

# 3-Component Quartz Force Sensor

Types 9027C, 9028C,  
9026C4

24x24x12 mm, -8 ... 8 kN

Quartz force sensors are able to measure the three perpendicular components of a dynamic or quasistatic force in any direction.

- Precise measurement regardless of the acting point of the force
- Large useable frequency range
- Compact size
- Rust free and sealed sensor case
- Plug connection via robust multipole connector

## Description

The 3-component force sensor is mounted under preload between two mounting flanges. The quartz force sensor can therefore measure compression and tensile forces.

The force measurement of the sensor is based on the piezoelectric principle. The application of a force results in the quartz washers in the sensor (one for each of the force components to be measured) yielding a charge proportional to the force. This is picked off by built-in electrodes and transferred to the corresponding connector.

The contact faces of the sensor are covered with ceramic discs to facilitate ground-isolated mounting of the sensor. The straightforward and vibration-resistant design of the sensor produces a very rigid structure. The resulting high natural frequency makes highly dynamic force measurements possible over a large frequency range.

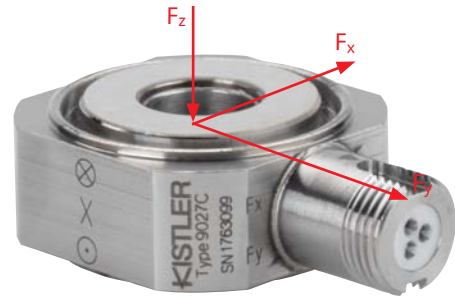
The cable connection of the sensors is made via a 3-pole connector V3 neg. (design patented). This is provided with a positioning aid for simple centering that also protects the plug and receptacle connector against unintended rotation.

After correct mounting the sensor is immediately ready for use without recalibration.

## Application

Kistler 3-component quartz force sensors measure simply, directly and precisely. They are used in the measurement of:

- Cutting forces in metal cutting processes
- Collision forces in crash tests
- Recoil forces of rocket motors
- Vibration and friction forces
- Ground reaction forces in biomechanics
- Vehicle forces on the road and test bed
- Forces on wind tunnel balances



## Technical Data Types 9027C, 9028C

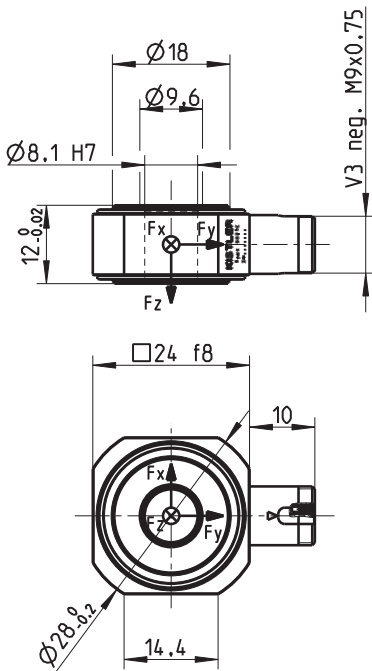
Range	$F_x, F_y$	kN	-4 ... 4	<sup>1)</sup>
	$F_z$	kN	-8 ... 8	<sup>1)</sup>
	$F_z$	kN	0 ... 28	<sup>2)</sup>
Overload	$F_x, F_y$	kN	-5/5	<sup>1)</sup>
	$F_z$	kN	-10/10	<sup>1)</sup>
Calibrated range	$F_x$	kN	0 ... 4	<sup>1)</sup>
	$F_y$	kN	0 ... 4	<sup>1)</sup>
	$F_z$	kN	0 ... 8	<sup>1)</sup>
	$F_z$	kN	0 ... 28	<sup>2)</sup>
Permissible moment loading	$M_x, M_y$	N·m	-22/22	<sup>1)</sup>
	$M_z$	N·m	-23/23	<sup>1)</sup>
Threshold		N	<0,01	
Sensitivity	$F_x, F_y$	pC/N	≈-7,8	<sup>1)</sup>
	$F_z$	pC/N	≈-3,8	<sup>1)</sup>
Linearity, each axis		%FSO	≤±0,25	<sup>1)</sup>
Hysteresis, each axis		%FSO	≤0,25	<sup>1)</sup>
Crosstalk	$F_z \rightarrow F_x, F_y$	%	≤±0,5	<sup>1)</sup>
	$F_x \leftrightarrow F_y$	%	≤±2	<sup>1)</sup>
	$F_x, F_y \rightarrow F_z$	%	≤±3	<sup>1) 3)</sup>
Operating temperature range		°C	-40 ... 120	
Insulation resistance at 20 °C		Ω	>10 <sup>13</sup>	
Ground isolation		Ω	>10 <sup>8</sup>	
Capacitance, each channel		pF	30	
Connector			V3 neg.	
Weight		g	30	
Degree of Protection EN60529				
	with cable Type 1698AA/AB		IP65	
	with cable Type 1698ACsp		IP67	

<sup>1)</sup> Standard mounting with 20 kN preload

<sup>2)</sup> Without preload

<sup>3)</sup> Crosstalk  $F_x, F_y \rightarrow F_z$  is ≤±2 %, if e.g. four sensors are mounted in a dynamometer.

**Dimensions 3-Component Quartz Force Sensor Types 9027C, 9028C**



Fi. 1: Dimensions Types 9027C, 9028C

**Sensor Variants**

**Type 9027C and 9028C**

Type 9027C and 9028C sensors differ only in the position of the connector in relation to the coordinate system (see Fig. 2). The technical data of both types are identical.

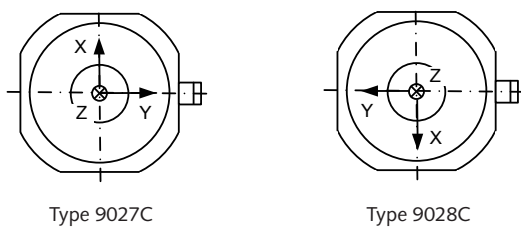


Fig. 2: 3-Component quartz force sensors Types 9027C and 9028C

**Type 9026C4**

**Set of four selected 3-component force sensors**

The Type 9026C4 set consists of two selected sensors of Types 9027C and 9048C. The force sensors are all ground to the same height and are mounted in multicomponent dynamometers and measuring platforms.

The connectors of the four sensors all point inwards (see Fig. 3). The four force sensors are selected so that when they are mounted in a dynamometer they exhibit the best possible specifications in terms of constant sensitivity and minimum crosstalk.

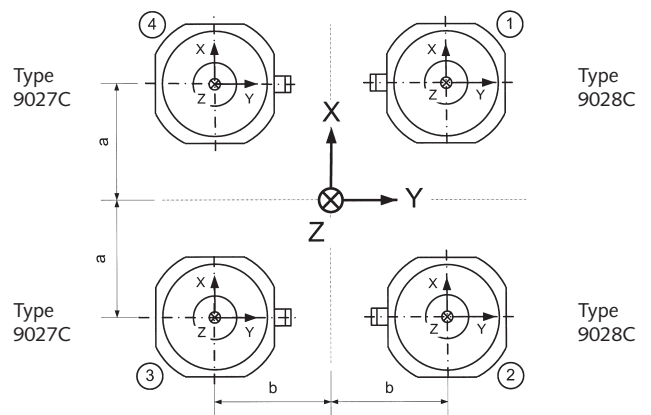


Fig. 3: Set of four selected 3-component force sensors Type 9026C4

**Mounting**

The force sensor must be mounted under preload. The shear forces  $F_x$  and  $F_y$  are transferred from the base and cover plate to the surface of the sensor through static friction.

The measurement ranges shown in the technical data apply to the standard preload.

The precise sensitivity of the preloaded sensor must be established by on-site calibration.

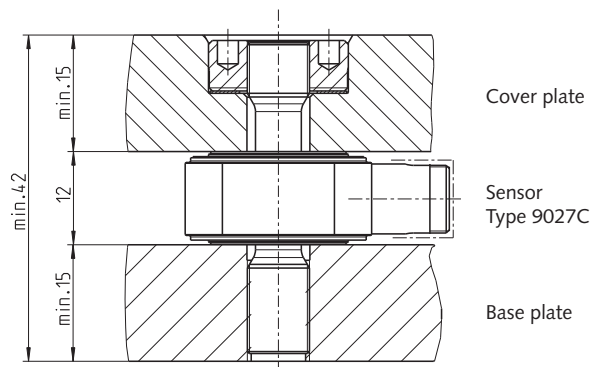
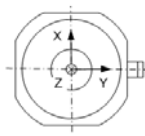
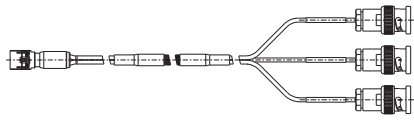
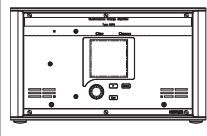
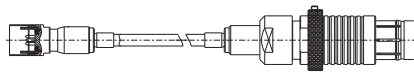
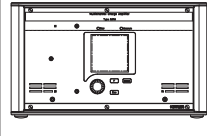
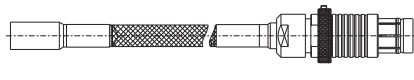


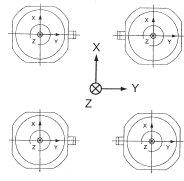

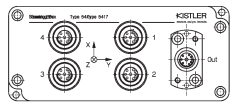

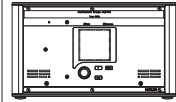


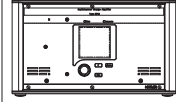
Fig. 4: Sensor mounting with standard preload

9027C\_000-726e-03.10

**Measuring System with 3-Component Quartz Force Sensor**

3-Comp. quartz force sensor with V3 neg. connector	Degree of protection EN60529	Connecting cable <sup>1)</sup>	Multichannel Charge amplifier <sup>2)</sup>	Meas. value
<b>Type 9027C, 9028C</b>   V3 neg.	IP65	<b>Type 1698AA...</b>   V3 pos. 3 x BNC pos.	<b>Type 5070Ax00xx</b>  	F <sub>x</sub> F <sub>y</sub> F <sub>z</sub>
		<b>Type 1698AB...</b>   V3 pos. Fischer 9 pole pos.	<b>Type 5070Ax01xx</b>  	
	IP67 Cable welded to sensor	<b>Type 1698ACsp</b>   V3 pos. Fischer 9 pole pos.		

**Measuring System with four 3-Component Quartz Force Sensor (Dynamometer)**

3-Comp. quartz force sensor, V3 neg. conn.	Degr. of prot. EN60529	Connecting cable <sup>1)</sup>	Summing box	Conn. cable <sup>1)</sup>	Multichannel charge amplifier <sup>2)</sup>	Meas. value
<b>Type 9026C4</b>   4 x V3 neg.	IP65	<b>Type 1698AB...</b> 4 pieces   V3 pos. Fischer 9 pole pos.	<b>Type 5417</b> IP65   148x62x35 mm	<b>Type 1687B...</b> 3-core   pos. pos.	<b>Type 5070Ax01xx</b>  	F <sub>x</sub> F <sub>y</sub> F <sub>z</sub>
		IP67 Cable welded to sensor		<b>Type 1698ACsp</b> 4 pieces   V3 pos. Fischer 9 pole pos..	4 x Fischer 9 pole neg. Fischer Flange 9 pole neg.	<b>Type 1677A...</b> 8-core   pos. pos.
					<b>Type 5070Ax21xx</b>  	F <sub>x</sub> F <sub>y</sub> F <sub>z</sub> M <sub>x</sub> M <sub>y</sub> M <sub>z</sub>

<sup>1)</sup> see Cables for multicomponent force sensors, dynamometer and measuring platforms data sheet 1687B\_000-545.  
<sup>2)</sup> see Multichannel charge amplifier for multicomponent force measurement data sheet 5070A\_000-485.

9027C\_000-726e-03.10

### Set Preloading Elements M8x1

(see data sheet 9461\_000-197)



Fig 5: Set preloading elements Type 9461

### 3-Component Quartz Force Link

(see data sheet 9327C\_000-725)

Type 9027C force sensor is also available premounted as a calibrated quartz force link.



Fig. 6: Quartz force link Type 9327C

### Paralleling

When building a dynamometer, the four quartz force links are mechanically paralleled. The measuring signals (electric charge) of the four sensors can also be paralleled (summed). The summated signal corresponds to the algebraic total of the individual forces.

Type 5417 summing box facilitates the simple and reliable interconnection of measuring signals.



Fig 7: Summing box Type 5417

### Measuring Signal Processing

For the measuring system a charge amplifier is needed. This converts the measuring signal (charge) into a voltage. The value that is output is exactly proportional to the force.

Type 5070A multichannel charge amplifier was built specifically for the multicomponent force measuring system.



Fig. 8: Multichannel charge amplifier Type 5070A...

There is also Type 5080A... charge amplifier. This provides an extended measuring range and a higher degree of accuracy, particularly when measuring low forces.



Fig. 9: Multichannel charge amplifier Type 5080A...

### Included Accessories

- None  
Set of preloading elements has to be ordered separately.

### Optional Accessories

- Set preloading elements, M8x1  
9461/  
9461sp
- Wrench adapter for Type 9461  
9475
- Connecting cable, 3-core  
1698AA...<sup>1)</sup>
- Connecting cable, 3-core  
1698AB...<sup>1)</sup>
- Connecting cable, 3-core  
1698ACsp<sup>1)</sup>
- Summing box  
5417

### Ordering Key

- **3-Component quartz force sensor**  
24x24x12 mm, -8 ... 8 kN  
**9027C**
- **3-Component quartz force sensor**  
24x24x12 mm, -8 ... 8 kN  
(Connector turned)  
**9028C**
- **Set of four chosen**  
**3-Component quartz force sensors**  
2 x Type 9027C, 2 x Type 9028C  
ground together  
**9026C4**

<sup>1)</sup> technical measurements and minimum bending radii are to be taken from data sheet 1687B\_000-545