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Torque sensor

Type 4503B...

with dual-range-option

Type 4503B... 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: 0.2 ... 5 000 N·m
- Ratio for second range: 1:10 or 1:5 of rated torque
- Speed ranges up to 50 000 1/min
- Accuracy class
  in standard measuring range: 0.05/0.1
  in the extended measuring range: 0.1/0.2/0.4
- 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 4503B... 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 4503B... 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.

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Technical data

Mechanical basic data

Measuring range	N·m	±0.2 ... 5 000
Rated torque M_{nom}	N·m	0.2 ... 5 000
Overload capacity at limiting torque		1.5 x M_{nom}
Alternating torque		0.7 x M_{nom}
Rupture torque		4 x 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	µs	<220
Noise with TP filter with Cut-off frequency (-3 dB) in measuring range 1:1	Hz % FSO	1 000 <±0.05
Output signal at M_{nom} (rated value)	VDC kHz	±0 ... 5/10 100 ±40
Load resistance	kΩ	>10
Operating temperature range (rated temperature range)	°C	10 ... 60
Service temperature range	°C	0 ... 70
Storage temperature range	°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		magnetoresistive
Output signal	V	5 TTL
Pulses per revolution (N)	–	60
Group delay	ms	<0.1
Load resistance	kΩ	≥2
Minimum rotational speed for sufficent pulse stability	min^{-1}	>2

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

Size		1 … 5
Measuring system		magnetoresistive
Amount of pulses per turn N (depending on n and f_{out})		2x 1 … 8 192
Group delay time between signal input rotation to signal output	ms	<0.1
Load resistance	kΩ	≥2
Minimum rotation for sufficient pulse stability Rotation angle (TTL)	1/min	>0
Output signal (TTL)	V	5 TTL
Max. jitter per edge J	°	±0.03
Jitter of the oscillation period Jp	%	= J[°] * N / 180° *100
Maximum permitted output frequency f_{out}	kHz	500 [1]
Amount of reference pulses per turn		1
Reference pulse width	°	0.25 x Period duration

[1] 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

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Measurement features

Size/Rated torque M_{nom}	N·m	**0.2**	**0.5**	**1**	**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^{-1}	20 000							12 000		8 000			5 000	
Version "H" (High Speed)	min^{-1}	50 000							30 000		20 000			10 000	
Measurement features in the measuring range 1:1 (single range)															
Accuracy class		0.1			0.05										
Linearity error including hysteresis	% FSO	<±0.1			<±0.05										
Rel. standard deviation of repeatability	% FSO	<±0.1			<±0.05										
Temperature influence zero point	%/10 K	<±0.1			<±0.05										
Temperature influence nominal value	%/10 K	<±0.1			<±0.05										

Size/Rated torque M_{nom}	N·m	**0.2**	**0.5**	**1**	**2**	**5**	**10**	**20**	**50**	**100**	**200**	**500**	–	–	–
	kN·m	–	–	–	–	–	–	–	–	–	–	–	**1**	**2**	**5**
Measurement features in the measuring range 1:5 / 1:10															
Accuracy class		0.4	0.2	0.1											
Linearity error including hysteresis	% FSO	<±0.4	<±0.2	<±0.1											
Rel. standard deviation of repeatability	% FSO	<±0.4	<±0.2	<±0.1											
Temperature influence zero point	%/10 K	<±0.4	<±0.2	<±0.1											
Temperature influence nominal value	%/10 K	<±0.4	<±0.2	<±0.1											

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General technical data

Size/Rated torque M_{nom}	N·m	0.2	0.5	1	2	5	10	20	50	100	200	500	–	–	–
	kN·m	–	–	–	–	–	–	–	–	–	–	–	1	2	5
Version "L" + "W" (Low Speed)															
Longitudinal load limit on the drive side [1]	N	80							150		250			450	
Transverse load limit on the drive side [1]	N	120							280		700			1 500	
Longitudinal load limit on the measurement side [1]	N	50			80				120		200			350	
Transverse load limit on the measurement side [1]	N	1.6	3.3	5	10	28	30	35	200		450			700	
Version "H" (High Speed)															
Longitudinal load limit on the drive side [1]	N	30							75		170			250	
Transverse load limit on the drive side [1]	N	100							200		400			800	
Longitudinal load limit on the measurement side [1]	N	30							40		100			160	
Transverse load limit on the measurement side [1]	N	1.6	3.3	5	10	28	30	35	100		250			450	

Other technical data

Size/Rated torque M_{nom}	N·m	0.2	0.5	1	2	5	10	20	50	100	200	500	–	–	–
	kN·m	–	–	–	–	–	–	–	–	–	–	–	1	2	5
Mechanical basic data															
Torsional rigidity c_T	kN·m/rad	0.08		0.15	0.38	0.78	1.72	2.70	11.7	15.2	74.0	97.8	134	506	685
Torsion angle at M_{nom}	°	0.14	0.35	0.38	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	kgcm²	0.051			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	kgcm²	0.285			0.285		0.276		0.71	0.72	5.99	6.41	6.59	58.7	60.6
Mass moment of inertia rotor	kgcm²	0.336			0.337		0.338		1.18	1.19	12.9	13.4	13.7	118	122
Natural frequency of the rotor (torsional vibration)	kHz	1.16		1.51	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 [2]															
Version "L" + "W" (Low Speed)	h	18632							24400		23900			21500	
Version "H" (High Speed)	h	12009							16275		11470			14638	

[1] 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.

[2] 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.

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Dimensions Type 4503B..., Measuring ranges 0.2 / 0.5 / 1 / 2 and 5 / 10 and 20 N·m

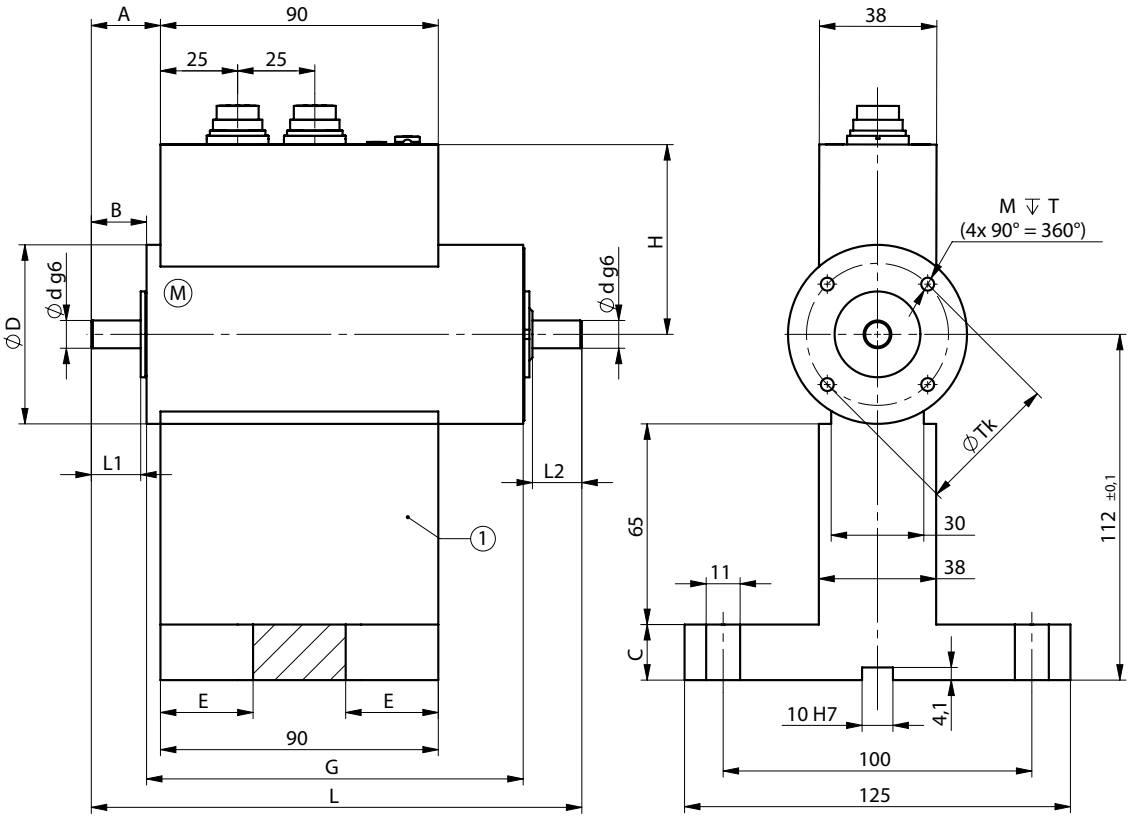


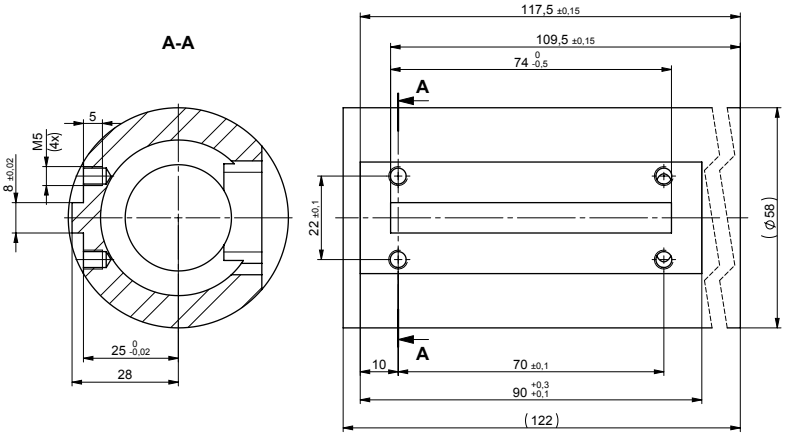
Fig. 1: Type 4503B... Size 1 and 2
All dimensions without tolerances comply with ISO 2768-mH

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

Dimensions size 1 and 2 in mm

Size	1			2	
Rated torque N·m	0.2	0.5	1	2 / 5	10 / 20
L	159			163	167
L1	16			18	20
L2	16			18	20
øD	58			58	58
ød g6	9			10	12
A	22.5			24.5	26.5
B	18			20	22
C	18			18	
E	30			30	
G	122			122	
H	61.5			61.5	
øTk	46			46	
M	M5 (4x90 °)			M5 (4x90 °)	
T	6 deep			6 deep	

Dimensions for mounting base (GU)



Connecting dimensions for mounting base	Size 1 and 2
N·m	Tightening torque
0.2 / 0.5 / 1	6 N·m (strength class of the screw: 8.8)
2 / 5	
10 / 20	

All dimensions without tolerances comply with ISO 2768-mH

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Dimensions Type 4503B..., Measuring ranges 50 / 100 N·m

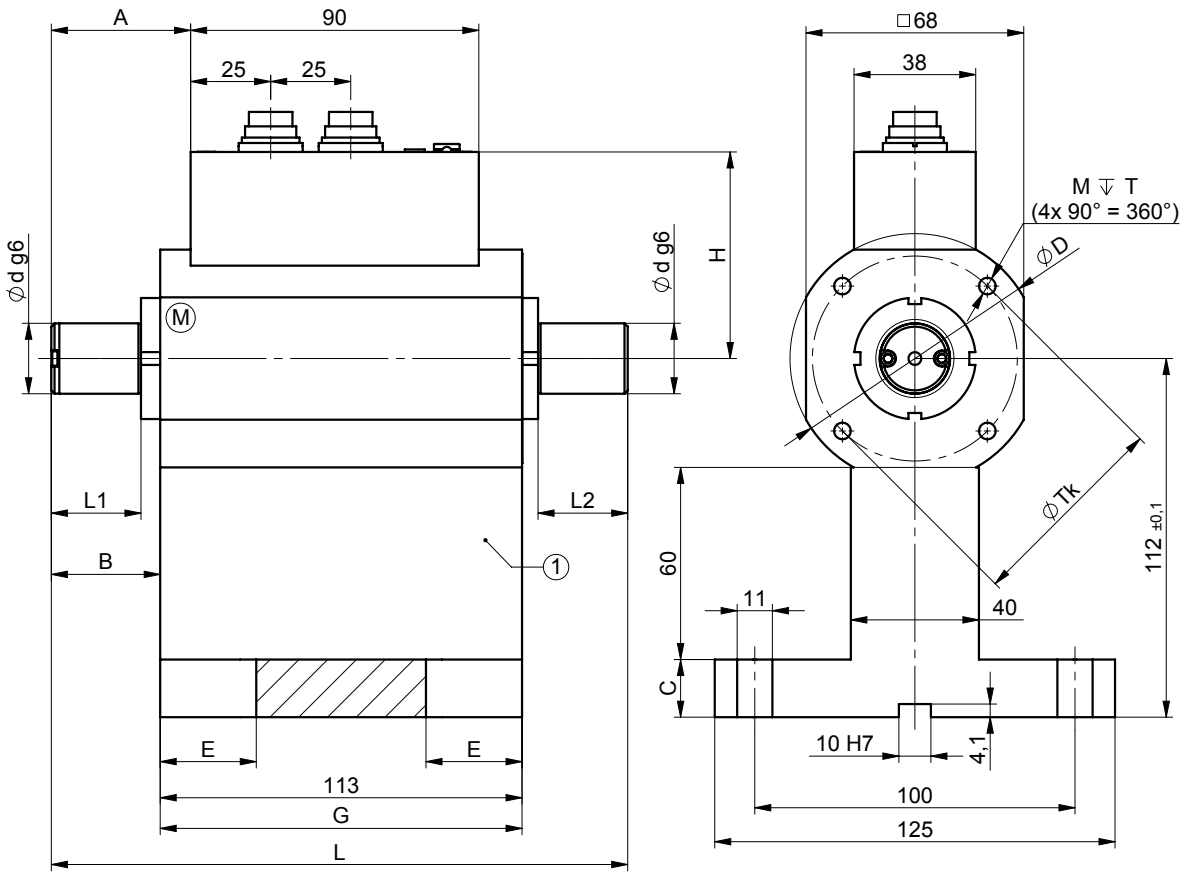


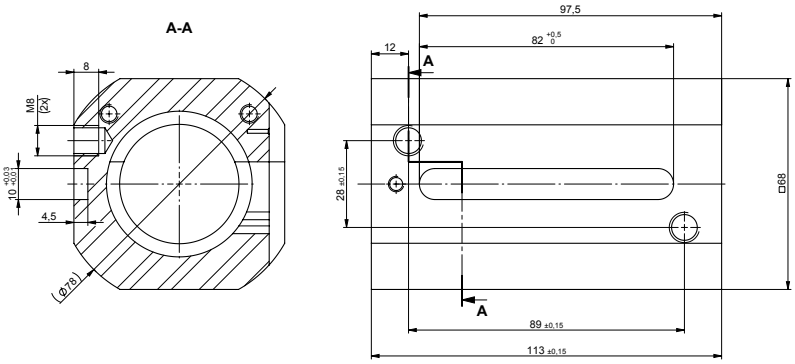
Fig. 2: Type 4503B... Size 3
All dimensions without tolerances comply with ISO 2768-mH

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

Dimensions size 3 in mm

Size	3
Rated torque N·m	**50 / 100**
L	180
L1	28
L2	28
øD	78
ød g6	22
A	43.5
B	34
C	18
E	30
G	113
H	64.5
øTk	64
M	M6 (4x90 °)
T	12 deep

Dimensions for mounting base (GU)



Connecting dimensions for mounting base	Size 3
N·m	**Tightening torque**
50	25 N·m (strength class of the screw: 8.8)
100	

All dimensions without tolerances comply with ISO 2768-mH

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

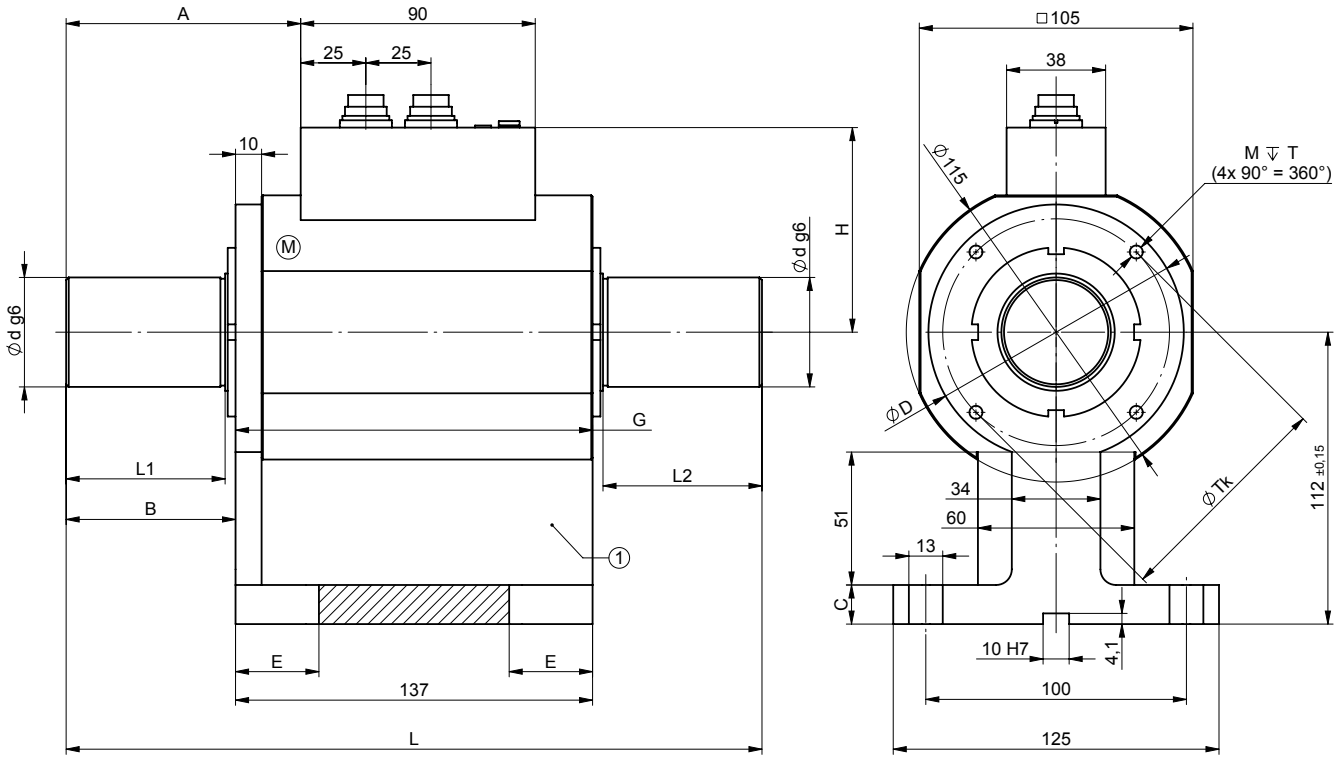


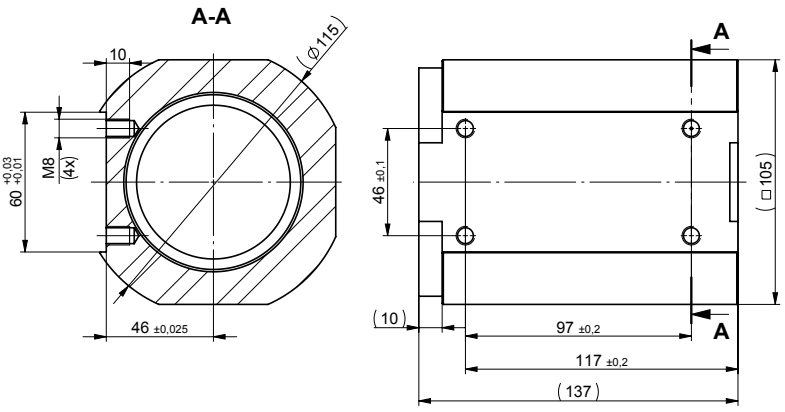
Fig. 3: Type 4503B... size 4
All dimensions without tolerances comply with ISO 2768-mH

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	Tightening torque
200	25 N·m (strength class of the screw: 8.8)
500	
1 000	

All dimensions without tolerances comply with ISO 2768-mH

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Dimensions Type 4503B..., Measuring ranges 2 000 / 5 000

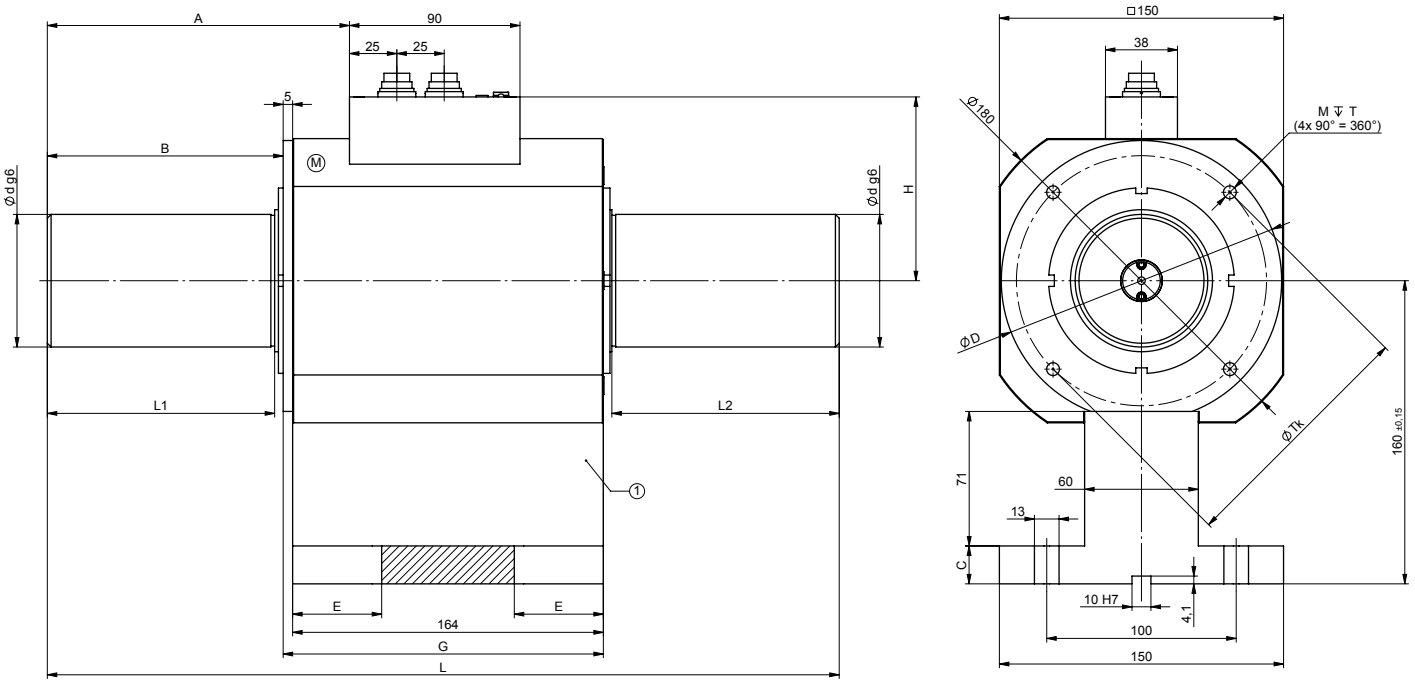


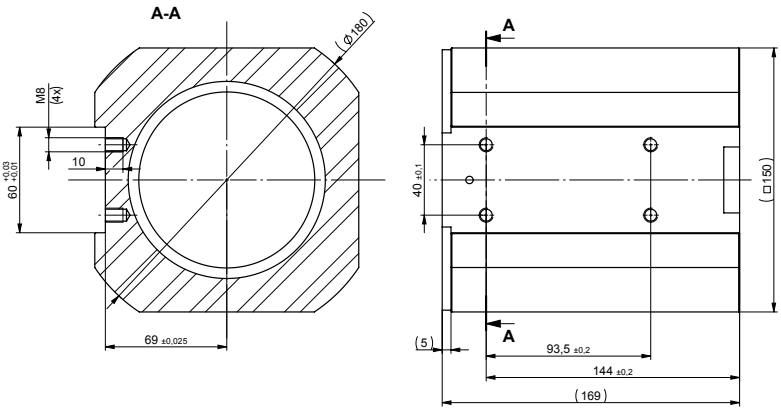
Fig. 4: Type 4503B... Size 5
All dimensions without tolerances comply with ISO 2768-mH

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

Dimensions size 5 in mm

Size	5
Rated torque N·m	**2 000 / 5 000**
L	418
L1	120
L2	120
øD	148
ød g6	70
A	159.5
B	124.5
C	20
E	47
G	169
H	97
øTk	132
M	M8 (4x90 °)
T	16 deep

Dimensions for mounting base (GU)



Connecting dimensions for mounting base	Size 5
N·m	**Tightening torque**
2 000	25 N·m (strength class of the screw: 8.8)
5 000	

All dimensions without tolerances comply with ISO 2768-mH

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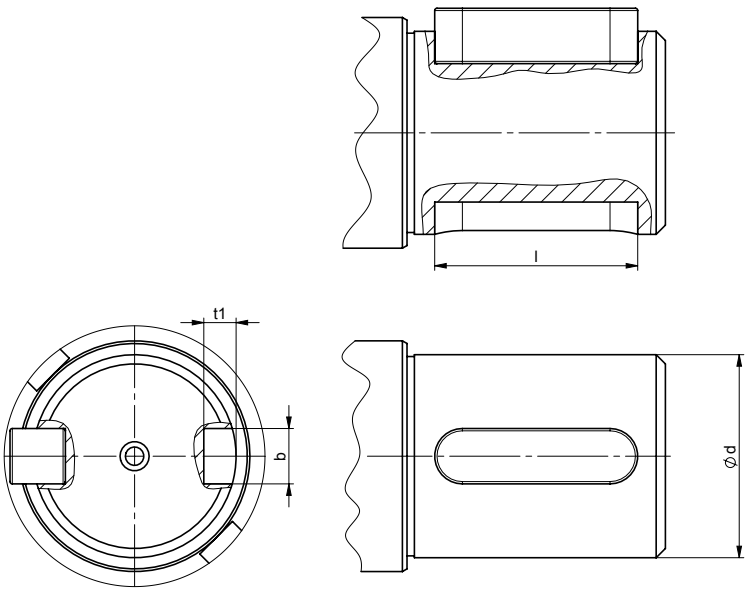
Dimensions feather key groove acc. to DIN 6885-1 (option P1)



Dimensions in mm

Size		1			2		3	4	5
Rated torque N·m		0.2	0.5	1	2 / 5	10 / 20	50 / 100	200 / 500 / 1 000	2 000 / 5 000
$ød_{g6}$	mm	9			10	12	22	42	70
b^{P9}	mm	3			3	4	6	12	20
t1	mm	$1.8^{+0,1}$			$1.8^{+0,1}$	$2.5^{+0,1}$	$3.5^{+0,1}$	$5^{+0,2}$	$7.5^{+0,2}$
l	mm	$12^{+0,2}$			$14^{+0,2}$	$16^{+0,2}$	$22^{+0,2}$	$50^{+0,3}$	$110^{+0,3}$

Feather key according to DIN 6885-1

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Mounting torque sensor Type 4503B... between drive and brake

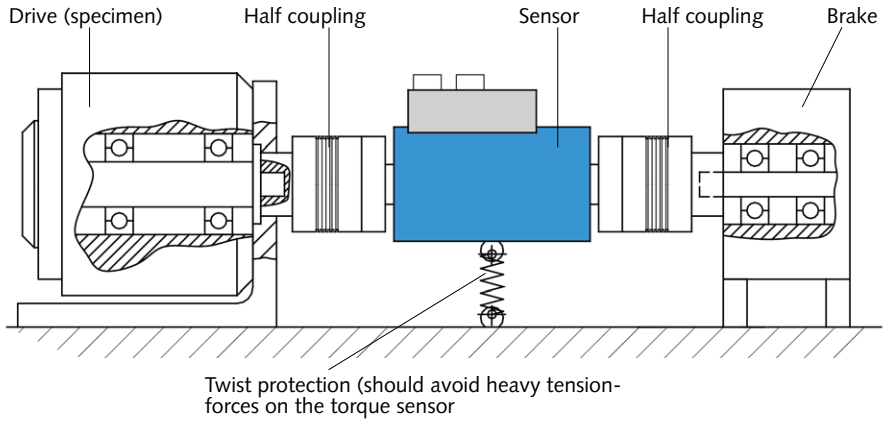


Fig. 5: Installation without holding bracket or housing base (GU).

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

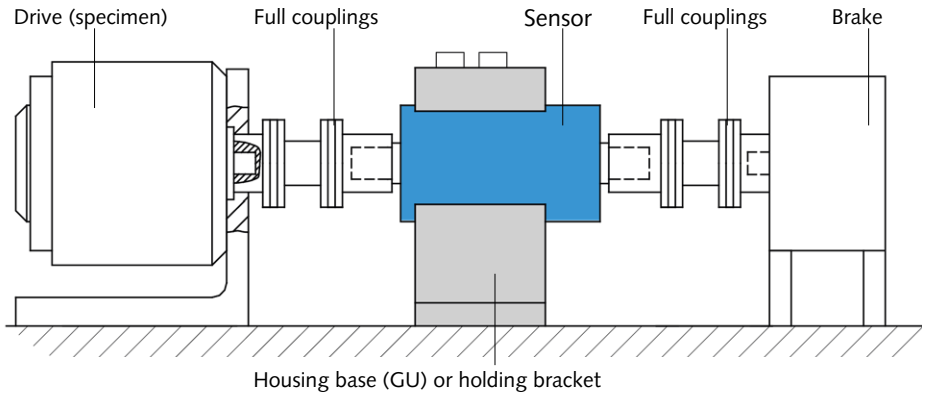
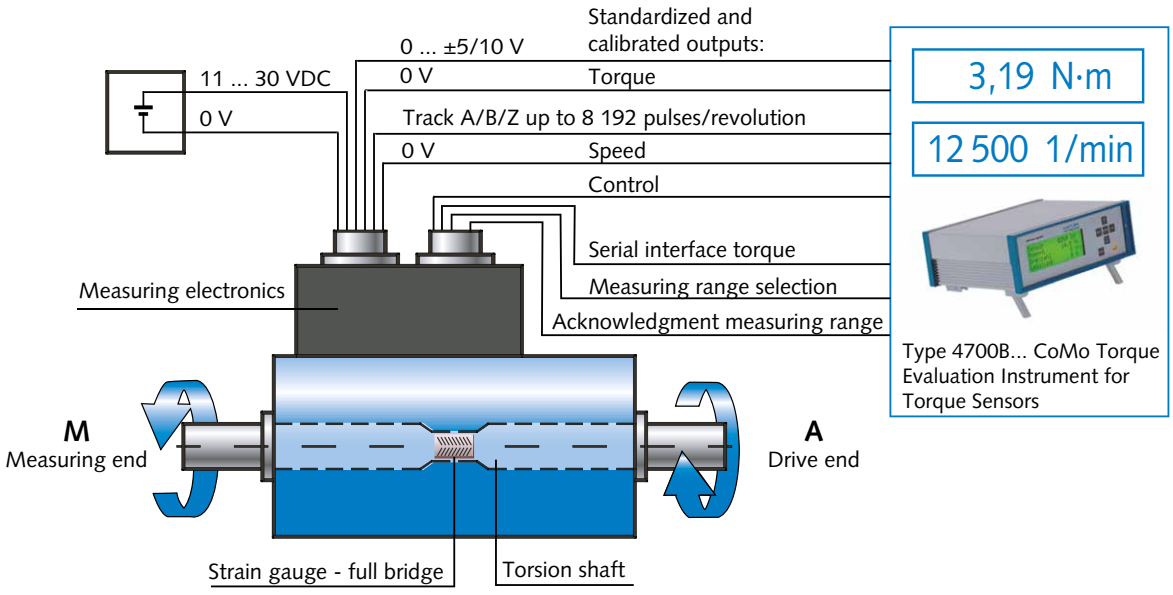


Fig. 6: Installation with holding bracket or housing base (GU).

Principle of function



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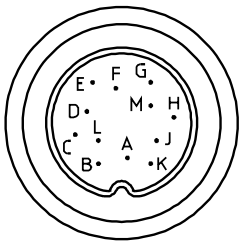
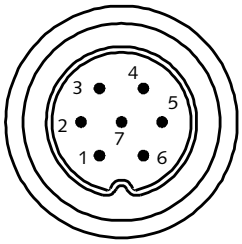
Electrical connections

Pin allocation of the 12 Pin built-in standard connector



Function	PIN	Description		
Supply voltage	F	$+U_B$	11 ... 30 VDC, power consumption <10 W	
	A	GND	Ground relating to $+U_B$	
Shield	M		In sensor connected to housing	
Torque output	C	U_A	Voltage output ±5/10 VDC at $\pm M_{nom}$ at >10 kΩ 5/10 VDC at control signal activation	Frequency output F^A Frequency output >2 kΩ 100 kHz ± 40 kHz
	D	AGND	Ground relating to U_A	Ground relating to F_A
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 $R_{i,K}$ = 10 kΩ	
RS-232C interface (CoMo Torque)	B	TXD	Digital send path to the CoMo Torque	
	L	RXD	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)

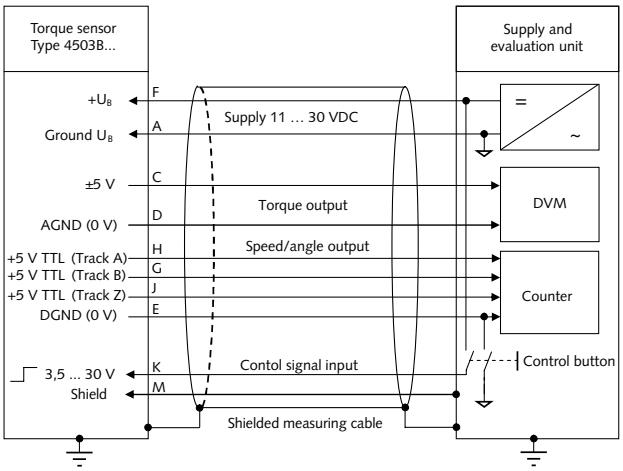


Fig. 5: Connection diagram of 12 pin built-in connector (standard)

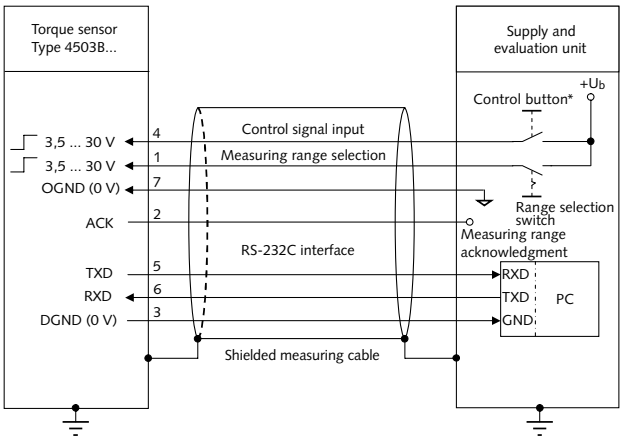


Fig. 6: Connection diagram of 7 pin built-in connector

U_B 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_A/AGND.

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Included accessories	Type/Art. No.
• USB Cable	55115378
• SensorTool	4706A
• Feather key (depending on sensor configuration)	

Optional accessories	Type/Art. No.
• 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 instument for torque sensors	4700B...

Cable according to the data sheet 000-615.

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
- **DAkkS:** Calibration per DIN 51309

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

Order example: **Type 4503B050LP000KA0**

Torque sensor with 1 measuring range: rated torque 50 N·m: **050**, version **L**: max. speed 12 000 min^{-1}, without feather key groove: **P0**, Standard output signal ±5 VDC and frequency 100 ±40 kHz: **00**, calibration WKS1 single range: **KA0**

Ordering key

Type 4503B □ □ □ □ □

Measuring ranges in N·m

0.2*	**0.2**
0.5*	**0.5**
1	**001**
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**

*Calibration DK5, D51, D52, DK8, D81, D82 not available

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 1:1 and 1:10	**KA1**
WKS 1 – dual range 1:1 and 1:5	**KA2**
WKS 2 – single range	**WA0**
WKS 2 – dual range 1:1and 1:10	**WA1**
WKS 2 – dual range 1:1 and 1:5	**WA2**
DAkkS 5 – single range, 5 measuring point	**DK5**
DAkkS 8 – single range, 8 measuring point	**DK8**
DAkkS 5 – dual range, 5 measuring point 1:1 and 1:10	**D51**
DAkkS 5 – dual range, 5 measuring point 1:1 and 1:5	**D52**
DAkkS 8 – dual range, 8 measuring point 1:1 and 1:10	**D81**
DAkkS 8 – dual range, 8 measuring point 1:1 and 1:5	**D82**