measure. analyze. innovate.

Test & Measurement Pressure

Measurement equipment for demanding T&M applications

www.kistler.com

About Kistler

A culture of innovation backed by a long history

A thirst for knowledge and a passion for technology inspired the foundation of Kistler Instrumente AG in 1959.
With the groundbreaking invention of the charge amplifier and the launch of the series production of the first quartz pressure sensors, Walter P. Kistler and Hans Conrad Sonderegger helped to bring about the global breakthrough for piezoelectric measurement technology. The triumphant progress of piezoelectric technology is inseparably linked to the evolution of this family firm, which has roots in both Switzerland and the USA.

The passion that inspired Kistler's two pioneers is still the hallmark of our company today. A unique culture of innovation opens up scope for new ideas, providing the fundamental basis for real success. Kistler operates its own facility for growing crystals according to a proprietary formula. These crystals are more sensitive and stable in fluctuating temperatures, so they deliver reliable results even in the most challenging applications.

The Kistler name is no longer merely a synonym for dynamic measurement technology: the company has also made a name for itself with piezoresistive, optical and strain gage measurement technology. The result: Kistler can always provide exactly the right technology to deliver the maximum benefit for our customers.

Alongside products for general measurements, Kistler offers complete solutions for specific applications including engine development, plastics processing and assembly technology.

Kistler continues to be a pioneer in measurement technology. To this day, Kistler physicists and engineers still share a personal passion for technology. Kistler is justly proud of its track record of longstanding relationships with its customers.

Facts and Figures about Kistler: **www.kistler.com/facts**

Contents

Test & Measurement

Measurement equipment for demanding T&M applications

Put your trust in Kistler's lengthy experience of pressure, acceleration, force strain and torque sensors, and the corresponding signal conditioning solutions for the T&M market. Kistler offers reliable, high-quality sensors for engineers, researchers, measurement technicians and students in a variety of applications.

Kistler leads the global market and is the largest provider of piezoelectric measurement technology. But in addition, Kistler's high-quality piezoresistive, capacitive and strain gage sensors are used in demanding applications by laboratories specializing in measurement, testing, research and development.
On the following pages, you can discover Kistler's diverse range of Test & Measurement products for measuring force and strain. This catalog will assist you with selecting the most suitable force or strain measuring chain for your application.
You can find detailed information about individual products on our data sheets, which can be downloaded from our website free of charge.
Our T&M Sales Team, and their contact partners in your area, will always be glad to hear from you.

Overview of markets

- Aerospace technology
- Transport and traffic
- Automobile engineering
- Shipbuilding and maritime industries
- Energy and environmental technology
- Oil and gas
- Chemical industry
- Pharmaceutical industry
- Semiconductor and electronics industry
- Paper and cellulose industry
- Food and beverage industry
- Construction and mining
- Medical technology
- Mechanical engineering
- University research

Your own measuring chain – in five steps

This catalog is structured so that it maps the entire measuring chain, from the sensor through to the signal conditioning solution. With the following overview, you can assemble a suitable pressure measuring chain for your application in just five steps.

You'll achieve the fastest result if you start out with the introduction to pressure measurement technology. Then, select the most suitable sensor technology for your application, and work through the category you have selected from the sensor, accessories and the cable to the signal conditioning solution.

Step 1 Introduction	Pressure measurement technology (p. 7)	
Step 2 Sensor	Piezoelectric pressure sensors (p. 13) PE IEPE	Piezoresistive pressure sensors (p. 45)
Step 3 Accessories	Mounting & accessories (p.22)	↓
Step 4 Cables	Cables (p. 24)	↓
Step 5 Signal conditioning	Signal conditioning PE / IEPE (p. 31)	↓
Step 6 Data acquisition	KiDAQ + KiStudio Lab SW-Package (p. 55)	

Focus on pressure measurement technology

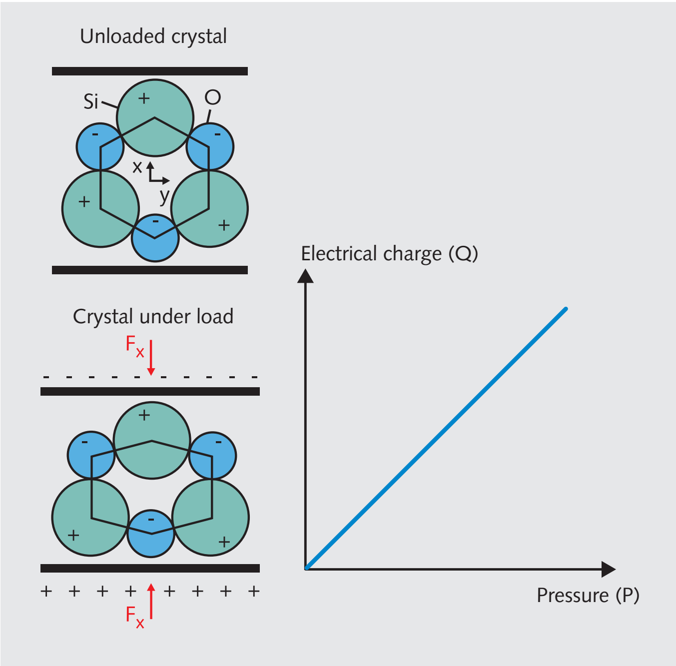
Focus on pressure measurement technology

Various measurement principles are used in pressure measurement technology. However, two principles have become established in practice: piezoelectric and piezoresistive pressure sensors. This catalog only covers piezoelectric and piezoresistive pressure sensors for T&M applications, and it highlights their main advantages.

In piezoelectric pressure sensors, the measuring element is based on a crystal that produces an electrical charge proportional to the pressure applied. In piezoresistive technology, the measuring element consists of a Silicon based Wheatstone-Bridge that extends minimally under pressure, so it changes the electrical resistance.

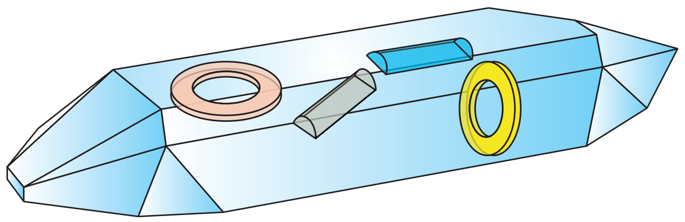
Fundamentals of piezoelectric measuring technology

The piezoelectric effect
The piezoelectric effect is exhibited by piezoelectric materials (such as quartz) that produce positive or negative electrical charges when a mechanical load is applied to their outer surfaces. The charge is generated because the positive and negative crystal lattice elements are displaced relative to one another, thereby forming an electric dipole. The charge generated as this happens is proportional to the force resp. pressure acting on the crystal.

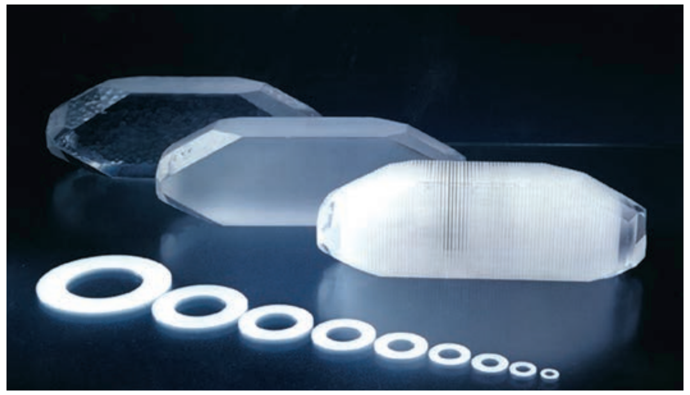


The mechanical load on a crystal produces an electrical charge. The electrical charge (Q) is proportional to the applied pressure (P).

Crystal as measuring elements
Measuring elements are cut out of the crystal in different shapes depending on the piezoelectric sensor characteristic needed.

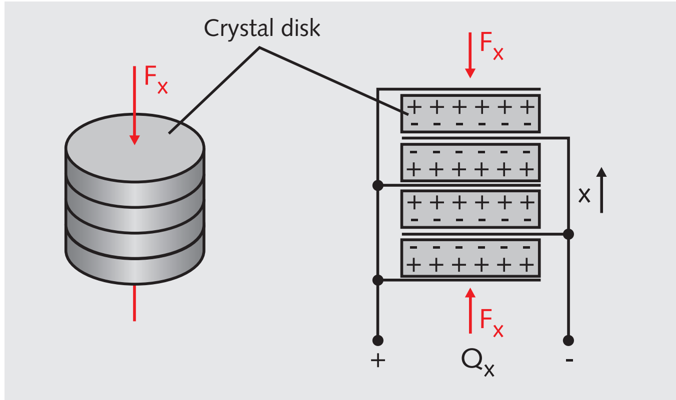


Different crystal element cut outs



Crystal disks as measuring elements

Piezoelectric crystals – PiezoStar versus quartz
The electrical charge generated by a single crystal disk depends only on the piezoelectric material, but not on its geometric dimensions. To produce sensors with higher sensitivity, several crystal disks can be stacked on top of one another and connected electrically in parallel. Alternatively, a piezoelectric material with higher sensitivity can be used (e.g. PiezoStar crystals).



Possibility of increasing the charge yielded

Kistler grows its own PiezoStar crystals which offer higher sensitivity, higher temperatures and better temperature stability than quartz. PiezoStar crystals are typically installed in sensors for measuring very small pressures or higher temperatures, so they extend the application range for commonly used quartz-based pressure sensors. Kistler offers piezoelectric pressure sensors based on both quartz and PiezoStar.

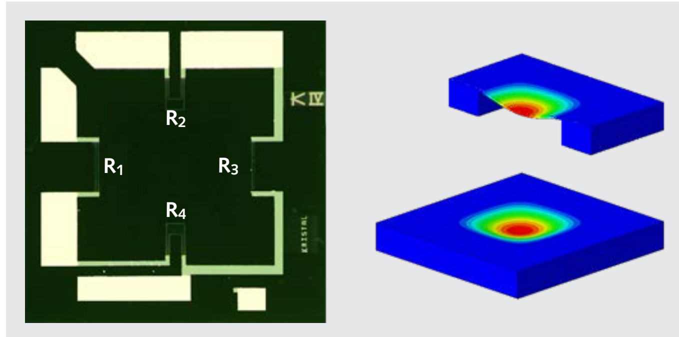
PiezoStar crystals

Piezoelectric measuring chain
A piezoelectric measuring chain basically consists of the (PE) sensor and an external charge amplifier or a sensor with built-in charge amplifier (IEPE) to convert the charge signal into a voltage signal.

Fundamentals of piezoresistive measuring technology

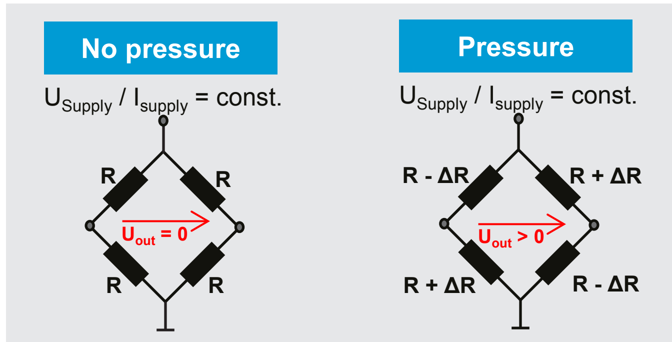
The piezoresistive effect
The piezoresistive effect is a change in the electrical resistivity of a material (e.g. semiconductor, metal) when mechanical strain is applied. The electrical resistance change is due to two causes; geometry change and conductivity change of the material. The change in resistance is much more pronounced for semiconductors than for metals.

Semiconductor as the measuring element
Kistler offers only piezoresistive pressure sensors based on silicon semiconductors. For this purpose, four Si-resistors are diffused into a semiconductor membrane and connected together in a Wheatstone bridge. Under the influence of the pressure, the diaphragm deforms affecting the electrical resistance of the four Si-resistors. The change in resistance is proportional to the applied pressure.



Si-chip with 4 resistors and pressure distribution on semiconductor

This also means that the differential voltage across the Wheatstone bridge is proportional to the applied pressure. The resulting differential voltage can be routed to the electrical connector for evaluation.



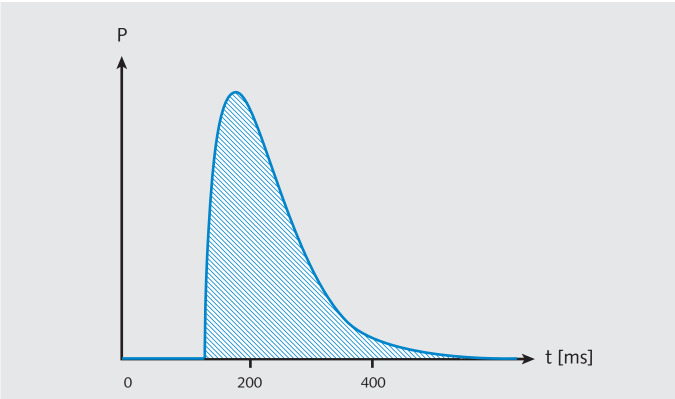
Piezoresistive Wheatstone bridge without pressure resp. with pressure

Piezoelectric vs. piezoresistive pressure sensors

Depending on the application, the use of a piezoelectric or piezoresistive pressure sensor is determined. The following sections outline the key difference between the two technologies, so as to simplify your decision-making process.

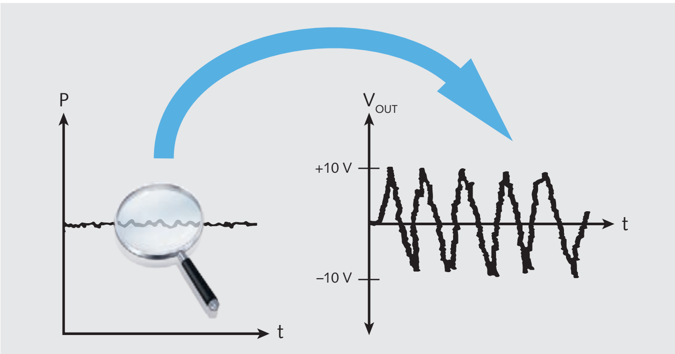
Piezoelectric pressure sensors

Dynamic pressure measurements
Piezoelectric pressure sensors have a high natural frequency of more than 500 kHz and are thus ideal for applications where fast pressure rise times of up to 1µs have to be measured.



Measurement of fast pressure rise times

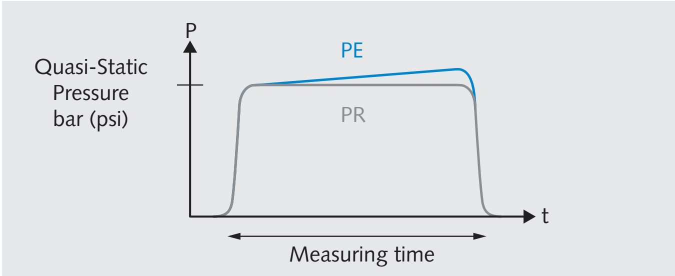
Measurement of pressure pulsations
Piezoelectric pressure sensors are the first choice for the measurement of very small pressure changes (pressure pulsations) at high static pressure levels. These enable the long-term measurement of very small pressure pulsations with high resolution and excellent signal-to-noise ratio for a frequency range of over 100 kHz.



Long-term measurement of smallest pressure pulsations with excellent sinal-to-noise ratio.

If, in the case of pressure pulsation measurement, the static pressure is also of interest, then the use of an additional piezoresistive pressure sensor is recommended.

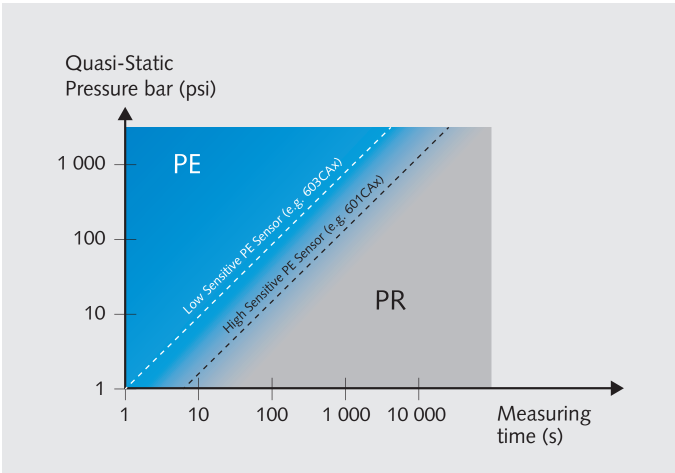
Quasi-static measurements
Due to their principle of operation, piezoelectric pressure sensors with charge output (PE) display a small drift when a static load is applied. By contrast, sensors based on the piezoresistive principle operate largely free of drift.



Drift in static pressure measurement of piezoelectric pressure sensors with charge output (PE).

In piezoelectric pressure sensors, the drift value always remains the same when a static load is applied, regardless of the measured pressure; therefor, the relative measurement error caused by the drift is always particularly unfavorable when small pressures are to be measured over a long period. However, measurements of large static pressures over lengthy measuring periods pose no problem. With piezoelectric pressure sensors, the measuring time therefor depends on the requirements for accuracy and the pressure to be measured.

The next graphic is intended to help you reach your decisions. It shows whether a piezoelectric pressure sensor can be used for your static measurement, or whether it is only appropriate to use a piezoresistive pressure sensor. The graphic very clearly shows that long measurement times pose no problems for piezoelectric pressure sensors if the pressures are sufficiently large. However, piezoresistive pressure sensors are clearly preferable for long-term monitoring tasks.



Measuring times and pressure ranges: piezoelectric (PE) vs. piezoresistive (PR) (basis: drift ±0.05 pC/s and measurement error of 1%)

Piezoresistive pressure sensors

Static pressure measurement
Piezoresistive pressure sensors are largely drift-free and are therefore the right technology for static long-term monitoring tasks.

Zero point
Piezoresistive pressure sensors measure against different zero points (absolute relative to vacuum, relative to ambient pressure and differential to another pressure), depending on the type of sensor.

The zero point for piezoelectric pressure sensors is given by the applied pressure at the start of the measurement.

Overview

In addition to the most important criterion, whether a static, quasi-static, dynamic pressure or a pressure pulsation is to be measured, there are other aspects which must be taken into account when selecting the measuring principle. The following overview table shows different criteria for which a measurement technology is preferable to the others, and thus serves as further decision support.

Criterion	Piezoelectric technology	PR technology
Static measurement		
Quasi-static measurement		
Dynamic measurement		
Pressure pulsations		
Small sensor dimensions		
Wide temperature range		
Suitability on temperature variation		

If you are not sure whether the piezoelectric or piezoresistive measuring technology is suitable for your application, please contact Kistler. Our T&M Sales Team will be glad to hear from you.

Piezoelectric pressure sensors

Piezoelectric pressure sensors

One of the most important selection criteria for piezoelectric pressure sensors is the output signal. Kistler offers piezoelectric pressure sensors with charge (PE) as well as voltage output (IEPE)

Piezoelectric pressure sensors are connected to an electronic circuit which converts the charge generated by the sensor into a proportional voltage. If this electronics is integrated into the sensor housing, it is referred to as a voltage output or IEPE or Piezotron sensor. If the electronics is an external device (charge amplifier), it is referred to as charge output or PE sensor.

Depending on the application, piezoelectric pressure sensors with charge or voltage output may be suitable. The following table shows a comparison of various features.

Piezoelectric Pressure Sensors	
Charge Output (PE)	**Voltage Output (IEPE, Piezotron)**
	
+ Quasi-static pressure measurement + Dynamic pressure measurement + Pressure pulsation measurement + Very wide temperature range + Adjustable pressure range	+ Dynamic pressure measurement + Pressure pulsation measurement + Standard cable (Handling) + Connection directly to IEPE-DAQ possible
– Special low noise high-impedance cable (Handling) – External charge amplifier	– Quasi-static pressure measurement – Limited temperature range – Fixed pressure range

Detailed explanations of the two versions are given in the following sections.

PE pressure sensors

PE sensors output a charge signal; hence the sensitivity is given as pico-coulombs per unit of pressure (e.g. pC/bar or pC/psi). Pressure applied to a PE sensor produces a negative going charge signal (hence the negative sensitivity of PE sensors), which then is converted into a positive voltage signal by the external charge amplifier.

Contrary to IEPE sensors, PE sensors don't need to be powered, as a charge signal is produced when pressure is applied to the piezoelectric material. However a low noise high impedance cable supplied by Kistler is used to connect the sensor to charge amplifier.

PE pressure sensors are connected to an external charge amplifier. This converts the charge into a voltage signal. Kistler offers charge amplifiers with analog outputs (which can then be connected to a DAQ) as well as digital charge amplifiers with integrated DAQ.

The measurement of dynamic pressure profiles and pressure pulsations is possible with PE as well as IEPE pressure sensors. PE measuring chains are used in particular when one of the following cases is present:

- Measurement of quasi-static pressures
- Measurement of extremely low or very high temperatures (no electronics in the sensor)
- Adjustable measuring ranges with only one pressure sensor (measuring range adjustable in the charge amplifier)

IEPE pressure sensors (Piezotron)

IEPE stands for Integrated Electronics Piezo Electric and refers to an industry standard for piezoelectric sensors with integrated electronic circuits that convert a charge into a voltage signal. Piezotron is the registered trademark of Kistler of IEPE sensors.

IEPE sensors output a voltage signal; hence the sensitivity is given as Milivolt per unit of pressure (e.g. mV/bar or mV/psi). Pressure applied to an IEPE sensor produces a positive voltage signal (hence the positive sensitivity of IEPE sensors).

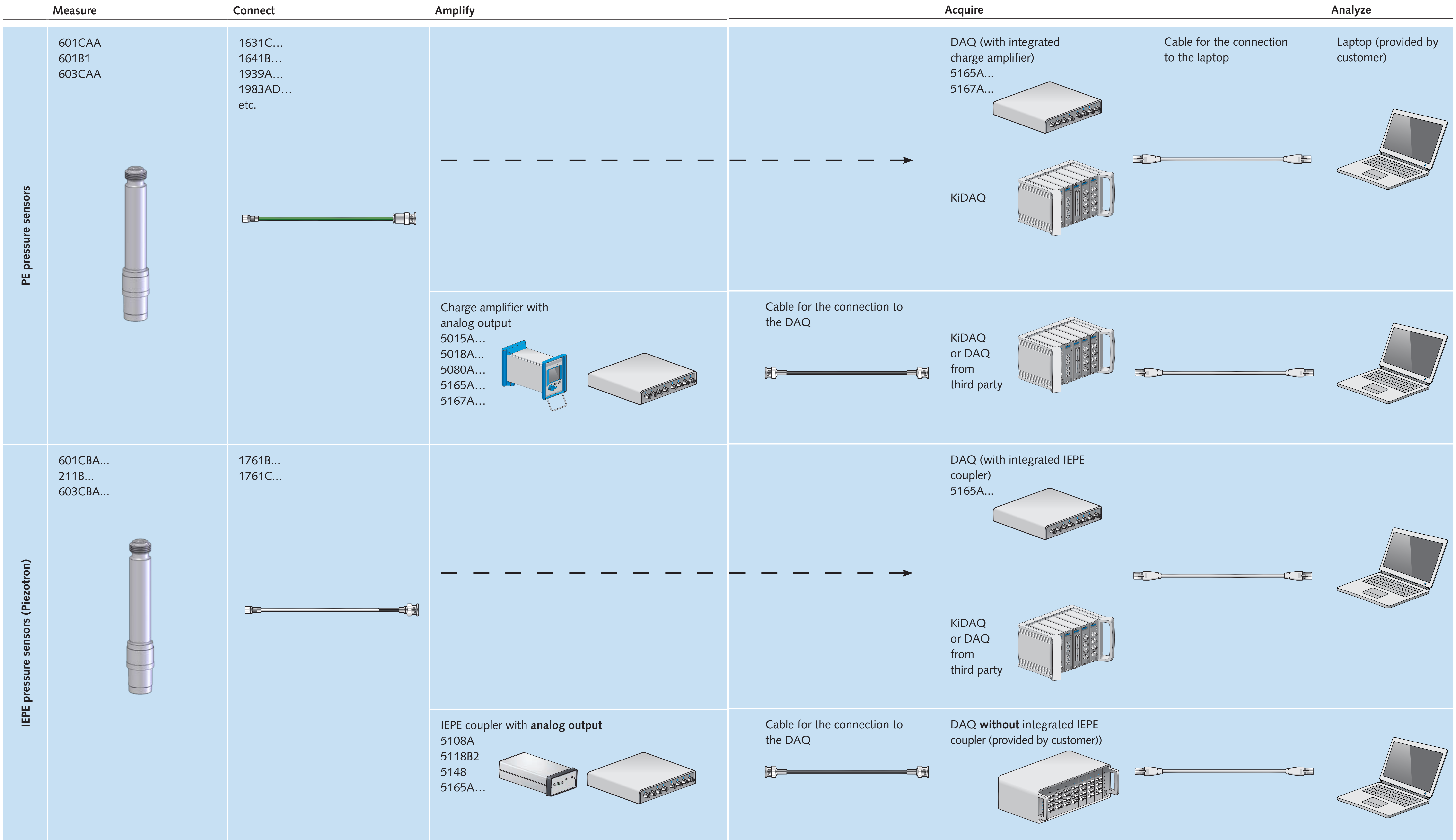
Contrary to PE sensors, IEPE sensors require built-in electronics to be powered. However, a standard two-wire cable suffices to power the sensor and transmit the voltage signal.

IEPE pressure sensors must be connected to current (IEPE) coupler. This provides the IEPE sensor with power and decouples the voltage signal from the power supply signal. IEPE pressure sensors can be connected with an external IEPE coupler to a DAQ or directly to IEPE-DAQ. Kistler offers both external IEPE couplers as well as digital IEPE couplers with integrated DAQ.

In all cases where only dynamic pressure profiles or pressure pulsations, at moderate temperatures and a fixed measuring range, are measured, IEPE pressure sensors are an optimal.

Piezoelectric pressure sensors

Measuring chains



Details from page 18 onwards
Details from page 24 onwards
Details from page 31 onwards

Piezoelectric pressure sensors

Product overview

Depending on the application, other requirements arise to use the piezoelectric pressure sensor. In some applications, high sensitivity is a priority, in others, however a very high natural frequency or fast rise time etc. The following overview gives a summary of the different pressure sensor families and their most important parameters.

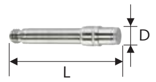
601C series
- PiezoStar crystal
- Pressure range up to 250 bar (3 636 psi)
- Extremely wide operating temperature range up to 350°C (662°F)
- Very high sensitivity and low noise
- High natural frequency and fast rise times
- Optimized thermal design
- Sensor housing welded (hermetically sealed)
- Small size
- Charge (PE) and voltage (IEPE) output

601B1/211B series
- Quartz crystal
- Pressure range up to 250 bar (3 636 psi)
- Wide operating temperature range up to 200°C (392°F)
- Medium sensitivity
- High natural frequency and fast rise times
- Acceleration compensated
- Sensor housing epoxy sealed (not hermetically sealed)
- Small size
- Charge (PE) and voltage (IEPE) output

603C series
- Quartz crystal
- Pressure range up to 1 000 bar (15 000 psi)
- Wide operating temperature range up to 200°C (392°F)
- Small sensitivity
- Very high natural frequency and very fast rise times
- Acceleration compensated
- Sensor housing welded (hermetically sealed)
- Small size
- Charge (PE) and voltage (IEPE) output

PE pressure sensors

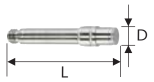
Product details

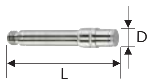
Technical Data	Type	601CAA	601B1	603CAA
Pressure range	bar psi	0 … 250 0 … 3 626	0 … 250 0 … 3 626	0 … 1 000 0 … 15 000
Sensitivity (nom.)	pC/bar pC/psi	–37.0 –2.6	–14.5 –1.0	–5.0 –0.35
Linearity (typ.)	% FSO	≤±0.1	≤±1.0	≤±0.4
Operating temperature range	°C °F	–196 … 350 –321 … 662	–196 … 200 –321 … 392	–196 … 200 –321 … 392
Rise time (10 … 90%)	μs	<1.4	<1.2	<0.4
Natural frequency	kHz	>215	>250	>500
Acceleration sensitivity	bar/g psi/g	0.0020 0.0290	0.0001 0.0020	0.00014 0.00200
Dimensions (L x D)  D L	mm inch	37.7 x 5.55 1.48 x 0.22	33.0 x 5.55 1.30 x 0.22	37.8 x 5.55 1.49 x 0.22
Weight	gram oz	4.5 0.16	3.9 0.14	4.8 0.17
Sensor housing hermetically sealed	–	Yes (welded)	No (Epoxy)	Yes (welded)
Material (Housing & diaphragm)	–	17-4 PH S.S.*	17-4 & 316L S.S.*	17-4 PH S.S.*
Connector	–	10–32 neg.	10–32 neg.	10–32 neg.

*) SS = Stainless Steel

IEPE pressure sensors

Product details

Technical data	Type	601C series							211B series	
		601CBA00001.5	601CBA00003.5	601CBA00007.0	601CBA000014.0	601CBA00035.0	601CBA00070.0	601CBA00250.0	211B6	211B5
Pressure range	bar psi	1.5 22	3.5 50	7.0 100	14.0 200	35.0 500	70 1 000	250 3 626	3.5 50	7.0 100
Sensitivity (nom.)	mV/bar mV/psi	3 333 230	1 429 100	714 50	357 25	143 9.9	71 4.9	20 1.4	1 450 100	725 50
Linearity (typ.)	% FSO	≤±1.0	≤±1.0	≤±1.0	≤±1.0	≤±1.0	≤±1.0	≤±1.0	≤±1.0	≤±1.0
Operating temperature range	°C °F	–55 … 120 –67 … 248	–55 … 120 –67 … 248	–55 … 120 –67 … 248	–55 … 120 –67 … 248	–55 … 120 –67 … 248	–55 … 120 –67 … 248	–55 … 120 –67 … 248	–55 … 120 –67 … 248	–55 … 120 –67 … 248
Rise time (10 … 90%)	µs	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.4	<1.2	<1.2
Natural frequency	kHz	>215	>215	>215	>215	>215	>215	>215	>250	>250
Time constant	s	2	3	3	3	3	3	3	20	30
Low frequency response –3 dB –5%	Hz Hz	0.080 0.243	0.053 0.161	0.053 0.161	0.053 0.161	0.053 0.161	0.053 0.161	0.053 0.161	0.008 0.024	0.005 0.015
Acceleration sensitivity	bar/g psi/g	0.0020 0.0290	0.0020 0.0290	0.0020 0.0290	0.0020 0.0290	0.0020 0.0290	0.0020 0.0290	0.0020 0.0290	0.0002 0.0020	0.0002 0.0020
Dimensions (L x D) 	mm inch	37.7 x 5.55 1.48 x 0.22	37.7 x 5.55 1.48 x 0.22	37.7 x 5.55 1.48 x 0.22	37.7 x 5.55 1.48 x 0.22	37.7 x 5.55 1.48 x 0.22	37.7 x 5.55 1.48 x 0.22	37.7 x 5.55 1.48 x 0.22	33.0 x 5.55 1.30 x 0.22	33.0 x 5.55 1.30 x 0.22
Weight	gram oz	3.7 0.13	3.7 0.13	3.7 0.13	3.7 0.13	3.7 0.13	3.7 0.13	3.7 0.13	3.9 0.14	3.9 0.14
Sensor housing hermetically sealed	–	Yes (welded)	Yes (welded)	Yes (welded)	Yes (welded)	Yes (welded)	Yes (welded)	Yes (welded)	No (Epoxy)	No (Epoxy)
Material	–	17-4 PH S.S.*	17-4 PH S.S.*	17-4 PH S.S.*	17-4 PH S.S.*	17-4 PH S.S.*	17-4 PH S.S.*	17-4 PH S.S.*	17-4 PH & 316L S.S.*	17-4 PH & 316L S.S.*
Connector	–	10–32 neg.	10–32 neg.	10–32 neg.	10–32 neg.	10–32 neg.	10–32 neg.	10–32 neg.	10–32 neg.	10–32 neg.

Technical data	Type	603C series					
		603CBA00014.0	603CBA00035.0	603CBA00070.0	603CBA00350.0	603CBA00690.0	603CBA01000.0
Pressure range	bar psi	14.0 200	35.0 500	70.0 1 000	350 5 000	690 10 000	1 000 15 000
Sensitivity (nom.)	mV/bar mV/psi	357 25	143 10	71 5	14 1	7 0.5	5 0.3
Linearity (typ.)	% FSO	≤±1.0	≤±1.0	≤±1.0	≤±1.0	≤±1.0	≤±1.0
Operating temperature	°C °F	–55 … 120 –67 … 248	–55 … 120 –67 … 248	–55 … 120 –67 … 248	–55 … 120 –67 … 248	–55 … 120 –67 … 248	–55 … 120 –67 … 248
Rise time (10 … 90%)	µs	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Natural frequency	kHz	>500	>500	>500	>500	>500	>500
Time constant	s	2	3	3	3	3	3
Low frequency response –3 dB –5%	Hz Hz	0.080 0.242	0.053 0.161	0.053 0.161	0.053 0.161	0.053 0.161	0.053 0.161
Acceleration sensitivity	bar/g psi/g	0.00001 0.00015	0.00001 0.00015	0.00001 0.00015	0.00001 0.00015	0.00001 0.00015	0.00001 0.00015
Dimensions (L x D) 	mm inch	37.8 x 5.55 1.49 x 0.22	37.8 x 5.55 1.49 x 0.22	37.8 x 5.55 1.49 x 0.22	37.8 x 5.55 1.49 x 0.22	37.8 x 5.55 1.49 x 0.22	37.8 x 5.55 1.49 x 0.22
Weight	gram oz	4.1 0.14	4.1 0.14	4.1 0.14	4.1 0.14	4.1 0.14	4.1 0.14
Sensor housing hermetically sealed	–	Yes (welded)	Yes (welded)	Yes (welded)	Yes (welded)	Yes (welded)	Yes (welded)
Material	–	17-4 PH S.S.*	17-4 PH S.S.*	17-4 PH S.S.*	17-4 PH S.S.*	17-4 PH S.S.*	17-4 PH S.S.*
Connector	–	10–32 neg.	10–32 neg.	10–32 neg.	10–32 neg.	10–32 neg.	10–32 neg.

*) SS = Stainless Steel

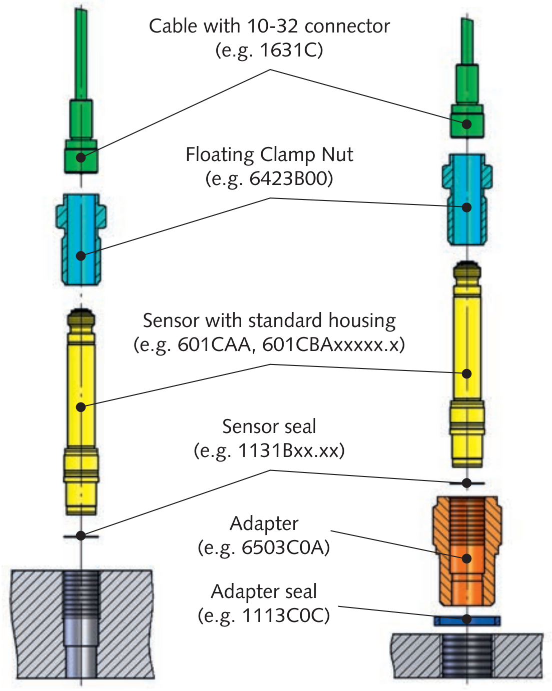
Piezoelectric pressure sensors

Mounting

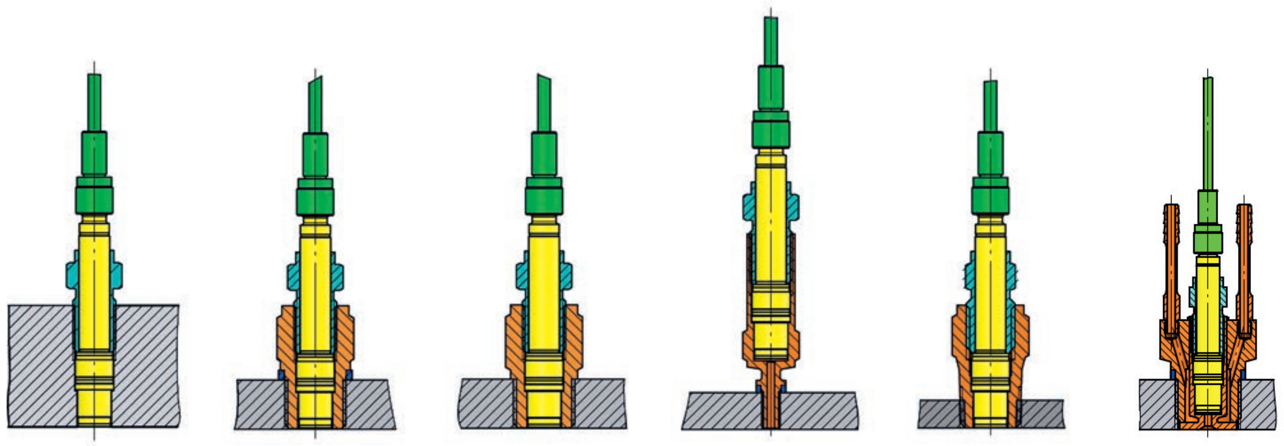
Mounting (sensors with standard housing)
Sensors with charge output (PE) and voltage output (IEPE) are available with standard housing. Sensors with a standard housing can either be installed directly or with an adapter.

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	Type 6503CxA Adapter	Type 6503CxD Adapter	Type 6507BxA Adapter	Type 6503C3A Adapter	Type 6509B Adapter
• Flush mounting • Complex drilling with special tool • Min. structural influences on pressure measurement (mechanical decoupling) • Ideal for close matrix alignment of sensors	• M10 and 3/8-24 UNF • Stainless steel (1.4542) • Flush mounting • Max. Pressure 1 000 bar (14 500 psi)	• 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)	• M3 and 5-40 UNC • Stainless steel (1.4542) • Recessed mounting • Max. Pressure 300 bar (4 350 psi)	• 1/8-27 NPTF • Stainless steel (1.4542) • Almost flush mounting • Max. Pressure 1 000 bar (14 500 psi)	• M14x1.25 • Water Cooling • Stainless steel (1.4542) • Max. Pressure 300 bar (4 350 psi) • Max. temperature 400°C (752°F)



Piezoelectric pressure sensors

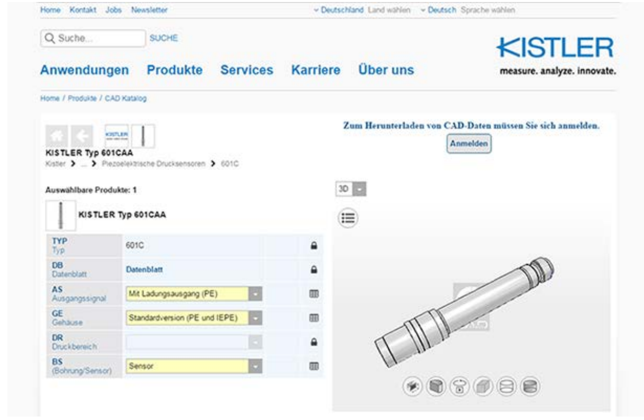
Accessories

Accessories (included)	Type/Art.-No.
• Sensor seal copper (5 pcs.)	1131BA0.15

Accessories (optional)	Type/Art.-No.
• Sensor seal copper (100 pcs)	1131BA0.15
• Sensor seal nickel (100 pcs)	1131BB0.20
• Floating clamp nut M7x0.75	6423B00
• Floating clamp nut 5/16-24-UNF	6423B11
• Adapter M10x1[1)]	6503C0A
• Adapter seal (S.S. / 25 pcs) for 6503C0A	1113C0B
• Adapter seal (Cu / 25 pcs) for 6503C0A	1113C0C
• Adapter 3/8-24-UNF[1)]	6503C1A
• Adapter seal (S.S. / 25 pcs) for 6503C1A	1113C1B
• Adapter seal (Cu / 25 pcs) for 6503C1A	1113C1C
• Adapter M3x0.5[1)]	6507B0A
• Adapter 5-40 UNC[1)]	6507B1A
• Adapter seal for 6507BxA	1117B0C
• Lubrication grease (Adapter)	1063
• Adapter M10x1 (ground isolated)	6503C0D
• Adapter 3/8-24 UNF (ground isolated)	6503C1D
• Adapter 1/8-27 NPTF	6503C3A
• Adapter M14x1.25	6501B0A
• Adapter seal (S.S / 1pc) for 6501B0A	1100A11
• Adapter M14x1.25 (water cooling)	6509B
• Adapter seal (Cu / 1pc) for 6509B	1111
• Temperature conditioning system	2621G
• Connector extender (configurable product)	6482A
• Extraction tool	1311
• Dummy sensor (standard housing)	6487AA
• Dummy sensor (short housing)	6487AB
• Step reamer (SC H7 Ø6.35/Ø5.58)	1331C
• Thread cutter M7x0.75	1351A0
• Thread cutter 5/16-24 UNF	1351A1
• RTV tool	1300A195
• RTV seal (S.S. / 25 pcs)	1131BC1.15
• RTV	1007A

1) 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).

CAD data
3D CAD models of sensors and accessories can be downloaded free of charge from Kistler's webpage and are available in different file formats.



3D CAD data can be downloaded free of charge from www.kistler.com/cad-catalog

Piezoelectric pressure sensors

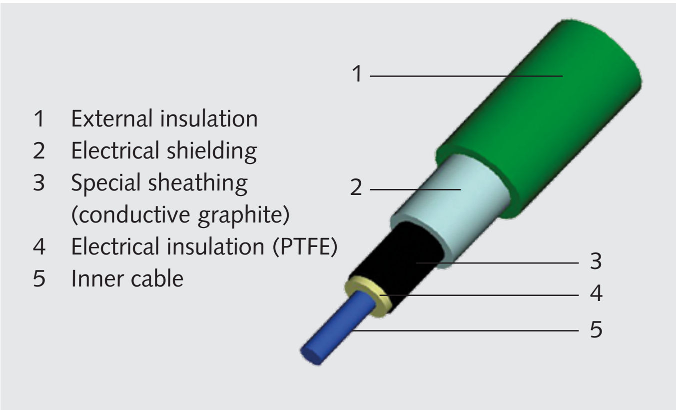
Cables

PE cable

Piezoelectric pressure sensors and charge amplifiers must be connected with a low noise high-impedance cable (insulation resistance >10^{13} Ω).

In contrast to standard coaxial cables, the innermost wire of high-impedance cables is insulated with PTFE (this reduces drift effects to the absolute minimum). In addition, a special graphite sheathing minimizes the triboelectric noise.
There are various versions for the outermost insulation which can be selected based on the application (see: Cable versions).

The points set out in the next two sections are especially important when measuring very small pressures.



Structure of a Kistler high-impedance cable

As well as using high-impedance cables when working with piezoelectric measuring chains, it is also important to ensure that connectors and sockets are always clean. It is recommended to leave the protective caps on the sockets of pressure sensors and charge amplifiers until they are connected. The protective caps should be installed again whenever components are disconnected or placed in storage. If connectors become dirty, they can be cleaned with Kistler Cleaning Spray, Type 1003.

The 'triboelectric effect' is the name of the phenomenon whereby the movement of a cable causes minimal charge to occur on the surface of the conductor. The special graphite sheathing on Kistler's high-impedance cables provides low triboelectric noise and therefor exhibit less than 1pC with high vibration. Nevertheless, strain relieving cables are the best practice to minimize cable motion.

IEPE cable

IEPE pressure sensors and IEPE couplers can be connected with a cost-effective standard coaxial cable or a low noise high-impedance PE cable.

Cable versions

PFA cable (ø2 mm / ø0.078")
The outer insulation of high-impedance PFA cable consists of a material similar to PTFE, so it exhibits excellent thermal stability and outstanding resistance to chemicals. PFA cable is suitable for most applications with temperatures up to 200°C.

PFA cable

PFA cable with stainless steel braiding (ø2.6 mm / ø0.102")
PFA cable with stainless steel braiding is especially advisable for applications where the cable is subject to mechanical stress (e.g. vibration-induced friction, sharp edges, etc.)

PFA cable with stainless steel braiding

FKM cable (ø2 mm / ø0.078")
FKM cable also features high thermal and chemical resistance, and can be used at temperatures of up to 200°C. In contrast to PFA cables, however, the cable connectors are vulcanized. Sealed solutions to IP68 can be achieved by welding the cable connector and the sensor connector.

FKM cable

PI cable
The use of PI cables is only recommended for applications with high temperatures up to 260°C. Since the use of PI cables is rare and requires special know-how, the corresponding products are not listed in this catalog. If you have a requirement, please contact your local Kistler sales center.

Cable lengths

All Kistler cables are available in standard and custom lengths. Standard lengths are kept in stock, so they offer the advantage of shorter delivery times.

Cable connections

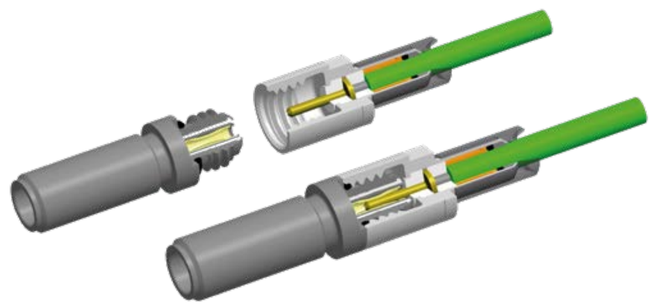
Cable connectors: sensor side
Two cable connectors are generally available to connect the cables to the sensor.

Because of the swivel nut, cables with a **KIAG 10-32 pos.** connector can be screwed and unscrewed with no need to rotate the entire cable at the same time. This is a particular advantage for applications that require frequent removal or reconnection of the cable.

KIAG 10-32 pos. – connector with rotatable swivel nut

The **KIAG 10-32 pos. int.** cable connector has an integrated thread so when it is screwed and unscrewed; the cable rotates at the same time. This connector is particularly advantageous if the cable connector has to be welded to the sensor. In the case of PFA cables, welding the cable connector to the sensor offers protection against detachment of the cable if the measuring chain is subject to strong vibration. If high sealing (IP68) is required, the FKM cable is preferred.

Requirements to weld the connector to the sensor, are stated at the time of order.

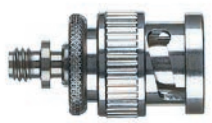


KIAG 10-32 pos. int. – connector with integrated thread

Cable connectors: signal conditioning side
A BNC pos. cable connector is required when connecting the sensor directly to the signal conditioner or coupler. Most cables are available with BNC (pos.) termination. However, these cables are not suitable for applications where the cable has to be routed through small openings.

Cables with a KIAG 10-32 pos. cable connector on bothsides are more suitable for this purpose. KIAG 10-32 connectors (Ø6mm) / (Ø0.226") have smaller diameters than BNC connectors (Ø15mm) / (Ø10.07"), so they can be routed through smaller openings. The KIAG 10-32 pos. (int.) cable connector can then be connected to the BNC socket of the signal conditioner with a Type 1721 coupling as shown below.

Cable with KIAG 10-32 pos. connector, both sides



Type 1721 coupling (KIAG 10-32 neg. to BNC pos.)

Piezoelectric pressure sensors

Overview of cables

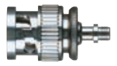
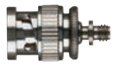
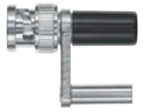
Sensor family	Cable														
	Technical data	Type	Connector		Length (standard) [m, ft] *	Length (custom) [m, ft]		Cable sheathing material	Operating temperature range [°C, °F]		Cable can be welded to sensor		Degree of protection to IEC/EN 60529		Comments
			left	right		min.	max.		min.	max.	yes	no	left	right	
PE Sensors 601CAA 601B1 603CAA		**1631C…**	KIAG 10-32 pos.	BNC pos.	0.5 / 1 / 2 / 3 / 5 / 10 / 20 1.6 / 3.3 / 6.6 / 9.8 / 16.4 / 32.8 / 65.6	0.1 0.3	100 328	PFA	–55 –67	200 392		•	IP65	IP40	Standard cable for most PE applications
		**1641B…**	KIAG 10-32 pos. 90°	BNC pos.	0.5 / 1 / 2 / 5 1.6 / 3.3 / 6.6 / 16.4	0.1 0.3	100 328	PFA	–55 –67	200 392		•	IP40	IP40	
		**1939A…**	KIAG 10-32 pos. int.	BNC pos.	1 / 2 / 3 3.3 / 6.6 / 9.8	0.1 0.3	100 328	PFA	–55 –67	200 392	•		IP65 –> screwed connection IP67 –> welded connection	IP40	
		**1635C…**	KIAG 10-32 pos.	KIAG 10-32 pos.	0.5 / 1 / 2 / 3 / 5 / 10 1.6 / 3.3 / 6.6 / 9.8 / 16.4 / 32.8	0.1 0.3	100 328	PFA	–55 –67	200 392		•	IP65	IP65	
		**1957A…**	KIAG 10-32 pos.	KIAG 10-32 pos.	1 3.3	0.1 0.3	10 33	PFA with stainless steel braiding	–55 –67	200 392		•	IP65	IP65	
		**1969A…**	KIAG 10-32 pos. int.	KIAG 10-32 pos. int.	1 3.3	0.1 0.3	10 33	PFA with stainless steel braiding	–55 –67	200 392	•		IP 65 –> screwed connection IP67 –> welded connection	IP65	
		**1967A…**	KIAG 10-32 pos. int.	KIAG 10-32 pos. int.	0.5 / 1 / 2 / 3 1.6 / 3.3 / 6.6 / 9.8	0.1 0.3	10 33	PFA with stainless steel braiding, ground-isolated	–55 –67	200 392	•		IP 65 –> screwed connection IP67 –> welded connection	IP65	
		**1983AD…**	KIAG 10-32 pos. int.	BNC pos.	2 / 5 6.6 / 16.4	0.1 0.3	20 66	FKM	–20 –4	200 392	•		IP68 –> screwed connection IP68 –> welded connection	IP40	
		**1983AC…**	KIAG 10-32 pos. int.	KIAG 10-32 pos. int.	0.5 / 1 / 1.5 / 2 / 3 / 5 1.6 / 3.3 / 4.9 / 6.6 / 9.8 / 16.4	0.1 0.3	20 66	FKM	–20 –4	200 392	•		IP68 –> screwed connection IP68 –> welded connection	IP65	
IEPE Sensors 601CBA… 211B… 603CBA…		**1761B…**	KIAG 10-32 pos.	BNC pos.	1 / 2 / 3 / 5 3.3 / 6.6 / 9.8 / 16.4	0.1 0.3	200 656	PTFE	–196 –320	200 392		•	IP65	IP40	Standard cable for most IEPE applications
		1762B…	KIAG 10-32 pos.	KIAG 10-32 pos.	1 / 2 / 3 / 5 3.3 / 6.6 / 9.8 / 16.4	0.1 0.3	200 656	PTFE	–196 –320	200 392		•	IP65	IP65	

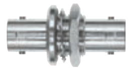
*) Cable ordering is in meters

Piezoelectric pressure sensors

Cable accessories

Couplings

Type		Connector	
		Left	Right
1701		BNC neg.	BNC neg.
1705		BNC pos.	M4x0.35 neg.
1721		BNC pos.	KIAG 10-32 neg.
1729A		KIAG 10-32 neg.	KIAG 10-32 neg.
1733		BNC pos.	Bananen-Buchsen

Type		Connector	
		Left	Right
1743		BNC pos.	2 x BNC neg.
1749		KIAG 10-32 pos.	2 x KIAG 10-32 neg.
1700A29		KIAG 10-32 neg.	KIAG 10-32 pos. int.
1703		BNC neg.	BNC neg.

Plastic protective caps

Type		To be used for
1851		BNC neg.
1861A		BNC pos.
1891		KIAG 10-32 neg.

The plastic protective caps reliably protect the connectors and sockets against contamination. If sensors or charge amplifiers are not being used or are in storage, it is advisable to protect the connectors with protective caps.

Accessories for PE measuring chains

Type		To be used for
5493		Insulation tester for the control of PE measuring chains. Measures the isolation of sensors, cables and charge amplifiers.
1003A		Cleaning and insulation spray for PE measuring chains

BNC cable, high insulation

Type	Connector		Length (standard) [m]	Length (custom) [m]		Cable sheath material	Operating temperature range [°C]		Deg. of protection to IEC/EN 60529	
	Left	Right		min.	max.		min.	max.	Left	Right
1601B... 	BNC pos.	BNC pos.	0.5 / 1 / 2 / 5 / 10 / 20	0.1	50	PVC	–25	70	IP40	IP40

Cable

Signal conditioning for piezoelectric sensors

Signal conditioning for piezoelectric sensors

Introduction

Signal conditioning is an important consideration to achieve the best measurement. Kistler offers a comprehensive product portfolio for signal conditioning and subsequent digitization of the data.

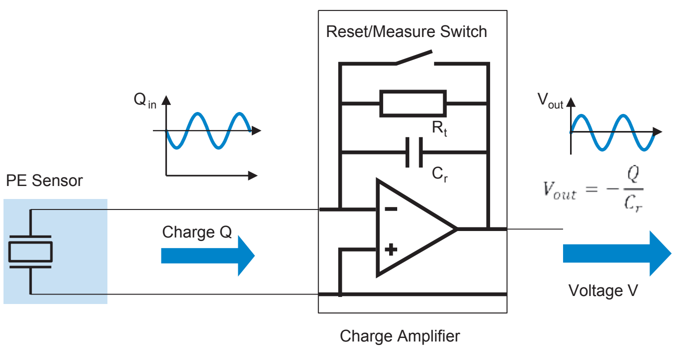
The signal conditioning to be used is dependent on the type of sensor (PE or IEPE) and should be selected as follows:

- **Charge amplifier** for PE sensors
- **IEPE (Piezotron) Coupler** for IEPE sensors

In addition to charge amplifiers and IEPE couplers, Kistler also offers so called dual-mode signal conditioners, which combine both functions in one device.

With the IEPE couplers, it should be noted that, in addition to pure couplers, there are also data acquisition systems with IEPE inputs. The IEPE coupler is integrated in such devices and IEPE sensors can be connected directly to the data acquisition system.

Charge amplifier



A charge amplifier is the appropriate signal conditioning solution for PE sensors. The amplifier converts the charge signal of the sensor into a proportional voltage signal and thus makes the measurement available for further processing.

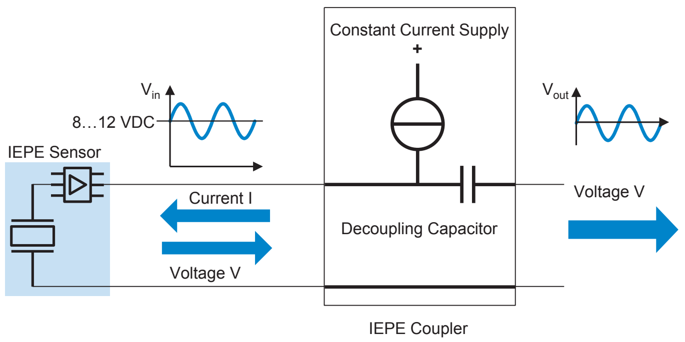
Kistler offers both charge amplifiers with analog outputs as well as digital charge amplifiers with integrated data acquisition (DAQ).

Further information on charge amplifiers is provided starting on page 33.

Charge amplifier with integrated DAQ

Charge amplifier without DAQ

IEPE (Piezotron) coupler



An IEPE coupler is to be used for signal conditioning for IEPE sensors. The coupler supplies a constant current to power the sensor and decouples the measured AC signal from the DC power supply.

Kistler's portfolio includes both IEPE couplers with analog outputs as well as digital IEPE couplers with integrated data acquisition (DAQ).

Further information on IEPE couplers is provided starting on page 38.

IEPE coupler with integrated DAQ

IEPE coupler without DAQ

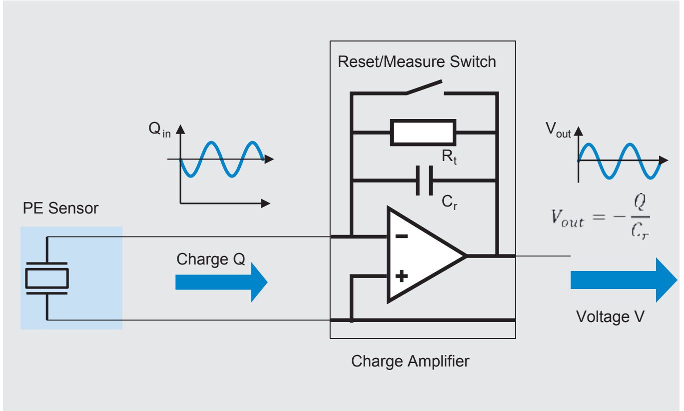
Charge amplifiers

The charge produced by a piezoelectric sensor is a variable that is difficult to access for measurement. The sensor is therefore connected to an electronic circuit which converts the charge signal into a voltage signal.

A charge amplifier converts the negative charge signal of the PE sensor into a positive voltage proportional to the pressure. Pressure sensors have a negative sensitivity as a matter of principle and give a negative charge under load.

The following figure shows the circuit diagram of a charge amplifier with its three essential components:

- Range capacitor C_r
- Time constant resistor R_t
- Reset/Measure switch



Circuit diagram of a charge amplifier

The **range capacitor C_r** is used to set the measurement range of the charge amplifier. This is done by switching between different range capacitors. Switching over the measurement ranges makes it possible to measure across several decades with high signal-to-noise ratio. Hence, for example, it is possible to use the same pressure sensor to measure pressures of a few hundred bar (thousand psi) and a few µbar (µpsi), simply by switching over the measurement range. Furthermore, the signal-to-noise ratio is excellent in both ranges.

The **time constant resistor R_t** defines the low frequency performance of the charge amplifier. In particular, the time constant determines the cut-off frequency for the high-pass characteristic of the charge amplifier. Switching between different time constant resistors makes it possible to change the high-pass characteristic.

The **Reset/Measure switch** is used to control the start of measurement or to set the zero point.

Selection criteria for charge amplifiers

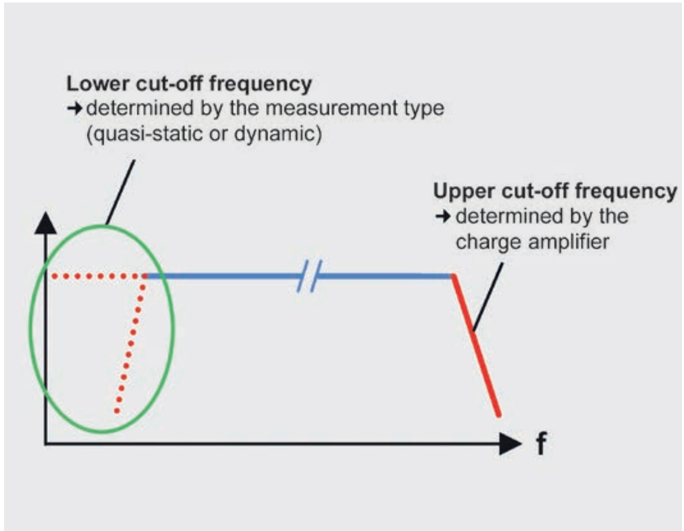
Various criteria determine the choice of a charge amplifier that is suitable for the corresponding application. The product overview on page 40 shows a selection of suitable charge amplifiers with all the criteria. The most important selection criteria for choosing a suitable charge amplifier are as follows:

- Number of channels
- Measuring range
- Measurement type
- Frequency range
- Use of data

The following sections give more detailed explanations of the 'frequency range' and 'measurement type' selection criteria.

Frequency range

The frequency range of a charge amplifier is defined by the lower and upper cut-off frequencies. The lower cut-off frequency is determined by the measurement type (quasi-static or dynamic) and related high-pass characteristic. The maximum upper frequency is only dependent on the low-pass characteristic of the charge amplifier, but not on the measurement type.



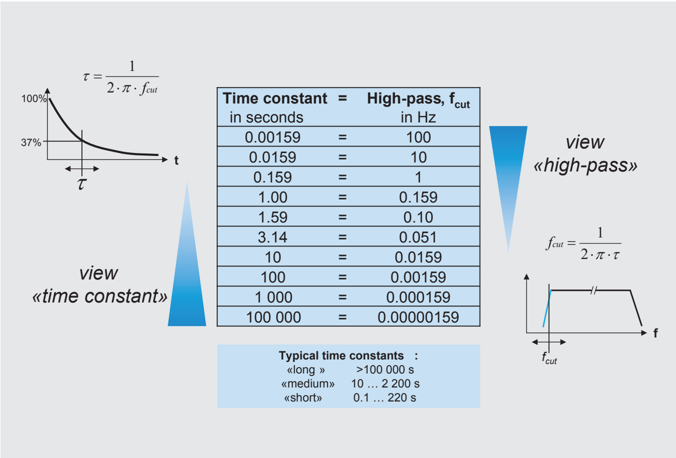
Frequency range: charge amplifier

Measurement type – quasi-static versus dynamic measurement

A distinction is made in piezoelectric measurement technology between quasi-static and dynamic measurements. Many charge amplifiers support both types of measurement, but there are some amplifiers that only permit one of the two measurement types. For this reason, it is critically important to have clear understanding of the type of measurement that should be used for the specific measurement task.

The measurement type determines the behavior of the charge amplifier in the lower frequency range, and is influenced by the time constant. The time constant determines the cut-off frequency of the high-pass characteristic of the charge amplifier, so it also determines the measurement type.

Time constant vs. high-pass
The time constant determines the cut-off frequency of the high-pass characteristic of the charge amplifier. The following diagram shows the relationship between the time constant (τ) and the high-pass cut-off frequency (f_{cut}). Depending on whether the time domain or the frequency domain is of interest, one or the other view is better suited.

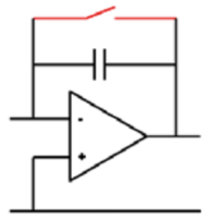
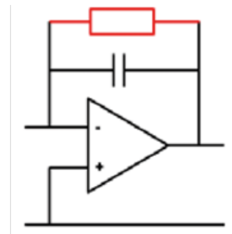
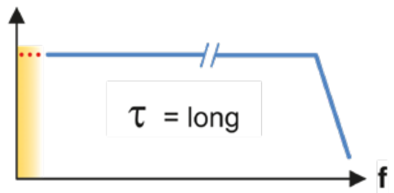
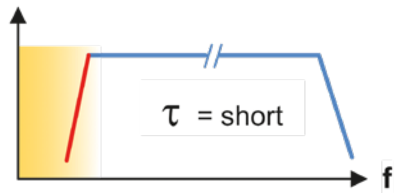
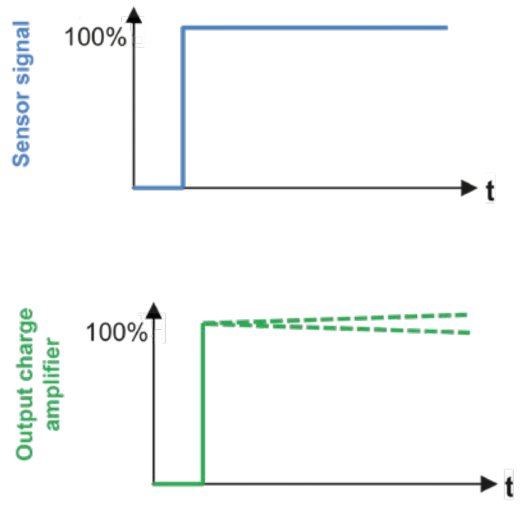


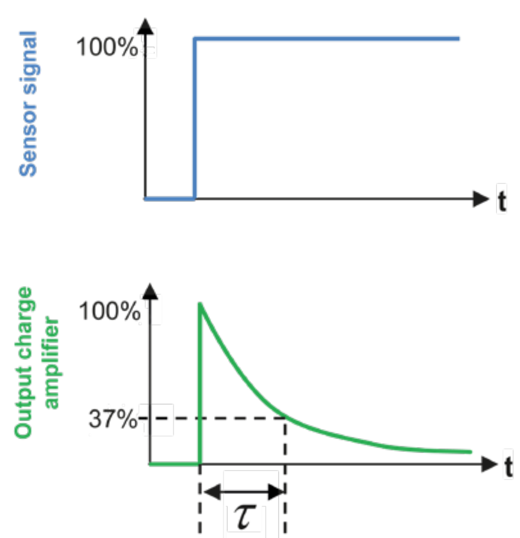
Time constant in seconds	=	High-pass, f_{cut} in Hz
0.00159	=	100
0.0159	=	10
0.159	=	1
1.00	=	0.159
1.59	=	0.10
3.14	=	0.051
10	=	0.0159
100	=	0.00159
1 000	=	0.000159
100 000	=	0.00000159

Typical time constants :
«long » >100 000 s
«medium» 10 … 2 200 s
«short» 0.1 … 220 s

Time constant vs. high-pass

The next table shows the influence of the measurement type resp. the time constant on the behavior of the charge amplifier in the frequency and time domain.

<table>
<tr><th>Quasi-static measurement</th><th>Dynamic measurement</th></tr>
<tr><td></td><td></td></tr>
<tr><td>• Time constant "long" (no time constant resistor)
• Behavior is comparable to DC mode of scope</td><td>• Time constant "short" (with time constant resistor)
• Behavior is comparable to AC mode of scope</td></tr>
<tr><td>• Behavior in the frequency domain:

</td><td>• Behavior in the frequency domain:

</td></tr>
<tr><td>• Behavior in the time domain:


-> Drift eventually becomes visible with longer measuring times</td><td>• Behavior in the time domain:


-> No drift due to the time constant</td></tr>
</table>

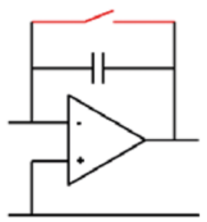
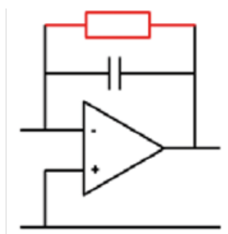
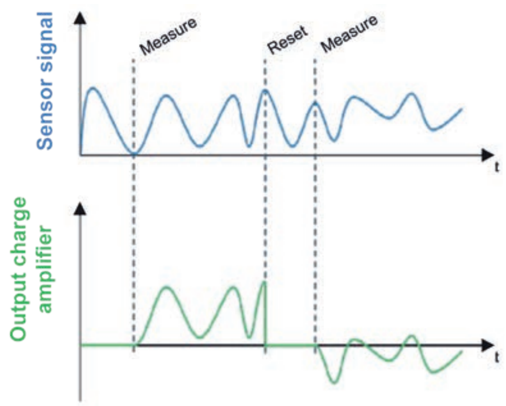
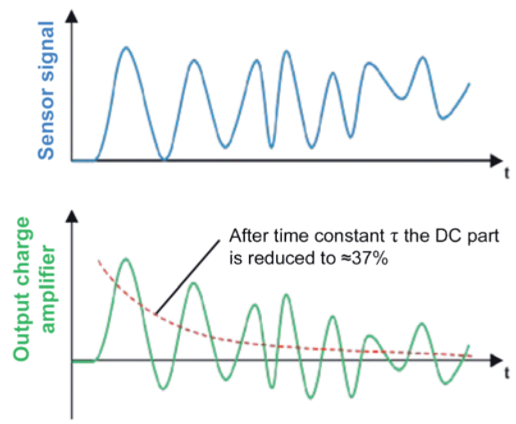
Applications where a static pressure has to be measured over a lengthy period therefore require a charge amplifier that supports quasi-static measurement (time constant "long").

Signal conditioning PE / IEPE

Reset/Measure

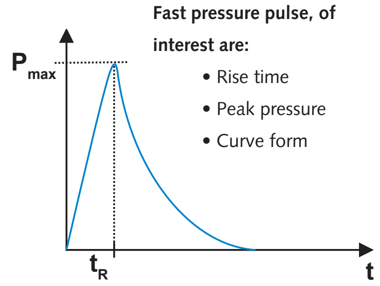
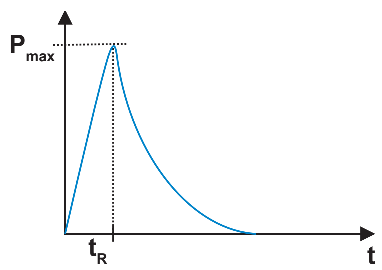
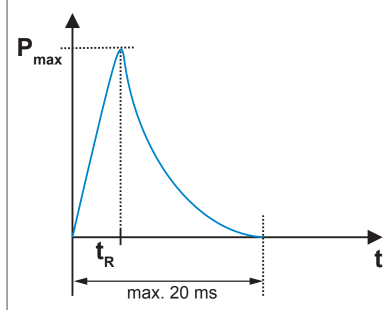
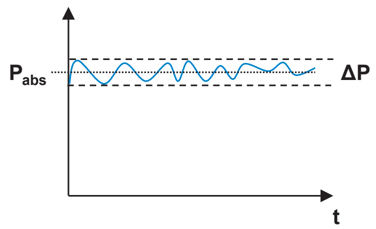
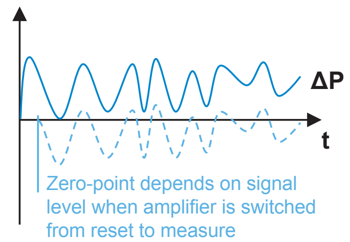
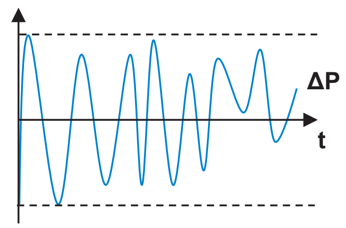
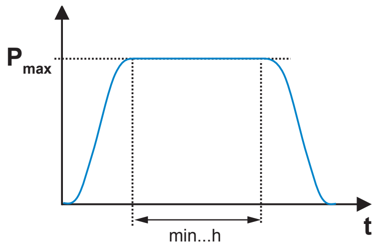
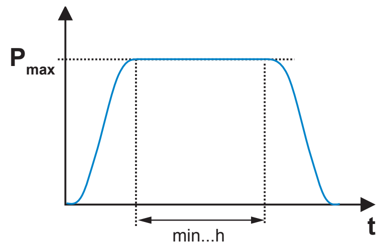
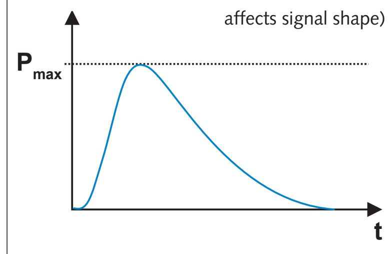
Due to its principle of operation, piezoelectric measurement does not permit measurements with an absolute zero reference. For quasi-static measurement, the zero point is defined at the start of the measurement with the Reset/Measure switch. For a dynamic measurement, however, it is not possible to set a zero point because measurements are made without a zero reference on account of the high-pass characteristic with short time constant.

The next table shows the behavior of the charge amplifier as regards the Reset/Measure switch for the two types of measurement.

Quasi-static measurement	Dynamic measurement
	
• Zero point is set on starting the measurement • Start of measurement is controlled by the Reset/Measure switch	• Measurement without zero reference, due to the time constant • No Reset/Measure signal is needed, or the charge amplifier is always operated in Measure mode.
• Behavior in the time domain: 	• Behavior in the time domain: 

Measurement signals and suitable measurement types

The next table shows the behavior of the charge amplifier for quasi-static and dynamic measurements, with the help of some typical examples of measurement signals. The examples are intended to assist you with the choice of the right measurement type for the specific measurement assignment.

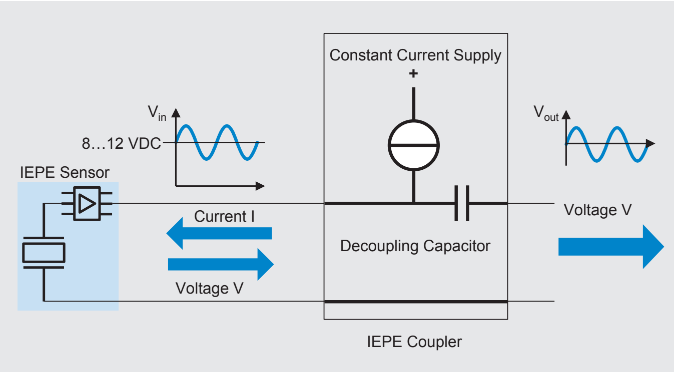
	Physical pressure signal	Charge amplifier output			
		Quasi-static measurement -> Time constant "Long"		Dynamic measurement -> Time constant "Short"	
Dynamic pressure measurement	Fast pressure pulse, of interest are: • Rise time • Peak pressure • Curve form 		✓		✓
Measurement of pressure pulsations	Pressure pulsations on top of static pressure (P_{abs} >> ΔP) 		✓		✓
Quasi-static pressure measurement	Pressure increase/decrease with static level over an extended period of time (min ... h) 	 -> Check section „Quasi-static measurements“ on page 10	✓	(short time constant affects signal shape) 	✗

IEPE (Piezotron) coupler

An IEPE coupler is required for the signal conditioning of the measuring signal of an IEPE sensor. The IEPE coupler supplies constant current to the electronics integrated in the sensor and decouples the dynamic measuring signal from the DC power supply.

The following figure shows the circuit diagram of an IEPE coupler with its two main components:

- Constant current supply
- Decoupling capacitor



Circuit diagram of an IEPE coupler

The IEPE sensor is connected to the IEPE coupler via a 2-wire cable. The IEPE coupler supplies the electronics integrated in the IEPE sensor with current through the **constant current supply.** Due to the current supply, a so-called bias voltage occurs in the range of 8 to 12V (depending on the IEPE sensor). The dynamic measurement signal is transmitted superimposed on the static bias voltage from the IEPE sensor to the IEPE coupler. The IEPE coupler decouples the measuring signal from the bias voltage with the **decoupling capacitor,** whereby the purely dynamic measuring signal is available at the output of the coupler without bias voltage.

Selection criteria for IEPE couplers

The selection of an IEPE coupler suitable for the application is subject to various criteria. The product overview on page 40 shows a selection of suitable IEPE couplers with all criteria. The most important selection criteria for choosing a suitable IEPE coupler are the following:

- Number of channels
- Measuring range
- Measurement type
- Frequency range
- Use of data

The following sections give more detailed explanations of the 'frequency range' and 'measurement type' selection criteria.

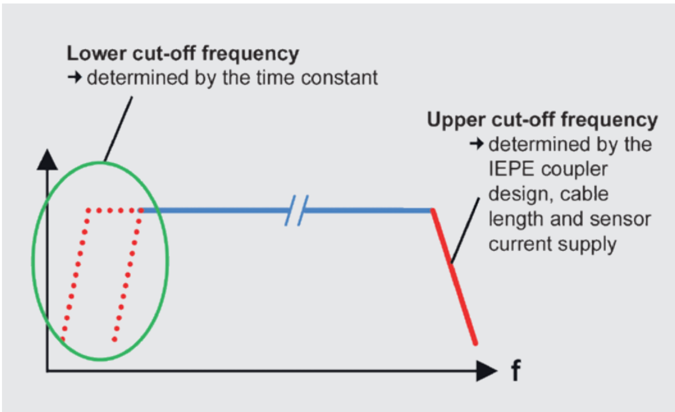
Frequency range

The frequency range of an IEPE coupler is defined by the lower and upper cut-off frequencies.

The lower cut-off frequency is defined by the time constant and therefor determines the high-pass characteristic. The upper cut-off frequency is defined by the low-pass characteristic which is a feature of all IEPE couplers.

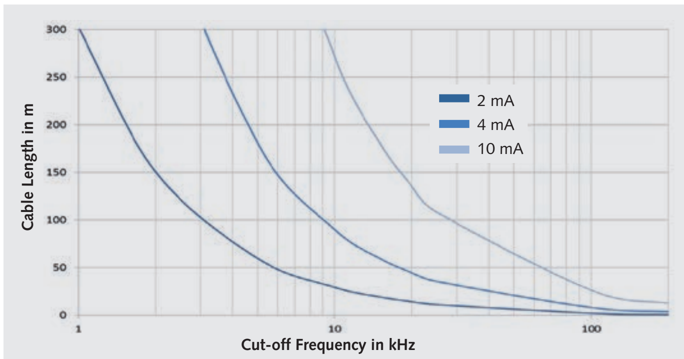
In addition to the system-dependent low-pass characteristic of the IEPE coupler, the following parameters have a considerable influence on the upper cut-off frequency:

- Cable length between sensor and coupler
- Sensor current supply



Frequency range IEPE coupler

The following diagram shows the influence of the cable length and the current supply on the upper cut-off frequency of a typical IEPE coupler, whereby the design of the input circuit of the coupler can influence the behavior.



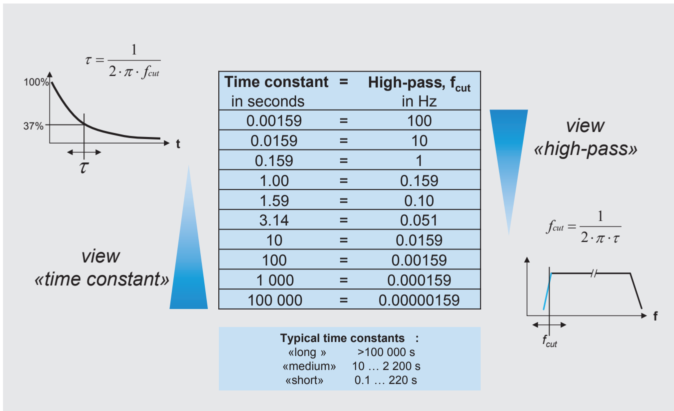
Upper cut-off frequency (–3dB, ±5V Signal):): Influence of cable length and current supply

Measurement type – only dynamic measurement

The type of measurement determines the behavior in the lower frequency range and is influenced by the time constant of the IEPE coupler.

With an IEPE coupler, in contrast to some charge amplifiers, only dynamic but not quasi-static measurements are possible (see section 'Measurement type – quasi-static vs. dynamic measurement' on page 34). The reason for this is the structure of the IEPE coupler with the decoupling capacitor, which filters out static signal components and this has a high-pass characteristic.

Time constant vs. high-pass
The time constant determines the cut-off frequency of the high-pass characteristic of the IEPE coupler. The following diagram shows the relationship between the time constant (**τ**) and the high-pass cut-off frequency (f_{cut}). Depending on whether the time domain or the frequency domain is of interest, one or the other view is better suited.



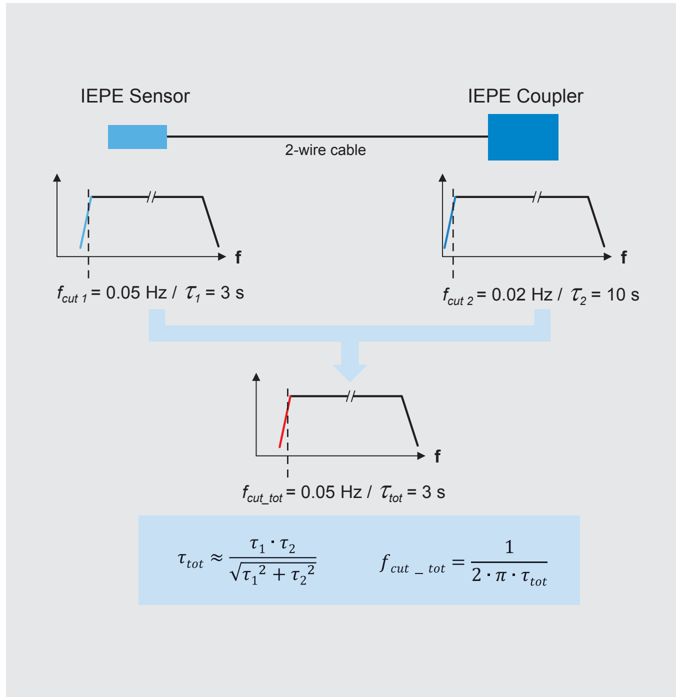
Time constant vs. high pass

An IEPE coupler typically has a time constant of less than 10s, with couplers having adjustable time constants.

IEPE measuring chain and time constants
In the case of the IEPE measuring chain, consisting of the IEPE sensor and the IEPE coupler, it should be noted that the sensor also has a time constant in addition to the coupler.

The time constant of the entire measuring chain is influenced by the time constant of the sensor and that of the coupler. When considering the total system, therefore, both time constants are of interest, with the shorter time constant being dominant.

The following example shows how the time constant of the entire measuring chain (τ_{tot}) can be determined from the IEPE sensor and IEPE coupler time constant. From the time constant of the total system, the cut-off frequency (f_{cut_tot}) of the high-pass characteristic of the entire measuring chain can then be derived again.



IEPE measuring chain – time constant and cut-off frequency

Charge amplifiers & IEPE couplers

Product overview

Type		Use cases: Dynamic Pressure Measurements	Use cases: Measurement of Pressure Pulsations	Use cases: Quasi-static Pressure Measurements	Suitable for: PE Sensors	Suitable for: IEPE Sensors	Number of channels	Measuring range: 1 mbar / 14.5 mpsi	Measuring range: 1 bar / 14.5 psi	Measuring range: 1 kbar / 14.5 kpsi	Measurement type[1]: Quasi-static	Measurement type[1]: Dynamic	Frequency range[2]: ≈0 Hz (quasi-static)	Frequency range[2]: 0.1 Hz	Frequency range[2]: 10 kHz	Frequency range[2]: 100 kHz	Operation: Display and rotary knob	Operation: LED's and switches	Operation: PC	Operation: LabVIEW™ (Virtual instrument driver)	Data usage: Analog output	Data usage: Integrated data acquisition	Additional information
5165A…		■	■		■	■	1 / 4	■	■	■		■		■	■	■			■	■	■	■	• Configuration and control via standard web browser • Flexible filtering options • Flexible 2-point scaling for analog outputs • Two Ethernet interfaces with integrated switch functionality • For multi-channel applications multiple devices (Type 5165A… as well as 5167Ax0) can be synchroni zed for data acquisition
5167Ax0…		■	■	■	■		4 / 8	■	■	■	■	■	■	■	■				■	■	■	■	
KiDAQ		■	■	■	■	■	n x 4		■	■	■	■	■	■	■				■			■	• Configuration and operation via KiStudio Lab software • Flexible filter options • Powerful post-processing analysis with jBEAM • Compatible with other measurands and third party sensors
5015A…		■	■	■	■	□	1	■	■	■	■	■	■	■	■	■	■			■	■		• Extensive statistical functions (shown on display)
5018A…		■	■	■	■	□	1	■	■	■	■	■	■	■	■	■	■				■		• Very low noise
5080A…		■	■	■	■	□	1 … 8	■	■	■	■	■	■	■	■	■	■		■		■		• Very low noise
5108A		■	■			■	1		■	■		■		■	■						■		• Fixed time constant (8s) and gain (1) • Operated from laboratory power supply
5118B2		■	■			■	1		■	■		■		■	■	■		■			■		• Adjustable gain (1x, 10x, 100x) • Adjustable time constant (5s, 25s) • Operated from line power or battery
5148		■	■			■	16					■						■			■		• Fixed time constant (10s) and gain (1)

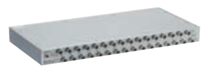
1) For charge amplifiers: see section "Measurement type – quasi-static versus dynamic measurement" on page 34
For IEPE couplers: see section "Measurement type – only dynamic measurement" on page 39

2) For charge amplifiers: see section "Frequency range" on page 33
For IEPE couplers: see section "Frequency range" on page 38

■ Fully applicable
□ Partially applicable

Charge amplifiers & IEPE couplers

Product details

Technical Data		Type	5165A...	5167Ax0...	KiDAQ	5015A...	5018A...	5080A...	5108A	5118B2	5148
											
Number of channels			1 / 4	4 / 8	2 / nx4	1	1	1 ... 8	1	1	16
Charge input			•	•	•	•	•	•			
	Measuring ranges	pC	±100 … 1 000 000	±100 … 1 000 000	±1 000 … 1 000 000	±2 ... 2 200 000	±2 ... 2 200 000	±2 … 2 200 000			
	Frequency range (–3 dB)	Hz	0.1 ...100 000	≈0 … >45 000 (FS range ≤ 195 000 pC) ≈0 … >15 000 (FS range > 195 000 pC)	≈0 ... 20 000 (FS range ≤ 10 000 pC) ≈0 ... 2 000 (FS range > 10 000 pC)	≈0 ... 200 000	≈0 ... 200 000	≈0 … 200 000			
	Time constants	s	Short: 1.6	Medium: depending on charge range Long: >100 000	Short / Long	Short / Medium / Long: depending on charge range	Short / Medium / Long: depending on charge range	Short / Medium / Long: depending on charge range			
	Connector type		BNC neg.	BNC neg.	BNC neg.	BNC neg.	BNC neg.	BNC neg.			
Piezotron input (IEPE)			•		•	o	o	o	•	•	•
	Sensor voltage supply	V	22		24	20	30	30	20	26	24
	Sensor current supply	mA	4 / 10		4	4	1 ... 15	1 ... 15	4	2 [4]	2 [5]
	Gain		1 / 10						1	1 / 10 / 100	1
	Frequency range (–3 dB)	Hz	0.1 ... 100 000		≈0 … 20 000	≈0 ... 200 000	≈0 ... 200 000	≈0 … 200 000	0.02 … 87 000	0.006 … 100 000	0.02 … 150 000
	Time constants	s	Short: 1.6		Short / Long	Short / Medium / Long [3]	Short / Medium / Long [3]	Short / Medium / Long [3]	Short: 8	Short: 5 / Medium: 25	Short: 10
	TEDS support		•								
	Connector type		BNC neg.		BNC neg. / Term. Strip	BNC neg.	BNC neg.	BNC neg.	BNC neg.	BNC neg.	BNC neg.
Voltage input			•		•	o	o	o			
	Measuring ranges	V	±1 ... 10		±0.1 … 10	±0.002 … 20	±0.002 … 30	±0.002 … 30			
	Frequency range (–3 dB)	Hz	0 ... 100 000		≈0 … 20 000	≈0 … 200 000	≈0 … 200 000	≈0 … 200 000			
	Connector type		BNC neg.		BNC neg. / Term. Strip	BNC neg.	BNC neg.	BNC neg.			
Analog output			•	•		•	•	•	•	•	•
	Output range	V	±10 (flexible 2-point scaling)	±10 (flexible 2-point scaling))		±2 / ±2.5 / ±5 / ±10	±10 / ±10 mit Offset –8	±10 / ±10 mit Offset -8	±10	±10	±10
	Connector type		BNC neg.	BNC neg		BNC neg.	BNC neg.	BNC neg. & D-Sub 15-pol. neg	BNC pos.	BNC neg.	BNC neg.
Operation	Display and rotary knob					•	•	•			
	LED's and switches									•	•
	PC		• (GUI via standard-Web-browser)	• (GUI via standard-Web-browser)	• (KiStudio Lab)			• (PC-Software)			
	LabVIEW (Virtual Instrument Driver)		•	•		•					
Interfaces	RS-232C					•	•	•			
	IEEE-488					o					
	USB 2.0						•	•			
	Ethernet		• (2x RJ45 with integr. switch functionality)	• (2x RJ45 with integr. switch functionality)	• (USB to Eth. Adapter)						
Integrated data acquisition			•	•	•						
	Sampling rate		≤200 kSps per channel, adjustable	≤100 kSps per channel, adjustable	≤100 kSps per channel, adjustable						
Housing/installation	Desktop unit		•	•	• (various housing types)	o	o	o	•	•	•
	19" rack-mounted unit		o (supporting plate available for mounting in 19" rack)	o (supporting plate available for mounting in 19" rack)		o	o	o			
Power supply	Mains power (115 / 230 VAC)		o (plug-in power supply av.)	o (plug-in power supply av.)	•	•	•	o		o (plug-in power supply av.)	• (plug-in power supply av.)
	DC power		•	•	•			o	•	•	•
	Voltage range	VDC	18 ... 30	18 ... 30	10 ... 30			11 ... 36	22 … 30	6 … 28, 4x 1.5V AA battery	8 … 20
eg. of protection (IEC/EN 60529)		°C	0 ... 60	0 ... 60	–40 ... 60	0 ... 50	0 ... 50	0 ... 50	0 ... 50	–20 ... 50	0 ... 50
Outer dimensions			IP20	IP20	IP20	IP40	IP40	IP40			
Outer dimensions	BxHxT	mm	218x50x223	218x50x223 [1] 218x93x223 [2]	(depending on housing type [6])	105x142x253	105x142x253	497x141x300	97x42x29	96x48x165	480x46x220

Key: • = Standard; o = Option/selectable

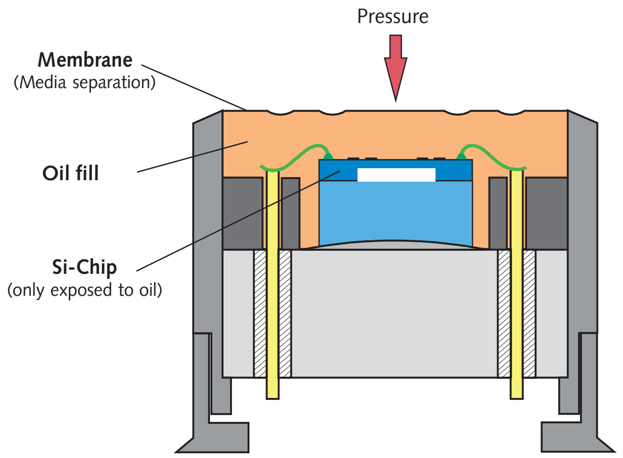
[1] Type 5167A40 (4-channel)
[2] Type 5167A80 (8-channel)
[3] depending on voltage range
[4] factory adjustable to 2 … 18mA
[5] factory adjustable to 2 … 4mA
[6] For dimensions of the various enclosure types, see KiDAQ System Data Sheet Doc. No. 003-335.

Signal conditioning PE / IEPE

Piezoresistive pressure sensors

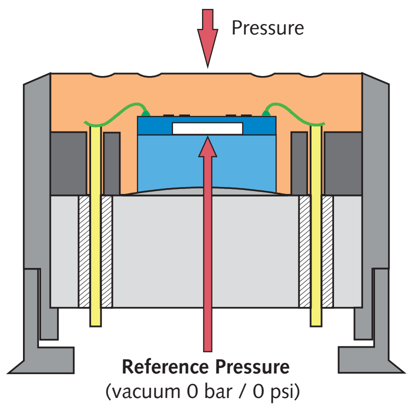
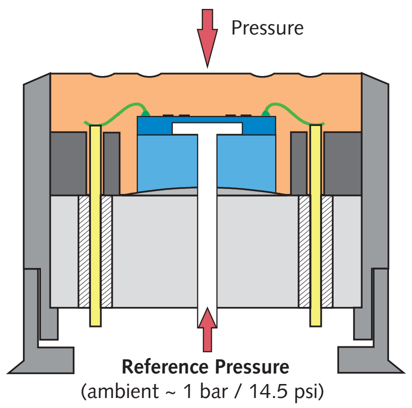
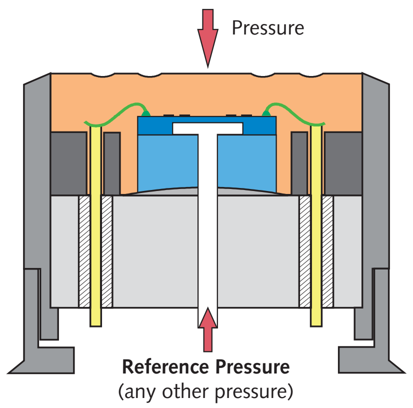
Piezoresistive pressure sensors

In addition to the appropriate pressure range, the physical measurement method must also be taken into account when selecting the piezoresistive pressure sensor. Piezoresistive pressure sensors measure the actual pressure in comparison to a reference pressure and can be subdivided into absolute, relative (gage) and differential pressure sensors.



In the case of piezoresistive pressure sensors, the pressure to be measured is sensed by the silicon chip via a membrane and incompressible silicone oil. The chip is supplied with power via an insulating glass feedthrough and bonding wires, and the pressure signal is output in mV. The pressure signal is then temperature compensated and is amplified to a corresponding V or mA output signal.

Depending on the application, absolute, relative (gage) or differential pressure sensors maybe suitable. The following table shows the different configurations of the corresponding pressure sensor type.

Piezoresistive pressure sensors		
Absolute Pressure Sensors	**Relative (Gage) Pressure Sensor**	**Differential Pressure Sensors**
		
Absolute pressure sensors measure the pressure compared to a vacuum enclosed in the sensor element.	Relative pressure sensors measure the pressure in relation to the ambient air pressure.	Differential pressure sensors measure the pressure difference between any two pressures. Differential pressure sensors therefor have two separate pressure connections (e.g. hose or threaded connection).

Piezoresistive pressure sensors

Product details

426xA

The piezoresistive pressure transmitters the 426xA families are suitable for demanding Test & Measurement applications and are available in various absolute, relative and differential pressure versions for the measurement of static pressures as well as dynamic pressures up to 2 kHz. Optionally the transmitter is also available in intrinsically safe versions.

The modular pressure transmitters are characterized by high accuracy and excellent long-term stability, even in harsh environments with high temperature extremes, high vibration and shock loads.

Configure the pressure transmitter suitable for your application via the online configurator:

www.kistler.com/prt

Technical Data	Type	4260A	4262A	4264A
Type of measurement		absolute	relative (gage)	differential
Pressure range (see online configurator for individual pressure ranges)	bar psi	1 / … / 350 15 / … / 5 000	–1 / … / 350 –15 / … / 5 000	–1 / … / 10 –15 / … / 150
Overload pressure	–	3 x pressure range	3 x pressure range	3 x pressure range
Accuracy [1]	±%	0.2 (≤1 bar / 15 psi) 0.1 (>1bar / 15 psi)	0.2 (≤1 bar / 15 psi) 0.1 (>1bar / 15 psi)	0.2 (≤1 bar / 15 psi) 0.1 (>1bar / 15 psi)
Operating temperature range	°C °F	–55 … 120 –40 … 250	–55 … 120 –40 … 250	–55 … 120 –40 … 250
Output signal	–	mV, V or mA	mV, V or mA	mV, V or mA
Size (L x D)	mm inch	ca. 78.0 x 24.9 ca. 3.07 x 0.98	ca. 78.0 x 24.9 ca. 3.07 x 0.98	ca. 97.0 x 24.9 ca. 3.82 x 0.98
Weight	gram oz	<225 <8	<225 <8	<225 <8
Material in media contact	–	Stainless steel 316L	Stainless steel 316L	Stainless steel 316L
Pressure port	–	Different options (see online configurator) www.kistler.com/prt		
Connector	–			
Wiring	–			
Certifications (for details check datasheet)	–	CE, RoHS 2, PED, Hazardous (Classified) Area		

[1] Accuracy includes non-linearity, hysteresis, and repeatability at room temperature

Product details

4080B(T)

The piezoresistive pressure transmitters of the 4080B series are characterized by an extremely compact and light construction. The completely media-separated measuring element enables reliable and accurate pressure measurements even in harsh environment. Because of its robustness, the 4080B(T) series is suitable for various demanding Test & Measurement applications where static pressures or dynamic pressures up to 5 kHz need to be measured.

The PT1000 sensor, integrated additionally into the pressure module, allows dynamic temperature measurements in the 4080BT series in liquids up to 200°C (392°F).

Technical data	Type	4080B	4080BT
Type of measurement		absolute	absolute
Pressure range	bar psi	5 / 10 / 20 / 130 / 250 73 / 145 / 290 / 1 885 / 3 626	5 / 10 / 20 73 / 145 / 290
Overload pressure	bar psi	10 / 20 / 30 / 200 / 300 145 / 290 / 435 / 2 900 / 4 351	10 / 20 / 30 145 / 290 / 435
Total Error Band [1]	±%FSO	<±2%	<±2%
Operating temperature range	°C °F	–40 … 150 –40 … 302	–30 … 150 –22 … 302
Compensated temperature range	°C °F	25 … 150 77 … 302	25 … 150 77 … 302
Output signal (Pressure)	V	0.2 … 4.2	0.2 … 4.2
Output signal (Temperature)	V	2.4 … 4.2	0.5 … 4.5
Pressure port	–	M6 x 1	M6 x 1
Connector	–	Integrated cable	Integrated cable
Protection degree	–	IP65	IP65
Size (L x D)	mm inch	48.7 x 11 1.92 x 0.43	42.6 x 11 1.68 x 0.43
Weight (without cable)	gram oz	<13.5 <0.48	<12 <0.42
Material in media contact	–	Stainless steel 316L	Stainless steel 316L

[1] The total error band (TEB) includes non-linearity, hysteresis, thermal FSO shift and thermal ZMO shift over the entire compensated temperature range.

Product details

4017A

The piezoresistive pressure transmitters of the 4017A series is the world smallest media-separated absolute pressure sensor (M5). This very compact, robust and light weighted pressure sensor enables reliable and accurate pressure measurements for various demanding Test & Measurement applications across a wide temperature range. The 4017A series is not only capable to measure static but as well dynamic pressures up to a few kHz.

The 4017A sensor needs to be operated with Kistler's digital amplifier Type 4624. Kistler's PiezoSmart system ensures automatic sensor identification and measurement readiness after connection to the amplifier (Plug & Play).

Optionally the sensor is also available in an Ex-certified version for use in hazardous areas (Zone 2) too.

Technical data	Type	4017A
Type of measurement		absolute
Pressure range	bar psi	5 / 10 / 20 / 50 73 / 145 / 290 / 725
Overload pressure	bar psi	15 / 30 / 40 / 100 218 / 435 / 580 / 1 450
Total error band [1]	±%FSO	<±1%
Operating temperature range	°C °F	–40 … 180 –40 … 356
Compensated temperature range	°C °F	–20 … 140 –4 … 284
Output signal (4624A amplifier)	–	V or mA
Pressure port	–	M5 x 0.5
Protection degree	–	IP67
Dead volume	mm^3 $inch^3$	86 0.005
Natural frequency (acoustic)	kHz	≥7
Size (L x D)	mm inch	6.2 x 30 0.24 x 1.18
Weight (without cable)	gram oz	3 0.1
Material in media contact	–	Stainless steel 316L

[1] The total error band (TEB) includes non-linearity, hysteresis, thermal FSO shift and thermal ZMO shift over the entire compensated temperature range.

Sensor solutions for high temperature, high pressure and shock pressure waves

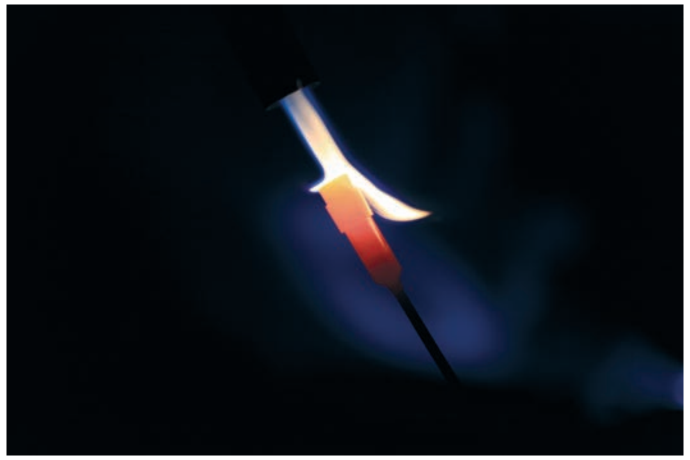
Sensor solutions for high temperature, high pressure and shock pressure waves

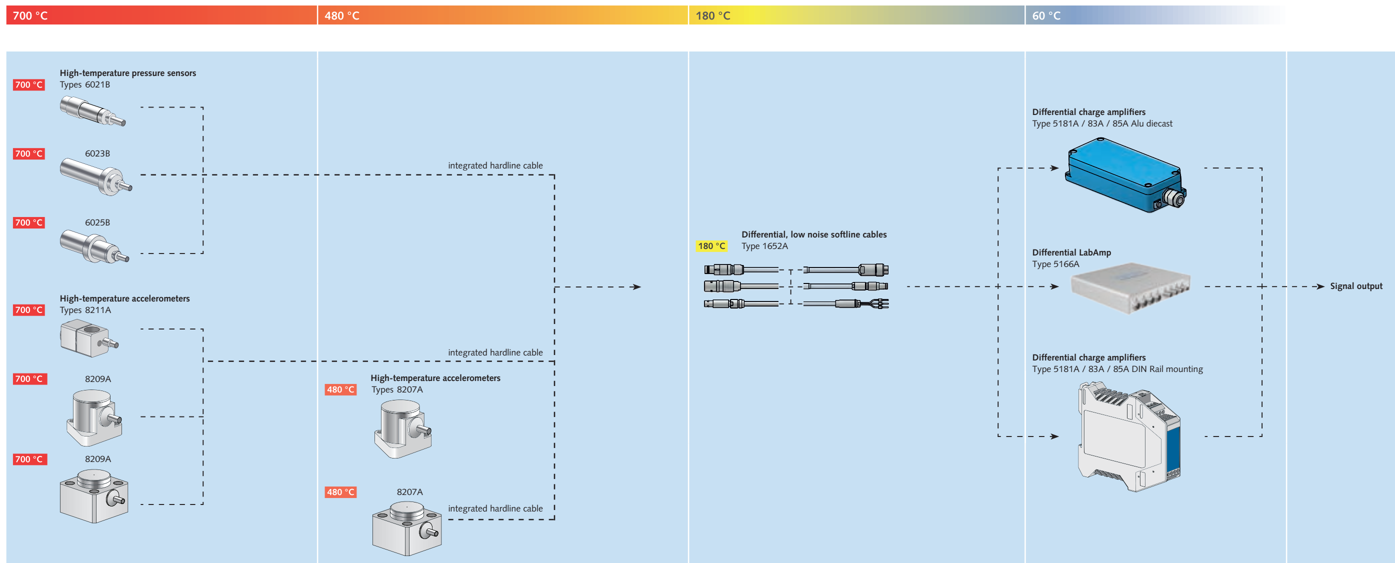
Sensor solutions for high temperature applications

Piezoelectric measurement chains for high-temperature pressure and acceleration measurements from Kistler have been specially designed for detecting pressure pulsations and vibrations in thermoacoustics under harsh environmental conditions and at extreme temperatures up to 700°C (1 300°F). For short periods of time, measurements can be made at significantly higher temperatures.

Designed for gas turbine monitoring, the pressure and acceleration measurement chains are generally suitable for monitoring turbomachinery and rocket engines. The existing solutions are also ideally suited for research and development of extreme applications such as continuous detonation engines, pressure oscillations in pipes and acoustic thermometry.To ensure the required reliability for continuous operating temperatures up to 700°C, the proprietary PiezoStar crystal technology and particularly robust sensors are used. For time-limited applications, the sensor technology can even be used up to 1 000°C (1 830°F).

Fully differential measuring chains allow highest resistance to electromagnetic interference. In combination with high sensitivity and low-noise electronics, this allows accurate acquisition of very low signals in difficult EMC environments. Kistler's modular portfolio allows individual electrode configurations for a wide range of applications in areas where the highest demands are placed on temperature resistance. All available components are compatible for Ex installations (Ex-nA, Ex-ia).





Sensor solutions for highest pressures & shock waves

High pressure

The portfolio includes application-specific solutions consisting of sensors and data acquisition for high-pressure applications such as internal pressure measurements, muzzle pressure measurements, pressure vessel measurements, igniter and inflator tests, and other industrial applications.

The wide range of high pressure sensors between 1 500 bar (22 kpsi) and 10 000 bar (145 kpsi) with shoulder sealing or front sealing sensor design offer great diversity for a variety of applications. To complement the sensor portfolio Kistler offers specific accessories such as diaphragm protection or thermal protection elements, various sealing and spacer rings, adapters and mechanical measuring and positioning aids.an.

The transient recorder Type 2519A offers integrated data acquisition of pressure, velocity (Type 2521A) and precision (Type 2523A) as well as their efficient evaluation software. With up to 10 MS/s, the system is ideally suited for recording various dynamic charge and voltage signals.

Advantages of high-pressure system solutions from Kistler:

- Long service life and thus low costs per measurement cycle
- EPVAT method (Electronic Pressure, Velocity and Action Time) and measurements according to different standards possible
- Automatic signal processing and generation of test reports for efficient and automatic evaluation after measurement
- Pulse generator (Type 6909) enables verification of the entire measuring chain before starting the measurement

6239A	6217A	6215	6213B
1 500 bar	2 000 bar	6 000 bar	10 000 bar
21 756 psi	29 008 psi	87 023 psi	145 038 psi

Portfolio overview piezoelectric high pressure sensors

Shock pressure wave

The acquisition of highly dynamic shock waves provides important know-how for the parameterization of energetic materials in free field measurements, the development of protective structures, protective clothing and protective materials.

The pressure signals are highly dynamic in this measuring environment and must not be distorted by long transmission cables. Kistler offers the robust Pencil Probe Type 6233A for the detection of shock pressure waves. These have an IEPE output that already provides a converted voltage signal. This enables interference-free signal transmission over greater distances.

Kistler offers sophisticated and highly dynamic measurement systems with a minimum 10 MS/s sampling rate, a selectable number of channels (4 to 64 channels or more) and a wide range of options for shock wave measurements. Various measurement windows, trigger options per channel, FFT and a wide range of mathematical functions are also available.

Advantages of dynamic shock pressure wave measurement with Kistler:

- Pencil probes with scaled measuring ranges from 1.7 to 70 bar (25 to 1 000 psi)
- Pencil Probes with multiple sensors to measure pressure drop and shock wave velocity (optional)
- Smart accessories (e.g. tube adapter, tripod adapter, etc.) enable efficient field measurements
- Time synchronization and a global zero point signal is enabled by a trigger box, which indicates the triggering of the event
- IEPE sensor technology enables cable lengths of more than 100 m

Pencil Probe Type 6233A

KiDAQ – Data acquisition

Creating a measurement solution with KiDAQ

With the integrated KiDAQ data acquisition system, Kistler offers engineers, researchers, measurement technicians and students everything they need for their measurement tasks: a reliable solution from one single source.

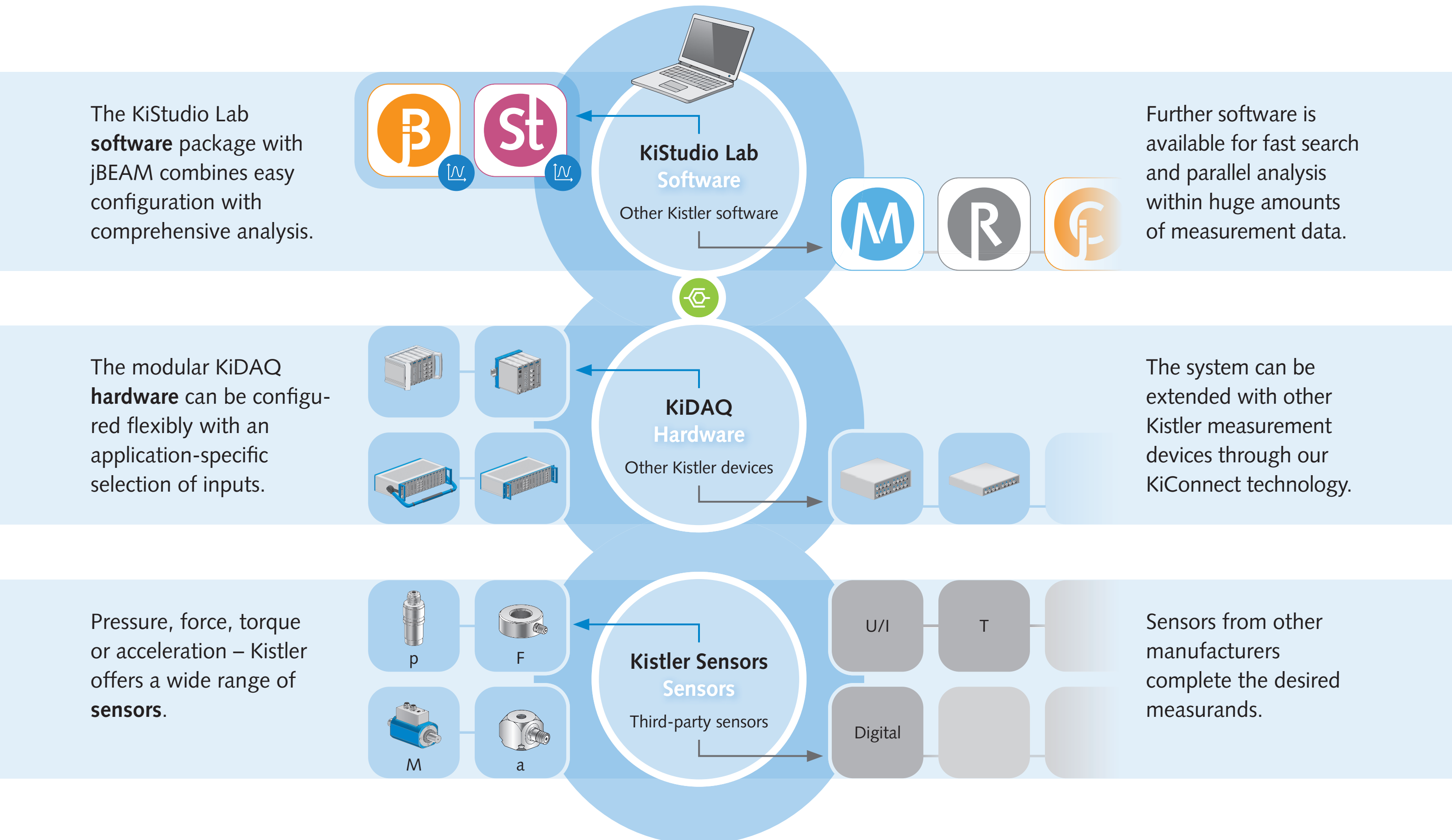
Sensors
Dynamic high-pressure measurements, accurate force measurements, and many other demanding test and measurement applications: no matter what the challenge, you can count on the extensive range of pressure, force, torque and acceleration sensors from Kistler to deliver reliable and precise values. Sensors from other manufacturers can also be connected to the KiDAQ hardware just as easily as Kistler's own products.

Measurement hardware
The KiDAQ data acquisition system from Kistler offers a wide choice of modules for a variety of measurands and sensors – ranging from simple voltage signals, measuring bridges and IEPE sensors to charge signals from piezoelectric sensors.
You are free to expand your test setup as you wish by adding other high-quality signal conditioning and data acquisition systems from the Kistler portfolio, such as LabAmp.

Data acquisition and analysis software
KiStudio Lab software makes it easy to configure your hardware components and perform your measurement tasks. The combination of KiStudio Lab and the comprehensive jBEAM Lab analysis tool gives you a host of visualization and analysis features as well as an automatic report generator to save valuable time on recurring tasks.

Connectivity with KiConnect
KiConnect is the connecting element inside the KiDAQ data acquisition system. Intelligent technology makes it simple to combine Kistler data acquisition devices into a logical measurement system and perform precise, time-synchronized measurements with the Precision Time Protocol (PTP).
- Multiple devices of the same or different types in one setup
- Distributed, time-synchronized measurements with PTP (IEEE 1588)

Advantages of the KiDAQ data acquisition system
- Benefit from the versatile modular hardware concept for applications in education, research, testing and qualification
- Create logical measurement systems with mixed hardware setups, including precise time synchronization with PTP thanks to Kistler's KiConnect technology
- Save time because the intuitive KiStudio Lab software makes it quick and easy to configure your measurement setups
- Gain better insights with the interactive analysis and visualization functions in jBEAM Lab



KiDAQ housing options

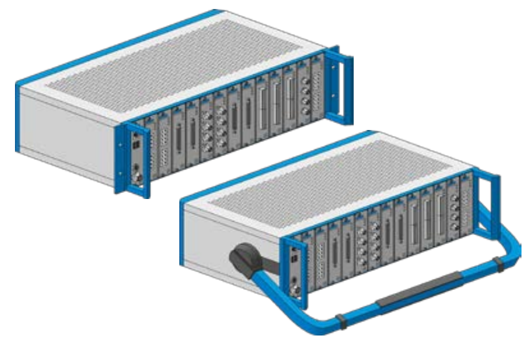
The KiDAQ data acquisition system features a modular design, giving you the flexibility to expand your solution as you wish. And with Kistler's KiConnect technology, you are not limited to one hardware device: you can build high-channel systems with multiple devices or even mix different hardware types in one setup – that's what we call a 'logical measurement system'.

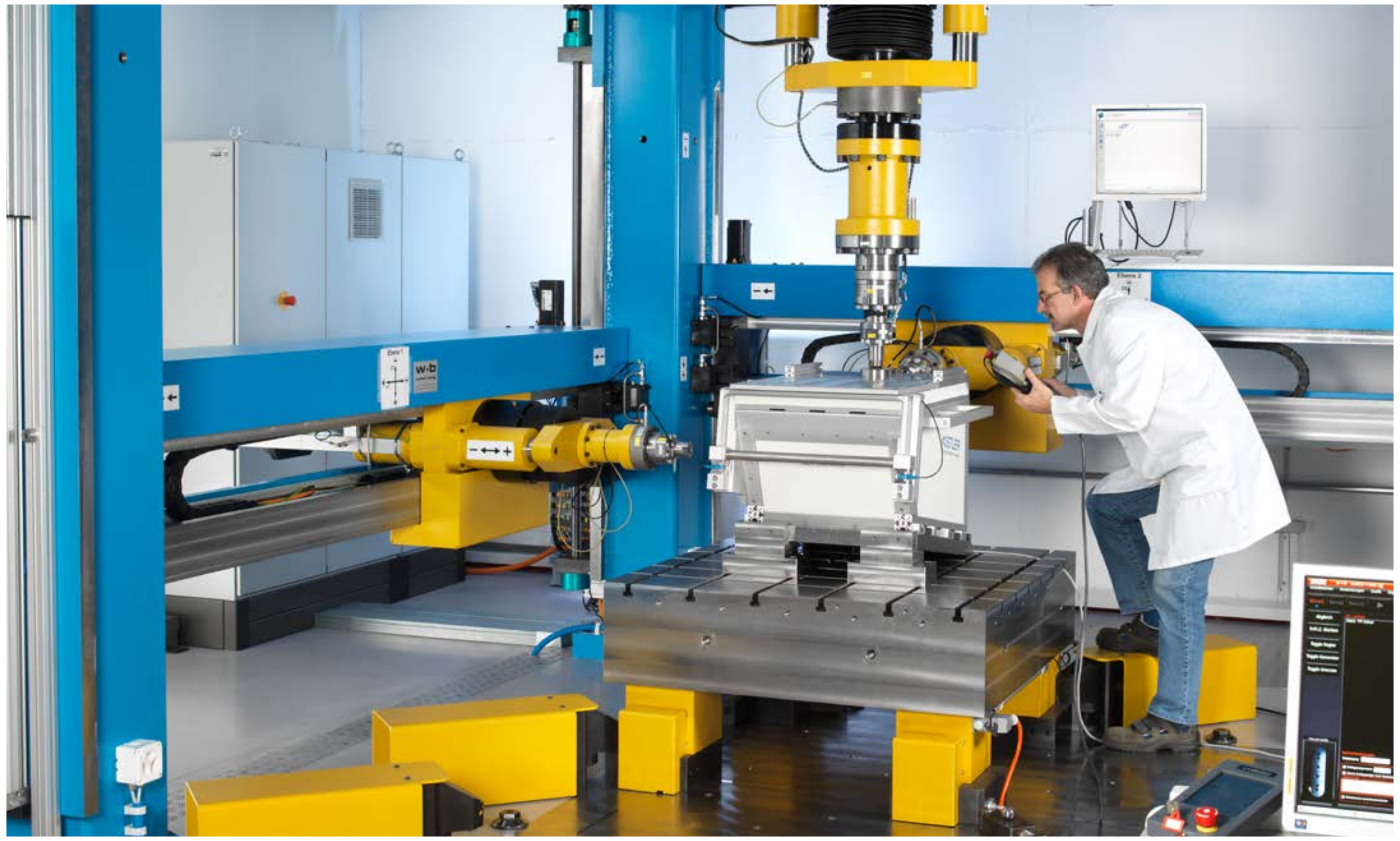
KiDAQ – the universal workhorse
Kistler offers a wide selection of measurement modules for KiDAQ systems, covering more than 20 different measurands. The modules are available in three different housing variants to ensure maximum flexibility for every measuring task.
- Choice of 19 different measurement modules for inputs such as voltage, current, resistance, temperature, strain gauges, and many more
- Universal modules with 2 or 4 analog inputs and sensor-specific modules with up to 8 inputs
- Available in three housing options: Rack, Portable and DIN Rail

LabAmp 5165A – the dynamic device
This flexible laboratory charge amplifier can be used wherever you need to measure dynamic signals of mechanical quantities with piezoelectric sensors, IEPE sensors (Piezotron) or sensors with voltage output.
- Purely dynamic piezoelectric measurements
- IEPE measurements
- Static and dynamic voltage measurements
- 1 or 4 universal inputs

LabAmp 5167A – the piezoelectric expert
Piezoelectric sensors produce an electric charge which is proportional to the load acting on the sensor. The amplifier converts this charge directly into digital values. The LabAmp 5167A can handle slow quasistatic signals as well as dynamic processes.
- Quasistatic and dynamic piezoelectric measurements
- 4 or 8 charge inputs

LabAmp 5165A LabAmp 5167A

KiDAQ Portable	KiDAQ DIN Rail	KiDAQ Rack
		
• Compact, robust housing for stationary and mobile measurements • Up to 13 measurement modules, individually selected for each application • Battery operation possible	• Standardized mechanical fastening for industrial environments (top-hat rail) • Any number of different measurement modules can be combined to create an application-specific data acquisition system	• Up to 13 measurement modules for a compact high channel count system • Either in a standard 19" housing for permanent installation on test benches – • Or in a convenient design including handles for flexible operation in the laboratory



Service

Service

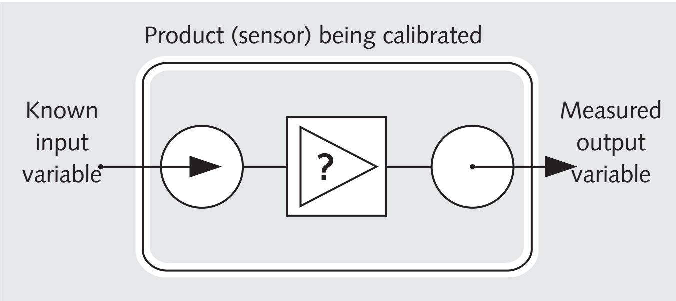
Calibration

Sensors and measuring instruments must be calibrated at regular intervals, as their characteristics- and, therefore, measurement uncertainties – can change over time due to use, aging and environmental factors. Customized calibration services from Kistler ensure precise measurements.

Pressure sensors are already calibrated during the final acceptance process in our factory. Instruments used for calibration at Kistler are traceable to national standards and subject to uniform international quality control. Calibration certificates docu-ment measured calibration values and conditions.

Fundamentals of Calibration

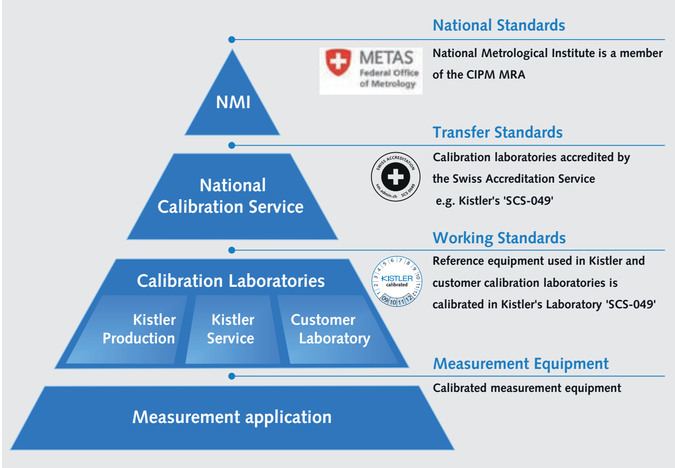
Calibration involves determining the relationship between a known input variable (e.g. bar, psi) and a measured output variable (e.g. pC, V). The procedure in each case is precisely defined (e.g. continuous or step-by-step) and the conditions under which calibration is carried out are specified (e.g. ambient temperature, air humidity). This approach guarantees that calibration delivers the same results on a reproducible basis.



Calibration – determination of the relationship between a known input variable and a measured output variable

Traceability Ensures Reliable Measurements

So that work can be undertaken according to the same quality standards on an international basis, the measuring equipment used must be subject to uniform quality assurance. To achieve this, all the measuring equipment used must be traceable to national measurement standards.
This means that when a measuring instrument or system is calibrated, its measurement results must be compared to the results from a higher-level measurement standard. In this way, a calibration hierarchy is created in which the topmost position is taken by the national measurement standard, which is located at the National Metrology Institute (NMI/METAS). All the measuring equipment used for calibration at Kistler is traceable to national standards.



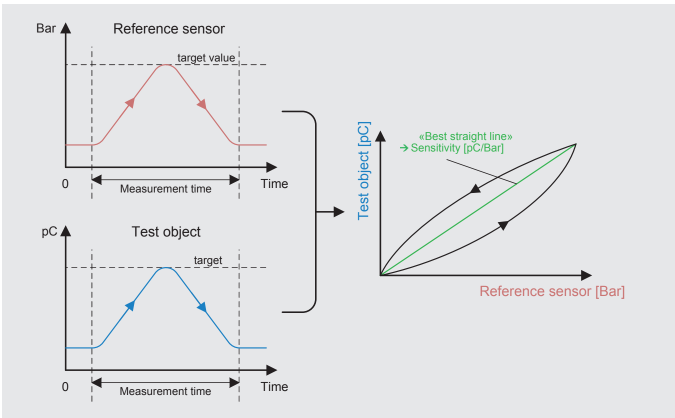
Calibration Hierarchy

Calibration Process

Calibration of a sensor (the test object) is carried out by comparing its output signal with the signal from a reference sensor. The precise sensitivity of the reference sensor is known and can be traced back to the national standard on the basis of the calibration hierarchy.

Kistler uses the continuous method for calibrating piezoelectric sensors. With this method, the load is continuously increased to the required value within a defined time and then reduced to zero again within the same time.

The resultant characteristic, which is never exactly linear, is approximated by a 'best straight line' that passes through the origin. The gradient of the straight line corresponds to the sensitivity of the sensor in the calibrated measuring range.



Continous calibration using a reference sensor

Kistler's calibration service

Kistler offers its customers a comprehensive calibration service throughout the world. This service ensures that Kistler sensors and systems are – and will remain – fully functional for the entire service lifetime of the equipment: the basis for precise and reliable measurement results.

Kistler's calibration service comprises the following calibrations:

EOL Calibration

The EOL (End-of-Line) calibration is carried out on every sensor in the Kistler Production Centre as the standard calibration during final acceptance testing prior to delivery of the product. The calibration results for each individual sensor are stored during this process. A calibration certificate is enclosed with all sensors on delivery.

Accredited Calibration

Accredited calibration to ISO/IEC 17025 is offered in selected Kistler Tech Centers and Tech Offices across the globe. The calibration processes are designed according to international recognized guidelines, and are audited by an accreditation body. Accredited calibration is typically used for transfer and work standards.

Recalibration

Regular calibration is recommended in order o guarantee measuring accuracy throughout the entire lifetime of Kistler's sensors and equipment and to meet the highest quality assurance criteria. The following two options are available for recalibration

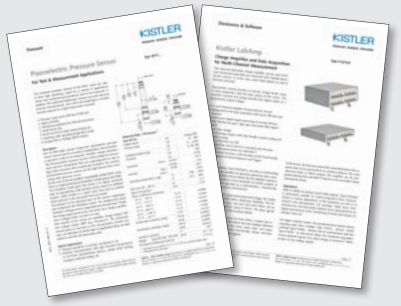
- Standard calibration, based on the EOL calibration
- Accredited calibration

Kistler offers recalibration for most sensors at its Tech Centers and Tech Offices across the globe. Our sales staff will be glad to advise you on recalibration issues, and to give you information about calibration services in your area.

Information overview

Test & Measurement – now online too!
As well as more extensive information about pressure sensors, you can also discover Kistler's entire Test & Measurement range by visiting our website. The portfolio covers a variety of measurands, sensor technologies and signal conditioning solutions for general measurements in research and development or test laboratories.
Other measurands: force & strain, acceleration & acoustic emission (AE), torque
www.kistler.com/t&m

Data sheets and manuals
You can find detailed information about individual products in our data sheets and manuals, which can be downloaded from our website free of charge.

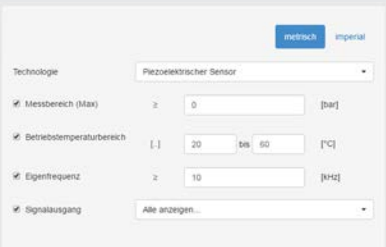


Who to contact
Whether you want advice, or support with your installation: on our website, you'll quickly and easily find a personal contact partner near you who can assist with measurand you require

www.kistler.com/t&m/pressure

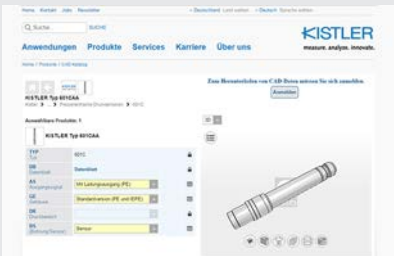
Component finder
Our interactive online Component finder offers various filter options that will make it easier for you to search for generic sensors and signal conditioning solutions.

www.kistler.com/t&m/
componentfinder



CAD data
Various Kistler 3D CAD models are at your disposal free of charge, so that you can integrate our products directly into your CAD designs. On our website, you can download the right file format for every CAD system.

www.kistler.com/cad-catalog



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Find out more about our applications:
www.kistler.com/applications

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