3 - X47/1 (GND)
X318 - X31/1 - X47/15 (12V-S)

Configuration

The dead man function must be activated through parameterisation.

Parameterisation takes place using the truck diagnostics in the notebook, category "Traction program".

Operating console

Direction indicator module (Fabli)

General

The direction of travel flasher module (1) comprises housing and a console. The housing is located below the steering wheel, screwed to the steering column.

The console integrates the direction switch (2) and flasher lever (3) controls and is screwed to the housing.

The **direction switch** switches three functions; the direction of actuation is indicated by the adjacent symbol:

- forwards
- Neutral
- Backwards

The **direction indicator switch** switches two functions; the direction of actuation is indicated by the adjacent symbol:

- right
- anticlockwise



1 Direction indicator module
2 Travel direction switch
3 Direction indicator switch

Retrofitting

For retrofitting, it may be necessary to change the truck central control MCU/TCU; see Electrical Connections

Undo the electrical

The direction of travel flasher module is connected to the truck central control MCU/TCU via the 4-pin CAN bus plug X45.

Since June 2007, the plug X45 has no longer formed part of standard equipment for the truck central control MCU/TCU.

X45/1 – CAN r H
X45/2 – CAN r L
X45/3 - CAN supply
X45/4 – GND F

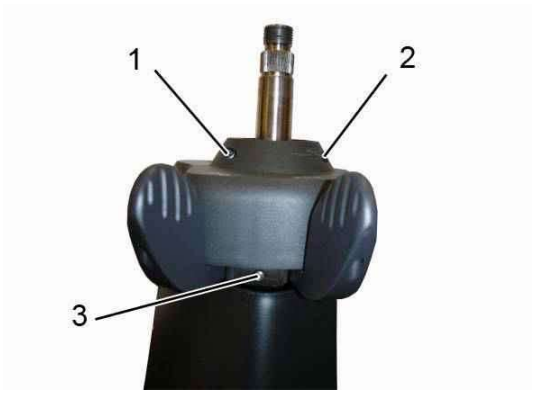
Removal

– Park the vehicle safely.

– Disconnect the battery plug with electric forklift trucks

– Remove the steering wheel

– Remove the console from the housing
– Unscrew the size 8 TORQUE screw (3)
– Unscrew the two cross-recessed screws (1) and (2)



– Disconnect plug X45
– Remove the console from the steering column



Installation

– Connect plug X45
– Connect the console to the housing
– Tightly screw in the two cross-recessed screws (1) and (2)
– Tightly screw in the size 8 TORQUE screw (3)
– Attach the steering wheel
– Connect the battery plug in electric fork lift trucks.
– Perform an operational test.

Configuration

The configuration must be parameterised again for all retrofitting and conversions related to the accelerator, direction of travel and hydraulic controls.

This affects the following components:

- Single pedal
- Double pedal
- Joystick, tip switch, mini-lever
- Lift lever
- Direction indicator module

Parameterisation takes place using the truck diagnostics in the notebook.

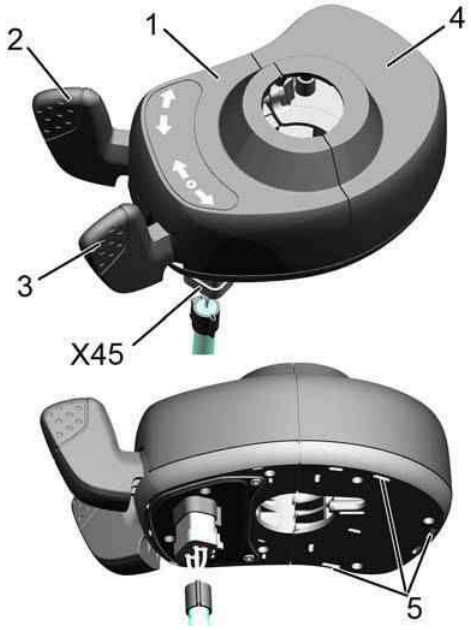
Turn indicator module for the drive direction, generation 2

Function

The turn indicator module for the drive direction (FABLI) is installed on all trucks with the "lighting and hand lever" equipment variant and on customer request. The turn indicators are activated and the drive direction is changed via the turn indicator module.

The FABLI consists of two parts. On the left is the operating unit (1) with the turn indicator switch (2) and drive direction switch (3), on the right is the flange housing (4).

The FABLI is screwed onto the steering column below the steering wheel.



1 Operating unit
2 Turn indicator switch
3 Drive direction switch
4 Flange housing
5 Openings to unlock the upper shell

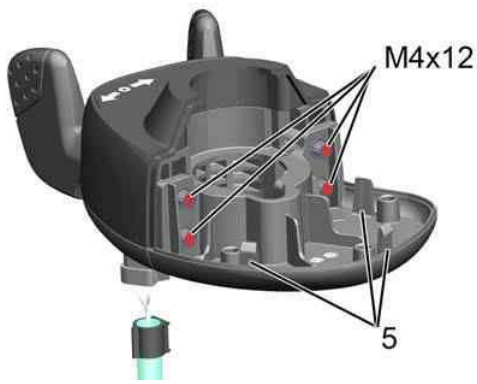
Technical data

CAN bus	CAN open as standard; integrated into the red CAN bus
Software	Device ID "K"
Protection class	
Temperature range	

Electrical connections

4-pin plug X45	
X45/1	CAN r H
X45/2	CAN r L
X45/3	12 V or 24 V
X45/4	Truck GND

Assembly



- Remove the upper shell from the flange housing. To do this, unlock the three latches (5) from below using a screwdriver.
- Screw the operating element and flange housing onto the steering column below the steering wheel using four socket head screws.
- Place the upper shell on the flange housing and snap it into place.
- Connect plug X45.

Parameterising

The configuration must be re-parameterised for all retrofitting and conversions related to the

FABLI. Parameterisation is performed using the truck diagnostics in the notebook.

Where necessary, load the current software flash package and start the calibration process; refer to the chapter entitled "Software compatibility".

A truck restart must always be performed after parameterising.

Drive direction turn indicator display

General



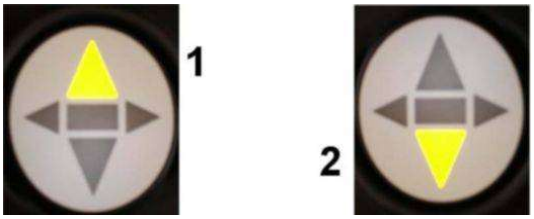
The drive direction turn indicator display is positioned to the right-hand side of the driver's field of vision in the front structure.

The five lights of the drive direction turn indicator display represent the drive direction, the turn indicators and malfunctions.

NOTE

Since October 2009, the drive direction turn indicator display is no longer being fitted to the trucks as a separate component. The drive direction turn indicator display is integrated in the generation 2 display operating unit.

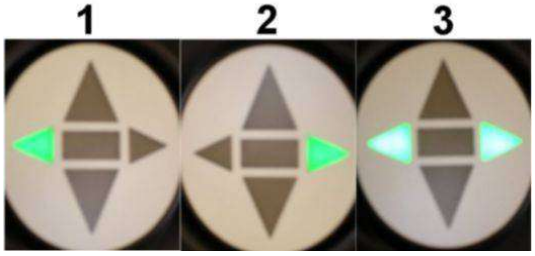
Direction of travel display



Direction of travel forwards (1)

Direction of travel backwards (2)

Flasher display



Left flasher (1)

Right flasher (2)

Hazard warning lights (3)

Fault display



Information, malfunction

If the fault display lights up, information is displayed at the same time in the display operating unit.

Undo the electrical

6-pin dynamic plug X17	
X17 - A1	to all lights 31 (GND)
X17 - A2	Forwards 1
X17 - A3	Backwards 1
X17 - B1	Right 1
X17 - B2	Left 1
X17 - B3	Message 1

Removal



⚠ CAUTION

The direction of travel flasher display is destroyed during removal.

Only remove the direction of travel flasher display if damaged.

The instrument is provided with spread clamps that clip under the edge when installed.

- Press out the drive direction turn indicator display; the spread clamps break off
- Disconnect plug X17 and remove the direction of travel flasher display

Installation

- Connect plug X17
- Check the direction of travel flasher display for correct operation
- This function inevitably determines the installation position
- Press the drive direction turn indicator display onto the holding fixture by lightly pressing on the edge

Display

Display operating unit (ABE 1) Generation 1

General



The display operating unit (ABE) is used to switch electrical accessories on and off via buttons. The integrated display shows information about driving.

The display operating unit is held in place inside the panelling by spring pressure to the right of the driver's seat.

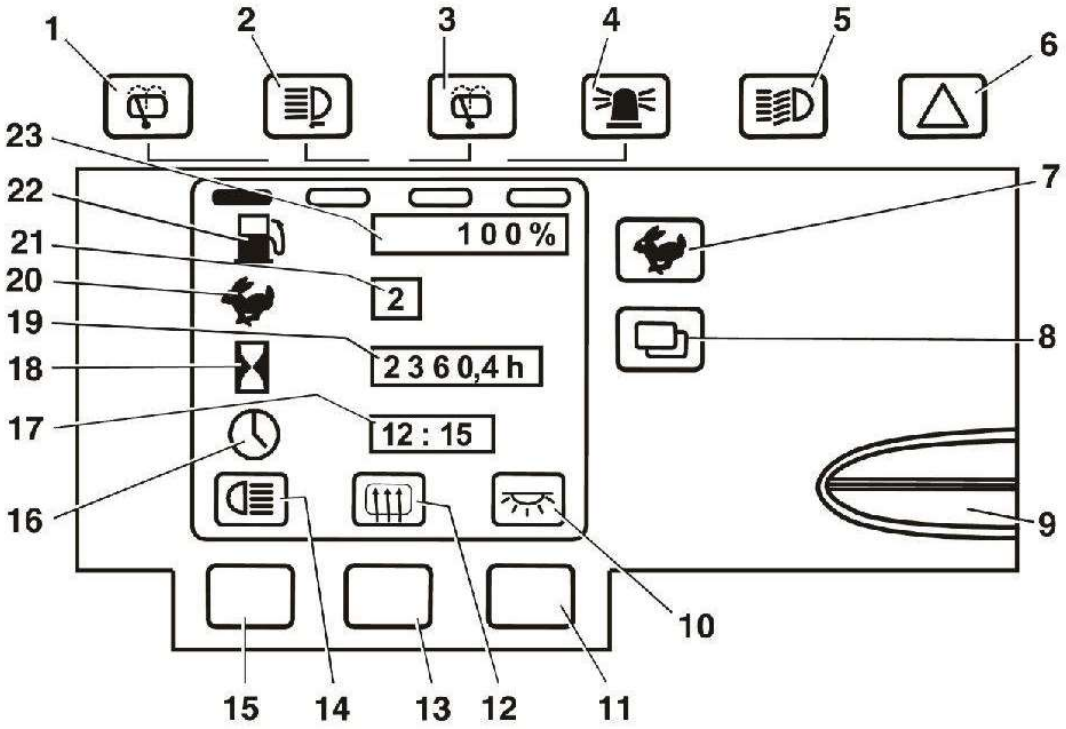
NOTE

The display operating unit was installed in various different trucks until October 2009. For this reason, the detailed description is contained in a separate workshop manual. See also the workshop manual "Display elements - display".

Electrical connections

6-pin MARK II plug X49	
X49/1	12 V
X49/2	Truck GND
X49/3	CAN r H
X49/4	CAN r L
X49/5	12 V
X49/6	Hazard warning system

Buttons and display



Number	Designation
1	"Windscreen wiper/washer" button
2	"Front searchlight" button
3	"Rear window wiper/washer" button
4	"Rotating beacon" button
5	"Lighting" button
6	"Hazard warning system" button
7	"Drive program change from 1-5" button
8	Button for "menu change" and changing the soft key columns
9	Card reader for FleetManager™ data card (variant)
10	Pictogram for soft key (11)
11	Soft key, here with "interior light" variant
12	Pictogram for soft key (13)
13	Soft key, here with "rear window heating" variant
14	Pictogram for soft key (15)
15	Soft key, here with "rear searchlight" variant
16	"Time" pictogram
17	Time display
18	"Operating hours" pictogram
19	Operating hours display
20	"Drive program" pictogram
21	Drive program display
22	"Battery indicator / tank display" pictogram
23	Battery charge or fuel level display

ABE 1
Installation and removal

Removal

– Park the truck safely.

– **Only for electric forklift trucks:** Disconnect the battery male connector.

⚠ CAUTION

The plastic surface is fragile!

The ABE must not be levered out of the assembly opening with tools.

– Remove the plastic plugs from the two assembly openings at the top edge of the panelling.

– Insert a screwdriver through the assembly openings and push down the retaining springs. This pushes the ABE forward out of the panelling.

– Disconnect plug X49 and remove the ABE.

▷



Installation

– Connect the plug X49.

– Attach the guide plates of the ABE to the lower edge of the assembly opening.

– Insert the ABE at the lower edge into the assembly opening until the springs engage.

Copying parameters
Only diesel/LPG trucks

In order to prevent a parameter loss, this parameter set is available as a copy in the ABE. When the ABE is changed, the parameter set must be copied from the remaining component.

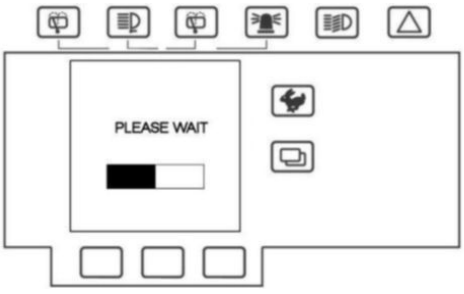
There are two ways of copying:

- Automatic transfer
- Manual transfer

Also see the chapter entitled "Parameter management".

The automatic transfer is indicated in the display by the `PLEASE WAIT` message with progress bar. This process can take several minutes and ends with a reset.

▷



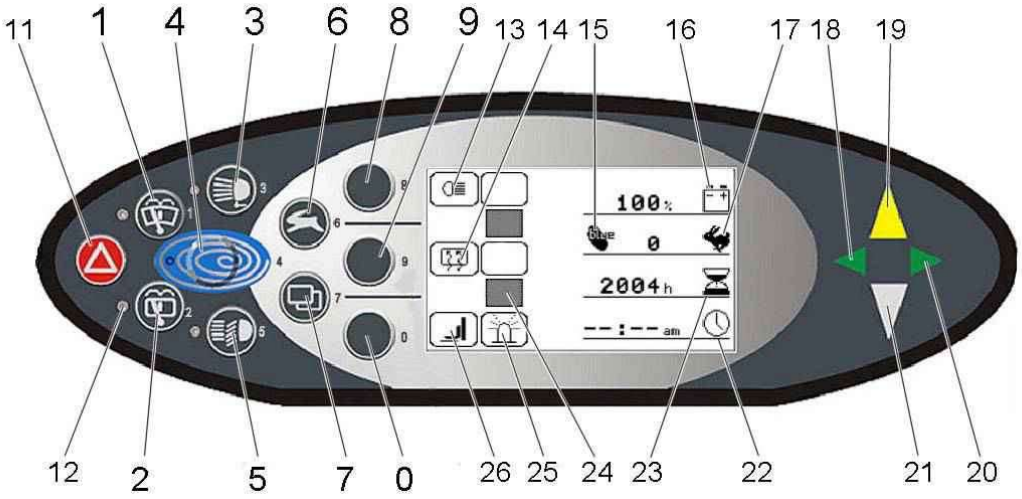
The manual transfer begins with the question in the display A–EEPROM VALID?. This means: "Are the parameters of the TCU (device A) supposed to be used?"

- Load software flash package; see chapter entitled "Software compatibility"
- Start calibration.
- Delete the error memory.
- Function check.



Display and operating unit, generation 2 (ABE 2)

Buttons and display



Number	Button assignment	
1	"Windscreen wiper/washer" button	Number 1 in programming mode
2	"Rear window wiper/washer" button	Number 2 in programming mode
3	"Searchlight" button	Number 3 in programming mode
4	"Blue-Q efficiency mode" button	Number 4 in programming mode
5	"Dipped beam / high beam" button	Number 5 in programming mode
6	"Drive program change from 1-5" button	Number 6 in programming mode
7	Button for "menu change" and changing the soft key columns	Number 7 in programming mode
8	Soft key, here with "searchlight / rear" variant	Number 8 in programming mode
9	Soft key, here with "heating system / rear window" variant	Number 9 in programming mode
0	Soft key, here with "mast vertical position" variant	Number 0 in programming mode
11	"Hazard warning system" button	
12	LED display for button active/inactive	
13	Pictogram for soft key (8), soft key column 1	
14	Pictogram for soft key (9), soft key column 1	
15	Pictogram status "Blue-Q active"	

Number	Button assignment
16	"Battery indicator / tank display" pictogram
17	"Drive program" pictogram
18	Left turn indicator display
19	Drive direction forwards display
20	Right turn indicator display
21	Drive direction backwards display
22	"Time" pictogram
23	"Operating hours" pictogram
24	Display for active soft key column; in this case, column 2 is active
25	Pictogram for soft key (0), soft key column 2; in this case, for the "rotating beacon" variant
26	Pictogram for soft key (0), soft key column 1; in this case, for the "vertical mast position" variant

Function

The display operating unit (ABE) is used to switch electrical accessories on and off via buttons. The integrated display shows information about driving.

The display operating unit is located in the front structure, to the right of the steering wheel.

NOTE

The display operating unit is installed in a number of trucks. For this reason, the detailed description is contained in a separate workshop manual. See also the workshop manual "Display elements - display".

Electrical connections

6-pin MARK II plug X49	
X49/1	12 V
X49/2	Truck GND
X49/3	CAN r H
X49/4	CAN r L
X49/5	12 V
X49/6	Hazard warning system

ABE 2
Installation and removal

Removal

– Park the truck safely.

– **Only for electric forklift trucks:** Disconnect the battery male connector.

– Undo the ABE at the lower edge and take it out of the assembly opening on the panelling.



⚠ WARNING

Risk of injury!

Gloves must be worn to protect hands.

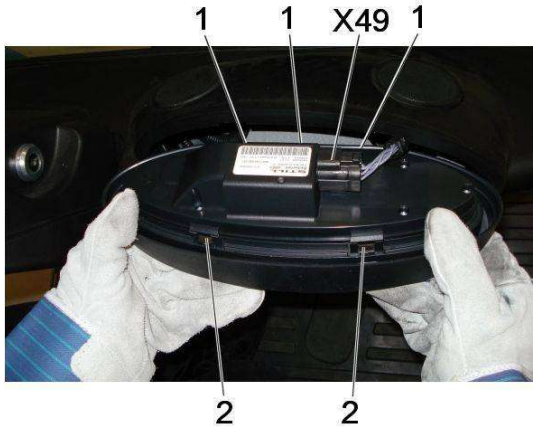
⚠ CAUTION

The plastic surface is fragile!

The ABE must not be levered out of the assembly opening with tools.

– Disconnect plug X49 and remove the ABE.

Installation



– Connect the plug X49.

– Attach the guide plates (1) of the ABE to the lower edge of the assembly opening.

– Insert the ABE at the lower edge into the assembly opening until the springs (2) engage.

Copying parameters
Only diesel/LPG trucks

In order to prevent a parameter loss, this parameter set is available as a copy in the ABE. When the ABE is changed, the parameter set must be copied from the remaining component.

There are two ways of copying:

- Automatic transfer
- Manual transfer

Also see the chapter entitled "Parameter management".

The automatic transfer is indicated in the display by the `PLEASE WAIT` message with progress bar. This process can take several minutes and ends with a reset.



The manual transfer begins with the question in the display `A-EEPROM VALID?`. This means: "Are the parameters of the TCU (device A) supposed to be used?"



– Load software flash package; see chapter entitled "Software compatibility"

– Start calibration.

– Delete the error memory.

– Function check.

General

General technical data - 48 Volt

Electrical system	6210 - 6217
Control electronics	Digital controller
Traction controller	Speed-regulated 4-quadrant three-phase AC converter
Pump controller	Speed-regulated 1-quadrant three-phase AC converter
Accelerator	Dual-action potentiometer, 4 kΩ each
Brake sensor for electric braking	4 kΩ potentiometer
Hydraulic transmitter	Electric displacement transducer
Speed	Max. 16 km/h Adjustable via 5 drive programs
Nominal voltage	48 Volt
Traction motor revolution control	Truck control unit (MCU)

Current limitation		
Traction motor		
Traction motors FM1 and FM2	Traction against block	231 A effective phase current (50 Nm)
	Traction against block with starting current boost only with SAC converter	335 A effective phase current (75 Nm)
Pump motor		
Pump motor HM	Tilt against over pressure	360 A effective phase current (52 Nm)
Traction converter 1U06, 1U07		
LAC 1	Regulation in the event of overtemperature	from 540 A effective to 0 A
LAC 1A	Regulation in the event of overtemperature	from 404 A effective to 0 A
SAC - 400	Regulation in the event of overtemperature	from 404 A effective to 0 A
Pump converter 1U03		
LAC 1	Regulation in the event of overtemperature	from 540 A effective to 0 A
SAC - 600	Regulation in the event of overtemperature	

Main contactor 1K1	
24 V (switched)	2-pin coil Contacts: changeable Contact material: silver alloy
Relay	
24 V (coil 255 Ω)	K1, K2
Fuses	
	see chapter "Fuses"
Traction battery G1 - standard	
48 V / 550 Ah	6211, 6212, 6213, 6215, 6216
48 V / 700 Ah	6214, 6217

Insulation resistance	
Electrical system Electrical equipment Traction battery	Min. 1000 Ω/volt ≈ > 48 kΩ Min. 1000 Ω/volt ≈ > 48 kΩ Min. 1000 Ω
Electrical protection type	
Electrical system Electrical equipment	IP 23, incl. cover IP 54 IP 54

General technical data - 80 Volt

Electrical system	6311, 6313, 6315
Control electronics	Digital controller
Traction controller	Speed-regulated 4-quadrant three-phase AC converter
Pump controller	Speed-regulated 1-quadrant three-phase AC converter
Accelerator	Dual-action potentiometer, 4 kΩ each
Brake sensor for electric braking	4 kΩ potentiometer
Hydraulic transmitter	Electric displacement transducer
Speed	Forwards 19.9 km/h, backwards 18 km/h Adjustable via 5 drive programs
Nominal voltage	80 Volt
Traction motor revolution control	Truck control unit (MCU)

Current limitation		
Traction motor		
Traction motors FM1 and FM2	Traction against block	150 A effective phase current (55 Nm)
	Traction against block with starting current boost	193 A effective phase current (75 Nm)
Pump motor		
Pump motor HM	Tilt against over pressure	237 A effective phase current (65 Nm)
Traction converter 1U06, 1U07		
LAC 1	Regulation in the event of overtemperature	from 316 A effective to 0 A
Pump converter 1U03		
LAC 2	Regulation in the event of overtemperature	from 612 A effective to 0 A

Main contactor 1K1	
24 V (switched)	2-pin coil Contacts: changeable Contact material: silver alloy
Relay	
24 V (coil 255 Ω)	K1, K2
Fuses	
	see chapter "Fuses"
Traction battery G1 - standard	
80 V / 420 Ah	6311, 6313, 6315

Insulation resistance	
Electrical system Electrical equipment Traction battery	Min. 1000 Ω/volt ≈ > 80 kΩ Min. 1000 Ω/volt ≈ > 80 kΩ Min. 1000 Ω
Electrical protection type	
Electrical system Electrical equipment	IP 23, incl. cover IP 54 IP 54

Overview of the controllers

Device		Description	Application
A	MCU	Truck control unit A44	Electric forklift trucks
	TCU	Truck control unit A44	IC truck
B	PU2	Pump converter 2U04	Electric truck: second left-hand pump motor (HM2, PM2)
D	FU1	Traction inverter 1U06	Electric truck: right-hand traction motor (FM1) IC truck: traction motor (1M1, 1M01)
E	FU2	Traction inverter 1U07	Electric truck: second left-hand traction motor (FM2) IC truck: second left-hand traction motor (1M1, 1M02)
F	PU1	Pump converter 2U03	Electric truck: right-hand pump motor (HM1, PM1)
	PU1-GR	Generator processor integrated in the converter to support the hydraulic pump	IC truck: equipment variant hybrid II
G	FMID	Card reader	FleetManager™ special equipment
H	VR	Valve processor integrated in TCU/MCU	Equipment variant for servo hydraulics
I	FIT	Joystick, fingertip and mini-lever	Equipment variant for servo hydraulics
J	ABE	Display operating unit	E truck and IC truck
K	FABLI	Travel direction indicator module	Equipment variant
L	CPP1	Roof CAN-Power-Port	Equipment variant
M	CPP2	Front CAN-Power-Port	Equipment variant
	CPP2B	Lighting CAN-Power-Port	
N	CPP3	Seat CAN-Power-Port	Equipment variant
O	CPP4	Rear CAN-Power-Port	Equipment variant
P	CIO	Battery carrier	Equipment variant for electric forklift trucks up to 3.5 t
R	CS	Acceleration sensor	Equipment variant for FleetManager™
S		Battery controller	Equipment variant for electric forklift trucks
	LIB	Lithium-ion battery	
T	SU	Control unit A43 (Supply Unit)	E truck (48 V/80 V)
	SDC1	DC/DC converter	Equipment variant for hybrid trucks
U	DFÜ	Remote data transfer	Equipment variant for FleetManager™
V	CPP5	Soot CAN-Power-Port	Equipment variant for particle filter
X	ELF	Control unit for the electric parking brake	Equipment variant
Y	RFID	RFID control unit	Equipment variant for RFID equipment

Device		Designation	Application
c	SHS1	Energy accumulator 1	Equipment variant for Hybrid trucks
d	SHS2	Energy accumulator 2	Equipment variant for Hybrid trucks

Electrical system

General

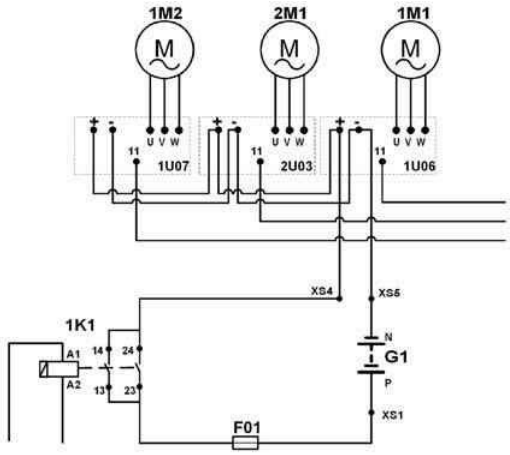
The truck is equipped with a front wheel drive and is powered by two speed-controlled asynchronous motors.

The hydraulic pump is also operated by a speed-controlled asynchronous motor.

Each of the three asynchronous motors is powered by an inverter. The inverters are controlled by the CAN bus (CANopen) via the Supply Unit and Main Control Unit.

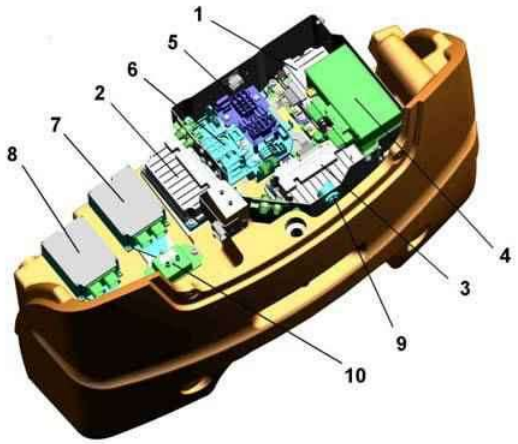
The control electronics are powered by an internal 12-Volt voltage supply from the Main Control Unit.

The additional electrical consumers have a 24-Volt supply from external voltage transformers. The number and power rating of the voltage transformers must be selected according to the overall rating of all of the equipment.



Electrical components

RX20 15 - 20
RX60 16 - 20



1	Traction inverter 1U06	6	Fuse box A21
2	Traction inverter 1U07	7	U1 voltage transformer
3	Pump inverter 2U03	8	U2 voltage transformer
4	Supply unit A43	9	Signal transmitter 4H2
5	Distributor card 7A21	10	Acceleration sensor

The number of electrical components in the counterweight depends on the equipment.

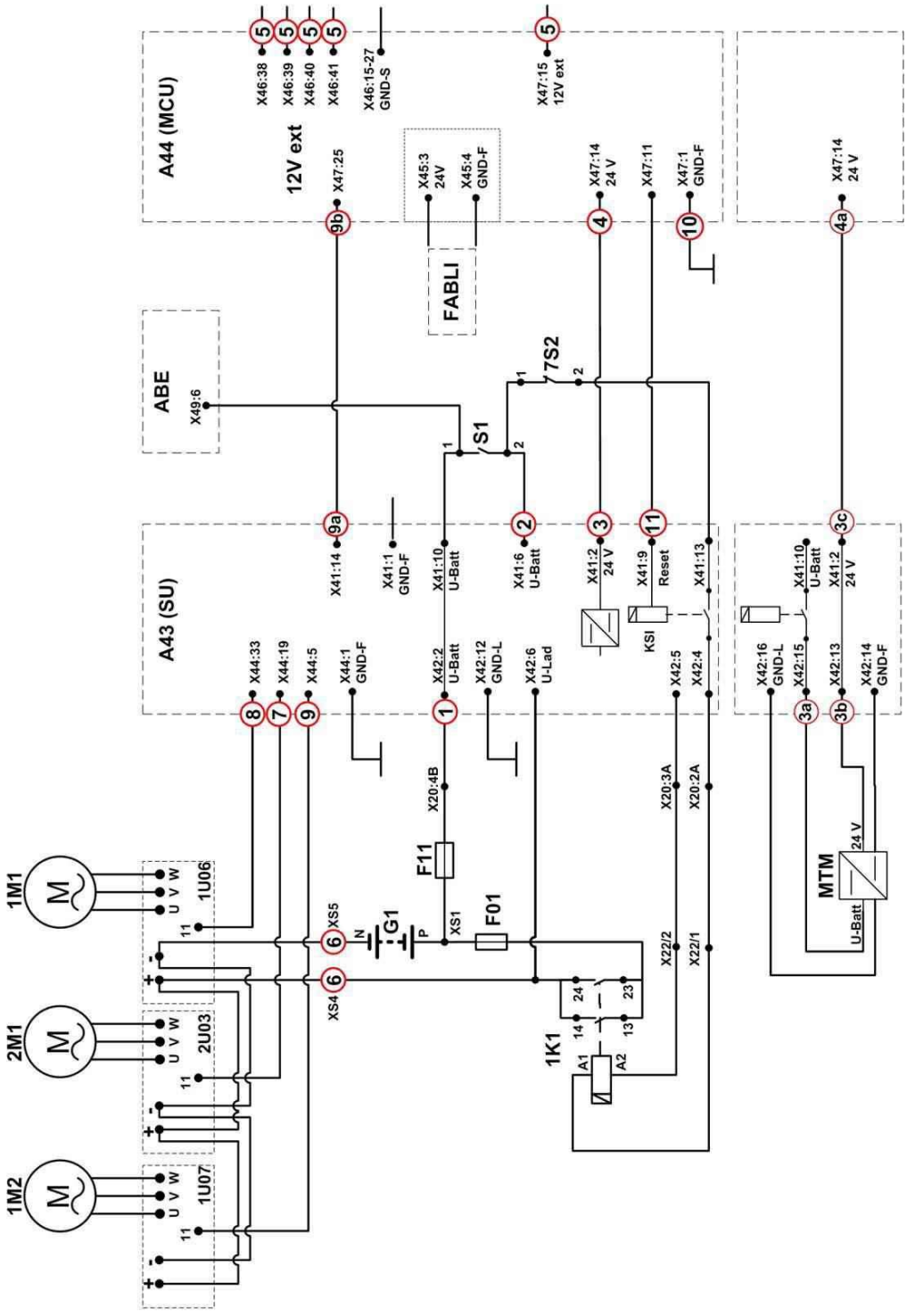
In the truck as standard:

- Traction inverters (1, 2)
- Pump inverter (3)
- Supply unit (4)
- Fuse box (6)

Variants of the additional electrical equipment:

- Signal transmitter (9)
- Distributor card (5)
- Voltage transformers (7-9)
  Version with one or two voltage transformers
- Acceleration sensor (10)

Switching on procedure for the electrical system



Components

ABE	Display operating unit
A43	Supply Unit
A44	Main Control Unit
FABLI	Drive direction turn indicator module
F01	Main fuse
F11	Fuse for SU / MCU
G1	Battery
S1	Key switch
7S2	Emergency off switch
1K1	Main contactor
1M2	Left traction motor
1M1	Right traction motor
2M1	Pump motor
1U06	Right traction motor converter
1U07	Left traction motor converter
2U03	Pump motor converter

Measuring points

1	U-Batt
2	U-Batt
3	24V CAN bus
4	24V CAN bus
5	12V sensor voltage
6	U-Batt, intermediate circuit
7	Release 2U03
8	Release 1U06
9	Release 1U07
10	Main contactor release
11	Main contactor release

Measuring points for the "external voltage transformer MTM"

3a	U-Batt
3b	24V from MTM
3c	24V CAN bus
4a	12V sensor voltage

Prerequisite for the measurement

– Emergency off switch unlocked.

– Handbrake applied.

– Key switch at ON.

U-Batt voltage supply to switch lock

– From batt.+ to fuse F11 in the fuse box

– From fuse F11 via plug X20/4B to the SU X42/2.

Measuring point (1)	Battery male connector ON
U-Batt	GND-L
X42/2	X42/12

– U-Batt from the SU X41/10 to switch lock S1/1 and warning light X49/5 in the ABE

– From switch lock S1/2 back to the SU X41/6.

– From switch lock S1/2 to emergency off switch 7S2.

Measuring point (2)	S1 ON
U-Batt	GND-L
X41/6	X42/12

Switching on procedure and run-up of controls

The battery male connector is connected and the key switch is in the ON position. Measurements (1) and (2) have given correct values. Regardless of the status of the emergency off switch, the 5-V processor supply and the internal 24-V supply are active.

NOTE

Since August 2006, the SU has an internal voltage transformer as standard. Until August 2006, the external voltage transformer MTM was required for the 24V supply. For the measurement (3), or (3a, 3b, 3c), these variants are to be considered (see below).

– The SU starts up and carries out a self-check.

– A safety relay in the SU issues the enable for U-Batt.

– The internal voltage transformer of the SU generates the 24V supply voltage from U-Batt for the MCU. All converters and the CAN bus participants, example: FABLI.

Measuring point (3)	
24 V CAN bus	GND-F
X41/2	X41/1

The supply voltage of the MCU is wired directly to the supply voltage of the converter. If the measurement (3) gives correct values, 24 Volt is also present at the converters (X44/2-1U07, X44/16-1U03, X44/30-1U06).

Measuring point (4)	
24 V CAN bus	GND-F
X47/14	X47/1

NOTE

A short circuit in one of the CAN bus participants, example FABLI leads to the failure of the 24V supply.

– The MCU carries out a self-check. At the same time, the 5V processor supply and the 12V transmitter supply are switched on in the MCU.

Measuring point (5)	
12 V	GND-S
X46/28	X46/15 to X46/27
X46/38	
X46/39	
X46/40	
X46/41	
X47/15	

– The MCU starts up the networks of the individual CAN bus participants in a defined sequence.

1. Supply Unit
2. Converter

2.1 Pump converter 2U03

2.1 Traction inverter 1U06 (FM1)

2.3 Traction inverter 1U07 (FM2)

3. Display and operating unit (ABE)
4. Additional electrical installation (FABLI, CPP)

– Once the SU is integrated into the network, it communicates with the MCU.

– The SU charges the converter intermediate circuit to at least 40V in 1.4 seconds.

NOTE

The intermediate circuit is charged for all converters at the same time. A defective converter will result in charging faults for all converters.

- *To find the defective converter, disconnect the converters individually and repeat the switching on process.*

Measuring point (6)	
U-Batt	Batt
XS4	XS5

– The converter node allocation takes place whilst the intermediate circuit is being charged. During the node allocation, the enable is set for a short time via the enable line. After this, the individual converters are allocated to the electric motors. The node allocation takes place in a defined sequence:

1. Pump converter 2U03
2. Traction inverter 1U06 (FM1)

3 Traction inverter 1U07 (FM2)

– Together with the MCU for node allocation, the SU enables the converters. The converters are enabled via the enable line X150/11-2U03, X151/11-1U06, X152/11-1U07. The enable signals can be measured via a level change.

Measuring points (9a), (9b)			Enable signal for the traction converter
(9a,b)	X41/14	X47/25	Level change to approx. 1.68 V

NOTE

If the enable lines of the converters are reversed, the converters will thus be controlled incorrectly.

Measuring points (7), (8), (9)			Converter enable signal	
(7)	X44/19 (Enable 2U03)	X44/1 (GND F)	Approx. 0 V	Enable direct to GND-F
(8)	X44/33 (Enable 1U06)	X44/1 (GND F)	Level change to approx. 1.68 V	Enable via internal switching (photocoupler)
(9)	X44/5 (Enable 1U07)	X44/1 (GND F)	Level change to approx. 1.68 V	Enable via internal switching (photocoupler)

– Approx. 1.7 seconds after the 24 V have been stabilised for the CAN bus, the enable for the safety relay KSI is set (reset). The KSI in the SU switches on (relay click is audible).

Measuring points (10), (11)			Supply 1K1	
(10)	X47/11	X47/1 (GND F)	Level change from 24 V to approx. 0.8 V	Enable direct to GND-F
(11)	X41/9	X47/1 (GND F)	Level change from 24 V to approx. 0.8 V	Enable direct to GND-F

– The supply voltage for K1 is present at the main contactor 1K1.

– If all security questions have been confirmed positively (all status bits are set), the contactor current regulation in the SU X42/5 is switched on

– Only now does the main contactor 1K1 close.

– The drives are ready.

– The drive unit and the hydraulics are now enabled. Prerequisite for this is the status of the handbrake and the seat contact switch.

Measuring point 3 for the external voltage transformer MTM:

This measurement (3) is only for trucks that are equipped with the external voltage transformer MTM.

– The SU starts up and carries out a self-check.

– A safety relay in the MTM issues the enable for U-Batt, (relay click is audible)

– The external voltage transformer MTM generates the 24V supply voltage from U-Batt for the MCU. All converters and the CAN bus participants, example: FABLI.

Measuring point (3a)	
U-Batt	GND-F
X42/15	X42/14
Measuring point (3b)	
24 V from MTM	GND-F
X42/13	X42/14
Measuring point (3c)	

24 V CAN bus	GND-F
X41/2	X42/14

The further measurements take place as for trucks with an internal voltage transformer.

Software compatibility

Software flash packages

Replacement control units can contain software versions that do not match the versions in the control units that are still in the truck. This will cause an invalid combination of software that can lead to errors in the truck.

An approved software flash package must be loaded whenever any of the control units in the truck are replaced. A software flash package contains compatibility-checked software versions for all control units. Loading a software flash package eliminates any invalid software combinations.

Please see the "STILL Flasher" and "Truck software overview" workshop manuals for more information on "software flash packages" and "loading flash packages".

Calibration

Once a software flash package has been loaded, all transmitters and sensors, as well as the joystick (variant), must be recalibrated.

– Connect the notebook to the truck. Start the truck diagnostics:

Jobs

▼

Calibration

▼

0. Sensors
1. Accelerator

For hand lever only

2.-5. Hydraulic sensor

Variant

6. Mast vertical

– Connect the notebook to the truck. Start the servo hydraulics diagnostics:

Jobs

▼

Joystick calibration

▼

Execute

PAN process

Function

⚠ CAUTION

A deactivated PAN process can lead to undefined faults in the truck.

The PAN process must always be activated.

In the truck, the PAN process ensures that the truck control unit (MCU / TCU) always operates all available controllers in the truck according to the current parameters.

Each time the truck is started, the PAN process ensures that the checksums of the individual controllers are compared with the checksums saved in the truck control unit (MCU / TCU).

In the event of parameter changes, software changes or changes of individual controllers, the PAN process ensures that the relevant controllers and the truck control unit (MCU / TCU) process the changes correctly.

It is essential that the PAN process always remains activated, otherwise the necessary checksum comparisons and adjustments cannot be carried out.

Error profile generated when a PAN process is not being performed correctly:

- After switching on, the display of the display operating unit remains frozen on the welcome screen.
- Please wait appears in the display during operation

The current status of the PAN process can be checked via the truck diagnostics.

F4: Monitoring

▼

Status

▼

Status PAN

Parameter management

Concept

The truck parameter set is stored in the truck control unit (MCU). In order to prevent a parameter loss, this parameter set is available as a copy in the supply unit (SU).

The parameter sets for SU, ABE, FU and PU are available as copies in the MCU.

As soon as one of these components is replaced, the parameter set copy must be copied from the remaining components.

⚠ CAUTION

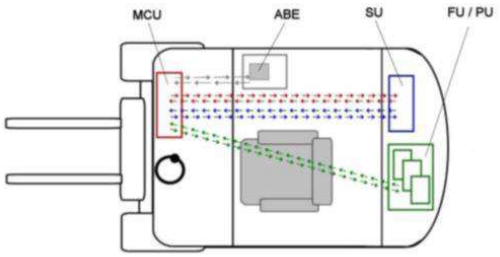
Parameter loss

If the MCU and SU are replaced at the same time, the parameters will be lost.

If the MCU and FU/PU are replaced at the same time, the parameters will be lost.

If the ABE and MCU are replaced at the same time, the parameters will be lost.

A truck parameter set must be loaded via the notebook in all cases.



MCU	Truck control unit
ABE	Display operating unit
SU	Supply unit
FU	Traction converter
PU	Pump converter

Copying parameters

There are two ways of carrying out the copying procedure:

- Automatic transfer

  Automatic transfer starts for components that do not have a functioning parameter set. This generally applies to brand-new components and spare parts.
- Manual transfer

  Manual transfer starts for components that have a functioning parameter set. This is an indication that the component has already previously been installed in a truck.

The automatic transfer is indicated in the display by the `PLEASE WAIT` message with progress bar. This process can take several minutes and ends with a reset.



NOTE

An automatic transfer generally takes place when a converter is installed.

The manual transfer begins with the question in the display A–EEPROM VALID?. This means: "Should the parameters of the MCU (device A) be used?"



Should the parameters of the MCU (device A) be used?

- Use the MCU parameters

  Confirm with button ☑

  Copy of parameters from the MCU to the SU
- Use the SU parameters

  Say no by pressing the ESC button

  Copy of parameters from the SU to the MCU

Confirm your answer to the security question ARE YOU SURE? again. In case of any doubt, the operation can still be interrupted.

Error ring buffer

The error ring buffer displays errors in the same temporal sequence in which they occurred. The precise temporal statement of the error helps with troubleshooting the truck. This is under the condition, however, that the time and date in the display operating unit is correctly set.

The following data is stored per error:

- A-errors of the truck control unit (A44, MCU/TCU)
- Date
- Time
- Designation of the error
- Operating hours of the truck control unit (A44, MCU/TCU)
- Operating hours of the truck

The error ring buffer is read out via the truck diagnostics in the notebook. To do this, start the diagnostics and carry out the action "Read out error ring buffer". A maximum of 256 errors are stored in the ring. These are automatically overwritten after 256 entries.

NOTE

The error ring buffer is not present until certain software versions. For details see the document "Truck software overview"

Intermediate circuit

Work on the electrical system

Before carrying out any work on the electrical system, the charging state of the intermediate circuit must be checked and a discharge process initiated as is necessary.

If you carry out work on the electrical system with a charged intermediate circuit, there is a risk of electric shocks caused by short circuits with tools and parts of the body.

⚠ DANGER

Due to the internal energy accumulator in the converters and control units, there may be dangerously high voltages at the electrical connections in the event of a fault — even after the battery male connector has been disconnected.

Do not touch live contact points such as the positive and negative connections of the power control units!

Before working on electrical power connections, always check the voltage between all contacts and between the contacts and the truck chassis using a suitable measuring device (capable of measuring up to 1000 V DC).

Discharge the intermediate circuit.

Discharge circuit

The discharge circuit is a device for discharging the intermediate circuit in converters in electric trucks.



Checking the discharge circuit

The bulb acts as a fuse against too high residual voltages in the intermediate circuit and can blow in the event of a fault.

For this reason, the bulb must be checked for correct function before and after every use and replaced if necessary.

Discharging the intermediate circuit

– Disconnect the battery male connector

– Connect the batt+ and batt- connections on the converter to the discharge circuit.

If there is any residual voltage still in the intermediate circuit, the bulb briefly flashes.

– Measure the voltage in the intermediate circuit

The intermediate circuit is considered discharged when the voltage is less than 11 V.

Insulation testing for electric trucks

General

Insulation testing must be carried out on the entire truck at least once a year as part of the FEM test. Insulation testing must also be carried out after any work on the electrical system or repairs to the electrical system.

Insufficient insulation values in the truck can lead to undefined errors that are not reliably detected via diagnostic processes.

The insulation of the entire truck is tested during this process.

If the event of insufficient measured values, insulation measurement is to be carried out on the following components in order to ensure that no errors have gone undetected:

- Traction motor
- Pump motor
- Battery

⚠ DANGER

Dangerously high voltages can be present in the electrical drive system (inverter, traction motor, pump motor)!

Always observe the safety information; see chapter entitled "Safety information".

Before working on the inverter, first check the charge state of the intermediate circuit voltage.

– If the intermediate circuit voltage is not discharged to 0 V, take particular care when working on the inverter.
– Follow the correct sequence for removing the inverter.

Nominal voltage	Test voltage	Test values for new trucks	Minimum value over the duration of service life
24 V	50 V/DC	Min. 50 kΩ	> 24 kΩ
48 V	100 V/DC	min. 100 kΩ	> 48 kΩ
80 V	100 V/DC	min. 200 kΩ	> 80 kΩ

Measuring aid

– STILL MetraHit ISO multimeter measuring device with measuring lines
– Discharge circuit; see chapter "Intermediate circuit".

– Short-circuit bridge for the battery male connector on the truck side.
– Short-circuit bridge for the main contactor, consisting of a short laboratory line and two crocodile terminals.

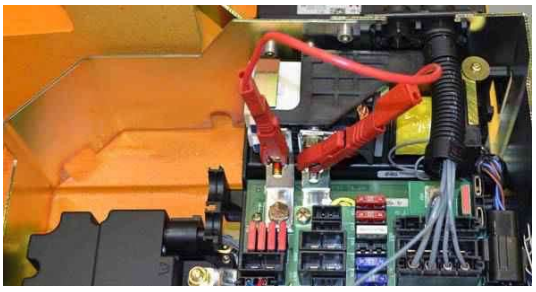


Preparation

– Disconnect the battery male connector.
– Discharge the intermediate circuit; see chapter "Intermediate circuit".
– Check that all fuses are inserted and main fuses screwed in.
– Attach short-circuit bridge on the truck side to the battery male connector.



– Connect short-circuit bridge to the main contactor.
– Unlock the emergency off switch.
– Switch lock ON



Measurement

– Set the measuring device to the truck-specific test voltage.
– Connect the black measuring line to a clean area on the truck chassis e.g. the screw joint at the chassis and counterweight.
– Insert both measuring lines into the measuring device; see the following schematic view
– Hold down the ENTER button and read the value.



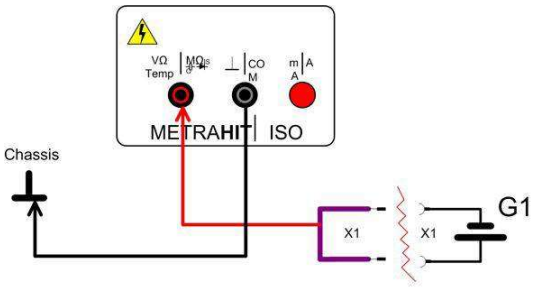
NOTE

The measurement may take a few seconds, as capacities are transferred between the truck chassis and the electronics.

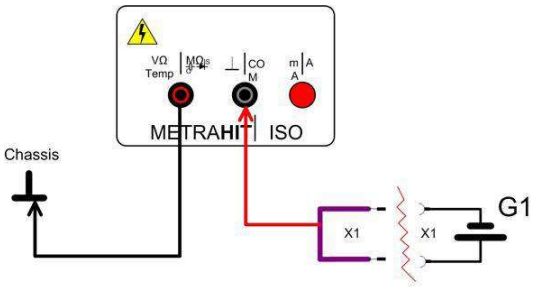
The measurement must be carried out with both polarities, as many electronic building

elements are installed with direction-dependent breakdown characteristics in the controllers.

– Insert the red measuring line of the short-circuit bridge into the positive terminal of the measuring device.



– Insert the red measuring line of the short-circuit bridge into the negative terminal of the measuring device.



Ideally, both measurements should produce the same value. If the values deviate from one another, the lower value is valid for the truck.

Follow-up work

The measurements have caused capacities to be created in the truck. These must be discharged in a defined manner.

– Leave the measuring device connected until the voltage value at the truck has decreased to < 10 V.

– Remove the discharge circuit from the main contactor.

– Remove the short-circuit bridge from the truck battery male connector.

Insulation testing on the drive battery

Extract from EN 1175-1, (U_{Batt} < 120 V)

Chapter 5.15.1, Test voltage:

- The insulation resistance of the truck and the battery must be tested individually.
- The test voltage must be greater than the nominal battery voltage but not higher than 100 V or three times the nominal battery voltage.

Chapter 5.15.1, Insulation resistance:

- The insulation resistance of the battery is tested when the battery is disconnected, filled and charged, and installed in the truck.
- The insulation resistance is tested between the electrically active parts of the battery and the battery tray.
- Test value [Ω] > (50 $^{\Omega}/_{V}$ x U_{Batt})

Measuring device

- STILL MetraHit ISO multimeter

Test values

Component	Recommended test voltage	Measurements		Nominal voltage U_{Batt}	Test values
Battery	50 V/DC	Batt+ Batt-	Battery tray	24 V	> 1200 Ω
	100 V/DC			48 V	> 2400 Ω
	100 V/DC			80 V	> 4000 Ω

Performing battery measurements

– Disconnect the battery male connector.

– Set the measuring device to the truck-specific test voltage.

– Measure from the battery positive terminal against an electrically conductive point on the battery tray.

– Measure from the battery negative terminal against an electrically conductive point on the battery tray.

Component insulation testing

General

During insulation testing of the entire truck, if the insulation values measured were insufficient, it is a good idea to test the components of the traction motor and pump motor individually.

⚠ DANGER

Dangerously high voltages may be present in the electrical drive system (converter, traction motor, pump motor)!

Always observe the safety information; see chapter entitled "Safety information".

Before working on the converter, first check the charging state of the intermediate circuit voltage.

– If the intermediate circuit voltage is not discharged to 0 V, take particular care when working on the converter.

– The correct sequence must be followed when removing the converter.

⚠ CAUTION

The test voltage can destroy electronic components.

Disconnect the electrical connections for all controllers.

Connect the temperature sensors to the short-circuit bridge.

Test values

Component	Test voltage	Measurements		Nominal voltage U_{Batt}	Test values
Traction motor, pump motor	500 V/DC	U, V, W	Housing	24 Volt	> 24 kΩ
				48 V	> 48 kΩ
				80 V	> 80 kΩ

Measuring device

- MetraHit Isomultimeter STILL
- Short-circuit bridge for the temperature sensors

Preparation

– Disconnect the battery male connector

– - De-energise the converter by disconnecting the power cables and the control cables

– - De-energise the truck control unit by disconnecting the SAAB plugs and the CAN bus plugs

– - Connect all electric motor temperature sensors to the short circuit plug

The connection cables and, if necessary, the CAN bus plug, must be disconnected from the components, depending on the equipment.

Electric motor measurement

– Set the measuring device to the truck-specific test voltage.

– Measure the windings U, V, W of the traction motor in relation to the housing.

– Measure the pump motor windings U, V, W in relation to the housing.

The measurements must be carried out one after another for each winding.

In order to verify a frame fault on electric motors, it may be necessary to increase the test voltage to 1000 V.

Follow-up work

– Connect the power cables and the control cables to the converters.

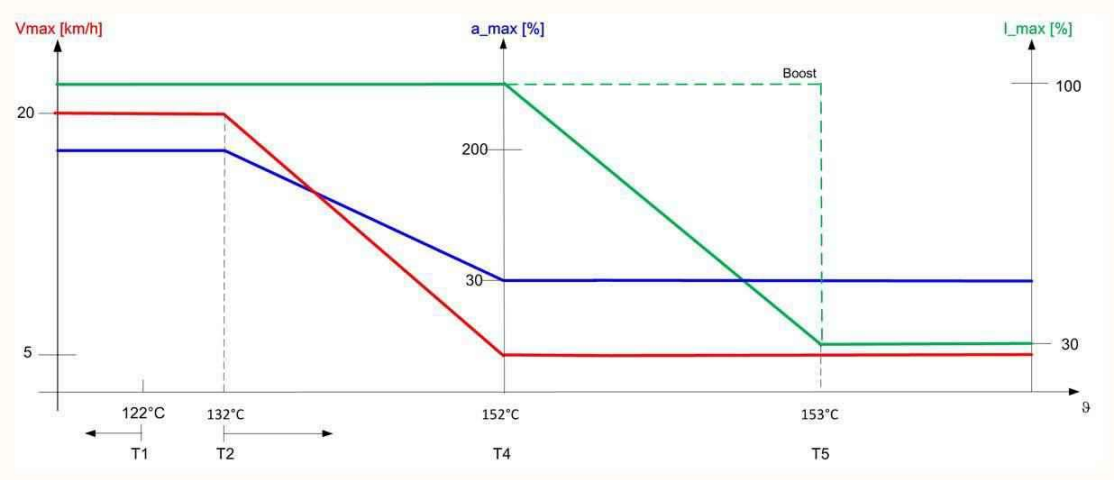
– Connect the SAAB plugs and CAN bus plugs to the truck control unit.

– Remove the short-circuit bridge from the temperature sensors.

The connection cables and, if necessary, the CAN bus plugs, must be connected to the components, depending on the equipment.

Temperature monitoring for the traction motor - 48 V

Thermal protection of the drives (TSA)



V [km/h]	Driving speed in km/h	
V_{max}	20 km/h	Maximum driving speed calculated
	16 km/h	Maximum driving speed in the drive programs
V_{min}	5 km/h	Maximum limit on driving speed due to overtemperature
a [%]	**Acceleration in %**	
a_{max}	115%	Maximum possible acceleration in drive program 5
a_{min}	30%	Maximum limit on acceleration due to overtemperature
I [%]	**Traction motor current in %**	
I_{max}	100%	Maximum possible traction motor current
I_{min}	30%	Maximum limit on traction motor current via the converter
T [°C]	**Temperature in the traction motor in °C**	
T1	122°C	The TRACTION MOTOR OVERTEMPERATURE error is reset as soon as this temperature is reached and the temperature falls below this value.
T2	132°C	Start of actual limitation of speed and acceleration. The TRACTION MOTOR OVERTEMPERATURE error is activated. The error message repeatedly reappears in the display.
T4	152°C	End of linear limitation of speed and acceleration Start of the linear regulation of the traction motor current via the converter
T5	153°C	End of the linear regulation of the traction motor current via the converter

The electric drive is protected against overtemperature by a two-stage temperature monitoring system, a process known as "thermal protection of the drives".

The converters evaluate the signals from the temperature sensors for the traction motor and transmit the temperature values to the truck control unit (MCU). The temperature values are processed in the MCU in accordance with the TSA characteristic curve.

In the first stage, an error is generated at temperature (T2) and limitation of the speed and acceleration begins. Thanks to linear reduction, the drive is usually able to re-establish its natural

temperature. If the traction motor temperature drops to the (T2) value, all limitations are cancelled. If the traction motor temperature drops to the (T1) value, the error is reset.

If it is not possible to re-establish the natural temperature, stage 2 is triggered.

In the second stage, the motor current is reduced at temperature (T4). This is accomplished by limiting the setpoint values that the MCU sends to the converter. From temperature (T5) onwards, the motor current is reduced to such an extent that only heavily limited driving is possible.

NOTE

Depending on the load on the truck, the reduction in motor current may bring the truck to a standstill.

Boost function

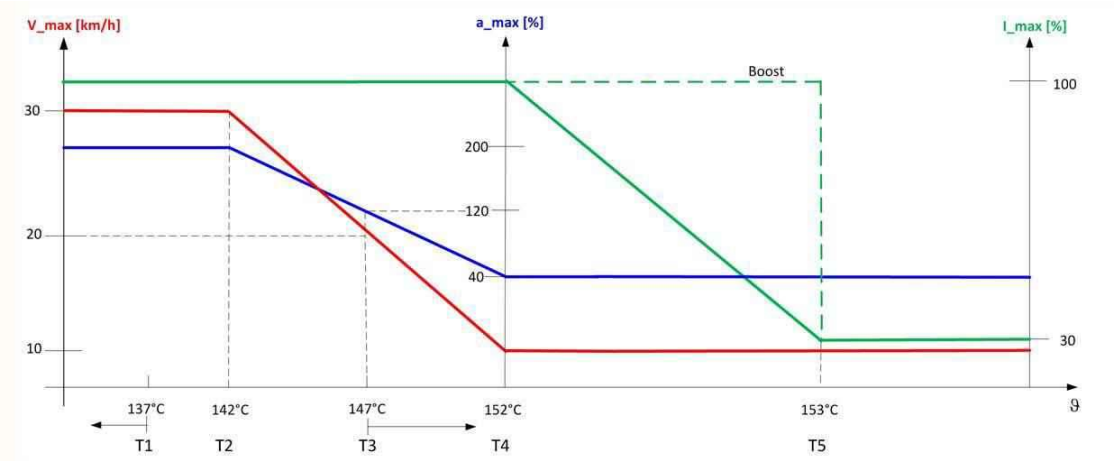
With regard to current limitation, it must be ensured that the truck can still be driven in potentially dangerous situations (e.g. when driving over a level crossing). The Boost function is included as a safety feature required by the system for thermal protection of the drives.

If the accelerator is not actuated for a period of 2 seconds and the truck speed is below 0.5 km/h, temperature-dependent current limitation is deactivated. The truck will travel in normal operation mode again for a short period.

Temperature-dependent current limitation is re-activated as soon as a truck speed of 2 km/h is exceeded or the accelerator is actuated for 2 seconds.

Temperature monitoring for the traction motor - 80 V

Thermal protection of the drives (TSA)



V [km/h]	Driving speed in km/h	
V_{max}	30 km/h	Maximum driving speed calculated
	20 km/h	Maximum driving speeds in the drive programs
V_{min}	10 km/h	Maximum limit on driving speed due to overtemperature
a [%]	**Acceleration in %**	
a_{max}	120 %	Maximum possible acceleration in drive program 5
a_{min}	40 %	Maximum limit on acceleration due to overtemperature
I [%]	**Traction motor current in %**	
I_{max}	100%	Maximum possible traction motor current
I_{min}	30 %	Maximum limit on traction motor current via the converter
T [°C]	**Temperature in the traction motor in °C**	
T1	137°C	The error TRACTION MOTOR OVERHEATING is reset as soon as this temperature is reached and when it falls below.
T2	142 °C	The calculated limitation of the speed and acceleration starts as soon as this temperature is reached. This has no effect on the truck.
T3	147°C	Start of actual limitation of speed and acceleration. The error TRACTION MOTOR OVERHEATING is activated. The error message re-appears in the display repeatedly.
T4	152 °C	End of the linear limitation of speed and acceleration Start of the linear regulation of traction motor current via the converter
T5	153 °C	End of the linear regulation of traction motor current via the converter

The electric drive is protected against overtemperature by two-stage temperature monitoring - "thermal protection of the drives".

The converters evaluate the signals from the temperature sensors for the traction motor and transmit the temperature values to the truck control unit (MCU). The temperature values are processed in the MCU in accordance with the TSA characteristic curve.

In the first stage, an error is generated at temperature (T3) and limitation of the speed and acceleration begins. Thanks to linear reduction,

the drive is usually able to re-establish its natural temperature. If the traction motor temperature drops to the (T1) value, the error is reset.

If it is not possible to re-establish the temperature management, stage 2 is triggered.

In the second stage, the motor current is reduced at temperature (T4). This is accomplished by limiting the setpoint values that the MCU sends to the converter. From temperature (T5) onwards, the motor current is reduced to such an extent that only heavily limited driving is possible.

NOTE

Depending on the load on the truck, the reduction in motor current can bring the truck to a standstill.

Boost function

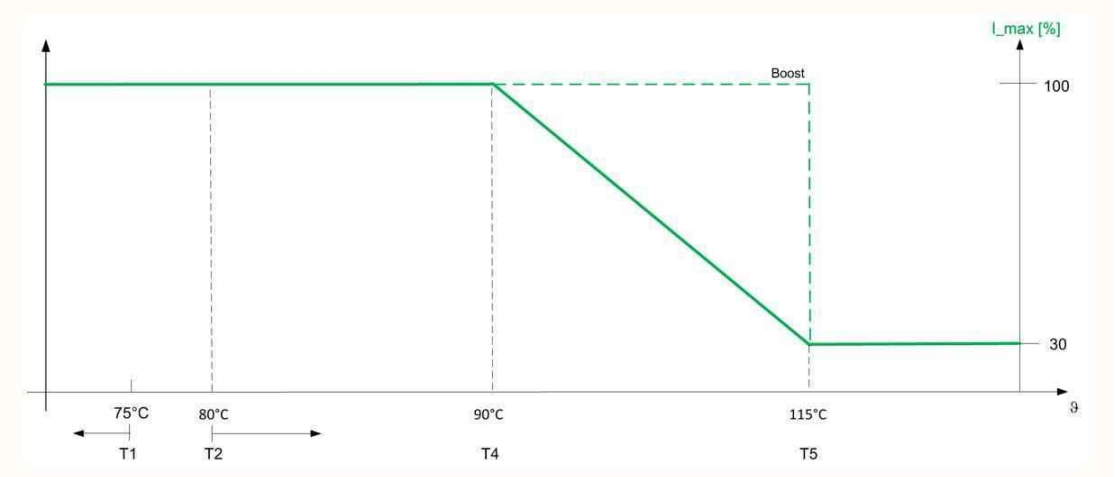
With regard to current limitation, it must be ensured that the truck can still be driven in potentially dangerous situations (e.g. when driving over a level crossing). The Boost function is included as a safety feature required by the system for thermal protection of the drives.

If the accelerator is not actuated for a period of 2 seconds and the truck speed is below 0.5 km/h, temperature-dependent current limitation is deactivated. The truck will travel in normal operation mode again for a short period.

Temperature-dependent current limitation is re-activated as soon as a truck speed of 2 km/h is exceeded or the accelerator is actuated for 2 seconds.

Temperature monitoring for the traction motor converter

Thermal protection of the drives

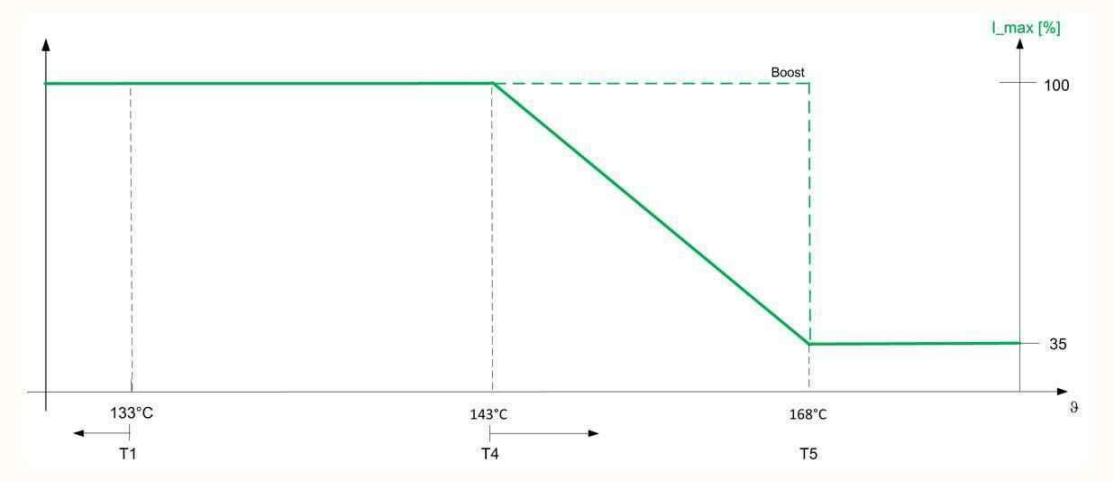


I [%]	Traction motor current in %	
I_{max}	100%	Maximum possible traction motor current
I_{min}	30%	Maximum limit on traction motor current via the converter
T [°C]	**Temperature at the heat sink of the traction motor converter**	
T1	75°C	The CONVERTER OVERTEMPERATURE error is reset as soon as this temperature is reached and the temperature falls below this value.
T2	80°C	The error CONVERTER OVERTEMPERATURE is activated. The error message repeatedly reappears in the display.
T4	90°C	Start of the linear regulation of the traction motor current via the converter
T5	115°C	End of the linear regulation of the traction motor current via the converter

The converter monitors its own temperature balance by means of an internal temperature sensor. If the temperature exceeds a critical value, the traction motor current is reduced linearly and an error is generated. If the temperature balance is re-established, the error is cleared and the reduction cancelled.

Pump motor temperature monitoring

Thermal protection of the drives (TSA)



I [%]	Pump motor current in %	
I_{max}	100%	Standard pump motor current
I_{min}	35%	Maximum limit on pump motor current via the converter
T [°C]	**Temperature in the pump motor in °C**	
T1	133°C	The error OVERHEATING MOTOR is reset as soon as this temperature is reached and when it falls below.
T4	143°C	Start of the actual limitation of pump motor current via the converter The error OVERHEATING MOTOR is activated. The error message re-appears in the display repeatedly.
T5	168°C	End of the linear reduction of pump motor current via the converter

The pump motor and pump converter are protected against overtemperature by temperature monitoring that provides "thermal protection of the drives".

The converter analyses the signals from the temperature sensor of the pump motor and transmits the temperature values to the truck control unit (MCU). The temperature values are processed in the MCU in accordance with the characteristic curve for thermal protection of the drives.

If the (T4) temperature is reached, an error is generated and the motor current is reduced linearly. This is accomplished by limiting the setpoint values that the MCU sends to the converter.

By the linear reduction of the motor current, it is normally possible for the pump motor to restore its temperature balance. If the pump motor temperature drops to the value (T1), the error will reset and the motor current reduction will be cancelled.

From the (T4) temperature upwards, the motor current is reduced to the extent that only very limited hydraulic functions are available.

NOTE

Depending on the load on the truck, the motor current reduction can lead to significant impairment of hydraulic functions, especially lifting operations.

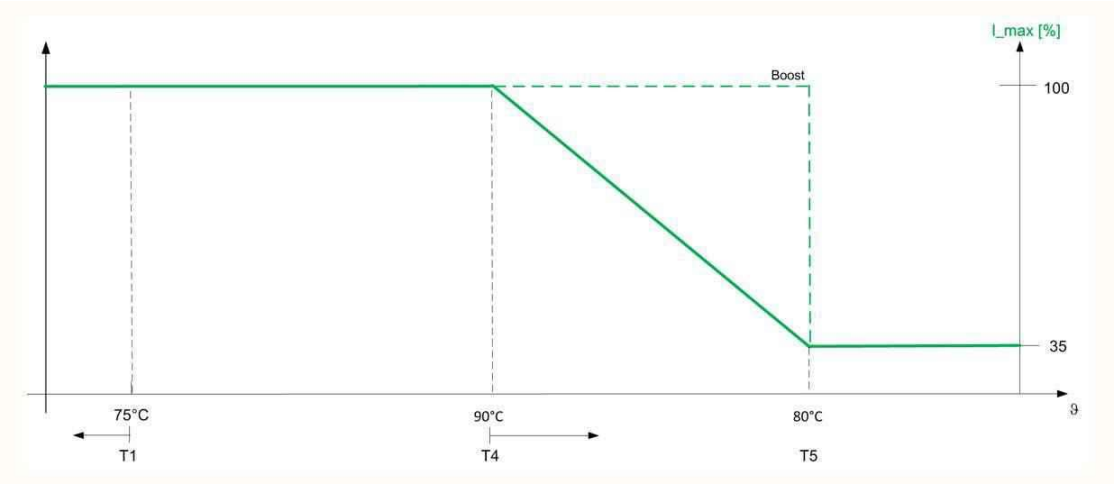
Boost function

With regard to current limitation, it must be ensured that the truck hydraulics can be operated. The Boost function is included as a safety feature required by the system for thermal protection of the drives.

If the pump motor is not operated for a period of 2 seconds, temperature-dependent current limitation is deactivated. The maximum current is available for 1 second.

Temperature monitoring for the pump motor converter

Thermal protection of the drives (TSA)



I [%]	Pump motor current in %	
I_{max}	100%	Standard pump motor current
I_{min}	35%	Maximum pump motor current limitation via the converter
T [°C]	**Temperature at the heat sink of the pump motor converter**	
T1	75°C	The CONVERTER OVERTEMPERATURE error is reset as soon as this temperature is reached and the temperature falls below this value.
T4	80°C	Start of the actual limitation of the pump motor current via the converter. The error CONVERTER OVERTEMPERATURE is activated. The error message repeatedly re-appears in the display.
T5	90°C	End of the linear reduction of the pump motor current via the converter.

The converter monitors its temperature balance by means of an internal temperature sensor. If the temperature exceeds a critical value, the traction motor current is reduced linearly and an error is generated. If the temperature balance is re-established, the error is reset and the reduction cancelled.

Available driving behaviour

	RX20 Facelift 2014	RX20	RX60 16-20	RX60 25-35	RX60 40-50
	6209–6217	6209–6217	6311, -13, -15	6321–6325 6345–6356	6326–6330 6367–6369
Speed-controlled with optimised performance	Series	Series	Series	Series	Series
Torque-regulated	Variant	Variant	Variant	Variant	Variant
Sprint mode	Series	No	No	No	Series
Blue Q	Series	Series	Series	Series	Series
Starting current boost	Series	Series (1)	Series	Series	Series
Stopping on a slope	Series	Series	Series	Series	Series
		(1) only with SAC converters			

All driving behaviour listed here is activated or deactivated via parameterising.

The availability is dependent on truck type, model and truck software.

Drive mode — driving behaviour Description

Speed-regulated/torque-regulated

The driving modes are distinguished by differences in the starting and braking characteristics.

Acceleration, deceleration and reversing are limited by the specifications of the drive program, regardless of the mode.

By default, the trucks are driven in speed-regulated mode.

Torque-regulated mode is activated by means of parameterisation in the relevant drive program.

The mode applies to that particular drive program and cannot be changed by the driver.

Speed-regulated mode

- When the accelerator pedal is released, deceleration is activated as per the traction program.
- If the truck is on a slope, it will slowly roll downhill at the regulated speed of 1 cm/sec.
- If the truck is under load on level ground, it is subject to drag.
- It is possible to start up the truck with the handbrake and footbrake actuated. This ensures that the truck can be started on a slope without rolling backwards.

Torque-regulated mode

- When the accelerator pedal is released, deceleration is activated as per the traction program.
- At deceleration of 15% the truck will coast.
- Dual pedal: The reversing delay when the pedal for the opposite drive direction is pressed takes precedence over the delay when the accelerator pedal is released.

  Reverse deceleration should be greater than just deceleration

  `DECELER 40%`

  `REVERSE 120%`
- If the truck is stationary on a slope with the downhill drive direction selected, it will roll downhill with no braking.
- If the truck is stationary on a slope with no drive direction selected or the uphill drive direction selected, it will roll downhill with braking.
- When under load on level ground, it is not subject to drag.
- It is possible to start up the truck with the handbrake and footbrake actuated. This ensures that the truck can be started on a slope without rolling backwards.

Speed-controlled with optimised performance

The drive mode "speed-controlled with optimised performance" is switched on as standard. The mode applies to that particular drive program and cannot be changed by the driver. It is only possible to switch to other driving modes through parameter changes.

Effects:

- The further the accelerator pedal is actuated, the greater the acceleration, until the respective drive program setting is reached.
- When the accelerator pedal is depressed, the truck brakes immediately depending on the respective drive program setting.
- For single-pedal control, the braking effect becomes greater the further the accelerator pedal is actuated during reversing (change of driving direction).
- For dual-pedal control, the braking effect becomes greater the further the contrary accelerator pedal is actuated.
- If the truck is positioned on a slope without a driver, it will roll at a regulated speed of 1 cm/sec slowly downhill. Safe parking can only be ensured with the parking brake engaged.
- If the truck is positioned on a slope with a driver, the truck behaves in accordance with the "Stopping on a slope" driving behaviour.
- If the truck is under load on level ground, it is subject to drag.

Sprint/ECO mode

In SPRINT mode, the performance of the traction drive increases, thereby improving the dynamic acceleration of the truck.

SPRINT/ECO mode is activated by means of parameterisation.

By default, the truck will be in ECO mode every time it is started up. SPRINT mode can be activated and deactivated by pushing the function key S (ECO mode).

If the drive overheats, SPRINT mode is automatically deactivated. The truck will drive in ECO mode. If the temperature balance has been restored, SPRINT mode can be activated again using the function key.

Starting current boost

Boosting the starting current increases the starting torque from stationary.

The starting current boost is activated by means of parameterisation.

The parameterised mode always applies for all drive programs and cannot be changed by the driver.

The current boost is active at every start-up for a maximum of 3 seconds, as long as the truck does not move.

Stopping on a slope

The "Stopping on a slope" driving behaviour is switched on as standard. The driving behaviour is set once and applies to all drive programs.

Effects that occur only when the driver is sitting and the seat contact switch is actuated.

- Function switched on

  Driver is sitting, the truck is stationary on the slope and does not roll downhill.
- Function turned off

  Driver is sitting, the truck is stationary on the slope and rolls at a regulated speed of 1 cm/sec slowly downhill.

  The truck remains stationary on the slope if the drive direction is neutral and the driver actuates the accelerator gently.

Blue-Q = IQ

General



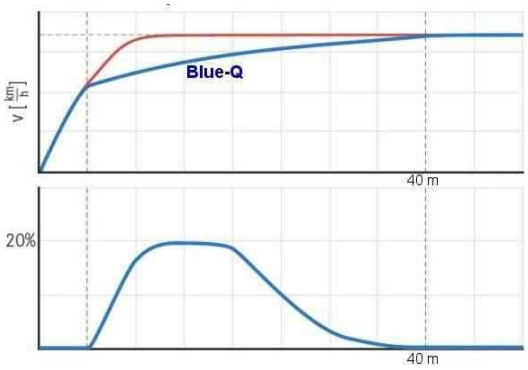
Blue-Q = IQ will stand for a STILL master concept of intelligent economic efficiency and environmental responsibility in the future.

Blue-Q stands for a clean environment, IQ stands for intelligence. The intelligent drive mode for economic efficiency and environmental responsibility

Blue-Q can be activated at the touch of a button and controls the drive unit and the activation of additional consumers.

Drive unit with optimised characteristic curve

By using intelligent characteristic curve optimisation of the drive, energy is saved whenever a reduction does not noticeably impair the dynamics of the work process.



Blue-Q maintains the truck dynamics when accelerating up to a speed of 7 km/h. Above this speed there is low acceleration, which results in energy savings. In this way, Blue-Q reduces energy consumption for stretches between 3 m and 40 m by up to 20%. Because Blue-Q does not affect the lifting capacity, a 10% saving based on a working cycle (with lifting) is achievable. On longer routes, you can also reach the maximum speed with Blue-Q.

Intelligent control of electrical consumers

Blue-Q mode regulates intelligent switching on/off of electrical consumers.

Depending on the equipment, the lighting, working spotlights, windscreen wipers, seat heaters and cab heating will automatically switch off after the driver's seat has been vacated.

When travelling in reverse for more than 3 km/h, the front working spotlight and windscreen wipers are switched off automatically.

Possible shut-off	Truck is stationary, driver is not seated	Truck is stationary, driver is seated	Shut-off depending on drive direction
Working spotlights	X	X	X
Lighting	X	X	
Windscreen wipers	X	X	X
Seat heater and cab heating	X		

Individual parameterising settings can be made using the truck diagnostics in the notebook to determine which of the electrical consumers are to be switched off.

Parameterising

Address	Value	Description
A 00 160	00	Blue-Q not activated
A 00 160	3A	Mode FIX Blue-Q is always ON once the truck is started
A 00 160	35	Mode STANDARD Blue-Q can be switched ON/OFF using the button
A 00 160	3F	Mode FIX-FLEX Blue-Q is active once the truck is started and can then be switched ON/OFF using the button. This mode is a combination of FIX and STANDARD

Wiring

CAN bus system

General

A CAN bus (Controller Area Network) is a "linear network" that comprises multiple participants based on microcontrollers. Due to the signal level technology used and the special structure of the data telegram, the CAN bus system is extremely resistant to interference at high transfer speeds.

Depending on the truck, there are several disconnected CAN bus systems that are used to transfer data between the controllers.

Resistors

In CAN bus systems, reflections at the ends of the wires can cause errors in the signal transmission. Resistors are placed in the wires to dampen these reflections. This is called "termination".

Depending on the truck and the installed CAN bus participants, these resistors are used in different ways.

- Terminating resistors of approx. 120 Ω define the start point and end point of the CAN bus. In between the start and end points are additional, high-ohmic CAN bus participants, usually decoupled with a resistor of approx. 40 kΩ.

  Terminating resistors can be tested when the truck is switched off.
- In newer truck generations, resistors of varying size are placed in one of the CAN bus participants (such as the truck control unit) via software. These resistors terminate the CAN bus as required.

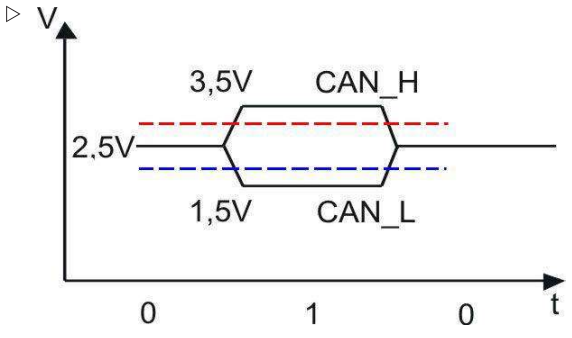
  It is not possible to test these resistors, as they are deactivated via the software when the truck is switched off.

Difference signal

The signals used are "difference signals". The difference is measured between the "CAN_L" and "CAN_H" signals.

If both signals are at an idle level of 2.5 V, there is no "difference signal". A "'0 information"' is transmitted.

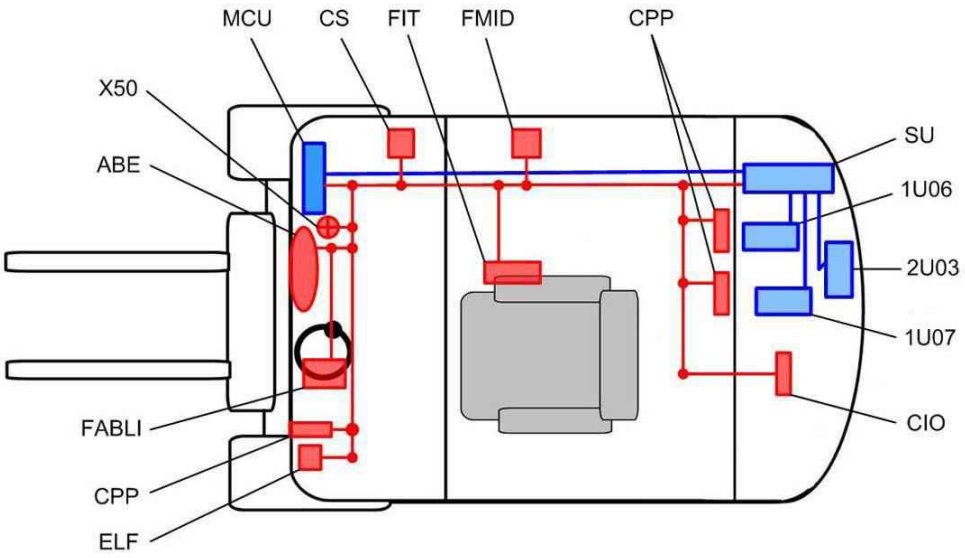
If the "CAN_H" signal is increased to 3.5 V and the "CAN_L" signal is simultaneously dropped to 1.5 V, a "difference signal " of 2 V is produced. A "'1 information"' is transmitted.



With a data transfer rate of 250 kBit/s, this 0/1 transmission occurs 250,000 times per second.

In terms of measuring technology, this means that averages are adjusted during operation. A value slightly over 2.5 V is measured for the "CAN_H" signal and a value slightly under 2.5 V is measured for the "CAN_L" signal.

CAN bus connections



Components		CAN bus	Resistance	Measurement
ABE	Display and operating unit	Red	—	
MCU	Truck control unit	Red	120 Ω	X47/20 - X47/21
		Blue	120 Ω	X47/10 - X47/24
FIT	Joystick, mini-lever	Red	—	
X50	Truck diagnostic connector	Red	—	
CPP	Variant, additional electrical installation	Red	—	
CIO	Variant, full extension of battery	Red	—	
FABLI	Variant, turn indicator module for the drive direction	Red	—	
FMID	Variant, FleetManager	Red	—	
CS	Variant, acceleration sensor	Red	—	
ELF	Variant, electric parking brake	Red	—	
SU	Supply unit	Red	120 Ω	X41/8 - X41/16
		Blue	120 Ω	X41/7 - X41/15
2U03	Pump motor converter	Blue	—	
1U06	Right-hand traction motor converter	Blue	—	
1U07	Left-hand traction motor converter	Blue	—	

There are independent CAN bus systems in this truck. These are used to transfer data between the controllers:

- Truck CAN bus (red)
- Converter CAN bus (blue)

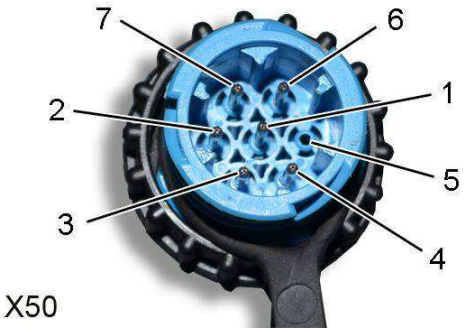
The MCU is the "master" and is connected to all CAN bus systems.

Voltage measurement

Voltage measurement	
CAN_H to GND	2.5 V–3.5 V
CAN_L to GND	1.5 V–2.5 V

Diagnostic connector X50 - 7-pin

PIN	Assignment
1	CAN H (red)
2	CAN L (red)
3	24 V
4	GND
5	Not assigned
6	Not assigned
7	Not assigned



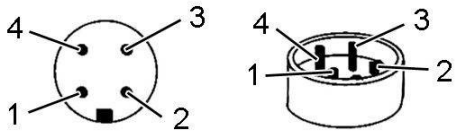
Diagnostic connector X50 - 4-pin

NOTE

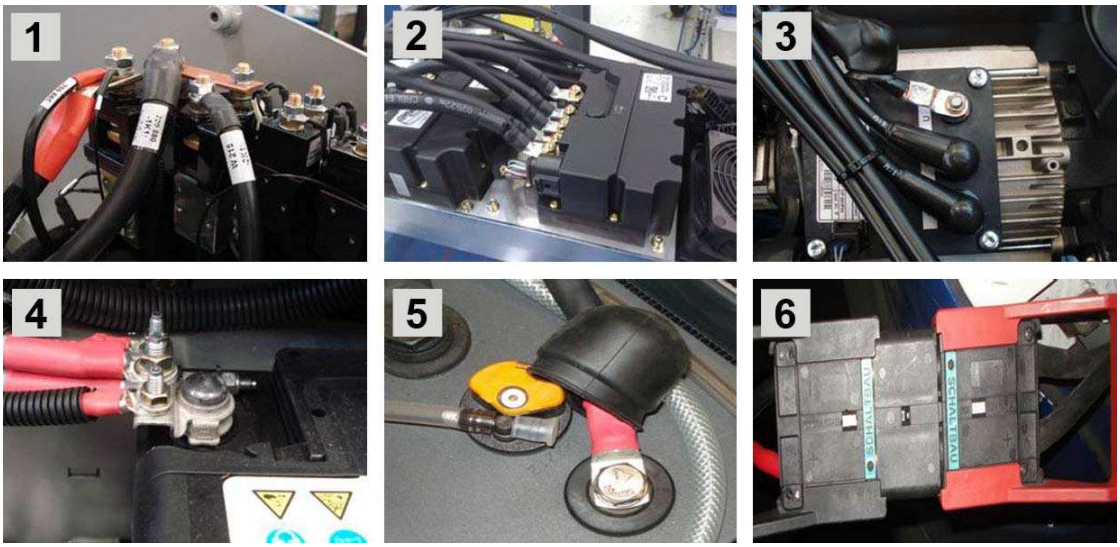
Up to the start of 2014, the diagnostic connector was located in the compartment on the right next to the driver's seat.

PIN	Assignment
1	CAN H (red)
2	CAN L (red)
3	24 V
4	GND

CAN-Bus X50



Power cables



Description

Power cables are electrical wires in accordance with VDE 0295 classes 5 and 6 with a wire cross-section of 10 mm^2.

In our trucks, the following components have power cables:

- Power contactor (1)
- Conductor rails and bolts in the fuse box (PDU)
- Converter (2)
- Electric motor (3)
- Starter battery (4)
- Traction battery (5)
- Battery male connector (6)

NOTE

The images are to be understood as examples; they may not apply to all trucks.

Contact elements

Solderless terminals and crimp connectors are used as contact elements for power cables.

The following contact elements are used:

- DIN 46234 crimp-type cable lugs (1)
- DIN 46235 compression and tubular cable lugs (2)
- Manufacturer-specific battery male connector contacts (3)



Maintenance guidelines for power cables

1000-hour maintenance

- Check all cable connections on the power cables for damage. Check that the connections are securely attached, check the condition and check for corrosion
- Check the condition of conductor rails and bolts and check for corrosion
- Remove oxidation residue
- Replace brittle and defective cables
- Check the tightening torques

Repair - Contact elements

Which contact element is required?

Due to the wide range of cable shoes available from different manufacturers, we distinguish between the following types:

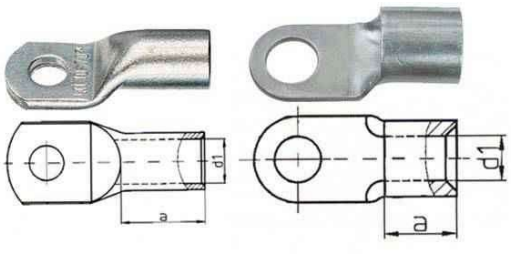
- DIN 46234 cable shoe
- DIN 46235 cable shoe
- Cable lug optimized for fine-stranded cables, similar to DIN 46235

Repair

The main difference between the cable shoes is in the interior diameter **d1** of the press sleeve.

– Measure the push-on length **a** of the press sleeve.
– Add 10% to the push-on length as a tolerance.

Push-on length + 10% = dimension L

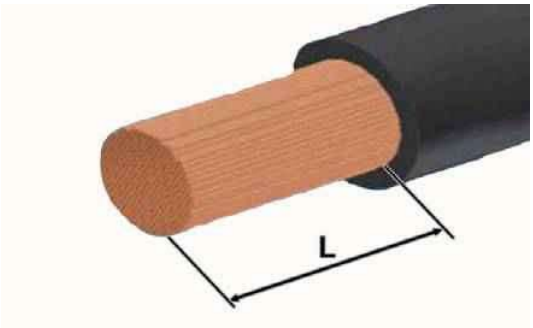


– Strip the cable along dimension L.

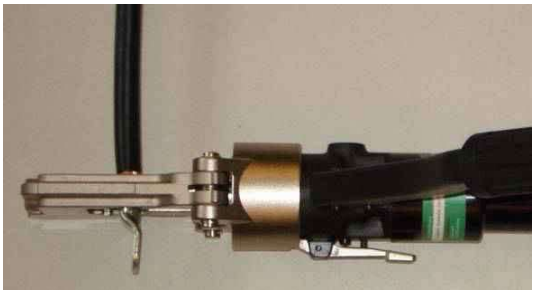
⚠ CAUTION

Damage to the separate wires causes a reduction in the cross-section. This leads to incorrect crimping, poorer transition resistance and increased heating.

Use a suitable tool.



– Push the contact element onto the stripped end of the cable and crimp centrally using the appropriate crimping die.
– Perform the crimping process until it is clearly noticeable that the pressure relief valve has been triggered.
– Open the crimping pliers using the release lever.



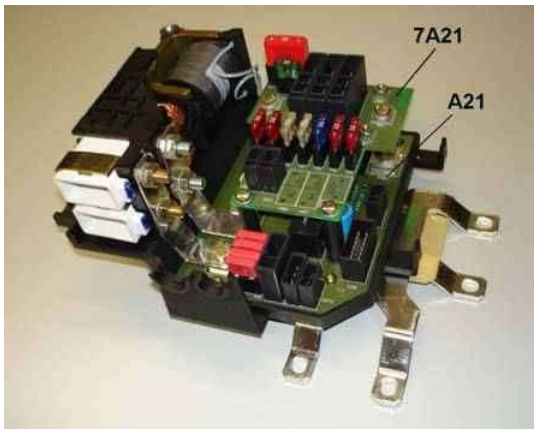
NOTE

Only crimp each contact once!

Electrical system

Fuse box

General



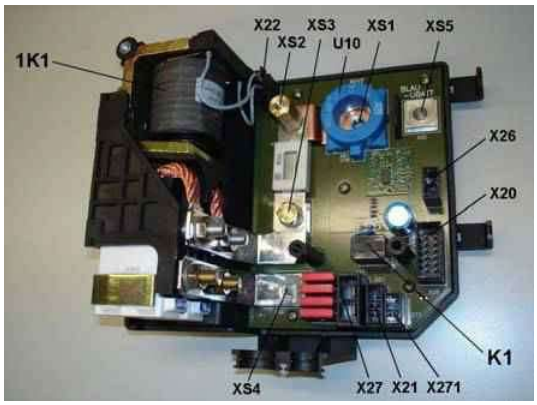
NOTE

The modular fuse box has been fitted as standard since August 2005.

The A21 fuse box is installed in the counterweight and includes the following components:

- Main contactor 1K1
- Main fuse F01
- Current sensor U10 for measuring battery current
- Horn relay K1
- Control fuses
- 7A21 converter PCB (variant)

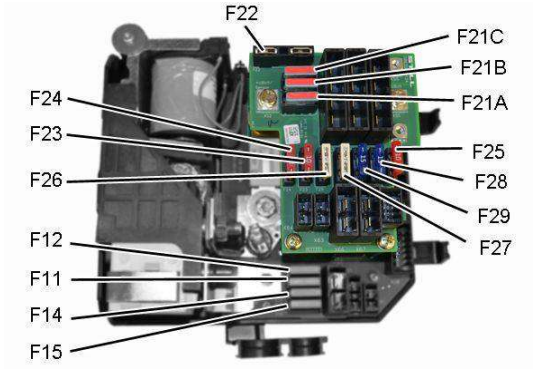
Undo the electrical



Screw connections		
XS1	Battery positive terminal	13 Nm
XS2	Distributor card supply	13 Nm
XS4	Batt+ after main contactor	13 Nm
XS5	Battery negative terminal	13 Nm

Plug	
X20	Control cables to the SU
X21	Signal horn
X22	Contactor coil
X26	Signal transmitter
X27	Voltage converters U1, U2
X271	Voltage converter U4, 5th hydraulics feed

Fuses



Fuses are located in various positions on the truck. As standard, each truck is equipped with the fuse box located at the rear in the counterweight.

Depending on the truck equipment, the 7A21 converter PCB for the 24-V power supply may be installed.

Fuses

Fuse		Connection	Location - exception
			PDU
F11	10 A	Supply Unit Main Control Unit	
F12	10 A	Signal horn	
F14	10 A	U4 voltage converter	
	20 A	Electric parking brake	
	10 A	48V searchlight	
F15	10 A	U4 voltage converter	
	10 A	Solenoid valve on attachment	
			7A21
F21	30 A	Voltage converter	Up to 2013
F21A	15 A	Voltage converter	As of 2014
F21B	15 A	Voltage converter	As of 2014
F21C	15 A	Voltage converter	As of 2014
F22	40 A	Heating system	U-Batt 48 V
	30 A		U-Batt 80 V
F23	10A	Option Board, Solenoid valve on attachment	
F24	10 A	CPP rear	
F25	10 A	Proportional technology	
F26	25 A	Roof CPP	
	10 A	RPP	
F27	25 A	Seat CPP	
	10 A	RPP	
F28	15 A	Front CPP	
	10 A	RPP	
F29	15 A	Option board, Material management system (MMS)	

Fuse plate
Until April 2005

General



NOTE

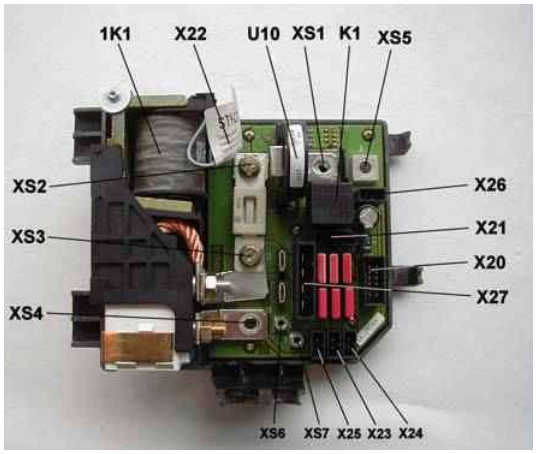
The fuse plate was installed as standard until August 2005 and was then replaced by the fuse box. The fuse plate is still available as a spare part.

The fuse plate is installed in the counterweight as a modular unit and includes the following components:

- Main contactor 1K1
- Main fuse F01
- Current sensor U10 for measuring battery current
- Horn relay K1
- Control fuses
- Optional fuses

In addition, it is also used as a distributor plate for supplying the additional electrical equipment.

Undo the electrical



Screw connections		
XS1	Battery positive terminal	13 Nm
XS2	Distributor card supply	13 Nm
XS4	Batt+ after main contactor	13 Nm
XS5	Battery negative terminal	13 Nm
XS6	Heating system positive supply	
XS7	Heating system negative supply	

Plug	
X20	Control cables to the SU
X21	Signal horn
X22	Contactor coil
X23	CPP 4, rear
X24	CPP 2, front structure
X25	Option board
X26	Signal transmitter
X27	5th hydraulics feed

Removal

– Disconnect battery plug.

– Remove the trademark emblem

– If necessary, disconnect the plug from the light strip
– Remove the covering. To do this, release, but do not unscrew completely, screw M6x10

⚠ WARNING

If the intermediate circuit is not discharged, there is a risk of electric shocks.

Check the intermediate circuit. Discharge if necessary.

– Remove the supply unit
– Release screw XS1 (M8x16)
– Release the two screws XS4 and XS5 (M8x40)
– Release the two ring eyelets XS6 and XS7
– Disconnect all plug connectors
– Disconnect the cable ties on the right-hand side of the fuse plate until the wiring harness is completely detached
– Move the cable under the fuse plate
– Remove the fuse plate by pulling it upwards

Installation

– Move the fuse plate to the left under the sheet metal cover

⚠ CAUTION

Be careful of the cable guide!

Cables must not become trapped!

– Insert screw XS4 (M8x40) and screw in a few turns
– Insert screw XS5 (M8x40) and screw in a few turns
– Insert screw XS1 (M8x16)
– Now screw in all three screws
– Attach the wiring harness on the right-hand side of the fuse plate using cable ties
– Screw in the two ring eyelets XS6 and XS7
– Connect all plug connectors
– Attach the covering and tighten the screw
– Attach the trademark emblem. If necessary, connect the light strip plug
– Functional test

Fuses
Until April 2005

General

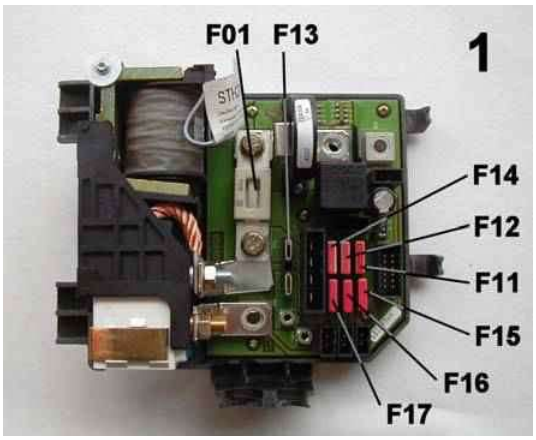
NOTE

The fuse plate was built in as standard until August 2005 and was then replaced by the fuse box. The fuse plate is still available as a spare part.

Fuses are located in two places on the truck.

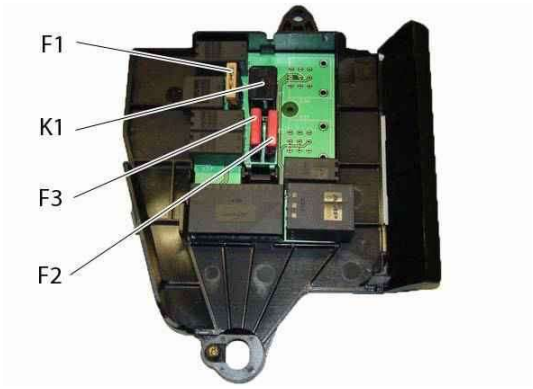
Fuse plate (1) ▷

- Main fuse
- Control fuses
- Fuses for add. electrical installation



Option board (2) ▷

- Control fuses
- Fuses for add. electrical installation



Fuses

Desig-nation	Value	Connection	Position
F01	400 A	Main fuse	Fuse plate
F11	10 A	Supply Unit Main Control Unit	Fuse plate
F12	5 A	Alarm horn	Fuse plate
F13	50 A	2 kW heater supply	Fuse plate
F14	20 A	1 kW voltage transformer	Fuse plate
F15	10 A	Proportional technology	Fuse plate
F16	10 A	Heater supply	Fuse plate
F17	15 A	Solenoid valve supply	Fuse plate

Desig-nation	Value	Connection	Position
F1	10 A	5. Hydraulics 24/48 V	Option board
F2	10 A	Clamp light	Option board
F3	10 A	Material Management System (terminal)	Option board

Contactor

General

As the main contactor, contactor 1K1 switches the power supply for the power electronics.

The contactor coil is designed for 24 volt operating voltage and is activated by current control.

The contactor is clamped on its side on the fuse plate by a stud bolt (S).



Technical data

Operating voltage of contactor coil	24 V
Coil resistance	Approx. 20 Ω
Protective circuit (in parallel) resistor & diode (in series)	Approx. 47 Ω 1N4001
Tightening torque	10^{+1} Nm
Contact pressure (fully activated)	≥ 9.0 Nm
Passage path	1.3 to 2.7 mm

Adjustments

- Fully actuate the contactor.
- Connect the centre of the contacts to the spring balance. Load with 9.0 N.
- Use the hexagon head screw that passes through the contact spring to adjust the contact pressure.
- Turn the hexagon head screw clockwise to increase the pressure.

NOTE

The contact spring has a certain amount of friction. The contact pressure is correctly adjusted when with a pull-down force load of 10 to 10.5 N, the contact does not close when being introduced slowly, but moves and remains closed when being introduced quickly.

Sensor system

Vertical lift mast position

General

With the "vertical lift mast position" comfort feature, goods such as rolls of paper can be positioned so that they are precisely vertical and thus avoid damage during unloading. In addition, the gentle running-in of the tilt cylinders into the end stops saves energy and reduces wear.

The function is only possible with servo hydraulics. The way in which the "vertical lift mast position" is operated depends on which operating devices are fitted in the truck.

Possible equipment variants are as follows:

- Mini-lever
- Joystick
- Fingertip

NOTE

For notes on operation, see the operating instructions.

Display of the "vertical lift mast position"



The driver can see the lift mast tilt in the display of the display operating unit. The bar shows the current lift mast position, the arrow indicates the "vertical lift mast" position.

End of the bar at the far left - max. backwards tilt
End of the bar at the far right - max. forwards tilt
End of the bar under the arrow - lift mast vertical

Automatic approach towards the "Vertical lift mast position"

When the driver actuates the tilt forwards function, the lift mast stops automatically as soon as the "Vertical lift mast position" is reached. The automatic approach of the "Vertical lift mast position" must be activated by the driver via the corresponding button on the display operating unit. When deactivated, the lift mast moves beyond the vertical position without stopping.

Gentle running-in to the end stops

The lift mast is braked gently at the end of its tilt range. This prevents a sudden impact caused by the lift mast and the truck does not jerk.

Manual calibration of the "vertical lift mast position"

Under certain circumstances, the lift mast cannot move exactly into the preset vertical position.

Possible causes:

- Uneven ground
- Bent forks or attachments
- Worn tyres
- A severely bent lift mast

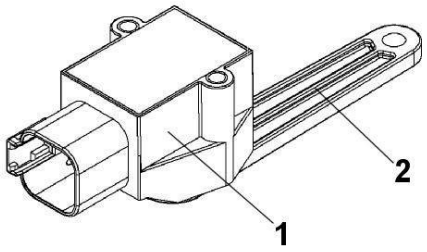
In this case, the customer can correct and store the changed vertical position by pressing and holding the corresponding button for "vertical lift mast position".

Tilt angle sensor 7B46

Function

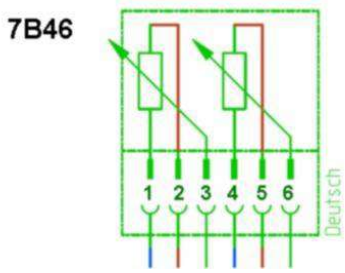
The tilt angle sensor functions without contacts via a magnetic field and a Hall sensor. The angle range is +60° to –60° without mechanical stops. The sensor is protected against short circuit with an unlimited short-circuit duration.

There are two variants of the tilt angle sensor and the only difference between the two is the length of the lever (80/100 mm).



1 Sensor
2 Lever

Electrical connections



7B46, 6-pin		RX50	RX20 RX60	RX70
7B46/1	GND	X20:S3/A2	X32C/3	X32C/3
7B46/2	12 V	X20:S3/A1	X32C/1	X32C/1
7B46/3	Signal OUT 1	X20:S3/B1	X32C/2	X32C/2
7B46/4	GND	X20:S4/A2	E54 - X31C/3	E54 - X31A/3
7B46/5	12 V	X20:S4/A1	E54 - X31C/1	E54 - X31A/1
7B46/6	Signal OUT 2	X20:S4/B1	E54 - X31C/2	E54 - X31A/2

Calibration via the display and operating unit

Calibration must always be performed after the first installation or replacement of the tilt angle sensor.

– Park the truck on even, level ground.
– Set lift mast to vertical. Check the vertical position using a spirit level.
– Apply the parking brake.
– Start calibration via the display and operating unit.
– Switch to service mode and select the `MAST` sub-item in the `CALIBRATION` menu item.
– Start calibration.

The forwards drive direction indicator flashes:

– Tilt the lift mast forwards to the end stop and leave it in this position.

The measured value is saved once both drive direction indicators start flashing. The lift mast must not be moved during this phase.

The reverse drive direction indicator flashes:

– Tilt the lift mast backwards to the end stop and leave it in this position.

The measured value is saved once both drive direction indicators start flashing. The lift mast must not be moved during this phase.

– Carry out a truck reset.
– Check the function of the vertical lift mast position.

Calibration via the diagnostics

Calibration must always be performed after the first installation or replacement of the tilt angle sensor.

– Connect the notebook to the truck and start the truck diagnostics:

`Action`
▼
`Calibration`
▼
`Vertical lift mast position`

The notebook shows the steps to be performed during calibration.

Error

Message text/error code	Comment	Response
A3130 VERTICAL MAST	Monitoring of both signals ► The sum of the signals does not lie between 6–10 V	
A3131 VERTICAL MAST	GND1 breakdown ► Sensor signal 1 is less than 0.2 V	► The hydraulics are disabled while the "vertical lift mast position" is activated via the button. ► When the "vertical lift mast position" is deactivated, the hydraulics are enabled again.
A3132 VERTICAL MAST	VCC1 breakdown ► Sensor signal 2 is greater than 9 V	
A3133 VERTICAL MAST	GND2 breakdown ► Sensor signal 2 is less than 0.2 V	
A3134 VERTICAL MAST	VCC2 breakdown ► Sensor signal 2 is greater than 9 V	
A3135 VERTICAL MAST ERROR	Angle measurement plausibility error ► The tilt function is actuated and the angle measurement does not change	

Tilt angle sensor parameters

Notes

When performing retrofits, the truck-specific parameters must be checked via the display and operating unit and changed as required.

Basic parameters

Service address	Value	Description
A 00 110	0B	Vertical lift mast position mode Function active, current position display, manual calibration
A 00 111	31	Input for vertical lift mast position Status button 10 (soft key 3)
A 00 112	02	Offset delay before end stop
A 00 233	11	Configuration of soft key button 3 "Lift mast vertical"
A 00 10F	Configuration of the lift mast vertical position characteristic curve	
	01	5060–5066 6210–6217 7311–7316
	02	6311, 6313, 6315 7321–7330
	03	6321–6325
	04	6327–6330
A 10 1B8	Positioning logic for vertical lift mast position	
	00	No stop when the lift mast is vertical
	01	Only stop if the lift mast is vertical during forward tilt (standard)
	02	Only stops if the lift mast is vertical during backwards tilt
	03	Always stops when the lift mast is vertical
	10	6321–6330 Swap forward tilt/backward tilt in trucks with reversed tilting hoses. This value is added to the upper values (10 + 01 = 11)

Characteristic curves for the positioning of the lift mast

Service address	6210–6217 6311, 6313, 6315	6321–6325	6327–6330	7311–7316	7321–7330	5060–5066
A 10 1A0	00h	00h	00h	00h	00h	00h
A 10 1A1	01h	01h	01h	01h	01h	01h
A 10 1A2	0Ah	20h	15h	10h	40h	0Ah
A 10 1A3	64h	96h	96h	96h	96h	64h
A 10 1A4	00h	00h	00h	00h	00h	00h
A 10 1A5	08h	2Eh	2Eh	40h	30h	08h
A 10 1A6	10h	35h	35h	80h	80h	10h
A 10 1A7	FAh	FAh	FAh	FAh	FAh	FAh
A 10 1A8	00h	00h	00h	00h	00h	00h
A 10 1A9	01h	01h	01h	01h	01h	01h
A 10 1AA	0Ah	1Eh	1Eh	20h	40h	0Ah
A 10 1AB	64h	E0h	E0h	E0h	E0h	64h
A 10 1AC	00h	00h	00h	00h	00h	00h
A 10 1AD	10h	28h	28h	20h	20h	10h
A 10 1AE	15h	46h	46h	80h	40h	15h
A 10 1AF	FAh	FAh	FAh	FAh	FAh	FAh
A 10 1B0	00h	00h	00h	00h	00h	00h
A 10 1B1	01h	01h	01h	01h	01h	01h
A 10 1B2	0Ah	20h	60h	20h	60h	0Ah
A 10 1B3	64h	E0h	E0h	E0h	C8h	64h
A 10 1B4	00h	00h	00h	00h	00h	00h
A 10 1B5	12h	28h	28h	20h	19h	12h
A 10 1B6	15h	37h	37h	80h	20h	15h
A 10 1B7	FAh	FAh	FAh	FAh	FAh	FAh
A 10 1B8	01h	11h	11h	01h	01h	01h

Installation of the vertical lift mast position

Retrofitting

When retrofitting the vertical lift mast position, note the following:

Chassis

- There must be bores for holding the tilt angle sensor in the chassis stiffener.
- Start of series production from calendar week 02/2010.

Spare parts

- In accordance with the truck-specific spare parts list

The software and parameters must be modified depending on the truck type.

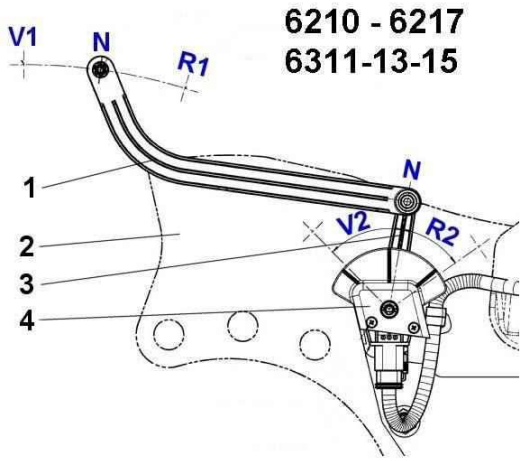
Software flash package

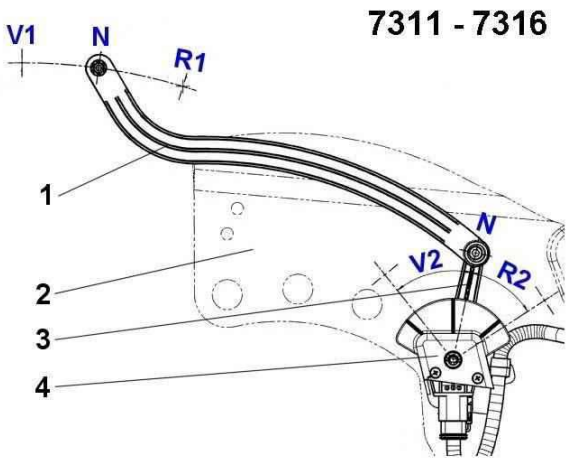
- Diesel and LPG truck
  Software flash package 0.43 or a more recent version
- Electric forklift truck
  Software flash package 1.02 or a more recent version

Parameters

- The truck-specific parameters are provided by your service centre.

Installation position





Components

1	Rod
2	Chassis stiffener
3	Lever
4	Tilt angle sensor

Mast tilt

V1	Maximum forwards
N	Lift mast vertical
R1	Maximum backwards

Movement of tilt angle sensor

V2	Maximum forwards
N	Neutral
R2	Maximum backwards

Truck type	Side of chassis (2)	Length of lever (3)	V1	V2	R1	R2
7310 - 7316	right	80 mm	8° + 1°	50.8°	9° + 1°	45°
6210 - 6217	right	80 mm	8° + 1°	54.1°	9° + 1°	45.4°
6311, 6313, 6315	right	80 mm	8° + 1°	54.1°	9° + 1°	45.4°

Load measurement

General



With the "load measurement" comfort feature, the weight of a lifted load can be determined. This weight is shown in the display operating unit. As a result, there is increased safety for the driver because the weight of the load to be transported is known.

Load measurement can be activated via a button on the ABE, and for mini-lever 2 and fingertip also via the F1 button. Load measurement is only possible when the truck is at a standstill.

The way in which the load measurement is operated depends on which hydraulic operating devices are fitted in the truck.

Possible equipment variants are as follows:

- Mini-lever
- Joystick
- Fingertip
- Hand lever

NOTE

For notes on operation, see the operating instructions.

Accuracy of the load measurement

The load measurement has an accuracy level of ±3% over the entire measurement range, based on the rated capacity of the truck.

The accuracy of the measurement is influenced by the transient effect of the load when the lowering movement is stopped abruptly. A noticeable vibration of the load has a positive effect on the accuracy of the measurement.

Prerequisite for an accurate and flawless load measurement:

- Hydraulic oil at normal operating temperature of 10 - 80 °C.
- Minimum loads:

  10% of the nominal load for trucks up to 2.5t.

  5% of the nominal load for trucks of 3.0t and more.
- Measurement within the first lifting stage.
- The load must rest before the measurement and noticeably swing freely after the abrupt stop.

Measurement principle

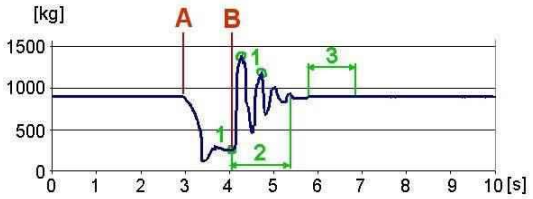
The transient effect after the lowering movement (B) has come to an abrupt stop is used for the load measurement.

Only then can the loss of friction that results while breaking away from the static position be disregarded for the evaluation.

Three values are determined for the evaluation:

- Value above the first maximum values (1) and minimum values (1) in the transient effect.
- Average value (2) during the whole transient effect.
- Value after the transient effect (3)

The most accurate load measurement is determined by aligning all three values.



Movement of the load

A Start of the lowering movement
B Abrupt stop of the lowering movement and start of the transient effect

Pressure signal

1 Minimum/maximum values for transient oscillation
2 Average value during the transient effect
3 Value after the transient effect

Zero adjustment operation

For aligning the different lift mast heights, fork arms and attachments and for calibrating the pressure sensor, a zero adjustment must be carried out before the load measurement. The zero adjustment should be carried out once a day without a load.

– Lift the forks (fork carriage with attachment as necessary) within the first lifting stage to a height of 300-800 mm above the ground.

– Set lift mast to vertical.

– On the ABE, press the button for load measurement for longer than 3 seconds.

In the display, the symbol switches to zero adjustment.

– Lower the forks quickly by approx. 100-200 mm. Quickly actuate and release the operating device for lowering so that it jumps back to neutral position.

For a valid zero adjustment, a weight of 0 kg is shown in the display.

Operation of the load measurement

– Lift the load within the first lifting stage to a height of 300-800 mm above the ground.

– Set lift mast to vertical.

– On the ABE, press the button for load measurement.

– Lower the load quickly by approx. 100-200 mm. Quickly actuate and release the operating device for lowering so that it jumps back to neutral position.

The load should now swing freely without touching the ground. After a short time, the weight of the load is shown in the display.

An invalid measurement is shown in the display with the value `-9999 kg`.

If a lowering procedure is not performed after the button is actuated, the `LOWER FORKS` message is shown in the display after approx. 3 - 5 seconds.

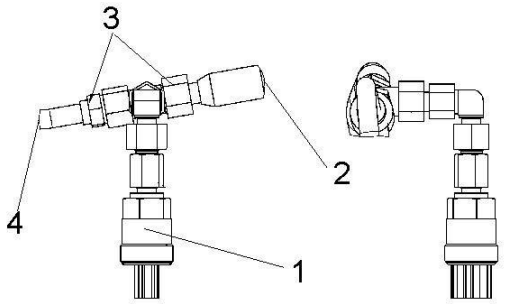
Load measurement pressure sensor

Function

The pressure sensor is used in the lifting hydraulic line or directly at connection H on the directional control valve block. The installation position is dependent on the truck type and is the same as that of the well known "load detection" FleetManager™ function.

Technical data

Pressure sensor	Danfoss, model MBS3250
Connection	G1/4 A
Measuring range	0 - 250 bar 0.5 - 5 Volt



1 Pressure sensor
2 on the lift mast
3 Lifting separation point (example)
4 on the directional control valve block

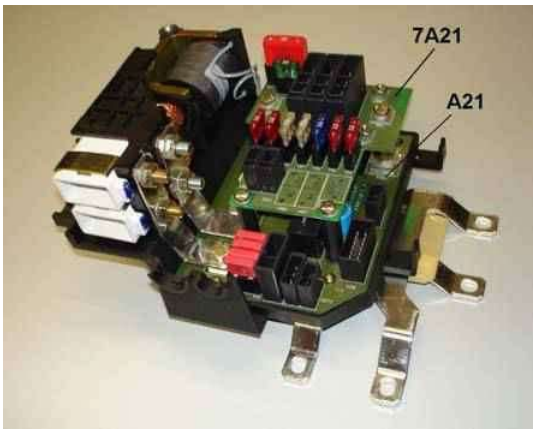
Electrical connections

Mark II plug, 3-pin				A22
7B45/1 br	Brown	12 V	3	X34A/1
7B45/2 bl	Blue	GND	2	X34A/3
7B45/3 sw	Black	Signal OUT 1	1	X34A/2

Additional electrical installations

7A21 converter PCB

General



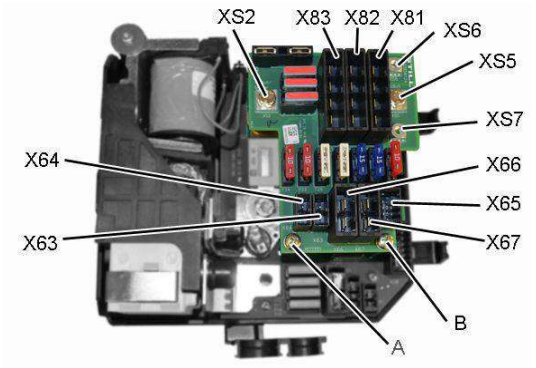
NOTE

The fuse box has been built into all trucks as standard since August 2005.

Depending on the truck equipment, the 7A21 converter PCB for the 24-V power supply may be installed.

The converter PCB rests on the fuse box. Four hexagon head bolts are used as a spacer block and mounting.

Undo the electrical



A		M5 x 10 - 2.5 Nm	Hexagon head bolt made from polyamide
B		M5 x 10 - 2.5 Nm	Hexagon head bolt made from polyamide
XS2	Batt+	M6 x 16 - 4.1 Nm	Hexagon head bolt
XS5	Batt-	M6 x 16 - 4.1 Nm	Hexagon head bolt
XS6	Heating system battery +		
XS7	Heating system battery -		
X63	Option board		
X64	CPP, rear		
X65	Option board CPP, front Servo hydraulics U4 voltage converter		
X66	CPP, roof		
X67	CPP, seat		
X81	Voltage converters U1, U2, U3		
X82	Voltage converters U1, U2, U3		
X83	Voltage converters U1, U2, U3		

Option Board

General



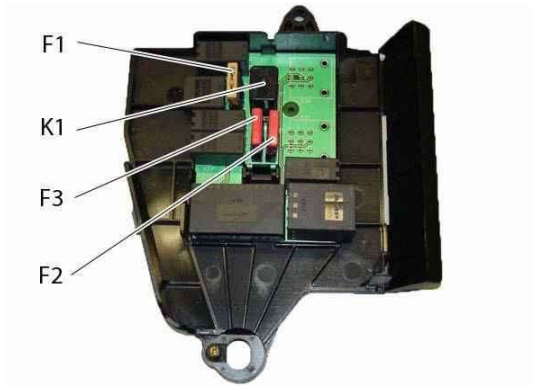
The Option Board A22 comprises a circuit board in a plastic housing and is always fitted to the front structure beneath the truck control unit (MCU, TCU). Depending on the truck equipment, the Option Board supplies the optional additional electrical equipment and sensor system.

The Option Board contains the following components:

- Electrical connections
- Fuses F1, F2 and F3
- Relay K1

The assignment of electrical connections varies according to the truck and individual equipment. For detailed information, see the truck operating circuit diagram.

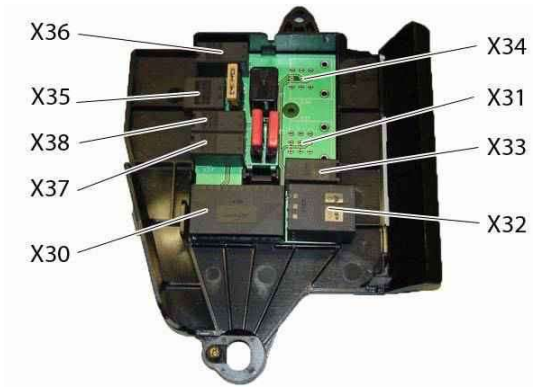
Fuses and relays



Fuse	
F1	5 A
F2	10 A
F3	10 A

Relays	
K1	5th hydraulic function

Electrical connections



Plug	Assignment
X30	Control cables for truck control unit TCU/MCU
X37	12 volt supply
X31	Reserve switch 4 (analogue)
	Dead man switch
	Reserve switch 2 (digital)

Plug	Assignment
X32	Reserve switch 1 (analogue)
	Right door contact switch
	Left door contact switch
X33	Fork carriage monitoring
X34	Lift limitation
	Load switching
	Load sensor
X35	5th hydraulic function feed
X36/2	5th hydraulic function controller
X38	F2 light Material management system (MMS)

CAN-Power-Port (CPP)

General

CPPs are designed for 12-V and 24-V on-board electrical systems and are used in all trucks. The individual CPPs can only be identified by their order number; see the truck-specific spare parts list. The location and number of CPPs in the truck varies according to the truck type and the equipment; see the chapter entitled "Overview of electrical components".

NOTE

The CPP 2B (lighting) was introduced in January 2010 and replaced the CPP 2 and CPP 4 (front structure, rear) in all trucks in the medium term. It is not possible to convert from CPP 2 and CPP 4 to CPP 2B.

Function

The CPP supplies and controls the various optional consumers within the additional electrical installation.

Each CPP has its own identifier and is controlled by the truck control unit (MCU, TCU) via the "red" peripheral CAN bus. The CPPs are all supplied via the fuse box.

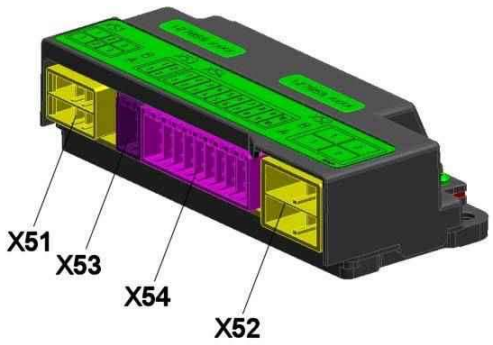
Parameterising

The CPPs are CAN bus participants and need to be registered using parameters. The outputs are parameterised using the truck diagnostics in the notebook.

The value for the output display of the additional electrical installation consists of two hexadecimal characters. The first character shows the CPP number (1-4), the second character shows the channel number (1-B). Both digits are shown in the truck-specific operating circuit diagram.

CPP 1/CPP 3

This CPP can be used to connect the various electrical consumers, which will vary according to the truck and equipment.



Plug	Assignment
X51	CAN bus (CAN r)
X52	Supply voltage
X53	2 x 2-pin plugs, 1 variable, 1 fixed switching output
X54	10 x 2-pin plugs with 7 variable switching outputs

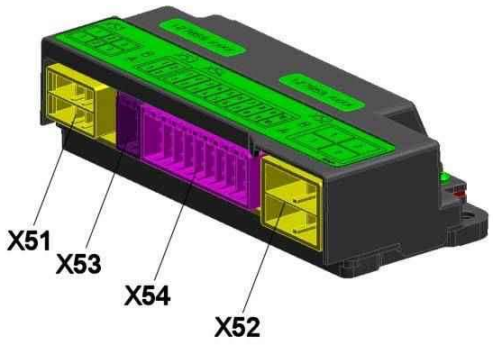
Slot	Max. load	Channel		Value	
				CPP 1	CPP 3
X53					
X53:1A	3.5 A	OUTPW 10	Permanent double assignment Wiper supply	12	32
X53:1B		OUTPW 2			
X53:2B	3.5 A	OUTPW 1		11	31
X54					
X54:1B	10 A	OUTPW 3	Permanent double assignment	13	33
X54:2B					
X54:3B	10 A	OUTPW 4	Permanent double assignment	14	34
X54:4B					
X54:5B	3.5 A	OUTPW 6		16	36
X54:6B	3.5 A	OUTPW 5		15	35
X54:7B	3.5 A	OUTPW 8		18	38
X54:8B	3.5 A	OUTPW 7		17	37
X54:9B	10 A	OUTPW 9	Permanent double assignment	19	39
X54:10B					

CPP 2B

The entire lighting system is connected via the CPP. It is therefore also called CPP lighting. Other electrical consumers cannot be connected.

NOTE

Since January 2010, the CPP 2B (lighting) has replaced CPP 2 and CPP 4. A conversion from CPP 2 and CPP 4 to CPP 2B is not possible.



Plug	Assignment
X51	CAN bus (CAN r)
X52	Supply voltage
X53	2 x 2-pin plugs, 2 switching outputs
X54	10 x 2-pin plugs, 14 slots, 8 switching outputs

NOTE

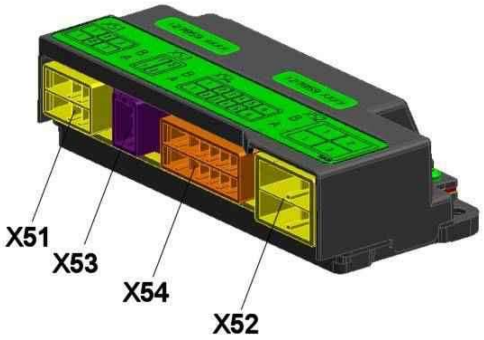
Please note the following information in relation to the I_{max} values:

- *The maximum currents must not be exceeded for each slot or dual slot.*
- *The total of all currents must not exceed 30 A.*

Slot	I_{max} [A]	Channel	Function	Address	Value
X53					
X53:1A	3.5	10	Front wiper, supply	A00 317	22
X53:1B		2			
X53:2B	3.5	1	Front wiper, interval	A00 318	21
X54					
X54:1B	9.2	3	Left headlight	A00 2D2	23
X54:3B			Right headlight		
X54:2B	2.1	11	Left side light	A00 2D7	2B
X54:6B			Left rear light		
X54:2A	1.75	6	Front left direction indicator	A00 2C9	26
X54:6A	1.75		Rear left direction indicator		
X54:4A	1.75	5	Front right direction indicator	A00 2C7	25
X54:8A	1.75		Rear left direction indicator		
X54:4B	2.1	4	Right side light	A00 2D9	24
X54:8B			Right rear light		
X54:5B	3.5	8	Left stop light	A00 2DC	28
X54:7B			Right stop light		
X54:9B	1.75	7	Left/right back-up light	A00 3E1	27
X54:10B	9.2	9	Blower heating system via output at reserve 4	A00 300	29

CPP 2/CPP 4

This CPP can be used to connect the various electrical consumers, which will vary according to the truck and equipment.



NOTE

Since January 2010, the CPP 2B (lighting) has gradually replaced CPP 2 and CPP 4 in all trucks. A conversion from CPP 2 and CPP 4 to CPP 2B is not possible.

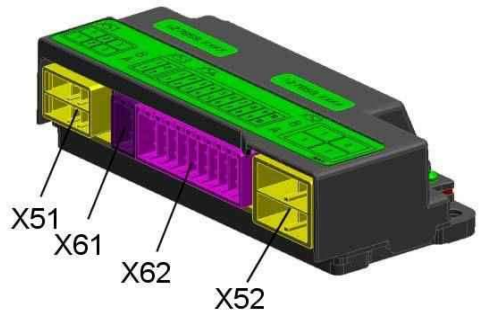
Plug	Assignment
X51	CAN bus (CAN r)
X52	Supply voltage
X53	2 x 2-pin plugs with 2 permanently assigned switching outputs
X54	6 x 2-pin plugs with 6 permanently assigned switching outputs

Slot	Plug	Max. load per slot	Channel		Value	
					Front CPP2	Rear CPP4
X53						
X53:1A	4-pin	3.5 A	OUTPW 10		22	42
X53:1B			OUTPW 2			
X53:2B		3.5 A	OUTPW 1		21	41
X54						
X54:1B	2-pin	10 A	OUTPW 4		24	44
X54:2B	2-pin	3.5 A	OUTPW 6		26	46
X54:3B	2-pin	3.5 A	OUTPW 5		25	45
X54:4B	2-pin	3.5 A	OUTPW 8		28	48
X54:5B	2-pin	3.5 A	OUTPW 7		27	47
X54:6B	2-pin	10 A	OUTPW 9		29	49

CPP battery carrier (CPP5)

The hydraulic battery carrier is activated via the CPP battery carrier.

The CPP battery carrier is a CIO (CAN Input Output). The CIO provides the inputs and outputs and evaluates the signals.



NOTE

The CPP battery carrier can be used exclusively for the hydraulic battery carrier. No other use is possible.

CPP5	Assignment	
X51	CPP3, X51	CAN bus (CAN r)
X52	CPP3, X52	Supply voltage

CPP5	Assignment	
X61		
X61:1A	X301/5 - white	9B17/1 - GND - yellow
X61:1B	X301/8 - yellow	9B17/4 - 12 V - green
X61:2A	X301/7 - green	9B17/3 - signal 2 - black
X61:2B	X301/6 - brown	9B17/2 - signal 1 - red
X62		
X62:1A	X301/12	9B15 - GND - blue
X62:1B	X301/14	9B15 - 12 V - brown
X62:1B	X301/9 - green	9B16 - 12 V - brown
X62:2B		9S24/1 - button 1, retract
X62:3A		9S24/2 - GND button 1+2
X62:3B		9S24/3 - button 2, extend
X62:4B	X301/13	9B15 - signal - black
X62:5A	X301/11 - blue	9B16 - GND - blue
X62:5B	X301/10 - pink	9B16 - signal - black
X62:6A	A2	9K37
X62:6B	A1	9K37
X62:7A	X301/4 - yellow	9Y11
X62:7B	X301/3 - green	9Y11
X62:8A	X301/2 - brown	8Y12
X62:8B	X301/1 - white	9Y12

Relay-Power-Port

General

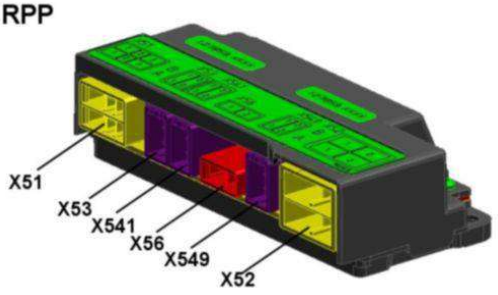
The Relay-Power-Port (RPP) is a simplified variant of the CPP and is a further development of the relay plate.

The RPP is not a CAN bus participant, but uses the CAN bus plug as a power supply only.

The RPP contains two internal relays, which are directly controlled by the outputs of the truck control unit (MCU, TCU). The truck control unit has three outputs for the external relays SK1, SK2, SK3. This enables three switching functions that can be carried out by two or three RPPs.

The location of the RPPs in the truck corresponds to the location of the CPPs and varies according to truck type; see the chapter "Overview of electrical components".

RPP



Electrical connections

RPP plug	
X51	Relay supply voltage
X52	Consumer supply voltage
X53	Normally open contacts for SK1/3

RPP plug	
X541	Parallel normally open contacts for SK1/3
X549	Normally open contacts for SK2
X56	Relay coil contacts

Supply voltage	
Electric forklift trucks 48 V and 80 V	Distributor card 7A21: X65, X66, X67
Electric forklift trucks only 48 V	Fuse box A21: X27
IC truck	Fuse box A21: X162

Parameterising

The RPPs are not CAN bus participants and do not need to be registered using parameters.

Parameterising of the outputs takes place using the truck diagnostics in the notebook.

RPP slot	MCU/TCU slot	Relay	Channel	Value
X56:2	X47:5	SK2 out	Option board channel 2 / RPP1 K2	02
X56:1	X47:33	SK1 out	Option board channel 1 / RPP1 K1	01
X56:1	X47:19	SK3 out	Option board channel 3 / RPP2 K1	03

Traction and working hydraulics control

Main Control Unit (MCU)

General



The Main Control Unit (MCU) is attached to the front right of the front structure and is protected by panelling.

The MCU consists of a control processor (SR) and a monitoring processor (UE). As the truck control unit, the MCU is responsible for controlling, regulating, monitoring and enabling.

In the extended version with servo hydraulics, the valve processor (VR) is built into the housing as an additional printed circuit board.

The individual MCU tasks are listed by function:

- Error management

  Fault number management A (MCU)
- Main fuse circuit

  Parent contactor controller

  Enabling and blocking of hydraulic and traction drive
- Traction drive

  Controller, control system, monitoring
- Hydraulic drive

  Controller, control system, monitoring
- Processing input signals from:

  Accelerator, brake sensor, hydraulic sensor

  Direction controls

  All switches in the front of the vehicle
- Discharge indicator

  Configuration using parameters

  Evaluation of the coarse and fine battery voltage and current provided by the Supply Unit.

  Calculation and representation of the battery residual capacity
- Monitoring and safety concept
- Add. electrical installation evaluation
- FleetManager data (BDE) processing
- Diagnostic, download
- Storing vehicle parameters

- Parameter backup for all other units
- Servo hydraulics (option)
- The buffer battery (G5)

  Data storage, as well as storing time, date, km counter and BDE

  The operating hours are securely stored in the EEPROM and are not lost even if the buffer battery is empty

Undo the electrical

Plug		
X47, X46	42-pin SAAB plug	Direct wiring of all standard functions for the drive unit
		12 volt output voltage for external transmitter and switch
		CANopen as standard
X48	42-pin SAAB plug	Servo hydraulics (variant)
X45	CAN bus connector	Supply of the drive direction turn indicator module (variant since June 2007)
G5	Cover	Buffer battery

MCU with servo hydraulics

General

The hydraulic control unit is a variant of the truck control unit MCU. The valve processor (VR) for the servo hydraulics is built into the truck control unit MCU as an additional printed circuit board.

From the outside, the variant can only be recognised by the additional SAAB plug X48.

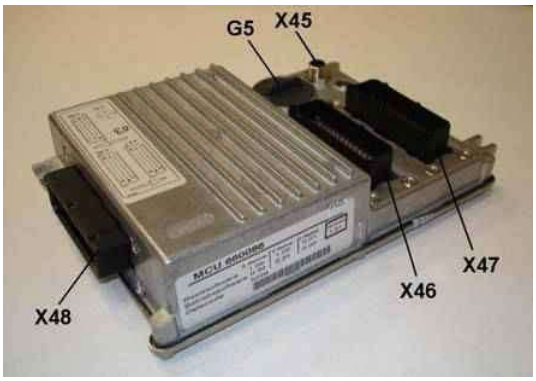
Construction, position and function are identical to the truck control unit in the standard design.

NOTE

For further information, refer to the chapter entitled "Main Control Unit"

The hydraulic control unit also takes over the following tasks in the truck control unit:

- Evaluation of the control, joystick, mini-lever, tip switch
- Activation of the release valve
- Activation of the individual solenoid coils in the proportional valves
- Distribution and forwarding of all signals relevant to the proportional technology to the truck control unit



X45 Drive direction turn indicator module (variant)
X46 MCU series
X47 MCU series
X48 Proportional technology (variant)
G5 Buffer battery

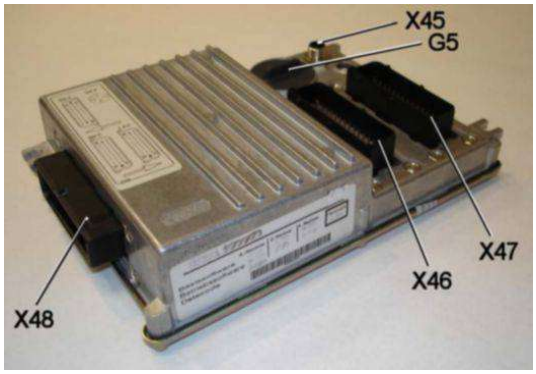
MCU generation 2

MCU 2 is an enhancement of MCU 1 with a larger processing capacity. New functions in the truck are only supported by MCU 2. The MCU 1 software will no longer be developed with the introduction of the new MCU 2.

NOTE

MCU 2 replaces MCU 1 completely. In the event of an error, MCU 1 is replaced by MCU 2. Retrofitting MCU 2 back to MCU 1 is not recommended.

MCU 2 can be identified clearly by referring to the identification plate and the software version. All software and hardware versions begin with V2.xx.





Changeover from MCU 1 to MCU 2

– Install MCU 2 as described in the chapter entitled "MCU - removal and installation".

– In trucks that are equipped with ABE 1, the corresponding software flash package must be loaded. Refer to the "Software overview" documentation.

Main Control Unit (MCU) Removal and installation

Spare part

If the MCU needs to be changed, there is some information that should be taken into consideration before removal:

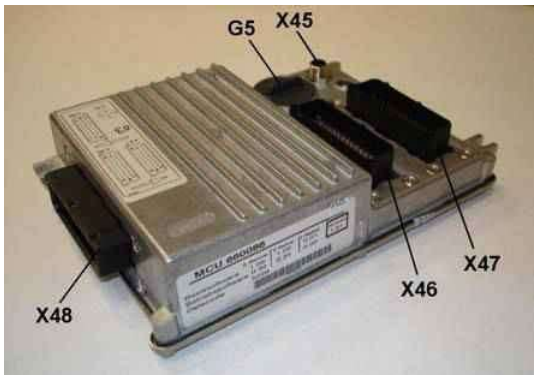
- As a rule, the spare part MCU does not contain any data or parameters.

  The data and parameters are saved both in the MCU and in the Supply Unit (SU) through constant automatic backups.

  Before carrying out service tasks, save a copy of the truck parameters on the notebook.
- It is important to take into consideration the truck equipment when ordering the MCU:

  Servo hydraulics (plug X48)

  Drive direction turn indicator module (plug X45)



X45	Drive direction turn indicator module (variant)
X46	MCU series
X47	MCU series
X48	Proportional technology version
G5	Buffer battery

Removal



- Park the truck safely.
- Disconnect the battery male connector.
- If necessary, remove the heating system.
- Remove panelling at the front structure.
- Disconnect the SAAB plugs and, as required, the CAN bus connector.
- Loosen the two M6 nuts and remove the MCU from the threaded bolts.

Installation

- Place the MCU onto the two threaded bolts and tighten the M6 nuts.
- Connect the SAAB plugs and, as required, the CAN bus connector.
- Fit the panelling to the front structure.
- If necessary, install the heating system.
- Connect the battery male connector.
- Set key switch S1 to ON.

The truck parameter set is stored in the MCU. In order to prevent a parameter loss, this parameter set is available as a copy in the Supply-Unit (SU). When one of the two components is changed, the parameter set must be copied from the remaining component.

There are two ways of copying:

- Automatic transfer
- Manual transfer

Also see the chapter entitled "Parameter management".

The automatic transfer is indicated in the display by the `PLEASE WAIT` message with progress bar. This process can take several minutes and ends with a reset.



The manual transfer begins with the question in the display `A-EEPROM VALID?`. This means: "Are the parameters of the MCU (device A) supposed to be used?"

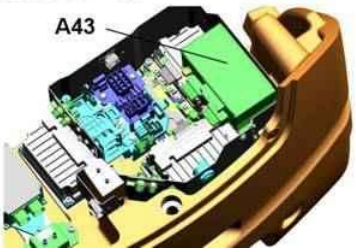


- Load software flash package and start calibration; see the chapter entitled "Software compatibility"
- Delete the error memory.
- Function check.

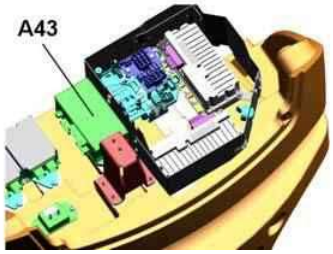
Supply Unit (SU)

General

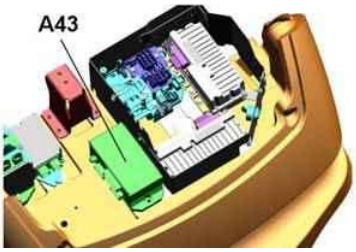
RX20 15 - 20
RX60 16 - 20



RX60 25 - 35



RX60 40 - 50



The Supply Unit (SU) is attached to the counterweight via the heat sink using a screw, and is protected by panelling.

The position of the SU varies according to the truck type.

NOTE

From August 2014, the second-generation SU will be installed for the first time in the RX20 Facelift 2014 and later in all other truck types.

The SU 2 can be identified clearly by referring to the identification plate and the software version. All software and hardware versions begin with V2.xx.

▷



The SU performs the following tasks in the truck control unit:

- Pre-charging the inverter intermediate circuit
- 24-V power supply for the CAN bus
- Distributing and forwarding the speed sensor signals to the MCU
- Monitoring the phasing of the motors
- Emergency off
- Processing input signals:
  Inverter release
  Additional electrical equipment variants
- Discharge indicator:
  Battery current measurement
  Battery voltage measurement
  Using correction parameters (adjustment values), the coarse and fine battery voltage is determined and forwarded to the MCU.
- Activation of key switch S1
- Activation of horn relay K1
- Activation of signal horn 4H1

Performance data

NOTE

Since August 2006, the SU has contained a built-in voltage transformer. The external MTM voltage transformer that was previously necessary is no longer required.

Voltage	24 V
Current	4.5 A

Undo the electrical



Connector		
X41	16-pin SAAB plug	Connection to the overhead guard
X42	16-pin SAAB plug	Connection to the fuse card
X43		Plug X43 has been omitted since August 2006. In the event of a conversion, please observe the changes in wiring.
X44	42-pin SAAB plug	Truck chassis switch and sensors
X40	CAN bus plug	CAN bus for variant (CPP)

Conversion to a built-in voltage transformer

To integrate an SU with a built-in voltage transformer into a truck electrical system with an MTM external voltage transformer, the following adaptions must be made to the wiring harness:

– Disconnect all the wires to the MTM at plug X42

– Discard the affected contacts at plug X42

Connector	Assignment
X42:13	+24 Volt MTM
X42:14	GND-F
X42:15	U-Batt
X42:16	GND-L

⚠ CAUTION

If the wires remain in the truck, this can lead to malfunctions in the electrical system.

Correctly remove the wires from the plug and close the slots.

– Close the slots in plug X42 with blind plugs
– Remove the MTM

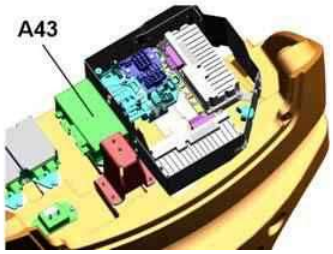
Supply Unit (SU)
Removal and installation

Removal

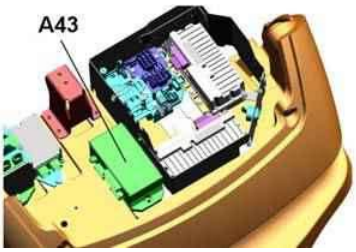
RX20 15 - 20
RX60 16 - 20



RX60 25 - 35



RX60 40 - 50



– Park the truck safely.
– Disconnect the battery male connector.
– Remove trademark emblem, loosening the left and right side screws but not unscrewing them completely.
– Optional: Disconnect plug X57 from the light strip.
– Remove the cover for the electronics.
– Discharge the intermediate circuit, see chapter "Intermediate circuit".

⚠ DANGER

Due to the internal energy accumulator in the converters and control units, in the event of a fault there can be dangerously high voltages at the electrical connections, even after the battery male connector has been disconnected.

Do not touch energised contact points such as the positive and negative connections of the power control unit!

Before working on electrical power connections, always check the voltage between all contacts and between the contact and the truck chassis using a suitable measuring device (capable of measuring up to 1000V DC).

Discharge the intermediate circuit.

– Disconnect all SAAB plugs and, if necessary, the CAN bus connector at the SU.

– Unscrew the mounting screw M10.
– Remove the SU from the counterweight.
– Clean the contact surfaces of the SU and counterweight of all heat-conducting paste residues.

Installation

– Apply a 0.5 mm thick layer of heat-conducting paste evenly over the contact surfaces of the SU and counterweight.

⚠ CAUTION

The internal power electronics in the converters and control units generate high temperatures that can lead to the destruction of these components.

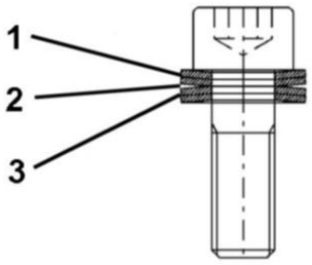
Apply a 0.5 mm thick layer of heat-conducting paste evenly over the clean contact surfaces.

Check tightening torques and mounting elements.

– **Trucks up to 2 t:** Position the SU on the contact surface in the counterweight and move under the joining plate of the sheet metal cover.
– **Trucks 2.5 t - 5 t:** Position the SU on the contact surface in the counterweight.



– Combine two disc springs in parallel to form a packet, and combine each two packets in alternate directions. Tightly screw the socket head screw M10x30 to the spring column; **tightening torque: 34 Nm**



– Connect all SAAB plugs and, if necessary, the CAN bus connector at the SU.
– Install and tighten the cover for the electronics.
– Install the trademark emblem.
– Optional: Connect plug X57 of the light strip.
– Connect the battery male connector.
– Set key switch S1 to ON.

The truck parameter set is stored in the MCU. In order to prevent a parameter loss, this parameter set is available as a copy in the Supply-Unit (SU). When one of the two components is changed, the parameter set must be copied from the remaining component.

There are two ways of copying:

- Automatic transfer
- Manual transfer

Also see the chapter entitled "Parameter management".

The automatic transfer is indicated in the display by the PLEASE WAIT message with progress bar. This process can take several minutes and ends with a reset. ▷



The manual transfer begins with the question in the display A–EEPROM VALID?. This means: "Are the parameters of the MCU (device A) supposed to be used?" ▷

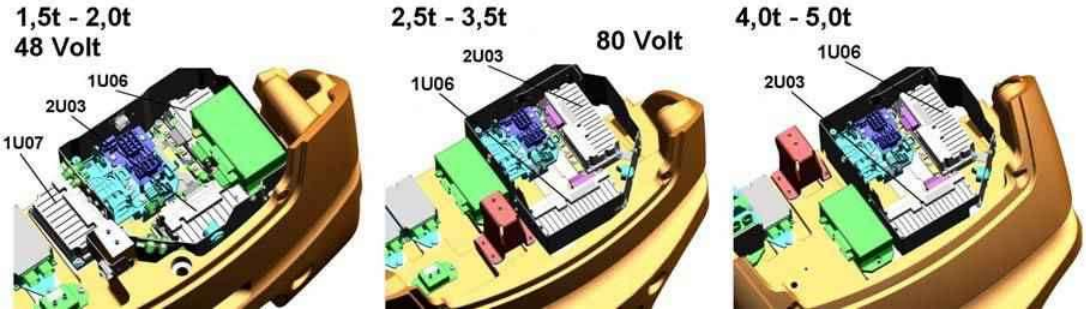


– Load software flash package and start calibration; see the chapter entitled "Software compatibility".
– Delete the error memory.
– Function check.

Converter

Inverters

General



Pump motor converter
2U03 2M1

Traction motor converter
1U06 1M1 - FM1 right
1U07 1M2 - FM2 left

Each of the asynchronous motors available in the truck is controlled by its own converter. The converters are attached to the counterweight via a heat sink and are protected by panelling.

The position and number of the converters, and their performance data, vary according to the truck type. The converters perform identical functions in the truck control unit.

The converters perform the following tasks in the truck control unit:

- Control and regulation of the relevant motor
- Speed measurement
- Temperature measurement and monitoring
- Communication with truck control unit MCU
- Communication with the Supply Unit

Converter LAC - 48/80 Volt

Technical data

48 Volt	Voltage	Rated current	Code letter	Generation
Traction converter 1U06, 1U07				
LAC 1 - HAF 400	48 V	540 A	A	2
LAC 1A - HAFS 400	48 V	404 A	A	3
Pump converter 1U03				
LAC 1 - HAF 600	48 V		B	2
LAC 1 - HAFS 600	48 V	540 A	B	3

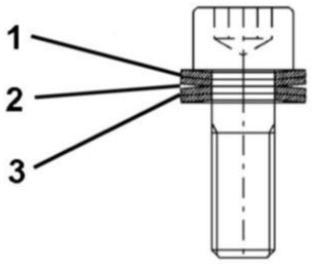
80 Volt	Voltage	Rated current	Code letter	Generation
Traction converter 1U06, 1U07				
LAC 1 - HAF 400	80 V	316 A	C	2

LAC 1 - HAFS 400	80 V		C	3
Pump converter 1U03				
LAC 2 - HAF 600	80 V	612 A	E	2
LAC 2 - HAFS 600	80 V		D	3

Tightening torques

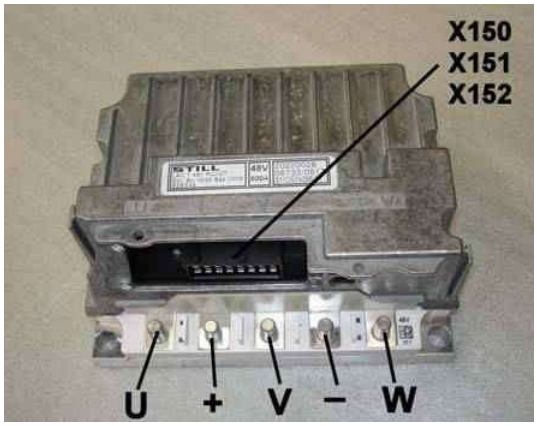
Mounting of the electrical components:	
(1)	2 disc springs in the same direction
(2)	2 packages each in the opposite direction
(3)	2 disc springs in the same direction

Tightening torques:	
Heat sink on counterweight Screw M10 x 30, DIN 912	34 Nm
Power cable stud bolt Nut M8 Conical spring washer	10 Nm



Electrical connections

Power connections	
–	Batt. – (GND-L)
+	U-Batt after main contactor
U	Motor field connection
F	Motor field connection
W	Motor field connection
X150 X151 X152	Control wiring harness



Plug assignment X150, X151, X152	
Pin 1	V monitoring (not used)
Pin 2	Not assigned
Pin 3	Temperature sensor +
Pin 4	Temperature sensor –
Pin 5	Rev sensor track A from supply unit
Pin 6	Rev sensor track B from supply unit
Pin 7	Rev sensor 10 V
Pin 8	Rev sensor GND-L
Pin 9	U monitoring (not used)
Pin 10	Not assigned
Pin 11	Enable signal from supply unit
Pin 12	Not assigned
Pin 13	CAN H connected to supply unit
Pin 14	CAN L connected to supply unit

Plug assignment X150, X151, X152	
Pin 15	24 V from supply unit
Pin 16	GND-F from supply unit

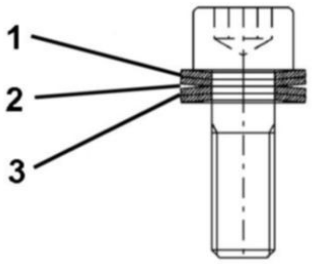
Converter SAC - 48 Volt

Technical data

48 Volt	Voltage	Rated current	Code letter	Generation
Traction converter 1U06, 1U07				
SAC 1 - 400	48 V	400 A	A	
Pump converter 1U03				
SAC 1 - 600	48 V	600 A	B	

Tightening torques

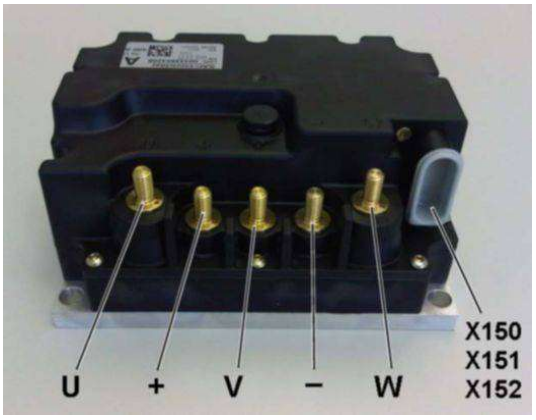
Mounting of the electrical components:	
(1)	2 disc springs in the same direction
(2)	2 packages each in the opposite direction
(3)	2 disc springs in the same direction



Tightening torques:	
Heat sink on counterweight Screw M10 x 30, DIN 912 Disc springs 4 x A20, DIN 2093	34 Nm
Power cable stud bolt Hexagon nut MS 8, ISO 4032 Spring washer MS 8.4, ISO 7089	8 Nm

Electrical connections

Power connections	
–	Batt. – (GND-L)
+	U-Batt after main contactor
U	Motor field connection
F	Motor field connection
W	Motor field connection
X150 X151 X152	Control wiring harness

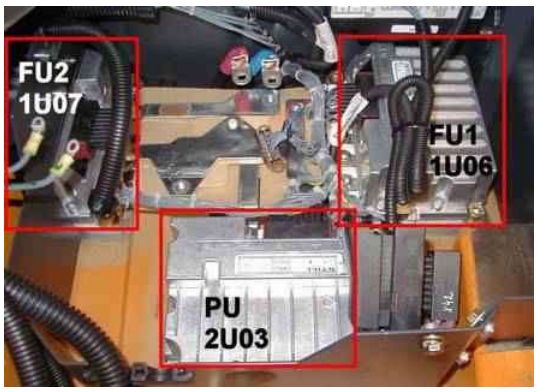


Plug assignment X150, X151, X152	
Pin 1	Rev sensor GND-L
Pin 2	GND-F from SU
Pin 3	Rev sensor track A from SU
Pin 4	CAN H connected to SU
Pin 5	Rev sensor track B from SU

Plug assignment X150, X151, X152	
Pin 6	CAN L connected to SU
Pin 7	Rev sensor 10 V
Pin 8	24 V from SU
Pin 9	U monitoring (not used)
Pin 10	Enable signal from SU
Pin 11	V monitoring (not used)
Pin 12	Temperature sensor +
Pin 13	W monitoring (not assigned)
Pin 14	Temperature sensor –

Converter - removal and installation

Preparations



NOTE

It is not recommended to change the converter types from LAC to SAC because various components are not compatible:

- *Threaded holes in the counterweight*
- *Wiring harness*
- *Conductor rails*

⚠ DANGER

Due to the internal energy accumulator in the converters and control units, in the event of a fault there can be dangerously high voltages at the electrical connections, even after the battery male connector has been disconnected.

Do not touch energised contact points such as the positive and negative connections of the power control unit!

Before working on electrical power connections, always check the voltage between all contacts and between the contact and the truck chassis using a suitable measuring device (capable of measuring up to 1000V DC).

Discharge the intermediate circuit.

Removal

NOTE

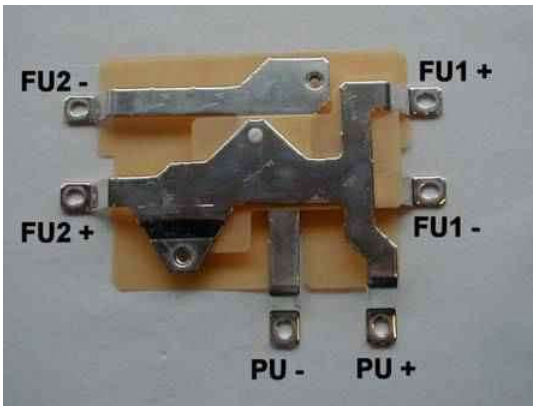
- *Work carefully to ensure that no parts fall into the electrical system.*
- *The views of the conductor rails may differ from the actual condition in the truck.*
- *The conductor rails are dependent on the converter type (LAC / SAC).*

Converter

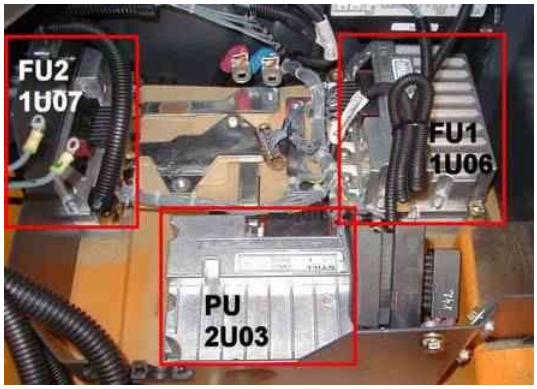
- Park the truck safely.
- Disconnect the battery male connector.
- Remove trademark emblem, loosening the left and right side screws but not unscrewing them completely.
- Optional: Disconnect plug X57 from the light strip.
- Remove the cover for the electronics.
- Discharge the intermediate circuit.
- Remove the supply unit.
- Remove the CPP as required.
- Remove the fuse plate.
- Unscrew the conductor rails to the converters. ▷



- Remove the conductor rail package with the lower insulation foil from the counterweight. ▷
- Disconnect plug X150 or X151, X152.
- Loosen the three phases U, V, W.
- Loosen the four mounting screws with short extender and 8-mm hexagon socket.
- Remove the converters.
- Clean the contact surfaces of the converters and counterweight of all heat-conducting paste residues.



Installation



NOTE

- *Work carefully to ensure that no parts fall into the electrical system.*
- *The views of the conductor rails may differ from the actual condition in the truck.*
- *The conductor rails, mounting elements and tightening torques are dependent on the converter type (LAC / SAC).*

⚠ CAUTION

Converters are destroyed by overheating!

Apply a thin layer (approx. 0.5 mm) of heat-conducting paste evenly over the clean contact surfaces.

Check tightening torques and mounting elements.

– Before installation, check whether the bottom plate of the converter lies flush on the contact surfaces in the counterweight.

– Apply a thin layer (approx. 0.5 mm) of heat-conducting paste evenly over the contact surfaces of the converter and counterweight.

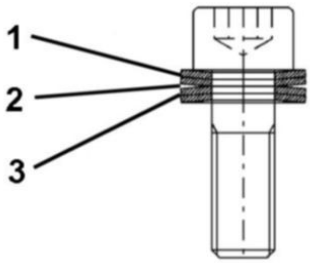
⚠ CAUTION

Risk of short circuit in the motor wiring!

The cable shoes of the motor cables must not come into contact with the conductor rails.

– Position the converters on the contact surface in the counterweight.

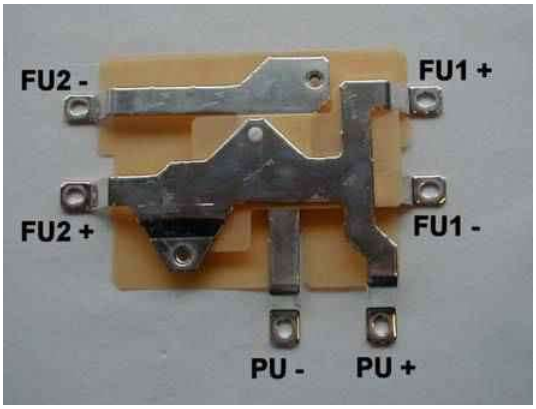
– Combine two disc springs (1, 3) in parallel to form a packet, and combine each two packets (2) in alternate directions, then tighten with a socket head screw.



– Screw in the three phases U, V, W evenly.



- Screw the conductor rails to the converters.
- Connect plug X150, X151, X152.
- Install the fuse plate.
- Install the CPP as required.
- Install the supply unit; see the chapter entitled "Removing and installing the supply unit".
- Install and tighten the cover for the electronics.
- Install the trademark emblem.
- Optional: Connect plug X57 of the light strip.
- Connect the battery male connector.
- Functional test



Traction battery

Battery

Acid density



The acid density can be used to calculate the no-load voltage U_o per battery cell.

U_o [volts] = acid density [kg/l] + 0.84

The acid density is tested using an acid siphon (hydrometer). The acid density can be read off directly on the float of the acid siphon.

The acid density decreases as the battery discharges.

Once the charging process is complete, it takes a certain amount of time for the acid above the plates to mix with the acid between the plates and then settle. In order to obtain accurate values, the measurement must only be taken approx. 30 minutes after the charging process is complete.

Battery type	Acid density [kg/l]	No-load voltage [V]	Charge state
PzS (standard lead battery)	1.27	2.11	100%
	< 1.13	< 1.97	20% (deep discharge)
PzS/L (performance-enhanced lead battery)	1.29	2.13	100%
	< 1.13	< 1.97	20% (deep discharge)
CSM (gel battery)	1.29	2.13	100%
	< 1.15	< 1.99	20% (deep discharge)

Battery discharge

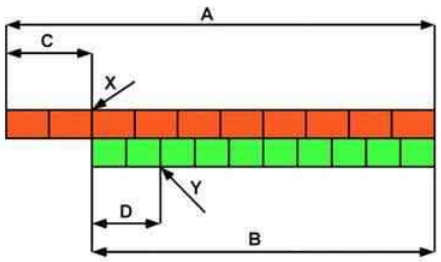
When switching on a fully charged, unloaded battery, it must have a **no-load voltage** of at least 2.1 V per cell. This corresponds to a **nominal battery capacity** of 100%.

The no-load voltage of the battery reduces as discharging progresses and depends on the **strength of the discharge current**. The stronger the discharge current, the lower the available **battery capacity**.

The discharge limit is determined using the **final discharged voltage**. Discharging the battery below the discharge limit is known as **deep discharging**.

To avoid deep discharge, the final discharge voltage is limited by means of the **cut-off threshold**. If the cut-off threshold is reached, a hydraulic restriction can be activated through parameterising.

Before the cut-off threshold is reached, it is possible to determine the residual charge still



A	Nominal battery capacity
B	Available battery charge
C	Residual battery capacity
D	Available residual battery charge
X	Shut-off threshold
Y	Warning threshold

available via the **warning threshold**. A flashing battery indicator in the display activates an alarm indicating the level of residual charge left.

Temperature-dependent battery capacity

The ideal operating temperature for batteries is between 20°C and 40°C. However, the maximum battery capacity is only reached at an optimum temperature of 27 - 30°C.

A decrease in temperature reduces the battery capacity by 1% for every 1°C. At a temperature of 0°C, the battery has a capacity loss of 27%. Only 73% of the maximum capacity remains available.

Electrolyte temperatures of over 55°C cause permanent damage to the battery and shorten the service life considerably.

Sulphated battery

If the battery is incorrectly handled, lead and sulphur bond together to form a hard lead sulphate. This process is known as permanent or hard sulphation.

Permanent sulphation can be detected by the discolouration of the plates. The positive plates turn light brown and the negative plates turn a matt, off-white colour. Sulphation reduces the capacity of the battery and its ability to be recharged.

Reasons for a sulphated battery:

- Frequent deep discharging
- Incorrect full charge
- Charging current too low
- Frequent intermediate charging
- Battery temperatures of over 55°C when charging and discharging

Service and maintenance

Always follow the battery manufacturer's notes and rules regarding the correct handling procedure for batteries.

2014 discharge indicator

Display

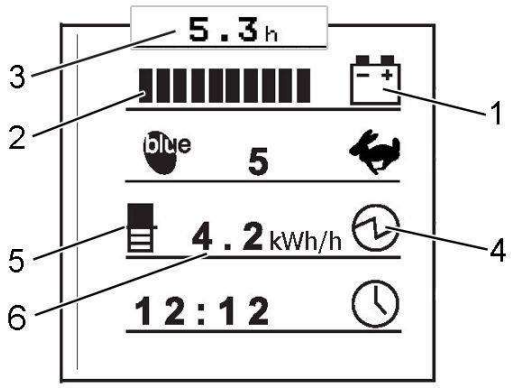
The display-operating unit shows the battery charge (1) as a segmented bar graph in 10% stages (2). At two bars, the display starts to flash. Hydraulic restriction is activated once no bars are visible. Speed reduction can also be activated via parameterisation.

Every 10 seconds, the display switches from showing the battery charge to the remaining operating time (3).

The power rating indicator (4) shows the current average energy consumption (6). Trends relating to the energy consumption (5) are displayed as a vertical bar graph.

NOTE

The display shown corresponds to the standard setting. The displays can be changed and adjusted via parameterisation.



1 **Battery charge**
2 Available battery charge [%]
3 Remaining operating time [h]
4 **Power rating indicator**
5 Typical energy consumption (trend)
6 Average energy consumption [kWh/h]

Improved initial measurement



The measuring procedure of the battery discharge indicator uses the voltage behaviour of the battery to determine the maximum charging state, or SOC (State-Of-Charge).

The recovery phase of the battery plays a role in this process. The measuring procedure is optimised for short battery recovery phases. An older battery can become increasingly inactive, which increases the recovery phase. As a result of this battery characteristic, the measured value can be up to 20% too high at a high charge level.

The improved initial measurement checks whether the battery has been recharged or not when the truck is switched on. If the battery has not been charged, the value used is the last value measured before the truck was switched off. As a result, the actual charging state of the battery is displayed when the truck switched on.

The lower cell voltage value can be adjusted during the initial measurement via parameterisation. If the value is not parameterised or is incorrectly parameterised, an error message will appear.

	Volt/cell
Specification	1.97
Value range	1.95–2.05

Measuring procedure

The discharge indicator is based mainly on three measuring procedures or calculation procedures:

- Discharge measurement (voltage measurement)
- Calculation of the charge drawn (current measurement)
- No load measurement

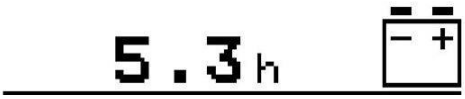
In addition, saved values from these measurements are used for the calculation.

The battery voltage is measured at the intermediate circuit. Using correction parameters (specified adjustment values), the voltage is determined here as fine battery voltage. This internally measured value cannot be measured by the service centre. The fine battery voltage is transmitted to the MCU.

The MCU processes this value in accordance with the parameters and subsequently calculates the available battery charge.

Remaining operating time

The remaining period shows how long the truck can continue to be used until the indicated available battery charge is 0% (no bars).



- The remaining operating time is dependent on the actual battery charge status (SOC) and average energy consumption.

  The average energy consumption is calculated from the consumption by the drive functions and hydraulic functions.

  The energy consumption is averaged out over the preceding 30 minutes.
- The drive program and the drive mode have an effect on the remaining operating time. The impact on the remaining operating time is determined by certain factors:

  Switching to a more energy-efficient drive programme increases the remaining period by approximately 5%.

  Switching to BLUE Q increases the remaining period by approximately 10%.

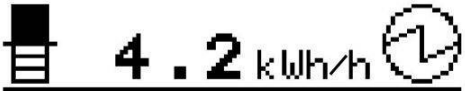
If the driver switches on a more energy-efficient drive programme or BLUE Q, the remaining period increases sharply.

If the driver switches on a more energy-intensive drive programme or sprint mode, the remaining period decreases sharply.

- The driver can influence the remaining operating time via his driving style and the driving cycle.

  The remaining period decreases faster than expected in the BLUE Q drive mode if, for example, the hydraulic functions are used a lot.
- When the truck is switched off, the last recorded values for the average energy consumption and the remaining period are retained. Both values change when the truck is driven.

Power rating indicator



The power rating indicator shows the average energy consumption [kWh/h] and trends.

Average energy consumption

- The average energy consumption is calculated from the consumption by the drive functions and hydraulic functions.
- The energy consumption is averaged out over the preceding 30 minutes.

Trend display

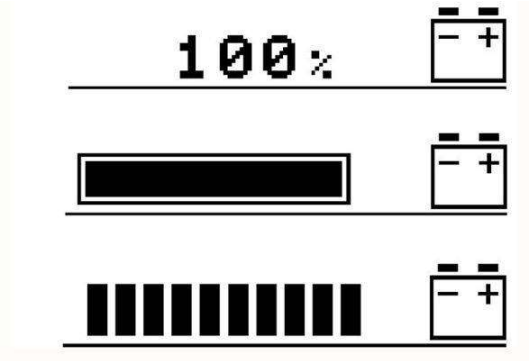
- The trend display supplements the average energy consumption display.
- The trend display compares the current energy consumption with the average energy consumption.

  The current energy consumption is averaged out over the preceding five minutes.
- When the truck is switched on, the trend symbol for the average energy consumption is displayed. The trend display only changes once the truck is in operation.

Symbol	Energy consumption trend
	Significant increase (> 50%)
	Increase (up to 50%)
	Slight increase (up to 30%)
	Average; no change
	Slight decrease (up to –30%)
	Decrease (up to –50%)
	Significant decrease (> –50%)

Discharge indicator

Display

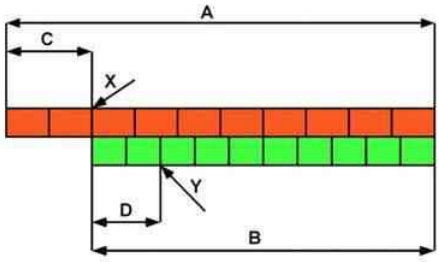


The display and operating unit displays the battery charge either as 10 bars or as a percentage.

At 20% residual battery charge or two bars, the display starts to flash.

At 0% residual battery charge or no bars, restriction of the hydraulics is activated.

Battery capacity



The diagram shows the proportion of battery capacity that is available for use, and the proportion that is processed by the discharge indicator.

(A) = 100% nominal battery capacity

(B) = 100% of the available battery charge, equivalent to approx. 80% of nominal battery capacity. The display shows battery charge either as 10 bars or as a percentage.

(C) = approx. 20% of the battery's residual capacity, which is not available. This protects the battery from deep discharging.

(D) = The available residual charge in the battery, indicated by a flashing battery indicator in the display.

(X) = Cut-off threshold, a configurable value that determines the discharge limit and activates hydraulic limitation. Valid value range: 1.83–2.00 Volt per cell; default 1.94 Volt per cell.

(Y) = Warning threshold, a configurable value which indicates the residual charge by means of a flashing battery indicator. Valid value range: 0–100%; default 20%.

A	Nominal battery capacity
B	Available charge in battery
C	Remaining capacity of battery
D	Remaining available capacity of battery
X	Switch-off threshold
Y	Warning threshold

Measuring procedure

The discharge indicator depends mainly on three measuring or calculating procedures:

- Discharge measurement (voltage measurement)
- Calculating the charge drawn
- Idling measurement

These measuring procedures are not affected by parameterisation.

The battery voltage is measured at the intermediate circuit. Using correction parameters (specified adjustment values), the voltage is

determined here as fine battery voltage. This internally measured value cannot be measured by the service centre.

The fine battery voltage is transmitted to the MCU. The MCU processes this value in accordance with the parameters and subsequently calculates the residual battery charge. This is then shown in the display.

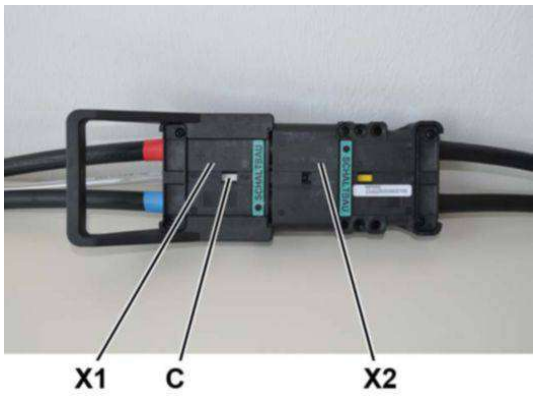
Initial measurement

The battery's recovery phase plays a key role in the initial measurement. The measurement is optimised for short battery recovery phases. An older battery can become more inactive, which increases the recovery phases. In the interests of safety, the lower value of the cell voltage can be adjusted during the initial measurement by means of parameterisation.

The mandatory default value is 1.97 Volt per cell. (Valid value range: 1.95–2.05 V). If this address is not parameterised or incorrectly parameterised, an error message will appear.

Battery plug

General



The battery male connector consists of two parts:

- X1: The battery male connector is the utility socket on the traction battery
- X2: The appliance plug is a component of the truck

The battery male connector (X1) is equipped with a handle and is connected firmly to the battery via contact bushings. The coding (C) prevents unsuitable operating voltages from being connected and prevents batteries from being connected to unsuitable battery chargers.

The appliance plug (X2) is mounted on the right side of the counterweight on a support mounting.

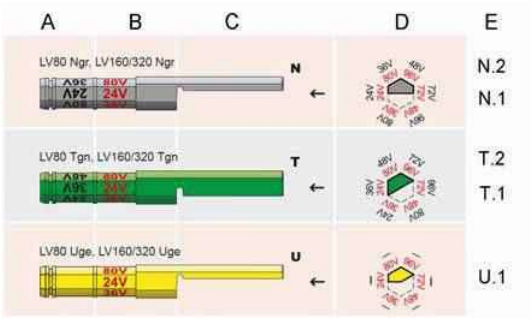
Electrical connections

X2 (+)	XS1 (Batt +)	F01	1K1
X2 (-)	XS5 (GND L)		

Encoding system

Each appliance plug must be equipped with an encoder, which ensures that a male connector can only be inserted into a female connector with the same operating voltage.

The coding is dependent on the battery voltage and battery technology (wet battery or dry battery).



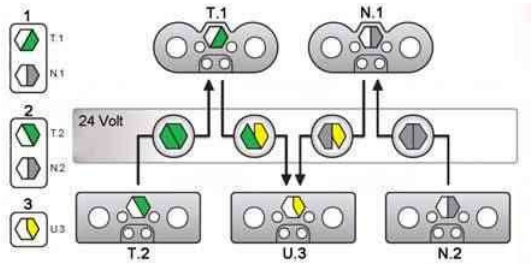
Series LV-HPc80, LV160, LV320

A	Pin
B	Bushing
C	Coding
D	Voltage coding
E	Application coding

Application coding

N.2	Pin housing for charging station - wet battery "N"
N.1	Bushing housing for battery connector - wet battery "N"
T.2	Pin housing for charging station - dry battery "T"
T.1	Bushing housing for battery connector - dry battery "T"
U.1	Pin housing for truck, universal "U"

Both halves of the plug are equipped with a coding pin between the contacts for this purpose. The coded operating voltage is visible in one section of the housing for the appliance plug.



Battery

1	Coding for battery bushing housing
T.1	Bushing housing - dry battery
N.1	Bushing housing - wet battery

Charging station

2	Coding for charging station pin housing
T.2	Pin housing for charging station - dry battery
N.2	Pin housing for charging station - wet battery

Truck

3	Coding for truck pin housing
U.3	Pin housing, universal

Pilot or auxiliary contact

As an option, appliance plugs can be equipped with pilot contacts or auxiliary contacts.

Pilot contacts are used to protect against the battery male connector being improperly disconnected from the battery charger when the battery is being charged. The pilot contact ensures that the charging current is switched off at the battery charger before the plug main contacts are disconnected completely.

The charger has to be adequately equipped.

Air duct for battery with electrolyte recirculation

Appliance plugs can be equipped with integrated ventilation for batteries with electrolyte circulation. The ventilation design is manufacturer-specific and is therefore incompatible with different appliance plugs. The ventilation design is not currently standardised.

Combination options

The equipment specified can be used in the following combinations:

- Plug/socket
- Plug/socket with two pilot contacts
- Plug/socket with ventilation
- Plug/socket with ventilation and two auxiliary contacts
- Plug/socket with two pilot contacts and two auxiliary contacts

Maintenance guidelines for appliance plugs

Description

Appliance plugs are battery plug connectors that are fitted in all electric trucks, and to traction batteries, battery chargers and charging stations.

Linguistic definition:

- The **appliance plug** is a component of the truck
- The **battery male connector** is the utility socket on the traction battery
- The **battery charger plug** is the appliance plug of the battery charger or the charging station

⚠ CAUTION

Damaged appliance plugs and utility sockets can cause damage to other appliance plugs and utility sockets as a result of alternating operation.

All appliance plugs and utility sockets belonging to a truck, battery and battery charger must be checked and replaced as required.

Maintenance tasks

- Check the housing and handle for damage
- Check the strain relief for correct operation
- Check the contact lock for correct operation
- Check the coding pin for damage
- Check the main current contacts for damage
- Optional: Check the air duct for leaks and correct operation
- Optional: Check the pilot contacts

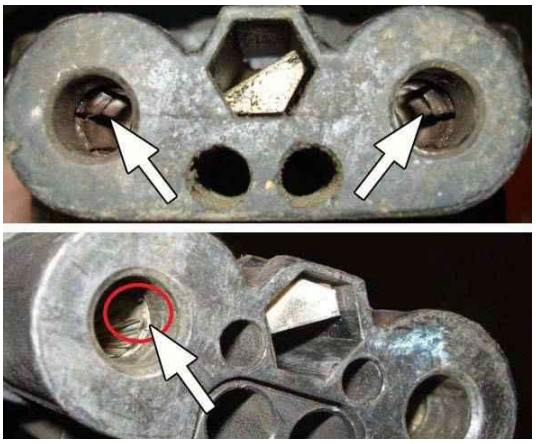
Damage to the main current contacts

Damage to the main current contacts is difficult to detect. Therefore, special care is important in this case. The images provide examples of damage to the main current contacts.

Main current contacts with clear fusing and burn-off:



Broken main current contacts:

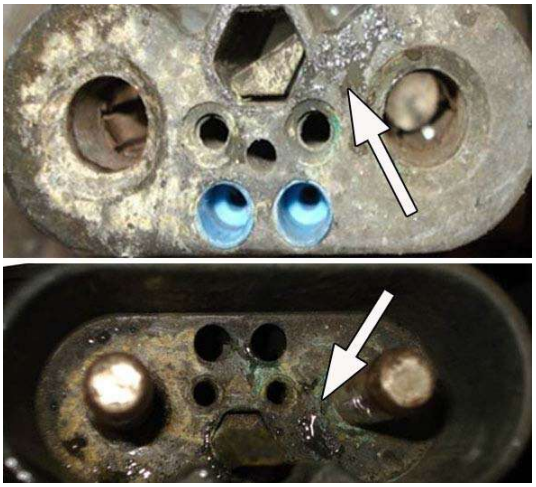


Battery male connector with damage due to acid.

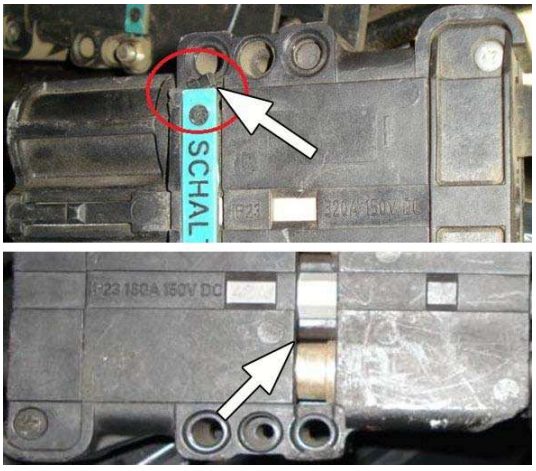
⚠ CAUTION

Battery male connectors covered with acid can damage battery charger plugs and appliance plugs.

If a plug covered with acid is noticed during maintenance, all plug partners must be checked for damage.



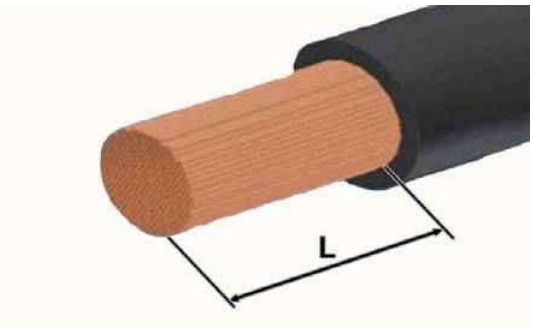
Contact bolt is damaged or is missing completely:



Repair - Battery male connector contacts

Schaltbau, Rema, Rema-SRx

– Strip the cable along **dimension L**; refer to the table below



Cable [mm^2]	Length (mm)
16 to 25	18
35 to 50	20
70 to 95	25

⚠ CAUTION

Damage to the separate wires causes a reduction in the cross-section. This leads to incorrect crimping, poorer transition resistance and increased heating.

Use a suitable tool.

– Using shrink tube if required, push the contact element onto the stripped cable end and crimp **3 mm** behind the contact retaining ridge using the appropriate crimping die.

– Perform the crimping process until it is clearly noticeable that the pressure relief valve has been triggered.

– After the crimping process, the gap between the insulation and the contact element must be no more than **1 mm**.

– Open the crimping pliers using the release lever.

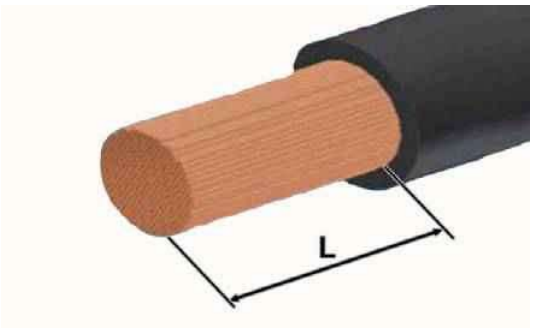


NOTE

Only crimp each contact once!

Anderson

– Strip the cable along **dimension L**; refer to the table below



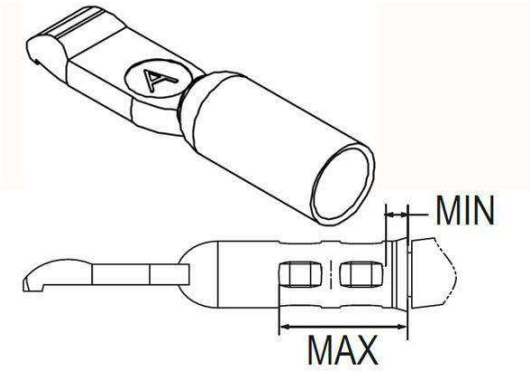
Plug	Length (mm)
SB 50	14
SB 120	24
SB 175	29
SB 250	35

⚠ CAUTION

Damage to the separate wires causes a reduction in the cross-section. This leads to incorrect crimping, poorer transition resistance and increased heating.

Use a suitable tool.

– Using shrink tube if required, push the contact element onto the stripped cable end and crimp using the appropriate crimping die.
– Start with the distance (MIN) of the first crimp. Depending on the plug, then complete a second crimp. Refer to the table for the relevant dimensions.



Plug	First crimp MIN [mm]	Second crimp MAX [mm]
SB 50	6.5	—
SB 120	10	—
SB 175	20	6.5
SB 250	22	13

– Perform the crimping process until it is clearly noticeable that the pressure relief valve has been triggered.
– Open the crimping pliers using the release lever.

Working with reducer sleeves

When working with reducer sleeves on battery main contacts, the following is to be noted:

- Only one reducer sleeve may be used per contact
- The use of reducer sleeves affects the maximum current load of a battery male connector. The smaller wire cross-section reduces the maximum current load
- Only appliance plugs from a single manufacturer and of a particular type may be connected
- The use of the reducer sleeve is dependent on the manufacturer; refer to the tables below

Schaltbau

			Schaltbau series LV			Schaltbau series LB		
Wire [mm^2]	Crimping insert [mm^2]	Reducing sleeve [mm^2]	80 A	160 A	320 A	80 A	160 A	320 A
50	70	70 to 50	No	No	Yes	No	No	Yes
35	50	50 to 35	No	Yes	Yes	No	Yes	No
25	50	50 to 25	No	Yes	Yes	No	Yes	No
16	35	35 to 16	No	No	No	No	No	No
16	25	25 to 16	Yes	No	No	Yes	No	No

Rema, Rema SRx

			Rema DIN 43589-1			Rema SRE / SRX	
Wire [mm^2]	Crimping insert [mm^2]	Reducing sleeve [mm^2]	80 A	160 A	320 A	160 / 175 A	320 / 350 A
50	70	70 to 50	No	No	No	No	No
35	50	50 to 35	No	Yes	Yes	Yes	Yes
25	50	50 to 25	No	Yes	Yes	Yes	Yes
16	35	35 to 16	Yes	Yes	No	Yes	No
16	25	25 to 16	Yes	Yes	No	Yes	No

General

General technical data

Hydraulic pump		RX20 (6210–6217)	RX60 (6311-6313-6315)
Type		High-pressure gear pump	
		Anticlockwise direction of rotation	
Delivery rate per rotation	[cm^3]	11	14

Tightening torques and connecting elements			
Hydraulic pump	[Nm]	56	2 x socket head screws M10 x 105, 10.9, DIN 912
Suction flange	[Nm]	9 $^{+1}$	2 x socket head screws M6 x 50, 8.8, DIN 912 2 x socket head screws M6 x 20, 8.8, DIN 912
Priority valve	[Nm]	9 $^{+1}$	4 x socket head screws M6 x 35, 8.8, DIN 912
	[Nm]	35	LS
	[Nm]	90	EF
	[Nm]	70	CF

Hydraulic speeds

Steering	rpm	400–800	Dynamic alignment
Auxiliary hydraulics		See the chapter entitled "Auxiliary hydraulics"	

Hand lever		RX20 (6210–6217)	RX60 (6311-6313-6315)
Lifting	rpm	3500	2800
Tilting Nominal lift < 3500	rpm	1150	1300
Tilting Nominal lift 3500–5000	rpm	800	630
Tilting Nominal lift > 5000	rpm	550	450

Servo hydraulics		RX20 (6210–6217)	RX60 (6311-6313-6315)
Lifting	rpm	3500	2600
Tilting Nominal lift < 3500	rpm	1150	1300
Tilting Nominal lift 3500–5000	rpm	800	640
Tilting Nominal lift > 5000	rpm	550	500

Hydraulic oil

Hydraulic tank			
Hydraulic oil, total filling quantity	[l]	27	Quality as per DIN 51524/part 3 HVLP or ISO VG 68

Hydraulic filter

Return line filter			
Degree of filtration	[µm]	20	
Operating pressure (maximum)	[bar]	10	
Triggering pressure - bypass valve	[bar]	3.4 ± 0.3	

Maintenance interval	3000 h or 2 years		
Tightening torque for maintenance cover	[Nm]	20	Tighten by hand

Intake filter		
Degree of filtration	[µm]	135
Maintenance interval	Maintenance free	

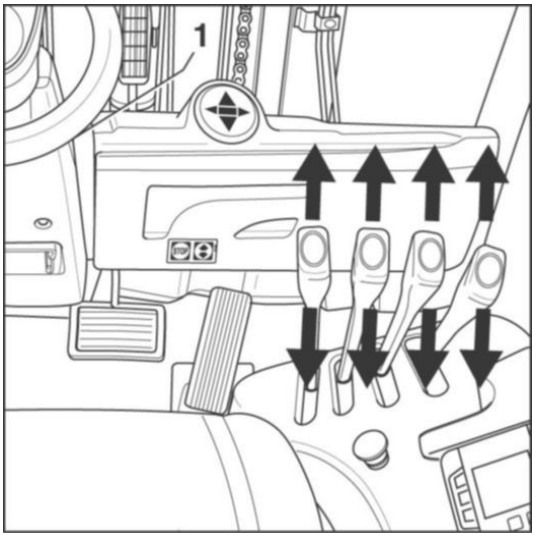
Breather filter		
Degree of filtration	[µm]	2 absolute
Maintenance interval	3000 h or 2 years	

High-pressure filter			
Degree of filtration	[µm]	12	
Tightening torque for hydraulic connections	[Nm]	200^{+20}	Pipe union M33 x 2
Maintenance interval	3000 h or 2 years		

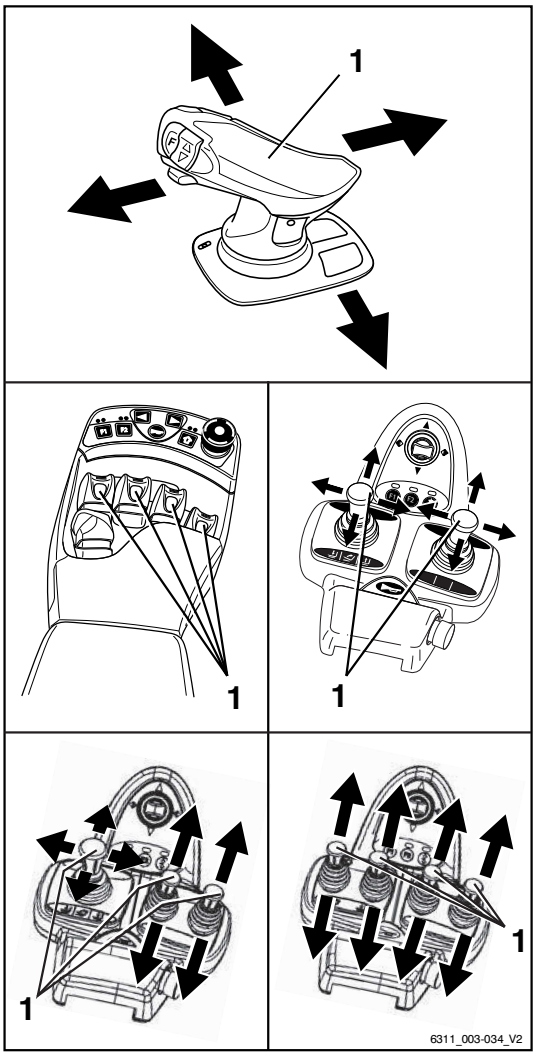
Depressurising the hydraulics

Multi-lever

- Switch on the key switch
- Lower the fork carriage
- Switch off the key switch
- Actuate all operating levers several times up to their end positions



Joystick 4Plus, mini-lever, fingertip switch



NOTE

- *The pressure in the hydraulics can be relieved on trucks equipped with MCU 2 with software version 2.06 or later.*
- *On trucks equipped with FleetManager™ or SIC, access authorisation must be enabled.*

– Switch on the key switch

– Lower the fork carriage

– Switch on the hazard warning system. Actuate the push button, even if the truck is not equipped with a hazard warning system.

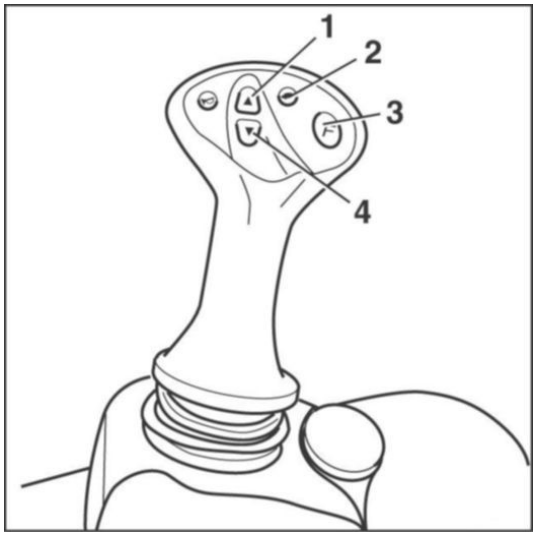
– Switch off the key switch

By actuating the hazard warning system, the electrical system will be prevented from switching off. The switch lock deactivates the converters and opens the main contactor.

– Now actuate the operating lever (1) for lifting, tilting and the auxiliary hydraulics.

Open the valves without the pump motor running. The pressure in the hydraulic system is relieved.

Joystick



– Switch on the key switch

– Lower the fork carriage

– Press the (1, 2, 3, 4) buttons at the same time

Lifting operating speeds

Truck 48 Volt		Lifting speed with nominal load [m/s] Tolerance ± 12%		
		Telescopic	NiHo	Triple
6209 – 6212	min.	0.40	0.40	0.40
	max.	0.52	0.50	0.50
6213, 6314	min.	0.40	0.38	0.38
	max.	0.50	0.48	0.48
6215 - 6217	min.	0.35	0.34	0.34
	max.	0.45	0.44	0.44
		Maximum permissible single values from lift 1 and lift 2 = 0.6 m/s		

Truck 80 Volt		Lifting speed with nominal load [m/s] Tolerance ± 12%		
		Telescopic	NiHo	Triple
6311	min.	0.47	0.46	0.45
	max.	0.59	0.58	0.57
6313	min.	0.46	0.44	0.43
	max.	0.58	0.56	0.55
6315	min.	0.40	0.38	0.37
	max.	0.50	0.48	0.47
		Maximum permissible single values from lift 1 and lift 2 = 0.6 m/s		

Testing

- Lift 1: Middle cylinder is extended.
- Lift 2: Outer cylinder is extended.
- For NiHo and triple lift masts, the mean value of the speeds measured for Lift 1 and Lift 2 is the one that counts.
- The maximum permissible single value from lift 1 and lift 2 must not be exceeded.
- Speeds are measured at operating temperature.

NOTE

Special equipment fitted to trucks may result in values varying from those stated.

Operating speeds for lowering

		Lowering speed with nominal load (m/s)
		Tele, NiHo, triple
6209–6212	Min.	0.41
	Max.	0.60

6213, 6314	Min.	0.41
	Max.	0.60
6215–6217	Min.	0.38
	Max.	0.60
6311	Min.	0.41
	Max.	0.60
6313	Min.	0.41
	Max.	0.60
6315	Min.	0.38
	Max.	0.60
	Min.	The fastest value at nominal load Tele - value from lift 1 NiHo/triple - value from lift 2
	Max.	Individual value with nominal load from lift 1 and lift 2

Testing

- Lift 1: Middle cylinder is extended.
- Lift 2: Outer cylinder is extended.
- Speeds must be measured at operating temperature.

⚠ CAUTION

The maximum lowering speed of 0.60 m/s must not be exceeded!

Do not adjust settings on lowering brakes.

Tilting operating speeds

		Tilt forwards with nominal load [seconds]						
Nominal lift [mm]			Tilt angle					
From	Up to		5°	6°	7°	8°	9°	10°	11°
	3500	min.	0.6	0.7	0.8	1.0.	1.1	1.2	1.3
		max. (1)	1.0.	1.2	1.4	1.6	1.8	2.0	2.2
		max. (2)	1.2	1.4	1.6	1.9	2.1	2.4	2.6
3500	5000	min.	1.0.	1.2	1.4	1.6	1.8	2.0	2.2
		max.	1.8	2.2	2.5	2.9	3.3	3.7	4.0
5000		min.	1.4	1.7	2.0	2.3	2.6	2.9	3.1
		max.	2.8	3.4	3.9	4.5	5.1	5.6	6.2
		(1): Hand lever (2): Servo hydraulics							

		Tilt backwards with nominal load [seconds]						
Nominal lift [mm]			Tilt angle					
From	Up to		5°	6°	7°	8°	9°	10°	11°

	3500	min.	0.4	0.5	0.6	0.7	0.8	0.9	1.0.
		max. (1)	0.8	1.0.	1.2	1.4	1.5	1.7	1.9
		max. (2)	0.9	1.2	1.4	1.6	1.7	2.0	2.2
3500	5000	min.	0.9	1.1	1.2	1.4	1.5	1.7	1.9
		max.	1.6	1.9	2.2	2.5	2.8	3.1	3.4
5000		min.	1.4	1.7	2.0	2.3	2.6	2.9	3.1
		max.	2.4	2.8	3.3	3.8	4.3	4.8	5.2
		(1): Hand lever (2): Servo hydraulics							

Testing

– Measurement is performed over the entire tilt range.

– Speeds are measured at operating temperature.

⚠ CAUTION

Operating error!

With the simultaneous actuation of more than one valve function, higher tilt speeds may occur.

Safety check

Forward tilt safety test

Test

– Pick up the nominal load and lift free of the ground.

– Park the truck on level ground and place the lift mast in the vertical position.

– Apply the parking brake.

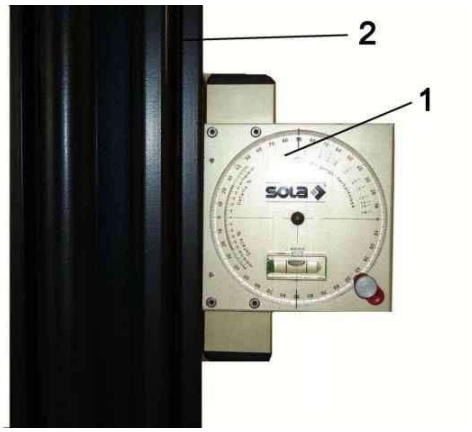
– Attach an angle measurement device, e.g. a spirit level (1) to the mast profile (2).

– Check whether the tilt slider of the directional control valve is in the neutral position.

– Turn the key switch to OFF.

– Measure the change in angle after one minute.

The lift mast must not tilt forwards automatically by more than 5° in 10 minutes.



Lowering safety test

Procedure

– Pick up the nominal load and lift to approx. 0.5 m.

– Park the truck on level ground and place the lift mast in the vertical position.

– Apply the parking brake.

– Check whether the lift transmitter of the directional control valve is in the neutral position.

– Turn the key switch to OFF.

– After approx. 2 minutes, apply markings to the fork carriage and outer mast.

– After waiting another 10 minutes, measure the distance lowered.

The lift mast must not automatically lower the load by more than **100 mm in 10 minutes**.

Safety checks of hose assembly

Proceed

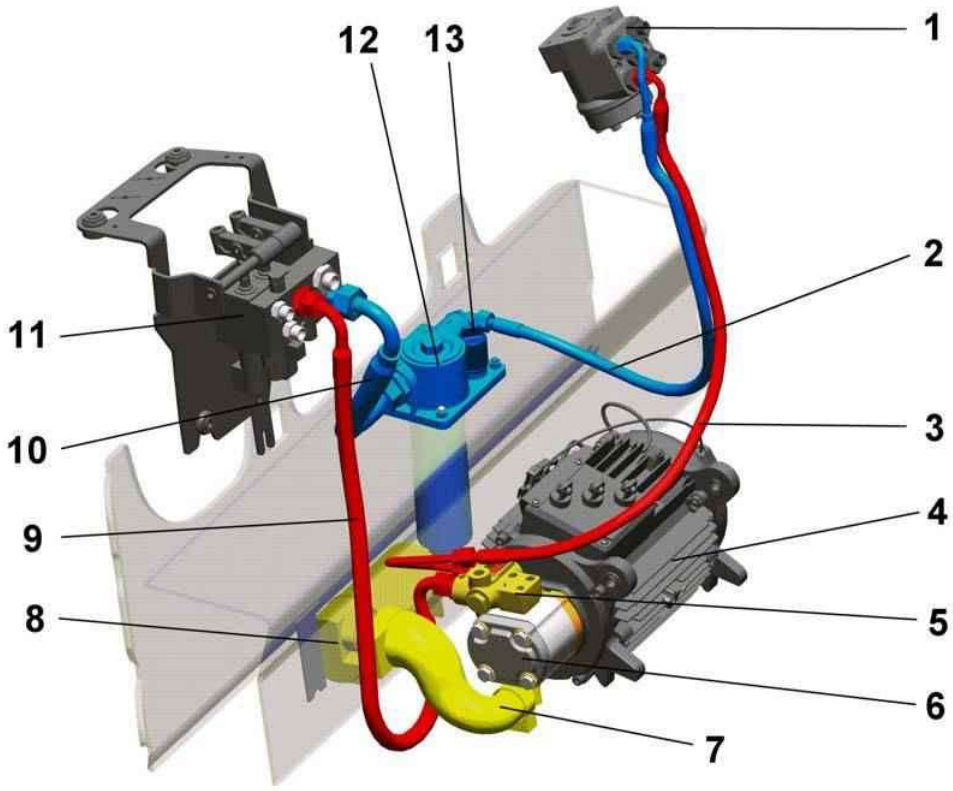
All hose lines must be checked at least once a year and must be replaced in the event of the following defects:

- The outer layer is breached all the way to the middle (wire mesh), e.g. abrasion spots and cracks.
- There is a connection error on the fitting with bubble formation.
- Leaks.
- There is damage or corrosion at the fitting and reduced rigidity of the connection between the fitting and the hose has been detected.
- The outer layer has been become stiff or brittle with cracks.
- There are deformation such as kinks, pinch points and torsion.

Basic hydraulics

Basic hydraulics

Structure



1	Steering unit	8	Suction filter
2	Steering return line	9	Working hydraulics pressure line
3	Steering pressure line	10	Working hydraulics return line
4	Pump motor	11	Directional control valve block
5	Priority valve	12	Return filter
6	Hydraulic pump	13	Breather, dipstick
7	Induction hose		

The hydraulic pump (6) is driven by the pump motor (4) via a tappet. Together they constitute the pump unit.

The hydraulic pump and the suction hose (7) are located **below** the oil level in the hydraulic tank. The welded hydraulic tank is built into the chassis.

The hydraulic pump draws the oil via a coarse, maintenance-free suction filter (8) and delivers it to the priority valve (5).

The priority valve is flange-mounted to the hydraulic pump and handles the oil distribution between the steering hydraulics and working hydraulics.

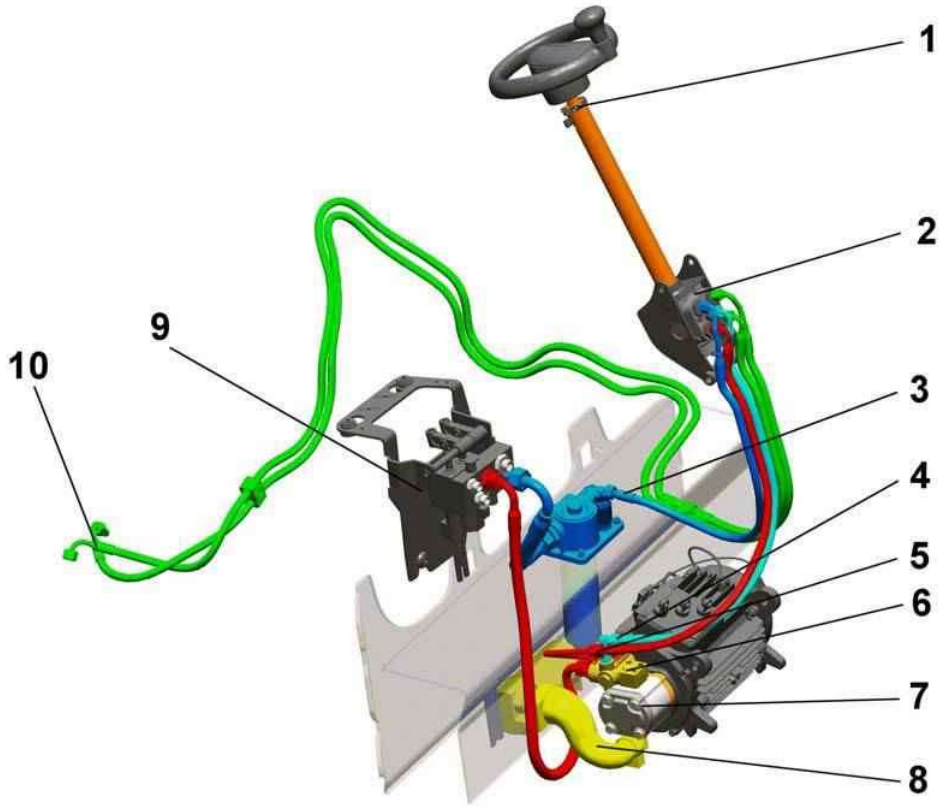
The returning oil from the steering hydraulics flows back to the tank unfiltered.

The returning or excess oil from the working hydraulics flows back to the tank via the return filter (12).

If the return filter is clogged, the by-pass valve opens and the oil returns to the tank unfiltered via the by-pass valve.

The breather (13) prevents soiling as the result of dirty air and is combined with the dipstick to form a single unit.

Steering hydraulics



1	Steering angle sensors	6	Priority valve
2	Steering unit	7	Hydraulic pump
3	Return line	8	Suction hose
4	LS signal line	9	Directional control valve block
5	Pressure line	10	Steering cylinder connection

Structure

The hydraulic pump (7) draws in the hydraulic oil from the hydraulic tank at the intake side and delivers it to the priority valve at the pressure side. The oil quantities required for steering and the working hydraulics are allocated in the priority valve. The steering always takes priority.

The volume of oil required for steering is delivered via the pressure line (5) to the steering unit (2).

The return line (3) directs the hydraulic oil back into the hydraulic tank unfiltered.

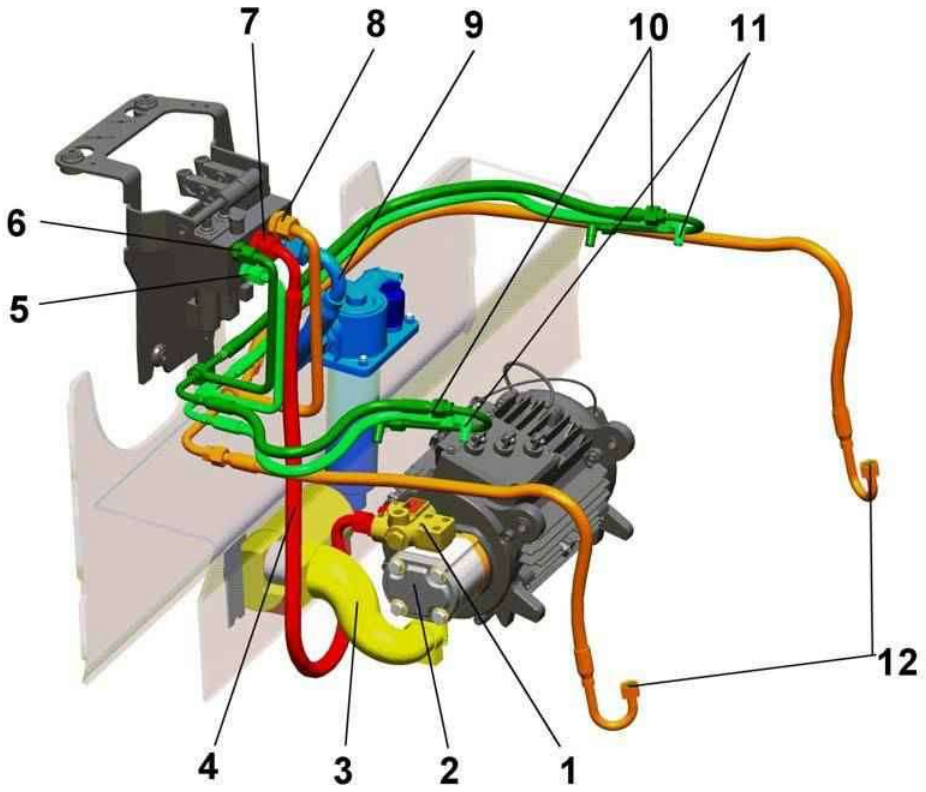
Function

As soon as the truck is driving at a speed of > 0.1 km/h, the pump motor starts running.

The oil volume required for steering is significantly lower than the oil volume required for the working hydraulics. For this reason, the speed is adjusted to a low value (steering speed) when the working hydraulics are not actuated. The steering speed is adjusted according to the steering movement and the speed at which the steering wheel is turned. See the chapter entitled "Steering system - Dynamic steering".

Working hydraulics

Structure



1	Priority valve	7	Connection P
2	Hydraulic pump	8	Connection H
3	Suction hose	9	Connection R (return line)
4	Pressure line	10	Forwards tilt cylinder
5	Connection B	11	Backwards tilt cylinder
6	Connection A	12	Lift cylinders

The hydraulic pump (2) supplies the oil to the priority valve (1) via the suction hose (3). The oil quantities required for steering and the working hydraulics are allocated in the priority valve. Steering always has the highest priority.

The oil volume for the working hydraulics is fed from the priority valve via the pressure line (4) to the directional control valve connection P.

When a slider is actuated, an oil volume corresponding to the displacement of the slider is supplied from connection H to the lift cylinders, from connection A or B to the tilt cylinders and, if necessary, to an attachment in the auxiliary hydraulics.

If a slider is only actuated slightly, the oil flows with a low circulation pressure through the directional control valve block from connection R to the tank via the return line (9).

The directional control valve block contains the following functional components:

- The pressure relief valve protects the hydraulic system against overloading.
- The lowering brake limits the lowering speed when lowering the load.
- Two load holding valves prevent the load from tilting on its own.
- The flow control valve limits the oil flow for tilting.

Hydraulic tank

Structure

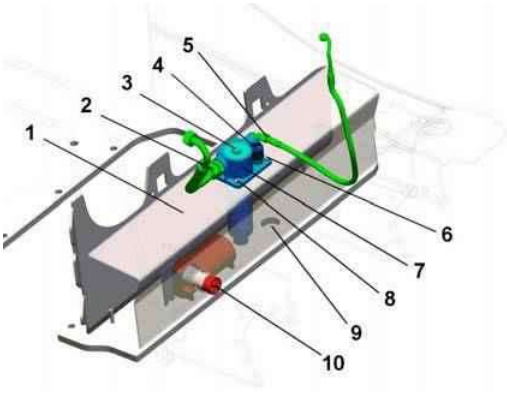
The hydraulic tank is a welded component built into the chassis at an angle in front of the battery compartment.

The filter housing is fixed to the tank by means of 4 nuts.

The return lines of the directional control valve and steering unit are screwed to the filter housing. Sealing is accomplished by means of sealing rings.

The suction connection is located below the oil level.

The breather is combined with the dipstick in the filter housing.



1	Hydraulic tank
2	Directional control valve block return line
3	Return filter cover
4	Breather filter with dipstick
5	Steering hydraulics return line
6	Fixing screws
7	Filter housing
8	Fixing screws
9	Oil drain plug
10	Suction connection

Hydraulic oil

Technical data

Fill quantity of hydraulic oil with carriage lowered and hydraulic system ready for operation:

- For the total filling quantity, see the chapter entitled "General Technical Data"
- For quality, see the chapter entitled "General Technical Data"

Maintenance interval

- 3000 operating hours or 2 years

Oil change

ENVIRONMENT NOTE

Hydraulic oil should be disposed of according to the environmental regulations.

– Position truck horizontally.

– Tilt lift mast backwards against stop.

– Lower fork carriage; if there are attachments, retract working cylinder.

– Disconnect battery plug.

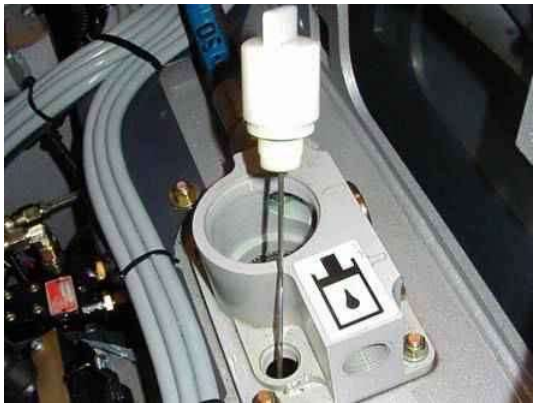
– Remove floorplate.

– Unscrew the dipstick and remove it

– Unscrew the hydraulic oil drain plug under the hydraulic oil tank; direct the hydraulic oil into a collection vessel.
– Screw in drain plug with a new seal (Cu A18x22) and tighten



– Fill with fresh hydraulic oil through the oil dipstick opening
– The oil level should be between the markings on the dipstick.
– Reinsert the dipstick and tighten it

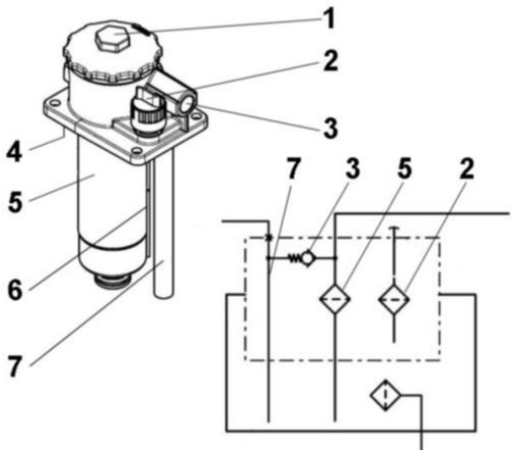


Return line filter

General

The hydraulic oil that returns from the directional control valve block is filtered in the return line filter. The hydraulic oil that returns from the steering flows back into the tank unfiltered.

If the return line filter is clogged, the hydraulic oil is rerouted via a bypass and subsequently flows back into the tank unfiltered.



1 Return line filter cover
2 Breather filter
3 Bypass valve
4 Seal
5 Return line filter
6 Dipstick
7 Steering return pipe

Technical data

Return line filter	
Degree of filtration	20 µm absolute
Filter material	Plastic mesh
Housing material	Polyamide PA66
Triggering pressure - bypass valve	3.4 $^{+0.5\ bar}_{-0.2\ bar}$
Tightening torque	11 Nm, 4 x M8 polystop nut with flat washer
Maintenance interval	3000 h or 2 years

ENVIRONMENT NOTE

The filter element must be disposed of in accordance with environmental regulations.

Changing the filter element

- Unscrew the filter cover
- Unhook the filter cover from the filter element and replace
- Hook the filter cover onto filter element
- Screw in the filter cover

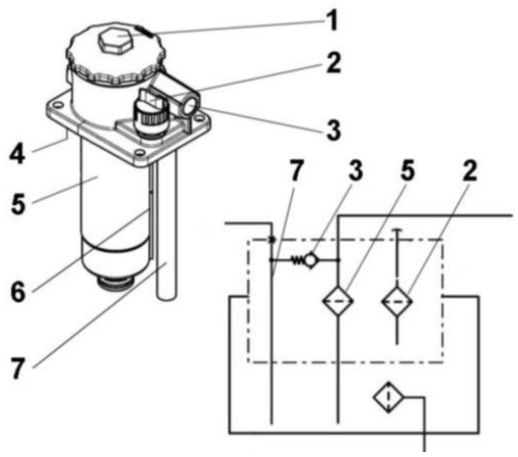
Changing the return line filter

- Disconnect the return lines
- Undo the 4 fastening nuts on the tensioned cover
- Completely remove the filter housing from the tank
- Place the seal in the tensioned cover for the filter housing
- Insert the filter housing into the tank
- Screw in four fastening nuts M8 with washers tightly
- Connect the return lines

Breather filter

General

The breather filter and the oil dipstick form a unit and are integrated in the return line filter housing. The filter prevents dust and dirt from entering the hydraulic tank.



1	Return line filter cover
2	Breather filter
3	Bypass valve
4	Seal
5	Return line filter
6	Dipstick
7	Steering return pipe

Technical data

Breather filter	
Degree of filtration	8 µ absolute
Filter material	Plastic mesh
Maintenance interval	3000 h or 2 years

ENVIRONMENT NOTE

The filter element must be disposed of in accordance with environmental regulations.

Changing the filter element

- Unscrew the breather filter
- Remove the filter cover
- Remove and replace the filter element
- Replace the filter cover
- Screw the breather filter back on.

Suction filter

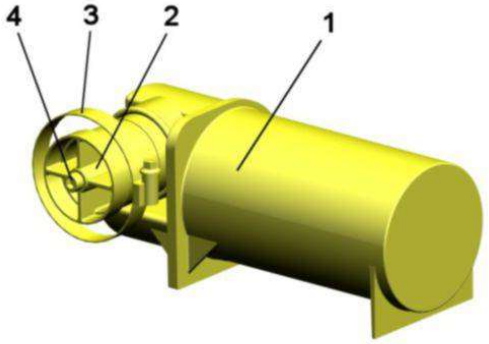
General

The hydraulic oil is drawn from the tank by the hydraulic pump via the intake hose and flows through the intake filter from the outside to the inside.

The filter insert is a coarse filter and maintenance-free.

Technical data

Degree of filtration	225 µm
Filter material	Stainless steel mesh
Housing material	Polyamide PA 66
Mounting screw	M6 x 1, 8^{+2} Nm



1 Filter cartridge
2 Thrust piece
3 Hose clip
4 Fixing screws

Removal

ENVIRONMENT NOTE

Hydraulic oil should be disposed of according to the environmental regulations.

– Drain the hydraulic oil.
– Release the hose clip (3) on the intake hose and remove the intake hose from between the tank and hydraulic pump.
– Release the mounting screw (4) on the filter cartridge tensioning piece.
– Pull out the tensioning piece (2).

NOTE

It may be necessary to strike the filter cartridge using a mandril to release it from the intake nozzle. Use material that does not splinter for this purpose!

– Remove the filter cartridge through the opening in the return line filter.

Installation

– Prior to installation, check that the sealing ring is properly seated on the filter connection and has not fallen into the tank.
– Tighten the mounting screw on the filter cartridge tensioning piece.
– Install the intake hose between the tank and hydraulic pump and secure it with the hose clip.

– Fill with hydraulic oil.

High-pressure filter

General

For servo hydraulics, it is a legal requirement (in accordance with VDMA (German Engineering Federation)) that in addition to the return line filter, an additional filter is installed in the pressure line upstream of the directional control valve.

The high-pressure filter is located in the pressure line between the connections (EF) of the priority valve and (P) of the directional control valve.

Technical data

Degree of filtration: 12 µm nominal

Filter material: non-woven plastic mesh

Maintenance interval: 3000 operating hours or 2 years

Changing the filter element

ENVIRONMENT NOTE

The filter element and any oil that escapes must be disposed of in an environmentally friendly manner.

– Place a collection vessel underneath. The oil volume that drains out is about 0.2l (capacity of the filter housing).
– Loosen the filter housing (2) at the hexagonal (3) with a SW30 box-end wrench and unscrew it.
– Pull the filter element downwards.
– Push the new filter element in until it stops.
– Clean the filter housing and screw on hand tight.



1 High-pressure filter
2 Filter housing
3 Hexagonal

Conical nipple fittings (CNF)

General

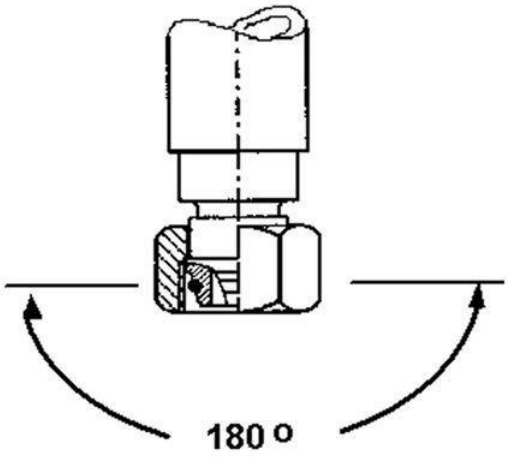
The conical nipple fitting is equipped with an integrated O-ring.

Tighten the fitting union nut until you feel a resistance and then turn it a maximum of a half revolution (180 degrees).

⚠ CAUTION

Tightening it even more can lead to deformation and leaking.

Tighten the union nut until it is firmly seated and then turn it a maximum of a half revolution.



Bolted joint

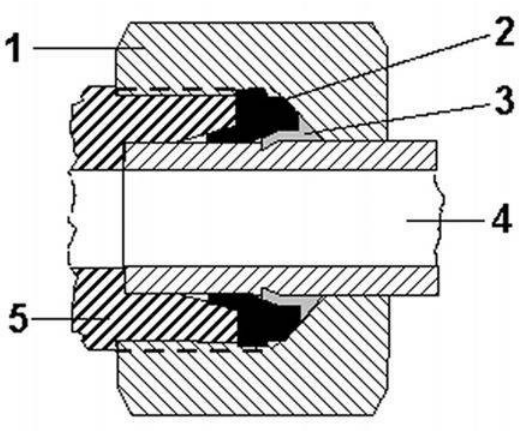
General

The screw joints consist of:

- Functional nut (union nut)
- Sealing ring (soft seal)
- Retaining ring (olive)
- Pipe
- Pipe adaptor

Assembly

– Saw pipe at right angles



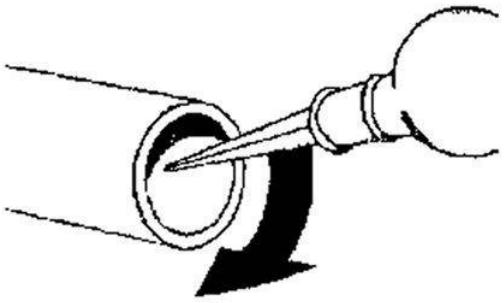
1 Functional nut
2 sealing ring
3 Retaining ring
4 pipe
5 fitting

– Deburr pipe on inside and outside

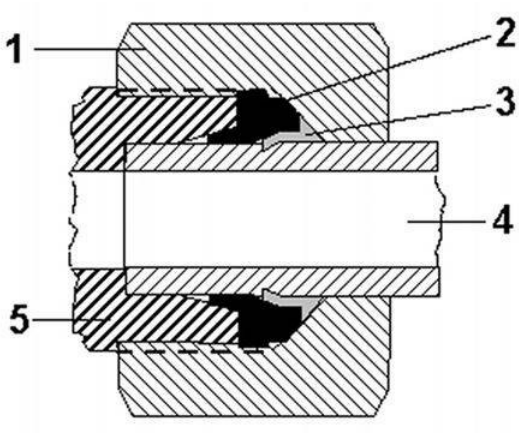
⚠ CAUTION

Sharp edges can damage the sealing ring.

Deburr pipe on inside and outside and clean.



– Screw the functional nut (1) with retaining ring (3) and seal (2)onto the pipe union (5) by hand ▷

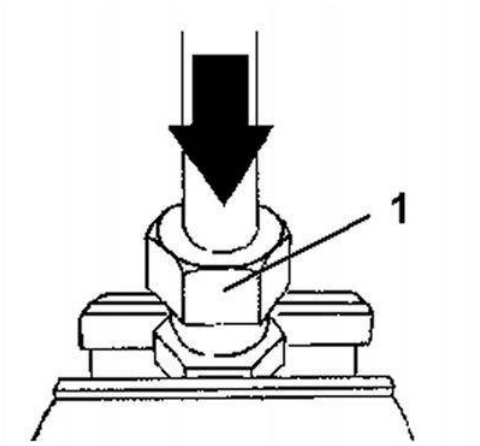


– Push the pipe end into the screw joint and press against the stop in the inner cone ▷

⚠ CAUTION

An insufficient insertion depth can lead to an insecure connection and leaks.

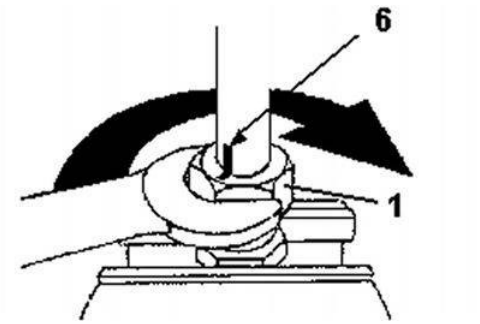
Insert pipe up to the screw stop.



– Tighten the functional nut (1) until you clearly feel an increase in connection strength, **approx. 1 to 1 ½ turns** ▷

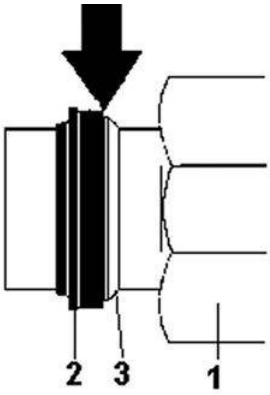
NOTE

A marking (6) on the pipe and functional nut makes counting the turns easier.



Test

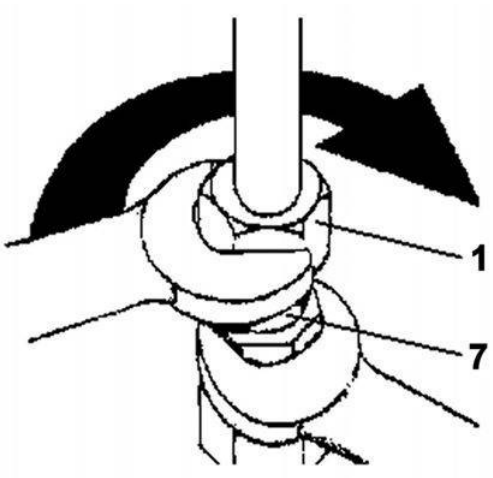
– After assembly, remove the functional nut (1) ▷
– Check whether there is a gap between the sealing ring (2) and retaining ring (3)



Repeat installation

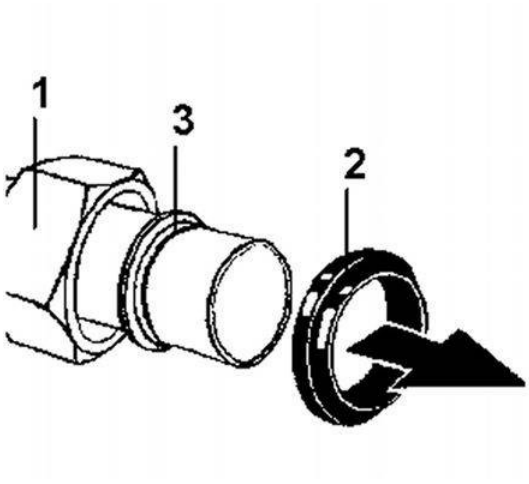
– Every time you loosen the functional nut (1), please proceed as in the initial assembly

– Tighten the functional nut (1) until you clearly feel an increase in connection strength, **approx. 1 to 1 ½ turns** ▷
– Hold the socket (7) together when doing so



Sealing ring replacement

– In the event of leaks at the screw joint, the sealing ring (2) can be removed from the free pipe end and replaced ▷

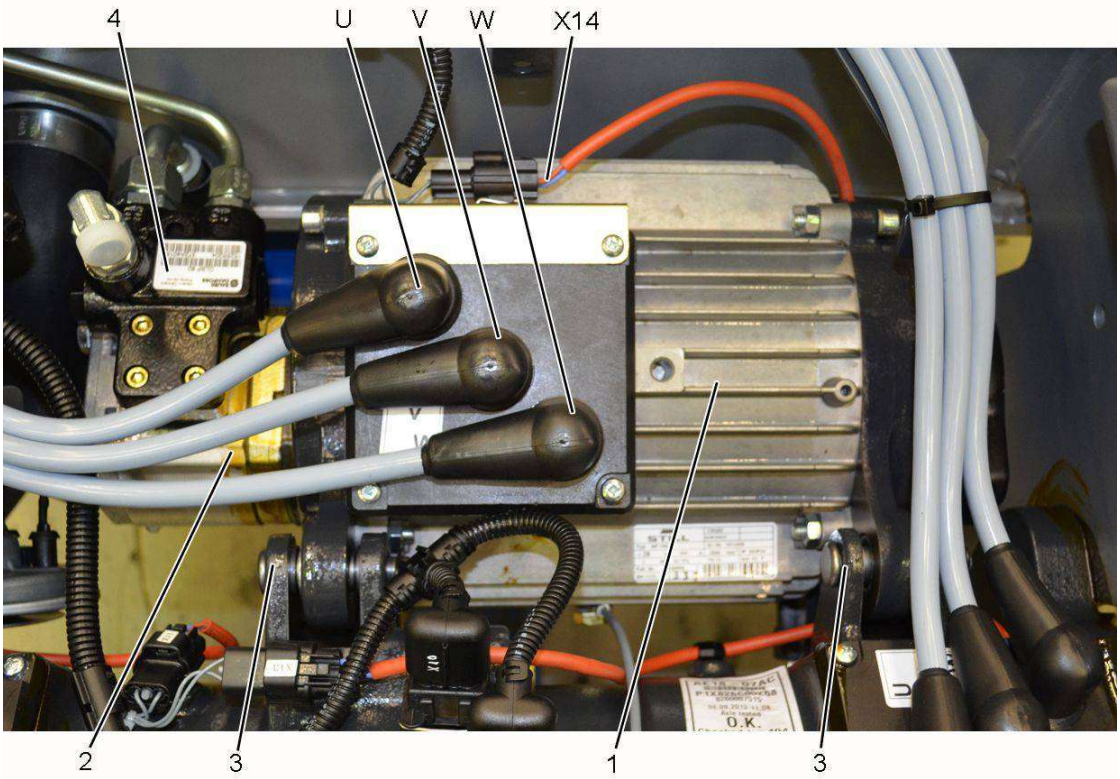


Pump unit

General technical data

Pump motor	6210 - 6216	6311, 6313, 6315
Manufacturer		
Type	AP 104 - L1	AP 108 - K2
Operating voltage	48 V	80 V
Engine type	4-pin AC motor with cage rotor	
Connection	Delta	Star
Rated voltage (nominal)	28 V	45 V
Rated current (nominal)	243 A	180 A
Rated speed (nominal)	2884 rpm	2680 rpm
Rated output (nominal)	9 kW	11 kW
Maximum speed	3500 rpm	3200 rpm
Mode of operation (nominal)	S3 - 15%	
Protection type	IP 54	
Insulation class	F	
Weight	Approx. 36 kg	
Cooling	Surface/convection	
Temperature sensor	KTY84-130	
Rev sensor	IFM sensor with trigger wheel	
	Transmitter-free control	

Pump unit



1	Pump motor
2	Hydraulic pump
3	Motor suspension
4	Priority valve

Electrical connections

X14	Temperature sensor
U	Motor power cable
V	Motor power cable
W	Motor power cable

General

The pump unit is connected to the drive axle at the top by two bolts and by two rubber-mounted motor supports at the bottom.

The hydraulic gear pump with the flange-mounted priority valve is located on the right-hand bearing shield for the pump motor. The pump is driven via a tappet.

Motor connections U, V and W are fed upwards and out of the motor as screw connections.

The temperature sensor is embedded into the stator winding. The plug for the sensor is routed out of the motor.

Pump motor

The pump motor is a three-phase AC asynchronous motor, which is equipped with short-circuit cage rotors.

Aluminium conductors are cast into the slots in the rotor laminations pack, and their ends are connected with short-circuit rings. The conductors with the short-circuit rings form the cage rotors and hold the rotor laminations pack together.

The stator consists of the 4-pole laminated stator core and the stator windings, which are pressed into the motor housing as a unit.

The applied voltage is induced in the rotor bars by the stator winding and causes a current to flow in the rotor. The resultant rotor current and the rotating field acting on the stator generate the torque.

Method of operation

The motor is controlled by a converter. The speed is changed by changing the frequency and voltage of the applied AC voltage.

In the motor, each of the three phases is distributed to four poles in the stator, thereby generating the rotating field required. The motor is operated in a three-phase delta connection and is supplied with pulsing voltage by the converter.

The motors are controlled using pulse width modulation at a clock frequency of approx. 16 kHz.

Electrical connections

Circuit diagram

The pump motor windings are wired in a triangular arrangement inside the motor.

Location of the electrical connections

Location and type of electrical connections:

- The three main power connections U, V and W are insulated and watertight screw connections and are led out of the motor through a removable terminal board.
- Rev sensor X14

  4-pin Junior Power Timer plug

  Plug not fitted when transmitter-free revolution control is used
- Temperature sensor X15

  4-pin mark II plug
- GND earth wire for the pump motor

Pump motor without rev sensor

48 Volt - 6210 - 6217

The pump motor is installed in the truck without a rev sensor and sensor disk. A rev sensor cannot be retrofitted in this pump motor.

The revolution control for the pump motor is calculated via a model calculation in the converter.

6210 - 6217

- Pump motor number 0009760940
- From Flash package V085
- Converter SAC V2017

80 Volt - 6311, 6313, 6315

The pump motor is installed with a rev sensor. However, the rev sensor is no longer evaluated by the software.

The revolution control for the pump motor is calculated via a model calculation in the converter.

6311, 6313, 6315

- From Flash package V085
- Converter LAC V076

Parameterising

Address	Value	Comment
A 00 0F6		Configuration of the hydraulic drive

	01	Transmitter-free control active
	00	Rev sensor available

Pump motor speed sensor

General



The speed of the pump motor 2M1 is registered by a speed sensor. It is situated on the left bearing shield under a covering, and is fixed in place using two screws. It consists of an inductive proximity switch.

This switch responds in the proximity of iron — in this case the 12 cams of the trigger wheel.

As the trigger wheel turns, the speed sensor delivers a voltage pulse at every cam.

The one-way speed sensor is supplied by the inverter with 10 V. The speed signal is connected directly to the inverter.

The evaluation takes place in the inverter whilst monitoring occurs in the Main Control Unit (MCU).

Electrical connections

NOTE

The location of electrical connections varies depending on the truck.

4-pin JPT plug X14			
X14/1	Red	X150/7	+10 V
X14/2	Blue	X150/5	Signal
X14/3	Black	X150/8	GND-L
X14/4			

Setting

- Release the two fixing screws
- The distance between the speed sensor and the trigger wheel is **2.8 ±0.2 mm**
- Tighten the two fixing screws

Testing

When the speed sensor is fitted, there is a simple way to check that it is functioning correctly:

⚠ CAUTION

Risk of injury from turning trigger wheel!

The motor must be de-energised; detach the motor connections!

– Detach the motor connections U, V, W at the pump motor
– Connect the multimeter between X14/3 (–) and X14/2 (+)
– Turn the pump motor trigger wheel manually
– The multimeter shows a clear voltage jump of approx. 8 V

Pump motor temperature sensor

General

The pump motor is monitored by a temperature sensor.

The watertight temperature sensor is embedded in the stator winding and is led out of the motor.

The evaluation of the signals is carried out in the inverter.

Technical data

Type: KTY84-130.

Power supply: approx. 1.7 mA

Electrical connections

NOTE

The location of electrical connections varies depending on the truck.

2-pin Mark II plug X14			
X15/1	Red	X150/3	Temp-MCT +
X15/2	Blue	X150/4	Temp-MCT -

⚠ CAUTION

An improperly conducted insulation test can destroy the temperature sensor.

Before conducting the insulation test, jumper the temperature sensor connections.

Testing

– Insert the test adapter into plug connector X15
– Compare the resistance value to the table

Reference values for temperature measurement

Temperature (°C)	Resistance (Ω)
-40	355
-30	386
-20	419
-10	455
0	493
10	533
20	576
25	598
30	621
40	668
50	718
60	769
70	824
80	880
90	939
100	1000
110	1063
120	1129
130	1197
140	1268
150	1340
160	1415
170	1493
180	1572
190	1654
200	1739
210	1825
220	1914

Changing the temperature sensor

A defective sensor can be exchanged with the aid of a repair kit containing a temperature sensor and two-component balancing mastic.

- Knead both components (yellow and blue) of the mastic together until the mass has a uniform green colour
- Continue kneading the green mass for at least 2 minutes until it is noticeably warm
- Unscrew the terminal board with the main power connections
- Press the sensor against the side of the winding using the balancing mastic

NOTE

Make sure that no mastic gets between the sensor and winding, as otherwise the temperature measurement will be incorrect.

– The balancing mastic is fully cured after approx. 2.5 hours

Pump motor removal

Removal

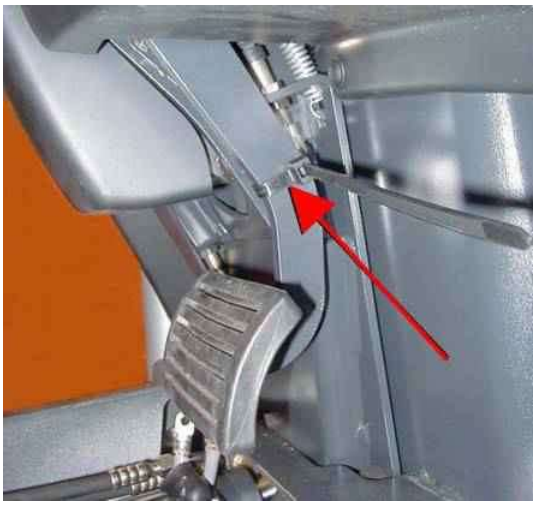
NOTE

Drain hydraulic oil at an early stage so that the oil has time to drain off.

ENVIRONMENT NOTE

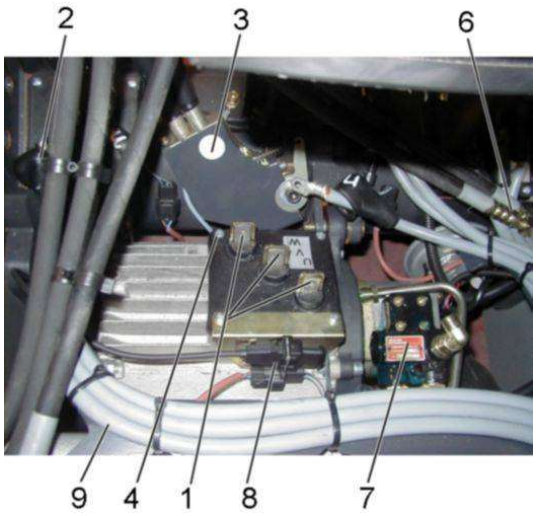
Follow environmental regulations when discarding hydraulic oil.

– Disconnect battery plug
– Jacking up the truck
– Activate parking brake
– Remove base plate with accelerator pedal
– Fully depress brake pedal and secure with cable ties ▷



– Screw on cover to the right on the valve block

- Unscrew power cables (1) on the pump motor and label them in advance, if necessary
- Unscrew power cables (2) on the motor and label them in advance, if necessary
- Remove cover of brake operation (3)
- Remove ground line (4) between pump motor and drive axle on pump motor
- Unscrew the cable guide plate (9) to provide more room for movement in the cabling
- Loosen the holder of the hydraulic lines to the steering cylinder to provide more room for movement in the hydraulic line
- Screw off return lines (6) of steering unit
- Remove hydraulic pump (7) (see Chapter "Hydraulic Pump").
- Disconnect connectors X14 and X15 (8)



- Use sling band and chain block to hook pump motor on overhead guard

NOTE

The chain must be pulled from the chain block by the steering wheel (see photo).



NOTE

In trucks with a cab, first remove the roof disk.

- To keep the pump motor balanced, pay attention to the position of the sling band and the joint



NOTE

The joint of the sling band must lie to the rear and left on the terminal board of the power cable.

– Pull safety split pins from the fixing bolts ▷



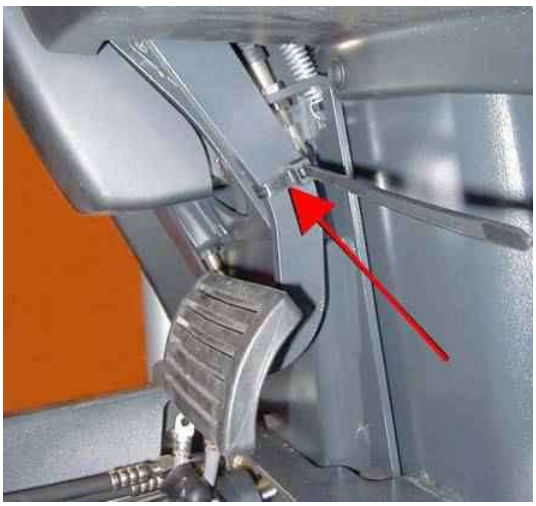
– Remove bolts. If necessary, push out using a long lock rod (Ø8 x 700). To do this remove the left wheel and use the mounting hole ▷
– Lift out the pump motor using the chain block
– Remove the entire pump motor towards the left out of the truck



Pump motor installation

Installation

– Disconnect battery plug
– Jacking up the truck
– Activate parking brake
– Remove base plate with accelerator pedal
– Fully depress brake pedal and secure with cable ties ▷
– Screw on cover to the right on the valve block



– Use sling band and chain block to hook pump motor on overhead guard ▷



NOTE

The chain must be pulled from the chain block by the steering wheel (see photo).

NOTE

In trucks with a cab, first remove the roof disk.

– To keep the pump motor balanced, pay attention to the position of the sling band and the joint ▷



NOTE

The joint of the sling band must lie to the rear and left on the terminal board of the power cable

– Drain pump motor and lower on the rubber-cushioned motor holder. ▷



NOTE

If necessary, swing the pump motor forward using a mounting lever, positioning the lever between tank and pump motor.

– As a mounting aid against twisting, insert a drift punch through the top left motor mount

Pump unit

– Insert bolt into the top right motor mount

– Remove drift punch and insert bolt into the top left motor mount

– Insert safety split pins into bolt

The bolts cannot be inserted by hand in older, dirty trucks. A long rod (Ø8 x 700) may be used to help punch in the bolts. In this case, proceed as follows:



– Remove the right wheel and use mounting hole

– Insert rod through mounting hole and through the top right motor mount

– Remove drift punch at left

– Align motor mount

– Place bolt and strike with rod

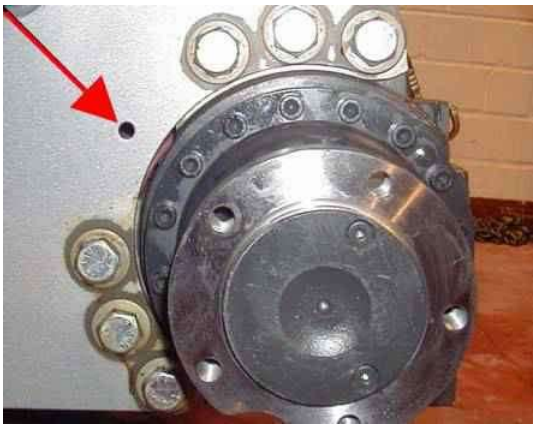
– Withdraw rod

– Align right motor mount

– Place bolt and strike with rod

– Insert safety split pins into bolt

– Mount right wheel



Then continue in the same way in both cases:

– Install hydraulic pump (see Chapter "Hydraulic Pump").

– Screw power cable (1) on the pump motor

– Screw power cable (2) on the motor to the left

– Mount cover of brake operation (3)

– Connect ground line (4) between pump motor and drive axle to pump motor

– Screw on cable guide plate (9)

– Screw on holder for hydraulic lines to the steering cylinder

– Screw on return lines (6) of steering unit

– Install hydraulic pump (7) (see Chapter "Hydraulic Pump")

– Connect connectors X14 and X15 (8)

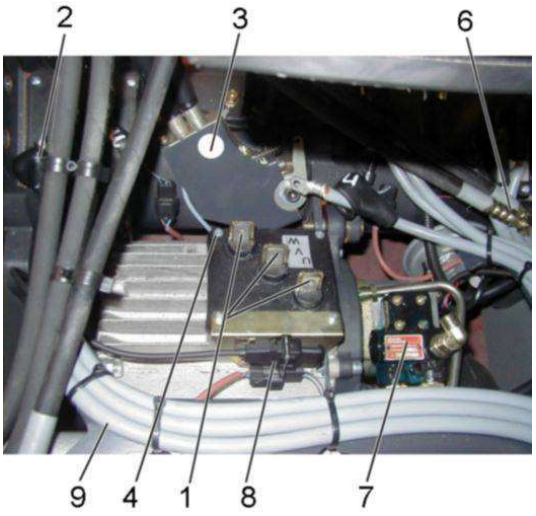
– Insert base plate with accelerator pedal

– Screw on cover to the right on the valve block

– Remove cable ties on brake pedal

– Connect battery plug

– Carry out functional test



– Use jack to lower truck

Hydraulic pump

Structure

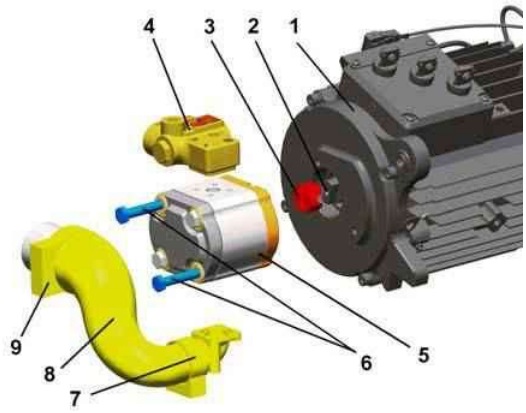
The hydraulic gear pump (5) is screwed to the right-hand bearing shield for the pump motor (1) by means of two diagonally positioned mounting screws (6). The two other screws hold the hydraulic pump together.

The hydraulic pump is driven by the armature shaft pinion (2) and the tappet (3). The priority valve (4) is flange-mounted directly onto the hydraulic pump.

The hydraulic pump draws the hydraulic oil from the hydraulic tank via the intake hose (8) and supplies the pressurised oil to the priority valve.

The directional control valve, and therefore the lifting, tilting and auxiliary hydraulics are supplied with oil via connection (EF) at the priority valve.

The steering unit is controlled and supplied with oil via connections (LS) and (CF) at the priority valve.



1 Pump motor
2 Armature shaft pinion
3 Tappet
4 Priority valve
5 Hydraulic pump
6 Fixing screws
7 Pump clip
8 Induction hose
9 Tank clip

Function

The hydraulic pump is connected to the pump motor via a tappet. The pump motor starts up once a hydraulic function is activated. The pump motor speed corresponds to the hydraulic function activated. The speeds of the hydraulic functions are set using parameters.

If multiple hydraulic functions are activated at the same time, the pump motor always runs at the highest speed required.

The hydraulic pump delivery volume is dependent on the speed of the pump motor. Oil is distributed to the steering hydraulics and working hydraulics by the priority valve.

Hydraulic pump — error detection

Error	Cause	Remedy
Noise in the hydraulic pump	The hydraulic system is leaking and is taking in air	- Check the radial seal ring in the pump motor - Check the O-ring between the intake hose and hydraulic pump - Mechanical damage in the hydraulic pump
Hydraulic oil is frothy		
Hydraulic functions are slow to respond		

Hydraulic pump
Removal and installation

Removal

NOTE

- *Place a collection vessel under the hydraulic pump.*
- *Dispose of used hydraulic oil in accordance with environmental regulations and do not re-use under any circumstances.*

The hydraulic pump is located below the oil level in the tank. The hydraulic pump intake pipe is situated beneath the hydraulic tank. Draining all of the hydraulic oil is to be avoided if possible. For this reason, it is important to follow the instructions for removal.

– Park the truck safely

– Tilt the lift mast forwards

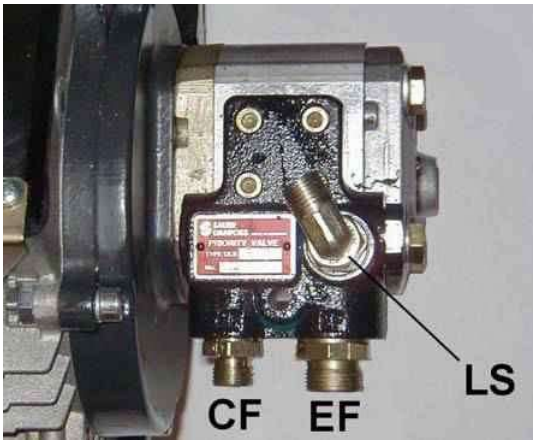
– In order to reduce the volume of oil in the tank, extend the lift mast as far as the ceiling allows and secure it

– Disconnect battery plug.

– Remove the floorplate with the accelerator pedal and disconnect the plug

– Detach the hydraulic connections on the priority valve

– Unscrew the priority valve from the hydraulic pump



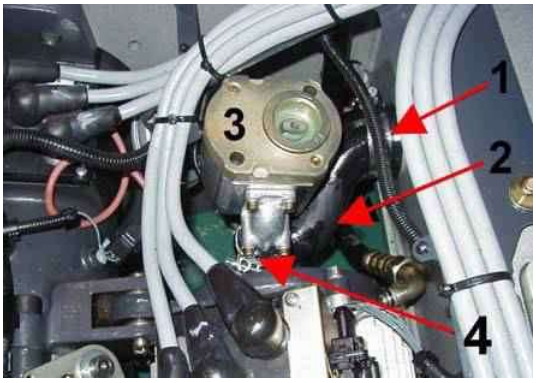
– Unscrew the two fixing screws of the hydraulic pump ▷



NOTE

Carry out any further work with the utmost caution, because any mistakes can easily cause all the oil to escape.

– Gently release the clip (1) of the suction hose on the pipe union of the hydraulic tank ▷
– Rotate the suction hose (2) anti-clockwise on the pipe union, until the hydraulic pump (3) is pointing vertically upwards



NOTE

During this procedure, the upper end of the suction hose is positioned just above the oil level in the tank.

– Attach the clip (1) on the pipe union of the hydraulic tank
– Release the suction hose clip (4) on the hydraulic pump intake pipe and remove the hydraulic pump ▷
– For any further work, the open suction hose must be protected against soiling
– Unscrew the intake pipe from the hydraulic pump



Installation

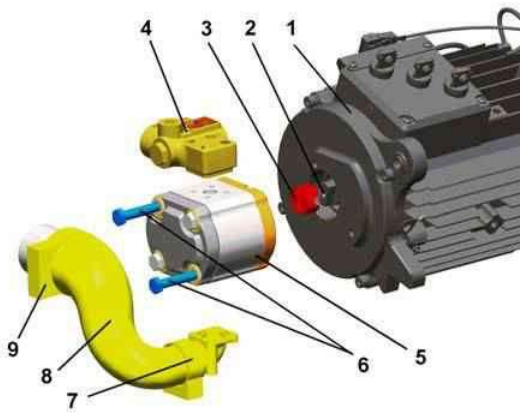
NOTE

- *Sealing rings must always be changed and greased before assembly.*
- *Check the quality of screws and hydraulic oil, as well as the correct tightening torques.*
- *For values, see "General technical data" in the chapter entitled "Hydraulics (general)".*

ENVIRONMENT NOTE

Dispose of used hydraulic oil in accordance with environmental regulations and do not re-use under any circumstances.

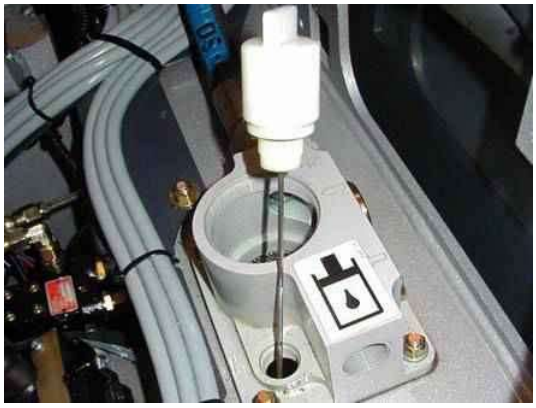
– Screw the intake pipe with O-ring onto the hydraulic pump
– Connect the suction hose with the hydraulic pump intake pipe
– Attach the clip on the hydraulic pump intake pipe
– Gently release the clip on the pipe union of the hydraulic tank
– Rotate the suction hose in a clockwise direction on the pipe union until the hydraulic pump is in the correct position in relation to the pump motor
– Attach the clip on the pipe union of the hydraulic tank
– Position the O-ring and tappet between the hydraulic pump and the pump motor
– Screw on the two fixing screws of the hydraulic pump
– Screw the priority valve with O-ring onto the hydraulic pump
– Attach the hydraulic connections to the priority valve



1 Pump motor
2 Armature shaft pinion
3 Tappet
4 Priority valve
5 Hydraulic pump
6 Fixing screws
7 Pump clip
8 Induction hose
9 Tank clip

- Top up the hydraulic oil to the mark on the dipstick
- Clean up any spilt hydraulic oil
- Connect the battery plug
- Switch on the switch lock
- Operate the steering and check the hydraulic connections for leaks
- Bleed the hydraulic system by operating the steering
- Install the floorplate with the accelerator pedal and connect the plug
- Operational test

▷



Tilt cylinder

Mast tilt

Truck	Load-bearing capacity [kg]	Tilt cylinder		Tilt		Overall height [mm]	
		L [mm]	Lift [mm]	Forwards [°]	Backwards [°]	From	Up to
Telescopic mast							
6209 - 6217 6311, 6313, 6315	1500 1600 1800 2000	332	78	7	4	1860	3260
		302	78	3	8	1860	3260
		314	66	7	6	1860	1960
						Windscreen	
						Windscreen and hose line	
NiHo lift mast							
6209 - 6217 6311, 6313, 6315	1500 1600 1800 2000	314	66	3	6	1860	2710
		332	78	7	4	1860	2710
		328	50	3	4	Windscreen with windscreen wiper and hose line	
Triple mast							
6209 - 6213 6215 - 6217 6315	1500 1600 1800 2000	314	66	3	6	1860	3260
		332	78	7	4	1860	3260
6214 6311, 6313	1600 1800	328	50	3	4	1860	2360
						Windscreen with windscreen wiper and hose line	
		314	66	3	6	1860	3260
		332	78	7	4	1860	3260

Tilt cylinder
Removal and installation

Removal

⚠ CAUTION

There is a risk of injury or damage to property!
Observe the safety instructions in chapter 001.

- Park the truck safely
- Tilt the lift mast forward
- Apply the parking brake
- Disconnect the battery male connector

⚠ CAUTION

The lift mast can tilt over forwards and backwards.

The lift mast must be secured in both directions.

– Disconnect the tilt cylinder from the outer mast. To do this, remove the locking ring and knock out the pins.
– Release the hydraulic connections at the tilt cylinder
– Disconnect the tilt cylinder from the chassis. To do this, remove the locking ring and rubber washers and knock out the pins.



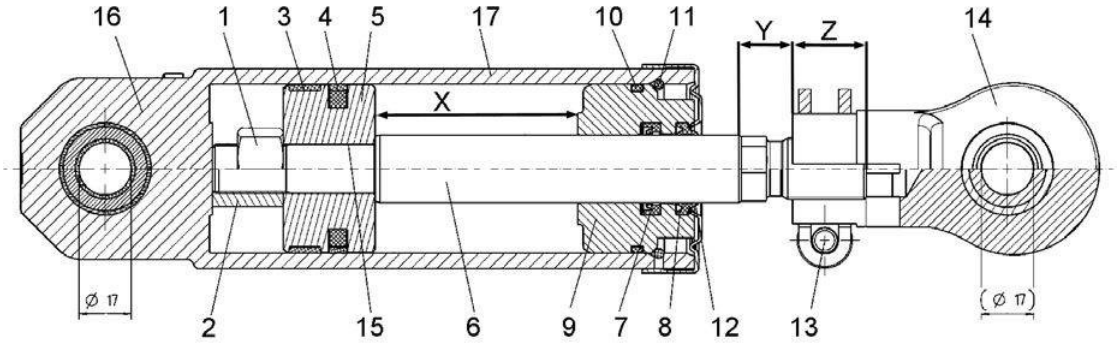
Installation

NOTE

Grease tilt cylinder bolts before installation!

– Connect tilt cylinder to chassis. To do this, knock in the pins and rubber washers and secure with a locking ring.
– Connect the tilt cylinder to outer mast. To do this, knock in the pins and secure with a locking ring.
– Screw on the hydraulic connections at the tilt cylinder.
– Check tilt cylinder for leaks.

Changing the set of seals (1500 - 2000 kg)



Setting dimensions

X Lift, dependent on spacer bush
Y Eye bolt setting dimension
Z Screw-in depths of the threads

Tilt cylinders

1 Hexagon nut
2 Variant: Spacer bush (changes the backwards tilt)
3 Piston guide ring
4 Piston seal
5 Piston
6 Piston rod
7 Locking ring
8 Grooved ring
9 Cylinder head
10 O-ring
11 Snap ring
12 Wiper
13 Clip
14 Eye bolt
15 Loctite 270
16 Cylinder bottom
17 Cylinder pipe

Eye bolt setting dimension

Type carrier	Load capacity class [kg]	Hexagon nut(1) secured with Loctite	Setting dimension (Y)	Minimum screw-in depth (Z)
6209 - 6217	1500 - 2000	130 +10 Nm	Max. 19 mm	22 mm (M20 x 1.5)
6311, 6313, 6315	1600 - 2000	130 +10 Nm		
7311 - 7316	1600 - 2000	130 +10 Nm	Max. 19 mm	
4041 - 4043	1600 - 2000	130 +10 Nm	Max. 19 mm -6 mm	22 mm +2/-6
4044 - 4046	1600 - 2000	130 +10 Nm	Max. 19 mm -6 mm	

Disassembly

⚠ CAUTION

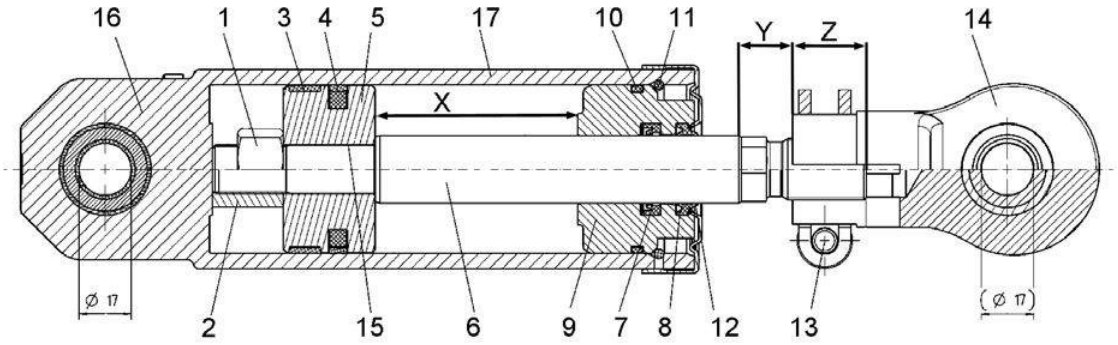
Component damage possible!

To protect the cylinder and the piston rod in the vice, protective soft jaws must be used!

– Clamp the tilt cylinder (16) in the vice at the cylinder bottom.
– Remove the threaded elbow pipes from the cylinder head (9) (thread projects into the cylinder).
– Using a plastic mandril, drive in the cylinder head a little

– Use a mandril to drive in the snap ring (11) through the bore in the cylinder pipe (17) and use a screwdriver to lever out the snap ring.
– Pull the piston rod (6) and cylinder head (9) out of the cylinder pipe (17).
– Clamp the piston rod in the vice
– Remove the eye bolt (14).
– Pull the cylinder head (9) off the piston rod (6).
– Remove the set of seals from the piston and cylinder head.

Assembly



– Check all parts for wear.
– Lightly grease the piston seal and piston guide ring and install.
– Fit the cylinder head (9) onto the piston rod (6) and seal with Loctite 270 (15).
– Screw the eye bolt (14) on to the thread of the piston rod (6); observe the setting dimension (Y) and minimum screw-in depth (Z).
– Prevent the eye bolt from turning by using the clip (13).
– Insert the piston rod (6) with the cylinder head (9) into the cylinder pipe (17).

NOTE

After assembly of the piston guide ring, piston seal and set of seals, insert the cylinder head into the cylinder pipe, taking care that the recess on the cylinder head faces the pipe adaptor bore.

– Fit the snap ring (11).

NOTE

- *When assembling a threaded elbow pipe, always use a new one.*
- *Note the location of the threaded elbow pipes.*

– During assembly, bear in mind that the location of the threaded elbow pipes depends on the design of the tilt cylinders.
– Insert the threaded elbow pipe and screw it in by hand up to the TUFLOK coating.
– Then use a tool to screw it in at least 4 turns and no more than 5.

⚠ CAUTION

Leakages caused by incorrectly fitted threaded elbow pipes.

If a threaded elbow pipe has been screwed in too far, it must not be unscrewed again. A new threaded elbow pipe must always be used.

Auxiliary hydraulics

Attachments

Load capacity up to 2000 kg

Attachment	Make	Type	Pump motor speed	
			1st attachment	2nd attachment
Shuttle fork arm	Griptech	RG4	1500	
Rotator	Meyer	5-1502N	1500	
Rotator	Meyer	5-1504N	1500	
Rotator, for attachment to sideshift	Meyer	5-1502N		1500
Rotator, for attachment to sideshift	Meyer	5-1504N		1500
Sideshift Fixed connection	Kaup	1T151P4	550	
Sideshift Fixed connection	Kaup	1T151P2	700	
Sideshift Fixed connection	Cascade	55F	700	
Sideshift Fixed connection	Bolzoni	HN4	700	
Fork prong positioner Fixed connection	Kaup	2T466	700	1900
Fork prong positioner Fixed connection	Kaup	2T163	700	800
Fork prong positioner Fixed connection	Meyer	6–2504F	700	1900
Multi pallet handler	Meyer	6–5204F	700	1900
Multi pallet handler	Kaup	2T429	700	1900
Clamp fork	Kaup	2T411	700	1900

Operating speeds

Attachment		
Rotator Rotary clamp	Rotational speed [rpm]	2–4
Sideshift with end position damping Push/pull attachments	Shift speed [m/s]	0.05–0.15
Clamps Fork prong positioners	Clamp speed [m/s]	No limitation
Shovels Tippers	Tipping speed [°/s]	10–60

Second operating function for attachments

Legal situation

Since 29th December 2009, standard ISO 3691 has been a legal requirement.

This standard specifies that attachments which hold the load by exerting pressure on it must be controlled additionally by a second operating function. This prevents an unintentional release of the load.

If such attachments (clamping devices) are retrofitted, the truck must also be retrofitted with a second operating function.

NOTE

The clamp locking mechanism is discussed in the following section.

Actuation

Component	Implementing the clamp locking mechanism
Hand lever	Actuate operating lever together with an additional switch
Joystick	Actuate the joystick function together with the F key. The auxiliary hydraulics function with F key is parameterised via the diagnostics in the notebook.
Fingertip Generation 2 mini-lever	Press the F key to enable the attachment function for 3 seconds. During this time, the attachment can be actuated via the corresponding operating lever. The function remains enabled until 3 seconds has passed without the operating lever being actuated.
Fingertip Generation 2 mini-lever	To enable, the operating lever must be moved forwards once by at least 1/3. The enable is indicated by the LED for the F2 key and remains active for approx. 1 second. During this time, the attachment can be actuated via the corresponding operating lever.
Generation 1 mini-lever	The function is not implemented for the generation 1 mini-lever.

Clamp locking mechanism with servo hydraulics

Configuration

NOTE

- *The parameters apply only for the fingertip and generation 2 mini-lever.*
- *For retrofitting, the current software flash package may have to be loaded into the truck.*
- *The addresses and values of trucks RX60-25-50 (6321–6630) partially deviate from the standard.*

Enable via the F key		
Address	**Value**	**Description**
A 00 3EC	27	Input for clamping function with servo hydraulics
A 00 3ED	1E	Time interval, from when the enable is reset. Default: 3 seconds
A 00 3EE	00	Clamping function configuration Default: enable via the F key
A 10 023	2C	Crossbar switch index for auxiliary hydraulics 2 axle
A 10 030	3A	Crossbar switch index for analogue switch 1, analogue input
A 10 031	1B	Crossbar switch index for analogue switch 1, Enable input

Enable via 1/3 actuation of the operating lever, four-way valve block		
Address	**Value**	**Description**
A 00 3EC	27	Input for clamping function with servo hydraulics
A 00 3ED	0A	Time interval, from when the enable is reset. Default: 1 second
A 00 3EE	02	Clamping function configuration Default: enable by moving the lever
	01	In RX60-25-50 (6321–6330)
A 00 3EF	C4	Setpoint value input from the operating device for the clamping version
A 10 023	39	Crossbar switch index for auxiliary hydraulics 2 axle
	38	In RX60-25-50 (6321–6330)
A 10 036	3A	Crossbar switch index for AND element 1, input A
A 10 037	1B	Crossbar switch index for AND element 1, input B
A 10 042	00	Crossbar switch index for setpoint value limiter, analogue input
	3A	In RX60-25-50 (6321–6330)
A 10 043	00	Crossbar switch index for setpoint value limiter, digital input
	31	In RX60-25-50 (6321–6330)
A 10 044	3A	Crossbar switch index for setpoint value limiter, analogue input
	00	In RX60-25-50 (6321–6330)
A 10 045	31	Crossbar switch index for setpoint value limiter, digital input
	00	In RX60-25-50 (6321–6330)
A 10 04D	3A	Crossbar switch index for universal output 1

Enable via 1/3 actuation of the operating lever, three-way valve block			
Address	**Value**	**Description**	
A 00 3EC	27	Input for clamping function with servo hydraulics	
A 00 3ED	0A	Time interval, from when the enable is reset. Default: 1 second	
A 00 3EE	02	Clamping function configuration Default: enable by moving the lever	
	01	In RX60-25-50 (6321–6330)	
A 00 3EF	C4	Setpoint value input from the operating device for the clamping version	
A 10 022	39	Crossbar switch index for auxiliary hydraulics 1 axle	
	38	In RX60-25-50 (6321–6330)	
A 10 036	2B	Crossbar switch index for AND element 1, input A	Four-way mini-lever
	3A		Duplicate mini-lever
	2B		Fingertip
A 10 037	1B	Crossbar switch index for AND element 1, input B	

Enable via 1/3 actuation of the operating lever, three-way valve block			
Address	Value	Description	
A 10 042	00	Crossbar switch index for setpoint value limiter, analogue input	
	2B	In RX60-25-50 (6321–6330)	Four-way mini-lever
	3A		Duplicate mini-lever
	3A		Fingertip
A 10 043	00	Crossbar switch index for setpoint value limiter, digital input	
	31	In RX60-25-50 (6321–6330)	
A 10 044	2B	Crossbar switch index for setpoint value limiter, analogue input	Four-way mini-lever
	3A		Duplicate mini-lever
	3A		Fingertip
	00	In RX60-25-50 (6321–6330)	
A 10 045	31	Crossbar switch index for setpoint value limiter, digital input	
	00	In RX60-25-50 (6321–6330)	
A 10 04D	2B	Crossbar switch index for universal output 1	Four-way mini-lever
	3A		Duplicate mini-lever
	2B		Fingertip

Clamp locking mechanism for hand levers

Parameterising

NOTE

- *The parameters apply to clamp locking mechanisms for hand levers, even those with Sauermann restraint systems.*
- *For retrofitting, the current software flash package may have to be loaded into the truck.*

Service address	Value	Description
A 00 36F	05	These service addresses are no longer used
A 00 370	37	
A 00 371	00	
A 00 372	05	Reserve 11 input at AND 2 output
A 00 373	37	Reserve 11 output at CPP 3, channel 8
A 00 374	00	Reserve 11 output parameter
A 00 326	8E	1 AND 2 input at reserve 2 low (knob on the 4th lever)
A 00 327	BC	Input 2 AND 2 "actuated on lever 4"

Electrical connections for hand levers

Seat CPP	E14	X54: 7

	E14	X54: 8

Accumulator

Accumulator

Function

Accumulators are hydro-pneumatic storage devices that draw on the compressibility of gas to store fluids. Accumulators comprise a fluid section and a gas section, with a membrane forming a separator. These sections are welded together to form a single unit. The gas section can be refilled. The fluid section is connected to the hydraulic circuit. The membrane features a valve plate in its base. When the gas section is completely empty, this valve plate closes off the hydraulic outlet. This prevents damage being sustained to the membrane.

If the pressure in the hydraulics system rises, the accumulator is filled with hydraulic oil and the volume of gas is compressed. If the pressure in the hydraulics system falls again, the compressed gas expands and pushes the hydraulic oil back into the hydraulic circuit. These damping characteristics can be altered as required by adjusting the pre-load pressure

Effect on the truck

At nominal load, the accumulator absorbs the vibrations prevailing in the lift mast. This reduces the impact factor and/or load factor for the frame and tilt cylinders when driving on uneven ground.

On all trucks with a nominal load of 5000 kg and a load centre of gravity of 600, the accumulator is a component relevant to safety that is subject to regular maintenance.

Technical data

Accumulator	
Gas, refillable	Nitrogen
Gas connection	M28 x 1.5
Max. operating pressure	250 bar
Pre-load pressure	130 bar
Min. operating pressure	40 bar
Hydraulic connection	G 1/2

Checking the accumulator

Maintenance

3000 hours/every two years

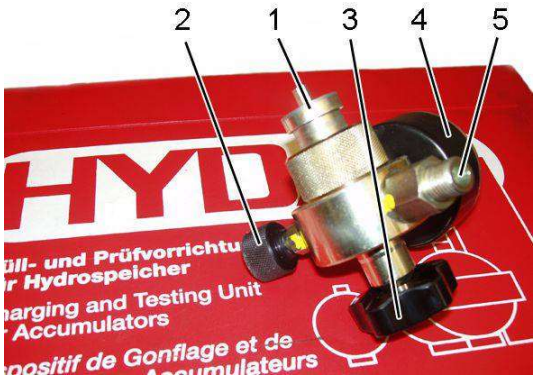
- Check the pre-load pressure.
- Check the connections to ensure they are secure and check for leaks.
- Check the fittings and safety systems to ensure they are in proper condition.
- Check the mounting elements.

Testing device

Using the testing device, you can check the pre-load pressure in the accumulator and reduce it as necessary. To do this, screw the testing device on to the gas valve on the accumulator.

If the accumulator also needs to be filled, the testing device must be connected to a standard nitrogen container via a filling hose.

The testing device is a screw joint fitting with a pressure gauge, non-return valve and a spindle attached. The spindle is used to open the gas valve for testing purposes.



1 Test port (accumulator)
2 Pressure release valve
3 Hand wheel
4 Pressure gauge
5 Filling connection (gas cylinder)

Checking the accumulator pressure

Remove the accumulator before checking it. This is the only way to reliably detect a faulty membrane.

– Unscrew the protective cap from the gas connection on the accumulator.
– Loosen the socket-head screw slightly, as this is very difficult to turn via the hand wheel on the testing device.
– Securely bolt the testing device on to the gas connection on the accumulator.
– Close the pressure release valve on the testing device.
– Open the accumulator via the hand wheel.
– Read the accumulator gas pressure on the pressure gauge.

Reducing the accumulator pressure

If the gas pressure is too high or the suspension properties are too hard, the pressure release valve can be used to reduce the pressure in a controlled manner.

– Open the accumulator via the hand wheel.
– Read the accumulator gas pressure on the pressure gauge.

– Slowly open the pressure release valve and relieve the pressure in a controlled manner.

The minimum pre-load pressure must not be below 40 bar, as otherwise the membrane will wear quickly.

Increasing the accumulator pressure

If the gas pressure is too low or the suspension properties are too soft, the filling connection can be used to increase the pressure.

– Set the pressure reduction valve to the required pressure.
– Open the accumulator via the hand wheel.
– Close the pressure release valve on the testing device.
– Read the accumulator gas pressure on the pressure gauge.
– Select a nitrogen cylinder that is as full as possible and connect to the filling connection. Increase the pressure in a controlled manner.

Hand lever

General technical data

Valve block with check valve for hydraulics blocking function

Valve block	6210 - 6217, 6311, 6313, 6315
Series	Since calendar week 39/2009
Manufacturer	Buchholz
Monoblock, three-way	Lift, tilt, auxiliary 1 for all overall heights
Monoblock, four-way	Lift, tilt, auxiliary 1, auxiliary 2 for all overall heights
Release valve for the hydraulics in accordance with EN-ISO 3691-1	The hydraulic functions are active when the seat contact switch is actuated, i.e. the driver is seated
Hydraulic oil temperature range	
	-20 °C to +95 °C
	briefly up to 115 °C
Tightening torques	
A1, B1, A2, B2, A3, B3	G3/8, 40 Nm
R	G3/4, 140 Nm
P, H	G1/2, 70 Nm
Emergency lowering screw	SW4, 2.5 Nm
Hydraulic transmitter	3.5 Nm
Valve block on valve block support	20 Nm

Valve block without check valve

Valve block	6210 - 6217, 6311, 6313, 6315
Series	Until calendar week 38/2009
Manufacturer	Have
Monoblock	Lift, tilt with end plate for all overall heights
Monoblock and auxiliary hydraulics 1	Lift, tilt, middle segment for auxiliary 1 with end plate for all overall heights
Monoblock and auxiliary hydraulics 1 and 2	Lift, tilt, middle segment for auxiliary 1 and end segment for auxiliary 2 for all overall heights
Hydraulic oil temperature range	
	-20 °C to +95 °C
	briefly up to 115 °C
Tightening torques	
A1, B1, A2, B2, A3, B3	G3/8, 70 Nm
P, H, R	G3/4, 180 Nm
M	G1/2, 20 Nm
Hydraulic transmitter	3.5 Nm
Valve block on valve block support	20 Nm

Tilt orifice

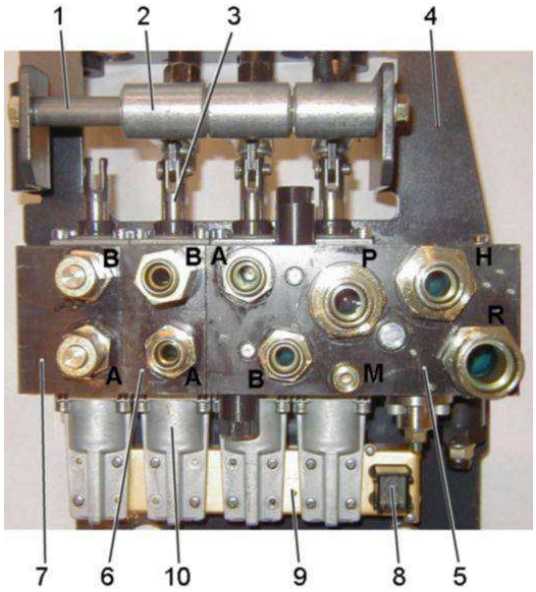
Overall height	6210 - 6217, 6311, 6313, 6315
Nominal lift < 3500 mm	Plug or orifice 39
Nominal lift 3500 - 5000 mm Spare part delivery condition	Delivery condition
Nominal lift > 5000 mm	Orifice 24
Tightening torques	
Exchange orifice M10 x 1	15 Nm

Hand lever valve block

Structure

The axle is bolted to the valve support and houses the levers for the operating levers. An individual operating lever can be retrofitted or removed for any retrofitting of three-way hydraulics to four-way hydraulics.

The operating lever for lifting is a combination lever that incorporates an electric rocker button.

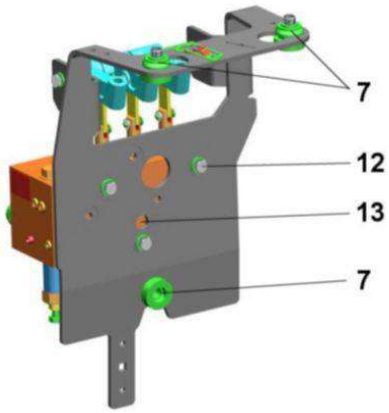


Valve block without check valve

1	Axle
2	Lever
3	Valve rod
4	Valve support
5	Lift/tilt valve block
6	Auxiliary hydraulics 1 middle segment
7	Auxiliary hydraulics 2 end segment
8	Connector X19
9	Sensor rail
10	Hydraulic sensor

The back of the valve block is fixed via three screws (12) to the valve support. The valve support houses the complete valve block and is connected via rubber-mounted mounting screws (7) to the cross wall of the overhead guard.

The tilt orifice (13) can be unscrewed at the back and changed.

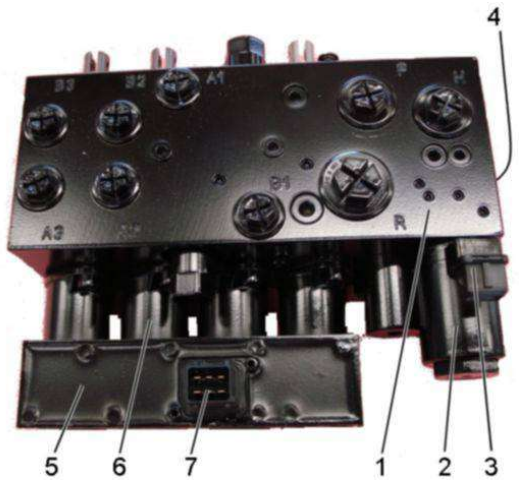


Valve block with check valve

Since calendar week 39/2009, the trucks have been equipped with valve blocks with a check valve as standard. The conversion of older trucks to the current standard is a lot of work and not intended.

The following components must be exchanged for a conversion:

- Valve block
- Valve block support
- Hydraulic hoses, pressure line, tilt forwards, tilt backwards
- Allen key (SW4) for emergency lowering to be kept in the truck
- Wiring harness, pre-assembled for 2Y46 at X46
- Software flash package V0.98 (or a more recent version)
- Parameterising
- Calibration



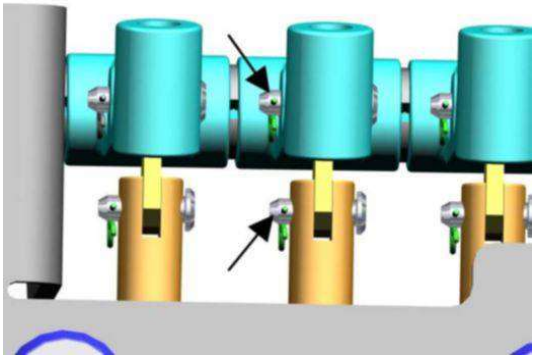
Valve block with check valve

1	Lift/tilt/auxiliary hydraulics valve block
2	Check valve for hydraulics blocking function
3	Plug 2Y46
4	Emergency lowering
5	Sensor rail
6	Hydraulic sensor
7	Connector X19

Maintenance instructions

Lubricate the following bearings:

- Bolt between lever and link
- Bolt between link and rod



Assembly instructions

- Spare part directional control valve blocks are delivered without screw joints and with a standard tilt orifice (nominal lift < 3500 mm).
- When making repairs on the directional control valve block, proceed with extreme care, as dirt and damage to the sealing surfaces can result in malfunctions and leakages.
- Always observe the tightening torques.
- The valve spools must not be turned.

Emergency lowering

If a load that is in a raised position can no longer be lowered due to an error in the valve control, manual emergency lowering is possible. The 4-mm Allen key required for this is part of the truck equipment.

NOTE

See chapter entitled "Valve block design".

- *The place where the Allen key is stored depends on the truck*
- *The position of the emergency lowering feature depends on the valve block type*

– Remove the panelling at the valve block

– Use the Allen key to slowly undo the screw for the emergency lowering feature in an anti-clockwise direction until lowering begins

– Do not undo the screw more than 1.5 turns

– If lowering still does not begin, there is a mechanical block. Do not under any circumstances continue to unscrew the emergency lowering feature

– After lowering is complete, the screw must be screwed back in again; do not exceed a tightening torque of **max 2.5 Nm**

– Fit the panelling at the valve block

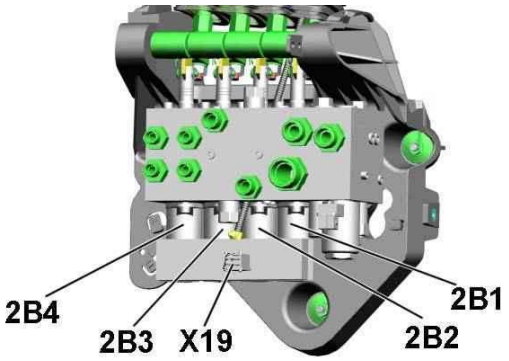
Hydraulic transmitter

General

The hydraulic transmitter comprises the valve spool and a transmitter fitted to the lower end of the spool. The return springs bring the unactuated valve spools back to their neutral position.

The transmitter is located in a housing. The housings of individual transmitters are screwed to the sensor strip.

The Hall sensors for the valves in the valve block, as well as the central plug, are integrated in the sensor strip.



Function

Actuation of the valve spool moves the transmitter in the housing and generates an output voltage in the sensor that is proportional to the spool stroke.

The return springs bring the unactuated valve spool back to its neutral position.

The sensors forward the voltage as signals to the truck control unit MCU. These values are converted in the MCU into speed setpoints for the pump motor.

Electrical connections

6-pin SAAB plug X19		
2B1	X19/1	X46/6
2B2	X19/2	X46/7
2B3	X19/3	X46/4
2B4	X19/4	X46/5
GND-S	X19/5	X46/24
12 V	X19/6	X46/39

Configuration

The configuration must be parameterised again for all retrofitting and conversions.

This affects the following components:

- Lift lever
- Three-way valve block
- Four-way valve block

A truck restart must always be carried out after parameterising. Calibration can only be carried out once these processes have been completed.

Calibration

Calibration must always take place after the hydraulic sensor has been replaced.

– Connect the notebook to the truck and start the truck diagnostics:

Actions
▼
Calibration
▼
0. Sensors

Once calibration is complete, error messages may be displayed.

Testing

– Insert SAAB adapter into the MCU plug connector X46

– Key switch ON

– Connect the digital multimeter to the test adapter according to the table and test the voltage

⚠ CAUTION

The lift mast moves while the transmitter is being tested and can cause damage

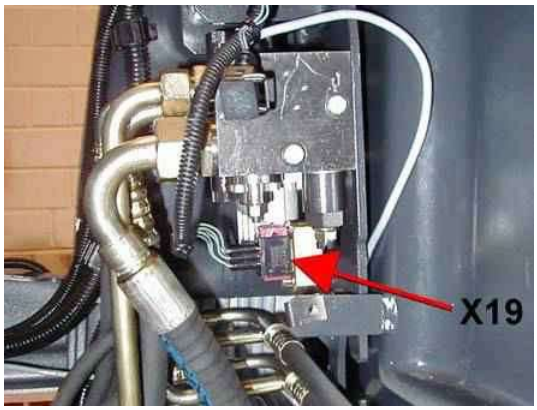
Pay attention to lift mast movements!

Transmitters	Measuring points		Voltage	
	Positive	Negative	Lever back	Lever forward
2B1 lift	X19/1	X19/5	5.5 V	2.0 V
2B2 tilt	X19/2			
2B3 auxiliary 1	X19/3			
2B4 auxiliary 2	X19/4			

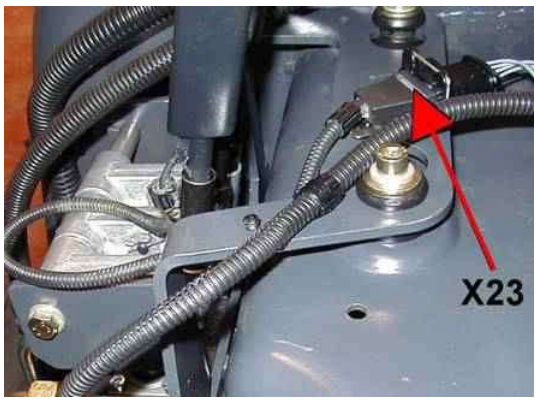
Dismantling and installing valve block

Removal

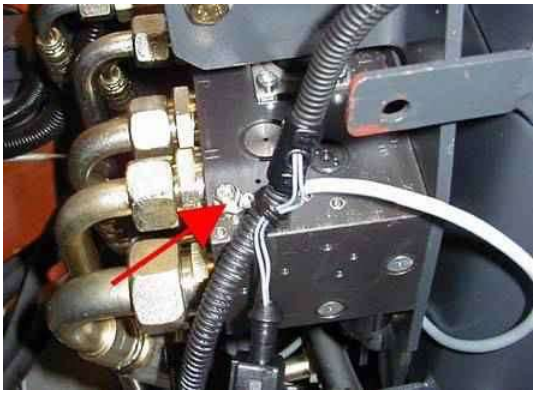
- Park the truck safely.
- Tilt the lift mast forward against the stop.
- Lower the fork carriage fully.
- Release the pressure from the hydraulics.
- Disconnect the battery male connector.
- Remove the bottom plate.
- Remove panelling on the valve block.
- Remove panelling on the right-hand side of driver's compartment and then disconnect all electric cables and the earth wire.
- Disconnect plug X19 and, if necessary, 2Y46. ▷



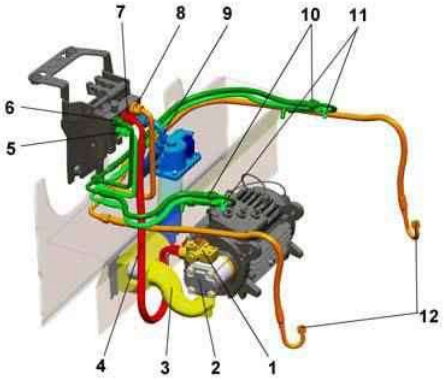
- Disconnect plug X23 from the multifunction lever. ▷



– Remove the valve block earth wire. ▷



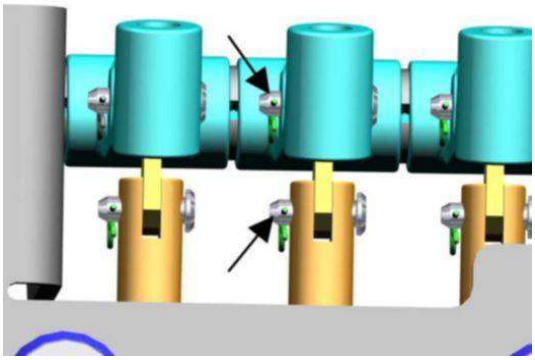
– Loosen all hydraulic connections (6-9) at the valve block. ▷



ENVIRONMENT NOTE

Collect any escaping hydraulic oil and dispose of it in an environmentally friendly manner.

– Loosen the lower rubber-mounted screw on the valve support, do not unscrew completely.
– Unscrew the two upper rubber-mounted screws on the valve support.
– Lift the valve support with valve block right up and out of the mount.
– Remove the fused plug and bolt between lever and valve rod ▷
– Unscrew the three mounting screws on the back of the valve support.
– Disconnect the valve block from the valve support.



Preparing the valve block

The valve block is supplied without screw joints and with a standard flow control valve (for nominal lifts of 3500 - 5000 mm).

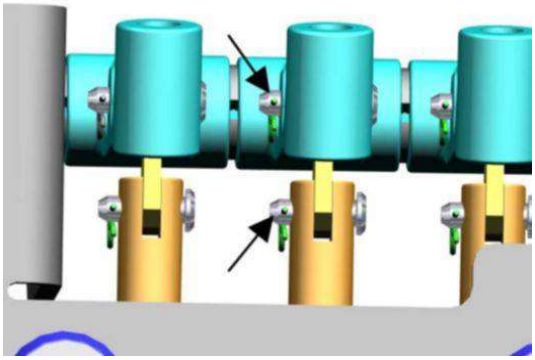
– The tilt orifice must be changed according to the lift mast nominal lift, see the chapter entitled "General technical data".
– Install all screw joints from the package group in the new valve block; check the tightening torques. See the chapter entitled "General technical data"

Installation

– Attach the valve block to the valve support using three mounting screws.

– Fit the safety plugs and bolts between the levers and valve spools. ▷

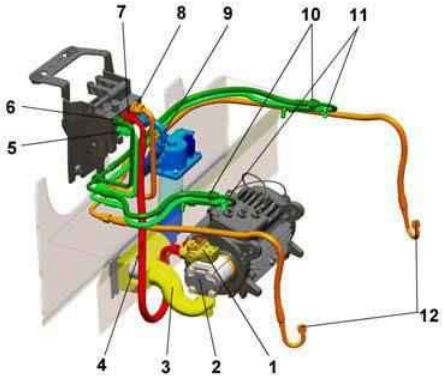
  Lubricate the following bearings:
  Bolt between lever and link
  Bolt between link and rod



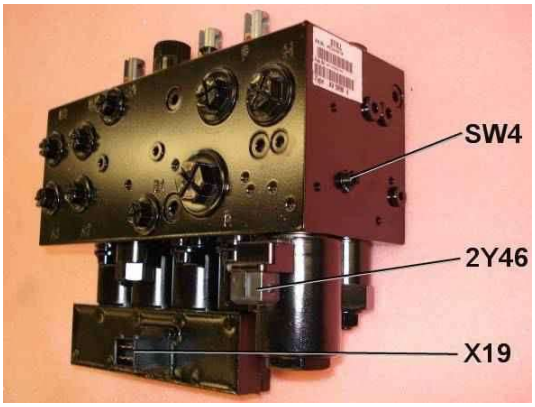
NOTE

The valve spools must not be turned in the valve block.

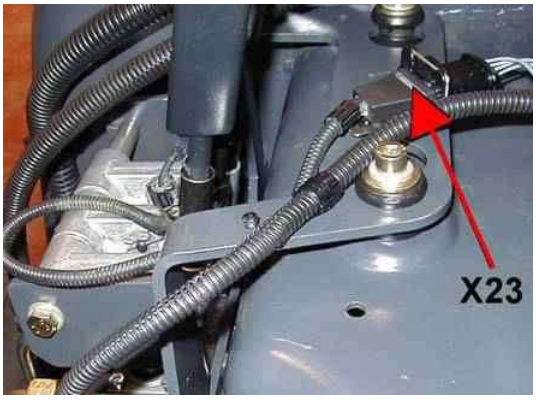
– Insert the valve support with valve block right into the mount from above.
– Screw the lower rubber-mounted screw tightly onto the valve support.
– Screw the two upper rubber-mounted screws tightly onto the valve support.
– Connect all hydraulic connections (6-9) to the directional control valve block, check the tightening torques. ▷



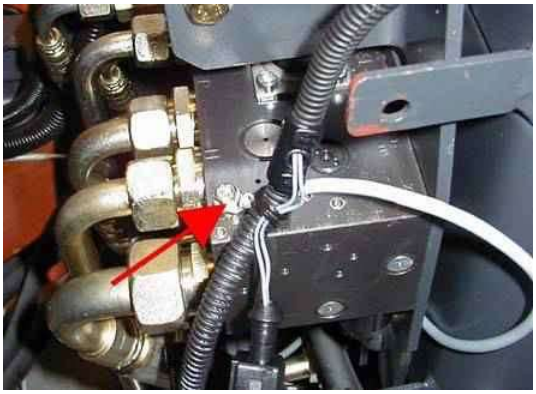
– Connect plug X19 and, if necessary, 2Y46. ▷



– Connect plug X23 of the multifunction lever. ▷



– Screw the earth wire tightly onto the directional control valve block. ▷



– Install panelling on the right-hand side of driver's compartment and then connect all electric cables and the earth wire.
– Install the panelling at the valve block.
– Refit the bottom plate.
– Top up the hydraulic oil if necessary.
– Connect the battery male connector.
– Carry out calibration
– Delete error list.
– Perform a functional test.

Directional control valve with blocking function (Buchholz)

Directional control valve with check valve 2Y46

General

The directional control valve is a monoblock design and comes in 2 versions:

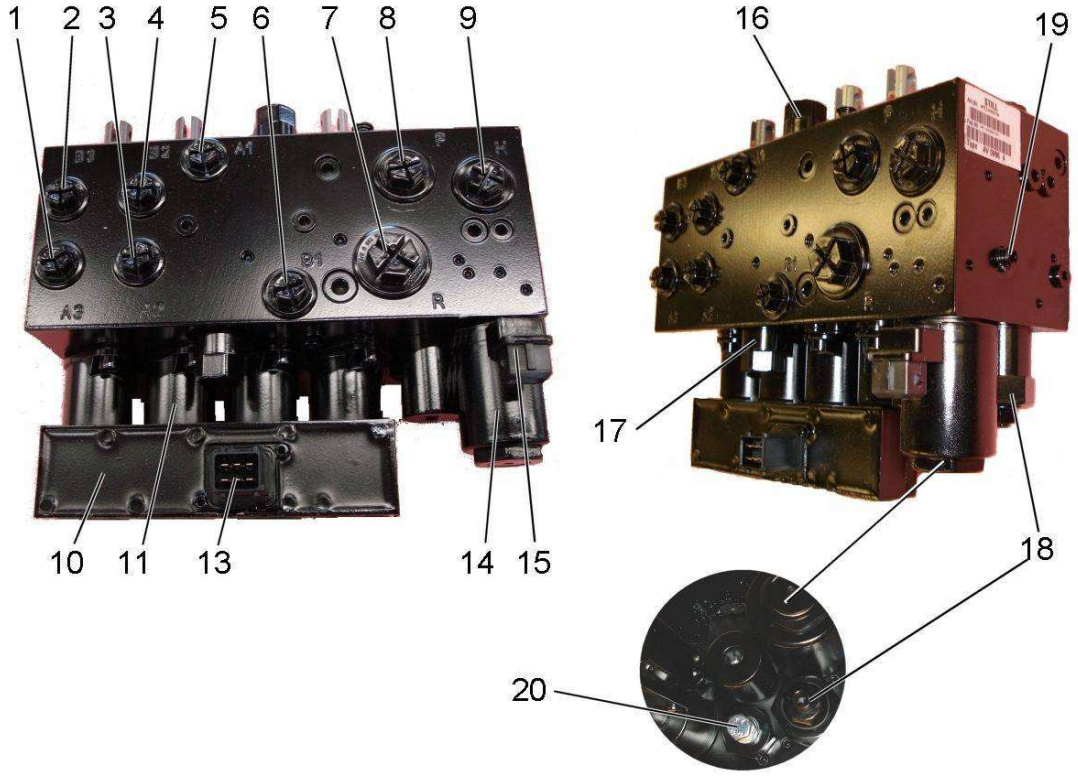
- Directional control valve, three-way
  Lift, tilt, auxiliary hydraulics 1
- Directional control valve, four-way
  Lift, tilt, auxiliary hydraulics 1, auxiliary hydraulics 2

The function and structure of the monoblocks are identical in both versions. If a truck is later equipped with third auxiliary hydraulics, the whole monoblock must be exchanged. In addition, an extra lever must be added to the controls.

The directional control valve contains additional functional components:

- Lowering-balance valve (lowering brake) in the lift valve spool
- Pressure relief valve
- Two load holding valves in the tilt valve spool
- Tilt orifice, depending on the nominal lift
- Check valve for hydraulics blocking function (from calendar week 39/2009)

Structure



1	A3 - auxiliary hydraulics 2
2	B3 - auxiliary hydraulics 2
3	A2 - auxiliary hydraulics 1
4	B2 - auxiliary hydraulics 1
5	A1 - tilt backwards
6	B1 - tilt forwards
7	R - tank return flow
8	P - pump pressure line
9	H - lifting, lowering
10	Sensor strip
11	Hydraulic transmitters 2B1–2B3
13	Plug X19
14	Check valve for hydraulics blocking function, since 2009
15	Plug 2Y46
16	Load holding valve, forwards
17	Load holding valve, backwards
18	Discharge pressure governor (lowering brake)
19	Emergency lowering
20	Pressure relief valve

Hydraulic transmitters that send signals to the sensors in the sensor strip are located at the lower end of the valve spools.

The hydraulic transmitters for the individual hydraulic functions generate signals corresponding to the valve spool displacement. The signals are transmitted to the truck control unit MCU via plug X19. From the signals, the MCU calculates the minimum required number of revolutions for the pump motor.

The tilt valve spool incorporates two load holding valves that prevent forwards and backwards tilting of the load on its own.

A tilt orifice that limits the oil flow for tilting is bolted to the back of the directional control valve. The tilt orifice used depends on the nominal lift of the lift mast.

The discharge pressure governor (lowering brake) in the lift valve spool ensures a constant lowering speed and does this largely irrespective of the size of the load.

The pressure relief valve protects the hydraulic system against overload.

The check valve for the hydraulics blocking function satisfies the regulations in accordance with the standard EN ISO 3691-1 and has been fitted as standard since calendar week 39/2009. The check valve releases the pressure as soon as the seat contact switch is closed, i.e. the driver is seated on the driver's seat.

Discharge pressure governor (lowering brake)

The discharge pressure governor (lowering brake) in the lift valve spool ensures a constant lowering speed that is largely independent of the size of the load.

After loosening the lock nut, the lowering speed can be changed via the adjusting threaded pin.

– Screwing in the screw increases the lowering speed
– Unscrewing the screw reduces the lowering speed

Check valve for hydraulics blocking function

Function

The check valve 2Y46 only enables the working hydraulics once the seat contact switch is closed.

None of the hydraulic functions can be activated unless the driver is seated on the driver's seat.

This safety function is defined in ISO 3691-1 and has been a legal requirement since 29th December 2009. The hydraulics blocking function must not be manipulated.

Electrical connections

2-pin JPT plug		
2Y46/1	X46/2	Lowering OFF
2Y46/2	X46/15	GND-S

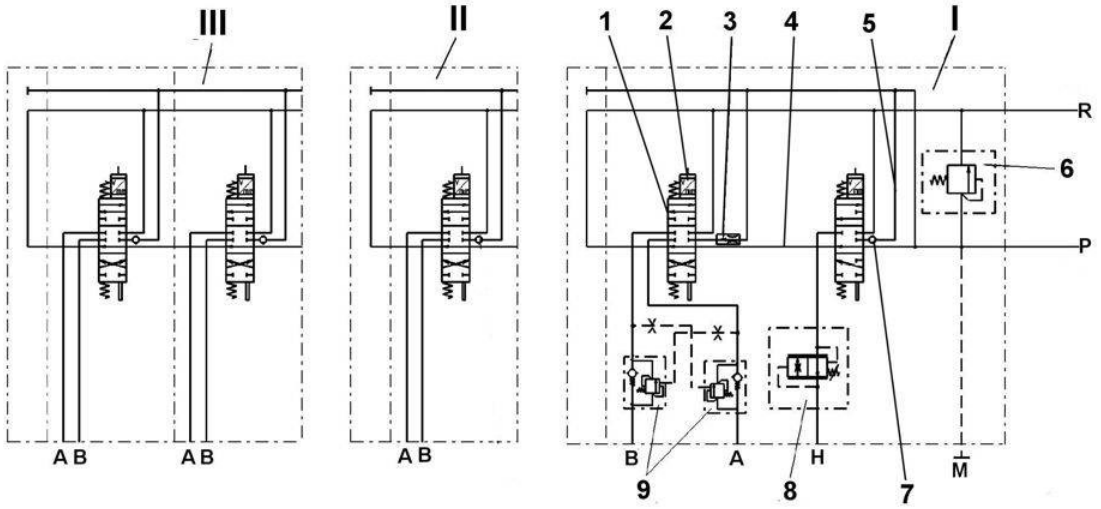
Error detection

Error	Cause	Remedy
Driver is not seated, "lowering" is blocked, "lifting" and "tilting" are possible.	The input pressure governor in the P input of the directional control valve is contaminated and therefore remains open permanently.	Install a new valve block.

Directional control valve without blocking function (Hawe)

Directional control valve - function

Circuit diagram



Directional control valve I

I	Directional control valve for tilting
P	Connection - pump main
R	Connection - return pipe to tank
H	Connection - lift cylinder
A	Connection - tilt backwards
B	Connection - tilt forward
M	Test port

Directional control valve II

II	Directional control valve addition 1
A+B	Connection - additional hydraulics

Directional control valve III

III	Directional control valve addition 2
A+B	Connection - additional hydraulics

Mounting parts

1	Valve rod
2	Hydraulic sensor
3	Flow control valve
4	Idle port
5	Pump port
6	Pressure relief valve
7	Back-pressure valve
8	Lowering brake
9	Load holding valve

Function

Activating the valve rod (1) will regulate the speed of the pump motor and thus the discharge of the hydraulic pump in proportion to the control rod stroke via the hydraulic sensor (2).

Only when the displacement of the rod is small will the oil entering through the pump main (P) flow back via the idle port (4) through the directional control valves up to the backup plate and from there through the return pipe (R) into the tank.

As the displacement of the rod increases, the idle port closes and the oil is conveyed through the pump port (5) to the consumers.

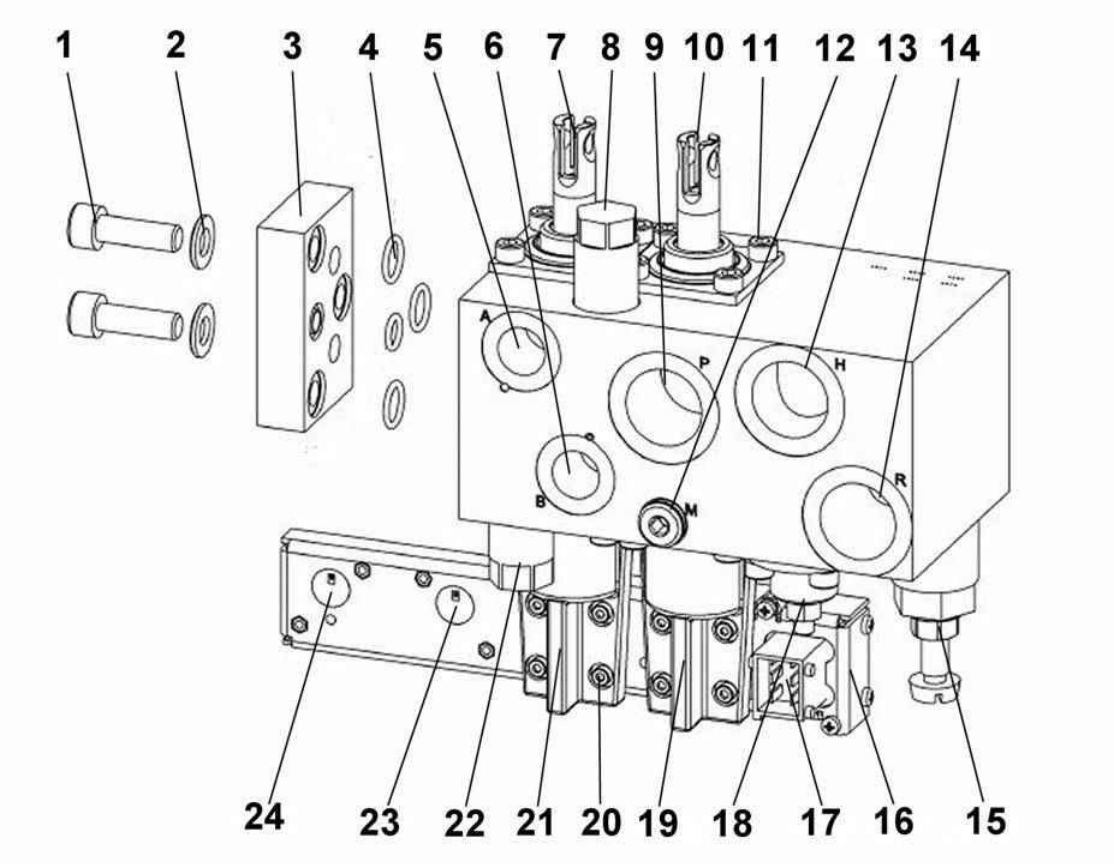
The pressure limiting valve (6) opens as soon as the set maximum pressure in the pump port is exceeded. The oil flows back through the return pipe (R) into the tank.

The back-pressure valves (7) are integrated in the directional control valves, preventing oil from flowing from the consumer back to the pump port (5).

The flow control valve (3) limits the oil amount for the tilting. The restrictor used depends on the mast.

Directional control valve for lifting/tilting

Arrangement



1	Blocking screw	13	Port H - lifting/lowering
2	Washer	14	Port R - return tank
3	Backup plate	15	Pressure relief valve
4	Sealing	16	Sensor rail
5	Port A - tilt backward	17	Connector X19
6	Port B - tilt forward	18	Lowering brake
7	Tilting valve rod	19	Lift hydraulic sensor
8	Load holding valve - forward	20	Screw of hydraulic sensor
9	Port P - pump pressure line	21	Tilt hydraulic sensor
10	Valve rod for lifting/lowering	22	Load holding valve, forward
11	Screw of cover plate	23	Sensor port, auxiliary 1
12	Test port $G^1/_8$?	24	Sensor port, auxiliary 2

The directional control valve contains the valve spools for lifting (10) and for tilting (7).

If no more directional control valves are provided for the auxiliary hydraulics, an end plate (3) is fitted at the tilt valve spool. This end plate seals the directional control valve.

Hydraulic transmitters that send signals to the sensors integrated in the sensor strip (16) are located at the lower end of the valve spools.

The hydraulic transmitters for lifting (19) and tilting (21) generate signals that correspond to the displacement of the valve spools in the sensor strip.

The signals are sent to the truck control unit (MCU) via plug X19 (9). They are then converted into speed setpoints for the pump motor.

The tilt valve spool contains two load holding valves that prevent the load from tilting forwards (8) or backwards (22) of its own accord.

A flow control valve is screwed into the back of the directional control valve. This flow control valve limits the oil flow used for tilting. The flow control valve is dependent on the overall height of the lift mast.

The lowering brake (18) in the lift valve spool ensures a constant lowering speed and does this largely irrespective of the size of the load.

The pressure relief valve (15) limits the maximum pressure of the entire hydraulic system.

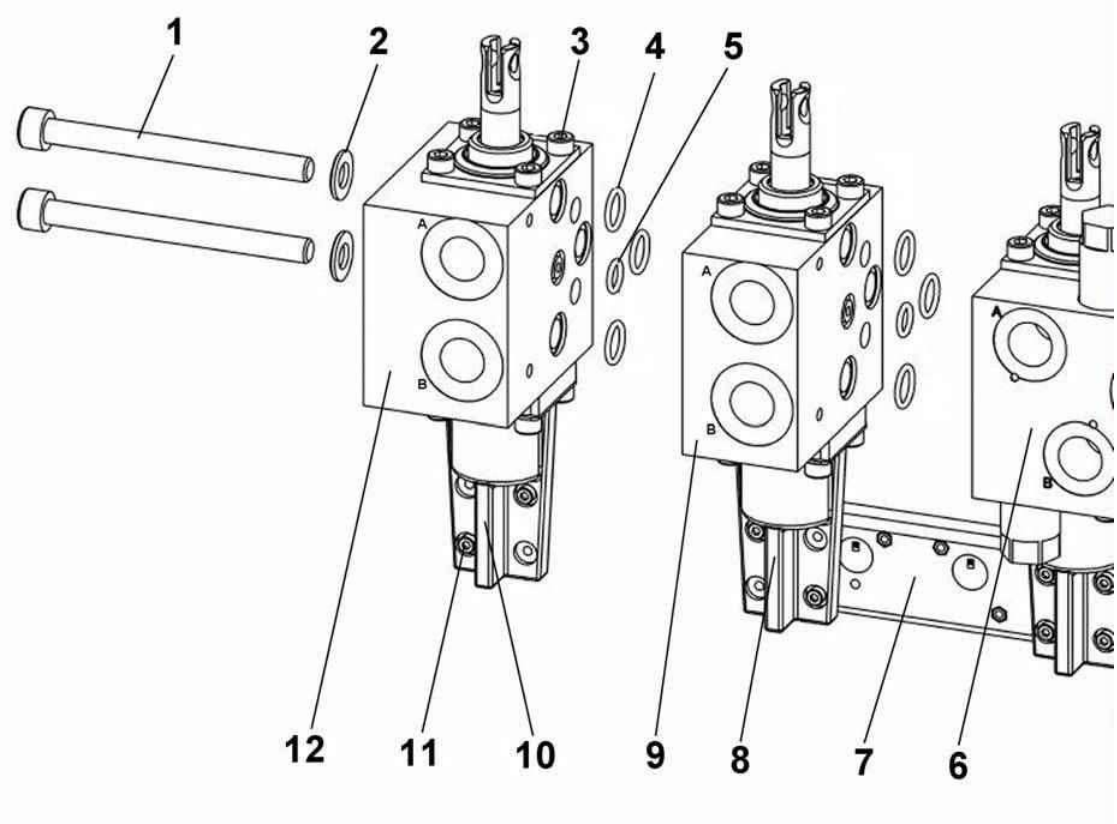
At measurement connection M (12), the pressure of the entire hydraulic system can be measured using a pressure gauge.

Mounting instructions

- Replacement directional control valve blocks are supplied without screw joins and with a standard flow control valve (for nominal lifts of 3500–5000 mm).
- When making repairs to the directional control valve block, proceed with extreme care, as dirt and damage to the sealing surfaces can result in malfunctions and leakages
- Note tightening torques.
- The valve spools must not be turned

Directional control valve - addition 1 and 2

Arrangement



1	Blocking screw	7	Sensor rail
2	Washer	8	Hydraulic sensor auxiliary 1
3	Screw of cover plate	9	Middle segment auxiliary 1
4	O-ring	10	Hydraulic sensor auxiliary 1 or 2
5	Support ring	11	Screw of hydraulic sensor
6	Terminal block	12	End segment of auxiliary 1 or 2

The directional control valve block for lifting and tilting is a connection block (6) to which one or two directional control valves can be added, depending on the equipment.

When adding an auxiliary hydraulics, the end segment (12) is attached to the connection block (6). In this version, the end segment with integrated end plate is the directional control valve for auxiliary hydraulics 1.

When adding two auxiliary hydraulics, the middle segment (9) and end segment (12) are attached to the connection block (6). In this version, the middle segment is the directional control valve for auxiliary hydraulics 1 and the end segment with integrated end plate is the directional control valve for auxiliary hydraulics 2.

The directional control valves for the auxiliary hydraulics are identical in function and design.

The directional control valves are sealed to one other in the flange surfaces via O-rings (4) and support rings (5).

The sensor strip (7) with the sensors for the auxiliary hydraulics is a component of the directional control valve block for lifting and tilting.

Mounting instructions

- Replacement directional control valve blocks are supplied without screw joins and with a standard flow control valve (for nominal lifts of 3500–5000 mm).
- When making repairs to the directional control valve block, proceed with extreme care, as dirt and damage to the sealing surfaces can result in malfunctions and leakages
- Note the tightening torques.
- The valve spools must not be turned

Pressure relief valve

General

The pressure relief valve (DBV) is integrated in the directional control valve block for lifting and tilting, limits the maximum pressure and protects the hydraulic system from overloading.

If a consumer is moved against the stop and the set final pressure value is exceeded, the DBV opens. This causes the conus (6) to be pushed out of the valve seat against the compression spring (5). The pressurised oil can flow out into the hydraulic tank via the return line.

After releasing the lock nut (2), the pressure setting can be changed via the adjustment screw (1).

- Screwing in the screw increases the pressure
- Unscrewing the screw reduces the pressure

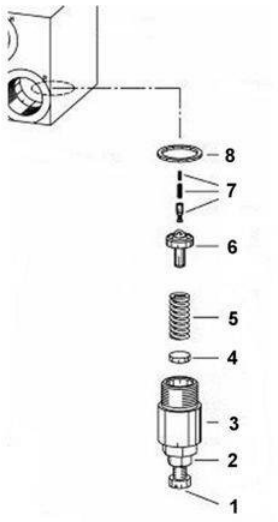
Technical data

Set value: 230±2.5 bar
Adjustment range: 60 to 280 bar

⚠ CAUTION

Do not exceed the maximum setting.

Only adjust the pressure relief valve with a pressure measurement.



1 Adjusting screw
2 Locknut
3 Housing
4 Thrust piece
5 Compression spring
6 Taper
7 Damping
8 Sealing

Possible causes of error

A contaminated pressure relief valve can cause pressure loss or reduced lifting and tilting power.

Cleaning the PLV might eliminate the pressure loss:

- Loosen locknut
- Unscrew adjusting screw until compression spring is relieved
- Activate consumer briefly and flush PLV
- Screw in adjusting screw until setting is reached
- Secure with locknut

Load holding valve

General

Load holding valves prevent the load from tilting forwards or backwards of its own accord. The directional control valve block for tilting is equipped with two load holding valves, one for forwards tilting and one for backwards tilting.

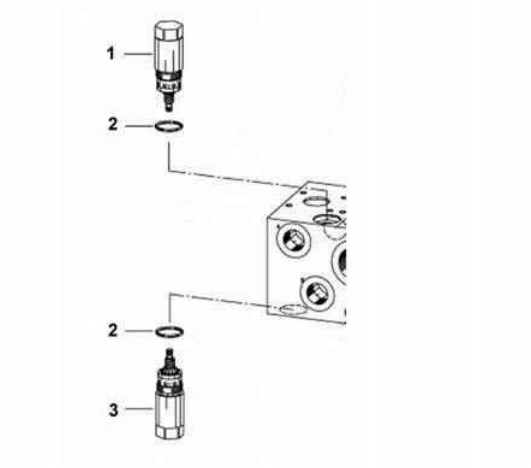
The lift mast must not tilt forwards automatically by more than 5° in 10 minutes.

NOTE

Observe the safety test for forwards tilting.

Technical data

Set value: 125 $^{+10}$ bar



1 Load holding valve, forward
2 Sealing
3 Load holding valve, back

Lowering brake

General

The lowering brake is a flow control valve and limits the maximum lowering speed of the load.

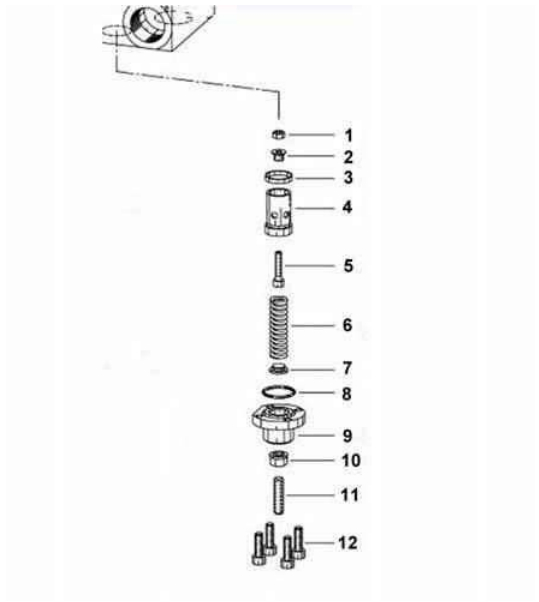
After loosening the lock nut (10), the lowering speed can be changed via the adjusting threaded pin (11).

– Screwing in the screw increases the lowering speed

– Unscrewing the screw reduces the lowering speed

Technical data

Setting range: 35 l/min at 150 bar



1	Nut
2	Socket
3	Ring
4	Piston
5	Screw
6	Compression spring
7	Disk
8	Sealing
9	Flange
10	Locknut
11	Adjusting grub screw
12	Screw

Servo hydraulics

General technical data

Directional control valve block

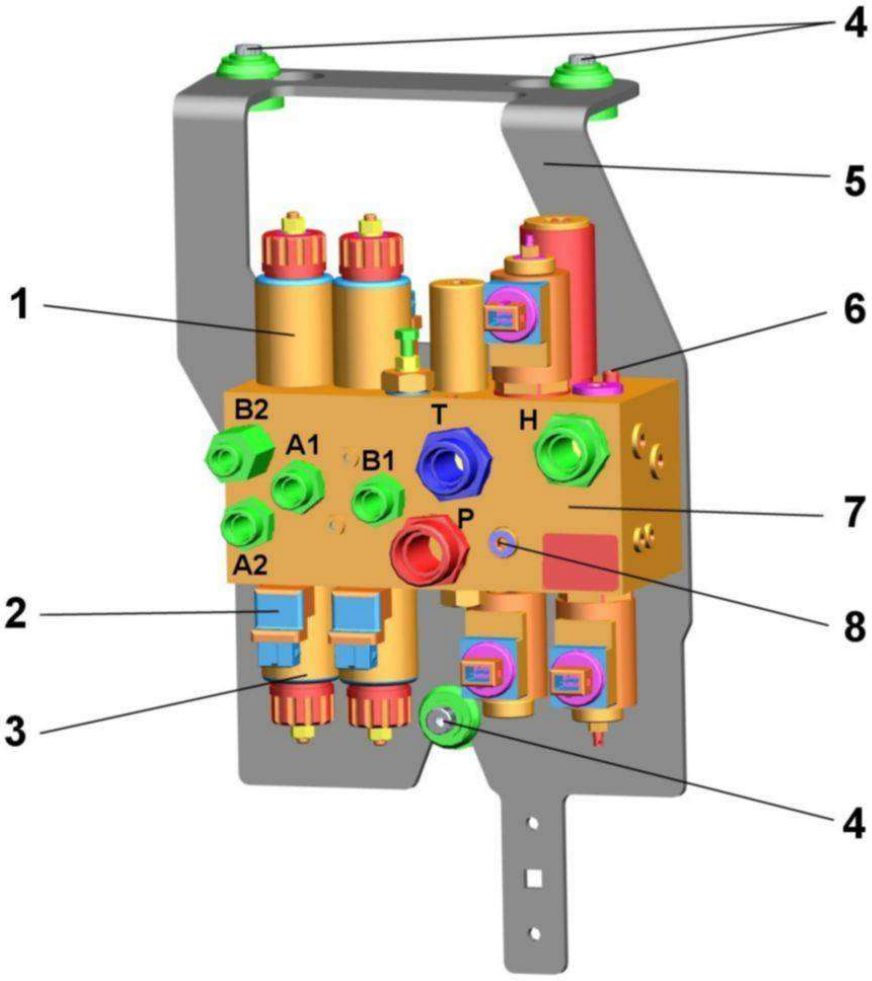
Servo hydraulics	6210 - 6217 6311, 6313, 6315
Manufacturer	Buchholz
Monoblock, three-way	Lift, tilt, auxiliary hydraulics 1 for all overall heights
Monoblock, four-way	Lift, tilt, auxiliary hydraulics 1, auxiliary hydraulics 2 for all overall heights
Solenoid coils	
Coil voltage	12 V
Coil current	1.8 A maximum
Coil resistance - lift, lower	6.0 Ohm
Coil resistance - tilt, auxiliary 1, auxiliary 2	8.0 Ohm
Hydraulic oil temperature range	
	-25 °C to +90 °C
	briefly up to 120 °C
Tightening torques	
A1, A2, A3, B1, B2, B3	70 Nm
P, T, H	180 Nm
Emergency lowering screw	2.5 Nm
Pressure relief valve	15 Nm
Valve block on valve block support	20 Nm

Tilt orifice

There is no tilt orifice available.

Servo hydraulics valve block

Structure

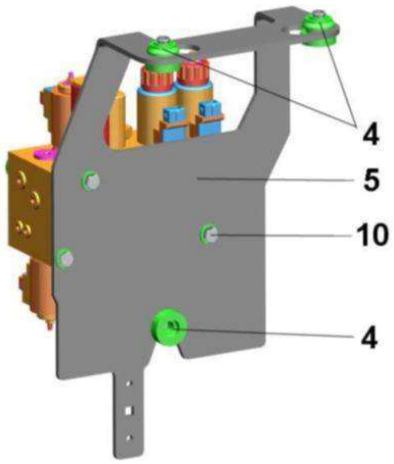


1	Solenoid coil	6	Emergency lowering
2	Plug	7	Lift/tilt/auxiliary 1 directional control valve block
3	Solenoid coil		
4	Fixing screws	8	Measuring point
5	Valve support		

The valve support (5) houses the complete valve block and is connected via mounting screws (4) to the cross wall of the overhead guard.

The back of the directional control valve is screwed to the valve support (5) with three rubber-mounted screws (10).

Actuation of the hydraulic functions can take place either by joystick, fingertip or mini-lever.



NOTE

The removal and installation of the valve block is performed in the same manner as for the hand lever.

Assembly instructions

- Spare part directional control valve blocks are delivered without screw joints.
- When making repairs on the directional control valve block, proceed with extreme care, as dirt and damage to the sealing surfaces can result in malfunctions and leakages.
- Always observe the tightening torques.
- The valve spools must not be turned.

Manual lowering

General

If the raised load can no longer be lowered due to a valve control failure, the load can be lowered manually.

To do so, proceed as follows:

NOTE

The 4mm Allen wrench is located in the tray to the right of the seat.

– Remove the valve block cover.

– Using the 4mm Allen wrench, slowly turn the manual lowering screw out until lowering starts.
– Do not turn the screw more than 1½ turns.
– If the load does not lower despite the screw being turned out, there is a mechanical blockage.
– After the lowering, turn the screw in with **max 2.5 Nm**.
– Refit the valve block cover.



Directional control valve block

General

The directional control valve is a monoblock design and comes in 2 versions:

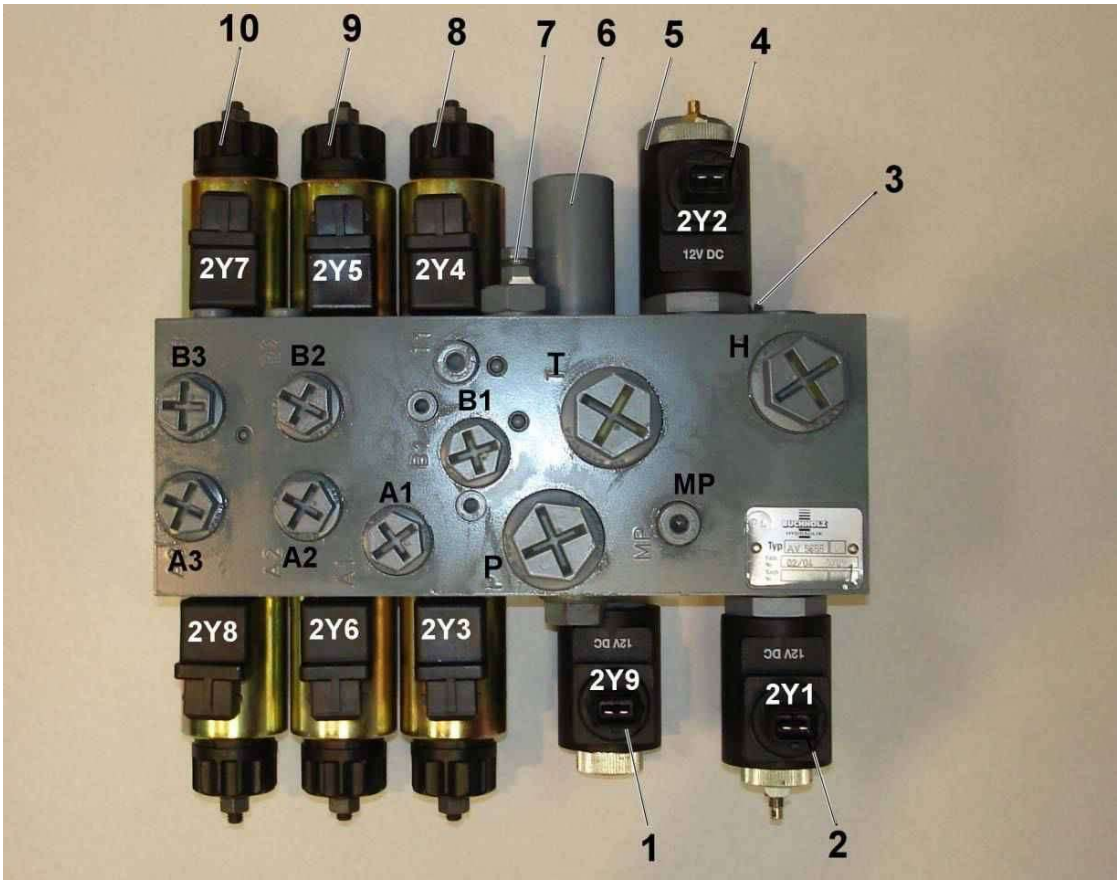
- Directional control valve, three-way
  Lift, tilt, auxiliary hydraulics 1
- Directional control valve, four-way
  Lift, tilt, auxiliary hydraulics 1, auxiliary hydraulics 2

The function and structure of the monoblocks are identical in both versions. If a truck is later equipped with auxiliary hydraulics, the whole monoblock must be exchanged.

The directional control valve block contains the following functional components:

- Lowering-balance valve (lowering brake)
- Check valve for hydraulics blocking function
- Pressure relief valve
- NO tilt orifices
  The tilt speed is restricted by the pump speed, dependent on the overall height of the lift mast. If lifting and tilting are actuated at the same time, the tilt speed is prioritised.

Chassis



Valve block

1	Check valve for hydraulics blocking function
2	Lifting valve
3	Emergency lowering
4	Lowering valve
5	Lowering-balance valve (lowering brake)
6	Inlet pressure balance
7	Pressure relief valve
8	Tilting valve
9	Auxiliary hydraulics 1
10	Auxiliary hydraulics 2

solenoids

2Y1	Lifting
2Y2	Lowering
2Y3	Tilting back
2Y4	Tilt forwards
2Y5	Auxiliary hydraulics 1
2Y6	Auxiliary hydraulics 1
2Y7	Auxiliary hydraulics 2
2Y8	Auxiliary hydraulics 2
2Y9	Check valve for hydraulics blocking function

The valve spools of the directional control valves are controlled by solenoid coils in proportion to the degree of actuation of the joystick, fingertip or mini-lever.

The directional control valves for tilting, auxiliary hydraulics 1 and auxiliary hydraulics 2 are fitted on both sides with solenoid coils.

The upper solenoid coils push the valve spools down and open the connections (B) to the pressure line (P), as well as the connections (A) to the return line (T).

The lower solenoid coils push the valve spools up and open the connections (A) to the pressure line (P), as well as the connections (B) to the return line (T).

Lifting and lowering are activated by separate valve spools that are each controlled by solenoid coils.

The solenoid coil (2Y1) moves the lift valve spool and opens the connection (H) to the pressure line (P).

The solenoid coil (2Y2) pushes on the lowering valve (1) and opens the connection (H) to the return line (T).

The check valve (2Y9) is located in the Load Sensing chain and releases the control pressure as soon as the seat contact switch is closed.

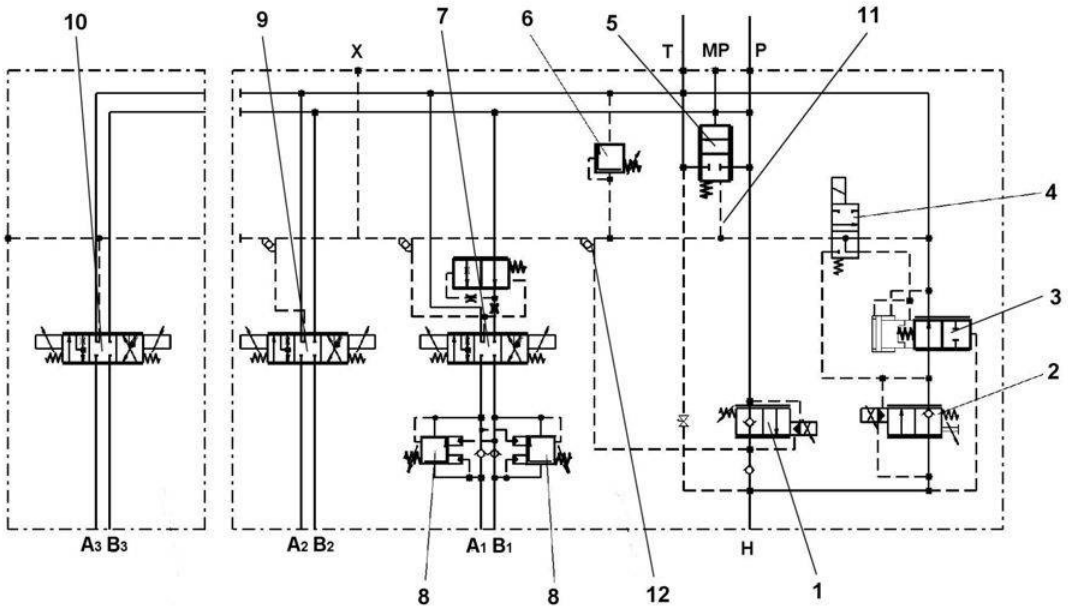
The lowering-balance valve (6) fulfils the functions of the lowering brake, and limits and regulates the lowering speed, regardless of the load.

The lowering speed is set by adjusting the lowering cartridge.

The pressure relief valve (2) protects the hydraulic system from overloading using the input pressure governor (5).

Directional control valve - method of operation

Schematic diagram



Directional control valve

T	Tank return line port
P	Pressure line port
H	Lift cylinder port
A1	Forward tilt port
B2	Backward tilt port
A2	Auxiliary hydraulics 1 port
B2	Auxiliary hydraulics 1 port
A3	Auxiliary hydraulics 2 port
B3	Auxiliary hydraulics 2 port
X	Test port
MP	Test port

Components

1	Lift control valve
2	Lowering directional control valve
3	Lowering-balance valve
4	Check valve
5	Inlet pressure balance
6	Pressure relief valve
7	Tilt directional control valve
8	Load holding valve
9	Aux 1 directional control valve
10	Aux 2 directional control valve
11	LS chain
12	Changeover valve

Method of operation

The movement of the joystick is forwarded as a signal via the peripheral CAN bus (CAN r) to the hydraulics control unit in the MCU. The hydraulics control unit evaluates the signals and controls the solenoid coils in the respective directional control valve.

The directional control valve block works according to the principle of 3-way current control. With the spool in neutral position, there is no pressure from the consumer side that affects the control channels. The control channels are depressurised.

The oil entering through the pressure line (P) can open the input pressure governor (5) against the spring force. The oil delivered by the pump is almost pressure-less as it flows through the return line (T) into the tank.

When a spool is moved, the pressure building up in the consumer acts via the control channels on the input pressure governor and closes it along with the spring force.

With a consumer stop (e.g. tilting against over pressure), the pressure in the control channels increases. The pressure relief valve (6) opens as soon as the set final pressure value is reached. The higher pressure in the pressure line (P) pushes the input pressure governor against the spring force and the entire amount of oil can flow via the opened return line (T) into the tank.

The check valve (4) is controlled via a solenoid coil by the hydraulics control unit. When actuated, the check valve closes the control cable against the return flow (T) and the lowering-balance valve (3) is enabled.

If the check valve is not actuated, no control pressure can build up in the control channels. The input pressure governor is not actuated and the pressure oil runs directly back into the tank. In addition, the lowering-balance valve is blocked and lowering is then not possible.

With the shuttle valves (12), it is guaranteed that the simultaneous actuation of several consumers causes the highest respective working pressure to reach the pressure governor via the control channels.

Mast bearings

Mast bearings, 1.0 t - 2.0 t

Technical data

Mast bearings			
Mast bearing screws, per side **Always replace, never reuse**	[Nm]	310	2 x M16 x 110-10.9 screws, ISO 4762 2 x M16 x 45-10.9 screws, ISO 4762 With Tuflok screw locking agent
Lubricant			

Function

The mast bearing is the same in all telescopic and triple masts.

Each mast bearing is screwed to the drive axle via two screws. Once the mast bearings are unscrewed from the drive axle, they can be removed from the bearing pins of the lift mast.

Maintenance and repair

The mast bearing must be lubricated via the lubricating nipple every 1000 operating hours. Depending on the application in which the truck is used, it may be necessary to lubricate the mast bearings even earlier.

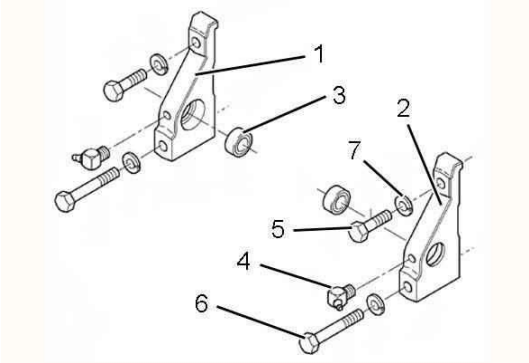
- Defective mast bearings must always be replaced in full and in pairs
- The mast bearing screws must always be replaced
- Old screws must not be reused
- It is not permitted to use uncoated screws with pourable plastics

Greasing

– To ensure that the grease also penetrates to the load-bearing points, the bearing must be unloaded.

– Slightly raise the lift mast on the outer mast using a hydraulic jack.

– Grease the mast bearings.



1 Right-hand mast bearing
2 Left-hand mast bearing
3 Spherical bearing
4 Conical lubricating nipple
5 Screw
6 Screw
7 Lock washer

Lift mast

General technical data

Lift mast	Profile 108 (1000–1800 kg); profile 117 (2000 kg)		
Line break safety devices	[Nm]	23 ± 2	
Outer cylinder hydraulic line	[Nm]		
Bleeder screws			
Support roller play; profile 108 (1000–1800 kg)			
Support roller diameter	[mm]	75.3	Standard size
Permissible radial play	[mm]	0.05	Minimum play
	[mm]	0.4–0.6	Maximum play
Permissible lateral play	[mm]	0.1	Minimum play
	[mm]	0.3–1.1	Maximum play
Middle roller in case of 6-roller fork carriage		The play of the middle roller is 0.2 mm larger than the play of the upper rollers	
Support roller play; profile 117 (2000 kg)			
Support roller diameter	[mm]	80.9	Standard size
Permissible radial play	[mm]	0.05	Minimum play
	[mm]	0.4–0.6	Maximum play
Permissible lateral play	[mm]	0.1	Minimum play
	[mm]	0.3–1.1	Maximum play
Middle roller in case of 6-roller fork carriage		The play of the middle roller is 0.2 mm larger than the play of the upper rollers	
6-roller fork carriage			
Upper support rollers in case of 6-roller fork carriage	[Nm]	60 ± 6	Countersunk screw, M12 x 25, ISO 10642 Loctite 242

Mast weight

The weights of lift masts vary depending on the model, load-bearing capacity and overall height.

Lift mast	Profile	Load capacity [kg]	Weight [kg] Without fork carriage, fork arms, attachments
Telescopic mast	108	1600 - 1800	Mast length (mm)/1000 x 114 + 59
NiHo mast			Mast length (mm)/1000 x 116 + 53
Triple mast			Mast length (mm)/1000 x 116 + 53
Telescopic mast	117	2000	Mast length (mm)/1000 x 139 + 52
NiHo mast			Mast length (mm)/1000 x 139 + 61
Triple mast			Mast length (mm)/1000 x 206 + 70

Hose safety valve of triplex mast

Function

The line break safety valve prevents the load from lowering at an accelerated rate and in an uncontrolled manner in the event of line breakage.

The line break safety valve features a valve disc that is lifted from the valve seat by spring force when in a quiescent state, thus keeping a flow cross-section free. Under normal operation, the spring keeps the valve open. In the event of a line breakage, the volume flow rate increases, the flow forces become greater than the spring force and the valve closes immediately. A small hole in the valve disc (orifice) allows the load to be lowered slowly when the valve is closed.

If there is more than one line break safety valve fitted in a lift mast, the sequence in which the line break safety valves close is critical. The sequence is critical to ensure safe conditions in the event of line breakage. For this reason, line break safety valves with differing trigger flows are fitted. The trigger flow [l/min] specifies the volume flow rate at which the individual line break safety valve closes.

⚠ CAUTION

If line break safety valves are missing or not of the correct size, this poses the risk of safety being jeopardised in the event of line breakage.

Use the correct line break safety valves as shown on the spare parts list.

Variants

The line break safety valves differ in terms of their basic type, overall size and trigger flow. Refer to the relevant spare parts list for details of the correct line break safety valve.

Manufacturer	Tightening torque
Hawe (4)	23 Nm
Buchholz (5)	23 Nm



NOTE

- *The settings of the line break safety valve must not be changed!*
- *Lift cylinders fitted as spare parts must be checked to ensure that the line break safety valves are pre-assembled correctly!*

Installation positions

The quantity and installation position of the line break safety valve depends on the type of lift mast, the load capacity class and the overall height. A distinction is drawn between three installation positions:

- Cylinder bottom
- Hydraulic adapter
- Cylinder bottom and hydraulic adapter

Telescopic		Left-hand outer cylinder			Right-hand outer cylinder	
Profile	Tonnage [kg]	Cylinder bottom	Hydraulic adaptor		Cylinder bottom	Hydraulic adaptor
108	1600 - 1800	0			1	
	1000 - 1800 From 2660 mm	1			1	
117	2000	0			1	
130	2500	0			1	
	3000 - 3500	0			1	
150	4000	0			1	
	4500 - 5000	0			1	

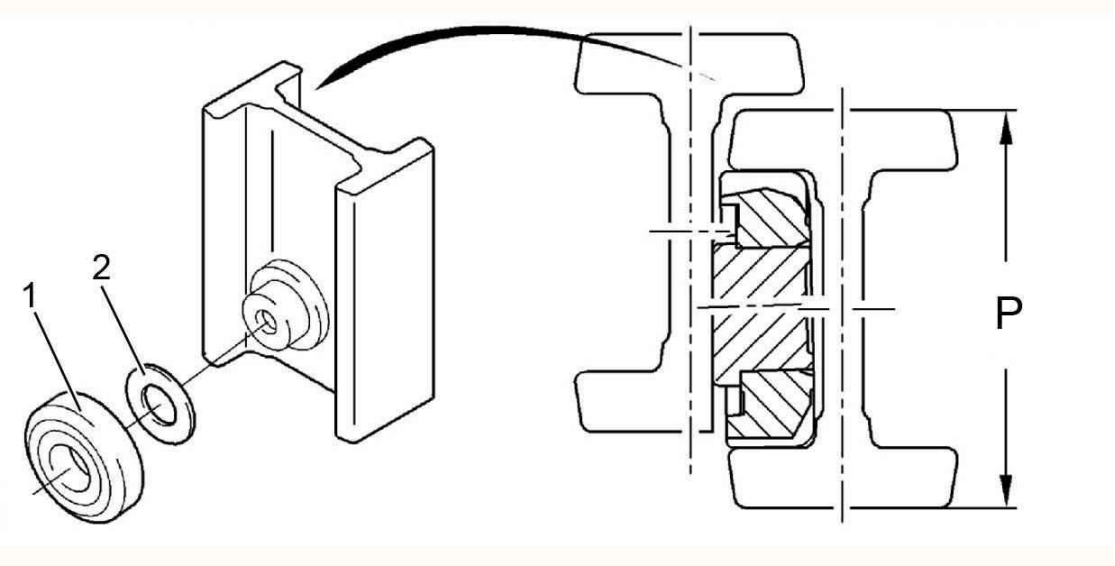
NiHo		Left-hand outer cylinder		Middle cylinder	Right-hand outer cylinder	
Profile	Tonnage [kg]	Cylinder bottom	Hydraulic adaptor	Cylinder bottom	Cylinder bottom	Hydraulic adaptor
108	1600 – 1800	1	1	1	1	
117	2000	1	1	1	1	
130	2500	1		1	0	0
	2500 From 2200 mm	1		1	1	1
	3000	1		1	0	0
	3500	1		1	0	0

Triple		Left-hand outer cylinder		Middle cylinder	Right-hand outer cylinder	
Profile	Tonnage [kg]	Cylinder bottom	Hydraulic adaptor	Cylinder bottom	Cylinder bottom	Hydraulic adaptor
108	1600 - 1800	1	1	1	1	
117	2000	1	1	1	1	
130	2500	0	0	1	1	
	3000	1	0	1	1	
	3500	1	0	1	1	
150	4000	1		1 each	0	
	4500	0		1 each	1	
	5000	0		1 each	1	

Legend:	
No entry	There is no hydraulic adapter present.

0	There is no line break safety valve installed at this point.
1	Number of line break safety valves installed.

Support roller play (108/117/130)



1 Support roller
2 Shim ring
P Profile sizes

After replacing the support rollers, the lateral and radial play between the mast profile and the support roller must be checked.

– The radial play is balanced using larger support rollers.

– The lateral play is balanced using shim rings.

Support roller play			
Permissible radial play	[mm]	0.05	Minimum play
	[mm]	0.4 - 0.6	Maximum play
Permissible lateral play	[mm]	0.1	Minimum play
	[mm]	0.3 - 1.1	Maximum play
6-roller fork carriage, centre roller	The play of the centre roller is 0.2 mm larger than the play of the upper rollers		

Profile sizes	Support rollers [mm]			
108	75.3	75.6	75.9	76.2
117	80.9	81.2	81.5	81.8
130	89.9	90.2	90.5	90.8

Profile sizes	Shim ring [mm] DIN 988			
108	35 x 45 x 0.1	35 x 45 x 0.3	35 x 45 x 1.0	
117	36 x 52 x 0.2	36 x 52 x 0.5		
130	40 x 50 x 0.2	40 x 50 x 0.5		

Load chains - Checking and cleaning

General

Multi-plate chains, also called leaf chains, are used as load chains. Leaf chains consist of chain pins and joining plates. The outer joining plates are given a press fit. A sliding fit is provided for the inner joining plates to ensure that the leaf chains can move freely.

Depending on the working cycle and place of use, the load chains may be subjected to high loads and will therefore wear more quickly. Load chains will stretch due to wear at the chain pins.

In order to keep wear and tear to a minimum, note the following:

- Clean load chains regularly.
- Spray load chains with STILL chain spray.
- Measure the chain elongation.
- Adjust the load chains evenly.
- Load chains must be evenly tensioned when under load.

Cleaning load chains

⚠ WARNING

Risk of accidents!

Load chains are safety elements

The use of cold/chemical cleaners or fluids that are corrosive or contain acid or chlorine can damage the chains and is therefore forbidden!

– Place a collection container under the lift mast.

– Clean with paraffin derivatives such as benzine (and follow the manufacturer's safety information)

– When cleaning with a steam jet, do not use additives.

– Remove any water in the chain links with compressed air immediately after cleaning. Move the chain around during this procedure.

– Spray the chain immediately with STILL chain spray. Move the chain around during this procedure.

Checking the load chains for damage

The load chains must be checked for the following external damage:

- broken joining plates
- broken bolts

- loose and crooked bolts
- surface rust
- stiff joints
- wear and tear, damage to the clamping bolt and end link

If any of the above-mentioned damage has occurred, the load chain must be changed without delay. If the load chain is damaged, it may break before reaching the permissible elongation.

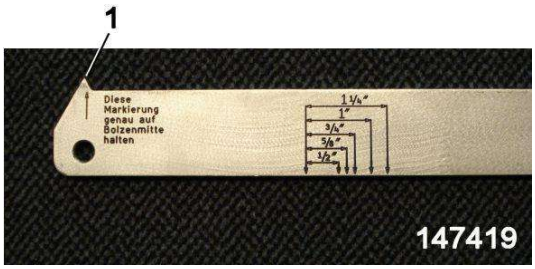
⚠ CAUTION

Improper repairs can lead to serious damage!

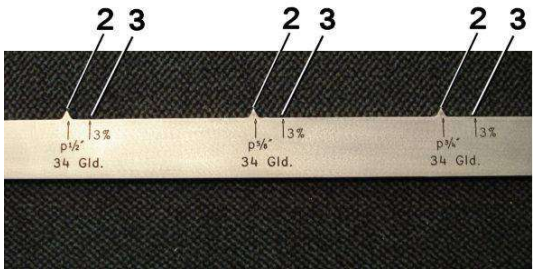
– Always replace the load chains. It is not permitted to carry out repairs to load chains.
– Load chains must always be replaced in pairs to ensure equal load distribution between the two load chains.
– Load chains must always be replaced in full, including the clamping bolt and end link.

Measuring the chain elongation

– Hold the marking (1) on the chain wear gauge against the middle of a chain pin. ▷



– Count off 34 chain links. Depending on the size of the chain, the marking (2) indicates the normal length of 34 chain links. ▷
– The marking (3) indicates the chain length at 3% elongation.



As soon as the specified maximum elongation of 3% has been reached, the load chain must be changed.

Run-out barrier

The end stop must lie within the lift cylinder when lift 1 is fully extended.

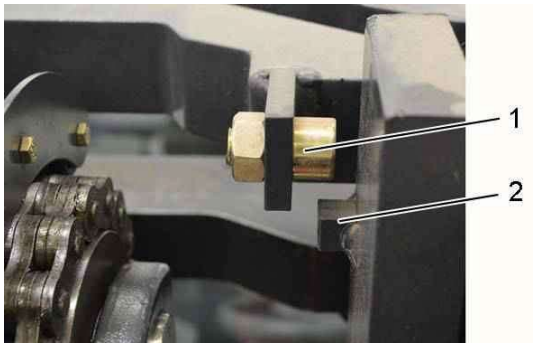
There must always be a minimum distance remaining between the run-out barrier (1) and fork cams (2) when lift 1 is fully extended.

The measured value is only a reference dimension.

Ideal air gap	10 - 20 mm
Minimum dimension	5 mm

For lift masts with a considerable overall height, the distance to the run-out barrier can be easily determined:

- Stick plasticine to the fork cams on the fork carriage.
- Raise the fork carriage to the stop.
- Use the slide gauge to measure the thickness of the plasticine.



Working on lift masts

Specifications

For the work described, it is important to know the overall weight of the lift mast, as well as the weight of the fork carriage and any attachments.

The following devices are required for the work described:

- Second truck or crane with a sufficient nominal load
- Safety chains and lifting slings with a sufficient nominal load
- Supporting blocks and europallet
- Hydraulic jack with sufficient nominal load, lifting bag if necessary

⚠ WARNING

Hydraulic oil is hazardous to health. Hydraulic oil is pressurised during operation.

– Do not spill the hydraulic oil.
– Spilt hydraulic oil must be cleaned up immediately using oil-binding agents.
– Comply with statutory regulations for disposal.
– Do not allow hydraulic oil to come into contact with hot engine parts.
– Do not allow hydraulic oil to come into contact with the skin.
– Avoid inhaling spray.
– To avoid injury, use the appropriate protective equipment (protective gloves, protection goggles, skin protection and skin care products).
– Release the pressure from the system before carrying out any work on the hydraulics.

Lift mast — removal

Removal

- Park the truck safely.
- If necessary, depressurise the hydraulics; see the chapter entitled "Depressurising the hydraulics".
- Remove the fork arms and, if necessary, the attachment.
- Raise and secure the fork carriage; see the chapter entitled "Securing the fork carriage".
- Loosen the mast bearing screws; do not completely unscrew them.
- Lower the fork carriage and put the lift mast into a vertical position.
- Apply the parking brake.
- Turn the key switch OFF.
- **For electric forklift trucks:** Disconnect the battery male connector.
- Attach a suitable lifting sling to the top of the outer mast crossmember.

▷



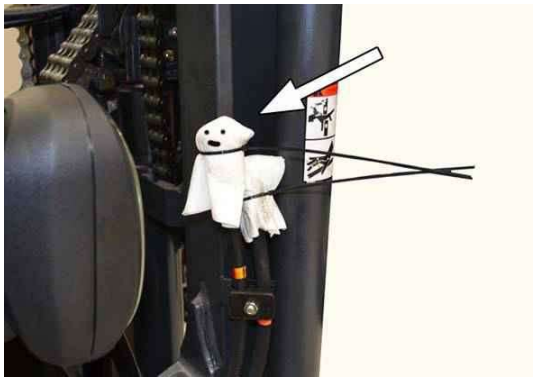
- Hook the lifting sling onto the forks on the second truck and secure in such a way that it cannot slip off the forks when lifting the lift mast. Tilt back the lift mast on the second truck, for example.
- Use the second forklift truck to raise the lift mast slightly until it is suspended taut on the lifting sling.
- Place collection vessels for hydraulic oil under the outer cylinders.
- Unscrew the hydraulic lines on both outer cylinders.

▷



- Depending on the equipment, unscrew the auxiliary hydraulic lines from the lift mast.

– Seal off hydraulic lines using plugs. Use cable ties to attach the loose hose ends to the lift mast.



⚠ CAUTION

As soon as the mast bearings and tilt cylinders are unscrewed, the weight of the lift mast is taken entirely by the lifting sling.

– Ensure that the lifting sling is seated securely on the lift mast.
– Ensure that the lift mast is raised slightly and is taut on the lifting sling.

– Unscrew the mast bearing screws and, if necessary, remove the mast bearings from the bearing pins.
– Depending on the equipment on the tilt cylinder, unscrew the mast vertical position lever.
– Disconnect both tilt cylinders from the outer mast. To do this, remove the locking ring and knock out the bolts.
– Lift out the lift mast using the second truck and set it down carefully on the prepared EUR-pallet.



⚠ CAUTION

Risk of damage to components.

Proceed with care when lifting out the lift mast. Ensure that the lift mast does not start to swing and collide with the truck.

Lift mast — installation

Installation

NOTE

- *Only use new mast bearing screws for the installation; see the chapter entitled "Mast bearings".*
- *Note the screw quality and tightening torques.*
- *See "General technical data" for values.*

– Safely park the truck.

– Attach a suitable lifting sling to the top of the outer mast crossmember.

– Hook the lifting sling onto the forks on the second truck and secure in such a way that it cannot slip off the forks when lifting the lift mast. Tilt back the lift mast on the second truck, for example.



⚠ CAUTION

Risk of damage to components.

Proceed with care when lifting the lift mast. Ensure that the lift mast does not start to swing and collide with the truck.

– Move the lift mast into position and screw on the mast bearing screws; see the chapter entitled "Mast bearings".

– Connect both tilt cylinders to the outer mast. To do this, knock in the bolts and secure them using the locking ring.

– Depending on the equipment on the tilt cylinder, bolt on the mast vertical position lever.



– Screw the hydraulic lines to the outer cylinders.

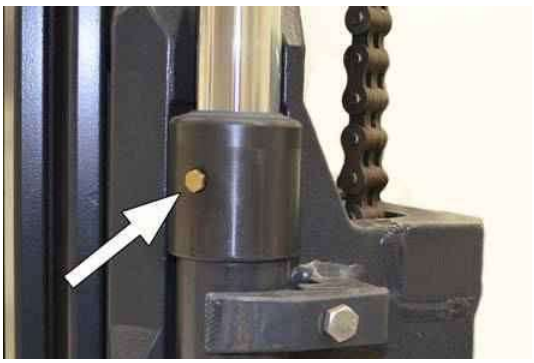
– Depending on the equipment, screw the auxiliary hydraulic lines on the lift mast.

– **For electric forklift trucks:** Connect the battery male connector.

– To bleed the lift cylinders, raise the fork carriage by approx. 300 mm.

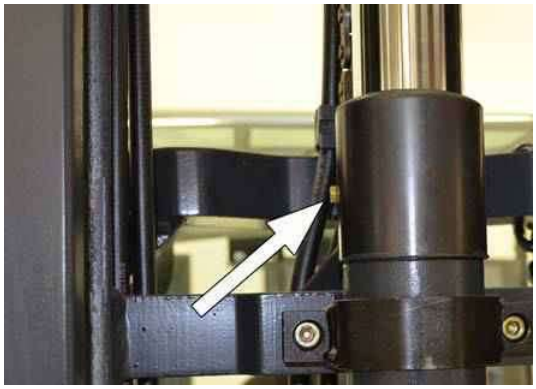


– On the outer cylinders, loosen the bleeder screw in the cylinder head by a maximum of one turn.



– In the case of NiHo and triple lift masts, also loosen the bleeder screw on the middle cylinder by a maximum of one turn.
– Screw the bleeder screw back in as soon as oil starts to leak out.
– Carry out this process for every lift cylinder.
– Check the hydraulics for leaks.
– Check the seating and position of the load chains and hose guides.
– Function check.

▷



Telescopic lift mast

Telescopic lift mast (108/117/130)

Function

The telescopic lift mast is a high-visibility lift mast. The mast profile is a double-T profile. The fork carriage and mast profiles are guided through support rollers (4); these also absorb the lateral forces.

When the load is lifted, the inner mast is also raised along with the fork carriage. After a small free lift of approx. 150 - 160 mm, the overall height of the truck changes immediately. This must be taken into consideration if there are low ceilings and gates.

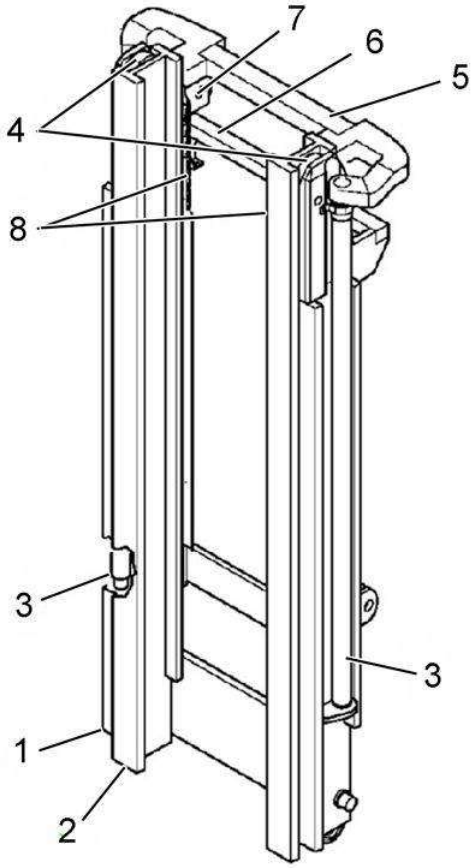
The telescopic lift mast consists of an inner mast (2) and an outer mast (1). A lift cylinder (3) is fitted on each side in the outer mast profiles. The lift pistons are connected to the inner mast crossmember (5).

The load chains (8) are connected to the outer mast crossmember (6) via clamping bolts. The load chains are redirected by chain rollers (7) on the inner mast. The end links of the load chains are connected to the fork carriage.

If the lift cylinders are supplied with hydraulic oil, the lift pistons extend and take the inner mast with them. The redirection of the load chains causes the inner mast to extend towards the fork carriage at a ratio of 1:2.

The end stop is located in the lift cylinder.

A run-out barrier prevents the fork carriage from tilting outwards; see the chapter entitled "Run-out barrier".

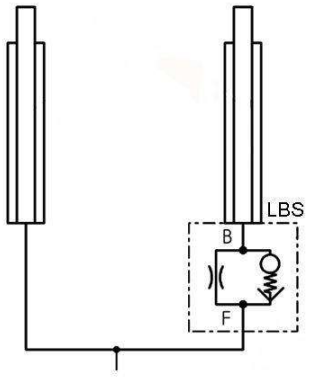


1 Outer mast
2 Inner mast
3 Lift cylinder
4 Support roller
5 Inner mast crossmember
6 Outer mast crossmember
7 Chain roller
8 Load chains

Hydraulic oil flow within the lift mast

The hydraulic oil comes from the directional control valve block. It is distributed via a T-piece and is directed down to the two outer cylinders on the left and right.

The line break safety valve (LBS) is installed in the outer cylinder. This valve prevents the load from lowering too quickly in the event of line breakage; see the chapter entitled "Line break safety valve".

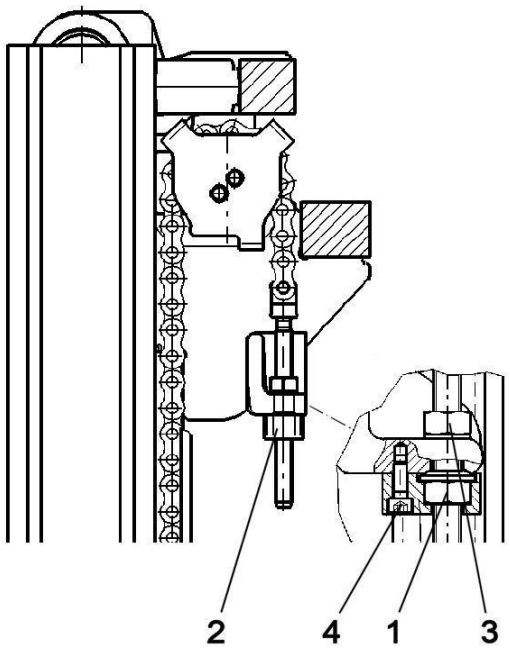


Adjusting the load chains Telescopic lift mast (108/117/130)

Adjusting the load chains

– Lower the lift mast and tilt it back fully.

– Unscrew the screw (4) on each side of the outer mast and remove the cap (2).



NOTE

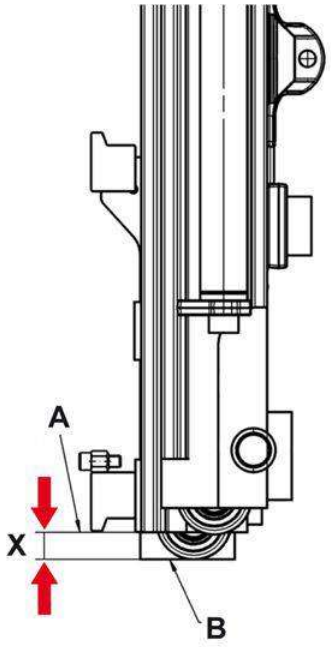
The screw (2) features a thread lock.

- *Secure the screw using Loctite 243.*

– Release the nut (3) on both sides.

– Evenly tension the two load chains at the tensioning nuts (1) until the dimension (X) is reached.

Adjustment dimensions:



A	Bottom edge of the inner mast
B	Bottom edge of the support roller
X	Setting dimension

Telescopic lift mast 108	
Load capacity [kg]	**Measurement X [mm]**
1000 – 1800	$27.5_{-2.5}$

Telescopic lift mast 117	
Load capacity [kg]	**Measurement X [mm]**
2000	$30.5_{-2.5}$

Telescopic lift mast 130	
Load capacity [kg]	**Measurement X [mm]**
2500 – 3500	$35.0_{-2.5}$

– Screw the nut (3) in place against the rubber washer on both sides so that it is loose. Do not tighten.

– Screw the cap (2) securely in place on both sides using a new Tuflok screw (4).

⚠ CAUTION

Damage due to the fork carriage coming into contact with the run-out barrier!

Never compensate for tyre wear by retightening the load chain because the load chain will then be too short.

NiHo lift mast

NiHo lift mast (108/117/130)

Function

The NiHo lift mast is a high-visibility lift mast. The mast profile is a double-T profile. The fork carriage and mast profiles are guided through support rollers (8); these also absorb the lateral forces.

When the load is lifted, the fork carriage is raised in free lift in lift 1. In free lift, the overall height of the truck does not change. In lift 2, the inner mast is also raised and the overall height of the truck is changed.

NOTE

Using a 6-roller fork carriage presents an exception in this regard. Even in lift 1, this fork carriage rises a few centimetres above the top of the inner mast, so that the overall height of the truck changes.

The NiHo lift mast consists of an inner mast (2) and an outer mast (1). A lift cylinder (3) is fitted on each side in the outer mast profiles. The lift pistons are connected to the inner mast crossmember (6) at the top.

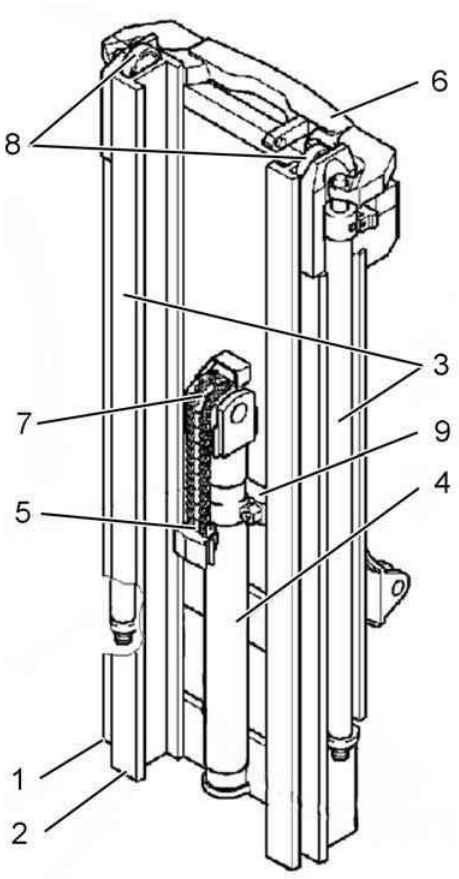
The middle cylinder (4) is installed within the inner mast. The load chain (5) is connected to the middle bridge piece for the inner mast (9) via a clamping bolt. The load chain is redirected by a chain roller (7) on the middle cylinder. The end link of the load chain is connected to the fork carriage.

When the lift cylinders are supplied with hydraulic oil, the lift piston of the middle cylinder extends first, taking with it the fork carriage via the load chain in lift 1.

When the middle cylinder is in the end position, the lift pistons of the outer cylinder extend, taking with them the inner mast in lift 2.

The end stop is in the cylinders.

A run-out barrier prevents the fork carriage from tilting outwards; see the chapter entitled "Run-out barrier".



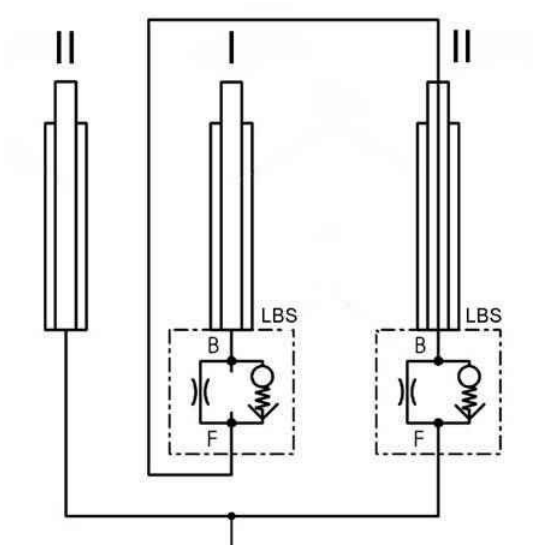
1 Outer mast
2 Inner mast
3 Outer cylinder
4 Middle cylinder
5 Load chain
6 Inner mast crossmember
7 Chain roller
8 Support rollers
9 Middle bridge piece for the inner mast

Hydraulic oil flow within the lift mast

The hydraulic oil comes from the directional control valve block. The hydraulic oil is then distributed via a T-piece and directed down to the two outer cylinders. The right-hand outer cylinder is closed at the top. In the left-hand outer cylinder, the hydraulic oil is directed through the piston rod and then down through a hose line to the middle cylinder.

Due to the varying piston areas, the middle cylinder is always raised first (lift 1) and then the two outer cylinders (lift 2); see the chapter entitled "Lifting sequence problem".

Line break safety valves (LBS) are installed in the outer cylinders and middle cylinder. These valves prevent the load from lowering too quickly in the event of line breakage; see the chapter entitled "Line break safety valve".



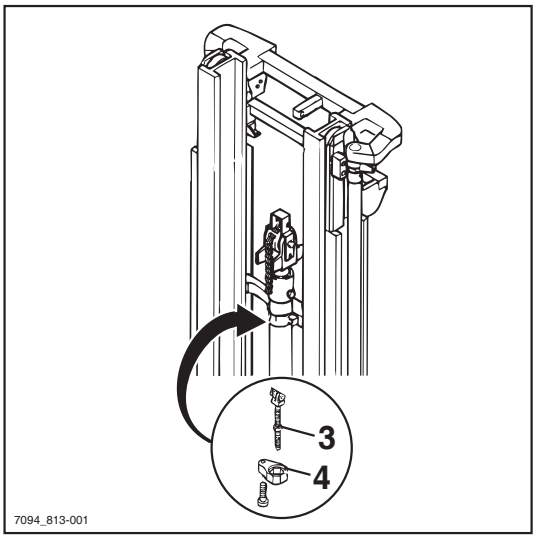
I	Lift 1
II	Lift 2
LBS	Line break safety valve

Adjusting the load chains NiHo lift mast (108/117/130)

Adjusting the load chain

– Lower the lift mast and tilt it back fully.

– Unscrew the screw on the middle cylinder and remove the cap (4).



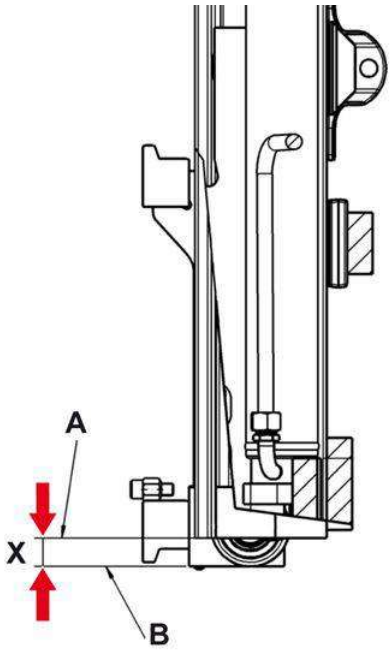
NOTE

The screw (2) features a thread lock.

- *Secure the screw using Loctite 243.*

– Tighten the load chain at the tensioning nut (3) until the dimension (X) is achieved.

Adjustment dimensions:



A	Bottom edge of the inner mast
B	Bottom edge of the support roller
X	Setting dimension

NiHo lift mast 108	
Load capacity [kg]	**Measurement X [mm]**
1000 – 1800	27.5 +0/-2.5

NiHo lift mast 117	
Load capacity [kg]	**Measurement X [mm]**
2000	25.5 +0/-2.5

NiHo lift mast 130	
Load capacity [kg]	**Measurement X [mm]**
2500 – 3000	35.0 +0/-2.5
3500	35.0+0/-2.5

– Screw the cap (1) on tightly using a screw (4). Secure the screw with Loctite.

⚠ CAUTION

Damage due to the fork carriage coming into contact with the run-out barrier!

Never compensate for tyre wear by retightening the load chain because the load chain will then be too short.

Triplex lift mast

Triple lift mast (108/117/130)

Function

The triple mast is a high-visibility lift mast. The mast profile is a double-T profile. The fork carriage and mast profiles are guided through support rollers (8); these also absorb the lateral forces.

The function of the triple lift mast is the same as the NiHo lift mast, but it has an increased lift height with the same overall height.

When the load is lifted, the fork carriage is raised in free lift in lift 1. In free lift, the overall height of the truck does not change. Only in lift 2 is the middle mast also raised, taking the inner mast with it via the outer load chains.

NOTE

Using a 6-roller fork carriage presents an exception in this regard. Even in lift 1, this fork carriage rises a few centimetres above the top of the inner mast, so that the overall height of the truck changes.

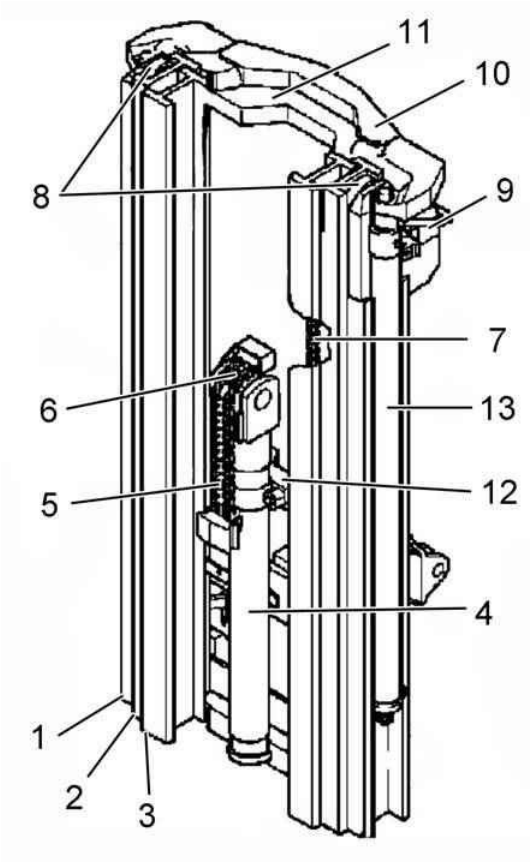
The triple mast consists of an inner mast (3), a middle mast (2) and an outer mast (1). A lift cylinder (13) is fitted on each side in the outer mast profiles. The lift pistons are connected to the middle mast crossmember (10). The middle cylinder (4) is installed within the inner mast.

An outer load chain (7) is connected via a clamping bolt on the upper outer mast crossmember (9) on each side. The load chains are redirected by chain rollers on the middle mast. The end links of the load chains are connected to the inner mast.

The middle load chain (5) is connected to the middle bridge piece for the inner mast (12) via a clamping bolt. The load chain is redirected by a chain roller (6) on the middle cylinder. The end link of the load chain is connected to the fork carriage.

When the lift cylinders are supplied with hydraulic oil, the lift piston of the middle cylinder extends first, taking with it the fork carriage via the middle load chain in lift 1.

When the middle cylinder is in the end position, the lift pistons of the outer cylinder extend, taking with them the middle mast in lift 2 and the inner mast via the outer load chains.



1	Outer mast
2	Middle mast
3	Inner mast
4	Middle cylinder
5	Middle load chain
6	Chain roller
7	Outer load chains
8	Support rollers
9	Outer mast crossmember
10	Middle mast crossmember
11	Inner mast crossmember
12	Middle bridge piece for the inner mast
13	Lift cylinder

The redirection of the outer load chains causes the inner mast to move towards the middle mast at a ratio of 1:2.

The end stop is in the cylinder.

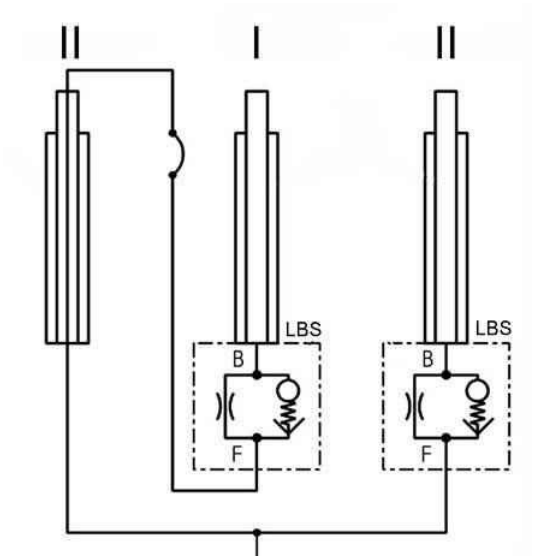
A run-out barrier prevents the fork carriage from tilting outwards; see the chapter entitled "Run-out barrier".

Hydraulic oil flow within the lift mast

The hydraulic oil comes from the directional control valve block, is distributed via a T-piece and is directed below into the two outer cylinders on the left and right. The right-hand outer cylinder is closed at the top. As for the left-hand outer cylinder, the hydraulic oil is directed through the cylinder head and then down through a hose line to the middle cylinder.

Due to the varying piston areas, the middle cylinder is always raised first (lift 1) and then the two outer cylinders (lift 2); see the chapter entitled "Lifting sequence problem".

Line break safety valves (LBS) are installed in the outer cylinders and middle cylinder. These valves prevent the load from lowering too quickly in the event of line breakage; see the chapter entitled "Line break safety valve".



I	Lift 1
II	Lift 2
LBS	Line break safety valve

Removing the support rollers in the lift mast

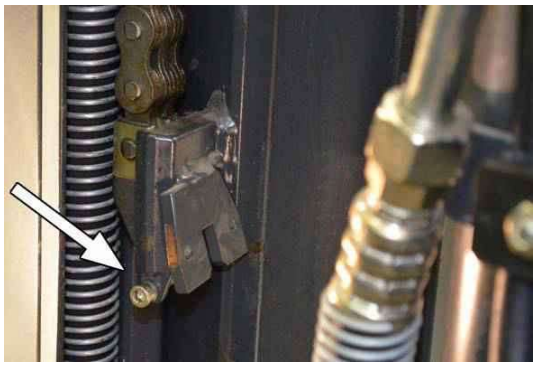
– Safely park the truck.
– Move the lift mast to its vertical position.
– Apply the parking brake.
– Raise the fork carriage and secure it to the inner mast crossmember using the safety chain.

OR:

– Remove the fork carriage; see the chapter entitled "Fork carriage"
– Turn the key switch OFF.
– **For electric forklift trucks**: Disconnect the battery male connector.

Support rollers: bottom of inner mast and top of middle mast

– If necessary, release the pressure from the hydraulics; see the chapter entitled "Releasing the pressure from the hydraulics".
– If necessary, loosen the auxiliary hydraulics hoses on the inner mast.
– Unscrew the load chain locking device on both sides at the bottom of the inner mast. ▷

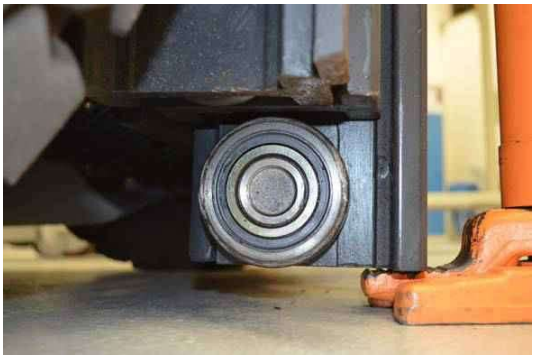


– Using the hydraulic jack, lift the inner mast until the load chains fall out of the lower guide. Set the load chains aside so that they do not become trapped when lowering the inner mast. ▷



– Slowly lower the inner mast until the support rollers are freely accessible at the bottom of the inner mast.

▷



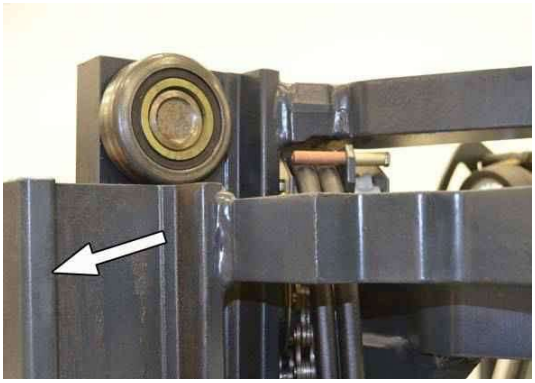
⚠ CAUTION

During the lowering process, the inner mast moves clear of the upper guide and tilts forwards slightly. Hydraulic hoses and other components may become damaged during this process. However the inner mast cannot fall out forwards!

– To avoid any possible damage, lower the hydraulic jack slowly.

– At the same time, the support rollers at the top of the middle mast become free. The inner mast is tilted forwards slightly.

▷



– Remove the 4 support rollers at the top and bottom from the bearing pins.
– Clean the bearing pins and fit new support rollers, adding shim rings as required.
– Adjust the play of the support rollers; see the chapter entitled "Support roller play"

Support rollers: bottom of middle mast and top of outer mast

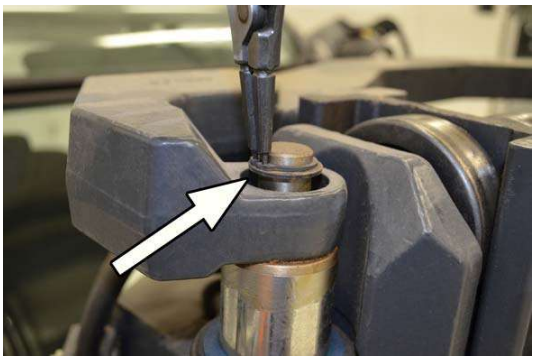
– Use the hydraulic jack to lift the inner mast until it is once again guided by the upper support roller on the middle mast.
– Place the inner mast on a flat supporting block. The inner mast must be placed in as low a position as possible to ensure there is sufficient room to remove the upper support roller from the bearing pin.

▷



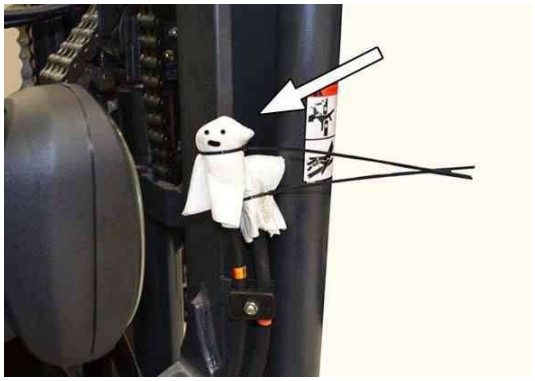
– At the top of the middle mast crossmember, disassemble the locking rings from the piston rods.

▷



– Left hand side: Unscrew the pipe line from the hydraulic adapter.
– Unscrew the auxiliary hydraulics hoses from the middle mast.

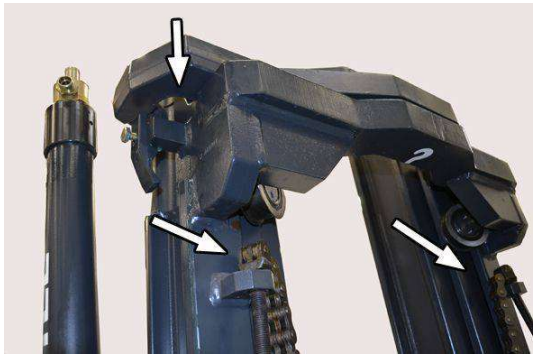
– Release the hydraulic hoses and protect them from contamination.
– Unscrew the hose guide from the chain roller.
– Unscrew the hose clips from the outer mast.



– Unscrew the tensioning pieces on the lift cylinders.
– Using the hydraulic jack, lift the middle mast until the lift cylinders are no longer guided in the middle mast crossmember.
– Move the lift cylinders aside.



– Remove the load chains from the chain roller and the outer mast crossmember.
– Remove the hose guide from the outer mast crossmember.



– Lower the middle mast as far as the outer mast crossmember and support it on a supporting block.
– If necessary, lower the inner mast until the bottom support rollers on the middle mast are freely accessible. Support the middle mast and inner mast on a supporting block.

NOTE

Do not lower the masts to the ground. It must be possible to bring the hydraulic jack into position to raise the masts!



– At the same time, the support rollers at the top of the outer mast become free.
– Remove the 4 support rollers at the top and bottom from the bearing pins.
– Clean the bearing pins and fit new support rollers, adding shim rings as required.
– Adjust the play of the support rollers; see the chapter entitled "Support roller play"

▷



Assembling the lift mast after replacing the support rollers

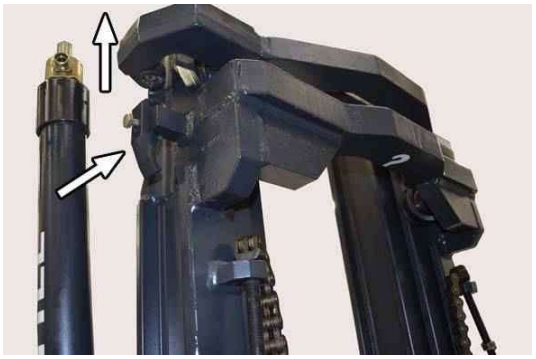
– Initial position after replacing the support rollers.

▷



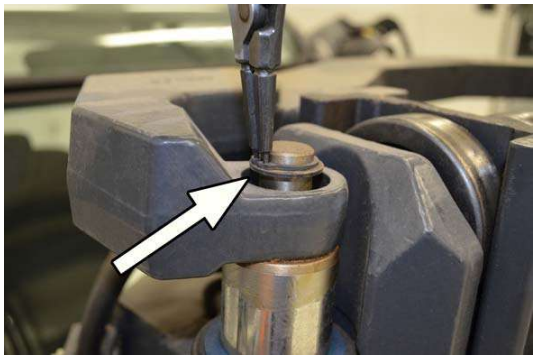
– Using a hydraulic jack, raise the middle mast until the chain rollers are above the outer mast crossmember.
– Loosely position the two lift cylinders using the tensioning pieces but do not tighten the tensioning piece at this point.
– Place the outer load chain over the chain roller, making sure that the chain anchor is in the correct position.
– Bring the hydraulic hoses with hose guide into position, but do not screw them tightly into place at this point. Connect the hydraulic hoses.
– Slowly lower the middle mast until the lift cylinders are routed through the middle mast crossmember.

▷



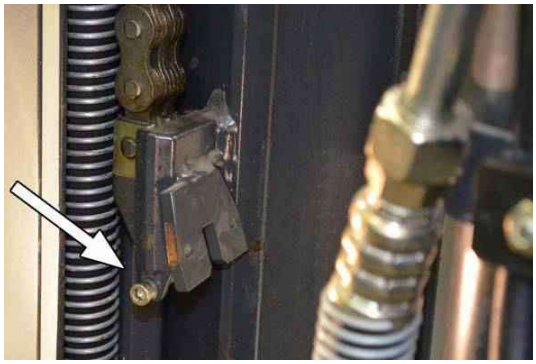
– Fit the locking rings for the piston rods on to the middle mast crossmember.

▷



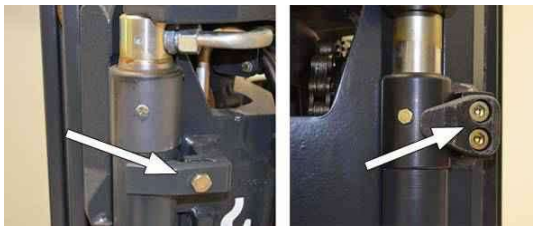
– Insert the load chains into the bottom of the inner mast and secure using the locking screw. If necessary, lift the inner mast for this purpose.
– Remove the supporting block from under the middle mast. The middle mast is now suspended on its load chains.

▷



– Tighten the tensioning pieces so that the lift cylinders are securely positioned.
– Left hand side: Screw the pipe line on to the hydraulic adapter.
– Screw the hose clips on to the outer mast.
– Screw the auxiliary hydraulics hoses on to the middle mast.
– Use the second truck to lift the fork carriage into the lift mast from above. See the chapter entitled "Installing the fork carriage"
– Adjust the load chains and tension them equally; see the chapter entitled "Adjusting the load chains"
– Screw the hose guide on tightly and tension the hydraulic hoses. The hydraulic hoses must not suffer impacts during operation.
– Perform a functional test and leak test.

▷



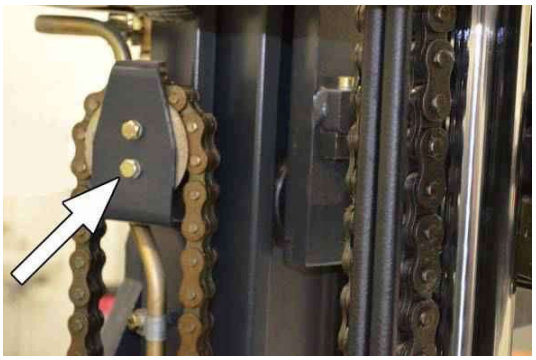
Outer load chains and chain rollers

Removing the outer load chains and chain rollers

- Safely park the truck.
- Move the lift mast to its vertical position.
- Apply the parking brake.
- Raise the fork carriage and secure it to the inner mast crossmember using the safety chain.
- Turn the key switch OFF.
- **For electric forklift trucks:** Disconnect the battery male connector.
- Lift the inner mast using a hydraulic jack so that the load chains hang loose. Using supporting blocks, secure the inner mast. ▷



- Unscrew the chain guide from the chain rollers on both sides.
- Remove the load chains from the chain rollers. ▷



- Remove the chain roller from the bearing pin, using a puller if necessary.
- Remove the load chains from the inner mast crossmember at the bottom and unscrew the load chains from the outer mast at the top. ▷



Installing the outer load chains and chain rollers

- Clean the bearing pins and coat them with multi-purpose oil.

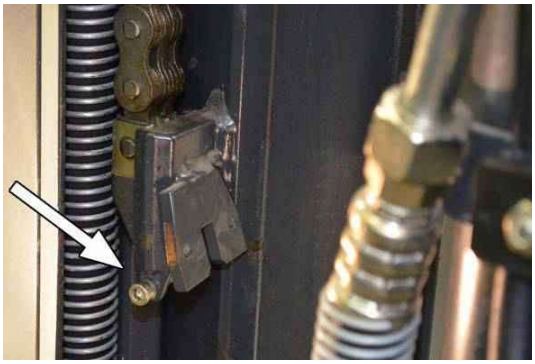
– Position the chain roller on the bearing pin. Using a hammer, carefully tap the inner ring.
– Place the load chain over the chain roller, noting the installation direction of the chain.
– Screw on the clamping bolt for the load chains to the top of the outer mast crossmember.

▷



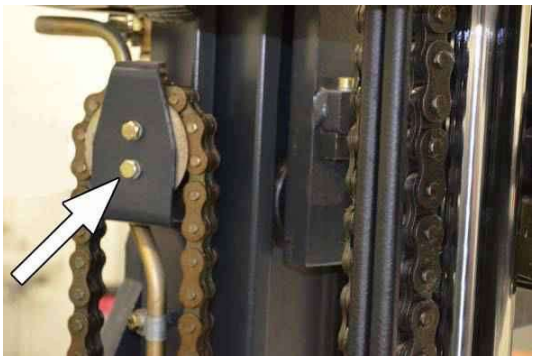
– Attach the chain anchor for the load chains in the inner mast at the bottom and secure using the locking screw.

▷



– Screw on the chain guide, together with the hose guide if necessary.
– Remove the supporting blocks from under the inner mast.
– **For electric forklift trucks:** Connect the battery male connector.
– Lift the fork carriage slightly, remove the safety chain and lower the fork carriage.
– Adjust the outer load chains; see the chapter entitled "Adjusting the outer load chains".

▷

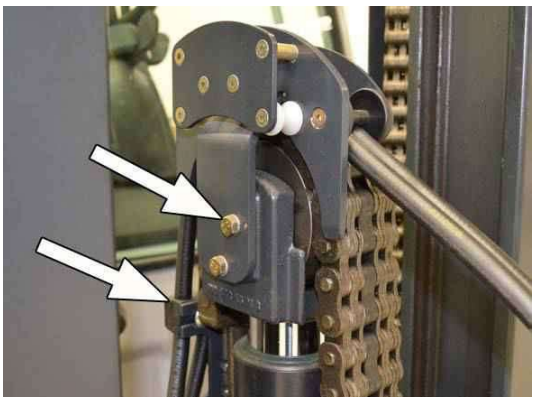


Middle load chain and chain roller

Removing the middle load chain and chain roller

- Safely park the truck.
- Move the lift mast to its vertical position.
- Apply the parking brake.
- Raise the fork carriage and place it on supporting blocks so that the load chain hangs loose.
- Turn the key switch OFF.
- **For electric forklift trucks:** Disconnect the battery male connector.
- **For auxiliary hydraulics:** Remove the hoses from the support and unscrew the hose guide from the fork clevis. Put everything to one side.
- Remove the load chain from the chain roller.

▷



- Press the chain roller pin out of the fork clevis. Remove the chain roller and set the spacer washers to one side.
- Detach the load chain on the fork carriage and unscrew it from the inner mast crossmember.

▷



Installing the middle load chain

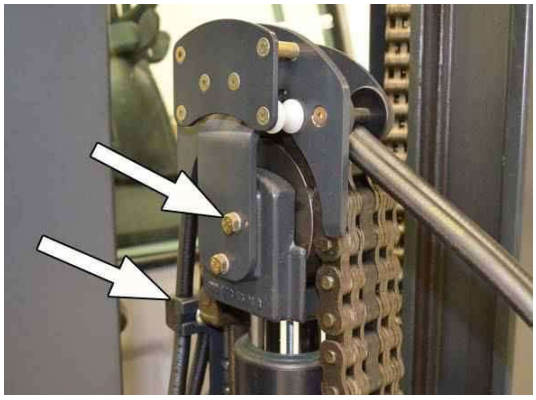
- Clean the fork clevis and coat it with multi-purpose oil.
- Insert the chain roller with spacer washers into the fork clevis. When doing so, note the installation position of the bolt.
- Place the load chain over the chain roller, noting the direction of the chain.
- Attach the load chains to the fork carriage and screw onto the inner mast crossmember.

▷



– **For auxiliary hydraulics:** Screw the hose guide onto the fork clevis and screw on the support for the hoses.
– **For electric forklift trucks:** Connect the battery male connector.
– Lift the fork carriage, remove the supporting blocks and lower the fork carriage.
– Adjust the middle load chain; see the chapter entitled "Adjusting the middle load chain".

▷



Adjusting the outer load chains Triple lift mast (108/117/130)

Adjusting the load chains

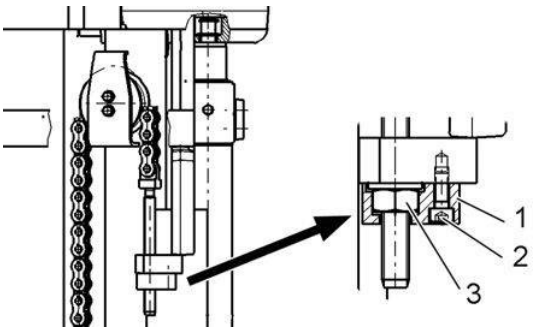
NOTE

Adjusting the outer load chain only ensures that the masts are flush with each other. The fork carriage position is adjusted via the middle load chain

– Lower the lift mast and tilt it back fully.

– Unscrew the screw (2) on each side of the outer mast and remove the cap (1).

▷



NOTE

The screw (2) features a thread lock.

- *Secure the screw using Loctite 243.*

– Tension both load chains equally at the clamping bolts (3) until the bottom edges of the middle mast, inner mast and outer mast are flush with each other.

▷



– Screw the cap (1) tightly into place on both sides using the screw (2).

⚠ CAUTION

Damage due to the fork carriage coming into contact with the run-out barrier!

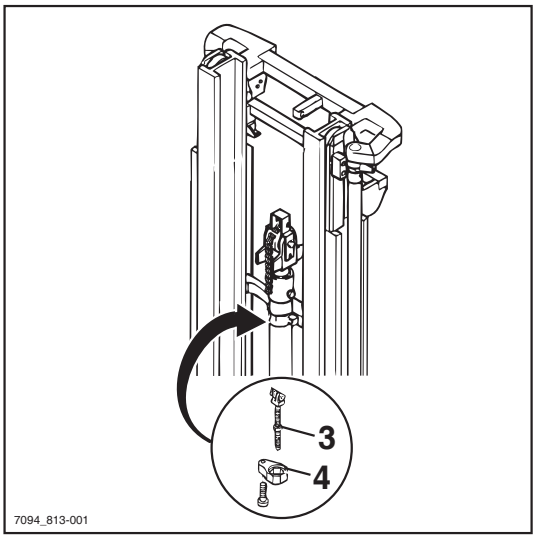
Never compensate for tyre wear by retightening the load chain because the load chain will then be too short.

Adjusting the middle load chain Triple lift mast (108/117/130)

Adjusting the load chain

– Lower the lift mast and tilt it back fully.

– Unscrew the screw on the middle cylinder and remove the cap (4).



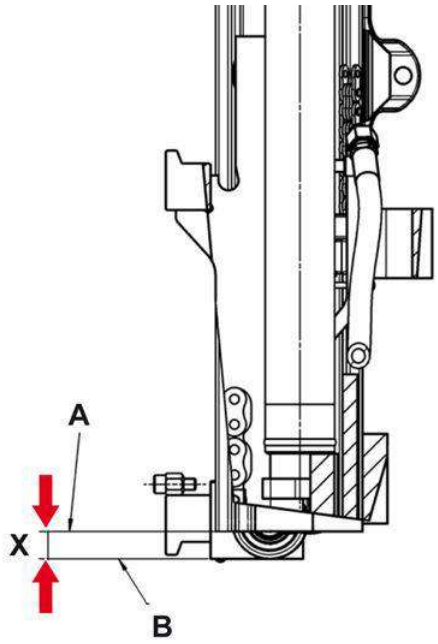
NOTE

The screw (2) features a thread lock.

- *Secure the screw using Loctite 243.*

– Tighten the load chain at the tensioning nut (3) until the dimension (X) is achieved.

Adjustment dimensions:



A	Bottom edge of the inner mast
B	Bottom edge of the support roller
X	Setting dimension

Triple lift mast 108	
Load capacity [kg]	**Measurement X [mm]**
1000 – 1800	27.5 +0/-2.5

Triple lift mast 117	
Load capacity [kg]	**Measurement X [mm]**
2000	25.5 +0/-2.5

Triple lift mast 130	
Load capacity [kg]	**Measurement X [mm]**
2500 – 3000	35.0 +0/-2.5
3500	35.0+0/-2.5

– Screw the cap (1) on tightly using a screw (4). Secure the screw with Loctite.

⚠ CAUTION

Damage due to the fork carriage coming into contact with the run-out barrier!

Never compensate for tyre wear by retightening the load chain because the load chain will then be too short.

Lift cylinder

Lift jack

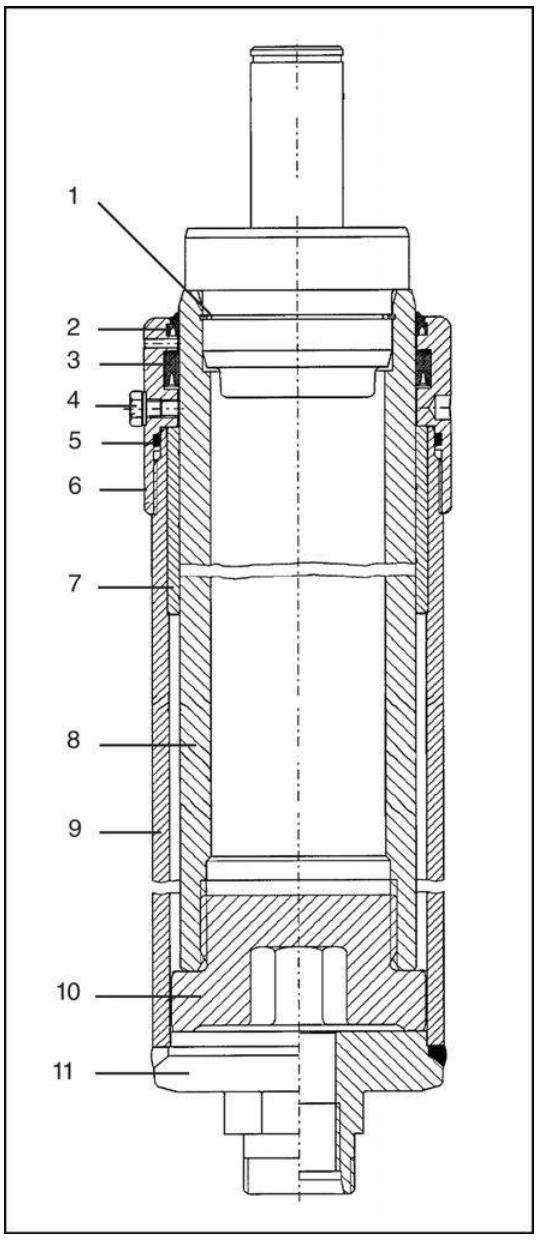
Construction

The lift cylinders are single-action cylinders.

The cylinder pipe is welded to the cylinder bottom. The cylinder head is bolted on to the cylinder pipe and secured using pourable plastics.

The seal between the cylinder head and cylinder pipe, and between the cylinder head and piston rod (piston barrel), is provided in the form of sealing rings. O-rings and grooved rings are used depending on the type of lift cylinder.

The lift is restricted by a piston cover screwed into the piston rod (piston barrel) and secured using pourable plastics.



1	Snap ring
2	Double wiper
3	Grooved ring
4	Bleeder screw with copper seal
5	O-ring
6	Cylinder head
7	Guide bush
8	Piston barrel/piston rod
9	Cylinder pipe
10	Piston cover
11	Cylinder bottom

Working on lift cylinders

Specifications

The following equipment is required to remove the lift cylinders:

- Safety chain and lifting sling with an adequate nominal load
- Supporting blocks
- Hydraulic jack

The following equipment is required to disassemble the lift cylinders:

- Vice
- Protective jaws
- Hot-air gun

⚠ CAUTION

Applying too much heat can lead to thermal damage.

Only heat threads secured with Loctite using a hot-air gun on a selective basis. Do not heat large areas of the thread using a naked flame.

⚠ WARNING

The hydraulic oil is pressurised during operation and is hazardous to your health.

– Do not spill the hydraulic oil.
– Spilt hydraulic oil must be cleaned up immediately using oil-binding agents.
– Comply with statutory regulations for disposal.
– Do not allow hydraulic oil to come into contact with hot motor parts.
– Do not allow hydraulic oil to come into contact with the skin.
– Avoid inhaling spray.
– To avoid injury, use the appropriate protective equipment (protective gloves, industrial goggles, skin protection and skin care products).

Outer cylinder

Removal

– Safely park the truck.
– Set the lift mast to vertical.
– Apply the parking brake.
– Raise the fork carriage and secure it to the inner mast crossmember using the safety chain.
– Lower the fork carriage until the safety chain is taut. The lift cylinders must be fully retracted.
– Turn the key switch OFF.
– **For electric forklift trucks:** Disconnect the battery male connector.

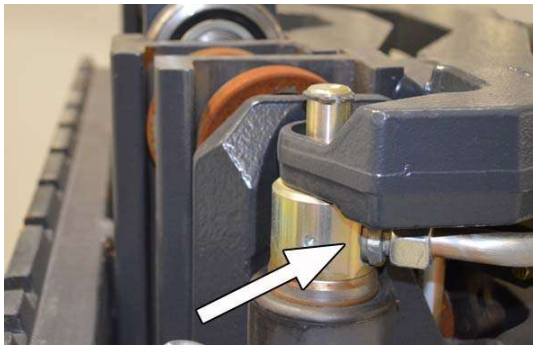
The process for removing the outer cylinders is virtually identical for both sides. Deviations are described in the next section.

– Place collection vessels for hydraulic oil under the outer cylinders.

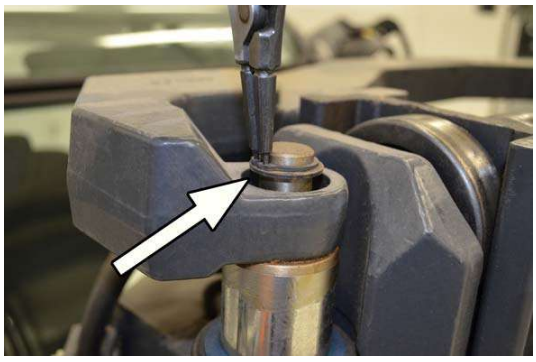
– Unscrew the hydraulic lines from the bottom of the outer cylinders. ▷



– Unscrew the hydraulic connection from the top of the hydraulic adapter. ▷



– At the top of the crossmember, disassemble the locking ring from the piston rods. ▷



– **For telescopic and NiHo lift masts:** Raise the inner mast using a hydraulic jack far enough for the outer cylinder to be accessed at the top on the crossmember. ▷



– **For triple lift masts:** Raise the middle mast using a hydraulic jack far enough for the outer cylinder to be accessed at the top on the crossmember.

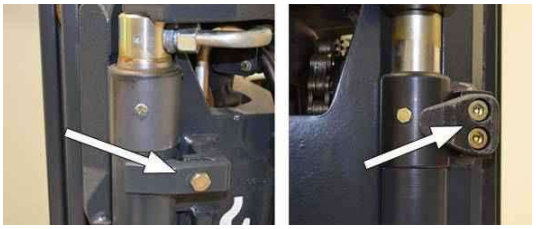


– Unscrew the tensioning pieces.

⚠ WARNING

Risk of injury! Without the tensioning piece, the outer cylinder will tip to the side.

Secure the outer cylinder to prevent it from tipping.

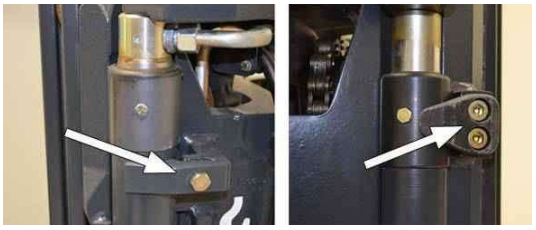


– The outer cylinder swivels to the side. Lift the outer cylinder out of the bottom holding fixture.

Installation

– Place the outer cylinder in the bottom holding fixture on the outer mast.

– Loosely position the outer cylinder using the tensioning piece but do not tighten the tensioning piece at this point.



NOTE

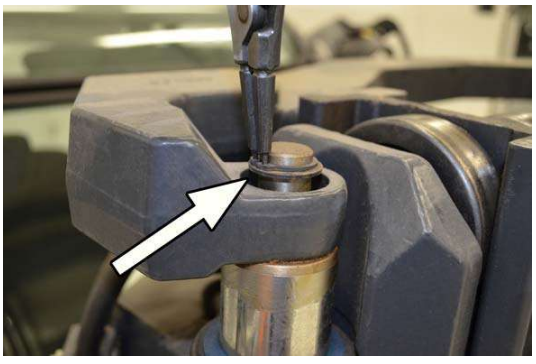
Note the location of the bleeder screw.

- *The bleeder screw faces outwards.*

– **For telescopic and NiHo lift masts:** Lower the inner mast using a hydraulic jack far enough for the outer cylinder to be guided through the crossmember of the inner mast.

– **For triple lift masts:** Lower the middle mast using a hydraulic jack far enough for the outer cylinder to be guided through the crossmember of the middle mast.

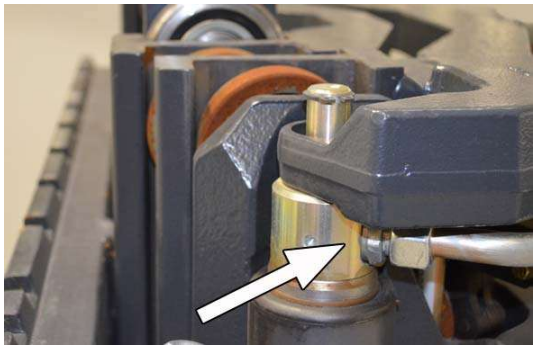
– Assemble the locking ring for securing the lift cylinder on the top of the crossmember.



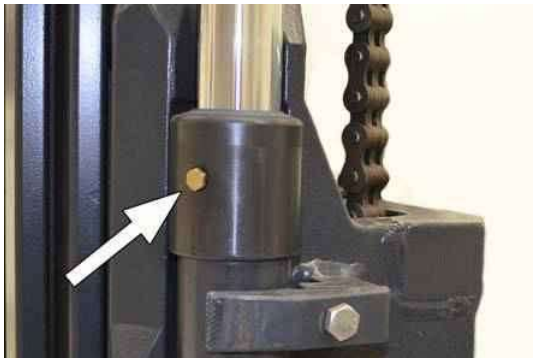
– Screw the hydraulic lines to the outer cylinders. ▷



– Screw the hydraulic connection to the top of the hydraulic adapter.
– Extend the lift cylinder until the safety chain is no longer under tension. ▷



– Open the bleeder screw on the outer cylinder a maximum of one turn.
– Tighten the bleeder screw again as soon as oil starts to leak out.
– Remove the safety chain and slowly lower the fork carriage.
– Check the hydraulics for leaks.
– Check the seating and position of the load chains and hose guides.
– Perform a function check. ▷



Disassembling/assembling the outer cylinder

Disassembling the left-hand outer cylinder

– Pull the piston rod approx. 20 cm out of the cylinder pipe.
– Using protective jaws, clamp the piston rod in the vice.

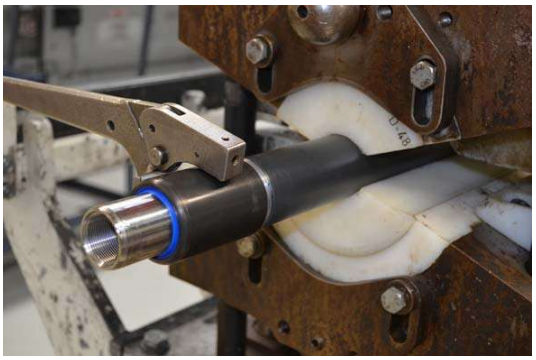
– Unscrew the hydraulic adapter. The hydraulic adapter is secured with Loctite, so it may be necessary to gently heat the thread.

The next steps of the disassembly process are the same for both of the outer cylinders.



Disassembling the left-hand and right-hand outer cylinder

– Using protective jaws, clamp the cylinder pipe loosely in the vice.
– Unscrew the cylinder head using a hook spanner. The cylinder head is secured with Loctite, so it may be necessary to gently heat the thread.
– Remove the cylinder head from the piston rod.
– Remove the set of seals.



Assembling the outer cylinder

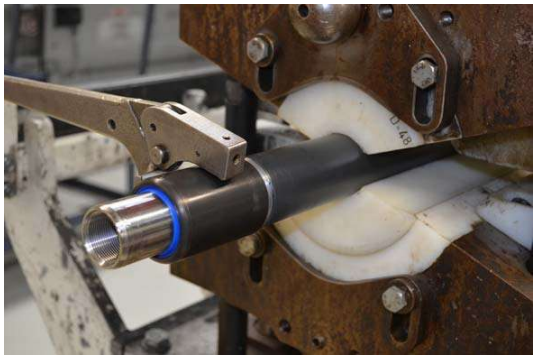
– Clean the cylinder head and check for signs of wear and damage.
– Insert a new set of seals into the cylinder head.
– Lightly coat the seals with hydraulic oil.



– Check the piston rod and the chamfer for damage.
– Clean and degrease the thread on the cylinder pipe and cylinder head.
– Secure the thread by spreading three drops of **Loctite 243** over the entire thread.



– Attach the cylinder head and screw it on as far as it will go using a hook spanner. Secure the cylinder head by knocking the hook spanner with two blows of the hammer.



Assembling the outer cylinder with hydraulic adapter

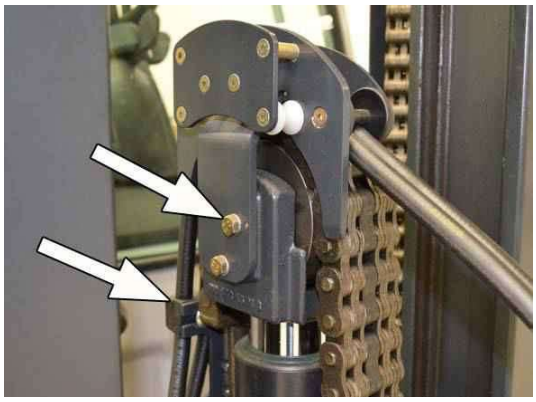
– Pull the piston rod approx. 20 cm out of the cylinder pipe.
– Using protective jaws, clamp the piston rod in the vice.
– Clean and degrease the thread in the cylinder pipe and hydraulic adapter.
– Secure the thread by spreading three drops of **Loctite 275** over the entire thread.
– Attach the hydraulic adapter and screw it on as far as it will go.



Centre cylinder

Removal

– Safely park the truck.
– Put the lift mast in its vertical position.
– Apply the parking brake.
– **For auxiliary hydraulics:** Remove the hoses from the support and unscrew the hose guide from the fork bearing. Put everything to one side.
– Raise the fork carriage and secure it to the inner mast crossmember using the safety chain.
– Fully lower the middle cylinder, ensuring that the load chain remains at the top.
– Turn the key switch OFF.
– **For electric forklift trucks:** Disconnect the battery male connector.



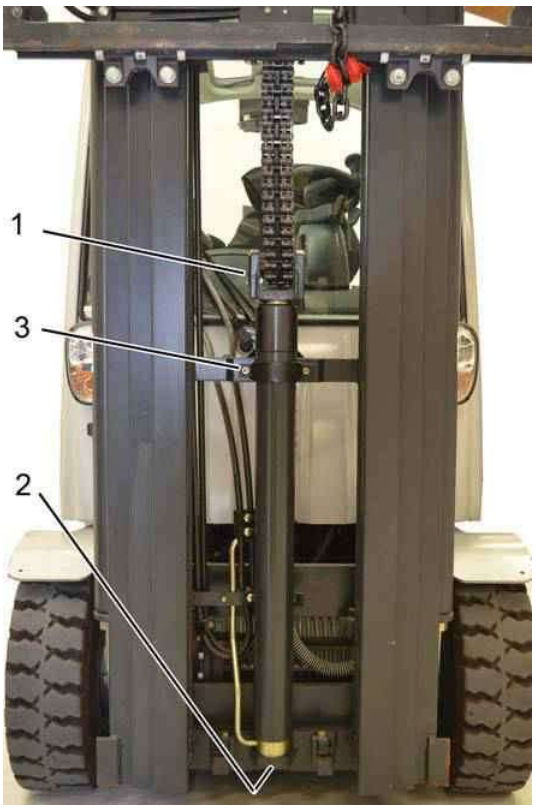
– Remove the chain roller pin from the fork bearing. Remove the chain roller and set the spacer washers to one side (1).
– Place a collection vessel for hydraulic oil under the middle cylinder.
– Release the hydraulic connection on the cylinder bottom (2) and protect against contamination.
– Unscrew the clip or tensioning piece from the middle bridge piece for the inner mast (3).

⚠ WARNING

Without the tensioning piece, the middle cylinder is not secured and may tip forward.

Secure the middle cylinder from tilting outwards by accident.

– Lift out the middle cylinder.



Installation

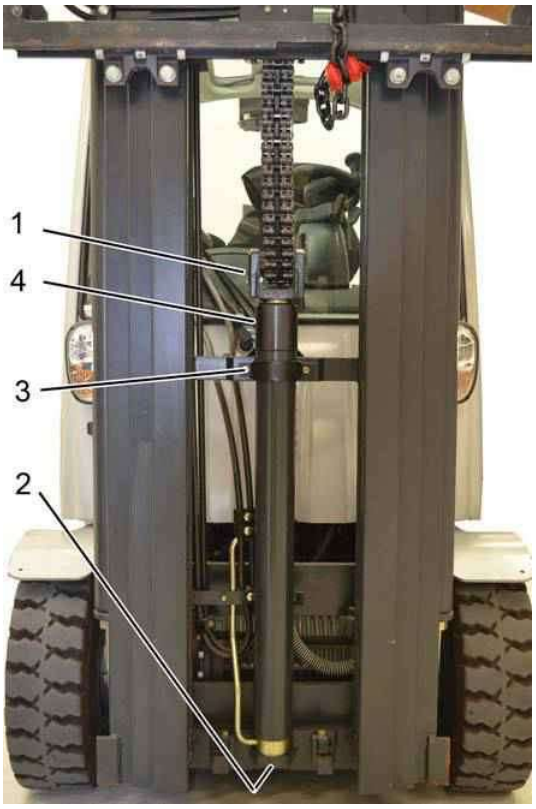
– Position the middle cylinder within the inner mast (2) and secure the middle cylinder in place using the clip or tensioning piece (3). Do not tighten the tensioning piece.

NOTE

Note the location of the bleeder screw (4).

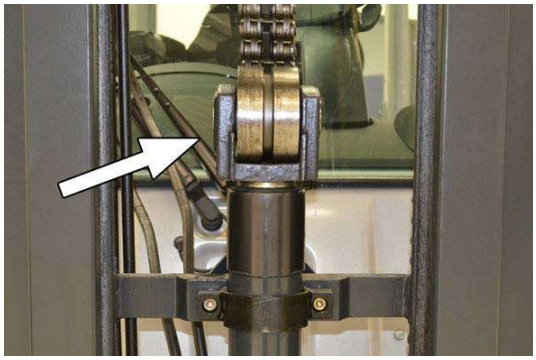
- *The bleeder screw points to the left or to the right by ± 30°*

– Screw the hydraulic connection with the sealing ring to the cylinder bottom (2).
– Tighten the clip or tensioning piece to the middle bridge piece for the inner mast (3).



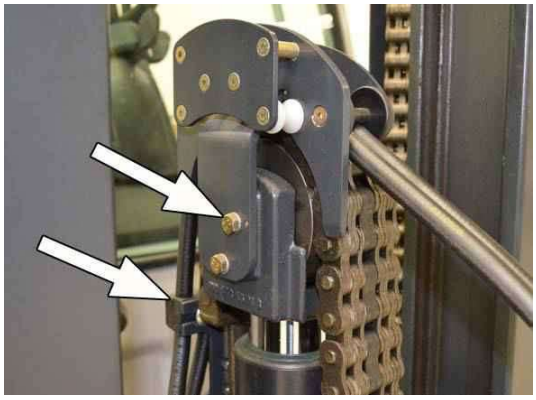
– Insert the chain roller with spacer washers into the fork bearing (1). When doing so, note the installation position of the bolt. See the chapter entitled "Middle load chain and chain roller".

▷



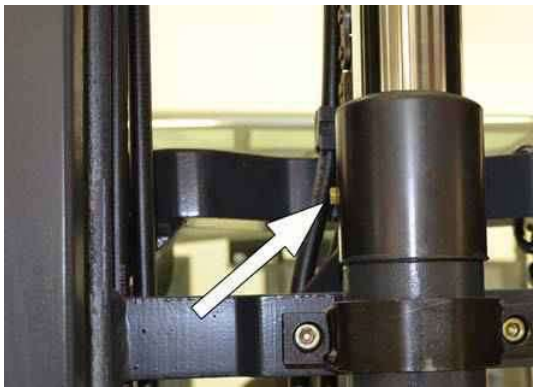
– Screw the hose guide and hoses to the fork bearing.
– Extend the lift cylinder until the safety chain is no longer under tension.

▷



– Loosen the bleeder screw on the middle cylinder by a maximum of one rotation.
– Screw the bleeder screw back in as soon as oil starts to leak out.
– Remove the safety chain and slowly lower the fork carriage.
– Check the hydraulics for leaks.
– Check the seating and position of the load chains and hose guides.
– Perform a function check.

▷

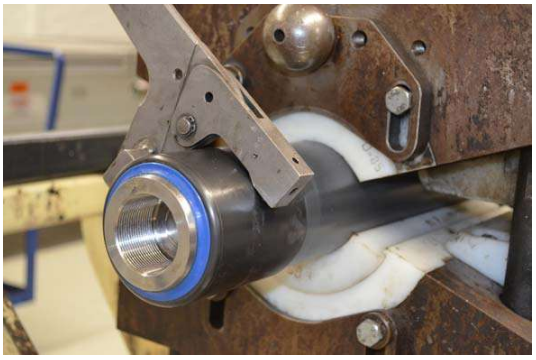


Disassembling/assembling the middle cylinder

Disassembly

– Pull the piston rod approx. 20 cm out of the cylinder pipe.
– Using protective jaws, clamp the piston rod loosely in the vice.
– Unscrew the fork clevis. The fork clevis is secured with Loctite, so it may be necessary to gently heat the thread.

– Using protective jaws, clamp the cylinder pipe in the vice.
– Unscrew the cylinder head using a hook spanner. The cylinder head is secured with Loctite, so it may be necessary to gently heat the thread.



– Remove the cylinder head from the piston rod.
– Remove the set of seals.

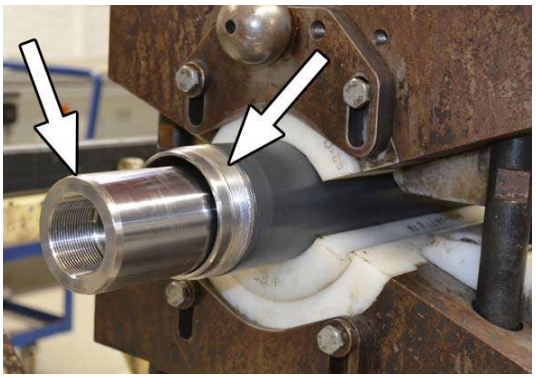


Assembly

– Clean the cylinder head and check for signs of wear and damage.
– Insert a new set of seals into the cylinder head.
– Lightly coat the seals with hydraulic oil.

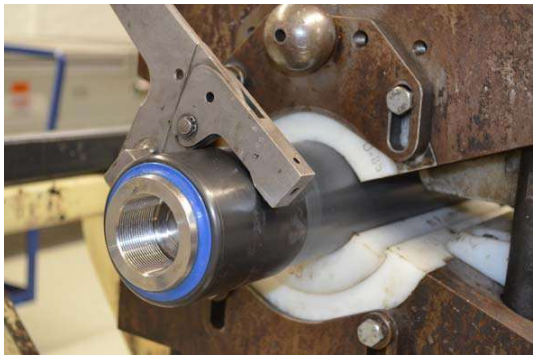


– Check the piston rod and the chamfer for damage.
– Clean and degrease the thread in the cylinder pipe and cylinder head.
– Secure the thread by spreading three drops of **Loctite 243** over the entire thread.



- Attach the cylinder head and screw it on as far as it will go using a hook spanner. Secure the cylinder head into its final position by knocking the hook spanner with two blows of the hammer.
- Clean and degrease the thread in the cylinder pipe and fork clevis.
- Secure the thread by spreading three drops of **Loctite 243** over the entire thread.
- Attach the fork clevis and screw it on as far as it will go. Secure the fork clevis into its final position by knocking it with three blows of the hammer.

▷



End position damping, type B (bottom)

General

While lowering during lift 2, the end position damping hydraulically brakes the piston rod of the right-hand outer cylinder just before it reaches its end position.

This prevents metal striking on metal.

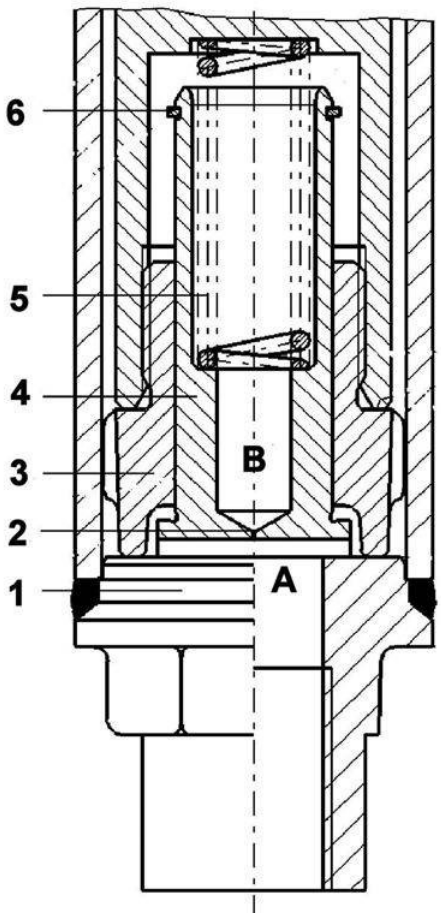
The right-hand outer cylinder is equipped with end position damping. In telescopic lift masts, end position damping is not installed.

Function

During lifting, the piston (4) is moved towards the cylinder bottom (1) by the spring force of the compression spring (5) until the snap ring (6) lies against the piston cover (3). The hydraulic oil is unrestricted as it flows out of the cylinder.

During lowering, the oil flows out of the cylinder unrestricted until the piston (4) reaches the cylinder bottom (1). The piston (4) is moved into the piston cover (3). As a result, the hydraulic oil flows from area (B) into area (A) via the orifice bore (2).

This pressure balancing brakes the lift mast hydraulically.



1 Reducer bore
2 Piston cover
3 Piston
4 Compression spring
5 Snap ring

End position damping, type A (top)

General

When lifting the fork carriage, the end position damping hydraulically brakes the piston rod just before it reaches its end position.

The end dampener is located in the piston cover.

Function

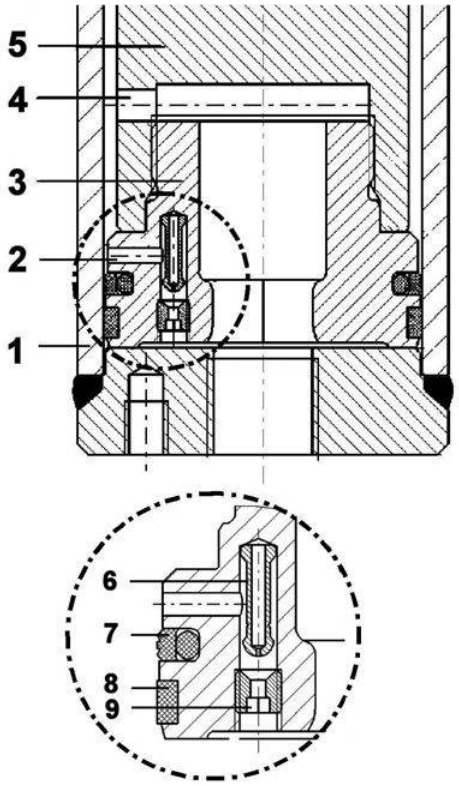
The piston rod (5) extends until the cross hole in the piston rod (4) is covered by the cylinder pipe (1). The lifting speed is reduced as soon as the cross hole is covered by the cylinder pipe.

Once the cross hole of the piston rod (4) is entirely covered by the cylinder head, the returning hydraulic oil has no direct return path.

As a result of the increasing pressure in the cross hole inside the piston cover (2), the valve piston (6) is forced into contact with the threaded pin (9).

The hydraulic oil flows back at a restricted rate via the cross hole (2), the orifice bore in the valve piston (6) and the threaded pin (9).

As a result, the piston rod is hydraulically braked before reaching its end position.



1 Cylinder pipe
2 Cross hole in piston cover
3 Piston cover
4 Cross hole in piston rod
5 Piston rod
6 Valve piston
7 Piston packing
8 Guide ring
9 Threaded pin

Fork carriage

Fork carriage

Removal

– Safely park the truck.

– Apply the parking brake.

– Put the lift mast in its vertical position.

– Remove the fork arms.

– If necessary, depressurise the hydraulics; see the chapter entitled "Depressurising the hydraulics".

– Depending on the equipment fitted, remove the attachment and auxiliary hydraulics hoses.

– Raise the fork carriage to a comfortable working height.

– Unscrew the hose guide from the fork carriage.

– Turn the key switch OFF.

– **For electric forklift trucks:** Disconnect the battery male connector.

– Unscrew the run-out barrier at the top of the inner mast.

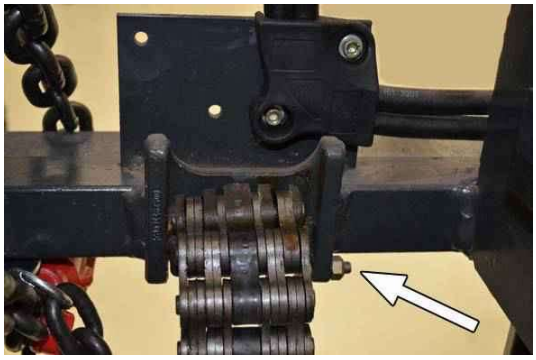
– Attach a suitable lifting sling to the fork carriage.

– Hook the lifting sling onto the forks on the second truck and secure in such a way that it cannot slip off the forks during the lifting process.

NOTE

- *For NiHo and triple lift masts, a middle load chain is used*
- *For telescopic lift masts, two outer load chains are used*

– Unscrew the load chain locking device on the fork carriage. ▷



– Detach the load chains from the fork carriage.

– Use the second truck to lift the fork carriage up and out of the lift mast.

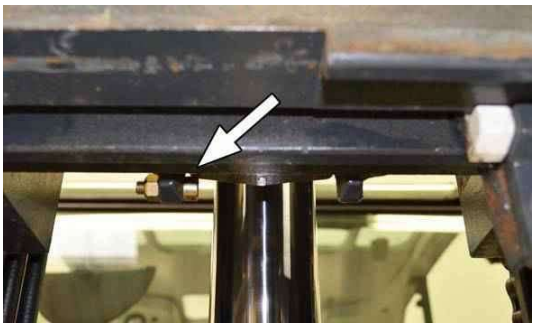
– Place the fork carriage on a EUR-pallet.

Installation

– Use the second truck to lift the fork carriage into the lift mast from above.

– Lower the fork carriage to a comfortable working height.

– Attach the load chains to the fork carriage.
– Screw in the load chain locking device on the fork carriage. Ensure that the screw overlaps the chain anchor sufficiently.



NOTE

If the fork carriage jams in the inner mast during assembly, gently tilt the lift mast back and forth in order to advance the fork carriage into the inner mast.

– Continue to lower the fork carriage until the load chain is taut.
– Remove the lifting sling from the fork carriage.
– Adjust the play of the support rollers; see the chapter entitled "Support roller play".
– Attach the fork arms. Depending on the equipment installed, fit the attachment and the auxiliary hydraulics hoses to the fork carriage.
– Function checking

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Workshop literature

Electric forklift truck

RX20-15 - 20, RX60-16 - 20



CE

6209 6210 6211 6212 6213 6214
6215 6216 6217 6311 6313 6315

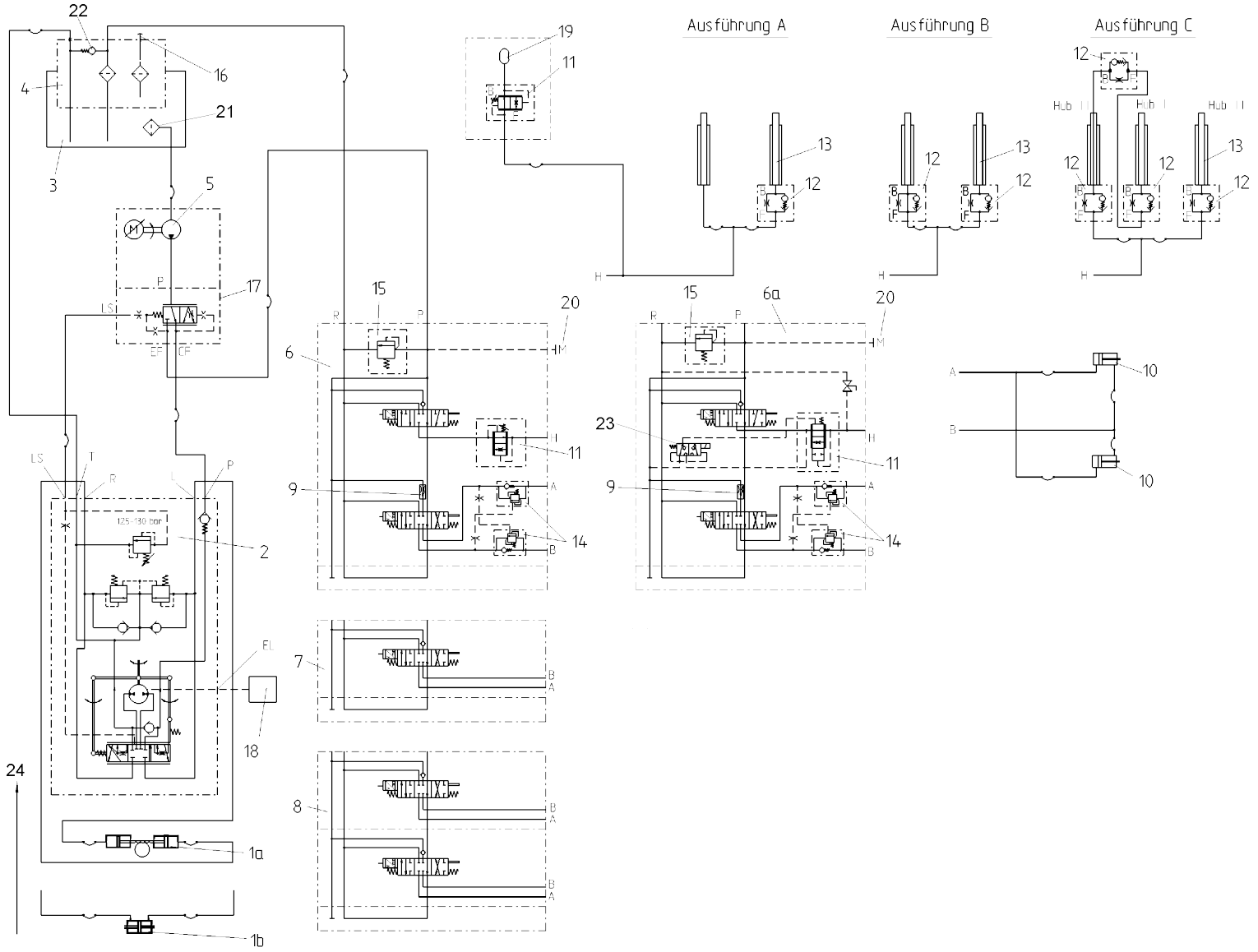
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Annex

Hydraulics

Hand lever until calendar week 38/2009



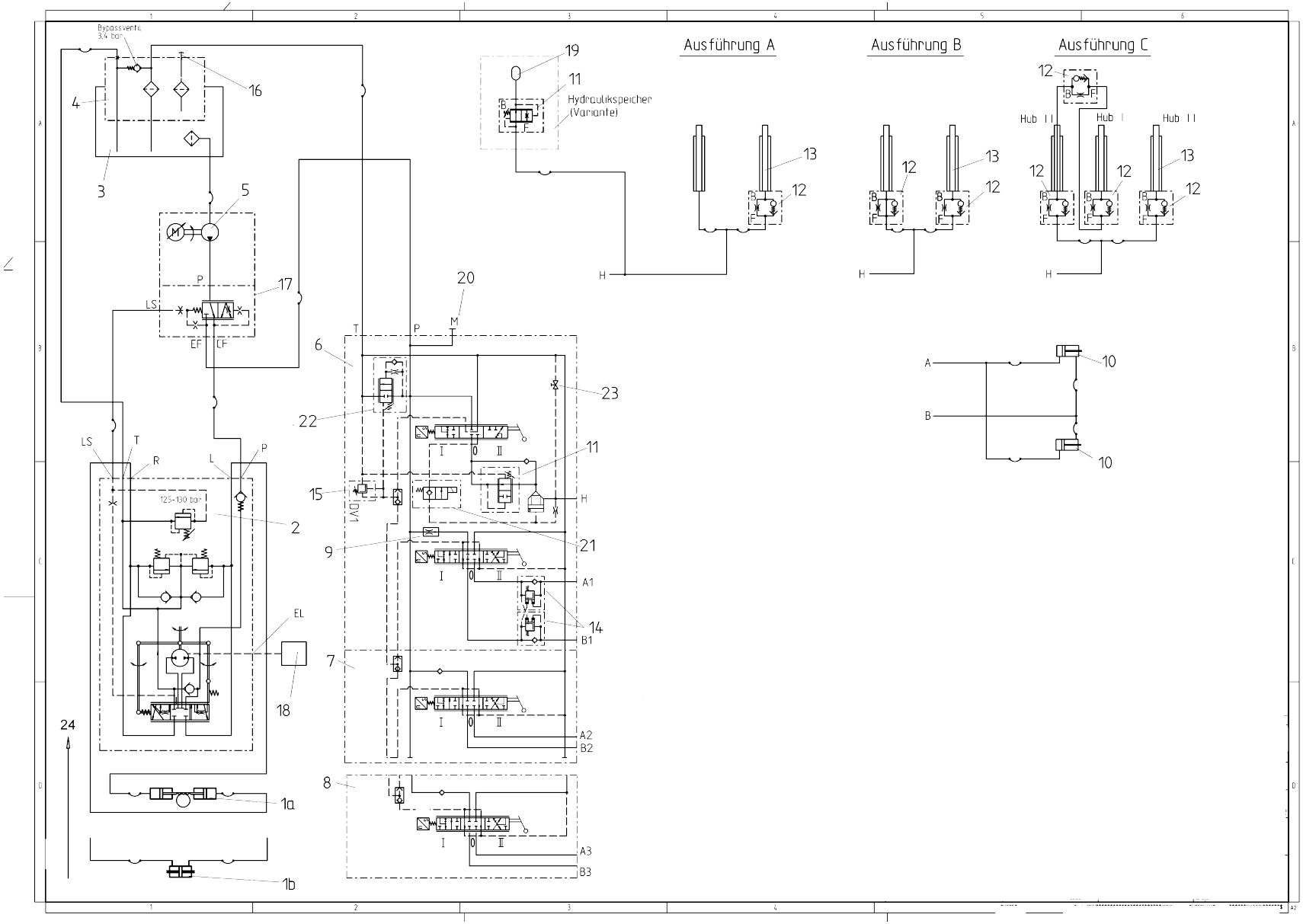
Hydraulics

1a	Steering cylinder fifth wheel axle	6a	Directional control valve block (version as of 2006)	13	Lift cylinders
1b	Steering cylinder swing axle	7	Directional control valve block - auxiliary hydraulics 1	14	Load holding valve
2	Steering unit	8	Directional control valve block - auxiliary hydraulics 2	15	Pressure relief valve
3	Hydraulic tank	9	Tilt orifice	16	Breather
4	Return filter	10	Tilt cylinder	17	Priority valve
5	Pump unit	11	Lowering brake	18	Pressure switch
6	Directional control valve block (lift/tilt)	12	Line breakage protection	19	Hydraulic accumulator (variant)

20	Mini measurement port				
21	Suction filter				
22	By-pass valve				
23	Release valve				
24	Direction of travel (steering cylinder)				

Hydraulic version according to lift mast				
Load capacity [kg]	Overall height [mm]	Tele-scopic	NiHo	Triple
1500 - 1800	≤ 2760	A	–	–
1500 - 1800	≥ 2810	B	–	–
1500 - 2000	≤ 2710	–	C	–
1500 - 2000	≤ 3260	–	–	C
2000	≤ 3260	A	–	–

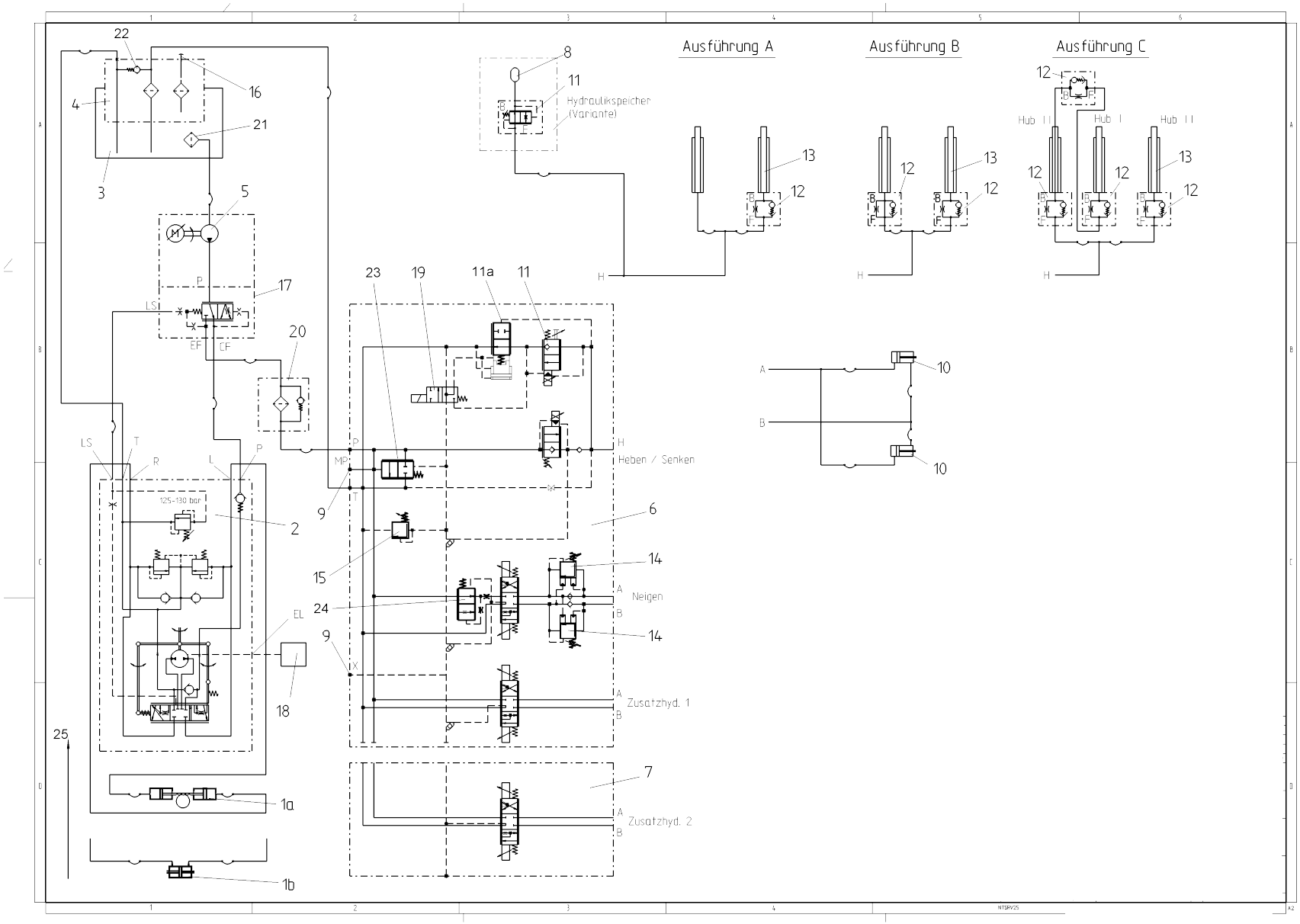
Hand lever from calendar week 39/2009



1a	Steering cylinder, turntable steering axle	7	Directional control valve block - auxiliary hydraulics 1	14	Load holding valve (125 bar)	21	Check valve for hydraulics blocking function
1b	Steering cylinder, swing axle	8	Directional control valve block - auxiliary hydraulics 2	15	Pressure relief valve (250 bar)	22	Pressure-balance valve
2	Steering unit	9	Tilt orifice	16	Breather filter	23	Emergency lowering
3	Hydraulic tank	10	Tilt cylinder	17	Priority valve	24	Drive direction (steering cylinder)
4	Return line filter	11	Lowering-balance valve	18	Pressure switch (electrical NC contact)		
5	Pump unit	12	Line break safety device	19	Hydraulic accumulator (variant)		
6	Directional control valve block - lifting/tilting	13	Lift cylinder	20	Mini measurement port		

Hydraulic version according to lift mast				
Load capacity [kg]	Overall height [mm]	Tele-scopic	NiHo	Triple
1500 - 1800	≤ 2760	A	–	–
1500 - 1800	≥ 2810	B	–	–
1500 - 2000	≤ 2710	–	C	–
1500 - 2000	≤ 3260	–	–	C
2000	≤ 3260	A	–	–

Servo hydraulics



Hydraulics

1a	Steering cylinder fifth wheel axle	9	Mini measurement port	17	Priority valve
1b	Steering cylinder swing axle	10	Tilt cylinder	18	Pressure switch
2	Steering unit	11	Valve for lowering	19	Check valve for hydraulics blocking function
3	Hydraulic tank	11a	Lowering brake	20	High-pressure filter
4	Return filter	12	Line breakage protection	21	Suction filter
5	Pump unit	13	Lift cylinders	22	By-pass valve
6	Directional control valve block - Lift-Tilt-Auxiliary 1	14	Load holding valve	23	Pressure governor
7	Directional control valve block - Lift-Tilt-Auxiliary 1, 2	15	Pressure relief valve	24	Flow control valve
8	Hydraulic accumulator (variant)	16	Breather	25	Direction of travel (steering cylinder)

Hydraulic version according to lift mast				
Load capacity [kg]	**Overall height [mm]**	**Tele-scopic**	**NiHo**	**Triple**
1500 - 1800	≤ 2760	A	–	–
1500 - 1800	≥ 2810	B	–	–
1500 - 2000	≤ 2710	–	C	–
1500 - 2000	≤ 3260	–	–	C
2000	≤ 3260	A	–	–

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