

# 3-Component Force Sensor

40x40x14 mm, -30 ... 30 kN

Type 9047C, 9048C,  
9046C4

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

- Accurate measurement independent of the force application point
- Wide frequency range
- Compact dimensions
- Stainless, sealed sensor case
- Rugged multipole plug connection

### Description

The sensor case contains three closely packed quartz rings mounted between two steel plates. Each quartz ring is sensitive to a force component. In accordance with the piezoelectric principle, the force produces a proportional electric charge. This is conducted via an electrode to the appropriate connector.

The two contact surfaces of the sensor are covered with ceramic layers, thereby allowing ground-insulated mounting in the machine structure.

The simple and vibration-resistant design of the sensor is very rigid resulting in a high natural frequency, which is a requirement for highly dynamic force measurements.

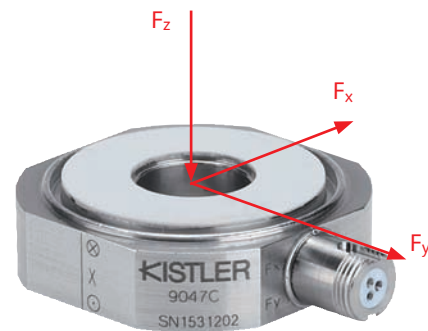
The three-pole connector V3 neg. (design protected) is provided with a positioning aid. This guarantees accurate assignment and centering of the connector pins and sockets before connection. The plug connection is protected against rotation.

Quartz 3-component force sensors allow simple, direct and very precise measurements.

### Application

3-component force sensors measure:

- Cutting forces during machining
- Impact forces in crash tests
- Recoil forces of rocket engines
- Vibration forces of components for space travel
- Friction forces
- Forces in product testing
- Ground reaction forces in biomechanics
- Vehicle forces on a road and a test stand
- Forces on a wind tunnel balance



Type 9047C

### Technical Data Type 9047C, 9048C

Range	$F_x, F_y$	kN	-15 ... 15 <sup>1)</sup>
	$F_z$	kN	-30 ... 30 <sup>1)</sup>
	$F_z$	kN	0 ... 100 <sup>2)</sup>
Overload	$F_x, F_y$	kN	-18/18 <sup>1)</sup>
	$F_z$	kN	-35/35 <sup>1)</sup>
Calibrated range	$F_x$	kN	0 ... 15 <sup>1)</sup>
	$F_y$	kN	0 ... 15 <sup>1)</sup>
	$F_z$	kN	0 ... 30 <sup>1)</sup>
	$F_z$	kN	0 ... 100 <sup>2)</sup>
Permissible moment load	$M_x, M_y$	N·m	-150/150 <sup>1)</sup>
	$M_z$	N·m	-150/150 <sup>1)</sup>
Threshold		N	<0,01
Sensitivity	$F_x, F_y$	pC/N	≈-8,1 <sup>1)</sup>
	$F_z$	pC/N	≈-3,7 <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>
Rigidity	$c_x, c_y$	N/μm	≈600
	$c_z$	N/μm	≈1 400

<sup>1)</sup> Standard mounting with preload of 70 kN

<sup>2)</sup> Without preload

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

**Other Technical Data Type 9047C, 9048C**

Operating temperature range	°C	–40 ... 120
Insulation resistance at 20 °C	Ω	>10 <sup>13</sup>
Ground insulated	Ω	>10 <sup>8</sup>
Capacitance, each channel	pF	70
Connecting plug		V3 neg.
Weight	g	91
Degree of protection according to EN60519		
with cable Type 1698AA/AB		IP65
with cable Type 1698ACsp		IP67

**Dimensions 3-Component Force Sensor Type 9047C, 9048C**

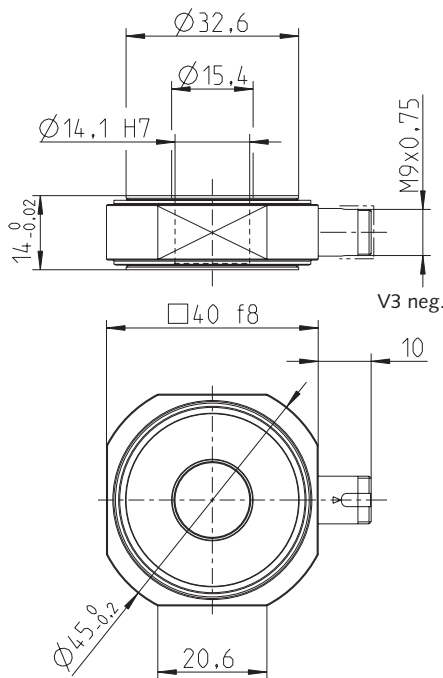


Fig. 1: Dimensions Type 9047C, 9048C

**Sensor Versions**

**Type 9047C and 9048C**

The sensor Type 9047C and 9048C 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.

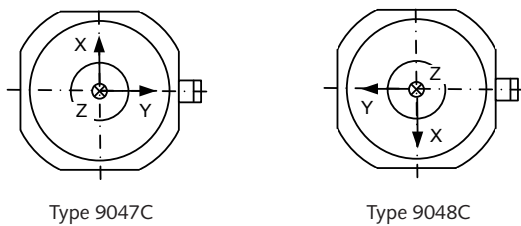


Fig. 2: 3-Component force sensor Type 9047C and 9048C

**Type 9046C4**

**Set of Four Matched 3-Component Force Sensors**

The set Type 9046C4 consists of four selected sensors two of each Type 9047C and 9048C. Jointly ground to the same height, they are used for installation in multi-component dynamometers and multi-component force plates.

The connectors of the four sensors are all directed inwards (see Fig. 3).

The four force sensors are selected so that they demonstrate optimum specifications with regard to constant sensitivity and minimal crosstalk when they are mounted in a dynamometer.

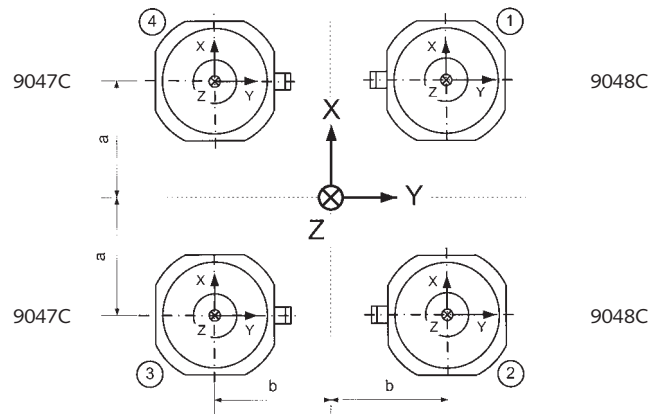


Fig. 3: Set of four matched 3-component force sensors Type 9046C4

**Mounting**

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

The measuring ranges indicated in the technical data are valid for the standard preload.

The exact sensitivity of the preloaded sensors must be confirmed by an on-site calibration.

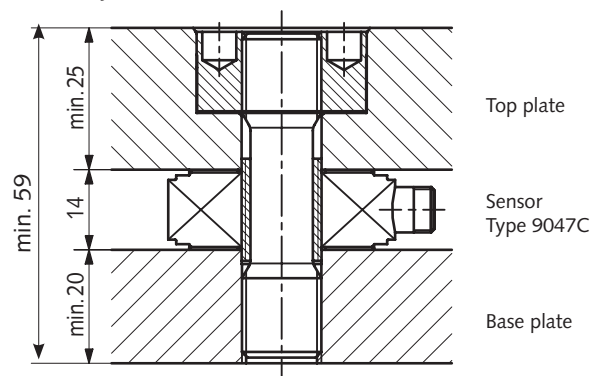


Fig. 4: Sensor mounting with standard preload

9047C\_000-592e-04.07



**Set of Preloading Elements M14x1,5**  
(see data sheet 9465\_000-198)



Fig. 5: Set of preloading elements Type 9465

**3-Component Force Link**

(see data sheet 9347C\_000-604)

The force sensor Type 9047C is also available ready mounted in the form of a calibrated quartz force link.



Fig. 6: Force Link Type 9347C

**Parallel Connection**

When a dynamometer is constructed, the four sensors of Type 9046C4 are connected mechanically in parallel. The measuring signals (electric charge) of the four sensors can also be connected in parallel (summed). The summed signal corresponds to the algebraic sum of the individual forces. The summing box Type 5417 allows simple and reliable connection of the measuring signals for the desired type of multi-component force measurement.



Fig. 7: Summing box Type 5417

**Measuring Signal Processing**

Charge amplifier channels are additionally required for the complete measuring system. These convert the measuring signal into a voltage. The reading is exactly proportional to the force applied.

The multi-channel charge amplifier Type 5070A... has been designed specifically for multi-component force measuring systems.



Fig. 8: Multi-channel charge amplifier Type 5070A...

**Included Accessories**

- None
- The set of preload elements must be ordered separately.

**Optional Accessories**

- |                                       |           |
|---------------------------------------|-----------|
| • Set of preloading elements, M14x1,5 | 9465      |
| • Key for Type 9465                   | 9472      |
| • Connecting cable, 3 wire            | 1698AA... |
| • Connecting cable, 3 wire            | 1698AB... |
| • Connecting cable, 3 wire            | 1698ACsp  |
| • Summing box                         | 5417      |

**Ordering Key**

- |   |               |
|---|---------------|
| • <b>3-Component Force Sensor</b><br>40x40x14 mm, –30 ... 30 kN   | <b>9047C</b>  |
| • <b>3-Component Force Sensor</b><br>40x40x14 mm, –30 ... 30 kN<br>(Connector rotated)                      | <b>9048C</b>  |
| • <b>Set of Four Matched 3-Component Force Sensors</b><br>2 x Type 9047C, 2 x Type 9048C<br>ground together | <b>9046C4</b> |

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