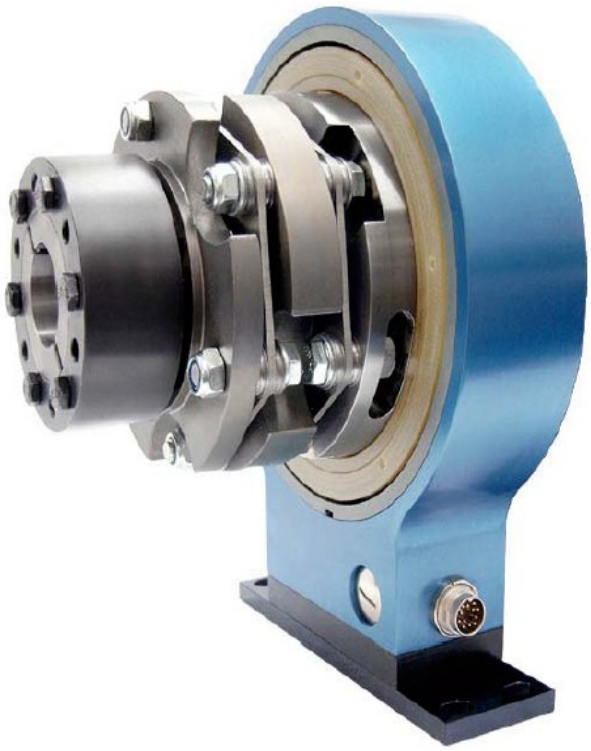
interface
ADVANCED FORCE MEASUREMENT

T1 Torque Coupling

Rotary Torque Transducer

Operation Manual



Company	Interface, Inc., 7401 E. Butherus Dr., Scottsdale, AZ 85260
Valid for...	Torque Transducer model T1
Copyright	© 2009 Interface, Inc.
Modification	Technical changes reserved.

References in this Text

1.6 Warning Notes; Page 6

Attention must be paid to the accident prevention regulations of the trade associations. Coverings and casings are necessary before operating the transducer. This is also valid for commissioning, maintenance and trouble shooting.
Duties of the coverings and casings are:

- ⇒ Protection from detaching parts
- ⇒ Protection from contusion and shear
- ⇒ Prevention from reaching rotating parts
- ⇒ Prevention from being tangled up and/or getting caught by parts

Coverings may

- ⇒ Not grind
- ⇒ Not rotate

Coverings are also necessary outside of operating and motion travel areas of persons. These demands can be modified if other sufficient safety devices are available. During operation, the safety precautions must be operative. By vibrations, damages can occur at the device.

4.0 Mechanical Assembly; Page 8

Caution: During the assembly inadmissibly large forces may not act on the transducer or the couplings. Connect the transducer electrically during the assembly and observe the signal, the measurement signal may not exceed the limit values

During the assembly, the transducer must be supported to protect if from falling down.

Admissible assembly offset from rotor to stator: see data sheet.

4.3.1 Couplings; Page 11

- The power transmission of the tension ring hubs or the clamping ring hubs is frictionally locked; the contact surface between tension ring and hub and between clamping ring and hub are lubricated during manufacture.
- Hub drillings and shaft ends must be totally free of grease during the assembly. Greasy or oily drillings or shafts do not transfer the maximum torque of the coupling.
- The shafts may not be equipped with a keyway.
- Hub and tension or clamping ring must be totally unbent, if necessary loosen the screws.

4.3.2 Alignment of the Measurement Arrangement; Page 11

 For further references see coupling manual and data sheet for the torque transducer.

4.3.3 Assembly Example of Hubs with Tension Ring; Page 11

 For further references see coupling manual.

4.3.4 Assembly Example of Hubs with Clamping Ring; Page 12

 For further references see coupling manual.

4.3.5 Assembly Example of Hubs with Feather Key Hub; Page 12

 For further references see coupling manual.

6.1 Engaging; Page 14

 Warming-up period for the torque transducer is approx. 5 min.

6.4.2 Natural Resonances; Page 15

 An operation of the device in natural resonance can lead to permanent damages.

1 Read First

1.1 Safety and Caution Symbols

Caution:
Injury Risk for Persons
Damage of the Device is possible.

Note:
Important points to be considered.

1.2 Intended Use

Torque transducers are intended for the measurement of torques. This measure is further suitable for control tasks. The valid safety regulations should be absolutely respected. The torque transducers are not safety components in the sense of the intended use. The transducers need to be transported and stored appropriately. The assembly, commissioning and disassembling must take place professionally.

1.3 Dangers

The torque transducer is fail-safe and corresponds to the state of technology.

1.3.1 Neglecting of Safety Notes

At inappropriate use, remaining dangers can emerge (i.e. by untrained personnel). The operation manual must be read and understood by each person entrusted with the assembly, maintenance, repair, operation and disassembly of the torque transducer.

1.3.2 Remaining Dangers

The plant designer, the supplier, as well as the operator must plan, realize and take responsibility for safety-related interests for the transducer. Remaining dangers must be minimized. Remaining dangers of the torque measurement technique must be pointed out.
Human mistakes must be considered. The construction of the plant must be suitable for the avoidance of dangers. A danger-analysis for the plant must be carried out.

1.4 Reconstructions and Modifications

Each modification of the transducers without our written approval excludes liability on our part.

1.5 Personnel

The installation, assembly, commissioning, operation and the disassembly must be carried out by qualified personnel only. The personnel must have the knowledge and make use of the legal regulations and safety instructions.

1.6 Warning Notes

Attention must be paid to the accident prevention regulations of the trade associations. Coverings and casings are necessary before operating the transducer. This is also valid for commissioning, maintenance and trouble shooting.
Duties of the coverings and casings are:

- ⇒ Protection from detaching parts
- ⇒ Protection from contusion and shear
- ⇒ Prevention from reaching rotating parts
- ⇒ Prevention from being tangled up and/or getting caught by parts

Coverings may

- ⇒ Not grind
- ⇒ Not rotate

Coverings are also necessary outside of operating and motion travel areas of persons. These demands can be modified if other sufficient safety devices are available. During operation, the safety precautions must be operative. By vibrations, damages can occur at the device.

2 Term Definitions

2.1 Terms

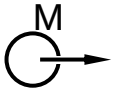
Measuring Side:
Mechanical connection of the torque transducer in which the torque to be measured is applied. Usually this side has the smallest moment of inertia.

Drive Side:
Mechanical connection of the torque transducer on the opposite side of the measuring side, usually with the largest moment of inertia. At static torque transducers the housing is fastened on this side.

Low Torque Resistance Side:
The shaft of the arrangement (drive, load) which can be turned considerably smaller with torque than the nominal torque of the torque transducer $M << M_{nenn}$.

2.2 Definition of the Pictograms on the Torque Transducer

The measuring side of the torque transducer is designated as follows:

Measuring side: 

or M

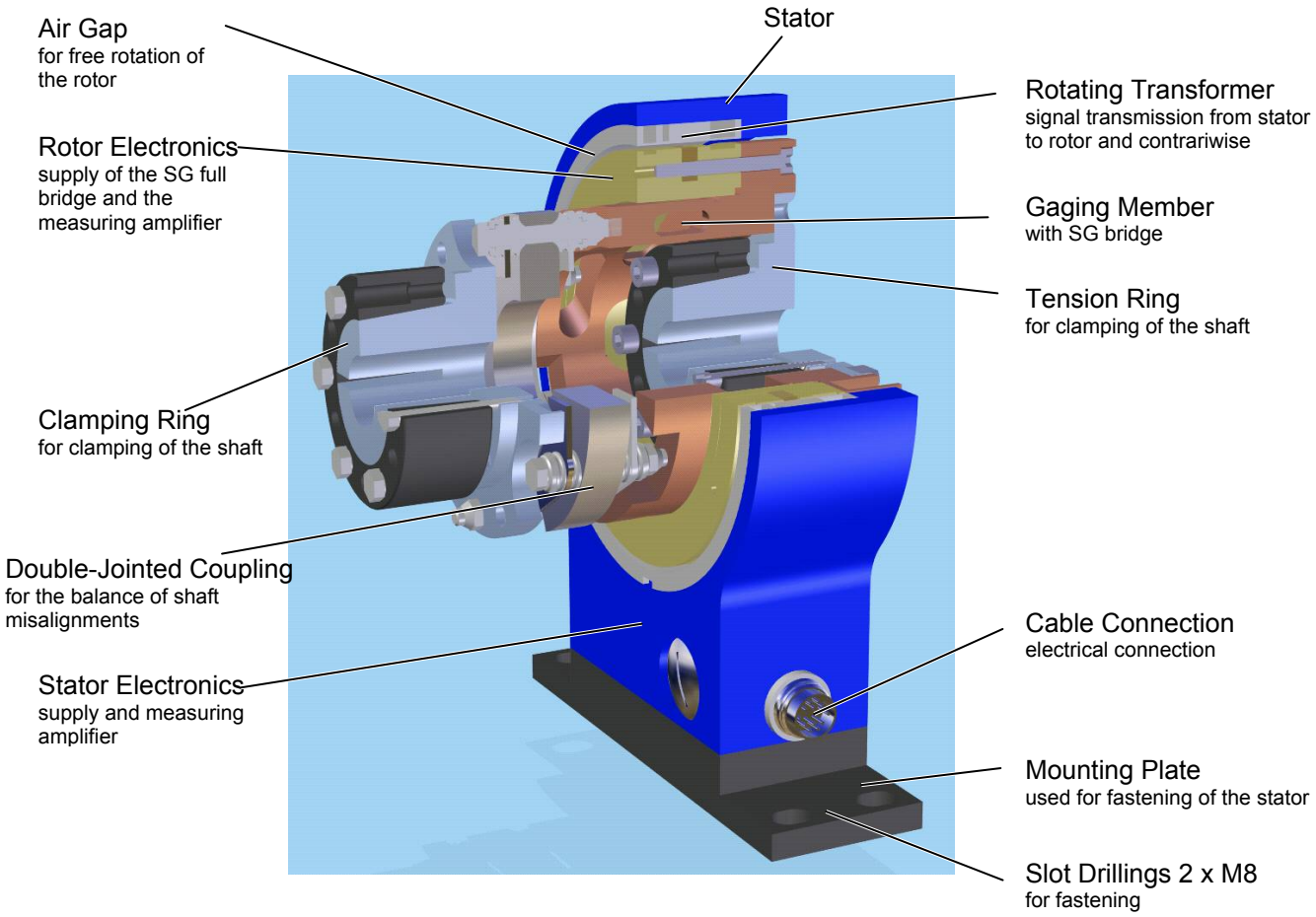
More information can be found on the data sheet, if needed.

3 Product Description

The transducer measures static and dynamic torques. The mounting position of the torque transducer is horizontally.
Caution: it is to be differentiated between measuring side and drive side, see data sheet of the transducer:
For more information consult factory 1-800-947-5598 or visit www.interfaceforce.com.

3.1 Mechanical Setup

The transducer consists of a stationary part, the stator and a rotary part, the rotor.



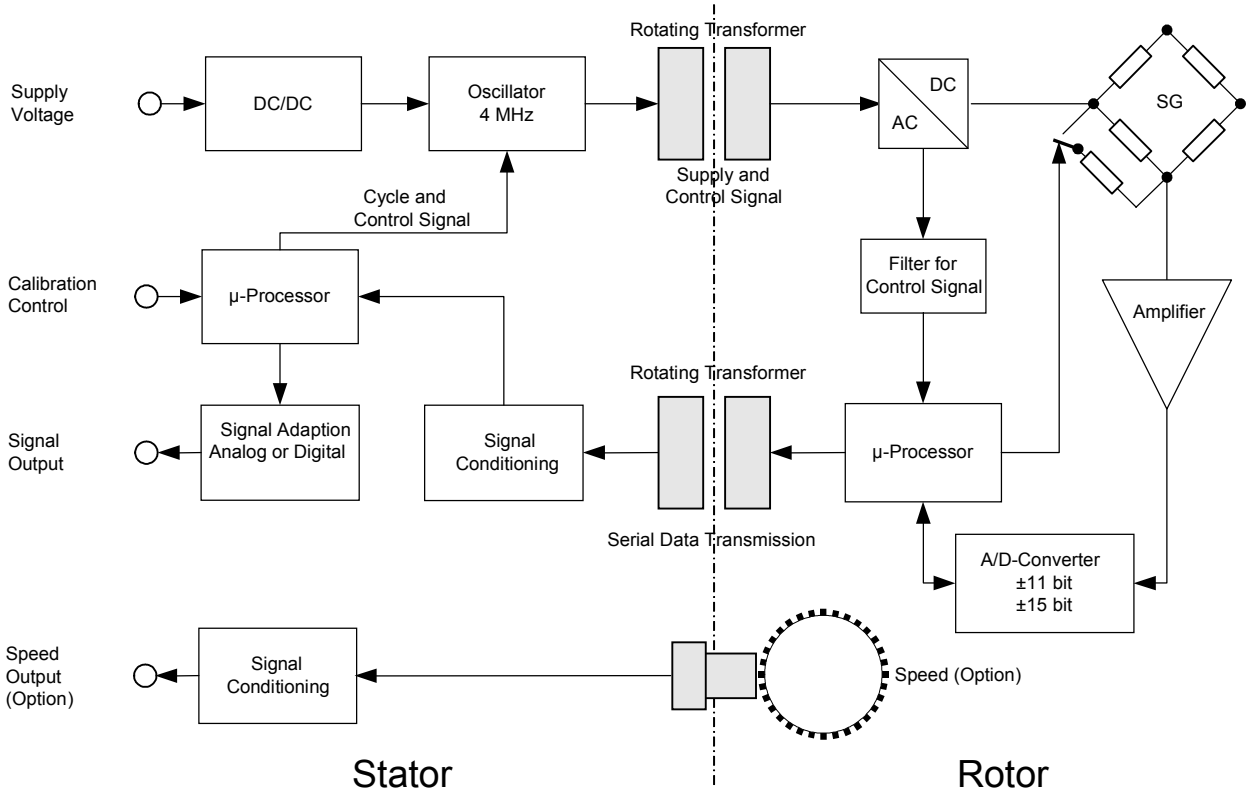
3.2 Electrical Setup

The supply of the rotor electronics occurs by an alternating voltage, generated in the stator, which transfers to the rotor through a rotating transformer. There, it is rectified and stabilized. With this supply, the strain gauge bridge is fed.

For the electrical calibration control of the transducer, a control signal is up-modulated to the supply by the µ-processor in the stator and transferred to the rotor. There, it is filtered and evaluated by the µPC, which also activates the internal switch for the detuning of the strain gauge bridge.

The measuring signal of the strain gauge bridge is conditioned in an amplifier and then converted into a digital signal, which will be transferred to the stator by another rotating transformer. Compared to the analog signal, the measuring signal in digital form is much more disturbance-free. The remaining distance of the measuring signal within the transducer occurs in digital form, completely. Thus, the measuring system achieves a high reliability of operation.

This signal is further conditioned in the stator, comes into a µ-processor, then - depending upon transducer type - it is converted to a voltage signal, digital signal or to current and will then reach the output of the transducer and can be directly measured at the connector.



3.2.1 Transducers with Analog Output

At this output, the digital signal is converted into DC voltage of 0V ±5V, proportionally to the torque and is available at the connector output.

3.2.2 Transducers with RS485 Interface

The torque transducer has a digital interface RS485 for the signal output and automatic transducer identification.
The protocol enables high dynamics.
See separate manual for further information.

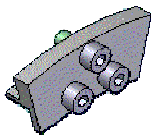
3.2.3 The Serial Communication

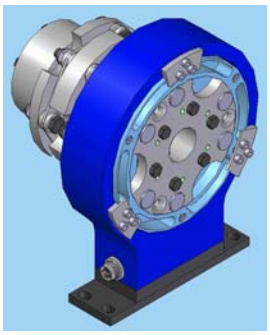
For more information consult factory (800) 947-5598 or visit www.interfaceforce.com

4 Mechanical Assembly

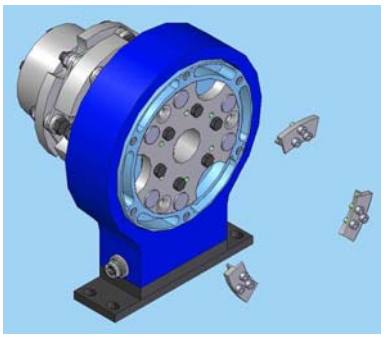
Caution: During the assembly inadmissibly large forces may not act on the transducer or the couplings. Connect the transducer electrically during the assembly and observe the signal, the measurement signal may not exceed the limit values.

During the assembly, the transducer must be supported to protect if from falling down.

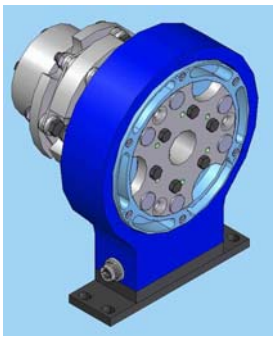
For transportation and easier assembly, the torque transducer is delivered with  fixing plates.



Assembled fixing plates



Removed fixing plates



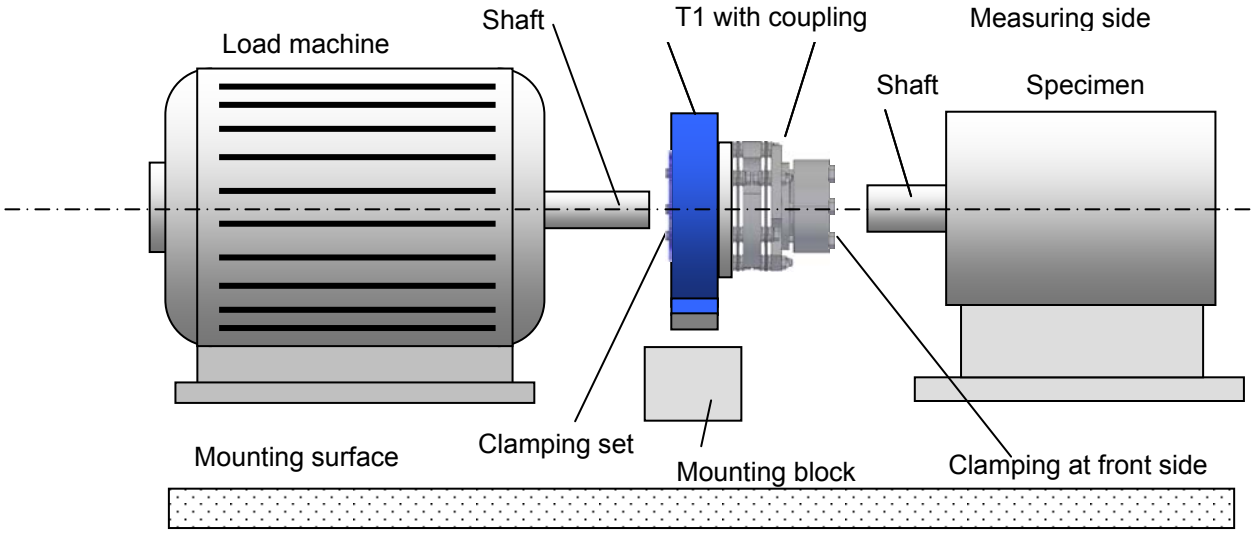
Without fixing plates

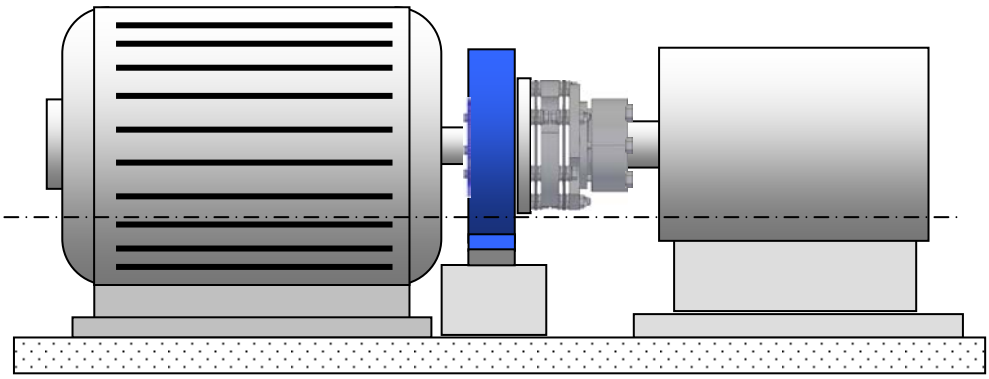
The installation and the alignment of the torque transducer occur with mounted fixing plates.
Afterwards remove the 3 fixing plates and control position of shaft to stator:

a) Axial alignment of the shaft
b) Evenness of the air gap (shaft may not grind at the stator)

4.1 Basic Assembly

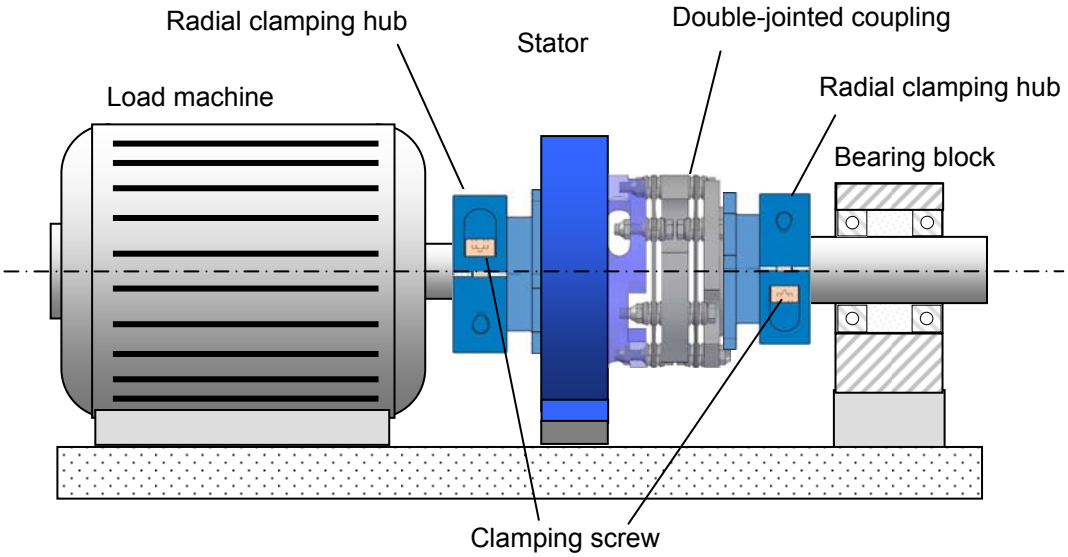
4.1.1 Example for assembly with Clamping Set





Setup completely assembled.

4.1.2 Example for Assembly with Radial Clamping Hub



4.2 Examples for Torque Transducers without integrated Couplings

By special adapters, the transducer can be connected to any connection element.
Disturbance variables such as:

- radial misalignments,
- angular misalignments,
- axial misalignments

always need to be balanced (double-jointed coupling).

4.2.1 Use of Centre Bore

Each part which is led-through the torque transducer means a torque shunt.

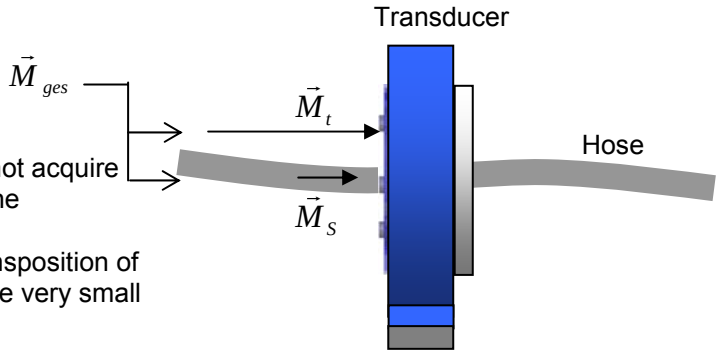
- By this, a part of the torque is led-through passed the transducer.
- This proportion is not measured → the shunt must be small compared to the measured torque.

The large centre bore is suitable for the lead-through of

- hydraulic hoses
- pneumatic hoses
- rods

Please Note

- The lead-through part may not acquire torque which will influence the measurement result
- The shunt torque for the transposition of the led-through parts must be very small against the applied torque.



At this configuration consider:

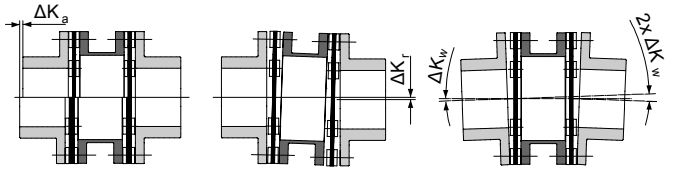
$$M_{ges} = M_t + M_S$$

$$M_t >> M_S \quad \Rightarrow \text{ i.e. } M_S < \frac{1}{1000} M_t$$

Otherwise a disturbance of the measuring signal will occur through the torque shunt.

4.3 Couplings

We recommend multi-disc couplings for our torque transducers. Couplings must be able to balance an axial, radial or angular offset of the shafts and not allow large forces to act on the transducer. The assembly instructions of the respective coupling manufacturer must be considered.



axial misalignment/radial misalignment/angular misalignment

4.3.1 Couplings

- The power transmission of the tension ring hubs or the clamping ring hubs occurs frictionally locked; the contact surface between tension ring and hub and between clamping ring and hub are lubricated on-site.
- *Hub drillings and shaft ends must be totally free of grease during the assembly. Greasy or oily drillings or shafts do not transfer the maximum torque of the coupling.*
- The shafts may not be equipped with a keyway.
- Hub and tension or clamping ring must be totally unbent, if necessary loosen the screws.

4.3.2 Alignment of the Measurement Arrangement

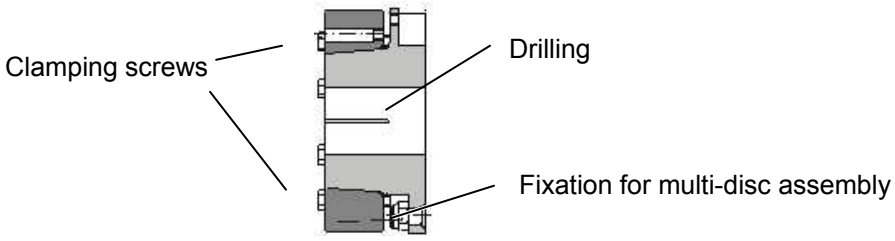
Precisely alignment of the couplings reduces the reaction forces and increases the durability of the couplings. Disturbance variables are minimized as well.
Due to the multitude of applications, an alignment of the coupling with a straight edge in two levels, vertical to each other, is sufficient.
However, in drives with high speed, an alignment of the coupling (shaft ends) with a dial gauge or a laser is recommended.

Further Points to be considered

- The axis height of the torque transducer (data sheet) must be considered.
- An air gap between rotor and stator must be available. The rotor may not touch the stator in any operating condition.
- Axial position of the rotor to the stator: see data sheet.

For further references see coupling manual and data sheet for torque transducer. ↕

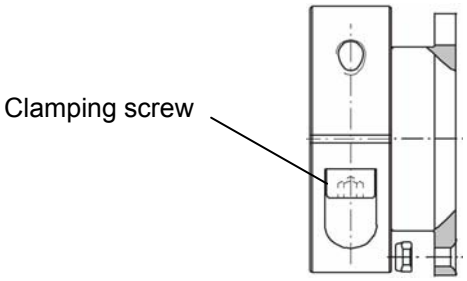
4.3.3 Assembly Example of Hubs with Tension Ring



- Shift the hubs with the proper appliance onto the shafts and position correctly.
- Uniformly tighten the clamping screws with the torque wrench **in sequence and in several circulations** to the torque indicated in table 1.
- Control the applied tightening torque after 5-10 operating hours.

4.3.4 Assembly Example of Hubs with Clamping Ring

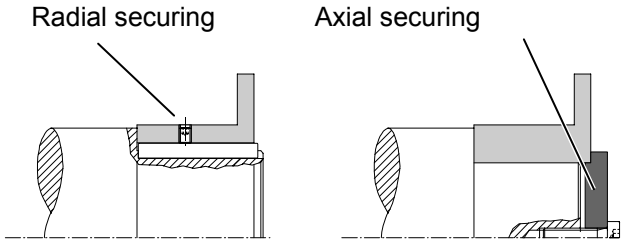
- Shift the hubs with the proper appliance onto the shafts and position correctly.
- Tighten the clamping screw with the torque wrench to the indicated torque.
- Control the applied tightening torque after 5-10 operating hours.



For further references see coupling manual

4.3.5 Assembly Example of Hubs with Feather Key Hub

- Shift the hubs with the proper appliance onto the shafts and fix them axially (see image below). The axial fixation occurs through a threaded pin (set screw), which radically presses on the feather key, or through a pressure-cap and a screw, fastened in centre thread of the shaft.
- The feather key must bear the complete hub length.



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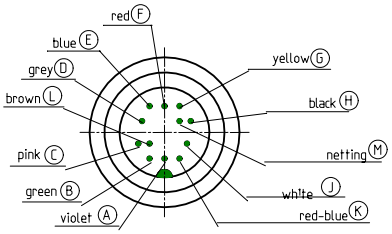
5 Electrical Connection

5.1 Pin Connection

Also see test certificate

12-pin	Analog Output		Digital Output	
Pin A	NC		NC	
Pin B	NC		NC	
Pin C	Signal	±5V / (±10V)	NC	
Pin D	Signal GND	0V	NC	
Pin E	Excitation GND	0V	Excitation GND	0V
Pin F	Excitation +	12 ... 28 VDC	Excitation +	12 ... 28 VDC
Pin G	Option Speed	TTL	Option Speed	TTL
Pin H	NC		NC	
Pin J	NC		Output B	RS485
Pin K	Calibration Control	L<2.0V; H>3.5V	NC	
Pin L	NC		Output A	RS485
Pin M	Housing		Housing	



View: socket on soldering side

5.2 Cable

Only use a shielded cable with preferably small capacity. We recommend measuring cables from our product range. They have been tested in combination with our transducers and meet the metrological requirements.

5.3 Shielding Connection

In combination with the transducer and the external electronics, the shield forms a Faraday Cage. By this, electro-magnetic disturbances do not have any influence on the measurement signal.

5.4 Running of Measuring Cables

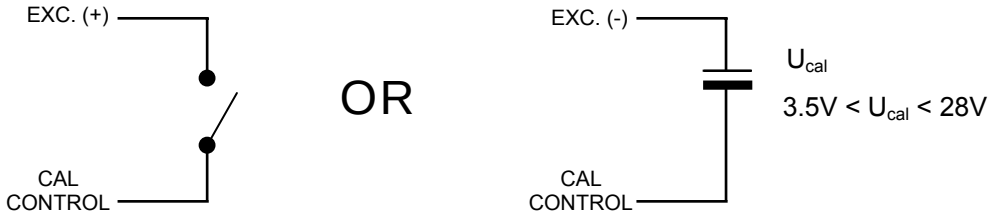
Do not run measuring cables together with control or heavy-current cables. Always assure that a large distance is kept to engines, transformers and contactors, because their stray fields can lead to interferences of the measuring signals.
If troubles occur through the measuring cable, we recommend running the cable in a grounded steel conduit.

5.5 Electrical Calibration

Use calibration control in unloaded condition of the torque transducer, only.

5.5.1 Calibration Control at Analog Output

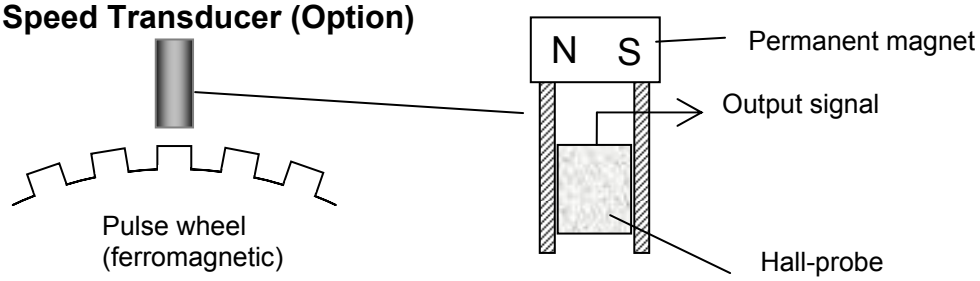
Applying of voltage of +3.5V to +28V enables the calibration control.



5.5.2 Calibration Control at RS485

The calibration control switch-on is carried out by a command.
(Only on units with RS485 option)

5.6 Speed Transducer (Option)



A hall transducer is located between the pulse wheel and the permanent magnet. If a tooth of the pulse wheel passes the energized hall transducer, the field intensity of the permanent magnet changes. By this, hall voltage occurs which is conditioned to a rectangular signal by the integrated evaluation electronics.

6 Measuring

6.1 Engaging

Warming-up period for the torque transducer is approx. 5 min. Afterwards the measurement can be started.

6.2 Direction of Torque

Torque means clockwise or clockwise torque if the torque acts clockwise when facing the shaft end. In this case a positive electrical signal is obtained at the output.
Torque transducers can measure both, clockwise and counter-clockwise direction.

6.3 Static/Quasi-Static Torques

Static and/or quasi-static torque is a slowly changing torque.
The calibration of the transducers occurs statically on a calibration device.
The applied torque may accept any value up to the nominal torque.

6.4 Dynamic Torques

6.4.1 General

The static calibration procedure of torque transducers is also valid for dynamic applications.
Note: The frequency of torques must be smaller than the natural frequency of the mechanical measurement setup.

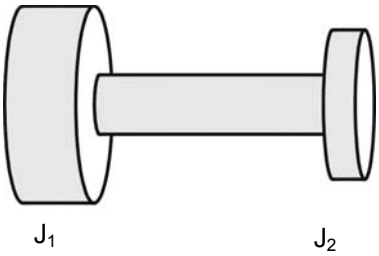
The band width of alternating torque must be limited to 70% of the nominal torque.

6.4.2 Natural Resonances

Estimate of the mechanical natural frequencies:

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

f_0 = Natural Frequency in Hz
J_1, J_2 = Moment of Inertia in kg*m²
c = Torsional Rigidity in Nm/rad



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Operation of the device in natural resonance can lead to permanent damages.

6.5 Speed Limits

The maximum speed indicated in the data sheet may not be exceeded in any operating state.

6.6 Disturbance Variables

By disturbances, measured value falsifications can occur by:

- Vibrations,
- Temperature gradients,
- Temperature changes,
- Arising disturbance variables during operation, i.e. imbalance,
- Electrical disturbances,
- Magnetic disturbances,
- EMC (electromagnetic disturbances),

Therefore avoid these disturbance variables by decoupling of vibrations, covers, etc.

7 Maintenance

To a large extend, the torque transducer is maintenance-free

7.1 Maintenance Schedule

Action	Frequency	Date	Date	Date
Control of cables and connectors	1x p.a.			
Calibration	< 26 months			
Control of fixation (flanges, shafts)	1x p.a.			

7.2 Rotating Torque Transducers

To a large extend, this transducer type is maintenance free.

7.3 Trouble Shooting

This chart is used for searching for the most frequent errors and their elimination

Problem	Possible Cause	Trouble Shooting
No signal	No transducer excitation	• Outside of permissible range • Connect excitation • Cable defect • No mains supply
	Signal output connected wrong	• Connect output correctly • Evaluation electronics defect
Transducer does not react to torque	Shaft not clamped	• Clamp correctly
	No power supply	• Outside of permissible range • Connect supply • Cable defect • No mains supply
	Cable defect	• Repair cable
	Connector connected wrong	• Connect correctly
Signal has dropouts	Axial position rotor to stator outside of tolerance	• Align rotor
	Cable defect	• Repair cable
Zero point outside of tolerance	Cable defect	• Repair cable
	Shaft mounted distorted	• Mount correctly
	Distorted shaft string	• Release from distortion
	Strong lateral forces	• Reduce lateral forces
	Distorted flanges	• Check evenness of flange-surfaces
	Shaft overloaded	• Send to manufacturer
Wrong torque indication	Calibration not correct	• Recalibrate
	Transducer defect	• Repair by manufacturer
	Torque shunt	• Eliminate shunt
Shaft drags	Shaft drags in the rotor	• Align shaft • Concentricity of the parts is not ensured
	Lateral forces too large	• Decrease lateral forces
Oscillations	Alignment of shaft not correct	• Align correctly
	Unbalance	• Balance the corresponding parts

8 Decommission

All transducers must be dismantled professionally. Do not strike transducer housings with tools. Do not apply bending moments on the transducer, i.e. through levers. The torque transducer must be supported to avoid falling down during the dismantling.

9 Transportation and Storage

The transportation of the transducers must occur in suitable packing.
For smaller transducers, stable cartons which are well padded are sufficient (i.e., air cushion film, epoxy crisps, paper shavings). The transducer should be tidily packed into film so that no packing material can reach into the transducer (ball bearings).
Larger transducers should be packed in cases.

9.1 Transportation

Only release well packed transducers for transportation. The transducer should not be able to move back and forth in the packing. The transducers must be protected from moisture.

Only use suitable means of transportation.

9.2 Storage

The storage of the transducers must occur in dry, dust-free rooms, only.
Slightly lubricate shafts and flanges with oil before storing (rust).

10 Disposal

The torque transducers must be disposed according to the valid provisions of law.

11 Calibration

At the time of delivery, torque transducers have been adjusted and tested with traceable calibrated measuring equipment at factory side. Optionally, a calibration of the transducers can be carried out.

11.1 Proprietary Calibration

Acquisition of measurement points and issuing of a calibration protocol Traceable calibrated measuring equipment is being used for the calibration. The transducer data are being checked during this calibration.

11.2 DKD-Calibration

The calibration of the transducer is carried out according to the guidelines of the DKD. The surveillance of the calibrating-laboratory takes place by the DKD. At this calibration, the uncertainty of measurement of the torque measuring instrument is determined.

11.3 Recalibration

The recalibration of the torque transducer should be carried out after 26 months at the latest.
Shorter intervals are appropriate:

- Overload of the transducer
- After repair
- After inappropriate handling
- Demand of high-quality standards
- Special traceability requirements