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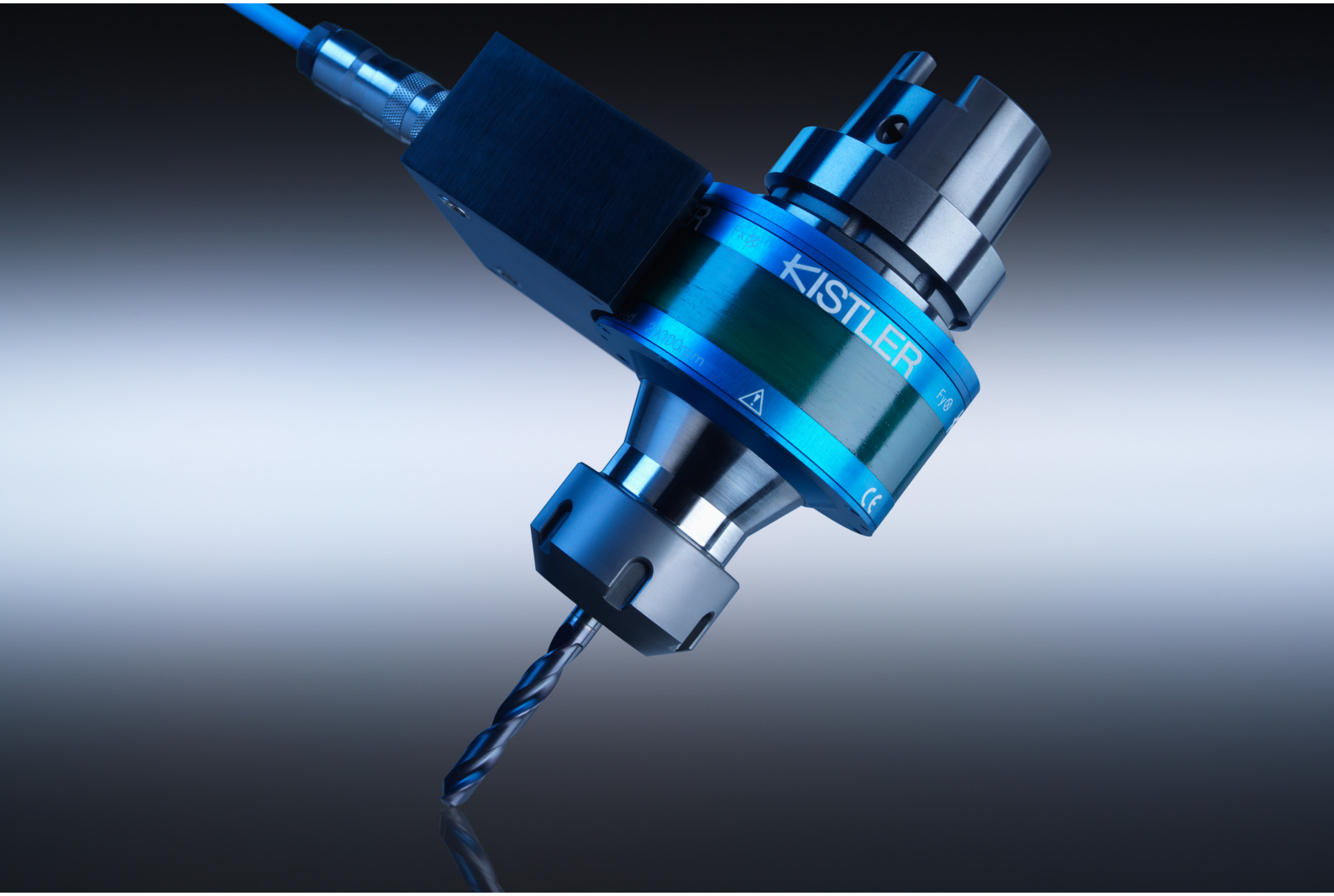

Product Catalog

Sensors and Solutions for Cutting Force Measurement

www.kistler.com

Kistler – Your Partner for Efficiency and Quality.

Sensors and systems for the measurement of forces and torques, for the analysis of force-distance and force-time characteristics and for the documentation of quality data in assembly and product testing are only one of the modules of the industry solutions from Kistler Instrumente AG. In addition to assembly and testing technology, we also offer special sensors and monitoring systems for mechanical production, for fuel engines, for automotive engineering, plastic processing and biomechanics.

Numbered among the core competencies at Kistler are development, production and utilization of sensor for the measurement of pressure, force, torque and acceleration. The measurement signals thus acquired can be processed and utilized through Kistler know-how and our electronics systems. The objective is the analysis of physical procedures. These are applied in the control and optimization of processes and in the enhancement of product quality in the manufacturing sector. Each year, Kistler invests 10 % of its revenues in research and development, thus providing innovative and economical solutions at the state-of-the-art of knowledge.

The Kistler Group is comprised of 30 Group companies. These are present around the globe in 30 countries at a total of 53 sites. Selected representatives distribute Kistler products and solutions in more than 30 additional countries.

Crystals form the basis of piezoelectric sensors

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Dynamometer Overview.

Dynamometers for Measurement of the Cutting Forces
Kistler offers a comprehensive program of dynamometers for the measurement of forces and torques in cutting processes. Many of these measurement devices can be used for various tasks. This provides the user with a maximum amount of flexibility. Stationary dynamometers differ mainly with respect to the direction of the pretension. The thermal energy that arises during cutting processes has a negative influence on the measurement signals. Dynamometers with horizontal pretension act against these negative influences and minimize them. They are therefore outstandingly suitable for measuring the cutting forces. Nonetheless, it is also true that dynamometers with vertical pretension have advantages of their own, e.g. the larger force range.

Selection Table
The adjacent selection table helps the user make a suitable selection. Dynamometers that are specially suitable for a desired machining application are marked with **++** . The dynamometer can also be used for applications that are marked with **+**. Limitations must be taken into account in such cases, e.g. with respect to accuracy or dynamic behavior.

	Type	Measurable components	Minimized influences of temperature	Turning	Milling	Drilling/ tapping	Surface grinding	Micro-machining
rotating	9170A	F_x, F_y, F_z, M_z	no		++	++		
	9124B	F_x, F_y, F_z, M_z	no		++	++		
	9125A	F_z, M_z	no		+	++		
stationary	9119AA1	F_x, F_y, F_z	yes		++	+	++	++
	9119AA2	F_x, F_y, F_z	yes	++	++	+	++	+
	9129AA	F_x, F_y, F_z	yes	++	++	+	++	
	9257B	F_x, F_y, F_z	no	+	++	+	++	
	9253B	F_x, F_y, F_z	no		+	+	+	
	9255C	F_x, F_y, F_z	no		++	+	++	
	9272	F_x, F_y, F_z, M_z	no	+	+	++		
	9366CC	F_x, F_y, F_z	no		++	+	+	

++ suitable
\+ limited suitability

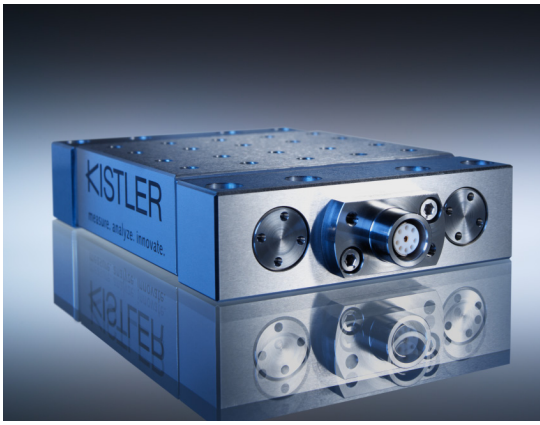
Measuring.

Measuring with Dynamometers
The measuring element is the core of every measuring chain. This records the physical variable to be measured and forwards it to subsequent devices in the form of a signal. The measuring elements used for the measurement of the forces and torques in the cutting processes are called Dynamometers and are all based on the piezoelectric measurement principle.

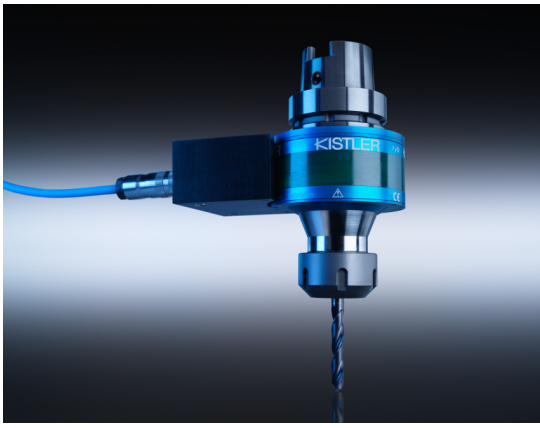
As a basic rule, a distinction is to be made between two families of dynamometers. On the one hand, there are the stationary dynamometers, that are mainly set up on the machinery table, while on the other hand there are the rotating Dynamometers – also called RCDs – that are retracted into the spindle via the spindle interface and rotate along with it.

Stationary Dynamometers
A stationary dynamometer is often the connecting element between the machine table of the machine tool and the workpiece. The workpiece is fastened on the dynamometer with which the reaction forces in manufacturing processes such as milling or drilling are measured. Stationary dynamometers are also used for turning applications. These are fitted directly to the turret with corresponding machine adapters. The tool is placed on the dynamometer with a suitable tool holder. Depending on the structure, the forces that arise are recorded by one or more multi-component force sensors and are available at the connector of the dynamometer in the form of charge signals.

Rotating Dynamometers
Rotating dynamometers (RCD) are mounted directly into the machine spindle via the spindle interface. The tool is mounted at the RCD with the aid of a tool holder. The RCD is used mainly in milling and drilling processes. In contrast to stationary dynamometers, only one multi-component sensor is installed in each rotating dynamometer. In addition to the sensor, the rotor also contains the charge amplifiers, i.e. the electronics that converts the charge into voltage, and the telemetry electronics. The measurement data is forwarded to the stationary part of the measuring chain via near-field telemetry, where it is subsequently made available as analog voltage signals.



Stationary Dynamometer Type 9129AA



Rotating Dynamometer Type 9170A

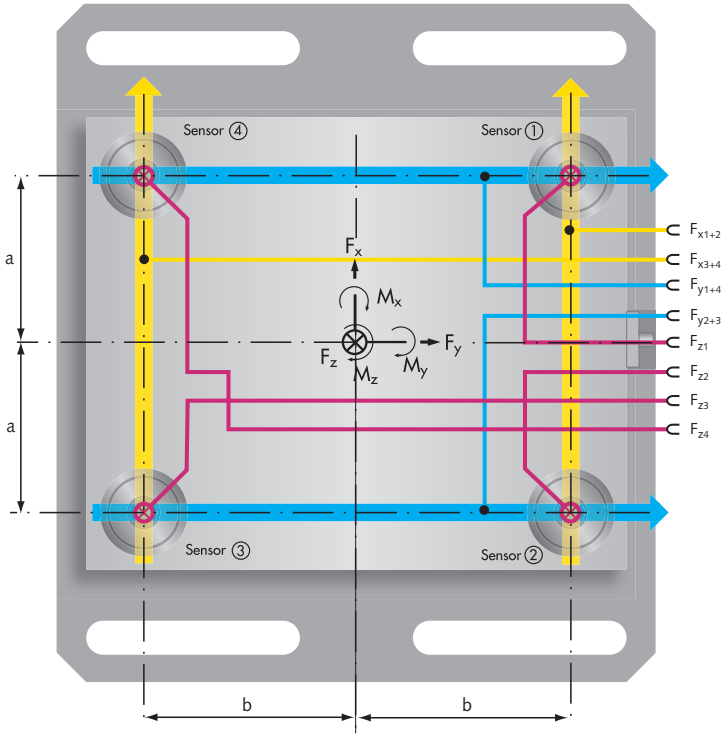
Multi-Component Force and Moment Measurement.

Special Feature of Stationary Dynamometers
All stationary 3-component dynamometers have the property of being able to be utilized as both a purely 3-component dynamometer and as a 6-component dynamometer.

This is made possible by the corresponding switching of the four 3-component force sensors in the interior of the dynamometer. The forces F_x, F_y and F_z are directly measured thereby, whereas the torques M_x, M_y and M_z are calculated with the aid of the individual force components and the sensor distances.

Cutting Force Measurement
With respect to the cutting force measurement, in addition to the measurement of the three orthogonal force components F_x, F_y and F_z, only the torque M_z is relevant for the determination of the drilling torque.

General Force Measurement
There are however numerous other measurement tasks in addition to the cutting force measurement for which not only the three components of the resulting force are of interest, but also the three components of the resulting torque vector. This is particularly true in cases where the point of applied force does not change during the measurement, which means that the distances required for the calculation of the torques remain constant.



Calculation of the Three Forces F_x, F_y, F_z and Three Moments M_x, M_y, M_z

$$F_x = F_{x1+2} + F_{x3+4}$$

$$F_y = F_{y1+4} + F_{y2+3}$$

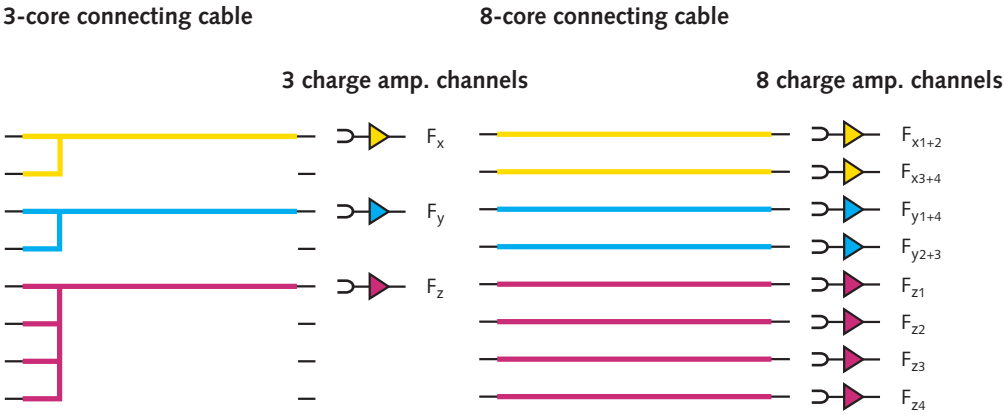
$$F_z = F_{z1} + F_{z2} + F_{z3} + F_{z4}$$

$$M_x = b\,(F_{z1} + F_{z2} - F_{z3} - F_{z4})$$

$$M_y = a\,(-F_{z1} + F_{z2} + F_{z3} - F_{z4})$$

$$M_z = b\,(-F_{x1+2} + F_{x3+4}) + a\,(F_{y1+4} - F_{y2+3})$$

Calculating the Forces and Moments
Three forces F_x, F_y und F_z and the moments M_x, M_y und M_z are calculated with Software DynoWare or analog with the 6-component summing amplifier in the charge amplifier. To calculate the moments, the distance of the sensors must be included.



3-component force measurement
In 3-component force measurement, the eight output signals from the dynamometer, as shown in the illustration, are summed in the three-core connecting cable. Three charge amplifiers are needed to convert the charge signal to a proportional output voltage.

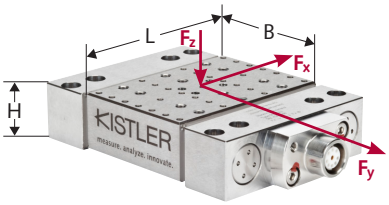
6-component force measurement
In 6-component force and moment measurement, the eight output signals are fed directly to the eight charge amplifiers by the eight-core connecting cable. These convert the charging signals into proportional output voltages and also calculate, depending on the specification of the charge amplifier, the torques M_x, M_y and M_z.

In General, a 6-Component Measuring System Provides

- The three components of the resultants of all applied forces, their direction but not their location in space
- The three components of the resulting moment vector related to the coordinate origin

Stationary Dynamometers

Multi-Component Dynamometer up to 4 kN



Technical Data	Type	9119AA1	9119AA2
Measuring range			
F_x, F_y, F_z	kN	–4 ... 4	–4 ... 4
Calibrated measuring range			
F_x, F_y, F_z	N	0 ... 4 000	0 ... 4 000
	N	0 ... 400	0 ... 400
	N	0 ... 40	0 ... 40
Sensitivity			
F_x, F_z	pC/N	≈–26	≈–26
F_y	pC/N	≈–13	≈–13
Natural frequency			
$f_n(x)$	kHz	≈6,0	≈4,3
$f_n(y)$	kHz	≈6,4	≈4,6
$f_n(z)$	kHz	≈6,3	≈4,4
Pretensioning direction		horizontal	horizontal
Operating temperature range	°C	–20 ... 70	–20 ... 70
LxWxH	mm	80x39x26	80x55x26
Weight	g	930	1 350
Degree of protection IEC/EN 60529 (w. conn. cable)		IP67	IP67
Connection		Fischer flange 9 pol. neg.	Fischer flange 9 pol. neg.

Characteristics
The dynamometer with the smallest mounting dimensions. As a result of the optimized structure and the choice of selected materials, natural frequencies of more than 6 kHz are reached in all 3 force directions (Type 9119AA1). Thanks to the utilization of high-sensitivity crystals in the dynamometer, sensitivities are achieved that are three times as great as those of conventional dynamometers. This enables accurate measurements of the smallest of forces. The horizontal pretensioning direction guarantees minimal influences of thermal effects on the measurement signals.

Accessories
Connecting cable Type 1687B5/1689B5 (3-comp.)
Connecting cable Type 1677A5/1679A5 (6-comp.)

Data sheet 9119AA1_003-060
9119AA2_003-055

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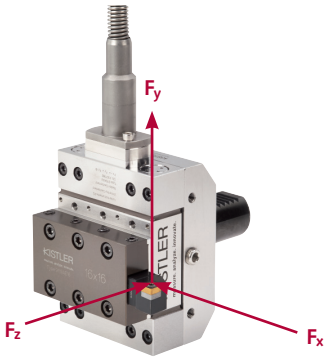
Applications
Cutting force measurement in micro-machining, hard turning, high speed machining, ultra-precision machining of brittle materials.

Grinding with dynamometer Type 9119AA2

Stationary Dynamometers

3-Component System for Measuring Cutting Force During Turning up to 3 kN



Technical Data	Type	9119AA2 [1]
Measuring range		
F_x, F_z	kN	–2 ... 2 [2]
F_y	kN	–3 ... 3 [2]
Calibrated measuring range		
F_x, F_z	kN	0 ... 2
	kN	0 ... 0,2
F_y	kN	0 ... 3
	kN	0 ... 0,3
Sensitivity		
F_x, F_z	pC/N	≈–26
F_y	pC/N	≈–13
Natural frequency		
f_n(x)	kHz	≈1,25 [3]
f_n(y)	kHz	≈1,5 [3]
f_n(z)	kHz	≈2,5 [3]
Operating temperature range	°C	–20 ... 70
Clamping surface	mm	55x80
Weight	g	depending on adaptor
Degree of protection IEC/EN 60529 (w. conn. cable)		IP67
Connection		Fischer flange 9 pol. neg.

[1] with adaptors Type 9119A...
[2] depending on adaptor
[3] applies to dynamometer Type 9119AA2 with machine adaptor Type 9119AB30S and toolholder Type 9119AE16, with tool (280 g)

Characteristics
This is a modular measuring system based on the dynamometer Type 9119AA2. Thanks to the utilization of high-sensitivity sensors, even the smallest of forces can be measured precisely. The assembling of machine adapters and tool holders is simple. A wide variety of conventional adapters that fit the dynamometer Type 9119AA2 is available.

Accessories
Machine adaptor with straight shank adaptor (VDI) Type 9119AB...
Machine adaptor with Capto Type 9119AC...
Machine adaptor with HSK-T Type 9119AH...
Toolholder for machine tool Type 9119AE...
Toolholder for boring bar Type 9119AF...
Connecting cable Type 1687B5/1689B5 (3-comp.)

Data sheet 9119AA2_003-055

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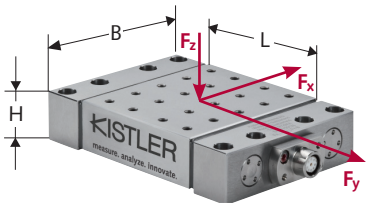
Applications
Measurement of small forces while turning on lathe with small turrets.

Stationary Dynamometers

Multi-Component Dynamometer with Top Plate 90x105 mm up to 10 kN



Technical Data	Type	9129AA
Measuring range		
F_x, F_y, F_z	kN	–10 ... 10
Calibrated measuring range		
F_x, F_y, F_z	kN	0 ... 10
	kN	0 ... 1
	kN	0 ...0,1
Sensitivity		
F_x, F_z	pC/N	≈–8
F_y	pC/N	≈–4,1
Natural frequency		
$f_n(x)$	kHz	≈3,5
$f_n(y)$	kHz	≈4,5
$f_n(z)$	kHz	≈3,5
Pretensioning direction		horizontal
Operating temperature range	°C	0 ... 70
LxWxH	mm	90x105x32
Weight	kg	3,2
Degree of protection IEC/EN 60529 (w. conn. cable)		IP67
Connection		Fischer flange 9 pol. neg.

Characteristics
The low profile and the wide measuring range make this dynamometer the ideal instrument for measurements on precision machine tools. The structure guarantees high natural frequencies in all three force directions. Negative influences of temperature effects during the measurement are significantly reduced by the horizontal pretensioning direction.

Accessories
Connecting cable Type 1687B5/1689B5 (3-comp.)
Connecting cable Type 1677A5/1679A5 (6-comp.)

Data sheet 9129AA_000-709

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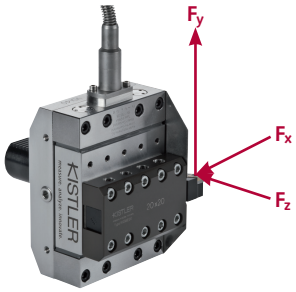
Applications
Cutting force measurement with milling, turning, surface grinding and drilling of mid-sized structural components.

Milling with dynamometer Type 9129AA

Stationary Dynamometers

3-Component Measuring System for Cutting Force Measurement During Turning up to 8 kN



Technical Data	Type	9129AA [1]
Measuring range (max. allowable)		
F_x, F_z	kN	–5 ... 5 [2]
F_y	kN	–8 ... 8 [2]
Calibrated measuring range		
F_x, F_z	kN	0 ... 5
	kN	0 ... 0,5
F_y	kN	0 ... 8
	kN	0 ... 0,8
Sensitivity		
F_x, F_z	pC/N	≈–8
F_y	pC/N	≈–4,1
Natural frequency		
f_n(x)	kHz	≈1,5 [3]
f_n(y)	kHz	≈1,5 [3]
f_n(z)	kHz	≈2,5 [3]
Operating temperature range	°C	0 ... 70
Clamping surface	mm	90x105
Weight	kg	depending on adaptor
Degree of protection IEC/EN 60529 (w. conn. cable)		IP67
Connection		Fischer flange 9 pol. neg.

[1] with adaptors Type 9129A...
[2] depending on adaptor
[3] applies to dynamometer Type 9129AA with machine adaptor Type 9129AB40 and toolholder Type 9129AE25, without tool

Characteristics
Measurement system of modular construction based on the dynamometer Type 9129AA with large measurement range. Not only machine adapters but also tool holders are mounted on the dynamometer with little effort. A wide variety of conventional adapters that fit the dynamometer Type 9129AA is available.

Accessories
Machine adaptor with straight shank adaptor (VDI) Type 9129AB...
Machine adaptor with Capto Type 9129AC...
Machine adaptor with clamping wedge Type 9129AD...
Toolholder for machine tool Type 9129AE...
Toolholder for boring bar Type 9129AF40
Connecting cable Type 1687B5/1689B5 (3-comp.)

Data sheet 9129A_000-710

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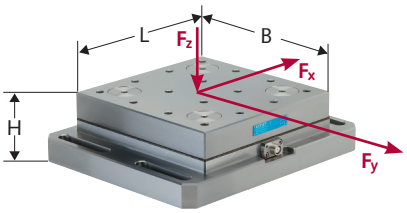
Applications
Cutting force measurement while turning on lathe with turrets.

Stationary Dynamometers

Multi-Component Dynamometer with Top Plate 260x260 mm up to 60 kN



Technical Data	Type	9255C
Measuring range		
F_x, F_y	kN	–30 ... 30
F_z	kN	–10 ... 60
Calibrated measuring range		
F_x, F_y	kN	0 ...30
	kN	0 ... 3
F_z	kN	0 ... 60
	kN	0 ... 6
Sensitivity		
F_x, F_y	pC/N	≈–7,9
F_z	pC/N	≈–3,9
Natural frequency		
$f_n(x)$	kHz	≈2,2
$f_n(y)$	kHz	≈2,2
$f_n(z)$	kHz	≈3,3
Pretensioning direction		vertical
Operating temperature range	°C	–20 ... 70
LxWxH	mm	260x260x95
Weight	kg	52
Degree of protection IEC/EN 60529 (w. conn. cable)		IP67
Connection		Fischer flange 9 pol. neg.

Characteristics
The robust dynamometer for heavy machining with the largest force range of all of the Dynamometers. The coupling to the machine table is accomplished with lateral flanges with oblong holes.
In addition, the dynamometer can be fastened through the center of the four sensors, thus enhancing the natural frequency.

Accessories
Connecting cable Type 1687B5/1689B5 (3-comp.)
Connecting cable Type 1677A5/1679A5 (6-comp.)

Data sheet 9255C_003-051

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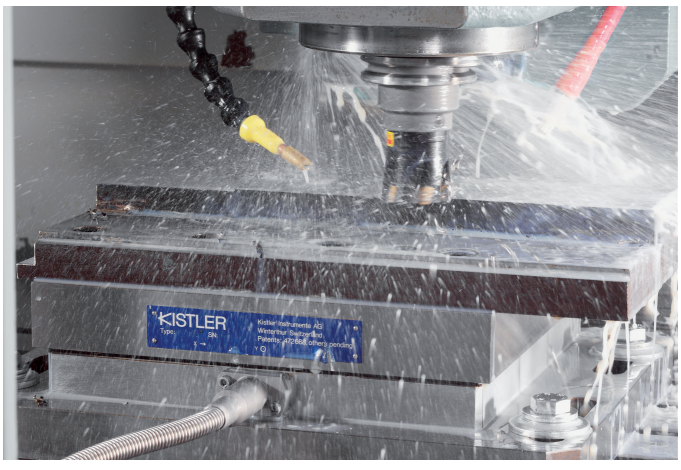
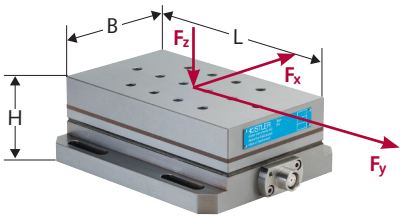
Applications
Measurement of large forces, mainly by milling, broaching and surface grinding of large structural components.



Face milling with dynamometer Type 9255C

Stationary Dynamometers

Multi-Component Dynamometer with Top Plate 100x170 mm up to 10 kN



Technical Data	Type	9257B
Measuring range		
F_x, F_y	kN	–5 ... 5
F_z	kN	–5 ... 10
Calibrated measuring range		
F_x, F_y	kN	0 ... 5
	kN	0 ... 0,5
F_z	kN	0 ... 10
	kN	0 ... 1
Sensitivity		
F_x, F_y	pC/N	≈–7,5
F_z	pC/N	≈–3,7
Natural frequency		
$f_n(x)$, $f_n(y)$	kHz	≈2,3
$f_n(z)$	kHz	≈3,5
Pretensioning direction		vertical
Operating temperature range	°C	0 ... 70
LxWxH	mm	170x100x60
Weight	kg	7,3
Degree of protection IEC/EN 60529 (w. conn. cable)		IP67
Connection		Fischer flange 9 pol. neg.

Characteristics
The dynamometer for universal use. The handy size and the ideal measurement range for many applications have made Type 9257B the most frequently built multi-component dynamometer. The connection with the machine table is accomplished with lateral flanges with oblong holes.

Accessories
Connecting cable Type 1687B5/1689B5 (3-comp.)
Connecting cable Type 1677A5/1679A5 (6-comp.)
Toolholder Type 9403

Data sheet 9257B_000-151

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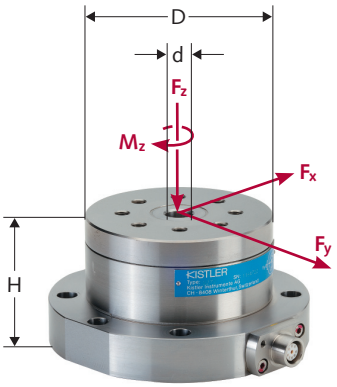
Applications
Cutting force measurement with milling, turning, surface grinding and drilling of mid-sized structural components.

Stationary Dynamometers

4-Component Dynamometer for Cutting Force Measurement in Drilling



Technical Data	Type	9272
Measuring range		
F_x, F_y	kN	–5 ... 5
F_z	kN	–5 ... 20
M_z	N·m	–200 ... 200
Calibrated measuring range		
F_x, F_y	kN	0 ... 5
	kN	0 ... 0,5
F_z	kN	0 ... 20
	kN	0 ... 2
M_z	N·m	0 ... ±200
	N·m	0 ... ±20
Sensitivity		
F_x, F_y	pC/N	≈–7,8
F_z	pC/N	≈–3,5
M_z	pC/N·m	≈–160
Natural frequency		
$f_n(x)$, $f_n(y)$	kHz	≈3,1
$f_n(z)$	kHz	≈6,3
f_n (M_z)	kHz	≈4,2
Pretensioning direction		vertikal
Operating temperature range	°C	0 ... 70
DxdxH	mm	ø100xø15x70
Weight	kg	4,2
Degree of protection IEC/EN 60529 (w. conn. cable)		IP67
Connection		Fischer flange 9 pol. neg.

Characteristics
As the only stationary dynamometer, this 4-component dynamometer can, in addition to the three force directions, also measure the torque M_z directly in the center of the dynamometer. This ensures that a precise determination of the torque is achieved.

Accessories
Connecting cable Type 1677A5/1679A5
Toolholder Type 9404

Data sheet 9272_000-153

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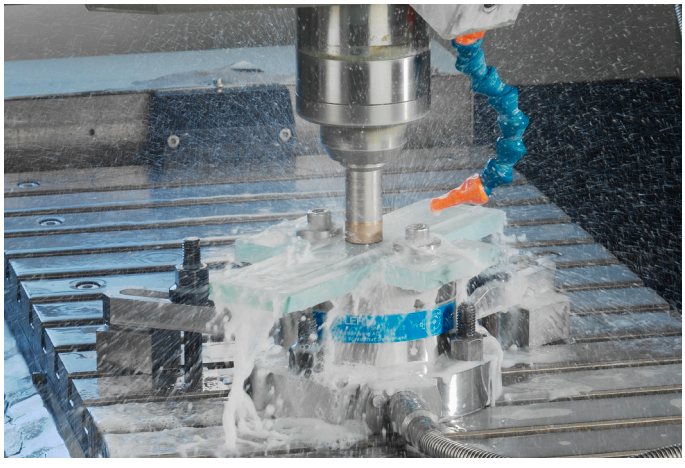
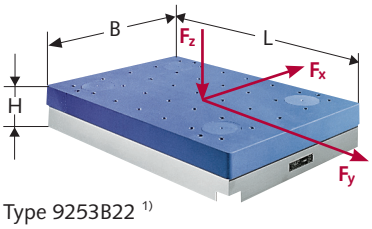
Applications
Cutting force measurement mainly with drilling. For training purposes, the device can also be utilized for cutting force measurements with milling or turning.



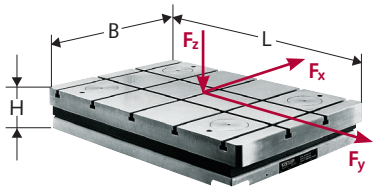
Force measurement with cutting of quartzes with dynamometer Type 9272

Stationary Dynamometers

Multi-Component Force Plate with Top Plate 400x600 mm up to 30 kN



Type 9253B22 [1]



Type 9253B23 [2]

[1] Top plate with tapped hole M10x18
[2] Top plate with T-grooves 10H12

Technical Data	Type	9253B22	9253B23
Measuring range			
F_x, F_y	kN	–15 ... 15	–12 ... 12
F_z	kN	–15 ... 30	–12 ... 25
Calibrated measuring range			
F_x, F_y	kN	0 ...15	0 ... 12
	kN	0 ... 1,5	0 ... 1,2
F_z	kN	0 ... 30	0 ... 25
	kN	0 ... 3	0 ... 2,5
Sensitivity			
F_x, F_y	pC/N	≈±7,8	≈±7,8
F_z	pC/N	≈±3,7	≈±3,7
Natural frequency			
$f_n(x)$	Hz	≈580	≈610
$f_n(y)$	Hz	≈550	≈570
$f_n(z)$	Hz	≈720	≈570
Pretensioning direction		vertical	vertical
Operating temperature range	°C	–20 ... 70	–20 ... 70
LxWxH	mm	600x400x100	600x400x100
Weight	kg	90	85
Degree of protection IEC/EN 60529 (w. conn. cable)		IP67	IP67
Connection		Fischer flange 9 pol. neg.	Fischer flange 9 pol. neg.

Characteristics
With a cover plate size of 400x600 mm, even larger workpieces can also be set up securely. The measurement platform is mounted through the center of the four feet on the machine tool table. In doing so, in contrast to all other stationary dynamometers, the base plate is dispensed with.

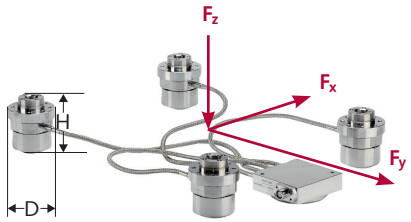
Accessories
Connecting cable Type 1687B5
Connecting cable Type 1677A5

Data sheet 9253B_000-146

Applications
Cutting force measurement with milling and surface grinding of large-sized structural components.

Stationary Dynamometers

Multi-Component Sensor Kit for Force Measurement up to 60 kN



Technical Data	Type	9366CC...
Measuring range		
F_x, F_y	kN	–25 ... 25 [1]
F_z	kN	–25 ... 60 [1]
Calibrated measuring range		
F_x, F_y	kN	0 ... 25
	kN	0 ... 2,5
F_z	kN	0 ... 60
	kN	0 ... 6
Sensitivity		
F_x, F_y	pC/N	≈–7,8
F_z	pC/N	≈–3,8
Natural frequency		
$f_n(x)$, $f_n(y)$, $f_n(z)$	Hz	≈200 ... 1 600 [1]
Pretensioning direction		vertical
Operating temperature range	°C	–20 ... 70
DxH	mm	72x90
Max. size of the top plate	mm	900x900
Weight	kg	7
Degree of protection IEC/EN 60529 (w. conn. cable)		IP67
Connection		Fischer flange 9 pol. neg.

[1] depending on material and size of the top plate

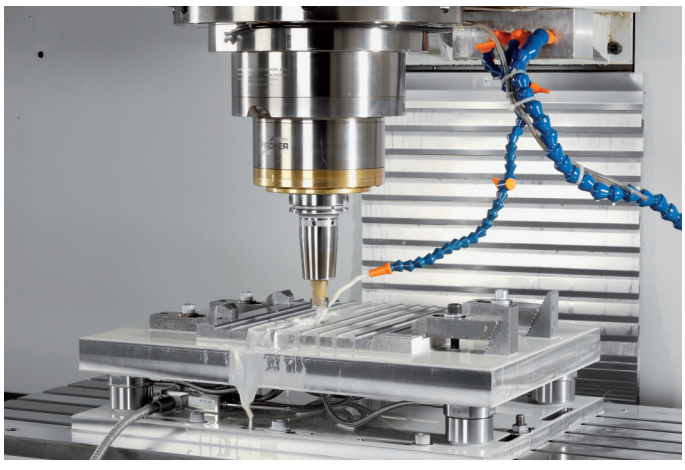
Characteristics
This ready-to-connect and calibrated multi-component kit allows the user to assemble multi-component measuring plates. Top plate sizes from 300x300 mm to 900x900 mm are possible.

Accessories
Connecting cable Type 1687B5 (3-comp.)
Connecting cable Type 1677A5 (6-comp.)

Data sheet 9366CC_000-681

CAD Download-Service
http://kistler.partcommunity.com

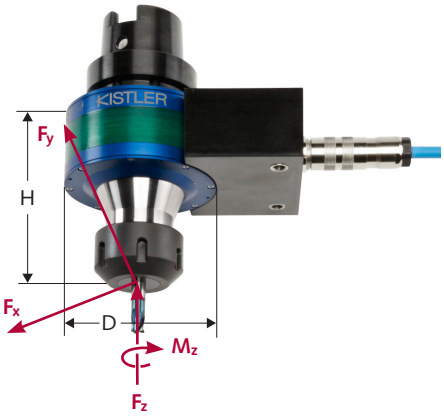
Applications
Cutting force measurement with milling and surface grinding of large-sized structural components.



Milling of Titanium on dynamometer Type 9366CC...

Rotating Dynamometers

Rotating 4-Component Dynamometer RCD for Cutting Force Measurement up to 20 000 1/min



Technical Data	Type	9170A...
Measuring range nominal		
F_x, F_y	kN	–5 ... 5 [1]
F_z	kN	–20 ... 20 [1]
M_z	N·m	–150 ... 150 [1]
Speed, max.	1/min	20 000 [1]
Sensitivity (min./max.)		
F_x, F_y	mV/N	≈2/≈20
F_z	mV/N	≈0,5/≈5
M_z	mV/N·m	≈66/≈1 000
Natural frequency		
$f_n(x)$	kHz	≈2 [2]
$f_n(y)$	kHz	≈2 [2]
$f_n(z)$	kHz	≈7,6 [2]
Operating temperature range	°C	0 ... 60
DxH	mm	85x95
Weight of Rotor	kg	1,6 [2]
Degree of protection IEC/EN 60529 (w. conn. cable)		IP67
Signal transmission		non-contacting

[1] depending on spindle adaptor and point of force application
[2] applies to rotor with spindle adaptor HSK-A63 and integrated ER type collet chuck adaptor (without tool)

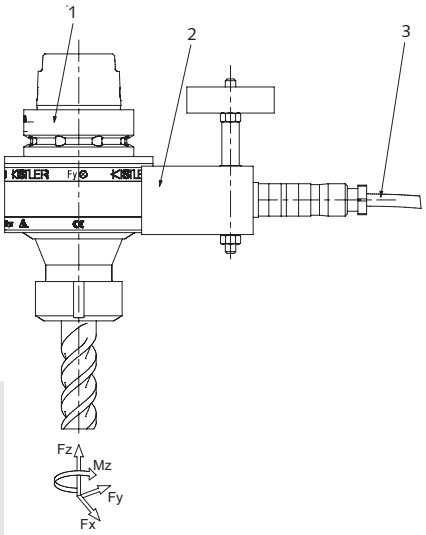
Characteristics
With this Rotating 4-component dynamometer (RCD), measurements are taken of the forces in radial direction (F_x, F_y) and in axial direction (F_z) and the torque in the machining processes with spindle speeds of up to 20 000 1/min. The coolant supply can take place internally. The transmission of the measurement signals and the energy supply takes place contact-free and thus also completely without any wearing. A wide variety of conventional spindle adapters is available for this RCD.

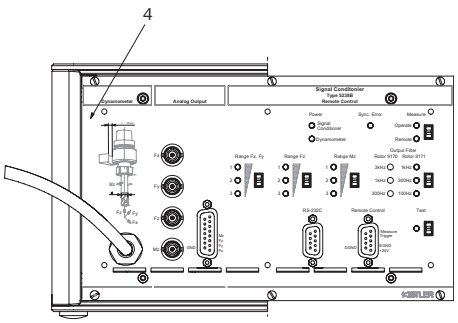
Accessories
Collet chuck Type 9169A...

Data sheet 9170A_000-995

CAD Download-Service
http://kistler.partcommunity.com

Applications
4-Component force and torque measurement on rotating tools during drilling and finishing processes during milling.

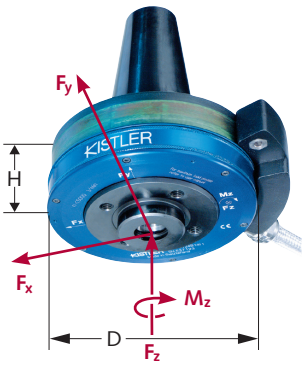




1 Rotor Type 9170A...
2 Stator Type 5236B
3 Cable Type 1500A95, L = 10 m
4 Signal Conditioner Type 5238B1/B2

Rotating Dynamometers

Rotating 4-Component Dynamometer RCD for Cutting Force Measurement up to 5 000 1/min



Technical Data	Type	9124B...
Measuring range nominal		
F_x, F_y	kN	–20 ... 20 [1]
F_z	kN	–30 ... 30
M_z	N·m	–1 100 ... 1 100
Speed, max.	1/min	5 000
Sensitivity (min./max.)		
F_x, F_y	mV/N	≈0,5/5
F_z	mV/N	≈0,35/3,5
M_z	mV/N·m	≈9/90
Natural frequency		
$f_n(x)$	kHz	≈1,0 [2]
$f_n(y)$	kHz	≈1,0 [2]
$f_n(z)$	kHz	≈2,7 [2]
Operating temperature range	°C	0 ... 60
DxH	mm	156x55
Weight	kg	6,2 [2]
Degree of protection IEC/EN 60529 (w. conn. cable)		IP67
Signal transmission		non-contacting

[1] depending on point of force application
[2] applies to rotor without spindle adaptor and without toolholder

Characteristics
The rotating 4-component dynamometer (RCD) is designed with the large measuring ranges and speeds of up to 5 000 1/min for heavy machining. A wide-variety selection of conventional spindle adapters is available. These are interchangeable, depending on the construction type of the RCD. The same applies for the tool holder. The transmission of the measurement signals is contact-free and without any wearing.

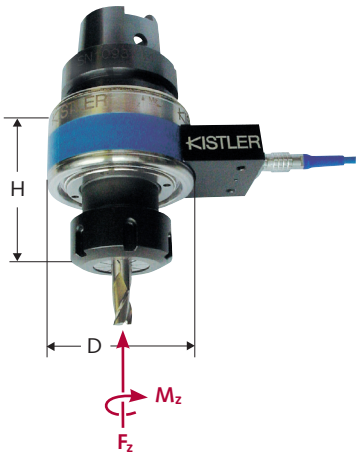
Accessories
Stator Type 5221B2
Cable Type 1500B19
Signal Conditioner Type 5223B...
Toolholder Type 9165

Data sheet 9124B_000-122

Applications
4-component force and torque measurement on rotating tools in heavy machining (drilling, milling).

Rotating Dynamometers

Rotating 2-Component Dynamometer RCD for Cutting Force Measurement up to 25 000 1/min



Technical Data	Type	9125A...
Measuring range nominal		
F_z	kN	–3 ... 3
M_z	N·m	–50 ... 50
Speed, max.	1/min	25 000
Sensitivity (min./max.)		
F_z	mV/N	≈3/30
M_z	mV/N·m	≈185/950
Natural frequency		
$f_n(z)$	kHz	≈5 [1)]
$f_n(M_z)$	kHz	≈2,5 [1)]
Operating temperature range	°C	0 ... 60
DxH	mm	74x79
Weight	kg	1,5 [1)]
Degree of protection IEC/EN 60529 (w. conn. cable)		IP67
Signal transmission		non-contacting

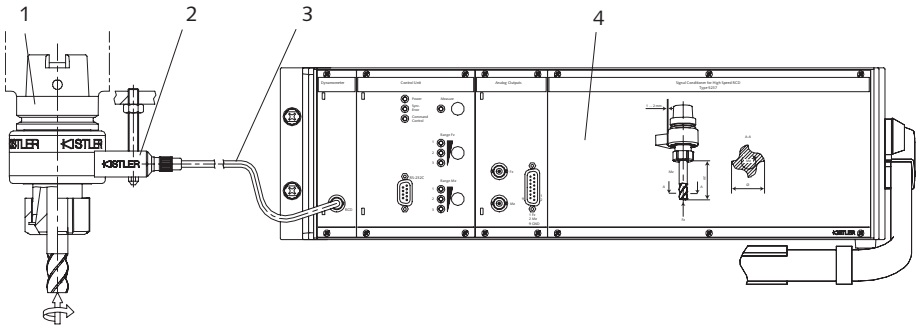
[1)] applies to rotor with spindle adaptor HSK-A63 and integrated ER type collet chuck adaptor (without tool)

Characteristics
This rotating 2-component dynamometer (RCD) is suitable for the measurement of axial forces as well as torques in high-speed machining with spindle speeds of up to 25 000 1/min. The coolant supply can take place internally. The transmission of measurement signals and the energy supply are both contact-free. A wide variety of conventional spindle adapters is available for this RCD.

Accessories
Collet chuck Type 9169A...

Data sheet 9125A_000-123

CAD Download-Service
http://kistler.partcommunity.com



1 Rotor Type 9125A...
2 Stator Type 5235
3 Cable Type 1500A37, L = 8 m
4 Signal Conditioner Type 5237A1/A2

Applications
2-component force and torque measurement with high-speed machining (milling, drilling).

Amplifying & Acquiring.

Charge amplifier Type 5080A...

Charge Amplifiers
Signal processing is of special significance for the measurement of mechanical variables such as force and torque. Piezoelectric sensors emit a charge that is proportional to the load on the sensor. The charge amplifier converts this charge into standardized voltage signals that can then be evaluated by the downstream signal processing. In order to fulfill the different requirements in everyday practice, Kistler offers a wide spectrum of charge amplifiers that differ from one another essentially in terms of design, number of measuring channels, accuracy and measuring range.

Data Acquisition Systems
PCs are usually used for measurement data acquisition. Here special demands are made of the software for the visualization and evaluation of the force signals with respect to functionality and user-friendliness. Kistler DynoWare is an all-purpose, easy-to-use software that is particularly suitable for force measurements with Dynamometers or single-component and multi-component force sensors. For signal analysis, DynoWare offers the users online visualization of the measurement curves in addition to useful calculation and graphics functions.

DynoWare supports the simple configuration of all of the charge amplifiers and Signal Conditioners available for cutting force measurement. In addition, it offers individual documentation of the measurement and saving of configuration and measurement data.

Charge Amplifier

High-End Multi-Channel Charge Amplifier for Multi-Component Force Measurement

Technical Data	Type	5080A...
Number of channels		1 ... 8
Measuring range FS	pC	±2 ... 2 200 000
Measuring range adjustment		continuos
Frequency range (–3 dB)	kHz	0 ... 200
Output signal	V	±10 / –8 ... 10
Module optional		– charge amplifier – Dual Mode (charge/Piezotron)
Power supply		
	VAC	100 ... 240
	VDC	11 ... 36
Input signal	Type/ connector	Piezoelectric, optional with: – BNC neg. – Fischer 9 pol. neg.
Output signal	Type/ connector	– BNC neg. – D-Sub 15-pol. neg.
Degree of protection IEC/EN 60529		IP40
Interface		– RS-232C – USB 2.0
Case, optional		– 19" rack module (DIN 41494) – Desktop unit with support bracket
Other features		Display of mechanical measurands

Characteristics
This charge amplifier has outstanding properties that make very precise measurements possible, particularly with small forces. It is exceptionally flexible in construction and can be modified to meet requirements at any time. In addition to purely charge amplifier modules, Dual-mode modules are also available to which sensors with charge output and sensors with integrated electronics (Piezotron®) can be connected.

Accessories
RS-232C cable Type 1200A27
Connecting cable Type 1700A111A2
Connecting cable Type 1700A113A2
Inductive proximity switch Type 2233B

Data sheet 5080A_000-744

CAD Download-Service
http://kistler.partcommunity.com

Applications
Laboratory charge amplifier for stationary dynamometers. Specially suitable for micro-machining.

Charge Amplifier

Multi-Channel Charge Amplifier for Multi-Component Force Measurement

Technical Data	Type	5070A...
Number of channels		
Type 5070Ax0xxx		4
Type 5070Ax1xxx		8
Type 5070Ax2xxx		8 with 6-component summing calculator
Measuring range FS, optional	pC	±200 ... 200 000
	pC	±600 ... 600 000
Measuring ranges adjustment		continuos
Frequency range (–3 dB)	kHz	≈0 ... 45
Output signal	V	±10
Supply voltage	VAC	100 ... 240
Input signal	Type/ connector	Piezoelectric, optional with: – BNC neg. – Fischer 9 pol. neg.
Output signal	Type/ connector	D-Sub 15 pol. neg.
Degree of protection IEC/EN 60529		IP40
Interface, optional		RS-232C RS-232C + IEEE-488
Case, optional		– 19" cassette for rack mounting – Desktop unit with support bracket – 19" cassette with panel mounting set
Other features		– Display of peak values – Display of mechanical measurands

Characteristics
This charge amplifier was developed especially for multi-component force measurement. Thanks to its large and continuously adjustable measuring ranges and the wide frequency range, this device is suitable in measuring chains with stationary Dynamometers for cutting force measurement.

Accessories
RS-232C cable Type 1200A27
Connecting cable Type 1700A111A2
Connecting cable Type 1700A113A2
Inductive proximity switch Type 2233B

Data sheet 5070A_000-485

CAD Download-Service
http://kistler.partcommunity.com

Applications
Laboratory charge amplifier for stationary Dynamometers for all types of cutting force measurement.

Data Acquisition System

DAQ-System for Data Acquisition of up to 28 Measuring Channels

Technical Data	Type	5697A...
Number of measuring channels		28
Resolution	Bit	16
Sampling rate max.		
with 1 channel	kS/s	1 000
with 8 channels	kS/s	125
with 16 channels	kS/s	62,5
Interface to PC		USB 2.0 Type B, fem.
Dimensions	mm	208x70x249
Weight	kg	2,2

Applications
Together with the DynoWare software, this data acquisition system is used in all types of cutting force measurement.

Characteristics
This all-purpose data acquisition system enables the acquisition of analog signals with up to 1 MHz. In combination with the DynoWare software, all Kistler laboratory charge amplifiers and signal conditioners can be controlled. The connection with the PC is via a USB interface. The DynoWare software is obtainable in the package with data acquisition system.

Accessories
RS-232C cable Type 1200A27
Connecting cable Type 1700A111A2
Connecting cable Type 1700A113A2
Inductive proximity switch Type 2233B

Data sheet 5697_000-745

Software

DynoWare – Windows® Software for Data Acquisition

Technical Data	Type	2825A...
Supported charge amplifiers	Types	5011, 5015A..., 5018A..., 5017, 5019, 5070A..., 5080A...
Supported Signal Conditioners for rotating dynamometers (RCD)	Types	5223B..., 5237A... 5238B...
Additional information		see Data sheet
Supported operating systems		Windows® XP Windows® Vista Windows® 7 Windows® 8

Windows® is a registered trade mark of Microsoft Corporation

Applications
DynoWare is particularly suitable for the recording and evaluation of cutting force signals.

Characteristics
This simple-to-operate software enables the configuration and control of all Kistler laboratory charge amplifiers and signal conditioners via RS-232C, IEEE-488 or USB. In addition, it offers the simultaneous recording of the measurement signals as well as useful signal evaluation and calculation functions. The measurement data acquired can be readily exported. The software is suitable for the acquisition and evaluation of any and all physical variables.

Accessories
Data acquisition system Type 5697A...

Data sheet 2825A_000-371

Connecting Cables, High Insulation

Cable, 8-Core, Temperature Range –5 ... 70 °C

Technical Data	Type	1677A5
Connection		Fischer 9 pol. pos., flange Fischer 9pol. pos
Length	m	5
Diameter	mm	12,3 (metal sheath)
Number of conductors		8
Used for		6-component measurement

Cable with Angle Connector, 8-Core, Temperature Range –5 ... 70 °C

Technical Data	Type	1679A5
Connection		Fischer angle 9 pol. pos., flange Fischer 9 pol. pos
Length	m	5
Diameter	mm	12,3 (metal sheath)
Number of conductors		8
Used for		6-component measurement

Cable, 3-Core, Temperature Range –5 ... 70 °C

Technical Data	Type	1687B5
Connection		Fischer 9 pol. pos., flange Fischer 9 pol. pos
Length	m	5
Diameter	mm	12,3 (metal sheath)
Number of conductors		3
Used for		3-component measurement

Cable with Angle Connector, 3-Core, Temperature Range –5 ... 70 °C

Technical Data	Type	1689B5
Connection		Fischer angle 9 pol. pos., flange Fischer 9 pol. pos
Length	m	5
Diameter	mm	12,3 (metal sheath)
Number of conductors		3
Used for		3-component measurement

Data sheet 1687B_000-545

Connecting Cables, Low-Resistance

Cable for Transmission of the Measuring Signals

Technical Data	Type	1700A111A2
Connection		D-Sub 15 pol. neg. D-Sub 15 pol. pos.
Length	m	2
Number of conductors		15

Cable for Transmission of the Measuring Signals

Technical Data	Type	1700A113A2
Connection		D-Sub 15 pol. neg. BNC pos.
Length	m	2
Number of conductors		8

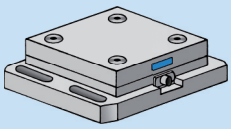
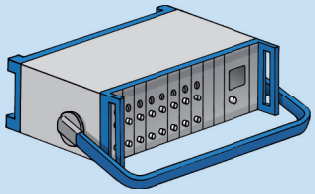
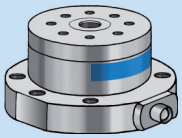
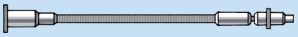
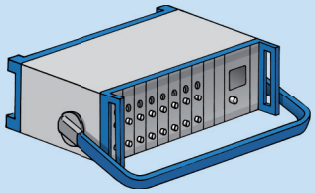
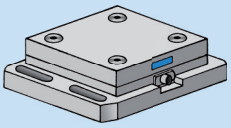
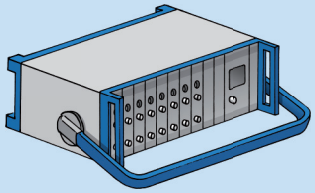
Cable for Transmission of the Communication Signals

Technical Data	Type	1200A27
Connection		D-Sub 9 pol. pos. D-Sub 9 pol. neg.
Length	m	5
Number of conductors		9

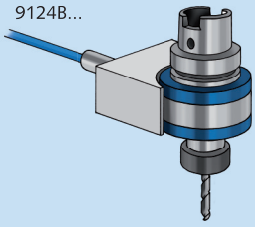
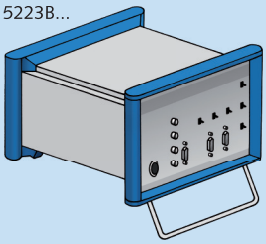
Data sheet 5697_000-745

Measuring Chains.

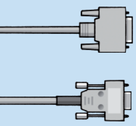
Stationary Dynamometers

	Measuring		Connecting		Amplifying	
3 Measuring Components	9119AA1 9119AA2 9129AA 9253B... 9255C 9257B 9366CC...		1687B5 1689B5		5070A... 5080A...	
4 Measuring Components	9272		1677A5 1679A5		5070A... 5080A...	
8 Measuring Components	9119AA1 9119AA2 9129AA 9253B... 9255C 9257B 9366CC...		1677A5 1679A5		5070A... 5080A...	

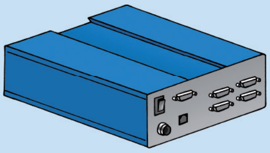
Rotating Dynamometers (RCD)

Rotating Dynamometers	9125A... 9170A... 9124B...		5235 5236B 5221B...	1500A37 1500A95 1500B19		5237A... 5238B... 5223B...	

Acquiring **Analyzing**

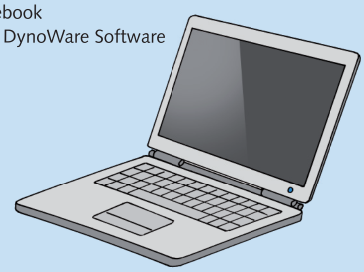


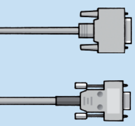
5697A...



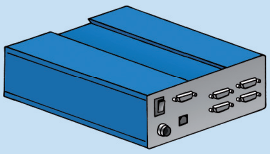
USB cable

Notebook
with DynoWare Software



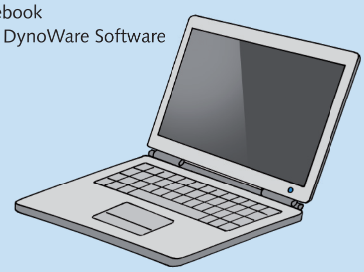


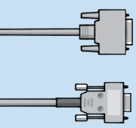
5697A...



USB cable

Notebook
with DynoWare Software





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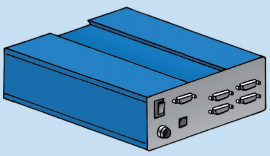

USB cable

Notebook
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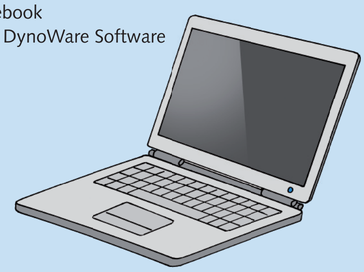

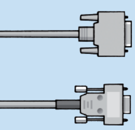

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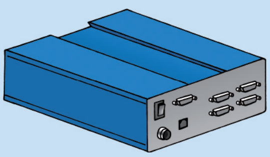

USB cable

Notebook
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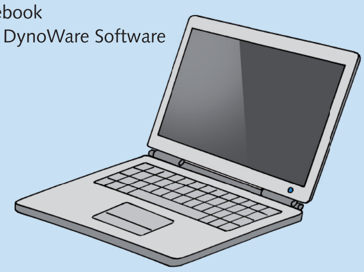

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