

## Torque sensor with dual-range-option

Type 4503BQ...

Type 4503BQ... torque sensors with built-in speed sensor operate on the strain gage principle. An integral, digital measurement conditioning system produces analog or digital output signals.

- Rated torque: 2 ... 5 000 N·m
- Two freely selectable measuring ranges
  - Single range sensor 10... 100%
  - Dual range sensor with two freely selectable measuring ranges:
    - First measuring range 10 ... 100%
    - Second measuring range 10 ... 95%
- Speed ranges up to 50 000 1/min
- Accuracy class
  - in standard measuring range: 0.05 (100%)
  - in second measuring range: 0.1 (10 ... 95%)
- Integrated high resolution speed/angle measurement sensor up to 8 192 pulses/revolution as option
- Serial data output RS-232C and USB interface

Additional advantages of second range:

- Freely selectable torque output frequency or voltage
- One sensor for two separately calibrated measuring ranges

### Description

The dual range sensor offers the advantage of freely scalable range switching, which allows highly accurate measurement of both the peak and particularly the operating torque.

The sensor offers an integrated high resolution speed/angle measurement sensor up to 8 192 pulses/revolution, freely scalable. Additionally, the rotational direction as well as an absolute zero point (Z-line) are available.

The voltage supply and the transmission of the measuring signals between the rotating shaft and the stator are contactless. Due to the low manufacturing tolerances and the high-quality balancing of the sensor, speed limits of up to 50 000 1/min can be achieved with the high-speed "H" version.



### Application

The Type 4503BQ... torque sensors are used:

- In automotive and vehicle engineering
- In the aviation and aerospace industry
- In mechanical and process plant engineering
- In the development and production of electric motors

They are universal in application, being suitable for the development laboratory, production or quality assurance.

With a torque sensor Type 4503BQ... you will solve your measurement requirement. They are typically used for testing of electric motors, generators, drive performance, measurement of transmission or spindle drive friction, at a manual workstation or in networked, automated production cells.

## Technical data

### Mechanical basic data

Measuring range Rated torque $M_{nom}$	N·m N·m	$\pm 2 \dots 5\,000$ 2 ... 5 000
Overload capacity at limiting torque Alternating torque Rupture torque		$1.5 \times M_{nom}$ $0.7 \times M_{nom}$ $4 \times M_{nom}$
Nominal Speed		depending on measuring range and design (see details)
Balancing class Q for version "L" and "W" for version "H"		6.3 2.5
Housing material		Anodized aluminum
Protection class		IP40

### General electrical specifications

Cut-off frequency -3 dB for voltage output	kHz	10
Group delay Moment at 10 kHz	$\mu s$	<220
Noise with TP filter with Cut-off frequency (-3 dB) in measuring range 1:1	Hz % FSO	1 000 < $\pm 0.05$
Output signal at $M_{nom}$ (rated value)	VDC kHz	$\pm 0 \dots 5/10$ 100 $\pm 40$
Load resistance	k $\Omega$	>10
Operating temperature range (rated temperature range)	$^{\circ}C$	10 ... 60
Service temperature range	$^{\circ}C$	0 ... 70
Storage temperature range	$^{\circ}C$	-25 ... 80
100% control input	VDC	"On" 3.5 ... 30 "Off" 0 ... 2
Supply voltage	VDC	11 ... 30
Power consumption	W	<10
Electrical connection		12 pin/7 pin built-in connector

### Speed measuring system (option Low Speed 60 "L")

Size		1 ... 5
Measuring system		magneto-resistive
Output signal	V	5 TTL
Pulses per revolution (N)	–	60
Group delay	ms	<0,1
Load resistance	k $\Omega$	$\geq 2$
Minimum rotational speed for sufficient pulse stability	$min^{-1}$	>2

### Speed/Angle of rotation measuring system (option High Speed "H" and Low Speed "W")

Size		1 ... 5
Measuring system		magneto-resistive
Amount of pulses per turn N (depending on n and $f_{out}$ )		$2 \times 1 \dots 8\,192$
Group delay time between signal input rotation to signal output	ms	<0,1
Load resistance	k $\Omega$	$\geq 2$
Minimum rotation for sufficient pulse stability Rotation angle (TTL)	1/min	>0
Output signal (TTL)	V	5 TTL
Max. jitter per edge J	$^{\circ}$	$\pm 0,03$
Jitter of the oscillation period $J_p$	%	$= J[^{\circ}] * N / 180^{\circ} * 100$
Maximum permitted output frequency $f_{out}$	kHz	500 <sup>1)</sup>
Amount of reference pulses per turn		1
Reference pulse width	$^{\circ}$	0,25 x Period duration

<sup>1)</sup> Maximum numbers of output pulses  $N^{max}$  = maximum allowable output frequency  $f_{out}$  (Hz) x 60 / rotational speed n ( $min^{-1}$ ).  
With 8 192 pulses means a maximum of 3 660  $min^{-1}$ .

### Noise immunity (EN 61326-1, Table 2)

Electromagnetic field (AM)	V/m	10
Magnetic field	A/m	100
Electrostatic discharge Contact discharge (ESD)	kV	8
Electrostatic discharge Air discharge (ESD)	kV	4
Fast transients (burst)	kV	1
Impulse voltage (surge)	kV	1
Conducted emissions (AM)	V	10

### Mechanical shock (EN 60068-2-27)

Number of cycles	–	1 000
Cycle time	ms	3
Acceleration shock	$m/s^2$	650

### Vibrational loads in 3 directions (EN 60068-2-6)

Frequency range	Hz	10 ... 2 000
Load duration	h	2.5
Acceleration (Amplitude)	$m/s^2$	200

### Measurement features

Size/Rated torque $M_{nom}$	N·m	2	5	10	20	50	100	200	500	–	–	–	
	kN·m	–	–	–	–	–	–	–	–	1	2	5	
Torque measuring system													
Nominal speed	$n_{nom}$												
Version "L" + "W" (Low Speed)	min <sup>-1</sup>	20 000			12 000			8 000			5 000		
Version "H" (High Speed)	min <sup>-1</sup>	50 000			30 000			20 000			10 000		
<b>Measurement features in 1st measuring range 10 ... 100%</b>													
Accuracy class		0.05 (100%) / 0.1 (10 ... 95%)											
Linearity error including hysteresis	% FSO	<±0.05 / <±0.1											
Rel. standard deviation of repeatability	% FSO	<±0.05 / <±0.1											
Temperature influence zero point	%/10 K	<±0.05 / <±0.1											
Temperature influence nominal value	%/10 K	<±0.05 / <±0.1											

Size/Rated torque $M_{nom}$	N·m	2	5	10	20	50	100	200	500	–	–	–
	kN·m	–	–	–	–	–	–	–	–	1	2	5
<b>Measurement features in the 2nd measuring range 10 ... 95%</b>												
Accuracy class		0.1										
Linearity error including hysteresis	% FSO	<±0.1										
Rel. standard deviation of repeatability	% FSO	<±0.1										
Temperature influence zero point	%/10 K	<±0.1										
Temperature influence nominal value	%/10 K	<±0.1										

### General technical data

Size/Rated torque $M_{nom}$	N·m	2	5	10	20	50	100	200	500	–	–	–
	kN·m	–	–	–	–	–	–	–	–	1	2	5
<b>Version "L" + "W" (Low Speed)</b>												
Longitudinal load limit on the drive side <sup>1)</sup>	N	80			150			250			450	
Transverse load limit on the drive side <sup>1)</sup>	N	120			280			700			1 500	
Longitudinal load limit on the measurement side <sup>1)</sup>	N	80			120			200			350	
Transverse load limit on the measurement side <sup>1)</sup>	N	10	28	30	35	200			450			700
<b>Version "H" (High Speed)</b>												
Longitudinal load limit on the drive side <sup>1)</sup>	N	30			75			170			250	
Transverse load limit on the drive side <sup>1)</sup>	N	100			200			400			800	
Longitudinal load limit on the measurement side <sup>1)</sup>	N	30			40			100			160	
Transverse load limit on the measurement side <sup>1)</sup>	N	10	28	30	35	100			250			450

### Other technical data

Size/Rated torque $M_{nom}$	N·m	2	5	10	20	50	100	200	500	–	–	–
	kN·m	–	–	–	–	–	–	–	–	1	2	5

### Mechanical basic data

Torsional rigidity $c_T$	kN·m/rad	0.38	0.78	1.72	2.70	11.7	15.2	74.0	97.8	134	506	685
Torsion angle at $M_{nom}$	°	0.30	0.37	0.33	0.43	0.25	0.38	0.15	0.29	0.43	0.23	0.42
Proportional mass moment of inertia of rotor measuring side	kgcm <sup>2</sup>	0.052		0.062		0.47	0.48	6.90	6.96	7.14	59.1	61.0
Proportional mass moment of inertia of rotor drive side	kgcm <sup>2</sup>	0.285		0.276		0.71	0.72	5.99	6.41	6.59	58.7	60.6
Mass moment of inertia rotor	kgcm <sup>2</sup>	0.337		0.338		1.18	1.19	12.9	13.4	13.7	118	122
Natural frequency of the rotor (torsional vibration)	kHz	1.95	1.99	2.55	2.55	2.46	2.99	1.88	2.33	2.70	1.67	1.96
Total weight sensor, approx.	kg	1.5			2.0			6.5			22.0	

### Balancing class according to DIN ISO 1940

Version "L" + "W" (Low Speed)	–	G 6.3										
Version "H" (High Speed)	–	G 2.5										

### Nominal lifetime of bearings $L_{10h}$ according to ISO2815 281 <sup>2)</sup>

Version "L" + "W" (Low Speed)	h	18632			24400			23900			21500	
Version "H" (High Speed)	h	12009			16275			11470			14638	

<sup>1)</sup> The effects of permissible parasitic forces can be up to 1% of nominal torque. Each type of irregular stress (Longitudinal or transverse force) is only permitted up to its specific load limit, provided none of the others will occur at the same time. If this condition is not met, the limit values must be reduced. If 50% of Transverse load limit occur at the same time, only 50% of Longitudinal load limit is permissible and the nominal (rated) torque must not be exceeded.

<sup>2)</sup> Nominal life in operating hours, which is reached or exceeded by 90% of a sufficiently large number of identical bearings before the first signs of material fatigue occur. The specified values are only valid if the load, speed, oscillation, shock and temperature limits are observed.

**Dimensions Type 4503BQ..., measuring ranges 2 / 5 / 10 and 20 N·m**

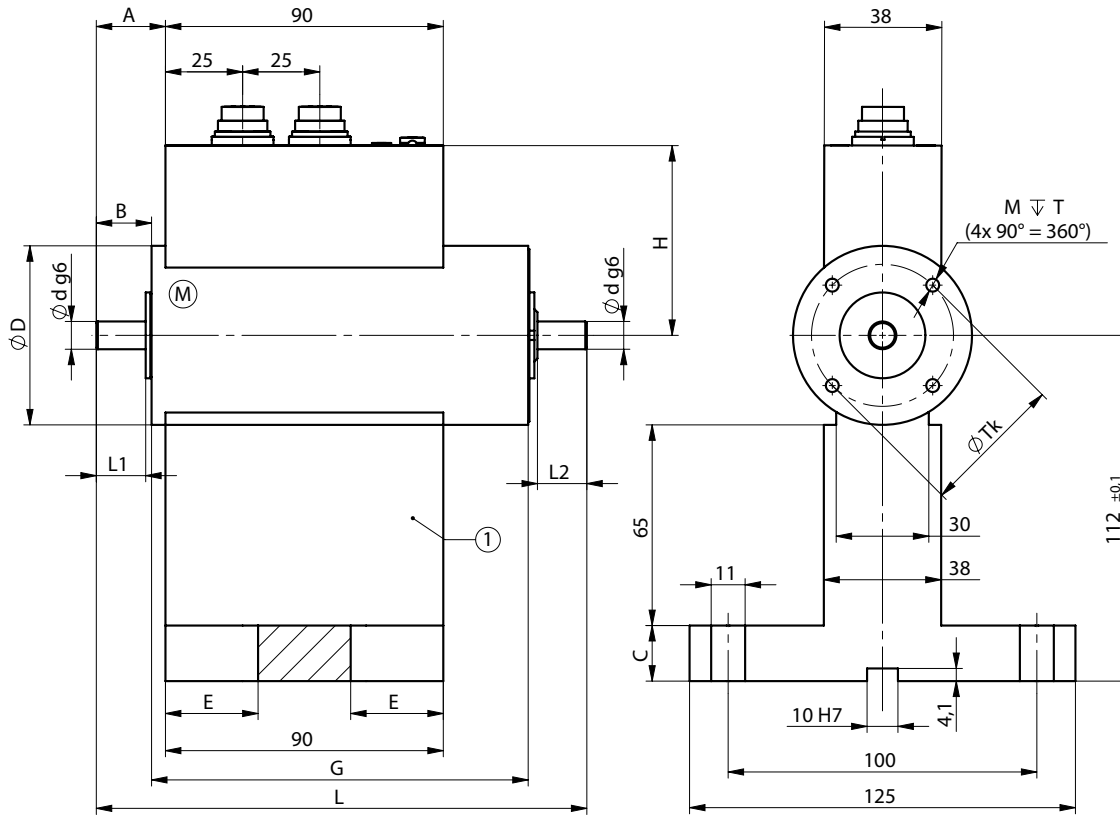


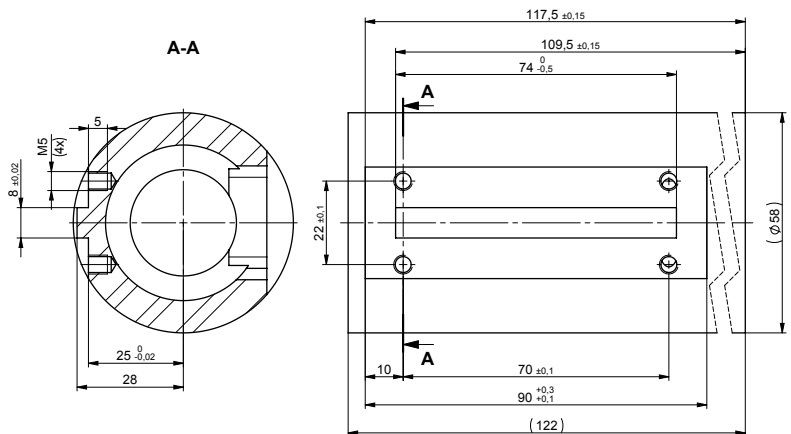
Fig. 1: Type 4503BQ... size 2  
All dimensions without tolerances comply with ISO 2768-mH

① = Option mounting base "GU"  
Ⓜ = Measuring end

**Dimensions size 2 in mm**

Size	2	
Rated torque N·m	2 / 5	10 / 20
L	163	167
L1	18	20
L2	18	20
$\phi D$	58	58
$\phi d g6$	10	12
A	24.5	26.5
B	20	22
C	18	
E	30	
G	122	
H	61.5	
$\phi Tk$	46	
M	M5 (4x90°)	
T	6 deep	

**Dimensions for mounting base (GU)**



Connecting dimensions for mounting base	Size 2
N·m	Tightening torque
2 / 5	6 N·m
10 / 20	(strength class of the screw: 8.8)

All dimensions without tolerances comply with ISO 2768-mH

4503BQ\_003-526e-12.22



**Dimensions Type 4503BQ..., Measuring ranges 200 / 500 / 1 000 N·m**

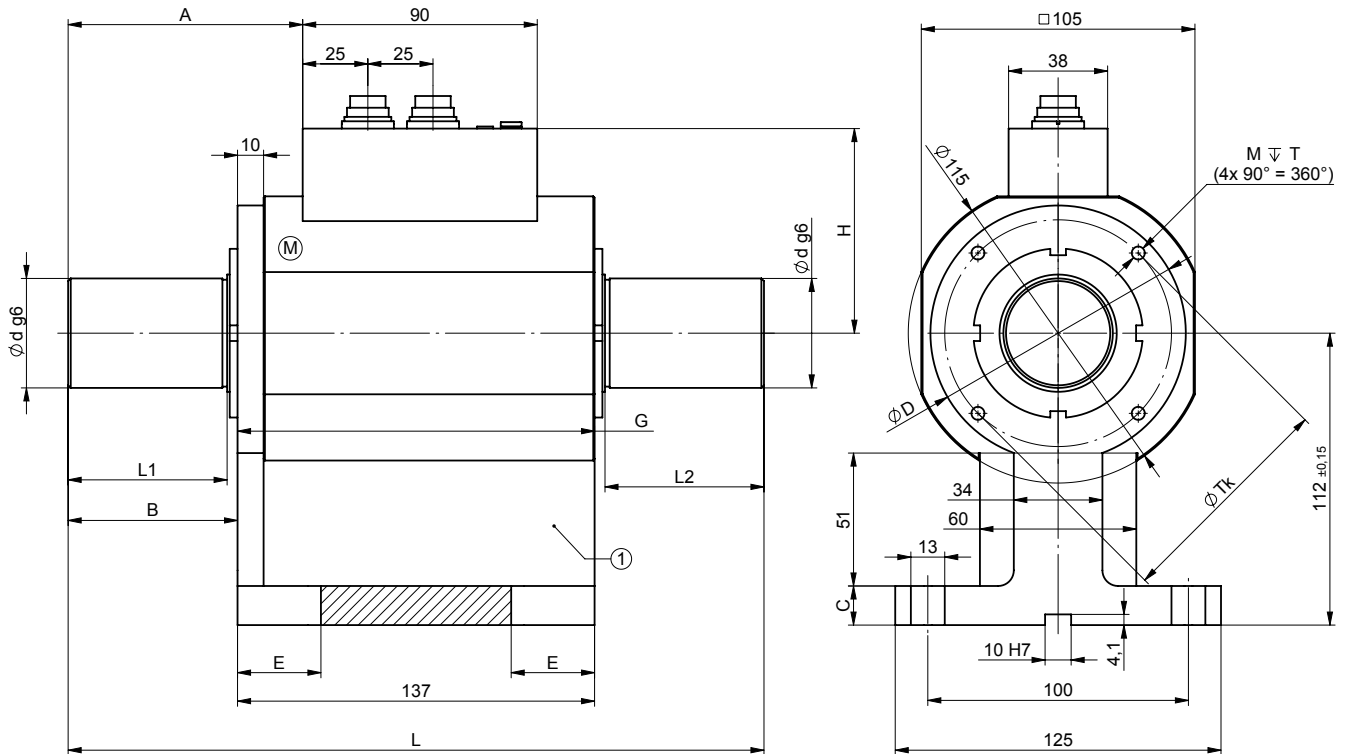


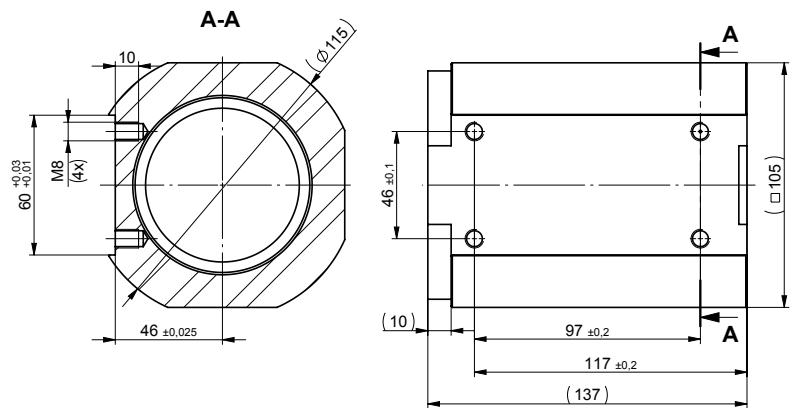
Fig. 3: Type 4503BQ... size 4  
All dimensions without tolerances comply with ISO 2768-mH

① = Option mounting base "GU"  
Ⓜ = Measuring end

**Dimensions size 4 in mm**

Size	4
Rated torque N·m	200 / 500 / 1 000
L	267
L1	61
L2	61
øD	98
ød g6	42
A	90
B	65
C	15
E	32
G	137
H	78.5
øTk	87
M	M6 (4x90°)
T	12 deep

**Dimensions for mounting base (GU)**



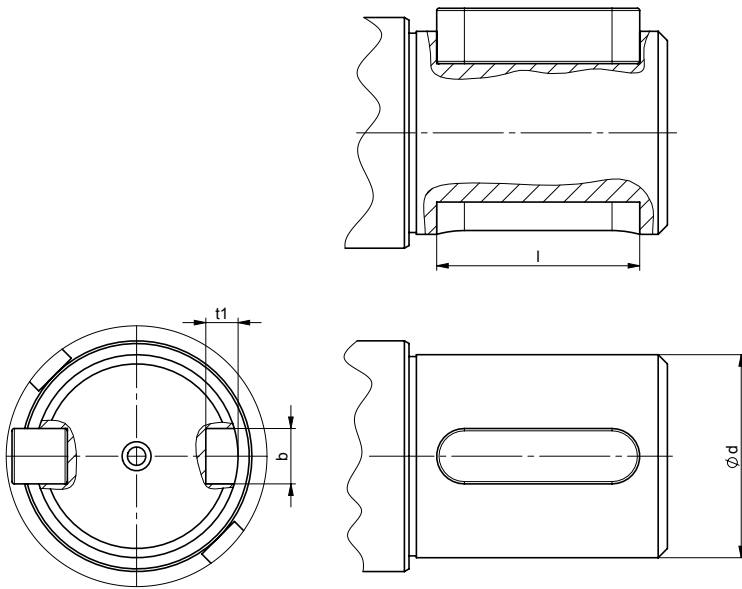
Connecting dimensions for mounting base	Size 4
N·m	<b>Tightening torque</b>
200	25 N·m (strength class of the screw: 8.8)
500	
1 000	

All dimensions without tolerances comply with ISO 2768-mH

4503BQ\_003-526e-12.22





**Dimensions feather key groove acc. to DIN 6885-1 (option P1)**

**Dimensions in mm**

Size		2		3	4	5
Rated torque N·m		2 / 5	10 / 20	50 / 100	200 / 500 / 1 000	2 000 / 5 000
$\varnothing d_{g6}$	mm	10	12	22	42	70
$b^{p9}$	mm	3	4	6	12	20
t1	mm	1.8 <sup>+0,1</sup>	2.5 <sup>+0,1</sup>	3.5 <sup>+0,1</sup>	5 <sup>+0,2</sup>	7.5 <sup>+0,2</sup>
l	mm	14 <sup>+0,2</sup>	16 <sup>+0,2</sup>	22 <sup>+0,2</sup>	50 <sup>+0,3</sup>	110 <sup>+0,3</sup>

Feather key according to DIN 6885-1

**Mounting torque sensor Type 4503BQ... between drive and brake**

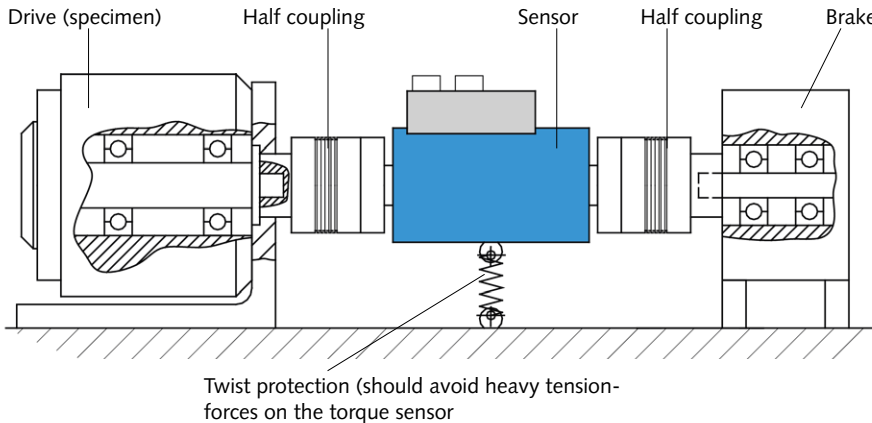


Fig. 5: Installation without holding bracket or housing base (GU).

**Mounting torque sensor Type 4503BQ... with holding bracket (GU) or housing base**

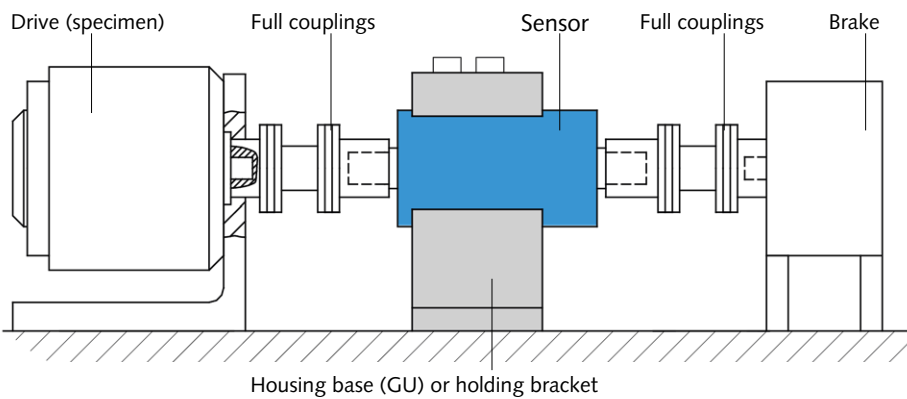
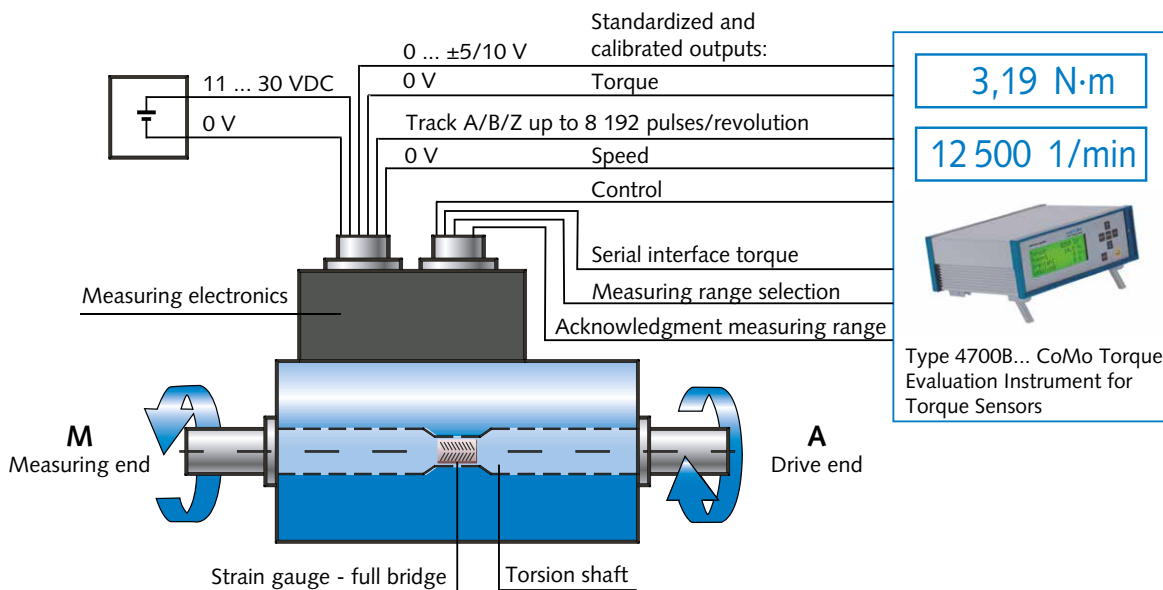


Fig. 6: Installation with holding bracket or housing base (GU).

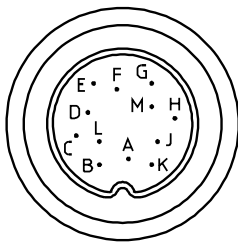
**Principle of function**



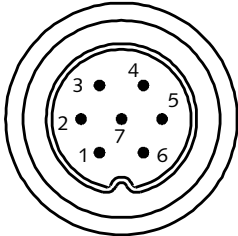
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**Electrical connections**

**Pin allocation of the 12 Pin built-in standard connector**

	Function	PIN	Description
	Supply voltage	F A	+U <sub>B</sub> GND 11 ... 30 VDC, power consumption <10 W Ground relating to +U <sub>B</sub>
	Shield	M	In sensor connected to housing
	Torque output	C	U <sub>A</sub> Voltage output ±5/10 VDC at ±M <sub>nom</sub> at >10 kΩ 5/10 VDC at control signal activation
		D	AGND Ground relating to U <sub>A</sub> Frequency output F <sup>±</sup> Frequency output >2 kΩ 100 kHz ± 40 kHz Ground relating to F <sub>A</sub>
	Speed-/angle of rotation pulses	H	Track A Active, TTL level
		G	Track B Active, TTL level, 90° displaced only option H, W
		J	Track Z Active, TTL level, reference pulse only option H, W
	100% control input	K	Control Off: 0 ... 2 VDC On: 3.5 ... 30 VDC R <sub>in</sub> = 10 kΩ
	RS-232C interface (CoMo Torque)	B L	TXD RXD Digital send path to the CoMo Torque Digital receive path
	Digital ground potential	E	DGND Ground relating to speed- or angle of rotation pulses, control input, digital connection to RS-232C

**Pin allocation of the 7 Pin built-in connector for range switch**

	Function	PIN	Description
	Measuring range selection	1	Amplification Normal (1:1) with 0 ... 2 VDC Extended (1:x) with 3.5 ... 30 VDC
	100% control input	4	Control Off: 0 ... 2 VDC On: 3.5 ... 30 VDC
		7	OGND Opto isolated ground for measuring range selection and control input
	RS-232C interface	5	TXD Serial send path of the torque sensor
		6	RXD Serial receive path of the torque sensor
		3	DGND Ground relating the RS-232C interface
	Scaling selector switch Acknowledgment output	2	ACK 0 VDC at normal (1:1) 24 VDC at (1:x)

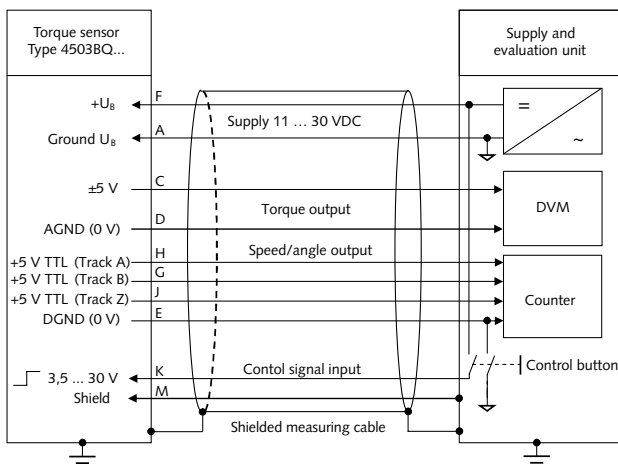


Fig. 5: Connection diagram of 12 pin built-in connector (standard)

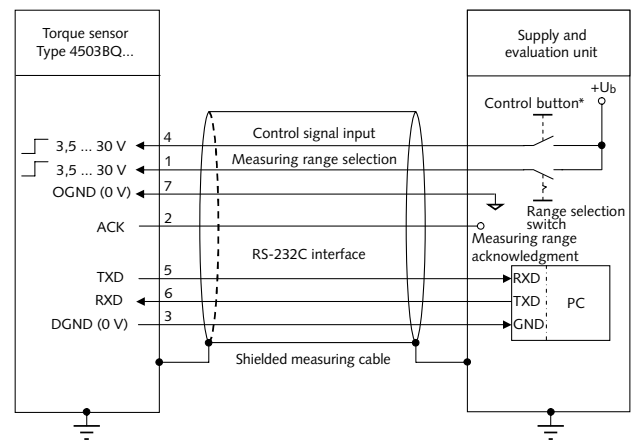


Fig. 6: Connection diagram of 7 pin built-in connector



**U<sub>B</sub> GND (A) and AGND (D) must not be connected (electronics can be damaged).**  
It is recommended to use a differential amplifier input for the output U<sub>A</sub>/AGND.

4503BQ\_003-526e-12.22

<b>Included accessories</b>	<b>Type/Art. No.</b>
• USB Cable	55115378
• SensorTool	4706A
• Feather key (depending on sensor configuration)	
<b>Optional accessories</b>	<b>Type/Art. No.</b>
• Mounting base "GU", for measuring ranges 0.2 ... 20 N·m	18030861
• Mounting base "GU", for measuring ranges 50 ... 100 N·m	18030862
• Mounting base "GU", for measuring ranges 200 ... 1 000 N·m	18030863
• Mounting base "GU", for measuring ranges 2 000 ... 5 000 N·m	18030864
• Female connector with solder eye 12 pin	18008371
• Female connector with solder eye 7 pin	18008363
• Connection cable, 5 m, 12 pin	18008935
• Connection cable, 5 m, 12 pin – open ends	18008943
• Connection cable, 5 m, 7 pin – open ends	18008996
• Connection cable 2.5 m, 12 pin – CoMo Torque	18008967
• Connection cable 5 m, RS-232C 7 pin/D-Sub 9 pin	18008994
• Connection cable, 5 m, 12 pin angle connector – open ends	18008956
• Connection cable, 5 m, 7 pin angle connector – open ends	18008702
• Connection cable 5 m, 12 pin – maXYmos TL	18026961
• Connection cable 5 m, 7 pin – maXYmos TL	18031756
• Connection cable 5 m, 12 pin – maXYmos BL	18029193
• ControlMonitor CoMo Torque Evaluation instrument for torque sensors	4700B...

Cable according to the data sheet 000-615.

## Ordering key Q version (Q = special calibration)

Type 4503BQ

### Measuring ranges in N·m

2	002
5	005
10	010
20	020
50	050
100	100
200	200
500	500
1 000	1K0
2 000	2K0
5 000	5K0

### Pulses per revolution

Low speed 60	L
High speed up to 2 x 8 192 + Z	H
Low speed up to 2 x 8 192 + Z	W

### Feather key groove

Without	P0
With	P1

### Output signal

Voltage ±5 VDC and Frequency 100 ±40 kHz	00
Voltage ±10 VDC and Frequency 100 ±40 kHz	B1

### Calibration

WKS 1 – Single range	KA0
WKS 1 – Dual range 1st XXX % and 2nd XX %	KAX
WKS 2 – Single range	WA0
WKS 2 – Dual range 1st XXX % and 2nd XX %	WAX
DAkS 3 – Single range, 3 measuring point	DK3
DAkS 3 – Dual range, 3 measuring point 1st XXX % and 2nd XX %	D3X
DAkS 5 – Single range, 5 measuring point	DK5
DAkS 5 – Dual range, 5 measuring point 1st XXX % and 2nd XX %	D5X
DAkS 8 – Single range, 8 measuring point	DK8
DAkS 8 – Dual range, 8 measuring point 1st XXX % and 2nd XX %	D8X

### 2nd Output range

95%	95
90%	90
85%	85
80%	80
75%	75
70%	70
65%	65
60%	60
55%	55
50%	50
45%	45
40%	40
35%	35
30%	30
25%	25
20%	20
15%	15
10%	10
No selection	00

### 1st Output range

100%	100
95%	095
90%	090
85%	085
80%	080
75%	075
70%	070
65%	065
60%	060
55%	055
50%	050
45%	045
40%	040
35%	035
30%	030
25%	025
20%	020
15%	015
10%	010

Our calibration service D-K-15127-01-00 provides traceable calibrations for torque sensors from all manufacturers.

Order example:

**Type 4503BQ050LP000WAX07060**

Type 4503BQ..., Torque sensor with measuring range: rated torque 50 N·m: **050**, version L: max. speed 12 000 min<sup>-1</sup>, without feather key groove: **P0**, Standard output signal ±5 VDC and frequency 100 ±40 kHz: **00**, calibration WKS2 dual range: **WAX**, 1st output range 70%: **070**, 2nd output range 60%: **60**

### Definition of calibration terms:

- **WKS 1:** Works calibration at 5 points right, 3 points left
- **WKS 2:** Works calibration at 5 points right and left, and repeat series
- **DAkS:** Calibration per DIN 51309