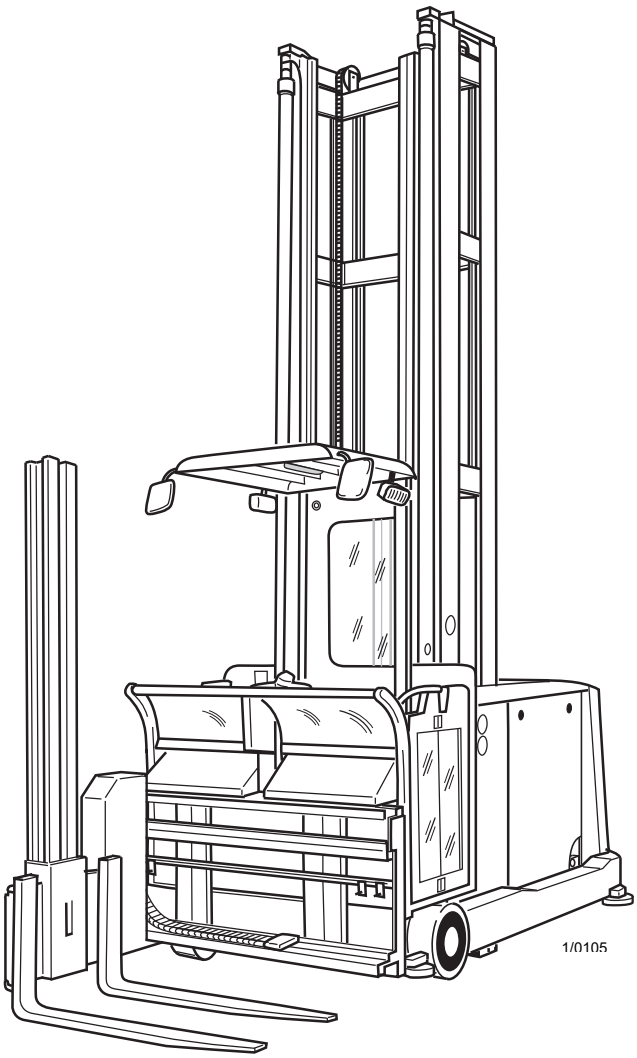
Workshop Manual DUAL15-3



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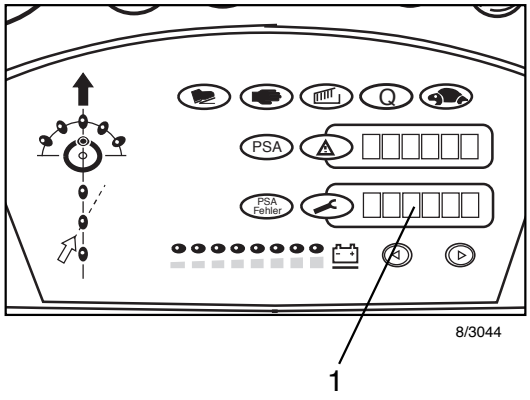
Temperatursensor integriert in der Kohlenbürsten-Brücke

If the temperature in the drive motor between the carbon brushes and stator of the drive motor rises to 160°C, the output of the drive motor is reduced by the travel and pump controller (emergency operation).
The error code "**FE2201**" appears on the operating console display (1) (see chapter "Error code".



To test the temperature sensor, the push-in connector X15 to the travel motor must be disconnected. A resistance measurement must then be made at the sensor end between pins X15:4 and X15:1. The temperature at the motor housing must then be measured.

The measured values must match those in the table to the right ±20Ω.

Remark: The temperature sensor is mounted in the carbon brush yoke. If the sensor is faulty, the entire carbon brush yoke must be replaced.

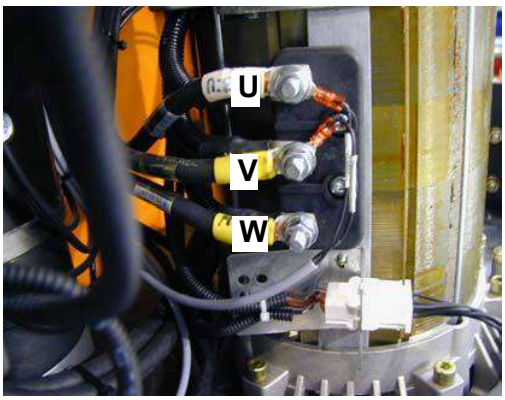
Temperature °C	Resistance Ω
25	600
50	720
70	840
100	1020
130	1220
150	1360
160	1450

Terminals

The alternating current motor is connected directly to the converter at its terminals **U**, **V** and **W**.

Also, the signal leads for phase monitoring are connected at motor terminals U and V.

Remark: If two phases, e.g. U + V, are swapped, the rotational direction of the motor is reversed, i.e. from forwards to reverse. The motor is then driven in the same direction, but the speed sensor registers the other direction. This makes the motor "hunt", i.e. alternate very rapidly in one direction and then the other.
Error message **FE2241** appears.



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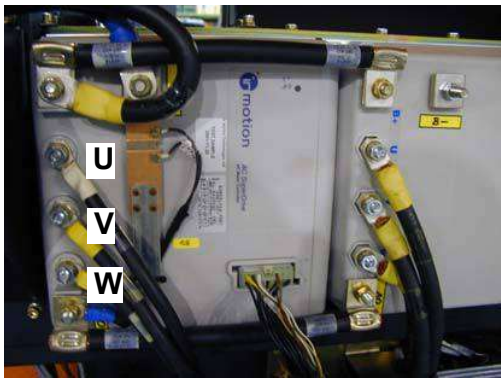

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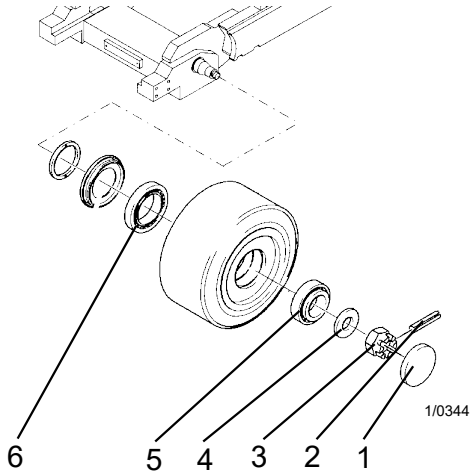
Replacing the idling wheels

Dimension of new wheel: diam. 370 x 160mm
Replace at residual diameter: 340mm

The idling wheels must be replaced when:
- the surface is heavily pitted,
- the surface is out of round,
- the surface is cracked,
- the residual diameter has been reached.



Removing the idling wheels

- Raise the cab to approx. 2m.
- Raise the idling wheel axle with a hydraulic jack and chock up the axle safely from below.
- Remove the cover cap (1).
- Remove the tensioning pin (2).
- Release the castellated nut (3).
- Pull out the disk (4).
- Take the wheel in both hands and pull it off the axle.
- Inspect the bearing shells and the tapered roller bearings (5), (6) for play and signs of wear. Replace if necessary.
- There are openings provided to help drive the tapered bearings (5), (6) out of the body of the wheel. They allow you to position the brass mandrel on the shoulder of the bearing shell. These points should be changed regularly to prevent distortion of the bearing shell.

Installing the idling wheels

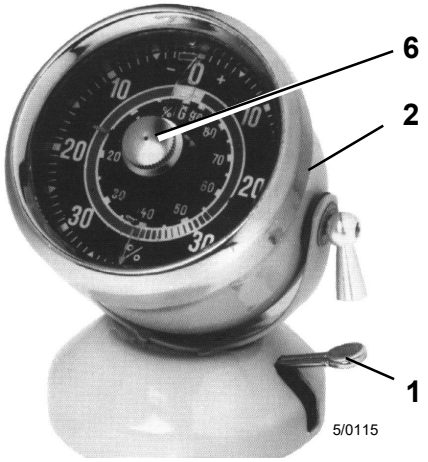
- Push on the wheel and disk (3) and then tighten the castellated nut (2) to 200Nm.
- Then release the nut again.
- Tighten the nut again until the wheel can only be turned by hand with difficulty.
- Insert a new tensioning pin.

Electromagnetic brake

Measuring the brake deceleration

General

The brake deceleration value is measured with the dynometer, Id. no. W8 050 605.



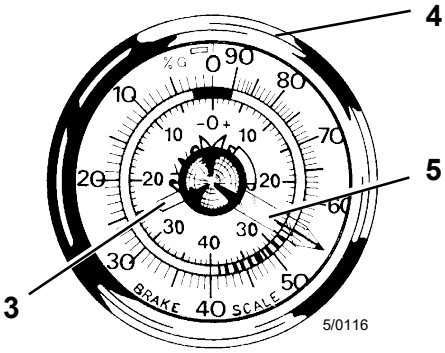
This works on the principle of the pendulum, which registers irregular movements with great precision.

During travel at a steady speed over an even surface, the pendulum always hangs vertically and shows zero on the dial (4). On acceleration, the pointer deflects to the right (clockwise) and on braking (deceleration), it moves to the left.

Preparations for measurement

Moisten the rubber sucker on the underside of the measuring instrument, then use the lever (1) to fasten the dynometer onto a horizontal surface.

The dial must face towards the driver's seat and be mounted in the direction of travel.



Before every deceleration measurement, the measuring case (2) must be tipped to move the measuring pointer (4) to zero.

The dynometer has been set <u>correctly</u> to the zero position when the measuring pointer can move almost a full turn to the left from zero and almost half a turn to the right when the case is tipped.

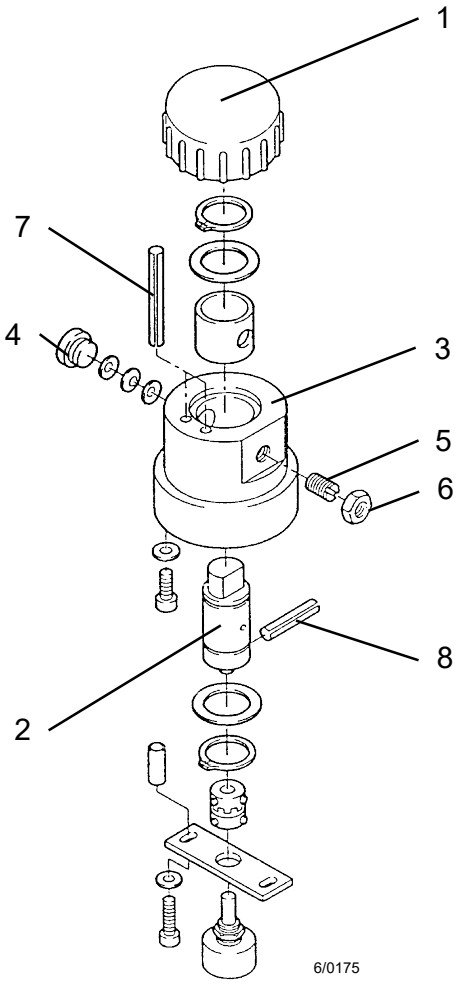
The maximum pointer (3) must be moved to the measuring pointer from the right using the knob at the centre of the dial (6).
During the braking process, the maximum pointer moves to the maximum deflection point together with the measuring pointer and remains there when the measuring pointer moves back to the zero position.

Adjusting the steering

Adjusting the turning force of the handwheel

In order to prevent the handwheel (1) turning accidentally when it is touched, there must be a certain amount of friction between the handwheel axis (2) and the guide.

This degree of friction can be altered by turning the adjusting screw (4).



Adjusting the retaining force in the straight on position

A spring-loaded ball centres the handwheel in the straight-on position (notch in the handwheel axle). The retaining force is increased by turning the adjusting screw (5) to the right. Lock with nut (6).

End stop

The mechanical end stop functions when a vertical pin (7) hits a horizontal pin (8).

Steering controller

Description

Remark: The steering controller must be isolated from the vehicle chassis when it is fitted.

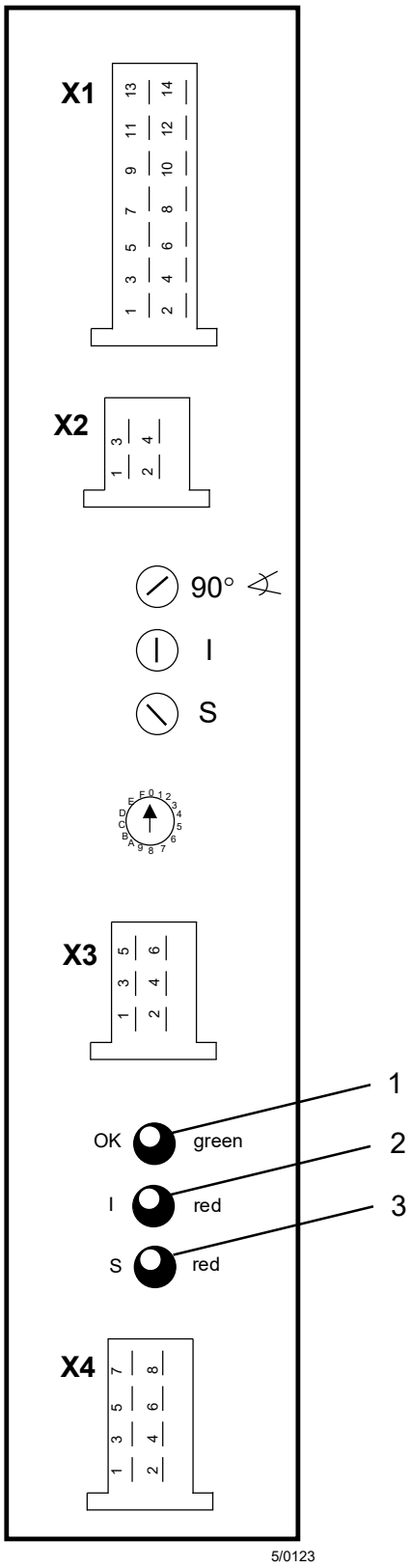
Safety test
After a supply voltage of 1+24V has been applied to X1.1 and 2+48V to X1.10, a safety test is carried out. The error memory checks the opened contact of the steering contactor 3K1 via the R, L and + terminals. If the result of this safety test is positive, the "Safety relay" output (X1:9) is set and the relay 3K1 picks up. 3K1 closes its contact and 48V are applied to R, L and +.

A green LED OK (1) indicates that the error memory has sent an enable signal.
The enable signal is removed (green LED goes off) if:

- Signal 2+48V is missing at X1.10
- There is a power supply error (internal 15V/7.5V)
- The external power supply is missing
- The steering contactor contact is not open before the test
- There is an actual value error (red LED (2)) e.g. cable to actual value potentiometer is broken
- There is a setpoint error (red LED (3)), e.g. cable to setpoint potentiometer is broken
- There is an output stage error
- There is a controller error
- There is a short-circuit error

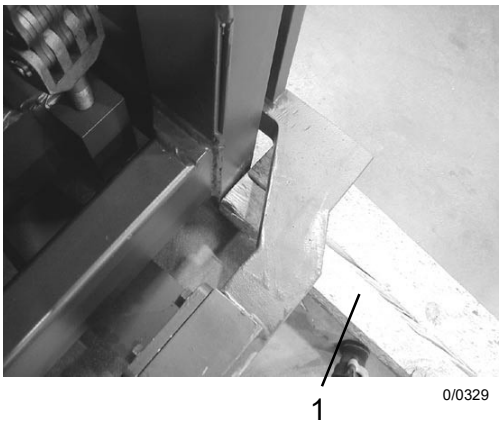
External enable
The output stage is enabled internally via input X1.3 (deadman's switch). This causes the "Steering OK" output (X1.8) to be set. Via this output, the vehicle control system (FZS) is informed that the steering is ready for operation. If this does not occur, the brake is not released! The steering remains active for about 2 seconds after X1.3 (enable) is switched off.

Remark: The error memory also switches the "Steering OK" output (X1.8) if errors occur.



Removing the mast

- Lift the mast horizontally forwards and out of the chassis.



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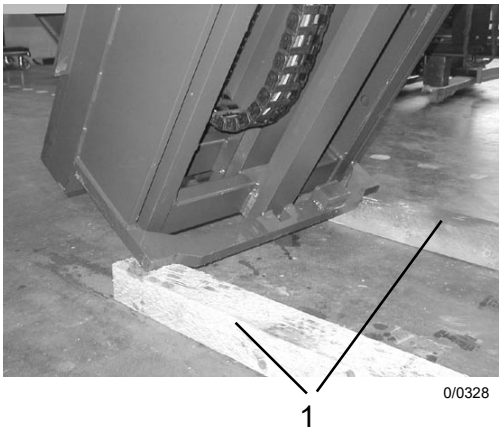
- Lay the mast on 2 squared timbers (1) to lay it down.

- Carefully lay down the mast.



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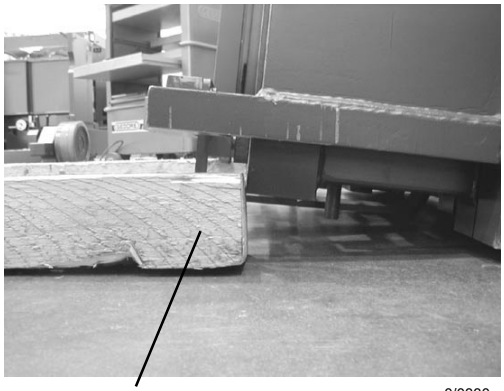
- Also support the upper part of the mast with 2 pieces of wood (2).

Installing the mast

To install the mast, follow the instructions for removal in reverse order (see sheet no. 7-01).

Note: On installation of the mast, the hydraulic leads to the main lift cylinders must be pushed through the opening in the chassis (3) to the outside, otherwise there is a risk that the hydraulic leads may be damaged.
Alternatively, the hydraulic supply leads to the main lift cylinders can be drawn back into the battery compartment while the mast is being removed or installed.



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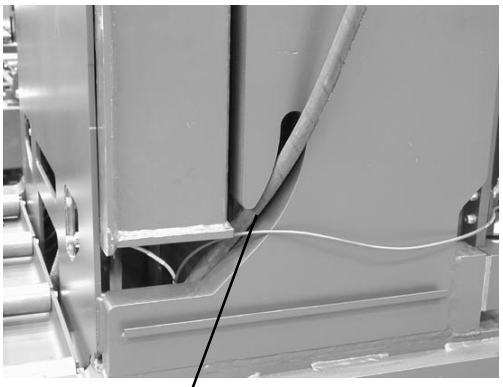
Remark: Do not reconnect the electrical and hydraulic connections until the mast is fully installed.



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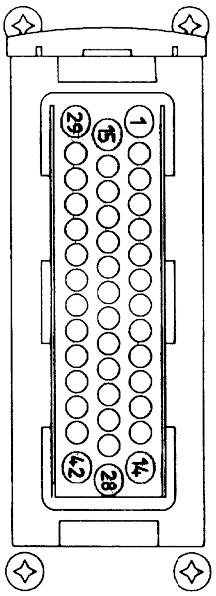
Pin assignment X11

Pin	Type	Signal	Description
28	Input	24V	Mobile personal safety equipment - deceleration
29	Input	+Batt.	Carbon brush monitor, drive motor (80V = carbon brushes OK)
30	-	-	not occupied
31	-	-	not occupied
32	-	-	not occupied
33	-	-	not occupied
34	Ausgang	24V	Activate negative feeder module A14
35	-	-	not occupied
36	-	-	not occupied
37	-	-	not occupied
38	Input	10V	Temperature monitor, drive motor
39	Input	10V	Incremental encoder signal, pump motor (Channel B)
40	-	-	not occupied
41	Input	24V	Mobile personal safety equipment - error
42	Input	24V	Mobile personal safety equipment - mode



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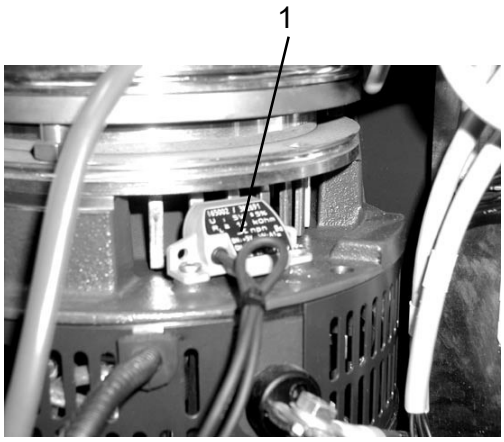
Incremental encoder monitor

General

There is an incremental encoder mounted on the drive motor and one on the pump motor. These incremental encoders are designed with two channels, for measurement of the speed and of the direction of rotation of the motor.
The supply voltage for the incremental encoders comes from the FPS.
The output signals of the incremental encoders are connected directly to the FPS, which monitors the motors for their speed and direction of rotation. In the event of an error, the affected motor is switched to idle by the FPS.



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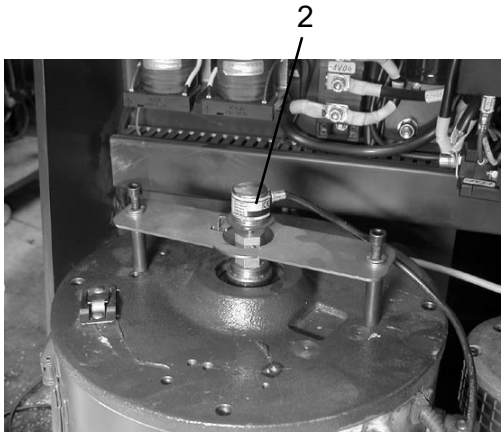
Remark: On the drive motor, the incremental encoder (1) is mounted on the counter wheel. On the pump motor, the incremental encoder is mounted on the rotary shaft of the motor. The incremental encoder for the drive and pump motors are not compatible.



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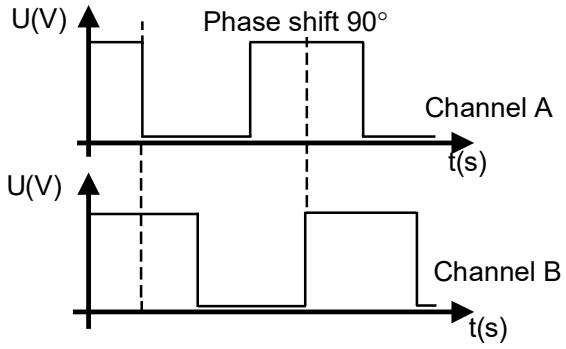
Description

The incremental encoders of the drive and pump motors are supplied with 10V by the FPS. Each incremental encoder supplies voltage signals of approx. 1V or approx. 9V at its outputs, depending on the switching status. These signals are phase shifted by 90°.

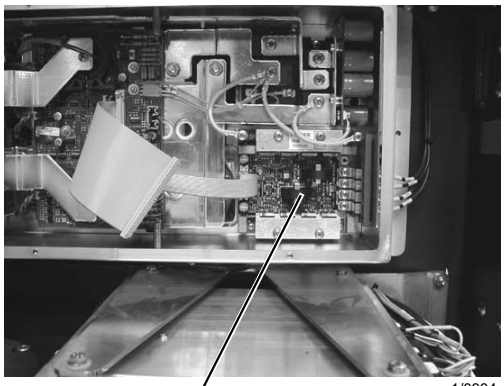


Removing the field regulator

Note: The field regulator of the FPS is one of the components in the vehicle that are at risk from electrostatic charges.
When handling these components, you should observe the following:

Before removal and installation, all electrostatic charges must be discharged from the human body by touching earthed steel elements like shelves, a heating pipe, etc.

When installing and removing components that are at risk from electrostatic charges, take care not to touch individual elements on the components, as there is still a risk they may be damaged, even if your body is electrostatically discharged!



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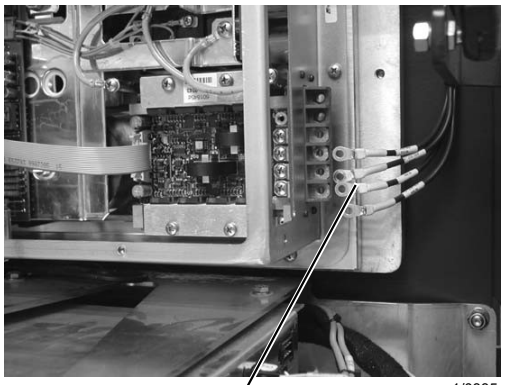
If an error has been ascertained in the FPS (see sheet no. 9-17) which makes it necessary to replace the field regulator (1), you should proceed as follows:

- Switch off the vehicle.
- Pull out the battery plug.
- Remove the control card (see sheet no. 9-20)
- Discharge any electrostatic charges in your body by touching an earthed steel unit (shelves, heating pipe, etc.).
- Check the labelling of the field connecting cables for the drive motor and pump motor (2) at the FPS and mark if necessary.
- Disconnect all 4 connecting cables (2) for the field coils of the drive and pump motors at the field regulator.
- Disconnect the two cables (3) from the field regulator that are mounted on the board spacer bracket.



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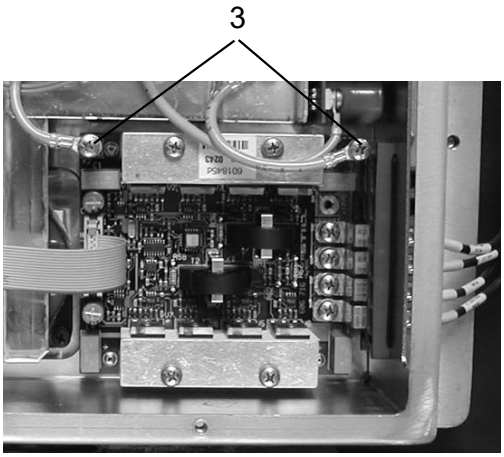

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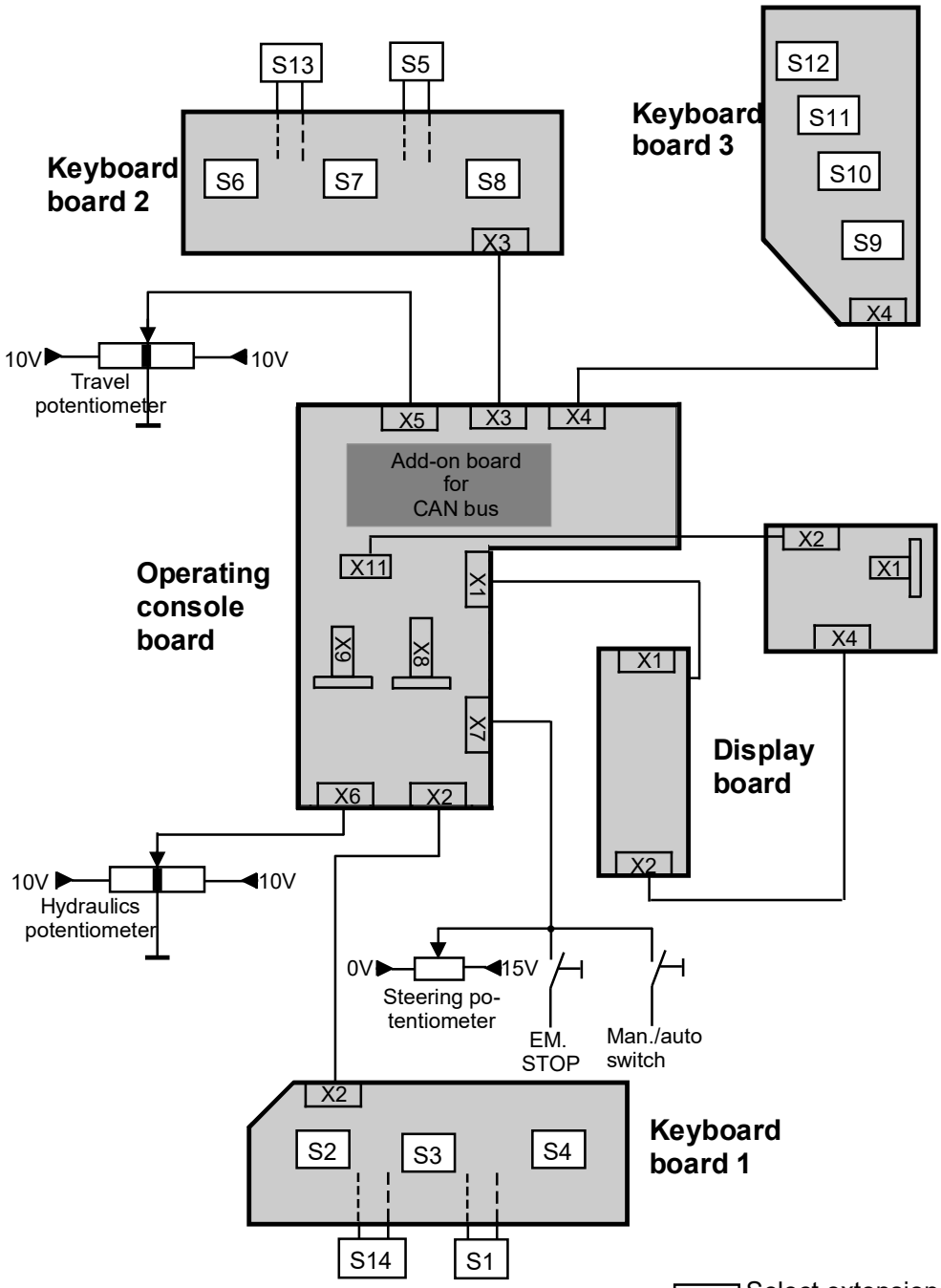
Block diagram



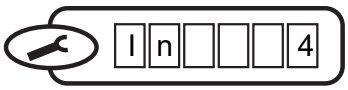
S1	2-handed operation			S10	Select extension reduction
S2	Select SSSB 180°	S6	Select additional lift	S11	Select fork adj. 1 cylinder
S3	Select SSSB 90°	S7	Select shifting	S12	Select fork adj. 2 cylinder
S4	Acknowledgement	S8	Select swivelling	S13	Select simultaneous lowering main lift and add. lift
S5	Select main lift	S9	Select horn	S14	No function

Operating console display

Information display

The operating console display can also be used to convey other important information to the driver, apart from the operating hours, the travel speed, the lift height and error codes.

The two letters "In" are always placed at the beginning of the code, so that it is immediately obvious that the message on the operating console display is an information message, e.g. "**In 4**".



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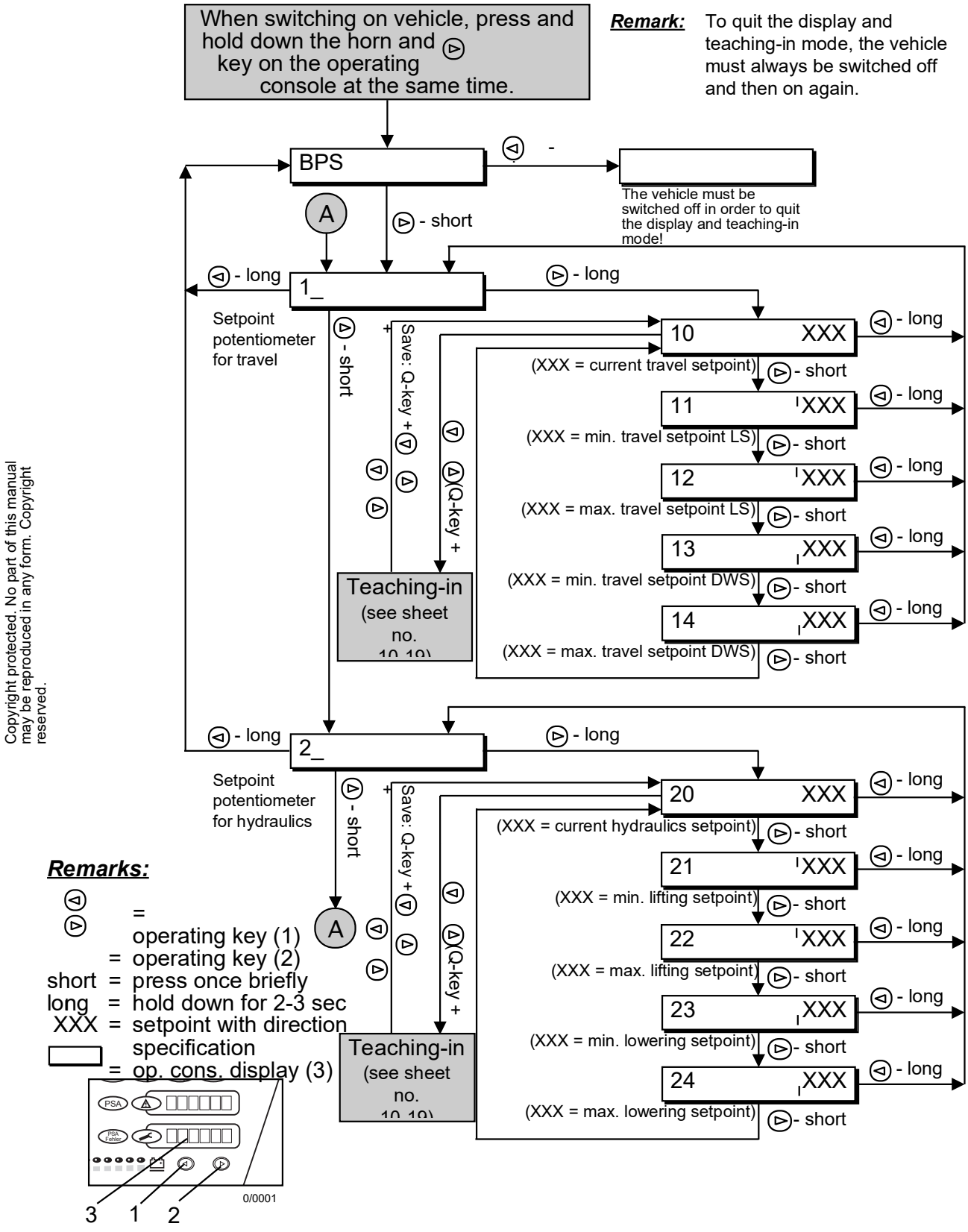
At the moment, it is possible that the following information can appear on the operating console display:

- **In 1**: The battery needs charging
- **In 2**: EMERGENCY-STOP switch actuated
- **In 3**: Traction cut-out activated
- **In 4**: Fork outside the vehicle contour
- **In 5**: Carbon brush monitor, drive motor
- **In 6**: Carbon brush monitor, pump motor
- **In 7**: "Individual driver adjustment" mode active (option)
- **In 8**: Error in start measurement of the discharge indicator (with AC vehicles only)

Remark: As long as an information message is displayed, it is not possible to switch the operating console display over to operating hours, travel speed in km/h or lift height in mm (height of top edge of fork) (see sheet no. 10-12).

Operating console display menu

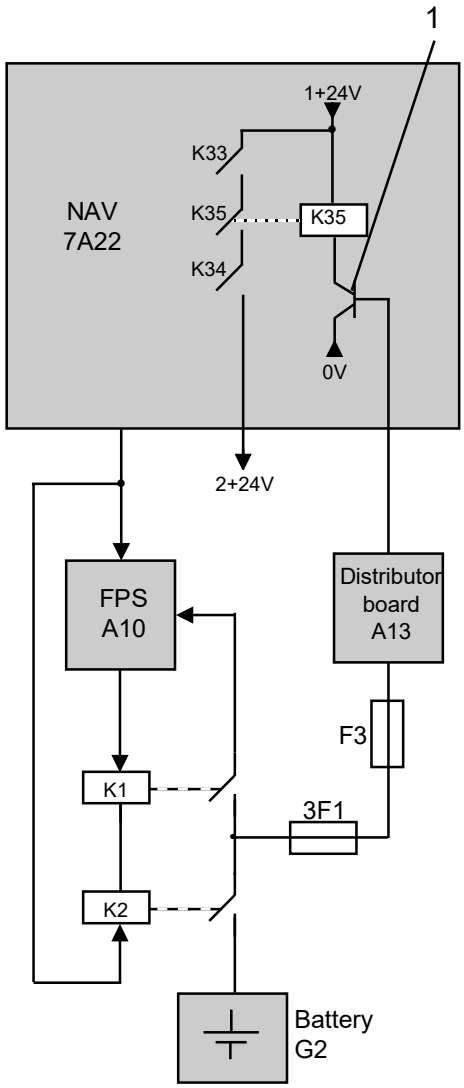


Safety relay K35

General

Safety relay K35 guarantees that the 2+24V supply voltage is not applied until after the main contactors pick up, and that the 2-24V supply voltage is switched off immediately if the main contactors drop out.

Remark: Safety relays K33 and K34 alone are not adequate for this function. Safety relays K33 and K34 can have picked up, but the main contactors still do not pick up or may already have dropped out (FPS error, main contactors faulty).



Description

If main contactors K1 and K2 pick up, the 2+battery voltage is applied to the transistor (1) in the NAV via fuse 3F1 and F3.
The transistor switches through and the safety relay K35 can pick up. The 2+24V supply voltage is enabled by relay contacts K33, K34 and K35, which are connected in series.

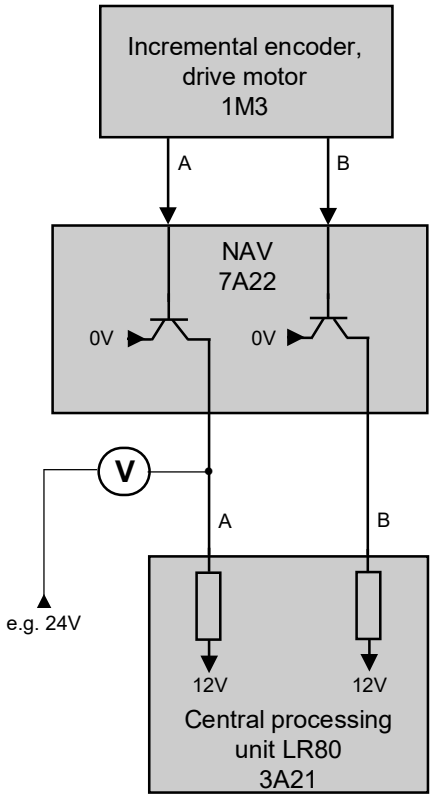
If the main contactors drop out, no voltage is applied to the transistor. Safety relay K35 drops out and opens its contact. This causes the 2+24 supply voltage to be switched off.

Remark: Switching off of the 2+24V supply voltage has the following effects:
- no enable signal for the FPS, operating console and steering controller can be sent via the deadman switch,
- all outputs of the LHC are switched off,
- all outputs of the vehicle control system except "Acknowledge PSA" and "Selection of the 2nd braking stage" are switched off.

Adaptation of incremental encoder signals

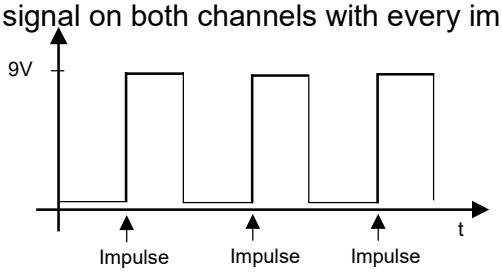
General

In vehicles with wire guidance, incremental encoder signals from the drive motor incremental encoder must be adapted for the LR80 central processing unit.

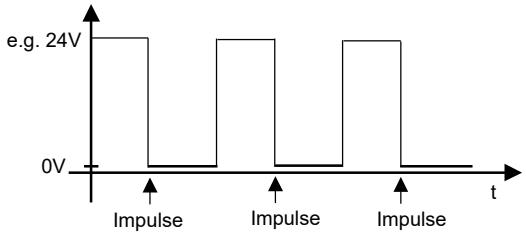


Description

The incremental encoder of the drive motor supplies a 9V signal on both channels with every impulse:



The central processing unit of the LR80 needs a 0V signal to detect the impulses:



Adaptation of the incremental encoder signals is carried out by the NAV.

Remark: In order to measure the incremental encoder signal between the NAV and the LR80, the incremental encoder signal must be measured against a positive voltage, e.g. 24V.

Safety instructions

The housing of the distance sensor may only be opened by trained personnel.

Remark: Damage to the measuring cable

Damage to the distance sensor

Do not let the measuring cable snap and do not pull it out over the given measuring range.

Caution: Risk of injury from whipping effect of the cable

Damage to the distance sensor

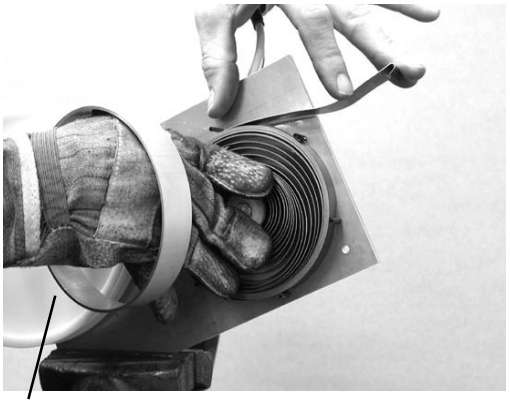
When opening the spring motor, please follow the working instructions precisely.

Danger: Risk of injury from pre-tensioned spring motor

Repair instructions

Installing a new spring:

- Lay the housing ring (1) over the hand you are going to use to press the new spring firmly onto the distance plate.
- Hold the spring around its circumference with your fingers (winding direction clockwise) and insert it between the steel pins and the spring driver.
- Keep hold of the spring and release about 6cm of the outer end of the spring.
- Carefully nip off the wire securing element with a pair of side cutting pliers so that the outer end of the spring projects.



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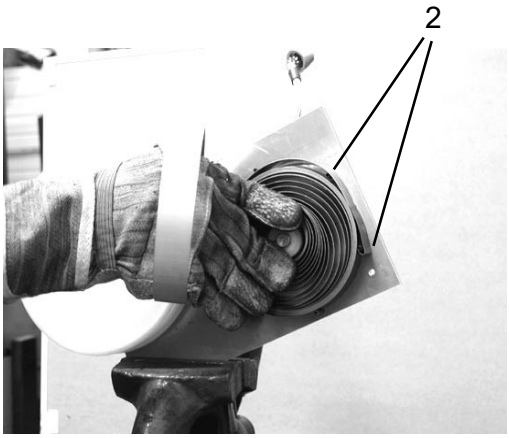
- Turn the tensioned spring so that the outer end of the spring (2) can pass around the outside past one steel pin and be engaged at the next steel pin.
- Hook the end of the spring on the steel pin.
- Push the housing ring off your wrist and over the spring.
- Use your free hand to press the spring down with a piece of wood or something similar and then carefully release it.
  The spring relaxes and sits tightly against the steel pins and the spring housing on the inside.



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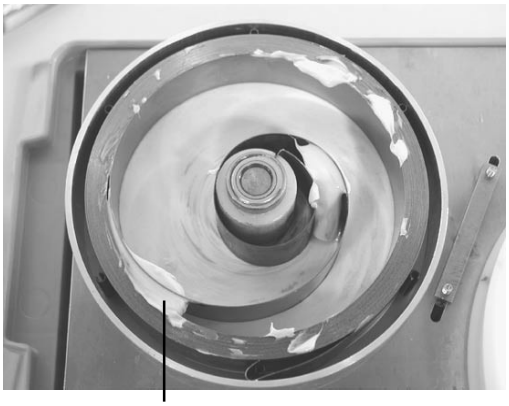
- Check the bent leg of the spring in the spring driver. While doing so, hold down the spring with a wooden strip or something similar

- If necessary, smear a little grease (3) onto the free spring coils.



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Initial commissioning

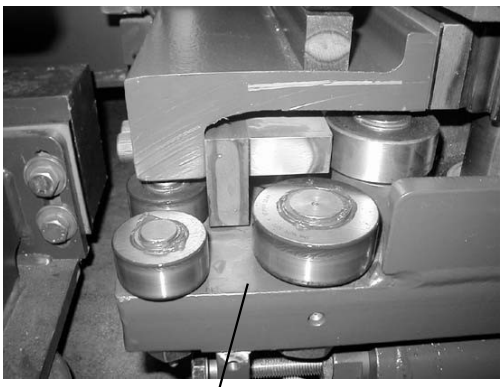
During initial commissioning, the following parameters must be checked and entered correctly using diagnosis software:

• Main lift function
- Maximum lift height in mm (see sheet 7-06).
- Measurement from the floor to the top edge of the fork when the lift carriage is fully lowered and the cab is lowered, in mm (standard setting: 60mm).
- Measurement from the floor to the standing height of the driver in the cab, in mm (standard setting: 435mm).

• Additional lift function
- Lift limitation before mechanical end stop, in mm (standard setting: 10mm).

• Side shift function
- Width of fork holder in mm (from mechanical end stop to mechanical end stop).
- Home position (fork in contour) to mechanical end stop, in mm (standard setting: 65mm).
- Overshift position to mechanical end stop in mm (standard setting: 10mm)

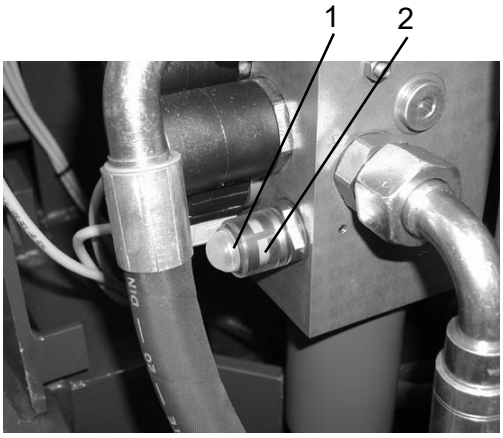
Remark: The overshift position to the mechanical end stop only needs to be set if the trilateral head is fitted with the option of shifting the side shift carriage beyond the fork frame (1).
If the TLH (trilateral head) does not offer this over-reach option, the same value should be entered for the "Over-reach position to mech. end stop" parameter as for the "Home position to mech. stop" parameter.



1/0059

Soiling indicator

The chassis valve block has a mechanical soiling indicator (1) with an inspection window (2) for the screw-mounted high-pressure filter (1).



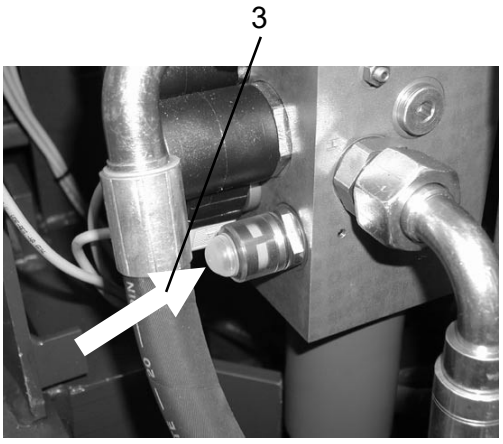
0/0304

If green is visible in the inspection window, the filter is in good order and the mechanical soiling indicator has not been triggered.

If red is visible in the inspection window, the mechanical soiling indicator has been triggered and the filter must be replaced.

The mechanical soiling indicator is triggered when a pressure drop of >7bar occurs over the filter.

Once the filter has been replaced, the mechanical soiling indicator must be reset manually by pushing in the direction of the arrow (3), so that the inspection window (2) is filled with green again.



0/0304

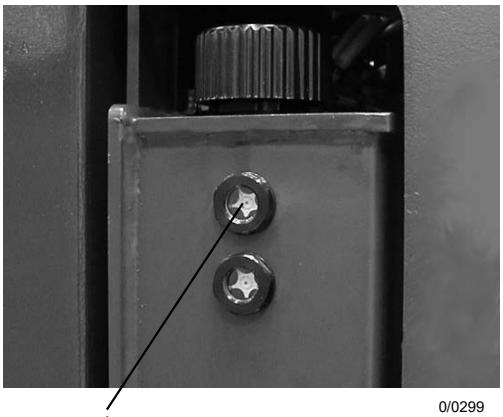
Remark: The soiling indicator may also be triggered by high pressure peaks. In order to ascertain whether the soiling indicator has been actuated by a soiled filter or a pressure peak, proceed as follows:

- Reset the mechanical soiling indicator by pushing in the direction of the arrow (3).
- Raise the main lift at 1/2 speed.
- If the soiling indicator responds immediately, the filter needs replacing.
- If the soiling indicator does not respond, a pressure peak has caused the soiling indicator to trigger early, and the filter does not need to be replaced.

Pump motor maintenance

For further details on this subject, please refer to the description of the drive motor (see sheet no. 2-07).

Oil level indicator



0/0299

On the right-hand side of the vehicle there are 2 inspection glasses on the oil tank. When the vehicle is filled with hydraulic oil, the oil level should be visible in the upper inspection glass (1).
If the oil level in the lower inspection glass is no longer visible, the hydraulic oil must be topped up without fail.

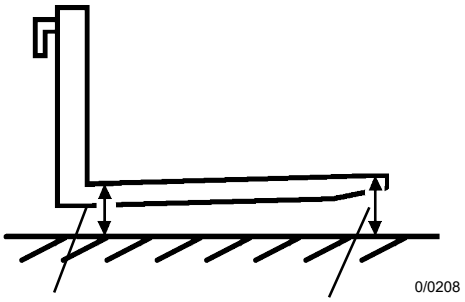
Important: The hydraulic oil level must be measured with the cab fully lowered and the addtional lift also fully lowered.

Remark: When the oil level can be seen in the centre of the upper inspection glass, there are approx. 47.5l of hydraulic oil in the tank.

When the oil level can be seen in the centre of the lower inspection glass, there are approx. 43l of hydraulic oil in the tank.

Adjusting work on the trilateral head

Adjusting the swivel shaft for the additional lift

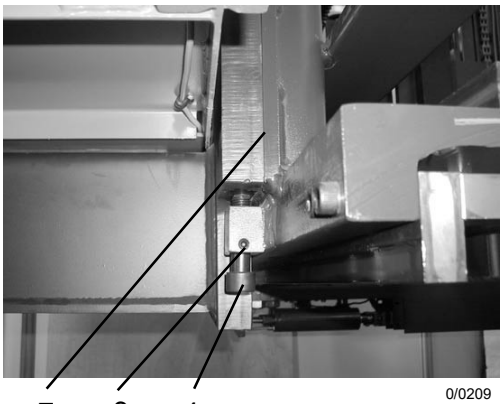


- Shift the side shift carriage into the centre position.
- Swive the fork into the straight-on position.
- Measure the height of the fork prong back.

Remark: If the two fork prongs are not set to exactly the same height, the mean value should be calculated.

- Measure the height of the fork prong tip (2).

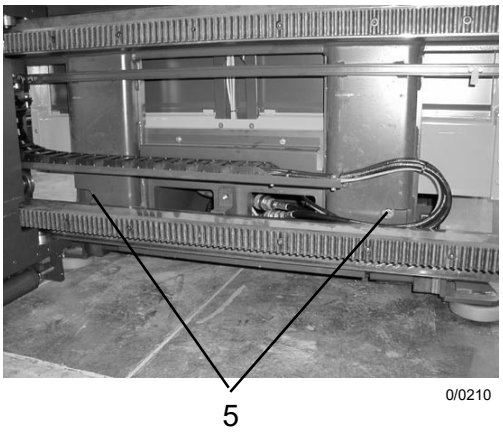
Remark: If the two fork prong tips are not set to exactly the same height, the mean value should be calculated.



The fork prong tips should be 5mm higher than the fork prong backs. If this is not the case, proceed as follows:

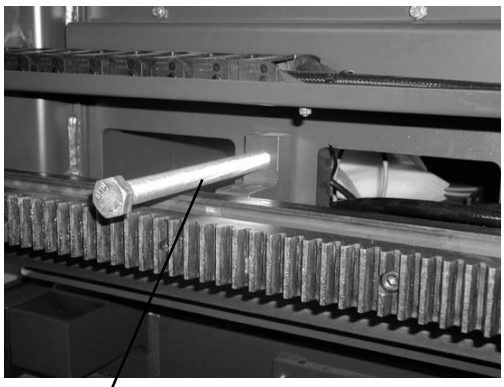
- Release the threaded pin (3) at the left and right of the fork holder.
- Release the clamping screw (4) at the left and right of the fork holder.
- Release the screw (5) at the left and right of the fork holder.
- Use a screw (M20) to push the TLH away from the cab at the bottom (6).

Remark: If there is no forcing screw available, the TLH can also be lifted with a hydraulic jack (see point 1, sheet no. 31-10).



- If the fork prong tips are too low in relation to the fork prong backs, the TLH should be lifted using a forcing screw (or hydraulic jack), until the required 5mm difference is reached.
  Finally, shims must be inserted (see point 2, sheet no. 31-10) between the TLH and the fork holder (7).

Remark: In order to insert the shims, the TLH must be raised higher than is finally necessary.



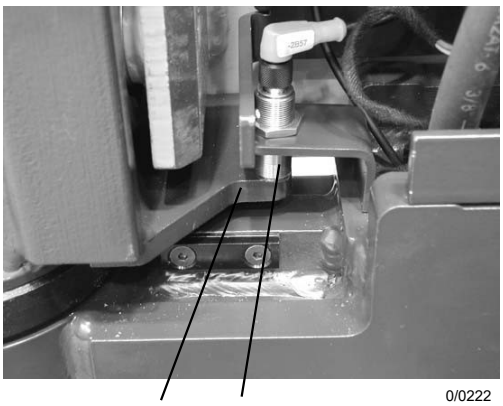
Adjusting work on the trilateral head

Adjusting the contour switches for swivelling

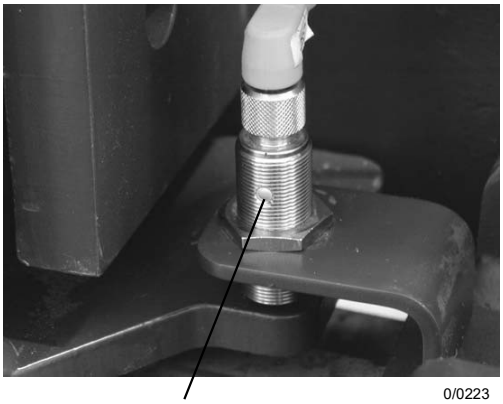
Remark: In order for the contour switch (inductive encoder) for swivelling to be set correctly, the 90° swivelling range to the left and right must be set correctly.

- Swivel the fork to the mechanical end stop at the left or right.
- The distance between the contour switch (1) and the fixed switching lug (2) should be 5 ± 2mm.
- When the contour switch is actuated, the red LED (3) in the threaded section of the contour switch lights up.

Remark: The LED on the contour switch (3) is not always visible, depending on how the element is installed.



0/0222



0/0223

Lifting chains

Checking the chain elongation

Main lift

Caution: Even if the wear limit has not yet been reached, we recommend that ***all chains (load chains and control chains)*** on the main lift should be replaced every 5000 operating hours, for safety reasons. This is because negative effects on the chains are very difficult to ascertain, due to ageing and material fatigue!

Elongation of the load chains on the main lift must be tested while installed with at least 10% of the rated load. It must not be elongated by more than 2%. The chain must be cleaned before the measurement is taken. The measurement must be carried out in the working area of the chain. The max. permissible chain elongation of 2% is 5 mm over 10 single links of a 1" chain (please see table below).
If a length of 259 mm is exceeded over 10 single links of a 1" main lift chain, the wear limit has been reached. The chain must be replaced.

General table of measurements for inch gauge chains
34 single links equivalent to -->

Chain pitch		34 links
1/2"	(12.70 mm)	431.80 mm
5/8"	(15.88 mm)	539.75 mm
3/4"	(19.05 mm)	647.70 mm
1"	(25.40 mm)	863.60 mm

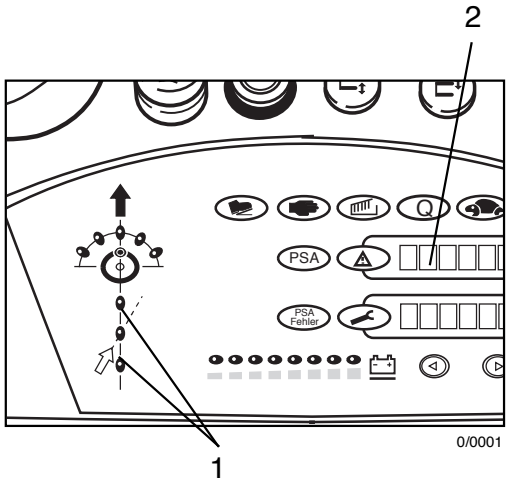
Chains with different pitches can be calculated from this information

Description of the operating modes

Automatic operation

Aisle travel

Both the aerials are positioned above the guide wire within the permissible tolerance range and the steered wheel is in the "straight-on" position (actual value potentiometer indicates straight on). The max. speed is v = 2.5 km/h outside the aisle and v = 6.5 km/h inside the aisle.



Remark: This vehicle is fitted with mechanical steering angle limitation as a standard feature.
The mechanical steering angle limitation also switches off the steering and vehicle travel if the ±3° switch is actuated, see "Steering angle limitation".

- The green LEDs (1) are on.
- The following appears on the LR80 display:

"**RAC-B:K1**" (Frequency channel 1 = 6.25kHz
"B" = reverse travel)
or
"**RAC-F:K2**" (Frequency channel 2 = 7.00kHz)
"F" = forwards travel)

RAC-B:K1
or
RAC-F:K2

Remark: While the vehicle is in motion, it is steered automatically by the inductive control system; at the same time, the two aerials monitor the low control tolerance to the guide wire. If this tolerance is exceeded, an EMERGENCY-STOP is initiated.
In the DWS travel direction, steering is only carried out with the DWS antenna.
In the LS travel direction, both antenna signals are used for the steering process.

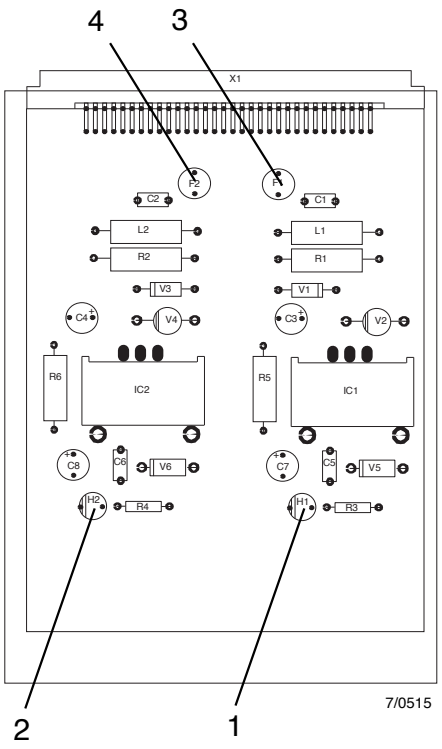
Adjusting chart LR80

Operation	Operating modeswitch position	Frequency switch position	Notebook/ Test number	Instructions	More details on sheet
1. Testing the steering mechanism				- Check four-point bearing for play - Check the gearwheels for damage - Idling wheels - Mechanism of actual value potentiom.	34-20
2. Testing the LR80 display	0	F		**Manual/auto switch not pressed:** A B C D E F G H (Red and green LED flash) **Manual/auto switch pressed:** 1 2 3 4 5 6 7 8 (Green LED flashes)	34-21
3. Balancing the digital filter	4 6	E E		**Forwards (AS)** V=80 R=A0 **Then:** Set with setpoint potentiometer R1 **First:** Set with setpoint potentiometer for steering **Reverse (LS)** H=80 R=A0 **Then:** Set with setpoint potentiometer R2 **First:** Set with setpoint potentiometer for steering CPU R2 R1	34-23
4. CPU	 B C D E F	 F F F F F		- Is the green safety LED on the central processing unit housing lit up? - Are the green LEDs for 5V and 12V voltage on the DC/DC converter lit up? - Are the following LR80 outputs set? Emergency-off Interval Automatic Interval Deceleration Interval Steering lock Interval Output stage enable Permanent Checking with **"ParaDig153"** service software	34-24 34-30

Central proccessing unit - DC/DC-converter

The DC/DC converter card is connected to +24V and supplies +5V and +12V at the output that cannot be adjusted.

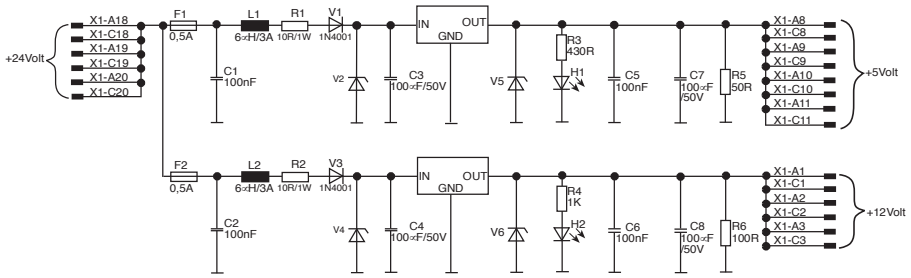
If the power supply of the central processing unit is in order, the LED H1 (1) for 5V and the LED H2 (2) for 12V must light up.
If this is not the case, check fuses F1 (3) and F2 (4).
If there is a faulty fuse, the DC/DC converter board must be replaced.



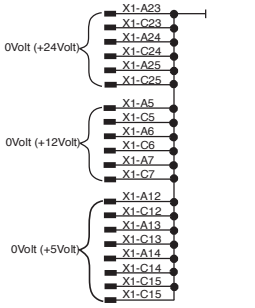
The two output voltages can be tested at the terminal connection (5) of the CPU card:

+5V: Voltage measurement between pins 3 and 4. The voltage must be between +4.95V and +5.20V.

+12V: Voltage measurement between pins 3 and 5. The voltage must be between +11.5V and + 12.5V.

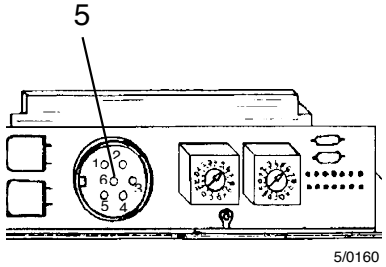


If one or both of the voltages are not correct, an error message appears on the LR80 display and the vehicle comes to an emergency stop. The DC/DC converter card must be replaced.



Remark: If the output voltages are within the tolerance range and one of the following error messages appears on the LR80 display:
- "12V voltage too high"
- "12V voltage too low"
- "5V voltage too high"
- "5V voltage too low"

the CPU card is faulty and must be replaced.



Steering output stage

Remark: The steering output stage must be isolated from the vehicle chassis when it is fitted.

Setting the service switch

The service switch (1) can be used to reduce the maximum power of the steering output stage and consequently the max. steering speed during adjustments.

Remark: The service switch is **not** an endless switch and may **only be set to max.** position "F".

	Schalterstellung	Ausgangsleistung
Normalbetrieb	7	100%
Reduzierung 1	C	30%
Reduzierung 2	D	40%
Reduzierung 3	E	50%
Reduzieung 4	F	60%

None of the other switch positions are used on this vehicle and they must not be set.

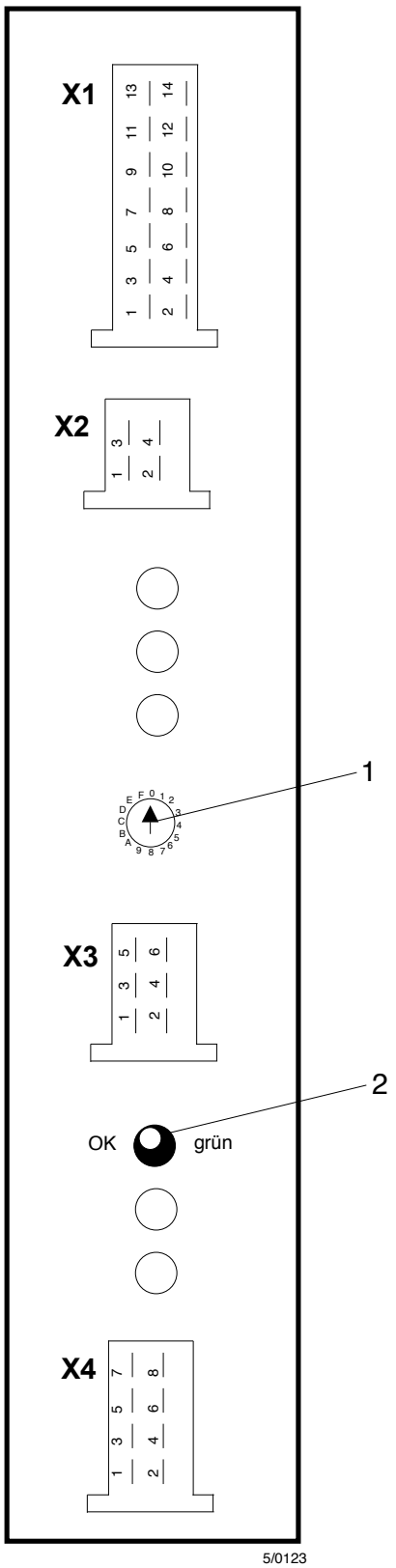
Enable LED

The green enable LED (2) indicates that the output stage is ready for operation and has not identified any errors during the switching-on self-test.

Possible errors:

- 1+24V supply voltage is missing at X1.1
- 80V at X1.10 is missing (EMERGENCY-STOP chain closed)
- Steering contactor 3K1 closed on switching on
- Amplifier faulty

Remark: In the event of an amplifier error, the following error message is shown on the LR80 display: "Amplifier current limitation faulty". Please see "Error messages".



Adjusting the actual value potentiometer (to approx. 11/02)

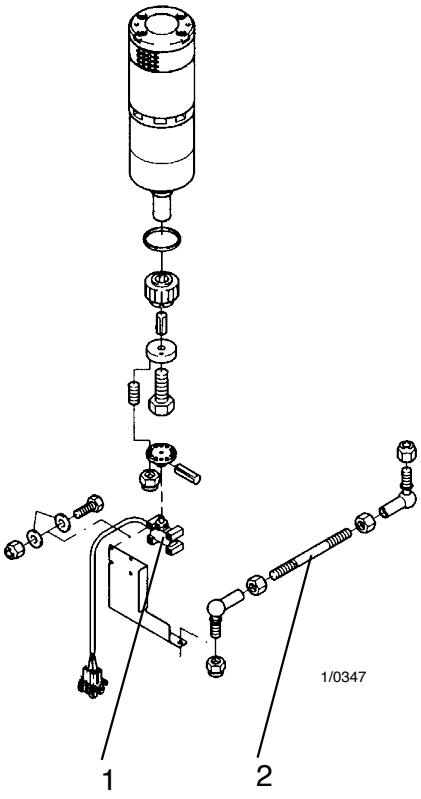
- Jack up the vehicle and switch it on.
- Set the offset potentiometer for "Straight-on travel" on the CPU board to "zero"
- Set the operating mode switch to "8"
- Leave the frequency switch in the set position.
- A message appears on the LR80 display, e.g.:

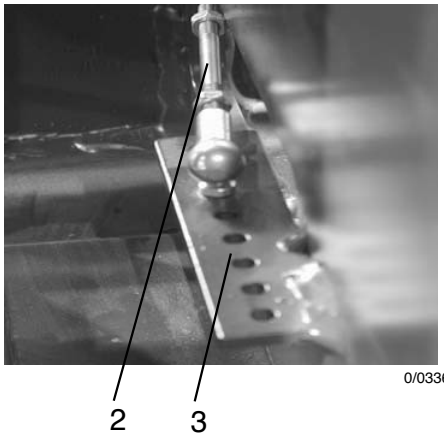
Setpoint specification Actual value registered

- Use the threaded pin (2) to move the potentiometer (1) on the punched strip or turn the threaded pin until the drive wheel reaches the straight-on position (visual check and test drive for straight-on travel).

Remark: Alternatively, the actual value potentiometer can be adjusted with the notebook:

- Start the terminal program (TEWAK) and enter the command "B001".
- Enter setpoint S800 on the notebook (represents setpoint specification for straight-on).
- Use the threaded pin (2) to move the potentiometer (1) on the punched strip or turn the threaded pin until the drive wheel reaches the straight-on position (visual check and test drive for straight-on travel).
- After making the adjustment, switch the actual value potentiometer back to normal operation with the "B000" command.

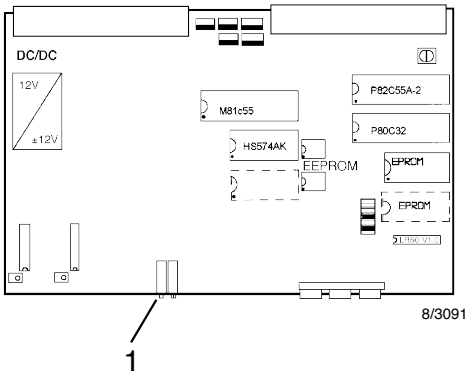




Mounting and adjusting the aerials

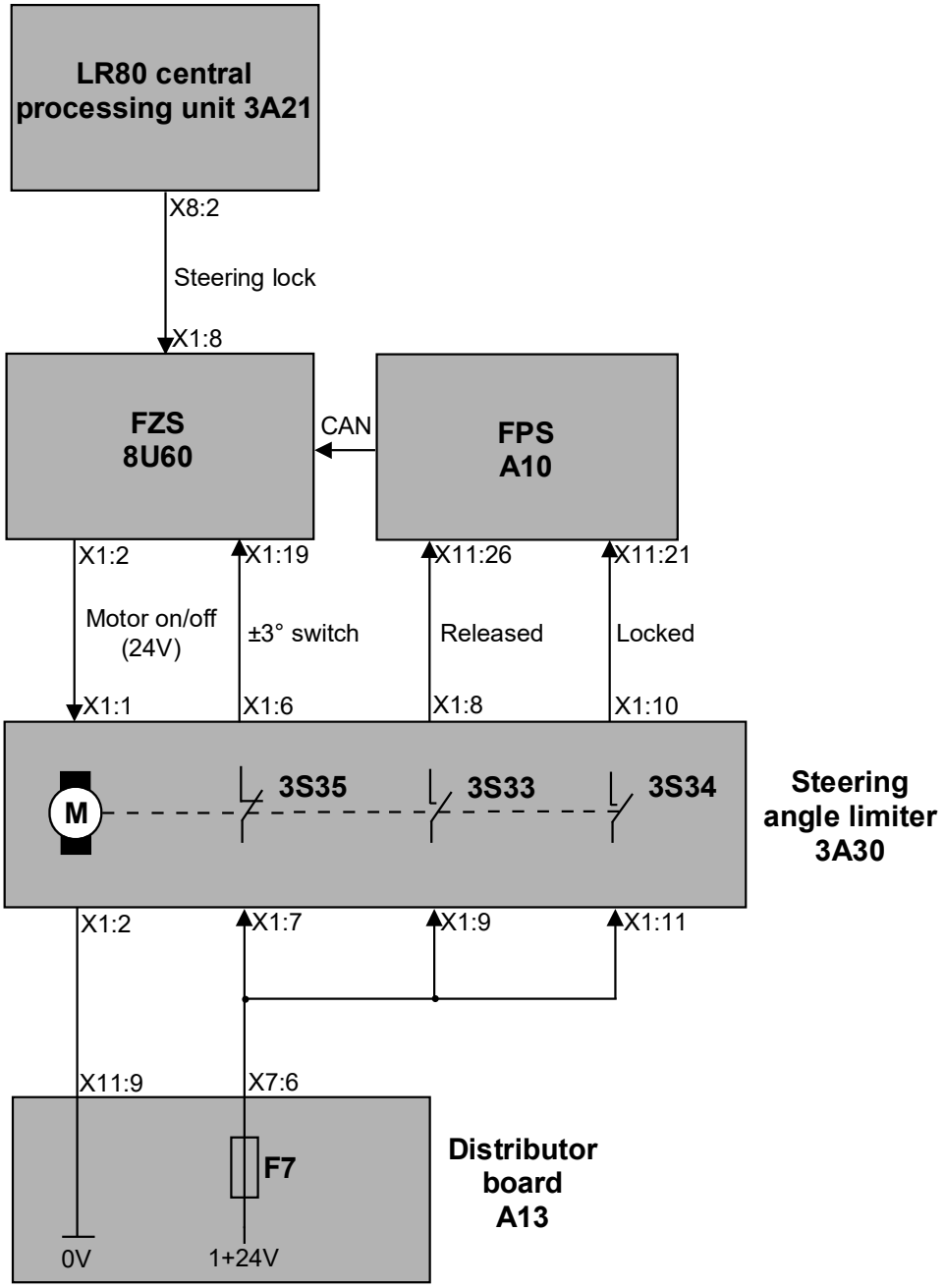
3. Setting the offset potentiometer for "Straight-on in direction of the drive wheel side" travel

- In automatic mode, drive the vehicle in the direction of the drive wheel over the guide wire.
- Watch the cable binder. Does the vehicle move along exactly over the wire? If not, turn the DWS offset potentiometer (1) by 2-3 turns.
- After every adjustment, test the vehicle again in the same way until it travels in a straight line.



Steering angle limiter

Block diagram for vehicles with distributor board A13



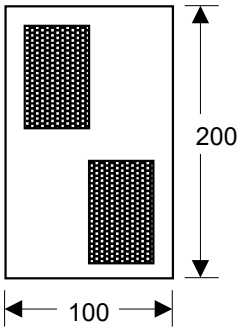
Aisle recognition

Aisle recognition sensors

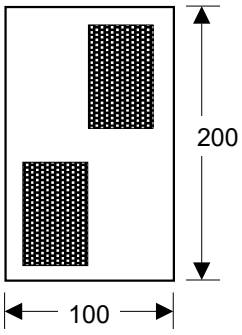
Two light barriers are mounted on each side of the mast, and act as the aisle recognition sensors. They are mounted one above the other (at a distance of 130mm).
An "A-reflector" is mounted at the open aisle end (aisle entrance).

Remark: If it is not possible to mount a reflector at the right for technical reson, a "B-reflector" can be mounted on the left.

A reflector



B reflector



The upper light barriers at the left and right of the mast are connected in series. If neither of the upper light barriers is actuated, a 24V signal is applied at input X1:35 of the vehicle control system (FZS).
If one of the two light barriers is actuated by a reflector, a 0V signal is applied at this input of the vehicle control system. This 0V signal is recognised as an "Inside aisle" signal.

The lower light barriers at the left and right of the mastare connected in series. If neither of the lower light barriers is actuated, a 24V signal is applied at input X1:13 of the vehicle control system (FZS).
If one of the two light barriers is actuated by a reflector, a 0V signal is applied at this input of the vehicle control system. This 0V signal is recognised as an "Outside aisle" signal.

The last switching function to be transmitted is the dominant one, i.e. a switching sequence "Outside aisle" and then "Inside aisle" means that the vehicle has been driven into the aisle. If the switching sequence is received in the opposite order, the vehicle is driving out of the asle.

Error messages

The error messages listed here are sent from the LR80 central processing unit to the operating console where they are displayed as moving text on the LR80 display.

Error message as continuous text	Solution
Emergency-stop wheel angle too high ?	- Check actual value potentiometer, check line connection. - When the error has been rectified, the LR80 must be reset.
Two drive control valves?? **Drive control valves??**	- Check function of direction input (connector X9). - Check line connection.
Inc. encoder fault?? **Wrong encoder direction??**	- Check function of path transmitter (connector X10). - Check line connection. - Possibly drive wheel blocking during braking - Replace the incremental encoder
EEPROM programming fault??	- EEPROM on LR80 CPU-plate faulty. Replace EEPROM. New programming attempt.
Emergency out * front coil fault* **Emergency out * back coil fault*** **Emergency out lateral deviation front too high??** **Emergency out lateral deviation back too high??**	- Check throughput of wire loop. - Measure current through wire loop (> 60mA). - When the error has been rectified, the LR80 must be reset.
Sensor front fault **Sensor back fault**	- Check line connection to relevant aerial. - Replace the aerial. (Front = DWS, Rear = LS)
Potentiometer manu fault	- Check the line connection. - Replace the setpoint potentiometer.
GEB??	- 2 seconds after a travel direction signal is applied, the LR80 central processing unit has not detected any signals from the incremental encoder

Steering errors

- **FE201**
  Only applies for vehicles with LR80!
  The 3S33 limit switch (released) of the steering angle limiter has not been actuated, although all the prerequisites for this are fulfilled. The FZS initiates an EMERGENCY-STOP and the motor drive signal for the mechanical steering angle limiter is interrupted immediately in order to prevent mechanical damage to the steering angle limiter.
  This error must be cancelled by switching off the vehicle.
  Travel: Travel is not possible
  Hydraulics: No hydraulic movements are possible

- **FE202**
  Only applies for vehicles with LR80!
  The 3S34 limit switch (locked) of the steering angle limiter has not been actuated, although all the prerequisites for this are fulfilled. The FZS initiates an EMERGENCY-STOP and the motor drive signal for the mechanical steering angle limiter is interrupted immediately in order to prevent mechanical damage to the steering angle limiter.
  This error must be cancelled by switching off the vehicle.
  Travel: Travel is not possible
  Hydraulics: No hydraulic movements are possible

- **FE203**
  Applies for vehicles with standard steering and LR80!
  This error code is displayed if the enable signal at X1:3 is removed from the steering controller or the steering amplifier (release of deadman switch or opening of the "enable" contact of the LR80 central processing unit) and the "Steering OK" signal is still applied at output X1:8 (24V) of the steering controller or steering amplifier after 6 seconds.
  This error must be cancelled by switching off the vehicle.
  Travel: Travel stop
  Hydraulics: No restrictions

- **FE204**
  Only applies for vehicles with LR80!
  This error code is displayed if the 3S33 switch (released) and the 3S34 switch (locked) of the steering angle limiter are actuated at the same time. The vehicle control system initiates an EMERGENCY-STOP.
  This error must be cancelled by switching off the vehicle.
  Travel: Travel is not possible
  Hydraulics: No hydraulic movements are possible

Errors in synchronous rotating/reaching movement 90°/180°

- **FE714**
  The position of the side reach is not in the right relation to the current rotating position for executing or continuing the synchronous rotating/reaching movement (SSSB) 180° or the optional SSSB 90° (drag error too great).
  Travel: Vmax = 2.5 km/h
  Hydraulics: No synchronous rotating/reaching movement possible

Errors in automatic breaking at end of aisle (EASS)

- **FE1108**
  Only applies for EASS magnetic!
  The magnetic switches do not switch in pairs when the vehicle enters the fast travel zone in the DWS direction (drive wheel side). If this error occurs, the vehicle is braked to a standstill and the red Q-LED on the operating console lights up.
  Rectify the cause of the error. Cancel the error by switching the vehicle off and then on again or by driving out of the aisle.
  Travel: Travel stop, Vmax = 2.5 km/h with Q-key pressed
  Hydraulics: No restrictions

- **FE1109**
  Only applies for EASS magnetic!
  This error is displayed if implausible magnetic switch statuses occur outside the aisle. Outside the aisle, the magnetic switches for speed reduction to v = 2.5 km/h should be open and the magnetic switches for the absolute stop should be closed. If this error occurs, the vehicle is braked to a standstill and the red Q-LED on the operating console lights up.
  Rectify the cause of the error. Cancel the error by switching the vehicle off and then on again or by driving out of the aisle.
  Travel: Travel stop, Vmax = 2.5 km/h with Q-key pressed
  Hydraulics: No restrictions

- **FE1110**
  Only applies for EASS magnetic!
  This error code is displayed when implausible magnetic switch statuses occur inside the aisle. If this error occurs, the vehicle is braked to a standstill and the red Q-LED on the operating console lights up.
  The error is cancelled automatically when the cause of the error is rectified.
  Travel: Travel stop, Vmax = 2.5 km/h with Q-key pressed
  Hydraulics: No restrictions

- **FE1111**
  Only applies for EASS magnetic!
  The magnetic switches do not switch in pairs when the vehicle enters the fast travel zone in the LS direction (load side). If this error occurs, the vehicle is braked to a standstill and the red Q-LED on the operating console lights up.
  Rectify the cause of the error. Cancel the error by switching the vehicle off and then on again or by driving out of the aisle.
  Travel: Travel stop, Vmax = 2.5 km/h with Q-key pressed
  Hydraulics: No restrictions

Travel and pump controller (FPS) errors

- **FE2161** (see chapter entitled "FPS, Table of errors")
  Pump motor temperature sensor short-circuit.
  The measuring circuit for temperature measurement of the pump motor has shorted between X11:23 and X11:38 of the FPS.
  Travel: No restrictions
  Hydraulics: No restrictions

  Remark: This error code is only displayed in SERVICE mode (please refer to the "SERVICE mode" chapter).

- **FE2162** (see chapter entitled "FPS, Table of errors")
  Drive motor temperature sensor cable breakage.
  The measuring circuit for temperature measurement of the drive motor has been interrupted between X11:22 and X11:23 of the FPS.
  Travel: No restrictions
  Hydraulics: No restrictions

  Remark: This error code is only displayed in SERVICE mode (please refer to the "SERVICE mode" chapter).

- **FE2164** (see chapter entitled "FPS, Table of errors")
  Pump motor temperature sensor cable breakage.
  The measuring circuit for temperature measurement of the pump motor has been interrupted between X11:23 and X11:38 of the FPS.
  Travel: No restrictions
  Hydraulics: No restrictions

  Remark: This error code is only displayed in SERVICE mode (please refer to the "SERVICE mode" chapter).

- **FE2165** (see chapter entitled "FPS, Table of errors")
  Drive motor temperature sensor earth contact (+ side).
  The measuring input X11:22 of the FPS is directly connected to 0V.
  Travel: No restrictions
  Hydraulics: No restrictions

  Remark: This error code is only displayed in SERVICE mode (please refer to the "SERVICE mode" chapter).

- **FE2167** (see chapter entitled "FPS, Table of errors")
  Pump motor temperature sensor earth contact (+ side).
  The measuring input X11:23 of the FPS is directly connected to 0V.
  Travel: No restrictions
  Hydraulics: No restrictions

  Remark: This error code is only displayed in SERVICE mode (please refer to the "SERVICE mode" chapter).

Travel and pump controller (FPS) errors

- **FE2231 to FE 2233**
  Internal FPS error, Service mode, Cl. 6
  Possible error: FPS faulty.
  Rectification: Replace the FPS.

- **FE2241**
  Speed monitoring, drive motor, Operation, Cl. 1
  The pulses generated by the speed sensor are compared with the speed from the converter. If the different is too large --> error. If the entire speed sensor is pulled off, no error message appears, but if the converter and FZS receive different speed sensor signals (e.g. when signal lead disconnected at the FZS), this error message appears.
  Possible error: Speed sensor has cable breakage, speed sensor faulty.
  Rectification: Check the power supply and the speed sensor signal leads to the FZS and to the converter. Replace the speed sensor.

- **FE2242 to FE 2252**
  Internal FPS error, Service mode, Cl. 6/1
  Possible error: FPS faulty.
  Rectification: Replace the FPS.

- **FE2253**
  Contactor lead disconnected, Operation, Cl. 6
  The internal FPS contactor driver is activated but there is no current flowing through the contactor coil.
  Possible error: Safety chain interrupted, main contactor coil not properly connected, main contactor faulty, FPS faulty.
  Rectification: Check the safety chain, check the main contactor coils for transmission, connect the main contactor coils properly, replace the main contactors, replace the FPS.

- **FE2254**
  CAN bus monitoring, hydraulic converter, Operation, Cl. 6
  The CAN protocol cannot be evaluated.
  Possible error: The CAN bus converter is faulty, converter not properly connected, converter faulty, FPS faulty, 120Ωterminal resistance at hydraulic converter is missing.
  Rectification: Check the CAN bus, replace the converter, replace the FPS.

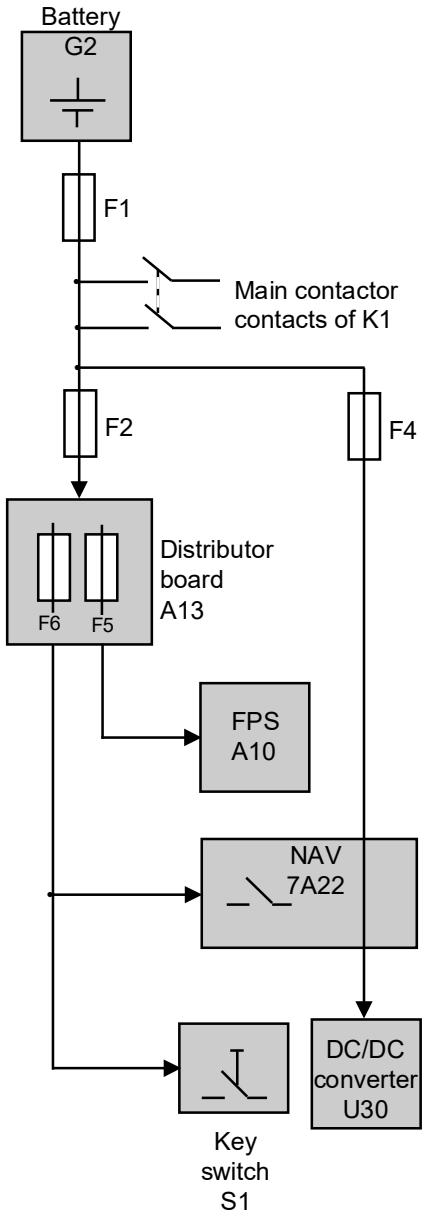
- **FE2255**
  CAN bus monitoring, travel converter, Operation, Cl. 6
  The CAN protocol cannot be evaluated.
  Possible error: The CAN bus converter is faulty, converter not properly connected, converter faulty, FPS faulty, 120Ωterminal resistance at hydraulic converter is missing.
  Rectification: Check the CAN bus, replace the converter, replace the FPS.

Voltage supply function
Battery voltage

When the battery plug is inserted, the battery voltage should be applied at the following components/pins:

- NAV, pin X1:4
- FPS, pin X11:1
- Key switch S1, terminal P
- DC/DC converter, pin IN+

Remark: If battery voltage is applied at all the listed components/pins, troubleshooting can be continued at 1+battery voltage.



If no battery voltage is measured at the NAV, pin X1:4, check the following:

- Connecting lead between battery plug and fuse F1 of the main current circuit (355A)
- Fuse F1 of the main current circuit
- Connecting lead between fuse F1 of the main current circuit and main contactor contacts of K1
- Connecting lead between main contactor contacts of K1 and fuse F2
- Fuse F2 (10A)
- Connecting lead between fuse F2 and distributor board A13, plug-in contact X3
- Fuse F6 (5A) on distributor board A13
- Connecting lead between distributor board A13, pin X13:2 and NAV, pin X1:4

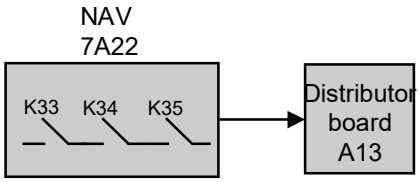
If no battery voltage is measured at the FPS, pin X11:1, check the following:

- Fuse F5 (5A) on distributor board A13
- Connecting lead between distributor board A13, plug-in contact X17 and FPS, pin X11:1

If no battery voltage is measured at the key switch, terminal P, check the following:

- Connecting lead between distributor board A13, pin X16:9 and key switch S1, terminal P

Power supply function
2+24V



After 2+battery voltage is applied to the NAV, pin X1:8, 2+24V should be applied at the following components:

- Distributor board A13, plug-in contact X2

Remark: If 2+24V is applied at all the listed components/pins, the power supply function is OK.

If no 2+24V is applied at distributor board A13, plug-in contact X2, check the following:

- Internal connection in the NAV between pins X1:29 and X1:42

Remark: If an interruption is found between these two pins in the NAV, the entire NAV must be replaced.

- Connecting lead between the NAV, pin X1:42 and distributor board A13, plug-in contact X2.

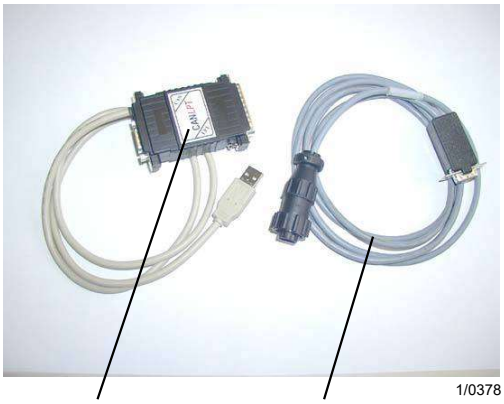
General

The "ParaDig" Service software is used for setting parameters, setting and resetting options and for diagnosis.

The ParaDig133 service software **must** be used for vehicle type 13-3.

The ParaDig153 service software **must** be used for vehicle type 15-3.

In order to work with the service software, you need a CAN-PC interface adapter (dongle) (1) and a special adapter cable (2).



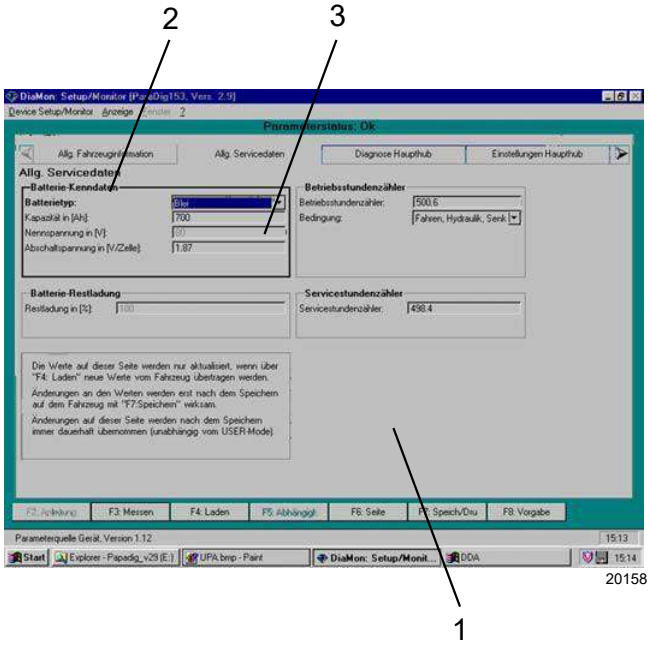
Working with ParaDig

Parameterising

General

In the ParaDig software, a basic differentiation is made between the pages for parameterising (1) and the pages for diagnosis (see "Working with ParaDig, Diagnosis").
The working method for the pages for parameterising and the pages for diagnosis is different.

On the pages for parameterising, when the software is started, the current vehicle settings are shown.
On the page shown to the right with the heading "General service data", the current configuration for the battery is displayed (2):



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- Battery type: lead battery
- 700Ah capacity
- Switch-off voltage at 1.87V/cell

If parameters on these pages are changed, they must be saved (see Saving settings) in order to test the change or to save it permanently.

Remark: Parameter values that are displayed in grey (3) cannot be changed.

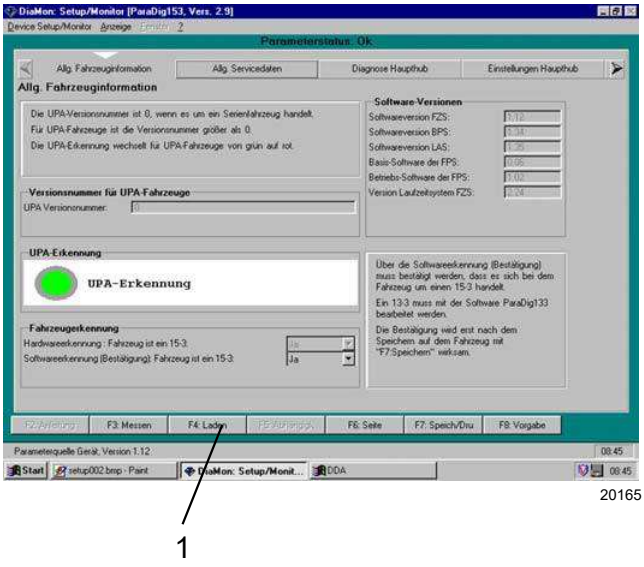
Working with ParaDig

Loading vehicle settings from a file

The "**F4: Load**" function key (1) can be used to load the current vehicle settings into the ParaDig from the vehicle (please see "Loading parameters from the vehicle") or from a file.

Remark: If you want to load vehicle settings from a file, the file must previously have been created with the ParaDig, please see "Saving vehicle settings in a file".

When the "**F4: Load**" function (1) is selected, a window with the heading "Loading" (2) opens.
In this window, you must select the option in which the vehicle settings are loaded from a "**Text file**" (3).



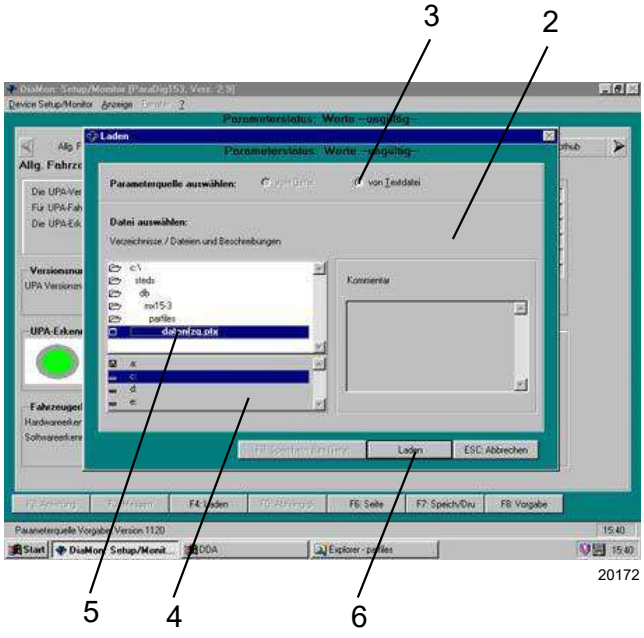
20165

Select the disk drive (4) and subdirectory (5) on which the file with the vehicle settings is located.
Select the file with the vehicle settings so that its background turns blue.

Remark: Only files with a "**.ptx**" extension are displayed.

Finally, the process is started by selecting "**Load**" (4).
As with the initial program start, all the parameters are now read out of the vehicle control system (FZS) into the ParaDig.

Remark: The "Load" window (2) does not close automatically after the parameters have been read in, but must be closed manually with "**ESC: Exit**" (5).

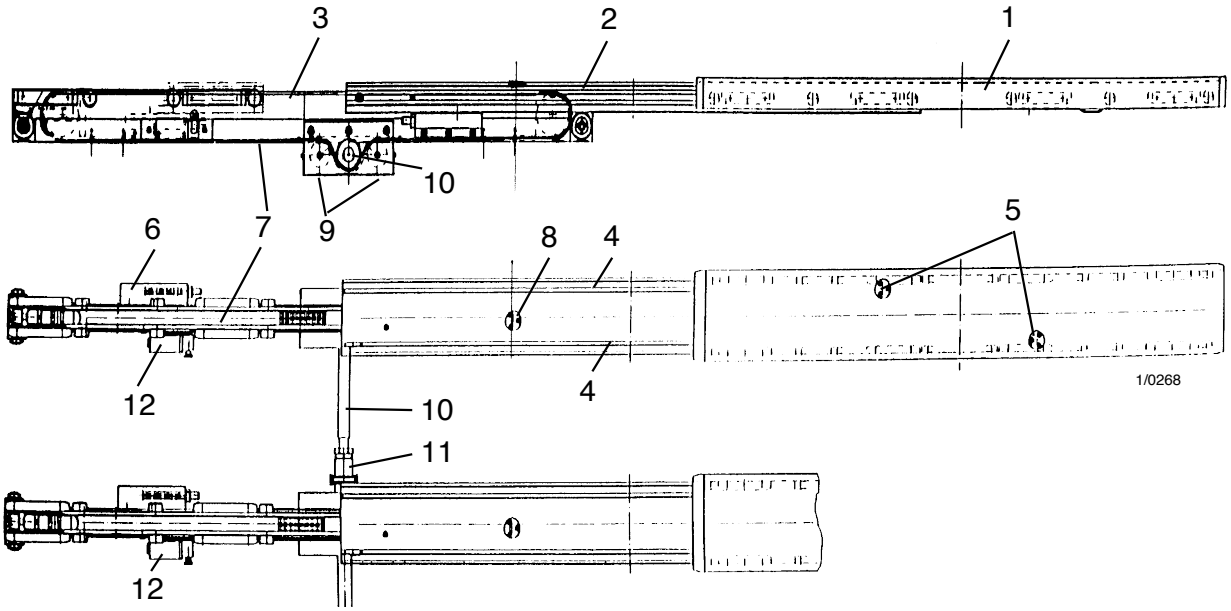


20172

Home position

In order for the fast travel signal of the industrial truck to be sent, the attachment must be in its home position. The home position is the position of the side reach device in which there is the same safety distance from the shelves at both sides.
There is a position switch (12) on each individual prong of the fork for monitoring this position. The switches are actuated by a trip cam on the upper carriage when the latter is in its home position.
The signal that is sent to the control system by these switches, which are connected in series, is also known as an HISP (head in safe position) signal or the fork-in-contour signal.
This signal is only for additional monitoring of the home position and is not used for positioning the head.

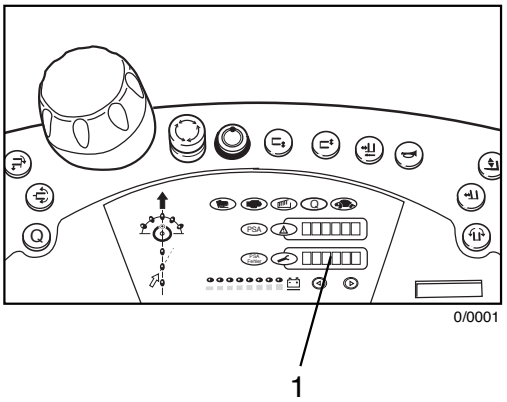
1 Upper carriage
2 Middle carriage
3 Lower carriage
4 Control chain
5 Chain anchor for control chain
6 Chain tensioner for control chain
7 Drive chain
8 Chain anchor for drive chain
9 Chain tensioner
10 Drive shaft
11 Shaft couupling
12 Fork-in-contour switch



Remark: The telescopic fork is shown here in an extended position

Monitoring of the distance sensor for reaching

The vehicle control system (FZS) monitors the potentiometer value and the position switch for the home position. If an error occurs in this measuring system, the appropriate error code appears on the operating console display (1). Please see the chapter on "Error codes".

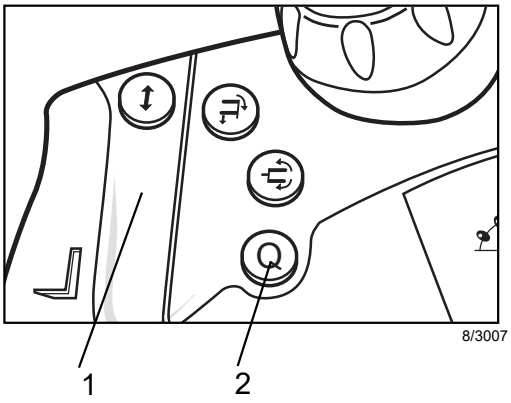


Important: After repair work has been carried out on the potentiometer or the position switches, the axis must be newly taught in. Please see the section on "Teaching in the distance sensor for reaching".

Filling the tank with hydraulic oil

- Select "Lower" with the hydraulics operating lever (1), pressing the Q-key (2) at the same time.
- Hydraulic oil is drawn along the plastic hose (3) and pumped into the hydraulic oil tank at a pre-defined pump speed. It is important to ensure that no air is drawn in through the hose.

Note: If no oil is drawn in through the plastic hose, air will subsequently have to be bled out of the suction lead between the tank and chassis valve block.

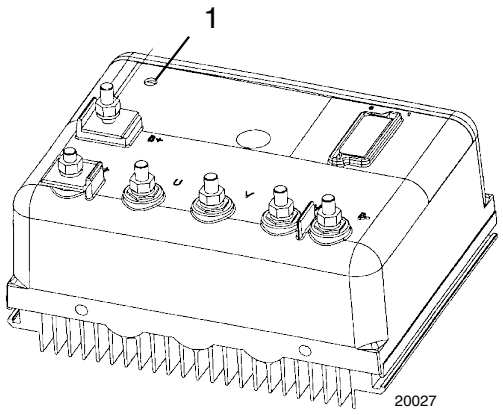


- Once the oil tank is full, use an open-ended spanner or the hand lever provided to move the switch-over element back from filling mode to normal mode.

Remark: To switch over the travel and pump controller from filling mode to normal mode, the vehicle must be switched off and then on again.

- Finally, the maximum pressure must be set to the value embossed on the factory nameplate in the cab, or, if not otherwise identifiable, to 275 bar. Please see "Setting the maximum pressure" for further information.

Function of the LED



There is a green LED (1) at the top left-hand side of the converter.

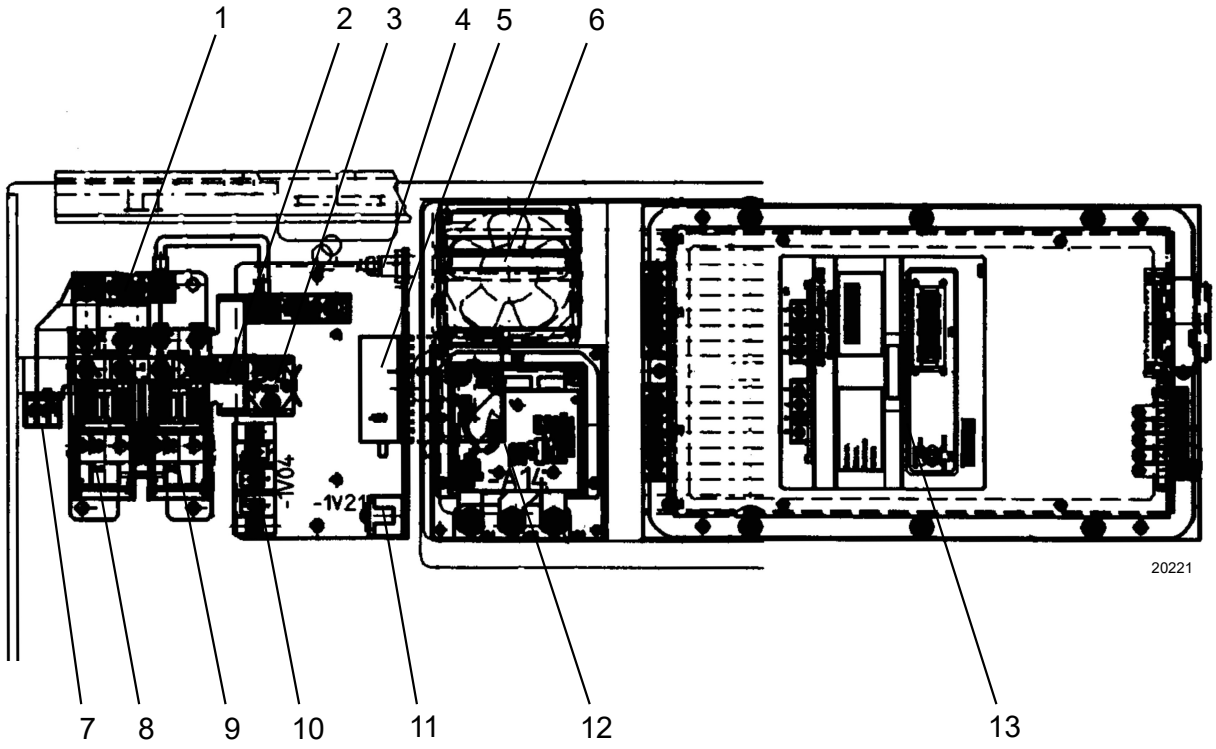
This LED has three different statuses:

LED not lit up:	Power supply not OK.
LED lit up:	Converter OK and active.
LED flashing:	Error, converter inactive.

After an error has occurred and been repaired, the key switch must be switched OFF/ON again to cancel the error status (see chapter entitled "Error code").

Remark: When the converter is switched on, the LED always flashes.

Main current component panel (to approx. 11/02)



1 Main current fuse F1 (355A)
2 Steering fuse 3F1 (50A)
3 Pump contactor 3K1
4 Earth distributor X100
5 DC/DC converter U30
6 Fan motor 9M6
7 Control fuses F4 (5A), F2 (10A), F3 (5A)
8 Main contactor K1
9 Main contactor K2
10 Diode module 1V04
11 Diode module 1V21
12 Negative feeder module A14
13 Travel and pump controller A10

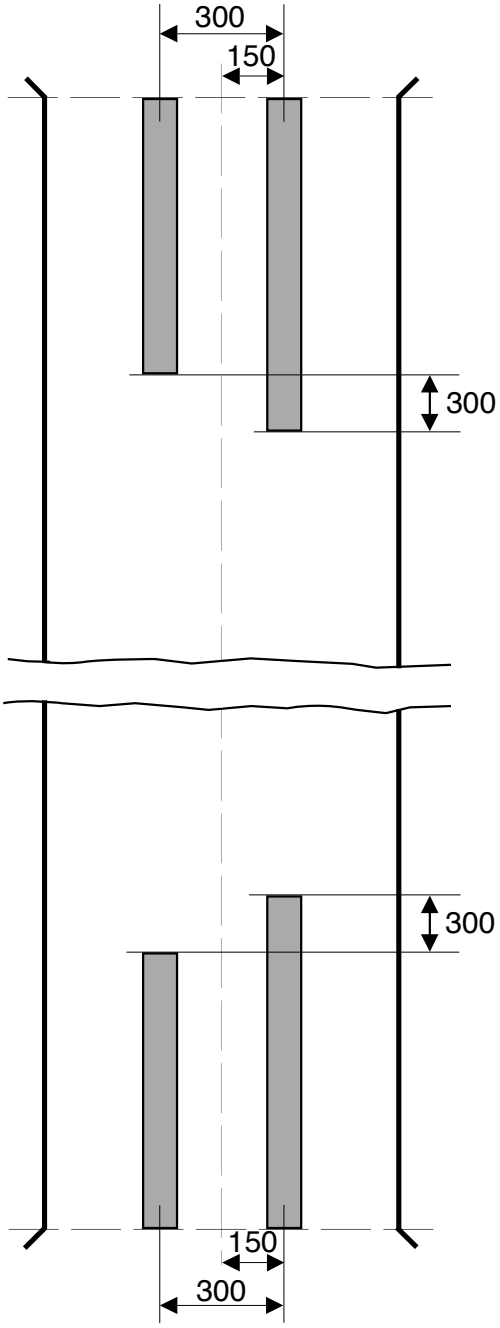
EASS inductive

Mounting the steel plates

Without absolute stop

- Accelerate the vehicle to max. speed, drive over the steel plates and check that the vehicle speed is max, 2.5 km/h at the end of the aisle.

To ensure that the steel plates are positioned correctly, you must select their position on the basis of the "worst" braking test.



EASS inductive

Suppression of metal elements that cause interference

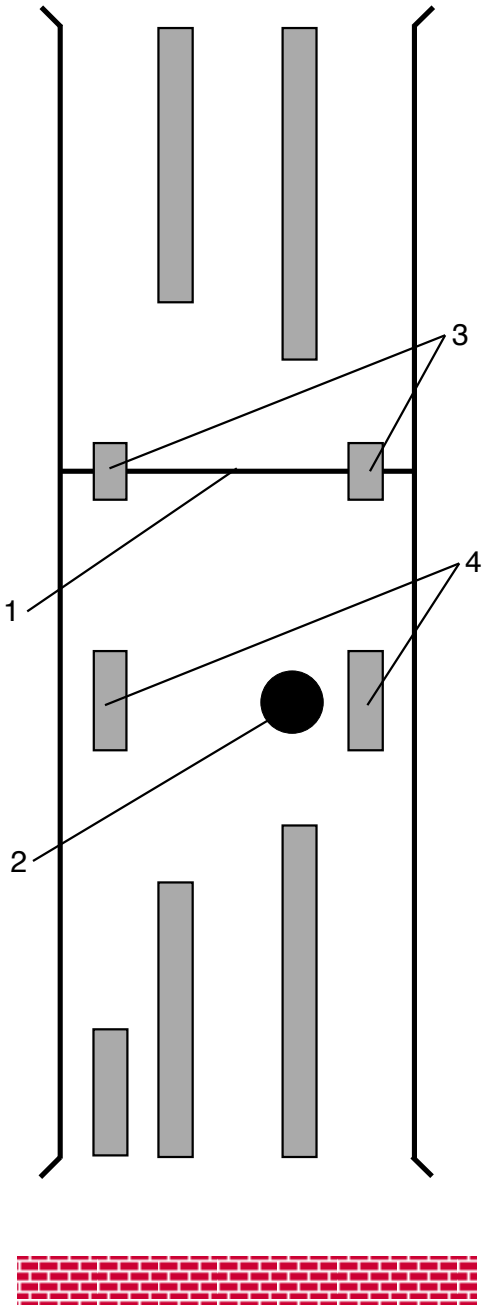
Occasionally, situations can occur in which expansion joints (1), manhole covers (2) or other metal elements in the shelf aisle floor in the area of the proximity switches can brake the vehicle unintentionally or make it switch into an error status.

There should not ever be any of these metallic objects in the area of the proximity switches in the entrance area (zone 1) or in the braking area (zone 4 and zone 5) in the shelf aisle.

If, however, there are metallic objects of this kind in the fast travel zone (zone 3), a simple measure can be taken to stop them having a negative effect on the automatic braking system.

All that is necessary is to lay 2 short steel plates (3, 4) with their ends flush in the area of the proximity switches for the absolute stop function. The two short steel plates must cover the metallic object in both travel directions.

Remark: In order for the metal elements that cause interference in zone 3 to be suppressed, the vehicle must be fitted with both proximity switches for the absolute stop function. If these two proximity switches are only needed for suppressing metal elements, it is not necessary to make any software changes or set any particular options.



EASS magnetic

Mounting the switching magnets

With absolute stop at closed aisle end

The switching magnets for speed reduction to v = 2.5 km/h are laid in the same way as for automatic braking without an absolute stop (please see "Without absolute stop").

The additional pair of magnets for the absolute stop (1) **must** always be laid 300 mm to the **right-hand side** of the longitudinal axis of the aisle as viewed looking towards the closed aisle end.

The position of the pair of magnets for the absolute stop must be selected so that the vehicle comes to a standstill at the point agreed with the customer.

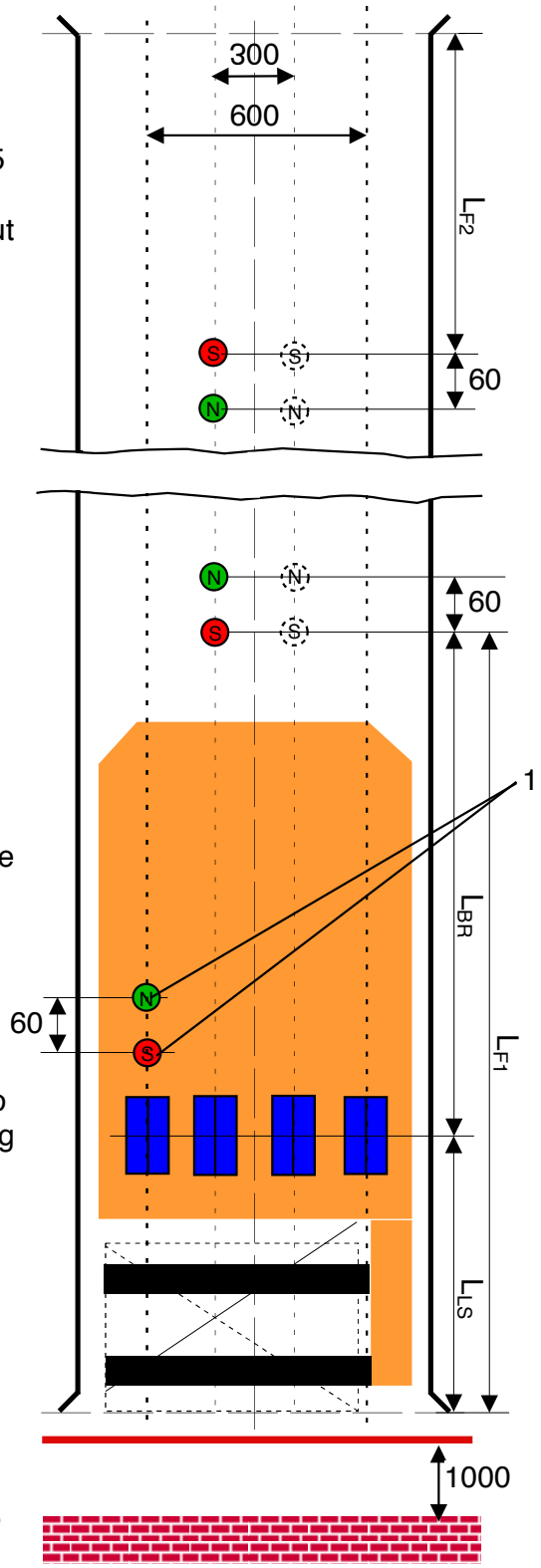
As for the switching magnets for speed reduction, it also applies for switching magnets for an absolute stop that towards the end of the aisle the switching magnet must be laid with the south pole facing upwards and towards the centre of the aisle the switching magnet must be laid with the north pole facing upwards.

The distance between the switching magnets must be 60 mm, measured from centre to centre.

You must determine and check the correct position for the switching magnets by conducting several braking tests with the vehicle (about 10 times) separately in each aisle:

Remark: The switching magnets should be stuck to the floor with adhesive tape for the braking tests.

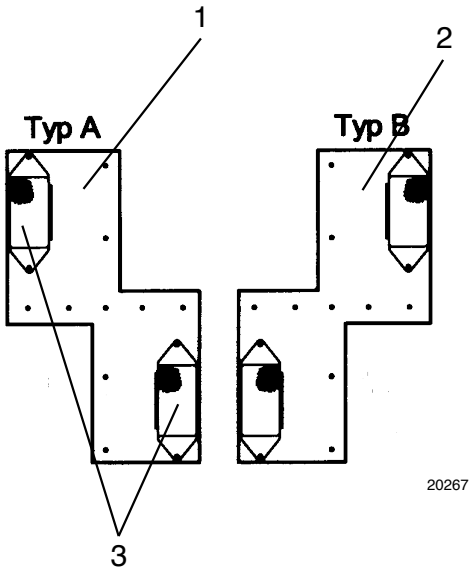
- Load the vehicle with the maximum permissible load.
- Bring the fork into the vehicle contour.
- Raise the cab just high enough to allow the vehicle still to travel at the maximum permissible speed.
- Accelerate the vehicle to max. speed, drive over the pairs of magnets and check where the vehicle comes to a standstill.



EASS reflexli

Reflector types

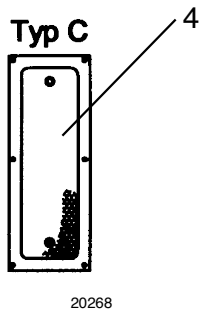
Reflector types A and B



And end-of-aisle area (zone) is characterised by two reflectors of type A (1) and type B (2). These two reflectors are generally mounted on the shelves at a defined height and distance from each other (please see "Mounting height of reflectors on the shelves").
On the reflector boards A and B, there are two reflecting mirrors (3) mounted on the reflector panels A and B which are vertically and horizontally offset. These reflecting mirrors are scanned by reflective light barriers, which are mounted in pairs and generally on both sides of the vehicle.
The upper light barrier generates the "Start of zone" signal and the lower light barrier generates the "End of zone" signal.
Abolutely irrespective of the direction in which the vehicle enters the aisle (load side (LS) or drive wheel side (DWS) at the front), only zone 1 is detected on the right hand side of the vehicle and only zone 2 on the left-hand side.
Whether zone 1 or zone 2 has an effect on the travel speed (automatic braking) depends on the direction of travel (please see "Division into zones").

Reflector type C - Check

Remark: The check (speed monitoring) in an EASS reflexli system is an extra function and is not included as standard.



The type C reflector (4) is mounted at a defined distance between a type B reflector and a type A reflector. The type C reflector for the check function is mounted at a different height from the two reflector types A and B.
This reflector is scanned by an additional reflective light barrier at each side of the vehicle (left and right).

EASS reflexli

Mounting the reflectors

Arrangement of the reflectors for automatic end-of-aisle braking

For speed reduction to v = 2.5 km/h at the aisle end, there must be a reflector type A (1, 2) and a reflector type B (3, 4) mounted at each end of the aisle.

Important: When viewed looking towards the end of the aisle, the reflectors at the start of the aisle must be mounted on the **left** and those at the end of the aisle on the **right**-hand side.

The type B reflector must always be mounted at the start of the aisle (3) and at the end of the aisle (4).

The exact position of the type A reflector depends on how the vehicle is driven out of the aisle.

If the vehicle always drives with the load at the front out of the same aisle end, the A type reflector (2) must be positioned in accordance with the measurement "L_{F1}" far into the aisle (please see "Definitions").

If the vehicle always drives with the drive wheel at the front out of the same aisle end, the A type reflector (1) must be positioned in accordance with the measurement "L_{F2}" far into the aisle (please see "Definitions").

If the vehicle sometimes drives with the load at the front and sometimes with the drive wheel at the front out of the same aisle end, the larger of dimensions "L_{F1}" and "L_{F2}" must always be used.

Important: If there is not a shelf upright in the position measured for mounting the A type reflector, the next shelf upright towards the centre of the aisle should be used.

Remark: If automatic braking is not needed at one end of an aisle, the only change necessary is that a pair of reflectors does not need to be mounted at this end of the aisle.