

Torque sensor with dual-range-option

Type 4503B...

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: 1.770 ... 44253.750 lbf-in
- Ratio for second range: 1:10 or 1:5 of rated torque
- Speed ranges up to 50,000 rpm
- 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 rpm 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.

Technical data

Mechanical basic data

Measuring range	lbf-in	±1.770 ... 44253.750
Rated torque M_{nom}	lbf-in	1.770 ... 44253.750
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)	°F	50 ... 140
Service temperature range	°F	32 ... 158
Storage temperature range	°F	–13 ... 176
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	kΩ	≥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})		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)	rpm	>0
Output signal (TTL)	V	5 TTL
Max. jitter per edge J	°	±0.03
Jitter of the oscillation period J_p	%	= $J[°] * N / 180° * 100$
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 (rpm).

With 8,192 pulses means a maximum of 3,660 rpm.

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	0.2	0.5	1	2	5	10	20	50	100	200	500	1,000	2,000	5,000
	lbf·in	1.77	4.43	8.85	17.70	44.25	88.51	177	442	885	1,770	4,425	8,850	17,701	44,254
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	1,000	2,000	5,000
	lbf·in	1.77	4.43	8.85	17.70	44.25	88.51	177	442	885	1,770	4,425	8,850	17,701	44,254
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									

General technical data

Size/Rated torque M_{nom}	N-m	0.2	0.5	1	2	5	10	20	50	100	200	500	1,000	2,000	5,000		
	lbf-in	1.77	4.43	8.85	17.70	44.25	88.51	177	442	885	1,770	4,425	8,850	17,701	44,253		
Version "L" + "W" (Low Speed)																	
Longitudinal load limit on the drive side ¹⁾	lbf	18						33.7			56.2			101.2			
Transverse load limit on the drive side ¹⁾	lbf	27						62.9			157.4			337.2			
Longitudinal load limit on the measurement side ¹⁾	lbf	11.2			18			27			45.0			78.7			
Transverse load limit on the measurement side ¹⁾	lbf	0.360	0.742	1.124	2.248	6.295	6.744	7.868	44.962			101.164			157.366		
Version "H" (High Speed)																	
Longitudinal load limit on the drive side ¹⁾	lbf	6.744						16.861			38.218			56.202			
Transverse load limit on the drive side ¹⁾	lbf	22.481						44.962			89.924			179.849			
Longitudinal load limit on the measurement side ¹⁾	lbf	6.744						8.992			22.481			35.969			
Transverse load limit on the measurement side ¹⁾	lbf	0.360	0.742	1.124	2.248	6.295	6.744	35	22.481			56.202			101.164		

Other technical data

Size/Rated torque M_{nom}	N-m	0.2	0.5	1	2	5	10	20	50	100	200	500	1,000	2,000	5,000
	lbf-in	1.77	4.43	8.85	17.70	44.25	88.51	177	442	885	1,770	4,425	8,850	17,701	44,253

Mechanical basic data

Torsional rigidity c_T	k lbf-ft/rad	0.06		0.11	0.28	0.58	1.27	1.99	8.63	11.21	54.58	72.14	98.83	373.22	505.93	
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	lb-in ²	0.0174			0.0178		0.0212		0.161	0.164	2.358	2.379	2.439	20.210	20.846	
Proportional mass moment of inertia of rotor drive side	lb-in ²	0.097			0.097		0.094		0.243	0.246	2.047	2.191	2.253	20.066	20.717	
Mass moment of inertia rotor	lb-in ²	0.115			0.115		0.116		0.403	0.407	4.409	4.579	4.681	40.35	41.70	
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.	lb	3.307						4.409			14.330			48.502		

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.

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

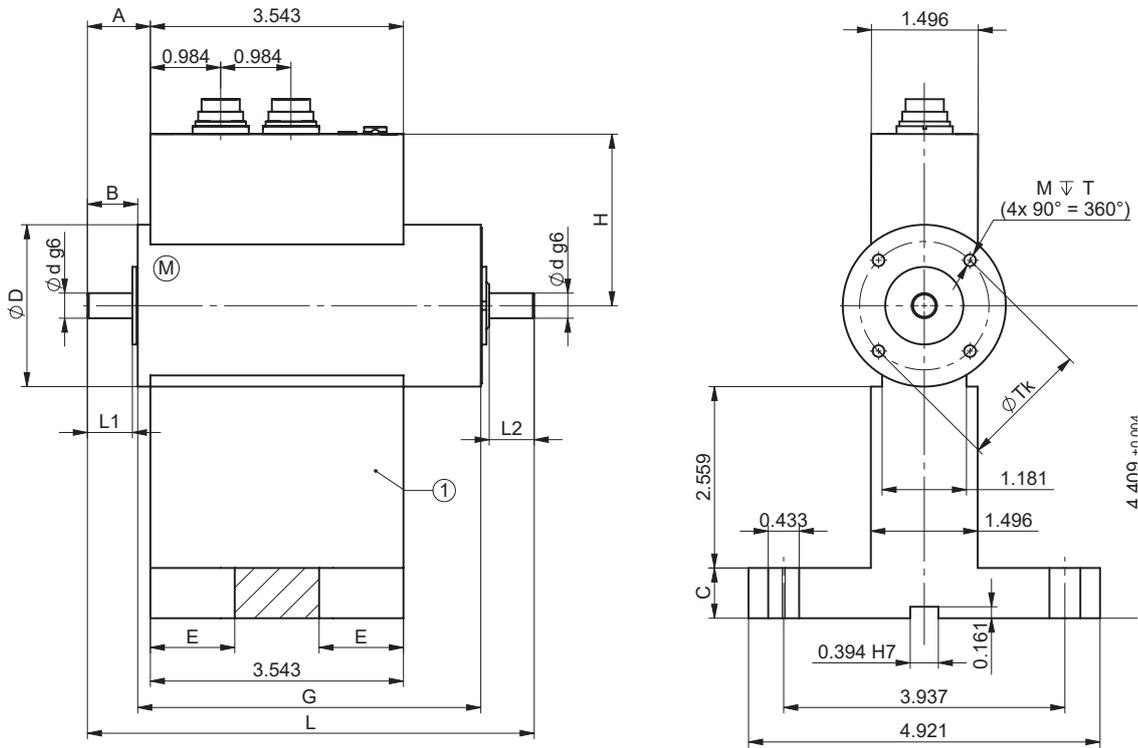


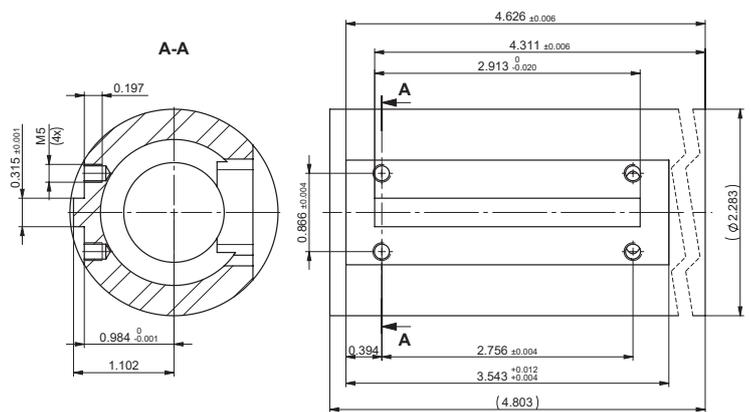
Fig. 1: Type 4503B... Size 1 and 2
All dimensions without tolerances comply with ISO 2768-mH

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

Dimensions size 1 and 2 in inch

Size	1			2	
Rated torque lbf-in	1.77	4.43	8.85	17.70 / 44.25	88.51 / 177
Rated torque N·m	0.2	0.5	1	2 / 5	10 / 20
L	6.260			6.42	6.57
L1	0.630			0.71	0.79
L2	0.630			0.71	0.79
øD	2.283			2.28	2.28
ød g6	0.354			0.39	0.47
A	0.886			0.96	1.04
B	0.709			0.79	0.87
C	0.709			0.71	
E	1.181			1.18	
G	4.803			4.80	
H	2.421			2.42	
øTk	1.811			1.81	
M	M5 (4x90°)			M5 (4x90°)	
T	0.24 deep			0.24 deep	

Dimensions for mounting base (GU)



Connecting dimensions for mounting base	Size 1 and 2
N·m	Tightening torque
0.2 / 0.5 / 1	53.1 lbf-in (strength class of the screw: 8.8)
2 / 5	
10 / 20	

All dimensions without tolerances comply with ISO 2768-mH

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

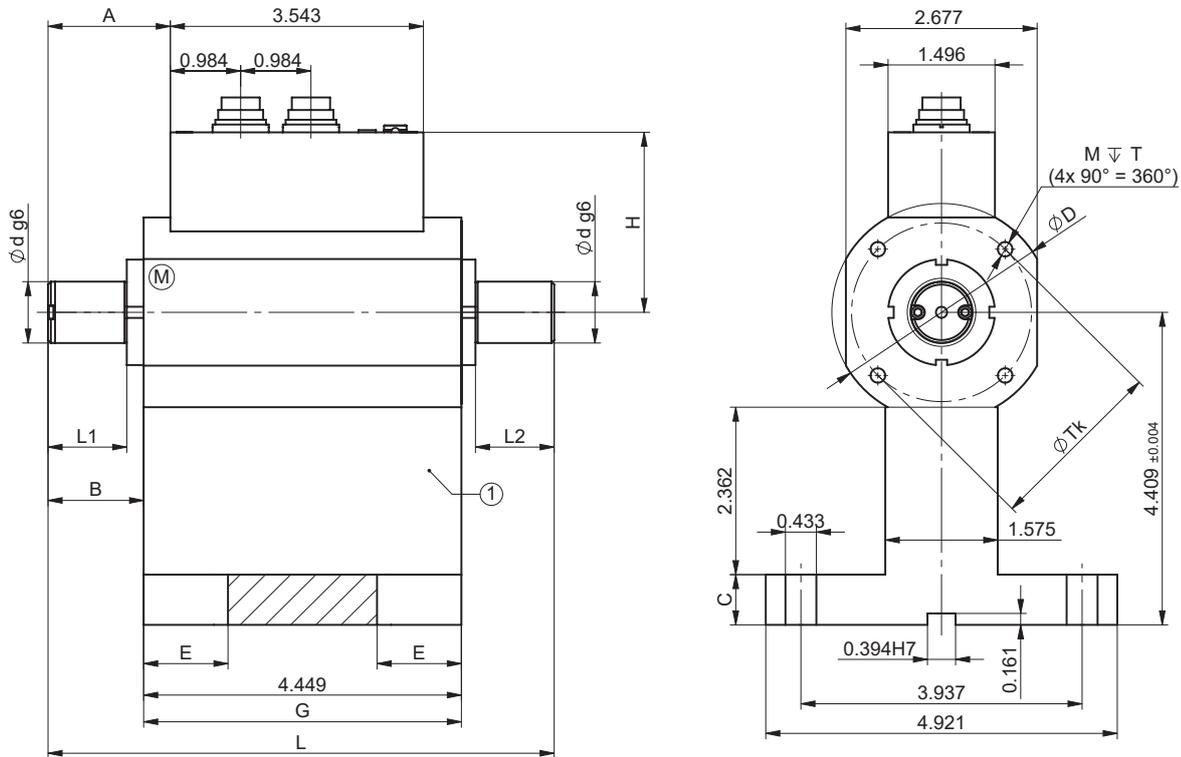


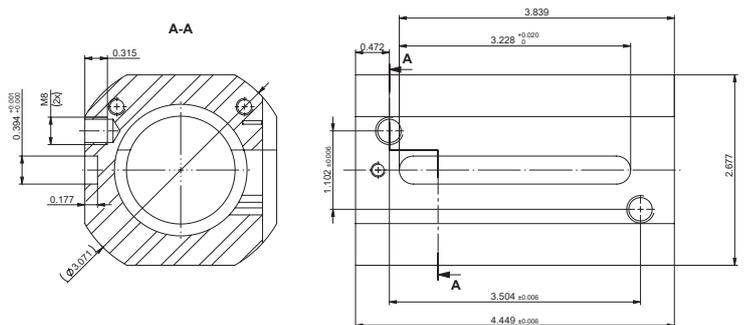
Fig. 2: Type 4503B... Size 3
All dimensions without tolerances comply with ISO 2768-mH

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

Dimensions size 3 in inch

Size	3
Rated torque lbf-in	442 / 885
Rated torque N·m	50 / 100
L	7.09
L1	1.10
L2	1.10
ϕD	3.07
$\phi d g6$	0.87
A	1.71
B	1.34
C	0.71
E	1.18
G	4.45
H	2.54
ϕTk	2.52
M	M6 (4x90°)
T	0.47 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

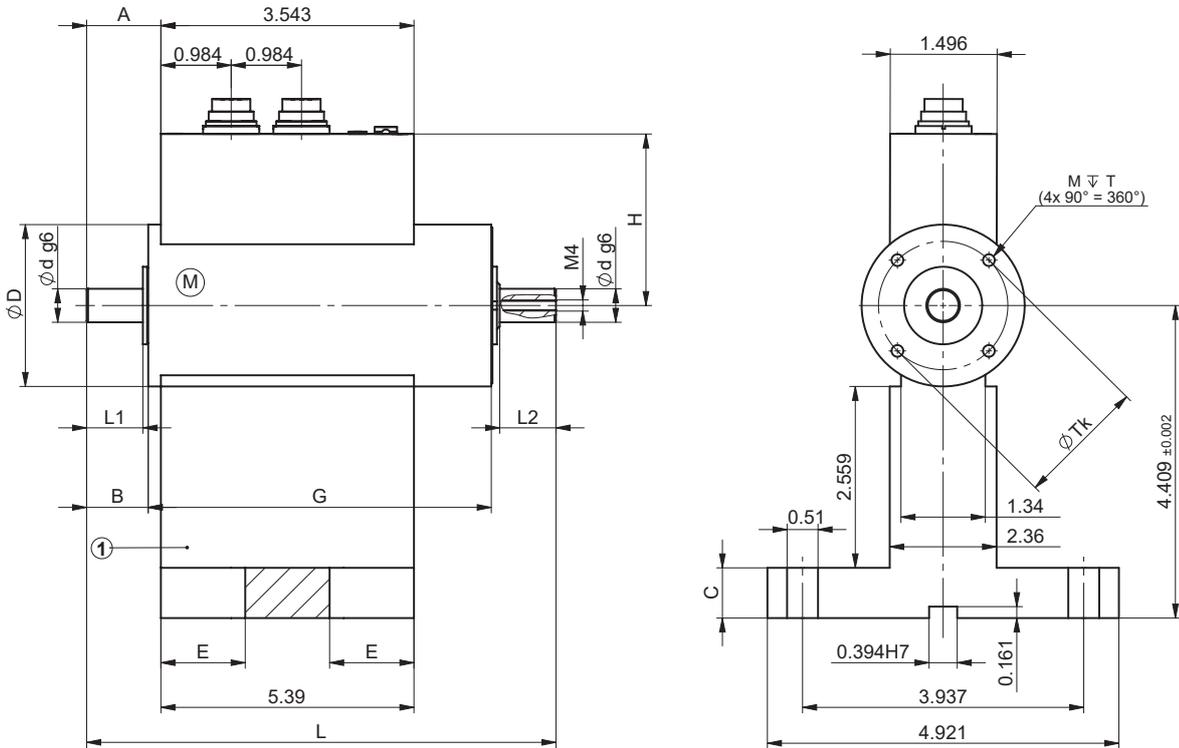


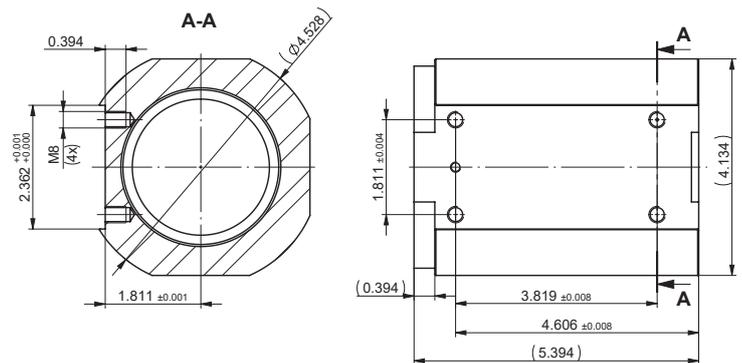
Fig. 3: Type 4503B... size 4
All dimensions without tolerances comply with ISO 2768-mH

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

Dimensions size 4 in inch

Size	4
Rated torque lbf-in	1770 / 4425 / 8850
Rated torque N·m	200 / 500 / 1,000
L	10.51
L1	2.40
L2	2.40
øD	3.86
ød g6	1.65
A	3.54
B	2.56
C	0.59
E	1.26
G	5.39
H	3.09
øTk	3.43
M	M6 (4x90°)
T	0.47 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 N·m

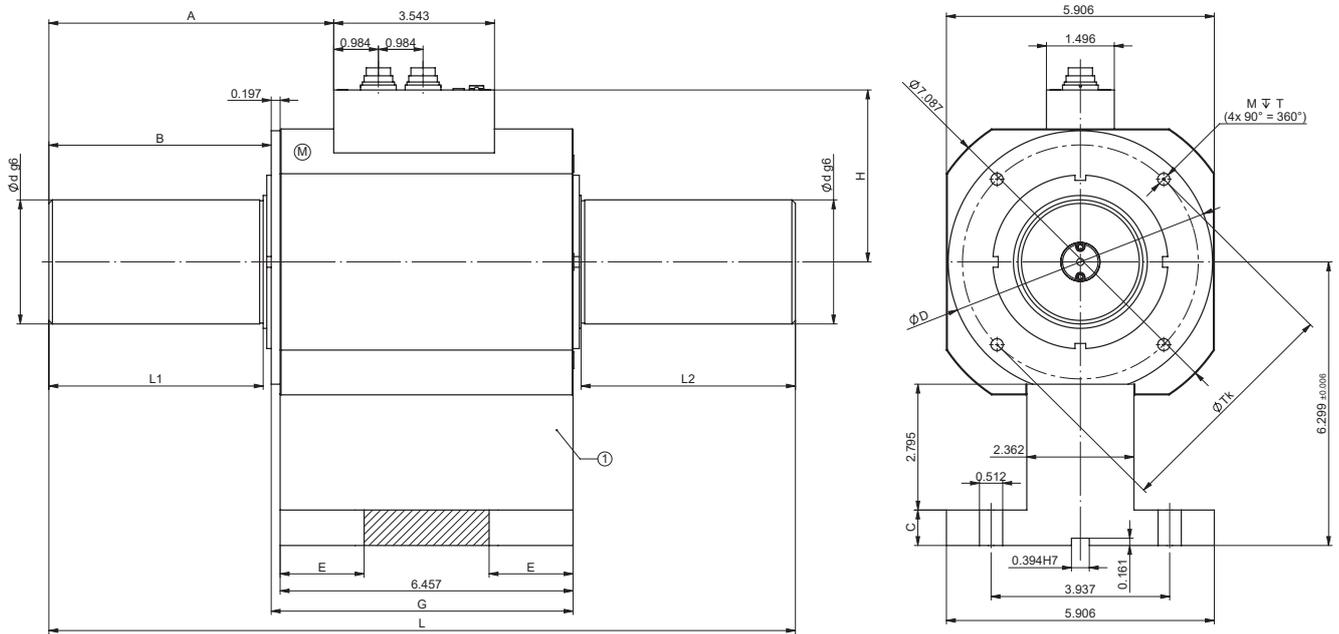


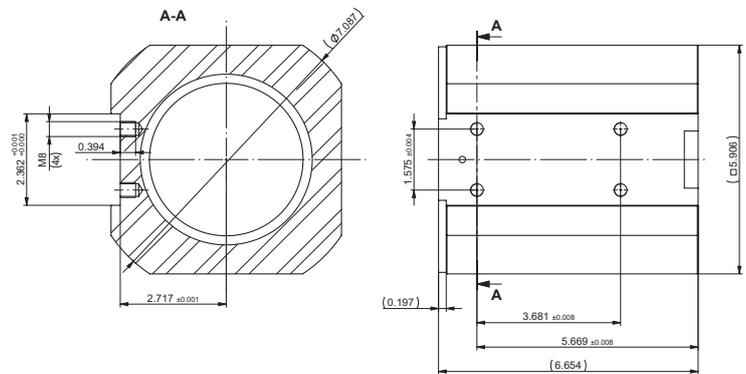
Fig. 4: Type 4503B... Size 5
All dimensions without tolerances comply with ISO 2768-mH

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

Dimensions size 5 in inch

Size	5
Rated torque lbf-in	17701 / 44253
Rated torque N·m	2,000 / 5,000
L	16.46
L1	4.72
L2	4.72
øD	5.83
ød g6	2.76
A	6.28
B	4.90
C	0.79
E	1.85
G	6.65
H	3.82
øTk	5.20
M	M8 (4x90°)
T	0.63 deep

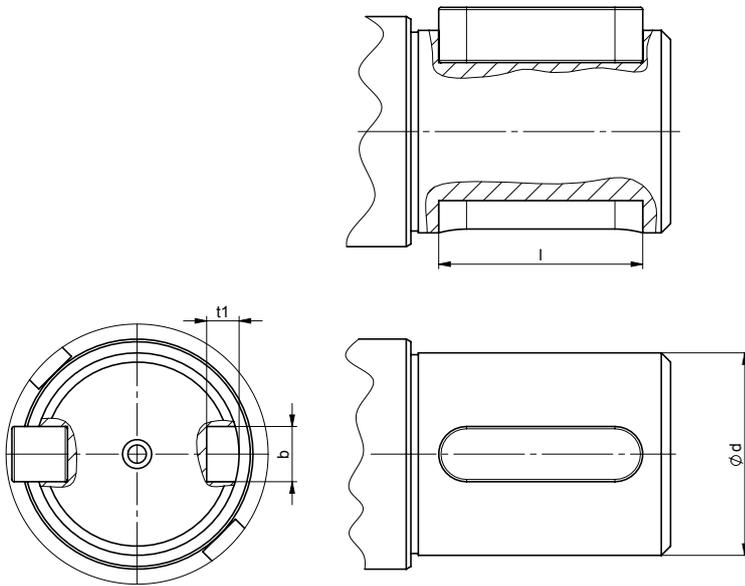
Dimensions for mounting base (GU)



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

4503B_000-767a-12.22

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

Dimensions in inch

Size		1			2				3		4			5	
Rated torque lbf·in	lbf·in	1.77	4.43	8.85	17.70	44.25	88.51	177	442	885	1,770	4,425	8,850	17,701	44,253
Rated torque N·m	N·m	0.2	0.5	1	2	5	10	20	50	100	200	500	1 000	2 000	3 000
Ø _{d_{g6}}	in	0.35			0.39		0.47		0.87		1.65			2.76	
b ^{P9}	in	0.12			0.12		0.16		0.24		0.47			0.79	
t1	in	0.071 ^{+0.004}			0.071 ^{+0.004}		0.1 ^{+0.004}		0.14 ^{+0.004}		0.2 ^{+0.008}			0.3 ^{+0.008}	
l	in	0.47 ^{+0.008}			0.55 ^{+0.008}		0.63 ^{+0.008}		0.87 ^{+0.008}		1.97 ^{+0.012}			4.33 ^{+0.012}	

Feather key according to DIN 6885-1

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

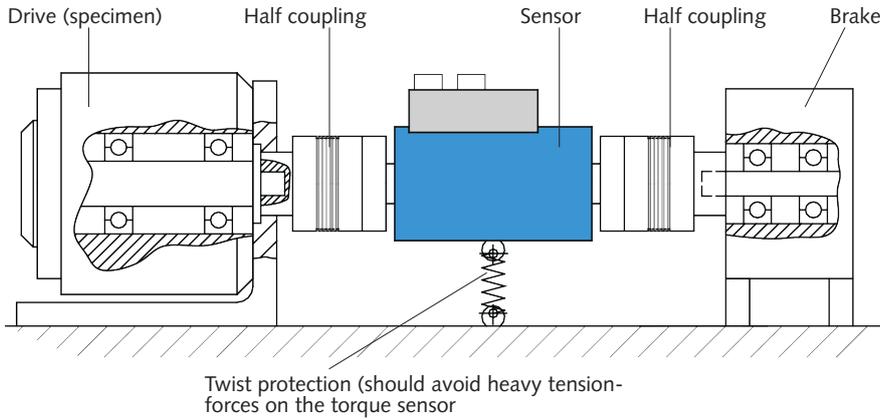


Fig. 5: Installation without holding bracket or housing base (GU).

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

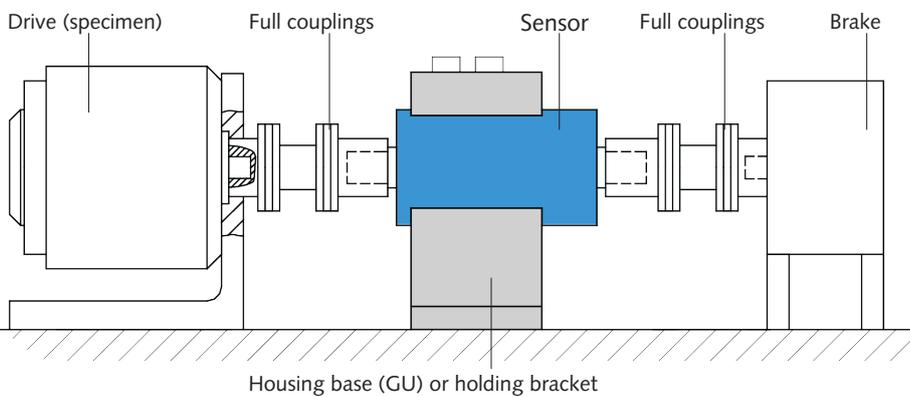
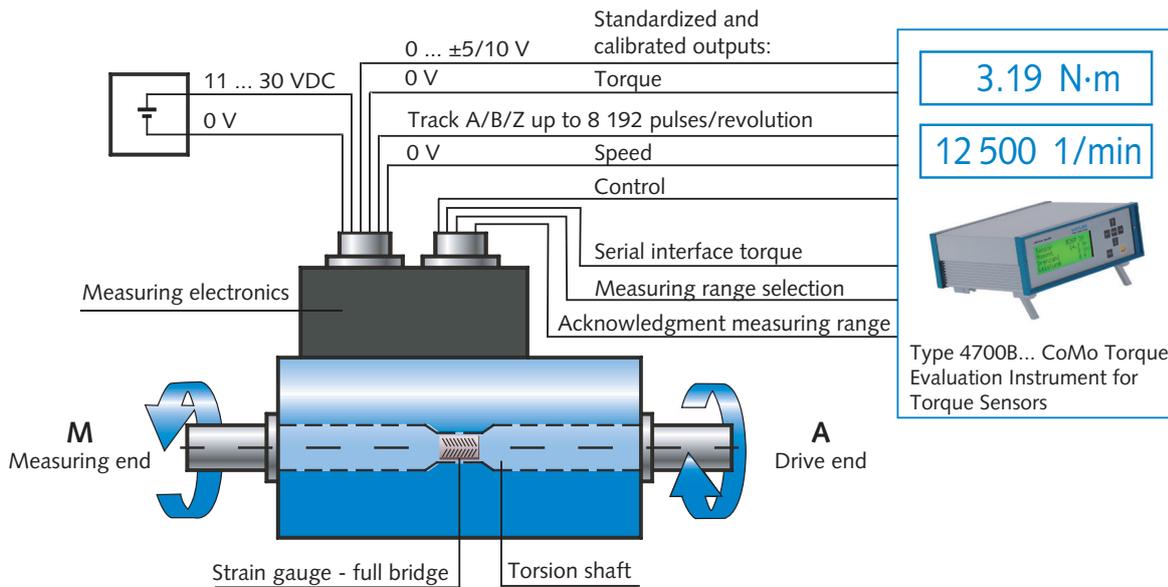


Fig. 6: Installation with holding bracket or housing base (GU).

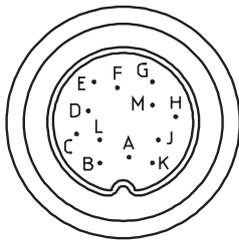
Principle of function



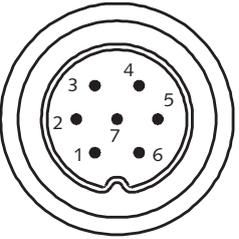
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Electrical connections

Pin allocation of the 12 Pin built-in standard connector

	Function	PIN	Description
	Supply voltage	F A	+U _B GND 11 ... 30 VDC, power consumption <10 W Ground relating to +U _B
	Shield	M	In sensor connected to housing
	Torque output	C	U _A Voltage output ±5/10 VDC at ±M _{nom} at >10 kΩ 5/10 VDC at control signal activation
		D	AGND Ground relating to U _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 _k = 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)

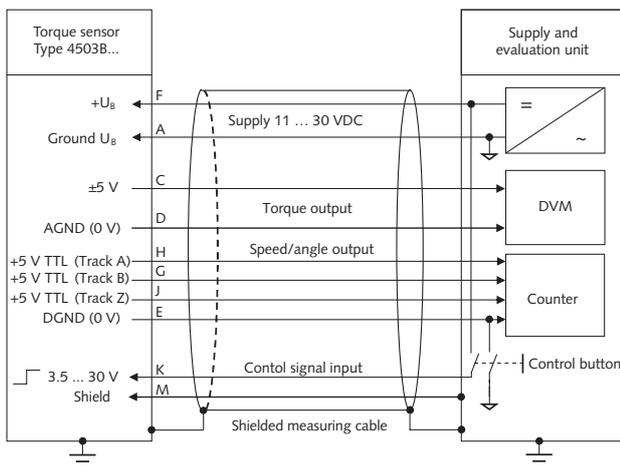


Fig. 5: Connection diagram of 12 pin built-in connector (standard)

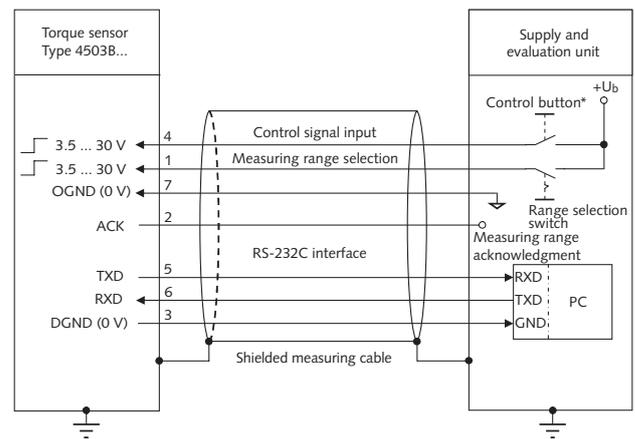


Fig. 6: Connection diagram of 7 pin built-in connector



U_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.

4503B_000-767a-12.22

Included accessories

- USB Cable
- SensorTool
- Feather key (depending on sensor configuration)

Type/Art. No.

55115378
4706A

Ordering keyType 4503B **Optional accessories**

- | | |
|---|----------|
| • 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... |

Type/Art. No.

18030861

18030862

18030863

18030864

18008371

18008363

18008935

18008943

18008996

18008967

18008994

18008956

18008702

18026961

18031756

18029193

4700B...

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 1:1 and 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

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**