

## The Company

Everything began in the year 1904. Carl von Linde and Hugo Güldner founded the “Güldner Motorenwerke”, the precursor of our company. No-one could imagine how dynamically this business would expand in the decades to follow. Today Linde Material Handling has over seven factories in Germany, France and Great Britain and a production site in China. More than 600 patents - many of them milestones in material handling engineering - attest to unrivalled innovative power, the basis for the success today and tomorrow.

Today, the Linde plant II in 63701 Aschaffenburg is one of the largest and most modern production facilities in the world. New assembly structures with only one direction of flow, trolleys without drivers, new supply systems, vacuum filling of the working hydraulics: The points were set correctly from the start to achieve maximum productivity and quality. The distances are short, as one might expect. In the entire assembly process, a Linde fork truck only travels approx. 2000 metres. It is therefore one of the fastest even before it sees the light of day.

People are always at the centre of our work, no matter what we plan, no matter what we do. On the one side are our employees, who receive a lot of room for development. On the other side are our customers. They measure us on the basis of productivity and quality, but also on the

basis of service and flexibility. We provide this worldwide in cooperation with our marketing and service organisations. With vehicles which, in the final analysis, are nothing else than the technical answer to their needs. Closeness to the customer is more than a word in this respect. It is lived reality.

Linde is one of the world's leaders in the sectors of material handling technology and hydraulics. The primary aim of our efforts is to offer our clients a convincing value for their money. Our decades of experience in material flow and the synergetic benefits of a large company allow us to tap new potential again and again. The most recent example is the Linde 39X with hydrostatic direct drive. A fork truck which links the fascination of technology and economy as no other forklift does.

We want to achieve a lot. We will give everything to achieve it. To be in a strong position in tomorrow's market you need more than yesterday's success. You need to be willing to work on yourself permanently. In research and development. In operations. And last, but not least, in service. In this respect, we have created the best conditions with our main plants in Aschaffenburg and the plants in Kahl, Weilbach and Ballenstedt.

Bruno Kulick  
Management

## Structure of the training document

This training document is based on the related seminar in the training centre and supplements it. The training document alone and without the accompanying training is not suited for self-study.

In order to allow you find the answer to problems at hand in the training document in case of a necessary repair, we want to give you some information on how and where you can find the desired information.

The training document is divided into numbered main sections. These main sections are again divided into subsections which in turn are also divided into more detailed subsections of the related section. The numbers and headings of the main sections and the subsections comply with internal guidelines and are retained for reasons of standardizations and continuity.

Overview of the main sections and (summarised) their content:

| Section | Content                                                                                                          |
|---------|------------------------------------------------------------------------------------------------------------------|
| 00      | Product information<br>Diagnosis                                                                                 |
| 01      | Motor<br>Internal combustion engine<br>Electric motor                                                            |
| 02      | Gearbox<br>Hydrostatic drive axle<br>Mechanical drive axle<br>Drives                                             |
| 03      | Body<br>Chassis<br>Operator's compartment                                                                        |
| 04      | Running gear<br>Steering system<br>Mechanical guidance<br>Inductive guidance<br>Wheels and tyres<br>Brake system |

## The truck series 394 H 40 - H 50



Power is redefined with the new generation of fork trucks H 40, H 45 and H 50 for very heavy duty: Unequalled operating comfort increases productivity, which, together with fuel economy and low service costs, translates into superior economy.

### Design of operator's compartment

The operator's compartment, developed according to the ergonomic findings, has an automobile-type quality, options like radio, heating and air conditioning are perfectly integrated in the cabin, numerous places to put things complete the picture. The indicators and switches installed in the canopy console of the truck are easily accessible. All mast functions can be operated sensitively with the Linde Load Control; the two levers integrated in the arm rest respond to the slightest movement of the finger. Also fatigue-free is the Linde dual-pedal control for fast reversing without shifting the feet; annoying road bumps are damped by the rubber-mounted drive axle. A low driving noise relieves the operator and environment and ensures, together with an excellent panorama view, the high safety standards.

### Chassis

The unit of overhead guard and chassis (Linde ProtectorFrame) guarantees the greatest possible stability and protection. The closed chassis

prevents dust and foreign particles from penetrating the assemblies. The engine bonnet can be opened wide, additional access covers make the fast servicing easier.

### Engine

The low-noise diesel engines convince with their state-of-the-art engine technology: high torque, fuel economy, low exhaust emissions (NO<sub>x</sub>, CO, HC), low soot emissions.

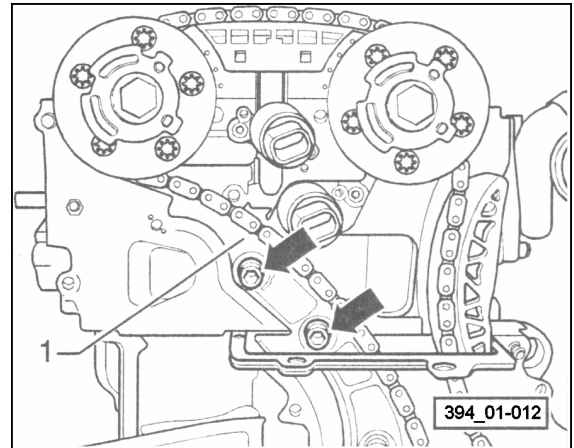
### Drive

No clutch, no transmission, no brake: The stepless Linde hydrostatic drive excels especially in extreme applications due to its low-wear technology.

### Electronic / electrical system

The Linde Truck Control (LTC) adjusts the engine speed intelligently to the particular demand of the hydraulic system and can be adapted individually to any task. All safety-related truck components such as microprocessors exist twice; a self-test makes servicing easier. The protection of the control unit and electric cables against moisture and dirt complies with the highest automotive standard and also increases functional reliability.

- Remove the fastening bolts (arrows) and take the chain guide (1) out.
- Put the camshaft chain aside.

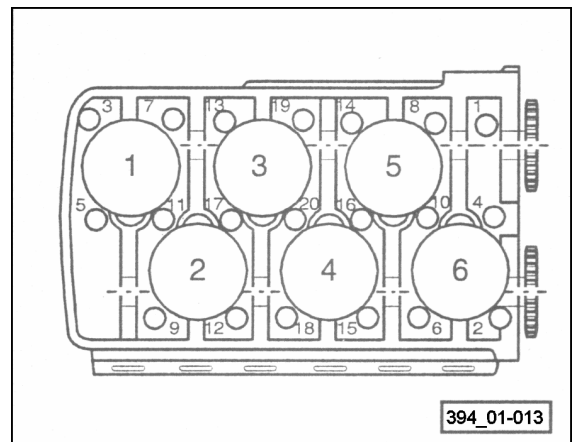


- Loosen the cylinder head bolts in the given sequence from the outside to the inside and remove them.

### NOTE

Use key 3452 for polydrive cylinder head bolts.

- Carefully remove the cylinder head with the help of a second mechanic.
- Put clean cloths into the cylinders to prevent dirt and abrasive residues from getting between the cylinder face and piston.
- Also prevent dirt and abrasive residues from getting into the coolant.
- Carefully clean the mating faces of cylinder head and cylinder block. Take care not to cause any long scoring or scratches (if emery paper is used, the grain should not be less than 100).
- Check the cylinder head for flatness.



## Cylinder head - installation

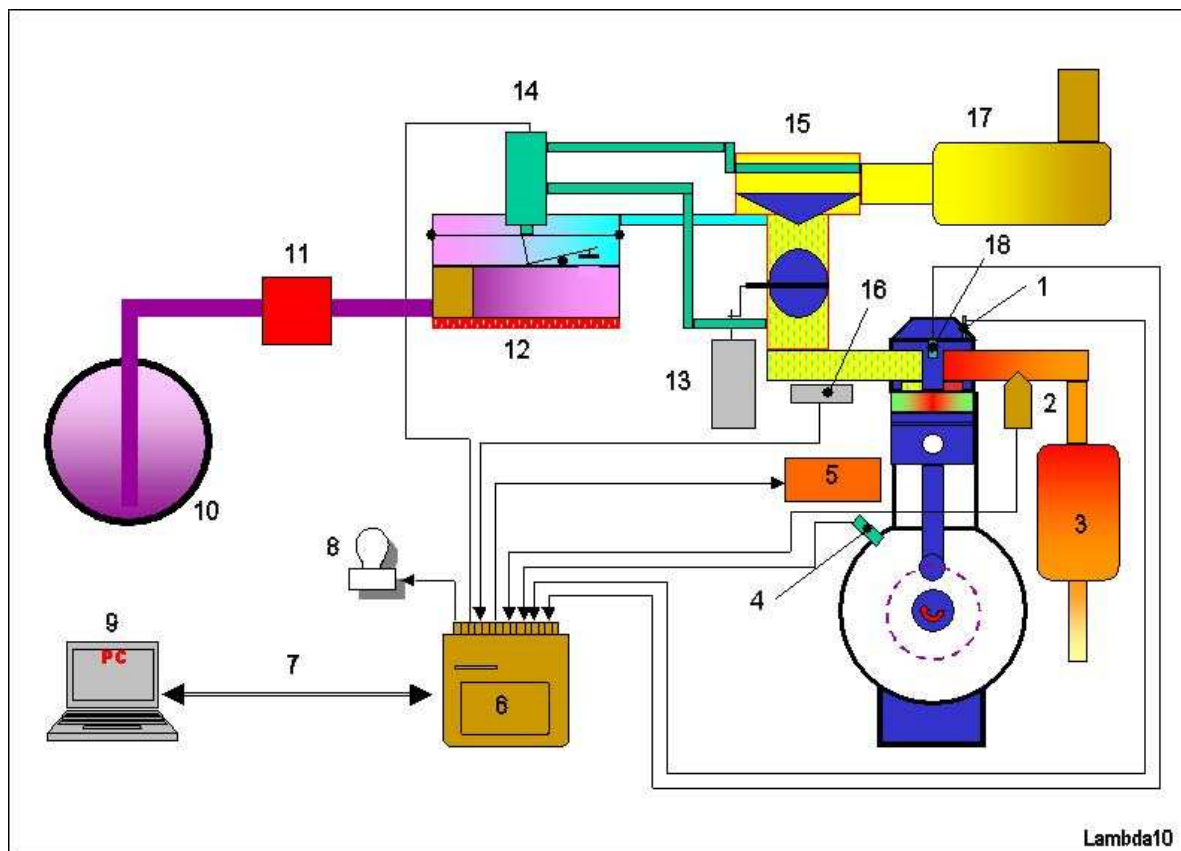
### NOTE

A LPG system from Impco is mounted at the engine inlet. That is why the cylinder head does not have any threads for the installation of the injection nozzles and can therefore not be replaced with a cylinder head from a car.

- When a replacement cylinder head is to be installed, first oil all mating faces of support elements, roller finger pivots and the cam faces of

## LPG engine

### Lambda control



- 1 Coolant temperature sending unit
- 2 Lambda sensor
- 3 Three-way catalytic converter
- 4 Speed sensor
- 5 Ignition coil
- 6 Control unit
- 7 Diagnostic cable 300 365 2504
- 8 Fault light
- 9 Diagnostic software

- 10 Gas bottle/gas tank
- 11 Shut-off valve and filter
- 12 Vaporiser
- 13 Throttle plate actuator
- 14 Control Valve
- 15 Mixer
- 16 Pressure and temperature sending unit
- 17 Air filter
- 18 Phase sensor

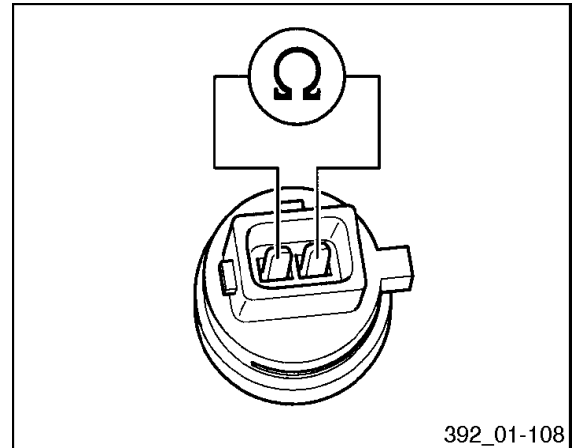
### Lambda control - description

The lambda control in conjunction with the catalytic converter represents the most efficient exhaust gas cleaning process for spark ignition engines available today.

The use of the three-way catalytic converter is especially effective. This catalyst is able to reduce hydrocarbons, carbon monoxide and nitrogen oxide by more than 90 % when the engine is operated in a very limited margin of error ( $\pm 1$  %) to keep the stoichiometric air-fuel ratio to  $\lambda = 1$ .

The stoichiometric air-fuel ratio is the theoretical mass ratio of 14 kg of air to 1 kg of LP gas required

- Disconnect the 2-pin plug from the intake pipe temperature sensor 0B4



- Check the resistance between the contacts of the intake pipe temperature sensor.

Area **A** shows the resistance values for the temperature range 0 - 50 °C, area **B**, the values for the temperature range 50 - 100 °C.

Examples of readings:

30 °C is in range **A** and corresponds to a resistance of 1.5 - 2 kΩ

80 °C is in range **B** and corresponds to a resistance of 275 kΩ to 375 kΩ

If the specified value is not obtained:

- Replace intake pipe temperature sensor 0B4
- Read out the fault history of the engine control unit
- If necessary, clear the fault history

If the desired value is obtained:

- Connect test adapter 7 917 299 010 to the cable loom of the engine control unit. (The engine control unit is not connected in this case).
- Check lines between the test adapter and plug for interruptions according to the circuit diagram
  - Contact 1 and socket 73
  - Contact 2 and socket 54

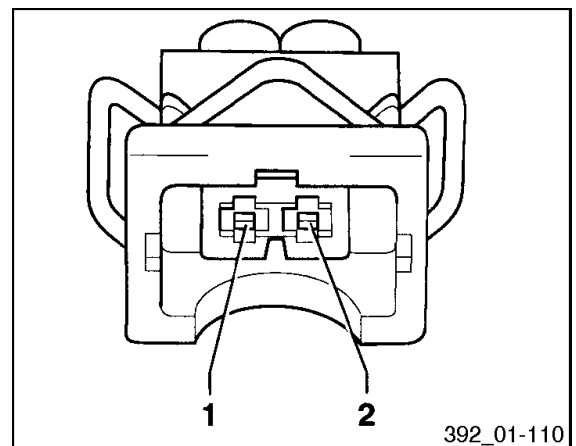
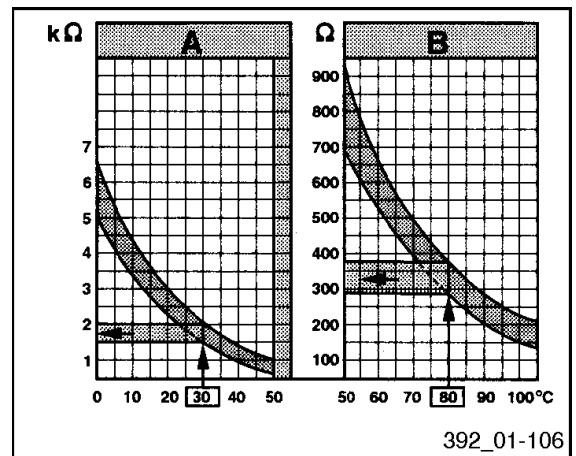
Cable resistance: maximum 1.5 Ω

- Also check the lines for line-to-line shorts, for shorts to battery negative and to battery positive

Desired value: ∞ Ω

If no fault is detected:

- Replace the control unit for direct injection system 0N1



- Measure the resistance between contacts 9 and 10 of the start of injection valve.

Desired resistance: 12 - 20  $\Omega$

If the desired resistance is not obtained:

- Replace the start of injection valve 0Y1.
- Subsequently read out the fault history of the engine control unit.
- If necessary, the clear the fault history

If the desired resistance is obtained:

- Connect the test adapter to the cable loom of the engine control unit. This does not connect the control unit.

- Using the wiring diagram, check the lines between test box and the 10-pin connector for interruptions.

- Contact 9 and socket 114
- Contact 10 and socket 1
- Contact 10 and socket 2

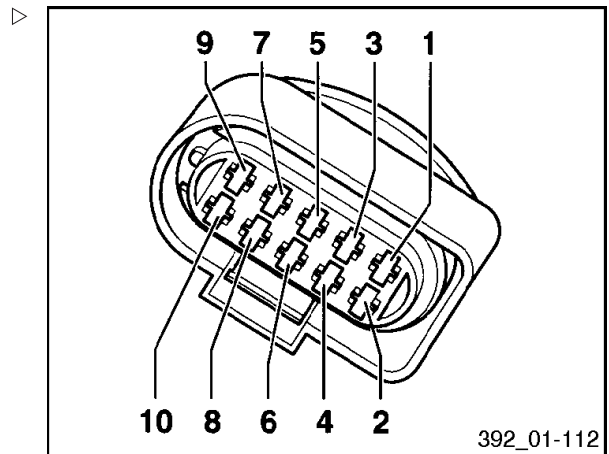
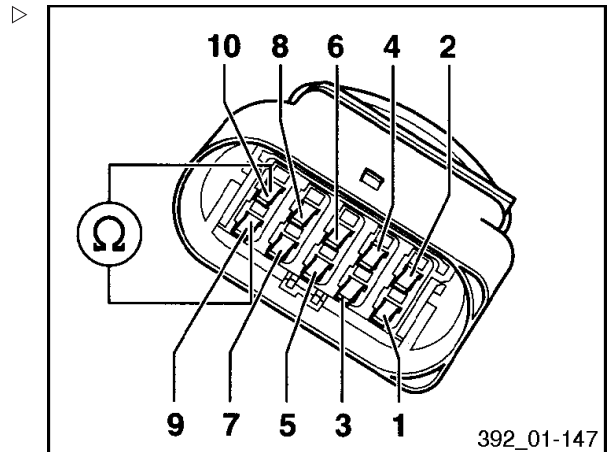
Max cable resistance 1.5  $\Omega$

- Also check the lines for line-to-line shorts, short to battery earth/engine earth and to battery positive.

Desired resistance: 8  $\Omega$

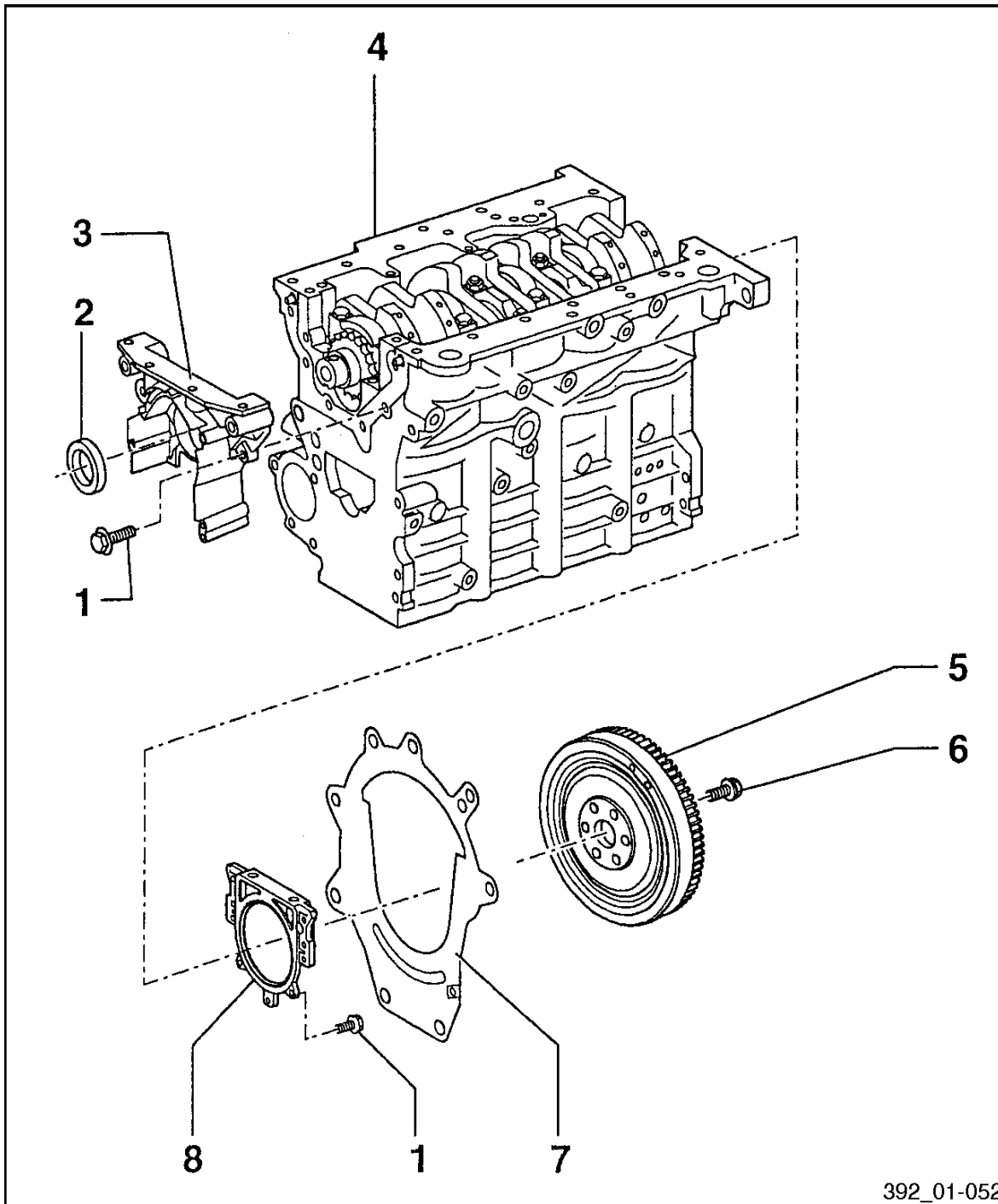
If no fault in the lines is detected:

- Replace the control unit for the direct diesel injection system 0N1



## Diesel engine

### Crankshaft sealing flange - removal and installation



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- 1 Bolt (torque 15 Nm)
- 2 Sealing ring
- 3 Sealing flange
- 4 Cylinder block

- 5 Flywheel
- 6 Bolt (torque 60 Nm)
- 7 Intermediate plate
- 8 Sealing flange

### Mass air flow sensor 0B6

The purpose of the mass air flow sensor is to determine the amount of fresh air supplied to the engine. The mass air flow sensor 0B6 is mounted in the intake pipe directly behind the air filter. It measures the mass air flow with a hot film sensor (1).

The hot film is heated with 12 V. The passing intake air cools the surface of the hot film. This cooling lowers the resistance of the hot film. The electronic control unit evaluates the drop in voltage caused by the change in resistance as the equivalent for the temperature and quantity of air taken in.

### Signal evaluation

The measuring result of the mass air flow sensor is the basis for the control of the percentage of recirculated exhaust gas to be added and the maximum quantity of fuel to be injected.

A smoke map stored in the control unit limits the amount of fuel injected if the mass air flow is too small for smokeless combustion.

### Substitute function

In the event of a failure, the charge pressure limit is reduced and constant values are specified for the optimum operation of the engine in various load ranges. The engine power is reduced as a result.

### Mass air flow sensor - check

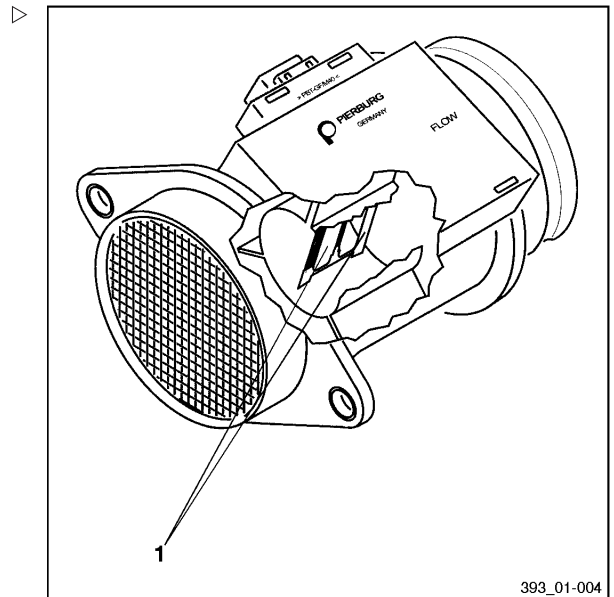
The mass air flow sensor signal is required by the control unit for the calculation of the permissible injection rate and for controlling the exhaust gas recirculation. The smaller the signal from the mass air flow sensor, the less fuel may be injected.

### Required special tools

- Test adapter 7 917 299 010
- Wiring diagram
- Laptop with software

### Prerequisites for testing

- Fuses must be OK.
- The battery voltage must be at least 11.5 V.
- All electric loads must be switched off.

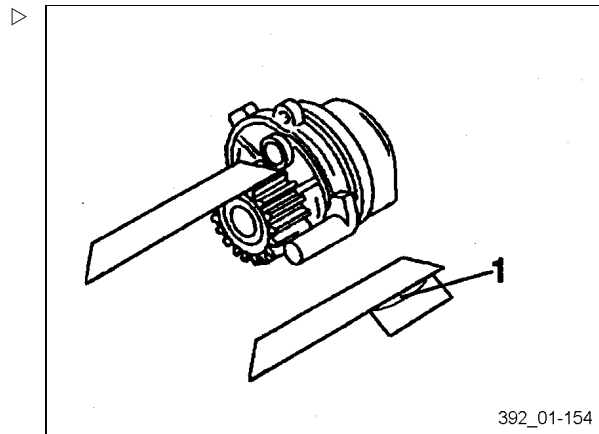


## Diesel engine

- Use the straight edge and feeler gauge to determine the wear (1) along the tooth length.

If the wear exceeds 0.30 mm, the water pump must be replaced.

Always replace together with the crankshaft pinion.



## Coolant - draining and filling

### Required special tools

- Pliers for spring clamps VW VAS 5024
- Antifreeze tester

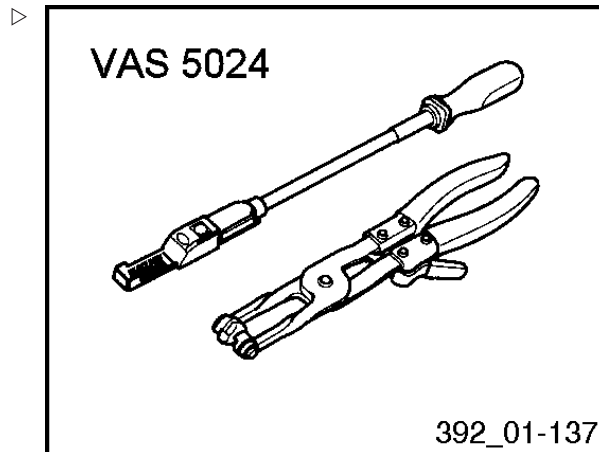
### Coolant - draining



#### WARNING

*When the expansion reservoir is opened, hot steam may escape, causing severe scalding. Cover the cap with a cloth and open it carefully!*

- Open the sealing cap of the coolant expansion reservoir.
- Use the pliers for spring band clamps VW VAS 5024 to pull off the lower coolant hose at the radiator.
- To drain the coolant from the engine also remove the connecting piece with the coolant regulator (arrows).



#### NOTE

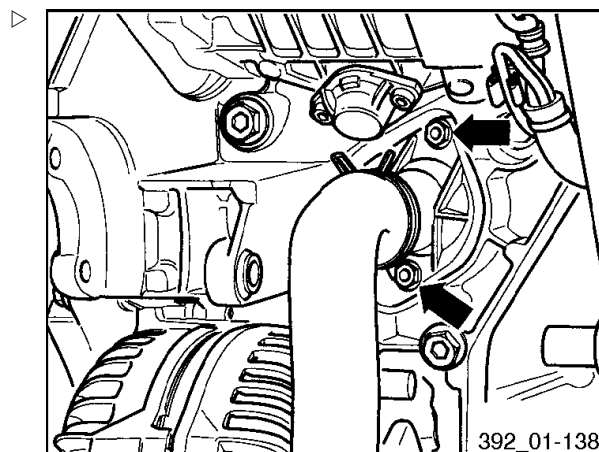
*Please observe the regulations for discarding coolant!*

### Coolant - filling



#### NOTE

- Only use G 12 acc. to TL VW 774 D as coolant additive. Characteristic feature: red colour.
- Never mix G 12 with other coolant additives. If the fluid in the recovery tank is brown, G 12



Remove the M8 x 1 screw coupling with high-pressure gauge from test point (1) and connect it to high-pressure test point (2) (low pressure gauge stays on port F") and then perform the check with the reverse accelerator.

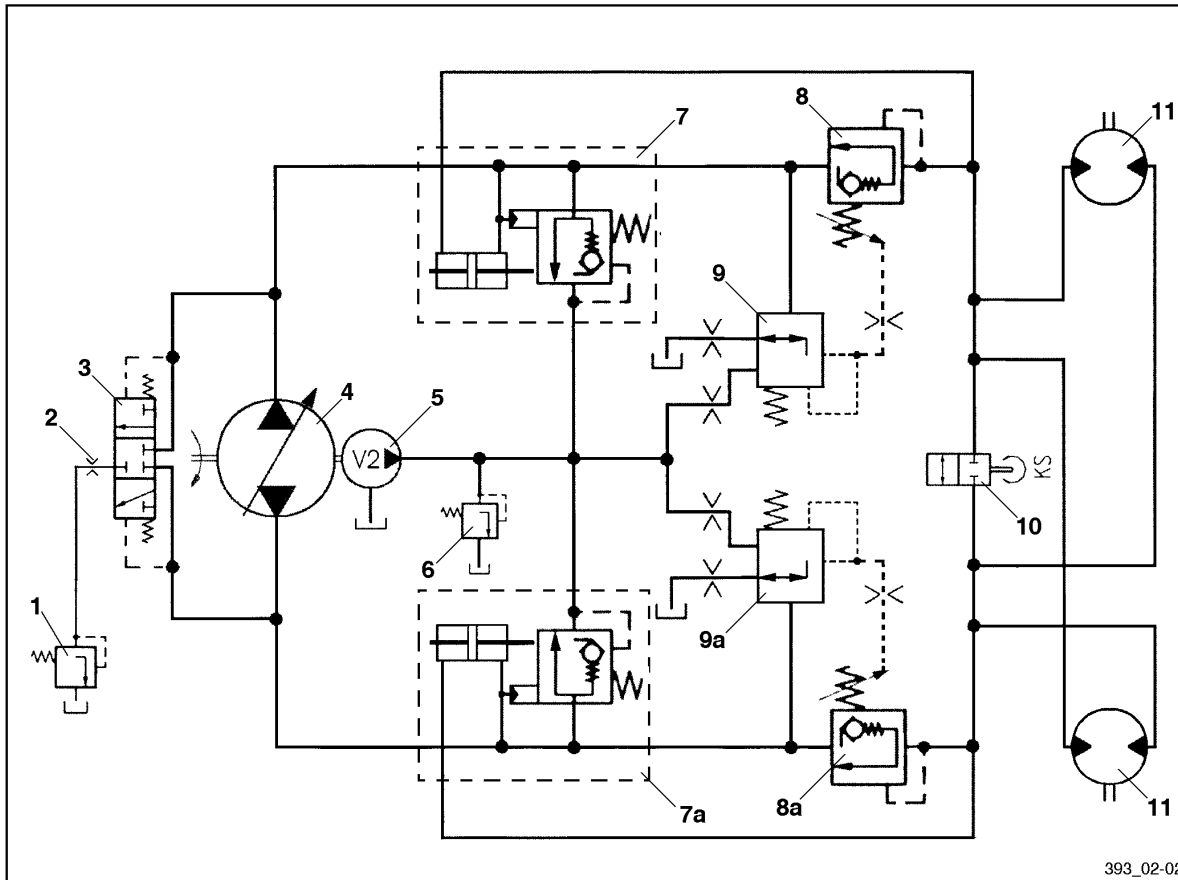
The readings now refer to the other direction of travel and components.

### Fault finding - travel drive

| Step Type    | Procedure                                                                                                                         | Yes (Test)                                                             | No (Test)                                 |
|--------------|-----------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|-------------------------------------------|
| 1<br>Action  | Connect screw coupling 000 951 6410 and the low pressure gauge to port F of the filter (C), engine at idling speed, brake applied |                                                                        |                                           |
| 2<br>Test    | LP approx. 21.0 bar?                                                                                                              | Go to steps 9 - 12                                                     | Go to step 3                              |
| 3<br>Action  | Seal port E at the brake release valve (e) with a blind plug and repeat the test.                                                 |                                                                        |                                           |
| 4<br>Test    | LP approx. 21.0 bar?                                                                                                              | Problem in the brake system. Please refer to "Hydraulic brake system " | Go to step 5                              |
| 5<br>Action  | Check or replace boost pressure valve, repeat the test.                                                                           |                                                                        |                                           |
| 6<br>Test    | LP approx. 21.0 bar?                                                                                                              | Go to steps 9 - 12                                                     | Go to step 7                              |
| 7<br>Action  | Disconnect axle AH 25 -03 with plug 000 951 3900, repeat the test.                                                                |                                                                        |                                           |
| 8<br>Test    | LP approx. 21.0 bar?                                                                                                              | AH 50 -03 defective, repair or replace.                                | HPV 105 -02 defective, repair or replace. |
| 9<br>Action  | Connect the laptop to the test connector. Connect screw coupling 000 951 6407 and the low pressure gauge to port F" (5).          |                                                                        |                                           |
| 10<br>Action | Start the engine, start "Pathfinder".                                                                                             |                                                                        |                                           |
| 11<br>Action | Select "Inputs/Outputs/Traction/Output Signals" and release the brake.                                                            |                                                                        |                                           |
| 12<br>Action | Depress the forward accelerator and reverse accelerator until iY4 is operated.                                                    |                                                                        |                                           |

## Brake system

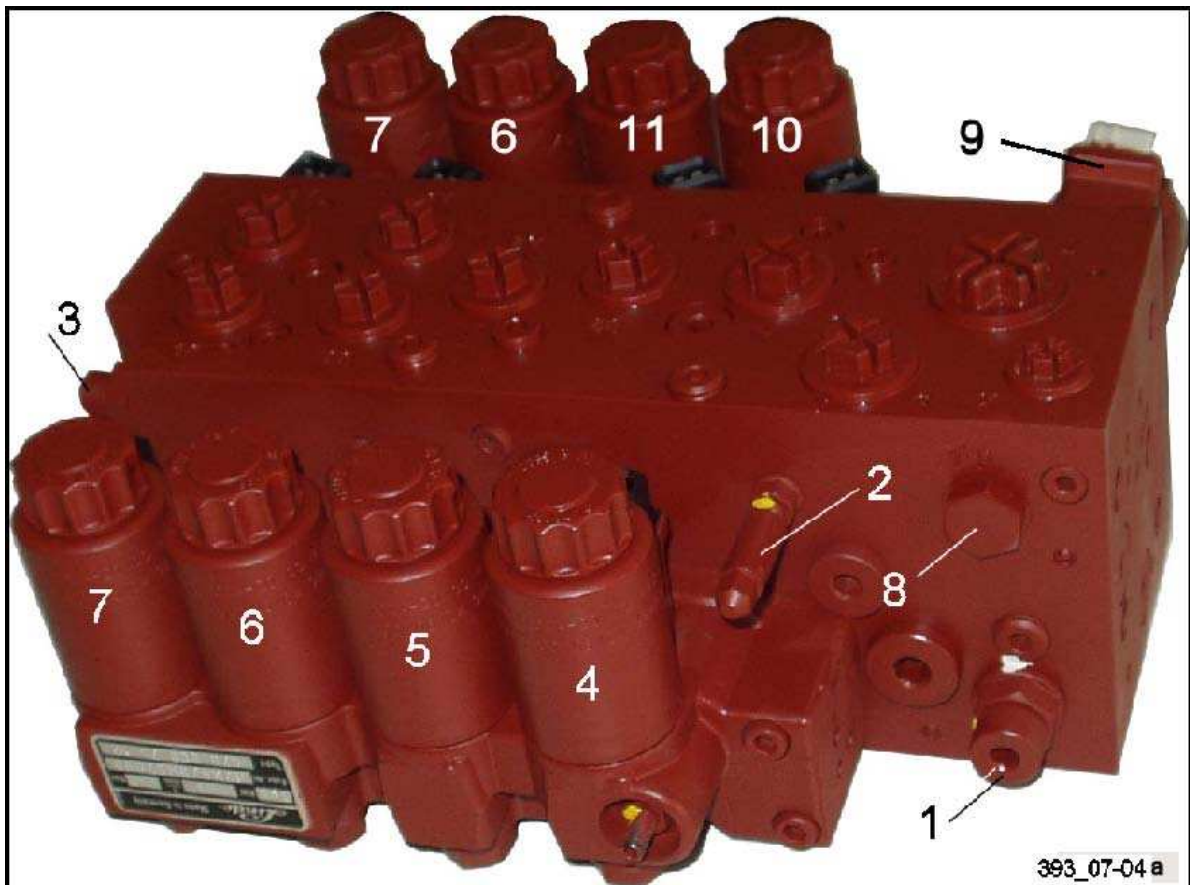
### Brake valves



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- |    |                                                              |    |                                                                                      |
|----|--------------------------------------------------------------|----|--------------------------------------------------------------------------------------|
| 1  | Pressure relief valve $p = 15$ bar                           | 8  | Brake valve, reverse direction                                                       |
| 2  | Restrictor                                                   | 8a | Brake valve, forward direction                                                       |
| 3  | Changeover valve                                             | 9  | Pilot valve for reverse direction, $p = 110$ bar for H 40, $p = 250$ bar for H 45/50 |
| 4  | HPV 105 -02                                                  | 9a | Pilot valve for forward direction, $p = 110$ bar for H 40, $p = 250$ bar for H 45/50 |
| 5  | Charging pump $V_2Q_2 = 16 \text{ cm}^3/\text{rev}$          | 10 | Bypass valve                                                                         |
| 6  | Boost pressure valve $p = 21.0$ bar                          | 11 | HMF 135                                                                              |
| 7  | Pressure relief valve, forward direction $p = 425^{+20}$ bar |    |                                                                                      |
| 7a | Pressure relief valve, reverse direction $p = 425^{+20}$ bar |    |                                                                                      |

### Functional description of control valve



- |   |                                                     |    |                                              |
|---|-----------------------------------------------------|----|----------------------------------------------|
| 1 | Pressure reducing valve for lifting and tilting     | 7  | Solenoid valve, auxiliary hydraulic system 2 |
| 2 | Emergency lowering                                  | 8  | Test point "P"                               |
| 3 | Pressure reducing valve, auxiliary hydraulic system | 9  | Release valve                                |
| 4 | Solenoid valve for lowering                         | 10 | Solenoid valve for lifting                   |
| 5 | Solenoid valve for backward tilting                 | 11 | Solenoid valve for forward tilting           |
| 6 | Solenoid valve, auxiliary hydraulic system 1        |    |                                              |

### Introduction

The valve explained in the following paragraphs is an LS control valve with electrohydraulic activation in monoblock design. The control valve is available either as triple monoblock (single auxiliary hydraulic section) or quadruple monoblock (double auxiliary hydraulic sections).

|           |                              |
|-----------|------------------------------|
| Section 1 | Lifting/Lowering             |
| Section 2 | Forward and backward tilting |
| Section 3 | Auxiliary hydraulic system 1 |
| Section 4 | Auxiliary hydraulic system 2 |

In the control valve housing, way valves, a balance valve for recirculating oil, pressure reducing valves, a safety valve and various check valves are located.

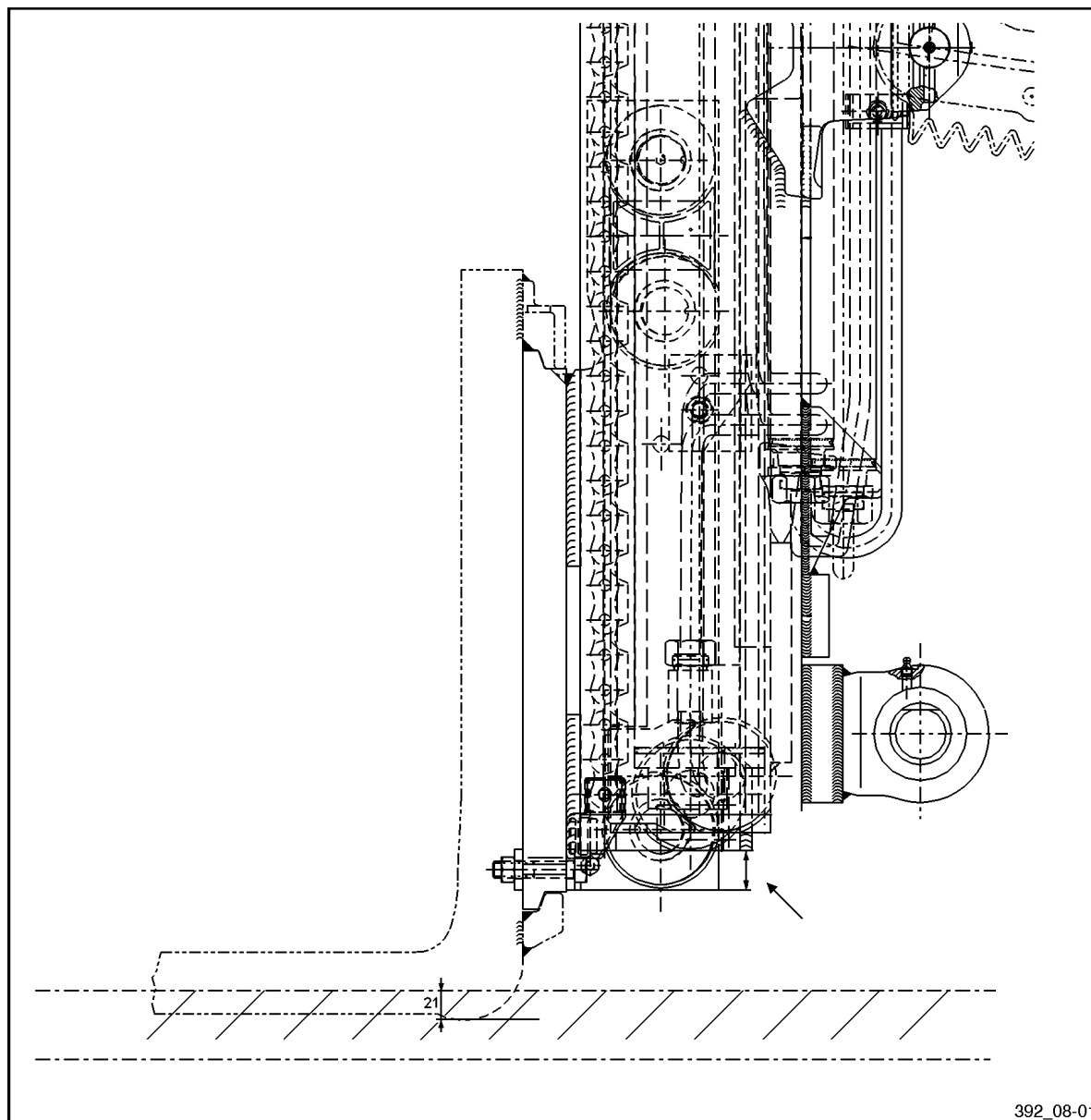
### Release valve, balance valve for recirculating oil, pressure reducing valve

The safety valve is a spool valve which influences both the LS signal path and the control pressure supply. When the joystick is not actuated, port 2Y9 on the safety valve is de-energised. This pushes the safety valve into the following position by means of spring power:

- The LS signal path is connected to the oil reservoir.

## Mast

### A dusting the lift chain (all series)



The lift chain lengthens with operation and must therefore be readjusted.

- Tilt the mast fully back and lower it completely.
- Adjust the chain at the adjusting nut of the chain anchor.
- The lower guide pulley of the fork carriage may project by no more than a third of its diameter from the inner mast channel.
- If two chains are used, make sure that the lengths of the two chains are identical.

- After locking the nuts, extend the mast as far as the stop and check the clearance to the safety stops.



#### NOTE

*If the fork carriage touches the safety stops although the lower rollers project from the profile, a piston head might have become loose, thus increasing the stroke inadmissibly.*

## Mast

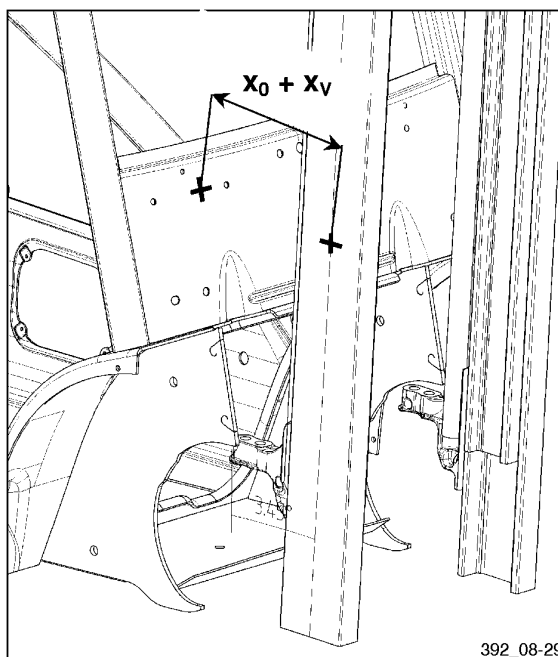
- Tilt mast forward from its mechanical limit stop by the distance  $X_V$  (forward tilt dimension).

For  $X_V$  see the table below.

- Measure the distance between truck-side and mast-side reference points.

The distance should be  $X_0 + X_V$ .

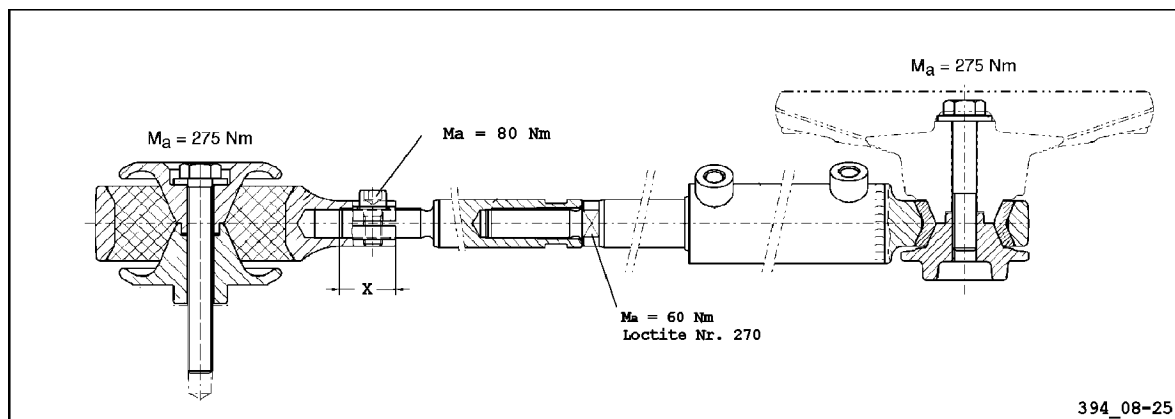
- Enter the value  $X_V$  in the diagnostic software.
- Calibrate the front electronic stop.
- Press the “Done” button in the diagnosis window.



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| Nominal forward-tilt <sup>4</sup> in degrees | All other masts of type 189 | H 40 standard LH 3100 to LH 3500 with OHG 3 to 6 | H 40 standard LH 3000 with OHG 3 - 6 |
|----------------------------------------------|-----------------------------|--------------------------------------------------|--------------------------------------|
|                                              | $X_V$ in (mm)               | $X_V$ in (mm)                                    | $X_V$ in (mm)                        |
| 0.0°                                         | 126                         | 120                                              | 113                                  |
| 0.5°                                         | 133                         | 127                                              | 120                                  |
| 1.0°                                         | 140                         | 134                                              | 127                                  |
| 1.5°                                         | 147                         | 141                                              | 134                                  |
| 2.0°                                         | 154                         | 148                                              | 141                                  |
| 2.5°                                         | 161                         | 155                                              | 148                                  |
| 3.0°                                         | 168                         | 162                                              | 155                                  |
| 3.5°                                         | 175                         | 169                                              | 162                                  |
| 4.0°                                         | 181                         | 176                                              | 169                                  |
| 4.5°                                         | 188                         | 183                                              | 176                                  |
| 5.0° <sup>5</sup>                            | 195                         | 189                                              | 182                                  |

## Tilt cylinder



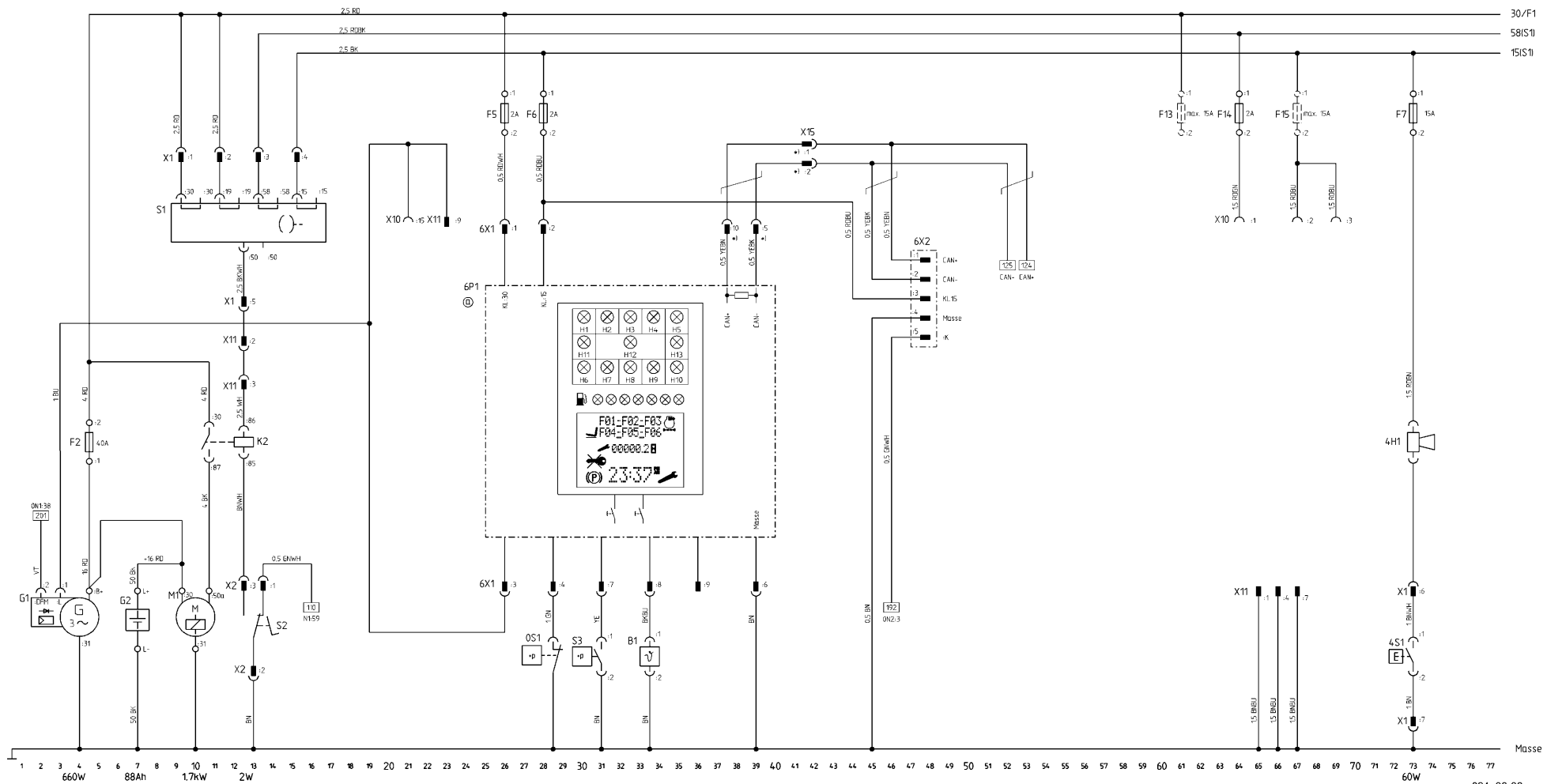
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<sup>4</sup> Backward tilt limitations are specified according to tonnage, type of mast, height of lift, mounted implement and tyres.

<sup>5</sup> Standard factory setting

## Electrical circuit diagrams

## Circuit Diagram Standard Equipment Diesel Engine, Sheet 1



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