

# 3-Component Force Sensor

Type 9016B4, 9017B, 9018B

Diameter 16,5 mm, -2 ... 2 kN

Force sensor for measuring the three orthogonal components of a dynamic or quasistatic force acting in an arbitrary direction.

- Miniature 3-component force sensor
- High sensitivity
- High rigidity
- Minimal crosstalk
- Multipole connector

### Description

The force sensor contains three crystal rings which are mounted between two steel plates in the sensor housing. Two are sensitive to shear and measure the force components  $F_x$  and  $F_y$ , while one is sensitive to pressure and measures the component  $F_z$  of a force acting on the sensor. The electrical charges proportional to the different components are conducted via electrodes to the corresponding connectors.

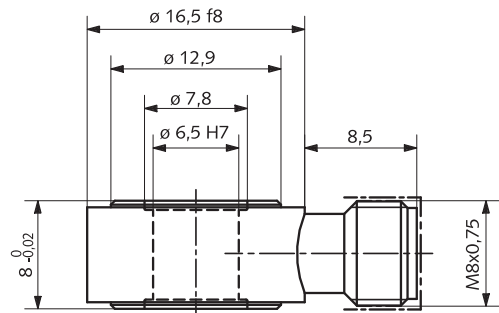
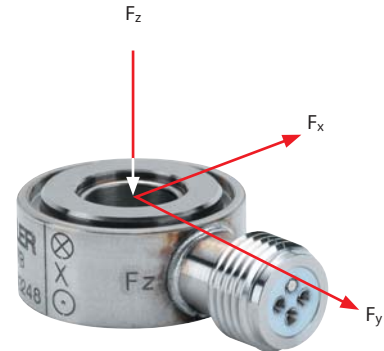
The crystal stack is protected by the corrosion resistant, tightly welded sensor case. The cable outlet serves to orient the sensor.

### Application

The crystal force sensors can measure the three orthogonal force components easily, directly and precisely, because these sensors feature an inherently low crosstalk.

### Application Examples

- Miniature cutting force dynamometer for ultra precise machining
- Windtunnel balance
- 3-Component force measurement in confined spaces



### Technical Data

Measuring range	$F_x, F_y$	kN	-1 ... 1 <sup>1)</sup>
	$F_z$	kN	-2 ... 2 <sup>1)</sup>
	$F_z$	kN	0 ... 12 <sup>2)</sup>
Overload	$F_x, F_y$	kN	-1,2/1,2 <sup>1)</sup>
	$F_z$	kN	-2,4/2,4 <sup>1)</sup>
	$F_z$	kN	12,4 <sup>2)</sup>
Calibrated measuring ranges	$F_x, F_y$	kN	0 ... 1 <sup>1)</sup>
	$F_z$	kN	0 ... 2 <sup>1)</sup>
	$F_z$	kN	0 ... 12 <sup>2)</sup>
Threshold		N	<0,01
Nominal sensitivity	$F_x, F_y$	pC/N	≈-26 <sup>1)</sup>
	$F_z$	pC/N	≈-11,5 <sup>1)</sup>
Linearity, each axis		% FSO	≤±1 <sup>1)</sup>
Hysteresis, each axis		% FSO	≤1 <sup>1)</sup>
Crosstalk	$F_z \rightarrow F_x, F_y$	%	≤±1,5 <sup>1)</sup>
	$F_x \leftrightarrow F_y$	%	≤±3,5 <sup>1)</sup>
	$F_x, F_y \rightarrow F_z$	%	≤±3,5 <sup>1)</sup>
Rigidity	$c_x, c_y$	N/μm	≈170
	$c_z$	N/μm	≈740

Max. moments	$M_x, M_y$	N·m	-5/5	<sup>1)</sup>
	$M_z$	N·m	-5/5	<sup>1)</sup>
Operating temperature range		°C	-50 ... 120	
Insulation resistance		$\Omega$	$\geq 10^{13}$	
Capacitance, each channel		pF	$\approx 39$	
Connector		M8x0,75 3-pole neg.		
Degree of protection (with cable connected)		EN60529	IP65	
Weight		g	8,5	

<sup>1)</sup> Standard mounting with preload of 10 kN

<sup>2)</sup> without preload

### Sensors Types 9017B and 9018B

The technical data of the Types 9017B and 9018B are identical, except that the orientation of their x- and y-axes with respect to the cable connection differs (Fig. 1). By combining both types, it is therefore possible to choose the direction of each sensors cable as required when building a dynamometer.

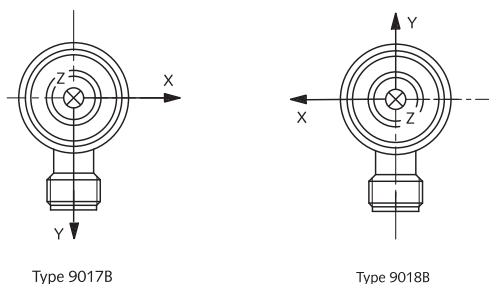


Fig. 1: Sensors Types 9017B and Type 9018B

### Type 9016B4

#### Set Consisting of Four Selected 3-Component Force Sensors

The set of four selected sensors consists of 2 each sensors Type 9017B and 9018B selected and ground to the same thickness. They are used for mounting into multicomponent dynamometers and force plates (Fig. 2).

The four force sensors are selected for uniform sensitivity and minimal crosstalk when they are mounted into a dynamometer.

This configuration permits a very compact mounting in a dynamometer.

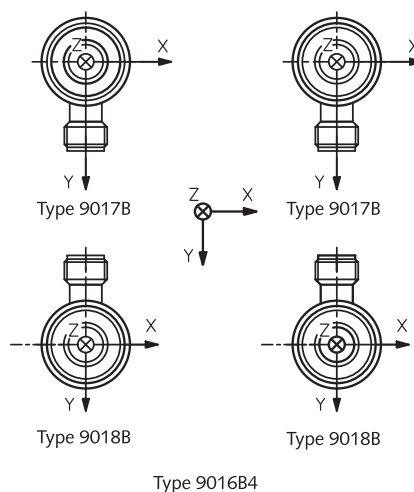


Fig. 2: Set consisting of four selected 3-component force sensors

9017B\_000-465e-07.10

### Mounting

The force sensors must be mounted under preload because the shear forces  $F_x$  and  $F_y$  require transmission through static friction from the base and cover plate to the surfaces of the force sensors. The necessary preload depends on the shear forces to be transmitted. The measuring ranges specified in the technical data apply for a standard preload of 10 kN.

The provided preloading bolt is screwed into the base plate and the thread is secured with Loctite Type 221. The centering of the sensor is done with the centering sleeve.

Prior to mounting the bearing surfaces of the base and cover plates must be cleaned with grease-dissolving solvent.

The sliding washer is mounted between the cover plate and the ring nut. It reduces the friction and consequently the tightening torque. Moreover, it protects the cover plate surface and the ring nut from corrosion. Before mounting the sliding surface should slightly be greased with Kistler grease Type 1063.

Before screwing in the preloading nut, its outer diameter and the thread of the preloading bolt should be greased.

The tightening of the nut is done with the wrench adapter Type 9479. If the Z-component of the sensor is connected to the charge amplifier, then the preload can directly be measured.

The wrench adapter Type 9479 is not included in the delivery; it must be ordered separately.

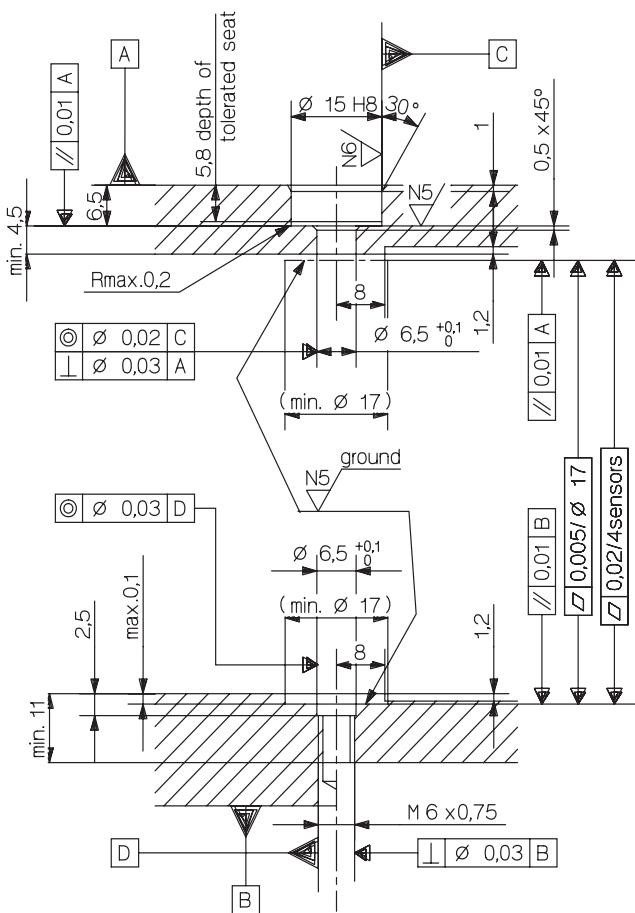
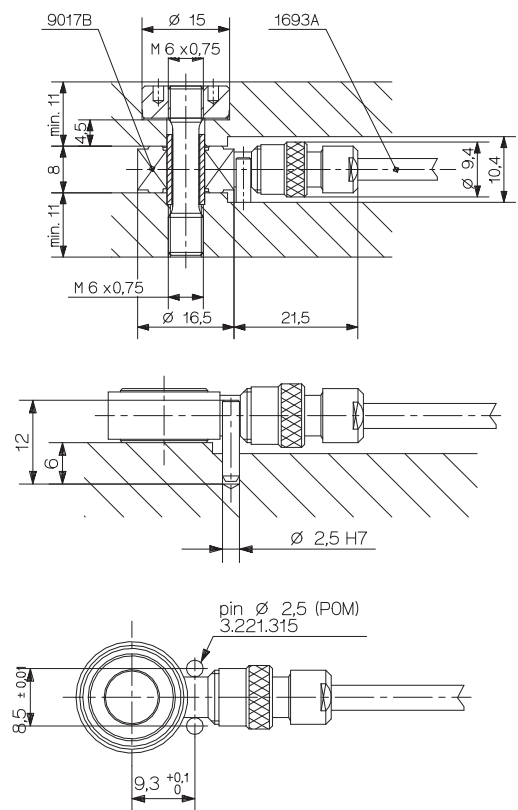


Fig. 3: Mounting of sensors



9017B\_000-465e-07.10

**Parallel Connections**

Several sensors of identical sensitivities can be paralleled directly. The charge amplifier connected then gives an output voltage which corresponds to the sum of all forces acting.

This is a great advantage when building force plates and dynamometers with which only the three components of the resulting force must be measured.

**Electronics**

Besides the force sensors, a 3-component force measuring system also requires three charge amplifiers, which convert the electrical charge signals of the sensor into voltages exactly proportional to the three components  $F_x$ ,  $F_y$  and  $F_z$  of the acting force.

In order to construct multicomponent dynamometers for measuring three forces and three moments, special multichannel charge amplifiers are available.

**Systems for Multicomponent Measurements**

For information concerning cable concept see information sheet 1687B\_000-545.

**Accessories Included**

- Preloading screw
- Ring nut
- Sliding washer
- Centering sleeve
- Positioning pin
- Grease

**Type/Art. No.**

- 3.322.401
- 3.322.402
- 3.322.352
- 3.221.316
- 3.221.315
- 1063

**Optional Accessories**

- Wrench adapter
- Connecting cable
- Connecting cable

**Type**

- 9479
- 1693A...
- 1694A...

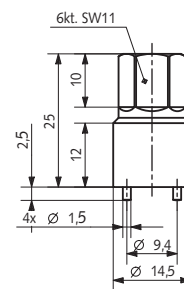


Fig. 4: Wrench adapter Type 9479

**Ordering Key**

- 3-component force sensor with standard coordinate system (see Fig. 1)
- 3-component force sensor like Type 9017B, but with coordinate system rotated 180 ° about z-axis (see Fig. 1)
- Set of four matched 3-component force sensors ground together, two of each Type 9017B and 9018B (see Fig. 2)

**Type**

- 9017B**
- 9018B**
- 9016B4**

9017B\_000-465e-07.10