Workshop literature

Electric forklift truck

RX60-25 - 35, RX60-40 - 50

RX60-25
RX60-30
RX60-35
RX60-40
RX60-45
RX60-50

CE

6321 6322 6323 6324 6325 6327
6328 6329 6330 6361 6362 6364
6367 6368 6369

171861 EN - 10/2015

first in intralogistics

Expansion of the series

With the RX60-50/600, a compact RX60-50 with a load centre of gravity 600 mm has been available since April 2010. The truck is 77 mm longer than the established RX60-50. Due to the higher load centre of gravity, changes have been made to this truck in comparison to the familiar RX60-50.

Changes:

- Reinforced chassis
- Reinforced lift mast with special mast rollers in connection with reduced nominal lift
- Reinforced fork carriage, standard FEM class 3
- Reinforced tilt cylinder with tilt angle 3° forwards and 6° backwards
- New steering axle
- New counterweight

Aside from a few exceptions, all variants of the established RX60-50 series are available.

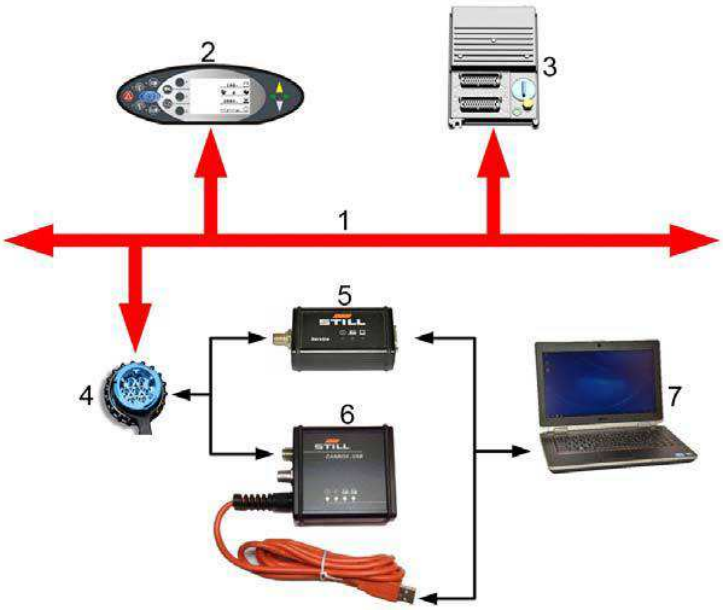
Exceptions:

- Speed reduction dependent on the steering angle
- Hydraulic battery carrier
- Integrated sideshifts

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 battery door, interlock and sensor for correct function and for damage														
Check the dual pedal variant for damage and correct function, and lubricate														
Tyres and wheels														
Check tyres for wear and check the air pressure														
Check wheels for damage and check the tightening torques														
Power unit														
Drive axle: Check mounting, check for leaks, and clean cooling fins														
Gearbox oil and multi-disc brake: Check oil level														
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														
Check the electric parking brake variant for damage and correct function														
Electric parking brake variant: Check 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 battery for damage and acid density; observe manufacturer's maintenance instructions														
Check battery male connector and cable for damage														
Hydraulic battery carrier: Check oil level and check for leaks														
Hydraulic battery carrier: Check all moving parts for wear, and lubricate														
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														

Diagnostic set-up



1	Truck CAN bus (red)	5	CAN box, serial
2	Display and operating unit (ABE)	6	CAN box, USB
3	Truck control unit (MCU, TCU)	7	Notebook
4	Diagnostic connector		

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 Sub-D plug or USB cable. In either case, the diagnostics options are always identical.

Connection, notebook with CAN box, USB ▷

The notebook (7) is connected directly to the CAN box via the connecting line.

The CAN box (3) is connected to the diagnostic connector on the truck (1) via the adaptor cable (2).

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

The differential housing with brake control (8) can be found next to the right drive wheel unit (4).

The drive axle is screwed to both sides of the chassis and also acts as a holding fixture for the pump unit (2).

The motor connections U, V, W (5) are fed upwards out of the motor as screw connections.

The speed sensor (7) is fitted in the axle from the outside, sealed with an O-ring and secured with a screw.

The temperature sensor is cast into the stator winding. The plug (6) is fed out of the motor.

Traction motor

The traction motor is a three-phase AC asynchronous motor, which is equipped with short-circuit cage rotors.

Aluminium conductors are fused into the grooving of the rotor core, which are connected at the ends with short-circuit rings. The conductors with the short-circuit rings form the cage rotors 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 motor is powered by an inverter. Change in speed takes place principally via a change in 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 inverter.

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

General technical data
Carraro EC 50

Drive axle	6327 - 6330, 6367 - 6369		
Manufacturer	Carraro, Juli		
Designation	EC 50		
Weight	[kg]	450	
Consumables			
Oil volume, right-hand side	[l]	1.60	Initial filling
Oil volume, right-hand side	[l]	1.52	Oil change
Oil volume, left-hand side	[l]	0.65	Initial filling
Oil volume, left-hand side	[l]	0.57	Oil change
Gearbox oil, incl. service brake	FUCHS TITAN Gear Hyp LD SAE 80W-90		

Connecting elements and tightening torques			
Wheel nuts, per wheel	[Nm]	640	10 x DIN 74361, M20 x 1.5 spherical collar nuts
Screw joint between the drive axle and pump motor	[Nm]	250	Right-hand bearing pin, M24 x 78
		930	Left-hand bearing pin, M24 x 100
Drive axle – chassis screw joint, left side Variant with conical spring washer	[Nm]	930	8 x DIN 933, M24 x 50-10.9 hexagon head screws 9 x DIN 6796 conical spring washers, galvanised
Drive axle – chassis screw joint, right side Variant with conical spring washer	[Nm]	930	9 x DIN 933, M24 x 50-10.9 hexagon head screws 9 x DIN 6796 conical spring washers, galvanised
Drive axle – chassis screw joint, left side Variant with lock washer	[Nm]	1080 Nm $^{+40}_{-20}$	8 x DIN 933, M24 x 50-10.9 hexagon head screws 9 x SK M24 lock washers
Drive axle – chassis screw joint, right side Variant with lock washer	[Nm]	1080 Nm $^{+40}_{-20}$	9 x DIN 933, M24 x 50-10.9 hexagon head screws 9 x SK M24 lock washers

Conical spring washer DIN 6796 ▷

Repair

The right drive wheel unit (3) can only be procured as a spare part together with the bearing shield (2). The differential gearbox and brake are integrated in the bearing shield.

The left drive wheel unit (1) is available as an individual part and is structurally identical to the right drive wheel unit.

For repairs to the outer drive wheel unit, the left drive wheel unit (1) can be used as a spare part for both sides.

Possible errors if the drive wheel unit is faulty:

- Damaged wheel screws
- Faulty wheel bearings and seals
- Noises in the planetary transmission

NOTE

Repairs to the drive wheel unit are difficult and time-consuming, and are not therefore to be recommended. The gearbox manufacturer's repair manual is absolutely necessary when making repairs.

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.

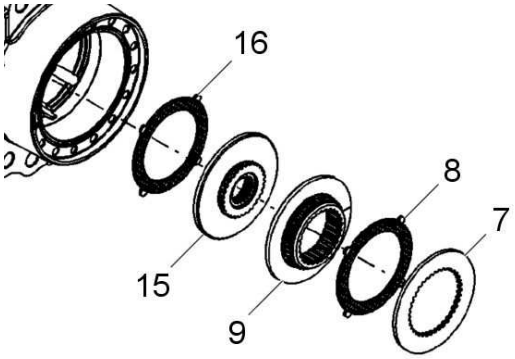
Profile parameter sets

- 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 M12 x 100
- Saw off the screw head

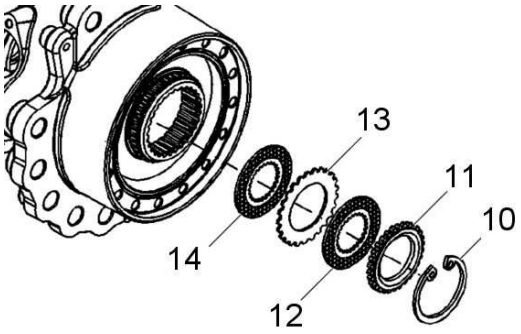
– Install the pressure discs (7, 9, 15) with the brake discs (8, 16) in the sequence shown. ▷



NOTE

The brake disc (16) is installed with the brake lining in the direction of the pressure disc (15). The brake disc (8) is installed with the brake lining in the direction of the pressure disc (7).

– Insert the pressure discs (10, 13) with the brake discs (12, 14) into the pressure disc (9) in the sequence shown. Secure the brake discs with locking ring (10). ▷



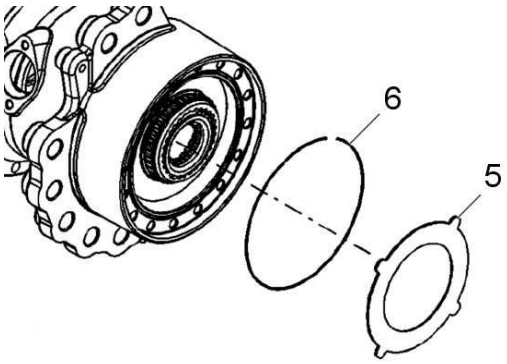
NOTE

The brake disc (14) is installed with the brake lining in the direction of the pressure disc (13). The brake disc (12) is installed with the brake lining in the direction of the pressure disc (11).

NOTE

With the aid of the gear shaft (3), the brake discs and pressure discs can be centred and then simply inserted. The gear shaft must be removed again afterwards.

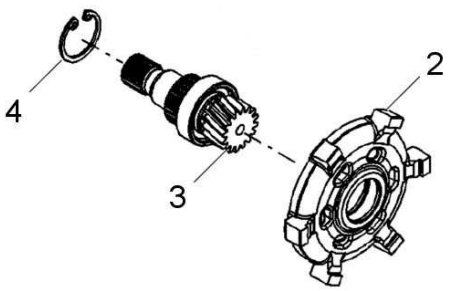
– Install the locking ring (6) and brake discs (5). ▷



NOTE

The brake disc (5) is installed with the brake lining in the direction of the brake package.

– Join the gear shaft (3) with the bearing block (2) and secure with the locking ring (4). ▷



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

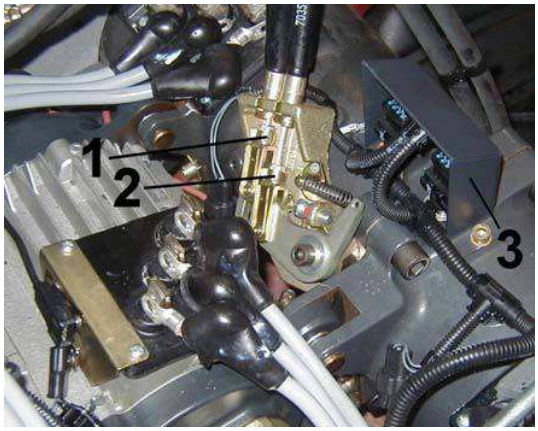
– Remove trademark emblem, loosening the left and right side screws but not unscrewing them completely

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

– Remove the covering of the electronics

– 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"

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

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

F4: Monitor
▼
Drive unit
▼
Engine speed

The following tables can be used to check the values.

CSC values for RX60-25-35

Forward travel			Reverse travel		
Steering angle [°]	Speed [km/h]	Speed [rpm]	Steering angle [°]	Speed [km/h]	Speed [rpm]
0	(20.00)	5565	0	(20.00)	5565
3	20.00	5565	3	20.00	5565
6	19.00	5287	6	19.00	5287
12	15.00	4174	12	15.00	4174
18	13.00	3617	18	13.00	3617
24	9.00	2504	24	9.00	2504
30	7.00	1948	30	7.00	1948
36	6.00	1670	36	6.00	1670
42	5.75	1600	42	5.75	1600
48	5.25	1461	48	5.25	1461
54	3.70	1030	54	4.67	1298
60	2.30	640	60	4.00	1113
66	2.30	640	66	4.00	1113
72	2.30	640	72	4.00	1113
78	2.30	640	78	4.00	1113
84	2.30	640	84	4.00	1113
90	2.30	640	90	4.00	1113

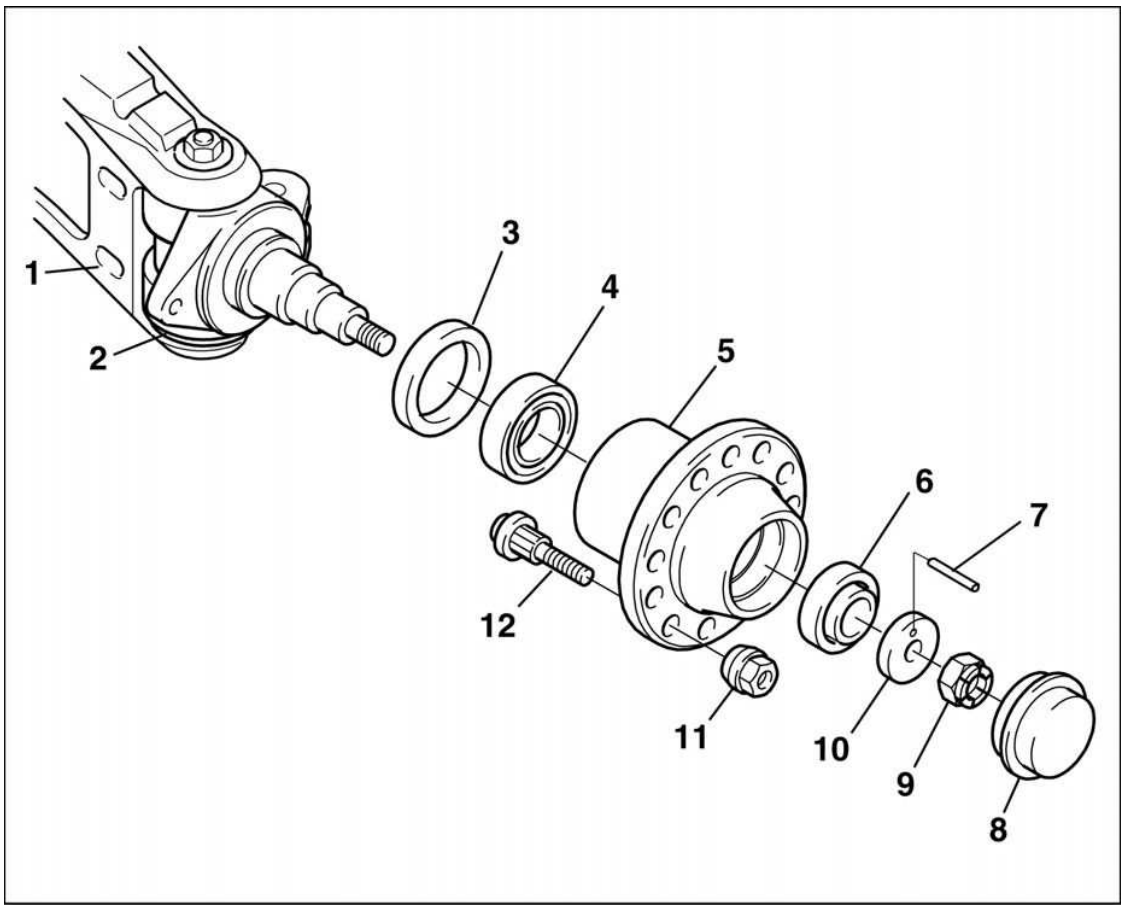
CSC values for RX60-40-50

Forward travel			Reverse travel		
Steering angle [°]	Speed [km/h]	Speed [rpm]	Steering angle [°]	Speed [km/h]	Speed [rpm]
0	(20.00)	4472	0	(20.00)	4472
3	20.00	4472	3	20.00	4472
6	20.00	4472	6	19.00	4248
12	18.20	4069	12	17.20	3846
18	16.00	3577	18	14.50	3242
24	13.00	2907	24	12.50	2795
30	10.00	2236	30	9.50	2124
36	8.50	1900	36	8.00	1789
42	8.00	1789	42	7.30	1632

– 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.

Actuating force of the handbrake

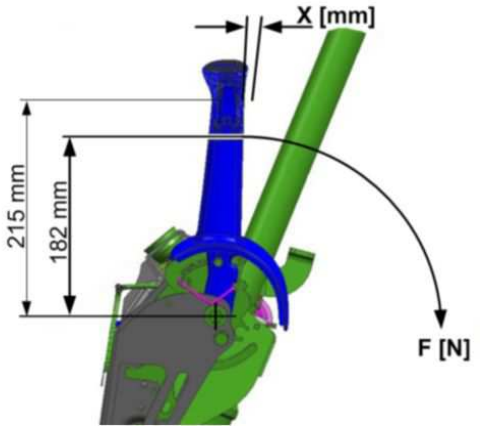
Adjustment

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	91–110
RX20-14-20, RX60-16-20	AE18-07	8	130 ±5	148–159
RX20-14-20 Facelift 2014	AE18-09	8	130 ±5	148–159
RX60-25-35	EC35	5	105 ±8	115–133
RX60-40-50	EC50	5	105 ±8	115–133
RX70-16-20	AD20E-02	8	100 ±8	109–128
RX70-22-35	8.20	4	125 ±8	138–157
RX70-40-50	EC50I	5	105 ±8	115–133

Adjust the brake cable of the handbrake so that the hand brake lever has an actuation distance of at least dimension **X**, without the brake lever on the axle being released from the zero position (also refer to the chapter entitled "Brake cable change, service brake").

Adjust the brake cable of the handbrake so that the specified actuating force is set when the handbrake is actuated.

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



– Attach the spring balance to the hand brake lever using a cable tie. The cable tie lies in the groove beneath the mobile handle.

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.*

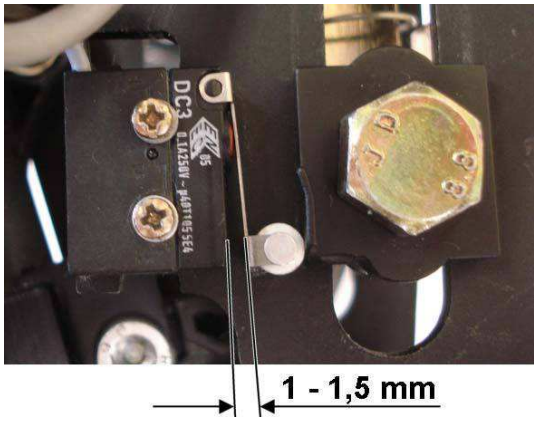
1000 operating hours

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

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

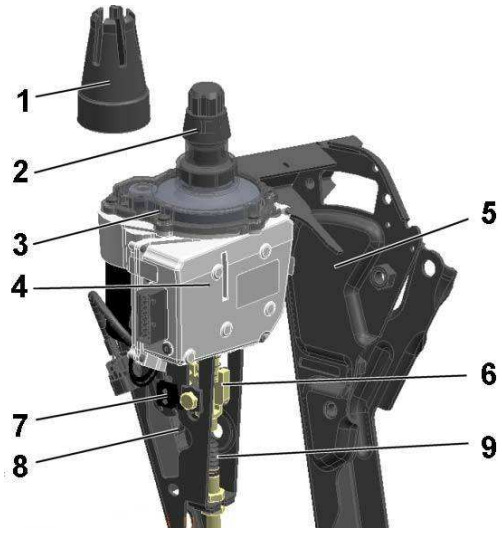
– Park the truck safely and secure the truck against rolling away.

– 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

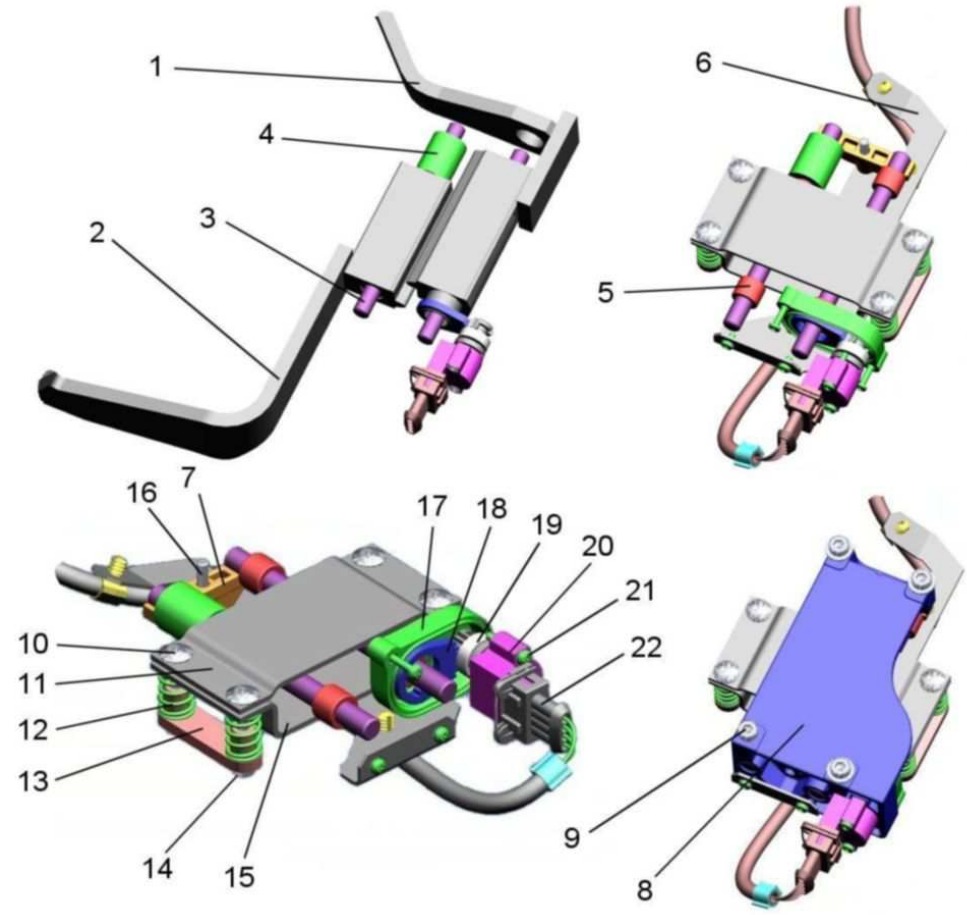


1 Hand wheel
2 Tappet for hand wheel
3 Drive unit
4 Controller
5 Console
6 Tension rod

Double pedal

Accelerator – dual pedal 2nd generation

Accelerator



1	Pedal, forwards
2	Pedal, backwards
3	Rod
4	Bush
5	Needle-roller bearing
6	Bearing block
7	Plate
8	Bearing block
9	Socket head screw
10	Coach bolt
11	Bracket, upper
12	Compression spring
13	Guide
14	Hexagon nut
15	Bracket, lower
16	Hexagon head screw, 10 Nm, Loctite
17	Protective cap
18	Pinion
19	Pinion gear
20	Potentiometer
21	Pan head screw
22	Wiring harness

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.

▼

```
0.  Sensors
```

Once calibration is complete, error messages may be displayed.

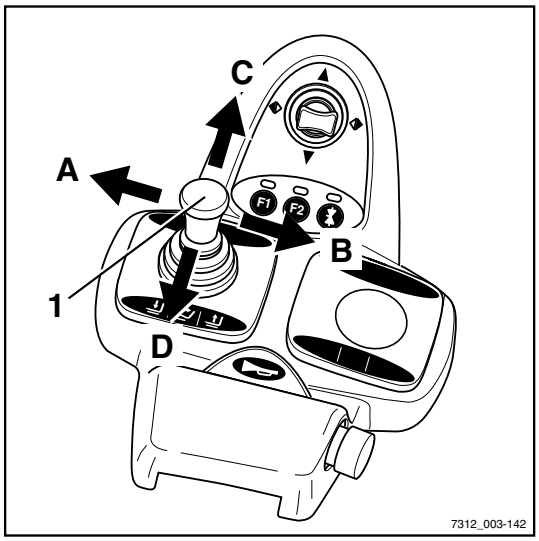
Generation 2 mini-lever Actuation

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:

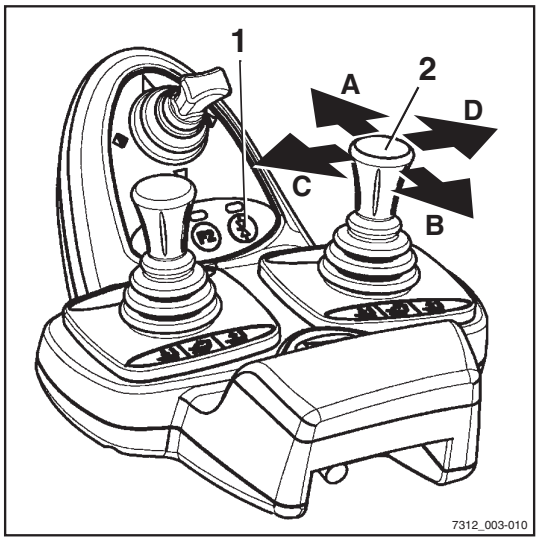
- To lift fork carriage:
  Move the left joystick in the direction of the arrow (B).
- To lower fork carriage:
  Move the left joystick in the direction of the arrow (A).
- To tilt the lift mast forwards:
  Move the left joystick in the direction of the arrow (C).
- To tilt the lift mast backwards:
  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

Drive direction turn indicator display

General

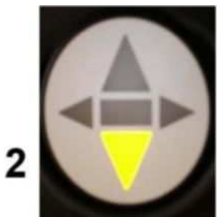
The drive direction turn indicator display is positioned to the right-hand side of the driver's field of vision in the front structure.

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.

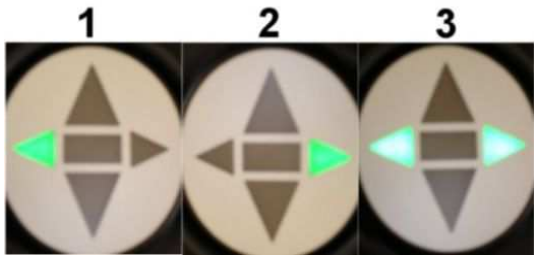
Direction of travel display



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

General technical data
6326 - 6330

Electrical system		
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 Speed reduction	Adjustable via 5 drive programs, max. 19.9 km/h Adjustable via 5 drive programs	
Nominal voltage	80 Volt	
Traction motor revolution control	Truck control unit (MCU)	
Current limitation		
Traction motor FM1	Traction against block without boost	369 A effective phase current (210 Nm)
	Traction against block with boost	529 A effective phase current (330 Nm)
Converter 1U06, LAC2B-80V		800 A effective
	Regulation in the event of overtemperature	From 51°C to 115°C, regulation from 800 A to 0 A
Pump motor HM	Tilt against over pressure	423 A effective phase current (108 Nm)
Converter 1U03, LAC2B-80V		800 A effective
	Regulation in the event of overtemperature	From 51°C to 115°C, regulation from 800 A to 0 A
Starting current boost	For 3 seconds, as long as the truck does not move	
Stopping on a slope	Standard: Rolls at a regulated speed of 1 cm/sec Variant: Truck remains stationary when the seat switch is activated	
Main contactor 1K1		
24 V (switched)	2-pin coil Contacts: changeable Contact material: silver alloy	
Relay		
24 V (coil 255 Ω)	K1, K2	
Fuse		
	see chapter "Fuses"	
Traction battery G1		
80 V / 840 Ah	6327, 6328, 6329, 6330	
Insulation resistance		
Electrical system Electrical equipment Traction battery	Min. 1000 Ω/volt - approx. 80 kΩ Min. 1000 Ω/volt - approx. 80 kΩ Min. 1000 Ω	
Electrical protection type		
Electrical system Electrical equipment	IP 23, incl. cover IP 54 IP 54	

▼

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

its natural temperature. If the traction motor temperature drops to value (T1), the error is reset.

If it is not possible to re-establish the temperature management, stage 2 is triggered.

During 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 component of 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.

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.

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

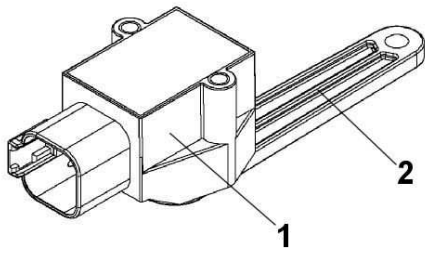
In this case, the customer can correct and store the changed vertical position by pressing and holding the corresponding button for "vertical lift mast position".

Tilt angle sensor 7B46

Function

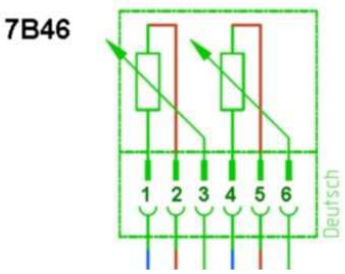
The tilt angle sensor functions without contacts via a magnetic field and a Hall sensor. The angle range is +60° to –60° without mechanical stops. The sensor is protected against short circuit with an unlimited short-circuit duration.

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

Option Board

General

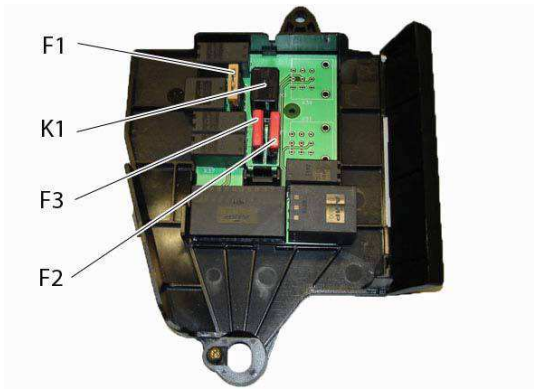
The Option Board A22 comprises a circuit board in a plastic housing and is always fitted to the front structure beneath the truck control unit (MCU, TCU). Depending on the truck equipment, the Option Board supplies the optional additional electrical equipment and sensor system.

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.

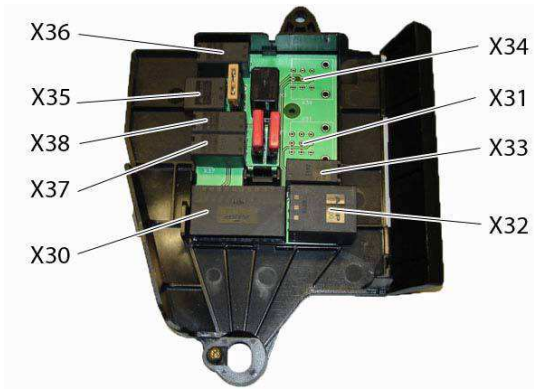
Fuses and relays



Fuse	
F1	5 A
F2	10 A
F3	10 A

Relays	
K1	5th hydraulic function

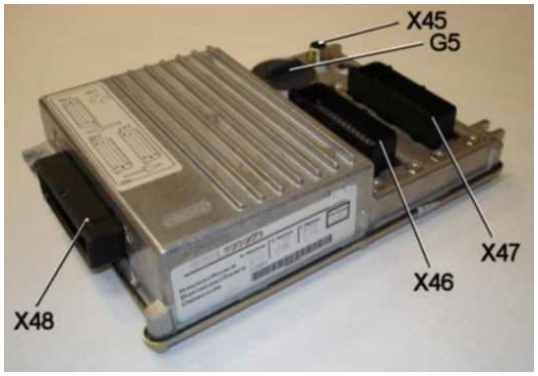
Electrical connections



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)

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:

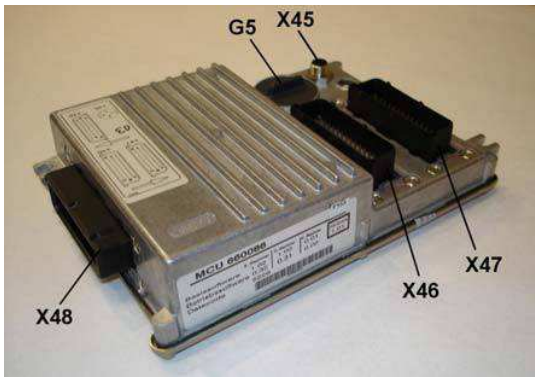
- As a rule, the spare part MCU does not contain any data or parameters.

  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

Plug assignment X150, X151	
Pin 13	**X150 only:** Phase signal W. Signal is not used in the truck control unit. **Caution:** The voltage on this pin can reach up to 120 V.
Pin 14	Temperature sensor –

Inverters
Removal and installation

Preparations

⚠ CAUTION

Depending on the truck type, the positions of the traction converter and pump converter are swapped around.

In the interest of safety, always check the inverter order number.

- 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).

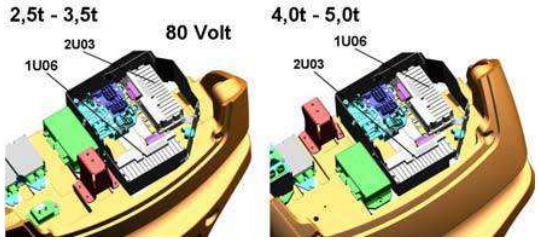
Discharge the intermediate circuit.

- Remove the fuse box.
- Unscrew the conductor rails to the converters; M8 nuts with disc spring.

NOTE

Work carefully to ensure that no parts fall into the electrical system.

▷



Converter
1U06 Traction motor
2U03 Pump motor

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.

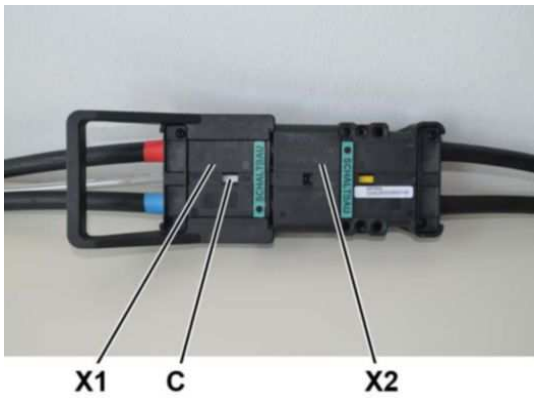
Initial measurement

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

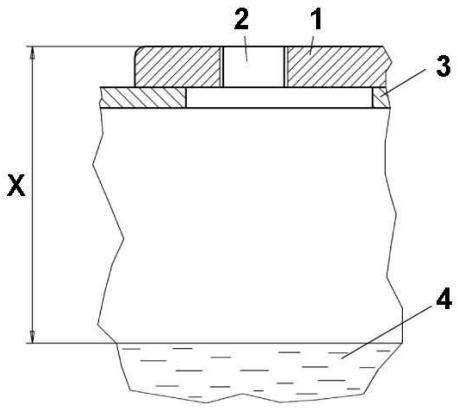
X2 (+)	XS1 (Batt +)	F01	1K1
X2 (-)	XS5 (GND L)		

Hydraulic oil

Technical data

The filling quantity for hydraulic oil also applies for the auxiliary hydraulics.

The levels apply with the carriage lowered and the hydraulic system ready for operation.



1 Return line filter
2 Dipstick opening
3 Hydraulic tank
4 Hydraulic oil
X Oil level

Truck		Oil volume [l]	Oil level X [mm]	Comment
RX50-10-15	5060–5066	21.6	132^{+10}_{-50}	Overall height ≤ 2100 mm
		24.3	107^{+15}_{-25}	Overall height > 2100 mm
RX20-14-20 RX60-15-20	6209 - 6217 6311, -13, -15	28	100 ±25	
RX60-25-35	6321 - 6325 6345 - 6356	36	122 ±15	
	6353 - 6356	39	100 ±25	Triple mast, overall height ≥ 3300 mm
RX60-40-50	6327 - 6330 6367 - 6369	54	162 ±15	
	6328 - 6330 6368 - 6369	58	122 ±15	Triple mast, overall height ≥ 3300 mm

Oil change

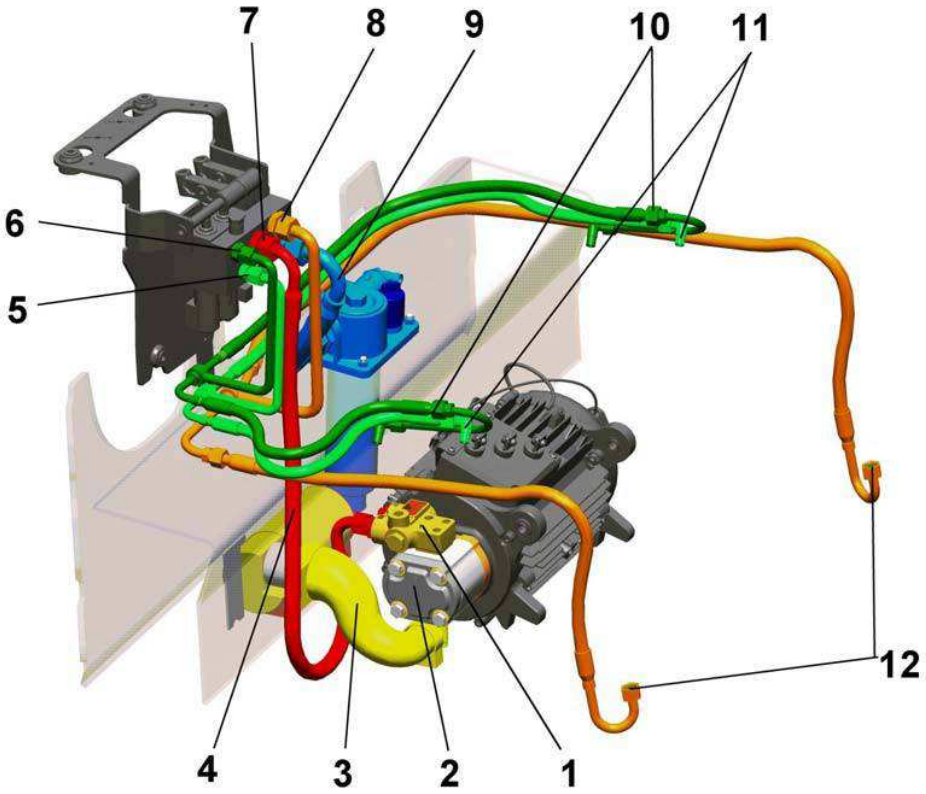
ENVIRONMENT NOTE

Hydraulic oil must be disposed of in accordance with environmental regulations.

- Position the truck on a horizontal surface
- Tilt lift mast backwards until it reaches the stop
- Lower fork carriage; if there are attachments, retract working cylinders
- Disconnect the battery male connector
- Remove the bottom plate
- Unscrew the breather filter
- Unscrew the hydraulic oil drain plug under the hydraulic tank and drain the hydraulic oil into a collection vessel

Working hydraulics

Structure



1	Priority valve
2	Hydraulic pump
3	Suction hose
4	Pressure line
5	Connection B
6	Connection A
7	Connection P
8	Connection H
9	Connection R (return line)
10	Forwards tilt cylinder
11	Backwards tilt cylinder
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:

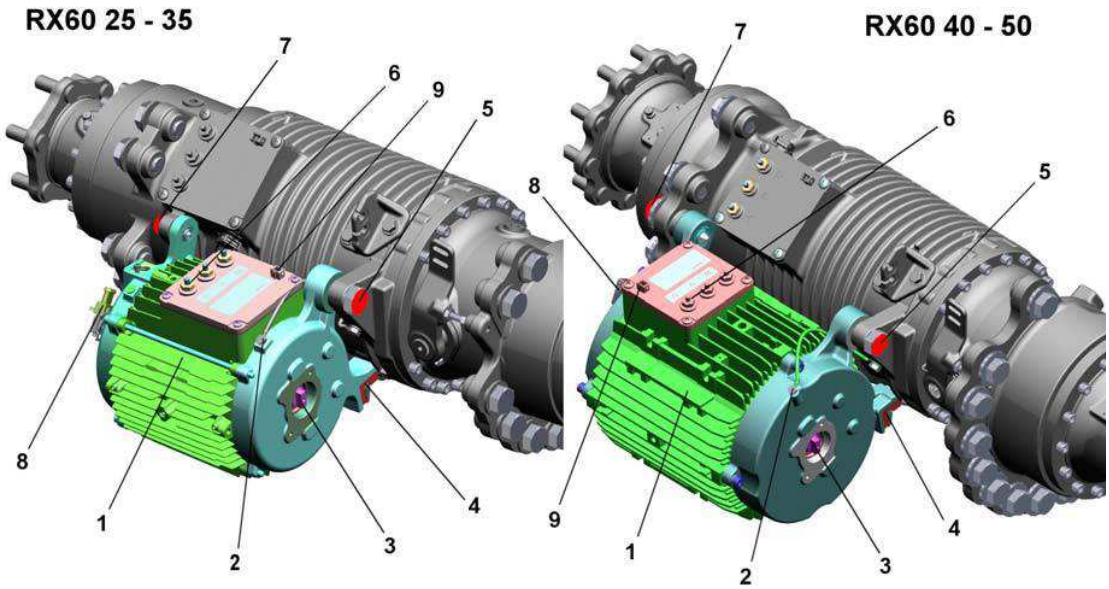
- The pressure relief valve protects the hydraulic system against overloading.
- The lowering brake limits the lowering speed when lowering the load.
- Two load holding valves prevent the load from tilting on its own.
- The flow control valve limits the oil flow for tilting.

Pump unit

General technical data

Pump motor		RX60-25-35	RX60-40-50
Manufacturer		Juli	
Designation			
Operating voltage	[V]	80	
Motor type		4-pin AC motor with cage rotor	
Connection		Star	
Design voltage (nominal)	[V]	45	43
Design current (nominal)	[A]	264	414
Design speed (nominal)	[rpm]	2590	2706
Design output (nominal)	[kW]	16	25
Maximum speed	[rpm]	3223	3580
Mode of operation (nominal)		S3 - 20%	
Protection type		IP 54	
Insulation class		F	
Weight	[kg]	54	88.5
Cooling		Surface / convection	
Temperature sensor		KTY84 - 130	
Rev sensor		Pin sensor	
		Transmitter-free control	

Pump unit



1 Pump motor
2 Earth cable
3 Hydraulic pump tappet
4 Support bearing spring element

6330	5000 LP600			3	6	Overall height 2150 to 3600 Standard
				6	6	Overall height 2150 to 3600 Variant

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 may 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 bolts
- Loosen 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 bolts

▷

Installation

NOTE

Grease tilt cylinder pins before installation!

- Connect tilt cylinder to chassis. To do this, knock in the bolts with rubber washers and secure with locking ring
- Connect tilt cylinder to outer mast. To do this, knock in the bolts and secure with locking ring
- Screw on hydraulic connections at tilt cylinder
- Check tilt cylinder for leaks

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	

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

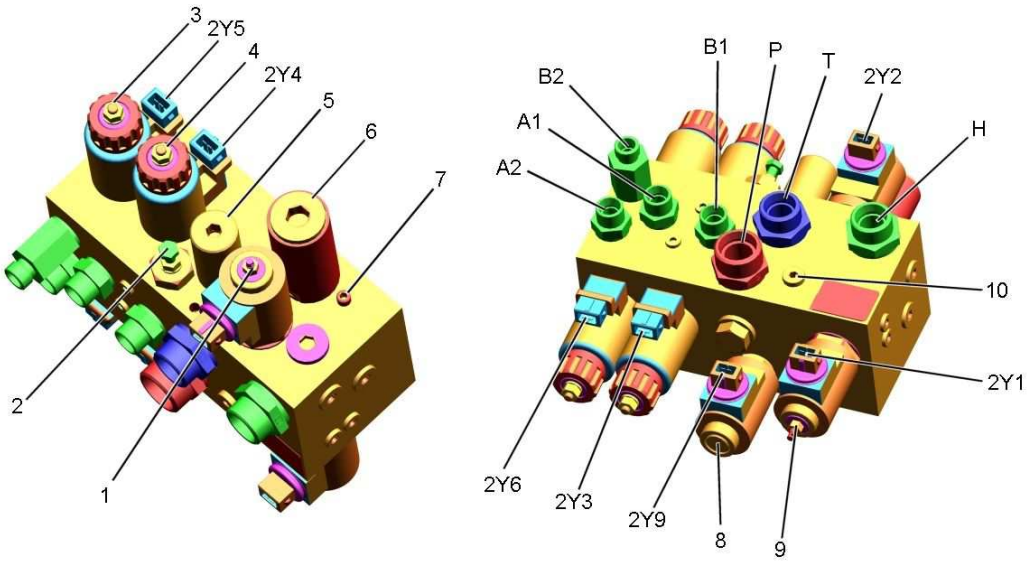
⚠ CAUTION

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			

Structure



Valve block

1	Lowering valve
2	Pressure relief valve
3	Auxiliary hydraulics 1
4	Tilting valve
5	Input pressure governor
6	Lowering-balance valve (lowering brake)
7	Emergency lowering
8	Check valve for hydraulics blocking function
9	Lifting valve
10	Measuring point

Solenoid coils

2Y1	Lifting
2Y2	Lowering
2Y3	Tilt back
2Y4	Tilt forwards
2Y5	Auxiliary hydraulics 1
2Y6	Auxiliary hydraulics 1
2Y9	Check valve for hydraulics blocking function

Connections

P	Pump pressure line
T	Tank return
H	Lifting/lowering
A1	Tilt backwards
B1	Tilt forwards
A2	Auxiliary hydraulics 1
B2	Auxiliary hydraulics 1

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 exhaust 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).

- 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.

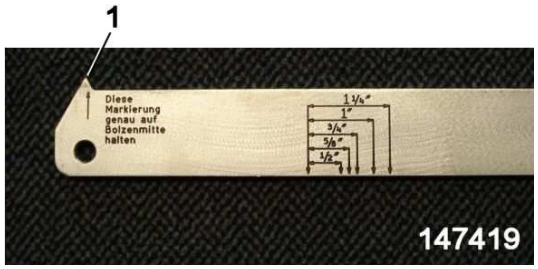
⚠ CAUTION

Improper repairs can lead to serious damage!

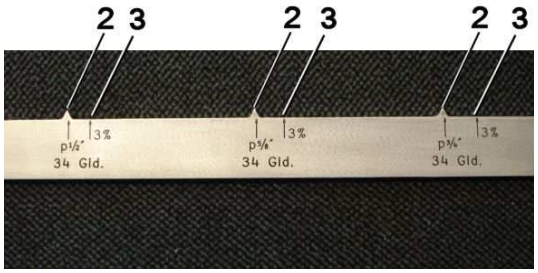
– Always replace the load chains. It is not permitted to carry out repairs to load chains.
– Load chains must always be replaced in pairs to ensure equal load distribution between the two load chains.
– Load chains must always be replaced in full, including the clamping bolt and end link.

Measuring the chain elongation

– Hold the marking (1) on the chain wear gauge against the middle of a chain pin. ▷

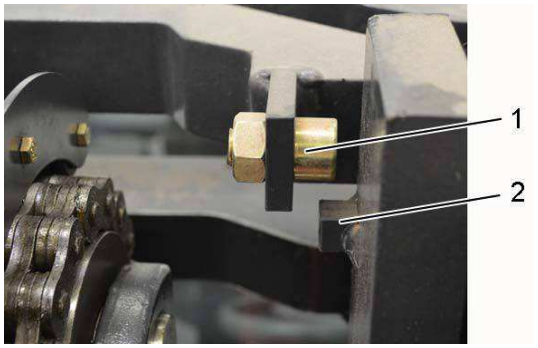


– Count off 34 chain links. Depending on the size of the chain, the marking (2) indicates the normal length of 34 chain links. ▷
– The marking (3) indicates the chain length at 3% elongation.



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

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.

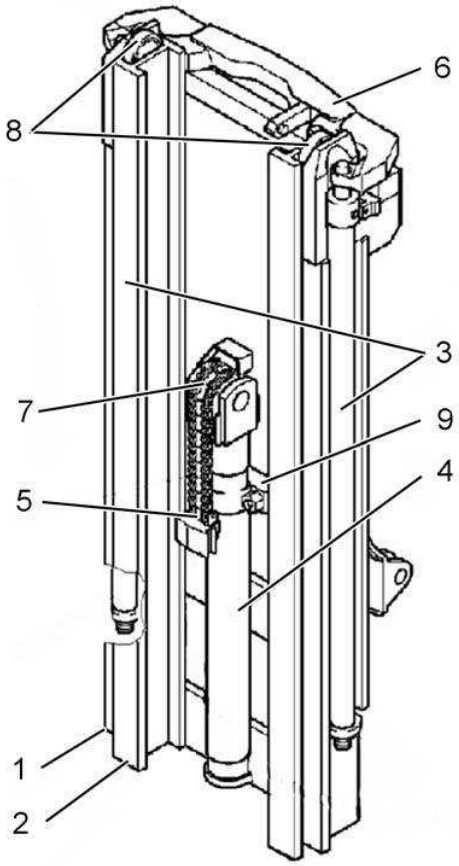
The middle cylinder (4) is installed within the inner mast. The load chain (5) is connected to the middle bridge piece for the inner mast (9) via a clamping bolt. The load chain is redirected by a chain roller (7) on the middle cylinder. The end link of the load chain is connected to the fork carriage.

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.

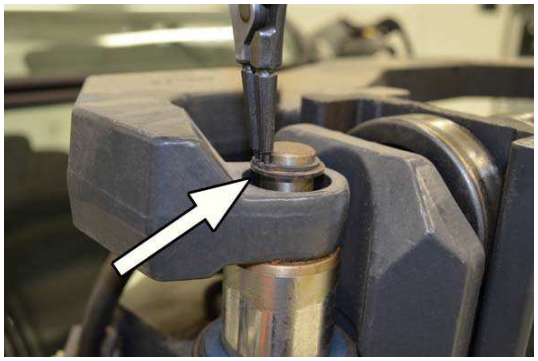
The end stop is in the cylinders.

A run-out barrier prevents the fork carriage from tilting outwards; see the chapter entitled "Run-out barrier".

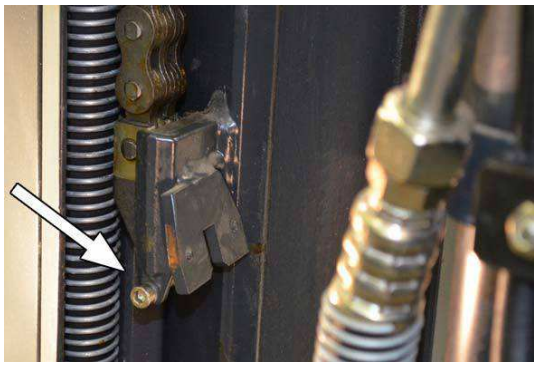


1 Outer mast
2 Inner mast
3 Outer cylinder
4 Middle cylinder
5 Load chain
6 Inner mast crossmember
7 Chain roller
8 Support rollers
9 Middle bridge piece for the inner mast

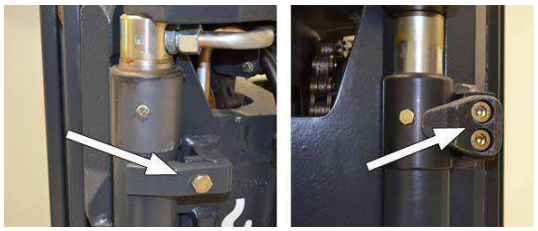
– Fit the locking rings for the piston rods on to the middle mast crossmember. ▷



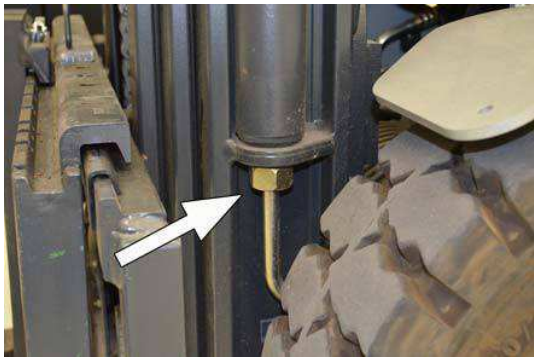
– Insert the load chains into the bottom of the inner mast and secure using the locking screw. If necessary, lift the inner mast for this purpose. ▷
– Remove the supporting block from under the middle mast. The middle mast is now suspended on its load chains.



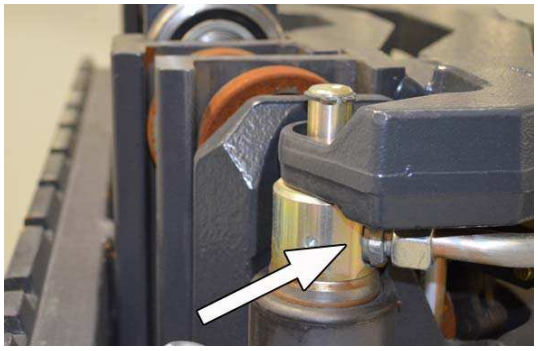
– Tighten the tensioning pieces so that the lift cylinders are securely positioned. ▷
– Left hand side: Screw the pipe line on to the hydraulic adapter.
– Screw the hose clips on to the outer mast.
– Screw the auxiliary hydraulics hoses on to the middle mast.
– Use the second truck to lift the fork carriage 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.



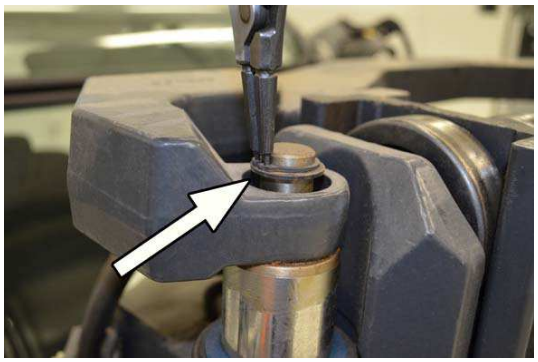
– Unscrew the hydraulic lines from the bottom of the outer cylinders. ▷



– 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. ▷

Middle cylinder end dampener

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

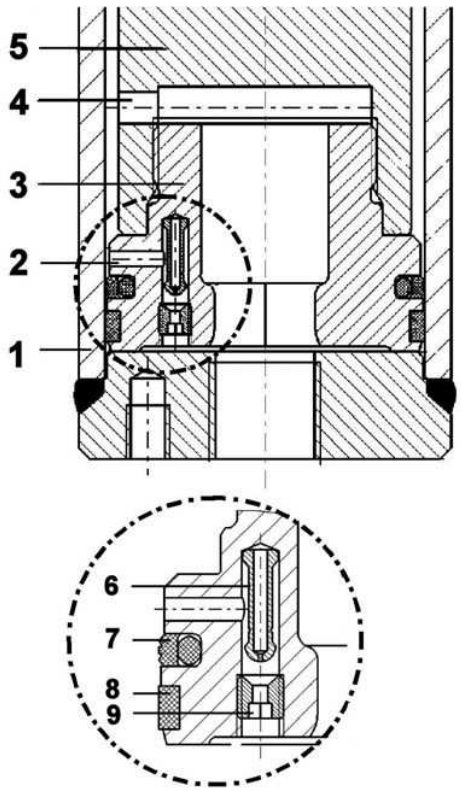
The piston rod (5) extends until the cross hole in the piston rod (4) is covered by the cylinder pipe (1). The lifting speed is reduced as soon as the cross hole is covered by the cylinder pipe.

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

- 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.

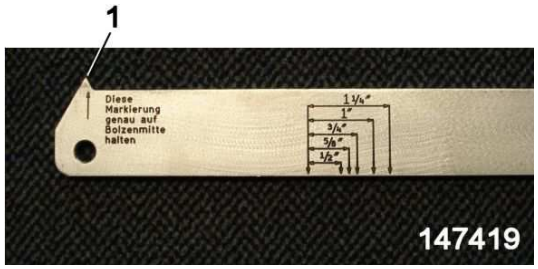
⚠ CAUTION

Improper repairs can lead to serious damage!

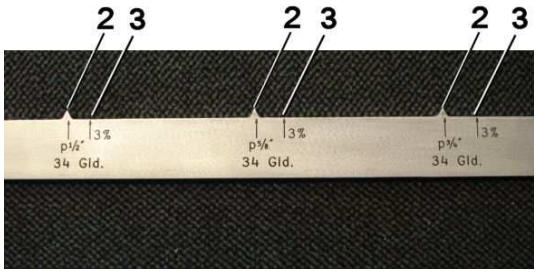
– Always replace the load chains. It is not permitted to carry out repairs to load chains.
– Load chains must always be replaced in pairs to ensure equal load distribution between the two load chains.
– Load chains must always be replaced in full, including the clamping bolt and end link.

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.

taking with them the middle mast in lift 2 and the inner mast via the outer load chains.

The redirection of the outer load chains causes the inner mast to move towards the middle mast in a ratio of 1:2.

The end stop is in the cylinder.

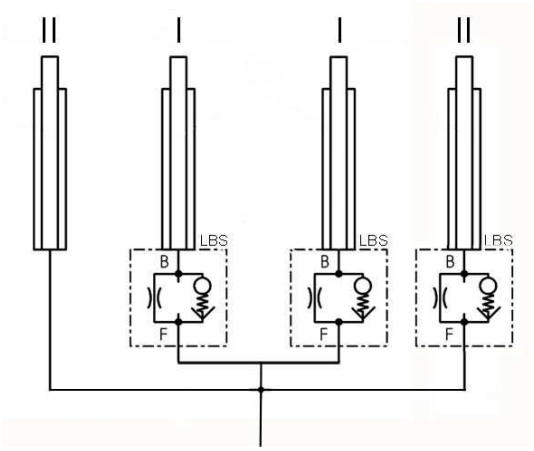
A run-out barrier prevents the fork carriage from tilting outwards; see chapter entitled "Run-out barrier".

Compressed oil flow within the lift mast

The hydraulic oil comes from the directional control valve block via a distributor and passes downwards into the two outer cylinders and the middle cylinders. The outer cylinders are closed at the top.

Due to the varying piston areas, the middle cylinders are always raised first (lift 1) and then the two outer cylinders (lift 2).

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 outer load chains Triple mast (150)

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.

Fork carriage - 2500-3500

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.

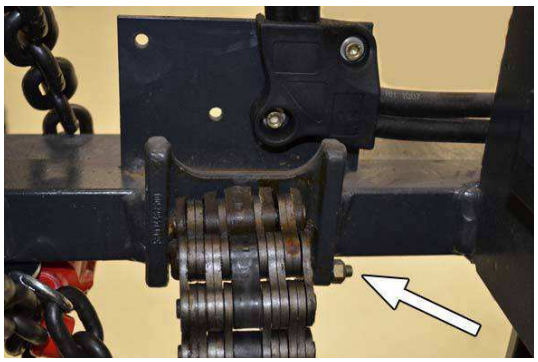
– Attach a suitable lifting sling to the fork carriage.

– 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.

STILL

Workshop literature

Electric forklift truck

RX60-25 - 35, RX60-40 - 50

RX60-25
RX60-30
RX60-35
RX60-40
RX60-45
RX60-50

CE

6321 6322 6323 6324 6325 6327
6328 6329 6330 6361 6362 6364
6367 6368 6369

171861 EN - 10/2015

first in intralogistics

Annex