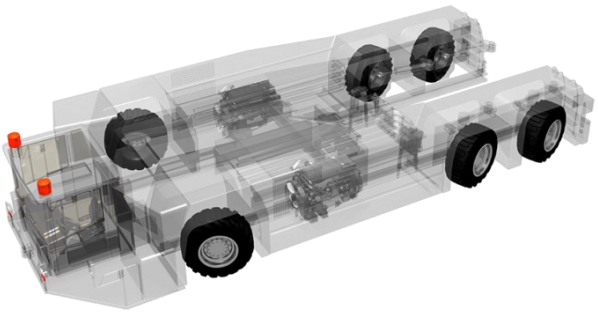
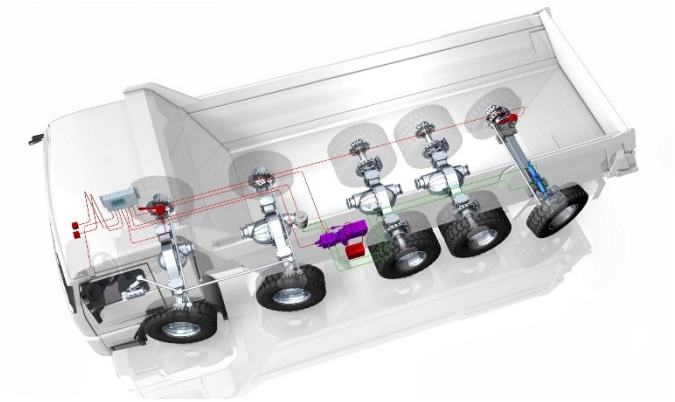
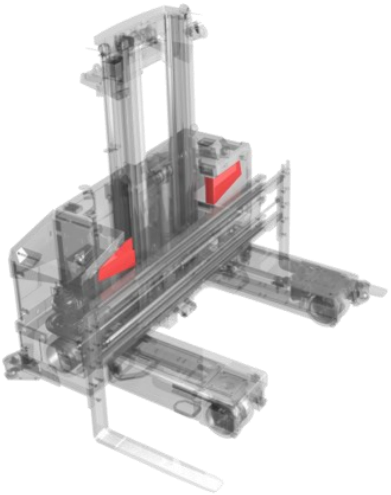
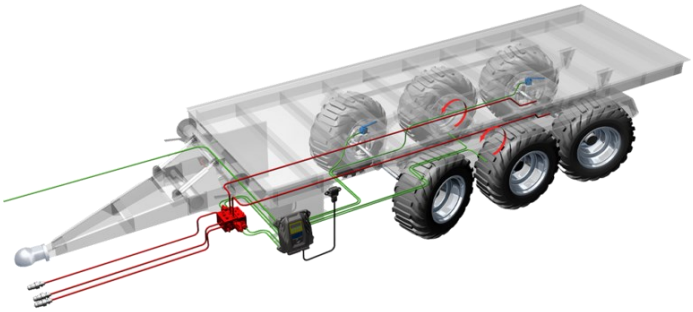
Installation Guideline

System Components









Version 2.01

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Version information

Version	Description	Status	Date	Name
2.00	Transfer of version 1.09 to the new layout	Draft	08.11.2024	S. Wieland
2.01	Adaptation regarding galvanic isolation and CAN bus wire cross-section	Released	03.02.2025	S. Wieland

ATTENTION!

The index should be enhanced with every new entry.

Reviews and Releases

Index	Department	Datum	Name
2.01	Hardware Development	05.02.2025	M. Handte
	Hydraulic Development	05.02.2025	H. Schuch
	Sensor Development	05.02.2025	S. Ingelfinger
	System Development	05.02.2025	E. Gerathewohl

Table of contents

1 General Information

1.1 About this Document

This document is primarily intended for technical specialists responsible for installing the system components of ME MOBIL ELEKTRONIK GMBH and commissioning the system.

The following knowledge is required:

- Very good knowledge of automotive electrics and hydraulic installation (trained specialist personnel)

This document describes the installation of the system components of ME MOBIL ELEKTRONIK GMBH, their electrical wiring and the hydraulic piping / tubing.

Read the instructions carefully before using the system or working on system components. Keep for future reference.

1.2 Explanation of Signs and Symbols

Safety instructions and important explanations are labelled with the following pictograms:

DANGER!

The safety instruction **DANGER** identifies particularly dangerous situations.
Failure to observe this warning may result in serious injury or death.

WARNING!

The safety instruction **WARNING** indicates a particularly dangerous situation.
If warnings are ignored, serious injuries may result.

ATTENTION!

The safety instruction **CAUTION** indicates a dangerous situation.
Failure to observe this warning may result in minor or moderate injuries.

NOTE!

The safety instruction NOTES indicates material dangers.
Failure to observe this instruction may result in damage to property.

Longer sequences of actions are numbered.

This symbol precedes explanations and tips.

► This symbol instructs you to carry out something.

1.3 Safety Information

The steering system can only meet the high safety requirements if all system components are installed and used in accordance with their intended purpose and the regulations.

WARNING!

Risk of personal injury due to unpredictable steering response during modifications

Modifications to the system and its components or the installation of the system in a different vehicle type or variant may lead to unpredictable steering response. There is a risk of accidents. Modifications to the system without the consent of ME MOBIL ELEKTRONIK GMBH are not permitted.

- ► Do not modify components
- ► Install only in approved vehicle types

NOTE!

Handling of the system:

- **Installation, commissioning and maintenance work** must be carried out by **trained specialists**.
- When working on the vehicle (painting, welding, etc.), ensure that the electronic components are adequately protected. When welding in particular, the safety electronics must be removed from the vehicle and electronic sensors (angle transducer, IMU, etc.) must be electrically disconnected beforehand. Electronic parts must be protected from overvoltage and static charges.

ATTENTION!

Safety concept:

The manufacturer of the vehicle must take appropriate measures to ensure the operational safety of the vehicle and the safety of persons working with the vehicle

ME cannot in any case be held responsible or liable for direct or indirect damage caused by system faults or possible errors in this document.

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2 Installation of the Safety Steering Computer

ATTENTION!

The installation site of the safety steering computer must be selected according to its classified ingress protection marking (refer to IP Code in the datasheet).

The installation site of the safety steering computer must be selected according to its classified ingress protection marking (refer to IP Code in the datasheet).

- ► Install the safety steering computer in a protected electrical enclosure, a housing or at least in a protected area of the vehicle**.**

WARNING!

The housing of the safety steering computer is not allowed to be opened.

NOTE!

If the safety steering computer is equipped with an integrated control panel, this should be easily accessible, operable and legible after installation.

3 Wiring

Faulty electrical installation is the main cause of malfunctions in the entire system. Error (event) messages frequently refer to inadmissibly high track differences of the angle transducers or to interferences in the CAN connection.

3.1 Basic Guidelines

To avoid errors in the electrical installation, observe the following basic guidelines:

- The electrical work must only be carried out by a **technically qualified specialist.**
- **Appropriate tools** must be used. This applies in particular to the manufacturing of crimp contacts.
- Only **crimp contacts approved by ME** may be used. When selecting the correct contact size, the selected cable cross section must be considered. **For the crimping procedure, the corresponding crimping pliers with matching crimping jaws must be used.**
- The cable set included in the delivery of the steering computers (EIZ...) usually includes an information leaflet containing information which clearly shows the correct processing.
- The **quality** of the crimpings must be **checked** by random sampling.
- If possible, **prefabricated and tested connection cables** should be used.
- In applications **subject to vibrations**, **cable harnesses must be fixed** to prevent friction corrosion at contacts.
- The supplied plugs and screw connections must be completely assembled in accordance with the instructions.
- Do not omit seals or such like.
- The plug connection must seal the contacts waterproof after assembly.
- Never insert individual wires into the connector plugs or high-strength cable glands. This applies particularly to the wiring of the safety angle transducer, unless it is supplied with a pre-assembled connection cable. To ensure tightness, the jacket of the connection cable must protrude sufficiently into the PG connection.
- The **shielding of cables** may only be connected (to the steering computer) **on one side**. Therefore, the shielding must, if necessary, be cut-off flush to the sensor side with the end of the sheath during insulation. The shielding shall not be connected to the sensor housing!
- The high-strength cable gland must be securely (and carefully) tightened in order to be waterproof and also to ensure strain relief. The cable may not be pulled out of the high-strength cable gland while a tractive force of 50 N is being applied.
- To connect the angle transducers, always use the **appropriate wire ferrules** (with protective shroud) and the corresponding crimping tool.
- If possible, route **control and signal lines as far away as possible** from other high power or power switching (cables to valve magnets) lines as the signals may be affected due to feed-through interference. Excess cable lengths may under no circumstances be eliminated by winding-up both the sensor and valve cables together.
- Minimum bending radiuses of the cables, regarding flexible parts, must be complied with.
- When laying cables, ensure that the cables are protected against sharp edges and may not be frayed due to movements of the cable harness.

3.1.1 Fixing of Cable Harnesses

Make sure that the wiring harnesses are fixed correctly. During individual applications with increased vibration requirements, the so-called fretting corrosion on contact points has been identified.

Information on this effect as well as a comprehensive description of possible remedies is available in the form of an electronic presentation.

3.2 Specifications for M12 Connectors

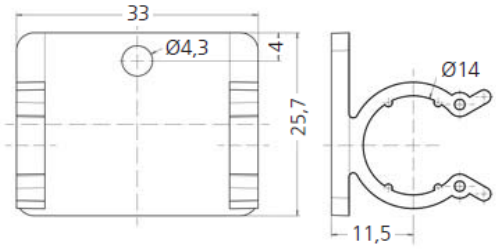
Observe the specifications for electromagnetic compatibility of M12 connectors and for compatibility of M12 connectors from various manufacturers, see the following chapters.

Tighten M12 connectors with a torque wrench in accordance with the manufacturer's specifications.

3.2.1 Electromagnetic Compatibility of M12 Connectors

The shield of M12 plug connectors with shielded cable is connected with the metallic screw fitting (sensor side). The metallic screw fitting must not come in contact with the vehicle chassis (ground). Otherwise, a ground loop could arise which affects the electromagnetic compatibility (EMC) negatively.

	Mounting clip 343 895 for cable with M12 plug connectors. The knurled nut of the plug connector must not come in contact with the vehicle chassis.

Mounting clip for M12x1 plug connectors	**Part number**
	ME 343 895

3.2.2 Compatibility of M12 Connectors from Different Manufacturers

The contact pins of M12 connectors are subject to varying fabrication tolerances depending on the manufacturer. Therefore, only with M12 female and male connectors of the same manufacturer an optimal contact can be ensured.

Contacts that do not fit optimally can lead to error messages from the monitoring functions due to contact resistances.

NOTE!

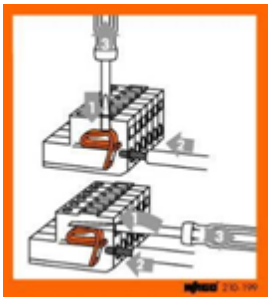
The following requirements for M12 connectors apply to ME systems:

- ► Only use female and male connectors of the same manufacturer
- ► Do not mix contact materials (gold-plated / tin-plated)

3.3 Specifications for WAGO Terminals

With WAGO terminals, the cables can be clamped with or without wire ferrules. If wire ferrules are used, they must be crimped using a 4-fold crimping tool (Variocrimp 4 from the company WAGO).Flat crimpings are not appropriate. Wire ferrules must be used in aggressive environments (chemical industry, steel industry ...).

3.3.1 WAGO terminal system series



- ► Open the inserted WAGO terminals with a small screwdriver (1).
- ► Insert the cable (2).
- ► Close the terminal again by removing the screwdriver from the terminal (3).

Wires with a conductor cross section of 0.08 - 2.5 mm² with or without wire end sleeves may be connected to the female connectors.

Connection without wire ferrules:

- Strip 8 ... 9 mm of insulation from the wires

Connection with wire ferrules:

- Strip the insulation of the wires according to the manufacturer's instructions.
- Select wire end ferrules corresponding to the conductor cross-section
- Use required 4-fold crimping pliers (Variocrimp 4 from WAGO).
- The stripped wire must reach to the front end of the sleeve.
- Isolation must stand on the sleeve base.
- Compression must be carried out over the entire length of the free wire ferrule.
- Do not damage, split or cut off individual wires.

3.3.2 WAGO terminal system series 236

- ► Open the inserted WAGO terminals with a small screwdriver (1).
- ► Insert the cable (2).
- ► Close the terminal again by removing the screwdriver from the terminal (3).

Wires with a conductor cross section of 0.08 - 2.5 mm² with or without wire end sleeves may be connected to the female connectors.

Connection without wire ferrules:

- Strip 5 ... 6 mm of insulation from the wires

Connection with wire ferrules:

- Strip the insulation of the wires according to the manufacturer's instructions.
- Select wire end ferrules corresponding to the conductor cross-section
- Use required 4-fold crimping pliers (Variocrimp 4 from WAGO).
- The stripped wire must reach to the end of the sleeve.
- Isolation must stand on the sleeve base.
- Compression must reach to the end of the sleeve.
- Do not damage, split or cut off individual wires.

3.3.3 WAGO terminal system series 734

Wires with a conductor cross section of 0.08 - 1.5 mm² with or without wire end sleeves may be connected to the female connectors.

Exception: For use in special areas with extremely corrosive strain, the use of single-wired or fine-wired copper conductors with properly crimped, molten tin coated wire ferrules or copper pin blade connectors is recommended.

3.3.3.1 Preparation

Observe the following instructions so that the wires can be inserted correctly into the female connectors.

Connection without wire ferrules:

- Strip 7 mm of insulation from the wires

Connection with wire ferrules:

- Strip the insulation of the wires according to the manufacturer's instructions.
- Select wire end ferrules corresponding to the conductor cross-section.
- Use required crimping pliers.
- The stripped wire must reach to the end of the sleeve.
- Isolation must stand on the sleeve base.
- Compression must reach to the end of the sleeve.

Do not damage, split or cut off individual wires.

3.3.3.2 Connecting conductor with unplugged female connector

Open clamping unit using the push-button (WAGO no.: 734-230, Figure 2) and insert conductor until conductor stop (Figure 1).

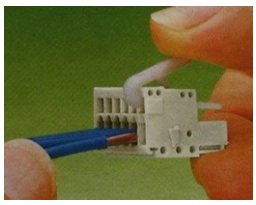


Figure 1

Figure 2 - - WAGO no.: 734-230

The clamping unit may also be opened on the side (Figure 3) using a screwdriver (size: 2,5 x 0,4 mm; WAGO no.: 210-619, Figure 4)

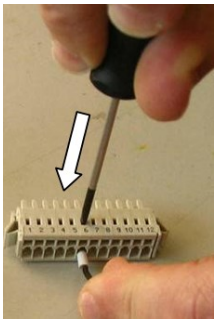


Figure 3

Figure 4 - WAGO no.:210-619

3.3.3.3 Connecting conductor with plugged female connector

Open the clamping unit using a screwdriver with the size 2.5 x 0.4 (WAGO no.: 210-619).

Turn the screwdriver by 90° (Figure 5). Then insert the conductor until conductor stop.

Do not open the clamping unit (Figure 6), by levering it as the contacts may be damaged.

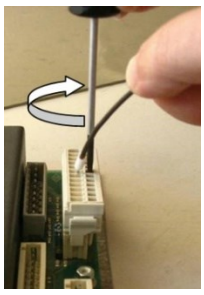


Figure 5

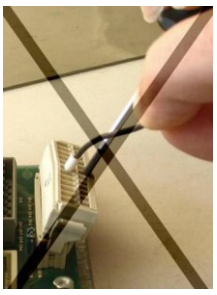


Figure 6

3.4 Guidelines for MCP Contacts (Tyco)

ATTENTION!

The quality of the crimp contacts is essential for the reliability and safety of the systems.

The following information and guidelines must be complied with.

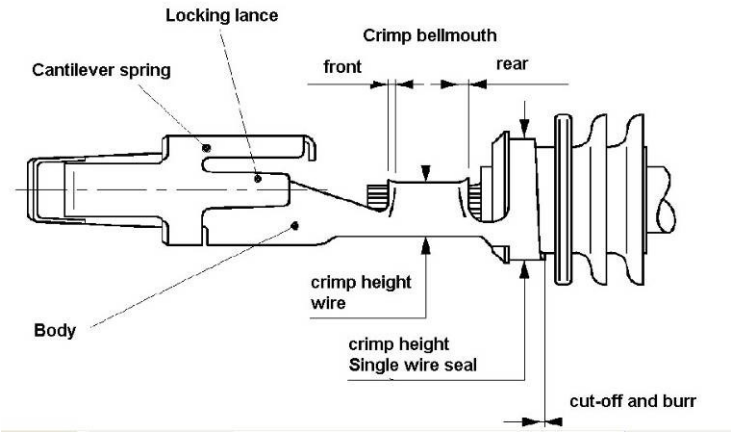
3.4.1 Correct Crimp for Contacts with Open Crimp Sleeve

Selection:

The contacts and single wire seals are designed for FLR wires according to DIN 72551 Part 5 and 6. Double wire stops (twin-lead stops) are not permitted due to the single wire seals.

Preparation:

Strip the wire according to the length specifications in the following crimping data table. Do not damage, split or cut off individual wires. The insulation must not be damaged or compressed in the sealing area. The surface must be free of impurities and residues.



Cut-off and burr:

The cut-off has to be visible after crimping. Maximum length is 0.5 mm. The burr at the cut-off must not exceed 0.08 mm.

Wire crimp:

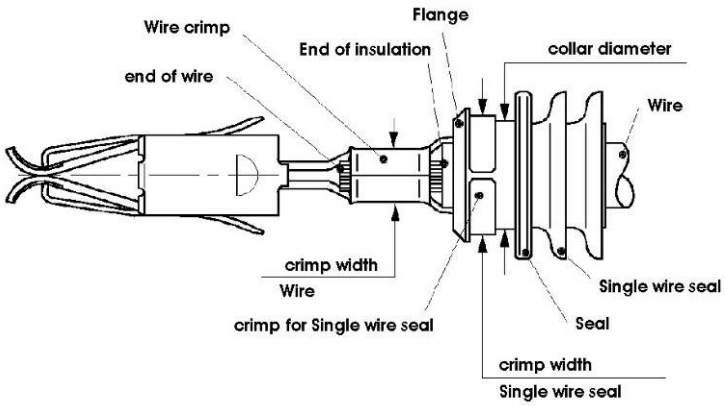
After crimping, the conductor end must jut out 0.1-0.5 mm from the front edge of the wire crimp.

For crimp shape, crimp heights and crimp widths as well as wire cross-sections refer to the following crimping data table.

The extraction values have to meet the requirements of DIN IEC 352 part 2.

A front side bell mouth is allowed. The allowed rear side bell mouth depends on the wire size:

0.2 - 0.5 mm² : 0.25 ±0.15 mm
0.5 - 2.5 mm² : 0.40 ±0.20 mm



3.4.2 Crimp for Single Wire Seals

3.4.2.1 Position of the insulation end

The insulation should end at the front edge of the single wire deal. It must not jut out more than 0.5 mm.

3.4.2.2 Position of the single wire seals

Single wire seals without collar have to end close to the front edge of the crimp. They must not jut out more than 1 mm. The collar of single wire seals with collar must be positioned in front of the crimp front edge.

3.4.2.3 Contact area

Crimping must neither damage nor bend the locking lance, cantilever spring or contact body.

3.4.3 Crimping Data for Tyco Junior-Power-Timer and Micro-Timer II Contacts

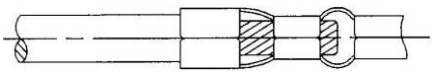
ME part no.	wire data				wire crimp			insulation crimp			crimp tools	
	wire ∅ [mm²]	wire type	insulation ∅ [mm]	stripped length [mm]	width [mm]	height [mm]	shape	width [mm]	shape	seal ME no.:	crimp tool: **A33 162 / 539635-1**	extraction tool ME / Tyco no.:
349 012	0.50 0.75 1.00	FLR	1.40 - 2.10	4.70 ±0.3	2.05	1.18 ±0.05 1.27 ±0.05 1.36 ±0.05	F	4.10	O	**349 014**	**A33 162-E05 / 539737-2**	**A32 601 / 1-1579007-6**
349 013	1,50 2,00 2,50	FLR	2,20 - 3,00	5.20 ±0.3	2,80	1,51 ±0.05 1,64 ±0.05 1,77 ±0.05	F	4.35	O	**349 015**	**A33 162-E05 / 539737-2**	**A32 601 / 1-1579007-6**
346 051	0,35 0,50	FLR	1,20 - 1,60	3.50 ±0.3	1,57	1,05 ±0.03 1,12 ±0.05	F	3.45	O	**346 063**	**A33 162-E01 / 539651-2**	**A33 163 / 539960-1**
346 052	0,50 0,75 1,00	FLR	1,20 - 1,60 1,40 - 1,90 1,90 - 2,10	3.80 ±0.3	2,03	1,18 ±0.05 1,27 ±0.05 1,36 ±0.05	F	3.45	O	**346 063 - 346 064**	**A33 162-E01 / 539651-2**	**A33 163 / 539960-1**

Tyco part numbers are available upon request.

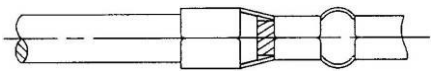
Note: Single wire seals must be used for these contacts.

3.4.4 Faulty Crimp Contacts

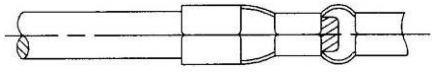
These crimp connections are to be rejected and must not be used in any case.



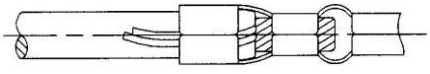
The cable was stripped too long. Insulation not visible. Insufficient fixing of insulation.



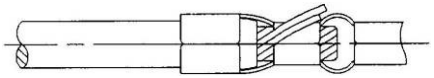
The cable was stripped too short. End of wire not visible. Insufficient wire crimp.



The insulation must not reach into the wire crimp. Insufficient wire crimp.



Single wires are located in the insulation crimp. Insufficient wire crimp. Risk of short circuit.



Single wires outside the crimp range. Risk of short circuit.

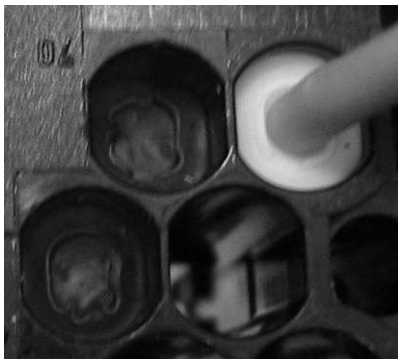
3.4.5 Mounting the Contacts into the Connector Housing

3.4.5.1 Locking contacts into the contact housing

► Insert the crimped contacts into the connector housing in a straight line from the rear side of the connector until a click is heard.

Avoid tilting the crimped contact.

3.4.5.2 Sealing unoccupied contact cavities



► Seal unoccupied contact cavities of the socket housing with a blind plug.

349 016 for JPT contacts

346 067 for MT 2 contacts

3.4.5.3 Extraction tool

Locked contacts must only be extracted out of their connector housings with the intended extraction tool in case of wiring modifications.

Refer to the crimping data table on the previous page to select the fitting extraction tool.

Extraction of locked contacts

Insert extraction tool from the front side of the connector. Pull contact out of the contact housing by pulling the wire cautiously.

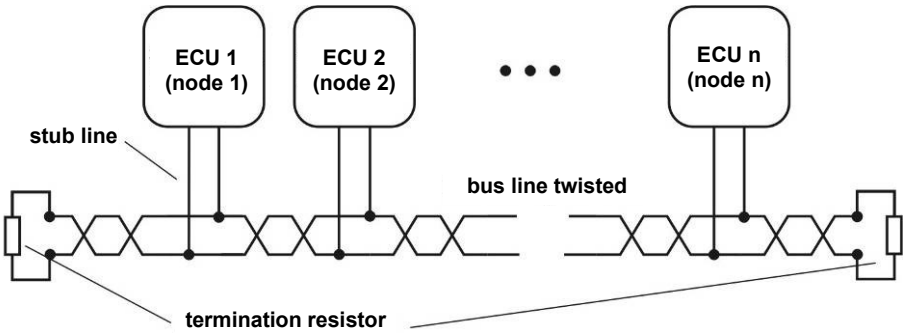
Refer to Tyco document numbers 114-18050 und 114-18081 for detailed instructions.

3.5 CAN-Bus Systems

3.5.1 General Definition

The bus wiring is a two-wire cable which has a terminating resistor on both ends.

The bus wiring should generally be **twisted in pairs**, especially with large bus lengths. Untwisted, shielded lines may, in exceptional cases, be used for short bus lengths.



With respect to high data transfer rates, the bus connections between several devices must have a linear structure in order to avoid reflexions and losses.

The individual CAN bus nodes (control devices) should, preferably, be connected via short stub line (see table) to the bus wiring. Line, plug and terminating resistors within CAN bus networks must comply with the requirements defined in ISO 11898.

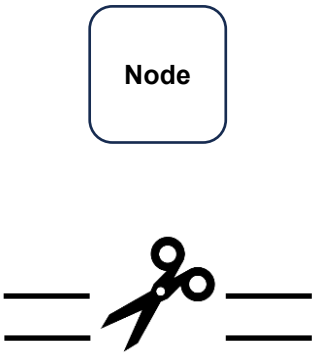
Data table:

baud rate	Maximum length of the bus line	Maximum length of the stub line	Minimum wire cross section	Specific wire resistance
20 kBit/s	3280 m	7,50 m	0,75 mm²	< 25 mΩ/m
50 kBit/s	1300 m	5,50 m	0,75 mm²	< 25 mΩ/m
100 kBit/s	640 m	3,75 m	0,50 mm²	< 40 mΩ/m
125 kBit/s	508 m	3,30 m	0,50 mm²	< 40 mΩ/m
250 kBit/s	244 m	2,25 m	0,34 mm²	< 60 mΩ/m
500 kBit/s	112 m	0,75 m	0,34 mm²	< 60 mΩ/m
1000 kBit/s	46 m	0,30 m	0,34 mm²	< 60 mΩ/m

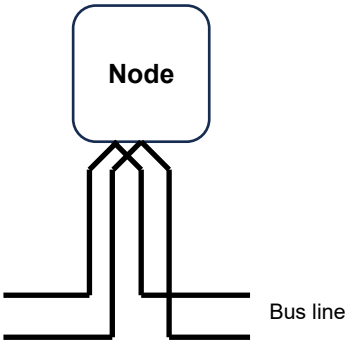
According to Etschberger "CAN Controller-Area-Network" ISBN 3-446-17596-2.

3.5.2 Connecting the Control Devices (Nodes) to the Bus Wiring

Disconnect bus wiring.



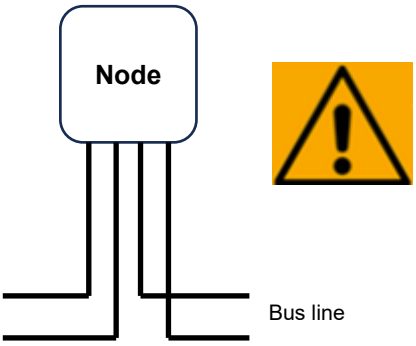
Connect bus wiring with the new node. Connect bus wiring using a twin-lead terminal (use the same terminals for input and transfer).



The bus wiring remains **closed** if the node is unplugged.

No additional transfer resistors.

For bus lines that are routed via separate connection terminals of the node, possible effects on the bus must be taken into account depending on the control unit type.



The bus wiring is **interrupted** if the node is unplugged.

The **contact resistances** of the individual terminals add up.

3.5.3 Selection Criteria for Connection Types

Stub line	Twin-lead terminal	Looped through
+ Node can be removed easily without disconnecting the CAN bus. + Single-wire sealing can be used. – Connector systems/terminals for coupling required.	+ Node can be removed without disconnecting the bus wiring. + Very short stub. + New nodes can easily be integrated into existing bus wiring. – Not appropriate for single-wire sealing. – High-quality crimping required.	+ Electromechanical simple connection. + Very short stub line. + New nodes can easily be integrated into existing bus wiring. + Single-wire sealing can be used. – High requirements for crimping and contacts (not appropriate for WAGO 734). – Disconnects the bus wiring upon removal of the node.

3.5.4 Galvanic Isolation

Galvanic isolation is mandatory if a **difference in ground potential greater than 1.5 V** can occur between any two nodes in a system.

Note that this difference changes when ground currents change due to the installation of new components (lighting) or when contact resistances at connectors increase over time.

3.5.5 CAN Bus Ground

- For non-galvanically isolated nodes, the CAN bus ground may only be connected at one point within the CAN network in order that no equalising current can flow across the CAN bus ground.
- For networks with exclusively galvanically isolated nodes, the CAN bus ground must be connected to ground at one point.

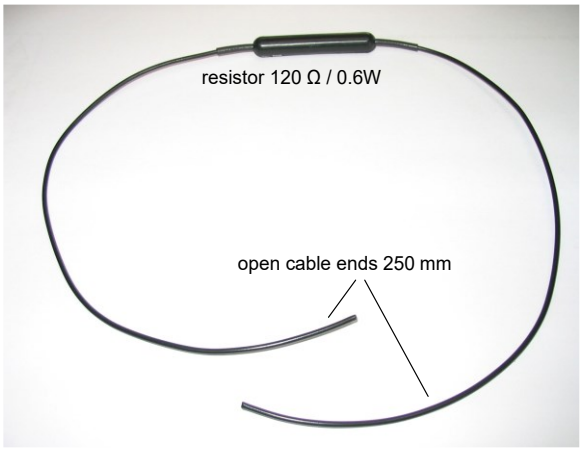
When disconnecting connectors during operation, ensure that the CAN bus is always disconnected from the ground.

3.5.6 Terminating Resistors

The **terminating resistors should not be located within connected control devices** as the bus wiring will no longer be correctly terminated when these control devices will be disconnected.

A moulded waterproof terminating resistor for external connection to the bus line is available from ME quoting the part no. 212 212.

Type:	metal film resistor, waterproof
Resistance:	121 Ω / 0,6 W
Power:	0.6 W
Connection:	open cable ends with a length of 250 mm and a wire cross section of 0.75 m²



3.5.7 Testing the CAN Bus

(1) Switch-off power supply

(2) Switch multimeter to resistance measurement

(3) Measure resistance between CAN-H and CAN-L at the terminals of the safety steering computer.

(4) Analyse measurement results:

60 Ω Correct connection of the CAN wiring.
The CAN bus is terminated on both ends with a 120 Ω terminating resistor.

120 Ω One terminal station has not been terminated correctly.
Disconnect CAN-H at one terminal to locate the error. If the resistance does not change, this terminal is the problem. If the resistance increases, the other terminal station is the problem.
It could also be possible that only one CAN bus terminating resistor has been installed.

≤ 40 Ω At least one terminating resistor too many has been installed.

> 120 Ω The bus has not been terminated at any side or the terminal stations do not have a terminating resistor.It could also be possible that an active terminating resistor has been installed in one of the control devices.

These measurement results are only valid if a passive resistor is used as terminating resistor. This measurement can not be performed for active resistors.

(5) Switch-on supply voltage.

(6) Switch multimeter to DC voltage measurement.

(7) Measure CAN-L and CAN-H against LGND. A voltage of approx. 2.5 V must result.
If CAN-H is above 3.0 V and CAN-L below 2.0 V, CAN-H and CAN-L have either been mixed up or the wire has not been correctly connected at the remote node.

3.6 Prefabricated Cables

Processing errors which occur during the manufacturing of crimp contacts are by far the most common cause of failure.

In this context, we offer prefabricated and tested connection cables for the most common components. Here's an excerpt:

- connection cable type 346 613 – XX (with HDSCS connector):
  cable socket with connection cable for various angle transducer types
- connection cable type 346 950 – XX (with Superseal connector):
  cable socket with connection cable for various angle transducer types
- connection cable type 343 814 – XXX (with M12 connector):
  cable socket with connection cable for various angle transducer types
- connection cable type 610 950-XX (jet plug):
  cable socket with connection cable for proportional hydraulic unit PHY 601 xxx
- connection cable type 349 204 – XX (cubic plug/DIN43650):
  connector with connection cable, LED and varistor for proportional hydraulics unit PHY 604 2xxx

Contact our technical sales team for further information.

4 Angle Transducers

The mounting and linkage of the angle transducers is of particular importance. As steering component, it has the same importance as, for example, a tie rod of the front axle. The following safety notes must be complied with.

DANGER!

If the steering component breaks, it must be assumed that the corresponding steering axle will swing out in an uncontrolled manner as would happen in the event of a breakage of a tie rod.

► Carry out mounting and linkage of the angle transducer in accordance with ECE-R79 (see paragraphs 5.1.4 and 5.3.1.1).

Drilling and welding of steering components may only be performed with the explicit approval of the vehicle manufacturer!

4.1 Mechanical Installation

DANGER!

No rotary backlash (clearance) between the angle transducer and axle is allowed as the steering axle may otherwise move within this clearance without being recognised by the steering computer.

A rotary backlash (clearance) is mostly perceived as oscillatory motion during which the steering axle slowly swings from one end of the rotary backlash to the other one.

► The linkage of the angle transducers should be without the need to exert force if possible.
If this is not possible, the permissible load data (see angle transducer data sheet) must not be exceeded.

4.1.1 Selecting the Installation Location

NOTE!

► Select the installation location of the angle transducer with regard to the following aspects:

- Do not limit the **ground clearance** of the vehicle with the angle transducer and its linkage.
- The angle transducer and its linkage may not be exposed to **external forces** when **the vehicle sinks into the ground.**
- If necessary, protect the installation location with appropriate metal covers and brackets.
- Make sure there is enough **clearance to adjoining vehicle components** (i.e. 10 mm, and under rough conditions at least 20 mm) under all operating conditions (e.g. compression/extension of the chassis, fully locked steering, snow chains fitted, etc.).
- Linkage of the angle transducer should be easy to check (i.e. accessible) by maintenance personnel.

► The angle transducer, lever, steering rod and fixings are safety-relevant components. Install these parts in accordance with the same requirements as those that apply to other steering components, i.e. they must be installed form-fitting and vibration-proof.

► Avoid installation within the centrifugal area of the tyres, snow chains or the roadway as well as areas prone to stone-chipping. If necessary, the angle transducer and the linkage must be solidly protected.

4.1.2 Requirements for Angle Transducer Mounting

NOTE!

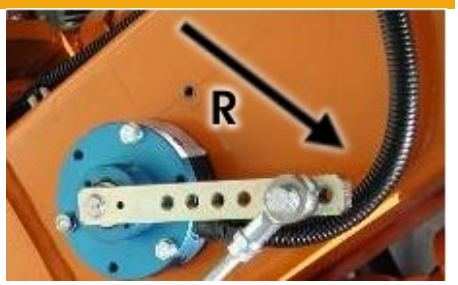
► The angle transducer must be steered/mounted in such a way that

- when the steering is fully engaged, the maximum deflection of the angle transducer shaft (and/or of the angle transducer lever) in relation to the middle position (straight ahead position) is located on both sides between 35% and 90% of the nominal range of the angle transducer.
- there is a possible proportional and linear relation of the tyre deflection angle to the sensor steering angle (ideally 1:1).
- the angle transducer is positioned in middle position if the axle is in a straight-ahead position in order to allow for electronic axle adjustment (depending on the steering computer, tolerances between ±4°…±7° are permissible).

4.1.2.1 Laying Cables

ATTENTION!

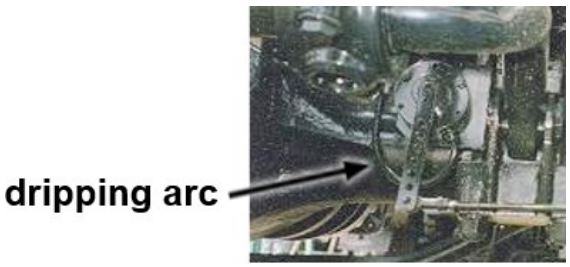
The minimum bending radius R for flexible and fixed connection cables may not be fallen below.
The minimum bending radii vary depending on the connection cable and can be found in the angle transducer data sheet.



Avoid kinking the connecting cable at the cable gland!

Lay the moving connection cable of the angle transducer in such a way that a bending load of the deflection process cannot be transferred from the cable to the cable gland. This can be done, for example, by attaching the fixing (cable clamp or so) directly to the cable gland.

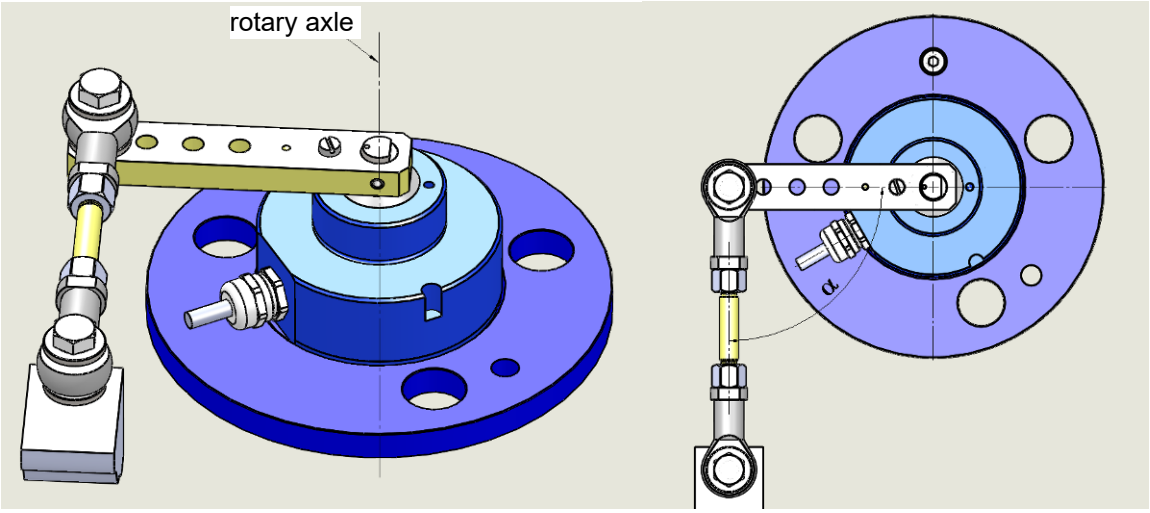
In order to prevent water from penetrating at the cable and screw connection, the connection cable should be laid downwards and preferably with a cable loop as a "dripping arc".



4.1.3 Installing with Steering Lever and Coupling Rod

4.1.3.1 Construction of the linkage

4.1.3.1.1 Mounting the angle transducer on the rotary axle

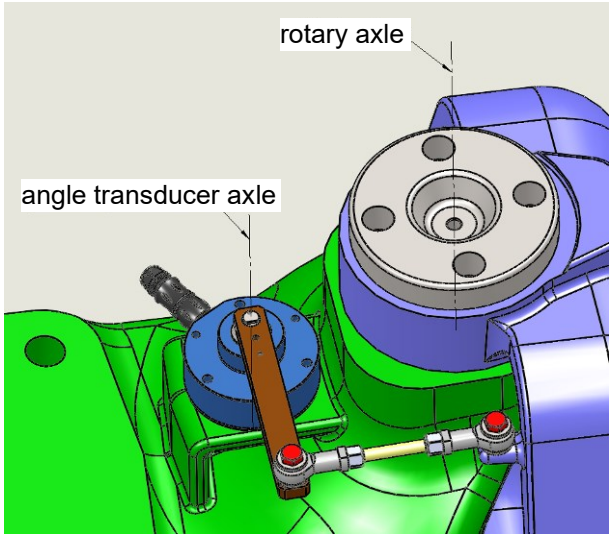


NOTE!

► The angle transducer must be steered/mounted in such a way that

- the rotary axle corresponds to the angle transducer axle (ideally, as shown, directly on the axle box cover)
  The maximum admissible deviation between the rotation centres is 0.8 mm
- the angle **α** between coupling rod and angle transducer level is within a range between 50° and 130° or ideally 90°.

4.1.3.1.2 Mounting the angle transducer shifted in relation to rotary axle

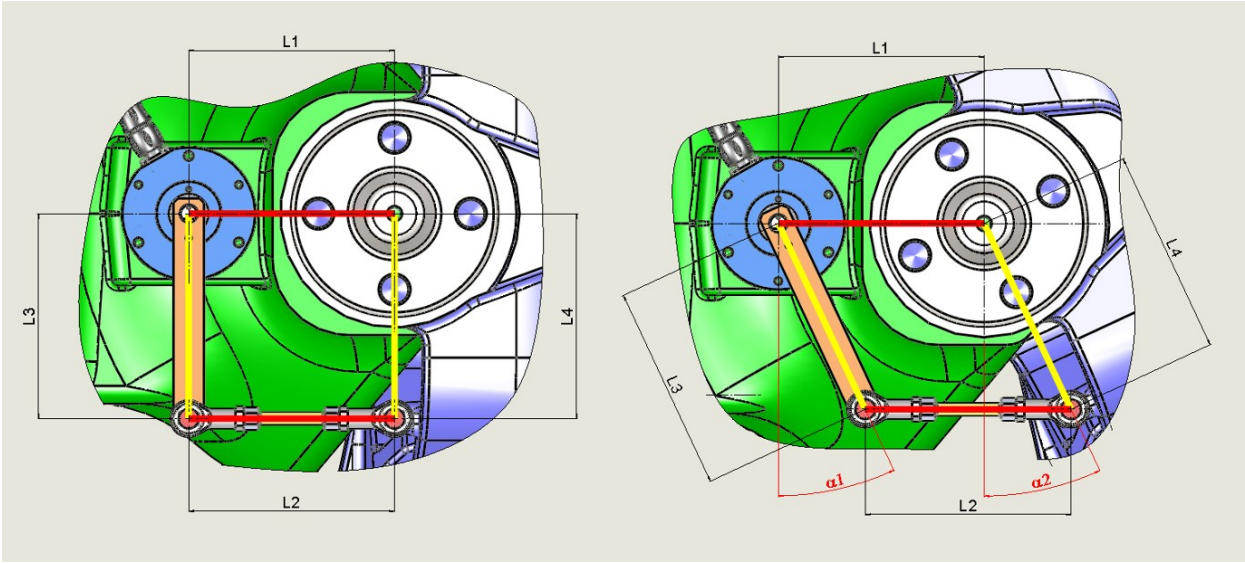


NOTE!

- ► The angle transducer must be linked/mounted in such a way that the distance between the angle transducer axle and the rotary axle together with the angle transducer lever and the coupling rod results in a **parallelogram**.

- ℹ This **parallelogram steering (L1 = L2 and L3 = L4) guarantees 1:1 transmission** of the steering angle α of the rotary axle to the angle transducer **(α1 = α2).**

  Every deviation from the parallelogram **(L1 ≠ L2, L3 ≠ L4)** will inevitably result in a **non-linear transmission relation (α1 ≠ α2)**.



4.1.3.2 General requirements

Note the following points for attaching the angle transducer linkage to the track rod, steering lever or the solid-end axle:

WARNING!

- Mount the transducer with **corrosion-protected screws** of a **sufficient strength class**.
- Use suitable **screw locking devices** (self-locking nut, thread-locking fluid high strength, locking elements such as split pins / safety wire etc.).
- A microencapsulated screw lock is factory-installed for the fastening screws of the coupling rod part number 530 982-x. This screw lock meets the requirements.
- When using microencapsulated screws and thread-locking fluid, make sure that the threads are free of grease (preparatory cleaning).
- Do not use microencapsulated screws several times (ensure when replacing them).
- If linkage is done via **cable clamps** on the steering lever or track rod, a **minimum of 4 M8 screws** must be used for fixation.
- Mount the linkage without the need to exert force. The elements of the linkage must **never** be **statically braced** together!
- If **strong vibrations** are to be assumed (e.g. mounting to the axle body), the angle transducer must be mounted and/or installed in such a way that **the occurring forces** will **not exceed** the **maximum load values (axial load and radial load)** as set out in the data sheet of the angle transducer. In this respect, it is recommended to select **the lever and the linkage as short as possible**.
  In the case of **extreme vertical vibration loads**, it is recommended to mount the angle transducer together with **the angle transducer shaft in horizontal position** (vertical lever steering) in order to reduce load on the angle transducer bearing.

If possible, use **existing attachment** points for the linkage.

4.1.3.3 Coupling rod design

The coupling rods must meet the following criteria:

WARNING!

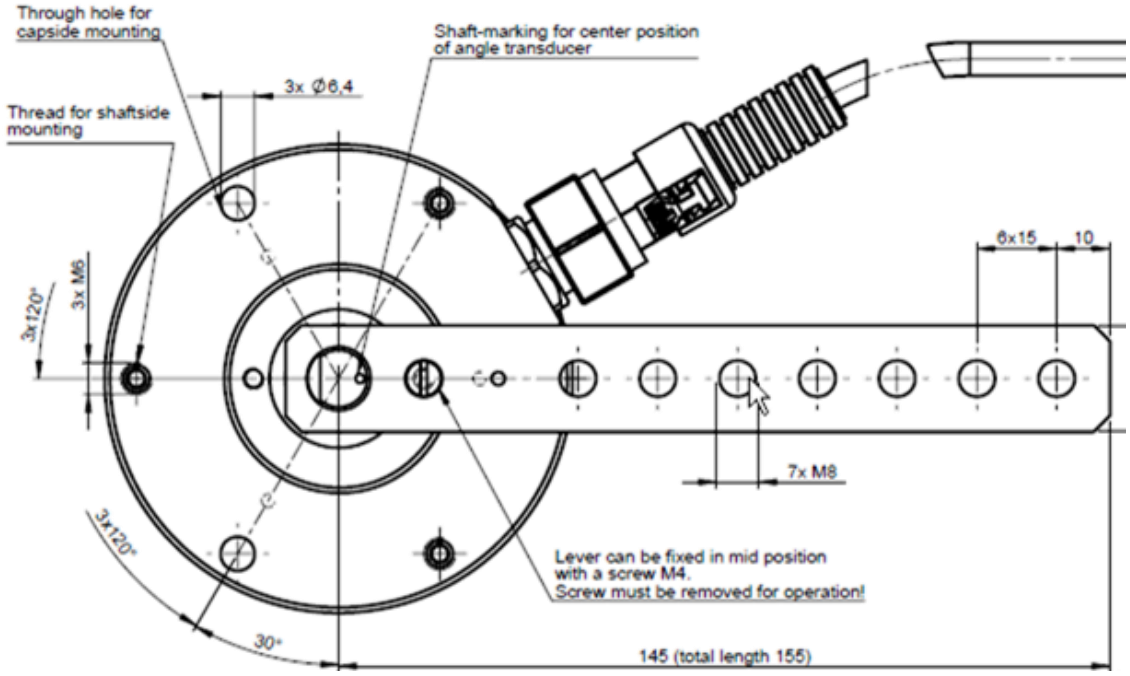
- Use **coupling rods with joints** must be used in order to balance out production and mounting tolerances and to keep the steering of the angle transducer tension-free.
- The rods must be made of **tough steel with reliable corrosion protection** (stainless steel should be used). The bar should have a minimum diameter of 8 mm. Regarding adjustment, the bar ends should have a right-handed and a left-handed thread with at least M8.
- Use **joint heads** with a minimum nominal size of 8 mm and a **form-fitting design**.
- Choose **the length and the design of the coupling** rod in such a way that the **maximum load values (axial load and radial load)** for all operating conditions set out in the data sheet of the angle transducer **will not be exceeded.**

If possible, use **standard coupling** rods from the MOBIL ELEKTRONIK range.

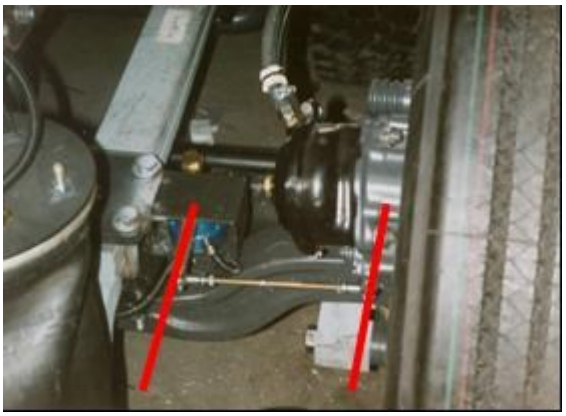
The coupling rod part number 530 982-x meets the above requirements.

The coupling rod part number 530 982-x is provided with grooves on the thread. These mark the maximum permissible unscrewing length. If a groove becomes visible, the maximum permissible unscrewing length has been reached.

4.1.3.4 Installation instructions for angle transducer mounting with steering lever



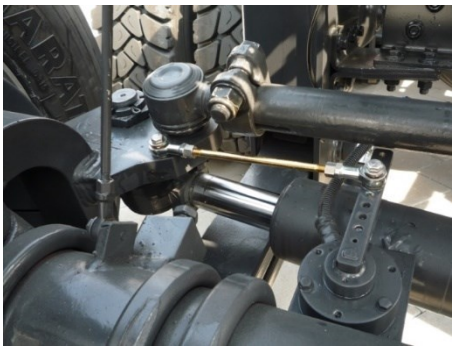
The angle transducers have a marking on the shaft to indicate the middle position.
Regarding angle transducers that are supplied with a lever, this middle position of the lever is fixed with a M4 plastic screw.



- ► Adjust your axle to middle position (e.g. driving straight ahead).
- ► Transfer the hole-pattern of the attachment drillings of the angle transducer to the attachment point on the vehicle.
- ► To ensure linear transmission of the measured value, the linkage should preferably be designed as a parallelogram.
- ► Remove the M4 plastic fixing screw of the lever middle position.
- ► Fine adjustment of the angle transducer steering can only be carried out by loosening the counter nuts between the coupling rod and the joint head and then twisting the coupling rod. Make sure that the minimum screw-in length of the threaded rod in the rod ends is not fallen below.
  At standard coupling rods from MOBIL ELEKTRONIK, this minimum screw-in depth is marked by a puncture on the coupling rod.
- ► Move or turn your rotary arm and/or the axle completely to the left and right. Check that the coupling rod and/or the lever do not collide with other vehicle components.

4.1.3.5 Installation examples for pendulum stroke axles

4.1.3.6 Installation examples for linkage via steering lever or track rods



4.1.3.7 Installation examples for linkage via steering knuckle or steering cylinder

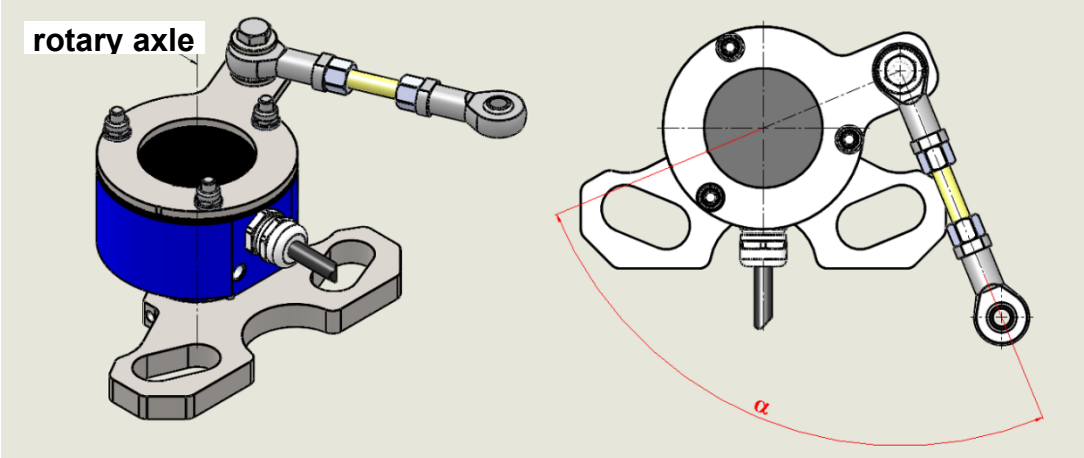
4.1.4 Overhead Mounting

Overhead mounting is a direct mounting of the angle transducer on the rotary axle, where the angle transducer is mounted with the shaft side and/or the lever on the rotary axle. Thus, **two different mountings are possible**:

1. Mounting of the angle transducer with the lever fixed to the rotary axle.
   The angle transducer housing is mounted to the frame or the axle by means of a flexible torque support.
   Balancing element:torque support
2. Mounting of the angle transducer with the shaft via a coupling to the rotary axle.
   The angle transducer housing is mounted to the frame or the axle.
   Balancing element: clutch

4.1.4.1 Mounting with torque support

4.1.4.1.1 Attaching with tappet and coupling rod

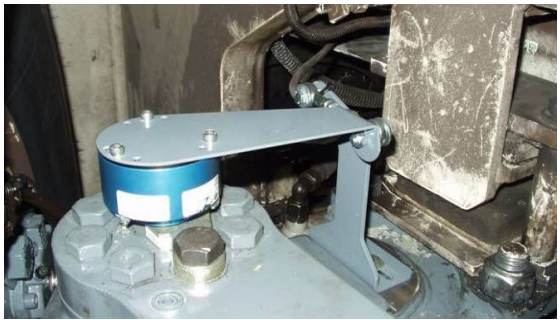


NOTE!

► The angle transducer must be steered/mounted in such a way that

- the rotary axle corresponds to the angle transducer axle (ideally, as shown, directly via the lever on the axle box cover)
  The maximum admissible deviation between the rotation centres is 0.8 mm
- the angle α between coupling rod and tappet is within a range between 50° and 130° or ideally 90°.

Installation example



Observe the following points when mounting the coupling rod:

WARNING!

- ► Mount the coupling rod and the tappet with **corrosion-protected screws** of a **sufficient strength class**.
- ► Use **suitable screw locking devices** (self-locking nut, thread-locking fluid high strength, locking elements such as split pins / safety wire etc.).
- ► A microencapsulated screw lock is factory-installed for the fastening screws of the coupling rod part number 530 982-x. This screw lock meets the requirements.
- ► When using microencapsulated screws and thread-locking fluid, make sure that the threads are free of grease (preparatory cleaning).
- ► Do not use microencapsulated screws several times (ensure when replacing them).
- ► The **tappet** must be attached to the angle transducer with at least **two screws**.
- ► If linkage is done via **cable clamps** on the frame or axle, a **minimum of 4 M8 screws** must be used for fixation.
- ► Mount the linkage **without the need to exert force**. The elements of the linkage must **never be statically braced together**!
- ► If **strong vibrations** are to be assumed (e.g. mounting to the axle body), the angle transducer must be mounted and/or installed in such a way that the **occurring forces will not exceed the maximum load values (axial load and radial load)** as set out in the data sheet of the angle transducer. Tappet and coupling rod need to be chosen accordingly.

Observe the following points when mounting the angle transducer:

WARNING!

- ► The angle transducer must be mounted with **corrosion-protected screws**.
- ► When mounting the lever directly onto the axle cover, the **strength class** of the mounting screws and the **corresponding tightening torque must be agreed upon with the axle manufacturer**.
- ► The **maximum surface compression** on the angle transducer lever must **not exceed** 630 N/mm².

i We recommend the use of HV-washers DIN EN 14399-6 – C45

If possible, use **existing fixing points** for the installation/linkage.

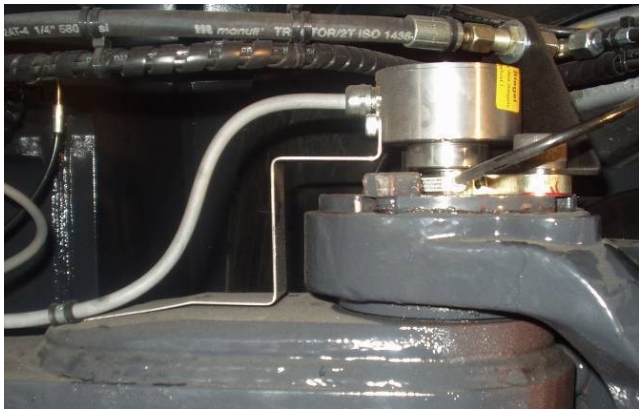
If possible, use **standard tappets** from the ME MOBIL ELEKTRONIK GMBH range (part number 530 983-....).

If possible, use **standard coupling rods** from the ME MOBIL ELEKTRONIK GMBH range.

The coupling rod part number 530 982-x meets the above requirements.

i The coupling rod part number 530 982-x is provided with grooves on the thread. These mark the maximum permissible unscrewing length. If a groove becomes visible, the maximum permissible unscrewing length has been reached.

4.1.4.1.2 Mounting with spring element



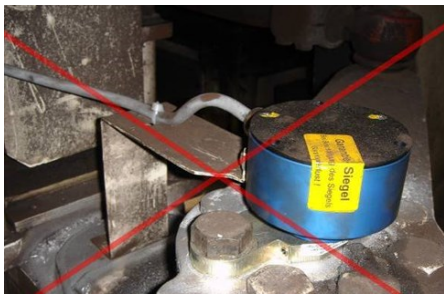

NOTE!

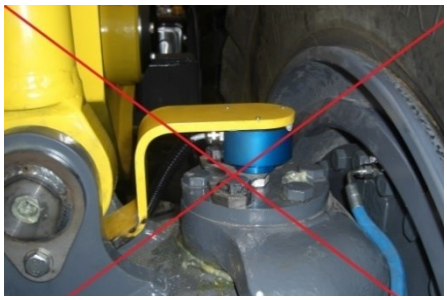
- The angle transducer must be linked/mounted in such a way that the rotary axle corresponds to the angle transducer axle.
  (ideally, as shown, directly above the lever on the axle bearing cover)
  The maximum admissible deviation between the rotation centres is 0.8mm!

Observe the following points when mounting the spring element:

WARNING!

- Mount the spring element with **corrosion-protected screws** of a **sufficient strength class**.
- Use suitable **screw locking devices** (self-locking nut, thread-locking fluid, locking elements such as Schnorr locking washers, etc.).
- The **spring element** must be fixed to the angle transducer and the axle with at least **two screws**.
- The **spring element** must have such a **shape and stiffness** that, under the operating conditions of the axle to be expected, the **occurring forces will not exceed the maximum load values (axial and radial load)** as set out in the data sheet of the angle transducer.
  Mounting-related **pre-stressing** of the spring element **must be avoided or considered**!
  Attention: If the spring element is too stiff, the angle transducer will eventually be damaged! (see figure below)



Material to be used for the spring element: Preferably **spring steel sheet with a thickness of 1 mm**.

If possible, use **existing fixing points** for the installation.

Observe the following points when mounting the angle transducer:

WARNING!

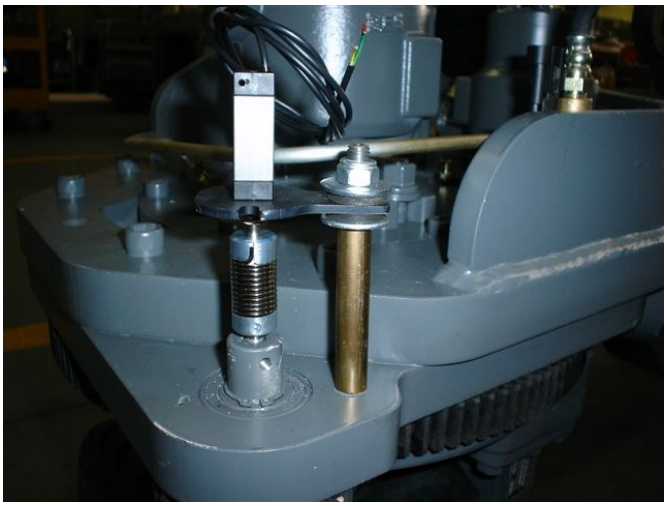
- ► Mount the angle transducer with **corrosion-protected screws**.
- ► When mounting the lever directly onto the axle cover, the **strength class** of the mounting screws and the corresponding **tightening torque must be agreed upon with the axle manufacturer**.
- ► The **maximum surface compression** on the angle transducer lever **must not exceed** 630 N/mm². We recommend the use of HV-washers DIN EN 14399-6 – C45.

i We recommend the use of HV-washers DIN EN 14399-6 – C45.

4.1.4.2 Mounting with coupling

Installation examples with claw coupling on the angle transducer shaft:

Installation examples with rubber element/spring element on the angle transducer shaft:



Observe the following points when **designing and mounting the angle transducer**:

WARNING!

- For **safety-related applications** such as steering, **form-fitting couplings** must be used. **Mounting** must also be carried out in a **form-fitting manner**.
- Take **environmental influences** into account. **Embrittlement and/or corrosion** of the coupling components may lead to **loss of the angle transmission**. Exposed **coupling components** need to be **protected** accordingly.
- The **coupling** must be designed in such a way **that axial and/or radial displacement** occurring under **operating condition** of the axle to be expected, as well as an **angle deviation** between angle transducer axle and rotary axle **is compensated**.
  Occurring forces may not exceed the maximum loading values (axial and radial load) as set out in the data sheet of the angle transducer.
- The **torsional stiffness** of the coupling must be chosen in such a way that **clearance-free angle** transmission is possible. **Torsional spring effects** during angle measurement **may prompt the axle to swing**!
- Mounting of the angle transducer and the coupling must be carried out **without the need to exert force**. The elements of the linkage **must never be statically braced together**!
- **Impacts due to clearance in the axle** must be **decoupled** and may not be transferred to the angle transducer!

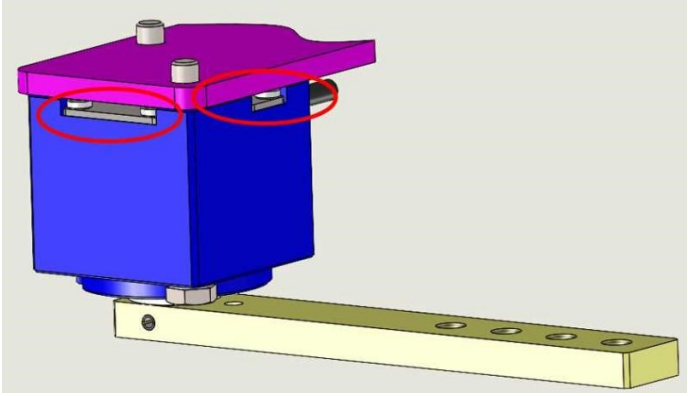
Note the following points for **attaching the angle transducer** to the axle or the solid-end axle::

WARNING!

- Mount the transducer with **corrosion-protected screws** of a **sufficient strength class**.
- Use **suitable screw locking devices** (self-locking nut, thread-locking fluid, locking elements such as Schnorr locking washers, etc.).
- Mount the angle transducer **without the need to exert force**. The elements of the linkage **must never be statically braced together**!
- If **strong vibrations** are to be assumed (e.g. mounting to the axle body), the angle transducer must be mounted and/or installed in such a way that the **occurring forces will not exceed the maximum load values (axial load and radial load)** as set out in the data sheet of the angle transducer. Coupling components need to be chosen accordingly.

ATTENTION!

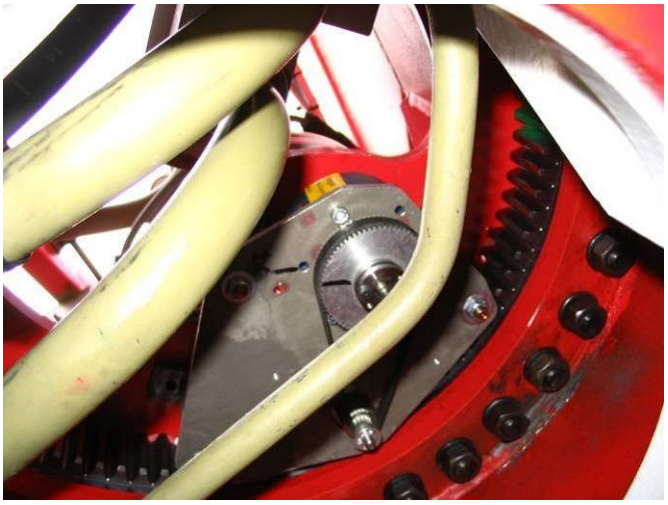
- ► Avoid overhead installation of the compact transducer in harsh environmental conditions. Water pockets will form on the cover seal (see figure).
- ► If overhead installation cannot be avoided, the pockets must be covered by a splash guard.



If possible, use **existing fixing points** for the installation/linkage.

4.1.5 Installing with Toothed Belt

Linkage via the toothed belt is mainly used if the angle transducer is not directly mounted on the axle for space reasons. It has the advantage that the angle transducer position (depending on the tooth distance) may be adjusted very flexibly.



NOTE!

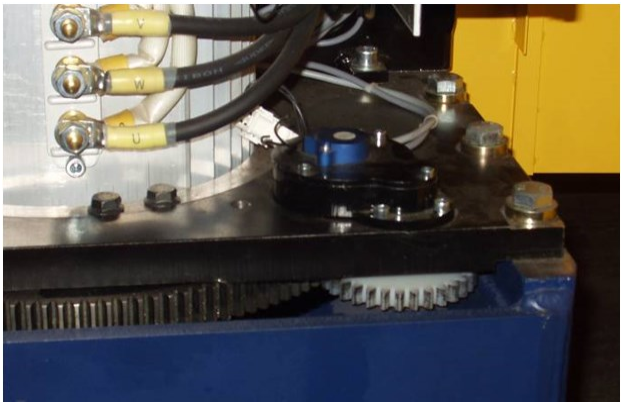
- ► The transmission ratio between the angle transducer and the rotary axle should be chosen in such a way that the fully angle transducer range (max. 90% of the nominal angle) is used.

Observe the following points when using **toothed belts for angle transmission**:

WARNING!

- Mount the transducer with **corrosion-protected screws** of a **sufficient strength class**.
- Use suitable **screw locking devices** (self-locking nut, thread-locking fluid, locking elements such as Schnorr locking washers, etc.).
- The toothed belt **must be pretensioned sufficiently** to allow to ensure **backlash-free transmission**. **Occurring forces may not exceed the maximum loading values for radial load** as set out in the data sheet of the angle transducer.
- Avoid a **recognisable height discrepancy** between input and output so that the **service life of the toothed belt** is not reduced, **and no axial forces occur at the angle transducer**.

4.1.6 Installation with Gear



Observe the following points when using **gears for angle transmission**:

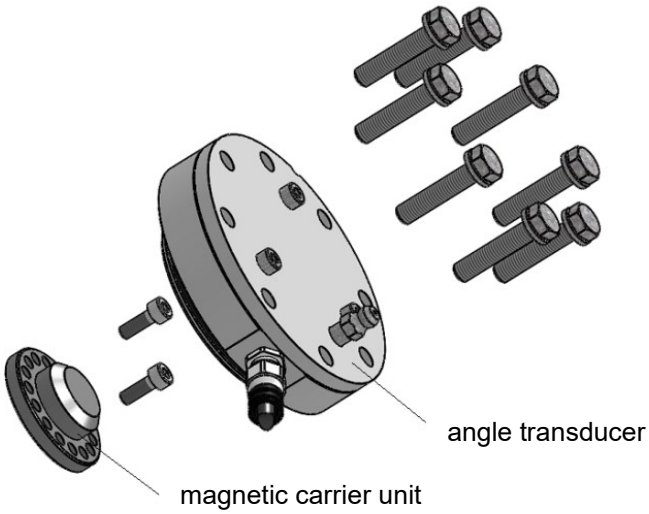
NOTE!

- The transmission ratio between the angle transducer and the rotary axle should be chosen in such a way that the fully angle transducer range (max. 90% of the nominal angle) is used.

WARNING!

- Mount the transducer with **corrosion-protected screws** of a **sufficient strength class**.
- Use **suitable screw locking devices** (self-locking nut, thread-locking fluid, locking elements such as Schnorr locking washers, etc.).
- Use a **backlash-free gear** for **backlash-free angle transmission**!

4.1.7 Two-part design for integration in steering knuckle bearing arrangements with grease lubrication pressure



Two-piece, axle-integrated angle transducers are a special variant since axle and angle transducer must be matched to each other.

The magnetic carrier unit is usually attached to the steering kingpin, the angle transducer to the steering knuckle. During the steering movement, the angle transducer thus rotates relative to the magnetic carrier unit on the kingpin.
The relevant and specific points to be observed are defined in the data sheet and in the installation instructions for the angle transducer.

In general, the following points must be observed:

4.1.7.1 Design of the linkage - integration in the axle bearing

DANGER!

- **The kingpin must be fixed rotationally rigid in the stub over the entire service life of the vehicle even under maximum ambient conditions!**

► Observe the installation geometry specified in the angle transducer data sheet.

► Ensure that the functional distance between the magnetic carrier unit and the angle transducer specified in the angle transducer data sheet is maintained for all operating conditions.
Consider bearing play and wear dimensions over the service life of the vehicle.

► Align the position of the middle position of the angle transducer on the axle with the steering angle of the axle. The steering range of the axle must always be within the measuring range of the angle transducer.

► Coordinate the environmental requirements of the installation areas with the data sheet of the angle transducer. For example, the maximum grease pressure for installation in axle bearings with grease pressure lubrication must be checked.

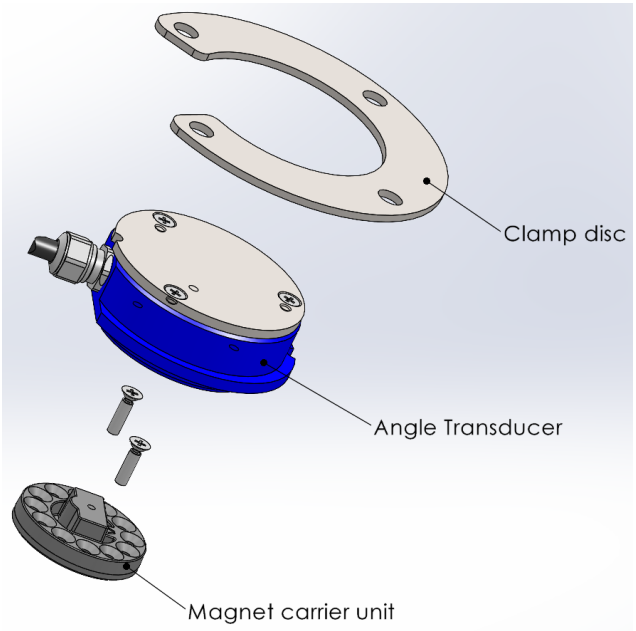
- **The mounting (screw connection) of the magnet carrier unit must hold the magnet carrier unit firmly on the kingpin even under maximum ambient conditions!**
- **The mounting (screw connection) of the angle transducer must hold the angle transducer firmly on the steering knuckle even under maximum ambient conditions!**

4.1.7.2 Installation

WARNING!

- For mounting the magnetic carrier unit and the angle transducer, use the mounting elements included in the scope of delivery.
- **Observe the parameters of the screw connections (tightening torque, tolerance, temperature, tightening sequence, etc.) specified on the data sheet of the angle transducer!**
- Observe the specifications in the chapter on cable laying.

4.1.8 Two-part design for integration in bearing arrangements without grease lubrication pressure



Two-part angle encoders for integration into bearings are an easy-to-integrate variant of this design. The magnet carrier unit is usually mounted on a fixed bearing bolt, while the angle encoder can rotate above the magnet carrier unit.

The relevant and specific points to be observed are defined in the data sheet and in the installation instructions for the angle transducer.

4.1.8.1 Design of the linkage - integration in the axle bearing

DANGER!

- **The bearing bolt must be fixed rotationally rigid for the entire service life of the vehicle even under maximum ambient conditions!**

► Ensure that the functional distance between the magnetic carrier unit and the angle transducer, specified in the angle transducer data sheet, is maintained for all operating conditions.
Consider bearing play and wear dimensions over the service life of the vehicle.

► Compare the measuring range of the angle transducer with the deflection angle of the bearing.
The deflection angle of the bearing must always be within the measuring range of the angle transducer.
The angle encoder can be readjusted within a small range using the clamping disc.

► Coordinate the environmental requirements of the installation areas with the data sheet of the angle transducer.

- **The mounting (screw connection) of the magnet carrier unit must hold the magnet carrier unit firmly on the kingpin even under maximum ambient conditions!**

- **The mounting (clamp disc) of the angle transducer must hold the angle transducer firmly on the bearing even under maximum ambient conditions!**

4.1.8.2 Installation

WARNING!

► Use the fastening elements included in the scope of delivery to attach the angle encoder.

► Use the screws (M3 x 12) included in the scope of delivery to fasten the magnet carrier unit. Recommended tightening torque: 0.6 ± 0.1 Nm.
Use medium-strength adhesive (e.g. Loctite 243) to secure the screws.

► Observe the specifications in the chapter on cable laying.

4.2 Electrical Connection of Angle Transducers

Electrical connection of the angle transducer to the steering electronics depends on the respective application and is described in the manual of the steering system.

ATTENTION!

Intrinsic safety of angle transducers:

The standards **ISO 13849** and **ISO 25119** require the **use of a compatible evaluation unit for intrinsic safety of angle transducers.**

5 Safety Steering Setpoint Generator

ATTENTION!

Intrinsic safety of steering setpoint generators:

The standards **ISO 13849** and **ISO 25119** require **the use of a compatible evaluation unit for intrinsic safety of steering setpoint generators.**

5.1 Mechanical Installation

WARNING!

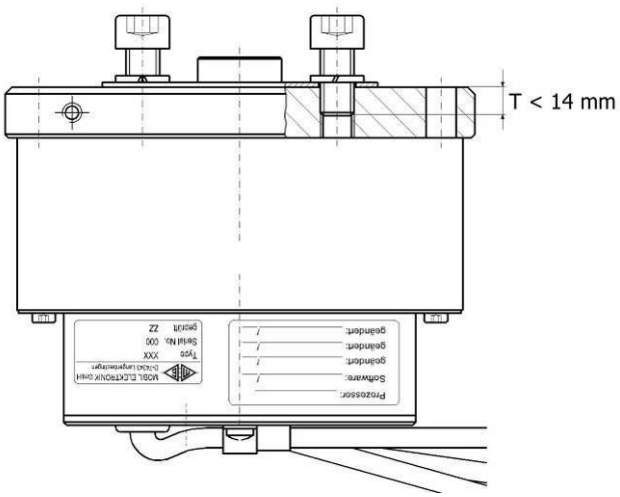
The models SLS 401 7xx are **not suitable for outdoor use**.

When used outdoors, additional sealing measures need to be performed on the housing and on the plug.

► Request appropriate information, if required.

When mounting the steering column flange, the maximum screw-in depth T of 14 mm as well as sealing of the threads must be observed.

In the case of larger screw-in depth (in particular if you do not use the originally supplied cylinder screws), there is a risk of damage/deforming of the brake resulting in an uneven movement of the steering column.



The steering setpoint device has a steering column toothwork as a shaft connection which is compatible to SAUER-DANFOSS-OTP steering columns. When mounting the steering columns, flush installation must be observed. Before final tightening of the cylinder screws, the steering wheel must be able to be fully rotated without getting stuck.

In the event of uneven running, the steering column must be realigned. If acceptable running cannot be achieved, please replace the steering column (toothing possibly too excentric) and check the screw-in depth of the cylinder screws (see above).

5.2 Electrical Connection

The SLS must be fitted with a separate fuse for each channel. Ideally, three separate voltage supplies must be used. Each voltage supply must be connected to a digital inputs of the steering computer for diagnostic purposes.

The following plugs must be used as mating plug for the steering-force simulator:

for plug J1:	8-pin (coupling) DIN 45326
for coupling J2:	8-pin (plug) DIN 45326
for plug J3:	5-pin (coupling) DIN 45322

In doing so, correct crimping must be observed. Preferably, prefabricated connection cables must be used. These cables can be purchased from **ME** quoting the following order numbers:

for plug J1:	**343 308-xx,** 8-pin coupling DIN 45326 with xx m cable
for coupling J2:	**343 358-xx,** 8-pin plug DIN 45326 with xx m cable
for plug J2:	**343 305-xx,** 5-pin coupling DIN 45322 with xx m cable

WARNING!

The connection cables should preferably be laid separately so that in case of shearing of the lines only one line will be affected.

It must be avoided by means of structural measures that no line to the steering setpoint device can be sheared or crushed.

6 Inertial measuring unit (IMU) 559 010-xx

6.1 Mechanical installation

DANGER!

If the mounting breaks, it is to be expected that the corresponding steering axle(s) will break out in an uncontrolled manner.

► **Attach the IMU in accordance with ECE-R79 (see section 5.3.1.1).**

6.1.1 Select installation location

The IMU can be installed in any position on the vehicle. It is therefore irrelevant whether the accelerations and rotation rates are recorded at the front or rear of the vehicle or near or away from the center of gravity.

HINT!

► Select the installation location of the IMU regarding the following aspects:

- Mounting on the vehicle main frame or to a component that is form-fit connected to it.
- Removed from components exposed to high heat (e.g. exhaust systems).
- Removed from radio technology equipment.
- Connected to the bus line with a stub line that is as short as possible (see chapter 3.5.1)
- Under all operating conditions (e.g. suspension compression and rebound, full steering lock, snow chain operation, etc.), ensure **sufficient clearance to neighboring vehicle parts** (i.e. 10 mm, at least 20 mm for rough use).
- The mounting should be easy to check (i.e. accessible) for maintenance personnel.

► The IMU is a safety-relevant component. Install this part in accordance with the same regulations as steering parts, i.e. **form-fit and vibration-proof**.

- Avoid installation in the skidding area of tires, snow chains or the road surface as well as in areas at risk of falling rocks. If necessary, protect the installation location with appropriate **plates and brackets**.

6.1.2 Mounting instructions

WARNING!

The following installation instructions must be observed to ensure that the complete system functions properly:

- The IMU must be installed with the ME type plate facing downwards.
- The plug of the IMU must point towards the rear of the vehicle.
- The IMU must be form-fitted with two M6 screws. The prescribed tightening torque of 6 $^{+/-1}$ Nm must be applied. Internal damage, e.g. due to improper installation, is detected and reported to the SLC.
- Do not disconnect/connect the plug if a supply voltage is connected.

6.1.3 Cable laying

HINT!

► Do not fall below the minimum bending radii for movable and fixed connection cables. The minimum bending radii vary depending on the connection cable.

► Avoid kinking the connecting cable at the plug connection

► Lay the moving connection cable of the IMU in such a way that the bending load of the deflection process cannot be transferred from the cable to the plug connection. This can be achieved, for example, by using a fastening (cable clamp, etc.).

► To prevent water from entering the cable and the plug connector, lay the connection cable downwards and preferably with a cable loop as a drip bend.

► Lay the cable in such a way that the stub line to the CAN connection is as short as possible.

6.2 Electrical Connection

WARNING!

The IMU is only designed for supply voltages **up to 16 V/DC**. For supply voltages of **24 V/DC**, for example, a **DC-DC converter** must be inserted in the wiring!

The following points must be observed when connecting to the CAN bus:

- ► Check that the CAN baud rate of the IMU matches that of the system
  ME order number: 559 010-10 → 500 kBaud
  ME order number: 559 010-11 → 250 kBaud
- ► Connect the IMU to the bus cable with a stub cable that is as short as possible.

Ensure correct crimping. Preferably use the ready-made connection cable. You can obtain this from **ME** under the following order number:

343 340, 4-pin AMP socket with 1m single wires for installation in EIZ 021 050

7 Hydraulics

To ensure fault-free functioning of the supplied hydraulic components observe the following instructions and recommendations.

This section of the installation instructions refers to hydraulic components only. It contains the most important instructions in order to safely commission, operate, maintain and decommission the components.

Compliance with the safety notes helps to avoid accidents, interferences and faults. Knowledge of the safety instructions as well as nationally and internationally applicable safety provisions is a basic requirement for safe handling and fault-free operation of the components.

NOTE!

► The contents of these installation instructions must be **read, understood and complied with** by all employees of the vehicle manufacturer being responsible for mounting, operation and service. This particularly applies to the safety notes.

7.1 General Safety Instructions

The following general safety instructions apply to all subsequent chapters of the hydraulics installation provisions.

ATTENTION!

All work on the hydraulics such as mounting, electrical and hydraulic connection, commissioning, demounting, maintenance and fault rectification **may only be performed by trained and authorised and technical qualified personnel.**

All work on the hydraulics must be performed in **pressure and voltage-free condition** and with **disconnected power supply** of the vehicle.

The vehicle must be **secured against unauthorised starting**.

Hydraulic systems must be regularly checked by **authorised and technically qualified persons (an expert)** and the **result must be documented**.

DANGER!

Modifications performed on the hydraulic components are not allowed.

NOTE!

When designing and using hydraulic components, the application specific **safety and accident prevention requirements** must be observed, e.g.

- DIN EN 292: Safety of machinery - Basic concepts, general principles for design
- DIN EN 982: Safety of machinery - Safety requirements for fluid power systems and their components
- DIN EN ISO 4413:2010 – General rules and safety requirements for hydraulic systems und their components

The manufacturer and the operator of the superordinated overall system, e.g. of the vehicle, are responsible for compliance with these requirements.

Hydraulic components may only be operated as a **component of the superordinated overall system**, e.g. of a vehicle.

Operation in **explosive environments** is not permitted.

Before performing **welding work** on the vehicle, the vehicle battery must be disconnected.

7.2 Transport and Storage

ATTENTION!

Handle valve blocks and hydraulic components **carefully and do not damage during unpacking and packing.**

Only transport and store valve blocks and hydraulic components **in their correct original packaging.**

Transport and store valve blocks and hydraulic components **protecting** them from environmental influences.

Immediately report **transport damages** to the carrier and ME.

Remove **dust protection** not before mounting the components.

7.3 Mounting and Installation

ATTENTION!

► Before performing mounting/demounting, all **pressure lines and pressure accumulators** in the hydraulic circuit need to be made **depressurised**.

► **Appropriate protective equipment** such as protective gloves, boots and glasses etc. must be worn before working on the hydraulics as

- hydraulic components may become very hot during operation
- hydraulic fluid may escape at high pressure
- hydraulic components are mostly massive and heavy units which may cause crushing injuries.

NOTE!

► When handling **hydraulic fluids**, the safety requirements and safety data sheets must be observed for the respective product.

The **line cross sections, volume flows, filter arrangements and pressures** according to the hydraulic plan must be complied with by the vehicle manufacturer.

The vehicle manufacturer must also ensure that all **pressurised fittings** must be designed for the corresponding nominal value.

7.3.1 Mounting/Mounting location

ATTENTION!

The hydraulic units may not be installed in the **centrifugal area of snow chains** or in zones prone to **stone-chipping.**

The direct contact with **splash water (e.g. of the wheels) and aggressive media (e.g. salt water) as well as installation in areas which are very dirty (e.g. wheelhouse)** must be avoided. As the case may be, the mounting location must be protected by means of protective covers.

The components of the hydraulic system must be positioned in a protected location away from **heat sources** such as combustion engines and exhaust systems.

Always use all **attachments points** of the hydraulic blocks as the hydraulic units are massive and relatively heavy units due to the high energy densities of a hydraulic system.

Use **corrosion proof screws** with appropriate screw locking.

For proportional hydraulic units and check valve units: The units should be installed within reach for manual emergency actuation**.**

For filters with an optical contamination indicator, the installation location must be selected so that the indicator is easy to read.

It must be possible to replace the filter during maintenance work.

7.3.2 Screw connections

NOTE!

The corresponding **torques according to the data sheet** must be complied with. The correct **torques** and screw connections are listed in the catalogues.

Screw connections must always be tightened using a **torque wrench.**

Sealing of screw connections should preferably be done using soft sealings in the screw connections. Usage of copper sealings, hemp, fluid thread sealing or teflon sealing tape is not allowed in hydraulic systems.

Commercially available components in accordance with DIN 3852 form B (sealing edge) or form E (soft seal) can be used as **connection fittings** on the hydraulic blocks. Deviations can be found in the data sheets. ME recommends screw-in spigots to **DIN EN ISO 9974-2** with soft seal or screw-in spigots to **DIN EN ISO 1179-2**.

7.3.3 Tubes and hoses

NOTE!

Risk of malfunction at steering system

The tube connections must have a flush and tension-free design.

Flexible hoses must be installed between vehicle parts which move relative to each other.

The **hoses** must be installed according to **ISO 4413**.

WARNING!

Uncontrolled behavior possible with incorrectly installed hose lines

Use hose assemblies according to DIN 20066 for a **maximum of 6 years**. The maximum storage period is two years. Store hose assemblies according to DIN 7716.

Further **installation instructions** for hose assemblies can be found in **DIN 20066**. When installing the hose assemblies, care must be taken to ensure that they are laid without risk of damage, chafing and insufficient bending radii.

7.3.4 Venting

ATTENTION!

Venting must be installed at the highest point of the hydraulic system. Air in the hydraulic system may result in considerable malfunctions due to its compressibility and cavitation facilitation.

Upon first commissioning, conscientious venting of the hydraulic system must be carried out. Once the hydraulic circuit has been opened during the life cycle of the vehicle, renewed venting is required.

7.3.5 Cleanliness

Components with narrow tolerances are used for the hydraulic system. Despite their robustness, they are **sensitive to dirt contained in the hydraulic oil**. It must be ensured that no external dirt may enter the system.

ATTENTION!

► **When performing mounting work on the hydraulic system, a high cleanliness standard must be maintained.**

► To guarantee chip and dirt-free areas, the tubes must be:

- precisely **trimmed** and
- **cleaned** with the corresponding devices before performing mounting work.

Dirt contained in the hydraulic oil may lead to blockages of the slide valves or leakages of the seat valves.

7.4 Operation

WARNING!

Operation of vehicles with leaking valve blocks or a leaking hydraulic system is dangerous and impermissible.

Hydraulic oil which escapes under pressure can lead to serious injuries, burns and fires. In addition, leaked hydraulic oil represents a considerable slipping/sliding danger for persons and vehicles.

Leakages must immediately be removed in accordance with the safety and installation instructions. Leaked hydraulic oil must immediately be covered with Oil binding agent.

Leaking hydraulic fluid can lead to serious water contamination and environmental damage.

Oil accidents are subject to report!

NOTE!

► Compliance with permissible environmental conditions must be ensured.

► Technical data (in particular maximum operating pressure and permissible temperatures) and in particular data stated on the nameplate and in the data sheet of the valve block must be observed and complied with.

7.5 Repair/Maintenance/Service

WARNING!

Repair, modifications or **reconstructions** of valve blocks and hydraulic components may only be performed by ME or by an authorised representative of ME.

Do **not touch screws secured with sealing wax**.

This symbol indicates **adjustment devices** which **must not be manipulated** by the customer.

DANGER!

Risk of steering system failure if hydraulic hoses are damaged!

The hydraulic hoses must be inspected regularly and replaced if there are signs of aging, damage, chafing or leakage.

NOTE!

- ► In the event of a breakdown of individual components and corresponding contamination of the hydraulic system with dirt particles and chips, the contaminated oil should be replaced with clean oil.
- ► Before re-commissioning, the remaining components must be cleaned, and the tube system must be flushed.

On serious damages all components susceptible against contamination should be replaced.

When using a high-pressure cleaner/steam-jet air ejector, the hydraulic blocks may not be exposed to the direct jet of the cleaning device.

Detailed information on the manual actuation of individual valves in the hydraulic blocks can be found in the corresponding data sheets. The symbols used there are explained in the following table:

Symbol	Explanation of how the operating device is operated
	with a tool
	with a hexagon key
	with a flat spanner.
	by hand, preferably by turning (1-2 Nm, hand-tight)
	with a blunt tool
	by applying thumb pressure (50 - 100 N) to the actuating device

ME recommends including the instructions from the data sheet into the documentation of the vehicle.

7.6 Steering Cylinders / Hydraulic Motors

NOTE!

The mechanical **connections between the cylinder/hydraulic motor and the axle** and/or chassis must be sufficiently and rigidly dimensioned in order to withstand the maximum operating pressure.

If an **arrangement of cylinders/hydraulic motors** is installed (e.g. centring system with separated cylinders for steering and centring circuit) which could counteract each other in the event of a fault, all mechanical and hydraulic connections must withstand these forces.

Regarding the steering forces, the steering cylinders and/or the hydraulic motors of the steering should be designed in such a way that the axles may also be moved on rough flooring when standing. The axle stops should withstand the steering forces in order to avoid damages during balancing operation.

Definition of the **hydraulic direction of rotation:** A hydraulic oil flow from **P to A** must lead to a **clockwise** rotation of the axle (seen from top).

In order to allow for good **venting of the cylinders** they should be installed with the connections pointing upwards.

7.7 Pump

NOTE!

The hydraulic pump must be chosen in accordance with the hydraulic plans.

7.8 Filter

NOTE!

The filters must be chosen in accordance with the hydraulic plans.

Data concerning **grade of filtration and the purity level** of the oil are set out in the data sheets und the hydraulic plans.

If not otherwise stated in the data sheet, ME recommends a high-pressure hose filter with 10 µm (absolute) to be arranged directly in front of the valve block. In doing so, the entire oil flow (full-flow system) of the valve block can be securely filtered and interferences are avoided.

The recommended purity grade is 18/16/13 according to ISO 4406:1999.

7.9 Hydraulic Tank

NOTE!

Choose the hydraulic tank in accordance with the hydraulic plans.

The hydraulic tank must be able to balance the different oil quantities during operation. Therefore, the following tank sizes must be observed:

NOTE!

The **tank** must be **twice as large as the required operating volume**.

Regarding a **hydraulic accumulator system, the oil level in the tank is subject to strong variations**. **The tank** should be dimensioned in such a way that it can balance the operating volume of the accumulator and the consumers.

ME recommends to **monitor the oil level** and the **tank oil temperature**, if not stated explicitly.

Upon consultation with ME and with corresponding design (wash plates, overall volume, temperature, etc.), a common tank can be used for several hydraulic systems in the vehicle.

7.10 Hydraulic Oil

The hydraulic oil is an essential component of the hydraulic system and requires particular attention..

ATTENTION!

Environmentally friendly pressure fluids (organic oils) and flame resistant hydraulic fluids are only permissible following a prior check and **written permission from ME**.

The oil may only be used **homogeneously**. **Mixing** with other types is not permissible. Oil viscosity and oil type as prescribed by ME are to complied with.

Usage of hydraulic fluids in the **brake systems** is not allowed.

Hydraulic fluids can be **harmful to health**. Inhalation of hydraulic oil or its fumes must therefore be avoided. Therefore, consuming food within the area of the hydraulic system is not allowed.

When handling hydraulic fluids, the **safety provisions** must be observed for the respective product. Corresponding product data sheets, safety data sheets and hazardous goods data sheets are available from the suppliers of the hydraulic fluids.

NOTE!

New hydraulic oil is generally contaminated. The hydraulic system must therefore be filled via a **filling filter** with a corresponding filter mesh as stated on the respective data sheet of the valve block..

The hydraulic components are designed to be used in combination with oils on the basis of mineral oils. Commercially available ATF oils according to DIN 51 502, UTTO and STOU oils and hydraulic oils according to DIN 51 524 and ISO 6743/4 are permitted.

ATF oils which have been approved by the vehicle manufacturer may also be used in ME hydraulic systems.

Oil viscosities must be used depending on the climatic zones in which the hydraulic system is primarily being operated. Exact viscosity data can be found in the data sheets of the systems.

To take account for the increased wear and tear during the run-in period, ME recommends the changing of the steering hydraulic fluid 500 operating hours following initial commissioning.

When complying with oil specifications and temperature thresholds as required by the installation instructions, further oil changes must be performed following 2000 operating hours or once a year. These data are general recommendations and can therefore not meet all the requirements of all applications.

High temperatures and pressures lead to an accelerated aging of the fluid and require that the oil change is performed at an earlier time. Longer intervals are possible with reduced loads and pressures. In the event of stresses or adverse environmental conditions, ME recommends to have a sample tested by an acknowledged and accredited testing laboratory in order to determine the optimum change interval.

When changing the type of the pressure fluid, the system must be profoundly flushed. Compatibility with sealing materials must be observed

When changing to environmentally friendly hydraulic fluids, follow the instructions in the manufacturer's manual.

NOTE!

Proof of maintenance and/or results of fluid analyses must be provided to use in the case of guarantee, liability and warranty claims.

7.10.1 Cooling

Oil temperatures that are too high result in an accelerated aging of the oil and an embrittlement of the hydraulic seals. The oil temperature depends on different parameters (tank volume, cooling air flow, design of the overall hydraulic system, etc.).

WARNING!

In the case of hydraulic oil temperatures that are continuously above the operation temperature stated in the data sheet, a cooling system must be installed.

ME recommends +80°C to be the upper limit of the continuous temperature of the hydraulic oil.

7.11 Hydraulic Valves

NOTE!

The valve blocks may not be directly installed on vehicle components that are exposed to vibrations and impacts.

On jerkily moved units, the movement direction of the valve pistons should not correspond to the main movement direction of the unit.

To prevent the valve block from overheating, it must be mounted in such a way that good ventilation is ensured.

The magnets of the hydraulic blocks may not be exposed to external mechanical loads, in particular no shearing forces.

Hydraulic slide valves should preferably be installed in such a way that the **slider axle** is in a **horizontal position**.

When mounting hydraulic valves, tighten the mounting screws **tension-free and crosswise** (torques: see data sheet of the respective valve block).

When **steering direction-dependent hydraulic functions via the PWM outputs** of an ME electronic system, observe the **effective direction** set out in the wiring diagram of the electronic system.

7.12 Hydraulic Accumulators

WARNING!

Repair and maintenance on hydraulic accumulators may only be performed by technically qualified personnel.

Brazing and welding work on hydraulic accumulators are prohibited.

The fixing of the accumulator must be stable in order that the accumulator is not pulled out of its fixing due to the kickback which results following the breakage of a connection line.

Requirements according to DIN 24 552, ISO 4413 and, if applicable, operating safety regulations must be complied with.

The hydraulic accumulator must be fully depressurised when maintenance works are to be performed.

Only operate hydraulic accumulators within the prescribed temperature range.

According to DIN EN ISO 12100 appropriate measures must be provided to depressurize the accumulator locally and indicate the accumulator pressure e. g. by a pressure gauge.

All hydraulic circuits which are still pressurized after switching off the power supply (e. g. engine stopped) have to be assigned with appropriate caution labels and equipped with a distinguishable depressurizing device.

The vehicle manufacturer has to include a description in the vehicle's documentation how to depressurize the hydraulic system for service or maintenance. Additionally visible information labels according to ISO 11648 'hydraulic accumulator under gas and oil pressure' (see left) must be applied. This label in included in the delivery of hydraulic accumulators. The position of the information label has to be described in the vehicle documentation.

Hydraulic accumulators should be installed in a standing position with the gas filling valve to the top. This ensures a certain storage effect even if the membrane has a tear.

Hydraulic accumulators should be installed easily accessible.

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7.13 Disposal

NOTE!

Components contaminated with hydraulic oil, oil binding agents and auxiliary materials (clothes, packaging, etc.) must be disposed of professionally in accordance with the respective laws applying in the country.

Waste oil must be disposed of at collecting points in accordance with local circumstances and applicable laws.

7.14 New Machinery Directive 2006/42/EC

If the vehicle is subject to the new **machinery directive**, the safety related part of the hydraulics may be classified as a safety component within the scope of the risk analysis carried out by the vehicle manufacturer.
In this case, the required performance level (PLr) according to EN 13849-1 of the safety chain must be reported to ME when placing the order.