Investigate and Optimize Your Structures with Kistler's Modal Portfolio

Modal Analysis
Accelerometers, Impact Hammers, Impedance Heads, Force Sensors and Electronics for Your Modal Analysis and Structural Studies

www.kistler.com
Sensor Solutions for Your Specific Application Needs
Accelerometers are used in every avenue of the dynamic test environment and Kistler has developed families of products covering this expansive range of applications. From ultra-low motions encountered in wafer fabrication technology to shock spectra reconstruction experienced in pyrotechnic separation event studies and everywhere in between, an optimal sensor solution is available. Static events are captured with the K-Beam® static and low frequency product offerings. Very high frequency activity is routinely measured using any of several miniature piezoelectric single-axis or triaxial types.

Many sensing technologies including piezoceramic, quartz and variable capacitance approaches have been extensively explored and are employed as needed to accommodate the demands of the specific application. Such applications include structural testing, aerospace and military, automotive/transportation, civil engineering or environmental stress screening.

Additional Information
- Easy setup of complex, high channel testing
- TEDS option available according to IEEE 1451.4 standard
- Easy mounting of sensors due to unique ‘clip’ techniques
- Accredited to ISO/IEC 17025 for pressure, force, acceleration and charge
Kistler Modal Analysis Instrumentation.

Expanding Your Capabilities

Reliable data reflecting the structural response is imperative to an accurate analysis. Structural dynamics studies using modal analysis present unique requirements for accelerometers and force sensors. Kistler’s comprehensive product line optimizes the measurement capability of your study. Complete specifications are listed in data sheets for each product at www.kistler.com.

Triaxial modal accelerometers, such as PiezoBeam® Type 8688A… and Ceramic Shear Type 8762A…, offer lightweight solutions ideal for applications where mass loading must be kept to a minimum. Impedance head Type 8770A… provides coincident force and acceleration data. Load cell Type 9712B… precisely measures single-axis force input. The impulse hammer product line Type 972xA uses the same Piezotron® IEPE low impedance, voltage mode as many of the accelerometers above to provide accurate measurement of input excitation. These hammers are used with accelerometers to perform structural analysis with the impact method.

Most Kistler Modal Analysis dedicated accelerometers are available with a TEDS option (Transducer Electronic Data Sheets). These sensors generate data sheet information that eases the setup of complex, high channel testing. Kistler has been a guiding force with the IEEE 1451.4 standard for this style of accelerometer. PiezoSmart® is Kistler’s trade name for TEDS sensors.

Kistler is accredited to ISO/IEC 17025 for pressure, force, acceleration and charge. For calibration services, please contact your local Kistler representative.

Operational Modal Analysis on a full car body

What is Modal Analysis Used For?

- Refinement of Finite Element (FE)-Model: prototype testing, inclusion of damping
- Trouble-shooting: reduce excessive vibration levels, ensure that resonances are away from excitation frequencies
- Simulation of ‘what if?’ scenarios: determination of forces, response to complex excitation, structural dynamic modification
- Structural assembly analysis: to predict dynamic behavior of assembled sub-components
Kistler PiezoBeam® Sensors.

Kistler PiezoBeam® Types 8640A..., 8688A...
Kistler pioneered this ceramic, beam-type, bimorph sensing element that also serves as the seismic mass. This construction provides a highly favorable mass to sensitivity ratio, unachievable with other types of piezoelectric accelerometers.

PiezoBeam triaxial modal accelerometers Type 8688A... and PiezoBeam single-axis modal accelerometers Type 8640A..., offer inexpensive solutions for SIMO or MIMO structural testing. Such testing includes pre-production investigations, which require a large number of high performing accelerometers at low cost. The Kistler PiezoBeam family allows for reduced mass loading on thin-walled structures important to multi-channel modal applications.

Advantages of Kistler PiezoBeam® Sensors
- Unique ceramic beam sensing element
- Easy clip mounting
- Reduce mass loading
- Ultra-low noise down to 140 μg
- Inexpensive
- TEDS option available
Unique Ceramic Beam Sensing Element
The PiezoBeam accelerometer incorporates a unique sensing element consisting of a ceramic beam supported by a center post that, when bending occurs as a result of being subjected to vibration, yields an electrical charge. The charge signal is converted by the internal low noise charge amplifier to a proportional high level voltage signal at an output impedance of less than 500 ohms. Patented methods are used to thermally compensate the sensing element. The sensing element design provides outstanding amplitude and phase response over a wide frequency range.

A clever welded titanium housing design allows for those sensors to be ground isolated when mounted using different dedicated mounting accessories from an adhesive mounting clip to a magnetic mounting base.

TEDS option
Last but not least, Types 8688A... and 8640A... provide an optional IEEE 1451.4 Transducer Electronic Data Sheet (TEDS). TEDS provides automatic transfer of sensor parameters to TEDS capable signal conditioning minimizing transcription errors and record keeping tasks.

The PiezoBeam accelerometer should be used under constant thermal operational conditions, such as closed laboratories. Accelerometers with shear design are common under changing temperature conditions.

<table>
<thead>
<tr>
<th>PiezoBeam® Modal Accelerometer Type 8640A...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mounted on Type 800M156 Ground Isolated Clip</td>
</tr>
<tr>
<td>Mounted on Type 800M158 Adhesive Mounting Stud</td>
</tr>
<tr>
<td>Mounted on Type 800M160 Magnetic Mounting Base</td>
</tr>
</tbody>
</table>

Typical Mounting Configurations At a Glance
The ground isolated mounting clip, adhesive mounting stud or magnetic mounting base are used to easily and quickly mount and orient the PiezoBeam® sensors. Please refer to page 10 for more details.
Kistler Impact Hammer Series Type 972xA

The dynamic response of a mechanical structure, while either in a development phase or an actual use environment, can be readily determined by impulse force testing. Dynamic quartz sensor elements contained within Kistler Type 972xA instrumented hammers are used to deliver a measurable force impulse (amplitude and frequency content) to excite the mechanical structure under test. Using an FFT analyzer, the transfer function of the structure can be determined from a force pulse generated by the impact of a hammer and the response signal measured with an accelerometer.

An impulse force test method yields extensive information about the frequency and attenuation behavior of the system under test. The stainless steel head of an impulse force hammer, equipped with the quartz, low impedance force sensor, accepts impact tips varying in hardness. As mentioned earlier, accelerometers operating in a voltage mode and featuring insensitivity to base strain, thermal transients and transverse motion are available to measure the response of the test specimens ranging from thin-walled structures to steel bridge members.

Kistler Impact Force Hammer

Features at a Glance

- Solutions from 500 ... 20,000 N [100 ... 4,500 lbf]
- Low impedance, voltage mode
- Quartz-sensing element guarantees long-term stability
- Accessories for various applications (various tips for pulse duration variation, extended mass for amplitude variations)
- Sensor cable integrated to hammer handle (BNC)
- Conforming to CE

Frequency response of the hammer Type 9722A... according to the impact tip used
Hammer Test Method: Easy Measuring
Chain Integrity Investigations

In practice, a true Delta Function pulse does not exist since its theoretical duration is zero. In general, as the impact duration increases, the range of excited frequencies decreases. Impact tips mounted to a force impulse hammer consist of different materials (steel, plastic, various density rubber tips), each yielding different excitation durations and different excitation frequency ranges. Depending upon the frequencies of interest of the structure under test, the appropriate impact tip and an extender mass (to increase the force range) are mounted to the hammer.

Advantages of a Hammer Test Method

• Fast and straightforward method to determine the frequency response function(s) of a structure
• Simple and reliable method for checking sensitivity at low frequencies
• Detection of changes in structure (e.g. cracks, other structural changes) is possible

Kistler K-Beam® Accelerometers.

Kistler MEMS Variable Capacitance Sensors for Very Low Frequency Investigations

Types 8315A(x) single-axis and 8395(x) triaxial K-Beam® MEMS technologies provide temperature stability and low noise for accurate measurement of low frequency events from DC up to 1,000 Hz bandwidth. They are ideal for civil infrastructure and automotive modal testing among many other applications.

Advantages of Kistler K-Beam® Accelerometers

• 2 ... 200 g measuring range
• Unique long term and thermal stability
• Various connectivity and signal output options (single, bipolar, differential)
• Possibility of driving long cable length without signal loss
• EMC protection; ground isolated
• Mounting accessories for adhesive, magnetic and screw configurations
Kistler LabAmp
for Dynamic Measurements.

Universal Amplifier and Data Acquisition Unit
The Kistler LabAmp Type 5165A... is not only an outstanding amplifier for dynamic signals, but also a data acquisition device delivering the 24-bit digitized measurement values directly to the computer. Via Ethernet, the amplifier can be directly connected to a host computer or through a network. It is configured and operated by a web-interface and conveniently accessible by a standard web-browser.

Advanced signal processing technology provides the Kistler LabAmp Type 5165A... with impressive flexibility. The frequencies of the high-pass, low-pass and notch filters can be directly entered as numerical values in Hz. The input signals can be flexibly routed to the analog outputs. The graphical user interface not only offers a simple and intuitive way to configure the device, but can also display different peak values or the root mean square of a signal.
This universal laboratory amplifier can be used wherever dynamic signals of mechanical quantities are measured with piezoelectric sensors, Piezotron sensors (IEPE) or sensors with single-ended voltage output. Piezoelectric sensors produce an electric charge, which varies in direct proportion with the load acting on the sensor. The amplifier converts this charge directly into digital values or a proportional output voltage.

**Key Features of the Kistler LabAmp Type 5165A...**

- 1 or 4 versatile, programmable inputs
- Frequency range 0.1 Hz ... 100 kHz
- Charge ranges from 100 ... 1,000,000 pC
- 24-bit data acquisition with up to 200 kSps per channel
- Fully flexible low-pass, high-pass and notch filter adjustment
- TEDS (IEEE 1541.4) for Piezotron®/IEPE sensors
- 1 or 4 analog outputs with fully flexible 2-point scaling
- Configuration and control in a standard web-browser
- Virtual instrument driver for LabVIEW™
- 2 Ethernet interfaces with included switch functionality
- Status indication per channel via LED

![Block diagram of Kistler LabAmp Type 5165A...](image-url)

![Kistler LabAmp Type 5165A... user interface (partial view)](image-url)
## Product Line Highlights.

### PiezoBeam® Accelerometers

<table>
<thead>
<tr>
<th>Technical Data</th>
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<th>...A10...</th>
<th>...A50...</th>
<th>...A5...</th>
<th>...A10...</th>
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<td>Range [Sensitivity]</td>
<td>g</td>
<td>±5</td>
<td>±10</td>
<td>±50</td>
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<td>±50</td>
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<td></td>
<td>[mV/g]</td>
<td>[1,000]</td>
<td>[500]</td>
<td>[100]</td>
<td>[1,000]</td>
<td>[500]</td>
<td>[100]</td>
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<td>0.5 ... 3,000</td>
<td>0.5 ... 3,000</td>
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<td></td>
<td>[mV/g]</td>
<td>[1,000]</td>
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<td>[10]</td>
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### Miniature Accelerometers

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### IEPE Impedance Head

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<tr>
<td>Range sensitivity g</td>
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<tr>
<td>Force range N (lbf)</td>
<td>±22 (±5)</td>
<td>±222 (±50)</td>
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<tr>
<td>Sensitivity mV/N</td>
<td>22</td>
<td>23</td>
<td>1000</td>
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<tr>
<td>[mV/lbf]</td>
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### IEPE Force Impact Hammers

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<td>2,000 [450]</td>
<td>5,000 [1,100]</td>
<td>5,000 [1,100]</td>
<td>20,000 [4,400]</td>
<td>20,000 [4,400]</td>
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<tr>
<td>Sensitivity mV/N</td>
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<tr>
<td>[mV/lbf]</td>
<td>50</td>
<td>[10]</td>
<td>[10]</td>
<td>[5]</td>
<td>[5]</td>
<td>[1]</td>
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<tr>
<td>Frequency response Hz</td>
<td>8,200</td>
<td>9,300</td>
<td>6,600</td>
<td>6,900</td>
<td>5,000</td>
<td>5,400</td>
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<td>250</td>
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### Charge Force Sensors

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<tr>
<td>Range compression N (lbf)</td>
<td>22,000 [5,000]</td>
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<tr>
<td>Range tension N (lbf)</td>
<td>2,200 [500]</td>
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<tr>
<td>Sensitivity pC/N</td>
<td>–11</td>
<td>–50</td>
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<tr>
<td>[pC/lbf]</td>
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### IEPE Force Sensors

<table>
<thead>
<tr>
<th>Technical Data</th>
<th>Type</th>
<th>...B5...</th>
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<th>...B250...</th>
<th>...B500...</th>
<th>...B5000...</th>
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<tbody>
<tr>
<td>Sensitivity pC/N</td>
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<td>22</td>
<td>4.5</td>
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<td>[pC/lbf]</td>
<td>[800]</td>
<td>[100]</td>
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Measuring Chains.

Impact Force Hammer Method

Generating/Measuring | Measuring | Connecting
--- | --- | ---
Impact Hammer Method Type 972x...

Input: Impact

Accelerometer Types 86xx, 87xx

Unit Under Test (UUT)

Cable Types 1761B..., 1756C..., 1784B...

Output Signals Type 1601B

Input Signals

Shaker/Frequency Sweep Method

Generating/Measuring | Measuring | Connecting
--- | --- | ---
Shaker Method

Customer supplied

Impedance Head Type 8770A...

Accelerometers Type 86xx, Type 87xx

Force Sensor Type 97128...

Input: Sweep

Accelerometer Types 86xx, 87xx

Unit Under Test (UUT)

Cable Types 1761B..., 1756C..., 1784B...

Output Signals

Cable Types 1761B..., 1756C..., 1784B...

Input Signals
Pressure, force, torque or acceleration: no matter which parameter demands your attention, Kistler has the right piezoelectric, piezoresistive or strain gage sensor to meet virtually any requirement when it comes to analyzing, testing and validating mechanical systems. Outstanding features guarantee the results you need — such as an exceptional breadth of measuring ranges from mbar to 10,000 bar, from mN to MN, from mNm to kNm and from 200 μg to 100,000 g. These products also cover extensive temperature ranges, from cryogenic to 350 °C (662 °F).

Kistler – Your Partner for Innovation.

Additional Information:

<table>
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<tr>
<th>Doc No.</th>
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<td>900-380</td>
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<td>K20.302</td>
<td>IEEE P1451.4: Measurement with Smart Transducers</td>
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<td>700-360e</td>
<td>Aviation &amp; Aerospace – Force Limited Vibration Testing</td>
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Expert advice and practical assistance for technical implementation is provided by our local Sales Centers or Sales Offices. For standardized calibration services, repairs to/with original parts, and product modifications, please contact your regional Tech Center.

To help you make the most effective use of Kistler measurement technologies, Kistler offers tailor-made training for all its products and systems – either at your own premises or at one of our Sales Centers.

Simply go to www.kistler.com/applications and click on to the section you are interested in to find the contact details of the relevant sales representative. Contact us today – we’re here to help!