

# Piezoelectric pressure sensor for Test & Measurement applications

Type 601C...

The miniature pressure sensors of the Type 601C series are, due to their high sensitivity, suited for a variety of applications where very small pressure pulsations need to be measured. In addition, the optimized diaphragm ensures accurate dynamic pressure measurements, even when the diaphragm is simultaneously exposed to a high thermal shock.

- Pressure range up to 250 bar (3 626 psi)
- High sensitivity
- Membrane optimized for high thermal shocks
- Small sensor size
- Short rise time & high natural frequency
- Extremely wide operating temperature range
- Charge (PE) or Voltage (IEPE) output

### Description

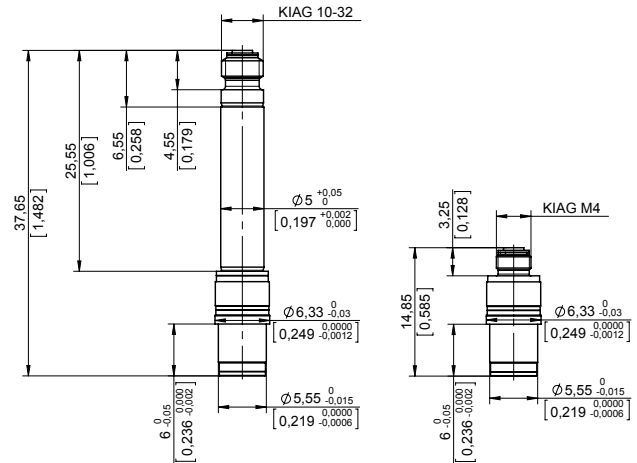
Due to their high natural frequencies, piezoelectric pressure sensors can be used for a variety of applications where dynamic pressures need to be measured. Another unique characteristic of piezoelectric pressure sensors is their ability to measure small pressure fluctuations that are superimposed on top of high static pressures with exceptional resolution. By contrast, piezoresistive pressure sensors are the right choice when measuring static pressure curves.

At the core of the all-welded, hermetically sealed Type 601C series there is a high performance PiezoStar crystal grown by Kistler. This PiezoStar crystal gives the sensor a far higher sensitivity than an equivalently sized pressure sensor based on synthetic Quartz, which results in a lower noise level and so enables lower pressure to be measured more accurately.

The pressure to be measured acts on the sensor's diaphragm and compresses the PiezoStar crystal. The compressed crystal produces a charge which is proportional to the pressure. Finally, the charge signal needs to be converted, by a charge amplifier, into a voltage which can then be read.

### Typical applications

- Pressure pulsations on compressors, pumps, turbines, propellers, etc.
- Dynamic pressure measurements with high thermal shocks as for example gas and dust explosions (Ex testing), pyro-technical devices, closed vessel testing, energetic material testing, sloshing or small dynamic pressures as for example sound pressure, etc.



### Charge (PE) vs. Voltage (IEPE) output

One of the most important selection criteria for piezoelectric pressure sensors is the output signal. Two variants of the sensor are available, charge output (PE) and voltage output (IEPE resp. Piezotron).

Piezoelectric pressure sensors are connected to an electronic circuit which converts the charge generated by the sensor into a proportional voltage. If the electronic circuit is integrated into the sensor housing, it is referred to as an IEPE sensor. If the electronics is an external device (charge amplifier), it is referred to as a PE sensor. Depending on the application, PE or IEPE sensors may be better suitable.

IEPE sensors are the ideal solution for the long-term measurement of small pressure pulsations (without any static pressure content) or the measurement of dynamic pressure profiles (up to a few tenths of a millisecond only). IEPE sensors will however, due to the built-in electronics, only work at moderate temperatures and come with a fixed measuring range.

PE sensors on the other hand are the right solution for the long-term measurement of small pressure pulsations (without any static pressure content), quasi-static or dynamic pressure profiles (up to a few minutes). PE sensors will, due to the external charge amplifier, operate at extreme temperatures too and allow for adjustable measuring ranges.

The instruction manual and pressure catalogue provides further details on PE and IEPE sensors, measuring chains as well as applications each technology is best suited for.

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This information corresponds to the current state of knowledge. Kistler reserves the right to make technical changes. Liability for consequential damage resulting from the use of Kistler products is excluded.

**Technical data – PE sensors<sup>1)</sup>****Type 601CA...**

Output signal	pC	Charge (PE)	Temp. coefficient of sensitivity		
Pressure range	bar	0 ... 250	25°C ... 100°C	%/°C	≈+0.009
	psi	0 ... 3 626	77°F ... 212°F	%/°F	≈+0.005
Calibrated partial range	%	2; 20; 100	25°C ... 350°C	%/°C	≈+0.014
Overload	bar	300	77°F ... 662°F	%/°F	≈+0.008
	psi	4 350	25°C ... -196°C	%/°C	≈-0.035
Sensitivity (nom.)	pC/bar	-37.0	77°F ... -321°F	%/°F	≈-0.019
	pC/psi	-2.6	Acceleration sensitivity (axial)	bar/g	≤0.0020
Linearity (typ.)	%FSO	≤±0.1		psi/g	≤0.0290
	(max.) %FSO	≤±0.3	Acceleration sensitivity (radial)	bar/g	≤0.0001
Operating temperature range	°C	-196 ... +350		psi/g	≤0.0015
	°F	-321 ... +662	Insulation resistance	Ω	≥10 <sup>13</sup>
Rise time (10 ... 90 %)	µs	<1.4	Weight Type 601CAA / 601CAB	gram	4.5/1.9
Natural frequency <sup>2)</sup>	kHz	>215	Housing and diaphragm material		17-4 S.S.

**Technical data – IEPE sensors<sup>1)</sup>****Type 601CBA...**

		00001.5	00003.5	00007.0	00014.0	00035.0	00070.0	00250.0
Output signal	V	Voltage (IEPE)						
Pressure range	bar	1.5	3.5	7	14	35	70	250
	psi	22	50	100	200	500	1 000	3 626
Maximum pressure	bar	250						
	psi	3 626						
Overload	bar	300						
	psi	4 350						
Sensitivity (nom.)	mV/bar	3 333	1 429	714	357	143	71	20
	mV/psi	230	99	49	25	9.9	4.9	1.4
Linearity	%FSO	≤±1.0						
Operating temperature range	°C	-55 ... +120						
	°F	-67 ... +248						
Rise time (10 ... 90%)	µs	<1.4						
Natural frequency <sup>2)</sup>	kHz	>215						
Time constant (nom.)	s	2	3					
Low frequency response -3 dB	Hz	0.080	0.053					
	-5%	0.242	0.161					
Temp. coefficient of sensitivity	25 ... 120°C	% / °C ≈+0.008						
	77 ... 248°F	% / °F ≈+0.005						
	25 ... -55°C	% / °C ≈-0.008						
	77 ... -67°F	% / °F ≈-0.005						
Acceleration sensitivity (axial)	bar/g	≤0.0020						
	psi/g	≤0.0290						
Acceleration sensitivity (radial)	bar/g	≤0.0001						
	psi/g	≤0.0015						
Supply voltage (by IEPE-Coupler)	VDC	22 ... 30						
Supply current (by IEPE-Coupler)	mA	2 ... 20						
Output bias voltage (nom.)	VDC	11						
Output voltage FSO	V	±5						
Weight	gram	3.6						
Housing and diaphragm material	-	17-4 S.S.						

<sup>1)</sup> Indications are valid for 23°C / 73°F (if not specified otherwise)<sup>2)</sup> Calculated from rise time

### Mounting (sensors with standard housing)

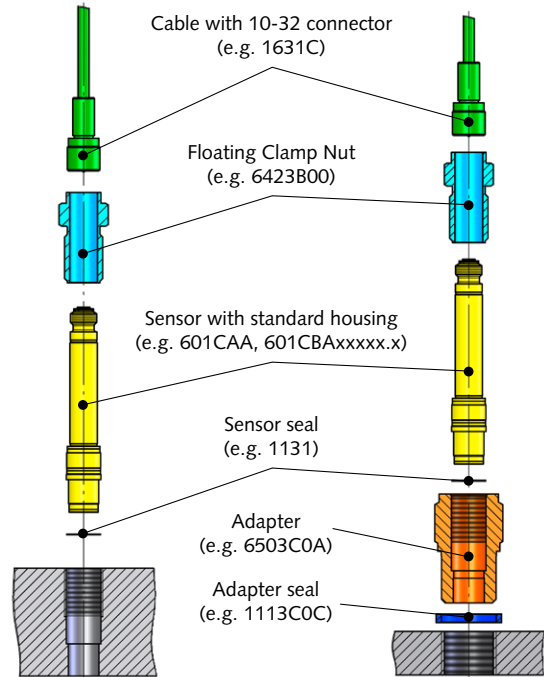
Sensors with charge output (PE) and voltage output (IEPE) are available with standard housing. Sensors with a standard housing can either be installed directly or with an adapter.

#### Direct Mounting

When the mounting location space is restricted, the sensor can be located in an appropriately dimensioned mounting bore, and then held in place with a floating clamp nut. Please note that for a reliable and accurate pressure measurement a precise machining of the mounting hole with special reamers and taps is required. For details on mounting hole fabrication please check the manual.

#### Adapter Mounting

Fitting sensors into a mounting adapter greatly simplifies the installation process (when space and wall thickness are not a premium). Use of a Kistler mounting adapter will eliminate the need to provide a precise mounting configuration and allow the installer to provide only a threaded hole of the size and depth required for the adapter selected. Special reamers or taps are not required when using an adapter. For details on mounting thread fabrication please check the manual. All sensors and adapters are available for download as 3D CAD files from Kistler's webpage.



#### Direct Mounting

- Flush mounting
- Complex drilling with special tool
- Min. structural influences on pressure measurement (mechanical decoupling)
- Ideal for close matrix alignment of sensors

#### Type 6503CxA Adapter

- M10 and 3/8-24 UNF
- Stainless steel (1.4542+AT)
- Flush mounting
- Max. Pressure 1 000 bar (14 500 psi)

#### Type 6503CxD Adapter

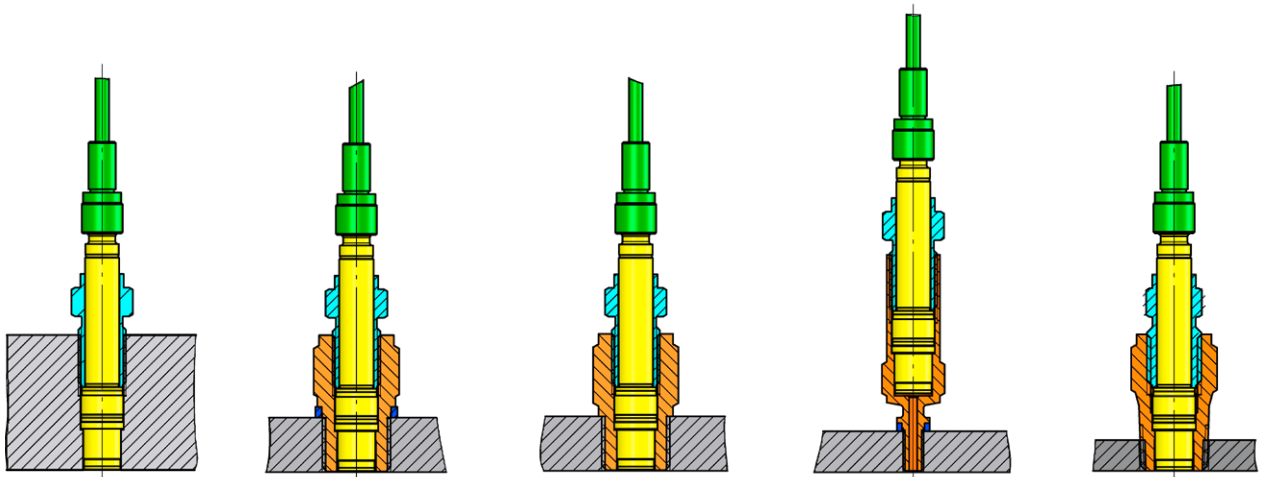
- M10 and 3/8-24 UNF
- Ground Isolating
- PEEK GF30 (glass fiber reinforced high performance plastic)
- Max. Pressure 100 bar (1 450 psi)
- Max. temperature 100°C (212°F)

#### Type 6507BxA Adapter

- M3 and 5-40 UNC
- Stainless steel (1.4542+AT)
- Recessed mounting
- Max. Pressure 300 bar (4 350 psi)

#### Type 6503C3A Adapter

- 1/8-27 NPTF
- Stainless steel (1.4542+AT)
- Almost flush mounting
- Max. Pressure 1 000 bar (14 500 psi)



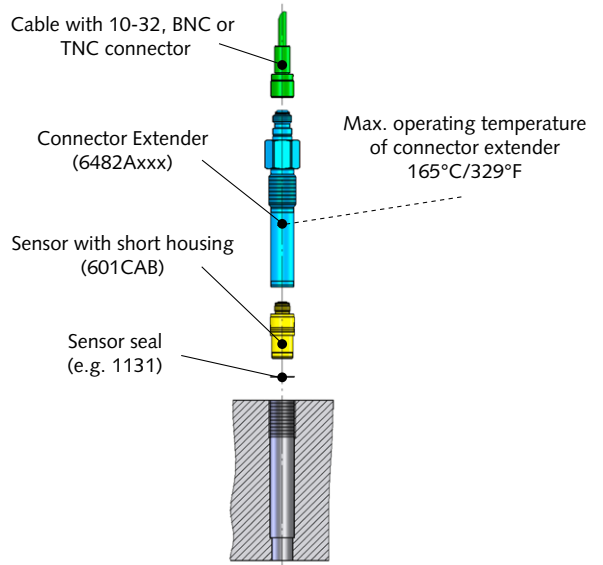
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**Mounting (sensors with short housing)**

Sensors with charge output (PE) are also available with short housing. For the mounting of these sensors a connector extender of Type 6482A is required. This mounting form is mostly only used where mechanical structures cannot be weakened.

Connector extenders are made to order and are therefore not stock items (unlike floating clamp nuts of Type 6423B). Customers can choose between three different connectors, two different threads and a variable length (see ordering key).

Please note that for a reliable and accurate pressure measurement a precise machining of the mounting hole with special reamers and taps is required (same as for direct mounting, see previous datasheet page). For details on mounting hole fabrication please check the manual. All connector extenders are available for download as 3D CAD files from Kistler's webpage.



**10-32 connector**  
Small coaxial 10-32 connectors are widely used in the sensor industry and therefore comes with a wide range of high impedance cable options. The small size further allows for sealing the sensor connector with thermo shrink sleeves. Attention needs to be paid to cleanliness of these small connectors.

**BNC connector**  
The BNC connector (bayonet lock) is much bigger and therefore sturdier and less sensitive to contaminations than the widely used 10-32 connector. Its large dimensions and big mass as well the difficulty to be sealed might however be a criterion for exclusion in some applications.

**TNC connector**  
The TNC connector (thread lock) has about the same size, and offers the same advantages and disadvantages, as the BNC connector. Thanks to the thread lock a good sealing against exterior influences is achieved and is therefore the preferred choice when conducting tests outside a laboratory environment.

**Ordering key (connector extender)**

Connector type	
BNC	0
TNC	1
10-32	2

Mounting thread	
M7x0.75	0
5/16-24 UNF	1

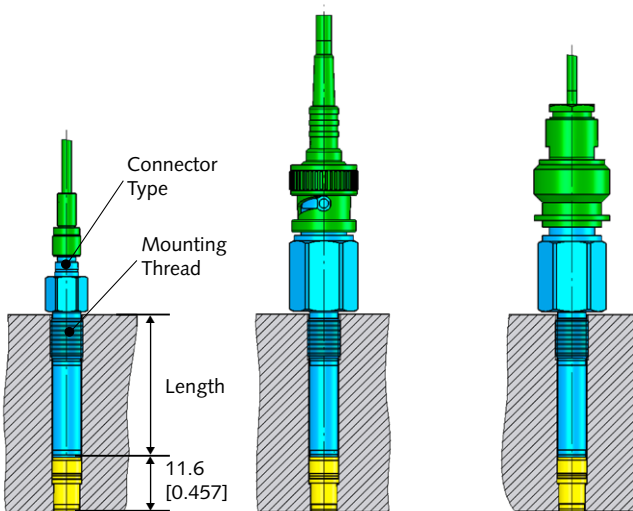
Length (in mm)	
010	SP
013 ... 200	SP

Type 6482A

**Ordering example**  
6482A with BNC, M7 thread, 10 mm length  
6482A with TNC, M7 thread, 15 mm length  
6482A with 10-32, UNF thread, 125 mm length

**Type**  
6482A00SP010  
6482A10SP015  
6482A21SP125

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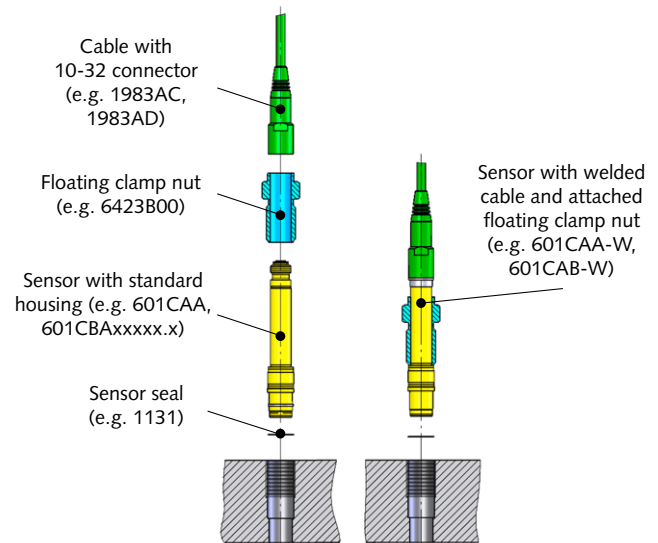
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## Waterproof solution (IP68)

For pressure sensors subject to water splashes or even used under water the IP68 rated cable Type 1983A shall be used. The Type 1983A cable, made of FKM rubber, comes with a vulcanized 10-32 connector and is only compatible to pressure sensors with a standard housing.

The Type 1983A cable can be screwed like any other standard cable, or optionally even be welded, to the pressure sensor. Welding, instead of screwing, the cable connector to the sensor offers protection against detachment of the cable in case of strong vibrations. Requirements to weld the connector to the sensor need to be stated at the time of order (see below ordering keys).

Both, screwed and welded, solutions have successfully been qualified for IP68 rating in water with pressures ranging from vacuum to 16 bar.



## Ordering key (PE sensor with welded 1983A cable)

Type 601CAA-W

### Floating clamp nut Type

6423B00	A
6423B11	B

### Cable Type

1983AD (with BNC pos. connector)	A
1983AC (with 10-32 pos. int. connector)	B

### Cable length (in m)

1 m (for 1983AC cable only)	1,0
2 m (for 1983AC and 1983AD cable)	2,0
3 m (for 1983AC cable only)	3,0
5 m (for 1983AD cable only)	5,0
Customized cable length (0.1 to 30.0 m)	SP

### Ordering example

601CAA with 6423B00 and 2 m 1983AD cable  
601CAA with 6423B00 and 6 m 1983AD cable  
601CAA with 6423B11 and 0.5 m 1983AC cable

### Type

601CAA-WAA2,0  
601CAA-WAASP6,0  
601CAA-WBSP0,5

## Ordering key (IEPE sensor with welded 1983A cable)

Type 601CBA-W  -

### IEPE pressure range

1.5 bar / 22 psi	00001.5
3.5 bar / 50 psi	00003.5
7 bar / 100 psi	00007.0
14 bar / 200 psi	00014.0
35 bar / 500 psi	00035.0
70 bar / 1 000 psi	00070.0
250 bar / 3 625 psi	00250.0

### Floating clamp nut Type

6423B00	A
6423B11	B

### Cable Type

1983AD (with BNC pos. connector)	A
1983AC (with 10-32 pos. int. connector)	B

### Cable length (in m)

1 m (for 1983AC cable only)	1,0
2 m (for 1983AC and 1983A cable)	2,0
3 m (for 1983AC cable only)	3,0
5 m (for 1983AD cable only)	5,0
Customized cable length (0.1 to 30.0 m)	SP

### Ordering example

601CBA00001.5 with 6423B00 and 2 m 1983AD cable  
601CBA00007.0 with 6423B00 and 6 m 1983AD cable  
601CBA00250.0 with 6423B11 and 7 m 1983AC cable

### Type

601CBA-W00001.5-AA2,0  
601CBA-W00007.0-AASP6,0  
601CBA-W00007.0-BBSP7,0

**Accessories (included)**

- Sensor seal copper (5 pcs.)

**Type/Art.-No.**

1131

**Accessories (optional)**

- Sensor seal nickel (1 pcs)
- Floating clamp nut M7x0.75
- Floating clamp nut 5/16-24-UNF
- Adapter M10x1<sup>1)</sup>
- Adapter seal (S.S. / 25 pcs) for 6503C0A
- Adapter seal (Cu / 25 pcs) for 6503C0A
- Adapter 3/8-24-UNF<sup>1)</sup>
- Adapter seal (S.S. / 25 pcs) for 6503C1A
- Adapter seal (Cu / 25 pcs) for 6503C1A
- Adapter M3x0.5<sup>1)</sup>
- Adapter 5-40 UNC<sup>1)</sup>
- Adapter seal for 6507BxA
- Lubrication Grease (Adapter)
- Adapter M10x1 (ground isolated)
- Adapter 3/8-24 UNF (ground isolated)
- Adapter 1/8-27 NPTF
- Connector extender (configurable product)
- Dummy sensor (standard housing)
- Dummy sensor (short housing)
- Step reamer (SC H7 Ø6.35/Ø5.58)

**Type/Art.-No.**

1131A  
6423B00  
6423B11  
6503C0A  
1113C0B  
1113C0C  
6503C1A  
1113C1B  
1113C1C  
6507B0A  
6507B1A  
1117B0C  
1063  
6503C0D  
6503C1D  
6503C3A  
6482A  
6487AA  
6487AB  
1331C

**Ordering key (sensor)****Output signal**

Charge (PE)	<b>A</b>
Voltage (IEPE)	<b>B</b>

**Housing**

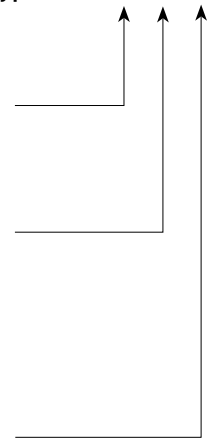
Standard housing (PE and IEPE)	<b>A</b>
Short housing (only PE)	<b>B</b>

**Pressure range (only IEPE)**

1.5 bar / 22 psi	<b>00001.5</b>
3.5 bar / 50 psi	<b>00003.5</b>
7 bar / 100 psi	<b>00007.0</b>
14 bar / 200 psi	<b>00014.0</b>
35 bar / 500 psi	<b>00035.0</b>
70 bar / 1 000 psi	<b>00070.0</b>
250 bar / 3 625 psi	<b>00250.0</b>

**Ordering example**

PE sensor with standard housing  
PE sensor with short housing  
IEPE sensor (250 bar/3 625 psi)

Type 601C   **Type**

601CAA  
601CAB  
601CBA00250.0

<sup>1)</sup> All of the adapters are delivered with 1 pc. of each adapter seal type and 1 pc. lubrication grease Type 1063 (except adapters Type 6503C0D, 6503C1D, 6503C3A).