

3-Component Force Link

Type 9377C

120x120x125 mm, -150 ... 150 kN

Quartz force link 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
- Easy installation
- Stainless, sealed sensor case
- Rugged multipole plug connection

Description

The 3-component force sensor is mounted under preload between two plates and measures both tensile and compression forces in all directions.

Based on the piezoelectric principle, a force produces a proportional electric charge. This is conducted via an electrode to the appropriate connector.

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

The 3-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.

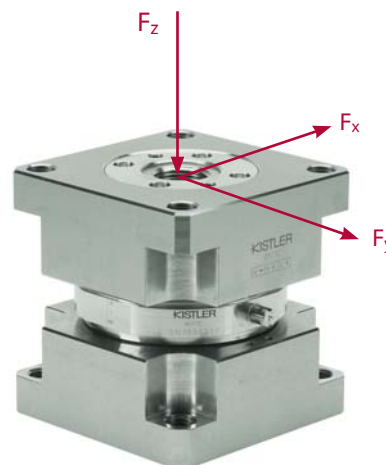
After correct installation, the sensor is ready for use without recalibration.

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

Application

3-component force links 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



Technical Data

Range (Without moment loading, e.g. when four force links are mounted in a force plate)	F_x, F_y	kN	-75 ... 75
Range (Example with force application point on the surface of the cover plate)	F_x, F_y	kN	-30 ... 30
Range (Force application point centric)	F_z	kN	-150 ... 150
Overload	F_x, F_y, F_z	%	10
Calibrated range (Force application point 10 mm below the surface of the cover plate)	F_x, F_y	kN	0 ... 30 0 ... 3
Calibrated range (Force application point centric)	F_z	kN	0 ... 150 0 ... 15
Permissible moment load ($M_z = 0; F_z = 0$)	M_x, M_y	N·m	-2 040/2 040
Permissible moment load ($M_{x,y} = 0, F_z = 0$)	M_z	N·m	-2 040/2 040
Threshold		N	≤0,01
Sensitivity	F_x, F_y	pC/N	≈-3,9
	F_z	pC/N	≈-1,95

Other Technical Data

Linearity, each axis		%FSO	$\leq \pm 0,5$ (0,25) ¹⁾
Hysteresis, each axis		%FSO	$\leq 0,5$ (0,25) ¹⁾
Crosstalk	$F_z \rightarrow F_x, F_y$	%	$\leq \pm 1$ (0,5) ¹⁾
(Crosstalk $F_x, F_y \rightarrow F_z$ is $\leq \pm 2$ % when, for example, four force links are mounted in a dynamometer)	$F_x \leftrightarrow F_y$	%	$\leq \pm 2$ (1,0) ¹⁾
	$F_x, F_y \rightarrow F_z$	%	$\leq \pm 3$ (1,5) ¹⁾
Rigidity	C_x, C_y	N/ μ m	$\approx 1\ 600$
	C_z	N/ μ m	$\approx 7\ 000$
Natural frequency	$f_n(x)$	kHz	$\approx 2,0$
	$f_n(y)$	kHz	$\approx 2,0$
	$f_n(z)$	kHz	$\approx 6,0$
Operating temperature range		°C	-40 ... 120
Insulation resistance at 20 °C		Ω	$> 10^{13}$
Ground isolated		Ω	$> 10^8$
Capacitance, each channel		pF	1 000
Connecting plug			V3 neg.
Weight		kg	10,5
Degree of protection			
with cable Type 1698AA/AB			IP65
with cable Type 1698Acsp			IP67

1) Typical values in brackets

Mounting

The two contact surfaces of the component which transfer the forces onto the force link must be flat, rigid and clean. When four force links are used to construct a dynamometer, they must be machined to the same level. The base and cover plates of the dynamometer must be selected for sufficient rigidity. The force links will be secured from the outside using four M16 screws in each case.



Fig. 1: Cutting force dynamometer constructed with four 3-component force links

Dimensions 3-Component Force Link Type 9377C

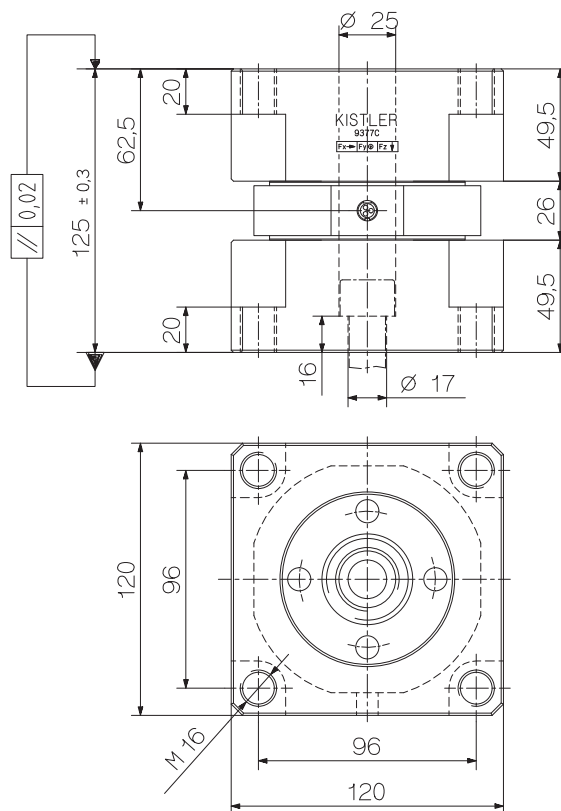
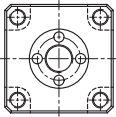
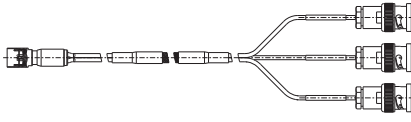
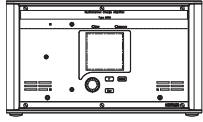
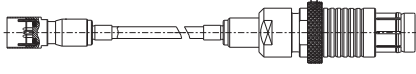
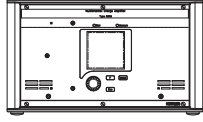
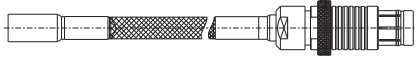


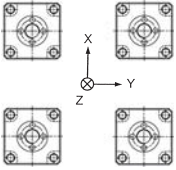
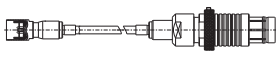
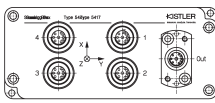
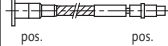
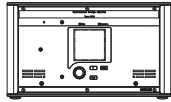

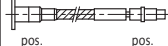
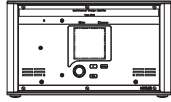
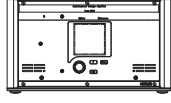
Fig. 2: Dimensions of 3-component force link Type 9377C

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Measuring System with 3-Component Force Link

3-Comp. Force Link with V3 neg. Connector	Degree of Protection EN60529	Connecting Cable ¹⁾	Multichannel Charge Amplifier ²⁾	Reading
<p>Type 9377C</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-pin pos.</p>	<p>Type 5070Ax01xx</p> 	
	IP67 cable welded to sensor	<p>Type 1698ACsp</p>  <p>V3 pos. Fischer 9-pin pos.</p>		

Measuring System with four 3-Component Force Links (Dynamometer)

3-Comp. Force Link with V3 neg. Connector	Degree of Protection EN60529	Connecting Cable ¹⁾	Summing Box	Connecting Cable ¹⁾	Multichannel Charge Amplifier ²⁾	Reading
<p>Type 9377C</p> <p>4 pcs.</p>  <p>4 x V3 neg.</p>	IP67 cable welded to sensor	<p>Type 1698AB...</p> <p>4 pcs.</p>  <p>V3 pos. Fischer 9-pin pos.</p>	<p>Type 5417</p> <p>IP65</p>  <p>148x62x35 mm</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>
		<p>Type 1698ACsp</p> <p>4 pcs.</p>  <p>V3 pos. Fischer 9-pin pos.</p>	<p>4 x Fischer 9-pin neg. Fischer Flange 9-pin neg.</p>  <p>pos. pos.</p>	<p>Type 1677A...</p> <p>8 wire</p>	<p>Type 5070Ax11xx</p> 	<p>F_{x12} F_{x34} F_{y14} F_{y23} F_{z1} F_{z2} F_{z3} F_{z4}</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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Introduction of Force

When only one force link is used, then if at all possible the resulting force vector should run through the center of the sensor. An eccentric introduction of force produces a moment load on the sensor. This is allowed only up to the specified values. The maximum force ranges must be reduced accordingly.

A sufficiently rigid constructed dynamometer with four force links largely prevents moment loads on the sensor element.

Parallel Connection

When a dynamometer is constructed, the four force links 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. Summing box Type 5417 allows simple and reliable connection of the measuring signals for the desired type of multi-component force measurement.



Fig. 3: 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.

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



Fig. 4: Multichannel charge amplifier Type 5070A...

Accessories Included

- None

Optional Accessories

- Connecting cable, 3 wire
- Connecting cable, 3 wire
- Connecting cable, 3 wire
- Summing box

Type

- 1698AA...¹⁾
- 1698AB...¹⁾
- 1698ACsp¹⁾
- 5417

Ordering Key

- **3-Component Force Link**
120x120x125 mm, -150 ... 150 kN

Type

9377C

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

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