measure. analyze. innovate.

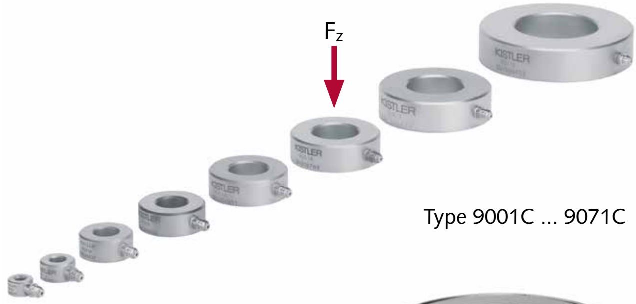
Piezoelectric force sensors

Types 9001C, 9011C, 9021C, 9031C, 9041C, 9051C, 9061C, 9071C, 9081C, 9091C

Piezoelectric ring force transducers for tensile and compression forces from 7.5 kN to 1 200 kN

Piezoelectric force sensors, also known as piezoelectric ring force transducers, for precise measurement of tensile and compressive forces in highest resolution.

- Two calibrated measuring ranges
- Linearity including hysteresis ≤±0.5%
- Extremely high stiffness
- Very compact design
- Extremely low threshold
- Degree of protection: IP68, dependent on cable
- No aging, unlimited service life



Type 9001C ... 9071C

Type 9081C, 9091C

Description

The 90x1 family is a piezoelectric (PE) sensor series for force measurement in the z-direction. The force to be measured is transferred directly to the quartz sensor element located within through the cover and base of the tightly welded steel case. When subjected to a mechanical load, quartz produces an electric charge that is proportional to that load. An outstanding property of quartz is the very low threshold and, thus, a high sensor sensitivity that remains extremely linear over the entire measuring range. Thus the behaviour in a certain measuring range is practically identical for all PE sensors, independent of their size.

This has three unique advantages:

- **Overload protection:** Even very small forces can be measured with a sensor with a large measuring range.
- **High stiffness:** To achieve a construction that is as stiff as possible, a larger sensor can also be used without negatively impacting the quality of the measurement signal.
- **Grouping:** Multiple sensors can simply be added together by electrically connecting them in parallel to a single charge amplifier. The output voltage is then proportional to the sum of all acting forces.

Application

A rugged design, reliability as well as good repeatability of the measurement values are the primary characteristics of these force sensors. Depending on the size of the force, quasistatic measurements can be performed over multiple minutes or hours, whereby the stability of the zero point is heavily dependent on the downstream charge amplifier.
Dynamic measurements (AC mode, peak-to-peak), on the other hand, can last any length of time. The measuring load washers have a practically unlimited service life

Application examples

- Forces in mounting technology
- Forces during spot welding
- Forces in presses
- Force changes in bolted joints under high static preload
- Impact resistance and fatigue strength
- Cutting and forming forces
- Braking and crash forces

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Technical data

--> to meet the specifications, the sensors must be operated and counterchecked with 20% preload!

Type		**9001C**	**9011C**	**9021C**	**9031C**	**9041C**	**9051C**	**9061C**	**9071C**	**9081C**	**9091C**
Nominal force	kN	7.5	15	35	60	90	120	200	400	800	1 200
Calibration preload	kN	1.5	3	7	12	18	24	40	80	160	240
Calibrated range 1	kN	0 … 6.0	0 … 12	0 … 28	0 … 48	0 … 72	0 … 96	0 … 160	0 … 320		
Calibrated range 2	kN	0 … 0.6	0 … 1.2	0 … 2.8	0 … 4.8	0 … 7.2	0 … 9.6	0 … 16	0 … 32	0 … 64	0 … 96
Calibrated range 3	kN									0 … 800	0 … 1 200
Load limit	kN	10.5	21	49	84	126	168	280	560	880	1 320
Sensitivity	pC/N	–4.1±0,2	–4.2±0.2	–4.4±0.2						–2.15±0.2	–2.1±0.2
Linearity incl. hysteresis [1]	%FSO	±0.5								±1	
Natural frequency (free-free) [2], calc.	kHz	≥170	≥120	≥75	≥53	≥51	≥42	≥32	≥20	≥14	≥9
Axial stiffness (calc.)	kN/µm	1.1	1.6	3.3	5.2	7.5	9.8	15.4	27.7	35.7	52.3
Lateral stiffness (calc.) [3]	kN/µm	0.20	0.31	0.74	1.3	1.8	2.4	3.9	7.6	9.2	12.9
Shear stiffness (calc.)	kN/µm	0.26	0.4	0.9	1.5	2.2	2.8	4.6	9.0	11.2	15.7
Torsional stiffness (calc.)	kNm/°	0.13	0.39	2.0	4.9	10	18	47	190	318	1 070
Bending stiffness (calc.)	kNm/°	0.13	0.9	2.02	5.2	11	21	55	217	381	1 311
Maximum bending moment [4] (Mz = 0), calc.	N·m	±5.3	±15	±61	±130	±244	±390	±800	±2 443	±5 452	±13 260
Max. sensitivity change Tref = 25°C	%/K	–0.01									
Operating temperature range	°C	–70 … 200								–40 … 100	
Insulation resistance (@23°C)	Ω	$\geq 1*10^{14}$							$\geq 1*10^{13}$	$\geq 1*10^{12}$	
Capacitance	pF	14	17	33	52	70	93	149	303	750	890
Connector type		KIAG 10-32 neg.									
Degree of protection (IEC 60529)	IP	See table, page 9									
Sensor material											
Cover plate		1.4821								1.4460	
Coat		1.4542								1.4057	
..'eight	g	3	7	20	36	70	80	157	370	910	2 180

[1] Bandwidth relative to the calibrated ranges
[2] In the non-mounted state (not preloaded), the natural frequency is reduced by the installation conditions
[3] Sensor resistance to shear and bending deformation. (Theoretical) assumption: The sensor is fixed at the bottom side, the shear force acts at the top side, so that the lever length is equal to the total sensor height.
[4] With a pretension of 50% of the **nominal force**

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Dimensions Type 9001C … 9071C

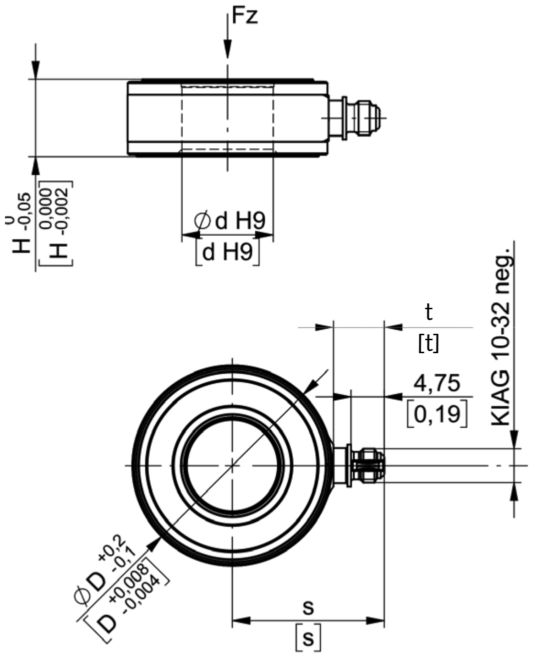

Fig. 1: Dimensions Type 9001C … 9071C in mm [in]

Dimensions metric [mm]

Type	d	D	H	s	t
9001C	4.1	10.3	6.5	12.75	7.25
9011C	6.5	14.5	8	14.85	7.25
9021C	10.5	22.5	10	18.6	7.25
9031C	13	28.5	11	21.65	7.25
9041C	17	34.5	12	24.65	7.25
9051C	21	40.5	13	27.65	7.25
9061C	26.5	52.5	15	33.65	7.25
9071C	40.5	77.25	17	45	6.75

Dimensions imperial [in]

Type	d	D	H	s	t
9001C	0.16	0.41	0.26	0.5	0.29
9011C	0.26	0.57	0.32	0.58	0.29
9021C	0.41	0.89	0.4	0.73	0.29
9031C	0.51	1.12	0.44	0.85	0.29
9041C	0.67	1.36	0.48	0.97	0.29
9051C	0.83	1.59	0.51	1.09	0.29
9061C	1.04	2.07	0.59	1.32	0.29
9071C	1.59	3.04	0.67	1.77	0.27

Dimensions Type 9081C and 9091C

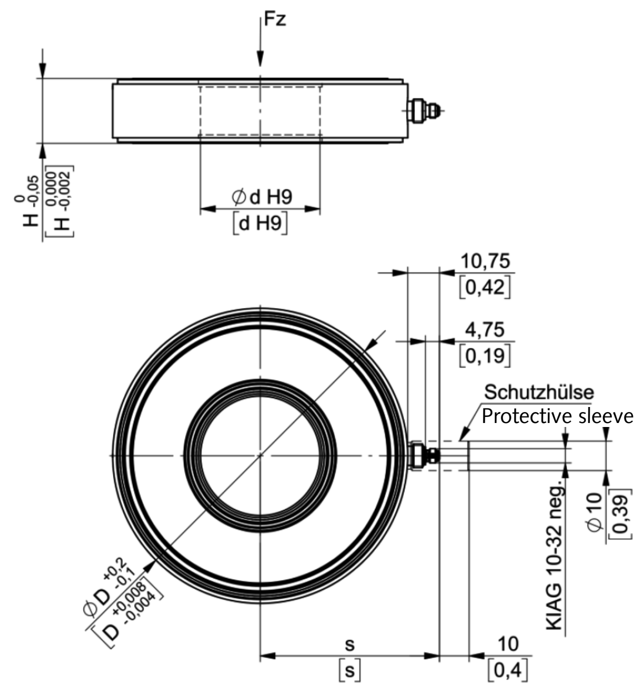

Fig. 2: Dimensions Type 9081C and 9091C in mm [in]

Dimensions metric [mm]

Type	d	D	H	s
9081C	40.5	100	22	60.75
9091C	72	145	28	83.25

Dimensions imperial [in]

Type	d	D	H	s
9081C	1.59	3.94	0.87	2.39
9091C	2.83	5.71	1.10	3.28

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Pretension
Piezoelectric force sensors are always used preloaded in a mounting structure. In general, a preloading force of at least 20% of the nominal force is recommended. The recommended, effective measuring range is thereby achieved and the design-related non-linearities in the lowest load range are eliminated.

Reasons for the pretension:
- Highest level of linearity and stability of the measurement signal.
- Measurement of tensile and compression forces, depending on the size of the pretension (see figure)
- Utilization of the high sensor stiffness for a large frequency range
- Ideal force distribution

The pretension must be selected so that the sum of preloading force (Fv) and the process force (±Fz) that arises lies within the measuring range of the sensor at all times (see graphic).
Provided it is technologically possible, the average loading of the sensor should be 50% of the nominal force. At this set point, the tolerance with respect to the bending moment is at its greatest (see below, "bending moment").
When pretensioning, the force must be measured with the sensor itself. The sensitivity specified in the technical data is to be used here. The mounting surfaces must be flat, stiff and, if possible, ground. A mounting kit Type 9422A is included in the delivery scope.

Sensor mounting
Force sensors Type 90x1C must always be mounted on flat, stiff and parallel surfaces under pretension, whereby the force should be uniformly distributed. In order to ensure this for a wide range of applications, Kistler offers an extensive range of mounting accessories.

Force transducers/load cells
The measuring load washer Types 9001C … 9071C are also available ready for installation as pre-calibrated force transducers (Types 9301C … 9371C). They are ideal for measuring compression and tensile forces; recalibration after mounting is no longer necessary.

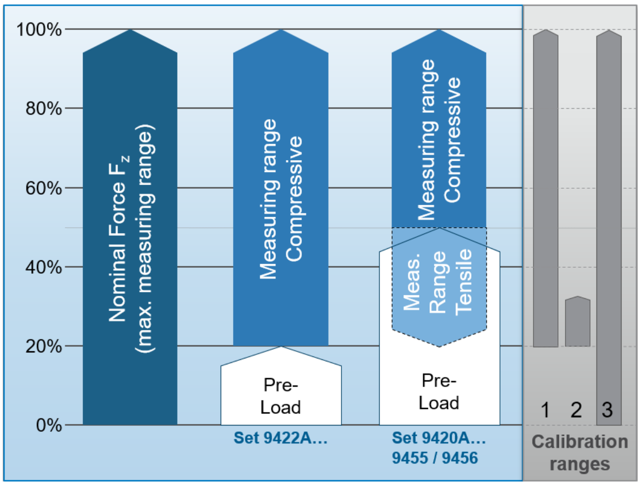

Fig. 3: Measuring and calibrated ranges

Calibration and measuring ranges
The expected error deviations of a sensor are directly dependent on the size of the measuring range and the choice of operating point. The smaller the measuring range the better the linearity and hysteresis. A sensor is typically pretensioned with 20% of the nominal force, which significantly improves the quality of the sensor. Depending on the size, the sensors of the 90x1 series are calibrated in two to three different ranges (see graphic).

Measurement directly in the force flux or as force shunt
Piezoelectric force sensors are used either directly in the force flux or in the force shunt, embedded in a machine structure.
Direct force measurements reach the highest accuracy and resolution, because most of the process force flows through the sensor.
Force shunt measurements, on the other hand, load the sensors with only a fraction of the process force and reach much higher measurement ranges, though at reduced sensitivity.

A detailed instruction manual with further explanations on installation, dimensioning and wiring can be found in the download area of our website www.kistler.com.

Bending moment

Bending moments M_B (M_x + M_y) increase the stress on one side of the sensor and decrease it on the other. This results in an uneven distribution of the axial force on the sensor, that can distort the measuring results.

In extreme cases, this can lead to a one-sided overload of the sensor or loss of the frictional connection, which can destroy the structure or cause it to slip. It ultimately depends on the applied axial force F_z which of the two cases occurs first in the event of an impermissible bending moment.

Maximum possible bending moment

Type	load limit F_z [kN]	max. bending moment M_B [N·m]
9001C	7.5	5.3
9011C	15	15
9021C	35	61
9031C	60	130
9041C	90	244
9051C	120	390
9061C	200	800
9071C	400	2 443
9081C	800	5 452
9091C	1 200	13 260

We use a normalized formula to calculate the allowable bending moment.

$$M_B[\%] \leq 100\% - 2x\,|50\% - F_z[\%]|$$

F_z is the total axial force on the sensor, so the sum of the preload F_v and the process force F_p.

Bending moment graph

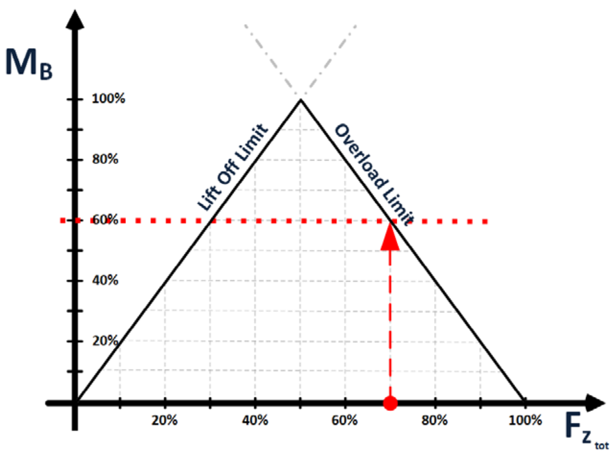

Fig. 4: Bending moment as a function of the axial force F_z

Example

A force transducer Type 9031C... is preloaded with F_v = 17 kN. What bending moment can be tolerated for process forces in the range F_p = 0 ... 20 kN?

$$F_v[\%] = \frac{17\text{ kN}}{60\text{ kN}} = 28\%$$

$$F_p[\%] = \frac{0\text{ kN}}{60\text{ kN}} \ldots \frac{20\text{ kN}}{60\text{ kN}} = 0 \ldots 33\%$$

$$F_z[\%] = F_v[\%] + F_p[\%] = 28 \ldots 61\%$$

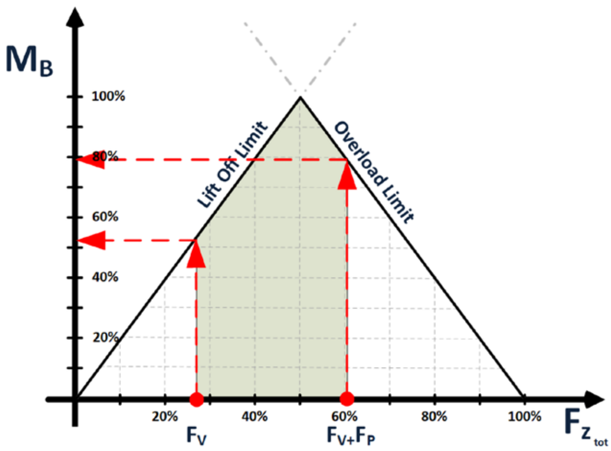

Fig. 5: maximum bending moment depending on preload and process force

$$M_B[28\%] = 100\% - 2 \times |50\% - 28\%| = 56\%$$
$$\triangleq 72.8\text{ Nm}$$
$$M_B[61\%] = 100\% - 2 \times |50\% - 61\%| = 78\%$$
$$\triangleq 101.4\text{ Nm}$$

The allowed bending moment depends on the applied total force F_z and reaches its peak at 30 kN, half the nominal axial force. In this case, when the process force is at 13 kN (17 kN+13 kN = 30 kN).

If the force curve in the process is not known, the lowest value is defined as the maximum load: 72.8 Nm.

Attention
Lateral loads $F_{x,y}$ and/or a torque M_z further reduce the measuring range. In case of tight safety margins regarding bending moments and suspected lateral loads or torque, better get in touch with our local sales.

Tensile forces

Tensile forces are only applicable as long as the preload is higher than the negative force: they reduce the (pre)load on the sensor, which can be measured accordingly.

Preloading set Type 9420Ax1

Preloading set 9420Ax1 can be used to measure compression and tensile forces in an application. The set with centering sleeve (1) and high-strength preloading bolts (2) can handle a pretension of up to 50% and is designed for a minimal force shunt and ideal centering. At the same time, it ensures an optimum force application. With the included insulating washers (5), the entire sensor can be installed electrically neutral.

3) Washer
4) Hexagonal nut

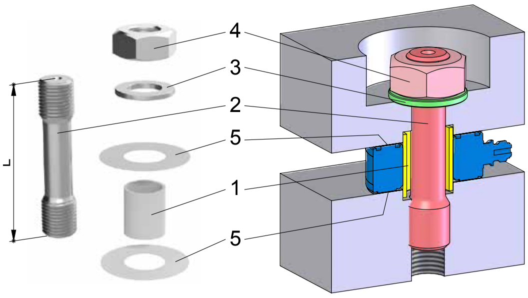

Fig. 6: Installation of preloading set Type 9420Ax1

	Type	9001C	9011C	9021C	9031C	9041C	9051C	9061C	9071C
Preloading set	**Type**	**9420A01**	**9420A11**	**9420A21**	**9420A31**	**9420A41**	**9420A51**	**9420A61**	**9420A71**
Force shunt	%	≈10	≈7	≈8	≈9	≈8	≈7	≈7	≈7
Thread		M4x0.5	M5x0.5	M8x1	M10x1	M12x1	M14x1.5	M20x1.5	M27x1.5

Preloading screw Type 9422Ax1

Customers who only measure positive forces in the Fz direction (compression forces) require a lower preload. Ideal for them is set 9422Ax1, consisting of preloading screw (1) and centering clip (2). The screw can be preloaded with up to 30% of the rated range. Further accessories such as insulating washers can be ordered separately if necessary.

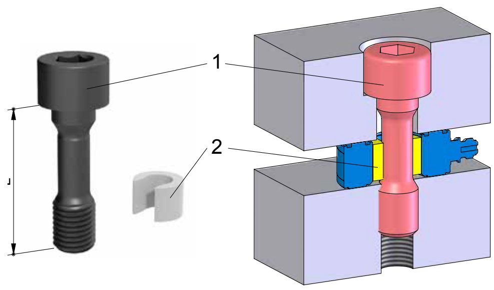

Fig. 7: Installation of preloading screw Type 9422Ax1

	Type	9001C	9011C	9021C	9031C	9041C	9051C	9061C	9071C
Preloading set	**Type**	**9422A01**	**9422A11**	**9422A21**	**9422A31**	**9422A41**	**9422A51**	**–**	**–**
Force shunt	%	≈7	≈8	≈9	≈9	≈9	≈9		
Thread		M3x0.5	M5x0.8	M8x1.25	M10x1.5	M12x1.75	M14x2		

Preloading sets Type 9455S and Type 9456S

With the preloading elements of Type 9455S and 9456S, a preloading force of up to 730 kN can be achieved without any specialized.

	Type	9081C	9091C
Preloading set	**Type**	**9455S**	**9456S**
Force shunt	%	≈9	≈9
Thread		M40x2.0	M64x3.0

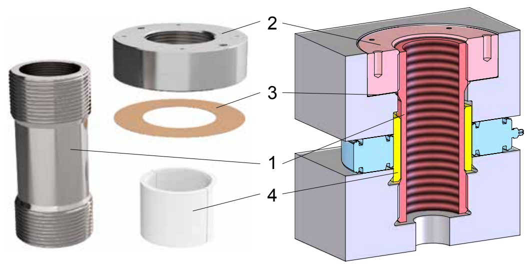

Fig. 8: Installation of preloading set Type 9455S/9456S

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Accessories

Force distributing ring Type 95x5

The contact surfaces must be just as flat and stiff as the contact surfaces of the sensor itself. If they cannot be finished, local overstressing and damage to the sensor surface must be prevented through the use of a force distributing ring (1).

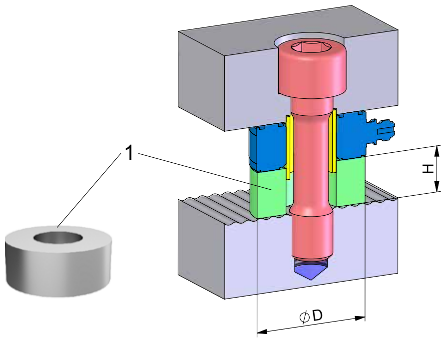

Fig. 9: Installation of force distributing ring Type 95x5

	Type	9001C	9011C	9021C	9031C	9041C	9051C	9061C	9071C
Force distributing ring	**Type**	**9505**	**9515**	**9525**	**9535**	**9545**	**9555**	**9565**	**9575**
D	mm	10	14	22	28	34	40	52	75
H	mm	6	8	10	11	12	13	15	17
D	*in*	*0.39*	*0.55*	*0.87*	*1.1*	*1.34*	*1.57*	*2.05*	*2.95*
H	*in*	*0.24*	*0.31*	*0.39*	*0.43*	*0.47*	*0.51*	*0.59*	*0.67*

Force distributing cap Type 95x9

The force to be measured must be distributed evenly on the contact surface of the force transducer. If a concentrated application of force cannot be avoided, a force distributing cap (1) compatible with the sensor ensures an ideal distribution of force.

2) Centering pin
3) Allen screw

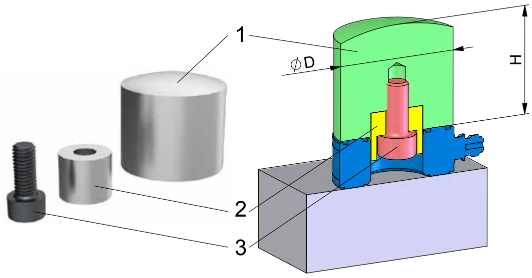

Fig. 10: Installation of force distributing cap Type 95x9

	Type	9001C	9011C	9021C	9031C	9041C	9051C	9061C	9071C
Force distributing cap	**Type**	**9509**	**9519**	**9529**	**9539**	**9549**	**9559**	**9569**	**9579**
D	mm	10	14	22	28	34	40	52	75
H	mm	10	15	20	25	30	40	50	60
D	*in*	*0.39*	*0.55*	*0.87*	*1.1*	*1.34*	*1.57*	*2.05*	*2.95*
H	*in*	*0.39*	*0.59*	*0.79*	*0.98*	*1.18*	*1.57*	*1.97*	*2.36*

Spherical washer Type 95x3

If the surfaces cannot be made perfectly parallel, a spherical washer (1) must be used to compensate for this. A finished, even contact surface is still required, however.

H* = height at 0° parallelism

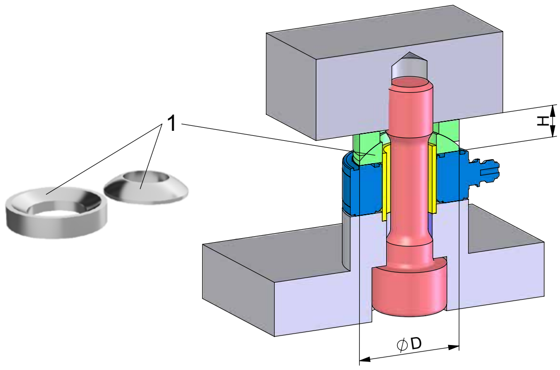

Fig. 11: Installation of spherical washer Type 95x3

	Type	9001C	9011C	9021C	9031C	9041C	9051C	9061C	9071C
Spherical washer	**Type**	**-**	**9513**	**9523**	**9533**	**9543**	**9553**	**9563**	**9573**
D	mm		12	21	24	30	36	52	75
H	mm		4	6	7	8	10	14	20
D	*in*		*0.47*	*0.83*	*0.94*	*1.18*	*1.42*	*2.05*	*2.95*
S	*in*		*0.16*	*0.24*	*0.28*	*0.31*	*0.39*	*0.55*	*0.79*

Insulating washers Type 95x7

In case of interference due to ground loops or an electrical potential that differs between the measurement object and the amplifier, the sensor must be installed insulated. The insulating washer sets ensure a clean potential separation. In order to function correctly, the insulating washers should only be used once, and only on finished contact surfaces.

Fig. 12: Insulating washers Type 95x7

Attention

These insulating washers with collar can only be used where there are no built-in, continuous centering bushes.

	Type	9001C	9011C	9021C	9031C	9041C	9051C	9061C	9071C
Insulating washer	**Type**	**–**	**9517**	**9527**	**9537**	**9547**	**9557**	**9567**	**9577**
D	mm		14	22	28	34	40	52	75
H	mm					1.125			
D	*in*		*0.55*	*0.87*	*1.1*	*1.34*	*1.57*	*2.05*	*2.95*
H	*in*					*0.0049*			

Measuring chain

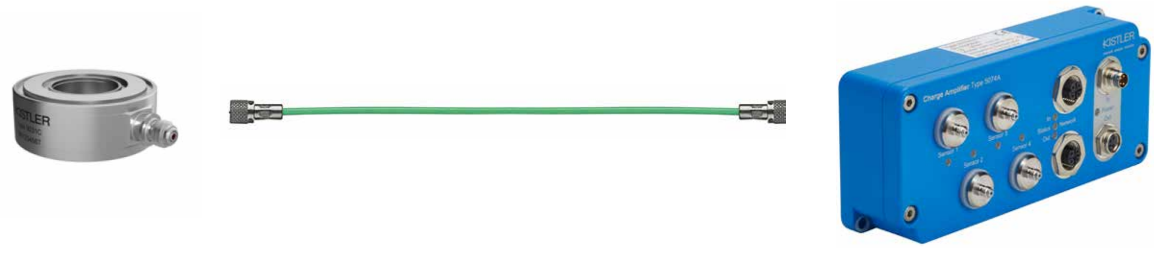

Fig. 13: Measuring chain

Connecting cable

All sensors of 9001…9091 feature a KIAG 10-32 neg. connection and are compatible accordingly with all KIAG 10-32 pos. cable connectors. Only high-insulation coaxial cables with low capacitance that produce only a very small amount of static electricity may be used as connecting cables for piezoelectric sensors. Kistler uses cables made of high-quality PFA or oil-proof FPM here.

On the sensor side, the IP protection class acc. to EN60529 is generally dependent on the used connector. For IP65, the standard 10-32 KIAG cable connector with knurled nut is used; for increased requirements in harsh environments, the industrial-suited 10-32 KIAG pos. int. version is used which, if necessary, can be tightly welded with the sensor case and IP68 achieved.

Compatibilities of cables and charge amplifiers

KIAG 10-32

Cable	Cable Properties	Length [m] min	Length [m] max	Temp. Range		IEC/EN 60529	Connector Sensor	Connector Amplifier	IEC/EN 60529		Industrial Amplifier 5030A	5039A	5073A…	5074A…	5877B…	Laboratory Amplifier 5015A…	5018A…	5080A…	5165A…	5167A…	DAQ KiDAQ
										Channels	1	1	1-4	1-4	1	1	1	1-8	1,4	4,8	4, …, 52
											IP65	IP65	IP60	IP67	IP53	IP20	IP40	IP40	IP20	IP20	IP20
1631C…	PFA	0.1	100	-55…200°C	Plug screwed	IP65	KIAG 10-32 pos.	BNC pos.	IP40	Plug screwed	-	✓	✓	-	✓	✓	✓	✓	✓	✓	✓
1641B…	PFA	0.1	100	-55…200°C	Plug screwed	IP65	KIAG 10-32 pos. 90°	BNC pos.	IP40	Plug screwed	-	✓	✓	-	✓	✓	✓	✓	✓	✓	✓
1633C…	PFA	0.1	50	-55…200°C	Plug screwed	IP65	KIAG 10-32 pos.	TNC pos.	IP65	Plug screwed	-	✓	✓	-	-	-	-	-	-	-	-
1635C…	PFA	0.1	15	-55…200°C	Plug screwed	IP65	KIAG 10-32 pos.	KIAG 10-32 pos.	IP65	Plug screwed	✓	-	-	✓	-	-	-	-	-	-	-
1957A…	PFA, steel braiding	0.1	10	-55…200°C	Plug screwed	IP65	KIAG 10-32 pos.	KIAG 10-32 pos.	IP65	Plug screwed	✓	-	-	✓	-	-	-	-	-	-	-
1900A23A12…	PFA superflexible, drag chain proven	0.3	20	-40…200°C	Plug screwed	IP67	KIAG 10-32 pos. hex	BNC pos.	IP40	Plug screwed	-	✓	✓	-	✓	✓	✓	✓	✓	✓	✓
1900A23A11…	PFA superflexible, drag chain proven	0.3	20	-40…200°C	Plug screwed	IP67	KIAG 10-32 pos. hex	KIAG 10-32 pos. hex	IP67	Plug screwed	✓	-	-	✓	-	-	-	-	-	-	-
1900A21A12…	FPM flexible steel hose	0.4	20	-20…200°C	Plug screwed	IP67	KIAG 10-32 pos. hex	BNC pos.	IP40	Plug screwed	-	✓	✓	-	✓	✓	✓	✓	✓	✓	✓
1900A21A11…	FPM flexible steel hose	0.4	20	-20…200°C	Plug screwed	IP67	KIAG 10-32 pos. hex	KIAG 10-32 pos. hex	IP67	Plug screwed	✓	-	-	✓	-	-	-	-	-	-	-
1983AD…	FPM	0.1	20	-20…200°C	Plug screwed	IP68	KIAG 10-32 pos. int.	BNC pos.	IP40	Plug screwed	-	✓	✓	-	✓	✓	✓	✓	✓	✓	✓
1939A…	PFA	0.1	20	-55…200°C	weldable[1]	IP67	KIAG 10-32 pos. int.	BNC pos.	IP40	Plug screwed	-	✓	✓	-	✓	✓	✓	✓	✓	✓	✓
1941A…	PFA	0.1	20	-55…200°C	weldable[1]	IP67	KIAG 10-32 pos. int.	TNC pos.	IP65	Plug screwed	-	✓	✓	-	-	-	-	-	-	-	-
1921…	PFA	0.1	20	-55…200°C	weldable[1]	IP67	KIAG 10-32 pos. int.	KIAG 10-32 pos.	IP65	Plug screwed	✓	-	-	✓	-	-	-	-	-	-	-
1969A…	PFA, steel braiding	0.5	10	-55…200°C	weldable[1]	IP67	KIAG 10-32 pos. int.	KIAG 10-32 pos. int.[2]	IP65	Plug screwed	✓	-	-	✓	-	-	-	-	-	-	-
1967A…	PFA, steel braiding, isolated	0.5	10	-55…200°C	weldable[1]	IP67	KIAG 10-32 pos. int.	KIAG 10-32 pos. int.[2]	IP65	Plug screwed	✓	-	-	✓	-	-	-	-	-	-	-
1983AC…	FPM	0.1	5	-20…200°C	weldable[1]	IP68	KIAG 10-32 pos. int.	KIAG 10-32 pos. int.[2]	IP65	Plug screwed	✓	-	-	✓	-	-	-	-	-	-	-
1700A29	*Adapter angled 90°*			*-55…200°C*		*IP65*	*KIAG 10-32 pos.*	*KIAG 10-32 pos.*	*IP65*												

[1] screwed: IP65
[2] welded: IP67

Charge amplifiers

Various criteria are decisive when selecting the right charge amplifier for a given application. Among the most important are the number of channels, the measuring range, the type of measurement and the frequency range. At this point, only a tabular summary is shown to provide an overview. More detailed information and explanations are available in the force product catalog and in the respective data sheets at www.kistler.com.

Digital laboratory amplifiers: LabAmp

The latest generation of universal laboratory charge amplifiers; with integrated data acquisition for dynamic or quasistatic measurements; network ready with web interface.

Fig. 14: LabAmp Type 5165A and Type 5167A

Analog laboratory amplifiers: Type 5015A, 5018A and 5080A

The proven analog charge amplifiers for laboratories and research. With very wide measuring range and high flexibility (Type 5080A).

Fig. 15: Laboratory charge amplifiers Type 5015A and Type 5080A

Industrial amplifiers

Size- and function-optimized amplifiers for continuous use in daily work. Bus-capable; some with further functions. (evaluation of force curves, etc.)

Fig. 16: Industrial amplifiers Type 5073A and 5074A (from left) At the right is the maXYmos BL Type 5867B…

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Included accessories	Type
• Special grease	1063
• Preloading screw for preloads for compression force measurement, including centering sleeve (only with sensors Type 9001C ... 9051C)	9422A01 … 9422A51

Optional accessories	
• Preloading element for preloads for pressure and tensile force measurement, including mounting accessories	9420A01 … 9420A71
• Preloading element for big force sensors Type 9081 and 9091	9455S, 9456S

Mounting accessories (optional)	
• Force distributing ring for piezoelectric force sensor	95x5
• Spherical washer for piezoelectric force sensor	95x3
• Insulating washer for piezoelectric force sensor	95x7
• Force distributing cap for piezoelectric force sensor	95x9

Cables (optional)

- Connection and extension cables according data sheet for cables for force and torque sensors

Ordering key

Type 90 ☐ C

Piezoelectric force sensor	
Range 0 … 7.5 kN	**01**
Range 0 … 15 kN	**11**
Range 0 … 35 kN	**21**
Range 0 … 60 kN	**31**
Range 0 … 90 kN	**41**
Range 0 … 120 kN	**51**
Range 0 … 200 kN	**61**
Range 0 … 400 kN	**71**
Range 0 … 800 kN	**81**
Range 0 … 1 200 kN	**91**