

T12

Digital Torque Transducer

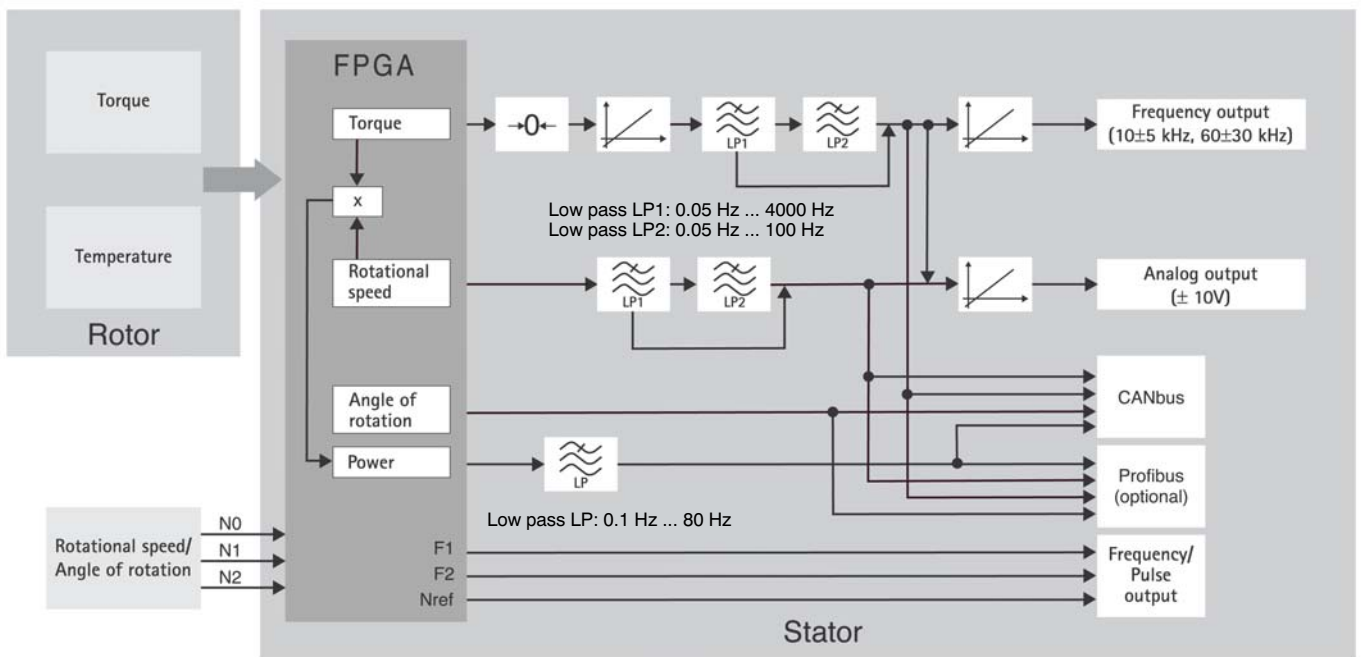


smart torque® by HBM

Special features

- Nominal (rated) torques of 100 N·m, 200 N·m, 500 N·m, 1 kN·m, 2 kN·m, 3 kN·m, 5 kN·m and 10 kN·m
- Nominal (rated) speeds from 10,000 rpm to 18,000 rpm
- Wide measurement frequency range up to 6 kHz (-3 dB)
- Fast digital transmission of measurement signals: 4,800 measured values/sec
- High resolution of 19 bit (integral method)
- Monitoring functions
- Extensive options

Block diagram signal flow



Specifications

Type		T12							
Accuracy class		0.03							
Torque measuring system									
Nominal (rated) torque M_{nom}	N·m	100	200	500					
	kN·m				1	2	3	5	10
for reference only	kft·lb	75	150	375	750	1,500	2,250	3,750	7,500
Nominal (rated) sensitivity (range between torque = zero and M_{nom})									
Frequency output 10 kHz/60 kHz		kHz							
Voltage output		V							
Sensitivity tolerance (deviation of the actual output quantity at M_{nom} from the nominal (rated) sensitivity)									
Fieldbusses		%							
Frequency output		%							
Voltage output		%							
Output signal at torque = zero									
Frequency output 10 kHz/60 kHz		kHz							
Voltage output		V							
Nominal (rated) output signal									
Frequency output		kHz							
with positive nominal (rated) torque 10 kHz/60 kHz		kHz							
with negative nominal (rated) torque 10 kHz/60 kHz		kHz							
Voltage output		V							
with positive nominal (rated) torque		V							
with negative nominal (rated) torque		V							
Low-pass filter LP1		Hz							
Low-pass filter LP2		Hz							
Load resistance									
Frequency output		kΩ							
Voltage output		kΩ							
Long-term drift over 48 h									
Voltage output		mV							
Measurement frequency range									
Frequency output/Voltage output		Hz							
Group delay time (Low pass LP1: 4 kHz)		μs							
Frequency output 10 kHz/60 kHz		μs							
Voltage output		μs							
Scale range									
Frequency output/Voltage output		%							
Resolution									
Frequency output 10 kHz/60 kHz		Hz							
Voltage output		mV							
Residual ripple									
Voltage output		mV							
Temperature influence per 10 K in the nominal (rated) temperature range									
on the output signal, related to the actual value of signal span									
Fieldbusses		%							
Frequency output		%							
Voltage output		%							
on the zero signal, related to the nominal (rated) sensitivity									
Fieldbusses		%							
Frequency output		%							
Voltage output		%							
Maximum modulation range²⁾									
Frequency output 10 kHz/60 kHz		kHz							
Voltage output		V							
Power supply									
Nominal (rated) supply voltage (DC) (separated extra low voltage)		V							
Current consumption in measuring mode		A							
Current consumption in start-up mode		A							

¹⁾ RS-422 complementary signals, observe terminating resistance.

²⁾ Output signal range with a repeatable relationship between torque and output signal.

Specifications (Continued)

Nominal (rated) torque M_{nom}	N·m	100	200	500						
	kN·m				1	2	3	5	10	
for reference only	kft·lb	75	150	375	750	1,500	2,250	3,750	7,500	
Nominal (rated) power consumption	W	< 18								
Maximum cable length	m	50								
Linearity deviation including hysteresis, related to the nominal (rated) sensitivity										
Fieldbusses	%	± 0.02 (± 0.01 optional)								
Frequency output 10 kHz/60 kHz	%	± 0.02 (± 0.01 optional)								
Voltage output	%	± 0.05								
Rel. standard deviation of the repeatability, per DIN1319, related to variation of the output signal										
Fieldbusses/frequency output	%	± 0.01								
Voltage output	%	± 0.03								
Shunt signal		50 % of M_{nom} or 10 % of M_{nom}								
Tolerance of shunt signal related to M_{nom}	%	± 0.05								
Speed measuring system/measuring system for angle of rotation										
		Optical, by means of infrared light and metallic slotted disc								
Mechanical increments	Number	360					720			
Positional tolerance of the increments	mm	± 0.05								
Tolerance of the slot width	mm	± 0.05								
Pulses per rotation (adjustable)	Number	360; 180; 90; 60; 45; 30						720; 360; 180; 120; 90; 60		
Pulse frequency at nominal (rated) speed n_{nom}										
Option 3, Code L ³⁾	kHz	90				72			120	
Option 3, Code H ³⁾	kHz	108				96			168	
Minimum speed for sufficient pulse stability	rpm	2								
Group delay time	µs	< 5 (typ. 2.2)								
Hysteresis of reversing the direction of rotation with relative vibrations between rotor and stator										
Torsional vibrations of the rotor	Degree	< approx. 2								
Radial vibration amplitudes of the stator	mm	< approx. 2								
Permitted degree of soiling, in the optical path of the sensor fork (lenses, slotted disc)	%	< 50								
Swirl influence on the zero point, related to nominal (rated) torque										
Option 3, Code L ³⁾	%	<0.05	<0.03	<0.03		<0.02		<0.01		
Option 3, Code H ³⁾	%	<0.08	<0.04	<0.03		<0.02		<0.01		
Output signal frequency/pulse output	V	5 ⁴⁾ symmetric; 2 square wave signals approx. 90° phase shifted								
Load resistance	kΩ	≥ 2								
Rotational speed										
Fieldbusses										
Resolution	rpm	0.1								
System accuracy (at torsional vibrations of max. 3 % of the current rot. speed with double speed frequency)	ppm	150								
Max. speed deviation at nominal (rated) speed (100 Hz-filter)	rpm	1.5								
Voltage output										
Measuring range	V	± 10								
Resolution	mV	0.33								
Scale range	%	10 ... 1,000								
Overmodulation limits	V	± 10.2								
Load resistance	kΩ	> 10								
Linearity error	%	< 0.03								
Temperature effect per 10 K in the nominal (rated) temperature range										
on the output signal, related to the actual value of signal span	%	< 0.03								
on the zero signal	%	< 0.03								
Residual ripple	mV	< 3								

³⁾ See page 18.

⁴⁾ RS-422 complementary signals, observe terminating resistances.

Specifications (Continued)

Nominal (rated) torque M_{nom}	N·m	100	200	500					
	kN·m				1	2	3	5	10
for reference only	kft·lb	75	150	375	750	1,500	2,250	3,750	7,000
Angle of rotation									
Accuracy	Degree	1 (typ. 0.1)							
Resolution	Degree	0.01							
Correction of the phase delay deviation between torque LP1 and angle of rotation for filter frequencies	Hz	4,000; 2,000; 1,000; 500; 200; 100							
Measuring range	Degree	0 ... 360 (singleturn) up to $\pm 1,440$ (multiturn)							
Power									
Measurement frequency range	Hz	80 (-1 dB)							
Resolution	W	1							
Full scale value	W	$P_{max} = M_{nom} \cdot n_{nom} \cdot \frac{\pi}{30}$ [M_{nom}] in N·m [n_{nom}] in rpm							
Temperature effect per 10 K in the nominal (rated) temperature range on the power signal, related to the full scale value	%	$\pm 0.05 \cdot n/n_{nom}$							
Linearity deviation including hysteresis, related to the full scale value	%	$\pm 0.02 \cdot n/n_{nom}$							
Sensitivity tolerance (deviation of the actual signal span of the power signal related to the full scale value)	%	± 0.05							
Temperature signal rotor									
Accuracy	K	1							
Measurement frequency range	Hz	5 (-1 dB)							
Resolution	K	0.1							
Physical unit	-	°C							
Sampling rate	Measure d values/s	40							
Fieldbusses									
CANbus									
Protocol	-	CAN 2.OB, CAL/CANopen compatible							
Sampling rate	Measure d values/s	max. 4,800 (PDO) per ISO 11898							
Hardware bus link									
Baud rate	kBit/s	1,000	500	250	125	100			
Maximum line length	m	25	100	250	500	600			
Connection	-	5-pole, M12x1, A-coding per CANopen DR-303-1 V1.3, potential separated from supply and measuring mass							
Profibus DP									
Protocol	-	Profibus-DP Slave, per DIN 19245-3							
Baudrate	MBaud	max. 12							
Profibus ident no.	-	096C (hex)							
Input data, max.	Byte	152							
Output data, max.	Byte	40							
Diagnosis data	Byte	18 (2·4 byte module diagnosis)							
Connection	-	5-pole, M12x1, B-coding, potential separated from supply and measuring mass							
Update rate ⁵⁾									
Konfiguration input ≤ 2	Measure d values/s	4800							
≤ 4		2400							
≤ 8		1200							
≤ 12		600							
≤ 16		300							
> 16		150							
Limit value switch (on fieldbusses only)									
Number	-	4 for torque, 4 for rotational speed							
Reference level	-	Torque LP1 or LP2 Rotational speed LP1 or LP2							
Hysteresis	%	0 ... 100							
Setting accuracy	Digit	1							
Response time (LP1= 4,000 Hz)	ms	typ. 3							

⁵⁾ With simultaneously activated CAN-PDOs, the profibus update rate is reduced.

Specifications (Continued)

Nominal (rated) torque M_{nom}	N·m	100	200	500						
	kN·m				1	2	3	5	10	
for reference only	kft·lb	75	150	375	750	1,500	2,250	3,750	7,500	
TEDS (Transducer Electronic Data Sheet)										
Number	-	2								
TEDS 1 (torque)	-	Optional voltage sensor or frequency sensor								
TEDS 2 (rotational speed/angle of rotation)	-	Frequency-/pulse sensor								
General data										
EMC										
EME (Emission per EN61326-1, table 3)										
RFI voltage	-	Class A								
RFI performance	-	Class A								
RFI field strength	-	Class A								
Immunity from interference (EN61326-1, table A.1)										
Electromagnetic field (AM)	V/m	10								
Magnetic field	A/m	30								
ESD										
Contact discharge	kV	4								
Air discharge	kV	8								
Burst	kV	1								
Surge	kV	1								
Line-conducted disturbance (AM)	V	3								
Degree of protection per EN 60529	-	IP 54								
Weight , approx. Rotor	kg	1.1	1.8	2.4	4.9		8.3	14.6		
Stator	kg	2.3			2.4		2.5	2.6		
Reference temperature	°C [°F]	+23 [73.4]								
Nominal (rated) temperature range	°C [°F]	+10 ... +60 [+50 ... +140]								
Service temperature range	°C [°F]	-10 ... +60 [+14 ... +140]								
Storage temperature range	°C [°F]	-20 ... +70 [-4 ... +158]								
Impact resistance, test severity level per DIN IEC 68; part 2-27; IEC 68-2-27-1987										
Number of impacts	n	1,000								
Duration	ms	3								
Acceleration (half-sine)	m/s ²	650								
Vibration resistance, test severity level per DIN IEC 68; part 2-6; IEC 68-2-6-1982										
Frequency range	Hz	5 ... 65								
Duration	h	1.5								
Acceleration (amplitude)	m/s ²	50								
Nominal (rated) speed n_{nom}										
Option 3, Code L ⁶⁾	rpm	15,000			12,000			10,000		
Option 3, Code H ⁶⁾	rpm	18,000			16,000			14,000 12,000		
Load limits⁷⁾										
Limit torque, (static) ± related to M_{nom}	%	200					160			
Breaking torque, (static) ± related to M_{nom}	%	> 400					> 320			
Axial limit force (static) ±	kN	5	10	16	19	39	42	80	120	
Axial limit force (dynamic) amplitude	kN	2.5	5	8	9.5	19.5	21	40	60	
Lateral limit force (static) ±	kN	1	2	4	5	9	10	12	18	
Lateral limit force (dynamic) amplitude	kN	0.5	1	2	2.5	4.5	5	6	9	
Bending limit moment (static) ±	N·m	50	100	200	220	560	600	800	1200	
Bending limit moment (dynamic) amplitude	N·m	25	50	100	110	280	300	400	600	
Oscillation bandwidth per DIN 50100 (peak-to-peak)⁸⁾	N·m	200	400	1,000	2,000	4,000	4,800	8,000	16,000	

⁶⁾ See page 18.

⁷⁾ Each type of irregular stress can only be permitted with its given limit values (bending moment, lateral or axial load, exceeding the nominal (rated) torque) if none of the others can occur. Otherwise the limit values must be reduced. If for instance 30 % of the bending limit moment and also 30 % of the lateral limit force are present, only 40 % of the axial limit force are permitted, provided that the nominal (rated) torque is not exceeded. With the permitted bending moments, axial, and lateral limit forces, measuring errors of about 0.3 % of the nominal (rated) torque can occur.

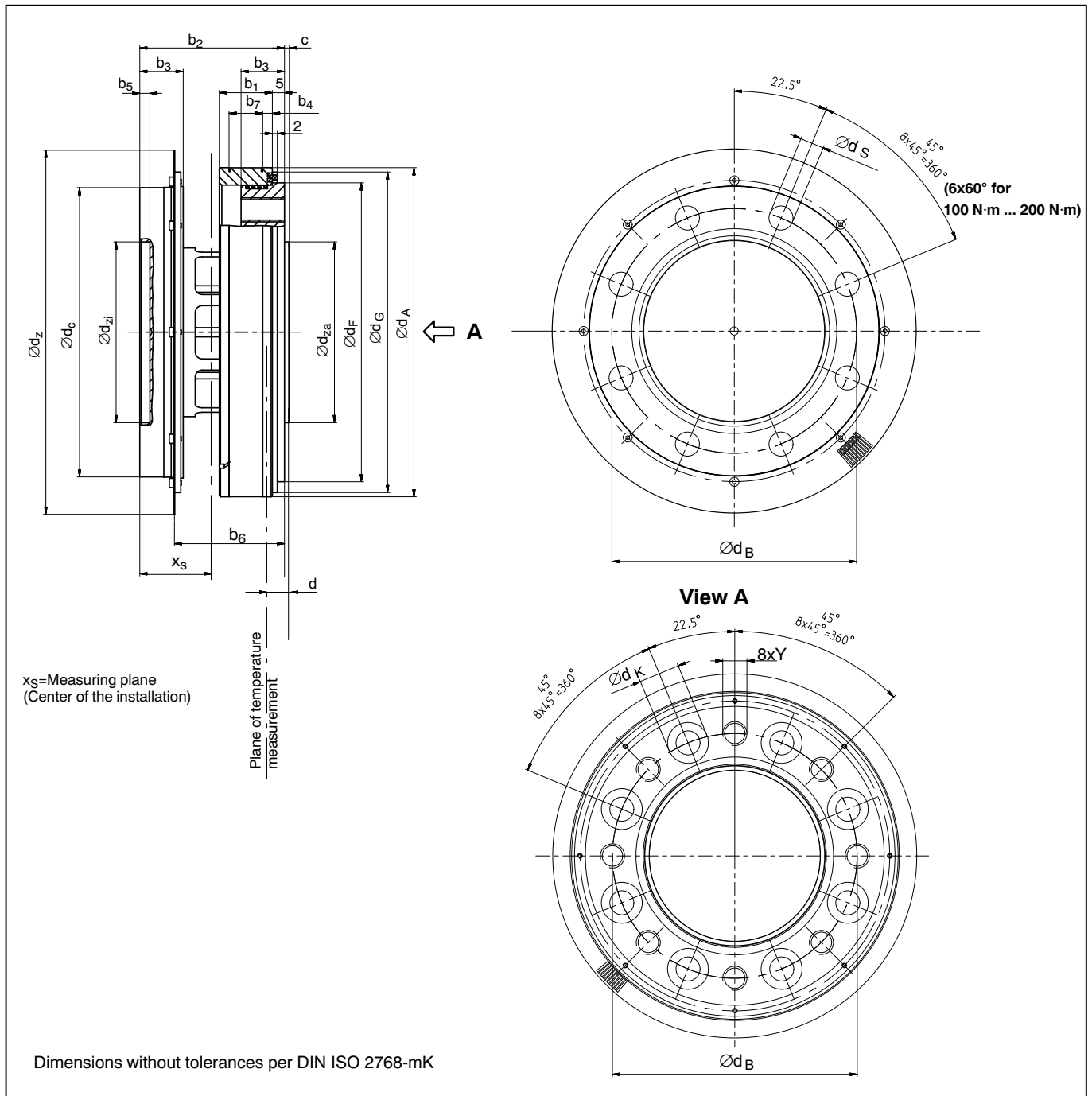
⁸⁾ The nominal (related) torque must not be exceeded.

Specifications (Continued)

Nominal (rated) torque M_{nom}	N·m	100	200	500					
	kN·m				1	2	3	5	10
for reference only	kft·lb	75	150	375	750	1,500	2,250	3,750	7,500
Mechanical data									
Torsional stiffness c_T	kN·m/rad	230	270	540	900	2,300	2,600	4,600	7,900
Torsion angle at M_{nom}	Degree	0.048	0.043	0.055	0.066	0.049	0,066	0,06	0,07
Axial stiffness c_a	kN/mm	420	800	740	760	950	1,000	950	1,600
Radial stiffness c_r	kN/mm	130	290	550	810	1,300	1,500	1,650	2,450
Stiffness with bending moment about a radial axis c_b	kN·m/degree	3,8	7	11.5	12	21.7	22.4	43	74
Maximum excursion at axial limit force	mm	< 0.02		< 0.03		< 0.05		< 0.1	
Additional max. radial run-out deviation at lateral limit force	mm	< 0.02							
Additional plane-parallel deviation at bending limit moment (with $\varnothing d_B$)	mm	<0.03		<0.05		<0.07			
Balance quality-level per DIN ISO 1940		G 2.5							
Max. limits for relative shaft vibration (peak-to-peak)⁹⁾ Undulations within the range of the connecting flanges per ISO 7919-3	μm	Normal mode (continuous operation)						$S_{(p-p)} = \frac{9000}{\sqrt{n}}$	
		Start-Stop mode/resonance ranges (temporary)						$S_{(p-p)} = \frac{13200}{\sqrt{n}}$	
		(n in rpm)							
Mass moment of inertia of the rotor									
I_y (around rotating axis)	kg·m ²	0.0023	0.0033	0.0059	0.0192	0.037	0.097		
I_y with optical speed measuring system	kg·m ²	0.0025	0.0035	0.0062	0.0196	0.038	0.0995		
Proportionate mass moment of inertia for assembly side									
without speed measuring system	%	58		56		54		53	
with optical speed measuring system	%	56		54		53		52	
Max. permissible static eccentricity of the rotor (radially) to stator center									
without speed measuring system	mm	± 2							
with speed measuring system	mm	± 1							
Max. permissible axial displacement of the rotor to stator	mm	± 2							

⁹⁾ The effects of radial deviation, eccentricity, defect of form, notches, marks, local residual magnetism, structural inhomogeneity or material anomalies on vibration measurements need to be taken into account and distinguished from the actual undulation.

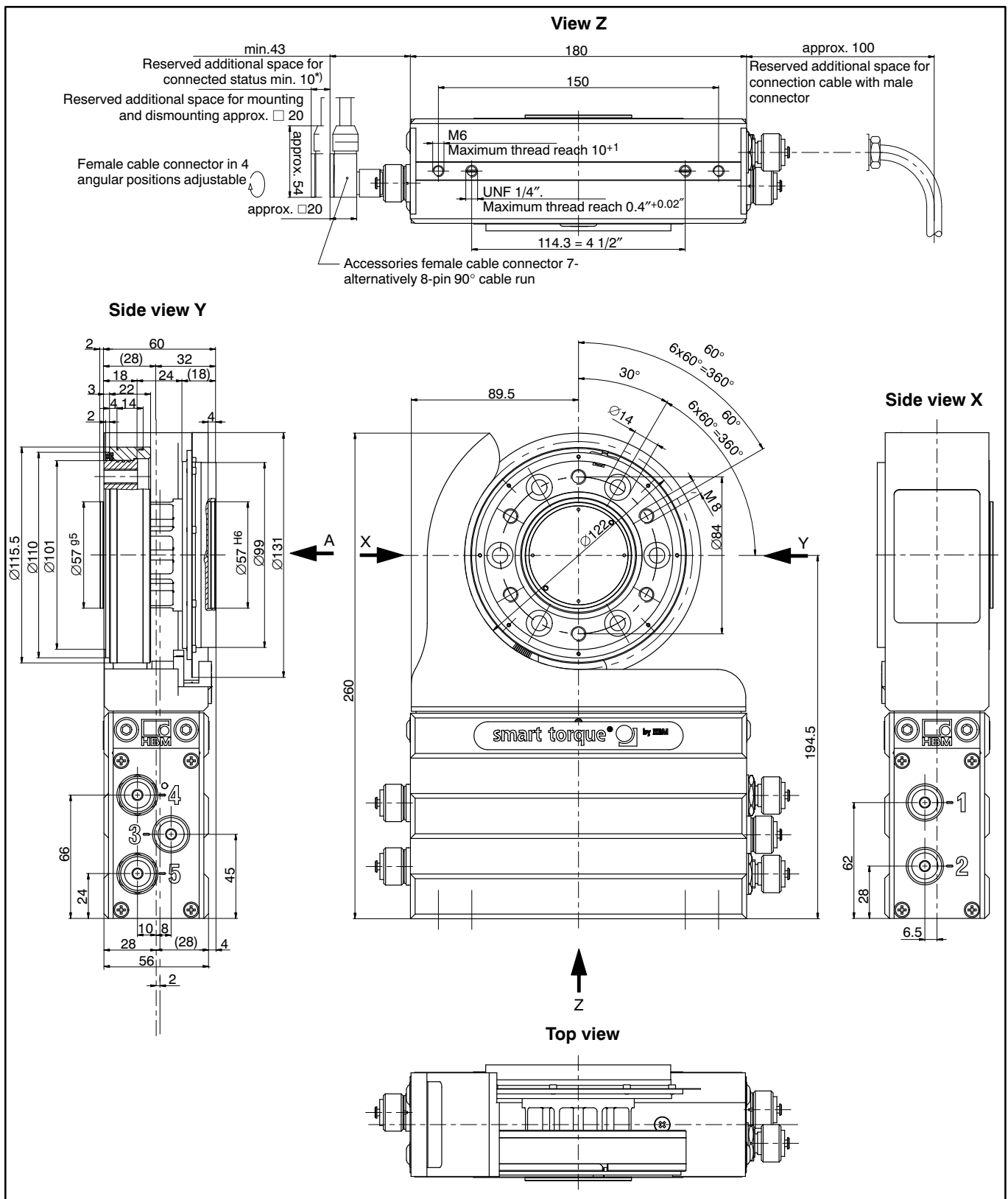
Rotor dimensions (in mm; 1 mm=0.03937 inches)



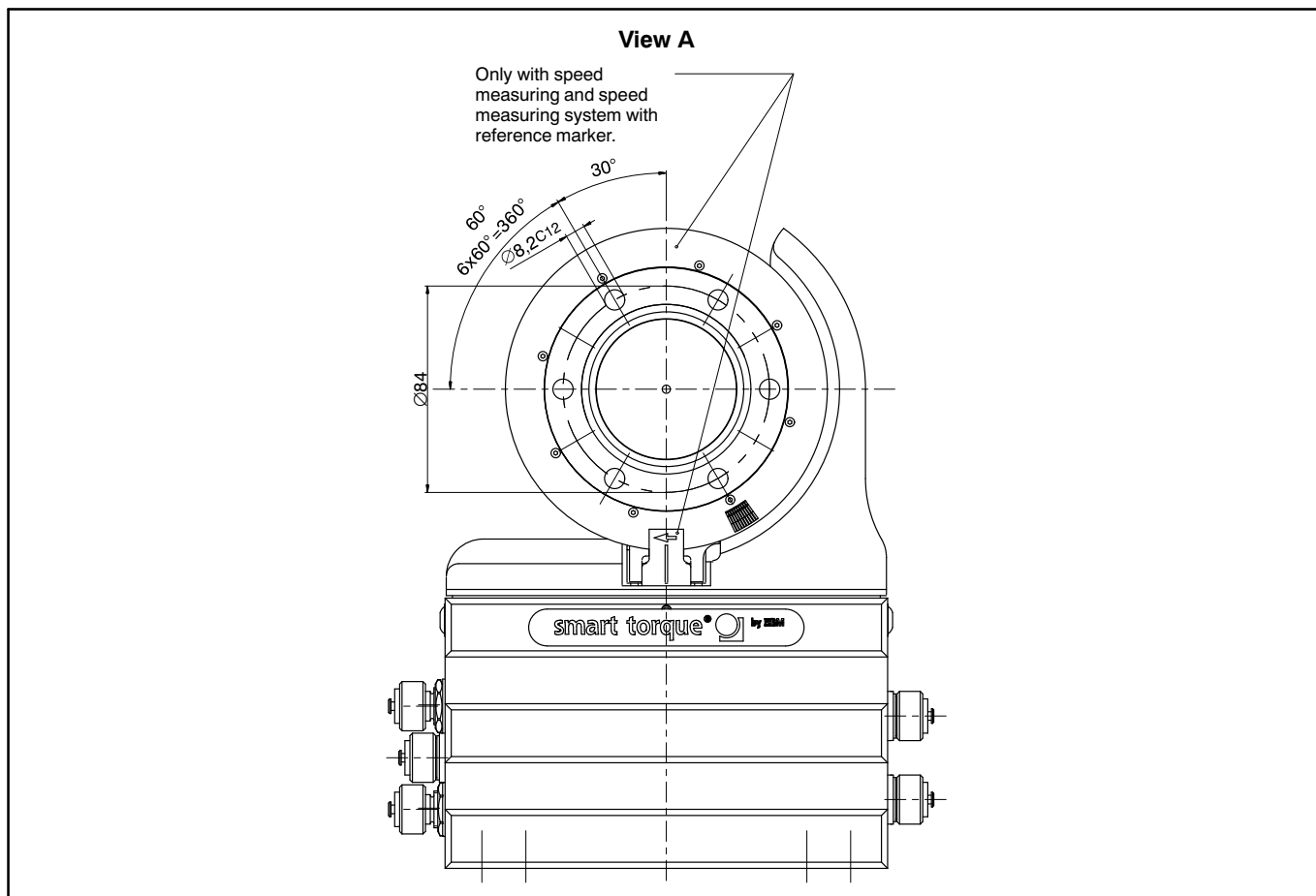
Measuring range	Dimensions in mm										
	b_1	b_2	b_3	b_4	b_5	b_6	b_7	c	d	x_s	Y
100 N·m/200 N·m	22	60	18	4	4	47.15	14	2	12.5	30	M8
500 N·m/1 kN·m	22	60	18	4	4	45.7	14	2	8	30	M10
2 kN·m/3 kN·m	23	64	20	5	4	47.7	14	2.5	8	32	M12
5 kN·m	24.8	84	26	3.3	3	62.7	17.5	2.8	8	42	M14
10 kN·m	24.8	92	30	3.3	4	66.7	17.5	3.5	10	46	M16

Measuring range	Dimensions in mm									
	$\varnothing d_A$	$\varnothing d_B$	$\varnothing d_C$	$\varnothing d_F$	$\varnothing d_G$	$\varnothing d_K$	$\varnothing d_S^{C12}$	$\varnothing d_z$	$\varnothing d_{za\ g5}$	$\varnothing d_{zi}^{H6}$
100 N·m/200 N·m	115,5	84	99	101	110	14	8,2	131	57	57
500 N·m/1 kN·m	136.5	101.5	120	124	133	17	10	151	75	75
2 kN·m/3 kN·m	172.5	130	155	160	169	19	12	187	90	90
5 kN·m	200.5	155.5	179	188	197	22	14.2	221	110	110
10 kN·m	242.5	196	221	230	239	26	17	269	140	140

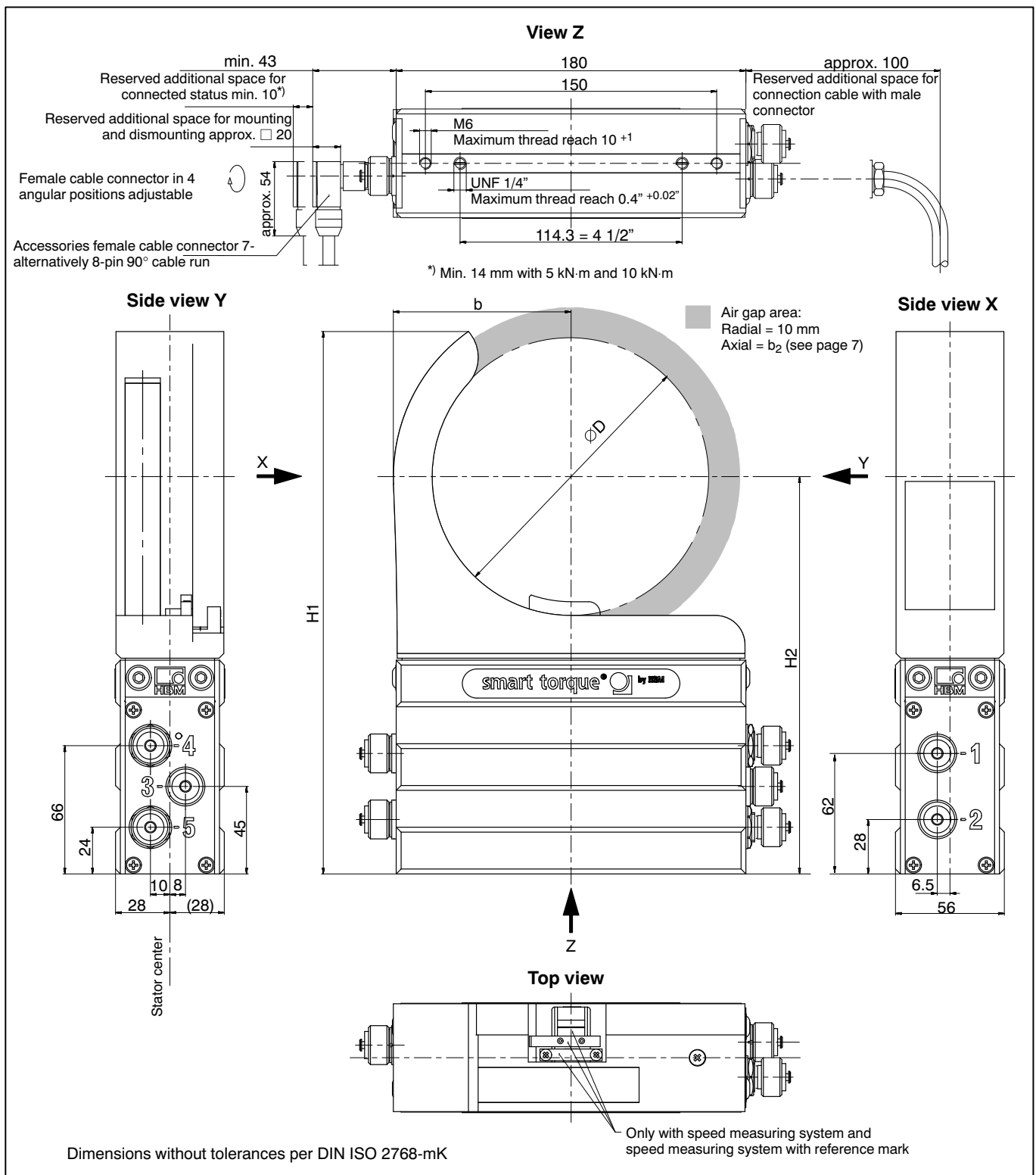
Stator dimensions 100 N·m ... 200 N·m (in mm; 1 mm=0.03937 inches)



Stator dimensions 100 N·m ... 200 N·m (in mm; 1 mm=0.03937 inches)

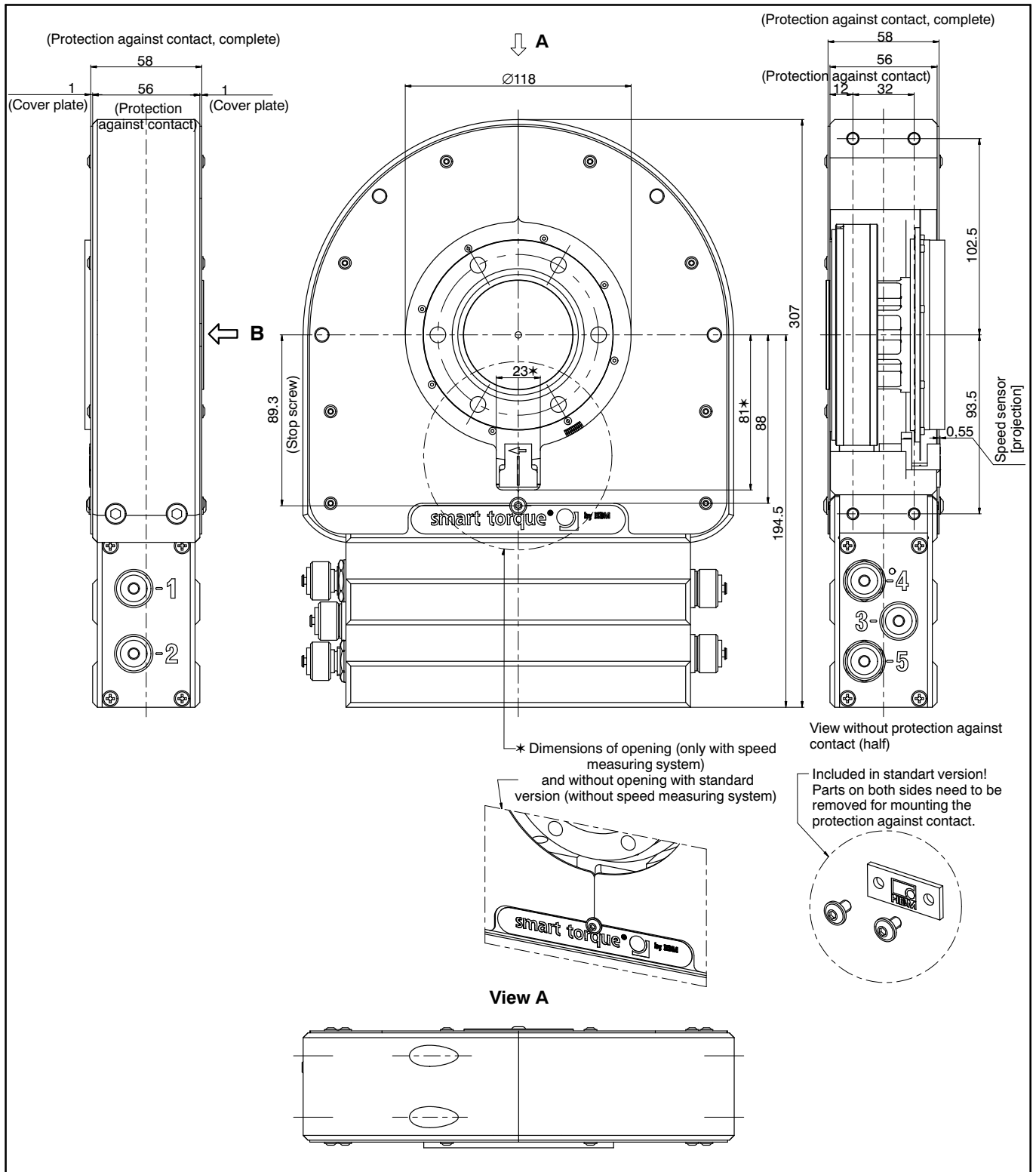


Stator dimensions 100 N·m ... 10 kN·m (in mm; 1 mm=0.03937 inches)

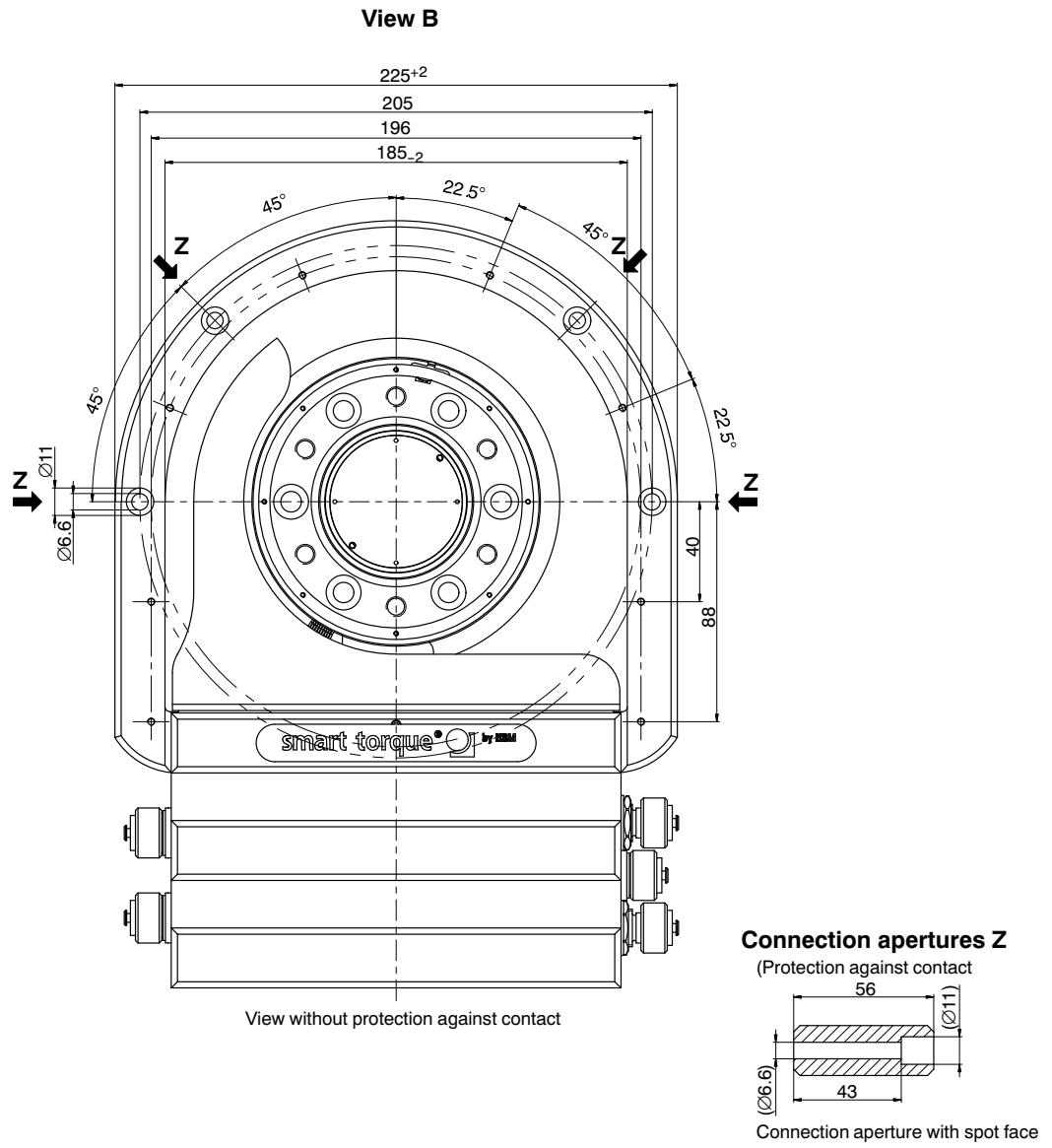


Measuring range (N·m)	Dimensions in mm			
	b	ØD	H1	H2
100	81	122	260	194,5
200				
500	91.5	143	280	204.5
1 k				
2 k	109.5	179	310	222.5
3 k				
5 k	123.5	207	333	239.5
10 k	144.5	249	369	263.5

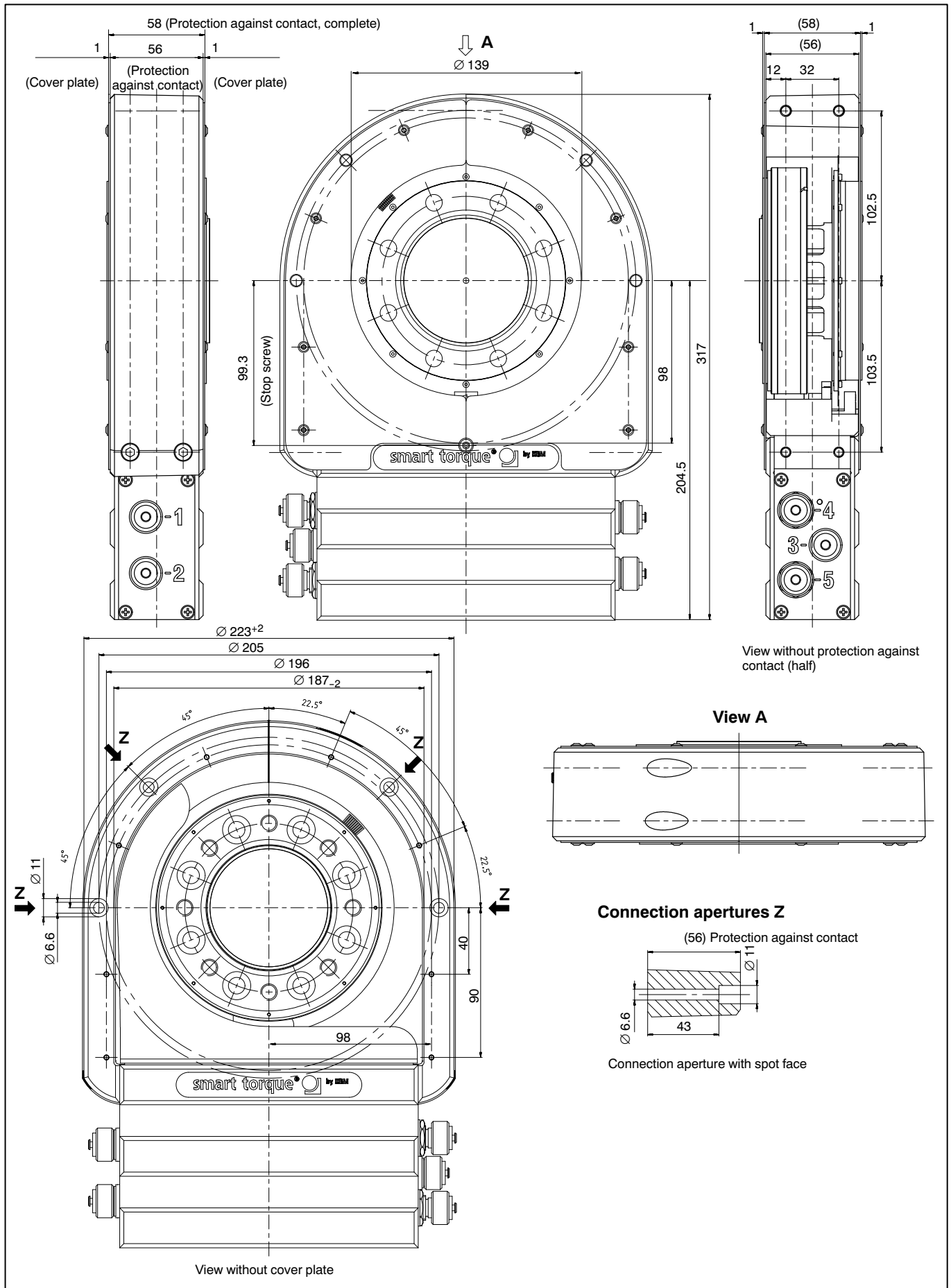
Stator dimensions 100 N·m ... 200 N·m with protection against contact (in mm)



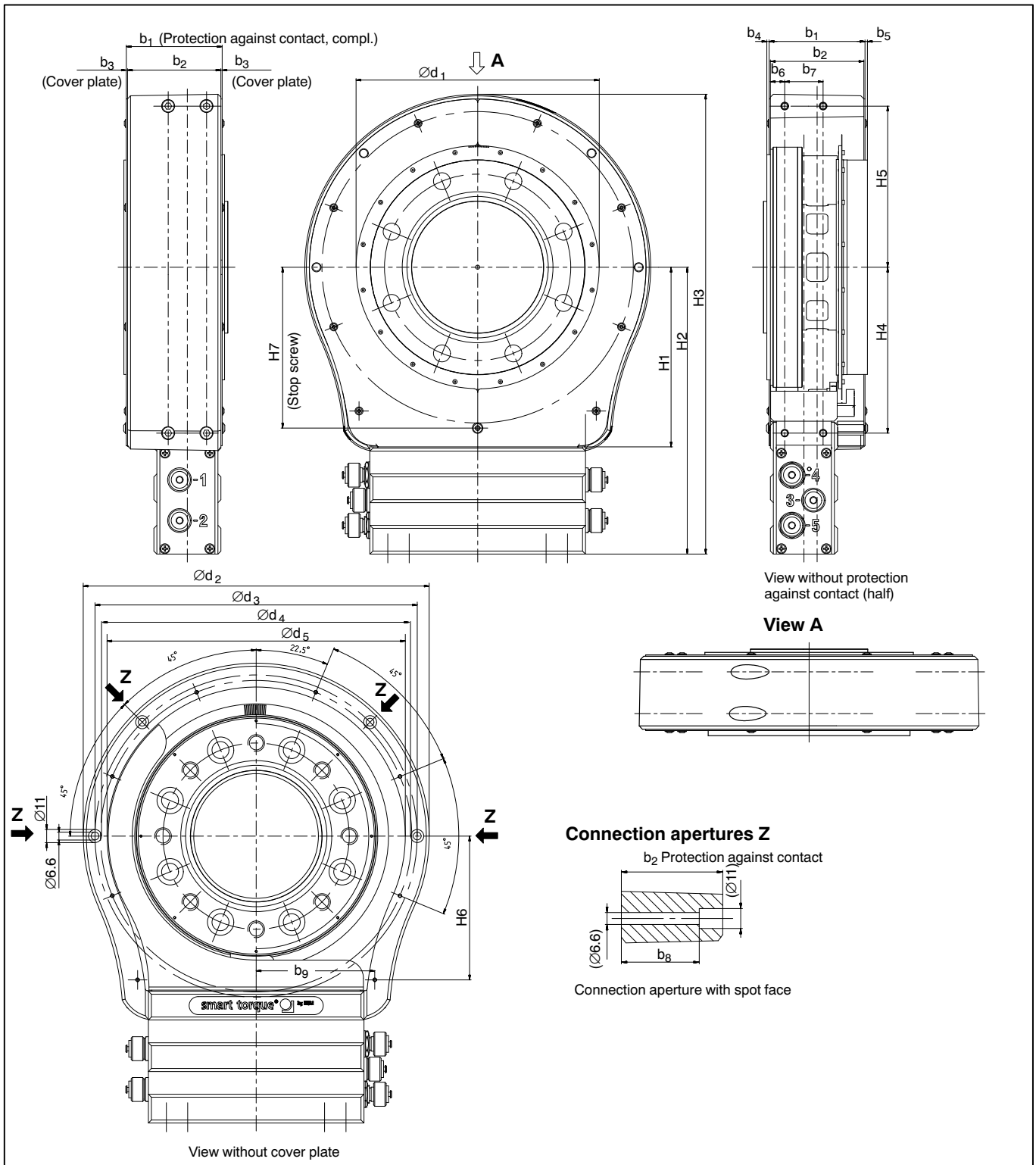
Stator dimensions 100 N·m ... 200 N·m with protection against contact (in mm)



Stator dimensions 500 N·m ... 1 kN·m with protection against contact (in mm)

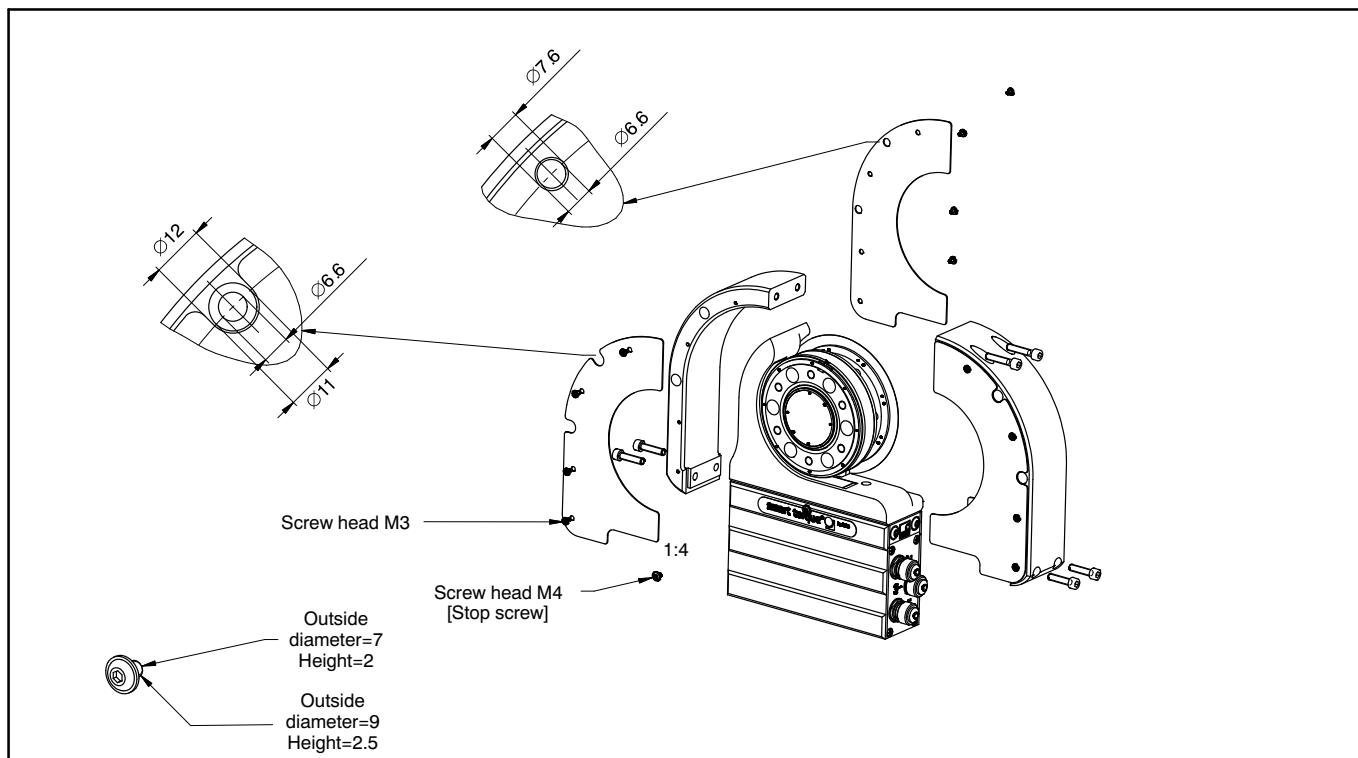


Stator dimensions 2 kN·m ... 10 kN·m with protection against contact (in mm)

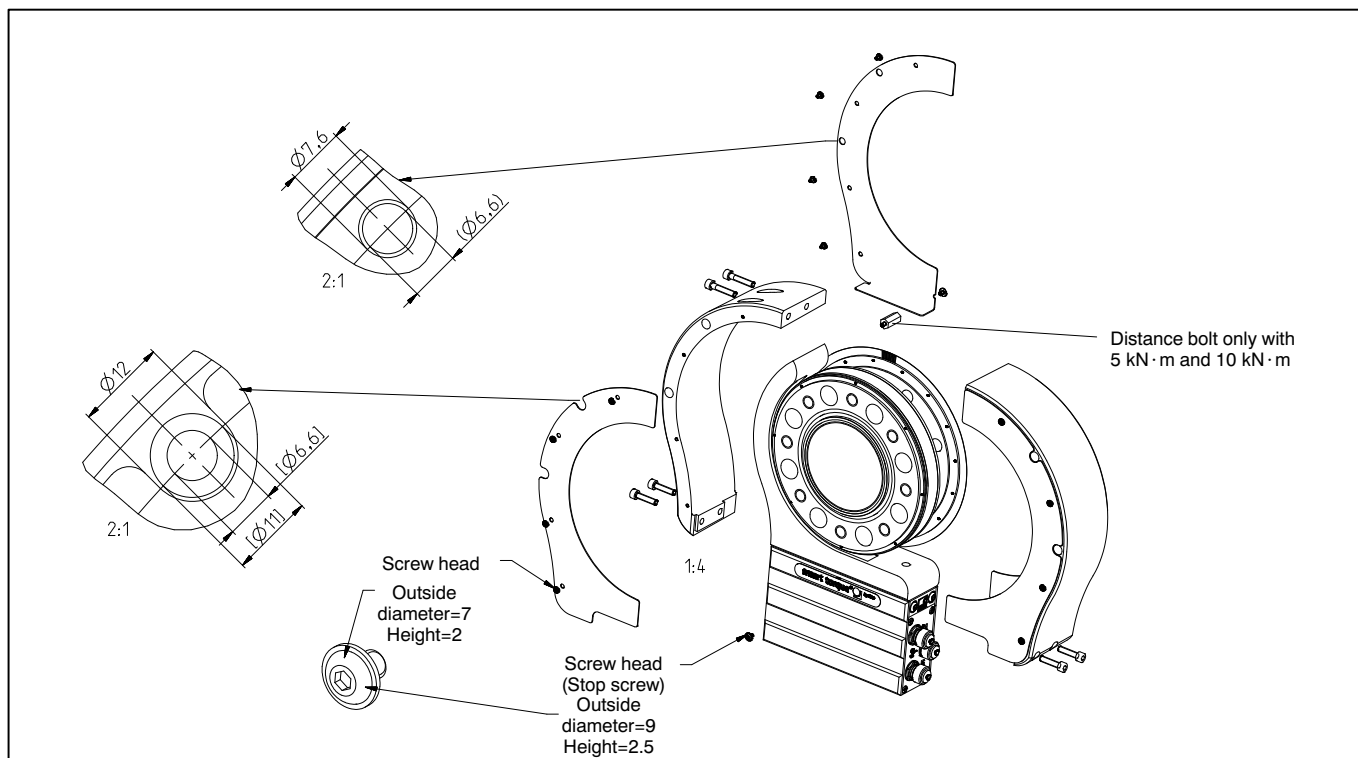


Measuring range	Dimensions in mm															
	b_1	b_2	b_3	b_4	b_5	b_6	b_7	b_8	b_9	H_1	H_2	H_3	H_4	H_5	H_6	H_7
2 kN·m/3 kN·m	58	56	1	2	4	12	32	43	97.5	116	222.5	353	121.5	120.5	107	117.3
5 kN·m	80	78	1	2	2	12	32	65	99	133	239.5	384	138.5	134.5	120	134.3
10 kN·m	88	86	1	2	2	12	32	73	99	157	263.5	429	162.5	155.5	145	158.3
Measuring range	Dimensions in mm															
	$\varnothing d_1$	$\varnothing d_2$	$\varnothing d_3$	$\varnothing d_4$	$\varnothing d_5$											
2 kN·m/3 kN·m	175	259^{+2}	241	232	223_{-2}											
5 kN·m	203	289^{+2}	269	260	249_{-2}											
10 kN·m	245	331^{+2}	311	302	291_{-2}											

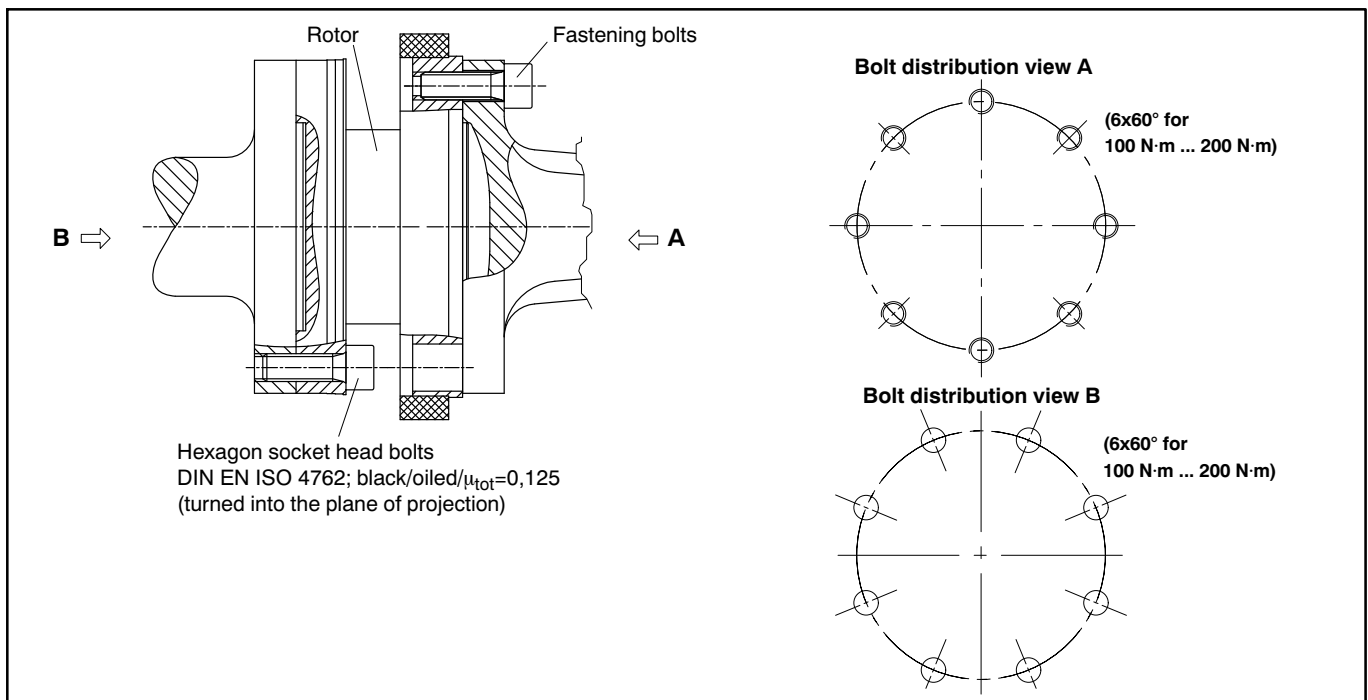
Dimensions cover plates 100 N·m ... 200 N·m (in mm)



Dimensions cover plates 500 N·m ... 10 kN·m (in mm)

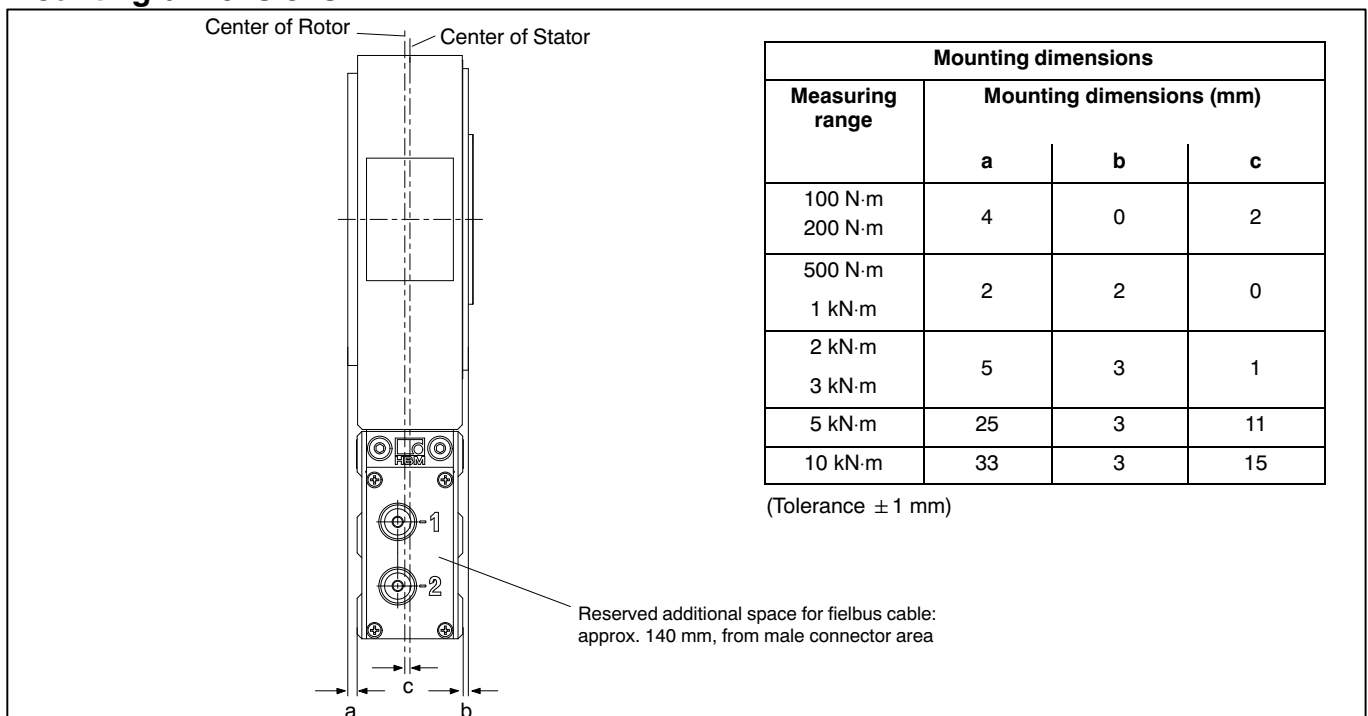


Bolted connection of the rotor

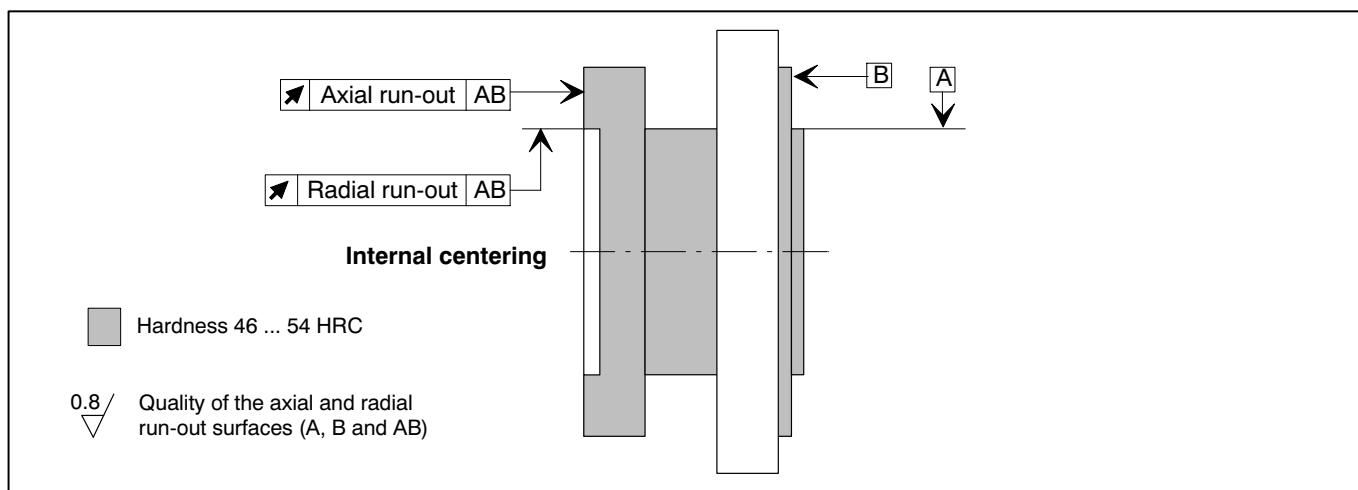


Nominal (rated) torque (N·m)	Fastening bolts	Property class of fastening bolts	Prescribed tightening moment (N·m)	
100	M8	10.9	34	
200				
500				
1k	M10		12.9	67
2k				
3k	M12			115
5k		135		
10k		220		
	M14			340
	M16			

Mounting dimensions



Radial and axial run-out tolerances



Measuring range (N·m)	Axial run-out tolerance (mm)	Radial run-out tolerance (mm)
100	0.01	0.01
200	0.01	0.01
500	0.01	0.01
1 k	0.01	0.01
2 k	0.02	0.02
3 k	0.02	0.02
5 k	0.025	0.025
10 k	0.025	0.025

Accessories, to be ordered separately:

Item	Order-No.
Ready made connecting cables	
Torque	
Connecting cable torque, Binder 423 7-pole - D-Sub 15-pole, 6 m	1-KAB149-6
Connecting cable torque, Binder 423 - pigtails, 6 m	1-KAB153-6
Rotational speed	
Connecting cable rot. speed, Binder 423 8-pole - D-Sub 15-pole, 6 m	1-KAB150-6
Connecting cable rot. speed, Binder 423 8-pole - pigtails, 6 m	1-KAB154-6
Connecting cable rot. speed, reference pulse, Binder 423 8-pole - D-Sub 15-pole, 6 m	1-KAB163-6
Connecting cable rot. speed, reference pulse, Binder 423 8-pole - pigtails, 6 m	1-KAB164-6
CANbus	
Connecting cable CANbus, M12 A-encoded - D-Sub 9-pole, connectable termination resistor, 6 m	1-KAB161-6
Male/female cable connectors	
Torque	
423G-7S, female cable connector 7-pole, straight cable entry, for torque output (connector 1, connector 3)	3-3101.0247
423W-7S, female cable connector 7-pole, 90° cable entry, for torque output (connector 1, connector 3)	3-3312.0281
Rotational speed	
423G-8S, female cable connector 8-pole, straight cable entry, for rot. speed output (connector 2)	3-3312.0120
423W-8S, female cable connector 8-pole, 90° cable entry, for rot. speed output (connector 2)	3-3312.0282
CANbus	
TERMINATOR M12/ termination resistor, M12, A-encoded, 5-pole, male connector	1-CANHEAD-TERM
Termination resistor CANbus M12, A-encoded, 5-pole, female connector	1-CAN-AB-M12
T-unit M12, A-encoded, 5-pole	1-CANHEAD-M12-T
Male/female cable connector/CANbus M12, female cable connector 5-pole M12, A-encoded, male cable connector 5-pole M12, A-encoded	1-CANHEAD-M12
PROFIBUS	
Connecting cable, Y junction, M12 female, B-encoded; M12 male, B-encoded; M12 female, B-encoded, 2 m	1-KAB167-2
Male/female cable connector/PROFIBUS M12, female cable connector 5-pole M12, B-encoded, male cable connector 5-pole M12, B-encoded	1-PROFI-M12
Termination resistor PROFIBUS M12, B-encoded, 5-pole	1-PROFI-AB-M12
T-unit PROFIBUS M12, B-encoded, 5-pole	1-PROFI-VT-M12
Connecting cable, by the meter	
Kab8/00-2/2/2	4-3301.0071
Kab8/00-2/2/2/1/1	4-3301.0183
DeviceNet cable	4-3301.0180
Miscellaneous	
Setup-Toolkit for T12 (T12 system CD, PCAN-USB adapter, connecting cable CANbus, 6 m)	1-T12-SETUP-USB

Modifications reserved.

All details describe our products in general form only. They are not to be understood as express warranty and do not constitute any liability whatsoever.

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