Instruction Manual

Rotating Torque Sensor
Type 4501A…

Version Q/QA
(with standard square connections)

Version R
(with shaft ends)

Version H/HA
(with standard hexagon connections)

4501A_002-406e-01.14

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Foreword

This manual applies to the rotating torque sensor Type 4501A… .

The instruction manual must be kept on hand for future use, and must be available at the site of implementation of the NC joining system, as needed.

The specifications in this manual can change at any time without prior notification. Kistler reserves the right to improve and to change the product for the purpose of technical progress without the obligation to inform persons and organizations as the result of such changes.

Original language of these operating instructions: German

Content

Total Pages 25

1. Introduction

Please take the time to thoroughly read this instruction manual. It will help you with the installation, maintenance, and use of this product.

To the extent permitted by law Kistler does not accept any liability if this instruction manual is not followed or products other than those listed under Accessories are used.

Kistler offers a wide range of products for use in measuring technology:

- Piezoelectric sensors for measuring force, torque, strain, pressure, acceleration, shock, vibration and acoustic-emission
- Strain gage sensor systems for measuring force and torque
- Piezoresistive pressure sensors and transmitters
- Signal conditioners, indicators and calibrators
- Electronic control and monitoring systems as well as software for specific measurement applications
- Data transmission modules (telemetry)
- Electromechanical NC joining modules and force-displacement monitors
- Test bed systems for electric motors and gear units for laboratory, manufacturing, and quality assurance

Kistler also develops and produces measuring solutions for the application fields engines, vehicles, manufacturing, plastics and biomechanics sectors.

Our product and application brochures will provide you with an overview of our product range. Detailed data sheets are available for almost all products.

If you need additional help beyond what can be found either online or in this manual, please contact Kistler's extensive support organization.

2. Important Information

2.1 Disposal Instructions for Electrical and Electronic Equipment

Do not discard old electronic instruments in municipal trash. For disposal at end of life, please return this product to an authorized local electronic waste disposal service or contact the nearest Kistler Instrument sales office for return instructions.

2.2 Symbols Used

NOTE
This symbol indicates instructions that enable more effective and more economic use of the NC joining module.

3. Application and Key Features

- Torque sensor with strain gages
- Signal transfer by slip rings
- Measurement of constant and variable torque
- Measurement of torque from the rotating shaft
- Integrated system for rotation angle measurement (only version QA)
- Suitable for laboratory use and quality control
- Ideal for use with power tools
- Primarily suitable for low speed ranges
- Suitable for momentary measurement of torque (intermittent duty)

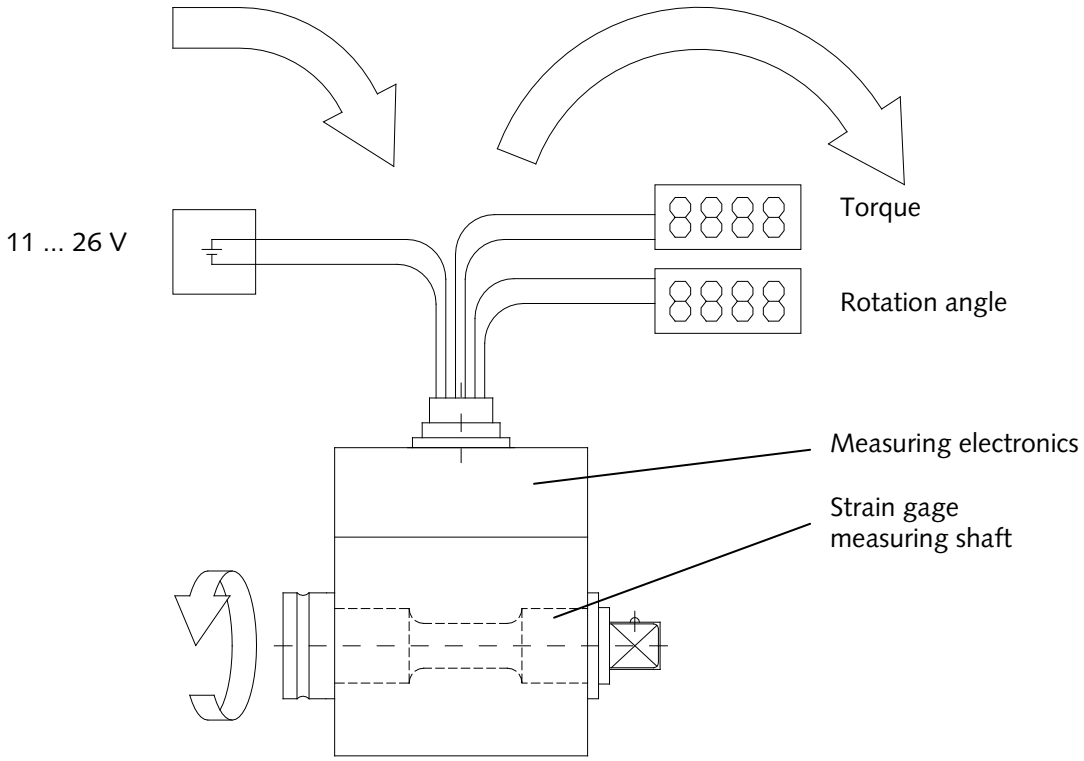


Fig. 1: Rotating torque sensor

4. Description

4.1 Mechanical Design

Torque sensors Type 4501A… comprise a rotating shaft mounted on bearings inside a housing. The shaft has a necked section - called the torsion zone - to which strain gages are attached and connected in a full bridge circuit. Slip rings and brushes provide the link between rotor and housing with two slip rings carrying the electric power supply to the strain gages on the rotating shaft. Two other slip rings serve to transfer the measuring signals from the rotating shaft to the stationary housing. The full bridge circuit is connected directly through the slip rings and brushes to the lead connector which is mounted on the housing of the torque sensor.
In version QA torque sensors an optical rotation angle measurement system is integrated. It consists of a pulse disk on the rotating shaft with 360 light-dark stripes. Two light barriers are installed into the stator. Inside the torque sensor there is a small electronics for processing of the angle pulses.

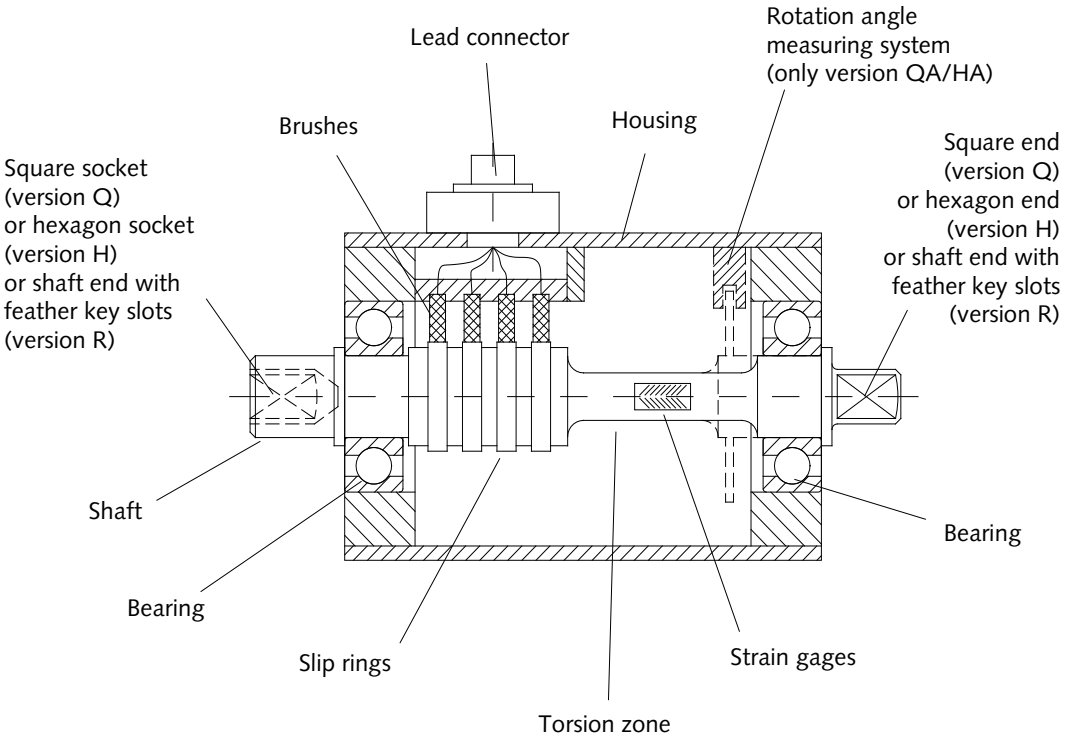


Fig. 2: Mechanical design rotating torque sensor Type 4501A...

4.2 Electrical Design

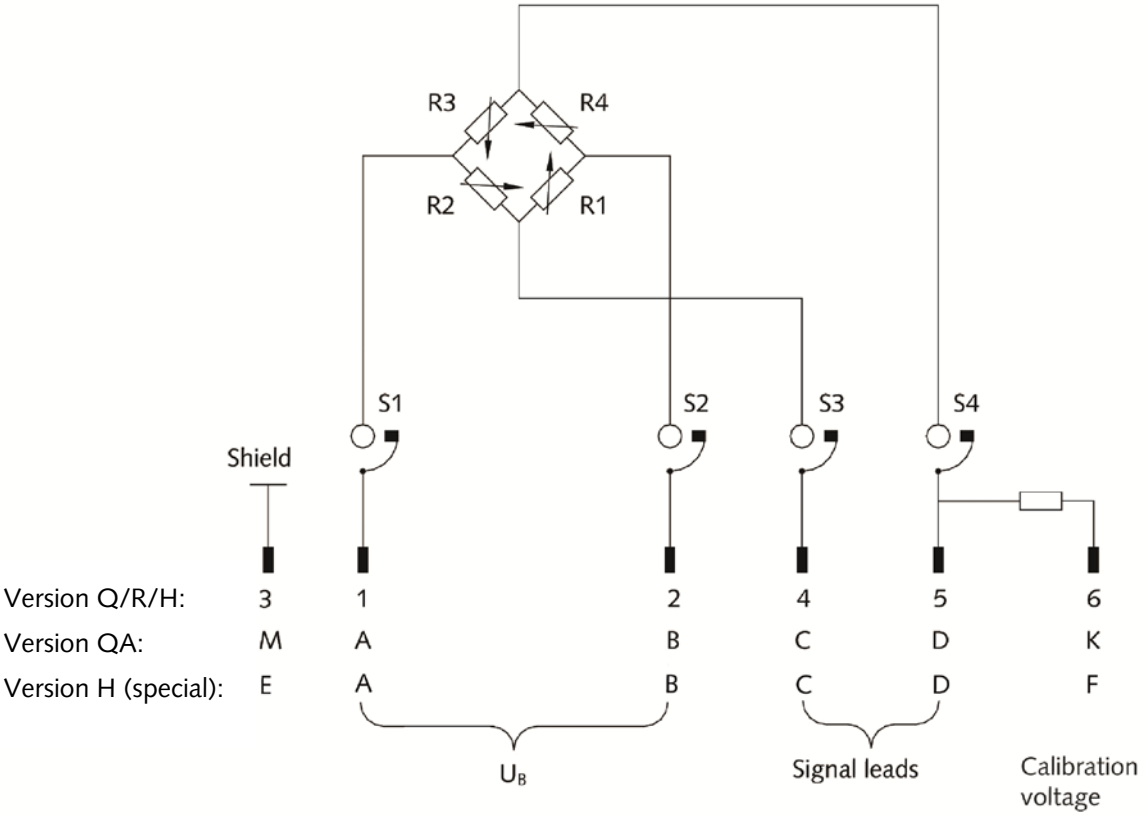


Fig. 3: Electrical design

- R1 ... R4 = Gages for measuring mechanical strain
- S1 ... S4 = Slip rings with brushes

4.3 Rotation Angle Measuring System (Version QA and HA only)

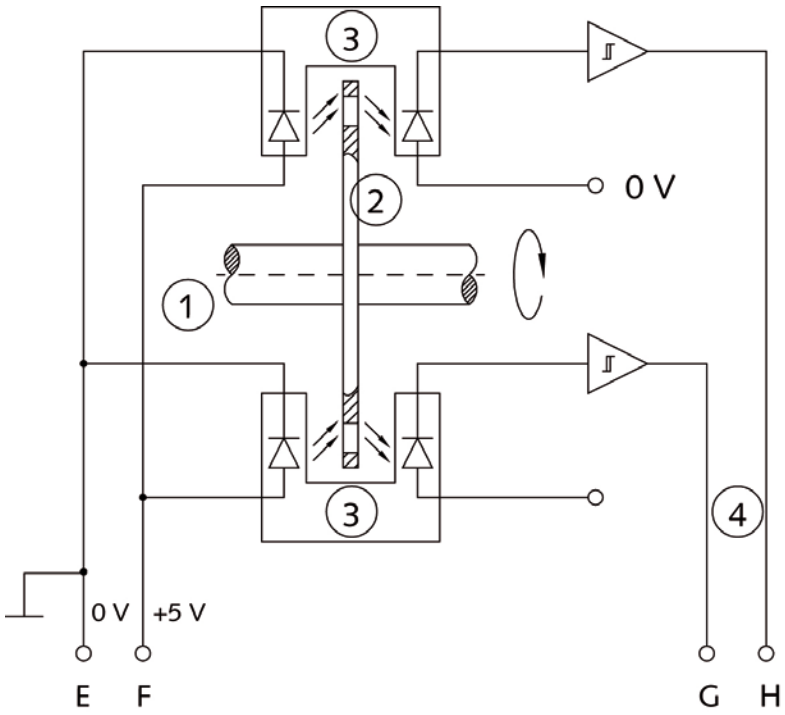


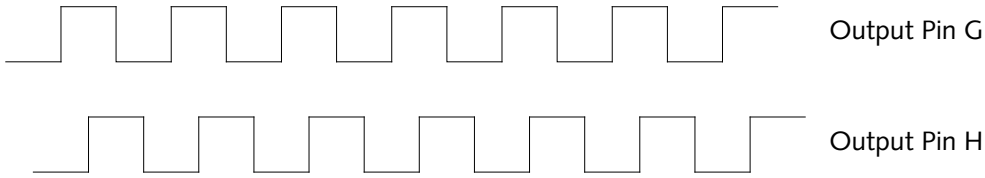
Fig. 4: Diagram showing the design of the rotation angle measuring system

1 Rotating shaft
2 Pulse disk
3 Forked light barrier with LED and photo diode
4 Operation amplifier

Features

- 360 light-dark stripes on the pulse disk
- Two forked light barriers shifted by phase angle 90°
- Pulse number proportional to the rotation angle

4.4 Adjustment for Angle-pulse Output (version QA only)



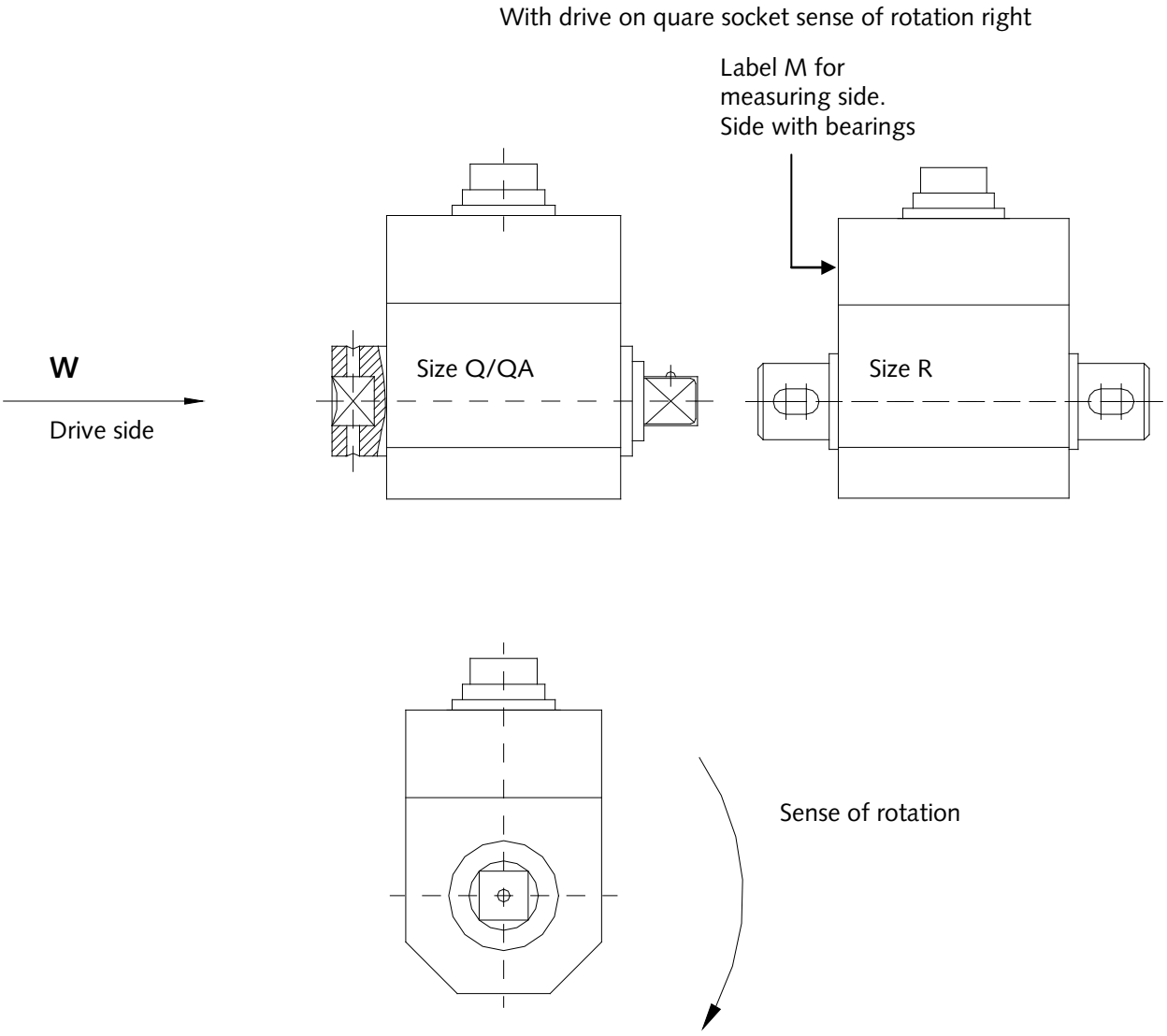


Fig. 5: Adjustment for angle-pulse output

5. Electrical Connections

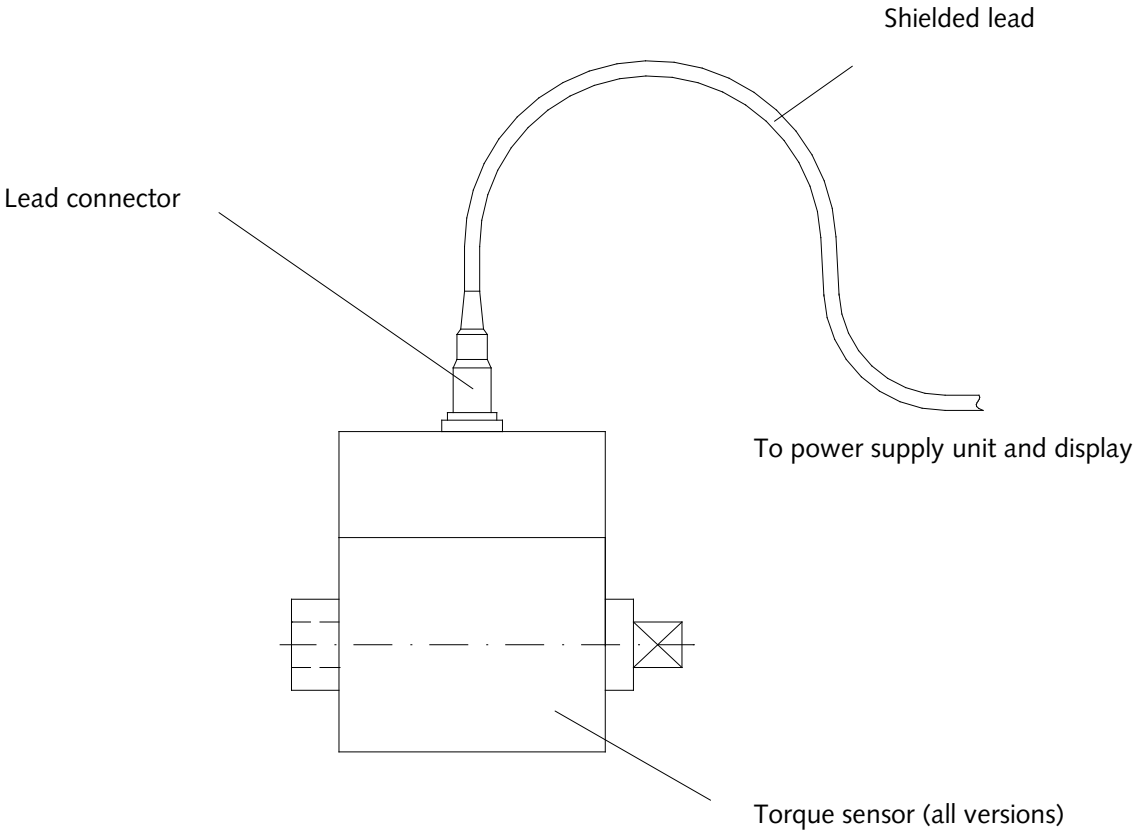
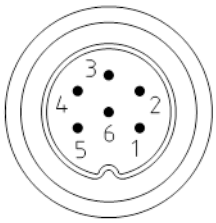


Fig. 6: Electrical connections

- Shielded lead of 0,25 mm²
  (version X: 0,14 mm²) cross section
- Factory-calibrated with 5 m of lead.
  A change in lead of 2,5 m will cause an error of approximately 1 %

5.1 Description of Interfaces

5.1.1 Versions Q/R/H

Function	PIN	Description	Top view built-in plug
– Power supply	1	e.g. 6 VDC	
+ Power supply	2	e.g. 6 VDC	
Shield	3	Not connected	
+ Measuring signal	4	2 mV/V approx. 350 Ω*	
– Measuring signal	5	2 mV/V approx. 350 Ω*	
– Power supply (Calibration voltage)	6	100 % calibration, causes 100 % signal	

* Customized, see calibration certificate

5.1.2 Connection Cable Q/R/H

5.1.2.1 Cable Diagram with Plugs on Both Sides Mat. No.: 18008930, Type KSM071860-5, Versions Q/R/H

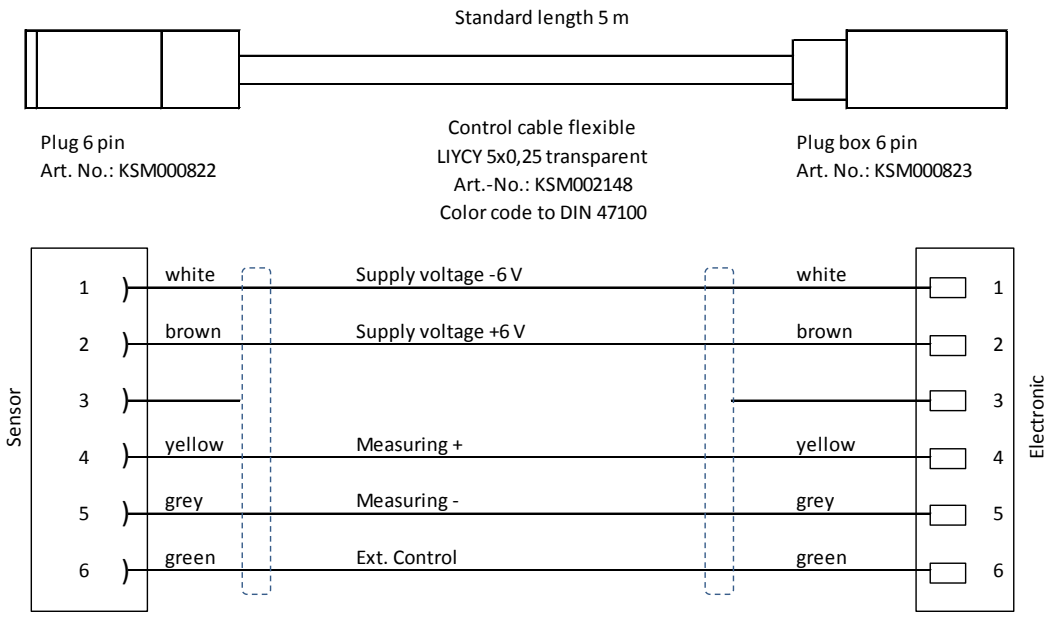


Fig. 7: Cable diagram connection cable

5.1.2.2 Cable Diagram, Plug (Transducer), Open Ends Mat. No.: 18008939, Type KSM103820-5, Versions Q/R/H

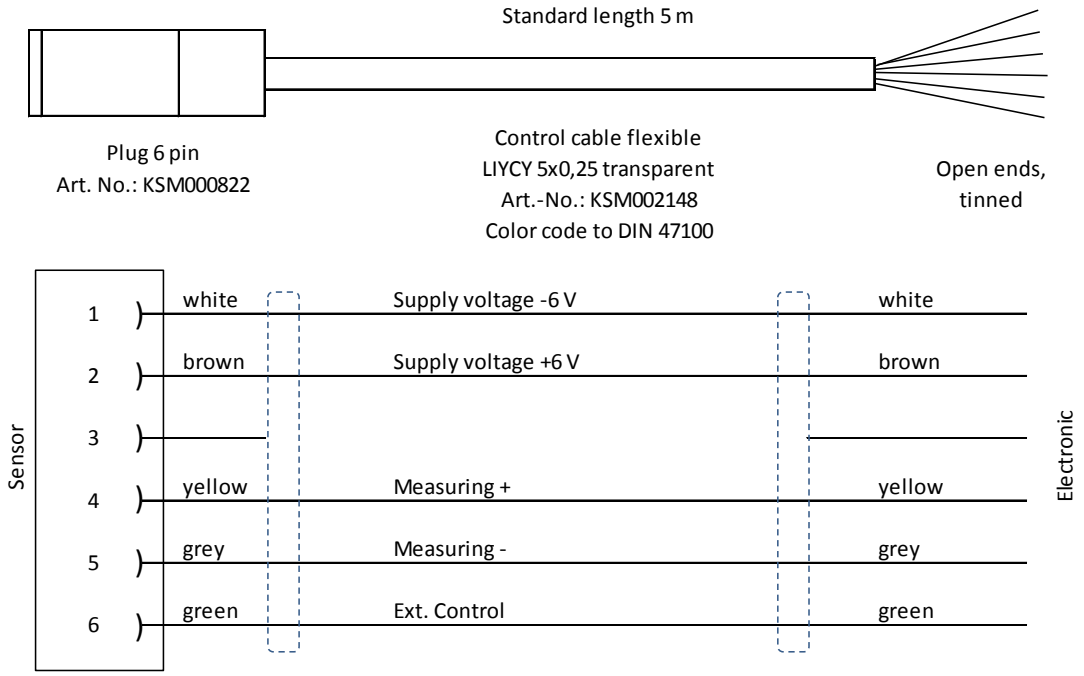
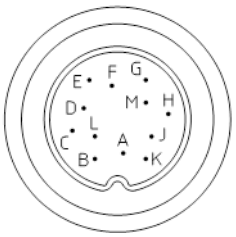


Fig. 8: Cable diagram, plug (transducer), open ends

5.1.3 Versions QA/HA

Function	PIN	Description	Top view built-in plug
– Power supply	A	Strain gage full bridge	
+ Power supply	B		
+ Measuring signal output	C		
– Measuring signal output	D		
Angle 0 V	E	Rotation angle pulses	
Angle +5 V ±10 %	F		
Pulse l, leading, TTL	G		
Pulse r, lagging, TTL	H	0 V	
Power supply (Calibration voltage)	K	100 % calibration, causes 100 % signal	
Shield	N	Not connected	

5.1.4 Connection Cables QA, HA

5.1.4.1 Cable Diagram with Plugs on Both Sides, Mat. No.: 18008955, Type KSM170690-5, Version QA and HA

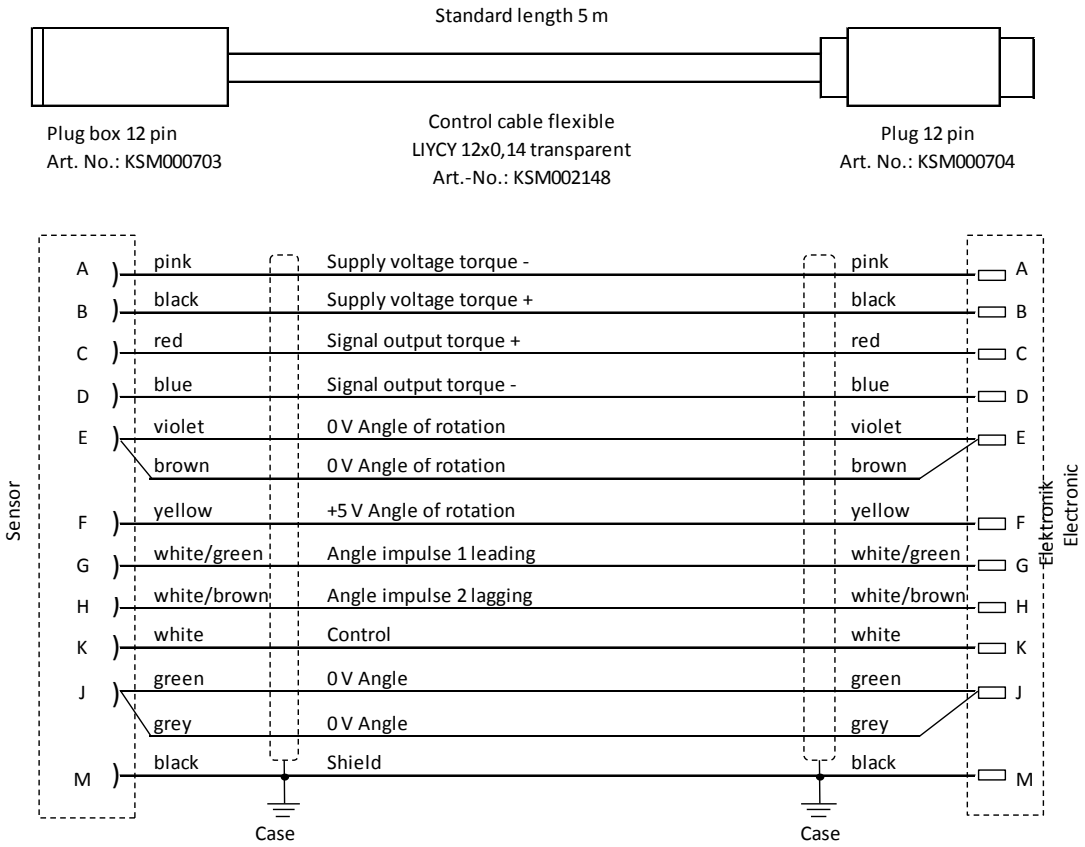


Fig. 9: Cable diagram connection cable

5.1.4.2 Cable Diagram, Plug (Transducer), Open Ends, Mat. No.: 18008958, Type KSM183150-5, Version QA and HA

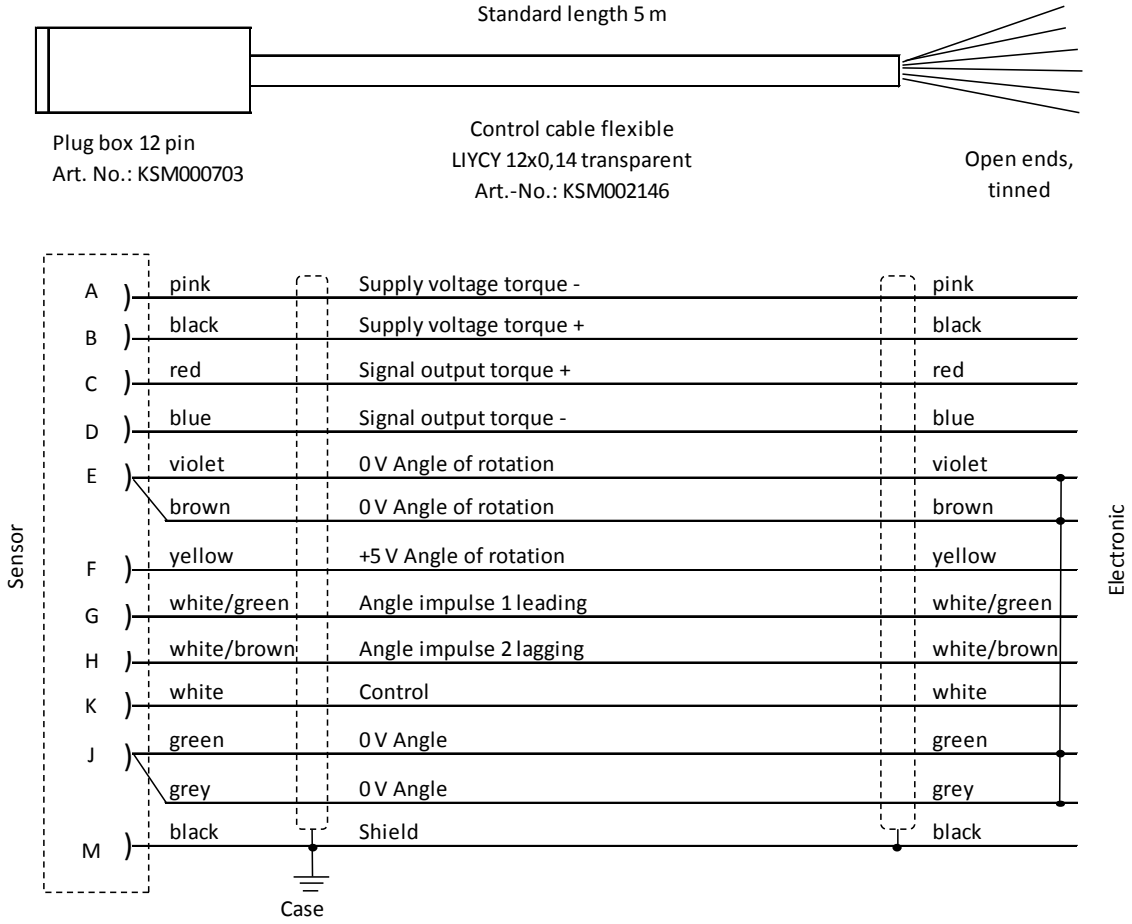
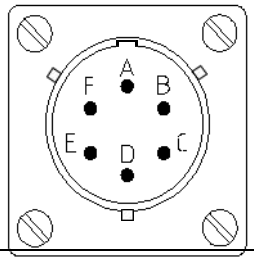


Fig. 10: Cable diagram, plug (transducer), open ends

5.1.5 Plug Series MIL, CA-Bayonet

Function	PIN	Description	Top view built-in plug
+ Power supply	A	z.B. +6 VDC	
– Power supply	B	z.B. −6 VDC	
– Output (measuring signal)	C	z.B. 2 mV/V ca. 350 Ω*	
+ Output (measuring signal)	D	z.B. 2 mV/V ca. 350 Ω*	
Shield	E	Im Sensor nicht belegt	
– 100 % control (supply) (Calibration voltage)	F	100 % Kalibrierung, d.h. 100 % Messsignal	

* Customized, see calibration certificate

5.1.6 Cable Diagram, Plug, Open Ends Mat. No.: 18025415, Type KSM007331, MIL/CA-Bayonet

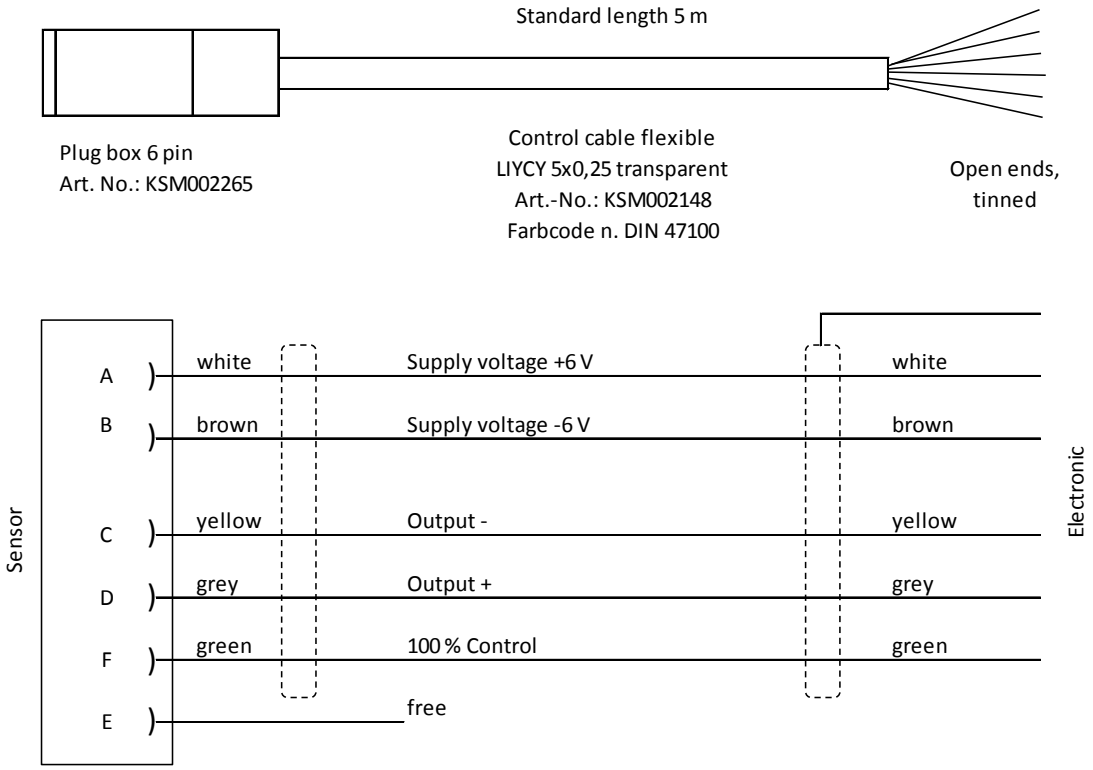


Fig. 11: Cable diagram, plug, open ends

5.2 Installing the Signal Lead

- Do not run the lead parallel to power cables or control circuits.
- Do not place the lead close to equipment producing strong electromagnetic fields, e.g. transformers, welders, contactors, electric motors, etc.
- If such situations cannot be avoided, run the lead inside earthed steel conduit.
- Excess lengths should be prevented. If it isn't possible to avoid, then do not lay excess lengths in closed loops.

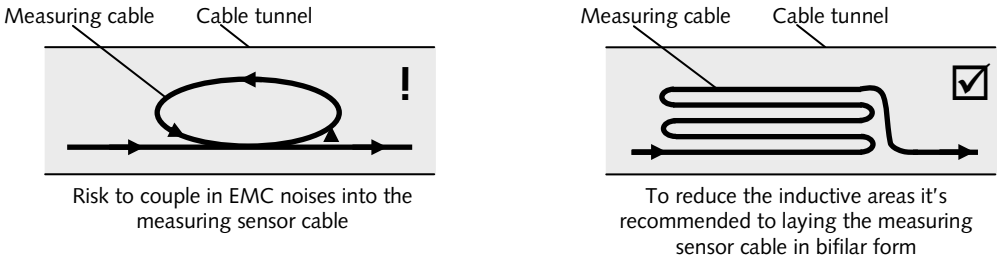


Fig. 12: Laying of the measuring cable

6. Using the Torque Sensor

6.1 Versions Q, QA, H, HA

- Torque sensors of version Q and QA have square connections for plug-in tools acc. to DIN 3121
- Torque sensor of version H have hexagon connections acc. to DIN 3126, form E/F
- The torque sensors are plugged on to the drive spindle as shown below

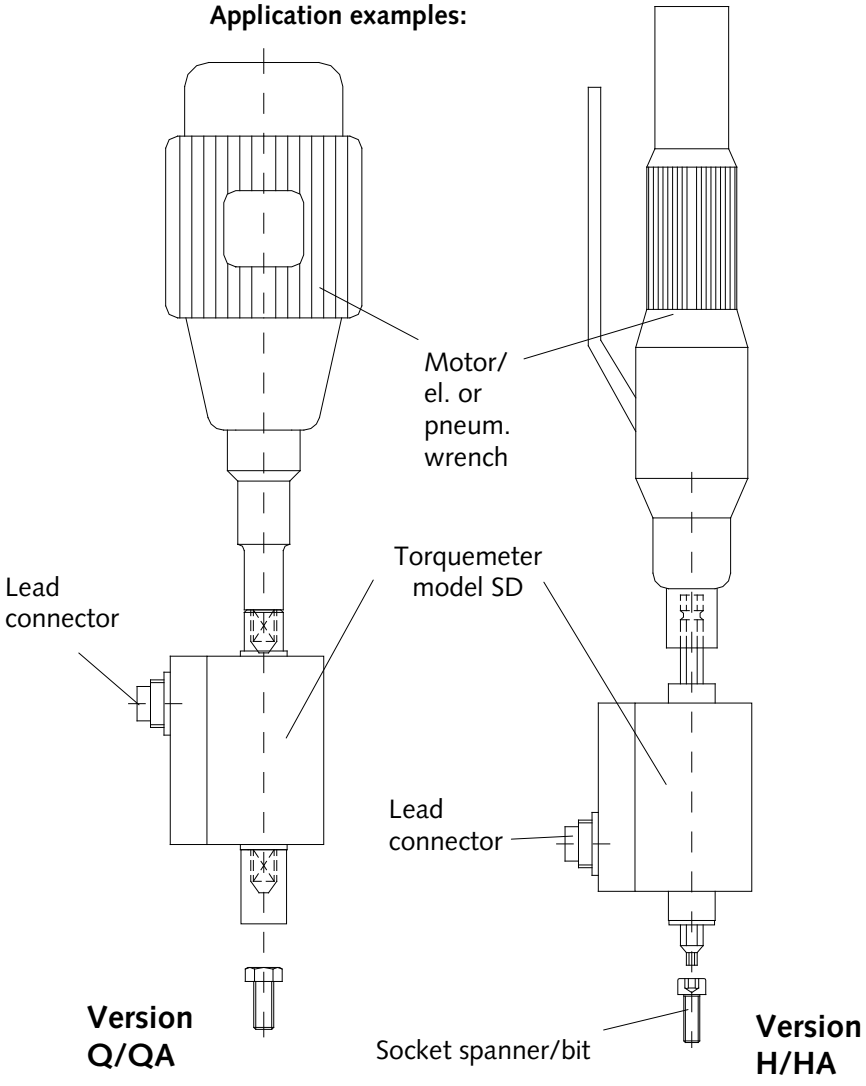


Fig. 13: Application examples versions Q/QA and H/HA

6.2 Version R

The torque sensor is adapted to the measuring application by couplings.

For a free floating installation we recommend two torsionally rigid half couplings.

Application example:

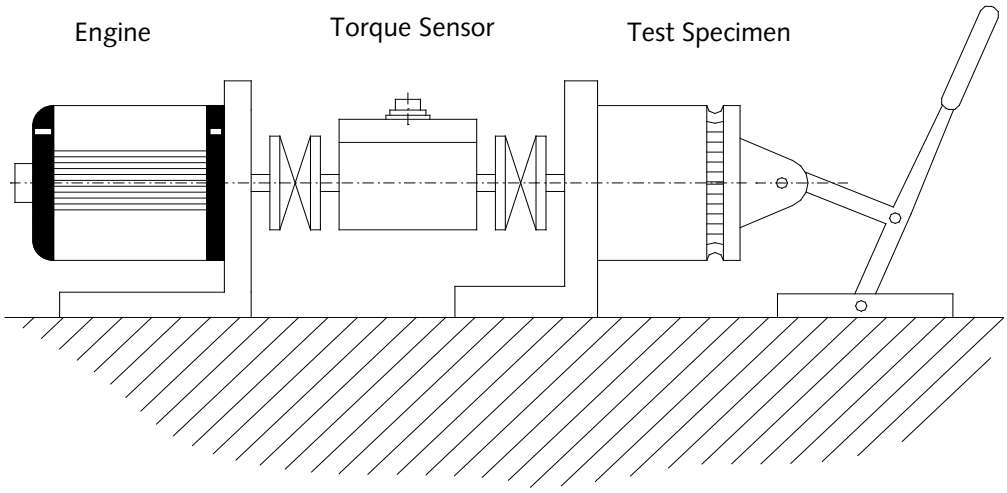


Fig. 14: Application example version R

7. Static Calibration

This procedure requires the use of a calibration device with a lever arm and weights for producing specific values of torque.

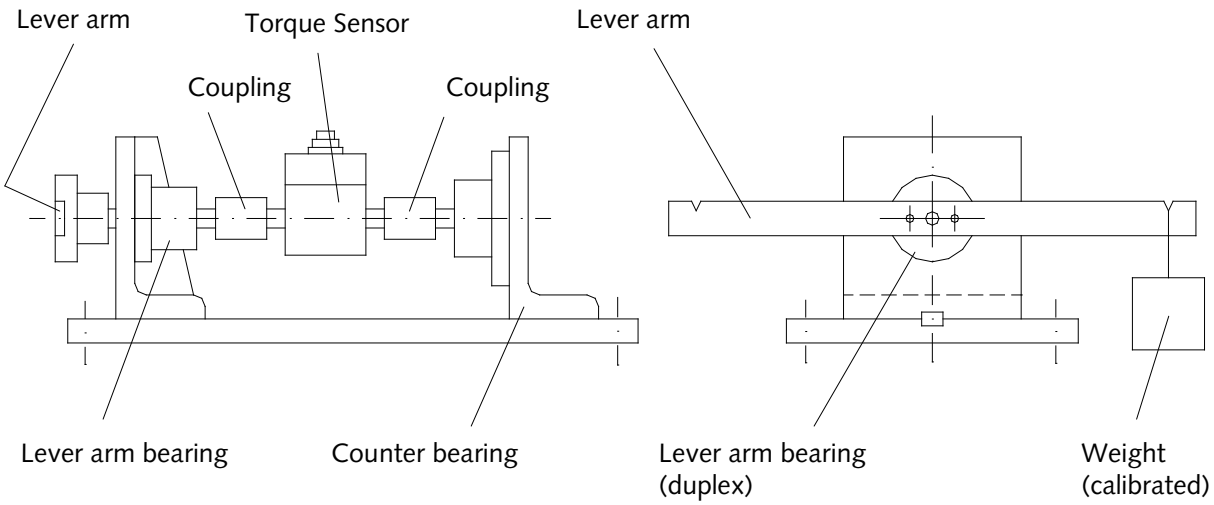
The calibration procedure is as follows

- Apply the rated value of torque to the torque sensor and then remove it again
- Adjust the zero reading accurately
- Apply a known value of torque to the torque sensor.
- Adjust the displayed reading to the corresponding value

Plotting a calibration curve

- Calibrate the torque sensor as described above.
- Apply torque in 1/10 steps up to the full rated value and then remove it again in the same way.
  A delay of at least 30 seconds must be allowed between the individual 1/10 steps so that each reading can stabilize before it is recorded

7.1 Making a Simple Calibration Device



Coupling = Loose half-couplings Type 2301A… or Type 2302A… or Type 2303A…

Fig. 15: Calibration device

7.2 Calculation Example for Lever Arm Length

$$L = \frac{M}{m \cdot g}$$, whereby

M = Torque
L = Length of lever arm required
m = Mass required
g = 9.80665 m/s²
(= standard gravity – varies with location)

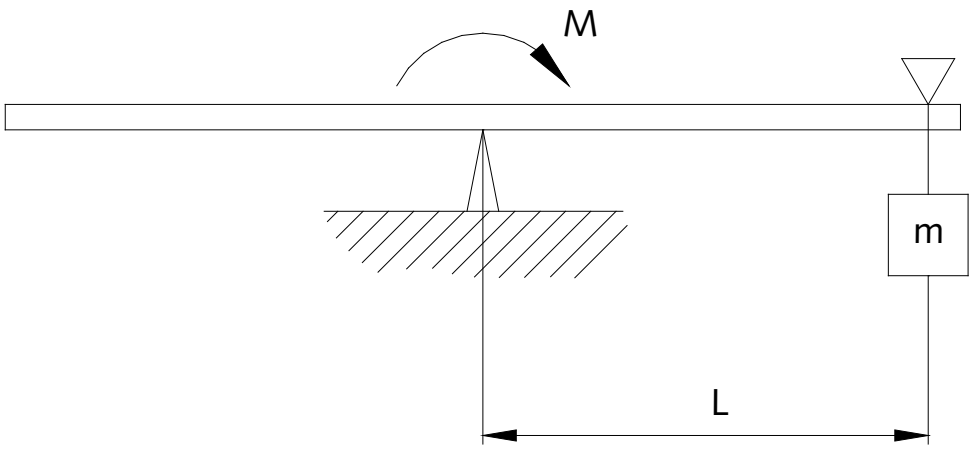


Fig. 15: Calculation of lever arm length

Example: m = 1 kg
M = 10 N·m

$$L = \frac{10N \cdot m}{1kg \cdot 9{,}80665\frac{m}{s^2}} \approx 1{,}0196m$$

8. Maintenance

- Gradual wear of the brushes and slip rings produces an electrically-conductive dust inside the torque sensor which might cause an electrical short between the slip rings and cause instability of the zero reading during rotation. Therefore, it is important to clean the torque sensor regularly.
- The recommended cleaning cycle is approximately 10^6 revolutions.
- In order to clean the interior, loosen the 4 fixing screws and remove the cover plate.
- Use a soft linen cloth, a fine hair brush or oil-free compressed air to clean the dust from the slip rings and the spaces between them.
- Carefully clean the brushes and the plastic part with the springs using a hair brush or oil-free compressed air.
- Version QA+HA: Be careful when cleaning, do not scratch the pulse wheel.
- Also clean the lead connector.
- Measure the brush thickness; it should be more than 0,5 mm. New brushes can only be fitted at the factory.
- Replace the cover plate carefully and re-tighten the fixing screws.
- Check the torque sensor:
  - Zero reading stable during rotation
  - Produce a torque by twisting the sensor by hand and note the reading
- If the torque sensor is used for precision work it should be recalibrated every year (either at the factory or by means of a suitable calibration device).

9. Repairs

Fault	Cause	Remedy
Shaft stiff to turn	Bearing defect due to: a) Torsional or flexural vibration b) High axial or radial loads c) Worn bearings d) Bent shaft	Return to factory
Zero shift less than 2 %	Torsional vibration Torsional shock	The zero reading can be readjusted at the display
Zero shift between approx. 2 and 5 % of full scale	Torque sensor has been overloaded Torsional vibration Torsional shock	The zero reading can be readjusted once at the display
Hysteresis between clockwise and anticlockwise torque	Torque sensor overloaded by high alternating loads or torsional vibration	Return to factory
Zero unstable during rotation	Slip rings and/or brushes dirty	Open and clean the torque sensor (see section 7)
Angle pulses roll out (only version QA)	Pulse disk and optical sensor are soiled by coal dust	Clean carefully

10. Ordering Key

Type 4501A □□

Measuring Ranges in N·m/
Available Versions

2	–	–	H	HA	–		**002**
6	Q	QA	H	HA	–		**006**
10	–	–	–	–	R		**010**
12	Q	QA	H	HA	–		**012**
20	–	–	H	HA	R		**020**
25	Q	QA	–	–	–		**025**
50	–	–	–	–	R		**050**
63	Q	QA	–	–	–		**063**
100	–	–	–	–	R		**100**
160	Q	QA	–	–	–		**160**
200	–	–	–	–	R		**200**
500	Q	QA	–	–	R		**500**
1 000	Q	QA	–	–	R		**1k0**

Versions
(Note Dependence with Measuring Range)

Square socket	**Q**
Square socket with rotational angle meas.	**QA**
1/4" hex	**H**
1/4" hex with rotational angle meas.	**HA**
Feather keyways	**R**

Order Example:

Type 4501A012QA

Torque sensor: rated torque 12 N·m: **012**, Version **QA**: square socket with Rotational angle measurement

11. Declaration of Conformity

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EC Declaration of Conformity
EG-Konformitätserklärung
Déclaration de conformité CE

Manufacturer Hersteller Fabricant	**Kistler Lorch GmbH** **73547 Lorch** **Germany**

declares that the product/erklärt, dass das Produkt/déclare que le produit

Name/Name/Nom	**Torque Sensor/Drehmomentsensor/Torque Capteur**
Type/Typ/Type	**4501A...**
Modules/Module/Modules	-
Options/Optionen/Options	**all/alle/toutes**

relates with the following standards/mit den folgenden Normen übereinstimmt/
est conforme aux normes suivantes

EMC Emission EMV Störaussendung Emission EMC	**EN 61000-6-4:2011-09**	**(Class A)**
EMC Immunity EMV Störfestigkeit Immunité EMC	**EN 61000-6-2:2006-03**	

Following the provisions of directive/Gemäss den Bestimmungen der Richtlinie/Conformément
aux dispositions de directive

2004/108/EG **(EMC / EMV / EMC)**

Lorch, December 2013

Franz Winter
General Manager

12. Index