

# 3-Component Force Link

120x120x125 mm, -150 ... 150 kN

Type 9377C

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.

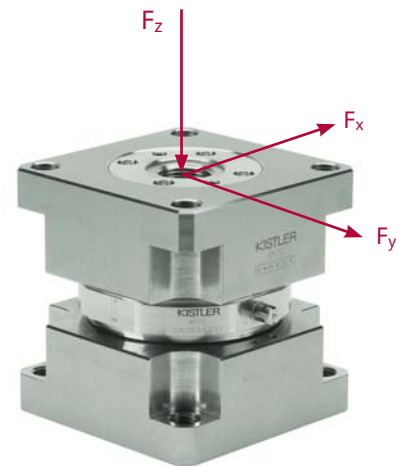
After correct installation, the sensor is ready for use without recalibration.

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

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**Other Technical Data**

Linearity, each axis		%FSO	$\leq \pm 0,5$ (0,25) <sup>1)</sup>
Hysteresis, each axis		%FSO	$\leq 0,5$ (0,25) <sup>1)</sup>
Crosstalk	$F_z \rightarrow F_x, F_y$	%	$\leq \pm 1$ (0,5) <sup>1)</sup>
(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) <sup>1)</sup>
	$F_x, F_y \rightarrow F_z$	%	$\leq \pm 3$ (1,5) <sup>1)</sup>
Rigidity	$C_x, C_y$	N/ $\mu$ m	$\approx 1\ 600$
	$C_z$	N/ $\mu$ 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		$\Omega$	$> 10^{13}$
Ground isolated		$\Omega$	$> 10^8$
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**

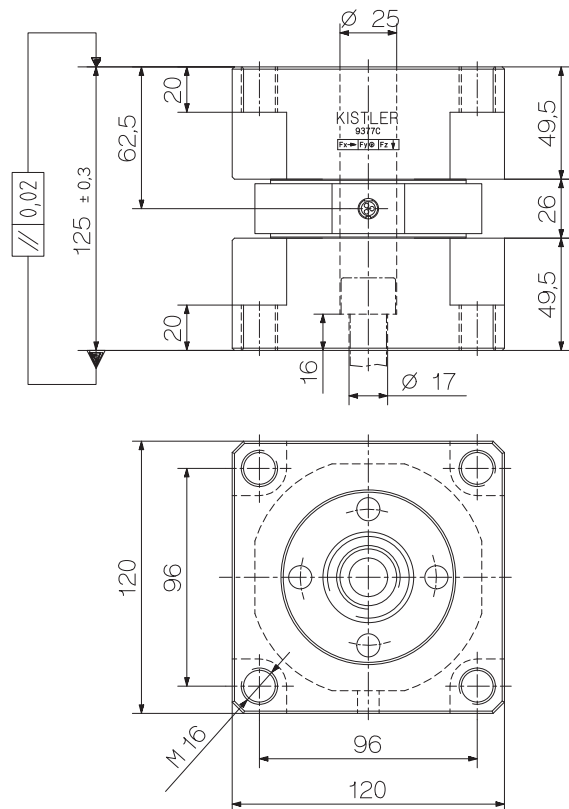
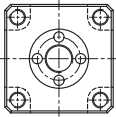
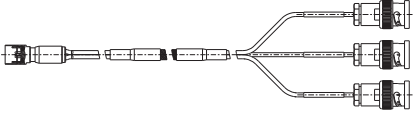
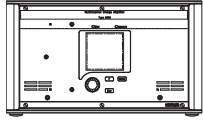
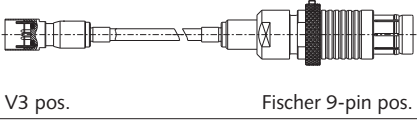
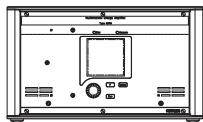
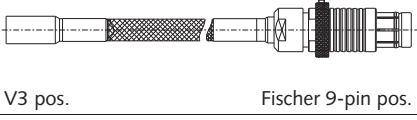


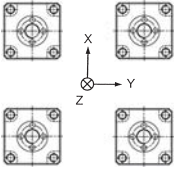
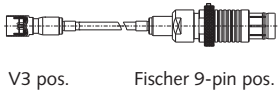
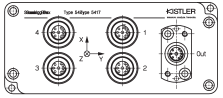

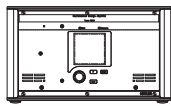


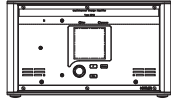
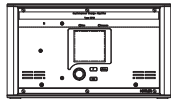
Fig. 2: Dimensions of 3-component force link Type 9377C

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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 <sup>1)</sup>	Multichannel Charge Amplifier <sup>2)</sup>	Reading
Type 9377C   V3 neg.	IP65	Type 1698AA...   V3 pos.                      3 x BNC pos.	Type 5070Ax00xx  	$F_x$ $F_y$ $F_z$
		Type 1698AB...   V3 pos.                      Fischer 9-pin pos.	Type 5070Ax01xx  	
	IP67 cable welded to sensor	Type 1698ACsp   V3 pos.                      Fischer 9-pin pos.		

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

3-Comp. Force Link with V3 neg. Connector	Degree of Protection EN60529	Connecting Cable <sup>1)</sup>	Summing Box	Connecting Cable <sup>1)</sup>	Multichannel Charge Amplifier <sup>2)</sup>	Reading
Type 9377C  4 pcs.   4 x V3 neg.	IP65	Type 1698AB...  4 pcs.   V3 pos.                      Fischer 9-pin pos.	Type 5417  IP65   148x62x35 mm	Type 1687B...  3 wire   pos.                      pos.	Type 5070Ax01xx  	$F_x$ $F_y$ $F_z$
		IP67 cable welded to sensor	Type 1698ACsp  4 pcs.   V3 pos.                      Fischer 9-pin pos.	4 x Fischer 9-pin neg.     Fischer Flange 9-pin neg.	Type 1677A...  8 wire   pos.                      pos.	Type 5070Ax11xx  
					Type 5070Ax21xx  	$F_x$ $F_y$ $F_z$ $M_x$ $M_y$ $M_z$

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<sup>1)</sup> see data sheet cables for multi-component force sensors, dynamometers and force plates 1687B\_000-545.

<sup>2)</sup> see data sheet multichannel charge amplifier for multi-component force measurement 5070A\_000-485.

### 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...<sup>1)</sup>  
1698AB...<sup>1)</sup>  
1698ACsp<sup>1)</sup>  
5417

### Ordering Key

- **3-Component Force Link**  
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<sup>1)</sup> Technical data and minimum bending radiuses are to be found in data sheet 1687B\_999-545.