KISTLER

measure. analyze. innovate.

Energetic materials testing

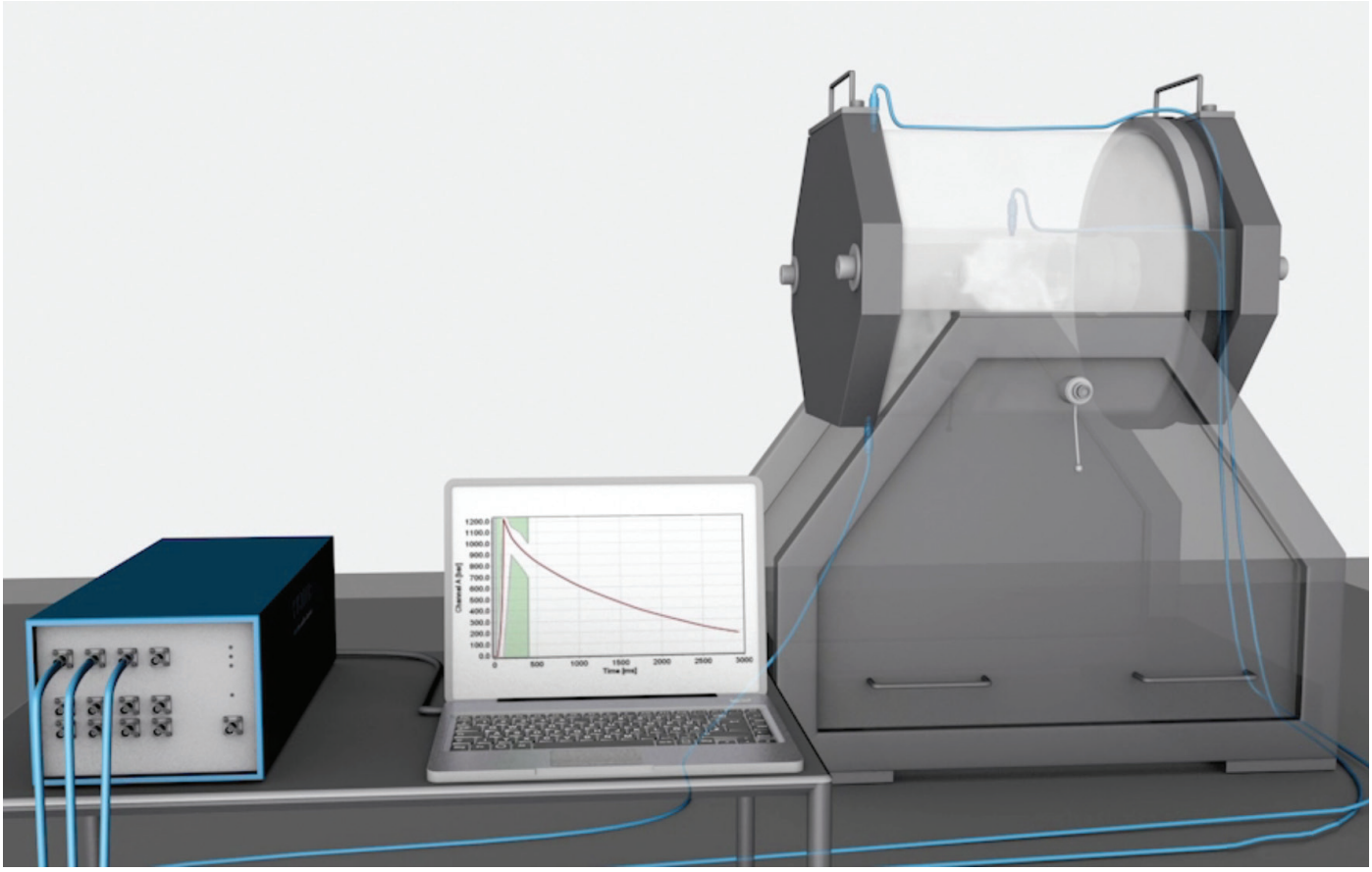
Pressure measuring solutions for the testing of airbag components, pyrotechnic actuators and propellants

www.kistler.com/energetic-materials

Kistler – Your Partner for Energetic Materials Testing

Kistler is the global leader in dynamic pressure, force, torque, and acceleration measurement. Cutting-edge technologies provide the basis for Kistler's durable systems and services and enable customers to analyze extreme pressure peaks for effective testing and improved product safety.

Content



Kistler pressure sensors for energetic materials testing can withstand extreme pressure peaks

Understanding high-speed pyrotechnic processes

Manufacturers of airbag components or energetic materials are interested in correcting quality issues at an early stage to save costs. Kistler measuring solutions enable the analysis of dynamic and high pressure pulses with an excellent time resolution.

Pressure profile over time
When testing airbag components or energetic materials, the pressure profile over time is one of the most crucial characteristics to identify. Pressure data can be used to analyze and optimize pyrotechnic products such as airbag components or powder actuated tools.

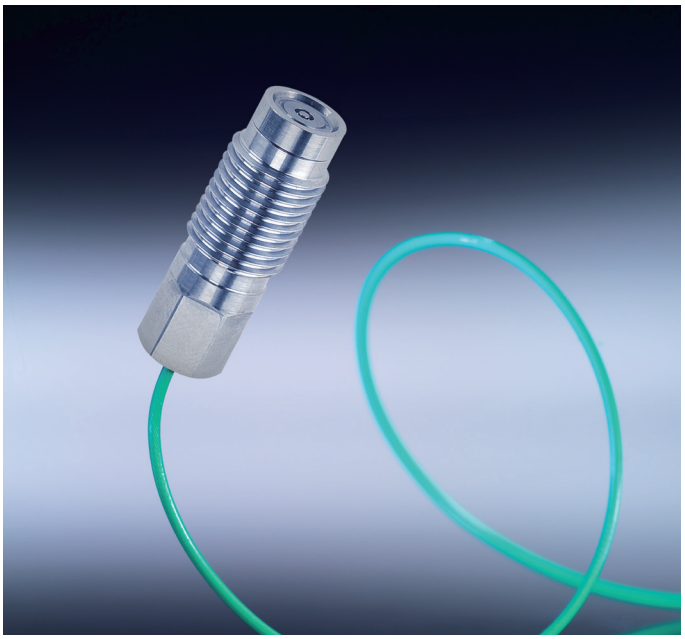
Extremely durable solutions
Kistler piezo-electric pressure sensors for energetic materials testing contain crystal measuring elements embedded in a solid metal casing. They can withstand extreme pressure peaks of several thousand bars. Acceleration compensation ensures accurate measurements – even under challenging vibration conditions. Membrane protectors are used to minimize the effects of abrasive soot and thermal shock.

Requiring little maintenance over many years, Kistler sensors are a long-term investment for thousands of test cycles.

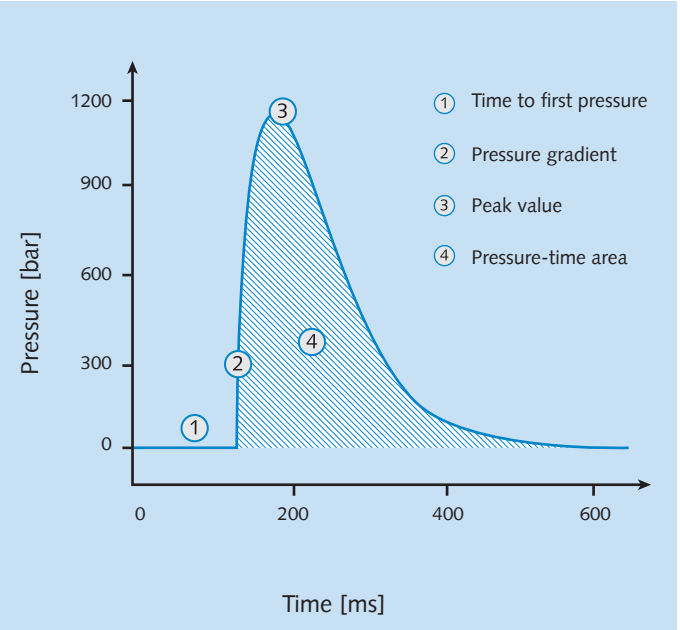
Advantages of Kistler Energetic Materials Testing Solutions
- Accurate analysis of extreme pressure peaks
- Reliable and durable measuring solutions
- Reduced R&D and quality cost through effective product testing
- Improved safety of airbag components or energetic materials

Discover all the benefits of our testing solutions online:
www.kistler.com/energetic-materials

Wide measuring range with high frequency response
Kistler's highly sensitive quartz or PiezoStar® crystal measuring elements precisely capture pressure over a wide range.
To measure the highly dynamic pressure rise during airbag ignition or inflation, sensors with a high frequency response are required. Thanks to the exceptional time resolution of Kistler sensors, airbag component or energetic materials manufacturers can register every detail of a pressure pulse and obtain all performance data needed to optimize quality or ensure product conformity.



Kistler quartz high-pressure sensor Type 6215BA for measurements up to 6 000 bar



Typical curve showing fast pressure rise during airbag ignition

Complete measuring chain with a modular setup
Kistler offers complete measuring chain solutions, consisting of sensors, electronics, data acquisition system and accessories that have been designed specifically for the acquisition of highly dynamic pressure signals. Kistler products are also compatible with third-party data acquisition systems, so that an integration into existing measurement setups is possible.

Mounting in limited space – even next to igniter elements
Kistler sensors are very compact and can be easily mounted directly on an airbag component or inside the wall of a test tank. A large portfolio of adapters and mounting accessories makes installation easy and ensures that the sensors can be placed exactly where they are needed. Thanks to their robustness, the sensors can be mounted close to the igniter element, and can withstand high temperature and acceleration shocks.

Key-features of Kistler energetic materials testing solutions
- Unique crystal measuring technology for rough conditions
- Extremely wide pressure range and high sensitivity
- Protection against thermal and mechanical shock
- Quick installation in limited space
- Accurate measurements over thousands of test cycles
- Complete measuring system from one single source

Experienced partner
Kistler has been setting standards in highly dynamic pressure measurement for more than forty years. We are at your side as an experienced partner with vast technical and application-specific know-how. Discover all the benefits of a solution that has been tried and tested in the field to deliver absolutely reliable measurement results in rough conditions.

One technology, many applications

The rapid burning of an energetic material generates an expanding gas which, in a confined space, exerts a pressure. Many products rely on this rapid gas expansion process to propell a nail in a powder actuated tool or to deploy an airbag. The Kistler pressure measurement solutions can be used for product or component testing in these varied applications.

Airbag component testing

In a crash situation, an electric trigger signal initiates the deployment of the airbag. This signal activates the igniter element which releases the energy needed to set off the inflator propellant. The airbag very quickly fills with gas to attenuate the effects of impact on the car occupants, preventing serious injury or death. The following two application examples show how Kistler measurement solutions can add value in the field of airbag component testing.

Airbag inflator testing
Kistler pressure sensors are a valuable tool for inflator development and testing. To meet the strict safety regulations, a fixed number of inflators from each production batch is subjected to conformity testing.

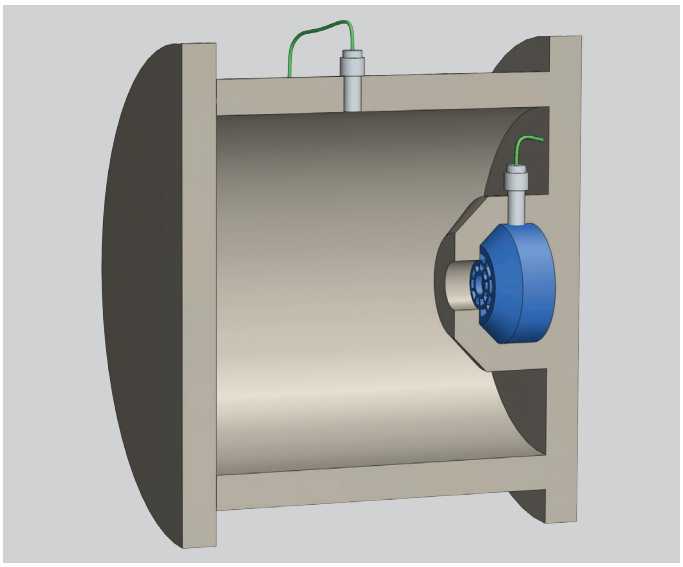
For testing, the airbag inflator – consisting of igniter, propellant and filter – is mounted inside a testing tank. Its highly dynamic gas generation and increase in pressure can be registered in real-time by Kistler pressure sensors. Thanks to their compact size, Kistler sensors can be mounted directly on the inflator component. Additionally, further sensors in the tank wall measure the tank pressure.

All inflator tests can be performed with Kistler technology and according to SAE J211 recommendations and filter settings.

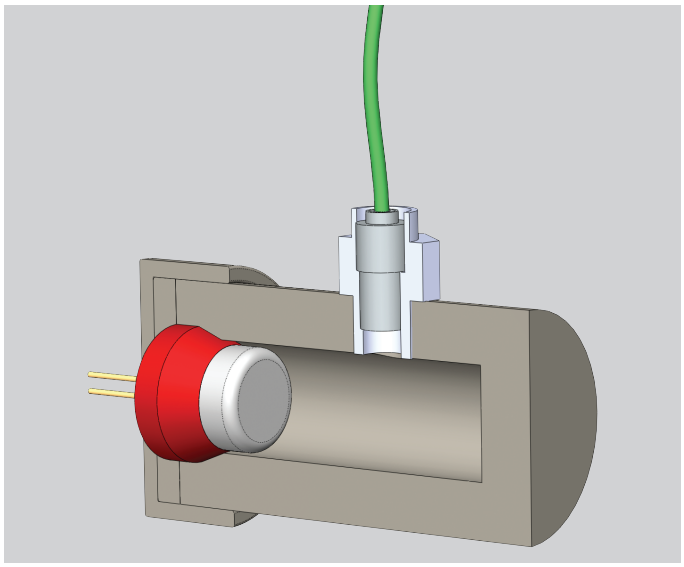
Airbag igniter element testing
The airbag igniter element is a very critical component of the airbag inflator. It serves as the primary explosive to initiate the gas formation process and ignites upon electric stimuli from a crash detector. The reliability of the igniter element is of utmost importance, and its quality has to be closely monitored. Its heat and pressure development over time as well as its ignition delay respective to the trigger signal are of particular interest.

As the ignition process takes only several microseconds, testing the igniter element requires sensors with a high frequency response, a major characteristic of Kistler sensors. These sensors can withstand even the roughest operating conditions and can be installed in confined spaces using a needle adapter.

Airbag igniter element testing with Kistler sensors can be conducted for R&D purposes to optimize products or for production monitoring purposes to ensure conformity.



In airbag inflator testing, the highly dynamic increase in pressure can be registered by using Kistler sensors

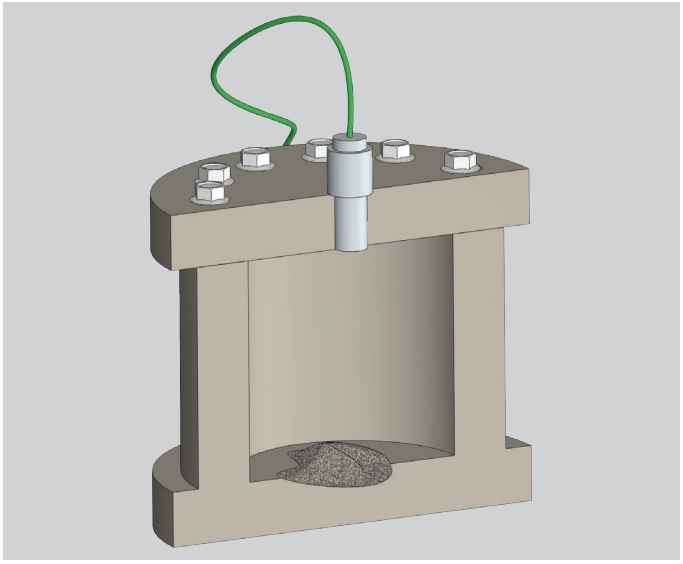


Testing the igniter element requires sensors with a high frequency response – a major characteristic of Kistler sensors

Closed vessel testing of energetic materials

Airbag components and other pyrotechnic devices contain energetic materials (propellants and primary explosives), which are also tested separately in production monitoring and R&D. For controlled detonation or combustion, these materials are placed inside a closed vessel or closed bomb-type test tank.

Kistler sensors are the ideal choice for any closed vessel test setup. They will resist extreme pressure and temperature environments, and their high frequency response allows extensive investigation of the high-speed detonation process. A wide variety of Kistler adapters ensure the sensors can be mounted at the desired spot within the vessel. With Kistler's modular product portfolio, measuring chains can be easily integrated into any existing system.

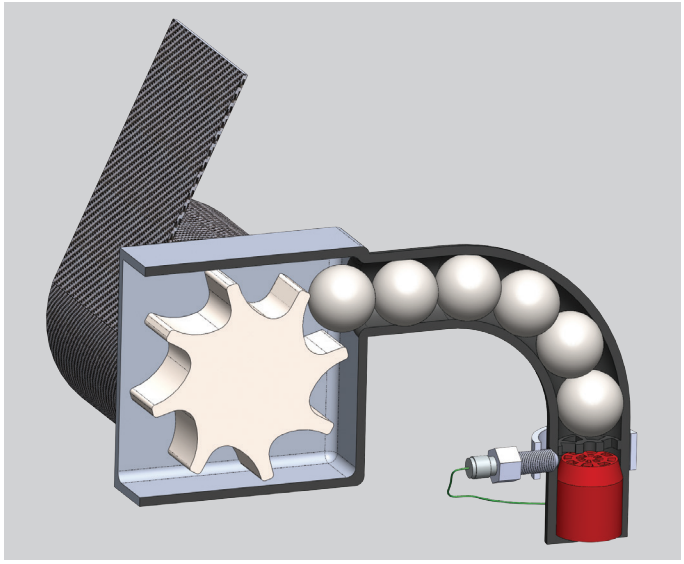


Kistler sensors are the ideal choice for any closed vessel test setup

Seatbelt pretensioners

Seatbelt pretensioners are a very important safety element used in modern automobiles. They enable a fast retraction of seatbelts during a crash and therefore ensure the safety of the passengers. Seatbelt pretensioners are based on a pyrotechnic process. Upon a trigger signal an explosive charge burns off and generates a rapidly expanding gas. This expansion process enables a mechanical movement of metal components that apply a torque on the seatbelt retractor.

This highly dynamic ignition and inflation process can be analyzed with Kistler measurement technology. The pressure sensors are placed close to the ignition element through an adapter on the enclosing pipe and capture the rapidly rising gas pressure. Our modular measurement technology allows a synchronized acquisition of additional signals such as force and torque in the mechanical retraction unit. Ultimately, the whole process from ignition to retraction is accurately represented and allows the localization of optimization potential inside the seatbelt retraction system.



Pressure measurement on seatbelt pretensioners require suitable sensor mounting adapters

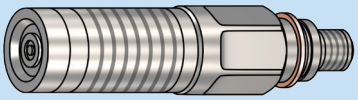
Measuring chains

Kistler offers complete measuring chain solutions. Place your trust in a complete system from a single company specialized in pressure measurement technology and calibration services.

Sensors
Our piezo-electric sensors provide exact and reproducible data through reliable and precisely measuring crystal elements. A specific sensor type is available for every pressure range and sensitivity requirement. The high frequency response of the sensors enables the measurement of pressure pulses with a duration of a few microseconds to several seconds. All the sensors are calibrated according to highest standards and are traceable up to the Swiss National Metrological Institute (METAS).

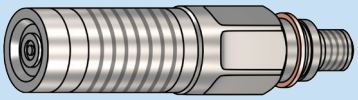
Cables and adapters
There are several adapters available to mount the Kistler sensors in different locations such as in the tank wall or on inflators in a test setup. Specific cables are designed for rough operating conditions and to withstand strong vibrations. They can be ordered with a variety of connector types for the compatibility with Kistler or any third-party measuring setups. Accessories such as membrane or thermal protectors enable more accurate measurements and a longer life time of the sensor.

Sensor Type 6215 or others



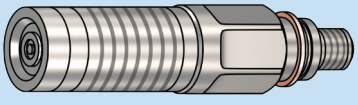
Cable Type 1631

Sensor Type 6215 or others



Cable Type 1631

Sensor Type 6215 or others

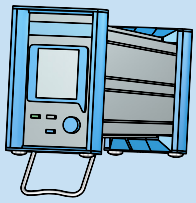


Cable Type 1631

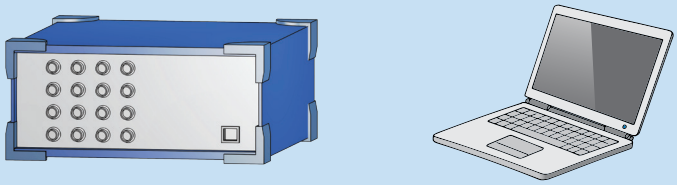
Charge amplifiers
Kistler is world-renowned for charge amplifiers. A high frequency response and a short group delay is what makes our systems indispensable for dynamic measurements. Kistler charge amplifiers also allow the setting of low pass filters and time constants to match the specific tests. Besides the single channel charge amplifiers also a multi-channel transient recorder or LabAmp are available that include the charge amplifer and data acquisition in one unit.

Data acquisition and software
Kistler provides a transient recorder with software to acquire and analyze fast signals. The transient recorder allows the acquisition of multiple signals, such as from addtional sensors or for triggering purposes. The software calculates the major values necessary for reports, such as time to first pressure or rise time. It is also possible to use an already etablished data acquisition system and combine it with our measuring chain.

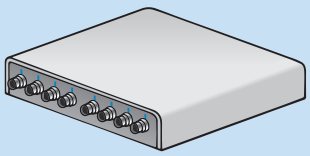
Charge amplifier Type 5018

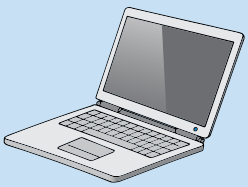


3rd-party data acquisition

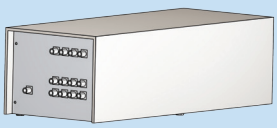


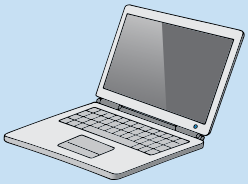
LabAmp Type 5165A





Transient recorder Type 2519A





Sensors and accessories

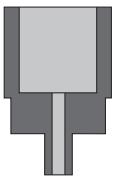
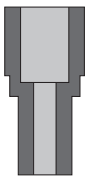
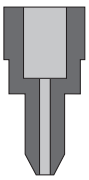
Kistler's large portfolio of sensors, adapters, and mounting accessories will perfectly match your test setup.

Sensors

Technical data	Type	601C	6217A
			
Range	bar	0 … 250	0 … 2000
Calibrated partial range	bar	2, 20, 100	0 … 200
Overload	bar	300	2 400
Sensitivity	pC/bar	–37	–13
Thread type		M8 (with Adapter 6423B) M10 (with Adapter 6503B)	M12
Natural frequency	kHz	>215	>180
Rise time	us	<1,4	–
Linearity for all ranges	%FSO	<0.5	<0,5
Comments		• Also as IEPE version available	• Low stress on the sensor due to the large M12 thread leads to very high lifetimes • Available with KIAG 10-32, BNC and TNC connector.
Applications		• When limited spacing is available • To measure with a high sensitivity in the lower pressure range up to 250 bar	• Igniter Testing Mounted in the tank wall for Closed Vessel Tests

Technical data	Type	6215	6213B
			
Range	bar	0 … 6000	0 … 10 000
Calibrated partial range	bar	0 … 600	1000, 8000
Overload	bar	6 600	11 000
Sensitivity	pC/bar	–1.4	–1.2
Thread type		M10	M12
Natural frequency	kHz	>240	>150
Rise time	us	1	2
Linearity for all ranges	%FSO	<1	<0.5
Comments		• Standard KIAG 10-32 Connector	• Standard KIAG 10-32 Conncector
Applications		• High pressure measurement close to the ignition source	• High pressure closed bomb testing

Adapters

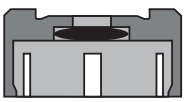
Technical data	Type	Needle adapter	Standard adapter	Calibration adapter
				
Application		• Mounting the sensor directly onto the airbag inflator • Ideal where spacing is limited	• Easy mounting in the tank wall • Allows the transition between thread types • Mounting with an adapter to protect the sensor	• Conical design allows a mounting where no thread is available
Thread Type		M12 to M4 (6576A22Q01)	M10 to M12 (6560AQ02)	M12 to M12 (6923A)
		M10 to M3 (6582A)	M10 to M14 (6551Q02)	
			M10 Adapter for 601C (6503B0A)	

Cables

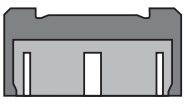
Technical data	Type	1699AA0.5	1631C
			
Connectors		KIAG 10-32 pos. to KIAG 10-32 neg.	KIAG 10-32 pos. to BNC pos.
Applications		Connection cable for highly vibrating test setups	Standard cable for high pressure sensors

Other accessories

Sensors (Thread Type)	6215 (M10)	6217A, 6213B (M12)
Membrane protectors	6567	6564
Thermal protection shield	6565A	6563A
Thermal protective plate	1181A	1181A
Surface finishing tool	1300A25	1300A23
Sealing joint	1100	1100
Lubrication grease	1063	1063



Thermal protection shield



Membrane protector

Electronics and software

Kistler offers complete charge amplifiers and data acquisition solutions for acquiring very fast signals. The systems are highly configurable and can be adapted to any test setup. Kistler sensors, charge amplifiers or data acquisition units work seamlessly together, but can also be integrated in any 3rd-party setup.

Charge amplifier

Technical data	Type	5018	5165A
			
Connector type		BNC	BNC
Measuring range	pC	2 … 2 200 200	100 … 1 000 000
Measuring error	%	<0,3	<0,5
Frequency response	Hz	200 000	100 000
Drift	pC/s	<0,03	<0,03
Group delay	us	2	12
Time constant	s	0,033 to 100 000	short
Lowpass filter		Butterworth 2nd order 10 HZ ... 100 kHz	Bessel, Butterworth 2./4. order 10 Hz ... 100 kHz
		• Converts charge input signals into a voltage output (1 channel) • RS-232 or USB interface • The short group delay enables the synchronization of multiple charge amplifiers or signal inputs	• 1 or 4 channels • Universal input (charge, voltage IEPE) • Ethernet • Integrated DAQ up to 200 kSa/s

Transient recorder

Technical data	Type	2519A
		
Channels		up to 4 voltage and 4 charge input channels
Input range voltage channels	V	1, 2, 5, 10
Sensitivity range charge channels	pC	2 600, 5 200, 10 600, 20 200
Sampling frequency		from 0.1 kSa/s to 10 MSa/s
Acquisition time window	s	4000 (0.1 kSa/s), 0.4 (1 MSa/s), 0.04 (10 MSa/s)
Number of ADC		8
Resolution	bit	14
		• Fast signal acquisition of up to 10 MSa/s • Synchronized acquisition of charge and voltage signals • Large raw data acquisition and analysis in the post processing phase • Versatile software for signal analysis (peak pressure, pressure rise, mask) and report generation

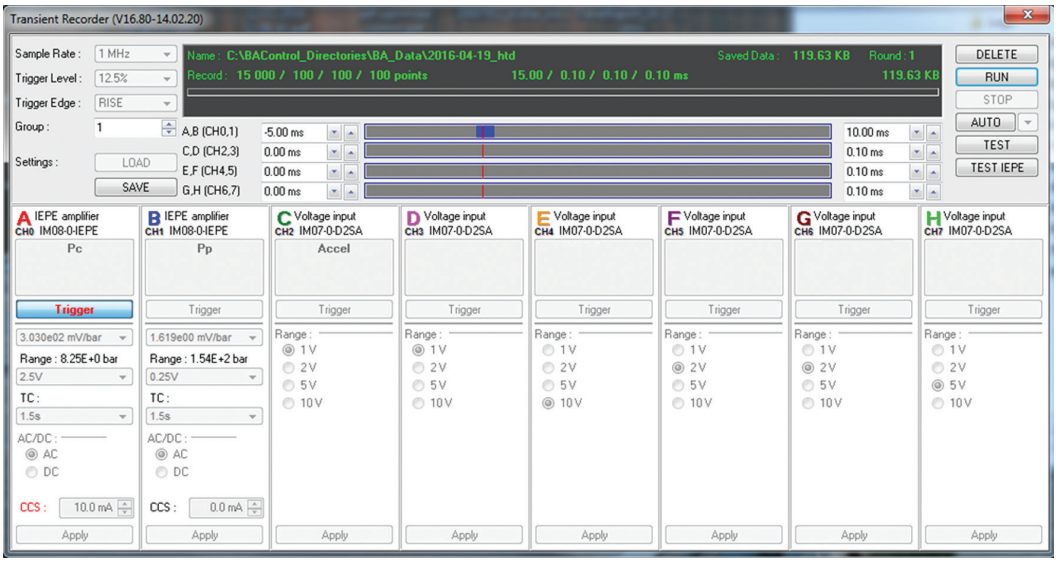
Control software

The TR Control Software included in the Transient Recorder 2519A allows the acquisition and analysis of highly dynamic signals. A control panel serves for the configuration of the data acquisition and the analysis window enables the viewing of the data and the definition of calculations. Among the many calculations on the signals that can be made, there are the following:

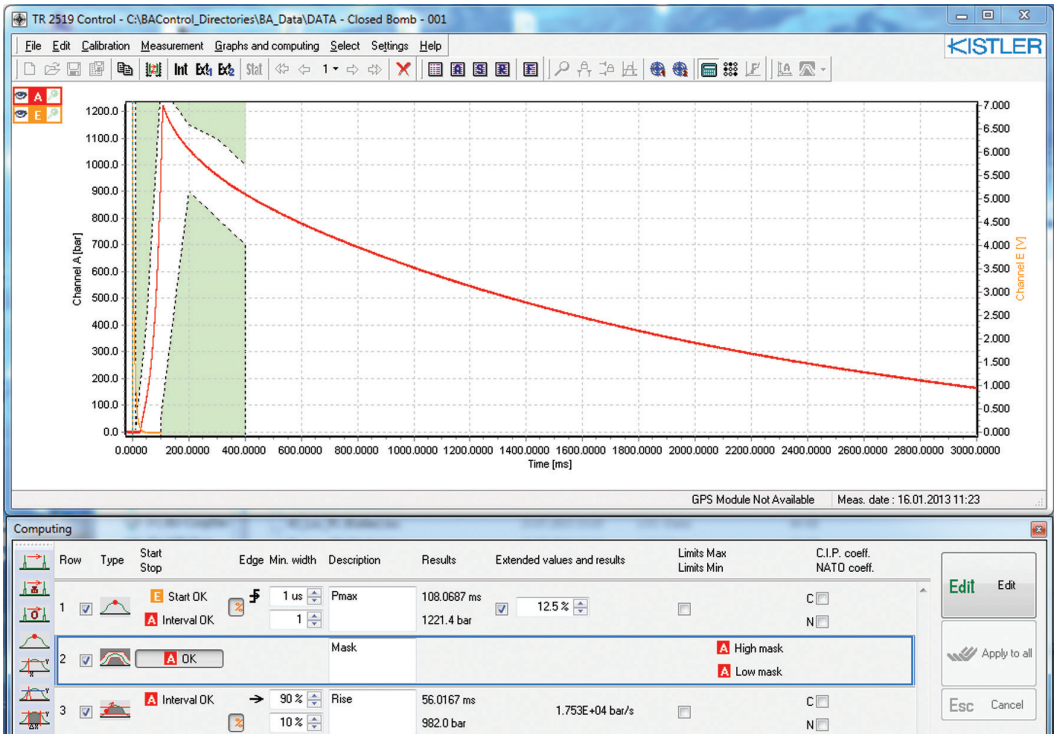
- Time to first pressure
- Gradient of pressure rise
- Peak pressure detection
- Masking
- many more

Through the control panel all the measurement parameters of the transient recorder can be set. It allows the setting of the sampling rate, level and slope of trigger and memory configuration.

Graphs and calculated data (pressure, time intervals, velocities, etc.) can be placed directly into reports, according to various standards.



Data acquisition configuration tab. Here the channels and the measuring time window are configured, as well as the trigger conditions and sampling rate.



Analysis window. The measured signals are represented in the window. Calculation tools enable the quantification and comparison of the measurements

Kistler service: customized solutions from A to Z

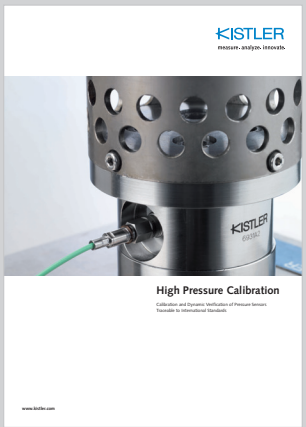
Kistler has been setting standards in highly dynamic pressure measurement for more than 50 years. We are at your side as an experienced partner with vast technical and application-specific know-how.

Kistler's engineering team will support you through every step of the process – from planning, initial set-up and on-site system training to regular maintenance and repair. Thanks to years of experience and close collaboration with our customers, Kistler can deliver customized solutions that meet the specific requirements for your application. Learn more about our solutions for Airbag Component and Energetic Material Testing at **www.kistler.com/energetic-materials**.

In addition to a vast portfolio for energetic materials testing, Kistler also offers sensors and systems for complete vehicle crash tests and crash dummy instrumentation. Learn more at **www.kistler.com/vehicle-safety**.

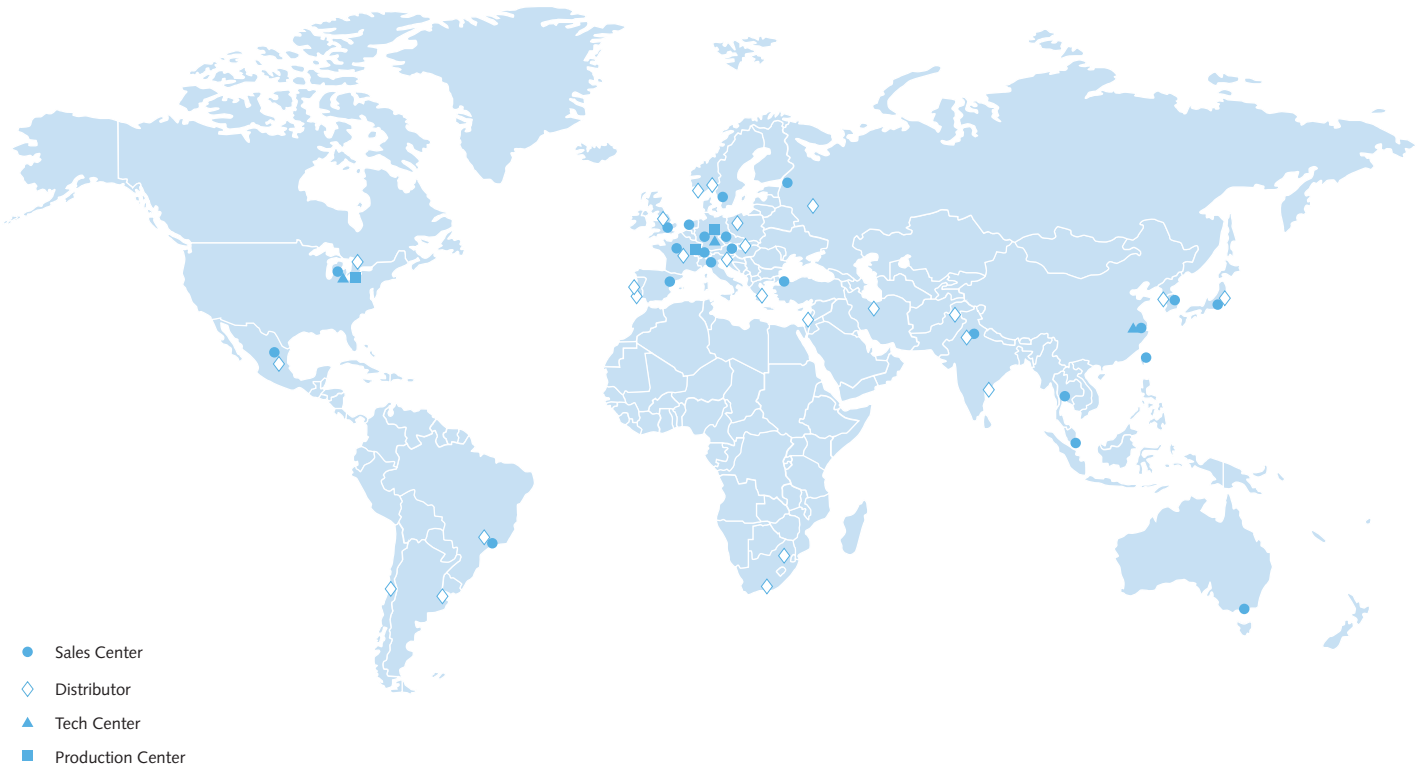
Kistler services at a glance

- Advisory
- Installation
- Commissioning support
- Periodic calibration
- Training/workshops



www.kistler.com/callibration

www.kistler.com/vehicle-safety



At our customers' service across the globe

Thanks to Kistler's global sales and service network, we are always close to our customers.

Kistler is the global leader in dynamic pressure, force, torque, and acceleration measurement. Customers benefit from Kistler's experience as a development partner, enabling them to optimize their products and processes and give them a sustainable competitive edge. Some 1,500 employees at 56 facilities worldwide offer individual application-specific support at local level. The Kistler Group reinvests 10 % of the revenue in innovation and research.

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Kistler Group includes the Kistler Holding AG and
all its subsidiaries in Europe, Asia, Americas and Australia.

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KISTLER

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