

3-Component Force Sensor

100x100x26 mm, -150 ... 150 kN

Type 9077C, 9078C,
9076C4

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 9077C

Technical Data Type 9077C, 9078C

Range	F_x, F_y	kN	-75 ... 75 ¹⁾
	F_z	kN	-150 ... 150 ¹⁾
	F_z	kN	0 ... 500 ²⁾
Overload	F_x, F_y	kN	-90/90 ¹⁾
	F_z	kN	-180/180 ¹⁾
Calibrated range	F_x	kN	0 ... 75 ¹⁾
	F_y	kN	0 ... 75 ¹⁾
	F_z	kN	0 ... 150 ¹⁾
	F_z	kN	0 ... 500 ²⁾
Permissible moment load	M_x, M_y	N·m	-2 040/2 040 ¹⁾
	M_z	N·m	-2 040/2 040 ¹⁾
Threshold		N	<0,01
Sensitivity	F_x, F_y	pC/N	≈-4,2 ¹⁾
	F_z	pC/N	≈-2,0 ¹⁾
Linearity, each axis		%FSO	≤±0,25 ¹⁾
Hysteresis, each axis		%FSO	≤0,25 ¹⁾
Crosstalk	$F_z \rightarrow F_x, F_y$	%	≤±0,5 ¹⁾
	$F_x \leftrightarrow F_y$	%	≤±1 ¹⁾
	$F_x, F_y \rightarrow F_z$	%	≤±1 ¹⁾
Rigidity	c_x, c_y	N/μm	≈1 800
	c_z	N/μm	≈8 000

¹⁾ Standard mounting with preload of 350 kN

²⁾ Without preload

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Other Technical Data Type 9077C, 9078C

Operating temperature range	°C	-40 ... 120
Insulation resistance at 20 °C	Ω	>10 ¹³
Ground insulated	Ω	>10 ⁸
Capacitance, each channel	pF	1 000
Connecting plug		V3 neg.
Weight	g	1 040
Degree of protection according to EN60529		
with cable Type 1698AA/AB		IP65
with cable Type 1698ACsp		IP67

Dimensions 3-Component Force Sensor Type 9077C, 9078C

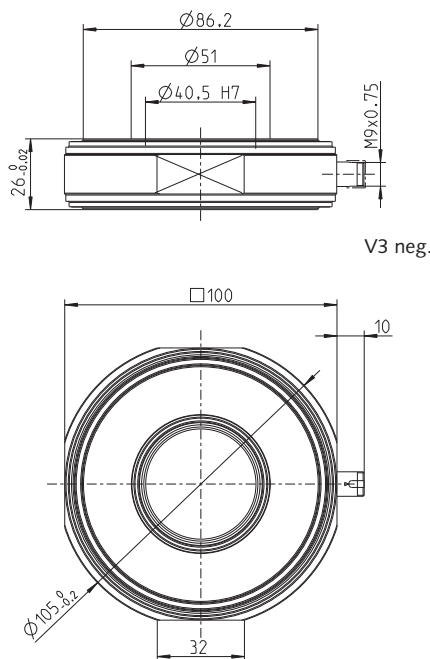


Fig. 1: Dimensions Type 9077C, 9078C

Sensor Versions

Type 9077C and 9078C

The sensor Type 9077C and 9078C 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.

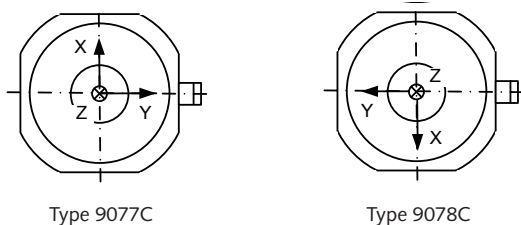


Fig. 2: 3-Component force sensor Type 9077C and 9078C

Type 9076C4

Set of Four Matched 3-Component Force Sensors

The set Type 9076C4 consists of four selected sensors, two of each Type 9077C and 9078C. 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.

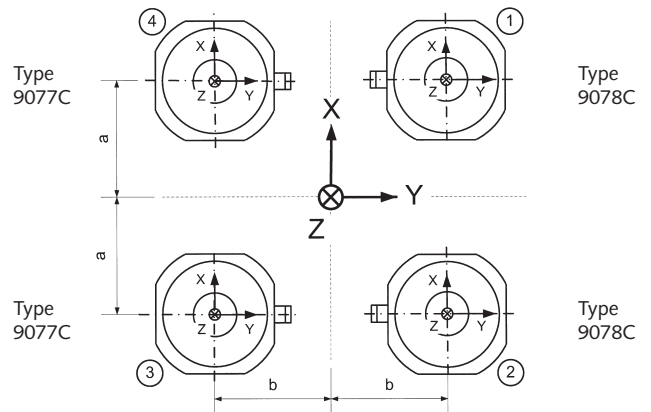


Fig. 3: Set of four matched 3-component force sensors Type 9076C4

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.

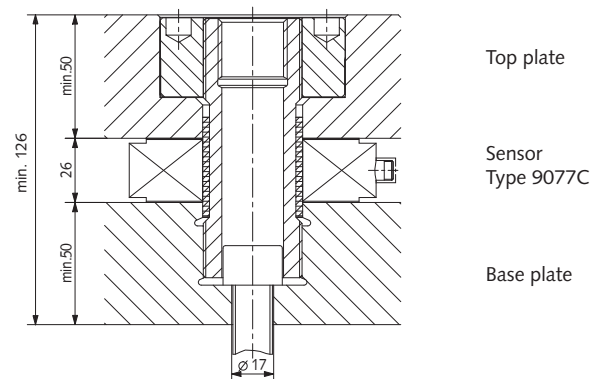


Fig. 4: Sensor mounting with standard preload

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Measuring System with 3-Component Force Sensor

3-Comp. Force Sensor with V3 neg. Connector	Degree of Protection EN60529	Connecting Cable ¹⁾	Multichannel Charge Amplifier ²⁾	Reading
<p>Type 9077C, 9078C</p> <p>V3 neg.</p>	IP65	<p>Type 1698AA...</p> <p>V3 pos. 3 x BNC pos.</p>	<p>Type 5070Ax00xx</p>	<p>F_x F_y F_z</p>
		<p>Type 1698AB...</p> <p>V3 pos. Fischer 9-pole pos.</p>	<p>Type 5070Ax01xx</p>	
	IP67 cable welded to sensor	<p>Type 1698ACsp</p> <p>V3 pos. Fischer 9-pole pos.</p>		

Measuring System with Four 3-Component Force Sensors (Dynamometer)

3-Comp. Force Sensor with V3 neg. Connector	Degree of Protection EN60529	Connecting Cable ¹⁾	Summing Box	Connecting Cable ¹⁾	Multichannel Charge Amplifier ²⁾	Reading
<p>Type 9076C4</p> <p>4 x V3 neg.</p>	IP65	<p>Type 1698AB...</p> <p>4 pcs.</p> <p>V3 pos. Fischer 9-pole pos.</p>	<p>Type 5417</p> <p>IP65</p>	<p>Type 1687B...</p> <p>3 wire</p> <p>pos. pos.</p>	<p>Type 5070Ax01xx</p>	<p>F_x F_y F_z</p>
		IP67 cable welded to sensor	<p>Type 1698ACsp</p> <p>4 pcs.</p> <p>V3 pos. Fischer 9-pole pos.</p>	<p>148x62x35 mm</p> <p>4 x Fischer Fischer Flange 9-pole neg. 9-pole neg.</p>	<p>Type 1677A...</p> <p>8 wire</p> <p>pos. pos.</p>	<p>Type 5070Ax11xx</p>
					<p>Type 5070Ax21xx</p>	<p>F_x F_y F_z M_x M_y M_z</p>

¹⁾ see data sheet cables for multi-component force sensors, dynamometers and force plates 1687B_000-545.

²⁾ see data sheet multichannel charge amplifier for multi-component force measurement 5070A_000-485.

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Set of Preloading Elements M40x2

(see data sheet 9455_000-195)



Fig. 5: Set of preloading elements Type 9455

3-Component Force Link

(see data sheet 9377C_000-612)

The force sensor Type 9077C is also available ready mounted in the form of a calibrated quartz force link.



Fig. 6: Force Link Type 9377C

Parallel Connection

When a dynamometer is constructed, the four sensors of Type 9076C4 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: Multichannel charge amplifier Type 5070A...

Accessories Included

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

Optional Accessories

- | | |
|-------------------------------------|-------------------------|
| • Set of preloading elements, M40x2 | 9455 |
| • Key for Type 9455 | 9473 |
| • Connecting cable, 3 wire | 1698AA... ¹⁾ |
| • Connecting cable, 3 wire | 1698AB... ¹⁾ |
| • Connecting cable, 3 wire | 1698ACsp ¹⁾ |
| • Summing box | 5417 |

Ordering Key

- | | |
|---|---------------|
| • 3-Component Force Sensor
100x100x26 mm, -150 ... 150 kN | 9077C |
| • 3-Component Force Sensor
100x100x26 mm, -150 ... 150 kN
(Connector rotated) | 9078C |
| • Set of Four Matched 3-Component Force Sensors
2 x Type 9077C, 2 x Type 9078C
ground together | 9076C4 |

¹⁾ Technical data and minimum bending radiuses are to be found in data sheet 1687B_999-545.

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