

## Triaxial load cell

Measuring range in  $F_z$   $\pm 3$  kN up to -200 ... 450 kN

Types 9317C, 9327C, 9347C,  
9367C, 9377C, 9397C

These triaxial piezoelectric force transducer are piezoelectric load cells for the exact measurement of all forces on the three orthogonal components acting in an arbitrary direction. Independent of the point of force application, the piezo force transducers with the installed triaxial force sensors of the 90x7 family measure all 3 components of the applied force in highest resolution.

The 3 axis load cell out of the 93x7 product family is optimally preloaded, calibrated and immediately ready to measure.

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

### Description

The 3 axis load cell 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.

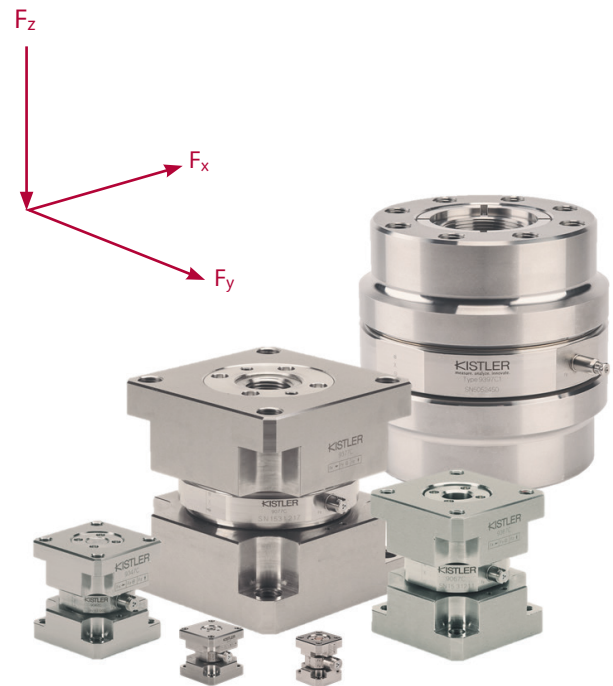
The 3-pole connector V3 neg. (design protected) is provided with a positioning aid. This guarantees accurate assignment and centering of the connector pins and sockets before connection. The plug connection is protected against rotation. After correct installation, the sensor is ready for use without recalibration.

Quartz triaxial force transducer allow simple, direct and very precise measurements.

### Application

3 axis load cells 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

Type			9317C	9327C	9347C	9367C	9377C	9397C
Range (Without moment loading, e.g. when four force links are mounted in a force plate)	Fx, Fy	kN	-1.5 ... 1.5	-4 ... 4	-15 ... 15	-30 ... 30	-75 ... 75	-100 ... 100
Range (Example with force application point on the surface of the cover plate)	Fx, Fy	kN	-0.2 ... 0.2	-1 ... 1	-5 ... 5	-10 ... 10	-30 ... 30	-60 ... 60
Range (Force application point centric)	Fz	kN	-3 ... 3	-8 ... 8	-30 ... 30	-60 ... 60	-150 ... 150	-200 ... 450
Overload	Fx, Fy, Fz	%	≤10	≤20	≤10	≤10	≤10	≤10
Calibrated range (Force application point 10 mm below the surface of the cover plate)	Fx, Fy	kN	0 ... 0.5 0 ... 0.05	0 ... 1 0 ... 0.1	0 ... 5 0 ... 0.5	0 ... 10 0 ... 1	0 ... 30 0 ... 3	0 ... 45 0 ... 4.5
Calibrated range (Force application point centric)	Fz	kN	0 ... 3 0 ... 0.3	0 ... 8 0 ... 0.8	0 ... 30 0 ... 3	0 ... 60 0 ... 6	0 ... 150 0 ... 15	0 ... 300 0 ... 30
Permissible moment load (Mz = 0; Fz = 0)	Mx, My	N·m	-8/8	-22/22	-150/150	-500/500	-2 040/ 2 040	-4 500/4 500
Permissible moment load (Mx,y = 0, Fz = 0)	Mz	N·m	-6/6	-23/23	-150/150	-500/500	-2 040/ 2 040	-11 000/ 11 000
Threshold		N	≤0.01					
Sensitivity	Fx, Fy	pC/N	≈-26	≈-7.8	≈-8	≈-7.6	≈-3.9	≈-3.7
	Fz	pC/N	≈-11	≈-3.8	≈-3.7	≈-3.9	≈-1.95	≈-1.95
Linearity, each axis		%FSO	≤±0.5					
Crosstalk (Crosstalk Fx, Fy → Fz is ≤±2% when, for example, four force links are mounted in a dynamometer)	Fz → Fx,Fy	%	≤±1	≤±1	≤±1	≤±1	≤±1	≤±1
	Fx ↔ Fy	%	≤±3	≤±3	≤±2	≤±2	≤±2	≤±2
	Fx, Fy → Fz	%	≤±4	≤±3	≤±3	≤±3	≤±3	≤±4
Stiffness	Axial	N/μm	877	1 379	2 749	3 880	8465	13 362
	Lateral <sup>(1)</sup>	N/μm	45	73	205	312	1 011	1 531
	Shear	N/μm	194	391	890	1 167	2 795	2 806
	Torsional	Nm/°	227	682	4 834	16 093	110 630	277 750
	Bending	Nm/°	222	625	4 572	14 778	106 540	332 180
Natural frequency	fn (x)	kHz	≈5	≈3.2	≈3.6	≈2.4	≈2.0	≈10.3
	fn (y)	kHz	≈5	≈3.2	≈3.6	≈2.4	≈2.0	≈10.3
	fn (z)	kHz	≈20	≈12	≈10	≈6	≈6.0	≈12.7
Operating temperature range		°C	-40 ... 120					
Insulation resistance at 20 °C		Ω	>10 <sup>13</sup>					
Ground isolated		Ω	>10 <sup>8</sup>					
Capacitance, each channel		pF	35	30	70	100	1 000	1 000
Connecting plug			V3 neg.					
Weight		kg	0.085	0.380	1.0	3.0	10.5	13.84
Degree of protection Depending on the type of used cable, Type 1698A ...			IP65 - IP68					

(1) Resistance of the sensor to shear and bending deformation. (Theoretical) assumption: The sensor is fixed at the bottom, the shear force acts at the top, so that the lever length is equal to the total sensor height.

## 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. All mounting holes of the 3-component load cells have an internal thread, which allows mounting with four dedicated screws. In addition, a central screw connection is possible, if necessary. The load cells of Type 9317C, 9327C, 9347C as well as 9367C can alternatively be fastened from the inside with four smaller screws. For information on the exact dimensioning or tightening torques, please consult the operating instructions at [www.kistler.com/force](http://www.kistler.com/force).

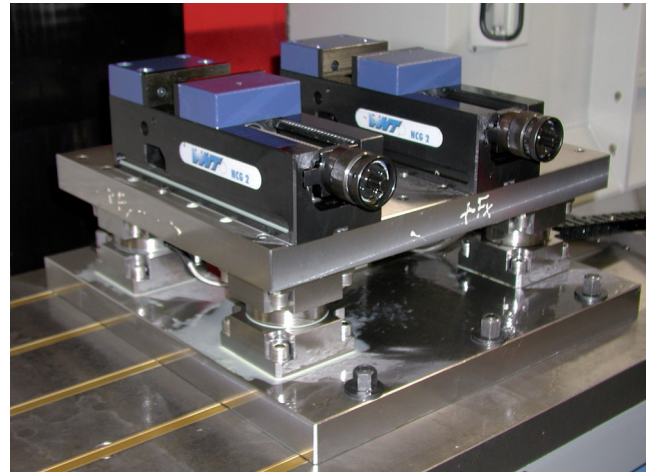


Fig. 1: Exemplary application of a 3-component force transducer, here using the Types 9347C/9348C as an example

## Dimensions 3 axis load cells

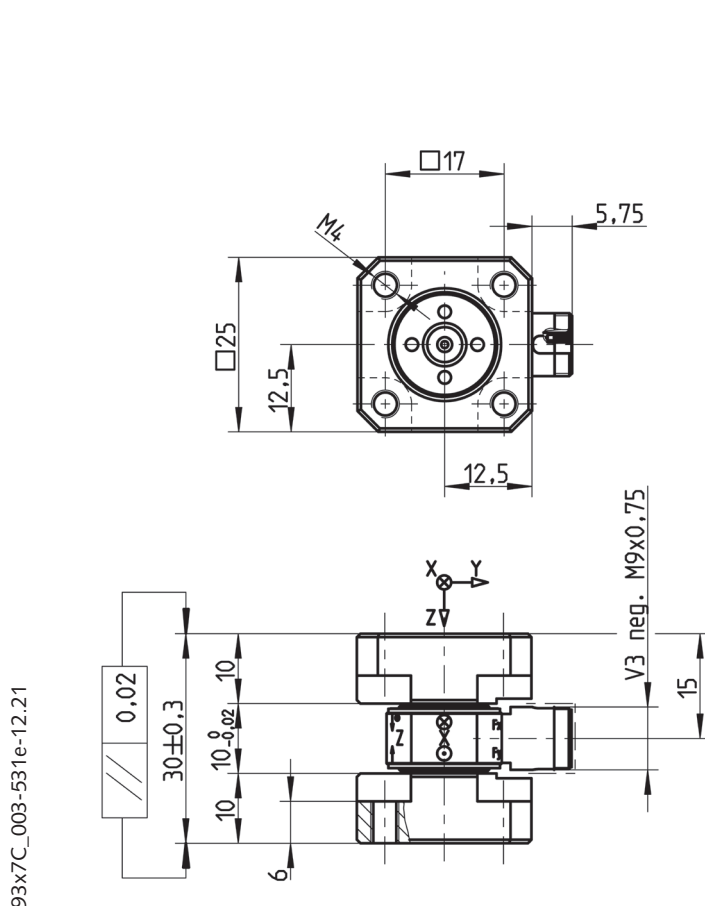


Fig. 2: Dimensions of the triaxial load cell Type 9317C

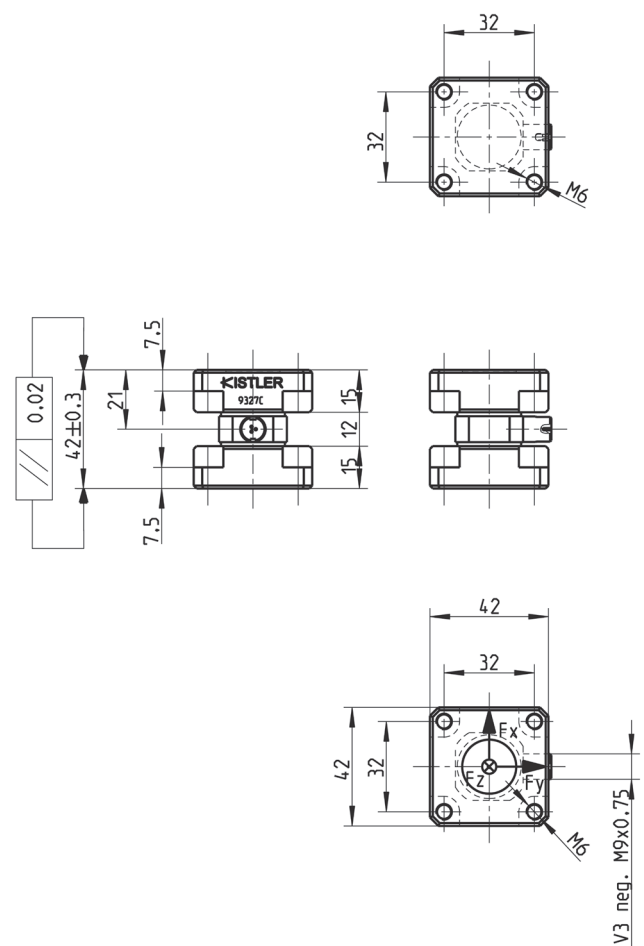


Fig. 3: Dimensions of the triaxial load cell Type 9327C

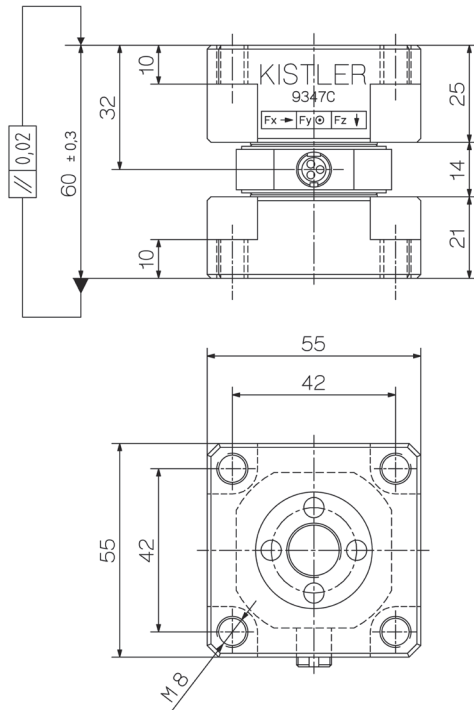


Fig. 4: Dimensions of the triaxial load cell Type 9347C

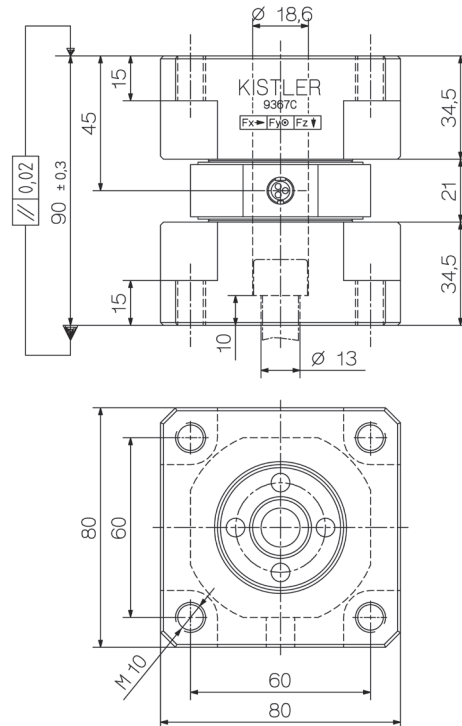


Fig. 5: Dimensions of the triaxial load cell Type 9367C

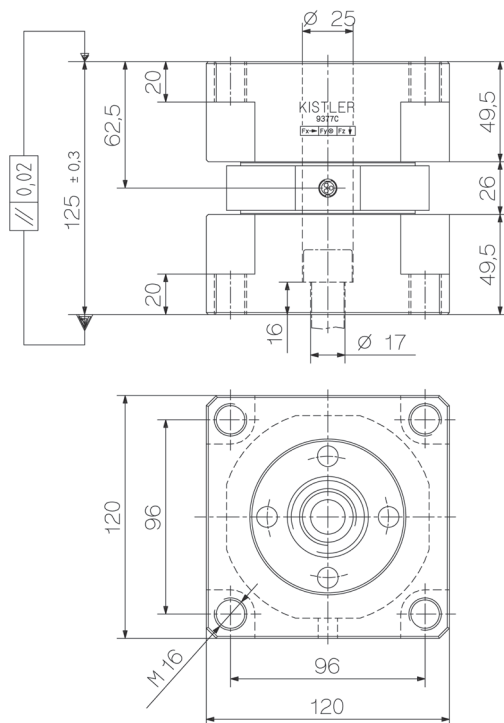


Fig. 6: Dimensions of the triaxial load cell Type 9377C

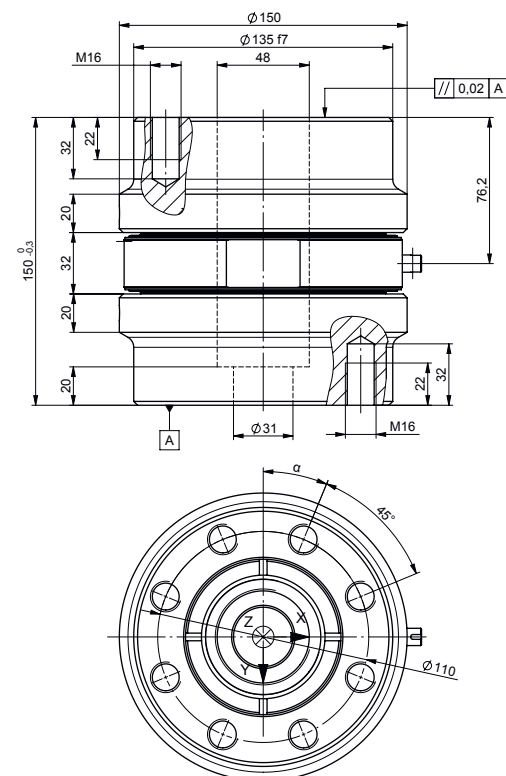


Fig. 7: Dimensions of the triaxial load cell Type 9397C1. (Beim 9397C3 ist das Lochbild um 22.5° gedreht.)

### 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 used as a dynamometer, four sensors of Type 90x6C4 are mechanically connected in parallel. The respective measuring signals (electrical charge) of the four sensors can also be connected in parallel (summed). The summing box Type 5417 enables the simple and reliable connection of the measuring signals for the desired Type of multi-component force measurement - either for a pure force measurement with 3 output channels (Type 5417Q01) or a complete dynamometer configuration with 8 outputs, which enables the calculation of bending and torsion moments (Type 5417).



Fig. 8: Summing box Type 5417

### Measurement signal processing

Charge amplifier channels are still required for the complete measurement system. These convert the measurement signal into an electrical voltage. The measured value is exactly proportional to the acting force.

The multichannel charge amplifier Type 5167A... was specially built for multiaxis force measurement systems.



Fig. 9: Multi-Channel charge amplifier Type 5167A...

### Included accessories

- none

### Optional accessories

- Connecting cable, 3 wire
- Summing box

Type  
1698A...  
5417

### Ordering key

• Triaxial force transducer 25x25x30 mm, -3 ... 3 kN	Type 9317C
• Triaxial force transducer 42x42x42 mm, -8 ... 8 kN	9327C
• Triaxial force transducer 55x55x60 mm, -30 ... 30 kN	9347C
• Triaxial force transducer 80x80x90 mm, -60 ... 60 kN	9367C
• Triaxial force transducer 120x120x125 mm, -150 ... 150 kN	9377C
• Triaxial force transducer D 150/135x150 mm, -200 ... 450 kN	9397C1
• Triaxial force transducer D 150/135x150 mm, -200 ... 450 kN 22.5° rotated	9397C3

## Measuring system with triaxial load cells

Triaxial load cell



Connecting cable



Charge amplifier



										Channels		Industrial Amplifier		Laboratory Amplifier		DAQ						
										1	5030A	5039A	5073A...	5074A...	5877B...	5015A...	5018A...	5080A...	5165A...	5167A...	KIDAQ	Sumner
										1	1	1-4	1-4	1	1	1	1-8	1-8	1-8	4.8	4, ... 52	5417
Output Signal	Cable	Cable Properties	Length [m]		Temp. Range	IEC/EN 60529	Connector Sensor	Connector Amplifier	IEC/EN 60529	IP65	IP65	IP60	IP67	IP67	IP20	IP40	IP40	IP20	IP20	IP20	IP65	
separate	3	1698AA...	PFA synthetic braiding	0.2	20	-40...120°C	IP65	3x BNC pos.	IP40	-	(✓)	✓	-	(✓)	(✓)	✓	✓	✓	✓	✓	-	
		1698AH...	PFA synthetic braiding	0.5	20			3x SMC neg.		-	-	-	-	-	-	-	-	-	-	-	-	
		1698AE...	PFA synthetic braiding	0.2	20			3x KIAG 10-32 pos.		IP65	(✓)	-	-	✓	-	-	-	-	-	-	-	-
		1698AN...	TPC black Ø3.6mm	0.5	20			3x KIAG 10-32 pos.		IP65	(✓)	-	-	✓	-	-	-	-	-	-	-	-
		1698AK...	TPC black Ø3.6mm	0.5	20		V3 pos. 90°	Fischer 9-pole pos.	-	-	-	-	-	-	-	✓	-	✓	-	✓		
		1698AF...	TPC black Ø3.6mm	0.5	20			3x Mini Coax neg.	IP40	-	-	-	-	-	-	-	-	-	-	-		
		1698AL...	TPC black Ø3.6mm	0.5	20			3x KIAG 10-32 pos.	IP65	(✓)	-	-	✓	-	-	-	-	-	-	-		
		1698AM...	PFA, steel braiding	0.3	10			3x KIAG 10-32 pos.	IP65	(✓)	-	-	✓	-	-	-	✓	-	✓	-		
		1698AB...	TPC black Ø3.6mm	0.5	20		V3 pos.	Fischer 9-pole pos.	-	-	-	-	-	-	-	✓	-	✓	-	✓		
		1698AI...	PFA, steel braiding	0.3	10			-	-	-	-	-	-	-	-	✓	-	✓	-	✓		
*no welding possible										(✓) more than one Amp needed												

## Dynamometer: measuring system with four triaxial load cells and summing box Type 5417

4 pcs of triaxial load cells



Connecting cable



Summing box Type 5417



Drop cable



Charge amplifier



										Industrial Amplifier		Laboratory Amplifier												
										5030A	5039A	5073A...	5074A...	5877B...	5015A...	5018A...	5080A...	5165A...	5167A...	KIDAQ				
										Channels	1	1	1-4	1-4	1	1	1	1-8	1-4	4,8	4, ... 52			
Output Signal	Cable	Cable Properties	Length [m]		Temp. Range	IEC/EN 60529	Fischer Connector Dynamometer	Connector Amplifier	IEC/EN 60529	IP65	IP65	IP65	IP53	IP20	IP40	IP40	IP20	IP20	IP20	IP20				
separate	8	Z16620sp	PFA	1	20	-5...70°C	plugged	IP40	9-pole pos.	8x BNC pos.	IP40	gesteckt	-	(✓)	(✓)	-	(✓)	(✓)	✓	✓	✓			
		1685B...	TPC black Ø5.6mm	1	20			IP65	9-pole pos.				-	-	-	-	✓	✓	✓	-	-	-		
		1686A...	TPC black Ø5.6mm	1	20			IP65	9-pole pos. 90°				-	-	-	-	✓	✓	✓	-	-	-		
		1681B...	PFA with flexible steel hose	1	20			IP65	9-pole pos.				-	-	-	-	✓	✓	✓	-	-	-		
		1677AQ01...	TPC black Ø5.6mm	1	20		boltable	IP65	Flange 9-pole pos.	Fischer 9-pole pos.			IP65	-	-	-	-	✓	✓	✓	✓	✓	-	-
		1677AQ02...	TPC, steel braiding	1	20			IP67	Flange 9-pole pos.					-	-	-	-	✓	✓	✓	✓	✓	-	-
		1677A...	PFA with flexible steel hose	1	20			IP67	Flange 9-pole pos.					-	-	-	-	✓	✓	✓	✓	✓	-	-
		1679A...		2	20			IP67	Flange 9-pole pos. 90°					-	-	-	-	✓	✓	✓	✓	✓	-	-

(✓) more than one Amp needed

2