Mounting Instructions

English

T10FS

HBM

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1 Safety instructions

FCC Compliance & Advisory Statement

Important

Any changes or modification not expressly approved by the party responsible for compliance could void the user's authority to operate the device. Where specified additional components or accessories elsewhere defined to be used with the installation of the product, they must be used in order to ensure compliance with FCC regulations.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

The FCC identifier or the unique identifier, as appropriate, must be displayed on the device.

<table>
<tr><th>Model</th><th>Measuring range</th><th>FCC ID</th><th>IC</th></tr>
<tr><td>T10S2</td><td>100 Nm, 200 Nm</td><td rowspan="5">2ADAT-T10S2TOS6</td><td rowspan="5">12438A-T10S2TOS6</td></tr>
<tr><td>T10S3</td><td>500 Nm, 1 kNm</td></tr>
<tr><td>T10S4</td><td>2 kNm, 3 kNm</td></tr>
<tr><td>T10S5</td><td>5 kNm</td></tr>
<tr><td>T10S6</td><td>10 kNm</td></tr>
</table>

Fig. 1.1 Location of the label on the stator of the device

The preferred position of the FCC label is on the type plate. If this is not possible for reasons of space, the label can be found on the rear of the stator housing.

Model: T10S2

FCC ID: 2ADAT-T10S2TOS6

IC: 12438A-T10S2TOS6

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Label example with FCC ID and IC number

Industry Canada IC

This device complies with Industry Canada standard RSS210.

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Cet appareil est conforme aux normes d'exemption de licence RSS d'Industry Canada. Son fonctionnement est soumis aux deux conditions suivantes : (1) cet appareil ne doit pas causer d'interférence et (2) cet appareil doit accepter toute interférence, notamment les interférences qui peuvent affecter son fonctionnement.

Important

Usage/Installation in the USA and Canada requires an EMI suppressor. Please refer to chapter 6.1.1, page 45.

Designated use

The T10FS torque flange is used exclusively for torque and rotation speed measurement tasks, and directly associated control and regulatory tasks. Use for any additional purpose shall be deemed to be *not* as intended.

In the interests of safety, the transducer should only be operated as described in the Operating Manual. It is also essential to comply with the legal and safety requirements for the application concerned during use. The same applies to the use of accessories.

The transducer is not a safety element within the meaning of its designated use. Proper and safe operation of this transducer requires proper transportation, correct storage, assembly and mounting, and careful operation.

General dangers of failing to follow the safety instructions

The transducer corresponds to the state of the art and is failsafe. The transducer can give rise to remaining dangers if it is inappropriately installed and operated by untrained personnel.

Everyone involved with mounting, starting up, maintaining, or repairing the transducer must have read and understood the Operating Manual and in particular the technical safety instructions.

Residual dangers

The scope of supply and performance of the transducer covers only a small area of torque measurement technology. In addition, equipment planners, installers and operators should plan, implement and respond to the safety engineering considerations of torque measurement technology in such a way as to minimize remaining dangers. On-site regulations must be complied with at all times. Reference must be made to remaining dangers connected with torque measurement technology.

Conversions and modifications

The transducer must not be modified from the design or safety engineering point of view except with our express agreement. Any modification shall exclude all liability on our part for any damage resulting therefrom.

Qualified personnel

The transducer must only be installed and used by qualified personnel, strictly in accordance with the specifications and with safety requirements and regulations. It is also essential to comply with the legal and safety requirements for the application concerned during use. The same applies to the use of accessories.

Qualified personnel means persons entrusted with siting, mounting, starting up and operating the product who possess the appropriate qualifications for their function.

Accident prevention

According to the prevailing accident prevention regulations, once the torque flange has been mounted, a covering agent or cladding has to be fitted as follows:

- The cover or cladding must not be free to rotate.
- The cover or cladding should avoid squeezing or shearing and provide protection against parts that might come loose.
- Covers and cladding must be positioned at a suitable distance or be arranged so that there is no access to any moving parts within.
- Covers and cladding must also be attached if the moving parts of the torque flange are installed outside peoples' movement and operating range.

The only permitted exceptions to the above requirements are if the various parts and assemblies of the machine are already fully protected by the design of the machine or by existing safety precautions.

Warranty

In the case of complaints, a warranty can only be given if the torque flange is returned in the original packaging.

1.1 Markings used in this document

Important instructions for your safety are specifically identified. It is essential to follow these instructions in order to prevent accidents and damage to property.

Symbol	Significance
DANGER	Warns of an *imminently* dangerous situation in which failure to comply with safety requirements *will* result in death or serious physical injury.
WARNING	This marking warns of a *potentially* dangerous situation in which failure to comply with safety requirements *can* result in death or serious physical injury.
CAUTION	This marking warns of a *potentially* dangerous situation in which failure to comply with safety requirements *can* result in slight or moderate physical injury.
Notice	This marking draws your attention to a situation in which failure to comply with safety requirements *can* lead to damage to property.
Important	This marking draws your attention to *important* information about the product or about handling the product.
Tip	This marking indicates application tips or other information that is useful to you.
Information	This marking draws your attention to information about the product or about handling the product.
Emphasis *See….*	Italics are used to emphasize and highlight text and references to other chapters and external documents.

1.2 Symbols on the product

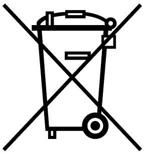
CE mark

The CE mark enables the manufacturer to guarantee that the product complies with the requirements of the relevant EC directives (the declaration of conformity is available at http://www.hbm.com/HBMdoc).

Model: T10S2
FCC ID: 2ADAT-T10S2TOS6
IC: 12438A-T10S2TOS6
This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Label example

Label example with Model number, FCC ID and IC number. Location on the stator of the device.



Statutory waste disposal mark

In accordance with national and local environmental protection and material recovery and recycling regulations, old devices that can no longer be used must be disposed of separately and not with normal household garbage.

If you need more information about waste disposal, please contact your local authorities or the dealer from whom you purchased the product.

2 Torque flange versions

In the case of option 2 “Electrical configuration", the T10FS torque flange exists in versions KF1, SF1 and SU2. The difference between these versions lies in the electrical inputs and outputs on the stator, the rotors are the same for all the versions of a measuring range. Alternatively, versions SF1 and SU2 can be equipped with a magnetic or optical speed measuring system (in the case of the optical system, with or without a reference pulse).

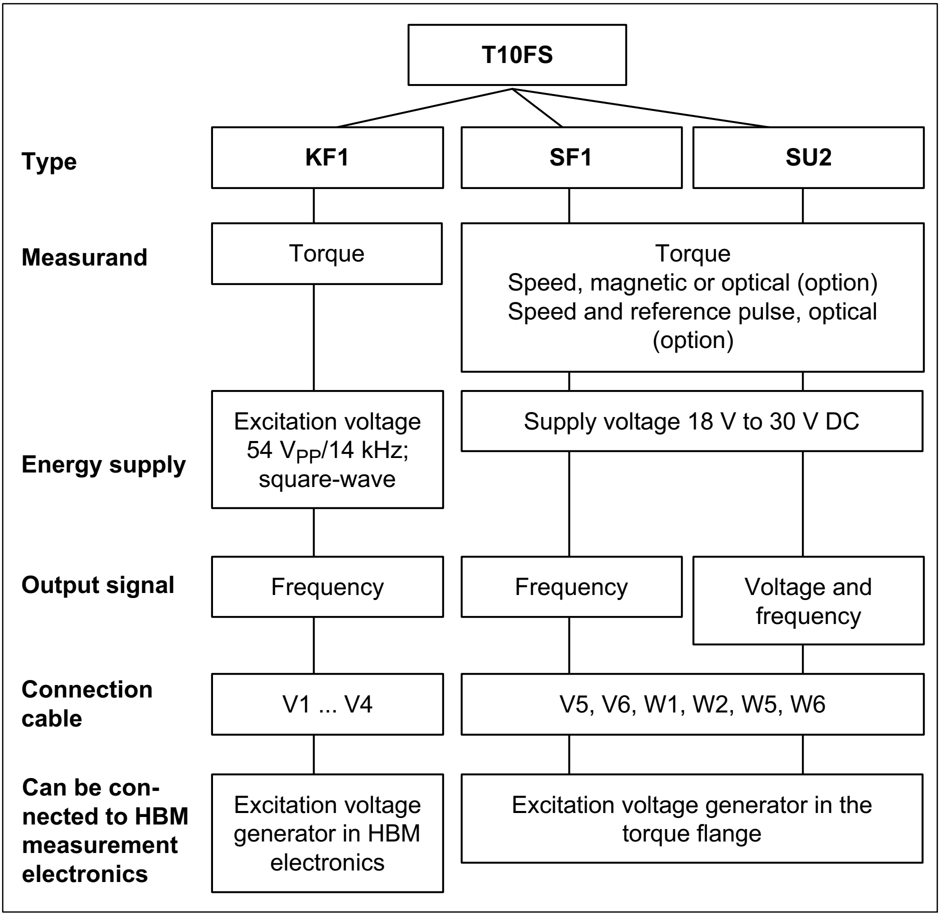


Fig. 2.1 T10FS versions

You can find out which version you have from the stator identification plate. The version is specified in the “T10FS-..." number there.

Example: T10FS-001R-*SU2*-S-0-V1-Y (*see also Page 89*).

3 Application

T10FS torque flanges record static and dynamic torque on fixed or rotating shafts and also return RS-422 signals with direction of rotation information to determine the speed. With an optical speed measuring system, a reference pulse can also be output with the speed pulses. Test beds can be extremely compact because of the short construction of the measurement flanges. They offer a very wide range of applications.

In addition to conventional test-bench engineering (engine, roll and transmission test benches), new solutions are possible for torque measurements partly integrated in the machines. Here, you benefit in full from the T10FS torque flange special characteristics:

- low rotor weights
- low mass moments of inertia
- small outside diameters
- no bearings, no slip rings

Thanks to the bearing-free design and the contactless transmission of excitation voltage and measured values, there are no friction or bearing heating effects.

Torque flanges are supplied for nominal (rated) torques from 100 N·m to 10 kN·m. Depending on the nominal (rated) torque, maximum speeds of up to 24 000 min^{-1} are permissible.

T10FS torque flanges are reliably protected against electromagnetic interference. They have been tested with regard to EMC according to the relevant European standards, and carry the CE mark.

4 Structure and mode of operation

Torque flanges consist of two separate parts: the rotor and the stator. The rotor comprises the measuring body and the signal transmission elements.

Strain gauges (SGs) are mounted on the measuring body. The rotor electronics for transmitting the bridge excitation voltage and the measurement signal are located centrally in the flange. The transmitter coils for contactless transmission of excitation voltage and measurement signal are located on the measuring body's outer circumference. The signals are sent and received by a separable antenna ring. The antenna ring is mounted on a housing that includes the electronic system for voltage adaptation and signal conditioning.

Connectors for the torque signal, the voltage supply and the speed signal (option) are located on the stator. The antenna ring should be mounted more or less concentrically around the rotor (*see Chapter 5*).

A magnetic or optical sensor performs the speed measurement. With a magnetic measuring system, a magnetized rotor is sampled by means of a MagnetoResistive sensor (MR).

The optical sensor works on the infrared transmitted light barrier principle. The reference pulse is generated by a magnet in the slotted disc and a magnetoresistive sensor. In the case of option 2 (speed measuring system), code L, the speed sensor is mounted on the stator, the customer attaches the associated slotted disc on the rotor. In the case of code H, the slotted disc is already mounted on the rotor.

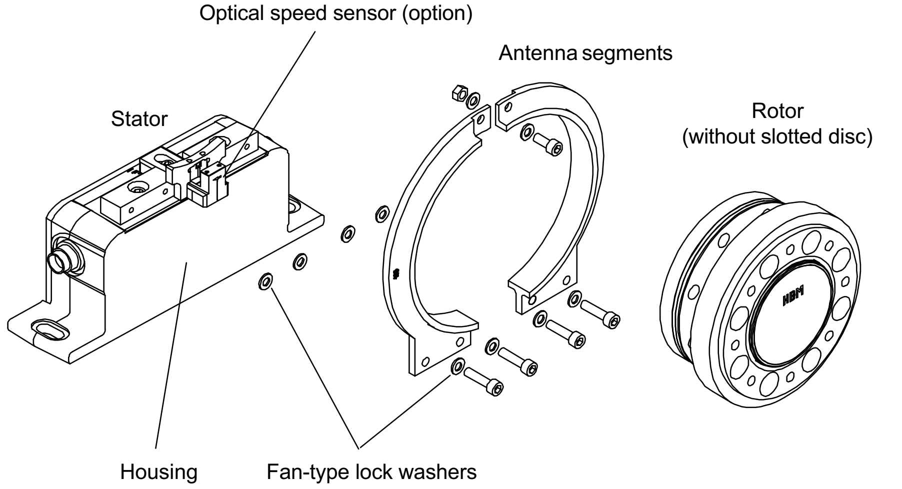


Fig. 4.1 Mechanical structure, exploded view

5 Mechanical installation

WARNING

Handle the torque flange carefully! The transducer could suffer permanent damage from mechanical shock (dropping), chemical effects (e.g. acids, solvents) or thermal effects (hot air, steam).

With alternating loads, you should cement the rotor connection screws into the mating thread with a screw locking device (medium strength) to exclude prestressing loss due to screw slackening.

An appropriate shaft flange enables the T10FS torque flanges to be mounted directly. It is also possible to mount a joint shaft or relevant compensating element directly on the rotor (using an intermediate flange when required). Under no circumstances must the permissible limits specified for bending moments, lateral and longitudinal forces be exceeded. Due to the T10FS torque flanges' high torsional stiffness, dynamic changes on the shaft train are minimized.

Important

The effect on critical bending speeds and natural torsional vibrations must be checked to avoid overloading the measurement flanges due to the resonance stepup.

Notice

Even if the unit is installed correctly, the zero point adjustment made at the factory can shift by approx. ±150 Hz. If this value is exceeded, we advise you to check the mounting conditions. If the residual zero offset when the unit is removed is greater than ±50 Hz, please send the transducer back to the Darmstadt factory for testing.
For correct operation, comply with the mounting dimensions (see Page 85).

5.1 Conditions on site

T10FS torque flanges are protected to IP54 according to EN 60529. They must be protected against coarse dirt particles, dust, oil, solvents and humidity. During operation, the prevailing safety regulations for the security of personnel must be observed (see “Safety instructions").

There is wide ranging compensation for the effects of temperature on the output and zero signals of the T10FS torque flange (*see Specifications on Page 91*). This compensation is carried out at static temperatures in extensive furnace processes. This guarantees that the circumstances can be reproduced and the properties of the transducer can be reconstructed at any time.

If there are no static temperature ratios, for example, because of the temperature differences between the measuring body and the flange, the values given in the specifications can be exceeded. So for accurate measurements, static temperature conditions must then be obtained by cooling or heating depending on the application. As an alternative, check thermal decoupling by means of heat radiating elements such as multi-disk couplings.

5.2 Installation orientation

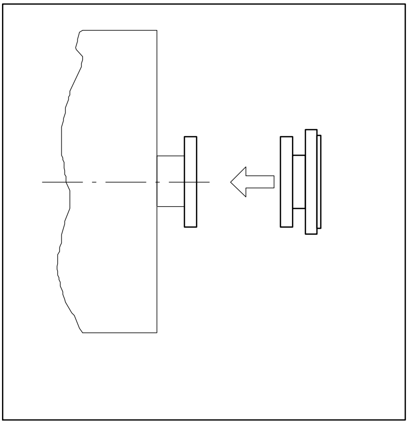
The measurement flange can be mounted in any position. With clockwise torque, the output frequency is 10 kHz to 15 kHz. With HBM amplifiers or with the “voltage output" option, a positive output signal (0 V ... +10 V) is present.

In the case of the speed measuring system, an arrow is attached to the head of the sensor to clearly define the direction of rotation. If the measurement flange moves in the direction of the arrow, connected HBM measuring amplifiers deliver a positive output signal (0 V ... +10 V).

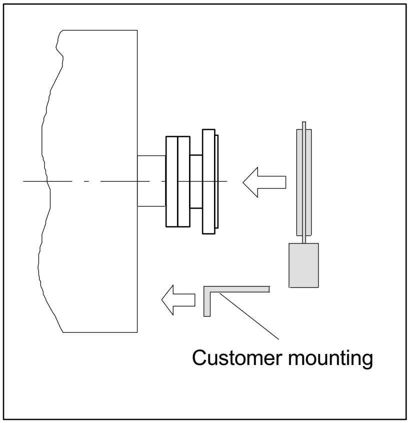
5.3 Installation options

In principle, there are two possibilities for torque flange mounting: with the antenna ring complete or dismantled. We recommend mounting as described in *Chapter 5.3.1*. If installation in accordance with *Chapter 5.3.1* is not possible (e.g. in the case of subsequent stator replacement or mounting with a speed measuring system), you will have to dismantle the antenna ring. It is essential in this case to comply with the notes on assembling the antenna segments (see “Mounting the stator" and “Mounting the slotted disc").

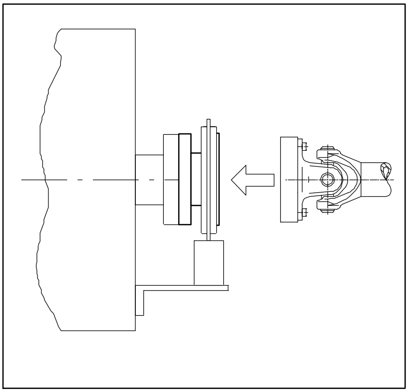
5.3.1 Installation without dismantling the antenna ring (without speed measuring system)



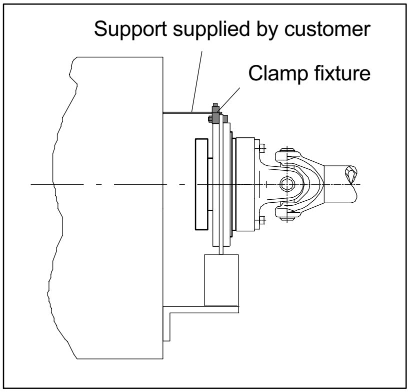
1. Install rotor



2 Install stator

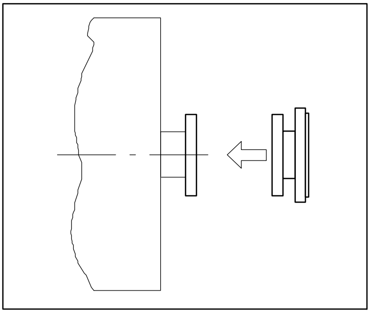


3. Finish installation of shaft train

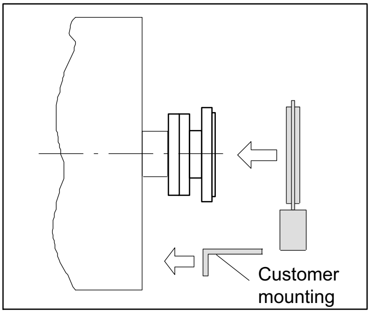


4. Mount the clamp fixture where required

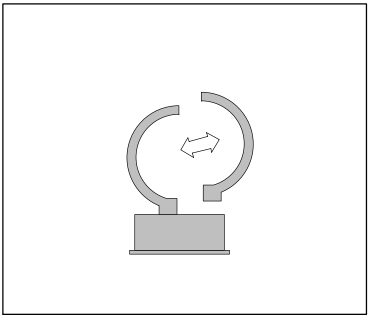
5.3.2 Installation with subsequent stator mounting (without speed measuring system)



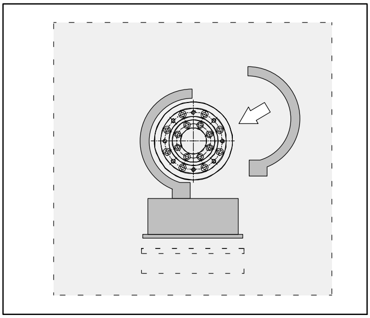
1. Install rotor



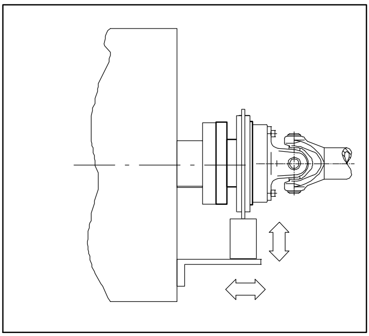
2. Install shaft train



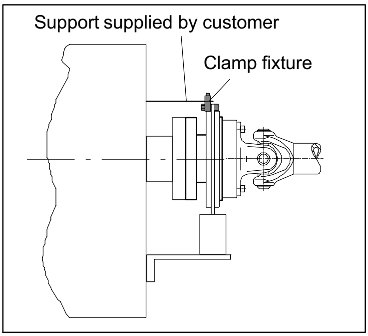
3. Remove one antenna segment



4. Install antenna segment around shaft train



5. Align stator and finish installation



6. Mount the clamp fixture where required

5.3.3 Installation example with couplings

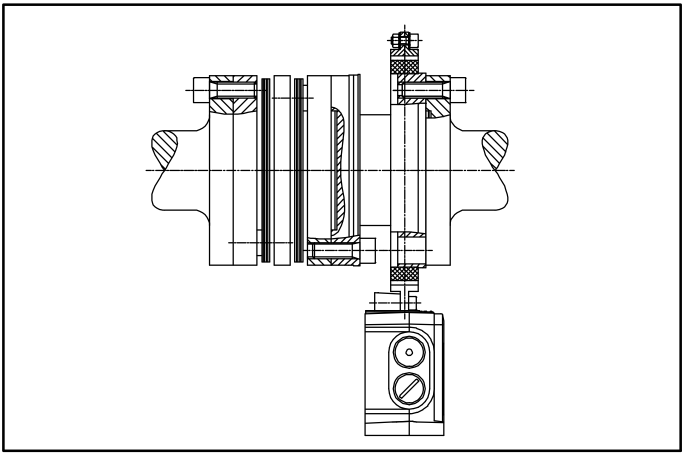


Fig. 5.1 Installation example with coupling

5.3.4 Installation example with joint shaft

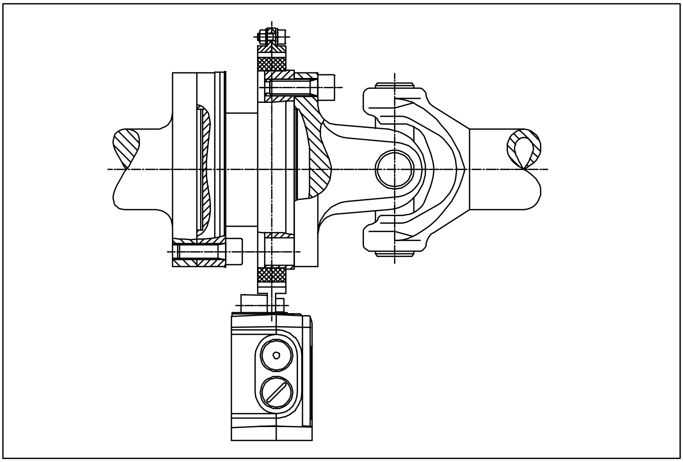


Fig. 5.2 Installation example with joint shaft

5.4 Mounting the rotor

Additional installation notes for the speed measuring system can be found in *Chapter 5.7, Page 32*.

Notice

Usually the rotor identification plate is no longer visible after installation. This is why we include with the rotor additional stickers with the important ratings, which you can attach to the stator or any other relevant test-bench components. You can then refer to them whenever there is anything you wish to know, such as the calibration signal. To explicitly assign the data, the identification number and the measuring range are engraved on the rotor where they can be seen from outside (see Fig. 5.3).

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1. Prior to installation, clean the plane surfaces of the measurement flanges and counter flanges. For safe torque transfer, the surfaces must be clean and free from grease. Use a piece of cloth or paper soaked in solvent. When cleaning, make sure that you do not damage the transmitter coils.

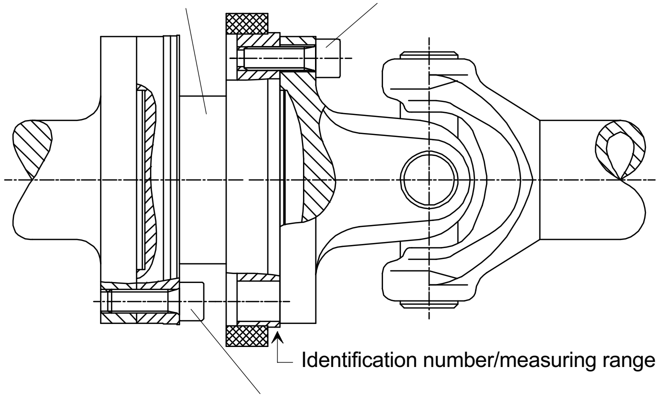


Fig. 5.3 Screwed rotor joint

2. For the bolted rotor connection, use eight *DIN EN ISO 4762 property class 10.9 hexagon socket screws (measuring range ≥ 3 kN·m: 12.9)* of a suitable length (dependent on the connection geometry).

   We recommend fillisterhead screws DIN EN ISO 4762, blackened, smoothheaded, permitted size and shape variance as per DIN ISO 4759, Part 1, product class A.

WARNING

With alternating load: Use a screw locking device (e.g. LOCTITE no. 242) to glue the screws into the counter thread to exclude prestressing loss due to screw slackening.

3. Fasten all screws with the specified tightening torque (*Tab. 5.1*).
4. For further mounting of the shaft train, there are eight tapped holes on the rotor. Also use screws of property class 10.9 (or 12.9) and fasten with the tightening torque specified in *Tab. 5.1*.

Important

With alternating loads, use a screw locking device to cement the connecting screws into place! Guard against contamination from varnish fragments.

Nominal (rated) torque (N·m)	Fastening screws (Z)[1]	Fastening screws Property class	Prescribed tightening torque (N·m)
100	M8	10.9	34
200			
500	M10	10.9	67
1k	M10		67
2k	M12		115
3k	M12	12.9	135
5k	M14		220
10k	M16		340

Tab. 5.1 Fastening screws

1) DIN EN ISO 4762912; black/oiled/μ_{tot}=0.125

5.5 Installing the stator

On delivery, the stator has already been installed and is ready for operation. The antenna segments can be separated from the stator, for example, for maintenance or to facilitate stator mounting. To stop you modifying the center alignment of the segment rings opposite the base of the stator, we recommend that you separate only one antenna segment from the stator.

If your application does not require the stator to be dismantled, proceed as described in points 2., 6., 7. and 8.

Version with speed measuring system

As the optical speed sensor includes the slotted disc, it is not possible to move the stator axially over the pre-assembled rotor. In this case, you should also comply with *Chapter 5.7*.

Notice

Check the screw connections of the antenna segments (see Fig. 5.4) both after initial installation and then at regular intervals for correct fit and tighten them if necessary.

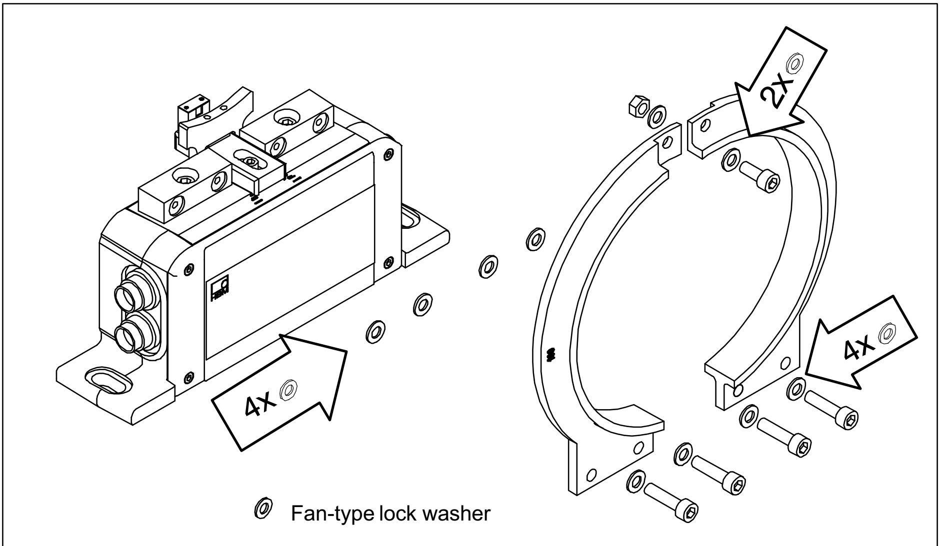
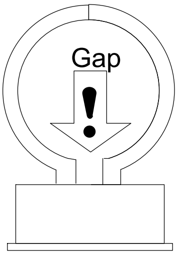


Fig. 5.4 Screw fittings of the antenna segments

1. Loosen and remove the screw fittings (M5) on one antenna segment. Make sure that the fan-type lock washers are not lost!
2. Use an appropriate base plate to install the stator housing in the shaft train so that there is sufficient possibility for horizontal and vertical adjustments. Do not fully tighten the screws yet.
3. Now reinstall the antenna segment removed under point 1. on the stator with two hexagon-socket screws and the fan-type lock washers. Make sure that none of the fan-type lock washers necessary for a defined contact resistance are missing (*see Fig. 5.4*)! Do not yet tighten the screws.
4. Install the two antenna segments' upper connecting screw so that the antenna ring is closed. Also pay attention to the fan-type lock washers.

5. Now tighten all antenna segment screw fittings with a tightening torque of 5 N·m.
6. Align the antenna and rotor so that the antenna encloses the rotor coaxially. Please comply with the permissible alignment tolerances stated in the specifications.
7. Now fully tighten the bolted stator housing connection.
8. Make sure that the gap in the lower antenna segment area is free of electrically conductive foreign bodies.



CAUTION

To make sure that they function perfectly, the fan-type lock washers (A5, 3-FST DIN 6798 ZN/galvanized) must be replaced after the bolted antenna connection has been loosened three times.

5.6 Installing the clamp fixture

Depending on the operating conditions, oscillations may be induced in the antenna ring. This effect is dependent on

- the speed
- the antenna diameter (depends in turn on the measuring range)
- the design of the machine base

To avoid vibrations, a clamp fixture is enclosed with the torque flange enabling the antenna ring to be supported.

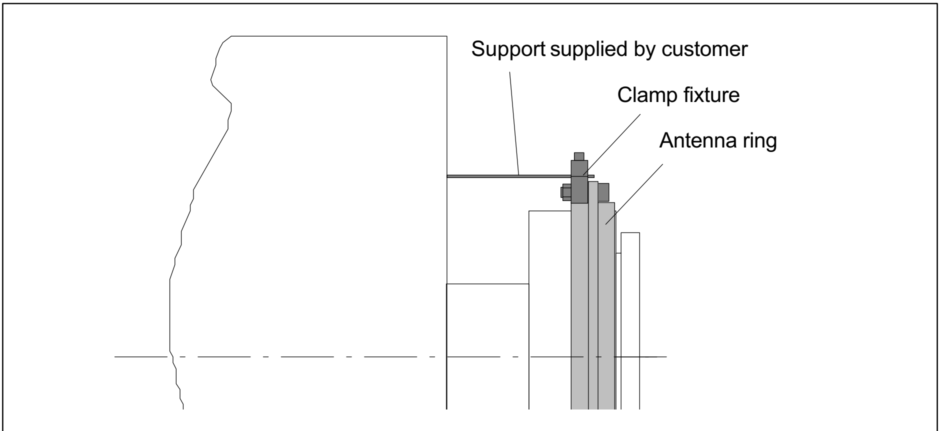


Fig. 5.5 Supporting the antenna ring

Mounting sequence

1. Loosen and remove the upper antenna segment screw fitting.
2. Fasten the clamp fixture with the enclosed screw fitting as shown in *Fig. 5.6*. It is essential to use the new fan-type locking washers!

3. Clamp a suitable support element (we recommend a threaded rod
∅ 3…6 mm) between the upper and lower parts of the clamp fixture and tighten the clamping screws.

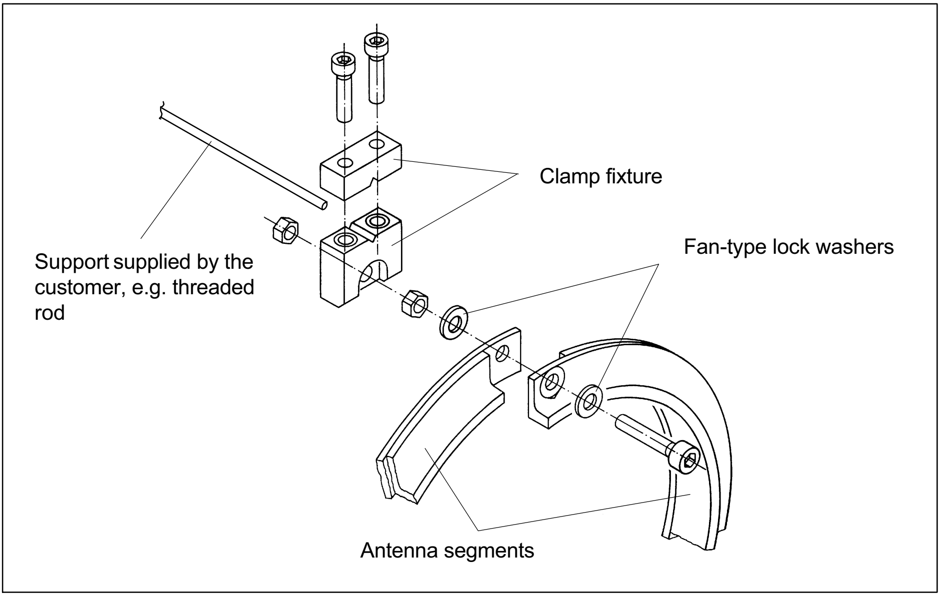


Fig. 5.6 Installing the clamp fixture

Notice

Use, e.g. plastic as the material. Do not use metallic material as this can affect the function of the antenna (signal transmission).

5.7 Mounting the slotted disc (optical speed measuring system)

To prevent the slotted disc of the optical speed measuring system being damaged in transit, it is not mounted on the rotor in the case of measurement flanges with option 2, code L (nominal (rated) speed 8000 min^{-1} to 15000 min^{-1}). Before installing the rotor, it must be attached in the shaft train. The associated speed sensor is already mounted on the stator.

The requisite screws, a suitable screwdriver and the screw locking device are included in the list of components supplied.

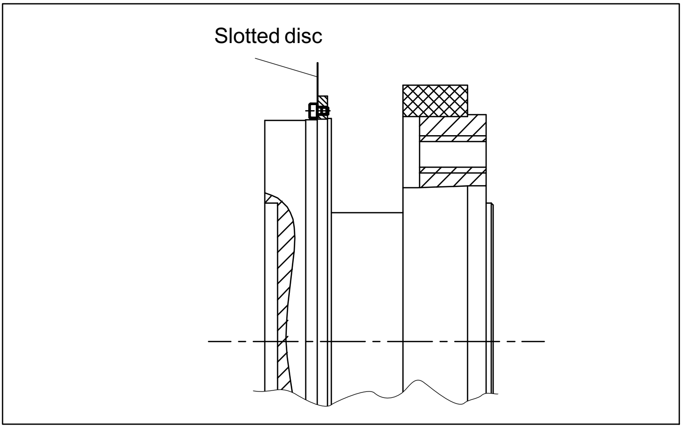


Fig. 5.7 Mounting the slotted disc on the rotor

Important

At all stages of the mounting operation, be careful not to damage the slotted disc!

Mounting sequence

► Push the slotted disc onto the rotor and align the screw holes.

► Apply some of the screw locking device to the screw thread and tighten the screws (tightening torque <15 N·cm).

5.8 Fitting the mounting elements (speed measuring system)

Three mounting elements with screws are included with the torque flange to prevent the speed sensor being damaged during installation. The mounting elements hold the rotor centrally in the antenna ring, making installation easier and safer.

Important

The mounting elements are only an aid to installation and must be removed before the initial operation of the torque flange!

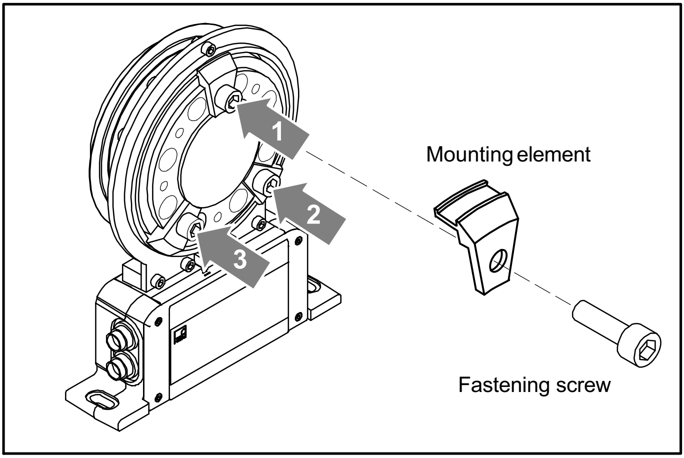


Fig. 5.8 Inserting the mounting elements

5.8.1 Fixing the mounting elements

1. Place the rotor with the identification plate upward on a flat base.

For the optical speed measuring system only:

Hold the stator at a slight slant and push it over the rotor until the slotted disc is located in the optical sensor (*Step A, Fig. 5.9*).

Tilt the stator over the rotor until the antenna ring completely covers the transformer (*Step B, Fig. 5.9*).

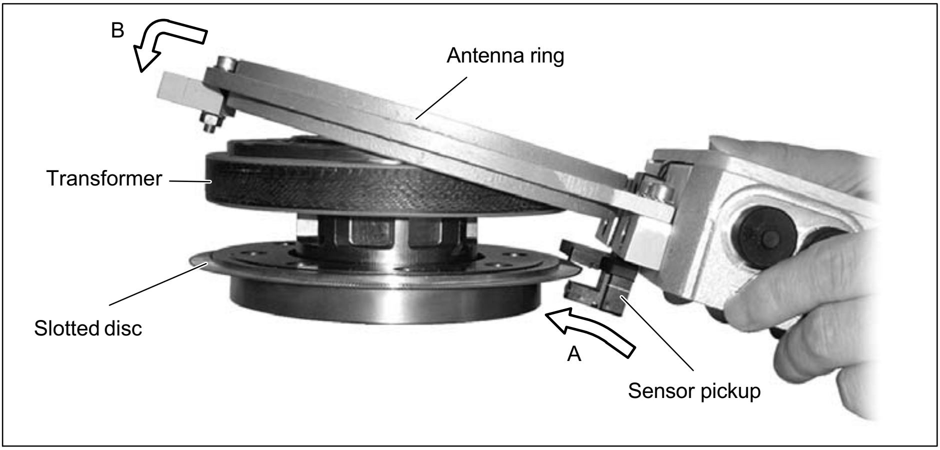


Fig. 5.9 Installing the mounting elements

2. Hold the stator centrally over the rotor and one after the other, push the three mounting elements between the transformer and the antenna ring. The mounting elements should be evenly distributed around the circumference (approx. every 120°).
3. Screw the fastening screws of the mounting elements into the tapped holes of the flange and gently tighten them by hand.

5.8.2 Mounting the torque flange with a speed measuring system

1. Mount the torque flange in the shaft train so that the bearing surface of the stator base lies on the prepared mounting surface free from play and stress.
2. Fasten the rotor with 8 screws in the shaft train (for the property class, *see Tab. 5.1, Page 26*). Initially, the screws should only be hand-tight.
3. Compensate for any possible misalignment of the stator by putting adjusting washers underneath or by adjusting the base.
4. Fasten the base retaining screws; only tighten them gently at first, so that the mounting elements do not get jammed.
5. Remove the mounting elements (if a mounting element should get jammed, try to move it to the left or right).

Notice

It is essential to keep the mounting elements and fastening screws in case any modifications are needed!

6. Tighten the stator retaining screws. The stator must rest at the markings or stops. The rotor must turn freely.
7. Check whether the axial and radial tolerances have been maintained.
8. With a torque wrench, definitively tighten the fastening screws of the rotor in a diagonally opposite sequence (for tightening torques, *see Tab. 5.1, Page 26*).

9. Use a test run (starting at low rotation speeds) to check the correct concentricity of the rotor.

When machines are flexibly suspended, pronounced radial and longitudinal movements may occur. If the movements exceed the permissible limits (*see Specifications, Page 91ff*) you must make sure that the stator follows the rotor's sequence of motions.

When couplings are used, there is a possible longitudinal and radial play to be taken into account.

5.9 Aligning the stator (speed measuring system)

The stator can be mounted in any position (for example, “upside down" installation is possible).

For measuring mode to operate perfectly, the speed sensor (pole ring/slotted disc) of the speed measuring system must be positioned at a defined point to the sensor.

Notice

To attach the stator, we recommend the use of M6 screws with plain washers (width of oblong hole, 9 mm). This size of screw guarantees the necessary travel for alignment.

5.9.1 Magnetic speed measuring system

Notice

With the magnetic speed measuring system, the stator pole ring and stator sensor head are perfectly matched to each other. To maintain the specified pulse quality, the transducer components provided in multiple deliveries must not be mixed up. Before installation, compare the identification numbers of the rotor and stator (also see note on Page 24)!

Axial alignment

There are markers on the sensor head for axial alignment (orientation lines). When installed, the axial inner surface of the pole ring should be exactly over the axial orientation line. Divergence of up to ±1.5 mm is permissible in measuring mode (total of static and dynamic shift).

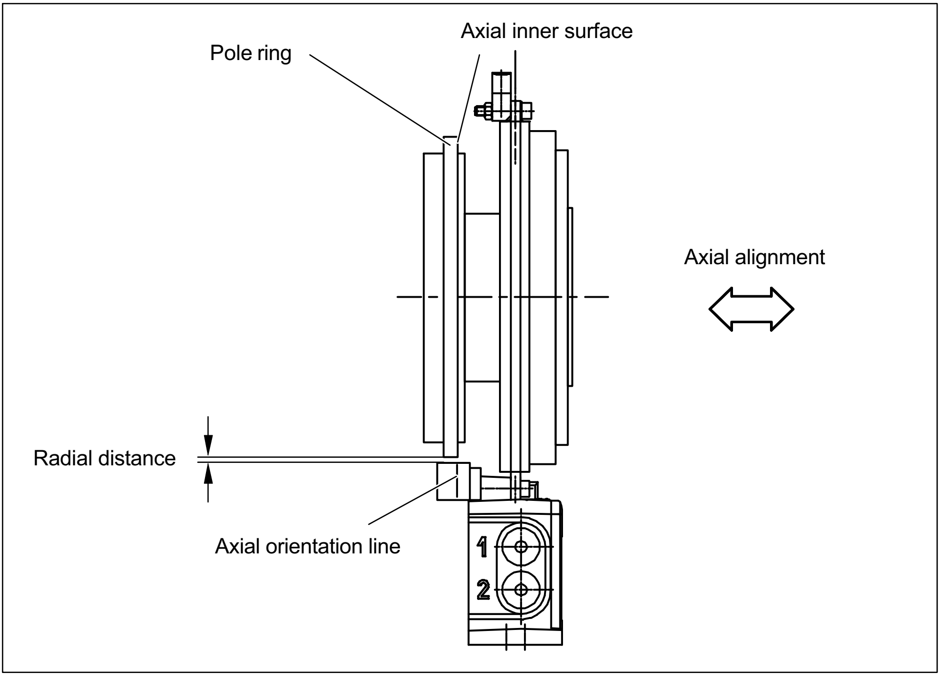


Fig. 5.10 Position of the pole ring to the sensor head

Radial alignment

The rotor axis and the axis of the speed sensor must be along a line at right angles to the stator platform. The radial distance is critical for the radial alignment (*see Fig. 5.10*). A vertical marker line on the head of the sensor serves as an orientation guide for the tangential alignment (*see Fig. 5.11*).

Notice

The mounting conditions are crucial for the pulse tolerance. Preferably try to keep to or undershoot the specified nominal (rated) distance given in Fig. 5.12. If the prescribed distance is exceeded, or the rotor is not optimally aligned with the stator, the pulse tolerance will increase.
The pulse precision can be optimized by setting the minimum distance (0.3 mm).

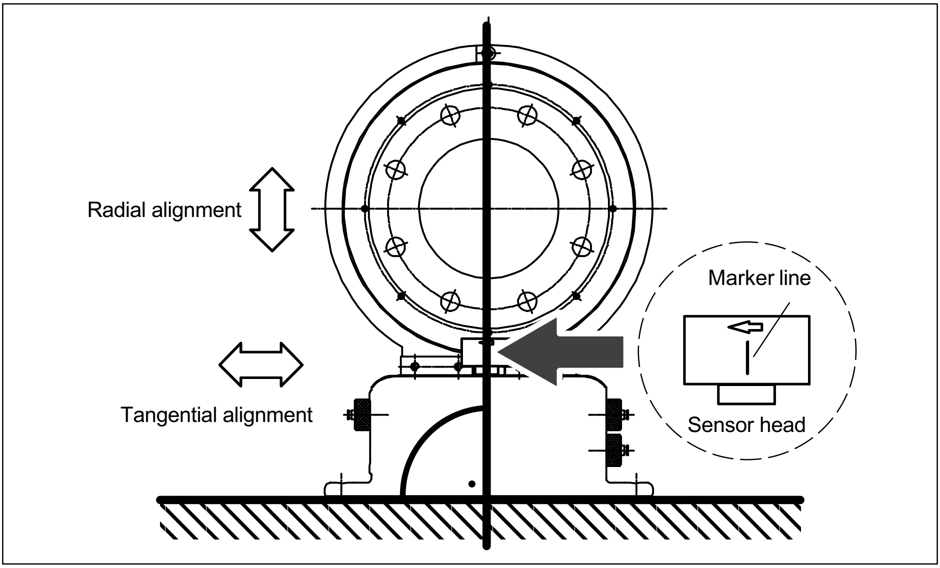


Fig. 5.11 Alignment marking on the sensor

Check the radial distance with a distance gauge and compensate for any possible misalignment of the stator by putting adjusting washers underneath or by adjusting the base of the stator. You can also use the central fastening screw on the sensor head for fine adjustments (setting range ±1.5 mm).

Measuring range	100 N·m ... 3 kN·m	5 kN·m/10 kN·m
Radial nominal distance in mm	1.0	1.2
Actuation distance range in mm	0.3 ... 1.8	0.3 ... 2.2

Fig. 5.12 Radial nominal distance for the magnetic speed measuring system

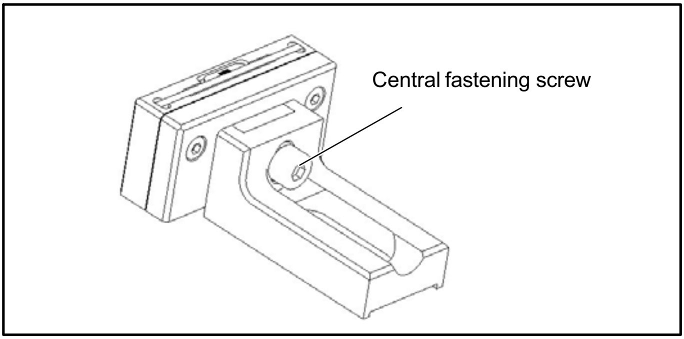


Fig. 5.13 Central fastening screw on the sensor head

1. Loosen the fastening screw (do not remove it!).
2. Set nominal distance a.
3. Tighten the screw at approx. 3 N·m.
4. Check the radial distance once again with a distance gauge.

5.9.2 Optical speed measuring system

Axial alignment

There are markers in the optical sensor for axial alignment (orientation lines). When installed, the slotted disc should be exactly above these alignment lines. Divergence of up to ±2 mm is permissible in measuring mode (total of static and dynamic shift).

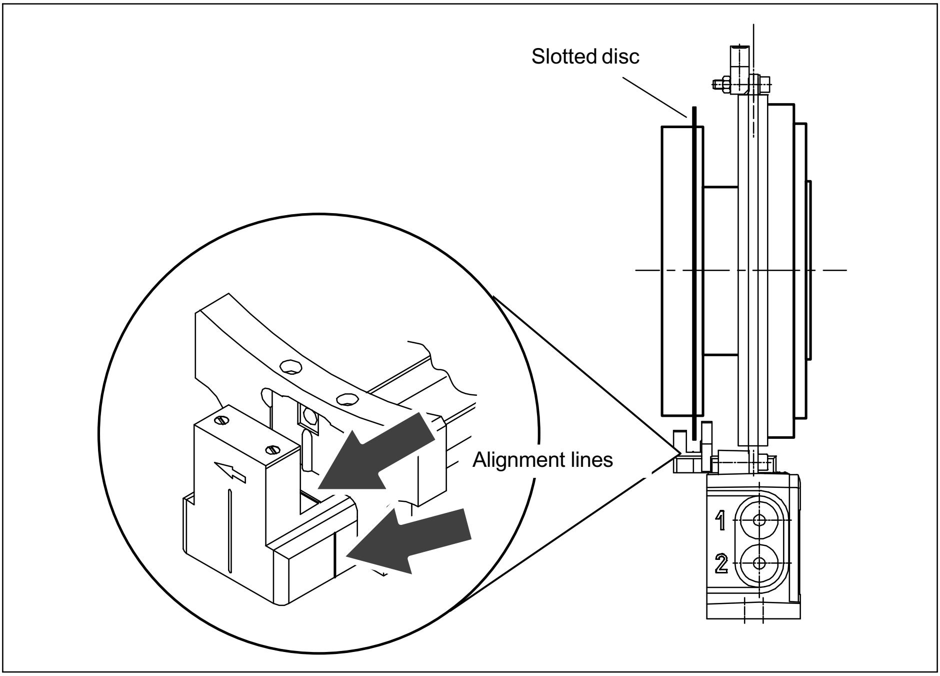


Fig. 5.14 Position of the slotted disc in the speed sensor

Radial alignment

The rotor axis and the optical axis of the speed sensor must be along a line at right angles to the stator platform. A vertical marker line on the head of the sensor serves as an orientation guide.

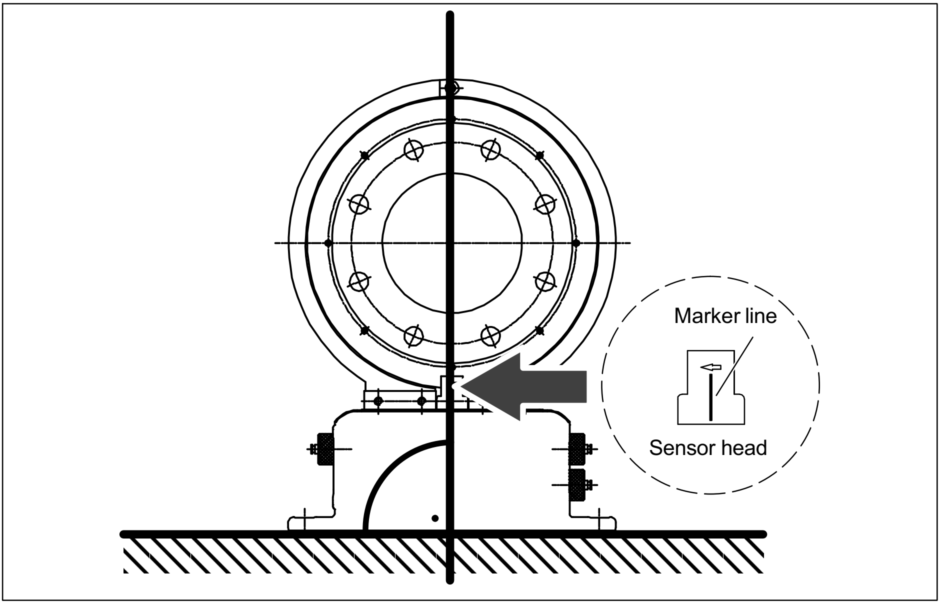


Fig. 5.15   Alignment marking on the sensor

6 Electrical connection

6.1 General information

To make the electrical connection between the torque transducer and the amplifier, we recommend using shielded, low-capacitance measurement cables from HBM.

With cable extensions, make sure that there is a proper connection with minimum contact resistance and good insulation. All plug connections or swivel nuts nuts must be fully tightened.

Do not route the measurement cables parallel to power lines and control circuits. If this cannot be avoided (in cable pits, for example), maintain a minimum distance of 50 cm and also draw the measurement cable into a steel tube.

Avoid transformers, motors, contactors, thyristor controls and similar stray-field sources.

Important

Transducer connection cables from HBM with attached connectors are identified in accordance with their intended purpose (Md or n). When cables are shortened, inserted into cable ducts or installed in control cabinets, this identification can get lost or become concealed. If this is the case, it is essential for the cables to be re-labeled!

6.1.1 FCC and IC compliant installation for US and Canada installation only

Use of EMI suppressor

To suppress high frequencies a EMI suppressor on the power cable has to be used. Use at least 3 loops of the cable.

Fastening must be done in an area not subject to mechanical loads (i.e. no unwanted vibrations, etc.) using cable ties fit for the specific application.

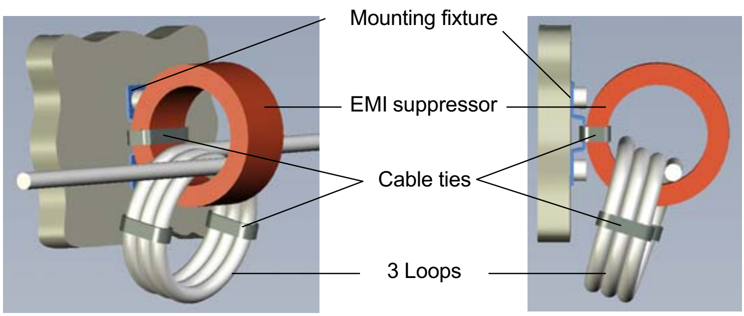


Fig. 6.1 Installation example EMI suppressor

Information

Consider longer cable of approximately 40 cm due to the installation of the EMI suppressor.

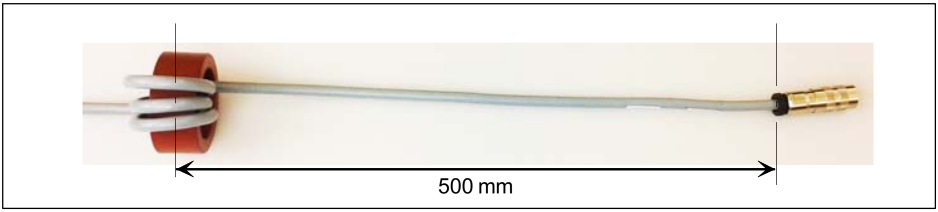


Fig. 6.2 Max. distance of EMI suppressor to connector

If the EMI suppressor has to be removed for any purpose (e.g. for maintenance), it must be replaced on the cable. Use only EMI suppressor of the correct type.

Type: Vitroperm R
Model No.: T60006-22063W517
Size: external diameter x internal diameter x height = 63 x 50 x 25

The installation requires a EMI suppressor to be added to the cable. Additional fixture should be used to prevent stress on the connector due to extra weight of the cable.

Important

The use of the EMI suppressor on the power cable (plug 1 or plug 3) is mandatory to ensure compliance with FCC regulations.

6.2 Shielding design

The cable shield is connected in accordance with the Greenline concept. This encloses the measurement system (without the rotor) in a Faraday cage. It is important that the shield is laid flat on the housing ground at both ends of the cable. Any electromagnetic interference active here does not affect the measurement signal. Special electronic coding methods are used to protect the transmission path and the rotor from electromagnetic interference.

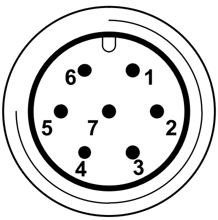
In the case of interference due to potential differences (compensating currents), operating voltage zero and housing ground must be disconnected on the amplifier and a potential equalization line established between the stator housing and the amplifier housing (copper conductor, 10 mm^2 wire cross-section).

If potential differences arise between the rotor and the stator on the machine, perhaps due to unchecked leakage, and this causes interference, it can usually be overcome by connecting the rotor directly to ground, for instance by a wire loop. The stator should be fully grounded in the same way.

6.3 Option 2, code KF1

The stator housing has a 7-pin (Binder 723) device connector, to which you link the connection cable for voltage supply and torque signal.

Binder 723



Top view

Conn. Binder Pin	Assignment	Wire color	MS3106 conn. Pin
1	Supply voltage zero	wh	A
2	No function	bk	B
3	Pre-amplifier supply voltage (+15 V)	bu	C
4	Torque measurement signal (12 V_{PP}; 5...15 kHz)	rd	D
5	No function		
6	Rotor excitation voltage (54 V/80 V_{PP}; approx.15 kHz)	gn	F
7	Rotor excitation voltage (0 V)	gy	G
	Shielding connected to housing ground		

6.3.1 Adaptation to the cable length

The transmission method between the rotor and the stator determines the function of the torque flange, which is dependent on:

- the installation situation (for example, covering, area free of metal parts)
- the length of the cable

- the tolerances of the excitation voltage supply

To allow for adaptation to the various conditions, there are three switches in the stator housing, which can be accessed by removing the stator cover (*see Fig. 6.3*).

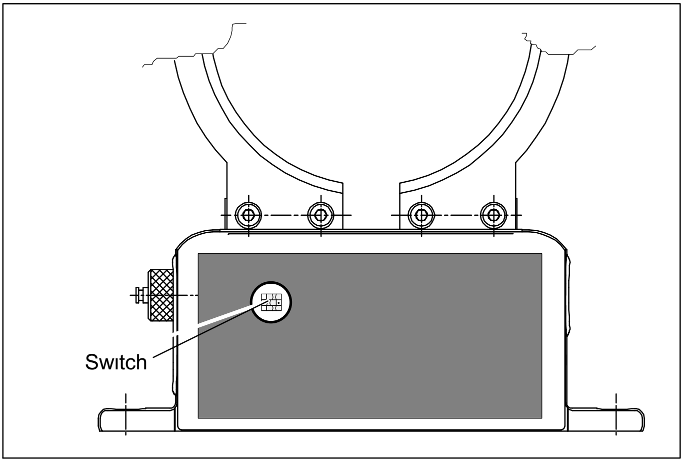
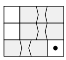
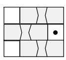
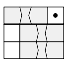


Fig. 6.3 Switches in the stator housing

Switch position		Example applications
1		a) Older amplifiers b) For when the calibration signal is unintentionally initiated with very short cables
2		Normal position (factory setting)
3		For cable lengths in excess of approx. 20 m

Please ensure that after changing to switch position 3, the calibration signal is not initiated.

Possible faults and their elimination

Fault: No signal at the output, amplifier indicates overflow.

Cause: Too little power, T10FS disconnects.

Remedy: Switch position 3.

Fault: The calibration signal has been triggered by mistake.

Remedy: Switch position 1.

6.4 Option 2, code SF1/SU2

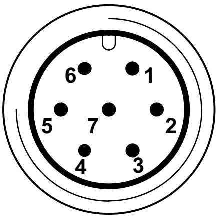
On the stator housing, there are two 7-pin device connectors (Binder 723) and in the case of the speed module option, there is also an 8-pin device connector, assigned in accordance with the selected option.

The supply voltage and the calibration signal of connectors 1 and 3 are direct-coupled via multifuses (automatically resetting fuses).

Assignment for connector 1

Voltage supply and frequency output signal.

Binder 723



Top view

Binder conn. Pin	Assignment	Wire color	Sub-D conn. Pin
1	Torque measurement signal (frequency output; 5 V[1]; 0 V) M	wh	13
2	Supply voltage 0 V; B	bk	5
3	Supply voltage 18 V to 30 V	bu	6
4	Torque measurement signal (frequency output; 5 V[1]/12) V)	rd	12
5	Measurement signal 0 V; M symmetrical	gy	8
6	Calibration signal trigger 5 V - 30 V	gn	14
7	Calibration signal 0 V; C	gy	8
	Shielding connected to housing ground		

1) Factory setting; complementary signals RS-422

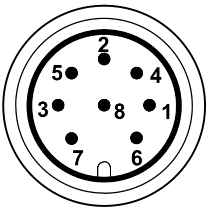
Important

The torque flanges of option 3, code SF1/SU2 are only intended for operation with a DC supply voltage. They must not be connected to older HBM amplifiers with square-wave excitation. This could lead to the destruction of the connection board resistances, or other errors in the measuring amplifiers (the torque flange, on the other hand, is protected and once the proper connections have been re-established, is ready for operation again).

Assignment 1 connector 2

Speed measuring system

Binder 723



Top view

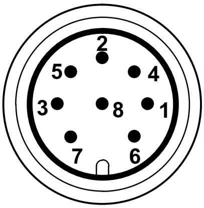
Conn. Binder Pin	Assignment	Wire color	Sub-D conn. Pin
1	Speed measurement signal (pulse string, 5 V[1]; 0°)	rd	12
2	No function	-	-
3	Speed measurement signal (pulse string, 5 V[1]; phase-shifted by 90 °)[2]	gy	15
4	No function	-	-
5	No function	-	-
6	Speed measurement signal (pulse string, 5 V[1]; 0°)	wh	13
7	Speed measurement signal (pulse string, 5 V[1]; phase-shifted by 90 °)[2]	gn	14
8	Supply voltage zero	bk	8
	Shielding connected to housing ground		

1) RS422 complementary signals
2) When switching to double frequency, static direction of rotation signal.

Assignment 2 connector 2

Speed measuring system with reference pulse

Binder 723



Top view

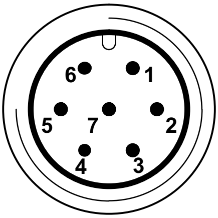
Conn. Binder Pin	Assignment	Wire color
1	Speed measurement signal (pulse string, 5 V[1]); 0 °)	rd
2	Reference signal (1 pulse/rev., 5 V[1])	bu
3	Speed measurement signal (pulse string, 5 V[1]; phase-shifted by 90 °)[2])	gy
4	Reference signal (1 pulse/rev., 5 V[1]))	bk
5	No function	
6	Speed measurement signal (pulse string, 5 V[1]; 0 °)	wh
7	Speed measurement signal (pulse string, 5 V[1]; phase-shifted by 90 °)[2]	gn
8	Supply voltage zero	ye
	Shielding connected to housing ground	

1) RS422 complementary signals
2) When switching to double frequency, static direction of rotation signal.

Assignment for connector 3

Voltage supply and voltage output signal.

Binder 723



Top view

Conn. Binder Pin	Assignment
1	Torque measurement signal (voltage output; 0 V M)
2	Supply voltage 0 V; B
3	Supply voltage 18 V to 30 V DC
4	Torque measurement signal (voltage output; ±10 V)
5	No function
6	Calibration signal trigger 5 V - 30 V
7	Calibration signal 0 V; C
	Shielding connected to housing ground

6.5 Supply voltage

The transducer must be operated with a separated extra-low voltage (18...30 V DC supply voltage), which usually supplies one or more consumers within a test bench.

Should the equipment be operated on a DC voltage network[1], additional precautions must be taken to discharge excess voltages.

The notes in this chapter relate to the standalone operation of the T10FS without HBM system solutions.

1) Distribution system for electrical energy with greater physical expansion (over several test benches, for example) that may possibly also supply consumers with high nominal (rated) currents.

The supply voltage is electrically isolated from signal outputs and calibration signal-inputs. Connect a separated extra-low voltage of 18 V ... 30 V to pin 3 (+) and pin 2 (B⊥) of connector 1 or 3. We recommend that you use HBM cable KAB 8/00-2/2/2 and relevant Binder sockets, that at nominal (rated) voltage (24 V) can be up to 50 m long and in the nominal (rated) voltage range, 20 m long (*see Accessories, Page 89*).

If the permissible cable length is exceeded, you can feed the supply voltage in parallel over two connection cables (connectors 1 and 3). This enables you to double the permissible length. Alternatively an on-site power pack should be installed.

If you feed the supply voltage through an unshielded cable, the cable must be twisted (interference suppression). We also recommend that a ferrite element should be located close to the connector plug on the cable, and that the stator should be grounded.

Important

At the instant of power-up, a current of up to 2 A may flow, which could switch off power packs with electronic current limiters.

7 Calibration

The T10FS torque flange delivers an electrical calibration signal that can be switched at the amplifier end for measurement chains with HBM components. The measurement flange generates a calibration signal of about 50% of the nominal (rated) torque. The precise value is specified on the type plate. Adjust the amplifier output signal to the calibration signal supplied by the connected torque flange to adapt the amplifier to the measurement flange. To obtain stable conditions, the calibration signal should only be activated once the transducer has been warming up for 15 minutes.

Notice

The measurement flange should not be under load when the calibration signal is being measured, since the calibration signal is mixed additively.

Important

To maintain measurement accuracy, the calibration signal should be connected for no more than 5 minutes. A similar period is then needed as a cooling phase before triggering the calibration signal again.

7.1 Calibration Option 2, code KF1

Increasing the excitation voltage from $54V_{PP}$ to $80V_{PP}$ (pins 6 and 7, connector 1), triggers the calibration signal.

7.2 Calibration Option 2, code SF1/SU2

Applying a separated extra-low voltage of 5 V to pin 6 (+) and 7 (⏚) on connector 1 or 3 triggers the calibration signal.

The nominal (rated) voltage for triggering the calibration signal is 5 V (triggered when U>2.7 V). The trigger voltage is electrically isolated from the supply voltage and the measurement voltage. The maximum permissible voltage is 30 V. When voltages are less than 0.7 V, the measurement flange is in measuring mode. Current consumption at nominal (rated) voltage is approx. 2mA and at maximum voltage is approx. 22 mA.

Notice

In the case of HBM system solutions, the measuring amplifier triggers the calibration signal.

8 Settings

Notice

You will find a table containing all the relevant switch positions on the back of the stator cover. Changes to the factory settings should be noted or entered here using a waterproof felt-tip pen.

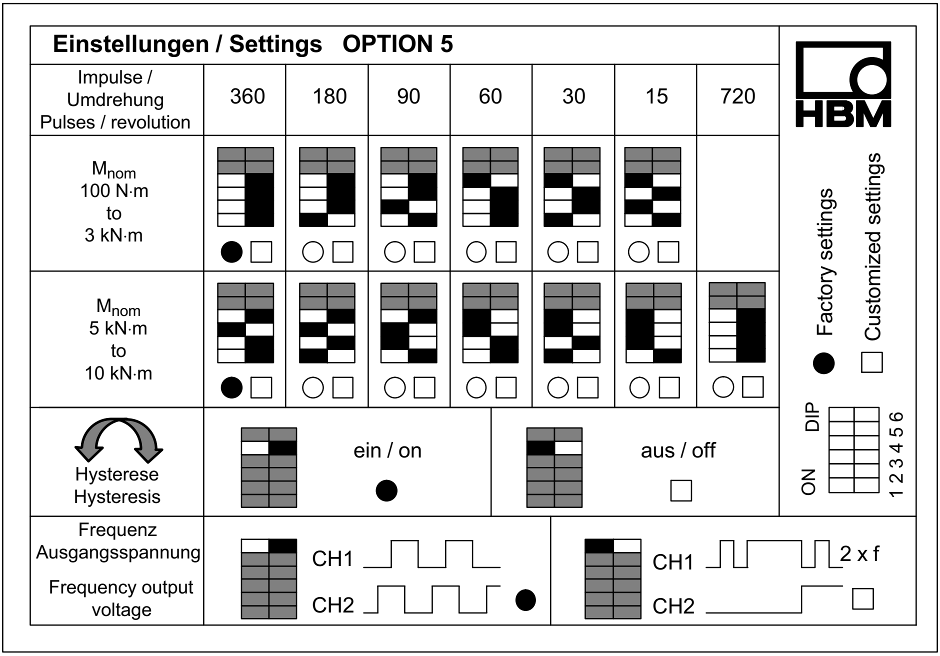


Fig. 8.1 Sticker with switch positions; optical speed measuring system

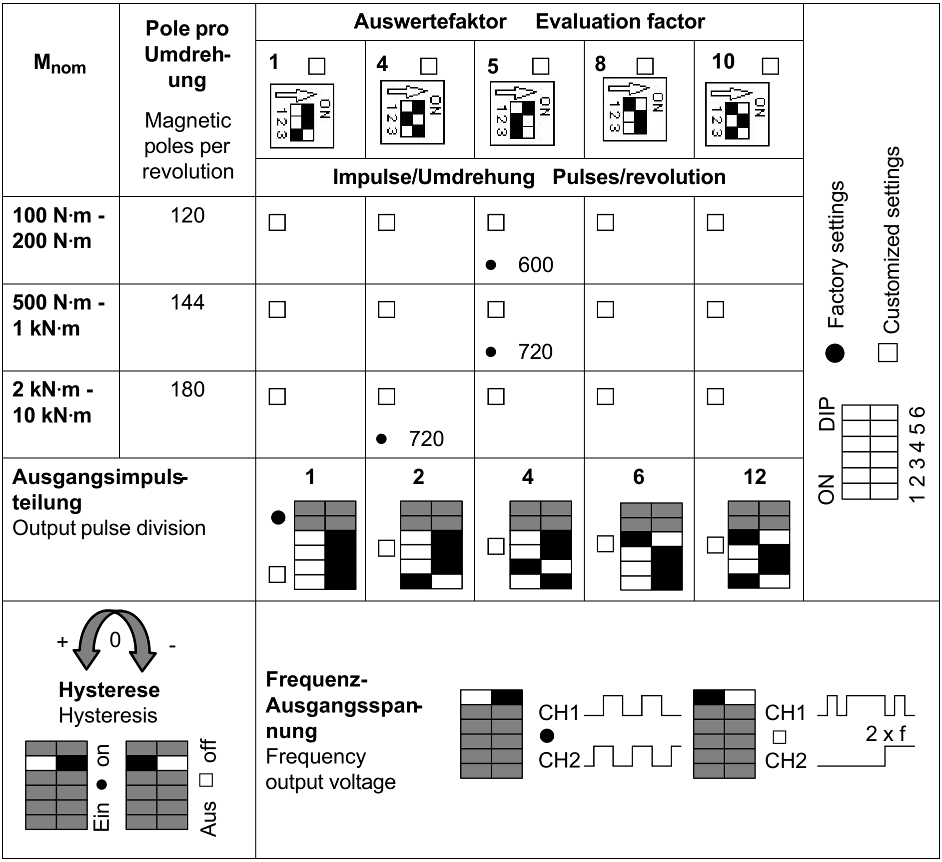


Fig. 8.2 Sticker with switch positions; magnetic speed measuring system

All adjustable pulse counts for the magnetic speed measuring system can be found in *Fig. 8.8, Page 67*). Please note all changes to the factory settings on the sticker.

8.1 Torque output signal, code KF1

The factory setting for the frequency output voltage is 12 V (asymmetrical). The frequency signal is on pin 4 opposite pin 1. It is not possible to change over.

8.2 Torque output signal, code SF1/SU2

The factory setting for the frequency output voltage is 5 V (symmetrical, complementary RS-422 signals). The frequency signal is on pin 4 opposite pin 1. You can change the output voltage to 12 V (asymmetrical). To do this, change switches S1 and S2 to position 1 (and pin 1 → M).

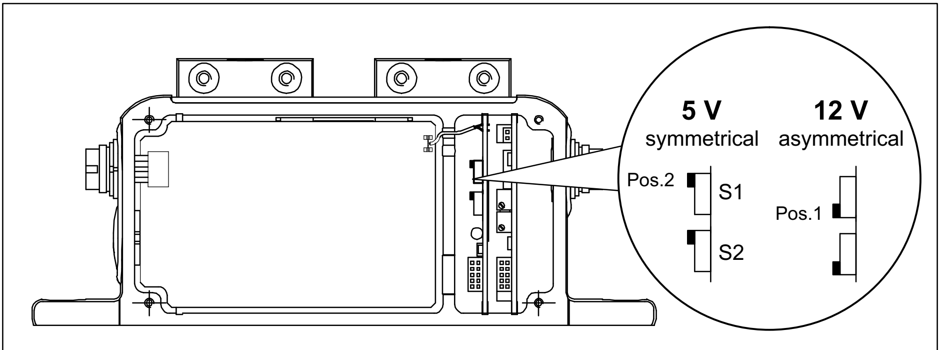


Fig. 8.3 Switch for changing the frequency output voltage

8.3 Setting up the zero point

In the case of the torque flange with the voltage output option (SU2), you can access two potentiometers by removing the stator cover. You can use the zero point potentiometer to correct zero point deviations caused by the installation. The balancing range is a minimum of ±400 mV at nominal (rated) gain. The end point potentiometer is used for compensation at the factory and is capped with varnish so that it cannot be turned unintentionally.

Important

Turning the end point potentiometer changes the factory calibration of the voltage output.

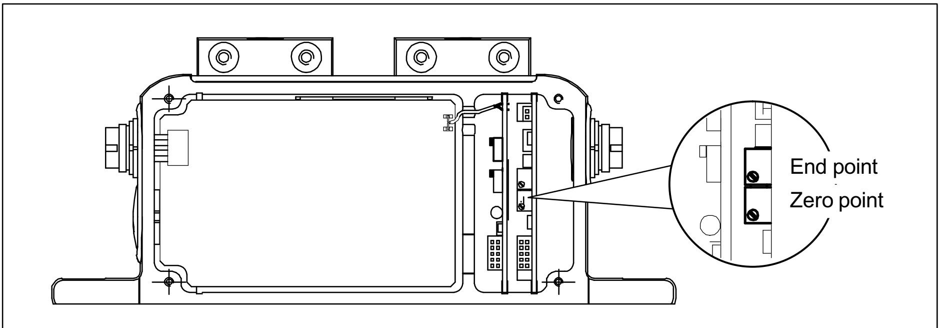


Fig. 8.4 Setting the voltage output zero point

8.4 Functional testing

8.4.1 Power transmission

If you suspect that the transmission system is not working properly, you can remove the stator cover and test for correct functioning. If the LED is on, the rotor and stator are properly aligned and there is no interference with the transmission of measurement signals. When the calibration signal is triggered, the LED shines more brightly.

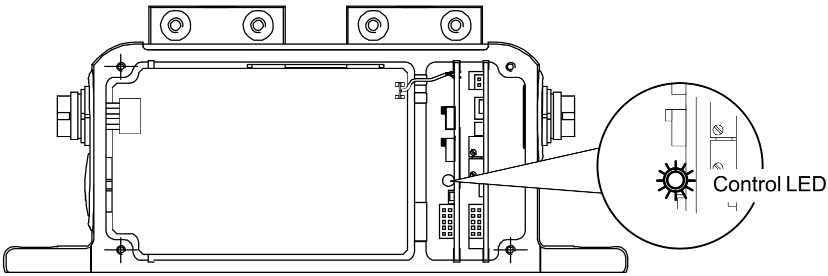


Fig. 8.5 Power transmission function test

8.4.2 Testing the optical speed module

When required, you can test the correct functioning of the speed measuring system.

- Remove the cover of the stator housing.
- Turn the rotor by at least 2 min^{-1}.

If both the control LEDs come on while you are turning the rotor, the speed measuring system is properly aligned and fully operational.

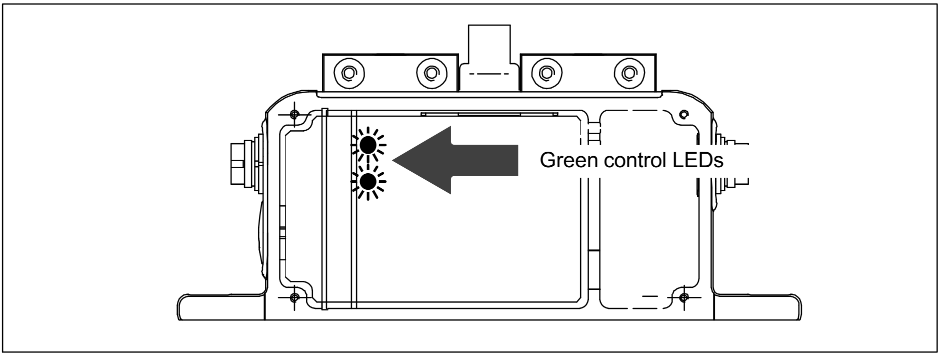


Fig. 8.6 Control LEDs of the speed measuring system

Important

When closing the cover of the stator housing, make sure that the internal connection cables are positioned in the grooves provided and are not trapped.

8.5 Setting the pulse count

8.5.1 Magnetic speed measuring system

With the magnetic speed measuring system, a magnetized rotor is sampled by means of an MR sensor (magnetoresistive sensor). The sensor produces two sinusoidal signals offset by 90°, from which up to 10 evaluation points can be generated per pole (can be adjusted with switches F1 ... F3). The output pulses can again be divided by means of the subsequent electronic system (switches S1 ... S4), thus making available a greater selection of output pulse counts per revolution (*see Fig. 8.8*).

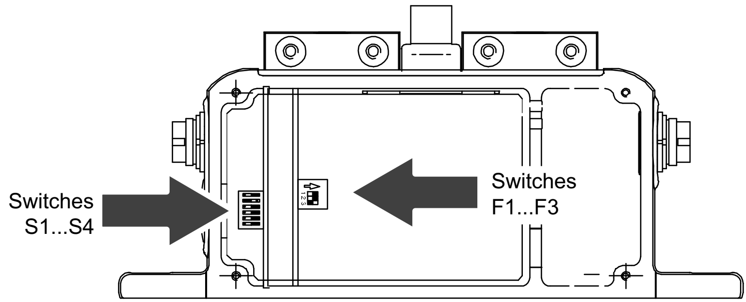
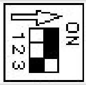
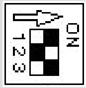
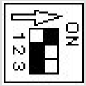
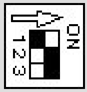
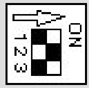
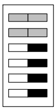
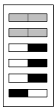
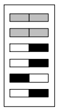
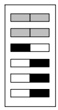
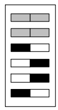


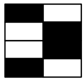
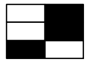
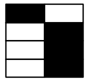
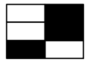
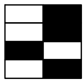
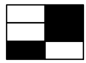
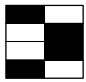
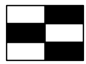
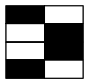
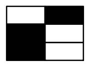
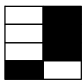
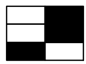
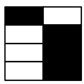
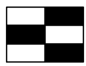
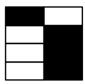
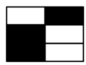
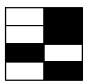
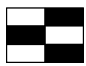
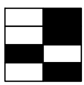
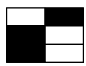
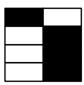
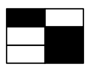
Fig. 8.7 Setting the pulse count; magnetic speed measuring system

M_{nom}	Poles per revolution	Evaluation factor				
		1 	4 	5 	8 	10 
		Pulses/revolution				
100 N·m-200 N·m	120	☐	☐	☐ ● 600	☐	☐
500 N·m-1 kN·m	144	☐	☐	☐ ● 720	☐	☐
2 kN·m-10 kN·m	180	☐	☐ ● 720	☐	☐	☐

Tab. 8.1 Evaluation points per pole (• = factory setting)

Output pulse division (6x DIP switches)	1	2	4	6	12
on	 ● ☐	 ○ ☐	 ○ ☐	 ○ ☐	 ○ ☐

Tab. 8.2 Switch settings for output pulse division (• = factory setting)

Output pulses/revolution			Switch position	
100 N·m / 200 N·m	**500 N·m / 1 kN·m**	**2 kN·m ... 10 kN·m**	**S1 ... S4**	**F1 ... F3**
10	12	15	4  1	1  3
20	24	30		
30	36	45		
40	48	60		
50	60	75		
60	72	90		
80	96	120		
100	120	150		
120	144	180		
150	180	225		
160	192	240		

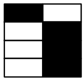
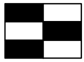
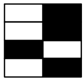
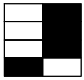
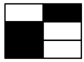
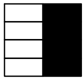
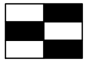
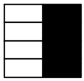
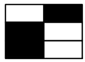
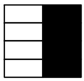
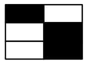
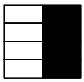
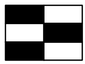
Output pulses/revolution			Switch position	
100 N·m / 200 N·m	**500 N·m / 1 kN·m**	**2 kN·m ... 10 kN·m**	**S1 ... S4**	**F1 ... F3**
200	240	300		
240	288	360		
300	360	450		
480	576	720*)		
600 1)	720 1)	900		
960	1152	1440		
1200	1440	1800		

Fig. 8.8 Switch settings for pulse count/revolution (■ ≙ switch lever)

1) Factory setting

The output pulse count is calculated according to the following formula:

$$\text{output pulse count} = \frac{\text{magnetic poles} \cdot \text{evaluation point per pole}}{\text{output pulse division}}$$

Notice

Please make sure that when you change the pulse count, you also change the pulse duration!
We recommend giving preference to the output pulse counts selected by switches F1...F3. By using pulse division (switches S1...S4), it is possible to increase the pulse tolerance stated in the specifications.
Other quantities, such as the eccentricity and the relative movement between the rotor and the stator can affect the pulse tolerance.

8.5.2 Optical speed measuring system

Notice

The factory setting is 360 pulses/revolution. Please make sure that when you change the pulse count, you also change the pulse duration!

$$\text{pulse duration} = \frac{1}{2 \cdot \text{pulse count} \cdot \text{speed}}$$

The number of pulses per rotor revolution can be adjusted by means of DIP switches S1 ... S4.

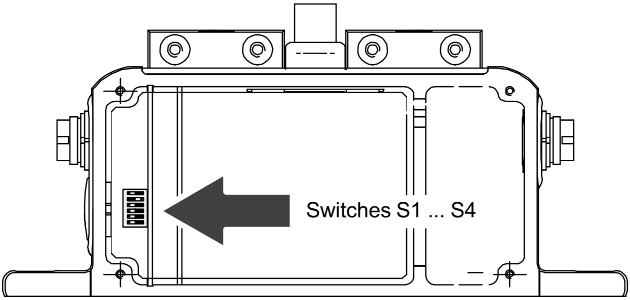
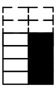
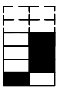
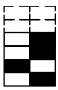
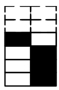
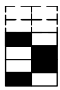
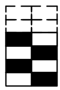
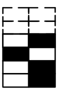
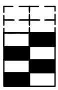
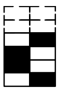
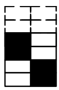
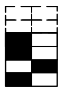
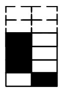
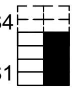


Fig. 8.9 Switches for setting the pulse count

Setting the pulse count

► Remove the stator cover.

► Use switches S1 ... S4 as per *Tab. 8.3* to set the required pulse count.

Pulses/revolution	360[1)]	180	90	60	30	15	720
Rated torque 100 N·m ... 3 kN·m	S4  S1						
Rated torque 5 kN·m ... 10 kN·m	S4  S1						S4  S1

Tab. 8.3 Switch settings for the pulse count
(■ ¢ switch lever)

1) Factory setting

8.6 Vibration suppression (hysteresis)

Low rotation speeds and higher relative vibrations between the rotor and the stator can cause disturbance signals that reverse the direction of rotation. Electronic suppression (hysteresis) to eliminate these disturbances is connected at the factory. Disturbances caused by the radial stator vibration amplitude and by the torsional vibration of the rotor are suppressed.

		Speed measuring system	
		magnetic	**optical**
Radial stator vibrations, approx.	mm	1	2
Torsional rotor vibrations, approx.	Deg.	1	2

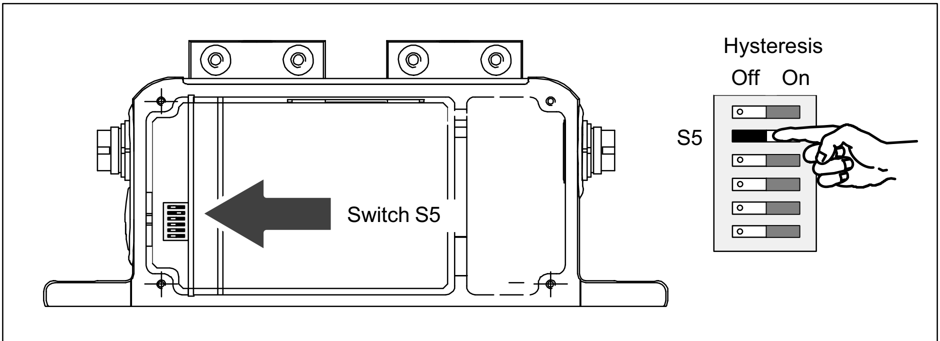


Fig. 8.10 Switch for switching off hysteresis

8.7 Form of speed output signal

In the factory setting, two 90° phase-offset speed signals (5 V symmetrical, complementary RS-422 signals) are available at the speed output (connector 2). You can double the pulse count set in each case by moving switch S6 to the “On" position. Pin 3 then outputs the direction of rotation as a static direction of rotation signal (pin 3 = +5 V, pin 7 = 0 V compared to pin 8), if the shaft turns in the direction of the arrow). At a speed of 0 min^{-1}, the direction of rotation signal has the last measured value.

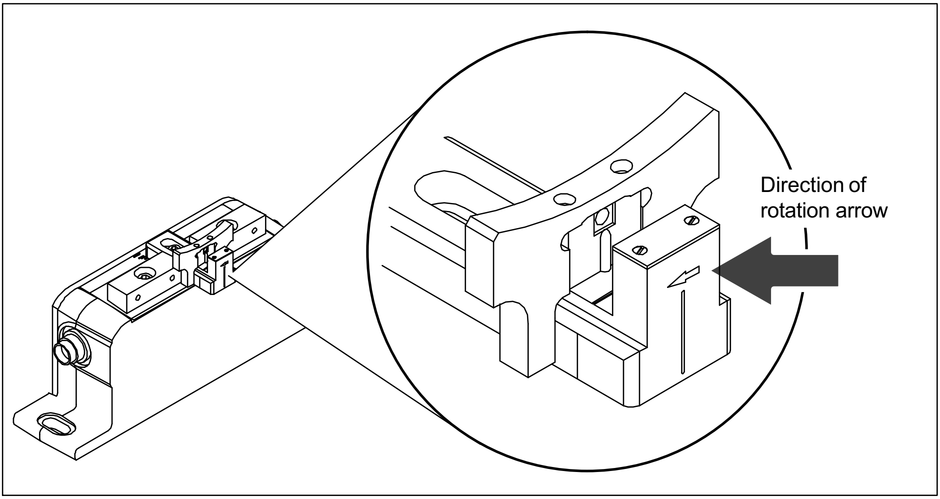


Fig. 8.11 Direction of rotation arrow on the head of the sensor

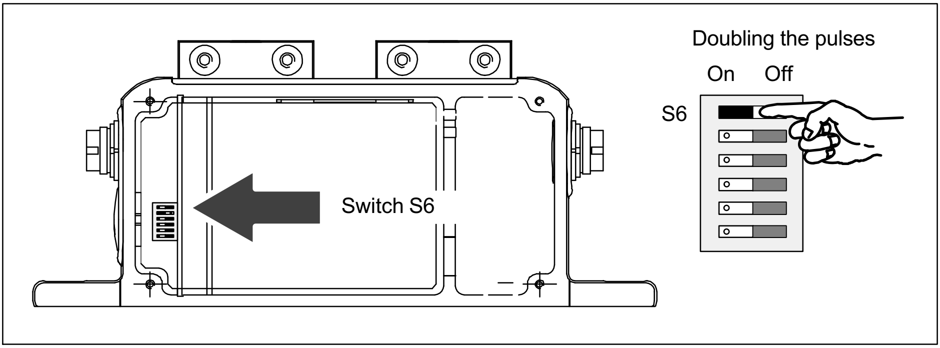


Fig. 8.12 Switch for doubling the pulses

8.8 Type of speed output signal

You can use switch S7 to change the symmetrical 5 V output signal (factory setting) to an asymmetrical signal of 0 V ... 5 V.

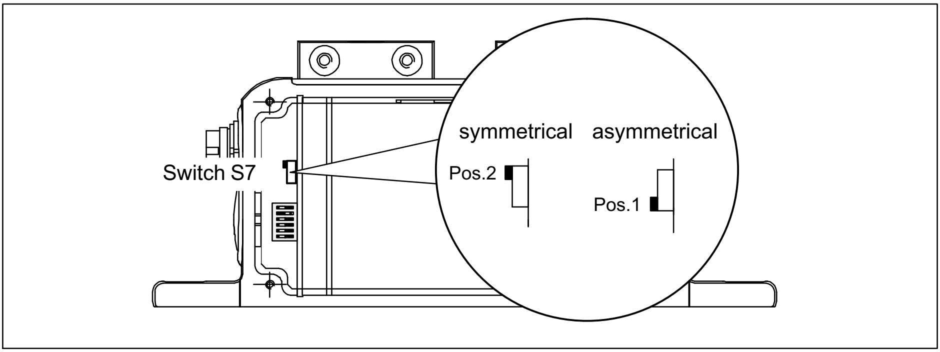


Fig. 8.13 Switch S7; symmetrical/asymmetrical output signal

8.9 Optical speed measuring system with a reference pulse

In the case of the reference pulse option, a magnet is integrated into the slotted disc of the speed measuring system, that generates a pulse at each full revolution of the rotor. The pulse can be picked up at connector 2 (*see Page 52*).

The reference pulse is synchronized with the speed output signal (5 V[1]), 0°) and is output if the reference marker is passed and a rising edge occurs during the speed signal.

The pulse length corresponds to the length of a speed increment, which depends on the chosen pulse count and speed (*for the calculation, see Page 64*).

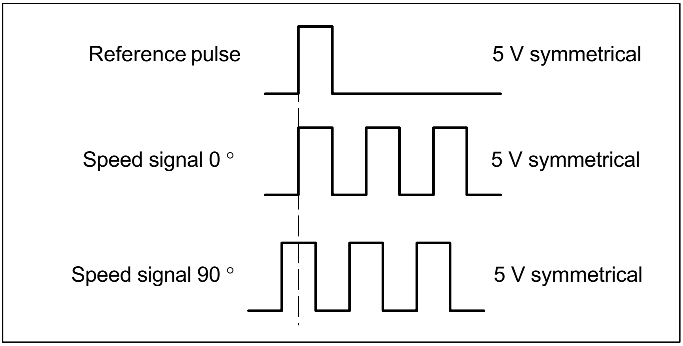


Fig. 8.14 Electrical condition of the reference pulse

When the speed measuring system and the reference pulse are properly synchronized, LED L4 flashes (minimum speed 2 min^{-1}) and stays on permanently from approx. 1000 min^{-1}. If the LED is *not* on, please change switch S8 (*see Fig. 8.15*).

1) RS-422 complementary signals

Important

When viewed from above, switch S8 is behind switch S7 in the opened stator housing.

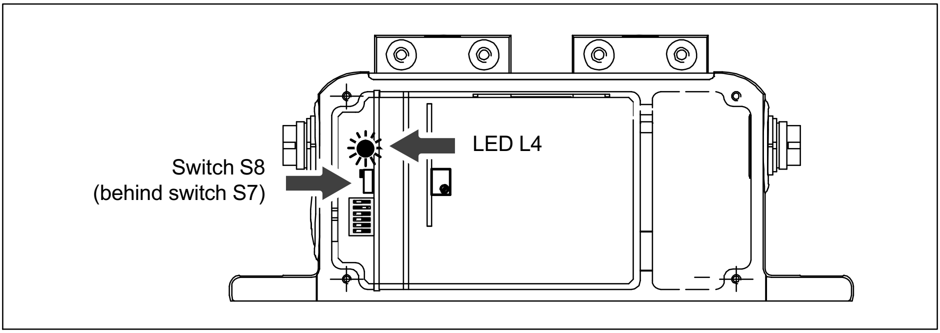


Fig. 8.15 Switch S8; optimizing the reference pulse

9 Loading capacity

Nominal torque can be exceeded statically up to the limit torque. If the nominal torque is exceeded, additional irregular loading is not permissible. This includes longitudinal forces, lateral forces and bending moments. Limit values can be found in the “Specifications" chapter, on *Page 91*.

9.1 Measuring dynamic torque

The torque flanges can be used to measure static and dynamic torques. The following rule applies to the measurement of dynamic torque:

- The T10FM calibration made for static measurements is also valid for dynamic torque measurements.
- The natural frequency f_0 for the mechanical measuring system depends on the moments of inertia J_1 and J_2 of the connected rotating masses and the T10FM's torsional stiffness.

Use the equation below to approximately determine the natural frequency f_0 of the mechanical measuring arrangement:

$$f_0 = \frac{1}{2\pi} \cdot \sqrt{c_T \cdot \left(\frac{1}{J_1} + \frac{1}{J_2}\right)}$$

f_0	=	natural frequency in Hz
J_1, J_2	=	mass moment of inertia in $kg \cdot m^2$
c_T	=	torsional stiffness in N·m/rad

- The mechanical vibration bandwidth (peak-to-peak) must be no more than 200 % (measuring range 100 N ナ ·m 400 %; measuring range 3 ... 10 kN · m 160 %) of the nominal (rated) torque identified for the T10FS. The vibration bandwidth must fall within the loading bandwidth specified by $-M_{nom}$ and $+M_{nom}$ (at 100 N·m: $-2\ M_{nom}$ and $+2\ M_{nom}$ [1]). The same also applies to transient resonance points.

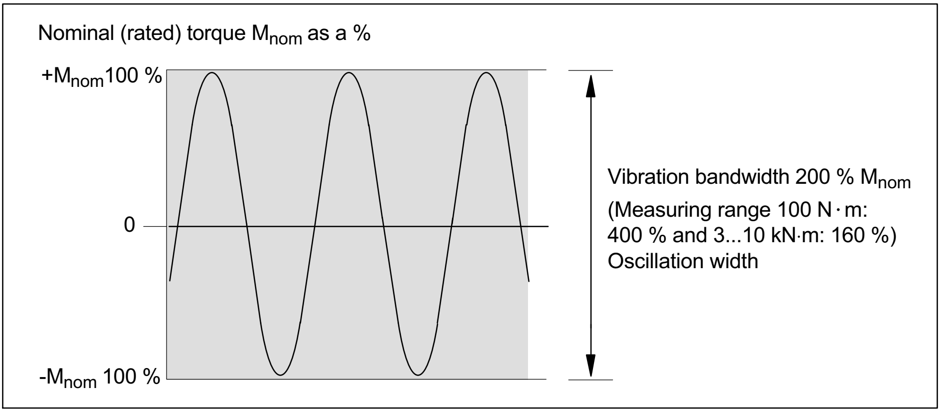


Fig. 9.1 Permissible dynamic loading

[1] Metrologically, however, the transducers can only be used up to the control range.

10 Maintenance

10.1 Torque flange maintenance

The torque measuring system is maintenance-free.

10.2 Speed module maintenance

10.2.1 Magnetic speed measuring system

The sensor head and the pole ring contain plastic components. You can clean these with a dry or spirit-impregnated cotton bud or cloth. Do not use any other solvent!

10.2.2 Optical speed measuring system

During operation and depending on the ambient conditions, the slotted disc of the rotor and the associated stator sensor optics can get dusty. This will become noticeable when the polarity of the display changes. Should this occur, the sensor and the slotted disc must be cleaned.

Use compressed air (up to 6 bar) to clean the slotted disc.

Carefully clean the optical system of the sensor with a dry cotton bud or one soaked with pure spirit. Do not use any other solvent!

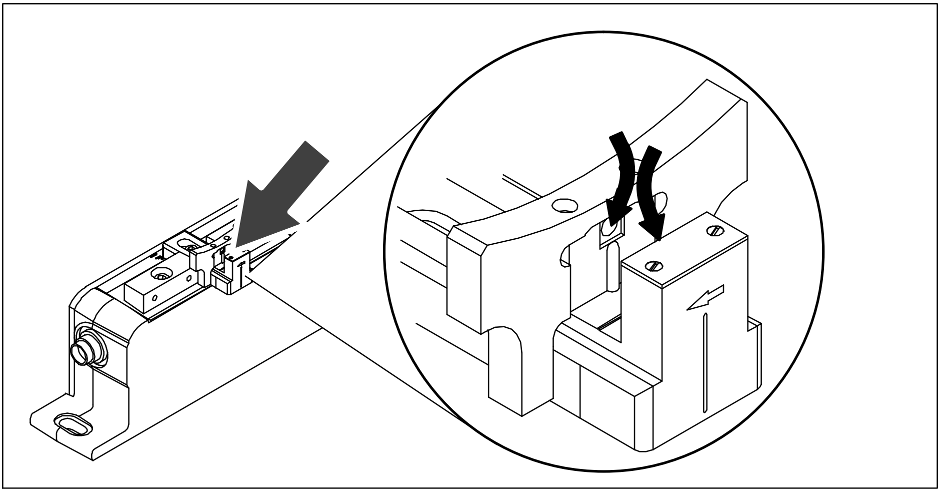
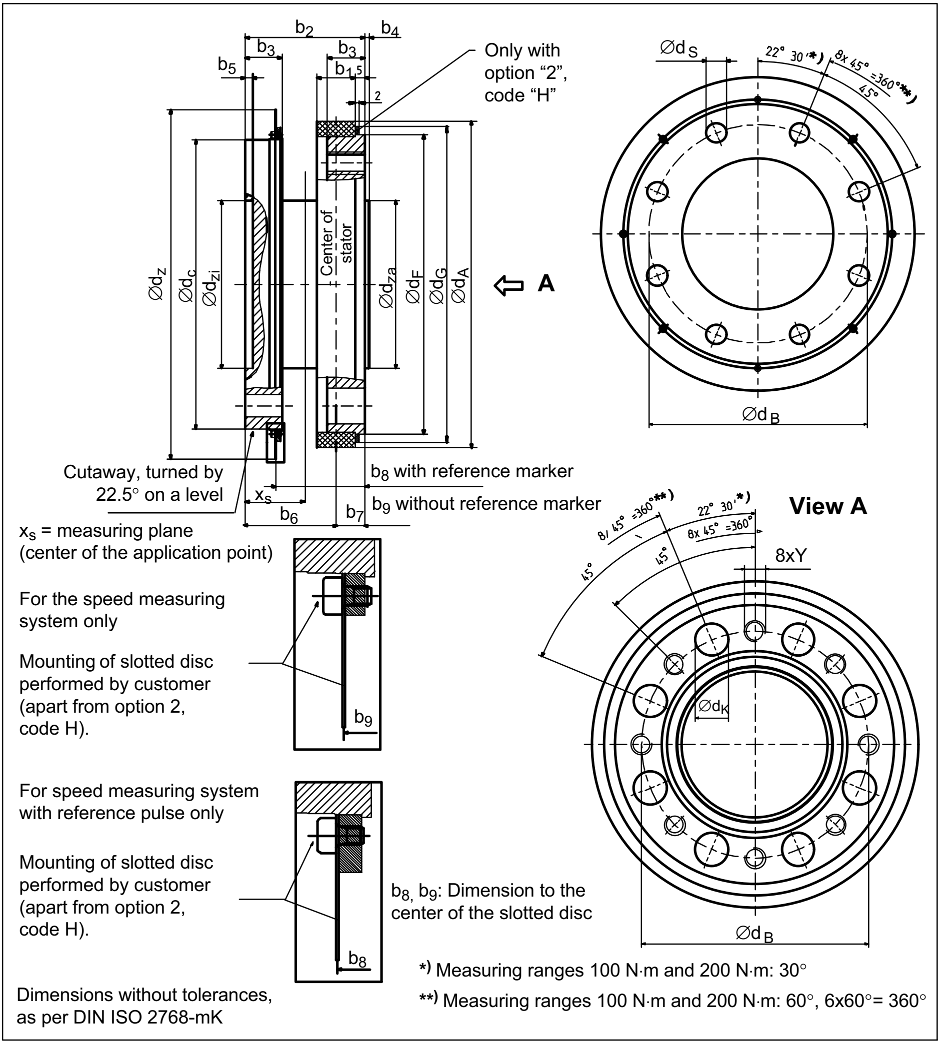


Fig. 10.1 Cleaning points on the optical speed sensor

11 Dimensions

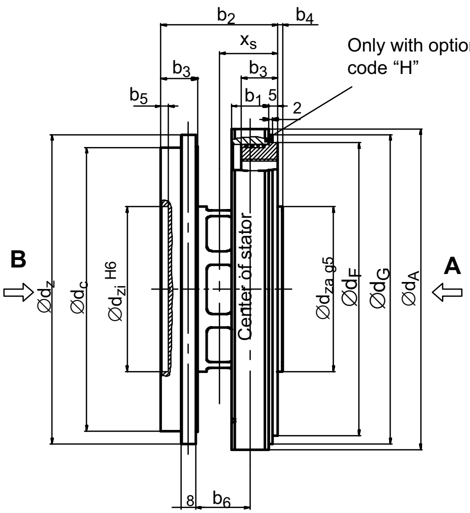
11.1 Rotor dimensions



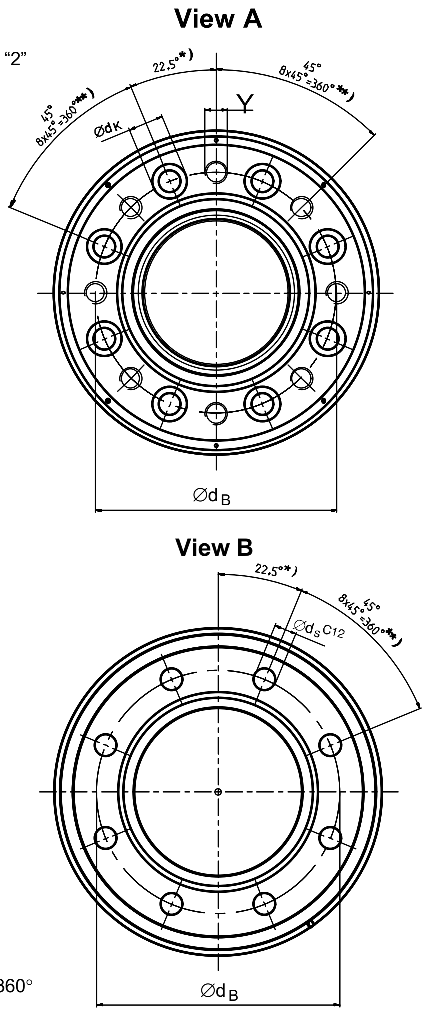
Measuring range	Dimensions (in mm; 1 mm = 0.03937 inches)										
	b_1	b_2	b_3	$b_{4+0.4}$	b_5	b_6	b_7	b_8	b_9	x_S	Y
100 N·m / 200 N·m	17.5	60	18	2	4	46.3	13.7	47.2	47.2	30	M8
500 N·m / 1 kN·m	17.5	60	18	2	4	46.3	13.7	45.5	45	30	M10
2 kN·m / 3 kN·m	20,5	64	20	2.5	4	48.8	15.2	47.5	47	32	M12
5 kN·m	22.5	84	26	2.8	3	67.8	16.2	62.7	62.7	42	M14
10 kN·m	28.5	92	30	3.5	4	72.8	19.2	66.7	66.7	46	M16

Measuring range	Dimensions (in mm; 1 mm = 0.03937 inches)									
	$\varnothing d_A$	$\varnothing d_B$	$\varnothing d_C$	$\varnothing d_F$	$\varnothing d_G$	$\varnothing d_K$	$\varnothing d_S$ ^{C12}	$\varnothing d_Z$	$\varnothing d_{za\ g5}$	$\varnothing d_{zi}$ ^{H6}
100 N·m / 200 N·m	119	84	99	101	110	14	8.2	131	57	57
500 N·m / 1 kN·m	139	101.5	120	124	133	17	10	151	75	75
2 kN·m / 3 kN·m	175	130	155	160	169	19	12	187	90	90
5 kN·m	209	155.5	180	188	-	22	14.2	221	110	110
10 kN·m	256	196	222	230	-	26	17	269	140	140

11.2 Rotor dimensions with the magnetic speed system



x_s = measuring plane (center of the application point)



Dimensions without tolerances, as per DIN ISO 2768-mK

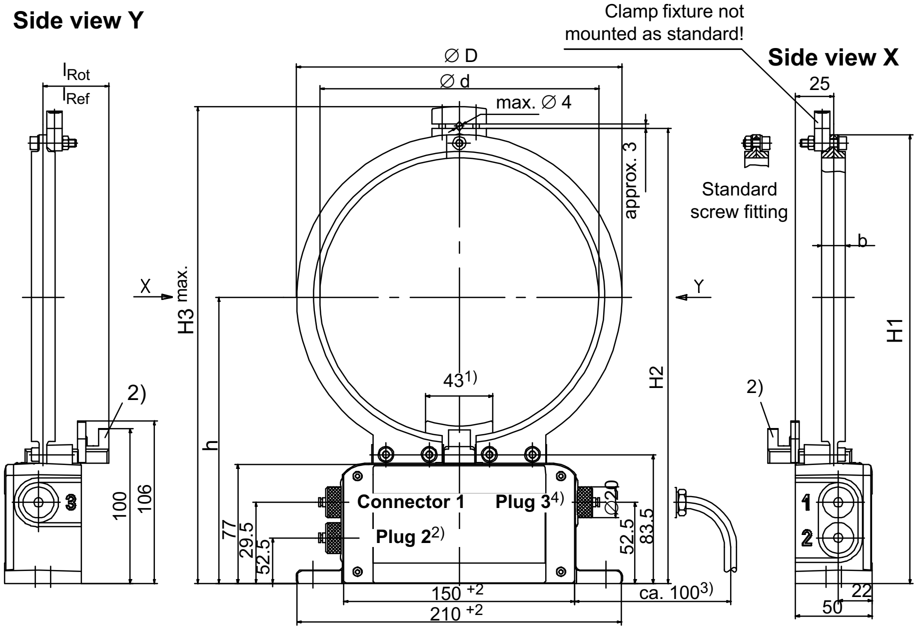
*) Measuring ranges 100 N·m and 200 N·m: 30°

**) Measuring ranges 100 N·m and 200 N·m: 60°, 6x60°= 360°

Measuring range	Dimensions (in mm; 1 mm = 0.03937 inches)							
	$\varnothing d_A$	$\varnothing d_B$	$\varnothing d_C$	$\varnothing d_F$	$\varnothing d_G$	$\varnothing d_K$	$\varnothing d_S^{C12}$	$\varnothing d_Z$
100 N·m 200 N·m	119	84	99	101	110	14	8,2	112.9
500 N·m 1 kN·m	139	101.5	120	124	133	17	10	132.9
2 kN·m 3 kN·m	175	130	155	160	169	19	12	168.9
5 kN·m	209	155.5	180	188	-	22	14,2	192.5
10 kN·m	256	196	222	230	-	26	17	239.7

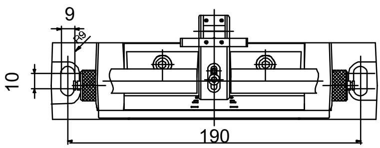
Measuring range	Dimensions (in mm; 1 mm = 0.03937 inches)									
	$\varnothing d_{za}$	$\varnothing d_{zi}$	b_1	b_2	b_3	$b_{4+0.4}$	b_5	b_6	x_S	Y
100 N·m 200 N·m	57	57	17.5	60	18	2	4	31	30	6xM8
500 N·m 1 kN·m	75	75	17.5	60	18	2	4	29	30	8xM10
2 kN·m 3 kN·m	90	90	20.5	64	20	2.5	4	30	32	8xM12
5 kN·m	110	110	22.5	84	26	2.8	3	44	42	8xM14
10 kN·m	140	140	28.5	92	30	3.5	4	45	46	8xM16

11.3 Stator dimensions



1) For option 5, code A only; otherwise 18mm
2) For the speed measuring system option only
3) Space for connection cable with connector
4) Does not apply to version KF1

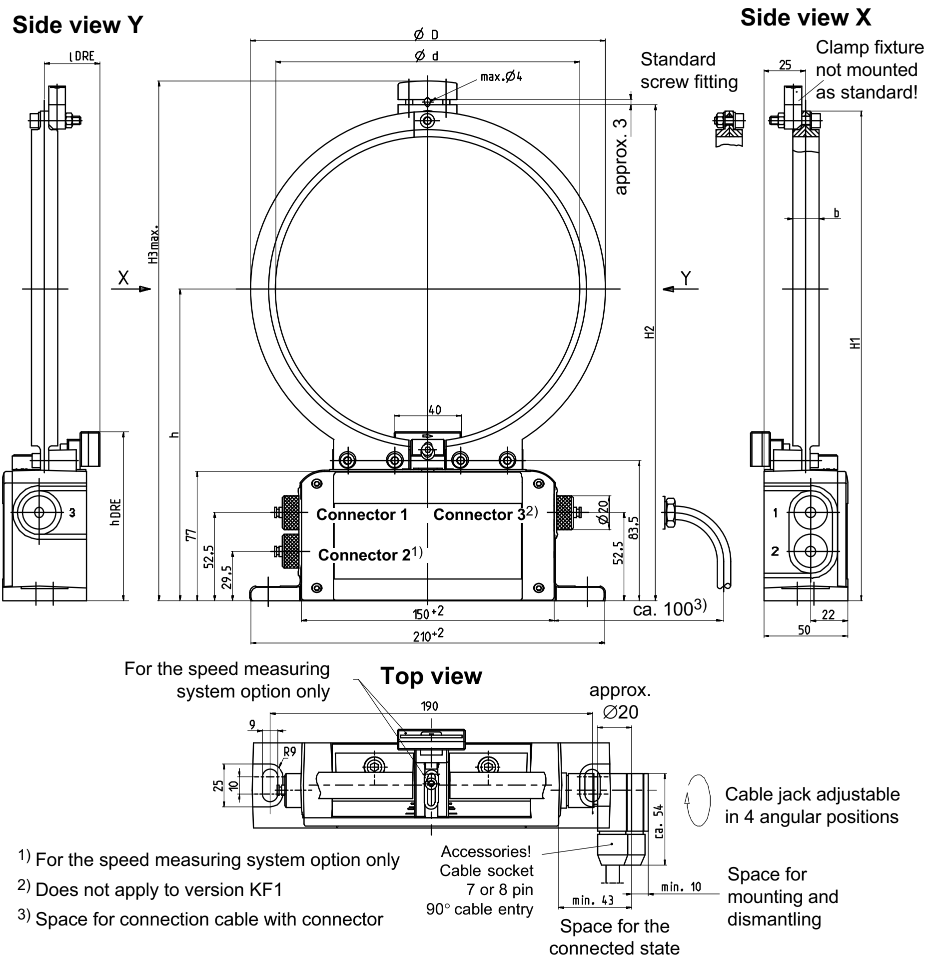
Top view



Accuracy of the cast base sizes as per DIN 1688-GTA 14/5

Measuring range	Dimensions (in mm; 1 mm = 0.03937 inches)								
	b	∅d	∅D	H1	H2	H3	h	l_{Rot}	l_{Ref}
100 N·m 200 N·m	17.5	125	155	235	239	253	157.5	42.5	42.5
500 N·m 1 kN·m	17.5	145	175	255	259	273	167.5	42	42.5
2 kN·m 3 kN·m	20.5	181	211	291	295	309	185.5	42.5	43
5 kN·m	22.5	215	245	324	329	343	202.5	57	57
10 kN·m	28.5	263	293	373	377	391	226.5	58	58

11.4 Stator dimensions with the magnetic speed system



1) For the speed measuring system option only

2) Does not apply to version KF1

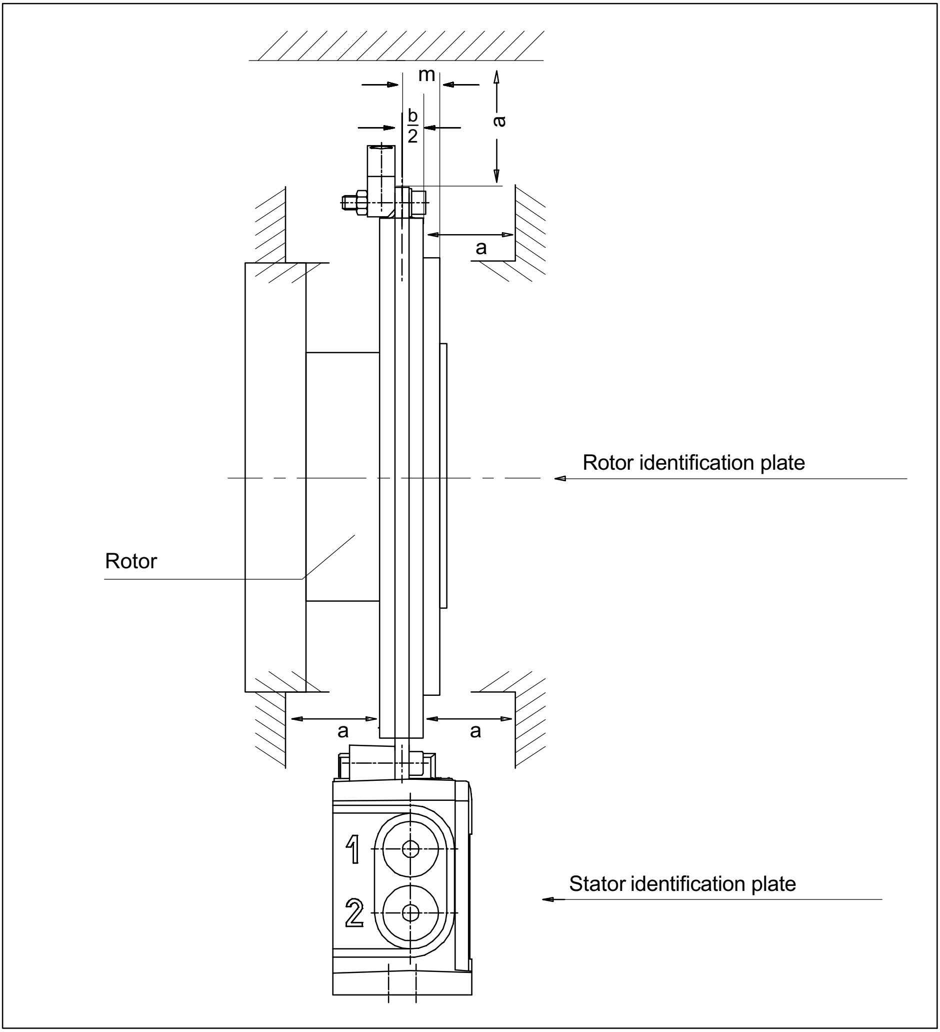
3) Space for connection cable with connector

Accuracy of the cast base sizes as per DIN 1688-GTA 14/5

Measuring range	Dimensions (in mm; 1 mm = 0.03937 inches)								
	b	∅d	∅D	H1	H2	H3	h	l_{ROT}	h_{ROT}[1)]
100 N·m 200 N·m	17.5	125	155	235	239	253	157.5	38	100
500 N·m 1 kN·m	17.5	145	175	255	259	273	167.5	36	100
2 kN·m 3 kN·m	20.5	181	211	291	295	309	185.5	37	100
5 kN·m	22.5	215	245	325	329	343	202.5	51	105.5
10 kN·m	28.5	263	293	373	377	391	226.5	52	105.5

1) Variable by ±1.5 mm at the head of the sensor

11.5 Mounting dimensions



Mounting dimensions			
Measuring range	Dim. "m" (mm)	Area free of metal parts (mm)	
		a	x
100 N·m 200 N·m	13.8	20	30
500 N·m 1 kN·m	13.8		28.5
2 kN·m 3 kN·m	15.3		28.5
5 kN·m	16.3		31.5
10 kN·m	19.3		34.5

12 Order numbers, accessories

Code	Option 1: Measuring range
100Q	100 N·m
200Q	200 N·m
500Q	500 N·m
001R	1 kN·m
002R	2 kN·m
003R	3 kN·m
005R	5 kN·m
010R	10 kN·m

Code	Option 2: Nominal (rated) speed
L	Nominal (rated) speed dependent on measuring range 8000 min^{-1} to 12000 min^{-1}
H	Nominal (rated) speed dependent on measuring range 12000 min^{-1} to 22000 min^{-1}

Code	Option 3: Electrical configuration
KF1	Output signal 10 kHz ±5 kHz, excitation voltage 14 kHz/54 V; square wave
SF1	Output signal 10 kHz ±5 kHz, supply voltage 18 ... 30 V DC
SU2	Output signal 10 kHz ±5 kHz and ±10 V, supply voltage 18 ... 30 V DC

Code	Option 4: Accuracy
S	Standard
G	Greater accuracy[1]; Lin. <±0.03% and TK_0 <±0.03 %

Code	Option 5: Speed measuring system [2]
0	No speed measuring system
1	With speed measuring system
A	With speed measuring system and reference pulse

Code	Option 6: Connection cable
V0	Without connection cable
V1	Torque connection cable for KF1, 423 free ends, 6m
V2*)	Torque connection cable for KF1, 423 free ends, max. 80 m
V3	Torque connection cable for KF1, 423 MS3106PEMV, 6m
V4*)	Torque connection cable for KF1, 423 MS3106PEMV, max. 80 m
V5	Torque connection cable for SF1/SU2, 423 D-Sub 15P, 6m
V6*)	Torque connection cable for SF1/SU2, 423 D-Sub 15P, max. 50 m
W1	Torque and speed, one cable each, 423 D-Sub 15P, 6m
W2*)	Torque and speed, one cable each, 423 D-Sub 15P, max. 50 m
W5	Torque and speed with reference pulse, one cable each, 423 free ends, 6 m
W6*)	Torque and speed with reference pulse, one cable each, 423 free ends, max. 50 m

Co	Option 7: Accessories
N	No accessories

1) For voltage output: Lin. <±0.05 %; TK_0 <±0.13 %

2) For option 3, code SF1, SU2 only

Order number:

K-T10FS - □□□□ - □ - □□□ - □ - □ - □□ - □ [ ] m*)

Ordering example:

K-T10FS - 5 0 0 Q - H - S F 1 - S - 0 - V 5 - N [ ] m*)

*) With selections V2, V4, V6, W2 and W6, please specify required length of cable.

Accessories, to be ordered separately

423G-7S, 7-pin cable socket, straight cable entry, for torque output (connectors 1, 3), Order No. 3-3101.0247

423W-7S, 7-pin cable socket, 90 ° cable entry, for torque output
(connectors 1, 3), Order No.: 3-3312.0281

423G-8S, 8-pin cable socket, straight cable entry, for speed output
(connector 2), Order No. 3-3312.0120

423W-8S, 8-pin cable socket, 90 ° cable entry, for torque output
(connector 2), Order No.: 3-3312.0282

Kab8/00-2/2/2 by the meter, Order No. 4-3301.0071

13 Specifications

Type		T10FS							
Accuracy class		0.05							
Torque measuring system									
Nominal (rated) torque M_{nom}	N·m	**100**	**200**	**500**	**1 k**	**2 k**	**3 k**	**5 k**	**10 k**
Nominal (rated) sensitivity (spread between torque = zero and nominal (rated) torque)									
Frequency output	kHz	5							
Voltage output	V	10							
Sensitivity tolerance (deviation of the actual output quantity at M_{nom} from the nominal (rated) sensitivity)									
Frequency output	%	±0.1							
Voltage output	%	±0.2							
Output signal at torque = zero									
Frequency output	kHz	10							
Voltage output	V	0							
Nominal output signal									
Frequency output									
at positive nominal (rated) torque	kHz	15 (5 V symmetrical[1]/12 V asymmetrical[2])							
at negative nominal (rated) torque	kHz	5 (5 V symmetrical[1]/12 V asymmetrical[2])							
Voltage output									
at positive nominal (rated) torque	V	+10							

Nominal (rated) torque M_{nom}	N·m	100	200	500	1 k	2 k	3 k	5 k	10 k
at negative nominal (rated) torque	V	-10							
Load resistance									
Frequency output	kΩ	≥2							
Voltage output	kΩ	≥5							
Long-term drift over 48 h									
Voltage output	mV	≤±3							
Measurement frequency range									
Voltage output	Hz	0 ... 1000 (-3 dB)							
Group delay									
Frequency output	ms	0.15							
Voltage output	ms	0.9							
Residual ripple									
Voltage output	mV	40 (peak-to-peak)							
Temperature effect per 10 K in the nominal (rated) temperature range									
on the output signal, related to the actual value of the signal spread									
Frequency output	%	<±0.05							
Voltage output	%	<±0.15							
on the zero signal, related to the nominal (rated) sensitivity									
Frequency output	%	<±0.05 (optional <±0.03)							
Voltage output	%	<±0.15 (optional <±0.13)							

Nominal (rated) torque M_{nom}	N·m	100	200	500	1 k	2 k	3 k	5 k	10 k
Maximum control range[3]									
Frequency output	kHz	4 ... 16							
Voltage output	V	-10.5 ... +10.5 (typ. ±11)							
Power supply (version KF1)									
Excitation voltage (square wave)	V	54±5% (peak-to-peak)							
Calibration signal triggering	V	80±5 %							
Frequency	kHz	approx. 14							
Max. current consumption	A	1 (peak-to-peak)							
Preamplifier excitation voltage	V	0/0/+15							
Preamplifier, max. current consumption	mA	0/0/+25							
Power supply (version SF1/SU2)									
Nominal (rated) supply voltage (separated extra-low voltage (SELV))	V_{DC}	18 ... 30; asymmetrical							
Current consumption in measuring mode	A	< 0.9							
Current consumption in startup mode	A	< 2							
Nominal (rated) power consumption	W	< 12							
Linearity deviation including hysteresis, relative to the nominal (rated) sensitivity									
Frequency output	%	<±0.05 (optional <±0.03)							
Voltage output	%	<±0.07 (optional <±0.05)							

Nominal (rated) torque M_{nom}	N·m	**100**	**200**	**500**	**1 k**	**2 k**	**3 k**	**5 k**	**10 k**
Rel. standard deviation of reproducibility									
according to DIN 1319, relative to the variation of the output signal									
Frequency output	%	< ±0.03	<±0.02						
Voltage output	%	<±0.03							
Calibration signal		approx. 50% of M_{nom}; more precise value on identification plate							
Tolerance of the shunt signal, related to M_{nom}	%	<±0.05							

1) RS-422 complementary signals; factory setting version SF1/SU2
2) Factory setting version KF1 (changeover not possible)
3) Output signal range in which there is a repeatable correlation between torque and output signal.

Specifications (continued)

Nominal (rated) torque M_{nom}	N·m	**100**	**200**	**500**	**1 k**
Magnetic speed measuring system					
Speed measuring system		Magnetic, by means of an MR (magnetoresistive) sensor and a magnetized plastic ring in the stainless steel ring. Multiplication by means of a real-time evaluation procedure			
Magnetic poles	No.	120		144	
Pulse tolerance					
at evaluation factor 1 per pole	Deg.	<0.1			
with the factory setting of the evaluation factor	Deg.	<0.2 (typ. <0.1)			
Pulses per revolution					
Possible settings[4] (evaluation factor per pole)	No.	120 (1); 480 (4); 600 (5); 960 (8); 1200 (10)		144 (1); 576 (4); 720 (5); 1152 (8); 1440 (10)	
Factory setting	No.	600 (5)		720 (5)[5]	
Possible settings through additional output pulse division[4]	No.	10 ... 1200		12 ... 1440	
Output signal	V	5[6] symmetrical 2 square-wave signals, approx. 90° out-of-phase			
Maximum output frequency	kHz	250			
Minimum rotational speed for sufficient pulse stability	min^{-1}	0			
Group delay	µs	<5 (typ. 1.3)			

Nominal (rated) torque M_{nom}	N·m	**100**	**200**	**500**	**1 k**
Hysteresis of reversal in the case of[7] relative vibrations between the rotor and the stator					
Torsional vibration of the rotor	Deg.	<approx. 1			
Radial vibration amplitude of the stator	mm	<approx. 1			
Load resistance	kΩ	≥2 (note termination resistances as per RS-422)			
Magnetic loading limit					
Remanent flux density	mT	>100			
Coercive field strength	kA/m	>100			
Permissible magnetic field strength for signal deviations per pole of < 0.1 degree	kA/m	<0.1			
Radial nominal distance between sensor head and magnetic ring	mm	1.0			
Actuation distance range	mm	0.3 ... 1.8			
Max. permissible radial shift of the rotor to the stator	mm	See actuation distance range; can be readjusted at the sensor head by ±1.5 mm.			

4) When changing to higher output pulse factors, note the maximum possible output frequency of 250 kHz.

5) Max. permissible rotation speed for speed measurement is 20500 min-1. At higher speeds, less output pulses must be set.

6) RS-422 complementary signals

7) Can be switched off

Specifications (continued)

Nominal (rated) torque M_{nom}	N·m	**2 k**	**3 k**	**5 k**	**10 k**
Magnetic speed measuring system					
Speed measuring system		Magnetic, by means of an MR (magnetoresistive) sensor and a magnetized plastic ring in the stainless steel ring. Multiplication by means of a real-time evaluation procedure			
Magnetic poles	No.	180			
Pulse tolerance					
at evaluation factor 1 per pole	Deg.	< 0.1			
with the factory setting of the evaluation factor	Deg.	< 0.2 (typ. < 0.1)			
Pulses per revolution					
Possible settings[8] (evaluation factor per pole)	No.	180 (1); 720 (4); 900 (5); 1440 (8); 1800 (10)			
Factory setting	No.	720 (4)			
Possible settings through additional output pulse division[8]	No.	15 ... 1800			
Output signal	V	5[9] symmetrical, 2 square-wave signals, approx. 90° out-of-phase			
Maximum output frequency	kHz	250			
Minimum rotational speed for sufficient pulse stability	min^{-1}	0			
Group delay	µs	<5 (typ. 2.2)			
Hysteresis of reversal in the case of[10] relative vibrations between the rotor and the stator					
Torsional vibration of the rotor	Deg.	<approx. 1			
Radial vibration amplitude of the stator	mm	<approx. 1			

Nominal (rated) torque M_{nom}	N·m	2 k	3 k	5 k	10 k
Load resistance	kΩ	≥2 (note termination resistances as per RS-422)			
Magnetic loading limit					
Remanent flux density	mT	>100			
Coercive field strength	kA/m	>100			
Permissible magnetic field strength for signal deviations per pole of < 0.1 degree	kA/m	<0.1			
Radial nominal distance between sensor head and magnetic ring	mm	1.2			
Actuation distance range	mm	0.3 ... 2.2			
Max. permissible radial shift of the rotor to the stator	mm	See actuation distance range; can be readjusted at the sensor head by ±1.5 mm.			

8) When changing to higher output pulse factors, note the maximum possible output frequency of 250 kHz.
9) RS-422 complementary signals
10) Can be switched off

Specifications (continued)

Optical speed measuring system									
Nominal (rated) torque M_{nom}	N·m	**100**	**200**	**500**	**1 k**	**2 k**	**3 k**	**5 k**	**10 k**
Speed measuring system		Optical, by means of infrared light and metallic slotted disc							
Mechanical increments	No.	360						720	
Positional tolerance of the increments	mm	±0.05							
Slot width tolerance	mm	±0.05							
Pulses per revolution Electrically adjustable	No.	360 [11]; 180; 90; 60; 30; 15						720; 360 [11]; 180; 90; 60; 30; 15	
Output signal	V	5[12] symmetrical; 2 square-wave signals, approx. 90° out-of-phase							
Minimum rotational speed for sufficient pulse stability	min^{-1}	2							
Group delay	µs	<5 (typ. 2.2)							
Hysteresis of reversing the direction of rotation[13] in the case of relative vibrations between the rotor and the stator									
Torsional vibration of the rotor	Deg.	<approx. 2							
Radial vibration amplitude of the stator	mm	<approx. 2							
Load resistance	kΩ	≥2 (note termination resistances as per RS-422)							
Degree of protection per EN 60529		IP 54							

Nominal (rated) torque M_{nom}	N·m	**100**	**200**	**500**	**1 k**	**2 k**	**3 k**	**5 k**	**10 k**
Permitted degree of soiling, in the optical path of the optical sensor (lenses, slotted disc)	%	<50							
Measuring system reference pulse									
Measurement system		Magnetic, by means of a magnetoresistive sensor and a magnet synchronized with the rising [11] or falling edge of the 0° output signal of the optical speed measuring system							
Output signal	V	5 symmetrical							
Pulse width		0.5 degree at 360 speed pulses/revolution (factory setting)							
Number of pulses per revolution		1							
Minimum rotational speed for sufficient pulse stability	min^{-1}	2							
Group delay	µs	<5 (typ. 2.2)							
Additional phase error at $<20\ min^{-1}$ $>20\ min^{-1}$	 Deg. Deg.	 typ. < 0.1; leading negligible							
Reproducibility at 360 speed pulses/revolution	Deg.	typ. <±0.04 (ideal installation, operates without vibration)							
General Information									
Degree of protection per EN 60529		IP 54							

Nominal (rated) torque M_{nom}	N·m	100	200	500	1 k	2 k	3 k	5 k	10 k
EMC									
Emission (per FCC 47 Part 15, Subpart C)									
Emission (per EN61326-1, Table 4)									
RFI field strength	-	Class B							
Interference immunity (EN61326-1, Table A.1)									
Electromagnetic field (AM)	V/m	10							
Magnetic field	A/m	30							
Electrostatic discharge (ESD)									
Contact discharge	kV	4							
Air discharge	kV	8							
Rapid transients (burst)	kV	1							
Impulse voltages (surge)	kV	1							
Conducted interference (AM)	V	3							
Degree of protection per EN 60529		IP 54							
Weight, approx. Rotor	kg	1.9	1.9	2.4	2.4	4.9	4.9	8.3	14.6
Stator	kg	1.2	1.2	1.2	1.2	1.3	1.3	1.3	1.3
Reference temperature	°C	+23							
Nominal (rated) temperature range	°C	+10 ... +60							
Operating temperature range	°C	-10 ... +60							
Storage temperature range	°C	-20 ... +70							

Nominal (rated) torque M_{nom}	N·m	100	200	500	1 k	2 k	3 k	5 k	10 k
Impact resistance, test severity level according to DIN IEC 68; Part 227; IEC 682271987									
Number	n	1000							
Duration	ms	3							
Acceleration (half sine)	m/s^2	650							
Vibration resistance, test severity level per DIN IEC 68, Part 2-6: IEC 68-2-6-1982									
Frequency range	Hz	5 ... 65							
Duration	h	1.5							
Acceleration (amplitude)	m/s^2	50							

11) Factory settings
12) RS-422 complementary signals
13) Can be switched off

Specifications (continued)

Rated torque	N·m	**100**	**200**	**500**	**1 k**	**2 k**	**3 k**	**5 k**	**10 k**
Nominal (rated) speed	min^{-1}	15000		12000				10000	8000
Nominal (rated) speed optional	min^{-1}	24000		22000		18000		14000	12000
Load limits[14]									
Limit torque, related to M_{nom}	%	400	200				160		
Breaking torque, related to M_{nom}	%	>800	>400				>320		
Longitudinal limit force	kN	5	10	16	19	39	42	80	120
Lateral limit force	kN	1	2	4	5	9	10	12	18
Bending limit moment	N·m	50	100	200	220	560	600	800	1200
Oscillation width per DIN 50 100 (peaktopeak)[15]	N·m	400	400	1000	2000	4000	4800	8000	16000
Mechanical values									
Torsional stiffness c_T	kN·m/ rad	270	270	540	900	2300	2600	4600	7900
Torsion angle at M_{nom}	Deg.	0.022	0.043	0.055	0.066	0.049	0.066	0.06	0.07
Stiffness in the axial direction c_a	kN/mm	800	800	740	760	950	1000	950	1600
Stiffness in the radial direction c_r	kN/mm	290	290	550	810	1300	1500	1650	2450
Stiffness during the bending moment in a radial axis c_b	kN · m/ degree	7	7	11.5	12	21.7	22.4	43	74
Maximum deflection at longitudinal force limit	mm	< 0.02		< 0.03		< 0.05		< 0.1	

Rated torque	N·m	**100**	**200**	**500**	**1 k**	**2 k**	**3 k**	**5 k**	**10 k**
Torsion angle at M_{nom}	Deg.	0.022	0.043	0.055	0.066	0.049	0.066	0.06	0.07
Additional max. radial run-out deviation at lateral limit force	mm	< 0.02							
Additional plane/ parallel deviation at bending moment limit	mm	< 0.03		< 0.05		< 0.07		< 0.07	
Balance quality level per DIN ISO 1940		G 2.5							
Max. limits for relative shaft vibration (peaktopeak)[16]									
Undulations in area of connection flange, based on ISO 7919-3									
Normal operation (continuous operation)	µm	$s_{(p-p)} = \frac{9000}{\sqrt{n}}$ n in min^{-1})							
Start and stop operation / resonance ranges (temporary)	µm	$s_{(p-p)} = \frac{13200}{\sqrt{n}}$ (n in min^{-1})							
Mass moment of inertia of the rotor									
I_V (around axis of rotation)	kg·m²	0.0026		0.0059		0.0192		0.0370	0.0970
I_V with optical speed measuring system	kg·m²	0.0027		0.0062		0.0196		0.0380	0.0995
I_v with magnetic speed measuring system	kg·m²	0.0029		0.0065		0.0203	0.0201	0.0390	0.1
Proportional mass moment of inertia for the transmitter side									
No speed measuring system	%	57		56		54		53	

Rated torque	N·m	**100**	**200**	**500**	**1 k**	**2 k**	**3 k**	**5 k**	**10 k**
With optical speed measuring system	%	55		54		53		52	
With magnetic speed measuring system	%	51							
Max. permissible static eccentricity of the rotor (radially) to the center point of the stator									
Without speed measuring system	mm	±2							
With optical speed measuring system (with or without a reference pulse)	mm	±1							
With magnetic speed measuring system	mm	±0.7							

Rated torque	N·m	100	200	500	1 k	2 k	3 k	5 k	10 k
Perm. axial displacement between rotor and stator									
Without speed measuring system	Mm	±3							
With optical speed measuring system (with or without a reference pulse)	Mm	±2							
With magnetic speed measuring system	mm	±1.5							

14) Each type of irregular stress (bending moment, lateral or longitudinal force, exceeding nominal (rated) torque) can only be permitted up to its specified static load limit provided none of the others can occur at the same time. If this condition is not met, the limit values must be reduced. If 30% of the bending limit moment and lateral limit force occur at the same time, only 40% of the longitudinal limit force is permissible and the nominal (rated) torque must not be exceeded. The permissible bending moments, longitudinal forces and lateral forces can affect the measurement result by approx. 0.3 % of the nominal (rated) torque.

15) The nominal (rated) torque for T10FS/200 N·m up to 10 kN·m must not be exceeded. With T10FS/100 N·m the nominal (rated) torque can be exceeded by 100 %.

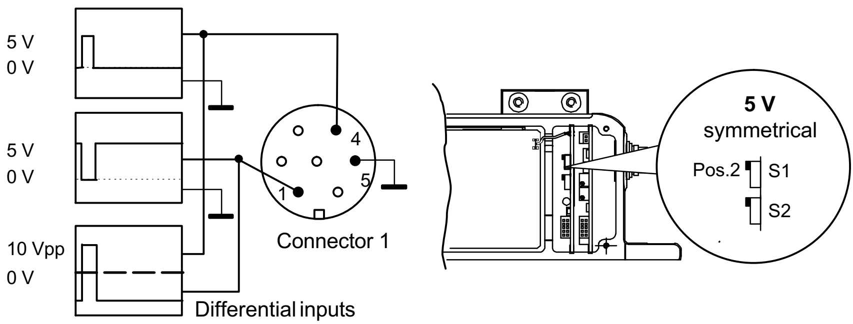
16) The influence of radial run-out deviations. Impacts, defects of form, notches, marks, local residual magnetism, structural variations or material anomalies need to be taken into account and isolated from the actual wave oscillation.

14 Supplementary technical information

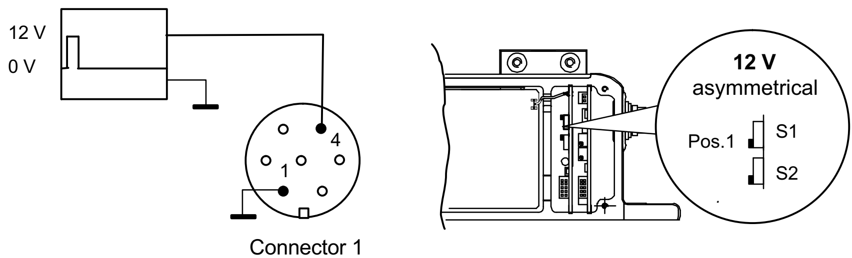
14.1 Output signals

14.1.1 Output MD torque (connector 1)

Symmetrical output signals (factory setting)

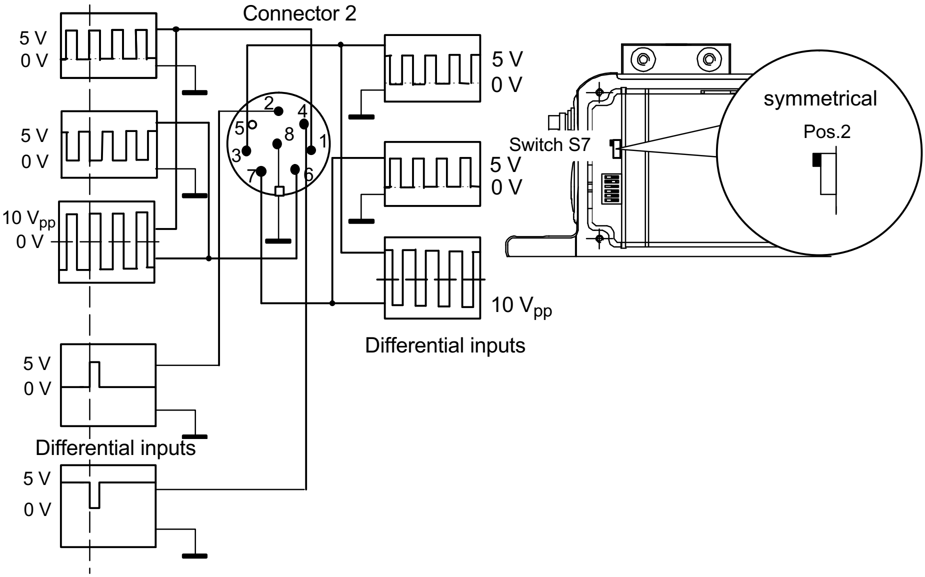


Asymmetrical output signal

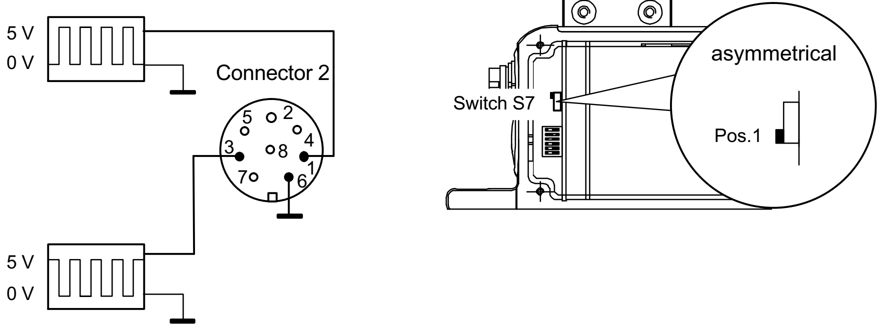


14.1.2 Output N: Speed and speed with a reference pulse (connector 2)

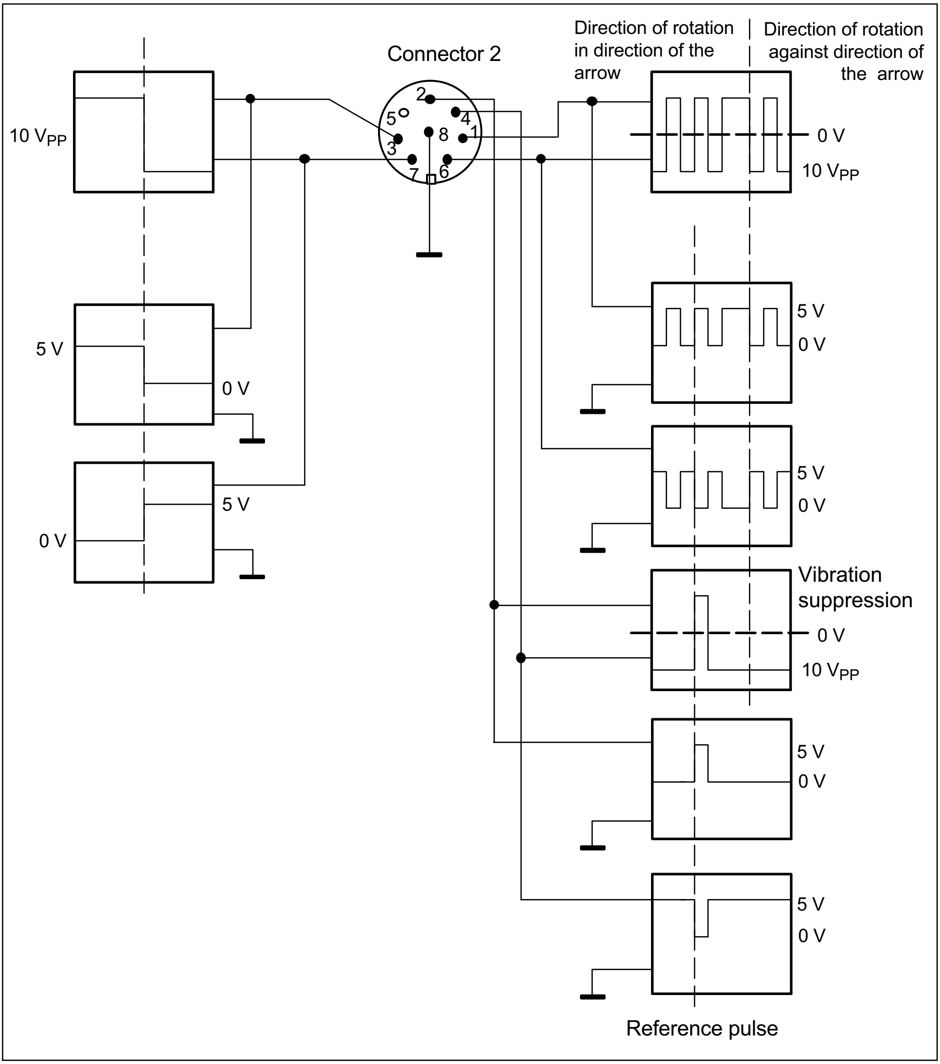
Symmetrical output signals (factory setting)



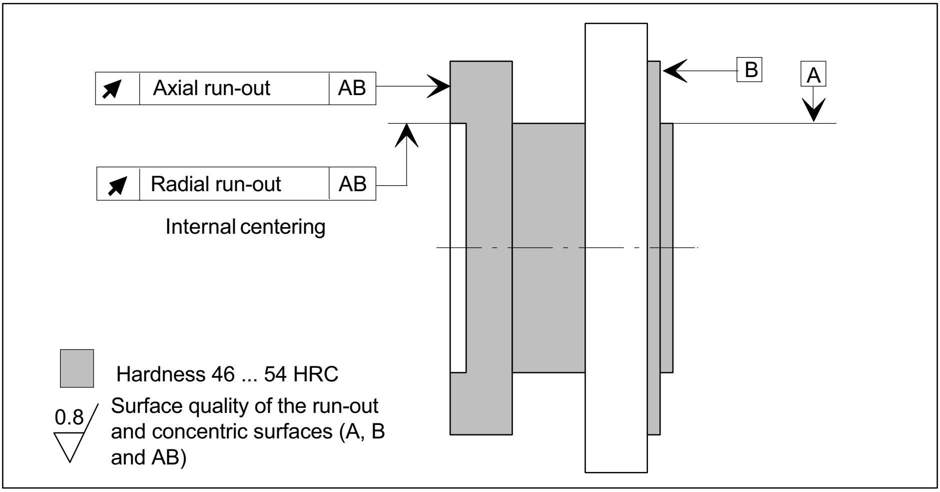
Asymmetrical output signal



14.1.3 Connector 2, double frequency, stat. direction of rotation signal



14.2 Axial and radial run-out tolerances



Measuring range	Axial runout tolerance (mm)	Radial run-out tolerance (mm)
100 N·m	0.01	0.01
200 N·m	0.01	0.01
500 N·m	0.01	0.01
1 kN·m	0.01	0.01
2 kN·m	0.02	0.02
3 kN·m	0.02	0.02
5 kN·m	0.02	0.02
10 kN·m	0.02	0.02

To ensure that the torque flange retains its characteristics once it is installed, we recommend that the customer also chooses the specified form and position tolerances, surface quality and hardness for the connections provided.

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