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Multicomponent Dynamometer

Type 9139AA

Wide force measuring range, up to 30 kN, cover plate 140x190 mm

Multicomponent dynamometer for measuring the three orthogonal components of a force. The stiff and robust design as well as the large measuring range permit the measurement of large forces, for example in high-performance cutting applications.

- Wide measuring range
- Patented and largely temperature-compensated design
- Compact and very robust design
- High natural frequency

Description

By using piezoelectric force sensors, this dynamometer not only measures large forces, but can also accurately measure small forces in the Newton range. The high natural frequency and the high sensitivity of piezoelectric sensors permit the acquisition of high-quality measuring signals of very dynamic processes in machining or in general force measurement applications.

The dynamometer consists of four 3-component force sensors mounted under high preload between the cover plate and the two lateral base plates.

A low temperature error is obtained by this special mounting of the sensors. Each force sensor contains three crystal rings, of which one is sensitive to pressure in the y-direction and the two others to shear in the x- and z-directions. The forces are measured practically without displacement.

The outputs of the four mounted force sensors are fed to the 9-pole flanged socket. There are also multicomponent force-moment measurements possible.

The four sensors are fitted so that they are ground-isolated. This largely eliminates ground loop problems.

The dynamometer is corrosion-resistant and protected against penetration by splashing water or cutting fluid. The dynamometer including connecting cable Type 1687B5 or Type 1677A5 meets the degree of protection IP67.

Application examples

- Multicomponent force measurement of large forces
- Cutting force measurement in high performance applications for example in
  - milling
  - surface grinding
  - drilling

Technical data

Measuring range (centrical)	F_x, F_y, F_z	kN	–30 ... 30
single component	M_x, M_y, M_z	N·m	–3 000 ... 3 000
Measuring range when components act simultaneously (centrical) 71 mm above dynamometer, M_x, M_y, M_z = 0	$\vec{F}_{x, y, z}$ (Force vector)	kN	–20 ... 20
Calibrated measuring range			
100 %	F_x, F_y, F_z	N	0 ... 30 000
10 %	F_x, F_y, F_z	N	0 ... 3 000
1 %	F_x, F_y, F_z	N	0 ... 300
Threshold		N	<0,01
Sensitivity	F_x, F_z	pC/N	≈–8,2
	F_y	pC/N	≈–4,2
Linearity			
Meas. range 1 ... 100 %		%/FSO	≤±0,3
Meas. range 0 ... <1 %		%/FSO	≤±0,5
Hysteresis			
Meas. range 1 ... 100 %		%/FSO	≤0,3
Meas. range 0 ... <10 %		%/FSO	≤0,5
Crosstalk	F_z –> F_x, F_y	%/FSO	≤±2
	F_x <–> F_y	%/FSO	≤±2
	F_x, F_y –> F_z	%/FSO	≤±2
Natural frequency	f_n (x)	kHz	≈2,9
(without additional mass)	f_n (y)	kHz	≈2,9
	f_n (z)	kHz	≈3,0
Operating temperature range		°C	–20 ... 70
Insulation resistance (20 °C)		Ω	$>10^{13}$
Ground isolation		Ω	$>10^{8}$
Degree of protection EN60529		–	IP67 [1)]
Weight			
Dynamometer		kg	≈12,9
Cover plate		kg	≈6,5
Mounting surface		mm	140x190

[1)] with connection cables Type 1687B5, 1689B5, 1677A5, 1679A5

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Dimensions

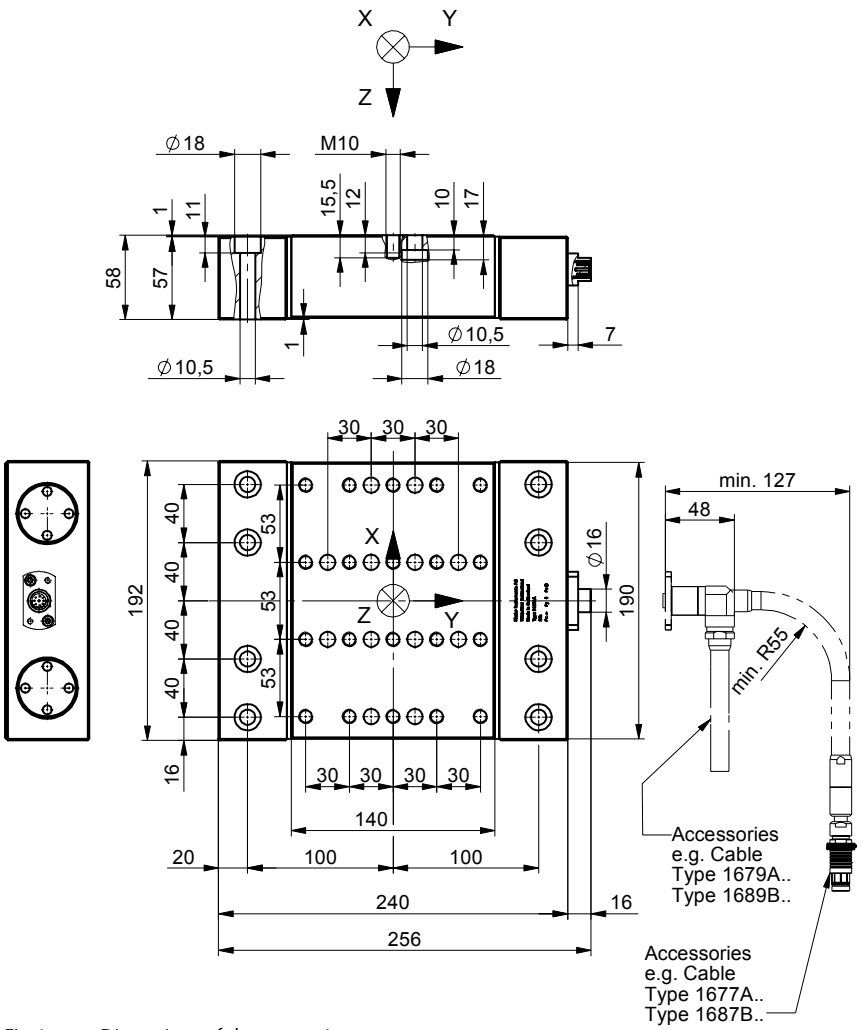

Fig 1: Dimensions of dynamometer Type 9139AA

Pin allocation

Pin No.	Output signals 1687B/1689B	Output signals 1677A/1679A
1	Ground	Ground
2	F_x	$F_{x\,1+2}$
3	–	$F_{x\,3+4}$
4	F_y	$F_{y\,1+4}$
5	–	$F_{y\,2+3}$
6	F_z	$F_{z\,1}$
7	–	$F_{z\,2}$
8	–	$F_{z\,3}$
9	–	$F_{z\,4}$

Mounting

The dynamometer can be mounted with eight screws to any face-ground, clean mounting surface such as on a machine tool table. The measuring instrument can also be mounted on a magnetic plate. It must be noted that uneven contact surfaces may cause internal distortions, placing additional heavy stresses on the individual measuring elements and increasing the cross talk.

There are M10 tapped blind holes in the mounting plate for clamping the force-introducing components such as workpieces. It is also possible to mount parts from below. The contact surfaces of the force-introducing parts must be surface ground to achieve good mechanical coupling to the cover plate.

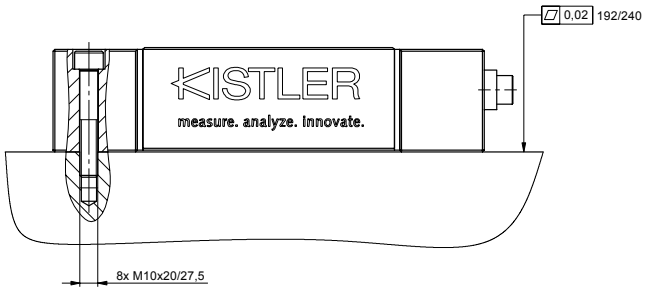

Fig. 2: Mounting of dynamometer Type 9139AA

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Processing the measurement signals
Charge amplifier channels are also needed to build a complete measuring system (e.g. Type 5080A...). These convert the measurement signal into an electrical voltage. The measured value is exactly proportional to the force acting.

Data acquisition and analysis
Kistler offers with the Type 5697A1 DAQ system an universal and easy to operate package, consisting of a hardware for the data acquisition and the DynoWare software. For details see data sheet 5697A_000-745.

3-component force measurement F_x, F_y, F_z

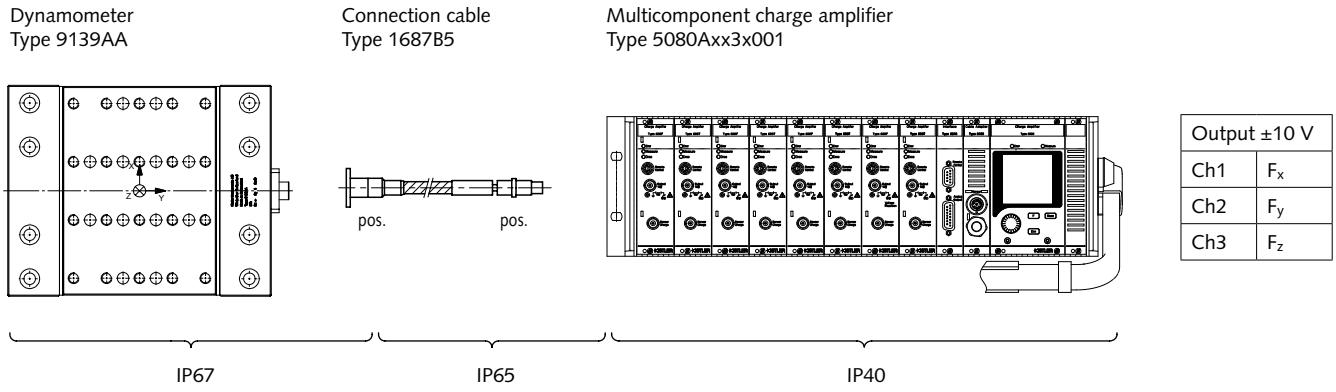

Fig. 3: Measuring system for 3-component measurement with multichannel charge amplifier

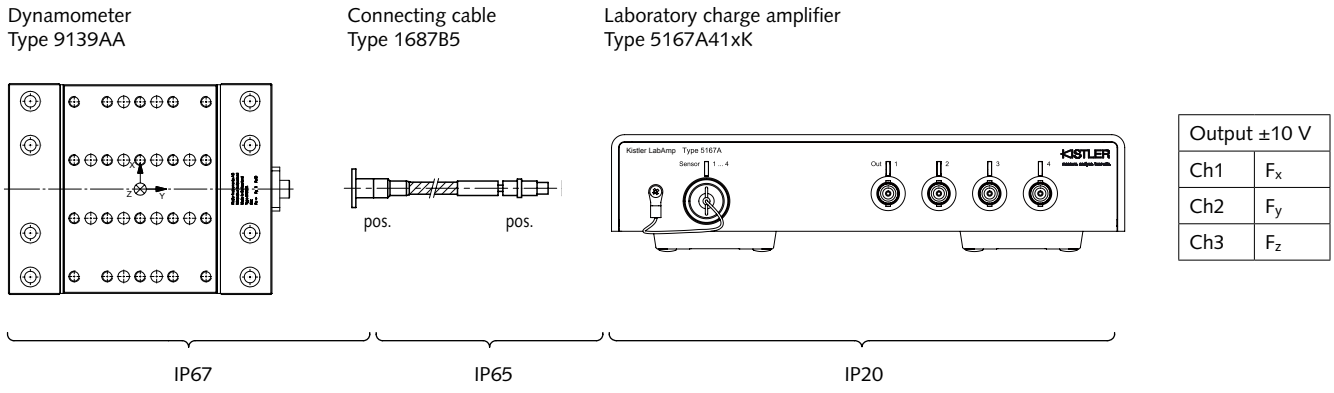

Fig. 4: Measuring system for 3-component measurement with laboratory charge amplifier

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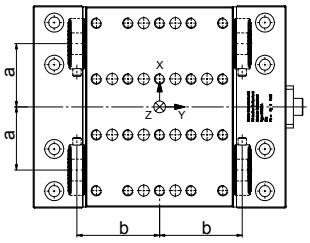
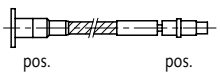
6-component measurement F_x, F_y, F_z, M_x, M_y, M_z

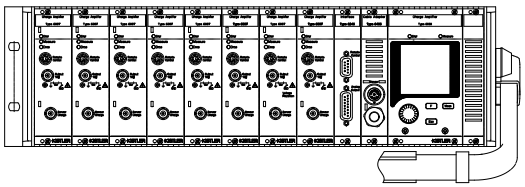
Dynamometer
Type 9139AA



Connection cable
Type 1677A5



Multichannel charge amplifier
Type 5080Axx8x004



Output ±10 V	
Ch1	F_{x1+2}
Ch2	F_{x3+4}
Ch3	F_{y1+4}
Ch4	F_{y2+3}
Ch5	F_{z1}
Ch6	F_{z2}
Ch7	F_{z3}
Ch8	F_{z4}

IP67 IP65 IP40

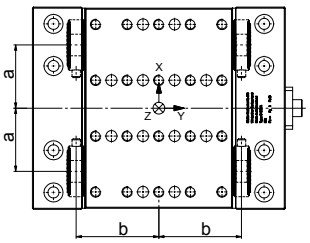
Degree of protection EN60529

Fig. 5: Measuring system for 6-component measurement with multichannel charge amplifier

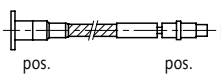
Value a,b für Type 9139AA:

a mm	b mm
60	78,5

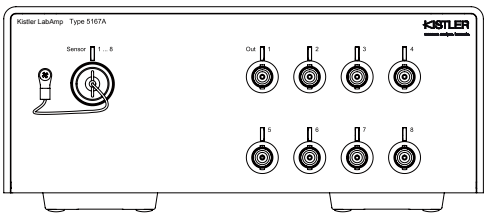
Dynamometer
Type 9139AA



Connection cable
Type 1677A5



Laboratory charge amplifier
Type 5167A81xK



Output ±10 V	
Ch1	F_{x1+2}
Ch2	F_{x3+4}
Ch3	F_{y1+4}
Ch4	F_{y2+3}
Ch5	F_{z1}
Ch6	F_{z2}
Ch7	F_{z3}
Ch8	F_{z4}

IP67 IP65 IP20

Degree of protection EN60529

Fig. 6: Measuring system for 6-component measurement with laboratory charge amplifier

Value a,b für Typ 9139AA:

a mm	b mm
60	78,5

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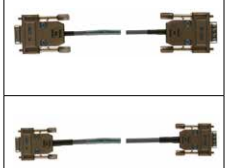
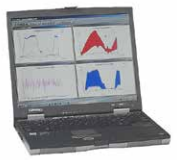
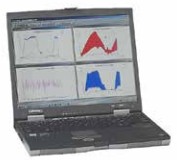
Typical measuring chain with DAQ system Type 5697A1

					
Dynamometer	Connection cable, high impedance	Charge amplifier	Connecting cable	DAQ system	Notebook (from customer side) with DynoWare
Type 9139AA	Type 16xx	Type 5080A	Type 1700A111A2	Type 5697A1	
			Type 1200A27		

Typical measuring chain with LabAmp system Type 5167A...

			
Dynamometer	Connection cable, high impedance	Charge amplifier with integrated DAQ	Notebook (from customer side) with DynoWare
Type 9139AA	Type 16xx	Type 5167A…	

Ordering code	**Type/Art. No.**
• Multicomponent dynamometer up to 30 kN, cover plate 140x190 mm	**9139AA**
Included accessories	
• Mounting screws M10x60 (8 pieces)	65012838

Optional accessories	**Type/Art. No.**
For 3-component force measurement F_x, F_y, F_z	
• Connecting cable, 3 wire, with flexible metal sheath (L = 5 m)	**1687B5**
• Connecting cable, 3 wire, steel braided, flexibel (L = 5 m)	**1687BQ02**
• Extension cable, 3 wire, high insulation (L = 5 m)	**1688B5**
• Connecting cable, 3 wire, with flexible metal sheath and angle connector (L = 5 m)	**1689B5**
For 6-component force and moment measurement F_x, F_y, F_z / M_x, M_y, M_z	
• Connecting cable, 8 wire, with flexible metal sheath (L = 5 m)	**1677A5**
• Connecting cable, 8 wire, with steel braided, flexibel (L = 5 m)	**1677AQ02**
• Extension cable, 8 wire, high insulation (L = 5 m)	**1678A5**
• Connecting cable, 8 wire, with flexible metal sheath and angle connector (L = 5 m)	**1679A5**