Test & Measurement
Pressure

Measurement equipment for demanding T&M applications
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
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

Step 2
Sensor

- Piezoelectric pressure sensors (p. 13)
  PE
  IEPE

- Piezoresistive pressure sensors (p. 45)

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Accessories

- Accessories (p. 23)

Step 4
Cables

- Cables (p. 24)

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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.

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).

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.

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

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.

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.

Piezoresistive Wheatstone bridge without pressure resp. with pressure
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.

Si-chip with 4 resistors and pressure distribution on semiconductor

Electrical charge (Q)
Pressure (P)
Unloaded crystal
Crystal under load
Crystal disks as measuring elements

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.
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.

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.

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.

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.

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Piezoelectric technology</th>
<th>PR technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Static measurement</td>
<td><img src="image" alt="Static measurement" /></td>
<td><img src="image" alt="Static measurement" /></td>
</tr>
<tr>
<td>Quasi-static measurement</td>
<td><img src="image" alt="Quasi-static measurement" /></td>
<td><img src="image" alt="Quasi-static measurement" /></td>
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<tr>
<td>Dynamic measurement</td>
<td><img src="image" alt="Dynamic measurement" /></td>
<td><img src="image" alt="Dynamic measurement" /></td>
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<tr>
<td>Pressure pulsations</td>
<td><img src="image" alt="Pressure pulsations" /></td>
<td><img src="image" alt="Pressure pulsations" /></td>
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<tr>
<td>Small sensor dimensions</td>
<td><img src="image" alt="Small sensor dimensions" /></td>
<td><img src="image" alt="Small sensor dimensions" /></td>
</tr>
<tr>
<td>Wide temperature range</td>
<td><img src="image" alt="Wide temperature range" /></td>
<td><img src="image" alt="Wide temperature range" /></td>
</tr>
<tr>
<td>Suitability on temperature variation</td>
<td><img src="image" alt="Suitability on temperature variation" /></td>
<td><img src="image" alt="Suitability on temperature variation" /></td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>Piezoelectric Pressure Sensors</th>
<th>Voltage Output (IEPE, Piezotron)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charge Output (PE)</td>
<td>Voltage Output</td>
</tr>
<tr>
<td>No built-in electronics</td>
<td>Built-in electronics</td>
</tr>
<tr>
<td>Charge output</td>
<td>Voltage Output</td>
</tr>
</tbody>
</table>

+ 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

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 Millivolt 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**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Connect</th>
<th>Amplify</th>
<th>Acquire</th>
<th>Analyze</th>
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</thead>
<tbody>
<tr>
<td>601CAA</td>
<td>1631C...</td>
<td>[Diagram of Measuring Chain]</td>
<td>DAQ (with integrated charge amplifier) 5165A... 5167A...</td>
<td>Laptop (provided by customer)</td>
</tr>
<tr>
<td>601B1</td>
<td>1641B...</td>
<td></td>
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</tr>
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<td>603CAA</td>
<td>1993A...</td>
<td></td>
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<td></td>
<td>1983AD...</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>etc.</td>
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</table>

**IEPE pressure sensors**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Connect</th>
<th>Amplify</th>
<th>Acquire</th>
<th>Analyze</th>
</tr>
</thead>
<tbody>
<tr>
<td>601CBA...</td>
<td>1761B...</td>
<td>[Diagram of Measuring Chain]</td>
<td>DAQ (with integrated IEPE coupler) 5165A...</td>
<td>Laptop (provided by customer)</td>
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<tr>
<td>211B...</td>
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<tr>
<td>603CBA...</td>
<td>1761C...</td>
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</tr>
</tbody>
</table>

**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 (3 626 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

### Technical Data

<table>
<thead>
<tr>
<th>Parameter</th>
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<td>Pressure range</td>
<td>bar</td>
<td>psi</td>
<td>psi</td>
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<tr>
<td></td>
<td>0 ... 250</td>
<td>0 ... 3 636</td>
<td>0 ... 1 000</td>
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<td>pC/bar</td>
<td>pC/psi</td>
<td>pC/psi</td>
</tr>
<tr>
<td></td>
<td>-37.0</td>
<td>-14.5</td>
<td>-5.0</td>
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<tr>
<td>Linearity (typ.)</td>
<td>% FSO</td>
<td>±0.1</td>
<td>±0.4</td>
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<tr>
<td>Operating temperature range</td>
<td>°C</td>
<td>°F</td>
<td>°F</td>
</tr>
<tr>
<td></td>
<td>-350</td>
<td>-662</td>
<td>-200</td>
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<td>kHz</td>
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<td>&gt;250</td>
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<td>psi/g</td>
<td>psi/g</td>
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<td>0.14</td>
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<td>No (Epoxy)</td>
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<td>–</td>
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<td>17-4 &amp; 316L S.S.*</td>
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<tr>
<td>Connector</td>
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<td>10–32 neg.</td>
<td>10–32 neg.</td>
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* SS = Stainless Steel
## IEPE pressure sensors

### Product details

#### Technical data

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<td><strong>601C series</strong></td>
<td></td>
<td></td>
<td></td>
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</tr>
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<td>1.5</td>
<td>3.5</td>
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<td>Sensitivity (mV/bar)</td>
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<td>0.053</td>
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<td>±0.3%</td>
<td>±0.3%</td>
<td>±0.3%</td>
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<tr>
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<td>&lt;0.4</td>
<td>&lt;0.4</td>
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<td>≥215</td>
<td>≥215</td>
<td>≥215</td>
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<td>Time constant (µs)</td>
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<td>3</td>
<td>3</td>
<td>3</td>
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<tr>
<td>Low-frequency response (dB)</td>
<td>–3</td>
<td>–3</td>
<td>–3</td>
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<td>Acceleration sensitivity (mV/g)</td>
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<td>0.0002</td>
<td>0.0002</td>
<td>0.0002</td>
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<td>Yes (welded)</td>
<td>Yes (welded)</td>
<td>Yes (welded)</td>
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### 601C series

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<td>Pressure range (bar)</td>
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<td>Sensitivity (mV/bar)</td>
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<td>Linearity (µV/F)</td>
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<td>±0.3%</td>
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<td>Rise time (ms)</td>
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<td>&lt;0.4</td>
<td>&lt;0.4</td>
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<tr>
<td>Natural frequency (kHz)</td>
<td>≥215</td>
<td>≥215</td>
<td>≥215</td>
<td>≥215</td>
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<tr>
<td>Time constant (µs)</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Low-frequency response (dB)</td>
<td>–3</td>
<td>–3</td>
<td>–3</td>
<td>–3</td>
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<td>Acceleration sensitivity (mV/g)</td>
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<td>0.0002</td>
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### 603C series

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<td>Pressure range (lb/in²)</td>
<td>690</td>
<td>1500</td>
</tr>
<tr>
<td>Sensitivity (mV/lb/in²)</td>
<td>10000</td>
<td>1500</td>
</tr>
<tr>
<td>Linearity (µV/lb/in²)</td>
<td>±0.3%</td>
<td>±0.3%</td>
</tr>
<tr>
<td>Rise time (ms)</td>
<td>&lt;0.4</td>
<td>&lt;0.4</td>
</tr>
<tr>
<td>Natural frequency (kHz)</td>
<td>≥500</td>
<td>≥500</td>
</tr>
<tr>
<td>Time constant (µs)</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Low-frequency response (dB)</td>
<td>–3</td>
<td>–3</td>
</tr>
<tr>
<td>Acceleration sensitivity (mV/lb)</td>
<td>0.00001</td>
<td>0.00001</td>
</tr>
<tr>
<td>Dimensions (L x D) (mm)</td>
<td>37.8 x 5.55</td>
<td>37.8 x 5.55</td>
</tr>
<tr>
<td>Weight (gram)</td>
<td>0.14</td>
<td>0.14</td>
</tr>
<tr>
<td>Sensor housing hermetically sealed</td>
<td>Yes (welded)</td>
<td>Yes (welded)</td>
</tr>
<tr>
<td>Material</td>
<td>17-4 PH S.S.</td>
<td>17-4 PH S.S.</td>
</tr>
<tr>
<td>Connector</td>
<td>10–32 neg.</td>
<td>10–32 neg.</td>
</tr>
</tbody>
</table>

---

*) 55 = Stainless Steel
Piezoelectric pressure sensors

Mounting

When mounting piezoelectric pressure sensors, the following two types of mounting are used:

- Direct installation
- Adapter installation

Depending on the application, one or the other type of mounting is better suited. The following table shows a comparison of features:

<table>
<thead>
<tr>
<th>Mounting Method</th>
<th>Direct Installation</th>
<th>Adapter Installation</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ Preferred mounting method for small spaces</td>
<td>+ Preferred mounting method (requires adequate mounting space)</td>
<td>+ Simple tapped hole to accept adapter</td>
</tr>
<tr>
<td>+ Ideal for application requiring close sensor to sensor spacing</td>
<td>+ Minimal structural influences on pressure measurement (mechanical decoupling)</td>
<td></td>
</tr>
<tr>
<td>- Complex drilling with special tools</td>
<td>- Physical space required</td>
<td></td>
</tr>
</tbody>
</table>

### Accessories

#### Floating clamp nut

<table>
<thead>
<tr>
<th>Typ</th>
<th>Thread (1)</th>
<th>SW</th>
</tr>
</thead>
<tbody>
<tr>
<td>SW 6423B00</td>
<td>M7x0.75</td>
<td>8</td>
</tr>
<tr>
<td>6423B11</td>
<td>5/16–24 UNF</td>
<td>9/32”</td>
</tr>
</tbody>
</table>

#### Sensor dummy

<table>
<thead>
<tr>
<th>Typ</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>6487AA</td>
<td>Sensor Dummy (Solid)</td>
</tr>
</tbody>
</table>

#### Adapter

<table>
<thead>
<tr>
<th>Typ</th>
<th>Outer (1)</th>
<th>Thread</th>
<th>Inner (2)</th>
<th>SW</th>
</tr>
</thead>
<tbody>
<tr>
<td>SW 6503C0A</td>
<td>M10x1</td>
<td>M7x0.75</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>6503C1A</td>
<td>3/8–24 UNC</td>
<td>5/16–24 UNF</td>
<td>7/16&quot;</td>
<td></td>
</tr>
<tr>
<td>6507B0A</td>
<td>M3x0.5</td>
<td>M7x0.75</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>6507B1A</td>
<td>5–40 UNC</td>
<td>5/16–24 UNF</td>
<td>11/32&quot;</td>
<td></td>
</tr>
</tbody>
</table>

#### Seal

<table>
<thead>
<tr>
<th>Typ</th>
<th>Material</th>
<th>Seal for</th>
</tr>
</thead>
<tbody>
<tr>
<td>1131</td>
<td>Copper</td>
<td>Sensor</td>
</tr>
<tr>
<td>1131A</td>
<td>Nickel</td>
<td></td>
</tr>
<tr>
<td>113C0B</td>
<td>Stainless Steel 1-4301 / 304</td>
<td>6503C0A</td>
</tr>
<tr>
<td>113C1C</td>
<td>Copper</td>
<td></td>
</tr>
<tr>
<td>1113C1B</td>
<td>Stainless Steel 1-4301 / 304</td>
<td>6503C1A</td>
</tr>
<tr>
<td>1113C0C</td>
<td>Copper</td>
<td></td>
</tr>
<tr>
<td>1117B0C</td>
<td>Copper</td>
<td>6507B0A</td>
</tr>
<tr>
<td>6507B1A</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*All of the adapters are delivered with 1 pc. of each adapter seal type and 1 pc. lubrication grease Type 1063. All sensors are delivered with 5 pcs of sensor sealing type 1131*. 
Piezoelectric pressure sensors

Cables

**PE cable**

Piezoelectric pressure sensors and charge amplifiers must be connected with a low noise high-impedance cable (insulation resistance >10¹³ 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.

**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**
  - 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.)

- **FKM cable**
  - 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.

**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.

---

**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 therefore exhibit less than 1pC with high vibration. Nevertheless, strain relieving cables are the best practice to minimize cable motion.

**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 without the 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.

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.

**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 both sides 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.

---

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 therefore exhibit less than 1pC with high vibration. Nevertheless, strain relieving cables are the best practice to minimize cable motion.

**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.
### Piezoelectric pressure sensors

**Overview of cables**

<table>
<thead>
<tr>
<th>Sensor family</th>
<th>Cable</th>
<th>Type</th>
<th>Connector</th>
<th>Length (standard) [m, ft] *</th>
<th>Length (custom) [m, ft]</th>
<th>Cable sheathing material</th>
<th>Operating temperature range [°C, °F]</th>
<th>Cable can be welded to sensor</th>
<th>Degree of protection to IEC/EN 60529</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>601CAA</strong></td>
<td>1631C...</td>
<td>KIAG 10-32 pos.</td>
<td>BNC pos.</td>
<td>0.5 / 1 / 2 / 3 / 5 / 10 / 20</td>
<td>0.1 / 0.3</td>
<td>100 / 328</td>
<td>PFA</td>
<td>–55 / –67</td>
<td>200 / 392</td>
<td>•</td>
</tr>
<tr>
<td><strong>601CBA...</strong></td>
<td>1641B...</td>
<td>KIAG 10-32 pos. 90°</td>
<td>BNC pos.</td>
<td>0.5 / 1 / 2 / 5</td>
<td>0.1 / 0.3</td>
<td>100 / 328</td>
<td>PFA</td>
<td>–55 / –67</td>
<td>200 / 392</td>
<td>•</td>
</tr>
<tr>
<td><strong>603CAA</strong></td>
<td>1929A...</td>
<td>KIAG 10-32 pos. int.</td>
<td>BNC pos.</td>
<td>1 / 2 / 3 / 6.6 / 9.8</td>
<td>0.1 / 0.3</td>
<td>100 / 328</td>
<td>PFA</td>
<td>–55 / –67</td>
<td>200 / 392</td>
<td>•</td>
</tr>
<tr>
<td><strong>601CBA...</strong></td>
<td>1635C...</td>
<td>KIAG 10-32 pos.</td>
<td>KIAG 10-32 pos.</td>
<td>0.5 / 1 / 2 / 3 / 5 / 10</td>
<td>0.1 / 0.3</td>
<td>100 / 328</td>
<td>PFA</td>
<td>–55 / –67</td>
<td>200 / 392</td>
<td>•</td>
</tr>
<tr>
<td><strong>601CBA...</strong></td>
<td>1957A...</td>
<td>KIAG 10-32 pos.</td>
<td>KIAG 10-32 pos.</td>
<td>1 / 3.3</td>
<td>0.1 / 0.3</td>
<td>10 / 33</td>
<td>PFA with stainless steel braiding</td>
<td>–55 / –67</td>
<td>200 / 392</td>
<td>•</td>
</tr>
<tr>
<td><strong>601CBA...</strong></td>
<td>1969A...</td>
<td>KIAG 10-32 pos. int.</td>
<td>KIAG 10-32 pos. int.</td>
<td>1 / 3.3</td>
<td>0.1 / 0.3</td>
<td>10 / 33</td>
<td>PFA with stainless steel braiding</td>
<td>–55 / –67</td>
<td>200 / 392</td>
<td>•</td>
</tr>
<tr>
<td><strong>601CBA...</strong></td>
<td>1967A...</td>
<td>KIAG 10-32 pos. int.</td>
<td>KIAG 10-32 pos. int.</td>
<td>0.5 / 1 / 2 / 3</td>
<td>0.1 / 0.3</td>
<td>10 / 33</td>
<td>PFA with stainless steel braiding, ground-isolated</td>
<td>–55 / –67</td>
<td>200 / 392</td>
<td>•</td>
</tr>
<tr>
<td><strong>601CBA...</strong></td>
<td>1983AD...</td>
<td>KIAG 10-32 pos. int.</td>
<td>BNC pos.</td>
<td>2 / 5</td>
<td>0.1 / 0.3</td>
<td>20 / 66</td>
<td>FKM</td>
<td>–20 / –4</td>
<td>200 / 392</td>
<td>•</td>
</tr>
<tr>
<td><strong>601CBA...</strong></td>
<td>1983AC...</td>
<td>KIAG 10-32 pos. int.</td>
<td>KIAG 10-32 pos. int.</td>
<td>0.5 / 1 / 1.5 / 2 / 3 / 5</td>
<td>0.1 / 0.3</td>
<td>20 / 66</td>
<td>FKM</td>
<td>–20 / –4</td>
<td>200 / 392</td>
<td>•</td>
</tr>
<tr>
<td><strong>601CBA...</strong></td>
<td>1761B...</td>
<td>KIAG 10-32 pos.</td>
<td>BNC pos.</td>
<td>1 / 2 / 3 / 5</td>
<td>0.1 / 0.3</td>
<td>200 / 656</td>
<td>PTFE</td>
<td>–196 / –320</td>
<td>200 / 392</td>
<td>•</td>
</tr>
<tr>
<td><strong>601CBA...</strong></td>
<td>1762B...</td>
<td>KIAG 10-32 pos.</td>
<td>KIAG 10-32 pos.</td>
<td>1 / 2 / 3 / 5</td>
<td>0.1 / 0.3</td>
<td>200 / 656</td>
<td>PTFE</td>
<td>–196 / –320</td>
<td>200 / 392</td>
<td>•</td>
</tr>
</tbody>
</table>

* Cable ordering is in meters
Piezoelectric pressure sensors

Cable accessories

### Couplings

<table>
<thead>
<tr>
<th>Type</th>
<th>Connector</th>
<th>Left</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>1701</td>
<td>BNC pos.</td>
<td>BNC neg.</td>
<td>BNC neg.</td>
</tr>
<tr>
<td>1705</td>
<td>BNC pos.</td>
<td>M4x0.35</td>
<td>BNC neg.</td>
</tr>
<tr>
<td>1721</td>
<td>BNC pos.</td>
<td>KIAG 10-32</td>
<td>KIAG 10-32 neg.</td>
</tr>
<tr>
<td>1729A</td>
<td>KIAG 10-32</td>
<td>KIAG 10-32 neg.</td>
<td>KIAG 10-32 neg.</td>
</tr>
<tr>
<td>1733</td>
<td>BNC pos.</td>
<td>Bananen-Buchsen</td>
<td></td>
</tr>
</tbody>
</table>

### Plastic protective caps

<table>
<thead>
<tr>
<th>Type</th>
<th>To be used for</th>
</tr>
</thead>
<tbody>
<tr>
<td>1851</td>
<td>BNC neg.</td>
</tr>
<tr>
<td>1861A</td>
<td>BNC pos.</td>
</tr>
<tr>
<td>1891</td>
<td>KIAG 10-32 neg.</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Type</th>
<th>To be used for</th>
</tr>
</thead>
<tbody>
<tr>
<td>5493</td>
<td>Insulation tester for the control of PE measuring chains. Measures the isolation of sensors, cables and charge amplifiers.</td>
</tr>
<tr>
<td>1003A</td>
<td>Cleaning and insulation spray for PE measuring chains</td>
</tr>
</tbody>
</table>

### BNC cable, high insulation

<table>
<thead>
<tr>
<th>Type</th>
<th>Connector</th>
<th>Length (standard) [m]</th>
<th>Length (custom) [m]</th>
<th>Cable sheath material</th>
<th>Operating temperature range [°C]</th>
<th>Deg. of protection to IEC/EN 60529</th>
</tr>
</thead>
<tbody>
<tr>
<td>16018...</td>
<td>BNC pos.</td>
<td>BNC pos.</td>
<td>0.5 / 1 / 2 / 5 / 10 / 20</td>
<td>0.1</td>
<td>50</td>
<td>PVC</td>
</tr>
</tbody>
</table>
Signal conditioning for piezoelectric sensors
Signal conditioning for piezoelectric sensors

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 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

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.

Table: Charge amplifier vs. IEPE (Piezotron) Coupler

<table>
<thead>
<tr>
<th>Charge amplifier</th>
<th>IEPE (Piezotron) Coupler</th>
</tr>
</thead>
<tbody>
<tr>
<td>PE Sensor</td>
<td>IEPE Sensor</td>
</tr>
<tr>
<td>Charge Q</td>
<td>Charge Q</td>
</tr>
<tr>
<td>Voltage V</td>
<td>Voltage V</td>
</tr>
<tr>
<td>Zero point</td>
<td>Zero point</td>
</tr>
<tr>
<td>Measurement range</td>
<td>Measurement range</td>
</tr>
<tr>
<td>Frequency range</td>
<td>Frequency range</td>
</tr>
<tr>
<td>Measurement type</td>
<td>Measurement type</td>
</tr>
<tr>
<td>Use of data</td>
<td>Use of data</td>
</tr>
</tbody>
</table>

A charge amplifier 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

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.
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 ($\tau$) and the high-pass cut-off frequency ($f_{\text{cut}}$). Depending on whether the time domain or the frequency domain is of interest, one or the other view is better suited.

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>
<thead>
<tr>
<th>Time constant</th>
<th>Quasi-static measurement</th>
<th>Dynamic measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;long&quot;</td>
<td>$\tau$ long (no time constant resistor)</td>
<td>$\tau$ short (with time constant resistor)</td>
</tr>
<tr>
<td>&quot;short&quot;</td>
<td>$\tau$ short (with time constant resistor)</td>
<td>$\tau$ short (with time constant resistor)</td>
</tr>
</tbody>
</table>

- Behavior in the frequency domain:
- Behavior in the time domain:

$\tau \cdot \pi \approx \frac{1}{2 f_{\text{cut}}}$

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

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”).
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.

<table>
<thead>
<tr>
<th>Quasi-static measurement</th>
<th>Dynamic measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Quasi-static waveform" /></td>
<td><img src="image2.png" alt="Dynamic waveform" /></td>
</tr>
</tbody>
</table>

- 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:

- Quasi-static measurement:
  - After time constant \( t \) the DC part is reduced to \( \approx 37\% \)

- Dynamic measurement:
  - Pressure increase/decrease with static level over an extended period of time (min ... h)
  - Check section „Quasi-static measurements“ on page 10

### 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.

<table>
<thead>
<tr>
<th>Physical pressure signal</th>
<th>Charge amplifier output</th>
<th>Dynamic measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quasi-static measurement</td>
<td>Time constant “Long”</td>
<td></td>
</tr>
<tr>
<td>Dynamic measurement</td>
<td>Time constant “Short”</td>
<td></td>
</tr>
</tbody>
</table>

- Fast pressure pulse, of interest are:
  - Rise time
  - Peak pressure
  - Curve form

- Pressure pulsations on top of static pressure
  - \( P_{\text{max}} \Rightarrow \Delta P \)
  - Zero-point depends on signal level when amplifier is switched from reset to measure

- Pressure increase/decrease with static level over an extended period of time (min ... h)
  - \( P_{\text{max}} \Rightarrow \Delta P \)
  - (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

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. 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

Circuit diagram of an 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.

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 therefore 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

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. Depending on whether the time domain or the frequency domain is of interest, one or the other view is better suited.

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 (τtot) can be determined from the IEPE sensor and IEPE coupler time constant. From the time constant of the total system, the cut-off frequency (fcut_τtot) of the high-pass characteristic of the entire measuring chain can then be derived again.

IEPE measuring chain – time constant and cut-off frequency

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

## Product overview

<table>
<thead>
<tr>
<th>Type</th>
<th>Use cases</th>
<th>Number of channels</th>
<th>Measuring range</th>
<th>Measurement type</th>
<th>Frequency range</th>
<th>Operation Data usage</th>
<th>Additional information</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dynamic Pressure</td>
<td></td>
<td>Measurement of pressure</td>
<td>PE / IEPE</td>
<td>≈0 Hz (quasi-static)</td>
<td>Display and rotary knob</td>
<td>LCB and switches, PC, LabVIEWtm (Virtual instrument driver), Analog output, Integrated data acquisition</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 / 4</td>
<td>1 mbar / 14.5 psi</td>
<td>Dynamic</td>
<td>0.1 Hz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5165A…</td>
<td></td>
<td></td>
<td>1 bar / 14.5 psi</td>
<td></td>
<td>10 kHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5167Ax0…</td>
<td></td>
<td></td>
<td>100 kHz</td>
<td></td>
<td>100 kHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Quasi-static Pressure</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KiDAQ</td>
<td></td>
<td>4 / 8</td>
<td>1 mbar / 14.5 psi</td>
<td>Dynamic</td>
<td>0.1 Hz</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 bar / 14.5 psi</td>
<td></td>
<td>10 kHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>100 kHz</td>
<td></td>
<td>100 kHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5015A…</td>
<td></td>
<td>n x 4</td>
<td>1 mbar / 14.5 psi</td>
<td>Dynamic</td>
<td>0.1 Hz</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 bar / 14.5 psi</td>
<td></td>
<td>10 kHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>100 kHz</td>
<td></td>
<td>100 kHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5018A…</td>
<td></td>
<td></td>
<td>Quasi-static</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Dynamic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5080A…</td>
<td></td>
<td>1 ... 8</td>
<td>1 mbar / 14.5 psi</td>
<td>Dynamic</td>
<td>0.1 Hz</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 bar / 14.5 psi</td>
<td></td>
<td>10 kHz</td>
<td></td>
<td></td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>100 kHz</td>
<td></td>
<td>100 kHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5108A</td>
<td></td>
<td></td>
<td>1 mbar / 14.5 psi</td>
<td>Dynamic</td>
<td>0.1 Hz</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 bar / 14.5 psi</td>
<td></td>
<td>10 kHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>100 kHz</td>
<td></td>
<td>100 kHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5118B2</td>
<td></td>
<td></td>
<td>Quasi-static</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Dynamic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5148</td>
<td></td>
<td>16</td>
<td>1 mbar / 14.5 psi</td>
<td>Dynamic</td>
<td>0.1 Hz</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 bar / 14.5 psi</td>
<td></td>
<td>10 kHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>100 kHz</td>
<td></td>
<td>100 kHz</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

### Technical Data

<table>
<thead>
<tr>
<th>Type</th>
<th>5165A...</th>
<th>5167Ax0...</th>
<th>KiDAQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of channels</td>
<td>1 / 4</td>
<td>4 / 8</td>
<td>2 / 4x4</td>
</tr>
</tbody>
</table>

#### Charge input
- **Measuring ranges:** µV
- **Frequency range (≤ 1 kHz):** Hz
- **Time constants:** s
- **Connector type:** BNC neg./Term. Strip

#### Piezotron input (IEPE)
- **Sensor voltage supply:** V
- **Sensor current supply:** mA
- **Frequency range (≤ 1 kHz):** Hz
- **Time constants:** s
- **TEDS support:**
- **Connector type:** BNC neg. & D-Sub 15-pol. neg.

#### Voltage input
- **Measuring ranges:** V
- **Frequency range (≤ 1 kHz):** Hz
- **Connector type:** BNC neg.

#### Analog output
- **Output range:** V
- **Connector type:** BNC neg.

#### Operation
- **Display and interry knob:**
- **LabVIEW (Virtual Instrument Driver):**
- **GUI via standard Web-browser:**
- **KiStudio Lab:**

#### Interfaces
- **RS-232C**
- **IEEE-488**
- **USB 2.0**
- **Ethernet**
- **(2x USB with integr. switch functionality)**
- **(USB to Eth. Adapter)**

#### Integrated data acquisition
- **Sampling rate:** kHz
- **(2x R4S with integr. switch functionality)**
- **(USB to Eth. Adapter)**

#### Housing/Installation
- **Desktop unit:**
- **19” rack-mounted unit:**
- **(supporting plate available for mounting in 19” rack)**
- **(supporting plate available for mounting in 19” rack)**

#### Power supply
- **Main power:** (115 / 230 VAC)
- **DC power:** VDC
- **Voltage range:** V
- **(plug-in power supply ac)**

#### Protection (IEC/EN 60529)
- **Degree of protection:** °C
- **Surface temperature:**°C

#### Other dimensions
- **Height:** mm
- **(depending on housing type)**

**Key:**
- ≤: Standard
- ≥: Option/selectable
- Type 5167A40 (4-channel)
- Type 5167A80 (8-channel)
- depending on voltage range
- unadjustable 2 ... 18mA
- factory adjustable to 2 ... 18mA
- factory adjustable to 2 ... 4mA

### Product details

- **Connector type:**
- **Time constants:** s
- **Frequency range (–3 dB):** Hz
- **Gain:**
- **Sensor current supply:** mA
- **Measuring ranges:** V
- **Voltage range VDC**
- **DC power:** VDC
- **Sampling rate:** kHz
- **Ethernet**
- **USB 2.0**
- **IEEE-488**
- **LabVIEW (Virtual Instrument Driver)**
- **PC-Software**

### Dimensions

- **5015A...**
- **5018A...**
- **5080A...**
- **5108A**
- **5118B2**
- **5148**

For dimensions of the various enclosure types, see KiDAQ System Data Sheet Doc. No. 003-335.
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.

<table>
<thead>
<tr>
<th>Absolute Pressure Sensors</th>
<th>Relative (Gage) Pressure Sensor</th>
<th>Differential Pressure Sensors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure</td>
<td>Pressure</td>
<td>Pressure</td>
</tr>
<tr>
<td>Reference Pressure (Vacuum 0 bar)</td>
<td>(ambient – 1 bar / 14.5 psi)</td>
<td>(any other pressure)</td>
</tr>
</tbody>
</table>

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 therfore have two separate pressure connections (e.g. hose or threaded connection).

426xA

The piezoresistive pressure transmitters for 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

---

<table>
<thead>
<tr>
<th>Technical Data</th>
<th>Typ</th>
<th>4260A</th>
<th>4262A</th>
<th>4264A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of measurement</td>
<td></td>
<td>absolute</td>
<td>relative (gage)</td>
<td>differential</td>
</tr>
<tr>
<td>Pressure range (see online configurator for individual pressure ranges)</td>
<td>bar</td>
<td>1 / … / 350</td>
<td>–1 / … / 10</td>
<td>–1 / … / 15</td>
</tr>
<tr>
<td></td>
<td>psi</td>
<td>15 / … / 5 000</td>
<td>–15 / … / 150</td>
<td>–15 / … / 150</td>
</tr>
<tr>
<td>Overload pressure</td>
<td></td>
<td>3 x pressure range</td>
<td>3 x pressure range</td>
<td>3 x pressure range</td>
</tr>
<tr>
<td>Accuracy 1)</td>
<td>±%</td>
<td>0.2 (c1 bar / 15 psi)</td>
<td>0.1 (c1 bar / 15 psi)</td>
<td>0.05 (c1 bar / 15 psi)</td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>°C</td>
<td>–55 … 120</td>
<td>–55 … 120</td>
<td>–55 … 120</td>
</tr>
<tr>
<td></td>
<td>°F</td>
<td>–40 … 250</td>
<td>–40 … 250</td>
<td>–40 … 250</td>
</tr>
<tr>
<td>Output signal</td>
<td></td>
<td>mV, V oder mA</td>
<td>mV, V oder mA</td>
<td>mV, V oder mA</td>
</tr>
<tr>
<td>Size (L x D)</td>
<td>mm x inch</td>
<td>ca. 78.0 x 24.9</td>
<td>ca. 78.0 x 24.9</td>
<td>ca. 78.0 x 24.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ca. 3.07 x 0.98</td>
<td>ca. 3.07 x 0.98</td>
<td>ca. 3.07 x 0.98</td>
</tr>
<tr>
<td>Weight</td>
<td>Gramm</td>
<td>&lt;225</td>
<td>&lt;225</td>
<td>&lt;225</td>
</tr>
<tr>
<td></td>
<td>Oz</td>
<td>&lt;8</td>
<td>&lt;8</td>
<td>&lt;8</td>
</tr>
<tr>
<td>Material in media contact</td>
<td></td>
<td>Stainless steel 316L</td>
<td>Stainless steel 316L</td>
<td>Stainless steel 316L</td>
</tr>
<tr>
<td>Pressure port</td>
<td></td>
<td>Different options</td>
<td>see online configurator</td>
<td>Stainless steel 316L</td>
</tr>
<tr>
<td>Connector</td>
<td></td>
<td><a href="http://www.kistler.com/prt">www.kistler.com/prt</a></td>
<td></td>
<td>Stainless steel 316L</td>
</tr>
<tr>
<td>Wiring</td>
<td></td>
<td>–</td>
<td></td>
<td>Stainless steel 316L</td>
</tr>
<tr>
<td>Certifications (for details check datasheet)</td>
<td></td>
<td>CE, RoHs 2, PED, Hazardous (Classified) Area</td>
<td></td>
<td>Stainless steel 316L</td>
</tr>
</tbody>
</table>

1) Accuracy includes non-linearity, hysteresis, and repeatability at room temperature
Piezoresistive pressure sensors

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).

<table>
<thead>
<tr>
<th>Technical data</th>
<th>4080B</th>
<th>4080BT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of measurement</td>
<td>absolute</td>
<td>absolute</td>
</tr>
<tr>
<td>Pressure range bar/psi</td>
<td>5 / 10 / 20 bar, 73 / 145 / 290 psi</td>
<td>10 / 20 / 30 bar, 145 / 290 / 435 psi</td>
</tr>
<tr>
<td>Overload pressure bar/psi</td>
<td>10 / 20 / 30 bar, 145 / 290 / 435 psi</td>
<td>10 / 20 / 30 bar, 145 / 290 / 435 psi</td>
</tr>
<tr>
<td>Total Error Band 1)</td>
<td>±%FSO &lt;±2%</td>
<td>±%FSO &lt;±2%</td>
</tr>
<tr>
<td>Operating temperature range °C/F</td>
<td>≥40 ... 150 °C, ≤40 ... 200 °C</td>
<td>≥30 ... 150 °C, ≤22 ... 300 °C</td>
</tr>
<tr>
<td>Compensated temperature range °C/F</td>
<td>25 ... 150 °C, 77 ... 302 °C</td>
<td>25 ... 150 °C, 77 ... 302 °C</td>
</tr>
<tr>
<td>Output signal (Pressure)</td>
<td>0.2 ... 4.2 V</td>
<td>0.2 ... 4.2 V</td>
</tr>
<tr>
<td>Output signal (Temperature)</td>
<td>2.4 ... 4.2 V</td>
<td>0.5 ... 4.5 V</td>
</tr>
<tr>
<td>Pressure port</td>
<td>M6 x 1</td>
<td>M6 x 1</td>
</tr>
<tr>
<td>Connector</td>
<td>Integrated cable</td>
<td>Integrated cable</td>
</tr>
<tr>
<td>Protection degree</td>
<td>IP6</td>
<td>IP6</td>
</tr>
<tr>
<td>Size (L x D) mm/inch</td>
<td>48.7 x 11/1.92 x 0.43</td>
<td>42.6 x 11/1.68 x 0.43</td>
</tr>
<tr>
<td>Weight (without cable) Gramm</td>
<td>&lt;13.5</td>
<td>&lt;12</td>
</tr>
<tr>
<td></td>
<td>O2</td>
<td>&lt;0.42</td>
</tr>
<tr>
<td>Material in media contact</td>
<td>Stainless steel 316L</td>
<td>Stainless steel 316L</td>
</tr>
</tbody>
</table>

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 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).

High-temperature pressure sensors
- Typen 6021A
- Typen 8211A
- Typ 6023A
- Typ 6025A
- Integrated hardline cable

High-temperature accelerometers
- Typen 6201A
- Typen 6203A
- Typen 6205A
- Typ 6207A
- Integrated hardline cable

Differential, low noise softline cable

Differential charge amplifier
- Type 5181A / 63A / 83A Alu decal

Signal output

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.

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

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 wave pressure 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

Portfolio overview piezoelectric high pressure sensors
- 6239A 1 500 bar / 21 756 psi
- 6217A 2 000 bar / 29 008 psi
- 6215 6 000 bar / 87 023 psi
- 6213B 10 000 bar / 145 038 psi

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KiDAQ – Data acquisition
KiDAQ: modular design, precise results

In research and development, every measurement task usually starts with a complex and lengthy test setup. This is due to the fact that measurement technicians or measurement engineers first have to connect the measurement elements of different origin, before they can assemble the system. With KiDAQ, the measurement technology experts from Kistler present an innovative and integrated data acquisition system that offers all components you need for a given measurement task from a single source.

KiDAQ is a modular system that can be flexibly expanded with additional measurement modules and measurement units at any time. The advantage here is that the measurement setup can be assembled easily and quickly and users can concentrate fully on their measurements and the subsequent analysis of the acquired data.

Remote information about the measurement uncertainty

A key advantage of the new KiDAQ data acquisition system is our KIXact technology, which automatically calculates the measurement uncertainty. Thanks to know-how across the entire measuring chain combined with Kistler’s vast application expertise, reliable statements about measurement uncertainty are now possible with this technology. That saves you the time and effort needed for a manual calculation of the measurement uncertainty, and it also helps to significantly reduce the uncertainty components in your measurement chain.

Advantages of the KiDAQ measuring system

- Modular and flexible configuration
- Fast and safe configuration with intuitive KiStudio Lab software
- Powerful measurement data analysis with jBEAM
- Improved confidence in measurements through KIXact technology
- Precise time synchronization across all measurement units
- Cloud-based platform enables future expansions, including those of partner companies

Thanks to the modular design and the various hardware models, KiDAQ can be used in a wide range of applications. Depending on the scope of the application, measurement technicians and engineers can choose from versatile designs for laboratory applications, permanent installation and for mobile use. From the range of hardware, software and sensors, select the exact components that you need for your measurement project – ensuring that you obtain the optimum data acquisition system for your specific application.

Unified logical measurement system

With the KiDAQ data acquisition system, Kistler offers engineers, researchers, measurement technicians and students the opportunity to combine everything they need for their measurement task in one setup. Various measurands and sensors can be used with different data acquisition hardware and be combined to a unified logical measurement system – just according the application requirements.

Measurands and sensors

The KiDAQ data acquisition system offers a wide selection of modules for various sensor technologies and more than 20 different measurands – from simple voltage signals across measurement bridges and IEPE sensors to charge signals from piezoelectric sensors.

Measurement hardware

The KiDAQ hardware is designed in a modular way and can be individually configured to match the required measurement performance and channel count. The Portable, Rack and DIN Rail models are designed so that they can be optimally used in various applications. The test setup can be extended as needed together with other high-quality signal conditioning and data acquisition systems from Kistler and – in future – with selected devices from third-party manufacturers.

KiConnect: The intelligent KiConnect technology allows the user to easily combine different measurement units to a logical measurement setup and perform precise, time-synchronized measurements thanks to the Precision Time Protocol (PTP). KiConnect is built up on state-of-the-art communications standards (TCP/IP and IoT-principles) and is therefore ready for distributed setups and cloud applications.

KiStudio Lab software package

Measurement devices are configured easily with the intuitive KiStudio Lab software, which provides an overview of the whole measurement setup and enables quick navigation. Acquired data can be easily exported for analysis with jBEAM. This post-processing software and provides both, a comprehensive toolbox for standard analysis and customizable calculations.

www.kistler.com
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 document 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.

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 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.

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 to 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.
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.

www.kistler.com/t&m/pressure

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 the_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