

# 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: 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
- Integral speed sensor, 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.

Power is supplied and the measurement signals transferred between the rotating shaft and the case without contact. In addition to suitable mounting of the shaft, low production tolerances and high grade balancing, this is a further prerequisite for the high speed limit of up to 50 000 1/min achieved with the "H" version.



### Application

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

- In automotive and vehicle engineering
- In the aeronautical industry
- In mechanical and process plant engineering
- In electric motor manufacture

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	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 $M_{nom}$
Built-in speed sensor	pulses/ revolut.	1x60
speed measurement optional		
Minimum rotational speed for sufficient pulse stability	min <sup>-1</sup>	>2
Nominal Speed		depending on measuring range and design (see details)
Balancing class Q		
for version "L" and "W"		6,3
for version "H"		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/Rotation angle measuring system (optional)

Size		1 ... 5
Measuring system		magneto-resistive
Output signal	V	5 TTL
Pulses per revolution (N)		2x 1 ... 8 192
Pulse tolerance (Jitter of each flank)	°	±0,03
Minimum rotational speed for sufficient pulse stability	min <sup>-1</sup>	>0
Admissible maximum output frequency $f_{out}$	kHz	500 <sup>1)</sup>
Group delay	µs	<100
Load resistance	kΩ	≥2
Jitter of the oscillation period ( $J_p$ )	%	$J_p = (0,03°/180°) \times N \times 100$

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

### Reference pulse measuring system (0-Index)

Measuring system		magneto-resistive
Output signal	V	5 TTL
Pulses per revolution		1
Pulse tolerance	°	≤0,03
Minimum rotational speed for sufficient pulse stability	min <sup>-1</sup>	>0
Group delay	µs	<100
Load resistance	kΩ	≥2

### 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	g	650

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

Frequency range	Hz	10 ... 2 000
Load duration	h	2,5
Acceleration (Amplitude)	g	200

### 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 <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 the measuring range 1:1 (single range)</b>															
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
<b>Measurement features in the measuring range 1:5 / 1:10</b>															
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	–	–	–		
	kN·m	–	–	–	–	–	–	–	–	–	–	–	1	2	5		
<b>Load limits<sup>1)</sup></b>																	
Limiting torque, referred to $M_{nom}$ <sup>2)</sup>	%	150															
Rupture torque, referred to $M_{nom}$	%	>400															
Oscillation width according to DIN 50100 (peak / peak) <sup>4)</sup>	%	70															
<b>Version "L" + "W" (Low Speed)</b>																	
Longitudinal load limit on the drive side <sup>3)</sup>	N	80						150			250		450				
Transverse load limit on the drive side <sup>3)</sup>	N	120						280			700		1 500				
Longitudinal load limit on the measurement side <sup>3)</sup>	N	50			80				120			200		350			
Transverse load limit on the measurement side <sup>3)</sup>	N	1,6	3,3	5	10	28	30	35	200			450		700			
<b>Version "H" (High Speed)</b>																	
Longitudinal load limit on the drive side <sup>3)</sup>	N	30						75			170		250				
Transverse load limit on the drive side <sup>3)</sup>	N	100						200			400		800				
Longitudinal load limit on the measurement side <sup>3)</sup>	N	30						40			100		160				
Transverse load limit on the measurement side <sup>3)</sup>	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	
<b>Mechanical basic data</b>																
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	kgcm <sup>2</sup>	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	kgcm <sup>2</sup>	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	kgcm <sup>2</sup>	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	
<b>Balancing class according to DIN ISO 1940</b>																
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>5)</sup>																
Version "L" + "W" (Low Speed)	h	18632						24400			23900		21500			
Version "H" (High Speed)	h	12009						16275			11470		14638			

<sup>1)</sup> Depending on rated torque

<sup>2)</sup> Please note the maximum permissible torque ( $T_{Kmax}$ ) of the coupling!

<sup>3)</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>4)</sup> The nominal torque must not be exceeded!

<sup>5)</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 4503B..., Measuring ranges 0,2 / 0,5 / 1 / 2 and 5 / 10 and 20 N·m**

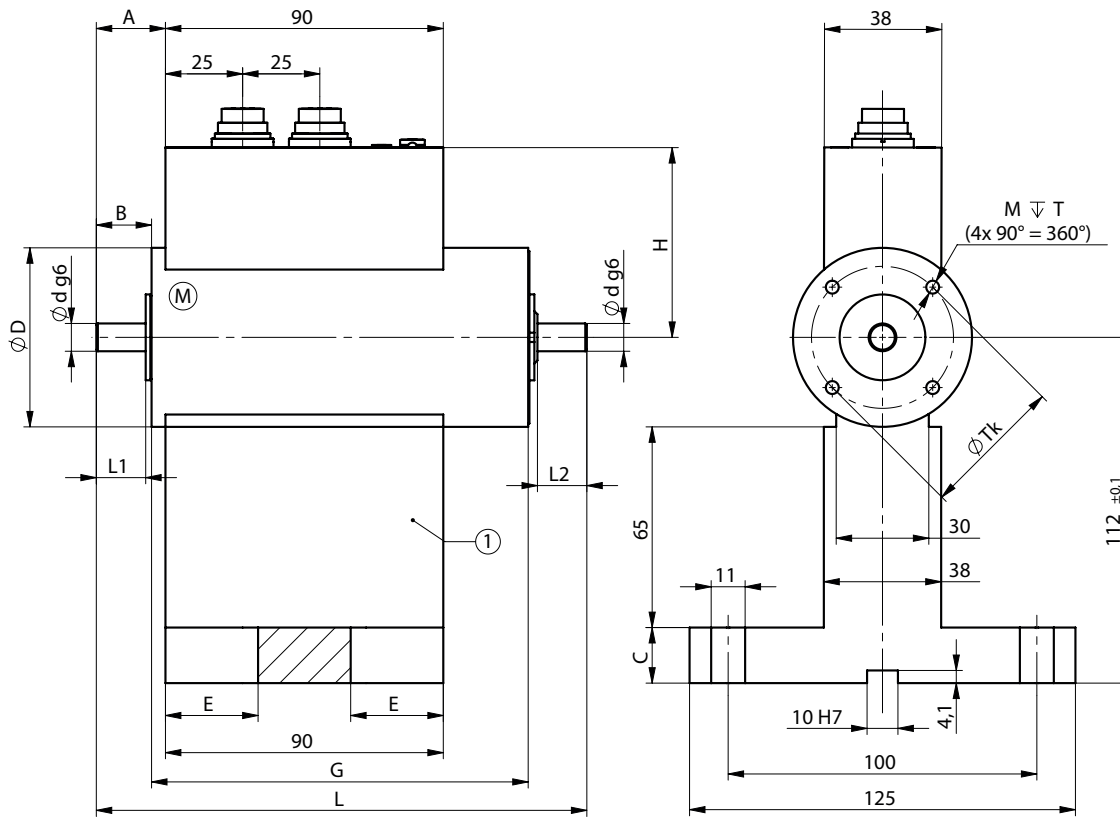


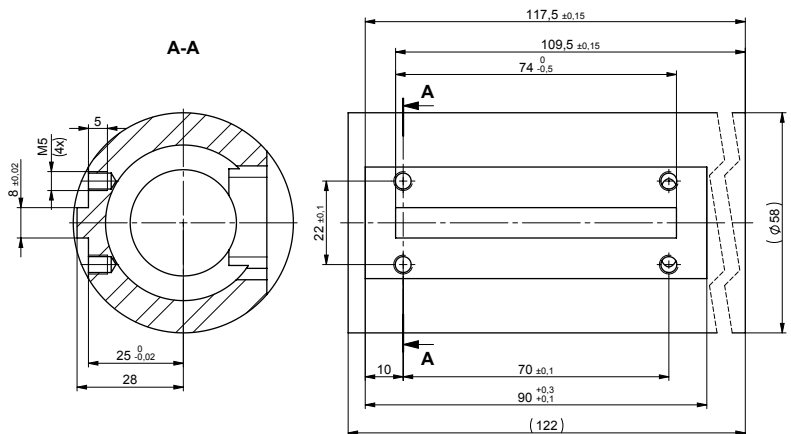
Fig. 1: Type 4503B... Size 1 and 2  
All dimensions without tolerances comply with ISO 2768-mH

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

**Dimensions size 1 and 2 in mm**

Size	1			2	
	0,2	0,5	1	2 / 5	10 / 20
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**

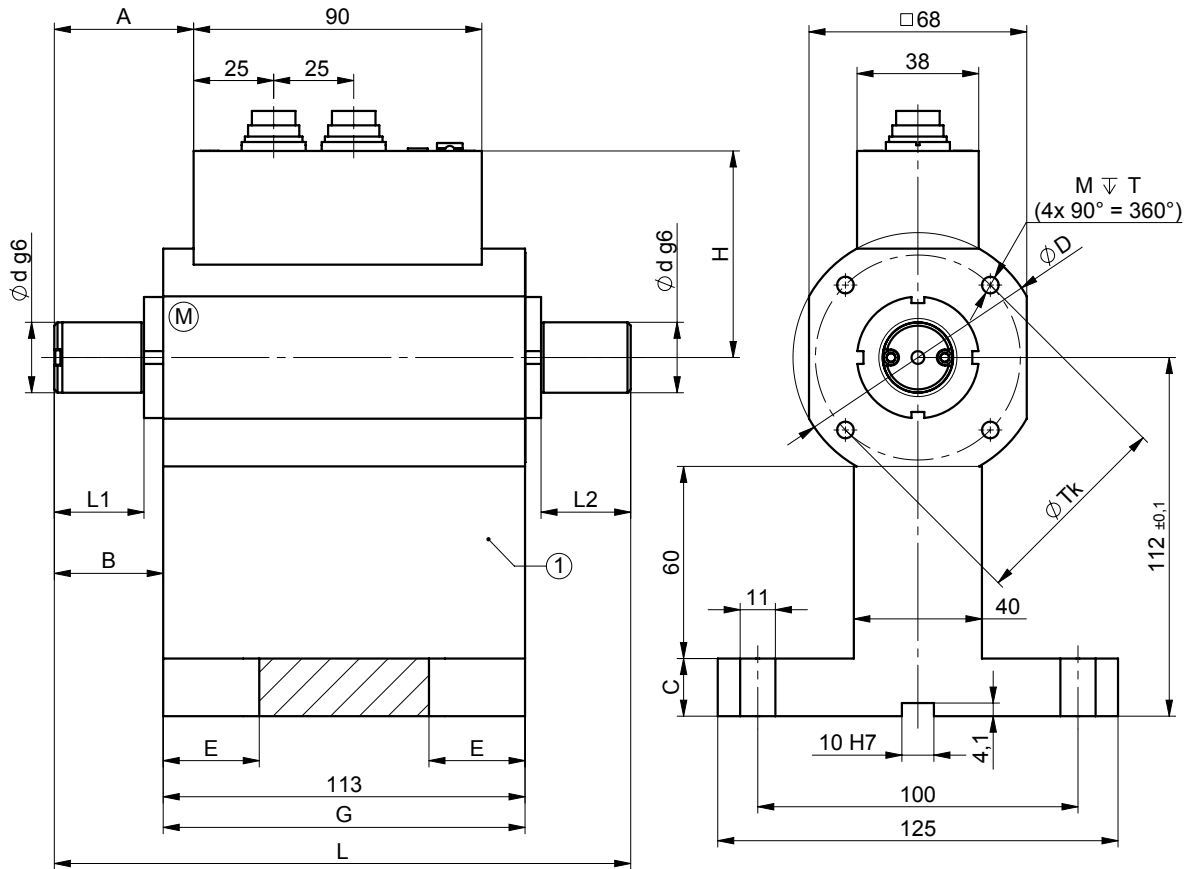


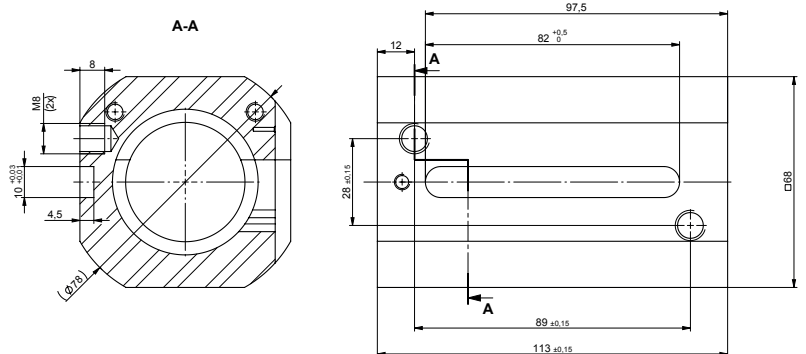
Fig. 2: Type 4503B... Size 3  
All dimensions without tolerances comply with ISO 2768-mH

Ⓜ = 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
∅D	78
∅d g6	22
A	43,5
B	34
C	18
E	30
G	113
H	64,5
∅Tk	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
100	(strength class of the screw: 8.8)

All dimensions without tolerances comply with ISO 2768-mH

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

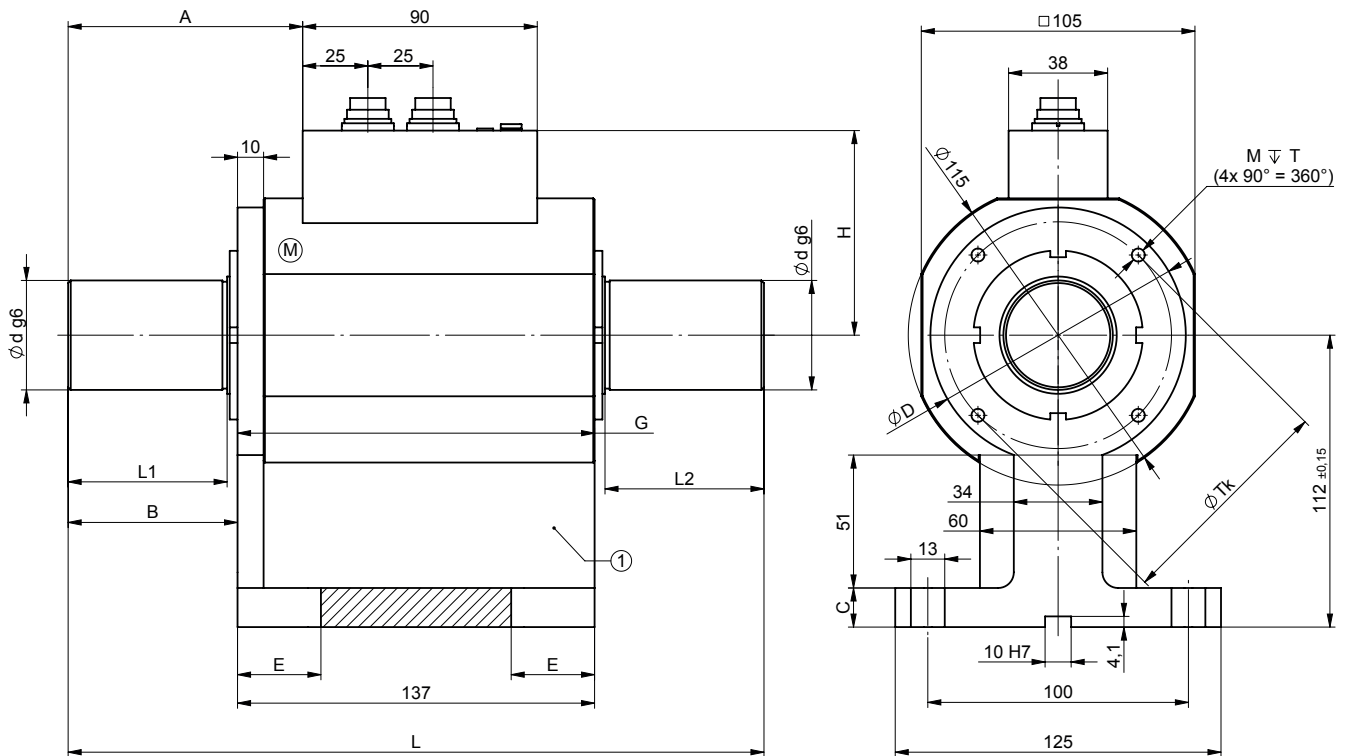


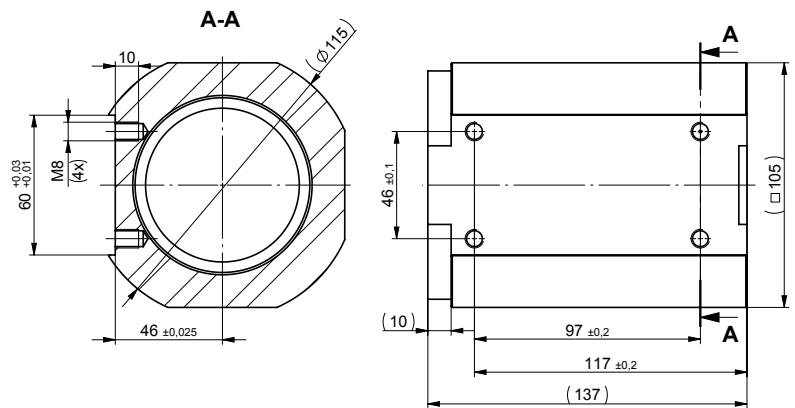
Fig. 3: Type 4503B... size 4  
All dimensions without tolerances comply with ISO 2768-mH

Ⓛ = 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

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

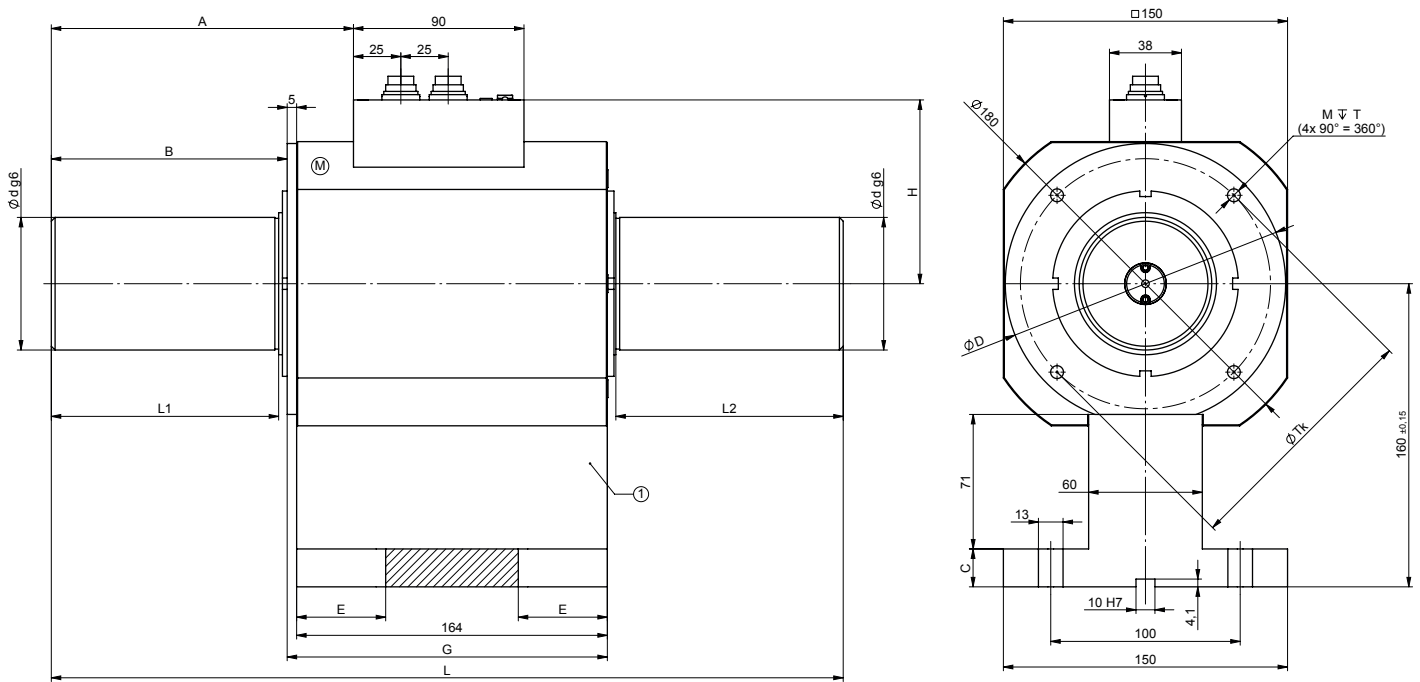


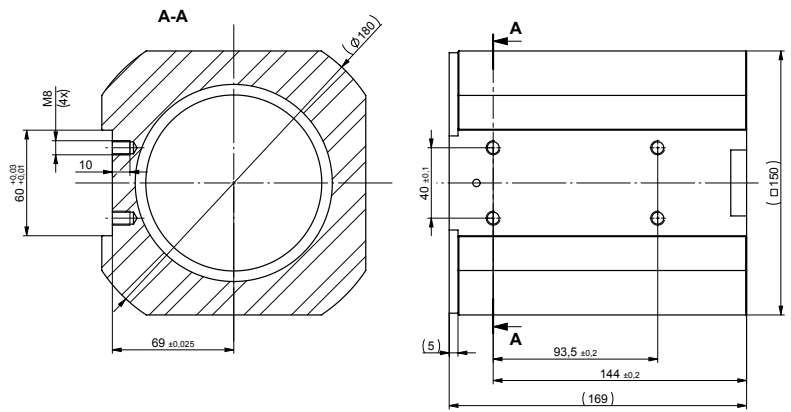
Fig. 4: Type 4503B... Size 5  
All dimensions without tolerances comply with ISO 2768-mH

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	143
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)

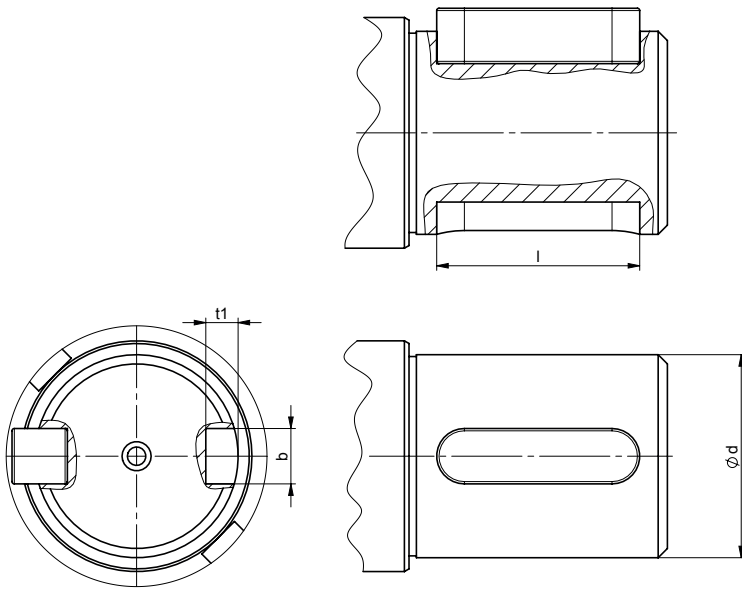


Connecting dimensions for mounting base	Size 5
N·m	Tightening torque
2 000	25 N·m
5 000	(strength class of the screw: 8.8)

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
$\varnothing d_{g6}$	mm	9			10	12	22	42	70
$b^{p9}$	mm	3			3	4	6	12	20
t1	mm	1,8 <sup>+0,1</sup>			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	12 <sup>+0,2</sup>			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 4503B... between drive and brake**

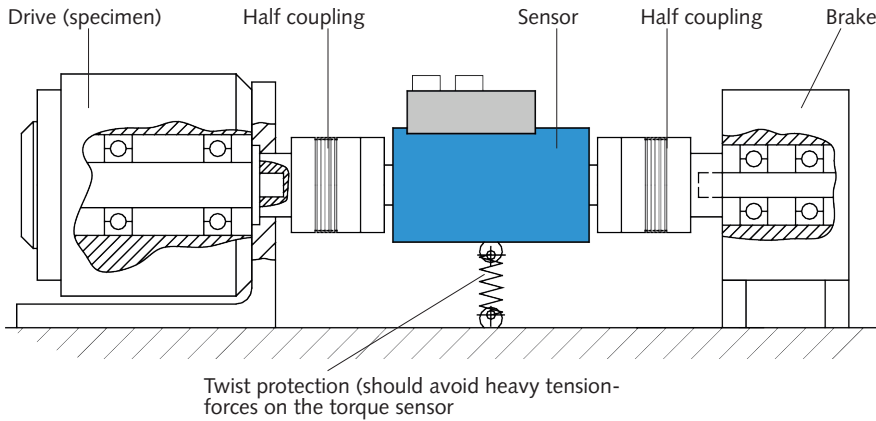


Fig. 5: Installation without holding bracket or housing base (GU).

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

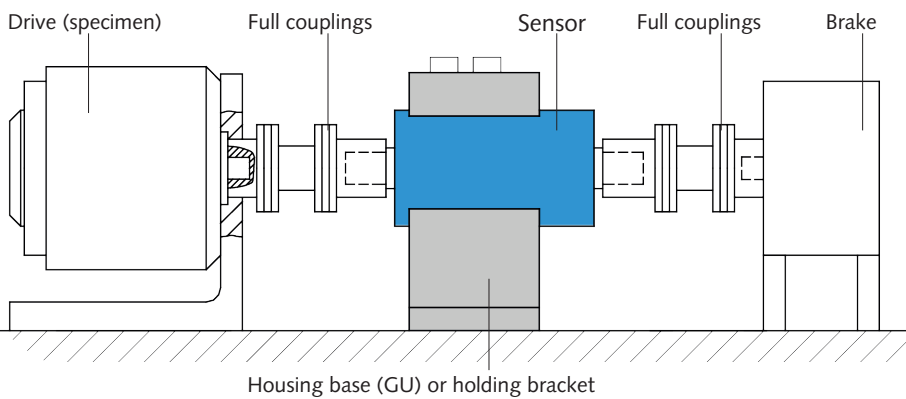
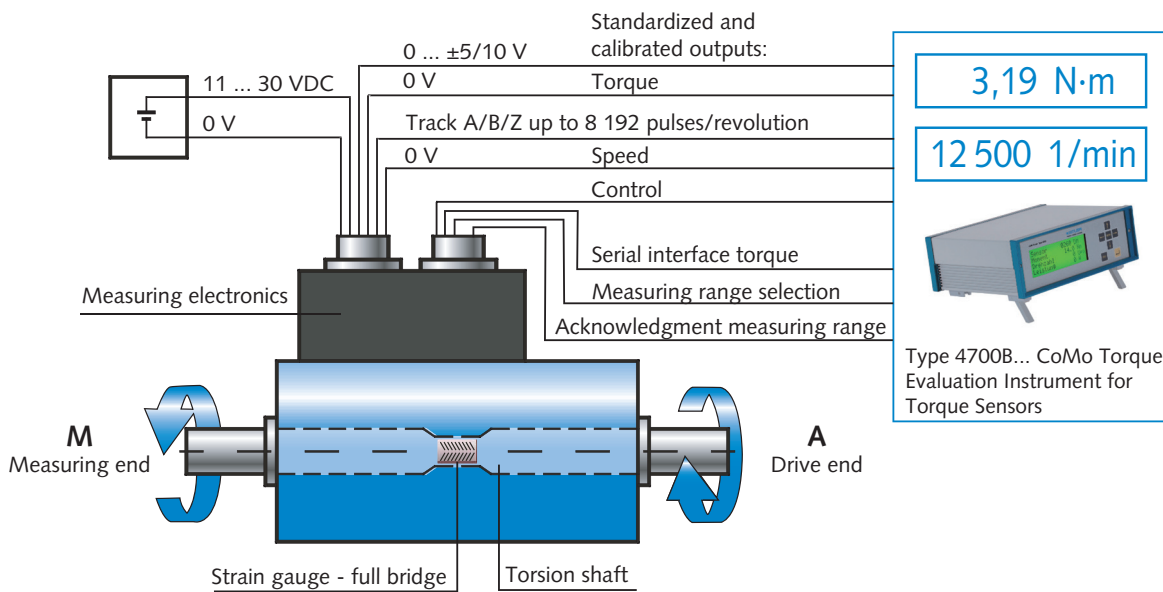


Fig. 6: Installation with holding bracket or housing base (GU).

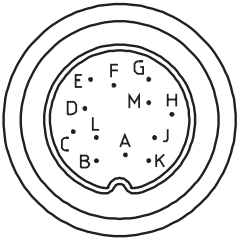
**Principle of function**



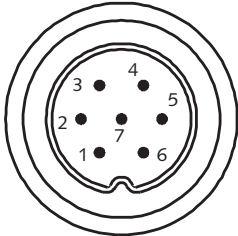
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**Electrical connections**

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

	Function	PIN	Description
	Supply voltage	F A	+U <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>
	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>K</sub> = 10 kΩ
	RS-232C interface (CoMo Torque)	B	TXD Digital send path to the CoMo Torque
	Digital ground potential	L	RXD Digital receive path
		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)

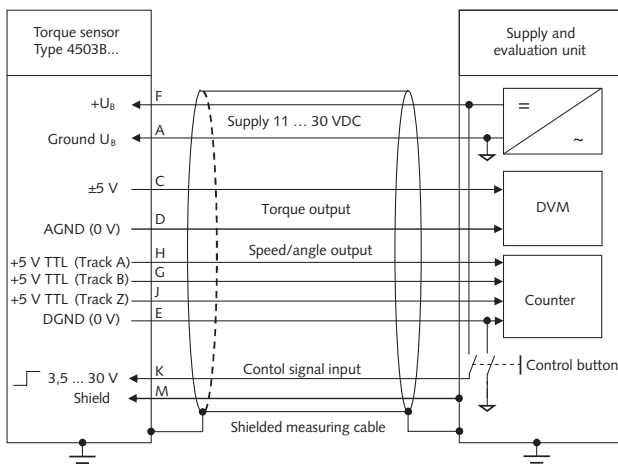


Fig. 5: Connection diagram of 12 pin built-in connector (standard)

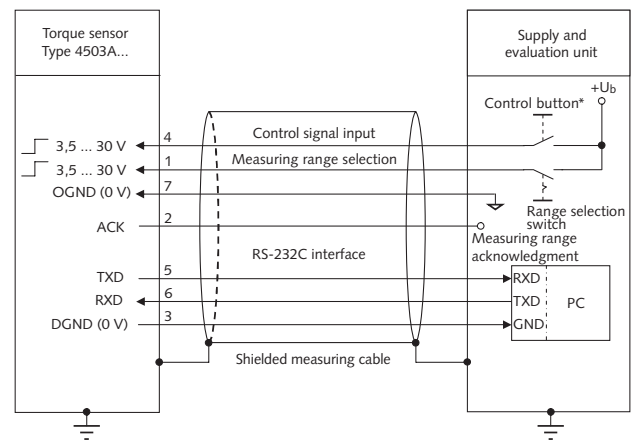


Fig. 6: Connection diagram of 7 pin built-in connector



**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.

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**Included accessories**

- USB Cable

**Type/Art. No.**

55115378

**Ordering key**Type 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**
- ControlMonitor CoMo Torque Evaluation instrument for torque sensors **4700B...**

**Measuring ranges in N·m**

0,2	<b>0,2</b>
0,5	<b>0,5</b>
1	<b>001</b>
2	<b>002</b>
5	<b>005</b>
10	<b>010</b>
20	<b>020</b>
50	<b>050</b>
100	<b>100</b>
200	<b>200</b>
500	<b>500</b>
1 000	<b>1K0</b>
2 000	<b>2K0</b>
5 000	<b>5K0</b>

**Pulses per revolution**

Low speed 60	<b>L</b>
High speed up to 2 x 8 192 + Z	<b>H</b>
Low speed up to 2 x 8 192 + Z	<b>W</b>

**Feather key groove**

Without	<b>P0</b>
With	<b>P1</b>

**Output signal**

Voltage ±5 VDC and Frequency 100 ±40 kHz	<b>00</b>
Voltage ±10 VDC and Frequency 100 ±40 kHz	<b>B1</b>

**Calibration**

WKS 1 – single range	<b>KA0</b>
WKS 1 – dual range 1:1 and 1:10	<b>KA1</b>
WKS 1 – dual range 1:1 and 1:5	<b>KA2</b>
WKS 2 – single range	<b>WA0</b>
WKS 2 – dual range 1:1 and 1:10	<b>WA1</b>
WKS 2 – dual range 1:1 and 1:5	<b>WA2</b>
DAkks 5 – single range, 5 measuring point	<b>DK5</b>
DAkks 8 – single range, 8 measuring point	<b>DK8</b>
DAkks 5 – dual range, 5 measuring point 1:1 and 1:10	<b>D51</b>
DAkks 5 – dual range, 5 measuring point 1:1 and 1:5	<b>D52</b>
DAkks 8 – dual range, 8 measuring point 1:1 and 1:10	<b>D81</b>
DAkks 8 – dual range, 8 measuring point 1:1 and 1:5	<b>D82</b>

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-15127-02-00 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<sup>-1</sup>, without feather key groove : **P0**, Standard output signal ±5 VDC and frequency 100 ±40 kHz: **00**, calibration WKS1 single range: **KA0**