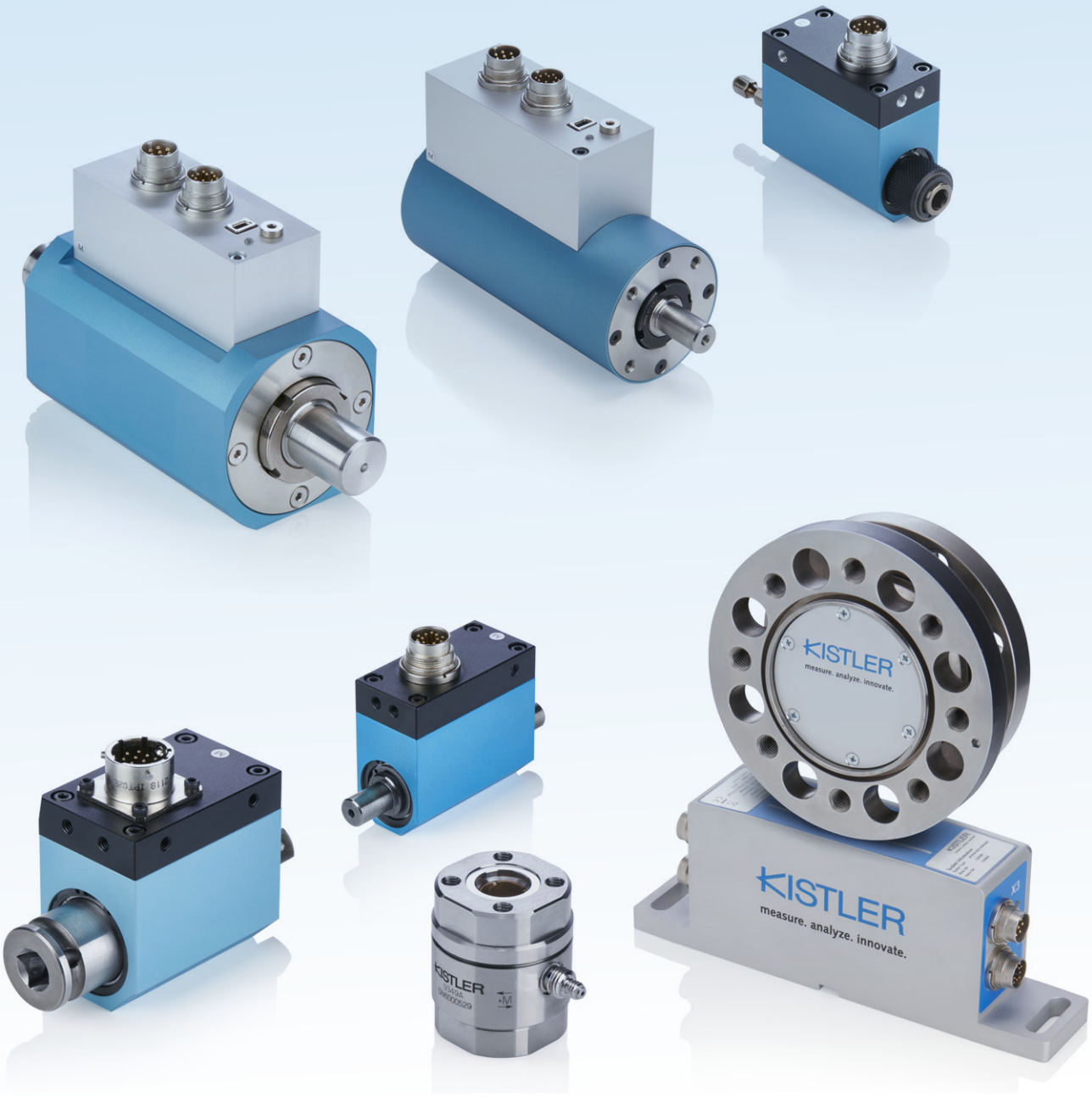
TORQUE SENSORS

Measurement instrumentation for process monitoring and quality assurance, test bench and drive technology

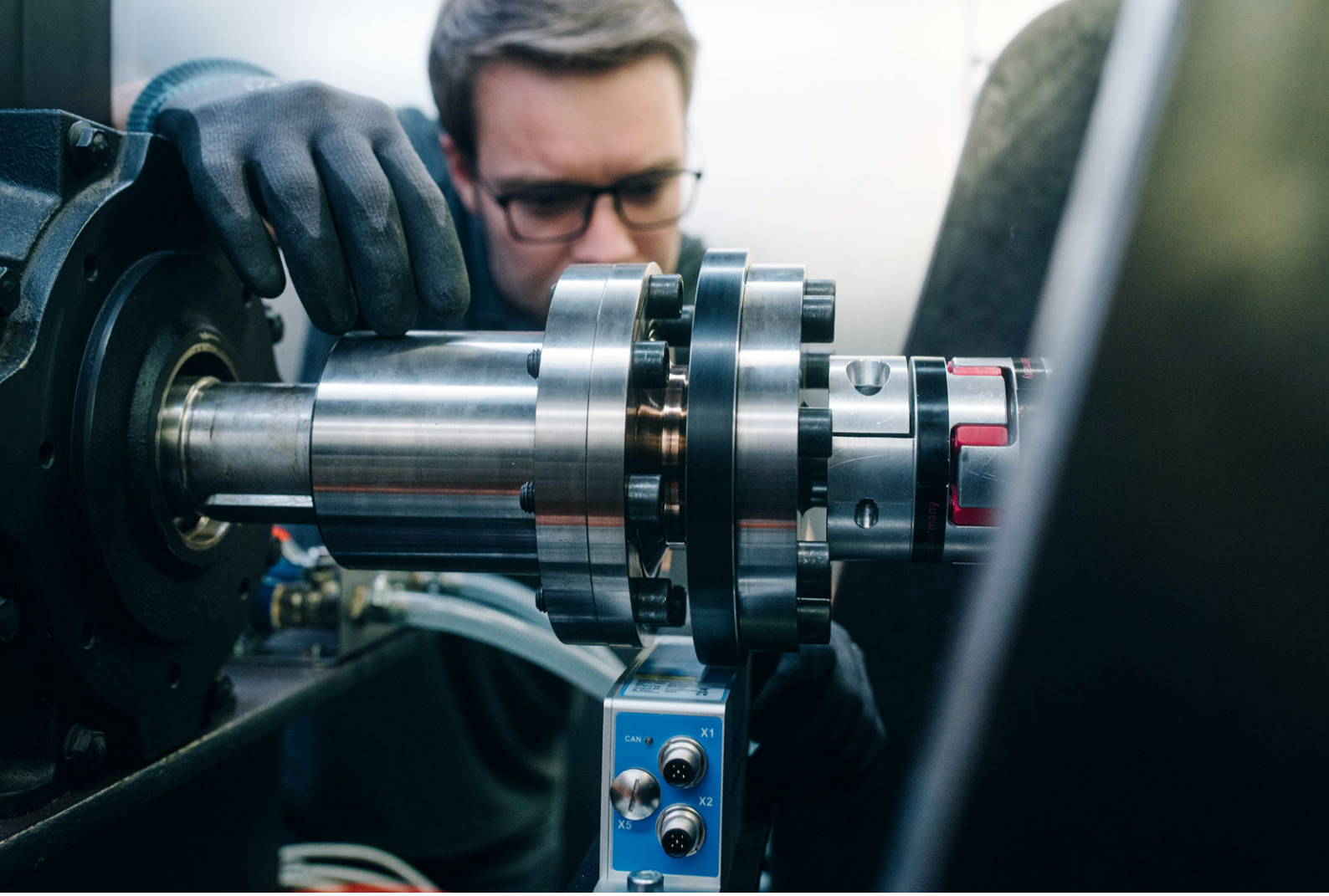


KISTLER

measure. analyze. innovate.

www.kistler.com

Content



Product testing and assembly process monitoring are just two of the many industrial activities where Kistler sensors are used

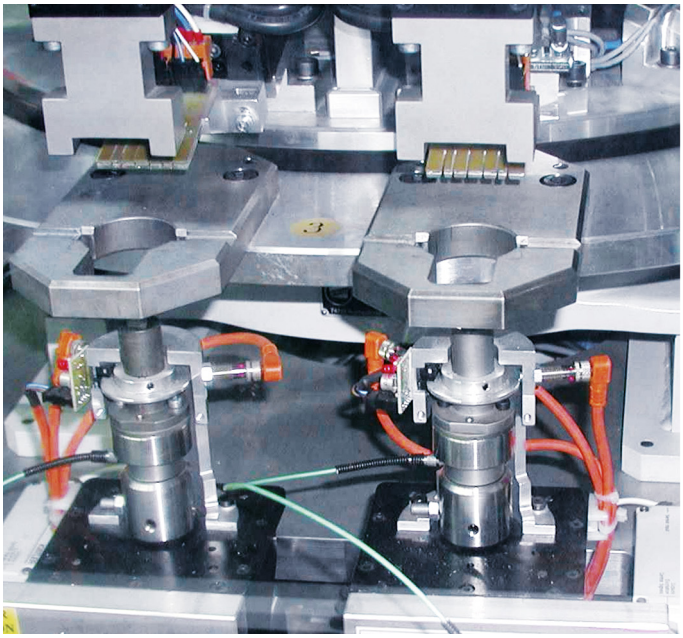
Reliability and efficiency in production and development

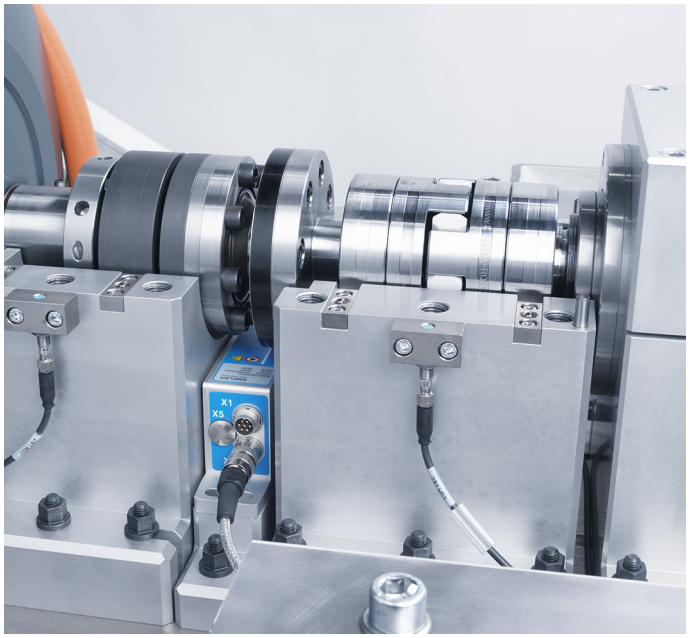
In industrial manufacturing, as well as research and development, standards for precision are becoming ever higher and time pressure is continually on the rise: these developments call for measuring systems that are both reliable and flexible. Thanks to close and continuous collaboration with research and industry partners, Kistler can offer a wide range of high-precision torque sensors that open up the way for innovative solutions in industrial measurement and system technology.

To achieve significant increases in safety, reliability and efficiency – in production, as well as R&D – action is required on two fronts: the mechanical and electrical characteristics of electrical machinery must undergo intensive testing; also, complete test bench systems must constantly be kept in line with the latest technological developments to ensure maximum precision and reliability. As a leading player in measurement and system technology, Kistler can draw on its wide range of torque sensors to offer the ideal solution for every application.

Benefits:

- Torque measurement is integrated in the production process
- Process monitoring ensures zero-defect production
- Quality costs are cut because deviations are detected at an early stage
- Process efficiency is optimized because the measuring equipment used is extremely flexible



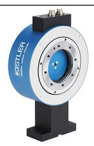


Product testing and process monitoring
Growing numbers of manufacturers rely on Kistler's sensor technology for industrial production so that they can monitor every single assembly step in the manufacture of safety-related components. Safety, reliability and efficiency almost always go hand-in-hand here: for example, suppliers to the automotive industry can only guarantee that their components will function perfectly if they can perform tests during their own production to reliably prevent failures after the components reach the customer.

Research and development
Development work on new combustion engines or transmissions, and analysis of power trains by simulation on the test bench, set high standards for the accuracy and flexibility of a test system. Especially when it comes to determining efficiency and power factors, a rugged and highly accurate torque sensor is essential. Thanks to an extensive range of products, Kistler can offer the right sensor to meet these needs in every application area.

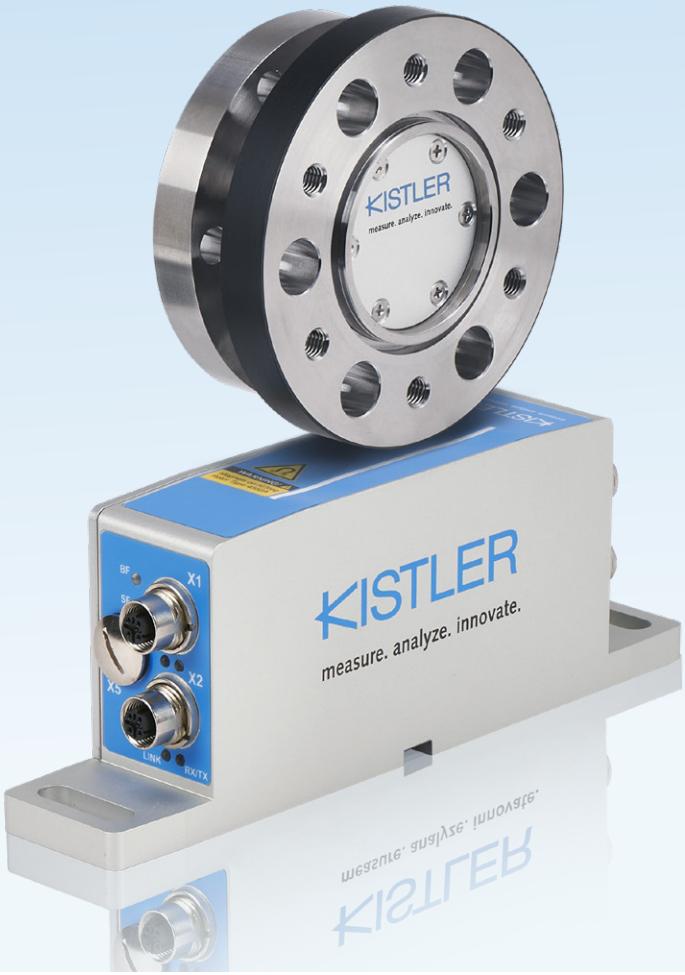
Increased process efficiency with Kistler – now online!
View our animation to experience convincing, first-class Kistler solutions – the sure way to optimize process efficiency: **www.kistler.com/maxymos**

Product overview: torque sensors

Type			Measuring range N·m
4501A...		Slip-ring torque sensor, strain gage	2 ... 1,000 0 ... ±2 to 0 ... ±1,000
4502A...		Mini-smart torque sensor, strain gage	0.5 ... 1,000 0 ... ±0.5 to 0 ... ±1,000
4520A...		Basic line torque sensor, strain gage	1 ... 1,000 0 ... ±1 to 0 ... ±1,000
4503B...		Torque sensor, optional dual range, strain gage	0.2 ... 5,000 0 ... ±0.2 to 0 ... ±5,000
4510B...		Torque measuring flange, strain gage	100 ... 20,000 0 ... ±100 to 0 ... ±20,000
4552A...		KiTorq torque measuring flange, strain gage	50 ... 10,000 0 ... ±50 to 0 ... ±10,000
4507A...		Reaction torque sensor (strain gauge)	10 ... 10,000 0 ... ±10 to 0 ... ±10,000
4509A...		Reaction torque sensor (strain gauge)	0,25 ... 100 0 ... ±0.25 to 0 ... ±100
9329A... to 9389A...		Force link, piezoelectric	0 ... ±0.1 to 0 ... ±1,000
9345B... 9365B...		Quartz force link Fz, Mz, piezoelectric	Fz, 0 ... ±1 kN to 0 ... ±20 kN, Mz 0 ... ±2.5 N·m to 0 ... ±200 N·m

Rated torque in N·m
Measuring range in N·m

Max. speed	Connector				Bearing	Sensor		Signal transmission rotor – stator		Signal output	Pages
	Square drive	Hex drive	Round shaft	Flange		Fixed	Rotating	Slip-ring	Contactless		
<3,000 1/min	•	•	•		•		•	•		0 ... 2 mV/V	9
12,000 1/min	•	•	•		•		•		•	0 ±5 VDC	10
10,000 1/min	•		•		•		•		•	0 ±10 VDC	11
50,000 1/min			•		•		•		•	0 ±5 VDC or 0 ±10 VDC and 100 ±40 kHz and RS-232C	12
12,000 1/min				•			•		•	0 ±10 VDC or 100 ±40 kHz and RS-232C	13
30,000 1/min				•			•		•	0 ... ±10 VDC or 100 ±40 kHz, or 10 ±5 kHz or 240 ±120 kHz and RS-232C/USB or fieldbuses	14
				•		•		Cable		1 mV/V	15
			•			•		Cable		1 mV/V	16
						•		Cable		±2170 ... ±100 pC/N·m (depending on size)	17
						•		Cable		±190 ... ±140 pC/N·m (depending on size)	18



Torque sensors

Depending on the application, torques are measured in very different force ranges. Kistler offers sensor systems for every application area in production, development and research. We make a distinction between two designs:

Torque sensors to measure on rotating shafts
Sensors of this type use strain gage technology. They offer maximum accuracy, a very rigid structure and excellent temperature stability. For these torque measuring shafts, transmission of the power supply and the measurement signal is largely contactless.

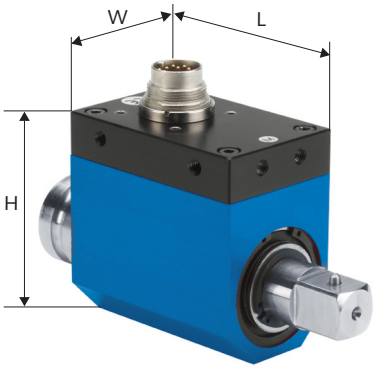
Several features make integration into existing test systems easy: contactless digital signal transmission from the rotor to the stator, integrated signal conditioning, standardized analog and frequency outputs, and numerous interfaces.

Reaction torque sensors (piezoelectric)
A torque acting on the sensor produces tangential shear stresses in the quartz disks. All the quartz disks are electrically connected in parallel, so the total output signal is proportional to the acting moment.

The sensor is integrated under high axial preload between a preload screw and a nut. The torque is therefore transmitted by frictional engagement to the shear-sensitive quartz disks. High resolution capacity and rugged structural design make it possible to measure the smallest dynamic changes, even with large torques.

Torque sensors for rotating shafts

Slip-ring torque sensor, 2 ... 1,000 N·m



Type 4501A...

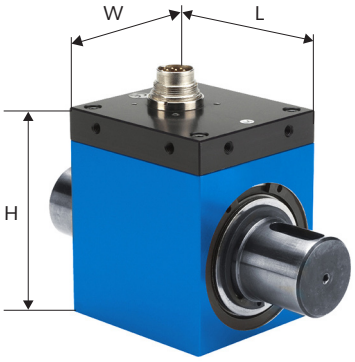
Technical data			Type 4501A...
Rated torque	M_{nom}	N·m	2/6/10/12/20/25/50/63/100/160/200/500/1,000
Maximum torque			1.5 × rated torque
Accuracy class			0.2
Rated value		mV/V	1 or 2 (depending on model)
Speed & angle measurement		pulses/rev.	2 × 360° (Option)
Rated speed		1/min	≤3,000 (Depending on measuring range)
Case material			hard-anodized aluminum
Dimensions	L W H	mm mm mm	44 ... 73 28 ... 73 52 ... 90
Operating temperature range		°C	5 ... 50

General technical data	
Deg. of protection to IEC/EN 60529	IP40
Connector	Binder, 6 or 12 pin
Data sheet: see www.kistler.com	**Type 4501A (000-596)**

Accessories	
Coupling socket, 6 pin 	**Type KSM000822**
Coupling socket, 12 pin 	**Type KSM000703**
Connecting cables 	**Type KSM071860-5, KSM185350-2,5, KSM185370-2,5, KSM103820-5, KSM183150-5**
Measuring amplifier for strain gage sensors 	**Type 4701A...**

Torque sensors for rotating shafts

Mini-smart torque sensor, 0.5 ... 1,000 N·m



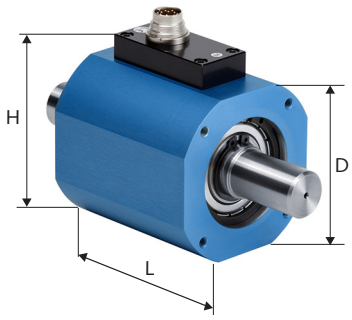
Type 4502A...

Technical data			Type 4502A...
Rated torque	M_{nom}	N·m	0.5/1/2/5/6/10/12/18/20/50/63/100/150/160/ 200/250/300/500/1,000
Maximum torque			1.5 × rated torque
Accuracy class			0.2
Output signal (rated value)	M_{nom}	VDC	5
Speed & angle measurement		pulses/rev.	2 × 360° (Option)
Rated speed		1/min	≤12,000 (Depending on measuring range)
Case material			hard-anodized aluminum
Dimensions	L W H	mm mm mm	44 ... 73 28 ... 73 52 ... 90
Operating temperature range		°C	10 ... 60

General technical data	
Deg. of protection to IEC/EN 60529	IP40
Connector	Binder, 12 pin
Data sheet: see www.kistler.com	**Type 4502A (000-597)**

Accessories	
Coupling socket, 12 pin 	**Type KSM000703**
Connecting cables 	**Type KSM185380-2,5, KSM124970-5**
Couplings 	**Type 2301A... to 2303A...**

Basic line torque sensor, 1 ... 1,000 N·m



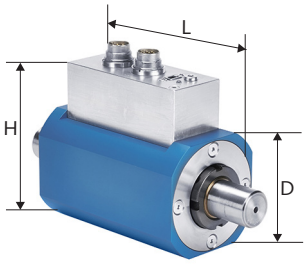
Type 4520A...

Technical data			Type 4520A...
Rated torque	M_{nom}	N·m	1/2/5/10/20/50/100/200/500/1,000
Maximum torque			1.5 × rated torque
Alternating torque			1 × rated torque
Accuracy class			0.5
Linearity error including hysteresis		% FSO	<±0.5
Output signal (rated value)	M_{nom}	VDC	10
Speed measurement		pulses/rev.	60
Rated speed		1/min	≤10,000 (Depending on measuring range)
Case material			hard-anodized aluminum
Dimensions	L D H	mm mm mm	58 ... 85 58 ... 91 70 ... 103
Operating temperature range		°C	10 ... 60

General technical data	
Deg. of protection to IEC/EN 60529	IP40
Connector	Binder, 12 pin
Data sheet: see www.kistler.com	**Type 4520A (000-765)**

Accessories	
Coupling socket, 12 pin 	**Type KSM000703**
Connecting cables 	**Type KSM071860-5, KSM185380-2,5, KSM124970-5**
Couplings 	**Type 2301A... to 2303A...**

Torque sensor, optional dual range



Type 4503B...

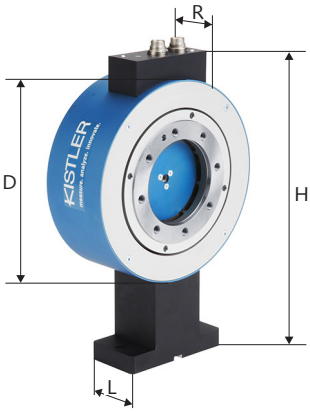
Technical data			Type 4503B...
Rated torque	M_{nom}	N·m	0.2/0.5/1/2/5/10/20/50/100/200/500/1,000/ 2,000/5,000
Maximum torque			1.5 × rated torque
Alternating torque			0.7 × rated torque
Accuracy class			0,05 / 0,1
Linearity error including hysteresis		% FSO	<+-0,05 or <+-0,1
Output signal (rated value)	M_{nom}	VDC kHz	±5 or 10 100 ±40
Speed & angle measurement		pulses/rev.	up to 8,192 + Z-pulse
Rated speed		1/min	50,000 (depending on measuring range)
Case material			hard-anodized aluminum
Dimensions	L D H	mm mm mm	122 ... 169 58 ... 148 90.1 ... 170.5
Operating temperature range		°C	10 ... 60

General technical data	
Deg. of protection to IEC/EN 60529	IP40
Connector	7 and 12 pin male plug
Data sheet: see www.kistler.com	**Type 4503B (000-767)**

Accessories	
Coupling socket, 7 pin 	**Type KSM000517**
Coupling socket, 12 pin 	**Type KSM000703**
SensorTool 	**Type 4706A**
Connecting cables 	**Type KSM124970-5, KSM186420-2,5, KSM186430-2,5, KSM219710-5**
Couplings 	**Type 2301A... to 2303A...**
Mounting base (GU) 	**GU for 0.2 ... 20 N·m Type 18030861** **GU for 50 ... 100 N·m Type 18030862** **GU for 200 ... 1,000 N·m Type 18030863** **GU for 2,000 ... 5,000 N·m Type 18030864**

Torque measuring flange for rotating shafts

Torque measuring flange: robust, bearingless, high accuracy, 100 ... 20,000 N·m



Type 4510B...

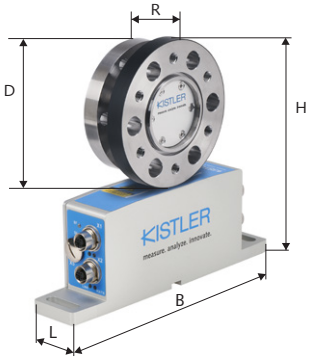
Technical data			Type 4510B...
Rated torque	M_{nom}	N·m	100/200/500/1,000/2,000/4,000/10,000/20,000
Maximum torque	M_{op}		min. 1.5 × rated torque
Alternating torque	M_{dyn}		1 × rated torque
Accuracy class			≤0.2
Linearity error including hysteresis		% FSO	<±0.1 or <±0.2 (depending on model)
Output signal (rated value)	M_{nom}	VDC kHz	10 (B1) or 100 ±40 kHz (B2) and RS-232C
Speed measurement		pulses/rev.	60
Rated speed		1/min	≤12,000 (depending on measuring range)
Case material			hard-anodized aluminum
Dimensions	L D H R	mm mm mm mm	60 197 ... 297 300.5 ... 362.7 78 ... 83.5
Operating temperature range		°C	10 ... 60

General technical data	
Deg. of protection to IEC/EN 60529	IP54
Connector	Binder, 7 and 12 pin
Data sheet: see www.kistler.com	**Type 4510B (000-737)**

Accessories	
Coupling socket, 7 pin 	**Type KSM000517**
Coupling socket, 12 pin 	**Type KSM000703**
Connecting cables 	**Type KSM124970-5, KSM186420-2,5, KSM186430-2,5, KSM219710-5**
SensorTool 	**Type 4706A**

Torque measuring flange for rotating shafts

KiTorq torque measuring flange: slim, robust, bearingless, high accuracy, 50 ... 10,000 N·m



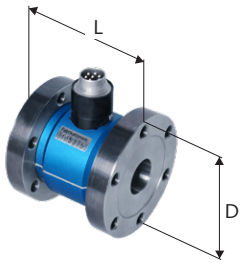
Type 4552A...
Connecting dimensions
according to DIN ISO 7646

Technical data			Type 4552A... KiTorq Rotor, Type 454xB... KiTorq Stator
Rated torque	M_{nom}	N·m	50/100/200/500/1,000/2,000/3,000/5,000 /10,000
Maximum torque			2 × rated torque
Alternating torque			1 × rated torque
Accuracy class			0.05
Linearity error including hysteresis		% FSO	0.03
Output signal (rated value)	M_{nom}	VDC kHz	10 or 10 ±5, 100 ±40, 240 ±120 and RS-232C/USB
Output signal (digital)			PROFINET, PROFIBUS, CANopen, EtherCAT, EtherNet/IP
Speed & angle measurement		pulses/rev.	up to 8,192 pulses + Z-pulse
Rated speed		1/min	30,000 (Depending on measuring range)
Case material			hard-anodized aluminum
Dimensions	L D H R W	mm mm mm mm mm	44 133 210.5 ... 242.5 48 ... 53 210
Operating temperature range		°C	10 ... 60

General technical data	
Deg. of protection to IEC/EN 60529	IP54
Connector	7, 12 and 14 pin male plug

Accessories	
Coupling socket, 7 pin 	**Type KSM000517**
Coupling socket, 12 pin 	**Type KSM000703**
Coupling socket, 14 pin 	**Type KSM038290**
SensorTool 	**Type 4706A**
Couplings 	**Type 2305A...**

Reaction torque sensor (strain gauge)

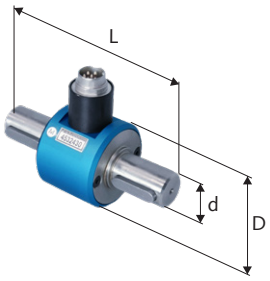


Type 4507A...

Technical data			Type 4507A10....10000
Rated torque	M_{nom}	N·m	10/25/50/100/200/500/1000/2000/5000/10000
Maximum torque			$1.5 \times M_{nom}$
Alternating torque			$0.7 \times M_{nom}$
Accuracy class		% FSO	±0.2
Linearity error including hysteresis		% FSO	±0.2
Output signal (rated value)	M_{nom}	mV/V	1
Case material			Aluminum, hard anodized
Dimensions	L D	mm mm	65 ... 180 70 ... 280
Operating temperature range		°C	-15 ... +55

General technical data	
Deg. of protection to IEC/EN 60529	IP45
Connector	6-pin panel connector

Accessories	
Cable socket with soldering lug 6-pin 	**KD6-pol 99-2022-09-06 Series 581**
Connection cable, 5m, 6-pin. 	**KSM071860-5**
Connection cable, 5 m, 6-pin - free ends 	**KSM103820-5**
Measuring amplifier 	**4701A...**
CoMo Torque evaluation device 	**4700B...**
Connection cable, 2.5 m, 6-pin - CoMo Torque 	**KSM185350-2,5**



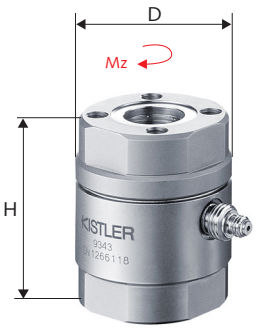
Type 4509A...

Technical data			Type 4509A0,25....100
Rated torque	M_{nom}	N·m	0.25/0,5/1/2/5/10/20/50/100
Maximum torque			$1.5 \times M_{nom}$
Alternating torque			$0.7 \times M_{nom}$
Accuracy class		% FSO	±0.2
Linearity error including hysteresis		% FSO	±0.2 ± 0.3 for M_{nom} 0.25Nm and 0.5Nm
Output signal (rated value)	M_{nom}	mV/V	1
Case material			Aluminum, hard anodized
Dimensions	L D d	mm mm mm	50 ... 100 38 ... 45 12 ... 18
Operating temperature range		°C	-15 ... +55

General technical data	
Deg. of protection to IEC/EN 60529	IP45
Connector	6-pin panel connector

Accessories	
Cable socket with soldering lug 6-pin 	**KD6-pol 99-2022-09-06 Series 581**
Connection cable, 5m, 6-pin. 	**KSM071860-5**
Connection cable, 5 m, 6-pin - free ends 	**KSM103820-5**
Measuring amplifier 	**4701A...**
CoMo Torque evaluation device 	**4700B...**
Connection cable, 2.5 m, 6-pin - CoMo Torque 	**KSM185350-2,5**

Reaction torque sensors (piezoelectric)



Type 9329A

Technical Data			Type 9329A	Type 9339A	Type 9349A
Measuring range		N·m	–1 ... 1	–10 ... 10	–25 ... 25
Calibrated meas. ranges		N·m	0 ... –1 0 ... –0.1 0 ... 0.1 0 ... 1	0 ... –10 0 ... –1 0 ... 1 0 ... 10	0 ... –25 0 ... –2.5 0 ... 2.5 0 ... 25
Sensitivity		pC/N·m	≈–2,170	≈–460	≈–230
Rigidity	C_{Mz}	N·m/µrad	≈0.02	≈0.10	≈0.19
Dimensions	D H	mm mm	20 26	30 34	36 42
Weight		g	50	137	243
Operating temperature range		°C	–20 ... 80	–40 ... 120	–40 ... 120

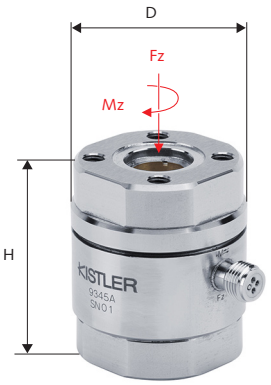
Technical data			Type 9369A	Type 9389A
Measuring range		N·m	–200 ... 200	–1,000 ... 1,000
Calibrated meas. ranges		N·m	0 ... –200 0 ... –20 0 ... 20 0 ... 200	0 ... –1,000 0 ... –100 0 ... 100 0 ... 1,000
Sensitivity		pC/N·m	≈–130	≈–100
Rigidity	C_{Mz}	N·m/µrad	≈0.90	≈1.54
Dimensions	D H	mm mm	54 60	100 130
Weight		g	800	6,720
Operating temperature range		°C	–40 ... 120	–40 ... 120

General technical data	
Deg. of protection to IEC/EN 60529	IP65 with connected cable IP67 with cable, Type 1983AD... and welded connector
Connector	KIAG 10-32 neg.
Preloaded	•
Calibrated	•
Data sheet: see www.kistler.com	**Type 9329A (000-463)**

Accessories	
Mounting flange 	**Type 9580A...**

Multi-component sensor

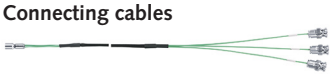
2-Component measuring element Fz, Mz



Type 9345B

Technical data			Type 9345B	Type 9365B
Measuring range	Fz	kN	–10 ... 10	–20 ... 20
Calibrated meas. ranges		kN	0 ... 1 0 ... 10	0 ... 2 0 ... 20
Sensitivity	Fz	pC/N	≈–3.7	≈–3.6
Rigidity	Cz	kN/µm	≈1.7	≈2.8
Measuring range		N·m	–25 ... 25	–200 ... 200
Calibrated meas. ranges		N·m	0 ... –25 0 ... –2.5 0 ... 2.5 0 ... 25	0 ... –200 0 ... –20 0 ... 20 0 ... 200
Sensitivity	Mz	pC/N·m	≈–190	≈–140
Rigidity	c (calculated)	N·m/µrad	≈0.19	≈0.92
Dimensions	D H	mm mm	39 42	56.5 60
Weight		g	267	834
Operating temperature range		°C	–40 ... 120	–40 ... 120

General technical data	
Deg. of protection to IEC/EN 60529	IP65 with connected cable
Connector	V3 neg.
Preloaded	•
Calibrated	•
Data sheet: see www.kistler.com	**Type 9345B (000-630)**

Accessories	
Connecting cables 	**Type 1693A..., 1694A..., 1695A..., 1698A...**

Process monitoring systems for every application

The Kistler maXYmos family now provides users with a simple system that can quickly and accurately accomplish a variety of product testing tasks.

The maXYmos BL and TL feature XY monitors that can monitor and evaluate the quality of a product or manufacturing step on the basis of a profile. With the help of evaluation objects (EOs), the user adapts the curve evaluation to the specific monitoring task. Based on this specification, the maXYmos then decides whether each individual workpiece is good or bad.

Due to a wide variety of Interfaces, maXYmos TL provides an ideal platform for acquiring and evaluating a very diverse range of measurands.

Kistler's tried-and-tested amplifiers guarantee that the sensor signals are correctly conditioned to provide values that can be displayed.

Benefits of the maXYmos Family:

- Universal operating philosophy for force-displacement and torque monitoring
- In-process monitoring of joining and assembly operations
- Early detection of quality deviations in the production process
- Faster feedback thanks to transparency in the production process
- Traceable process results
- Additional test routines are eliminated

Monitoring devices

maXYmos TL XY monitor

Type 5877...

Technical data		Type 5877...
Number of measuring channels		1 × X/Y ... 8 × X/Y
Resolution per channel	Bit	24
Accuracy class	%	0.1
Sensors that can be connected	Channel X Channel Y	Via menu choice: Potentiometer, transmitter ±10 V, incremental, SSI, LVDT, inductive, EnDat Via menu choice: Piezo, strain gage, transmitter ±10 V
Measuring functions		Y(X), Y(t), Y(X,t), X(t)
Curve evaluation using evaluation objects (EOs)	Type	UNI-BOX, HÜLLKURVE, LINE-X, LINE-Y, NO PASS, HYSTERESE-Y, HYSTERESE-X, GRADIENT-Y, GRADIENT-X, TUNNELBOX-X, TUNNELBOX-Y, BREAK, CALC, AVERAGE, GET-REF, SPEED, TIME
Evaluation results via	Dig. outputs Fieldbus Optical	IO, NIO IO, NIO, process values Curve, process values, trend display, traffic light
Data transfer via	Interface	Ethernet TCP/IP, USB, fieldbus: Profibus DP, EtherNet/IP, ProfiNet, EtherCat, CC-LINK
Power supply	V	24 (18 ... 30)
Housing		Front panel or desktop/wall mounting
Data sheet: see www.kistler.com		**Type 5877A (003-273)**

Accessories	
Display Module (DIM) Completes an existing Measuring and Evaluation Module (MEM) by adding a touchscreen	**Type 5877AZ000**
Measuring Module (MEM) Extends an existing maXYmos TL system with an additional XY channel pair	**Type 5877B0**
Basic Connector Set **(1 set included in scope of delivery)**	**Type 5877AZ010**
Standard Rail Clip **To mount the Measuring Module (MEM) on a DIN mounting rail**	**Type 5877AZ...**
Windows® Software Basic Version	**Type 2830A1**
Windows® Software Plus Version	**Type 2830A2**
Power supply, 240 VAC/24 VDC	**Type 5781B5**

maXYmos TL XY monitor

Type 5867A...

Technical data		Type 5867B...
Number of measuring channels		1 × X/Y
Resolution per channel	Bit	24
Accuracy class	%	0.3
Sensors that can be connected	Channel X Channel Y	Potentiometer, transmitter ±10 V* Piezo, strain gage, transmitter ±10 V*
Measuring functions		Y(X), Y(t), Y(X,t), X(t)
Curve evaluation using evaluation objects (EOs)	Type	UNI-BOX, LINE-X, LINE-Y, NO-PASS, ENVELOPE

Evaluation results via	Dig. outputs Fieldbus Optical	IO, NIO IO, NIO, process values Curve, process values, traffic light
Power supply	VDC	18 ... 30
Signal input	Type/connector	Piezoelectric/BNC neg.
Data transfer via	Interface	Ethernet TCP/IP, USB, fieldbus: Profibus DP, ProfiNet, EtherCAT, EtherNet IP, CC-LINK
Power supply	V	24 (18 ... 30)
Housing		Panel or desktop/wall mounting
Data sheet: see www.kistler.com		**Type 5867B (003-054)**

Accessories	
Connector Set for Strain Gage Version (1 set included in scope of delivery)	**Type 5867AZ010**
Connector Set for Piezo Version (1 set included in scope of delivery)	**Type 5867AZ011**
Windows Software Basic Version	**Type 2830A1**
Windows Software Plus Version	**Type 2830A2**
Netzteil 240VAC/24VDC	**Type 5781B5**
maXYmos BL Seq. Mode	**Type 2832A1**

CoMo torque evaluation instrument

Type 4700B...

Technical data			**Type 4700B...**
Number of channels		y1 = M/t, y2 = n/t	2
Signal inputs	Strain gage Active Frequency	mV/V VDC kHz	±0.5 ... 3.5 (full bridge, 4/6 wire) ±5 ... ±10 ≤400
Cutoff frequency (–3 dB)		kHz	0.1 ... 1
Speed/rotation angle input Tracks A, B		kHz	≤300
Sensor excitation voltages		V	24 stabilized 5 strain gage unipolar 5 stabilized ±12 stabilized
Output signals, 3 channels		V	±10
Digital control			8 digital inputs TTL 8 digital outputs TTL or 24 VDC
Interfaces			RS-232C, USB 2.0
Data sheet: see www.kistler.com			**Type 4700B (000-944)**

Accessories	
Connecting cables	**Type KSM185350-2,5 for Type 4501A... Q/R,** **Type KSM185370-2,5 for Type 4501A... QA,** **Type KSM186420-2,5 for Type 4503A.../4504... analog,** **Type KSM186430-2,5 for Type 4503A.../4504... frequency,** **Type KSM185380-2,5 for Type 4502A.../4520A...**

Charge amplifiers for piezoelectric sensors

ICAM Industrial charge amplifier

Type 5073A4...

Technical data	Type 5073A1...	Type 5073A2...	Type 5073A3...	Type 5073A3...	Type 5073A5...
Number of channels	1	2	3	4	1 (4 inputs summed)

General technical data		
Number of measuring ranges		2 (switchable)
Measuring range adjustment		continuously variable
Measuring range 1 FS Measuring range 2 FS	pC pC	±100 ... 1,000,000 ±100 ... 1,000,000
Frequency (–3 dB)	kHz	≈0 ... 20 (<±10,000 pC) ≈0 ... 2 (<±1,000,000 pC)
Deg. of protection to IEC/EN 60529		optional IP60 (BNC)/IP65 (TNC)
Output signal	V mA	±10 4 ... 20 (only Type 5073A1... and 5073A2...)
Power supply	VDC	18 ... 30
Signal input	Type/ connector	piezoelectric/optional BNC neg. piezoelectric/optional TNC neg.
Interface		RS-232C (for parameterization)
Other features		Peak memory Adjustable output offset Low-pass filter
Data sheet: see www.kistler.com		**Type 5073A (000-524)**

Accessories	
RS-232C cable, null modem, 5 m, D-Sub 9 pin pos./ D-Sub 9 pin neg.	**Type 1200A27**
Cable D-Sub/ 15 pin neg. with flying leads one end	**Type 1500A41...**

Strain gage amplifier

Measuring amplifier for strain gage sensors, mounted in aluminum casing

Version A

Versions B and C

Technical data			Type 4701A...A	Type 4701A...B	Type 4701A...C
Number of channels			1	1	1
Signal input	Strain gage	mV/V	approx. 1.5	approx. 1.0/2.0 (0.5 ... 3.0, full or half bridge, max. bridge input resistance 1,000 Ω)	
	Resistive	V			input 0 ... 5 (input resistance 1 ... 5 kΩ)
Cutoff frequency (–3 dB)		kHz	1	1	1
General technical data					
Deg. of protection to IEC/EN 60529			with cable glands: IP54	with connectors: IP40	with connectors: IP40
Output signal		V	±0 ... 5 or ±0 ... 10	±0 ... 5 or ±0 ... 10	±0 ... 5 or ±0 ... 10
Power supply		VDC	24 non-stabilized (±10%)	24 non-stabilized (±10%)	24 non-stabilized (±10%)
Connector		Signal input	cable gland with soldering terminals	6 pin socket	6 pin socket
		Signal output	cable gland with soldering terminals	6 pin connector	6 pin connector
Data sheet: see www.kistler.com			**Type 4701A (000-621)**	**Type 4701A (000-621)**	**Type 4701A (000-621)**
Accessories					
Connecting cable, 5 m, 6 pin/6 pin				**Type KSM071860-5**	
Connecting cable, 5 m, 6 pin/free				**Type KSM103820-5**	**Type KSM103820-5**
Connecting cable, 5 m, 5 pin/5 pin					**Type KSM106410-5**

Software

SensorTool – PC software to parameterize, visualize and analyze torque sensor technology

Technical data	Type 4706A
Supported equipment	Torque sensors, Type 4503B..., 4510B..., 4550A..., 4551A... CoMo Torque Evaluation Instrument, Type 4700B... Strain Gage Meter, Type 4703B
Data sheet: see www.kistler.com	**Type 4706A (000-626)**

Couplings

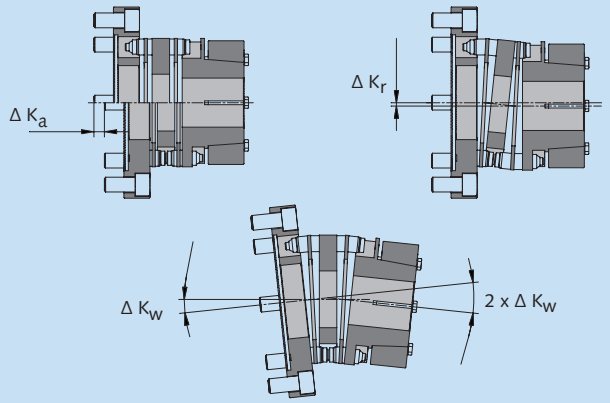
Torque on rotating shafts is measured directly in the machinery train, between a drive and a loading machine. External influences such as shear forces, axial forces or bending moments may affect the measurement signal. Couplings are used to exclude influences of this sort.

Couplings for use between the shaft and the sensor differ with regard to their flexibility. Some couplings can only correct a mechanical misalignment in one direction (these are known as singly flexible couplings); others are flexible in two directions (doubly flexible couplings) or in all directions.

Choosing the Coupling
The choice of coupling can be a crucial factor in measurement quality. For very dynamic measurements, the coupling must be highly torsion-proof; this is because the coupling changes the resonances of the mechanical structure with its torsion resistance, and this can cause undesirable torsional vibrations.

With its two disk assemblies, the multi-disk coupling compensates for angular, axial and radial shaft misalignment.

Permitted shaft displacements for coupling elements



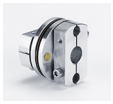
Product overview: couplings

Couplings for measuring flanges

Type		Name	For (sensor)	Max. speed1/min
2300A…S… **2305A…S...**		Torsion-proof multi-disk coupling Clamping hub	Torque measuring flange Type 4552/4551/4550...	8,000 ... 15,000
2300A…F… **2305A…F...**		Torsion-proof multi-disk coupling Flange connection	Torque measuring flange Type 4552/4551/4550...	8,000 ... 15,000
2300A…A… **2305A…A...**		Adapter flange for drive side	Torque Mmasuring flange Type 4552/4551/4550...	8,000 ... 15,000

Note: Couplings for torque measuring flanges Type 4550A... and Type 4510B... available upon request

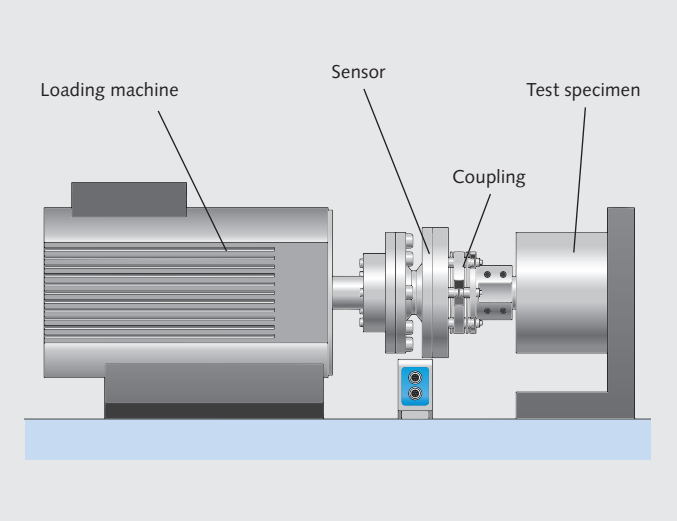
Couplings for Rotating Torque Sensors

Type		Name	For (sensor)	For (measuring ranges)
2301A...		Torsion-proof, doubly flexible metal bellows coupling	Torque sensor Type 4520A..., Type 4502A..., and Type 4503A...	5 ... 1,500 N·m
2302A...		Torsion-proof, singly flexible miniature coupling	Torque sensor Type 4501A..., Type 4502A..., Type 4503A... and Type 4520A...	up to max. 36 N·m
2303A...		Torsion-proof, doubly flexible miniature coupling	Torque sensor Type 4501A..., Type 4502A..., Type 4503A... and Type 4520A...	up to max. 36 N·m

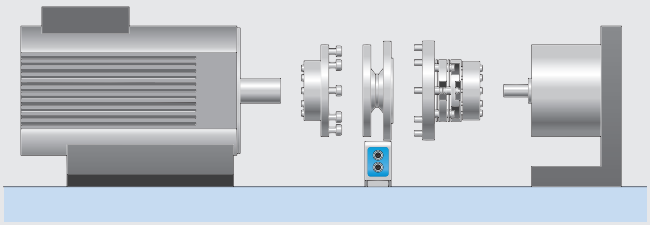
Application examples and adaptation options for measuring flanges

In principle, the choice of coupling is determined by the type of mounting for the torque sensor. For torque measuring flanges, a doubly flexible coupling is generally used between the torque sensor and the test specimen. On the drive side, the connection is made with a single adapter flange, without a coupling. With regard to torque measuring shafts, a distinction is made between fixed and self-supporting mountings. Different types of coupling are used in each case. With a fixed mounting, the connection is usually made with doubly flexible couplings, whereas singly flexible couplings are chosen for self-supporting mountings.

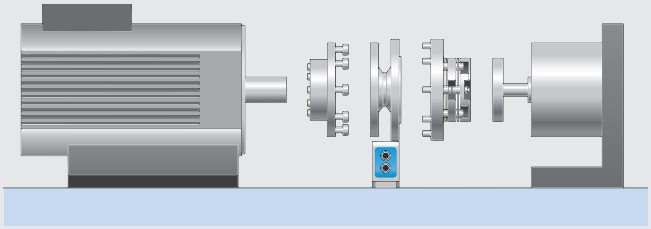
Application example



Adaptation options

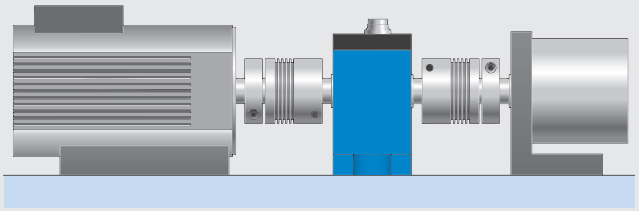


Adapter flange + coupling Type 2305A... Version S: Clamping hub



Adapter flange + coupling Type 2305A... Version F: Flange

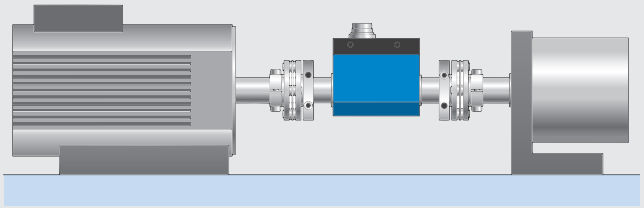
Application examples for rotating torque sensors



Torque sensor e.g. Type 4502A...RAU, Type 4503B...
and Type 4520A... + coupling, Type 2301A...

Application
The coupling allows compensation when the torque sensor is mounted in a fixed position in the line shafting. Possibilities for lateral and axial compensation are always a mandatory requirement in order to prevent measuring errors and damage to the sensor. For sensors with a fixed housing (or mounting base), a doubly flexible coupling must be fitted on both sides. Clamping hubs are used for the mounting on both sides. The frictional connection ensures that the installation is absolutely free of play.

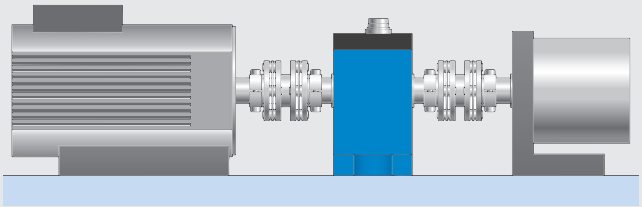
Data Sheet Type 2301A (000-673)



Torque sensor, Type 4502A...R/RA and Type 4520A...
+ coupling, Type 2302A...

Application
The coupling allows compensation when a self-supporting mounting is used for torque sensors in a line shafting. Angular compensation for each coupling is always a mandatory requirement in order to prevent measuring errors and damage to the sensor. It is recommended that this type of mounting only be used for torque sensors >50 N·m with a speed <500 1/min.

Data Sheet Type 2302A (000-671)



Torque sensors, Type 4502A...RAU, Type 4503B... and Type 4520A...
+ coupling, Type 2303A...

Application
The coupling allows compensation when the torque sensor is mounted in a fixed position in the line shafting. Possibilities for lateral and axial compensation are always a mandatory requirement in order to prevent measuring errors and damage to the sensor. For sensors whose housing (or mounting base) is installed in a fixed position, a doubly flexible coupling must be fitted on both sides. Clamping hubs are used for the mounting on both sides.

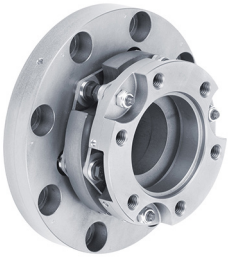
Data Sheet Type 2303A (000-672)

Couplings for torque sensors

Torsion-proof multi-disk coupling for torque measuring flange, Type 4550A…

Coupling
Type 2305A... Version S
with clamping hub

Technical data			Type 2305A10…	Type 2305A16…	Type 2305A40…
Coupling for sensor			Type 4552A100…	Type 4552A200…	Type 4552A500…
Rated torque	T_{KN}	N·m	100	300	650
Peak transient torque	T_{Kmax}	N·m	150	450	975
Outside diameter of coupling	DaK	mm	69	77	104
Torsion resistance (per assembly)	C_T	10^3 N·m/rad	60	90	320
Overall torsion resistance	$C_{Toverall}$	10^3 N·m/rad	30	45	160



Coupling
Type 2305A... Version F with
flange

Technical data			Type 2305A64…	Type 2305A300…	Type 2305A500…
Coupling for sensor			Type 4552A1K…	Type 4552A2K/3K…	Type 4552A5K…
Rated torque	T_{KN}	N·m	1,100	3,500	5,800
Peak transient torque	T_{Kmax}	N·m	1,650	5,250	8,700
Outside diameter of coupling	DaK	mm	123	167	198
Torsion resistance (per assembly)	C_T	10^3 N·m/rad	1,350	3,480	11,900
Overall torsion resistance	$C_{Toverall}$	10^3 N·m/rad	675	1,740	5,950

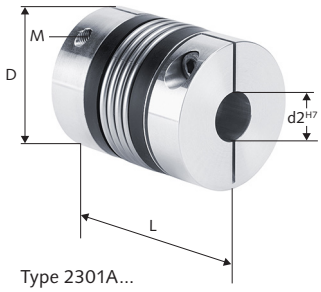
Adapter flange (rigid)
Type 2305A... Version A
with clamping hub

General technical data	
Data sheet: see www.kistler.com	**Type 2305A (000-972)**

Accessories	
Mounting screws	**Type 4550A...**

Couplings for torque sensors

Metal bellows coupling with clamping hubs



Type 2301A...

Technical data			Type 2301A15	Type 2301A30	Type 2301A60
Rated torque	T_{KN}	N·m	15	30	60
Torsion resistance	C_{Tdyn}	10^3 N·m/rad	20	39	76
Mass moment of inertia	J	10^{-3} kg·m²	0.06	0.12	0.32
Dimensions	L	mm	59	69	83
	d2H7 (min … max)	mm	8 … 28	10 … 30	12 … 35
	D	mm	49	55	66
	M		M5	M6	M8
Mass		kg	0.15	0.3	0.4

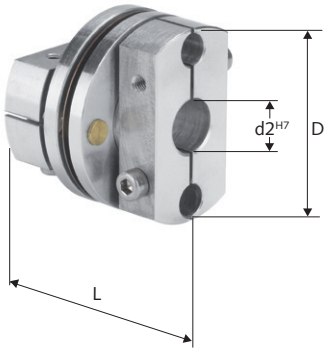
Technical data			Type 2301A80	Type 2301A150	Type 2301A200
Rated torque	T_{KN}	N·m	80	150	200
Torsion resistance	C_{Tdyn}	10^3 N·m/rad	129	175	191
Mass moment of inertia	J	10^{-3} kg·m²	0.8	1.9	3.2
Dimensions	L	mm	94	95	105
	d2H7 (min … max)	mm	14 … 42	19 … 42	22 … 45
	D	mm	81	82	90
	M		M10	M10	M12
Mass		kg	0.8	1.7	2.5

Technical data			Type 2301A300	Type 2301A500	Type 2301A800
Rated torque	T_{KN}	N·m	300	500	800
Torsion resistance	C_{Tdyn}	10^3 N·m/rad	450	510	780
Mass moment of inertia	J	10^{-3} kg·m²	7.6	14.3	16.2
Dimensions	L	mm	111	133	140
	d2H7 (min … max)	mm	24 … 60	35 … 60	40 … 75
	D	mm	110	124	134
	M		M12	M16	2×M16
Mass		kg	4	7.5	7

Technical data			Type 2301A1500
Rated torque	**T_{KN}**	**N·m**	**1,500**
Torsion resistance	**C_{Tdyn}**	**10^3 N·m/rad**	1,304
Mass moment of inertia	**J**	10^{-3} kg·m²	43
Dimensions	L	mm	166
	d2H7 (min … max)	mm	50 … 80
	D	mm	157
	M		2×M20
Mass		kg	12

General technical data			
Peak transient torque	T_{Kmax}	N·m	brief overload of up to 1.5 times value permissible
Max. speed	n_{max}	1/min	<10,000
Operating temperature range		°C	–30 … 120
Data sheet: see www.kistler.com			**Type 2300A (000-667)**

Torsion-proof miniature coupling, singly flexible, with clamping hubs



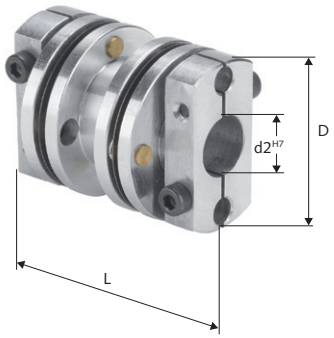
Type 2302A...

Technical data			Type 2302A25	Type 2302A37	Type 2302A50
Rated torque	T_{KN}	N·m	0.39	1.56	6.17
Peak transient torque	T_{Kmax}	N·m	0.54	2.19	8.64
Torsion resistance	C_{Tdyn}	10^6 N·m/rad	3.89	25.986	39.768
Mass moment of inertia	J	10^{-6} kg·m²	1.83	11.1	28.56
Max. speed	n_{max}	1/min	64,000	44,000	36,000
Dimensions	L	mm	20.2	29.1	30.4
	d2H7 (min … max)	mm	3 … 10	4 … 14	6 … 18
	D	mm	25.4	35.8	44.5
Mass		kg	0.022	0.062	0.1

Technical data			Type 2302A62	Type 2302A75
Rated torque	T_{KN}	N·m	24.7	36.2
Peak transient torque	T_{Kmax}	N·m	34.6	50.7
Torsion resistance	C_{Tdyn}	10^6 N·m/rad	103.572	161.76
Mass moment of inertia	J	10^{-6} kg·m²	78.61	159.4
Max. speed	n_{max}	1/min	28,000	24,000
Dimensions	L	mm	36.6	41
	d2H7 (min … max)	mm	10 … 24	12 … 28
	D	mm	57.4	64
Mass		kg	0.195	0.278

Data sheet: see www.kistler.com	Type 2302A (000-671)

Torsion-proof miniature coupling, doubly flexible, with clamping hubs

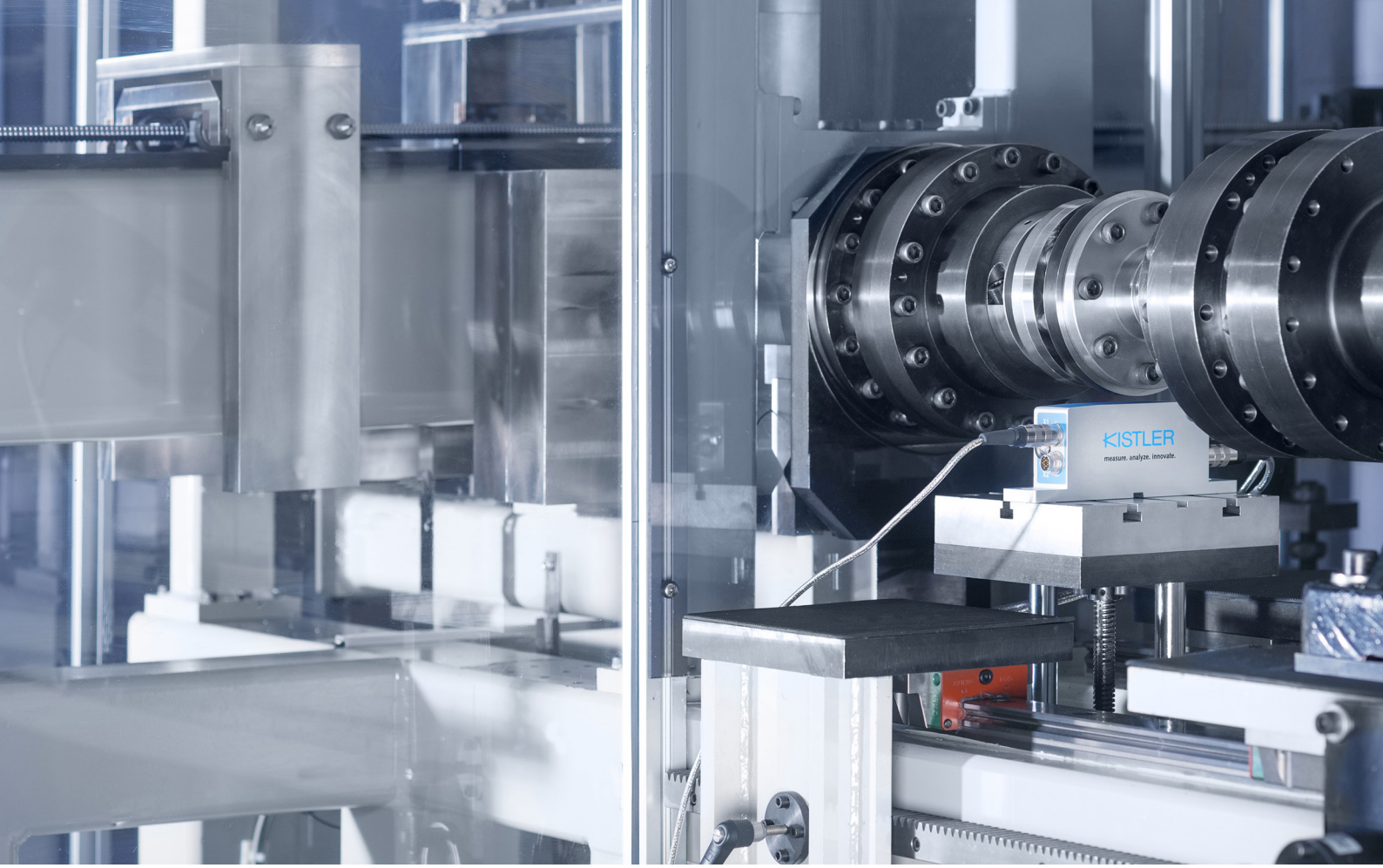


Type 2303A...

Technical data			Type 2303A25	Type 2303A37	Type 2303A50
Rated torque	T_{KN}	N·m	0.39	1.56	6.17
Peak transient torque	T_{Kmax}	N·m	0.54	2.19	8.64
Torsion resistance	C_{Tdyn}	10^3 N·m/rad	0.425	1.324	2.984
Mass moment of inertia	J	10^{-6} kg·m²	2.023	11.1	31.7
Max. speed	n_{max}	1/min	64,000	44,000	36,000
Dimensions	L	mm	34	48	54
	d2H7 (min … max)	mm	3 … 10	4 … 14	6 … 18
	D	mm	25.4	35.8	44.5
Mass		kg	0.028	0.077	0.133

Technical data			Type 2303A62	Type 2303A75
Rated torque	T_{KN}	N·m	24.7	36.2
Peak transient torque	T_{Kmax}	N·m	34.6	50.7
Torsion resistance	C_{Tdyn}	10^3 N·m/rad	5.179	8.088
Mass moment of inertia	J	10^{-6} kg·m²	115.673	201.8
Max. speed	n_{max}	1/min	28,000	24,000
Dimensions	L	mm	66	71
	d2H7 (min … max)	mm	10 … 24	12 … 28
	D	mm	57.4	64
Mass		kg	0.26	0.355

Data sheet: see www.kistler.com	Type 2303A (000-672)



Torque measurement technology

Whether the test object is a torsion bar or a fast-running drive shaft: knowledge of the torques that occur provides information about static and dynamic loads, running characteristics of transmissions and – in combination with speed measurements –about the performance of a power train.

For torque measurements on rotating shafts, strain gage technology is the preferred choice. Maximum accuracy, a structure with the maximum possible rigidity and high temperature stability are the key requirements here.

For modern torque measuring shafts, transmission of the power supply and the measurement signal is usually contactless. If the bearing for the measuring shaft is also eliminated – as in the case of Types 4550A.../4551A... and Type 4510B... – the result is a high-precision measuring instrument that is completely wear-free.

Piezoelectric sensors prove effective for applications to measure reaction moments: the requirements here are large measuring ranges, an extremely high overload factor and high resolution. These sensors can also capture very small torque fluctuations without problems, even in the case of extremely high mechanical loads.

Strain gage or piezoelectric? Solutions for every requirement!

Strain gage torque sensors for
- Measurements on rotating shafts
- Maximum precision
- Continuous dynamic and static measurements

Piezoelectric reaction torque sensors for extremely high overload protection
- High signal resolution, even for the smallest partial ranges
- Wide frequency range

Measuring chains

In order to integrate sensor technology into a given application, it is advisable to clarify these points in advance; this will provide the basis for selecting the relevant components to generate the measuring chain:

- Type of signal: voltage, frequency, digital (fieldbus/Ethernet) or charge for piezoelectric sensors
- Number of pins of the selected output
- Pin allocation for sensor and evaluation unit (see data sheet)

When installing the cables, make sure that the maximum permitted cable length is not exceeded. It is advisable to use original Kistler cables only.

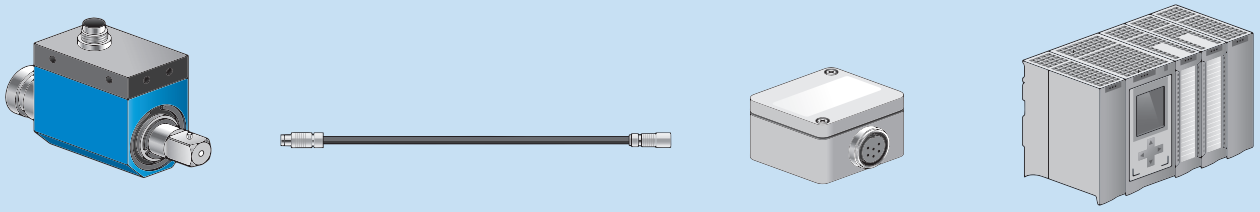
Most torque sensors based on strain gage technology already have an internal amplifier. The sensors can be connected with the appropriate evaluation unit, or directly with the PLC in some cases.

Piezoelectric torque sensors require a charge amplifier. After the sensor signals have been converted, they can be evaluated by an amplifier in the customer's system.

For the analysis of dedicated XY processes (such as torque-rotation angle monitoring), the maXYmos family is highly suitable thanks to its user-friendly operation and wide variety of interfaces (Y-channel: piezo, strain gage, +/– 10 V; X-channel: potentiometer, +/– 10V, incremental).

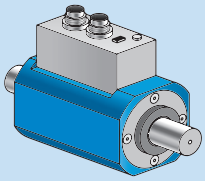
Measure	Connect	Amplify	Monitor & control

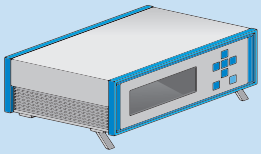
Measuring chains to test transmissions



Type 4501A — Type 4701A — SPS

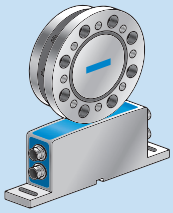
Type 4501A — Type 5867A

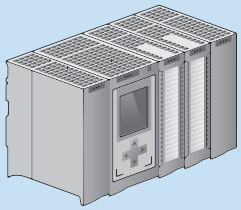




Type 4503B

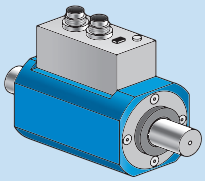
Type 4700B

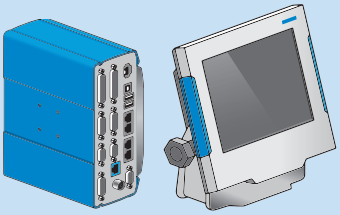




Type 4552A

SPS

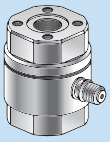


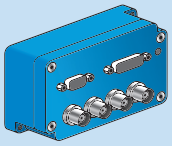


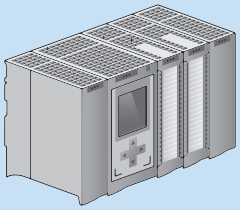
Type 4503B

Type 5877

Measuring chains to test rotary switches



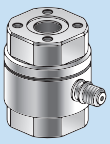


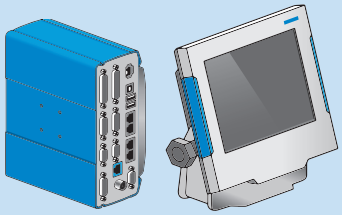


Type 9329A

Type 5073A

SPS





Type 9329A

Type 5877

Calibration

Sensors and measuring instruments must be calibrated at regular intervals, as their characteristics – and hence, measurement uncertainties – can change over time due to frequent use, aging and environmental factors. Instruments used for calibration are traceable to national standards and subject to uniform, international quality control. Calibration certificates document calibration values and conditions.

Safe and reliable measurements
Quality assurance systems and product liability laws call for systematic monitoring of all test equipment used to measure quality characteristics. This is the only way of ensuring that measurement and test results provide a reliable and trustworthy basis for quality control.

All sensors and electronic measuring devices are subject to some degree of measurement uncertainty. As the deviations involved can change over time, the test equipment must be calibrated at regular intervals.

This involves determining the deviation of the measured value from an agreed upon, correct value; this is the reference value, also referred to as the calibration standard. The result of a calibration can either be used to assign the actual values of the measurand to the readings or to determine correction factors for display. The required information is documented on the calibration certificate.

Calibration process
During calibration, sensors are subjected to known quantities of a physical input variable (such as torque) and the corresponding values of the output variable are recorded. The quantitative value of this load is accurately known, as it is measured with a traceably calibrated 'factory standard' at the same time. Depending on the method, sensors are calibrated either across the entire measuring range or in a partial range, i.e. according to choice:

- at a single point,
- continuously, or
- stepwise at several different points.

Measuring ranges
As standard, Kistler offers traceable calibrations from 0.005 N·m – 100,000 N·m. Additional measurement ranges are available upon request.

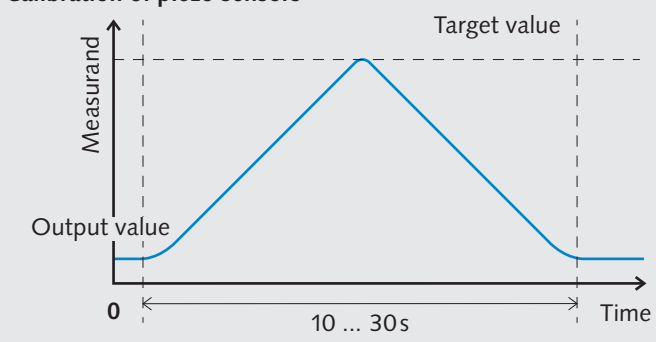
During continuous calibration, the load is continuously increased to the required value within a defined time and then reduced to zero within the same time. A 'best straight line' passing through the origin is defined for the resultant characteristic, which is never exactly linear. The gradient of this line corresponds to the sensitivity of the sensor within the calibrated measuring range.

Step-by-step calibration involves the application of a load with or without unloading between successive increases or decreases, depending on the calibration method used. The process is halted after each increment until the measurement stabilizes.

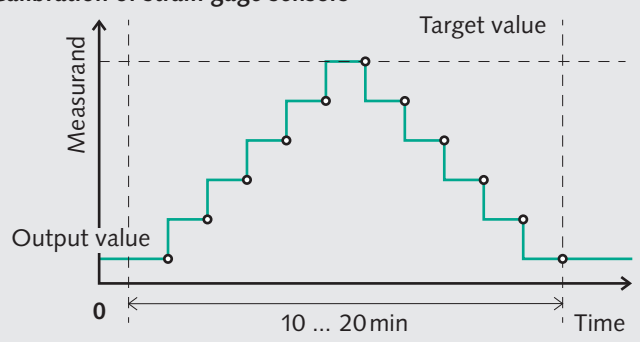
Linearity is determined by the deviation of the characteristic from the best straight line. Hysteresis corresponds to the maximum difference between the rising and falling characteristics. Most Kistler single-axis or multiaxial force and torque sensors are factory calibrated.

This continuous approach is the most suitable calibration method for piezoelectric sensors. Strain gage sensors are preferably calibrated step-by-step.

Calibration of piezo sensors



Calibration of strain gage sensors



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Kistler service: customized solutions from A to Z

Kistler offers sales and service wherever automated manufacturing processes take place.

In addition to sensors and systems, Kistler offers a host of services – from professional advice on installation to speedy worldwide deliveries of spare parts. For an overview of the services we offer and detailed information on our training courses, visit **www.kistler.com**.

Kistler service at a glance:

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- Process optimization
- Periodic onsite calibration of sensors
- Education and training events
- Development services

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