T12HP

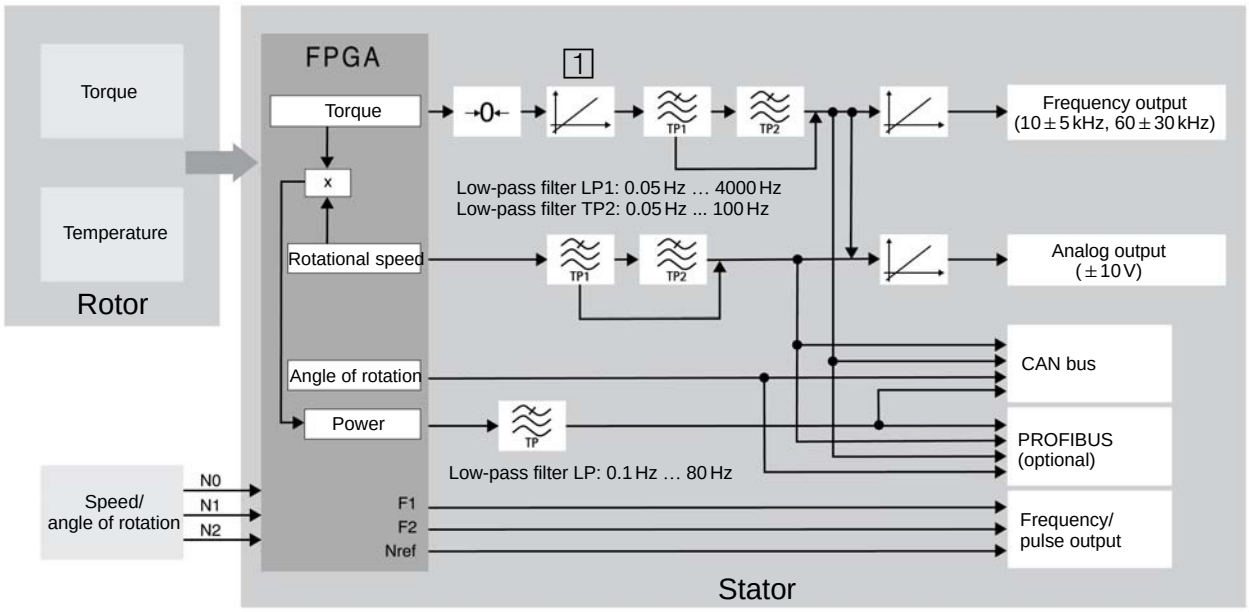
Digital transducer

Special features

- **Nominal (rated) torque 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) rotational speeds of 10,000 rpm to 22,000 rpm**
- **Large measurement frequency range up to 6 kHz (-3 dB)**
- **Fast digital measurement signal transmission of 4800 measured values/s**
- **High resolution of 19 bits (integrative method)**
- **Monitoring functions**
- **Excellent temperature behavior with TC_0 of 0.005%/10K**
- **Minimal linearity deviation, including hysteresis of 0.007%**
- **Extensive options**

Data sheet

Signal flow block diagram



Specifications

Type		T12HP								
Accuracy class		0.02								
Torque measuring system										
Nominal (rated) torque M_{nom}	N·m	100	200	500						
	kN·m				1	2	3	5	10	
Nominal (rated) rotational speed n_{nom}										
Option 4, code L [1]	rpm	15,000		12,000				10,000		
Option 4, code H [1]	rpm	18,000		16,000				14,000	12,000	
Option 4, code F [1], [8], [9]	rpm	22,000		20,000		18,000		not available		
Linearity deviation including hysteresis, related to nominal sensitivity										
Fieldbuses, frequency output 10 kHz/60 kHz										
For a max. torque in range:										
between 0% of M_{nom} and 20% of M_{nom}	%	< ± 0.005 (optional < ± 0.003)								
> 20% of M_{nom} and 60% of M_{nom}	%	< ± 0.010 (optional < ± 0.005)								
> 60% of M_{nom} and 100% of M_{nom}	%	< ± 0.015 (optional < ± 0.007)								
Voltage output										
For a max. torque in range:										
between 0% of M_{nom} and 20% of M_{nom}	%	< ± 0.015								
> 20% of M_{nom} and 60% of M_{nom}	%	< ± 0.035								
> 60% of M_{nom} and 100% of M_{nom}	%	< ± 0.05								
Rel. standard deviation of repeatability per DIN 1319, related to the variation of the output signal										
Fieldbuses/frequency output	%	± 0.005								
Voltage output	%	± 0.03								
Temperature effect per 10 K in the nominal (rated) temperature range										
on the output signal, related to the actual value of the signal span										
Fieldbuses/frequency output	%	± 0.02								
Voltage output	%	± 0.05								
on the zero signal, related to the nominal sensitivity										
Fieldbuses/frequency output	%	± 0.01 (optional ± 0.005)								
Voltage output	%	± 0.04								
Nominal sensitivity (spread between torque = zero and nominal (rated) torque)										
Frequency output 10 kHz/60 kHz	kHz	5/30								
Voltage output	V	10								
Sensitivity tolerance (deviation of the actual output quantity at M_{nom} from the nominal sensitivity)										
Frequency output	%	± 0.05								
Voltage output	%	± 0.1								
Output signal at torque = zero										
Frequency output 10 kHz/60 kHz	kHz	10/60								
Voltage output	V	0								
Nominal (rated) output signal										
Frequency output										
with positive nominal (rated) torque 10 kHz/60 kHz	kHz	15/90 (5 V symmetrical) [2])								
with negative nominal (rated) torque 10 kHz/60 kHz	kHz	5/30 (5 V symmetrical [2])								
Voltage output										
at positive nominal (rated) torque	V	+10								
at negative nominal (rated) torque	V	-10								
Scaling range										
Frequency output/voltage output	%	10 ... 1000 (of M_{nom})								
Resolution										
Frequency output 10 kHz/60 kHz	Hz	0.03/0.25								
Voltage output	mV	0.33								
Residual ripple										
Voltage output	mV	3								

[1] See page 15.
[2] RS-422 complementary signals, note termination resistance.

Specifications (continued)

Nominal (rated) torque M_{nom}	N·m	100	200	500					
	kN·m				1	2	3	5	10
Maximum modulation range [3]									
Frequency output 10 kHz/60 kHz	kHz	4 ... 16/24 ... 96							
Voltage output	V	-10.2 ... +10.2							
Load resistance									
Frequency output	kΩ	≥ 2							
Voltage output	kΩ	≥ 10							
Long-term drift over 48 h									
Voltage output	mV	±3							
Measurement frequency range									
Frequency output/voltage output -1 dB	Hz	0 ... 4000							
Frequency output/voltage output -3 dB	Hz	0 ... 6000							
Low-pass filter LP1	Hz	0.05 ... 4000 (fourth-order Bessel, -1 dB); factory setting 1000 Hz							
Low-pass filter LP2	Hz	0.05 ... 100 (fourth-order Bessel, -1 dB); factory setting 1 Hz							
Group delay (low pass LP1: 4 kHz)									
Frequency output 10 kHz/60 kHz	µs	320/250							
Voltage output	µs	500							
Energy supply									
Nominal (rated) supply voltage (DC) (safety extra-low voltage)	V	18 ... 30							
Current consumption in measuring mode	A	< 1 (typ. 0.5)							
Current consumption in startup mode	A	< 4							
Nominal (rated) power consumption	W	< 18							
Maximum cable length	m	50							
Shunt signal		50 % of M_{nom} or 10 % of M_{nom}							
Tolerance of the shunt signal, related to M_{nom}	%	±0.05							
Speed/angle of rotation measuring system Optical, using infrared light and a 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 revolution (adjustable)	Number	360; 180; 90; 60; 45; 30						720; 360; 180; 120; 90; 60	
Pulse frequency at nominal (rated) rotational speed n_{nom}									
Option 4, code L [4]	kHz	90		72				120	
Option 4, code H [4]	kHz	108		96				168	
Option 4, code F [4]	kHz	132		120		108		not available	
Minimum rotational speed for sufficient pulse stability	rpm	2							
Group delay	µs	< 5 (typ. 2.2)							
Hysteresis of direction of rotation reversal in the case of relative vibrations between rotor and stator									
Torsional vibration of the rotor	degrees	< approx. 2							
Radial vibrations of the stator	mm	< approx. 2							
Permitted degree of contamination, in the optical path of the sensor pickup (lenses, slotted disc)	%	< 50							
Effect of turbulence (slotted disk) on the zero point related to the nominal (rated) torque									
Option 4, code L [4]	%	< 0.05	< 0.03	< 0.03		< 0.02		< 0.01	
Option 4, code H [4]	%	< 0.08	< 0.04	< 0.03		< 0.02		< 0.01	
Option 4, code F [4]	%	< 0.12	< 0.06	< 0.05		< 0.03		not available	
Output signal for frequency/pulse output	V	5 [5] symmetrical; 2 square-wave signals, approx. 90° out-of-phase							
Load resistance	kΩ	≥ 2							

[3] Output signal range in which there is a repeatable correlation between torque and output signal.

[4] See page 15.

[5] RS-422 complementary signals, note line terminations.

Specifications (continued)

Nominal (rated) torque M_{nom}	N·m	100	200	500					
	kN·m				1	2	3	5	10
Rotational speed									
Fieldbuses									
Resolution	rpm	0.1							
System accuracy (with torsional vibrations of max. 3% of the current rotational speed at 2x rotational frequency)	ppm	150							
Max. rotational speed deviation at nominal (rated) rotational speed (100 Hz filter)	rpm	1.5							
Voltage output									
Measurement range	V	±10							
Resolution	mV	0.33							
Scaling range	%	10 to 1000							
Overload limits	V	±10.2							
Load resistance	kΩ	> 10							
Non-linearity	%	< 0.03							
Nominal (rated) power consumption	W	< 18							
Maximum cable length	m	50							
Temperature effect per 10 K in the nominal (rated) temperature range									
on the output signal, related to the actual value of the signal span	%	< 0.03							
on the zero signal	%	< 0.03							
Residual ripple	mV	< 3							
Angle of rotation									
Accuracy	degrees	1 (typ. 0.1)							
Resolution	degrees	0.01							
Correction of runtime deviation between torque LP1 and the angle of rotation for filter frequencies	Hz	4000; 2000; 1000; 500; 200; 100							
Measurement range	degrees	0 ... 360 (single-turn) to ±1440 (multi-turn)							
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 measurement signal span of the power signal related to the full scale value)	%	±0.05							
Temperature signal of the rotor									
Accuracy	K	1							
Measurement frequency range	Hz	5 (-1 dB)							
Resolution	K	0.1							
Physical unit	-	°C							
Sample rate	Measured values/s	40							

Specifications (continued)

Fieldbuses						
CAN bus						
Protocol	-	CAN 2.0B, CAL/CANopen-compatible				
Sample rate	Measured values/s	max. 4800 (PDO)				
Hardware bus link		as per ISO 11898				
Baud rate	kBit/s	1000	500	250	125	100
Maximum line length	m	25	100	250	500	600
Connection	-	5-pin, M12x1, A-coding per CANopen DR-303-1 V1.3, electrically isolated from power supply and measurement ground				
PROFIBUS DP						
Protocol	-	PROFIBUS DP Slave, per DIN 19245-3				
Baud rate	MBaud	max. 12				
PROFIBUS Ident Number	-	096C (hex)				
Input data, max.	bytes	152				
Output data, max.	bytes	40				
Diagnostic data	bytes	18 (2 · 4 byte module diagnosis)				
Connection	-	5-pin, M12x1, B-coding, electrically isolated from power supply and measurement ground				
Update rate [6]						
Configuration entries ≤ 2	Measured values/s	4800				
≤ 4		2400				
≤ 8		1200				
≤ 12		600				
≤ 16		300				
> 16		150				
Limit value switches (on fieldbuses only)						
Number	-	4 for torque, 4 for rotational speed				
Reference level	-	Torque low pass 1 or low pass 2 Rotational speed low pass 1 or low pass 2				
Hysteresis	%	0 ... 100				
Adjustment accuracy	digits	1				
Response time (LP1 = 4000 Hz)	ms	typ. 3				
TEDS (Transducer Electronic Data Sheet)						
Number	-	2				
TEDS 1 (torque)	-	A choice of voltage sensor or frequency sensor				
TEDS 2 (speed/angle of rotation)	-	Frequency/pulse sensor				

6) When CAN PDOs are activated simultaneously, the update rate on the PROFIBUS is reduced.

Specifications (continued)

Nominal (rated) torque M_{nom}	N·m	100	200	500					
	kN·m				1	2	3	5	10
General information									
EMC									
Emission (EME) (per FCC 47, Part 15, Section C)									
Emission (per EN61326-1, Table 3)									
RFI voltage	-					Class A			
RFI power	-					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			
Electrostatic discharge (ESD)									
Contact discharge	kV					4			
Air discharge	kV					8			
Fast transients (burst)	kV					1			
Impulse voltages (surge)	kV					1			
Conducted interference (AM)	V					3			
Degree of protection per EN 60 529						IP 54			
Reference temperature	°C					23			
Nominal (rated) temperature range	°C					+10...+70			
Operating temperature range	°C					-10...+70			
Storage temperature range	°C					-20...+75			
Mechanical shock and impact testing per EN 60068-2-27									
number	n					1000			
Duration	ms					3			
Acceleration (half sine)	m/s^2					650			
Vibration testing per EN 60068-2-6									
Frequency range	Hz					5 ... 2000			
Duration	h					2.5			
Acceleration (amplitude)	m/s^2					100			
Load limits [7]									
Limit torque, (static) ±	% of M_{nom}				200			160	
Breaking torque, (static) ±	% of 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	8.5	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 width per DIN 50100 (peak-to-peak) [9]	N·m	200	400	1000	2000	4000	4800	8000	16000

7) Each type of irregular stress (bending moment, lateral or axial force, exceeding nominal (rated) torque) can only be permitted up to its specified limit, provided none of the others can occur at the same time. If this condition is not met, the limit values must be reduced. If 30% of the bending limit moment and lateral limit force occur at the same time, only 40% of the axial limit force is permissible and the nominal (rated) torque must not be exceeded. The effects of 10% of the permissible bending moments, axial and lateral forces on the measurement result are ≤ ± 0.02% of the nominal (rated) torque.

8) Limit loads / Option 4, Code F (high-speed version): Limit loads (bending moment, lateral, axial force and oscillation width (peak-to-peak)) are reduced by 20%.

9) The nominal (rated) torque must not be exceeded.

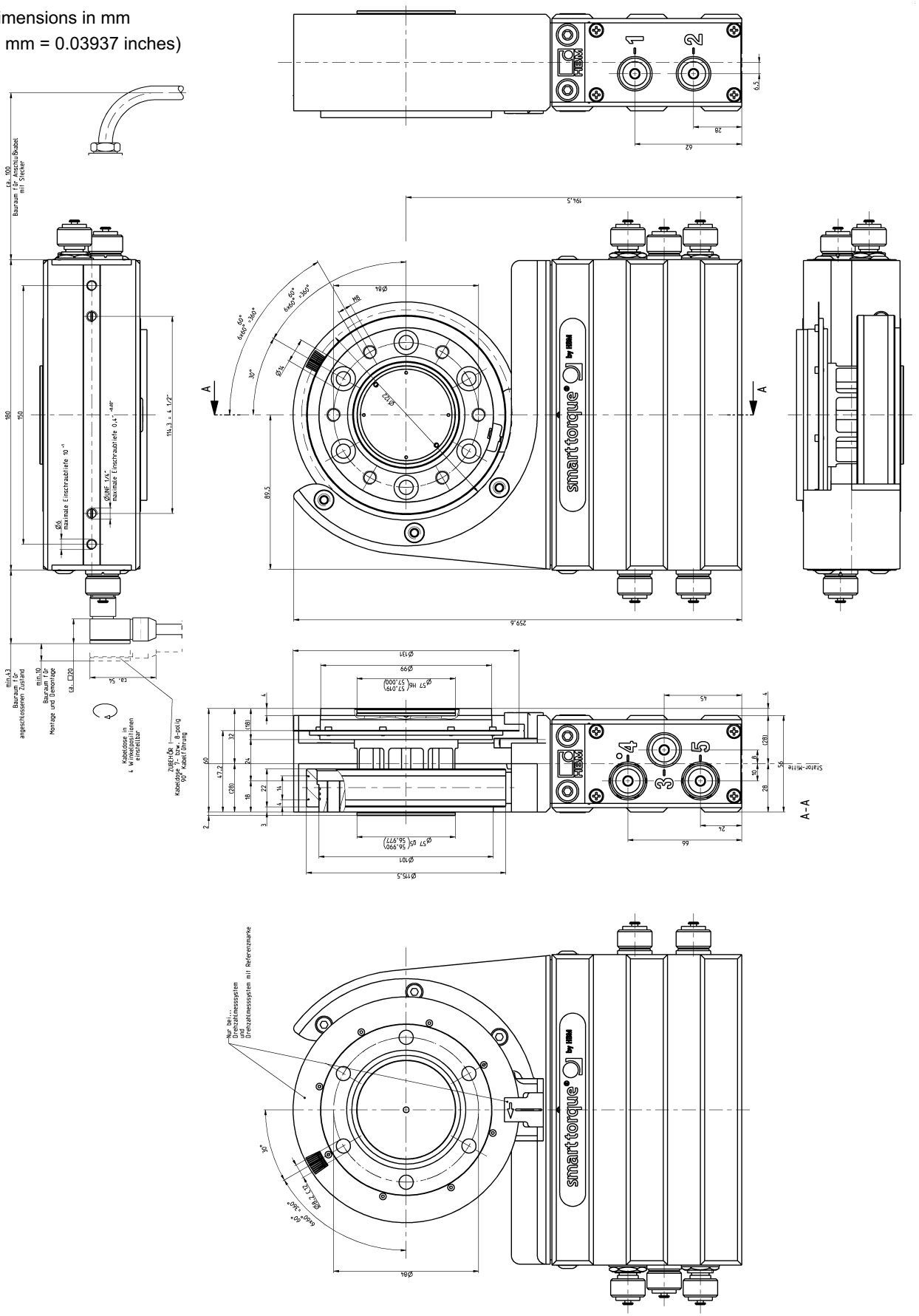
Specifications (continued)

Nominal (rated) torque M_{nom}	N·m	100	200	500					
	kN·m				1	2	3	5	10
Mechanical values									
Torsional stiffness c_T	kN·m/rad	230	270	540	900	2300	2600	4600	7900
Torsion angle at M_{nom}	degrees	0.048	0.043	0.055	0.066	0.049	0.066	0.06	0.07
Stiffness in the axial direction c_a	kN/mm	420	800	740	760	950	1000	950	1600
Stiffness in the radial direction c_r	kN/mm	130	290	550	810	1300	1500	1650	2450
Stiffness during the bending moment round a radial axis c_b	kN·m/deg.	3.8	7	11.5	12	21.7	22.4	43	74
Maximum deflection at axial limit force	mm	< 0.02		< 0.03		< 0.05		< 0.1	
Additional max. radial deviation at lateral limit force	mm	< 0.02							
Additional deviation from plane parallelism at bending limit moment (at ∅ 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) [10] Undulations in the connection flange area, based on ISO 7919-3	µm	Normal operation (continuous operation) $s_{(p-p)} = \frac{9000}{\sqrt{n}}$ Start and stop operation/resonance ranges (temporary) $s_{(p-p)} = \frac{13200}{\sqrt{n}}$ (n in rpm)							
Mass moment of inertia of the rotor									
I_V (around rotary axis)	kg·m²	0.0023	0.0033	0.0059		0.0192		0.037	0.097
I_V with optical rotational speed measuring system	kg·m²	0.0025	0.0035	0.0062		0.0196		0.038	0.0995
Proportional mass moment of inertia for the transmitter side									
without rotational speed measuring system	%	58		56		54		53	
with optical rotational speed measuring system	%	56		54		53		52	
Max. permissible static eccentricity of the rotor (radially) to the center point of the stator									
without rotational speed measuring system	mm	±2							
with rotational speed measuring system	mm	±1							
Max. permissible axial displacement of the rotor to the stator	mm	±2							
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

[10] The influence of radial deviations, impact, defects of form, notches, marks, local residual magnetism, structural inhomogeneity or material anomalies on the vibrational measurements needs to be taken into account and isolated from the actual undulation.

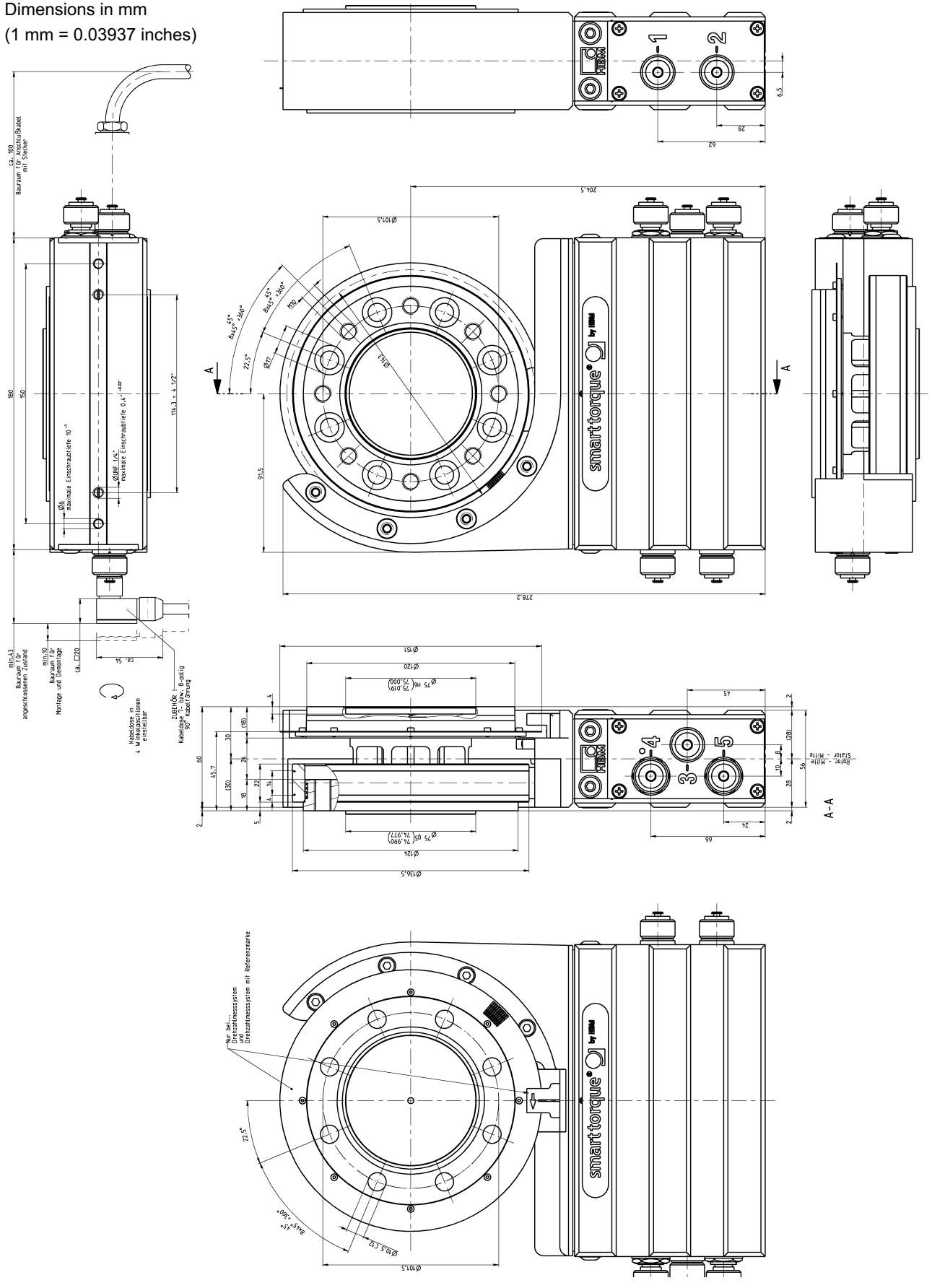
Complete measurement flange, T12HP/100 Nm to 200 Nm, with rotational speed measuring system

Dimensions in mm
(1 mm = 0.03937 inches)



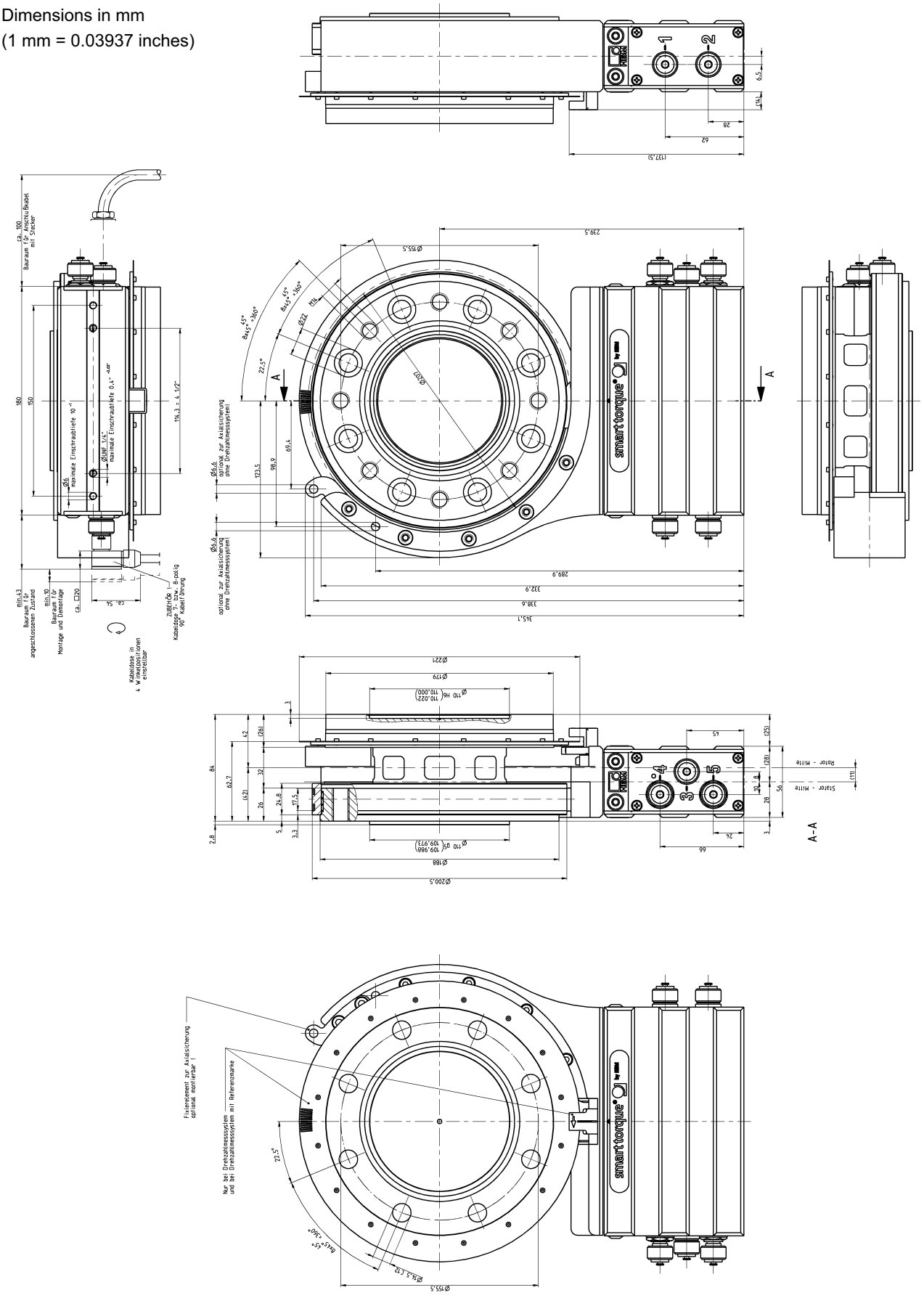
Complete measurement flange, T12HP/500 Nm to 1 kNm, with rotational speed measuring system

Dimensions in mm
(1 mm = 0.03937 inches)



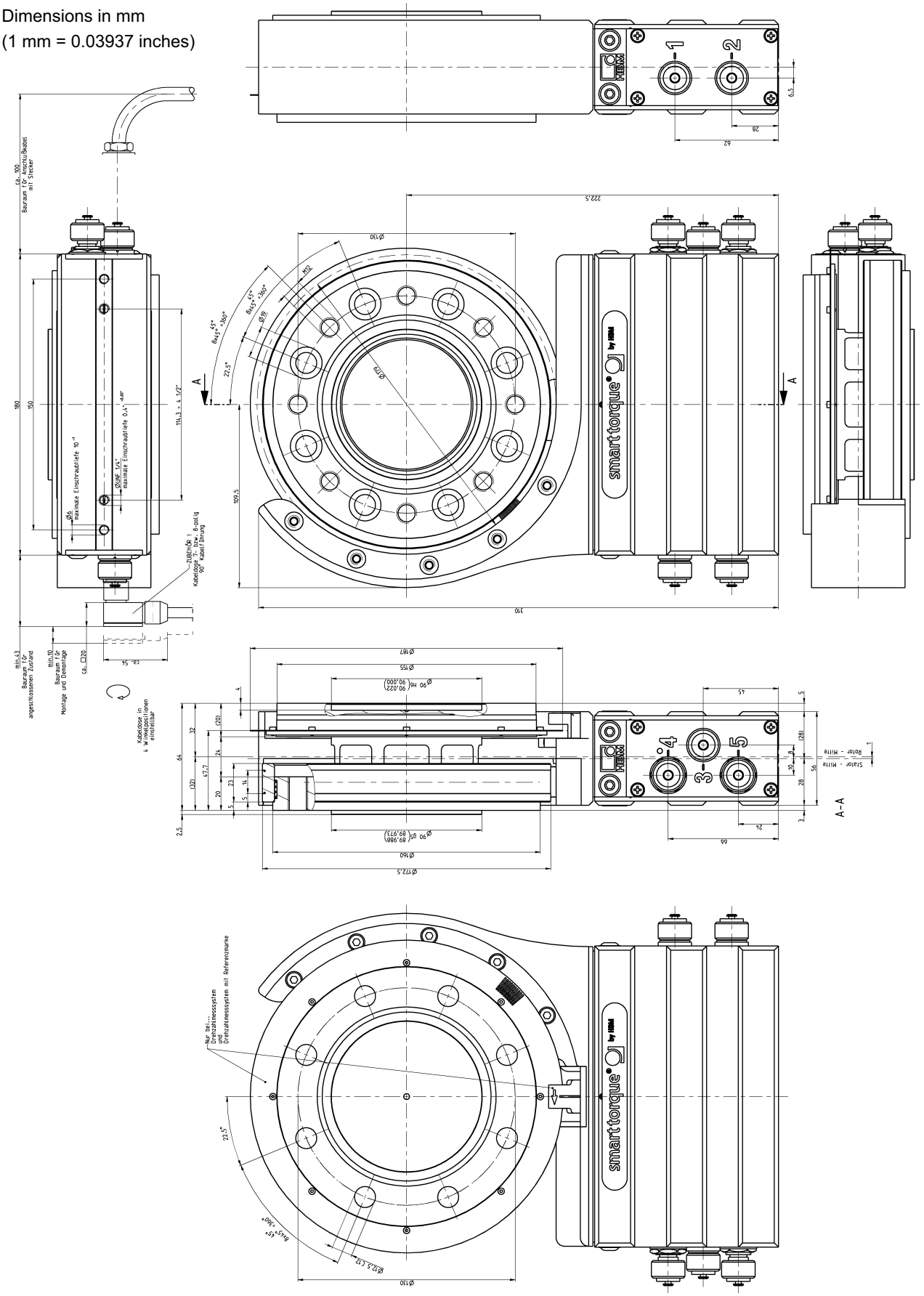
Complete measurement flange, T12HP/5 kNm, with rotational speed measuring system

Dimensions in mm
(1 mm = 0.03937 inches)



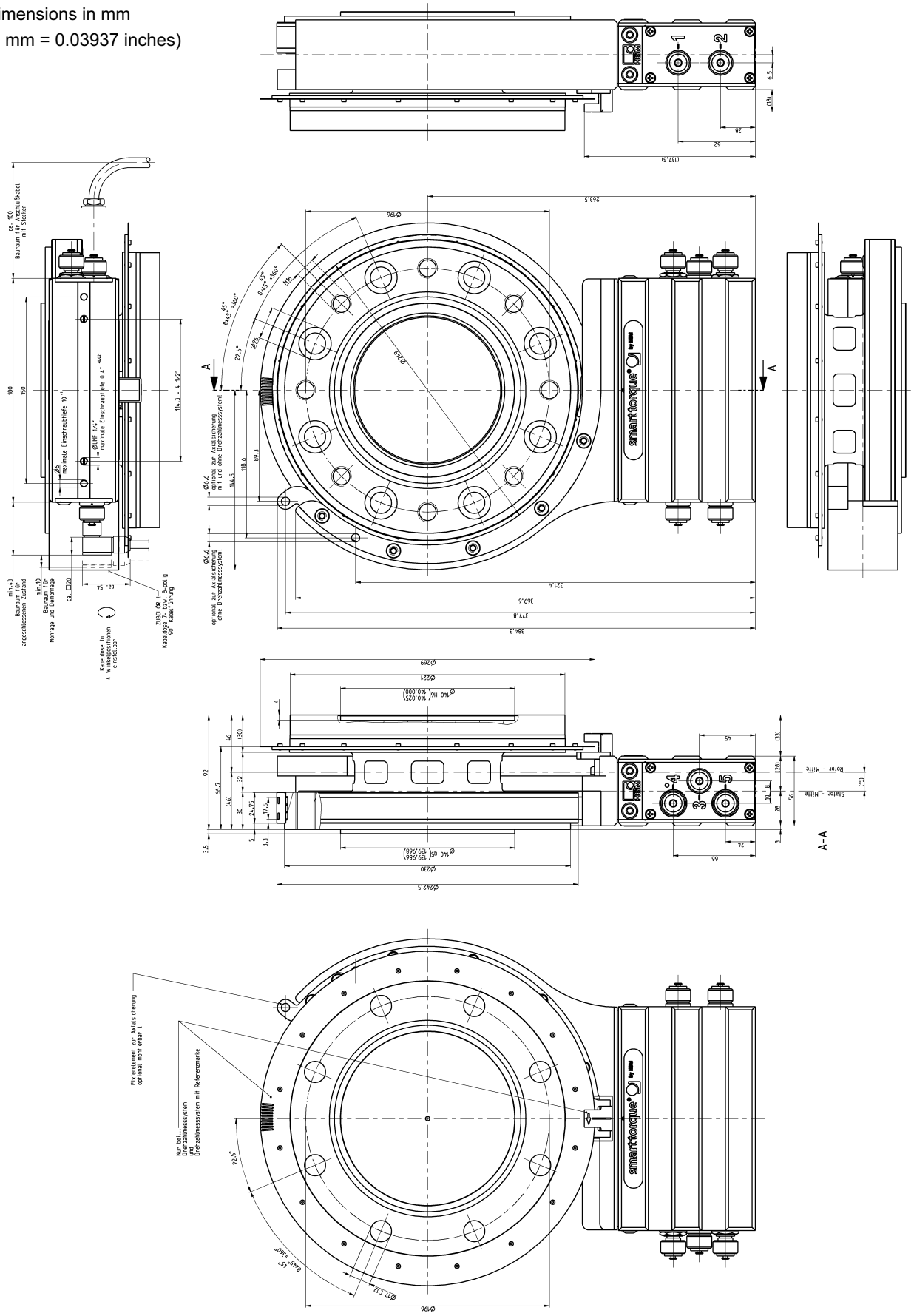
Complete measurement flange, T12HP/2 to 3 kNm, with rotational speed measuring system

Dimensions in mm
(1 mm = 0.03937 inches)

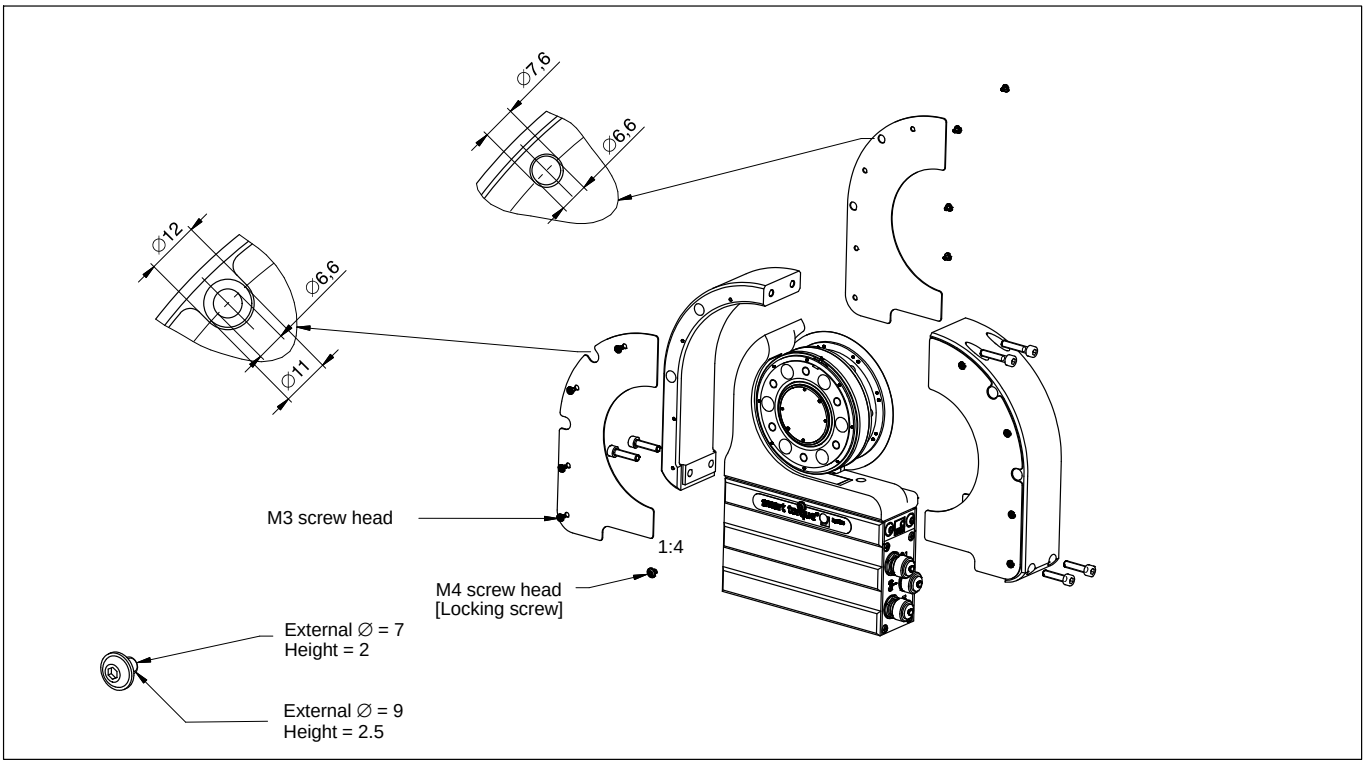


Complete measurement flange, T12HP/10 kNm, with rotational speed measuring system

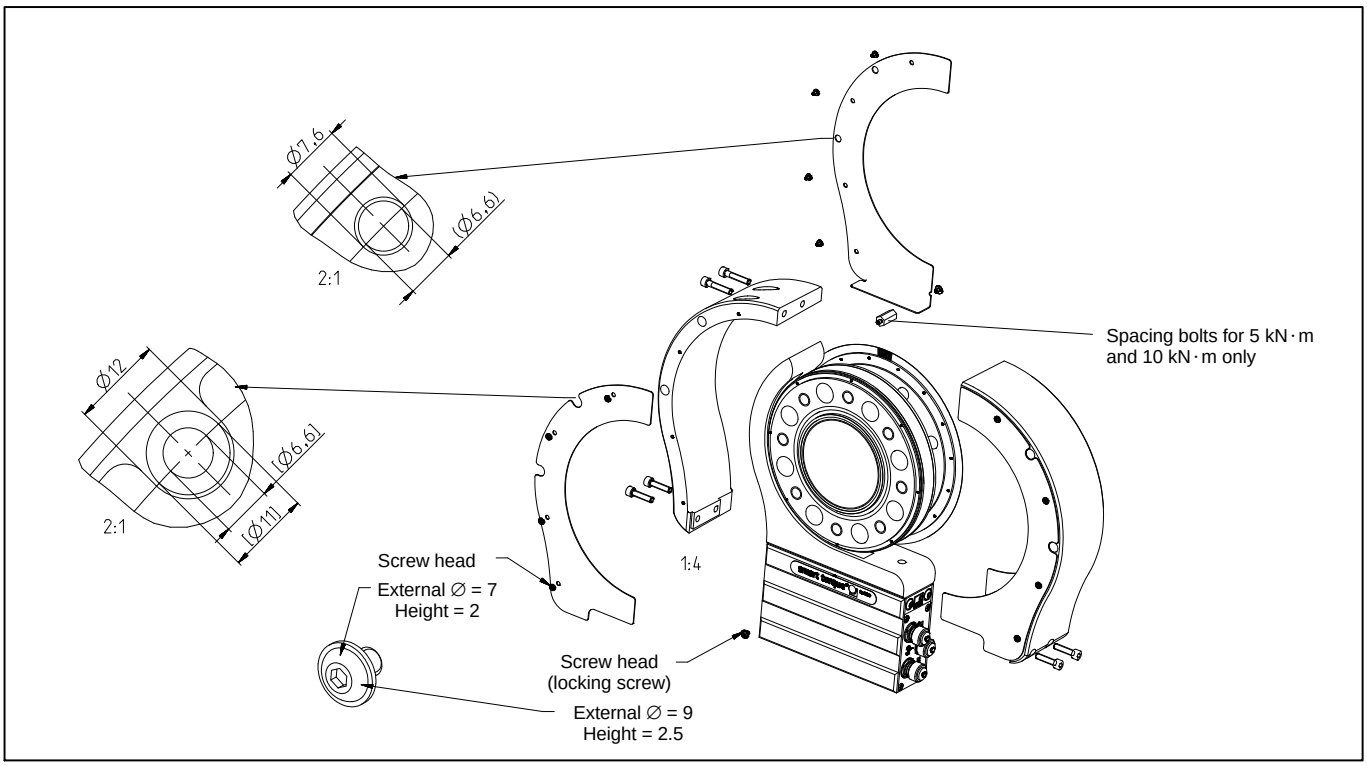
Dimensions in mm
(1 mm = 0.03937 inches)



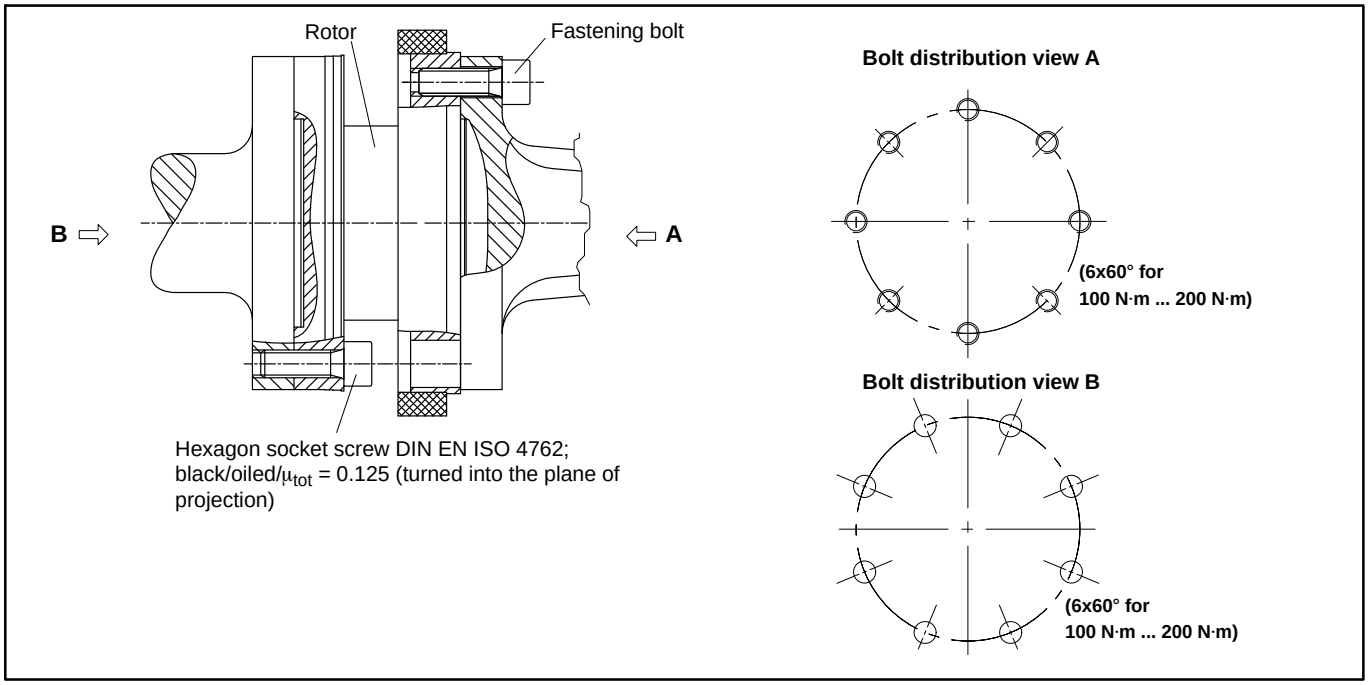
Plates for protection against contact 100 N·m ... 200 N·m (in mm)



Plates for protection against contact 500 N·m ... 10 kN·m (in mm)

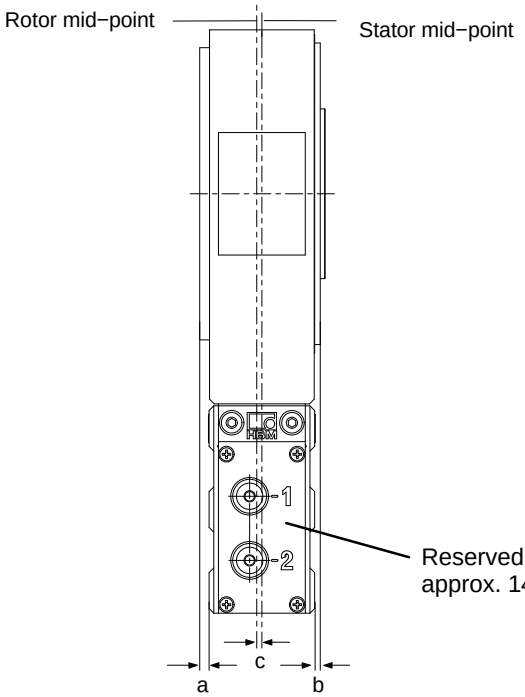


Bolted rotor connection



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

Mounting dimensions

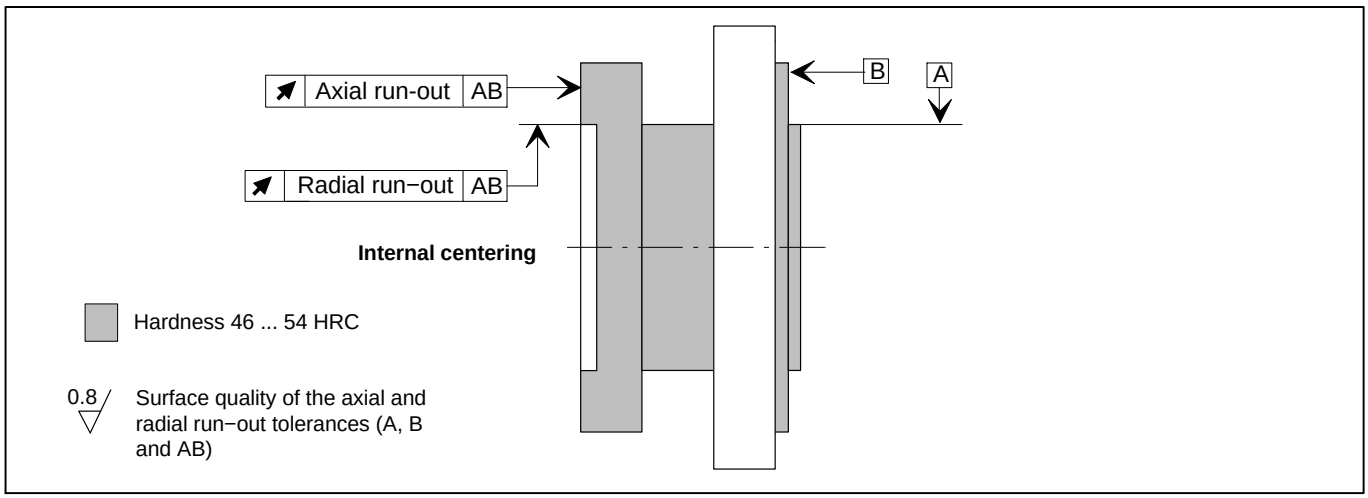


Mounting dimensions			
Measurement range	Mounting dimension (mm)		
	a	b	c
100 N·m 200 N·m	4	0	2
500 N·m 1 kN·m	2	2	0
2 kN·m 3 kN·m	5	3	1
5 kN·m	25	3	11
10 kN·m	33	3	15

(Tolerance ±1 mm)

Reserved add. space for fieldbus connection cables:
approx. 140 mm, from plug connection tag

Radial and axial run-out tolerances



Measurement 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

Ordering number

	Code	*Measurement range*
1	**S100Q**	100 Nm
	S200Q	200 Nm
	S500Q	500 Nm
	S001R	1 kNm
	S002R	2 kNm
	S003R	3 kNm
	S005R	5 kNm
	S010R	10 kNm

	Code	*Components*
2	**MF**	Complete
	RO	RO
	ST	ST

	Code	*Accuracy*
3	**S**	Lin. ≤ ±0.015 %; TC0 ≤ ±0.010 %/10 K
	U	Lin. ≤ ±0.007 %; TC0 ≤ ±0.005 %/10 K

	Code	*Nominal (rated) rotational speed*
4	**L**	10,000-15,000 rpm, rel. to meas. range
	H	12,000-18,000 rpm, rel. to meas. range
	F	18,000-22,000 rpm, rel. to meas. range (exclusively available for measuring ranges 100Nm to 3kNm)

	Code	*Electrical configuration*
5	**DF1**	Output 60 kHz ±30 kHz
	DU2	Output 60 kHz ±30 kHz and ±10 V
	SF1	Output 10 kHz ±5 kHz
	SU2	Output 10 kHz ±5 kHz and ±10 V

	Code	*Bus connection*
6	**C**	CANopen
	P	CANopen and Profibus DPV1

	Code	*Rotational speed measuring system*
7	**N**	No rotational speed measuring system
	1	Optical
	A	Optical and reference pulse

	Code	*Protection against contact*
8	**N**	No
	Y	Yes

	Code	*Customized modification*
9	**U**	None

K-T12HP - **S** [ ][ ][ ][ ] - [ ][ ] - [ ] - [ ] - [ ][ ][ ] - [ ] - [ ] - [ ] - **U**

1	2	3	4	5	6	7	8	9

Accessories, to be ordered separately

Article	Ordering number
Connection cable, set	
Torque	
Torque connection cable, Binder 423 7-pin - D-Sub 15-pin, 6 m	1-KAB149-6
Torque connection cable, Binder 423 - free ends, 6 m	1-KAB153-6
Rotational speed	
Rotational speed connection cable, Binder 423 8-pin - D-Sub 15-pin, 6 m	1-KAB150-6
Rotational speed connection cable, Binder 423 8-pin, free ends, 6 m	1-KAB154-6
Rotational speed connection cable, reference pulse, Binder 423 8-pin - D-Sub 15-pin, 6 m	1-KAB163-6
Rotational speed connection cable, reference pulse, Binder 423 8-pin - free ends, 6 m	1-KAB164-6
CAN bus	
CAN bus M12 connection cable, A-coded - D-Sub 9-pin, switchable termination resistor, 6 m	1-KAB161-6
Plugs/sockets	
Torque	
423G-7S, 7-pin cable socket, straight cable entry, for torque output (plug 1, plug 3)	3-3101.0247
423W-7S, 7-pin cable socket, 90° cable entry, for torque output (plug 1, plug 3)	3-3312.0281
Rotational speed	
423G-8S, 8-pin cable socket, straight cable entry, for rotational speed output (plug 2)	3-3312.0120
423W-8S, 8-pin cable socket, 90° cable entry, for rotational speed output (plug 2)	3-3312.0282
CAN bus	
TERMINATOR M12/termination resistor, M12, A-coded, 5-pin, plug	1-CANHEAD-TERM
Termination resistor, CAN bus M12, A-coded, 5-pin, socket	1-CAN-AB-M12
T-SPLITTER M12/T-piece M12, A-coded, 5-pin	1-CANHEAD-M12-T
Cable plug/socket/CAN bus M12, cable socket 5-pin M12, A-coded, cable plug 5-pin M12, A-coded	1-CANHEAD-M12
PROFIBUS	
Connection cable, Y-splitter, M12 socket, B-coded; M12 plug, B-coded; M12 socket, B-coded, 2 m	1-KAB167-2
Cable plug/socket/PROFIBUS M12, cable socket 5-pin M12, B-coded, cable plug 5-pin M12, B-coded	1-PROFI-M12
Termination resistor PROFIBUS M12, B-coded, 5-pin	1-PROFI-AB-M12
T-piece PROFIBUS M12, B-coded, 5-pin	1-PROFI-VT-M12
Connection 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
Other	
Setup toolkit for T12 (System-CD T12, PCAN-USB adapter, CAN bus connection cable, 6 m)	1-T12-SETUP-USB