KISTLER

measure. analyze. innovate.

Pressure Sensors

for ultra-precise pressure measurement

Pressure means more to us than just physics

Definition of pressure
Physics defines pressure as "force per unit area". However, though technically precise, this abstract definition does not tell the whole story. We have only to glance around us to see that pressure is a phenomenon that comes in many forms.

Pressure in our daily lives
When we look out of the window in the morning, it is atmospheric pressure that determines whether we see blue skies or black clouds. And it is steam pressure in the espresso machine that determines the enjoyment of our first cup of coffee. Then, tire pressure may well decide whether we get to the business meeting on time. Does our printer give us sharp or blotchy characters – everything depends on the pressure in the cartridge. The way we perceive the events of the day is very much conditioned by our well-being and blood pressure. Combustion chamber pressure is the main factor affecting our car's fuel consumption and running costs. And, finally, it is fuel pressure for satellite guidance systems that allows us to make our intercontinental phone calls in the evening to exchange ideas and thoughts.

A passion for pressure
From ultra-slow pressure changes close to an absolute vacuum through to the ultra-fast pressure peaks of an explosion, we at Kistler have the expertise to measure pressure in every application with precision and reliability. It is thanks to this capacity that Kistler sensors and transmitters are to be found everywhere from the bottom of the deepest boreholes, to Formula 1 racing engines, to space probes on the outer edges of the solar system.

With our wealth of experience, our sophisticated infrastructure and our totally committed staff, we are able to offer tailor-made solutions that bring you the maximum benefit.

Pressure means more to us than just physics. It is our passion!

www.kistler.com

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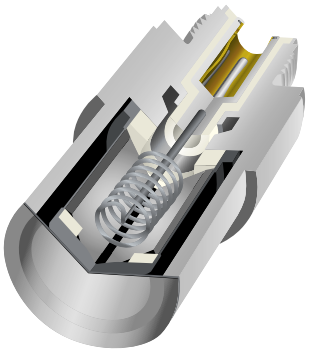
Kistler for piezoelectric measurement...

Kistler has been developing and producing piezoelectric quartz sensors for measuring pressure since 1957. These have stood the test of time and supplied reliable results under even the most extreme conditions. Today, a new generation of unique, proprietary crystals is increasingly supplementing quartz as sensor elements.



Section through a piezoelectric pressure sensor

Piezoelectric pressure sensors

The piezoelectric effect – the prefix "piezo" comes from the Greek piezein, "to press" – was discovered by the Curie brothers in 1880. They found that the surfaces of certain crystals – including quartz – become electrically charged when the crystal is subjected to mechanical stress. This charge is exactly proportional to the force acting on the crystal. It is measured in picocoulombs (1 pC = 10^{-12} coulomb).

As piezoelectric sensors are active devices, they can produce data only in a quasi-static application rather than truly static measurement. However, they are ideal for the accurate acquisition of ultra high-speed phenomena.

Piezoelectric crystals have a whole series of advantages that make them suitable for measuring dynamic pressure. These include superb linearity, high natural frequencies, and stable sensitivities even at high temperatures and pressures.

Piezoelectric pressure sensors are also very rigid in construction compared with devices based on other measuring principles. This means that even at maximum load the diaphragm is deflected only a few micrometers.

Charge and voltage output

Kistler offers piezoelectric sensors with either voltage or charge output.
A charge amplifier mounted in series converts the signal from the latter into a voltage signal.

Sensors with voltage output incorporate an impedance converter (Piezotron®) in the cable plug. An external power unit (coupler) supplies this converter and separates the measurement signal from the supply voltage.

Application sectors

Piezoelectric pressure sensors are the instrument of choice wherever rapidly changing pressures at temperatures from –196 °C to 350 °C have to be measured and recorded as accurately as possible.

The range of applications is extremely wide, from the development of combustion engines to the process industry, plastics production and much more.

To enable the use of crystals with accurately defined properties for each application, Kistler grows its own.

...and piezoresistive measurement

Piezoresistive sensors from Kistler are used for measuring gas and liquid pressures, and for truly static pressure measurement. Precise, reproducible results are achieved under even the most adverse conditions.

Piezoresistive sensors

The piezoresistive principle is based on the semiconductor effect first described in 1954. Under mechanical stress, the change in the electrical resistance of semiconductors is up to two orders of magnitude greater than in metals.

This discovery opened up completely new potential applications compared with the metal strain gage methods used at the time. Since then, other similar techniques have emerged, such as thin film on metal and thick layer on ceramic.

Measuring element

With piezoresistive measurement, an elastic diaphragm of single-crystal silicon is deflected under pressure. A Wheatstone bridge made of semiconducting resistor elements is diffused into the diaphragm. As this bridge is unbalanced in proportion to the pressure applied, it produces a similarly proportional voltage, which is then amplified and analyzed. Kistler uses three different types of sensors to allow measurement of an extremely wide variety of pressures:

Oil-filled sensor

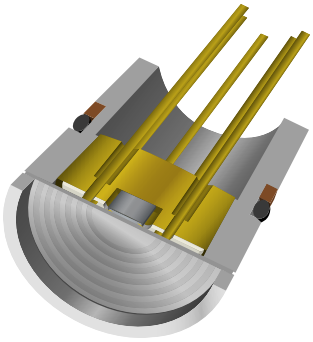
A stainless steel enclosure protects the measuring element from its surroundings. An elastic steel diaphragm and an oil cushion transmit the pressure to the piezoresistive measuring element.

Block type sensor

A robust diaphragm transmits the pressure directly to a silicon block element with built-in semiconductor bridges. This oil-free piezoresistive sensor developed by Kistler is ideally suited to measuring higher pressures at high ambient temperatures.

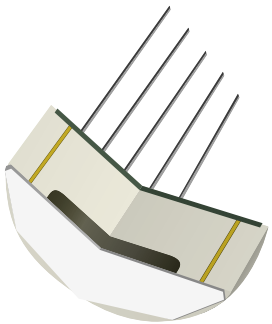
Ceramic sensor

These sensors use as their diaphragm element a ceramic disc with a thickness that varies depending on the pressure range. The thick layer method is used to print the precision resistors directly on the diaphragm, the sensor being adjusted by trimming the resistors with a laser. Piezoresistive ceramic measuring cells from Kistler are used for cost-effective applications or for large quantities.



Measuring element with pressure transmitted by an oil cushion

High pressure sensor with block type measuring element



Ceramic sensor with bridge imprinted using thick layer technique

Pressure Measuring Systems

Every system for measuring pressures consists of five main components, namely the sensor, connecting cables, signal amplifier and indicator. It makes absolutely no difference whether piezoelectric sensors with charge or voltage output, or piezoresistive sensors, are being used.

Though you are obviously free to use Kistler sensors with other electronics, this is not advisable, as a measuring system with Kistler components offers major advantages:

- system adjusted and calibrated in factory
- carefully matched components
- ease of installation
- system supplied with test certificate

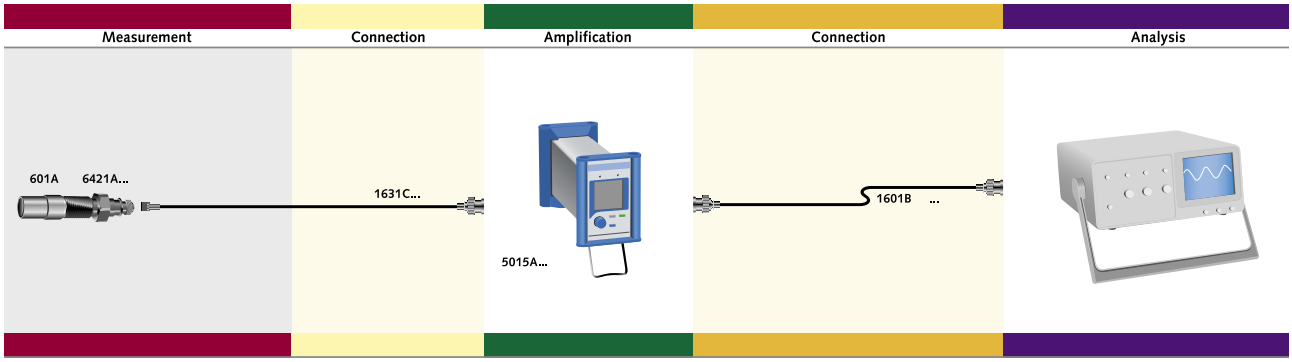
Piezoelectric sensor with charge output

The signal from the sensor has a very high impedance and is connected to the charge amplifier with a special, high-insulation cable. This converts the charge signal into a low-impedance voltage signal which can be displayed and processed as required.

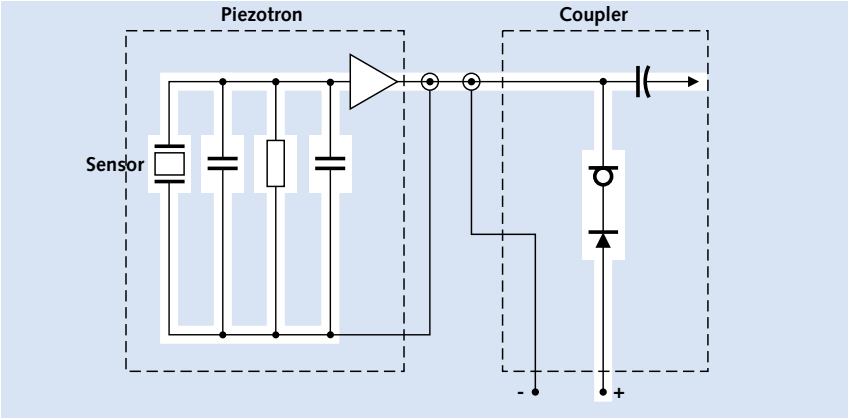
Piezoelectric sensor with voltage output

The signal is converted into a voltage directly in the sensor. The sensor requires a suitable power supply such as built into many styles of signal conditioners or couplers.

As these pressure measuring systems are highly cost-effective and easily assembled, they are ideal for industrial applications.



Schematic of piezoelectric measuring system with charge output sensors (high impedance)

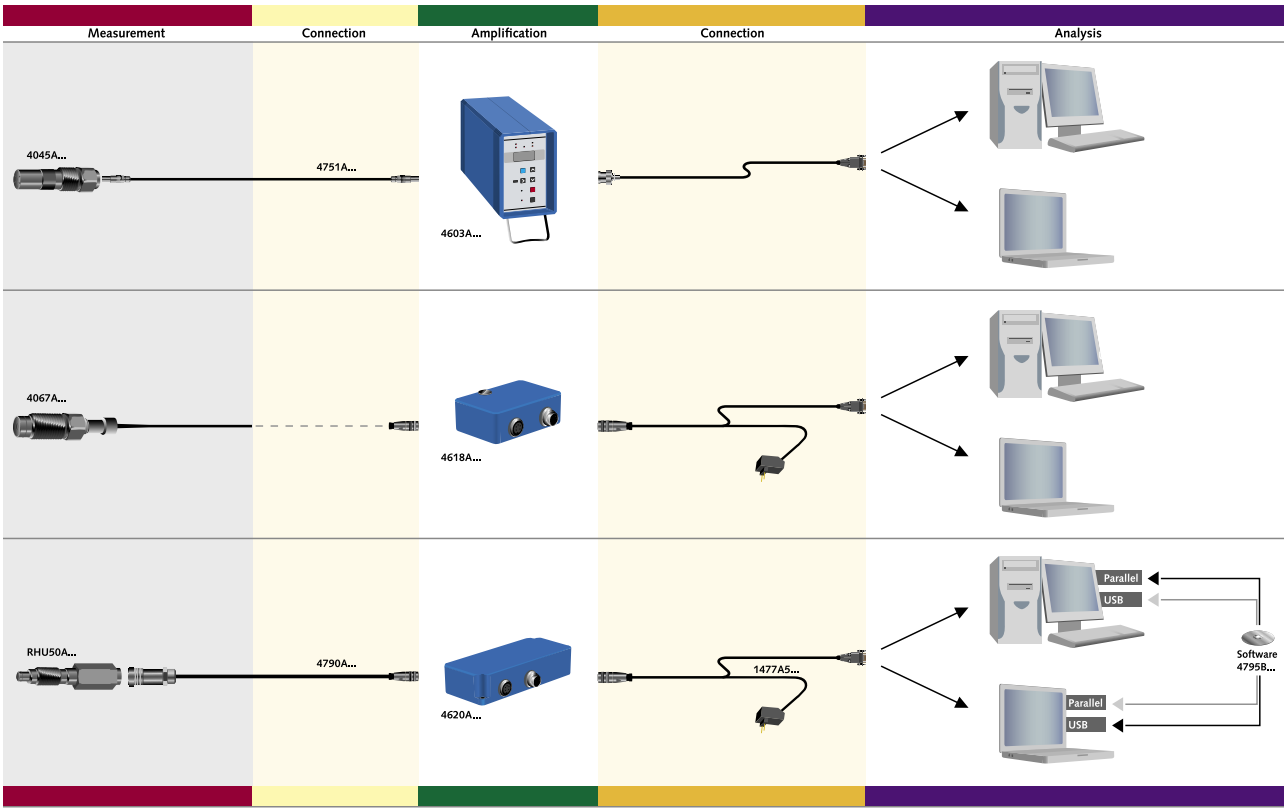


Kistler Piezotron® pressure measuring system (7613C) with coupler in customer unit

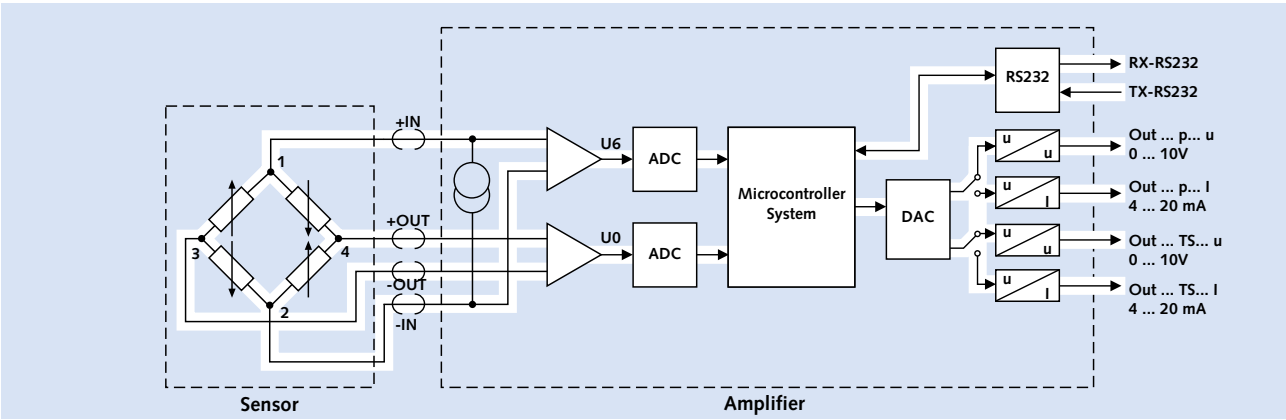
Piezoresistive sensor

The sensors are combined with different amplifiers, depending on the requirements. The amplifiers condition the signal of the unbalanced Wheatstone bridge in the sensor and pass it on to the indicator or analysis unit.

A Kistler pressure measuring system with piezoresistive sensors usually consists of sensor, connecting cable and amplifier. The indicator and/or analytical electronics typically consist of oscilloscopes, data acquisition units or a PLC, and are generally provided by the customer.



Schematic of piezoresistive pressure measuring system



Sensor, connecting cables and amplifier of piezoresistive measuring system from Kistler (Type RHU56B10SD22)

General Pressure Measurement
Industrial Applications

Durable sensors designed for highly dynamic traffic engineering applications

Extremely reliable and long-lasting, hermetically sealed sensors for the aerospace industry

Sensors offering explosion protection and heat resistance up to 350 °C for the oil and gas industry

Sensors made of ceramics or corrosion-resistant metals for the chemical industry

Instrumentation from Kistler for static and dynamic pressure measurement is characterized by reliability, precision and flexibility. It offers a choice of piezoelectric and piezoresistive pressure sensors and measuring systems optimized for each application. The range of applications is correspondingly wide, with Kistler pressure measuring instrumentation having been tried and tested over many years in such areas as mechanical engineering, aerospace, the chemical industry, research, traffic engineering, energy and medical engineering.

Traffic engineering

Kistler sensors and transmitters measure pressures from 0,2 to 3 000 bar at ambient temperatures from –40 to 350 °C, in accuracy classes from 0,05 to 2% FS. The sensors are highly resistant, even to aggressive media. Typical applications include brake systems, general control systems, closing systems, safety barriers, compressors, transmission control systems and hydraulic power packs.

Benefits/purpose
- long service life
- large number of load cycles
- highly dynamic loadings

Aerospace

In space travel, the smallest error can have catastrophic life-threatening consequences. For this extremely demanding field, Kistler has developed special pressure sensors and undertaken extensive system tests. One typical application is the monitoring of pressure in the fuel tanks of satellites.

Benefits/purpose
- reliable signals from extremely sensitive sensors
- long service life of up to 15 years from robust construction and high reliability
- hermetically sealed sensors ensure the equipment is resistant to extreme environmental conditions
- resistant to radiation

High Pressure

Oil and gas

In the oil and gas industry, Kistler sensors and transmitters are typically used in off-shore installations, down-hole monitoring systems, wellhead equipment and general high-temperature and high-pressure applications.

Benefits/purpose
- explosion-protected sensors
- robust construction
- able to withstand temperatures up to 350 °C
- high accuracy

Process industry

The most important criteria for sensors used in the process industry are reliability and the resistance of the constituent materials. Ceramics or corrosion-resistant metals are employed. Typical applications in this wide field include metering pumps, autoclaves, bioreactors, compressors, etc.

Benefits/purpose
- very resistant to media used
- low dead volume
- explosion-protected sensors

Measurement of explosion pressures

Kistler front-sealing high-pressure sensors are regarded as reference units throughout the world. They are used for developing explosives in airbag detonators through to weapon testing and development. For example, one of Kistler's pressure sensors is used as the NATO standard for acceptance testing of ammunition.

Benefits/purpose
- high measurement repeatability due to very low sensitivity to installation conditions
- excellent linearity over entire measuring range
- long service life thanks from sealing and optimized diaphragm design
- dirt resistant

Airbag:
Durable front-sealing sensors with linear characteristic for measuring explosion pressures

Sensors for measuring explosion pressures in weapons development

Engine Research and Development

Cylinder pressure measurement

Pressure indication provides an excellent basis for the thermodynamic analysis of the combustion process in engines. This measurement is therefore a standard tool in engine development; its basis is the highly precise measurement of the combustion chamber pressure based on the crank angle.

The volume of the combustion chamber can be determined relatively easily from the position of the crankshaft. Measurement of the pressure inside the cylinder, on the other hand, is an enormous challenge because it is not just the highly dynamic physical pressure and temperature phenomena affecting the sensor itself that have to be mastered. It is also necessary to solve other problems, such as access to the combustion chamber or the positioning of the sensor.

Optimal properties of Kistler crystals

Growing our own crystals enables us to tailor them to this application, with accurately defined characteristics optimized for the various mechanical and electrical requirements. Thus, the optimum solution for each engine application is to be found in our extensive range of piezoelectric sensors.

This choice is not limited to different sizes of cooled and non-cooled sensors that can be installed directly into the combustion chamber in a separate bore. In addition, we supply sensors that can be mounted in existing passages to the combustion chamber.

Sensors for gasoline engines

For gasoline engines, Kistler offers spark plugs with a built-in pressure sensor. These "measuring spark plugs" allow quick and efficient access to the combustion chamber. We offer them with a variety of geometries, electrodes and heat values.

Sensors for diesel engines

For diesel engines, Kistler supplies sensors for injection pressure measurement and fully functional glow plugs as well as glow plug adapters with integrated pressure sensor. This measuring principle also allows safe and cost-effective access to the combustion chamber via the existing plug bores.

Intake/exhaust valve measurement

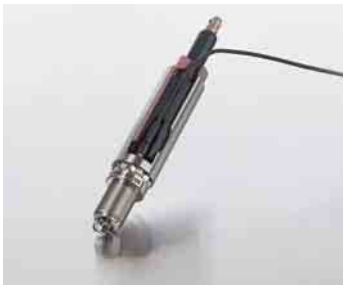
We have a large selection of piezoresistive sensors to ascertain the absolute pressure conditions in the induction and exhaust ports.

Signal conditioning

An extensive range of amplifiers serves to condition the signals. From single channel amplifiers through to complete amplification systems with built-in PiezoSmart sensor identification, Kistler covers every conceivable application.

Combustion chamber pressure determines engine power output and efficiency

Combustion chamber pressure in diesel engines can be measured with fully functioning glow plugs from Kistler

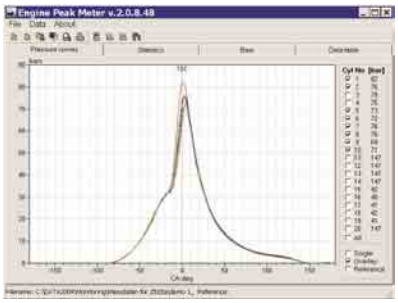


For gasoline engines, Kistler provides spark plugs with built-in pressure sensor

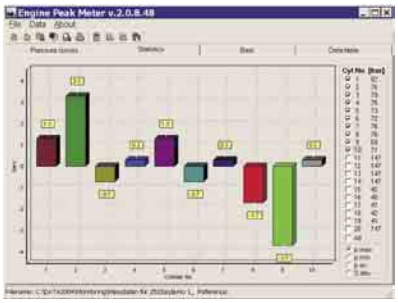
SCP:
For sensor identification and signal processing close to the sensor

Kistler's PiezoSmart® electronic sensor identification makes checklists superfluous

Engine Monitoring



Peak pressure indication



Cylinder pressure leakage

Cylinder pressure monitoring

What is now expected of engines is lower emissions, higher efficiency and maximum reliability. This can be achieved only through optimal cylinder pressure monitoring and/or control.

Kistler's strength as the pioneering market leader in combustion engine measurements lies in the development of long-lasting sensors for continuous monitoring and control of the operation of large diesel and gasoline engines.

Injection pressure monitoring

Monitoring injection pressure in combination with cylinder pressure provides valuable diagnostic information. For this application, Kistler offers both piezoelectric and piezoresistive pressure sensors.

Benefits/purpose

- Early detection of damage
- Optimization of service intervals

Gas engines

Combustion must be optimized in each and every cylinder to achieve low emissions and the maximum possible efficiency. To this end, Kistler has developed sensors and charge amplifiers optimized for controlling and monitoring gas engines.

Low short-term drift and excellent long-term stability make them ideally suited for this demanding measurement function. We also offer UL or ATEX-certified industrial charge amplifiers for signal conditioning.

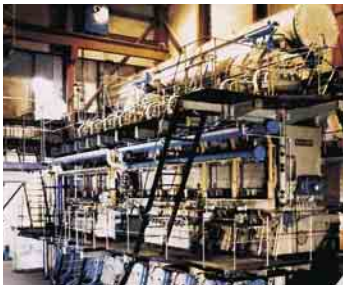
Benefits/purpose
- Cylinder adjustment
- Detection and control of knocking
- Detection of misfiring
- Limiting of peak pressure
- Power output computation (pmi)

Diesel engines

For many years, our sensors have been used worldwide for measuring cylinder pressure on the indicator valve of marine diesel engines. Kistler supplies such cylinder pressure sensors to well-known engine manufacturers and producers of engine monitoring systems. The company's robust and long-lasting sensors also yield reliable measurement data for continuous monitoring for years on end.

Benefits/purpose
- Reduction of consumption
- Service interval optimization
- Early detection of damage

Pressure measuring sensors allow optimization of combustion characteristics for each individual cylinder of gasoline engines



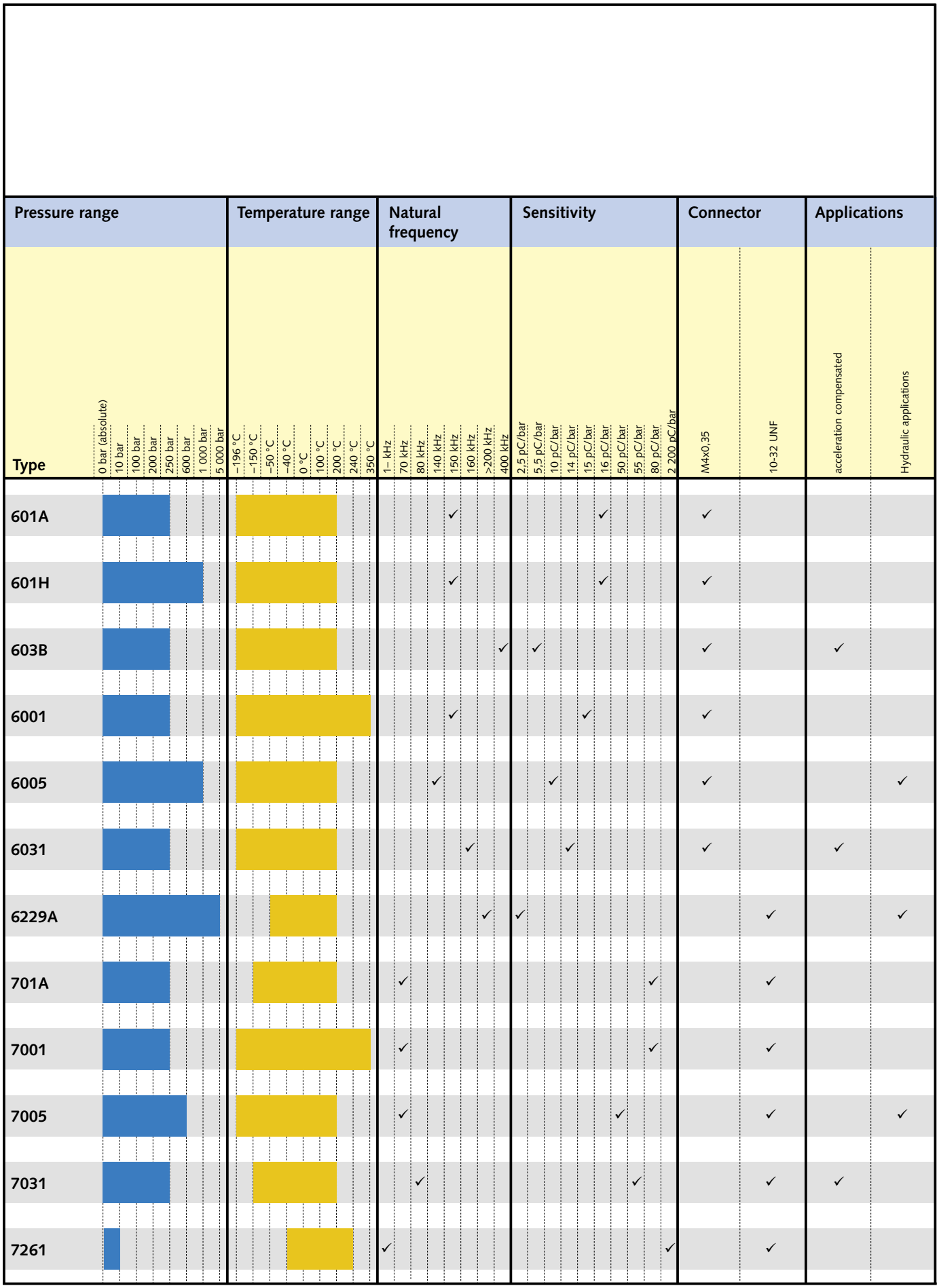
Pressure measuring sensors help optimize service intervals of marine diesels

Pressure measurement makes it possible to cut fuel consumption of diesel engines

Measuring systems with built-in charge amplifier are easily handled and installed

System-integrated sensors yield substantial benefits for low installation costs

General Pressure Measurement



Type	Pressure range: 0 bar (absolute)	10 bar	100 bar	200 bar	250 bar	600 bar	1 000 bar	5 000 bar	Temperature range: –196 °C	–150 °C	–50 °C	–40 °C	0 °C	100 °C	200 °C	240 °C	350 °C	Natural frequency: 1– kHz	70 kHz	80 kHz	140 kHz	150 kHz	160 kHz	>200 kHz	400 kHz	Sensitivity: 2,5 pC/bar	5,5 pC/bar	10 pC/bar	14 pC/bar	15 pC/bar	16 pC/bar	50 pC/bar	55 pC/bar	80 pC/bar	2 200 pC/bar	Connector: M4x0,35	10-32 UNF	Applications: acceleration compensated	Hydraulic applications
601A																						✓									✓						✓			
601H																						✓									✓						✓			
603B																									✓		✓										✓		✓		
6001																						✓								✓							✓				
6005																					✓						✓									✓				✓
6031																							✓					✓								✓		✓		
6229A																								✓		✓											✓			✓
701A																			✓															✓		✓				
7001																			✓															✓		✓				
7005																			✓												✓					✓			✓
7031																				✓													✓			✓		✓		
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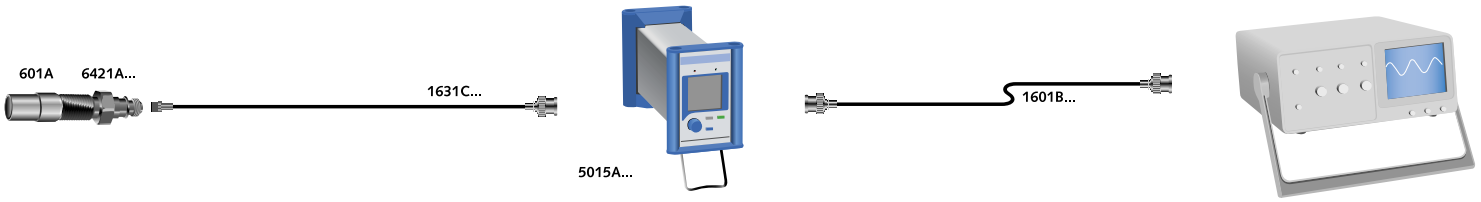
Piezoelectric Sensors



Product configuration / for use with: / Sensors	Adapters									Cooling adapters			Connecting nipple											Mounting nut		Connecting cable					
	6501 M14x1,25	**6503** M10x1	**6505** M10x1 (Sealing cone)	**6507** M3	**6581** M14x1,25 (schock-ins. up to 20 bar)	**7501** M14x1,25	**7503** Adapter M5	**7553** G1/2"	without adapter	**6509** M14x1,25	**7505** M18x1,5	**7507** M14x1,25	**6401** BNC	**6411** TNC	**6421** 10-32 UNF	**6421A5** 10-32 UNF	**6421A14** 10-32 UNF	**6421A20** 10-32 UNF	**6421A24** 10-32 UNF	**6461** 10-32 UNF	**6461A20** 10-32 UNF	**7401** BNC	**7411** TNC	**7423**	**6423** M4	1601B... (BNC pos. – BNC pos., <70 °C)	1609B... (TNC pos. – BNC pos., <70 °C)	1610B... (TNC pos. – BNC pos., <200 °C)	1631C... (10-32 UNF pos. – BNC pos., <200 °C)	1651C... (M4 pos. – BNC pos., <200 °C)	
601A	●	●	●	●					●	●			●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	
601H	●	●	●	●					●	●			●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	
603B	●	●	●	●	●				●	●			●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	
6001	●	●	●	●					●	●			●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	
6005	●	●	●	●					●	●			●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	
6031	●	●	●	●					●	●			●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	
6229A									●																				●	
701A						●	●	●	●		●	●										●	●	●		●		●			
7001						●	●	●	●		●	●										●	●	●		●		●			
7005						●	●	●	●		●	●										●	●	●		●		●			
7031						●	●	●	●		●	●										●	●	●		●		●			
7261									●																				●	

	Extension cable	Electronic components				Additional information
	1603B... (BNC neg. – BNC pos.)	5011B...  Charge amplifier	5015A...  Charge amplifier	5041E...  Charge amplifier	5058A...  Charge amplifier	
	●	●	●	●	●	Page 18
	●	●	●	●	●	Page 18
	●	●	●	●	●	Page 18
	●	●	●	●	●	Page 19
	●	●	●	●	●	Page 19
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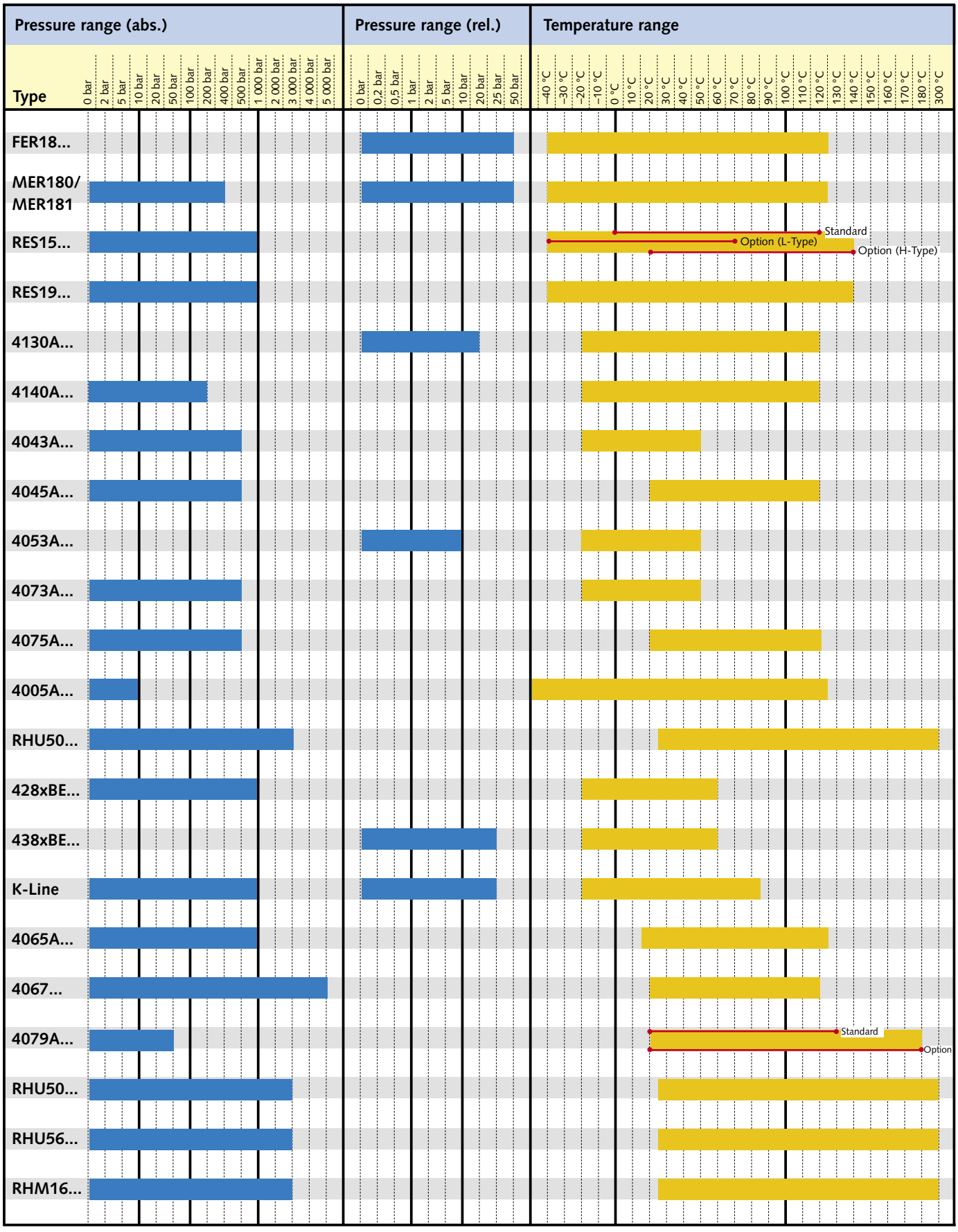
General Pressure Measurement



Piezoresistive Sensors/Transmitters/Measuring Chains

Product configurations		Output signal				Compensation		Product configuration	Connecting cable
		4-20 mA	0-10 V	mV/V	Temp. Signal	internal	external	for use with: Sensor/Transmitter	4751A... 4753A... 4761A... 4763A... 4765A... 4767A... 4790A... integr. cable
Sensoren	FER18... 			✓		✓		FER18...	
	MER180/MER181 			✓		✓		MER180/MER181	
	RES15... 			✓	✓		✓	RES15...	
	RES19... 			✓	✓		✓	RES19...	
	4130A... 			✓	(✓)	✓		4130A...	
	4140A... 			✓	(✓)	✓		4140A...	
	4043A... 			✓	(✓)	✓		4043A...	<70 °C, <200 °C
	4045A... 			✓	(✓)	✓		4045A...	<70 °C, <200 °C
	4053A... 			✓	(✓)	✓		4053A...	<70 °C, <200 °C
	4073A... 			✓	(✓)	✓		4073A...	<70 °C, <200 °C
	4075A... 			✓	(✓)	✓		4075A...	<70 °C, <200 °C
	4005A... 			✓	✓		✓	4005A...	
	RHU50... (OEM) 			✓	✓		✓	RHU50... (OEM)	
Messketten/Transmitter	428xBE... Standard Ex 	✓				✓		428xBE...	
	438xBE... Standard Ex 	✓				✓		438xBE...	
	K-Line 	✓	✓			✓	(✓)	K-Line (Transmitter)	
	4065A... (Measuring chain) 	✓	✓		✓		✓	4065 (Measuring chain) ●	●
	4067... (Measuring chain) 	✓	✓		✓		✓	4067 (Measuring chain) ●	●
	4079A... 	✓	✓		✓		✓	4079A... ●	●
	RHU50... (Measuring chain) 	✓	✓		✓		✓	RHU50... (Meas. chain) ●	●
	RHU56... (Measuring chain) 	✓	✓		✓		✓	RHU56... (Meas. chain) ●	●
	RHM16... (Measuring chain) 	✓	✓		✓		✓	RHM16... (Meas. chain) ●	●

	Amplifier			Further info
	4618A...  Analog amplifier	4620A...  Digital amplifier	4603A...  Laboratory amplifier	
				Page 23
				Page 23
	●	●		Page 24
	●	●		Page 24
	●			Page 25
	●			Page 25
	●		●	Page 46
	●		●	Page 46
	●		●	Page 47
	●		●	Page 48
	●		●	Page 48
	●	●		Page 46
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	(●)	(●)	(●)	Page 27
	●			Page 47
	●	●		Page 48
		●		Page 29
	●	●		Page 29
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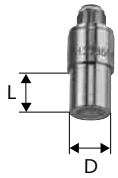
	●	●		Page 29

Piezoelectric sensors

Pressure range 0 ... 250 bar/1 000 bar



Technical data		Type 601A	Type 601H
Calibrated pressure measuring ranges	bar	0 ... 2,5	0 ... 10
	bar	0 ... 25	0 ... 100
	bar	0 ... 250	0 ... 1 000
Overload	bar	500	1 200
Natural frequency	kHz	≈150	≈150
Linearity	%FSO	<±0,5	<±0,8
Sensitivity	pC/bar	–16	–16
Temperature range	°C	–196 ... 200	–196 ... 200
Acceleration sensitivity	bar/g	<0,001	<0,001
Dimensions	D (mm)	5,5	5,5
	L (mm)	6	6

Connection
M4x0,35

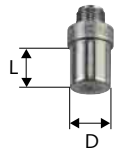
Characteristics
Small dimensions, wide temperature range, high natural frequency.

Applications
Pressure measurement on compressors, pneumatic and hydraulic systems (except injection pumps).

Accessories
Adapters: Types 6501, 6503, 6505, 6507, 6509
Connecting nipples: Types 6401, 6411, 6421, 6461
Mounting nut: Type 6423
Connecting cables: Types 1601B..., 1609B..., 1610B..., 1631C..., 1651C...

Data sheet 601A_000-379

Pressure range 0 ... 200 bar, high natural frequency, acceleration-compensated



Technical data		Type 603B
Calibrated pressure measuring ranges	bar	0 ... 10
	bar	0 ... 20
	bar	0 ... 200
Overload	bar	350
Natural frequency	kHz	≈400
Linearity	%FSO	<±1
Sensitivity	pC/bar	–5,5
Temperature range	°C	–196 ... 200
Acceleration sensitivity	bar/g	<0,0001
Dimensions	D (mm)	5,5
	L (mm)	6

Connection
M4x0,35

Characteristics
Acceleration-compensated, small dimensions, high natural frequency, wide temperature range, pressure range: vacuum up to 200 bar at temperatures up to 200 °C.

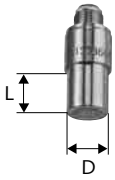
Applications
Measurement of pressure fluctuations of high-frequency or short rise time in strongly vibrating test units, pressure measurements in shock tubes, measurement of the pressure propagation of explosion waves.

Accessories
Adapters: Types 6501, 6503, 6505, 6507, 6581, 6509
Connecting nipples: Types 6401, 6411, 6421, 6461
Mounting nut: Type 6423
Connecting cables: Types 1601B..., 1609B..., 1610B..., 1631C..., 1651C...

Data sheet 603B_000-012

Piezoelectric sensors

Pressure range 0 ... 250 bar, high temperature



Technical data		Type 6001
Calibrated pressure measuring ranges	bar	0 ... 2,5
	bar	0 ... 25
	bar	0 ... 250
Overload	bar	350
Natural frequency	kHz	≈150
Linearity	%FSO	<±0,8
Sensitivity	pC/bar	–15
Temperature range	°C	–196 ... 350
Acceleration sensitivity	bar/g	<0,001
Dimensions	D (mm)	5,5
	L (mm)	6

Connection
M4x0,35

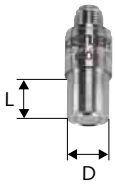
Characteristics
Small dimensions, wide temperature range, high natural frequency.

Applications
Pressure measurement on combustion engines, compressors, pneumatic and hydraulic systems (except injection pumps).

Accessories
Adapters: Types 6501, 6503, 6505, 6507, 6509
Connecting nipples: Types 6401, 6411, 6421, 6461
Mounting nut: Type 6423
Connecting cables:
Types 1601B..., 1609B..., 1610B..., 1631C..., 1651C...

Data sheet 6001_000-377

Pressure range 0 ... 1 000 bar, long service life



Technical data		Type 6005
Calibrated pressure measuring ranges	bar	0 ... 10
	bar	0 ... 100
	bar	0 ... 1 000
Overload	bar	1 500
Natural frequency	kHz	≈140
Linearity	%FSO	<±0,8
Sensitivity	pC/bar	–10
Temperature range	°C	–196 ... 200
Acceleration sensitivity	bar/g	<0,001
Dimensions	D (mm)	5,5
	L (mm)	6

Connection
M4x0,35

Characteristics
Rugged construction, small dimensions, long service life, wide temperature range.

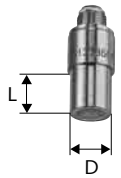
Applications
Measurement of dynamic and quasi-static pressures, e.g. pressure surges in hydraulic and pneumatic systems (injection pressure in combustion engines).

Accessories
Adapters: Types 6501, 6503, 6505, 6507, 6509
Connecting nipples: Types 6401, 6411, 6421, 6461
Mounting nut: Type 6423
Connecting cables:
Types 1601B..., 1609B..., 1610B..., 1631C..., 1651C...

Data sheet 6005_000-378

Piezoelectric sensors

Pressure range 0 ... 250 bar, acceleration-compensated



Technical data		Type 6031
Calibrated pressure measuring ranges	bar	0 ... 2,5
	bar	0 ... 25
	bar	0 ... 250
Overload	bar	350
Natural frequency	kHz	≈160
Linearity	%FSO	<±1
Sensitivity	pC/bar	–14
Temperature range	°C	–196 ... 200
Acceleration sensitivity	bar/g	<0,0001
Dimensions	D (mm)	5,5
	L (mm)	6

Connection
M4x0,35

Characteristics
Acceleration-compensated, small dimensions (weight 2,5 g), high natural frequency, wide temperature range.

Applications
Measurement of rapid pressure variations on strongly vibrating test units, available as a special version with a diaphragm optimized against thermal shock for cylinder pressure measurement in racing engines with very high speeds (Type 6031U18).

Accessories
Adapters: Types 6501, 6503, 6505, 6507, 6509
Connecting nipples: Types 6401, 6411, 6421, 6461
Mounting nut: Type 6423
Connecting cables:
Types 1601B..., 1609B..., 1610B..., 1631C..., 1651C...

Data sheet 6031_000-380

Pressure range 0 ... 5 000 bar

Technical data		Type 6229A
Calibrated pressure measuring ranges	bar	0 ... 500
	bar	0 ... 5 000
Overload	bar	6 000
Natural frequency	kHz	>200
Linearity	%FSO	<±1
Sensitivity	pC/bar	–2,5
Temperature range	°C	–50 ... 200
Acceleration sensitivity	bar/g	<0,004
Dimensions	D (mm)	8,5
	L (mm)	16,7

Connection
10-32 UNF

Characteristics
Front-sealing high-pressure sensor, insensitive to different tightening torques and mounting conditions (patented anti-strain design), high natural frequency, long service life, also available with integral impedance converter.

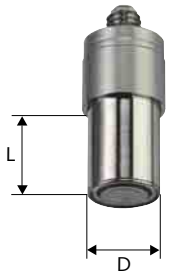
Applications
Pressure measurement on hydraulic high-pressure systems, e.g. fuel injection pumps on diesel engines.

Accessories
Connecting cables:
Type 1631C...

Data sheet 6229A_000-044

Piezoelectric sensors

Pressure range 0 ... 250 bar, high sensitivity



Technical data		Type 701A
Calibrated pressure measuring ranges	bar	0 ... 2,5
	bar	0 ... 25
	bar	0 ... 250
Overload	bar	400
Natural frequency	kHz	≈70
Linearity	%FSO	<±0,5
Sensitivity	pC/bar	–80
Temperature range	°C	–196 ... 200
Acceleration sensitivity	bar/g	<0,001
Dimensions	D (mm)	9,5
	L (mm)	12

Connection
10-32 UNF

Characteristics
High sensitivity, wide temperature range, corrosion-resistant, small size.

Applications
Measurement of rapid pressure variations, pressure measurements in combustion engines, compressors, pneumatic and hydraulic systems (except injection pumps).

Accessories
Adapters: Types 7501, 7503, 7533, 7505, 7507
Connecting nipples: Types 7401, 7411
Mounting nut: Type 7423
Connecting cables: Types 1601B..., 1609B..., 1610B...

Data sheet 701A_000-050

Pressure range 0 ... 250 bar / 0 ... 600 bar

Technical data		Type 7001	Type 7005
Calibrated pressure measuring ranges	bar	0 ... 2,5	0 ... 6
	bar	0 ... 25	0 ... 60
	bar	0 ... 250	0 ... 600
Overload	bar	350	1 000
Natural frequency	kHz	≈70	≈70
Linearity	%FSO	<±0,8	<±0,8
Sensitivity	pC/bar	–80	–50
Temperature range	°C	–196 ... 350	–196 ... 200
Acceleration sensitivity	bar/g	<0,002	<0,003
Dimensions	D (mm)	9,5	9,5
	L (mm)	12	12

Connection
10-32 UNF

Characteristics
7001: High sensitivity, wide temperature range, small dimensions.

7005: Long service life, wide temperature range, rugged in continuous operation, small dimensions.

Applications
7001: Measurement of rapid pressure variations, pressure measurements in combustion engines, compressors, pneumatic and hydraulic systems (except injection pumps).

7005: Measurement of dynamic pressures in hydraulic systems.

Accessories
Adapters: Types 7501, 7533
Cooling adapters: Types 7505, 7507
Connecting nipples: Types 7401, 7411
Mounting nut: Type 7423
Connecting cables: Types 1601B..., 1609B..., 1610B...

Data sheet 7001_000-047
7005_000-048

Piezoelectric sensors

Pressure range 0 ... 250 bar, acceleration-compensated

Technical data		Type 7031
Calibrated pressure measuring ranges	bar	0 ... 2,5
	bar	0 ... 25
	bar	0 ... 250
Overload	bar	350
Natural frequency	kHz	>80
Linearity	%FSO	<±1
Sensitivity	pC/bar	–80
Temperature range	°C	–196 ... 200
Acceleration sensitivity	bar/g	<0,0001
Dimensions	D (mm)	9,5
	L (mm)	12

Connection
10-32 UNF

Characteristics
Acceleration-compensated, high sensitivity, wide temperature range, small dimensions.

Applications
Measurement of rapid pressure variations on strongly vibrating test objects (Type 7031 is around 10 times less vibration-sensitive than standard type 701A).

Accessories
Adapters: Types 7501, 7533
Cooling adapters: Types 7505, 7507
Connecting nipples: Types 7401, 7411
Mounting nut: Type 7423
Connecting cables:
Types 1601B..., 1609B..., 1610B...

Data sheet 7031_000-051

Pressure range 0 ... 10 bar, highest sensitivity

Technical data		Type 7261
Calibrated pressure measuring ranges	bar	0 ... 1
	bar	0 ... 10
Overload	bar	12
Natural frequency	kHz	>13
Linearity	%FSO	<±0,8
Sensitivity	pC/bar	–2 200
Temperature range	°C	–40 ... 240
Acceleration sensitivity	bar/g	<0,001
Dimensions	D (mm)	35
	L (mm)	55,8

Connection
10-32 UNF

Characteristics
Quartz crystal low-pressure sensor for measuring dynamic and quasi-static pressures from vacuum to 10 bar. Mounting thread M33x1.

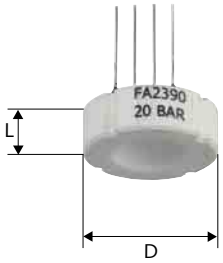
Applications
Dynamic and quasi-static pressure measurements, e.g. in pipelines of fans and compressors for investigating the oscillatory behavior of columns of air and air pressure fluctuations.

Accessories
Connecting cable:
Type 1631C...

Data sheet 7261_000-053

Piezoresistive sensors

Ceralite OEM relative pressure sensor



Technical data		Type FER18R...
Pressure range	bar (rel.)	0 ... 2 / ... / 0 ... 50
Sensitivity	mV/V	1,5 ... 4,5
Linearity (BSL) & hysteresis	%FSO	±0,3
Operating temperature range	°C	0 ... 70
Min./max. temperature	°C	–40/125
Supply	VDC	5 ... 30
Natural frequency	kHz	>50
Material		Ceramic-Alumina, Al_2O_3 96%
Dimensions	D (mm)	18
	L (mm)	6,35

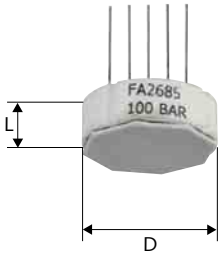
Connection
Pins

Characteristics
Monolithic ceramic measuring cell, increased stability and linearity, temperature-compensated (0 … 70 °C), zero offset laser-trimmed, corrosion and abrasion resistant, shock and vibration resistant, wide temperature range, simple mounting (one sensor thickness for all ranges), budget priced.

Applications
OEM applications, measurement and monitoring in industrial systems and measuring equipment, automotive applications and process industries.

Data sheet FER18R_000-099

Ceramet OEM relative/absolute pressure sensor



Technical data			Type MER180R/181R	Type MER180A/181A
Pressure range		bar (rel.)	0 ... 1 / ... / 0 ... 50	
		bar (abs.)		0 ... 1 / ... / 0 ... 400
Sensitivity	MER180...	mV/V	1,6 ... 4,5 trimmed	1,6 ... 4,5 trimmed
	MER181...	mV/V	1,6 ... 6,5 untrimmed	1,6 ... 6,5 untrimmed
Linearity (BSL) & hysteresis		%FSO	0,4	0,4
Operating temperature range		°C	0 ... 70	0 ... 70
Min./max. temperature		°C	–40/125	–40/125
Supply		VDC	5 ... 30	5 ... 30
Natural frequency		kHz	>50	>50
Material			Ceramic-Alumina, Al_2O_3 96%	
Dimensions		D (mm)	18	18
		L (mm)	6,15 ... 7,3	6,15 ... 7,3

Connection
Pins

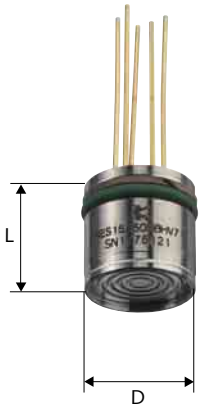
Characteristics
Rugged ceramic measuring cell, zero offset laser-trimmed, temperature compensated, corrosion and abrasion resistant, shock and vibration resistant, simple mounting, budget-priced. The sensitivity of MER181 is untrimmed. With the MER180, the output signal can be individually trimmed if required (according to pressure range 1,6 … 4,5 mV/V).

Applications
Industrial OEM applications, measurement and monitoring in industrial systems and measuring equipment.

Data sheet MER18_000-096

Piezoresistive sensors

OEM absolute pressure sensor, 15 mm



Technical data		Type RES15A...	Type RES15A...V61	Type RES15A...V73
Pressure range	bar (abs.)	0 ... 20 / ... / 0 ... 1 000		
Sensitivity	mV/FSO @ 1 mA	75 ... 200	75 ... 200	75 ... 200
Linearity (BSL) & hysteresis	%FSO	±0,25	±0,25	±0,25
Operating temperature range	°C	0 ... 120	0 ... 120	0 ... 120
Min./max. temperature °C	Standard:	0 ... 120	0 ... 120	0 ... 120
	L-Typ:	–40 ... 70	–40 ... 70	–40 ... 70
	H-Typ:	20 ... 140	20 ... 140	20 ... 140
Supply	mA	0,5 ... 4	0,5 ... 4	0,5 ... 4
Cut-off frequency	kHz	>100	>100	>100
Material		1.4435	Hastelloy	Titan
Dimensions	D (mm)	15	15	15
	L (mm)	15,1	15,1	15,1

Connection
Flexible wire/pins

Characteristics
Oil-filled measuring cell, corrosion-resistant diaphragm, high accuracy, high natural frequency, long term stability, good reproducibility, very good temperature behavior, absolute pressure, low energy consumption, open Wheatstone bridge, also available with temperature range –40 … 70 °C or 20 … 140 °C.

Applications
Industrial automation and measuring instruments (e.g. pressure transmitters, analyzers for physical quantities, food and medialprocessing applications, aerospace technology, braking systems for vehicles, borehole probes for the petroleum industry, research projects, hydraulic measuring systems).

Accessories
O-ring: Type 5.110.153
Support ring: Type 1100A93

Data sheet RES15A_000-057

OEM absolute pressure sensor, 19 mm

Technical data		Type RES19A...	Type RES19A...V61
Pressure range	bar (abs)	0 ... 20 / ... / 0 ... 1 000	
Sensitivity	mV/FSO @ 1 mA	75 ... 200	75 ... 200
Linearity (BSL) & hysteresis	%FSO	±0,25	±0,25
Operating temperature range	°C	–40 ... 120	–40 ... 120
Min./max. temperature	°C	–50/140	–50/140
Supply	mA	0,5 ... 4	0,5 ... 4
Cut-off frequency	kHz	>160	>160
Material		1.4435	1.4435/Hastelloy
Dimensions	D (mm)	19	19
	L (mm)	13,2	13,2

Connection
Pins

Characteristics
Oil-filled measuring cell, corrosion-resistant diaphragm, high accuracy, high natural frequency, long term stability, very good temperature behavior, absolute pressure, low energy consumption, open Wheatstone bridge.

Applications
Industrial automation and measuring instruments (e.g. pressure transmitter, analyzers for physical quantities, devices for foodstuffs and pharmacological sectors, aerospace technology, braking systems for vehicles, borehole probes for the petroleum industry, research projects, hydraulic measuring systems).

Accessories
O-ring: Type 1100A71
Support ring: Type 1100A69 from ≥200 bar

Data sheet RES19A_000-059

Piezoresistive sensors

OEM relative/absolute pressure sensor, small pressure range, integrated compensation

Technical data		Type 4130A...	Type 4140A...
Pressure range	bar (rel.)	0 ... 0,2 / ... / 0 ... 20	
	bar (abs.)		0 ... 1 / ... / 0 ... 200
Sensitivity	mV/FSO @ 1 mA	30 ... 200*	75 ... 200*
Linearity (BSL) & hysteresis	%FSO	±0,25	±0,25
Operating temperature range	°C	–20 ... 120	–20 ... 120
Min./max. temperature	°C	–40/140	–40/140
Supply	mA	0,5 ... 4	0,5 ... 4
Cut-off frequency	kHz	>5 ... >80*	>15 ... >180*
Material		1.4435	1.4435
Dimensions	D (mm)	19	19
	L (mm)	15	15

* Dependent on pressure range

Connection
Flexible wire

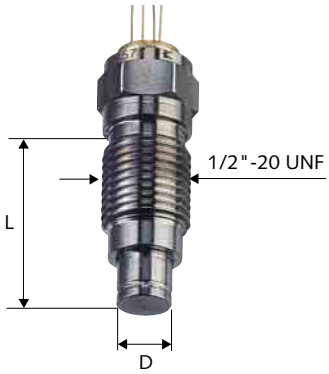
Characteristics
Oil-filled measuring cell, high natural frequency, high accuracy, long term stability, integral temperature compensation, relative and absolute pressure, low energy consumption, closed Wheatstone bridge.

Applications
Industrial automation and measuring instruments (e.g. pressure transmitters, analyzers for physical quantities, level meters, medical equipment, research projects, hydraulic and pneumatic systems, braking systems for vehicles, etc.).

Accessories
O-ring: Type 1100A71

Data sheet 4130A_000-058

OEM absolute pressure sensor, high pressure range



Technical data		Type RHU50B...V9G
Pressure range	bar (abs.)	0 ... 100 / ... / 0 ... 3 000
Sensitivity	mV/FSO @ 1 mA	75 ... 425*
Linearity (BSL) & hysteresis	%FSO	± 0,5 (with amplifier)
Thermal hysteresis	%FSO	± 1
Operating temperature range	°C	25 ... 300
Min./max. temperature	°C	–10/350
Supply	mA	0,5 ... 2
Natural frequency	kHz	>100
Material		17-4PH
Dimensions	D (mm)	7,8
	L (mm)	26,3

* Dependent on pressure range

Connection
Pins

Characteristics
Silicon block-type measuring cell, high temperature/high pressure sensor in rugged construction without pressure transmission medium, excellent stability, high accuracy as well as high natural frequency, static as well as dynamic acquisition of pressure signals.

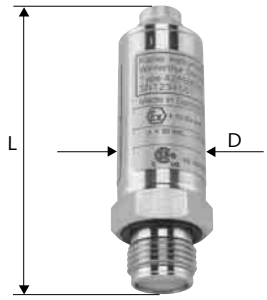
Applications
The RHU50B… OEM sensors can be used for a wide range of demanding high temperature and high pressure applications: hot water cooling systems, down hole, etc.

Accessories
Seal: Type 1100A13

Data sheet RHU50_000-085

Piezoresistive transmitters

Relative/absolute pressure transmitter



Technical data		Type 428xBE...	Type 438xBE...
Pressure range	bar (rel.)		0 ... 0,2 / ... / 0 ... 20
Pressure range	bar (abs.)	0 ... 1 / ... / 0 ... 1 000	
Output signal	mA	4 ... 20	4 ... 20
Linearity & hysteresis (BSL)	%FSO	±0,25	±0,25
Operating temperature range	°C	–20 ... 60	–20 ... 60
Min./max. temperature	°C	–40/85	–40/85
Supply	VDC	12 ... 30	12 ... 30
Cut-off frequency	kHz	>5	>5
Material		1.4435	1.4435
Dimensions	D (mm)	26,9	26,9
	L (mm)	91,5	91,5
Intrinsic safety		ATEX II 1/2G EEx IIC T4	

Connection
Hirschmann connector (DIN 43650)
Binder connector
Cable

Characteristics
Pressure transmitter with oil-filled measuring cell, high accuracy, excellent long term stability, excellent temperature behavior, high dynamic loading, absolute or relative pressure, long life, intrinsic safety EEx ia, in relative or absolute pressure version, CE conformity.

Applications
Universal in mechanical and plant engineering (e.g. process technology, chemical, petrochemical processing, oil production and offshore engineering, servovalves, gas distribution systems).
Process connection:
G1/2" front-flush, G1/2" thread
Pressure gage DIN 16288.

Accessories
Cable connector IP40:
Type 1500A73
Cable connector IP67:
Type 1500A75

Data sheet 428xB_000-539

Relative/absolute pressure transmitter: K-Line

Technical data		Type RA...C1...	Type RA...V1...
Pressure range	bar (rel.)	0 ... 0,2 / ... / 0 ... 20	0 ... 0,2 / ... / 0 ... 20
Pressure range	bar (abs.)	0 ... 1 / ... / 0 ... 1 000	0 ... 1 / ... / 0 ... 1 000
Output signal	mA or V	4 ... 20	0 ... 10
Linearity & hysteresis (BSL)	%FSO	±0,25	±0,25
Operating temperature range	°C	–20 ... 85	–20 ... 85
Min./max. temperature	°C	–40 ... 85	–40 ... 85
Supply	VDC	12 ... 30	16 ... 30
Cut-off frequency	kHz	>3 ... >4	>3 ... >4
Material		1.4435	1.4435
Dimensions	D (mm)	26,9	26,9
	L (mm)	97	97

Connection
Hirschmann connector (DIN 43650)
Binder connector
Cable

Characteristics
Industrial universal pressure transmitter with oil-filled measuring cell, high accuracy, excellent long term stability, excellent temperature behavior, high loading, long service life, standard version RAG25 with G1/4" thread, also available with other thread connections.

Applications
Process technology, mechanical and plant engineering, hydraulic and pharmacological industries, construction machine and vehicle manufacture, metrology and hydrometry, injection molding technology, aerospace technology, level metering.

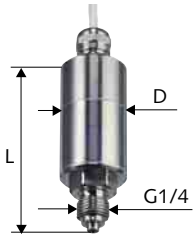
Accessories
Hirschmann connector IP65:
Type 1500A89
Binder connector IP67:
Type 1500A75

Data sheet RAG_000-080

General Pressure Measurement

Railroad braking systems

Absolute pressure transmitter for braking systems



Technical data		Type RAT25A...C1...	Type RAT25A...V1...
Pressure range	bar (abs.)	0 ... 10 / ... / 0 ... 160	
Output signal	mA or V	4 ... 20	0 ... 10
Linearity (BSL) & hysteresis	%FSO	±0,25	±0,25
Operating temperature range	°C	–40 ... 80	–40 ... 80
Min./max. temperature	°C	–40/80	–40/80
Supply	VDC	12 ... 32	16 ... 32
Cut-off frequency	kHz	>4	>4
Material		1.4435	1.4435
Dimensions	D (mm)	26,9	26,9
	L (mm)	74	74

Connection
Integral cable

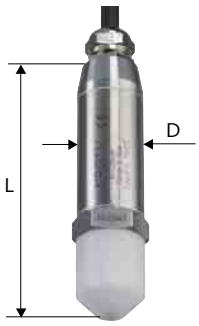
Characteristics
Compact design based on the K-Line transmitter. Wide temperature range combined with superlative accuracy and reliability. MIL 810-E tested. Without potentiometer and hermetically sealed against vibration and humidity.

Applications
Specially developed for use in railroad braking systems. Low-pressure version for air brakes, high-pressure types for hydraulic brakes in railway systems.

Data sheet RAT25A_000-528

Level metering

Immersion probe/pressure transmitter



Technical data		Type C1 RTC28R...C1...	Type V1 RTC28R...V1...
Pressure range	bar (rel.)	0 ... 0,2 / ... / 0 ... 10	0 ... 0,2 / ... / 0 ... 10
Output signal	mA / V	4 ... 20	0 ... 10
Linearity (BSL) & hysteresis	%FSO	±0,25	±0,25
Operating temperature range	°C	0 ... 50	0 ... 50
Min./max. temperature	°C	–20/85	–20/85
Supply	VDC	12 ... 30	16 ... 30
Cut-off frequency	kHz	>3	>3
Material		1.4435	1.4435
Dimensions	D (mm)	26,9	26,9
	L (mm)	109	109

Connection
Integral cable

Characteristics
Excellent long-term stability, excellent temperature behavior, compact construction, relative or absolute pressure, long service life, high accuracy, CE conformity.

Applications
Level metering, e.g. in tank systems without side access, ground-water level monitoring, water and waste-water treatment, water-storage reservoirs, building excavations, well and borehole probes, marine research.

Data sheet RTC28R_000-087

Piezoresistive measuring chains

Low-pressure measuring chain with amplifier Type 4620A...

Connection
Fischer Type SE102A054

Technical data		Type 4079A...
Pressure range	bar (rel.)	0 ... 5 /... / 0 ... 50
Output signal	mA	4 ... 20
Linearity & hysteresis (BSL)	%FSO	<±2
Operating temperature range		
Sensor	°C	–25 ... 180
Amplifier	°C	0 ... 60
Supply voltage	VDC	18 ... 30
Natural frequency (sensor)	kHz	>22
Material, sensor body		1.4542 (17-4PH)
Dimensions (sensor)	D (mm)	9,5
	L (mm)	11,9

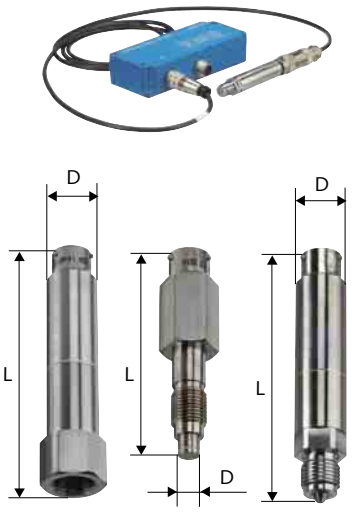
Characteristics
Measuring system with bending bar principle consisting of sensor, connecting cable and signal amplifier Type 4620A…, small mounting dimensions, operating temperature up to 180 °C.

Applications
This measuring chain can be used for process monitoring in the processing of polymers as cavity pressure sensor or as universal hydrostatic pressure measuring probe up to 50 bar.

Note: Connecting cable Type 4767A… between sensor and amplifier is contained in the included accessories.

Data sheet 4079A_000-414

RH high-pressure measuring chain with digital amplifier Type 4620A...



RHM16... RHU50... RHU56...

Connection
Binder connector

Technical data		Type RHM16...	Type RHU50...	Type RHU56...
Pressure range	bar (abs.)	0 ... 100 / ... / 0 ... 3 000	0 .. 100 / ... / 0 ... 3 000	0 ... 100 / ... / 0 ... 3 000
Output signal	mA / V	4 ... 20/0 ... 10	4 ... 20/0 ... 10	4 ... 20/0 ... 10
Linearity & hysteresis (BSL)	%FSO	<±0,5/0,1	<±0,5/0,1	<±0,5/0,1
Thermal hysteresis	%FSO	<±1	<±1	<±1
Operating temperature range	°C	25 ... 225	25 ... 225	25 ... 225
Min./max. temperature	°C	0/300	0/300	0/300
Supply	VDC	18 ... 30	18 ... 30	18 ... 30
Cut-off frequency (sensor)	kHz	>100	>100	>100
Material		17-4PH	17-4PH	17-4PH
Process connection		M16x1,5	1/2-20 UNF-2A	9/16-18 UNF-3A
Dimensions, sensor	D (mm)	19	7,8	19
	L (mm)	95,5	77	97,5

Characteristics
Measuring system with silicon block-type measuring cell consisting of sensor, connecting cable and signal amplifier, high accuracy over a wide temperature range thanks to digital compensation, temperature signal from the sensor, zero point taring, digital inputs and outputs, serial interfaces RS232/ RS485.

Applications
Sensors of the RH series can be used in many applications with stringent requirements. In process technology over a wide temperature range, erosive and corrosive applications.

Accessories
Software Type 4795B...

Data sheet RH_000-084

High-pressure Sensors/Transmitters

Version			Pressure range							Temperature range							Mounting thread				Natural frequency				Output signal					Connecting socket			
Type	piezoelectric	piezoresistive	100 bar	1000 bar	1600 bar	2000 bar	3000 bar	4000 bar	5000 bar	–50 °C	0 °C	50 °C	100 °C	150 °C	200 °C	250 °C	300 °C	M10x1 (Front seal)	1/2"-20 UNF (Shoulder seal)	9/16"-18 UNF (Shoulder seal)	M16x1,5 Internal thread	20 kHz	>100 ... >200 kHz*1	≥100 kHz	<200 kHz	4-20 mA	0-10 V	mV	–10 V ... +10 V*2	Temperature signal	10-32 UNF	Pins	Cable on sensor	MIL C-26482 Connector
6229A...	✓		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	●							●				●		●			
RHU50B... (OEM)		✓	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		●					●				●		●		●		
4067...		✓	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	●					●			●	●			●			●	
RHU50...		✓	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		●					●		●	●			●				●
RHU56...		✓	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			●				●		●	●			●				●
RHM16...		✓	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■				●			●		●	●			●				●

*1 depending on pressure range
*2 with charge amplifier

High-pressure Sensors/Ballistics

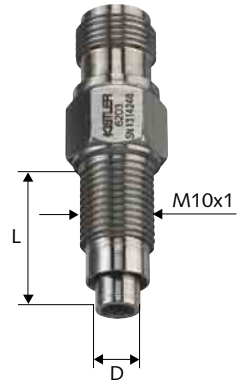
Version	Pressure range										Temperature range								Mounting thread			Natural frequency			Connecting socket	
Type	100 bar	1000 bar	2000 bar	3000 bar	4000 bar	5000 bar	6000 bar	7000 bar	8000 bar	9000 bar	10000 bar	–50 °C	0 °C	50 °C	100 °C	150 °C	200 °C	250 °C	300 °C	M10x1 (Front seal)	M10x1 (Shoulder seal)	M12x1 (Front seal)	<150 kHz	<170 kHz	<240 kHz	10-32 UNF	TNC (7/16-28 UNEF)
6203			■	■	■	■								■	■	■	■	■	■		●			●			●
6213B...		■	■	■	■	■	■	■	■	■	■			■	■	■	■	■	■			●	●			●	
6215		■	■	■	■	■								■	■	■	■	■	■	●					●	●	

Product configuration		Connecting cable				Electronic components				Further info
Used with: / Sensor/measuring chain		on the sensor	Connection by the customer	4790A...	1631C...	4618A... Analog amplifier	4620A... Digital amplifier	5011B... Charge amplifier	5015A... Charge amplifier	
Sensors	6229A... 				●			●	●	Page 20
Sensors	RHU50B... (OEM) 		●			●	●			Page 25
Meas. chains/Transmitter	4067... (Meas. chain) 	●				●	●			Page 49
Meas. chains/Transmitter	RHU50... (Meas. chain) 			●		●	●			Page 28
Meas. chains/Transmitter	RHU56... (Meas. chain) 			●		●	●			Page 28
Meas. chains/Transmitter	RHM16... (Meas. chain) 			●		●	●			Page 28

Product configuration		Connecting cable			Amplifier/ Electronic components		Accessories					Further info
Used with: / Sensor/measuring chain		1609B...	1631C...	1699A0,5	5011B... Charge amplifier	5015A... Charge amplifier	1181A Thermal protective plate	6563A Thermal protection shield	6564 Thermal protection shield	6565A Thermal protection shield	6567 Diaphragm protector	
6203		●			●	●	●					Page 32
6213B...			●	●	●	●	●	+ ●	●			Page 32
6215			●	●	●	●	●		+	●	●	Page 33

Ballistic High-pressure measurement

Pressure range 0 ... 5 000 bar



Technical data		Type 6203
Pressure range	bar	0 ... 5 000
Overload	bar	5 500
Natural frequency	kHz	>170
Linearity	%FSO	<±1
Sensitivity	pC/bar	–2,0
Temperature range	°C	–196 ... 200
Shock-resistance (axial)	g	10 000
Acceleration sensitivity	bar/g	<0,01
Dimensions	D (mm)	6
	L (mm)	20

Connection
TNC

Characteristics
High-pressure sensor for measuring dynamic pressures from 1 000 bar to 5 000 bar. Suitable for ballistic measurements.
The design of the sealing face allows the option of installation with a flush-fitted or set-back diaphragm.

Applications
General pressure measurement in internal ballistics. Suitable for artillery, rifles and detonation chambers.
For new applications, we recommend the use of Type 6215.

Accessories
Cable: Type 1609B...
Dummy sensor: Type 6443
Adapter for Type 6905A: Type 6921
Thermal protective plate: Type 1181

Data sheet 6203_000-040

Pressure range 0 ... 10 000 bar

Technical data		Type 6213B...
Pressure range	bar	0 ... 10 000
Overload	bar	11 000
Natural frequency	kHz	>150
Linearity	%FSO	<±0,5
Sensitivity	pC/bar	–1,2
Temperature range	°C	–196 ... 200
Shock-resistance (axial)	g	10 000
Acceleration sensitivity	bar/g	<0,01
Dimensions	D (mm)	10,5
	L (mm)	18

Connection
10-32 UNF

Characteristics
Front-sealing high-pressure sensor suitable for ballistic and hydraulic pressure measurements up to 10 000 bar. Its patented anti-strain design renders it insensitive to different tightening torques and mounting conditions. The sensor is distinguished by very good linearity, extremely long service life and good long term stability.

Applications
Ideally suited for all ballistic measurements and measuring arrangements and as a reference sensor. Despite its extremely wide measuring range, this sensor is ideal for measuring relatively low pressures of a few hundred bar; a thermal protective plate can be used.

Accessories
Cable: Type 1631C...
Thermal protective plate: Type 1181
Thermal protective shield: Type 6563A...
Dummy plug: Type Z13195
Adapter for Type 6905A: Type 6923

Data sheet 6213B_000-042

Ballistic High-pressure measurement

Pressure range 0 ... 6 000 bar

Technical data		Type 6215
Pressure range	bar	0 ... 6 000
Overload	bar	6600
Natual frequency	kHz	>240
Linearity	%FSO	<±1
Sensitivity	pC/bar	–1,4
Temperature range	°C	–50 ... 200
Shock-resistance (axial)	g	10 000
Acceleration sensitivity	bar/g	<0,005
Dimensions	D (mm)	8,5
	L (mm)	18

Connection
10-32 UNF

Characteristics
Front-sealing high-pressure sensor suitable for all ballistic pressure measurements from 100 to 6 000 bar.
The sensor complies with NATO standards, has an extremely long service life and very good long term stability.

Applications
Ideal for all ballistic measurements. Depending on the measuring arrangement, the sensor can be installed with an additional thermal protection shield or diaphragm protector.

Accessories
Cable: 1699A0,5, 1631C...
Thermal protective plate: Type 1181A...
Thermal protection shield: Type 6565A...
Diaphragm protector: Type 6567
Dummy plug: Type 6449
Adapter Type 6905A...: Type 6925
Reduction sleeve: Type Z14998

Data sheet 6215_000-043

Engine Development

Sensor type			Mtg. thread			Pressure range (abs.)										Temperature range												Product configuration
Type	Sensor	Measuring chain	M5x0,8/M5x0,5	M12x1	M14x1,25	0 bar	2 bar	5 bar	10 bar	20 bar	50 bar	100 bar	200 bar	400 bar	500 bar	1000 bar	–40 °C	–30 °C	–20 °C	–10 °C	0 °C	10 °C	20 °C	30 °C	40 °C	50 °C	60 °C	70 °C	80 °C	90 °C	100 °C	110 °C	120 °C	for use with: Sensor
4005A...	✓	✓	✓																														4005A...
4043A...	✓				✓																												4043A...
4045A...	✓				✓																												4045A...
4073A...	✓			✓																													4073A...
4075A...	✓			✓																													4075A...

Compensated temperature range

Engine Development

Sensor type			Mtg. thread		Vers.		Pressure range (abs.)											Temperature range																Product configuration
Type	Sensor	Measuring chain	M7x0,75	M10x1	piezoelectric	piezoresistive	0 bar	2 bar	5 bar	10 bar	20 bar	50 bar	100 bar	500 bar	1 000 bar	2 000 bar	5 000 bar	–50 °C	–40 °C	–30 °C	–20 °C	–10 °C	0 °C	10 °C	20 °C	30 °C	40 °C	50 °C	70 °C	80 °C	100 °C	110 °C	120 °C	200 °C	for use with: Sensor
4065A...		✓	✓			✓																													4065A...
4067A...		✓		✓		✓																													4067A...
6229A...	✓			✓	✓																														6229A...

Calibrated partial range

Low-pressure Sensors, Inlet/Outlet Measurement

Mechanical adapter							Cooling adapter							Connecting cable							Extension cable			Amplifier			Further info
6597 Adapter M14x1,25	**6599** Adapter M12x1	**7501** Adapter M14x1,25	**7551** Adapter G1/2"	**7553** Adapter G1/2"	**7503** Adapter M5		**7531** Switch adapter G1/2"		**7525** M14x1,25	**7511** M14x1,25	**7507** M14x1,25	**7505** M18x1,5		4751A...	4753A...	4761B...	4763B...	4765B...	4767B...	on sensor with 2 m length		4757A2	4757A5	4757sp	**4618A...** Analog amplifier	**4603A...** Laboratory amplifier	**4665** (SCP) amplifier module	
●	●								●											●		●	●	●	●		Page 47
			●							●				<70 °C						●					●	●	Page 47
															<200 °C					●					●	●	
			●							●				<70 °C						●					●	●	Page 47
															<200 °C					●					●	●	
		●		●	●		●				●	●		<70 °C						●					●	●	Page 49
															<200 °C					●					●	●	
		●		●	●		●				●	●		<70 °C						●					●	●	Page 49
															<200 °C					●					●	●	

High-pressure Sensors, Injection

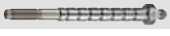
Clamp adapters									Mechanical adapters					Connecting cable				Extension cable			Piezoresistive amplifier		Piezoelectric amplifier		Further info
6533A21 (pipe dia. 6 mm)	**6533A22** (pipe dia. 1/4")	**6533A28** (pipe dia. 8 mm)	**6533A28** (pipe dia. >8 ... 13 mm)	**6533A11** (pipe dia. 6 mm)	**6533A12** (pipe dia. 1/4")	**6533A18** (pipe dia. 6 ... 8 mm)	**6533A19** (pipe dia. 8 ... 13 mm)	**6533A110** (pipe dia. 13 ... 20 mm)	**6919** Adapter for pressure generator 690	**6925** Adapter for pressure generator 690	**4155** Adapter M14x1,25	**6503** Adapter M10x1		**6447** Dummy sensor	**6449** Dummy sensor	4761B	1631C... (10-32 UNF pos.-BNC pos., <200 (C)	on sensor with 2 m length	4757A2	4757A5	4757sp	1603B... (BNC neg.- BNC pos.)	**4618A...** Analog amplifier	**4665** (SCP) amplifier module	**5011** Laboratory charge amplifier	**5064** (SCP) Charge amplifier module	
●	●	●	●						●		●	●		●				●	●	●		●				Page 48
																●							○			
				●	●	●	●	●		●				●			●	●	●	●		●				Page 48
																●							○			
				●	●	●	●	●		●				●			●				●			●	●	Page 20

○ For PiezoSmart® sensors

Engine Development

Type	Version						Mounting diam.				Mounting thread						Pressure range							Temperature range									
	Sensor	Probe	Measuring spark plug	PiezoSmart sensor identification	cooled	uncooled	4 mm	4,4 mm	6,2 mm	9,9 mm	M5 0,5	M8x0,75	M10x1	M12x1,25	M14x1,25	Mounting with mountig sleeve	0 bar	50 bar	100 bar	150 bar	200 bar	250 bar	300 bar	–50 °C	0 °C	50 °C	100 °C	150 °C	200 °C	250 °C	300 °C	350 °C	400 °C
6052C...	✓			✓		✓		✓			✓																					
6053CC...		✓		✓		✓		✓			✓																					
6055C...		✓		✓		✓		✓			✓																					
6056A		✓		✓		✓		✓			✓																					
6057A...		✓		✓		✓	✓				✓																					
6058A		✓		✓		✓	✓				✓																					
6081A...		✓		✓		✓	✓				✓																					
6113A...			✓	✓		✓							✓																			
6115A...			✓	✓		✓								✓																		
6117B...			✓	✓		✓									✓																	
6125B...	✓			✓		✓			✓				✓																			
6041A	✓			✓	✓							✓																				
6043A...		✓		✓	✓							✓																				
6061B	✓			✓	✓								✓																			
6067C...	✓			✓	✓					✓						✓																
7061B...	✓			✓	✓																											

High Pressure Sensors, Cylinder Pressure

Product configuration	Mechanical adapters													Connecting cable												Coupling		
for use with: / Sensor	**6473A...** Mounting sleeve (M10x1)	**6444A...** Mounting sleeve (3/8"x24 UNF)	**6472Asp** 70 ... 150 Mounting sleeve	**6525Asp...** Mounting sleeve	**6517B...** Spark plug adapter	**6531Q...** Glow plug adapter	**6535Q...** Glow plug adapter	**6542Q...** Glow plug adapter	**6544Q...** Glow plug adapter	**6442** Dummy sensor	**6444** Dummy sensor	**6445** Dummy sensor	**6475** Dummy sensor	**1631C...** (10-32 UNF pos. - BNC pos.)	**1635C...** (10-32 UNF pos. - 10-32 UNF pos.)	**1919A1** (M4 pos. integr. - 10-32 UNF pos.)	**1921** (M4 pos. integr. - 10-32 UNF pos.)	**1927A1** (M4 pos. integr. - 10-32 UNF pos. integr.)	**1929A1** (M4 pos. - M4 pos.)	**1957A1** (10-32 UNF pos. - 10-32 UNF pos.)	**1967A1** (10-32 UNF pos. integr. - 10-32 UNF pos. integr.)	**1969A1** (Metal cable 10-32 UNF pos. integr. - 10-32 UNF pos. integr.)	**1983AC1** (10-32 UNF pos. integr. - 10-32 UNF pos. integr.)	**1989A1** (M3 pos. - M3 pos.)	Integrated on sensor/probe	**1705** (M4 neg. - BNC pos.)	**1706** (M3 neg. - BNC pos.)	**1721** (10-32 UNF neg. - BNC pos.)
6052C... 				●	●	●						●							●							●		
6053CC... 						●								●						●							●	
						●									●												●	
						●								●						●							●	
6055C... 							●																					
							●								●												●	
							●													●							●	
6056A 								●																	●			
6057A... 							●							●														
							●								●												●	
							●													●							●	
6058A 									●																●			
6081A... 																										●		
6113A... 																												
6115A... 																												
6117B... 														●														
6125B... 	●	●																			●							
	●	●																										
6041A 													●							●						●	
6043A... 																				●						●		
6061B 									●							●											●	
6067C... 			●							●						●											●	
7061B... 														●	●								●				●	

	Amplifier			Further info
	5011B...	5064A...		
				
	Charge amplifier with case	2-channel charge amplifier SCP		
	●	●		Page 39
	●	●		Page 39
	●	●		Page 40
	●	●		Page 40
	●	●		Page 41
	●	●		Page 41
	●	●		Page 43
	●	●		Page 43
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	●	●		Page 42
	●	●		Page 46

Piezoelectric sensors

M8 sensor, cooled

Technical data		Type 6041A
Pressure range	bar	0 ... 250
Sensitivity	pC/bar	≈–20
Natural frequency	kHz	≈70
Linearity	%FSO	<±0,5
Temperature range	°C	–50 ... 350
Sensitivity change		
50 °C ±35 °C (cooled)	%	±0,5
200 °C ±150 °C (uncooled)	%	<±2
Thermal shock		
Δ p (short time)	bar	<±0,25
Δ p mi	%	<±2
Δ p max	%	<±1
Dimensions	D (mm)	11,5
	L (mm)	8

Connection
M4x0,35

Characteristics
Miniature water-cooled cylinder-pressure sensor (M8 thread). Thermal shock-optimized double diaphragm, long service life due to TiN coating and metal-braided cable.

Applications
This miniature sensor Type 6041A is ideal for thermodynamic measurements in compact multi-valve engines which have a limited amount of space. Its low temperature shock sensitivity and very stable zero point produce precise measuring results.

Accessories
Cable: Type 1929A1
Transitional coupling: Type 1705
CrNi steel seal: Type 1100A31
Connecting tube: Type 1225A1
Dummy sensor: Type 6475
Adapter for Type 6904: Type 6589

Data sheet 6041A_000-013

M8 probe, cooled

Technical data		Type 6043A....
Pressure range	bar	0 ... 250
Sensitivity	pC/bar	≈–20
Natural frequency	kHz	>70
Linearity	%FSO	<±0,5
Temperature range	°C	–50 ... 350
Sensitivity change		
50 °C ±35 °C (cooled)	%	±0,5
200 °C ±150 °C (uncooled)	%	<±2
Thermal shock		
Δ p (short time)	bar	<±0,25
Δ p mi	%	<±2
Δ p max	%	<±1
Dimensions	D (mm)	9,8
	L (mm)	8

Connection
M4x0,35

Characteristics
Thermal shock-optimized double diaphragm, water-cooled miniature cylinder pressure sensor (M8 thread), long service life due to TiN coating and metal-braided cable.

Applications
The probe Type 6043A allows cylinder pressure to be measured also in engines which have a limited amount of space: multi-valve engines, motorcycle and other small engines.

Accessories
Cable: Type 1929A1
Transitional coupling: Type 1705
CrNi steel seal: Type 1100A31
Connecting tube: Type 1225A1
Adapter for Type 6904: Type 6589

Data sheet 6043A_000-014

Piezoelectric sensors

M5 miniature sensor, uncooled

Technical data		Type 6052C...
Pressure range	bar	0 ... 250
Sensitivity	pC/bar	≈–20
Natural frequency	kHz	≈160
Linearity	%FSO	<±0,4
Temperature range	°C	–50 ... 350
Sensitivity change		
200 °C ±50 °C	%	<±0,5
23 ... 350 °C	%	<±2
Thermal shock		
Δ p (short time)	bar	<±0,5
Δ p mi	%	<±2
Δ p max	%	<±1,5
Dimensions	D (mm)	4,4
	L (mm)	10

Connection
M4x0,35

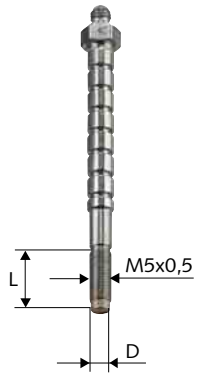
Characteristics
Good temperature stability, low thermal shock error and long service life due to front seal, acceleration-compensated, very high sensitivity.

Applications
The sensor allows measurements in engine combustion chambers under minimum space conditions: multi-valve engines, motorcycle and other small engines.

Accessories
Cable: Type 1929A1 in included accessories
Coupling: Types 1705, 1700A13
Mounting sleeve: Type 6525Asp...
Dummy sensor: Type 6445
Adapter for 6904: Type 6585A
O-ring: Art. No. 5.110.078

Data sheet 6052C_000-552

M5 miniature measuring probe, uncooled



Technical data		Type 6053CC...
Pressure range	bar	0 ... 250
Sensitivity	pC/bar	≈–20
Natural frequency	kHz	≈160
Linearity	%FSO	<±0,4
Temperature range	°C	–50 ... 350
Sensitivity change		
200 °C ±50 °C	%	≈ ±0,5
23 ... 350 °C	%	<±2
Thermal shock		
Δ p (short time)	bar	<±0,5
Δ p mi	%	<±2
Δ p max	%	<±1,5
Dimensions	D (mm)	4,4
	L (mm)	14,5

Connection
10-32 UNF

Characteristics
Good temperature stability of the sensitivity, acceleration-compensated, requires only 6 mm mounting bore, low thermal shock error and long service life due to front seal, very high sensitivity.

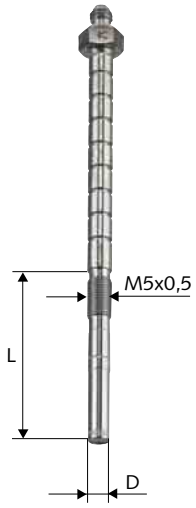
Applications
The miniature probe allows engine combustion chamber pressure to be measured under critical mounting conditions: e.g. on multi-valve engines, motorcycle and other small engines.

Accessories
Cable: Types 1631C..., 1635C..., 1957A1
Coupling: Types 1Y721, 1729
Dummy sensor: Type 6445
Adapter for 6904: Type 6585A
O-ring: Type 1100A81
Thermal protection: Type 6539A1
Diaphragm protect.: Type 6539A2

Data sheet 6053CC_000-571

Piezoelectric sensors

M5 miniature measuring probe, uncooled, thread set back



Technical data		Type 6055C...
Pressure range	bar	0 ... 250
Sensitivity	pC/bar	≈–20
Natural frequency	kHz	≈160
Linearity	%FSO	<±0,4
Temperature range	°C	–50 ... 350
Sensitivity change		
200 °C ±50 °C	%	≈ ±0,5
23 ... 350 °C	%	<±2
Thermal shock		
Δ p (short time)	bar	<±0,5
Δ p mi	%	<±2
Δ p max	%	<±1,5
Dimensions	D (mm)	4,4
	L (mm)	35

Connection
10-32 UNF

Characteristics
Particularly suitable for measurements with glow plug adapter Type 6535Q..., good temperature stability of the sensitivity, acceleration-compensated, low thermal shock error and long service life due to front seal, very high sensitivity.

Applications
The miniature probe allows engine combustion chamber pressure to be measured under critical mounting conditions: e.g. on multi-valve engines, motorcycle and other small engines. For cylinder pressure indication on diesel engines using glow plug adapter Type 6535Q... .

Accessories
Cable: Types 1631C..., 1635C..., 1957A1
Coupling: Types 1721, 1729A
Adapter for 6904: Type 6591
O-ring: Type 1100A61
Thermal protection: Type 6539A1
Diaphragm protection: Type 6539A2

Data sheet 6055C_000-572

M5 miniature measuring probe, uncooled, version in standard length

Technical data		Type 6056A
Pressure range	bar	0 ... 250
Sensitivity	pC/bar	≈–20
Natural frequency	kHz	≈130
Linearity	%FSO	<±0,4
Temperature range	°C	–50 ... 350
Sensitivity change		
200 °C ±50 °C	%	<±0,5
23 ... 350 °C	%	<±2
Thermal shock		
Δ p (short time)	bar	<±0,5
Δ p mi	%	<±2
Δ p max	%	<±1,5
Dimensions	D (mm)	4,4
	L (mm)	33,5

Connection
M3x0,35

Characteristics
Good temperature stability of the sensitivity, acceleration-compensated, requires only 4,5 mm mounting bore, low thermal shock error and long service life due to front seal, very high sensitivity.

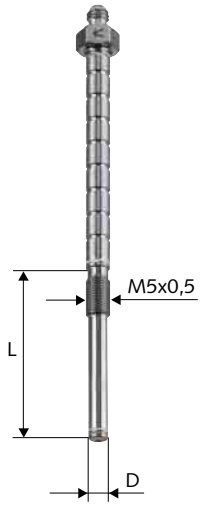
Applications
High-temperature pressure sensor for uncooled direct installation in glow adapter for pressure measurement in combustion engines. Simple mounting with standard length for glow plug adapter Type 6542Q... .

Accessories
Cable: Type 1989A1
Adapter: Type 1706

Data sheet 6056A_000-529

Piezoelectric sensors

M5 miniature measuring probe, uncooled, 4 mm probe tip



Technical data		Type 6057A...
Pressure range	bar	0 ... 250
Sensitivity	pC/bar	≈–15
Natural frequency	kHz	>130
Linearity	%FSO	<±0,6
Temperature range	°C	–50 ... 350
Sensitivity change		
200 °C ±50 °C	%	<±1,5
Thermal shock		
Δ p (short time)	bar	<±0,8
Δ p mi	%	<±4
Δ p max	%	<±2
Dimensions	D (mm)	4,0
	L (mm)	35

Connection
10-32 UNF

Characteristics
Particularly suitable for pressure indication with glow plug adapter; low thermal shock error due to front seal, very high sensitivity due to new piezoelectric crystal.

Applications
The miniature probe allows engine combustion chamber pressure to be measured under critical mounting conditions: e.g. on multi-valve engines, motorcycle and other small engines. For cylinder pressure indication on diesel engines by means of glow plug adapter Type 6535Q… .

Accessories
Cable: Types 1631C..., 1635C..., 1957A1
Adapter for Type 6904: Type 6591
Coupling: Types 1721, 1729A
O-ring: Type 1100A61

Data sheet 6057A_000-019

M5 miniature measuring probe, uncooled, version in standard length

Technical data		Type 6058A
Pressure range	bar	0 ... 250
Sensitivity	pC/bar	≈–16
Natural frequency	kHz	≈130
Linearity	%FSO	<±0,4
Temperature range	°C	–50 ... 400
Sensitivity change		
200 °C ±50 °C	%	<±0,5
23 ... 350 °C	%	<±2,5
Thermal shock		
Δ p (short time)	bar	<±0,5
Δ p mi	%	<±2
Δ p max	%	<±1,5
Dimensions	D (mm)	4,0
	L (mm)	33,5

Connection
M3x0,35

Characteristics
Good temperature stability of the sensitivity, acceleration-compensated, requires only 4,1 mm mounting bore, low thermal shock error and long service life due to front seal, very high sensitivity.

Applications
High-temperature pressure sensor for uncooled direct installation in glow adapter for pressure measurement in combustion engines. Simple mounting with standard length for glow plug adapter Type 6544Q… .

Accessories
Cable: Type 1989A1
Adapter: Type 1706

Data sheet 6058A_000-573

Piezoelectric sensors

M10 ThermoComp® quartz pressure sensor, cooled

Technical data		Type 6061B
Pressure range	bar	0 ... 250
Sensitivity	pC/bar	≈–25
Natural frequency	kHz	≈90
Linearity	%FSO	<±0,5
Temperature range	°C	–50 ... 350
Sensitivity change		
50 °C ±35 °C (cooled)	%	<±0,5
200 °C ±150 °C (uncooled)	%/°C	<±2
Thermal shock		
Δ p (short time)	bar	<±0,2
Δ p mi	%	<±1
Δ p max	%	<±1
Dimensions	D (mm)	13,5
	L (mm)	10

Connection
M4x0,35

Characteristics
Water-cooled cylinder pressure sensor, thermal shock optimized double diaphragm, long service life due to TiN coating and metal braided cable.

Applications
The miniature sensor Type 6061B is particularly suitable for thermodynamic measurements. The sensor has a low temperature error and excellent zero point stability thanks to water cooling.

Accessories
Cable: Type 1919A1
Transition coupling: Type 1721, 1725, 1729A
CrNi steel seal: Type 1100A3
Connecting tube: Type 1225A1
Dummy sensor: Type 6442

Data sheet 6061B_000-020

Ø10 mm ThermoComp® precision cylinder pressure sensor, cooled

Technical data		Type 6067C...
Pressure range	bar	0 ... 250
Sensitivity	pC/bar	≈–25
Natural frequency	kHz	≈90
Linearity	%FSO	<±0,5
Temperature range	°C	–50 ... 350
Acceleration sensitivity		
Sensitivity change		
50 °C ±35 °C (cooled)	%	<±0,5
200 °C ±150 °C (uncooled)	%	<±2
Thermal shock		
Δ p (short time)	bar	<±0,2
Δ p mi	%	<±1
Δ p max	%	<±1
Dimensions	D (mm)	9,9
	L (mm)	9,5

Connection
M4 pos. integrated

Characteristics
Water-cooled cylinder pressure sensor, thermal shock optimized double diaphragm, long service life due to TiN coating and metal cable. Changes with respect to Type 6067B: optimized mounting sleeve for simple sensor removal.

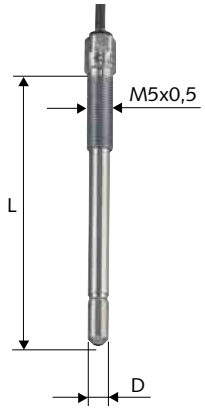
Applications
The miniature sensor Type 6067C... is particularly suitable for thermodynamic measurements where there is insufficient space for mounting sensor Type 6061B (M10). Its excellent linearity over the entire range and high sensitivity also allow gas exchange investigations with good accuracy.

Accessories
Cable: Type 1919A1
Transition coupling: Types 1721, 1725, 1729A
Dummy sensor: Type 6444C
Seal: Type 1100A3

Data sheet 6067C_000-021

Piezoelectric sensors

Miniature high-temperature measuring probe, uncooled



Technical data		Type 6081A...
Pressure range	bar	0 ... 250
Sensitivity	pC/bar	–9,5
Natural frequency	kHz	≈120
Linearity	%FSO	<±0,8
Temperature range	°C	–50 ... 350
Sensitivity change		
200 °C ±50 °C	%	<±1
Thermal shock		
Δ p (short time)	bar	<±0,8
Δ p mi	%	<±4
Δ p max	%	<±2
Dimensions	D (mm)	4
	L (mm)	30 ... 50

Connection
Cable direct to probe

Characteristics
Miniature sensor for indicating measurements, simple handling, rugged, available in various lengths, mounting insensitivity due to 90° taper.

Applications
Small size and rugged design for engines with complex build geometry, can also be used without problem in knocking combustion. The angled sealing surface places only minor requirements on quality of the mounting bore.

Accessories
Mounting key: Type 1300A9
Coupling: Types 1705, 1700A13

Data sheet 6081A_000-494

Measuring spark plug M10x1 with integrated cylinder pressure sensor

Technical data		Type 6113A...
Pressure range	bar	0 ... 200
Sensitivity	pC/bar	≈–9,5
Natural frequency	kHz	>100
Linearity	%FSO	<±0,8
Temperature range	°C	–50 ... 250
Sensitivity change		
200 °C ±50 °C	%	<±1
Thermal shock		
Δ p (short time)	bar	<±0,8
Δ p mi	%	<±4
Δ p max	%	<±2
Dimensions seal flat	L (mm)	16/26,5

Connection
10-32 UNF

Characteristics
Interchangeable ceramics, measurement without indicating bore in M10 spark plug hole, highest natural frequency, sensor front-flush mounted, various heat ranges and spark locations possible, suitable for plotting knock-limit curves.

Applications
Cylinder pressure measurement with the measuring spark plug is used without engine modification. Applications where a separate measuring bore is to be omitted. A typical application is setting of knock limit values for the engine electronics in production and racing engines.

Accessories
Spark plug extension connector: Type 1700B15
Ignition cable extension for Type 6115A...: Type 1500A49
Adapter for Type 6904: Type 6593
Coupling: Types 1721, 1725, 1729A
Protection sleeve: Art. No. 3.315.041

Data sheet 6113A_000-574

Piezoelectric sensors

Measuring spark plug M12x1,25 with integrated cylinder pressure sensor

Technical data			Type 6115A...
Pressure range		bar	0 ... 200
Sensitivity		pC/bar	≈–9,5
Natural frequency		kHz	>100
Linearity		%FSO	<±0,8
Temperature range		°C	–50 ... 250
Sensitivity change			
200 °C ±50 °C		%	<±1
Thermal shock			
Δ p (short time)		bar	<±0,8
Δ p mi		%	<±4
Δ p max		%	<±2
Dimensions	seal flat	L (mm)	19/26,5

Connection
10-32 UNF

Characteristics
Interchangeable ceramics, measurement without indicating bore in M12 spark plug hole, highest natural frequency, sensor front-flush mounted, various heat ranges and spark locations possible, suitable for plotting knock-limit curves.

Applications
Cylinder pressure measurement with the measuring spark plug is used without engine modification. Applications where a separate measuring bore is to be omitted. A typical application is setting of knock limit values for the engine electronics in production and racing engines.

Accessories
Spark plug extension connector: Type 1700B15
Ignition cable extension for Type 6115A...: Type 1500A49
Adapter for Type 6904: Type 6593
Coupling: Types 1721, 1725, 1729A

Data sheet 6115A_000-416

Measuring spark plug M14x1,25 with integrated cylinder pressure sensor

Technical data			Type 6117B...
Pressure range		bar	0 ... 200
Sensitivity		pC/bar	≈–15
Natural frequency		kHz	≈130
Linearity		%FSO	<±0,6
Temperature range		°C	–50 ... 350
Sensitivity change			
200 °C ±50 °C		%	<±1,5
Thermal shock			
Δ p (short time)		bar	<±0,8
Δ p mi		%	<±4
Δ p max		%	<±2
Dimensions	seal flat	L (mm)	19/22/26,5
	seal conical	L (mm)	17,5/23,5/25,4

Connection
10-32 UNF

Characteristics
Measurement without indicating bore, highest natural frequency, sensor front-flush, high sensitivity, high accuracy, various thermal values and spark locations available.

Applications
The cylinder pressure measurement with the measuring spark plug is used in those applications where a separate measuring bore is to be omitted. A typical application is setting knock limit values for the engine electronics in production and racing engines.

Accessories
Cable: Type 1927A1
Spark plug extension connector: Type 1700B15
Ignition cable extension for Type 6117B...: Type 1500A49
Calibration adapter: Types 6588A..., 6587A...
Coupling: Types 1721, 1725, 1729A

Data sheet 6117B_000-022

Piezoelectric sensors

ThermoComp® quartz pressure sensor, ground-insulated, uncooled

Technical data		Type 6125B...
Pressure range	bar	0 ... 250
Sensitivity	pC/bar	≈–16
Natural frequency	kHz	≈75
Linearity	%FSO	<±0,5
Temperature range	°C	–50 ... 350
Sensitivity change		
200 °C ±50 °C (cooled)	%	<±1
200 °C +150 °C/–177 °C	%	<±2
Thermal shock		
Δ p (short time)	bar	<± 0,3
Δ p mi	%	<±2
Δ p max	%	<±1
Dimensions	D (mm)	6,2
	L (mm)	10

Connection
Cable direct to sensor

Characteristics
Ground-insulated, small load-change drift, very low thermal shock error, available with oil-resistant cable Type 1983AC1.

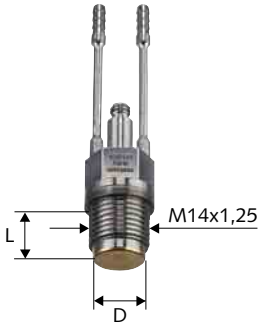
Applications
The uncooled sensor Type 6125 is particularly suitable for accurate measurements in spark-ignition and diesel engines with limited mounting space. Due to its minimal load change drift, this sensor is ideal also for transient engine tests.

Accessories
Cable: Types 1967A1 or 1983AC1
Adapter Type 6906A: Types 6952A1, 6952A2
Dummy sensor: Type 6469A
Coupling: Types 1721, 1725, 1729A

Data sheet 6125B_000-025

Piezoresistive sensors

M14 ThermoComp® quartz pressure sensor, cooled



Technical data		Type 7061B...
Pressure range	bar	0 ... 250
Sensitivity	pC/bar	≈–80
Natural frequency	kHz	≈45
Linearity	%FSO	<±0,5
Temperature range	°C	–50 ... 350
Sensitivity change		
50 °C ±35 °C (cooled)	%	<±0,5
200 °C ±150 °C (uncooled)	%	<±2
Thermal shock		
Δ p (short time)	bar	<±0,1
Δ p mi	%	<±0,5
Δ p max	%	<±0,5
Dimensions	D (mm)	12
	L (mm)	13

Connection
10-32 UNF

Characteristics
Polystable quartz elements keep the sensitivity largely constant in the range –50 … 350 °C, and the sensor also continues to function even if the water cooling fails. With long-life, TiN coated diaphragm.

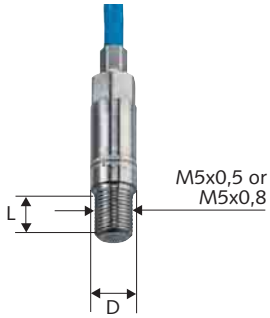
Applications
Water-cooled precision pressure sensor, particularly suitable for use in combustion engines, for high precision thermodynamic measurements. As a result of its insensitivity to thermal shocks and its zero point stability, the sensor Type 7061B… is ideal for measurements in combustion chambers where wide temperature fluctuations occur.

Accessories
Cable: Types 1631C..., 1635C..., 1969A1
CrNi steel seal: Type 1111A
Coupling: Types 1721, 1725, 1729A
Connecting tube: Type 1225A1
Polyethylene hose: Type 1203Bsp
Viton hose: Type 1203Csp
Adapter for Type 6904A: Type 7915
Dummy plug: Type 7441A

Data sheet 7061B_000-052

Piezoresistive sensors

M5 miniature absolute pressure sensor with amplifier



Technical data		Type 4005A...
Pressure range	bar (abs)	0 ... 2 / ... / 0 ... 10
Output signal (amplifier)*	V	0 ... 10
Linearity & hysteresis (BSL)	%FSO	<±0,3
Operating temperature range		
Sensor (min./max.)	°C	–40 ... 125
Amplifier (min./max.)	°C	0 ... 60
Supply	VDC	18 ... 30
Frequency range, –3 dB (meas. chain)	kHz	0 ... >40
Material		Armco 17-4PH
Dimensions (sensor)	D (mm)	6,2
	L (mm)	4

* depending on pressure range

Connection
Cable direct to sensor

Characteristics
Compact design, high natural frequency, extremely low acceleration sensitivity, low mass, supplied as measuring chain with Type 4618A.

Applications
With its small size, small dead volume and high natural frequency, this sensor is ideally suited for intake manifold testing.

Accessories
Cable: Types 4757A2, 4757A5, 4757Asp
Adapter: Types 6597, 6599
Cooling adapter: Type 7525

Data sheet 4005A_000-490

M14 miniature absolute pressure sensors for gas exchange measurements

Technical data		Type 4043A...	Type 4045A...
Pressure range	bar (abs)	0 ... 1 / ... / 0 ... 500	0 ... 1 / ... / 0 ... 500
Sensitivity	mV/bar	1 / ... / 500	1 / ... / 500
Linearity & hysteresis (BSL)	%FSO	<±0,3	<±0,3
Operating temperature range	°C	–20 ... 50	20 ... 120
Min./max. temperature	°C	–40/70	
Cut-off frequency*	kHz	>14 ... >200	>14 ... >200
Material		1.4301	1.4301
Dimensions	D (mm)	12	12
	L (mm)	16	16

* depending on pressure range

Connection
Fischer Type SE 102A054

Characteristics
Integral temperature compensation, high natural frequency, good linearity, available as V39 version with cable connection.

Applications
Intake and exhaust pressure measurement on combustion engines, materials processing.

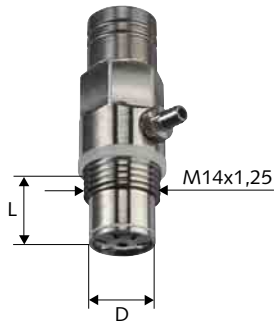
Options
For temperature signal use version V64.

Accessories
Cable: Types 4751A, 4761A, 4765A
Cooling adapter: Type 7511
Copper seal: Type 1111
Nickel seal: Type 1111A

Data sheet 4043A_000-003

Piezoresistive sensors

M14 differential pressure sensor



Connection
Fischer Type SE 103A054

Technical data		Type 4053A...
Pressure range	bar (rel.)	0 ... 1 / ... / 0 ... 10
Sensitivity	mV/bar	50 / ... / 500
Linearity & hysteresis (BSL)	%FSO	<±0,3
Operating temperature range	°C	–20 ... 50
Min./max. temperature	°C	–40/70
Cut-off frequency*	kHz	>15 ... >50
Material		1.4301
Dimensions	D (mm)	12
	L (mm)	16

* depending on pressure range

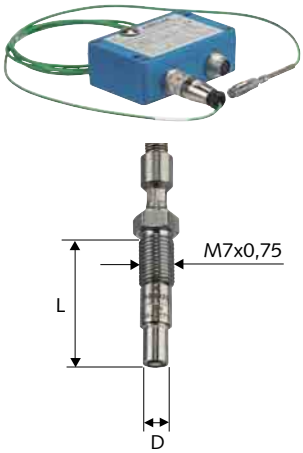
Characteristics
Integral temperature compensation, high natural frequency, measurement relative to reference pressure.

Applications
Measurement of static pressures which are modulated by high frequency events.

Accessories
Cable: Types 4603, 4611, 4751A..., 4761A..., 4765A...
Copper seal: Type 1111
CrNi seal: Type 1111A
Plastic seal: Type 1119
Dummy sensor: Type 7441A

Data sheet 4053A_000-004

Measuring chain/high-pressure sensor with amplifier up to 1 000 bar



Connection
Cable direct to sensor

Technical data		Type 4065A...
Pressure range	bar (abs.)	0 ... 200 / ... / 0 ... 1 000
Output voltage (amplifier)	V	0 ... 10
Linearity & hysteresis (BSL)	%FSO	<±0,5 ... <±1
Operating temperature range		
Sensor	°C	20 ... 120
Amplifier	°C	0 ... 60
Supply	VDC	18 ... 30
Frequency range*	kHz	>40 ... >100
Material (sensor)		17-4 PH
Dimensions (sensor)	D (mm)	5
	L (mm)	25,3

* depending on pressure range

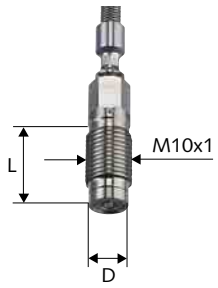
Characteristics
For static and dynamic pressure, high natural frequency, shoulder-sealing, integrated connecting cable, supplied with adjustable amplifier Type 4618A... .

Applications
Optimization of injection systems of combustion engines as well as gas pressure measurements. Measurements on hydraulic systems.

Accessories
Cable: Type 4757A...
Seal: Type 1100A77
Dummy sensor: Type 6447
Clamp adapter: Types 6533A21, 6533A22, 6533A28, 6533A29
Adapter for 6905A: Type 6919
Adapter: M14x1,25 Type 4155
Adapter: M10x1 Type 6503
Spare amplifier: Type 4618A...

Data sheet 4065A_000-005

Measuring chain/high-pressure sensor with amplifier up to 5 000 bar



Technical data		Type 4067...
Pressure range	bar (abs.)	0 ... 1 000 / ... / 0 ... 5 000
Output voltage (amplifier)	V	0 ... 10
Linearity & hysteresis (BSL)	%FSO	<±0,5
Operating temperature range	°C	
Sensor	°C	20 ... 120
Amplifier (4618A...)	°C	0 ... 70
Supply	VDC	18 ... 30
Cut-off frequency*	kHz	>100 ... >200
Material (sensor)		17-4 PH
Dimensions (sensor)	D (mm)	8,5
	L (mm)	18,6

* depending on pressure range

Connection
Cable direct to sensor

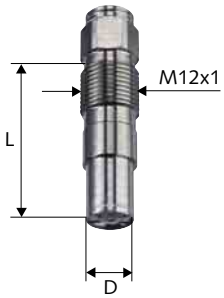
Characteristics
Front sealing, small size for static and dynamic pressure, high natural frequency, integrated connecting cable, supplied with adjusted amplifier Type 4618A... .

Applications
Optimization of injection systems for diesel engines, measurements on hydraulic systems.

Accessories
Cable: Type 4767A2
Extension cable: Type 4757A...
Dummy sensor: Type 6449
Clamp adapters: Types 6533A11, 6533A12, 6533A18, 6533A19, 6533A110
Adapter for pressure generator Type 6905A: Type 6925
Spare amplifier: Type 4618A...

Data sheet 4067_000-006

M12 miniature absolute pressure sensors for gas exchange measurements



Technical data		Type 4073A...	Type 4075A...
Pressure range	bar (abs)	0 ... 10 / ... / 0 ... 500	0 ... 10 / ... / 0 ... 500
Sensitivity*	mV/bar	1 ... 50	1 ... 50
Linearity & hysteresis (BSL)	%FSO	<±0,3	<±0,3
Operating temperature range	°C	–20 ... 50	20 ... 120
Cut-off frequency*	kHz	>45 ... >200	>45 ... >200
Material		1.4301	1.4301
Dimensions	D (mm)	9,5	9,5
	L (mm)	35	35

* depending on pressure range

Connection
Fischer Type SE 102A053

Characteristics
Integral temperature compensation, high natural frequency, good linearity, available as V39 version with cable connection.

Applications
Induction and exhaust pressure measurement on combustion engines, process engineering.

Options
For temperature signal use version V64.

Accessories
Cable: Types 4763A..., 4767A...
Adapter: Type 7501
Copper seal: Type 1135
Nickel seal: Type 1135A...
Teflon seal: Type 1137
Cooling adapter: Types 7505, 7507
Switching adapter: Type 7531
Adapter: Type 7503

Data sheet 4073A_000-003

Engine Monitoring

Type	Application				Version			Connecting socket			Product configuration
	Cylinder pressure monitoring	Injection pressure monitoring	Offline monitoring	Online monitoring	Piezotron	With charge amplifier	Without charge amplifier	Fischer SE 103	M12x1 (8 pin)	10-32 UNF	for use with: / Sensor/measuring chain
6013CA	✓			✓			✓	✓			**6013CA** 
6302A...	✓			✓			✓			✓	**6302A...** 
6613CA	✓			✓		✓			✓		**6613CA** 
6729A		✓	✓		✓			✓			**6729A** 
7013C	✓		✓				✓	✓			**7013C** 
7613C	✓		✓		✓			✓			**7613C** 

For output of charge amplifier 5029A...

Adapter						Connecting cable				Electronics			Further info
6582A1 (M14x1,25)	**6582A2** (BSP R1/2")	**7513A... + 6582A1** (M14x1,25)	**7513A...** (Thompson Adapter)	**7519A1** (Indicating valve for sensor with M10 thread)	**7523A10** (G1/2")	**1673A..** (KE 103 - BNC pos.)	**1700A69** (Connector M12x1, Output, Cable length = 10 m, Cable end with 3 strands)	**1700A71** (Connector M12x1, Output, Cable length = 10 m, Cable end with 4 strands)	**1787A...** (Connector M12x1, Output, Cable length A5 = 5 m, A20 = 20 m Cable end with 8 strands)	**5029A...**  Charge amplifier	**2516A1**  Engine-Peak-Meter	**2516A2** Engine-Peak-Meter	
●	●	●		●		●	○	○	○	●			**Page 52**
							○	○	○	●			**Page 52**
●	●	●		●	●		●	●	●			●	**Page 53**
						●							**Page 55**
			●			●	○	○	○	●			**Page 54**
			●			●					●		**Page 54**

Cylinder pressure

M10 cylinder pressure sensor without amplifier

Technical data		Type 6013CA
Pressure range	bar	0 ... 250
Overload	bar	300
Natural frequency	kHz	>85
Linearity	%FSO	<±1
Sensitivity	pC/bar	–21
Temperature range	°C	–50 ... 350
Dimensions	D (mm)	8,8
	L (mm)	10

Connection
Fischer Type SE103

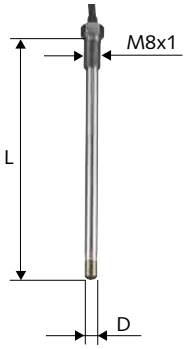
Characteristics
Rugged sensor with integrated Viton® cable Ø 5,5 mm, very good long term stability, small thermal shock, outstanding life expectancy.

Applications
Continuous application in gas and diesel engines, suitable for knock control and performance measurement.

Accessories
Cable: Type 1673A ...
Adapter: Types 6582A1, 6582A2

Data sheet 6013_000-402

M8 measuring probe without amplifier



Technical data		Type 6302A...
Pressure range	bar	0 ... 250
Overload	bar	300
Natural frequency	kHz	>100
Linearity	%FSO	<±1
Sensitivity	pC/bar	–9,5
Temperature range	°C	–50 ... 350
Dimensions	D (mm)	6
	L (mm)	50 ... 190

Connection
10-32 UNF

Characteristics
Measuring probe with integrated cable, as well as union nut and taper seal for easy mounting, very good long term stability, available in various probe and cable lengths.

Applications
Continuous application in engines with limited space for installation, suitable for knock control and performance measurement.

Accessories
Charge amplifier: Type 5029A...

Data sheet 6302_000-506

Cylinder pressure

M10 cylinder pressure sensor with amplifier

Technical data		Type 6613CA
Pressure range	bar	0 ... 250
Overload	bar	300
Natural frequency	kHz	≈20
Linearity	%FSO	<±1
Sensitivity	mV/bar	10
Temperature range	°C	–50 ... 350
Dimensions	D (mm)	8,6
	L (mm)	10

Connection
M12x1

Characteristics
Rugged sensor with integrated Viton® cable Ø 5,5 mm, very good long term stability, small thermal shock, outstanding life expectancy.

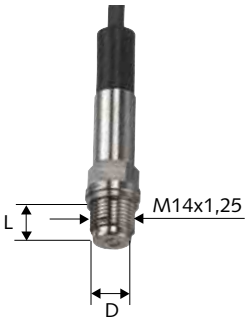
Applications
For use with engines with speeds >500 1/min. This sensor has a voltage output and also two measuring ranges.

Accessories
Adapter: M14x1,25 Type 6582A1
Adapter: BSP R1/2" Type 6582A2
Adapter: G1/2" Type 7523A10

Data sheet 6613C_000-404

Cylinder pressure

M14 cylinder pressure sensor without amplifier



Technical data		Type 7013C
Pressure range	bar	0 ... 250
Overload	bar	300
Natual frequency	kHz	>70
Linearity	%FSO	<±0,5
Sensitivity	pC/bar	–40
Temperature range	°C	–50 ... 350
Dimensions	D (mm)	12
	L (mm)	12

Connection
Fischer Type SE 103

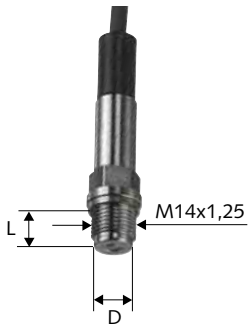
Characteristics
Rugged Viton® cable Ø 5,5 mm, very good linearity, small thermal shock.

Applications
Measurements in combustion chambers under difficult conditions such as particulate concentrations, moisture etc. This sensor is largely insensitive to combustion residues and is thus suitable for rough conditions as well as for long term measurements.

Accessories
Cable: Types 1673A2, 1673A5, 1700A19
Nickel seal: Type 1100A1
Thompson adapter: Type 7513A
Adapter for Type 6905A: Type 7915

Data sheet 7013C_000-049

M14 cylinder pressure sensor with Piezotron® amplifier



Technical data		Type 7613C
Pressure range	bar	0 ... 250
Overload	bar	300
Natural frequency	kHz	>70
Linearity	%FSO	<±0,5
Sensitivity	mV/bar	20
Temperature range	°C	–50 ... 350
Cable length	L (m)	1,5
Dimensions	D (mm)	12
	L (mm)	12

Connection
Fischer Type SE 103

Characteristics
Rugged Viton® cable Ø 5,5 mm, very good linearity, small thermal shock, very good linearity with integrated Piezotron amplifier.

Applications
Measurements in combustion chambers under more difficult conditions such as dirt, moisture etc. This sensor is largely insensitive to combustion residues and is thus suitable for rough conditions as well as for long term measurements.

Accessories
Cable: Types 1673A2, 1673A5, 1700A19
Nickel seal: Type 1100A1
Thompson adapter: Type 7513A...
Adapter for Type 6905A: Type 7915
Engine Tester: Type 2507B...
Engine Peak Meter: Type 2515A...

Data sheet 7613C_000-054

Injection pressure

Injection pressure sensor with Piezotron® amplifier

Technical data		Type 6729A
Pressure range	bar	0 ... 2 000
Overload	bar	5 000
Natual frequency	kHz	>200
Linearity	%FSO	<±1
Sensitivity	mV/bar	2,5
Temperature range	°C	–50 ... 200
Dimensions	D (mm)	8,5
	L (mm)	4,1

Connection
Fischer Type SE103

Characteristics
Rugged Viton® cable Ø 5,5 mm, high natural frequency.

Applications
Pressure measurement on hydraulic high-pressure systems, e.g. injection systems for diesel engines.

Accessories
Seal: Type 1100
Dummy plug: Type 6443
Adapter for Type 6905A: Type 6925
Clamp adapter: Type 6533A...

Data sheet 6729A_000-045

Electronics & Software

Multi-channel amplifier systems

SCP/SCP-Compact

Platform \ Module	Charge amplifier	Charge amplifier with sensor identification PiezoSmart	Piezoresistive amplifier with sensor identification PiezoSmart	Amplifier interface Signal conditioning 0 ... 10 V	Voltage amplifier
Desktop version  **2853A110**	 **5064A1**	 **5064A2**	 **4665**	 **5613A1Q01**	 **5227A1Q01**
Rack version  **2853A120**					
Rack version  **2854A11...**					
Portable  **2854A13...**					

Single-channel amplifier systems

Charge Amplifiers

Laboratory charge amplifier	Charge amplifier with digital signal conditioning	Charge amplifier on Euro-card	In-line charge amplifier	Charge amplifier	Handheld charge amplifier
 **5011B...**	 **5015A...**	 **5058A...**	 **5029A...**	 **5041E...**	 **5995A**

Piezoresistive amplifiers

Laboratory amplifier	Analog amplifier	Digital amplifier
 **4603B...**	 **4618A...**	 **4620A2**

Multi-channel amplifier systems

SCP/Signal Conditioning Platform

Technical data			Type 2853A...	Type 2853A...Y48
Number of slots (with expansion)		–	8 (16)	8 (16)
Max. number of channels "Engines"		–	16 (32)	16 (32)
Supply voltage		VAC/VDC	100 ... 240 (±10 %)	11...36
Max. power output		W	95	80
Degree of protection (EN60529)		IP	40	40
Operating temperature range		°C	0 ... 50	0 ... 50
Weight (without measuring modules)		kg	5,6	5,6
Dimensions	Height	HE	3	3
	Width	TE	84 (19")	84 (19")
	Depth	mm	min. 400	min. 400

Connection
Analog interface card Type 5225A1:
D-Sub 37 pin female

CPU interface card Type 5615
RS232: D-Sub 9 pin female
Digital outputs: D-Sub 15 pin female

Can-Bus: D-Sub 9 pin male

Characteristics
Universal and modular force plate for close to sensor signal conditioning. It is available as desktop/rack versions Type 2853A110/A120 and can be expanded with an additional unit Type 2853A010/A020. The SCP can be remote controlled and its parameters set via a digital interface. The CPU interface Type 5615 and the analog interface Type 5225A1 are contained in the included accessories.

Applications
Application-specific measuring modules are available for "Engines", "Plastics" and "Acceleration".

Accessories
SCP software: Type 7.643.014
Serial interface cable:
Type 1200A27
Blank front panels:
7TE Type 5700A09
5TE Type 5700A17

Data sheet 2854A_000-409

SCP-Compact/Signal Conditioning Platform

Technical data			Type 2854A...
Number of slots		–	4/6
Max. number of channels "Engines"		–	8/12
Supply voltage		VDC	10 ... 36
Max. power output		W	70
Degree of protection (EN60529)		IP	40
Operating temperature range		°C	0 ... 50
Weight (without measuring modules)		kg	3,5
Dimensions	Height	HE	2
	Width	TE	84 (19")
	Depth	mm	min. 400

Connection
Analog interface card (integrated):
D-Sub 37 pin female

CPU interface card (integrated)
RS232: D-Sub 9 pin female
Digital outputs: D-Sub 15 pin female

Can-Bus: D-Sub 9 pin male

Characteristics
Due to the small dimensions and low voltage power supply of 10 ... 36 VDC, SCP-Compact is most suited for in-vehicle testing.

Applications
Application-specific measuring modules are available for "Engines", "Plastics" and "Acceleration".

Accessories
SCP software: Type 7.643.014
Serial interface cable:
Type 1200A27
Blank front panels:
7TE Type 5700A09
Power supply (AC adapter):
Type 5781A1

Data sheet 2854A_000-409

Multi-channel amplifier systems

SCP/charge amplifier

Technical data		Type 5064A1
Number of channels	–	2
Measuring range (without offset)	pC	±100 ... ±50 000
Measuring range (with –8 V offset)	pC	±162 ... ±50 000
Output voltage	V	0 ... ±10, -8 ... +10
Frequency voltage	kHz	≈0 ... >80
Error (0 ... 60 °C)	%	<±0,5
Drift (at 25 °C, DrCo off)	pC/s	<±0,05
Group delay time	µs	<4
Operating temperature range	°C	0 ... 60
Weight	kg	0,41
Dimensions, front panel	mm	128,7x35
Height	HE	3
Width	TE	7

Connection
Signal inputs BNC neg.
Signal inputs BNC neg.

Actuation, supply and signal transfer
64 pin DIN41612

Characteristics
Microprocessor-controlled charge amplifier with digital parameter setting and analog signal conditioning for the SCP. It provides differential inputs with common ground connections and on/off drift compensation, preset low-pass filter and can be remote controlled.

Applications
Signal conditioning with high bandwidth for piezoelectric sensors, e.g. for pressure indication on combustion engines.

Data sheet 2854A_000-409

SCP/charge amplifier with PiezoSmart® sensor identification

Technical data		Type 5064A2
Number of channels	–	2
Measuring range (without offset)	pC	±100 ... ±50 000
Measuring range (with –8 V offset)	pC	±162 ... ±50 000
Output voltage	V	0 ... ±10, –8 ... +10
Frequency range	kHz	≈0 ... >80
Error (0 ... 60 °C)	%	<±0,5
Drift (at 25 °C, DrCo off)	pC/s	<±0,05
Group delay time	µs	<4
Operating temperature range	°C	0 ... 60
Weight	kg	0,42
Dimensions, front panel	mm	128,7x35,0
Height	HE	3
Width	TE	7

Connection
Signal inputs TRIAX
Signal outputs BNC neg.

Actuation, supply and signal transfer
64 pin DIN41612

Characteristics
Microprocessor-controlled charge amplifier with digital parameter setting and analog signal conditioning for the SCP. It provides differential inputs with common ground connections and PiezoSmart automatic sensor identification, on/off drift compensation, low pass filter, remote control.

Applications
Signal conditioning with high bandwidth for piezoelectric sensors with PiezoSmart sensor identification, e.g. for pressure indication on combustion engines. The amplifier can also be operated with sensors without sensor identification.

Accessories
Adapter
BNC neg. – Triax Type 1704A1
10-32 UNF – Triax Type 1704A2
M4x0,35 – Triax Type 1704A3

Data sheet 2854A_000-409

Multi-channel amplifier systems

SCP/piezoresistive amplifier with PiezoSmart® sensor identification

Technical data		Type 4665
Number of channels	–	2
Gain	–	10 ... 250
Additional gain	–	1 ... 10
Output voltage	V	0 ... ±10, –8 ... +10
Frequency range	kHz	≈0 ... >90
Error (0 ... 60 °C)	%	<±0,5
Sensor supply	mA	1 or 4
Operating temperature range	°C	0 ... 60
Weight	kg	0.32
Dimensions, front panel	mm	128,7x35,0
Height	HE	3
Depth	TE	7

Connection
Signal inputs Fischer 5 pin
Signal outputs BNC neg.

Actuation, supply and signal transfer
64 pin DIN41612

Characteristics
Microprocessor-controlled piezoresistive amplifier with digital parameter setting and analog signal conditioning for the SCP. It is provided with PiezoSmart automatic sensor identification, zero point setting at the input, adjustable low-pass filter, remote controlled.

Applications
Signal conditioning for piezoresistive sensors with or without PiezoSmart sensor identification, e.g. for low pressure indication on combustion engines.

Data sheet 2854A_000-409

SCP/amplifier interface

Technical data		Type 5613A1Q01
Number of channels	–	2
Measuring range	V	±10
Gain	–	1
Frequency range	kHz	0 ... >50
Error (0 ... 60 °C)	%	<±0,1
Input resistance	kΩ	>300
Output voltage	V	0 ... ±10
Voltage supply ext. equipment	V	24
Operating temperature range	°C	0 ... 60
Weight	kg	0,16
Dimensions, front panel	mm	128,7x35,0
Height	HE	3
Width	TE	7

Connection
Signal inputs D-Sub 9 pin female
Signal outputs BNC neg.

Actuation, supply and signal transfer
64 pin DIN41612

Characteristics
Microprocessor-controlled amplifier with digital parameter setting and analog signal conditioning for the SCP. It is provided with a voltage supply for external amplifiers and can be remote controlled.

Applications
Signal conditioning for 0 … 10 V signals from external amplifiers such as Type 4618. This allows measuring signals from piezoresistive sensors, e.g. for injection pressure measurements on combustion engines, to be transferred to the SCP.

Data sheet 2854A_000-409

Multi-channel amplifier systems

SCP/voltage amplifier

Technical data		Type 5227A1Q01
Number of channels	–	2
Input voltage range	V	0 ... ±10
Gain (adjustable)	–	10, 5, 2, 1
Frequency range	kHz	0 ... >50
Error (0 ... 60 °C)	%	<±0,5
Input resistance	MΩ	10
Output voltage	V	0 ... ±10
Zero point error	mV	<20
Operating temperature range	°C	0 ... 60
Weight	kg	0,21
Dimensions, front panel	mm	128,7x35,0
Height	HE	3
Width	TE	7

Connection
Signal inputs BNC neg.
Signal outputs BNC neg.

Actuation, supply and signal transfer
64 pin DIN41612

Characteristics
Microprocessor-controlled amplifier with digital parameter setting and analog signal conditioning for the SCP. It is provided with differential inputs with common ground connections.

Applications
For the amplification of any voltage signals, even with different potentials of the signal sources.

Data sheet 2854A_000-409

Single-channel amplifier systems

Labratory charge amplifier

Technical data		Type 5011B...
Measuring range	pC	±10 ... ±999 000
Frequency range	kHz	≈0 ... 200
Output voltage	V	±10
Accuracy (range-dependent)	%	<±3 ... <±0,5
Voltage supply	VAC	115/230
Temperature range	°C	0 ... 50
Weight	kg	2,0
Dimensions	B (mm)	94
	H (mm)	151
	T (mm)	195

Connection
Input/output: BNC neg.

Characteristics
Charge amplifier with LCD display, pushbutton operation and LED status displays; continuously adjustable wide measuring range, time constants "Long", "Medium" and "Short" as well as flexible adjustable low-pass filter; measurement can be controlled via digital input; all functions are optionally remote controllable via serial or parallel interface.

Applications
Measurement of mechanical quantities (pressure, force, acceleration) with piezoelectric sensors.

Options
Drift compensation Y50, power supply 115 V a.c. …Y26, parallel interface IEEE-488 Type 5605A, serial interface RS-232C Type 5611A.

Accessories
Connector for remote control connection: Type 1564
RS-232C cable: Type 1475A3
RS-232C adapter: Type 1469

Data sheet 5011B_000-296

Charge amplifier, digital signal conditioning

Technical data		Type 5015A...
Measuring range	pC	±2 ... ±2 200 000
Frequency range	kHz	≈0 ... 200
Output voltage	V	±10 ... ±2
Accuracy (range-dependent)	%	<±3 ... <±0,5
Voltage supply	VAC	115/230
Temperature range	°C	0 ... 50
Weight	kg	2,3
Dimensions	B (mm)	105,3
	H (mm)	142
	T (mm)	253,2

Connection
Input/output: BNC neg.
Remote control: 6 pin DIN 45322

Characteristics
Charge amplifier with LCD display and menu-guided operation – all important settings are visible at a glance; direct display of measurand as well as maximum, minimum and mean values, LED status displays.

Applications
Measurement of mechanical quantities (pressure, force, acceleration) with piezoelectric sensors. Not recommended for indication measurements on engines!

Options
Voltage input with power supply for Piezotron sensor Type 5015Axxx1.
Parallel interface IEEE-488 Type 5015Ax1xx

Accessories
RS-232C cable: Type 1200A27
D-Sub adapter: Type 1479

Data sheet 5015A_000-297

Single-channel amplifier systems

Charge amplifier on Euro-card

Technical data		Type 5058A...
Measuring range	pC	±10 ... ±1 000 000
Frequency range	kHz	≈0 ... >80
Output voltage	V	±10
Voltage supply	VDC	<±15
Temperature range	°C	0 ... 50
Weight	kg	0,190
Dimensions, form M without partial front panel	(mm)	100x160x20,3

Connection
Input/output: BNC neg.

Characteristics
5 measuring rang.es, positive and negative peak memory, low-pass filter fitted as standard, "Track/Hold" and "Track/Peak" mode switching, manual or external control.

Applications
In industrial measuring technology, particularly for multichannel systems and for fitting in 19" systems.

Options
With manual control.

Accessories
Wire-wrap multi-point connector, M-series 105 form, number of pins 52+2, row a+c

Data sheet 5058A_000-308

In-line charge amplifier

Technical data		Type 5029A...
Measuring range	pC	±100 ... ±2 000
	pC	±100 ... ±5 000
Frequency range	kHz	≈0 ... >20
Output voltage	V	0 ... 5
Voltage supply	VDC	7 ... 32
Temperature range	°C	–10 ... 90
Weight	kg	0,07
Dimensions	D (mm)	18,5
	L (mm)	85,5

Connection
Input: 10-32UNF
Output: M12x1 (8 pin pos.)

Characteristics
2 measuring ranges adjustable with digital potentiometers, no Reset function, drift compensation, in rugged case.

Applications
For continuous operation in rough conditions.

Accessories
Connecting cable:
Types 1700A69, 1700A71, 1787A5

Data sheet 5029A_000-511

Single-channel amplifier systems

Charge amplifier

Technical data		Type 5041E...
Measuring range	pC	±100 ... ±99 900
Frequency range	kHz	≈0 ... 50
Output voltage	V	±10
Voltage supply	VDC	±15 or 24
Temperature range	°C	0 ... 50
Weight	kg	0,160
Dimensions, form M	B (mm)	51
	H (mm)	33
	T (mm)	135

Connection
Input: BNC neg.
Output: terminals

Characteristics
Simple connector mounting, range setting with coding switch. LED for Operate and Overload.

Applications
This charge amplifier is designed for industrial applications and intended for panel mounting.

Accessories
None

Data sheet 5041E_000-305

Handheld charge amplifier

Technical data		Type 5995A
Measuring range	pC	±200 ... ±200 000
Output voltage	V	0 ... ±2
Voltage supply (Battery)	VDC	9
Weight	kg	0,3
Dimensions	B (mm)	80
	H (mm)	172
	T (mm)	35

Connection
Input: BNC neg.

Characteristics
Immediate display and evaluation, handy due to battery supply. Charge amplifier, preload measuring instrument and evaluation in one unit.

Applications
Mobile charge amplifier with display for measurements with piezoelectric sensors. Displays of the instantaneous value of the signal as well as positive and negative peak values. The measuring signal is available at the analog monitor output for further processing (e.g. oscilloscope or data acquisition). Range setting is menu-guided by entering the sensor sensitivity and mechanical measuring range.

Accessories
Couplings: Type 1731A 2 x Ø 4 mm pos. – BNC neg. , Type 1717 TNC pos. – BNC pos., Type 1719 TNC neg. – BNC pos., Type 1721 Microdot 10-32 UNF neg. – BNC pos., Type 1743 2xBNC neg. – BNC pos., Type 1705 M4x0,35 neg. – BNC pos.
Extension cable: Type 1603B... BNC neg. – BNC pos.

Data sheet 5995A_000-312

Single-channel amplifier systems

Piezoresistive amplifier

Technical data		Type 4603B...
Input signals	mV	±100 ... ±1 000
Sensor supply	mA/V	4 / 24
Output voltage	V	±0 ... 1/2/5/10
Output current	mA	0 / 4 ... 20
Frequency range	kHz	0 ... >150
Error (0 ... 50 °C)	%	<±0,4
Supply voltage	VAC	230 /115
Temperature range	°C	0 ... 50
Dimensions	BxHxT (mm)	94x151x195
Weight	kg	≈2

Connection
Fischer D103 A054
Phönix 5 pin
BNC

Characteristics
Scalable voltage output, parallel current output. The voltage output is scalable 1-2-5-10 V, e.g. according to the particular sensor measuring range. An output with load-independent current 0/4 … 20 mA. Is available as well.

Applications
All amplifier functions can be set in dialog form by means of the two-line LCD high-contrast display using 4 buttons: type of supply, calibration current (for current-fed sensors), pressure measuring range, sensor sensitivity, zero offset, zero shift, unit pressure (bar, Pa, psi), low-pass filter, output voltage and current.

Accessories
Calibration plug: Type 4901B...
Interface for retrofitting IEEE-488: Kistler Type 5605A...
Interface for retrofitting RS-232C: Kistler Type 5611A...

Data sheet 4603B_000-291

Piezoresistive amplifier, for onsite operation

Technical data		Type 4618A0	Type 4618A2	Type 4618A4
Input signals	mV	±50 ... ±1 000	±50 ... ±1 000	±50 ... ±1 000
Sensor supply	mA	1,5	1,5	1,5
Output voltage	V	0 ... ±10	0 ... ±10	-
Output current	mA	4 ... 20	–	4 ... 20
Frequency range	kHz	0 ... >40	0 ... >40	0 ... >40
Error (0 ... 60°)	% FSO	±<0,2	±<0,2	±<0,2
Supply voltage	VDC	18 ... 30	18 ... 30	18 ... 30
Temperature range	°C	0 ... 60	0 ... 60	0 ... 60
Dimensions	BxHxT (mm)	98x34x64	98x34x64	98x34x64
Weight	kg	0,250	0,250	0,250
Remarks			Temperature output	Temperature output

Connection
Binder connector

Characteristics
Analog amplifier for piezoresistive sensors with two limit switches (optocouplers).

Applications
Universal measuring amplifier for piezoresistive sensors with constant current supply. Allows simultaneous measurement of pressure and temperature with the standard pressure sensors. Rugged aluminum case, suitable for industrial applications and onsite operation.

Accessories
Power pack: Type 5779A1

Data sheet 4618A_000-293

Single-channel amplifier systems

Piezoresistive amplifier with digital compensation

Technical data		Type 4620A2
Input signals	mV	50 ... 1 000
Sensor supply	mA	1
Output voltage	V	0 ... 10
Output current	mA	4 ... 20
Frequency range	Hz	0 ... >225
Error (0 ... 60°)	%FSO	±0,1
Supply voltage	VDC	18 ... 30
Temperature range	°C	0 ... 60
Dimensions	BxHxT (mm)	150x34x64
Weight	kg	0,390

Connection
Binder connector

Characteristics
Digital compensation for maximum accuracy with third-order polynomial. Outputs for pressure and temperature 4 … 20 mA or 0 … 10 V d.c. External reset (taring) of the zero point.
RS-232 interface for data transfer. 2 pushbutton limit values or 4 configurable digital inputs and outputs.

Applications
The digital amplifier Type 4620 was specially developed for use with piezoresistive pressure sensors with silicon measuring cell. It allows digital compensation of the sensor data and calculates the current pressure and temperature values based on an individually determined, sensor-specific set of coefficients stored in the amplifier EEPROM.

Accessories
Software: Type 4795B...
Power pack: Type 5779A1

Data sheet 4620A_000-199

Signal conditioning units

Insulation tester

Technical data		Type 5493
Measuring range	Ω	10^{11} ... $4x10^{13}$
Measuring voltage	V	5
Max. permissible voltage	V	700
Max. cable length	m	100
Power supply (Battery)	V DC	9
Weight	kg	0,3
Dimensions	B (mm)	80
	H (mm)	172
	T (mm)	35

Connection
Input: BNC neg.

Characteristics
Service unit for measuring the insulation resistance. Logarithmic display, extremely simple to operate, automatic off-switching when not in use.

Applications
Equipment requiring high insulation resistance is checked periodically or before use. The insulation tester Type 5493 has been developed for this purpose. It is designed as a service unit with battery supply and is therefore particularly suitable for routine and field service testing of piezoelectric sensors, charge amplifiers, electrometer amplifiers, cables and also components such as capacitors.

Data sheet 5493_000-354

Engine Peak-Meter

Technical data		Type 2516A1	Type 2516A2
Measuring range	bar	0 ... 250	60 ... 800
Range of engine speed	1/min	25 ... 4 000	25 ... 4 000
Number of pressure cycles (adjustable)	–	1 ... 100	1 ... 100
Number of data memories	–	2	2
Memory capacity per memory	Data record	20	20
Sampling rate per revolution		720	720
Power supply (battery)	VDC	9	9
Weight	kg	0,35	0,35
Dimensions	B (mm)	92	92
	H (mm)	182,5	182,5
	T (mm)	45	45

Connection
Thompson adapter
Signal output BNC neg.
RS-232C: D-Sub connector 9 pin

Characteristics
Handy peak pressure measuring instrument for measuring the cylinder pressure of combustion engines with a speed range up to 4 000 1/min. Immediate on-site data evaluation.
Type 2516A1: Version with Piezotron amplifier Type 7631C
Type 2516A2: Version with charge amplifier Type 6613A

Applications
The 2516A… is a rugged measuring instrument for monitoring engines with speeds up to 4 000 1/min. The data evaluation software contained in the included accessories allows changes in the peak pressure to be visualized and recorded.

Accessories
Power adapter Art. No. 5.510.293
Software for data evaluation Art. No. 7.642.025
RS-232C cable for data transfer Art. No. 5.590.250
Adapter cable Art. No. 5.590.270

Data sheet 2516A_000-553

Signal conditioning units

Plug-in display unit

Technical data		Type DAZ35A...
Input signals	mA	4 ... 20
Display type	LED	red
Display	No. of digits	4
Connection	DIN	43650
Display frequency	Hz	3
Error	%	±<0,2
Temperature range	°C	0 ... 60
Dimensions	BxHxT (mm)	42x52x48
Weight	g	85

Connection
Fischer 103A 054
AMP terminals

Characteristics
Clearly legible 4-digit LED display, no auxiliary energy necessary, display range freely programmable, simple mounting, 90° rotation.
Options: 1 open collector output, intrinsically safe EEx ib IIC T4.

Applications
The plug-in display unit Type DAZ35 is a universal onsite display unit for K-Line and Ceraline-S two-wire pressure transmitters. It can also be used for other measuring transducers with 4 … 20 mA two-wire technique.

Accessories
Power pack: Type 5779A1

Data sheet DAZ35A_000-200

Accessories – Cables

Cables, high-insulation, triboelectrically optimized

Connecting cables					Extension cables				
M3 pos. integrated	M4 pos. 	M4 pos. integrated 	10-32 UNF pos. 	10-32 UNF pos. integrated 	BNC pos. 	TNC pos. 	10-32 UNF neg. 	BNC neg. 	
	1651C...		**1631C...**		**1601B...**	**1609B...** **1610A...**		**1603B...**	BNC pos. 
		1929A... **1983AA...**							M4 pos. integrated 
		1983AB... **1975A...**		**1967A...** **1969A...** **1983AC...**			**1699A0,5**		10-32 UNF pos. integrated 
	1655C...	**1919** **1921**	**1635C...** **1957A...**				**1637C...** **1648**		10-32 UNF pos. 
					1673A...				Fischer neg. KE 103 
1989A...									M3 pos. integrated 

Cables, low-impedance, for piezoresistive sensors

Connecting cables				Extension cable	Sensors	
Type 4603 	**Type 4618** 	**Type 4620** 				
4751A... **4761A...**	**4765A...**					**4043A...** **4045A...** **4053A...**
4753A... **4763A...**	**4767A...**					**4073A...** **4075A...**
		4759A...				**RA...** **(K-Line V95)**
	4790A... **4790A...Q01**	**4790A...** **4790A...Q01**				**RHU50** **RHU56** **RHM16**
	Cable on sensor			**4757A...**		**4065**
	Cable on sensor	**Cable on sensor**		**4757A...**		**4067**

Accessories

Cables

Connecting cable, high-insulation, temperature range –25 … 70 °C

Technical data		Type 1601B...
Connection		BNC pos./BNC pos.
Degree of prot. (EN60529)	IP	40/40
Length	m	0,5/1/2/5/10/20/sp*
Cable material/version		PVC/black
Diameter	mm	3,2
Used for		General use

Extension cable, high-insulation, temperature range –25 … 70 °C

Technical data		Type 1603B...
Connection		BNC neg./BNC pos.
Degree of prot. (EN60529)	IP	40/40
Length	m	2/5/10/20/50/sp*
Cable material/version		PVC/black
Diameter	mm	3,2
Used for		General use

Connecting cable, high-insulation, temperature range –25 … 70 °C

Technical data		Type 1609B...
Connection		TNC pos./BNC pos.
Degree of prot. (EN60529)	IP	65/40
Length	m	2/5/10/20/50/sp*
Cable material/version		PVC/black
Diameter	mm	3,2
Used for		Nipple: 6411, 7411 Sensors: 6229A..., 6203

Connecting cable, high-insulation, high-temperature, temperature range –55 … 200 °C

Technical data		Type 1610A...
Connection		TNC pos./BNC pos.
Degree of prot. (EN60529)	IP	65/40
Length	m	2/5/10/sp*
Cable material/version		PFA/green
Diameter	mm	2
Used for		Nipple: 6411, 7411
		Sensors: 6229A..., 6203

Data sheet 1601B_000-352

sp* = Special length to customer specifications

Accessories

Cables

Connecting cable, high-insulation, high-temperature, temperature range –55 … 200 °C

Technical data		Type 1631C...
Connection		10-32UNF pos./BNC pos.
Degree of prot. (EN60529)	IP	65/40
Length	m	0,5/1/2/3/5/10/20/sp*
Cable material/version		PFA/green
Diameter	mm	2
Used for		Nipple: 6421, 6461, 7421, 7461 Sensors: 6053BB..., 6211, 6213B..., 6515..., 701A, 7001, 7061B..., 6125B..., 6055BB..., 6057A...

Technical data		Type 1635C...
Connection		10-32UNF pos./10-32UNF pos.
Degree of prot. (EN60529)	IP	65/65
Length	m	0,5/1/2/5/10/sp*
Cable material/version		PFA/green
Diameter	mm	2
Used for		Piezoelectric pressure sensors with 10-32UNF neg. connection as 1631C..., when used with socket wrench

Technical data		Type 1651C...
Connection		M4 pos./BNC pos.
Degree of prot. (EN60529)	IP	65/40
Length	m	0,5/1/2/5/10/sp*
Cable material/version		PFA/green
Diameter	mm	2
Used for		Piezoelectric pressure sensors with 10-32UNF neg. connection e.g. for sensors: 601A, 6001, 6005

Technical data		Type 1655C...
Connection		M4 pos./10-32UNF pos.
Degree of prot. (EN60529)	IP	65/65
Length	m	1/2/5/sp*
Cable material/version		PFA/green
Diameter	mm	2
Used for		Piezoelectric pressure sensors with 10-32 UNF neg. connection

Data sheet 1601B_000-352

sp* = Special length to customer specifications

Accessories

Cables

Connecting cable, high-insulation, high-temperature, temperature range –55 … 200 °C

Technical data		Type 1919
Connection		M4 pos. (integrated)/10-32UNF pos.
Degree of prot. (EN60529)	IP	65/65
Length	m	1/sp*
Cable material/version		PFA/with stainless steel braiding
Diameter	mm	2,6
Used for		Piezoelectric pressure sensors with M4 neg. connection e.g. for sensors: 6061B, 6067C...

Technical data		Type 1921
Connection		M4 pos. (integrated)/10-32UNF pos.
Degree of prot. (EN60529)	IP	65/65
Length	m	0,6/sp*
Cable material/version		PFA/green
Diameter	mm	2
Used for		Piezoelectric pressure sensors with M4 neg. connection e.g. for sensors: 6061B, 6067C...

Technical data		Type 1927A...
Connection		M4 pos. (special)/10-32UNF pos. (integrated)
Degree of prot. (EN60529)	IP	65/65
Length	m	1/sp*
Cable material/version		Viton® or metal sheath
Diameter	mm	2,6
Used for		Piezoelectric pressure sensors with 10-32 UNF neg. connection e.g. for sensors: 6117, 6617

Technical data		Type 1929A...
Connection		M4 pos. (integrated)/M4 pos. (integrated)
Degree of prot. (EN60529)	IP	65/65
Length	m	1/sp*
Cable material/version		PFA/with stainless steel braiding
Diameter	mm	2,6
Used for		Piezoelectric pressure sensors with M4 neg. connection e.g. for sensors: 6041A, 6043A...

Data sheet 1601B_000-352

sp* = Special length to customer specifications

Accessories

Cables

Connecting cable, high-insulation, high-temperature, temperature range –55 … 200 °C

Technical data		Type 1957A...
Connection		10-32UNF pos./10-32UNF pos.
Degree of prot. (EN60529)	IP	65/65
Length	m	1/sp*
Cable material/version		PFA/with stainless steel braiding
Diameter	mm	2
Used for		Piezoelectric pressure sensors with 10-32 neg. connection

Technical data		Type 1967A...
Connection		10-32UNF pos. (integrated)/10-32UNF pos. (integrated)
Degree of prot. (EN60529)	IP	65/65
Length	m	1/sp*
Cable material/version		PFA/insulated metal sheath
Diameter	mm	2,6
Used for		Piezoelectric pressure sensors with 10-32 UNF neg. connection, e.g. for sensor: 6125B...

Technical data		Type 1969A...
Connection		10-32UNF pos. (integrated)/10-32UNF pos. (integrated)
Degree of prot. (EN60529)	IP	65/65
Length	m	1/sp*
Cable material/version		PFA/with steel braiding
Diameter	mm	2,6
Used for		Piezoelectric pressure sensors with 10-32 UNF neg. connection, e.g. for sensor: 7061B...

Technical data		Type 1975A...
Connection		M4 pos. (integrated)/10-32UNF pos. (integrated)
Degree of prot. (EN60529)	IP	65/65
Length	m	0,5/1/sp*
Cable material/version		PFA/with steel braiding
Diameter	mm	2,6
Used for		Piezoelectric pressure sensors with M4 neg. connection

Data sheet 1601B_000-352

sp* = Special length to customer specifications

Accessories

Cables

Connecting cable, high-insulation, high-temperature, temperature-range –55 ... 200 °C, oilproof

Technical data		Type 1983AA...
Connection		M4 pos. (integrat.) /M4 pos. (integrat.)
Degree of prot. (EN60529)	IP	67/65
Length	m	0,5/1/1,5/2/sp*
Cable material/version		Viton®/black
Diameter	mm	2
Used for		Piezoelectric pressure sensors with M4 neg. connection e.g. for sensors: 6041A, 6043A..., 6052B...

Technical data		Type 1983AB...
Connection		M4 pos. (integrated) /10-32UNF pos. (integrated)
Degree of prot. (EN60529)	IP	67/65
Length	m	0,5/1/1,5/2/sp*
Cable material/version		Viton®/black
Diameter	mm	2
Used for		Piezoelectric pressure sensors with M4 pos. connection e.g. for sensor: 6061B

Technical data		Type 1983AC...
Connection		10-32UNF pos. (integrated)/10-32UNF pos. (integrated)
Degree of prot. (EN60529)	IP	67/65
Length	m	0,5/1/1,5/2/sp*
Cable material/version		Viton®/black
Diameter	mm	2
Used for		Piezoelectric pressure sensors with 10-32 UNF neg. connection e.g. for sensors: 6125B..., 7061B...

Technical data		Type 1989A...
Connection		M3 pos. (integrated)/ M3 pos. (integrated)
Degree of prot. (EN60529)	IP	65/65
Length	m	1
Cable material/version		Viton®/black
Diameter	mm	2
Used for		Piezoelectric pressure sensors with M3 neg. connection e.g. for sensor: 6056A...

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sp* = Special length to customer specifications

Accessories

Cables

Connecting cable, high-insulation, high-temperature, temperature range –55 ... 200 °C

Technical data		Type 1699A0,5
Connection		10-32UNF pos. (integrated/ 10-32UNF neg.
Degree of prot. (EN60529)	IP	65/65
Length	m	0,5
Cable material/version		PFA/green
Diameter	mm	2
Used for		6215

Connecting cable, high-insulation, high-temperature, temperature range –55 ... 200 °C

Technical data		Type 1673A...
Connection		Fischer KE103 neg./BNC pos.
Degree of prot. (EN60529)	IP	65/40
Length	m	2/5
Cable material/version		PFA green
Diameter	mm	3,2
Used for		Piezoelectric pressure sensors with Fischer SE103 pos. connection e.g. for sensors 7013C, 7613C

Extension cable, high-insulation, high-temperature, temperature range –55 ... 200 °C

Technical data		Type 1637C...
Connection		10-32UNF pos./10-32UNF neg.
Degree of prot. (EN60529)	IP	65/65
Length	m	5
Cable material/version		PFA/green
Diameter	mm	2
Used for		Piezoelectric pressure sensors with 10-32 neg. connection

Extension cable, high-insulation, high-temperature, temperature range 100 ... 350 °C

Technical data		Type 1648
Connection		10-32UNF neg./10-32UNF pos.
Application		in a dry environment
Length	m	1
Cable material/version		Glass fiber braiding
Diameter	mm	3,5
Used for		Piezoelectric pressure sensors with 10-32 neg. connection
Characteristics		high-temperature resistant radiation resistant

Data sheet 1601B_000-352

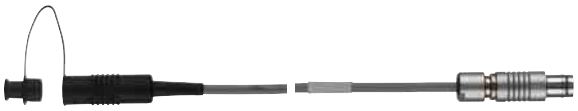
sp* = Special length to customer specifications

Accessories

Cables

Connecting cables, low impedance, temperature range 0 ... <70 °C

Technical data		Type 4751A...
Connection		5 pin/5 pin
Degree of prot. (EN60529)	IP	67/67
Length	m	2/5/10
Cable material/version		PVC/gray
Diameter	mm	3,9
Used for		Connecting cable for 4603B..., with sensors e.g. 4043A..., 4045A..., 4053A...



Technical data		Type 4753A...
Connection		5 pin/4 pin
Degree of prot. (EN60529)	IP	67/67
Length	m	2/5/10
Cable material/version		PVC/gray
Diameter	mm	3,9
Used for		Connecting cable for 4603B..., with sensors e.g. 4073A..., 4075A...

Technical data		Type 4759A...
Connection		4 pin/5 pin
Degree of prot. (EN60529)	IP	67/67
Length	m	2/5/10
Cable material/version		Siliflex®/black
Diameter	mm	5,25
Used for		Connecting cable for K-Line (V95) to amplifier Type 4620A...

Data sheet 1601B_000-352

Accessories

Cables

Connecting cables, low impedance, temperature range –40 ... <85 °C

Technical data		Type 4765B...
Connection		5 pin/5 pin
Degree of prot. (EN60529)	IP	67/67
Length	m	2/5/10
Cable material/version		Viton®/black (to <180 °C)*
Diameter	mm	4,3
Used for		Connecting cable for 4618A... with sensors e.g. 4043A..., 4045A..., 4053A...

Technical data		Type 4767B...
Connection		5 pin/4 pin
Degree of prot. (EN60529)	IP	67/67
Length	m	2/5/10
Cable material/version		Viton®/black (to <180 °C)*
Diameter	mm	4,3
Used for		Connecting cable for 4618A... with sensors e.g. 4073A..., 4075A...

Technical data		Type 4769A...
Connection		8 pin/5 pin
Degree of prot. (EN60529)	IP	67/67
Length	m	5/10
Cable material/version		PVC/gray
Diameter	mm	4,6
Used for		Connecting cable for 4618A... with 4643 for sensors e.g. 4067..., 4065A...

Technical data		Type 4790A...
Connection		6 pin/5 pin
Degree of prot. (EN60529)	IP	67/67
Length	m	2/5/10
Cable material/version		Siliflex®/black (to < 180 °C)*
Diameter	mm	5,25
Used for		Connecting cable for 4618A... and 4626A... RH sensors

Data sheet 1601B_000-352

* This value applies specifically only to the cable

Accessories

Cables

Connecting cables, low impedance, temperature range –40 ... <120 °C

Technical data		Type 4761B...
Connection		5 pin/5 pin
Degree of prot. (EN60529)	IP	67/67
Length	m	2/5/10
Cable material/version		Viton®/black (to <180 °C)*
Diameter	mm	4,3
Used for		Connecting cable for 4603B..., with sensors e.g. 4043A..., 4045A..., 4053A...

Technical data		Type 4763B...
Connection		5 pin/4 pin
Degree of prot. (EN60529)	IP	67/67
Length	m	2/5/10
Cable material/version		Viton®/black (to <180 °C)*
Diameter	mm	4,3
Used for		Connecting cable for 4603B..., with sensors e.g. 4073A..., 4075A...

Technical data		Type 4790A2Q01
Connection		6 pin/5 pin
Degree of prot. (EN60529)	IP	67/67
Length	m	2/5/10
Cable material/version		Siliflex®/black (to < 180 °C)*
Diameter	mm	5,25
Used for		Connecting cable for 4618A... RH sensors

Connecting cables, low impedance, temperature range –40 ... <85 °C

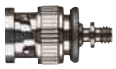
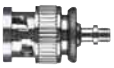
Technical data		Type 4757A...
Connection		5 pin/5 pin
Degree of prot. (EN60529)	IP	67/67
Length	m	2/5/10
Cable material/version		Siliflex®/black
Diameter	mm	5,25
Used for		Extension cable for 4065A..., 4067...

Data sheet 1601B_000-352

* This value applies specifically only to the cable

Accessories – Couplings

Couplings, high-insulation

Connection interface						
BNC neg.	BNC pos.	10-32UNF neg.	10-32UNF pos.	10-32UNF pos. integrated	M4 neg.	
 **1701**						BNC neg.
 **1725**	 **1721**	 **1729A**		10-32UNF pos. integrated 10-32UNF neg.  **1700A29**		10-32UNF neg.
	 **1705**	 **1700A13**	 **1700A31**		 **1700A23**	M4 neg.

Couplings

Coupling, high-insulation

Technical data	Type 1700A13
Connection	10-32UNF neg. M4-neg.

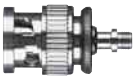
Technical data	Type 1700A23
Connection	M4-neg. M4-neg.

Technical data	Type 1700A29
Connection	10-32UNF pos. (integrated) 10-32UNF neg.

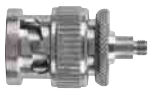
Technical data	Type 1700A31
Connection	10-32UNF pos. M4-neg.

Technical data	Type 1729A
Connection	10-32UNF neg. 10-32UNF neg.

Technical data	Type 1701
Connection	BNC-neg. BNC-neg.



Technical data	Type 1705
Connection	BNC-pos. M4-neg.



Technical data	Type 1706
Connection	BNC-pos. M3-neg.

Technical data	Type 1721
Connection	BNC-pos. 10-32UNF neg.

Technical data	Type 1725
Connection	BNC-neg. 10-32UNF neg.

Data sheet 1601B_000-352

Cable plugs and sockets

Cable plugs, low-impedance

Technical data		Type 1500A81
Connection		5 pin
Protective class (EN60529)	IP	67

Cable sockets, low-impedance

Technical data		Type 1500A57
Connection		8 pin
Protective class (EN60529)	IP	67

Technical data		Type 1500A61
Connection		14 pin
Protective class (EN60529)	IP	67

Technical data		Type 1500A73
Connection		4 pin
Protective class (EN60529)	IP	40

Technical data		Type 1500A75
Connection		4 pin
Protective class (EN60529)	IP	67

Technical data		Type 1500A77
Connection		4 pin
Protective class (EN60529)	IP	40

Technical data		Type 1500A83
Connection		5 pin
Protective class (EN60529)	IP	67

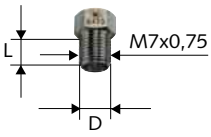
Technical data		Type 1500A87
Connection		6 pin/MIL
Protective class (EN60529)	IP	67

Technical data		Type 1500A89
Connection		4 pin
Protective class (EN60529)	IP	65

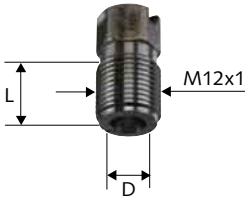
Accessories

Screw-in nipple

Mounting nuts



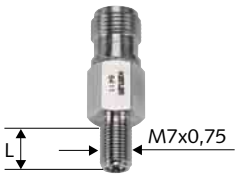
Technical data		Type 6423
Plug		–
Max. temperature	°C	240
Recommended sensors		601A, 601H, 6031
Dimensions	D (mm)	5,15
	L (mm)	6



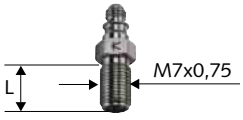
Technical data		Type 7423
Plug		–
Max. temperature	°C	240
Recommended sensors		701A, 701H, 7031
Dimensions	D (mm)	6,5
	L (mm)	12

Connecting nipples, high-insulation

Technical data		Type 6401	Type 6401A20
Plug		BNC	BNC
Max. temperature	°C	240	240
Recommended sensors		601A, 601H, 6031	601A, 601H, 6031
Recommended adapters		6503, 6505	6501
Dimensions	L (mm)	10	20



Technical data		Type 6411	Type 6411A20
Plug		TNC	TNC
Max. temperature	°C	240	240
Recommended sensors		601A, 601H, 6031	601A, 601H, 6031
Recommended adapters		6503, 6505	6503, 6505
Dimensions	L (mm)	10	20



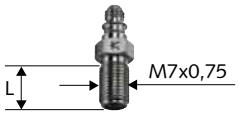
Technical data		Type 6421	Type 6421A5	Type 6421A14
Plug		10-32UNF	10-32UNF	10-32UNF
Max. temperature	°C	240	240	240
Recommended sensors		601A, 601H, 6031	601A, 601H, 6031	603B
Recommended adapters		6503, 6505	6511sp	6503
Dimensions	L (mm)	10	5	14

Data sheet 6401_000-069

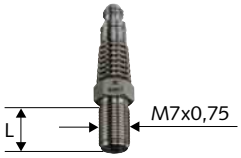
Accessories

Screw-in nipple

Connecting nipples, high-insulation



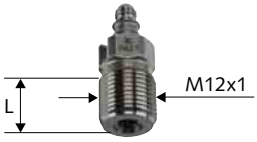
Technical data		Type 6421A20	Type 6421A24
Plug		10-32UNF	10-32UNF
Max. temperature	°C	240	240
Recommended sensors		601A, 601H, 6031	603B
Recommended adapters		637, 642, 644, 6501, 6509	6501
Dimensions	L (mm)	20	24



Technical data		Type 6461	Type 6461A20
Plug		10-32UNF	10-32UNF
Max. temperature	°C	350	350
Recommended sensors		6001	6001
Recommended adapters		6503, 6505, 6507, (6511sp)	6501
Dimensions	L (mm)	10	20

Technical data		Type 7401
Plug		BNC
Max. temperature	°C	240
Recommended sensors		701A, 701H, 7031
Recommended adapters		7501, 7503
Dimensions	L (mm)	12

Technical data		Type 7411
Plug		TNC
Max. temperature	°C	240
Recommended sensors		701A, 701H, 7031
Recommended adapters		7501, 7503
Dimensions	L (mm)	12



Technical data		Type 7421
Plug		10-32UNF
Max. temperature	°C	240
Recommended sensors		701A, 701H, 7031
Recommended adapters		737, 741A, 742, 7501
		7503, 7505, 7507
Dimensions	L (mm)	12

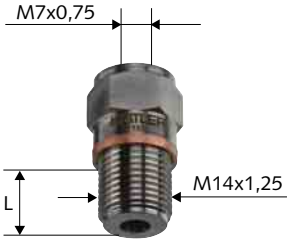
Technical data		Type 7461
Plug		10-32UNF
Max. temperature	°C	350
Recommended sensors		7001
Recommended adapters		7501, 7503
Dimensions	L (mm)	12

Data sheet 6401_000-069

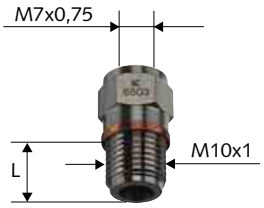
Accessories

Adapters

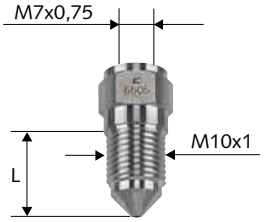
Adapters for piezoelectric and piezoresistive sensors



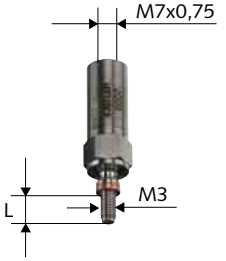
Technical data		Type 4155	Type 6501
Recommended sensors		4065A..	601A, 601H, 6031, 6001, 6005 with nipples 64 ... A20 603B with nipples 6421A24
Dimensions	L (mm)	13	13



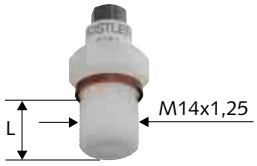
Technical data		Type 6503
Recommended sensors		4065A... 601A, 601H, 6031, 6001, 6005 with nipples 64 ... 603B with nipples 64..A14
Dimensions	L (mm)	8,5



Technical data		Type 6505
Recommended sensors		4065A..., 601A, 601H, 6031, 6001, 6005 with nipples 64.., 603B with nipples 64..A14
Dimensions	L (mm)	14,5



Technical data		Type 6507
Recommended sensors		4065A.., 601A, 601H, 6031, 6001, 6005 with nipples 64.., 603B with nipples 64..A14
Dimensions	L (mm)	5,8



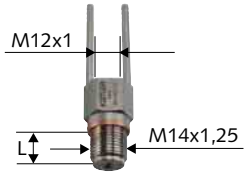
Technical data		Type 6581
Recommended sensors		603B with nipples 6421A24
Remarks		Max. pressure range 10 bar
Material		Delrin®
Dimensions	L (mm)	14

Data sheet 6501_000-070

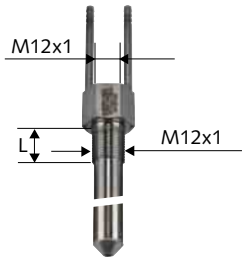
Accessories

Cooling adapters

Adapters for piezoelectric and piezoresistive sensors

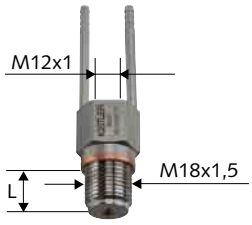


Technical data		Type 6509
Remarks		Water-cooled
Recommended sensors		601A, 601H, 6031, 6001, 6005 with nipples 64..A20 603B with nipples 6421A24
Dimensions	L (mm)	13

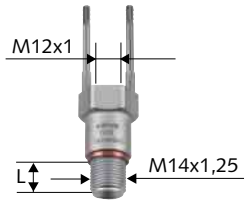


Technical data		Type 6515sp
Remarks		–
Recommended sensors		601A, 601H, 6031, 6001, 6005 with nipples 6421Asp
Dimensions	L (mm)	14

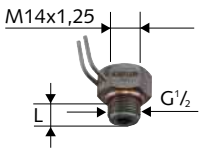
Technical data		Type 6521
Recommended sensors		6125B...
Dimensions	L (mm)	10



Technical data		Type 7505
Remarks		Water-cooled
Recommended sensors		4075 701A, 7031, 7001, 7005 with nipples/74..
Dimensions	L (mm)	16



Technical data		Type 7507
Remarks		Water-cooled
Recommended sensors		4075 701A, 7031, 7001, 7005 with nipples/74..
Dimensions	L (mm)	13



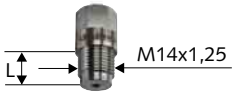
Technical data		Type 7511
Recommended sensors		4045, 4075 in adapters 7501, 7507
Dimensions	L (mm)	12,5

Data sheet 6501_000-070

Accessories

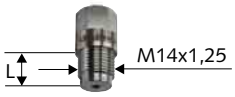
Adapters

Adapters for piezoelectric sensors



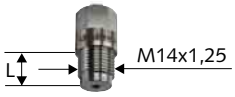
Technical data		Type 6583	Type 6584	Type 6585A
Recommended sensors		6121A1, 6123A1, 6125A10/11, 6127A1	6121A2, 6123A2, 6125A20/21 6127A2	6051, 6052C... 6053CC...
Dimensions	L (mm)	13	13	13

Total length is dependent on type



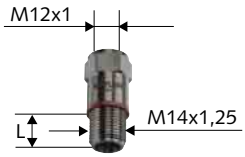
Technical data		Type 6586	Type 6587A	Type 6588A
Recommended sensors		6067B	6117BF..,	6117BC...,
Dimensions	L (mm)	13	13	13

Total length is dependent on type

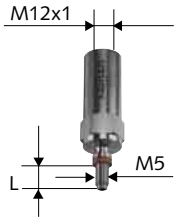


Technical data		Type 6589	Type 6590	Type 6594
Recommended sensors		6041A, 6043A...	6229, 4067A, 6961A	7013C, 7061B...
Dimensions	L (mm)	13	13	13

Total length is dependent on type



Technical data		Type 7501
Recommended sensors		4073, 4075 701A, 7031, 7001, 7005 with nipples/74.. with nipples
Dimensions	L (mm)	13



Technical data		Type 7503
Recommended sensors		4073, 4075 701A, 7031, 7001, 7005 with nipples/74.. with nipples
Dimensions	L (mm)	9

Data sheet 6501_000-070

Accessories

Adapters

Briden adapters for injection lines

Technical data		Type 6533A11	Type 6533A12
Line diameter D	mm/"	6	1/4
Recommended sensors		6229 , 4067A...	6229 , 4067A...

Technical data		Type 6533A18	Type 6533A19
Line diameter D	mm	8	8 ... 13
Recommended sensors		6229, 4067A...	6229 , 4067A...

Technical data		Type 6533A21	Type 6533A22
Line diameter D	mm/"	6	1/4
Recommended sensors		6005, 4065A...	6005, 4065A...

Technical data		Type 6533A28	Type 6533A29
Line diameter D	mm	8	8 ... 13
Recommended sensors		6005, 4065A...	6005, 4065A...

Data sheet 6501_000-070

Accessories

Adapters

Spark plug adapter

Technical data		Type 6517B...
Recommended sensors		6052...
Dimensions	L (mm)	17

Data sheet 6517B_000-491

Glow plug adapter

Technical data		Type 6531Q...	Type 6535Q...
Recommended sensors		601, 6052, 6053	6055, 6057
Pressure range	bar	250	
Thread		M8x1, M10x1	M8x1, M10x1
Length		Customized version	

Data sheet 6531Q_000-075

Technical data		Type 6542Q...
Recommended sensors		6056A...
Pressure range	bar	250
Thread	mm	M8x1, M10x1
Length		Customized version

Data sheet 6542Q_000-570

Technical data		Type 6544Q...
Recommended sensors		6058A...
Pressure range	bar	250
Thread	mm	M8x1, M10x1
Length		Customized version

Data sheet 6542Q_000-570

Mounting sleeve

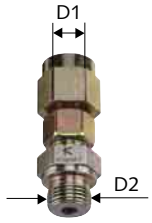
Technical data		Type 6525Asp...
Recommended sensors		6052
Thread	mm	M7x0,75, M8x0,75
Dimensions	L (mm)	50 ... 200 (Customized version)

Data sheet 6501_000-070

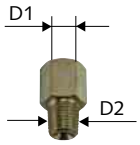
Accessories

Adapters

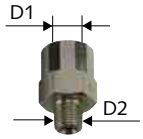
Adapters for piezoresistive pressure transmitters



Technical data		Type 4169A1
Remarks		Adapter with orifice (dia. 0,5 mm)
Recommended sensors		Pressure transmitter: K-Line 428xBE.../438xBE...
Dimensions	D1	G1/2"
	D2	G1/2"

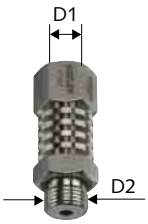


Technical data		Type 4169A2
Recommended sensors		Pressure transmitter: K-Line 428xBE.../438xBE...
Dimensions	D1	G1/4"
	D2	1/4"-18NPT



Technical data		Type 4169A3
Recommended sensors		Pressure transmitter: K-Line 428xBE.../438xBE...
Dimensions	D1	G1/4"
	D2	1/8"-18NPT

Technical data		Type 4173A1
Recommended sensors		Pressure transmitter: K-Line 428xBE.../438xBE...
Dimensions	D1	G1/2"
	D2	1/8"-18NPTF



Technical data		Type 4173A2
Recommended sensors		Pressure transmitter: K-Line 428xBE.../438xBE...
Dimensions	D1	G1/2"
	D2	G1/2"

Technical data		Type 4173A3
Recommended sensors		Pressure transmitter: K-Line 428xBE.../438xBE...
Dimensions	D1	G1/4"
	D2	G1/4"

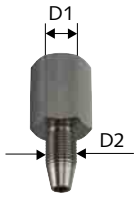
Data sheet 6501_000-070

Accessories

Adapters

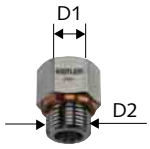
Adapters for piezoresistive pressure transmitters/sensors

Technical data		Type 4173A4
Recommended sensors		Pressure transmitter: K-Line 428xBE.../438xBE...
Dimensions	D1	G1/2"
	D2	G1/2"



Technical data		Type 4173A5
Recommended sensors		RH sensors
Dimensions	D1	1/2-20UNF
	D2	1/2-20UNF

Technical data		Type 4173A6	Type 4173A7
Recommended sensors		Pressure transmitter: K-Line	428xBE.../438xBE...
Dimensions	D1	1/4"-18NPT	G1/2"
	D2	1/2"-20UNF	M16x1,5



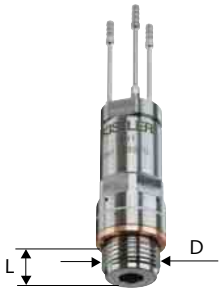
Technical data		Type 7551	Type 7553
Recommended sensors		4043A... / 4045A...	4073A.../4075A...
Dimensions	D1	M14x1,25	M12x1
	D2	G1/2"	G1/2"

Data sheet 6501_000-070

Accessories

Adapters

1/2" switching adapter with integrated water cooling



Technical data		Type 7531
Recommended sensor		4075A...
Measuring pressure	bar	<15
Control air pressure	bar	2 ... 6
Switching delay	ms	≈10
Cooling water flow	l/min	0,5
Length of measuring channel	mm	26
Tightening torque	Nm	25
Dimensions	D (mm)	G1/2"
	L (mm)	12,5
Weight	g	260

Connection
Control line connection (air)
Cooling system connection (induction/exhaust)

Characteristics
Two-way switching adapter with water cooling for cooling piezoresistive pressure sensors in the induction/exhaust systems of combustion engines. Vibration damping is used to prevent signal interference from component vibrations. Ideal for low-pressure indications. Reliable up to exhaust gas temperatures of 1050 °C.

Applications
The pressure sensor is exposed to the hot gases only for the period of the measurement (e.g. 100 cycles) through the use of the cooled two-way switching adapter Type 7531. This is done by actuating a pneumatic valve in the adapter.

Accessories
Viton® hose for cooling water and control air Type 1203Csp
Cooling tube Type 1225A1
Copper seal Type 1107

Data sheet 7531_000-077

M14 switching adapter with integrated water cooling

Technical data		Type 737	Type 741A
Recommended sensors		701A, 7001, 4075A...	701A, 7001
Measuring pressure	bar	<15	<150
Control air pressure	bar	<≈15	<≈15
Switching delay	ms	≈10	≈5
Cooling water flow	l/min.	0,5	0,5
Length of measuring channel	mm	26	26
Weight	g	260	260
Dimensions	D (mm)	M14x1,25	M14x1,25
	L (mm)	13	13

Connection
Control line connection (air)
Cooling system connection (induction/exhaust)

Characteristics
Switching adapters with integrated water cooling are used in engine measurement technology for low-pressure indications in the cylinder and gas exchange channels. A differentiation is made between the two-way switching adapter for switching on the ambient pressure in the induction and exhaust channels (Type 737) and the automatic switching adapter for low-pressure indications in cylinders of slow-running engines (Type 741A).

Applications
Typ 737: The pneumatic two-way switching adapter is used for induction and exhaust channel measurement in a combustion engine for switching on the atmospheric pressure.

Typ 741A: The automatic switching adapter is a pressure limiting valve. It is used for low-pressure indications in cylinders of large slow-running engines. Only the piezoelectric sensor Types 701A and 7001 respectively can be used as pressure sensors.

Accessories
Viton® hose for cooling water and control air Type 1203Csp
Cooling tube Type 1221
Mounting nut for Type 701A or 7001, 7421

Data sheet 737_000-071

Cooling system

Temperature conditioning unit

Technical data		Type 2621E
Cooling water reservoir	l	≈6
Flow rate/sensor	l/min	0,25 ... 0,5
Water pressure	bar	1,7 ±0,2
Thermostat control range	°C	50 ±3
Heating power	W	800
Cooling power (at 35 °C temp.)	W	>2 200
Sensor connections		10
Voltage	V AC	230/115
Power consumption	VA	1 100
Dimensions	B (mm)	200
	H (mm)	759
	T (mm)	696
Weight, total (without cooling water)	kg	≈50

Characteristics
Temperature conditioning unit with closed system for up to 10 water-cooled sensors and adapters. The coolant is stabilized at 50 °C. The special pump pumps the cooling water without pulsation, thereby ensuring stable, precise and reliable measurements even over long periods of time.

Applications
For water-cooled cylinder pressure sensors and exhaust pressure sensors as well as for cooling adapters.

Accessories
Cooling hose: Type 1203Csp

Data sheet 2621E_000-540

Crank angle encoder

Crank angle encoder

Technical data		Type 2613B
TTL crank-angle signal		
Resolution	° KW	0,1 ... 6
Dynamic accuracy at 10 000 rpm		
Signal delay	° KW	+0,02
TTL trigger signal (TRG)		
Resolution	° KW	0,1 ... 6
Speed range	rpm	1 ... 20 000
Operating temperature range		
Sensor and amplifier	°C	–30 ... 60
Flange, crank angle encoder	°C	–30 ... 100
Supply		
With stabilized voltage	V DC	5 ±0,25
Current consumption	mA	200
With unstabilized voltage	V DC	6 ... 24
Current consumption	mA	200 ... 400
Weight (sensor)	g	460
Weight (amplifier)	g	300
Dimensions (amplifier)	mm	98x64x37

Characteristics
The crank angle encoder Type 2613B… provides the basis for all crank angle related measurements. Three TTL square signals can be tapped off at its output: an angle marker signal with adjustable resolution (0,1° … 6°), a crankshaft-synchronized trigger signal and an additional angle marker signal with fixed resolution (1°). The crank angle encoder can be used in conjunction with most engine indicating instruments. Speed range 1 … 20 000 rpm, very rugged and mechanically highly stress-resistant.

Applications
The crank angle encoder can be used in all cases where the angle or volume information from the combustion chamber is needed to calculate the pmi and the combustion process.

Accessories
Remote control unit
Type 2613B5
AVL adapter cable Type 2613B6

Data sheet 2613B_000-366

TDC sensor system

TDC sensor with integrated amplifier and power supply

Technical data		Type 2629B...
TDC sensor		
Principle		Capacitance
Adapter		M10x1, M14x1,25
Adjustment range in longitudinal direction		≈80 mm
Power supply		230/115 Volt ±10 %, 50-60 Hz, 3,2 VA
Connections		Power plug, 4 pin socket for TDC amplifier, BNC socket for TDC signal output
Dimensions	(LxWxH)	125x80x57 mm
Weight	kg	0,5
Amplifier		
Principle		Capacitance-voltage converter
Sensitivity	V/pF	4
Output	V	0 ... 10, short-circuit proof, switchable to charge output
Power supply	VDC	12 ... 15, 50 mA
Max. cable length to TDC power supply	m	10

Characteristics
The TDC system consists of the TDC sensor with integrated amplifier and power supply. It is used for the dynamic measurement of the top dead center (TDC) on piston machines.

The TDC system consists of:
TDC sensor
TDC amplifier
Power supply
Power cord

Applications
The TDC sensor Type 2629B… is used for dynamic TDC measurement when the engine is in unfired mode. It is installed in the engine nozzle holder or spark plug bore.
Accurate measurement of the TDC is a major factor for precise pressure indication on combustion engines.

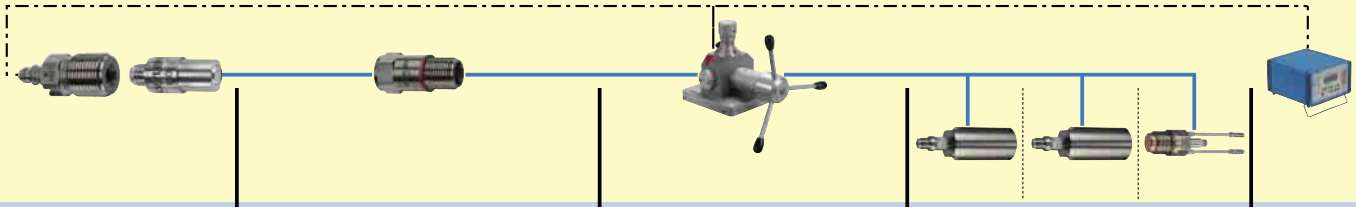
Accessories
Adapters: Types 6592A1 M10x1, 6592A2 M14x1,25, 6592A3 M14x1,25 tapered

Data sheet 2629B_000-541

Calibration

Calibration of piezoelectric sensors (continuous and/or dynamic) up to 500 bar

System configuration

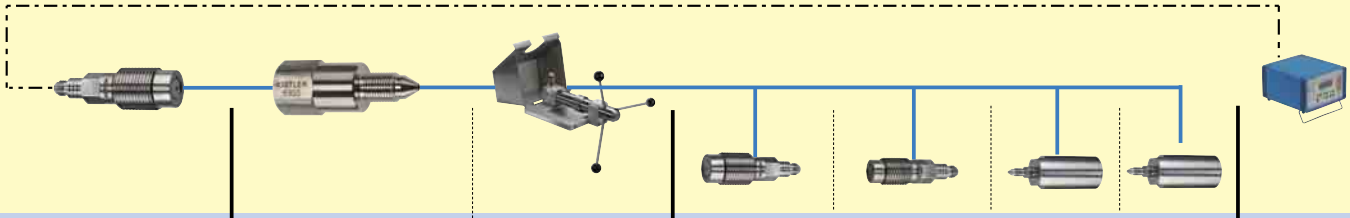


Sensor to be tested	Adapter and connector nut (see accessories)												Pressure generator	Reference sensors			Calibrator
	7501	6501	6583	6584	6585A	6586	6587A	6588A	6589	6591	6593	6594 or without adapter	(continuous and/or dynamic) 6904	(0 ... 250 bar) SCS continuous measurement 6961A250	(0 ... 500 bar) SCS continuous measurement 6961A500	(0 ... 250 bar) SCS continuous & dynamic measurement 7061B...	6907B...
601A		✓											✓	✓		✓	✓
6001		✓											✓	✓		✓	✓
6005		✓											✓		✓[1]	✓	✓
6013C...			✓										✓	✓		✓	✓
6031		✓											✓	✓		✓	✓
6041A...									✓				✓	✓		✓	✓
6043A...									✓				✓	✓		✓	✓
6052C...					✓								✓	✓		✓	✓
6053CC...					✓								✓	✓		✓	✓
6055C...										✓			✓	✓		✓	✓
6057A...										✓			✓	✓		✓	✓
6061B...			✓										✓	✓		✓	✓
6067B...						✓							✓	✓		✓	✓
6115AF											✓		✓	✓		✓	✓
6117BC...								✓					✓	✓		✓	✓
6117BF...							✓						✓	✓		✓	✓
6125B1			✓										✓	✓		✓	✓
6125B2				✓									✓	✓		✓	✓
6517BF...							✓						✓	✓		✓	✓
6517BC...								✓					✓	✓		✓	✓
701A	✓												✓	✓		✓	✓
7005	✓												✓		✓[1]	✓	✓
7013C...												✓	✓	✓		✓	✓
7031	✓												✓	✓		✓	✓
7061B...												✓	✓	✓		✓	✓

✓[1] Calibration possible only in the range up to 500 bar

Calibration of piezoelectric high-pressure sensors <10 000 bar

System configuration

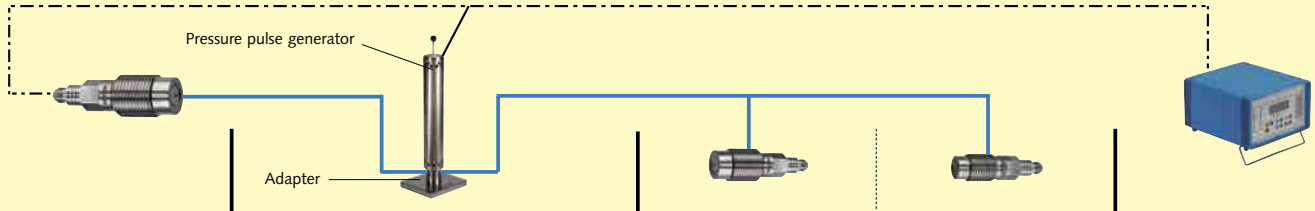


Sensor to be tested	Adapter M10 x 1				Pressure generator	Reference sensors				Calibrator
	6919	6921	6923	6925	(continuous) 6906	(0 ... 8 000 bar) continuous measurement 6213BK + adapter 6923[4]	(0 ... 5 000 bar) continuous measurement 6229AK + adapter 6925[4]	(0 ... 2 000 bar) SCS continuous measurement 6962B2000	(0 ... 8 000 bar) SCS continuous measurement 6963B8000	6907B...
601H (+ conn. nipple 6421)	✓				✓			✓		✓
6203		✓			✓		✓		✓	✓
6211		✓			✓	✓			✓	✓
6213B...			✓		✓	✓[2]			✓[2]	✓
6215				✓	✓	✓			✓	✓
6229AK				✓	✓		✓	✓[3]		✓
6229A...				✓	✓		✓	✓[3]	✓	✓

✓[2] Calibration possible only in the range up to 8 000 bar
✓[3] Calibration possible only in the range up to 2 000 bar
[4] To order the adapter separately

Dynamic function control of piezoelectric sensors up to 5 000 bar

System configuration



Sensor to be tested	Pressure pulse generator with adapter				Reference sensors		Calibrator
	(dynamic/sinusoidal) Pressure pulse generator 6909 + adapter 6931A1	6931A2	6931A3	6931A6	(0 ... 8 000 bar) 6213BK	(0 ... 5 000 bar) 6229AK	6907B...
6203	✓					✓	✓
6211	✓				✓		✓
6215		✓			✓		✓
6213B...			✓		✓		✓
6229		✓				✓	✓
				✓		✓	✓

Pressure generators

Pressure generator for continuous and dynamic pressure measurement

Technical data		Type 6904
Pressure generator	bar	continuous/pulsed
Pressure range, pulse	bar	0 ... 250
Pressure range, continuous	bar	0 ... 700
Mounting thread	mm	2 x M14x1,25
Weight	kg	6
Dimensions	B (mm)	240
	H (mm)	150
	T (mm)	166

Connection
Mounting thread: M14x1,25

Characteristics
Generates continuous pressure curves and pressure pulses. Pressure limiting valve protects against overload and is also suitable for low pressure ranges of 0 … 5 bar.

Applications
Continuous pressure generator for the periodic calibration of quartz and silicon pressure sensors for quality control purposes (e.g. ISO 900xx). Dynamic comparative measurements for checking the dynamic behavior of quartz and silicon pressure sensors.

Accessories
Reference sensor: Types 7061BK, 6961A250, 6961A500
Calibrator: Type 6907B...
Precision charge calibrator: Type 5395A...

Data sheet 6904_000-359

Pressure generator for hydraulic high-pressure <10 000 bar

Technical data		Type 6906
Pressure generator	bar	continuous/stepwise
Pressure range	bar	0 ... 10000
Mounting thread	mm	2 x M10 cone
Weight	kg	15
Dimensions	B (mm)	280
	H (mm)	250
	T (mm)	500

Connection
Mounting thread:
M10 with conical sealing

Characteristics
Continuous pressure rise up to 10 000 bar with swiveling protective hood.

Applications
Continuous as well as stepwise pressure generation for checking or comparative calibration of high-pressure sensors for quality control purposes (e.g. ISO 900x). It is possible to maintain the pressure built-up for a maximum of 5 minutes (e.g. for calibrating a measuring chain).

Accessories
Reference sensor: Types 6213BK, 6229AK
Calibrator: Type 6907B...
Precision charge calibrator: Type 5395A...

Data sheet 6906_000-360

Calibration

Pressure generators

Pressure pulse generator for generating sinusoidal pressure pulses

Technical data		Type 6909
Pressure range, pulse	bar	25 ... 5000
Pulse width	ms	5 ... 10
Mounting bore		see adapter Type 6931A...
Weight	kg	19
Dimensions	B (mm)	190
	H (mm)	≈690 (when retracted)
	T (mm)	220

Connection
Thread adapter for the most common Kistler pressure sensors – see Type 6931A...

Characteristics
Dynamic function test for 25 … 5000 bar, simple to operate, wide pressure range.

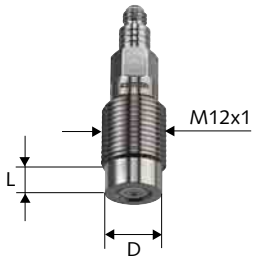
Applications
For generating sinusoidal pressure pulses of 25 … 5000 bar with a pulse width of milliseconds. Along with the calibrator Type 6907B… and a reference sensor, the pressure pulse generator Type 6909 provides a system for dynamic function testing of pressure sensors.

Accessories
Calibrator: Type 6907B1
Reference sensor: Types 6213BK, 7061BK, 6229AK
Sensor adapter: Type 6931A...

Data sheet 6909_000-361

Piezoelectric reference sensors

Piezoelectric reference sensor for pressure generator Types 6906/6909



Technical data		Type 6213BK
Pressure range	bar	10000
Overload	bar	11000
Natural frequency	kHz	150
Linearity	%FSO	≤±0,3
Sensitivity	pC/bar	–1,2
Calibration		Kistler factory calibration
Dimensions	D (mm)	10,5
	L (mm)	5

Connection
10-32 UNF

Characteristics
Front sealing high-pressure sensor for pressure measurements up to 10000 bar. As a result of its excellent measuring characteristics as well as good linearity and long-term stability, it is ideal for use as a reference sensor for calibration systems.

Applications
Ideal for all ballistic measurements and measuring arrangements and as a reference sensor. Despite its extremely wide measuring range, this sensor is ideal for measuring relatively low pressures of a few hundred bar.

Accessories
Seal: Type 1100
Adapter: for pressure generator Types 6905A.../6906
Type 6931A3 for pressure generator Type 6909

Data sheet 6213B_000-042

Piezoelectric reference sensors

Piezoelectric reference sensor for pressure generator Types 6906/6909

Technical data		Type 6229AK
Pressure range	bar	5 000
Overload	bar	6 000
Natural frequency	kHz	200
Linearity	%FSO	≤±0,5
Sensitivity	pC/bar	–2,5
Calibration		Kistler factory calibration
Dimensions	D (mm)	8,5
	L (mm)	4,1

Connection
10-32 UNF

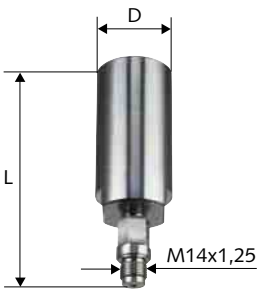
Characteristics
Front sealing high-pressure sensor for pressure measurements up to 5 000 bar. As a result of its excellent measuring characteristics as well as good linearity and long-term stability, it is ideal for use as a reference sensor for calibration systems.

Applications
Pressure measurement on hydraulic high-pressure systems. Despite its extremely wide measuring range, this sensor is ideal for measuring relatively low pressures of a few hundred bar.

Accessories
Seal: Type 100
Adapter: Type 6925 for pressure generator Types 6905A.../6906
Type 6931A3 for pressure generator Type 6909

Data sheet 6229A_000-044

Piezoelectric reference sensor for pressure generator Type 6904



Technical data		Type 6961A250
Pressure range	bar	250
Overload	bar	350
Natural frequency	kHz	1
Linearity	%FSO	≤±0,3
Sensitivity	pC/bar	–80
Calibration		SCS calibration
Dimensions	D (mm)	40
	L (mm)	120

Connection
10-32 UNF

Characteristics
Consists of a pressure sensor (Type 7061BK...), which is permanently fitted and sealed in a particularly rugged calibration adapter. The adapter ensures that the calibration is not affected by the mounting process or temperature fluctuations. It also provides protection against mechanical damage.

Applications
This reference pressure sensor is particularly appropriate as a reference standard in the calibration laboratory. The Type 6961A... reference sensor together with a pressure generator Type 6904 and calibrator Type 6907 constitutes a calibration system for the periodic calibration of piezoelectric pressure sensors for quality control purposes (e.g. ISO 900x).

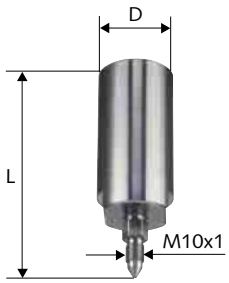
Accessories
Pressure generator: Type 6904
Calibrator: Type 6907

Data sheet 6961A_000-358

Calibration

Piezoelectric reference sensors

Piezoelectric reference sensor for pressure generator Type 6906



Technical data		Type 6962B2000	Type 6963A8000
Pressure range	bar	2 000	8 000
Overload	bar	5 000	10 000
Natural frequency	kHz	1	1
Linearity	%FSO	≤±0,3	±0,3
Sensitivity	pC/bar	–2,5	–1,2
Calibration		SCS calibration	SCS calibration
Dimensions	D (mm)	40	40
	L (mm)	115	115

Connection
10-32 UNF

Characteristics
Consists of a pressure sensor (Type 7061BK…), which is permanently fitted and sealed in a particularly rugged calibration adapter. The adapter ensures that the calibration is not affected by the mounting process or temperature fluctuations. It also provides protection against mechanical damage.

Applications
This reference pressure sensor is particularly appropriate as a reference standard in the calibration laboratory. The reference sensor combined with a pressure generator Type 6906 and calibrator Type 6907 constitutes a calibration system for the periodic calibration of piezoelectric pressure sensors for quality control purposes (e.g. ISO 900x).

Accessories
Pressure generator: Type 6906
Calibration: Type 6907

Data sheet 6961A_000-358

Charge calibrators

Charge calibrator

Technical data		Type 5357B...
Charge range (6 range)	pC	±10 ... 999000
Error (15 ... 35 °C)	%	<±0,5
Error (0 ... 50 °C)	%	<±0,8
Interface		IEEE-488-1978, RS-232C
Power supply (selectable)	VAC	230/115 (48 ... 62 Hz)
Weight	kg	≈2
Dimensions	B (mm)	94
	H (mm)	151
	T (mm)	195

Connection
Charge output:
Version 1: Type BNC neg.
Version 2 ... 5: Type Fischer 5 pin

Characteristics
The charge calibrator can be used to check and calibrate piezoelectric measuring systems. The charge calibrator is connected to the measuring chain either in place of the sensor or in parallel with it. Up to five charge amplifiers can be connected. Operation is via keyboard or optional interfaces. The parameters set appear on the LCD.

Applications
A typical application is the combination of a charge calibrator with 1 to 5 charge amplifiers. The advantages of charge calibration increase the more complex the measuring system is. Two things are thereby achieved: greater measuring accuracy (this applies to the accuracy of the calibrator and not the sum of the accuracies of all instruments in the measuring chain) and a check as to whether or not an instrument in the measuring chain has become maladjusted since the last inspection.

Accessories
Type 1629: Connecting cable for an additional 4 charge amplifier, Fischer 5 pin pos. – 4xBNC pos.

Data sheet 5357B_000-335

Calibration

Charge calibrators

Precision charge calibrator

Technical data		Type 5395A...
Power source (2 ranges)	V	±1, ± 10
Error, voltage range	%rdg + %FSO	<± (0,015 + 0,005)
Charge range (6 ranges)	pC	±100 ... ±2 000 000
Error, voltage range	%rdg + %FSO	<± (0,04 + 0,005)
Input voltage range	V	0 ... ±11,5
Interface		IEEE-488
Power supply (selectable)	VCA	230/115 (48 ... 62 Hz)
Weight	kg	4
Dimensions	B (mm)	236
	H (mm)	151
	T (mm)	255

Connection
Voltage output: BNC neg.
Charge output: BNC neg.
Monitor input: BNC neg.
Monitor output: BNC neg.

Characteristics
This calibrator contains an adjustable precision power source to which are connected reference capacitors and a monitor to measure the output voltage of the item tested. A selection can be made between a continuous signal or charge pulses. The optimized mark-space ratio of the charge pulses reduces the unavoidable errors (dielectric after-effect, LV drift) to a minimum.

Applications
The precision charge calibrator Type 5395A… is used for calibrating charge amplifiers.

Accessories
Type 2835A1-3: PC software for calibrating charge amplifiers and monitors with the precision charge calibrator Type 5395A…

Type 1700A57: Coaxial cable BNC-2 mm for connection Type 5857: (>V3.3) or Type 5859 and Type 5395A...

Type 1700A58: Adapter for sensor input of Type 5852 (from >V3.3) or Type 5859 with Type 5395A...

Data sheet 5395A_000-337

Calibrator

Calibrator for dynamic and quasistatic calibration

Technical data		Type 6907B...
Number of measuring channels		2
Measuring range	pC	±10 ... 999 000
Output voltage	VDC	0 ... ±10
Interface		IEE-488/RS-232C
Temperature range	°C	15 ... 35
Weight	kg	5
Dimensions	B (mm)	213,2
	H (mm)	128,7
	T (mm)	229,5

Connection
Voltage output: BNC neg.
Measuring input: BNC neg.

Characteristics
Universal calibrator for dynamic function testing and quasistatic calibration, high measuring accuracy, powerful software for evaluation and management of calibration data and the production of protocols.

Applications
Portable calibrator for dynamic function testing and quasistatic calibration of pressure sensors.

Accessories
High-pressure generator: Type 6905A
Pressure generator: Type 6904
Pressure pulse generator: Type 6909
Ref. sensors: Types 6213BK, 6229K, 7061BK

Data sheet 6907B_000-382

Calibration system

6-channel calibration manifold for high- and room temperature

Technical data		Type 6935A...	Type 6935A0
Number of sensors	–	6	6
Pressure range	bar	0 ... 250	0 ... 250
Calibration procedure	–	continuous	continuous
Temperature range	°C	20 ... 250	room temperatur
Power supply	VAC	230/115	–
Weight	kg	12	8
Dimensions	B (mm)	280	280
	H (mm)	350	350
	T (mm)	330	180

Connection
Sensor connection: M14x1,25

Characteristics
Multiple calibration ports allow simultaneous calibration of up to six pressure sensors. Heated versions of the manifold are fitted with high performance electric heating cartridges. The accurate temperature control, together with minimised trapped air volumes allow for quick and effective calibration of multiple high temperature pressure sensors, under conditions similar to that applied during Kistler works calibrations.

Applications
Calibration manifold for the calibration of up to 6 pressure sensors over a wide temperature range. Especially suited for the calibration requirements of combustion engine R&D laboratories. The Calibration Manifold Type 6935A… enables customer-site laboratories to calibrate pressure sensors at temperatures that simulate typical operating conditions.

Accessories
Calibration Fluid Type 1055
Blanking Plugs Type Z18553-20
Cu-Be Seal Type Z18553-30
Torque Wrench Type 1300A11

Data sheet 6935A_000-517

Physical Basis of Piezoelectric Pressure Measurement

Piezoelectric effect

Though the piezoelectric effect was discovered in 1880, it remained a mere scientific curiosity until about 1940. The electrical charge developed by certain crystals when subjected to mechanical stress was initially not seen to be of any practical significance. However, the founders of the company, Walter P. Kistler and H.C. Sonderegger, recognized its potential and the challenge posed by its exploitation, the charge signals requiring conversion and amplification before they can be analyzed. By patenting the first charge amplifier for piezoelectric signals in 1950, Kistler opened up the possibility of a practical application for an effect that had been known for decades. Piezoelectric sensors are active electrical devices. In other words, they produce an electrical output signal only when the crystals experience a change in mechanical load. They have excellent dynamic and quasistatic properties but cannot perform truly static measurements.

Piezoelectric sensors based on single crystals

Most Kistler sensors use a quartz crystal as the measuring element. It basically consists of thin sheets or discs of quartz cut from the crystal extremely accurately along the appropriate axis. These elements are sensitive to either compressive or shear stress. There is also a polystable transverse cut for high-temperature pressure sensors (see Figures 1 and 2). The quartz element produces a charge signal directly proportional to the force applied. Quartz sensors are extraordinarily stable, robust and compact, qualities which explain why their use is so widespread in research and development, production and testing. Own growth of the new PiezoStar® crystals since 1998.

Charge and voltage output

Kistler offers piezoelectric sensors with charge or voltage output. The former require a charge amplifier (or an external impedance converter), which converts the charge into a voltage signal. Sensors with a voltage output require an external power unit (coupler), which supplies the electronics in the sensor and decouples the useful signal from the output bias voltage.

Dynamic characteristics of sensors

Piezoelectric sensors can be regarded as underdamped spring-mass systems with a single degree of freedom. At about one fifth of the resonant frequency, the increase in amplitude is about 5 %. It can be attenuated with a low pass filter. Most signal conditioning units (charge amplifiers, couplers) from Kistler therefore have plug-in or switchable low pass filters.

Charge amplifiers

The charge amplifier basically consists of an inverting voltage amplifier with high no-load gain and capacitive negative feedback. A MOSFET or a JFET at the input serves to ensure the necessary high insulation resistance and minimum leakage current.

Time constant and drift

Within a period of time equivalent to one time constant, a voltage will decay to about 37 % of its initial value. The time constant determines the lower cut-off frequency (AC coupling, i.e. high pass filter). Drift is defined as an undesirable change in output signal over a long period of time. The main cause is the unavoidable leakage currents of the MOSFET or JFET, and insufficient input insulation resistance. The drift determines the possible duration of quasistatic measurements and depends on the measuring range chosen. Many Kistler charge amplifiers offer three selectable time constants: Long (used for quasistatic measurement), and Medium and Short, which give AC coupling. In this case, the amplifier acts as a high pass filter and eliminates the effect of the drift on the measurement.

Dual mode charge amplifiers

These amplifiers allow operation of either piezoelectric sensors with charge output or sensors with voltage output. In this case, the amplifier acts as a coupler with adjustable gain.

External impedance converters

Sensors with charge output can also be operated with an external impedance converter. This allows the wide temperature range of the sensor to be combined with the simple and cost-effective signal conditioning of a coupler.

Sensors with voltage output

Kistler launched the first piezoelectric sensor with integrated electronics in 1966. This Piezotron® circuit very quickly became a standard for pressure sensors. It is supplied by a constant current source and provides a voltage signal proportional to the measurand. An ordinary two-conductor cable of almost any length can be used between sensor and coupler. The system is virtually immune to electrical and magnetic interference fields. Piezotron sensors are constrained by a time constant.

Various excellent properties make quartz suitable for use as a measuring element:

- high permissible surface pressure of about 150 N/mm^2
- withstands temperatures up to 500 °C
- very high rigidity, high linearity and negligible hysteresis
- practically constant sensitivity over a wide temperature range
- extremely high insulation resistance (10^{14} Ω) allows measurement of low frequencies (<1 Hz)

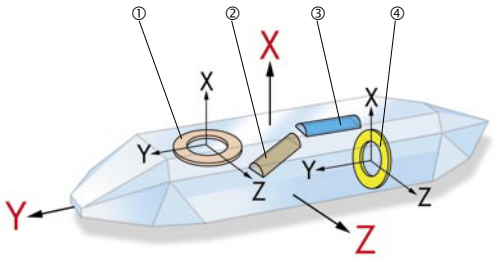


Figure 1
Quartz crystals and possible cuts

① = Cut for longitudinal effect
② = Polystable cut
③ = Cut for transverse effect
④ = Cut for shear effect

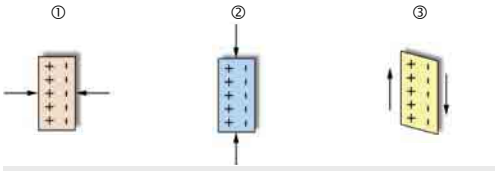


Figure 2
Piezoelectric effects in quartz

① = Longitudinal effect
② = Transverse effect
③ = Shear effect

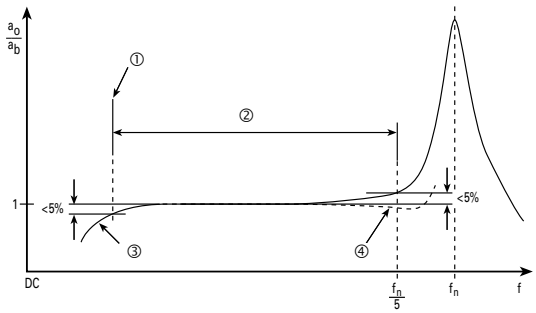


Figure 3
Typical frequency response

① = lower cut-off-frequency, determined by time constant τ = RC
② = useful frequency range
③ = high pass filter
④ = with low pass filter

Physical Basis of Piezoresistive Pressure Measurement

Piezoresistive effect

The term piezoresistive implies that an electrical resistance is changed by pressure. A piezoresistive sensor works by exploiting this effect when a silicon crystal is subjected to mechanical stress. This stress changes the value of the resistors implanted in the silicon. The change is proportional to the pressure and can be measured using a bridge.

Integrated circuit technology allows extremely small resistor networks and active elements to be integrated on the silicon chip, which can be designed to act as a pressure diaphragm as well. The main advantages of this technology over conventional metal strain gages are high sensitivity, compactness and a high natural frequency.

As indicated in the introduction, Kistler's current piezoresistive sensors are highly integrated, with the resistors implanted on the front of the silicon chip. The chip is then etched from behind.

This means the central portion becomes the pressure diaphragm and the edge the mounting surface (Figure 1).

The silicon chip is then anodically bonded to a sheet of glass. This has a reference hole for relative pressure measurements, whereas for absolute pressure measurements a vacuum is produced between the silicon diaphragm and the glass sheet during the bonding process. This design guarantees thermal stability and minimizes hysteresis. The measuring cells are extremely sensitive and ideal for small to medium pressures. More rigid designs (such as the silicon block type) are suitable for high pressures.

Ceramic measuring cells are recommended for applications requiring cost-effective sensor technology and lower measuring accuracy.

Static and dynamic characteristics

Piezoresistive measuring cells made of silicon have excellent static measuring characteristics. Silicon is a single crystal and remains elastic up to its breaking point. It does not undergo any plastic deformation. For this reason, silicon cells are very stable and their properties do not change even over a long period of time. Their dynamic characteristics are also excellent. As a result of their small dimensions, the natural frequency of the silicon cells is very high. Depending on the pressure range (diaphragm thickness), it can be between 15 and 200 kHz.

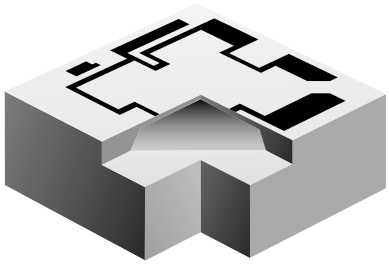
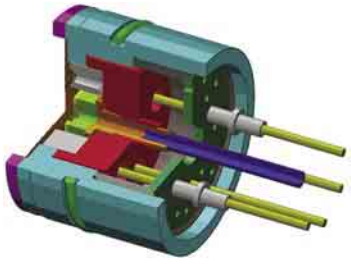


Figure 1
Silicon chip with diffused resistors



Silicon chip with pressure transmitted by an oil cushion

Signal conditioning

The actual measuring signal produced by piezoresistive pressure sensors is a voltage output from Wheatstone bridge resistors. The low-noise voltage amplifiers used for signal conditioning also include a constant current, low voltage power supply to energize the pressure sensor. To achieve maximum overall accuracy, the typical configuration is a complete measuring system, consisting of a pressure sensor with a sensor-tuned amplifier.

To offset measuring errors due to temperature, some piezoresistive amplifiers are supplied with so-called "digital compensation". To this end, the sensor is measured at various temperatures and pressures and the resulting error matrix is approximated by means of a polynomial and registered in the amplifier. This permits continuous and automatic correction of the measured pressure and a further improvement in overall precision.

The Wheatstone bridge resistances can be used simultaneously to determine the temperature of the measuring element. Thus, certain piezoresistive amplifiers offer the option of an additional temperature output to be used in measuring the temperature of the medium.

Main advantages of piezoresistive sensors with silicon construction:

- long service life under alternating stresses
- excellent stability
- high measurement reproducibility
- compactness
- resistant to impact and vibration
- high output voltage
- high natural frequency
- good linearity

With these high performance properties, piezoresistive sensors can be used for a wide range of applications.

4620A
Piezoresistive amplifier with digital compensation

4618A...
Piezoresistive amplifier for on-the-spot operation

Calibration

The alpha and omega of quality assurance

ISO quality management systems have become so widely established that measuring and test equipment needs to be traceably calibrated to international standards.

ISO quality management systems require compliance with and documentation of the following points:

- Choice of suitable measuring and test equipment (as accurate as necessary rather than as accurate as possible)
- Definition, implementation and recording of regular maintenance
- Periodic recalibration
- Ensuring conformity (traceable calibration of measuring system to international standards)

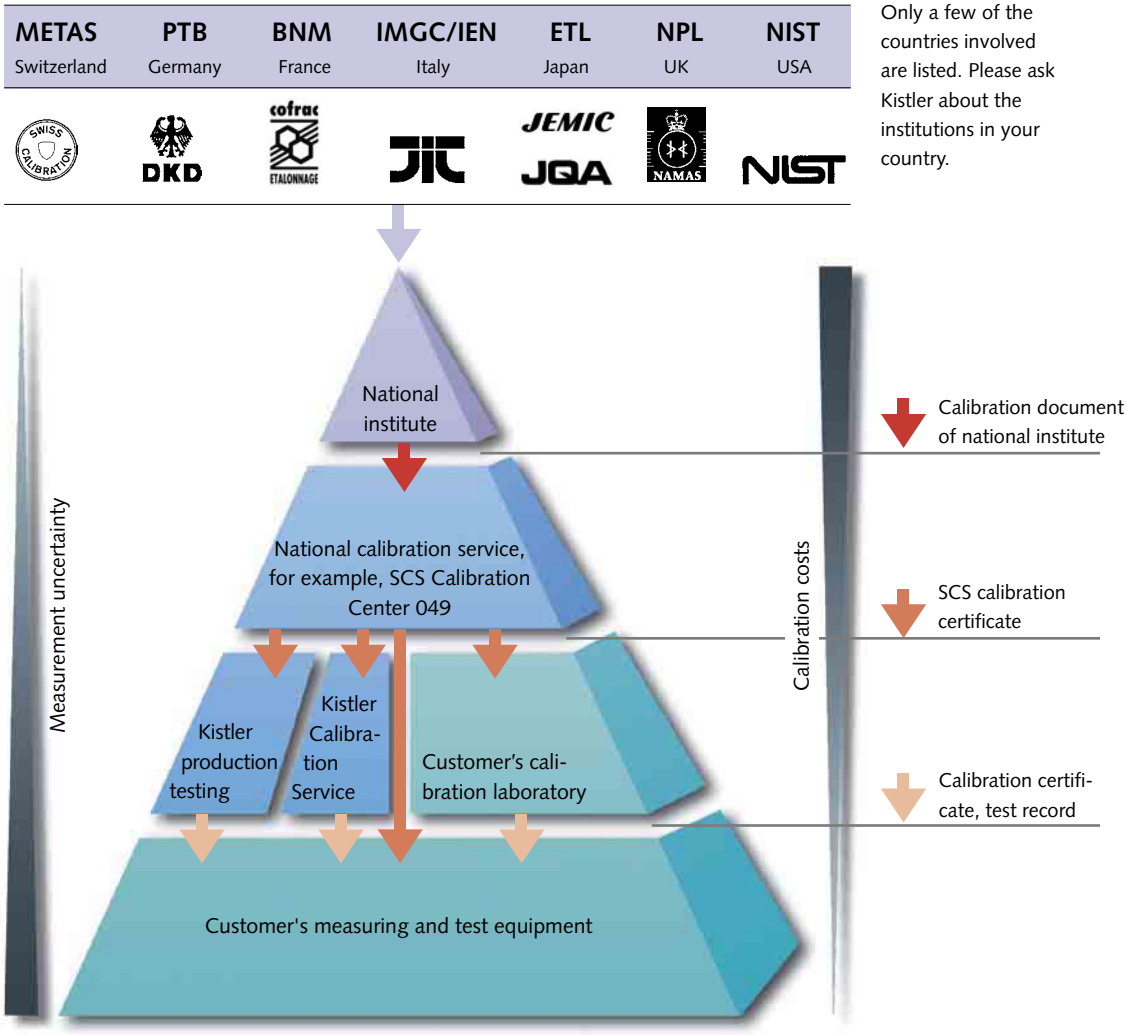
Calibration centers

The national calibration centers are organized on a hierarchical basis. At the top are the primary laboratories, that is to say the national institutes responsible for implementing, keeping and making available the SI units in accordance with ISO 31 and 1000.

Many countries have now affiliated a calibration service to these laboratories. This monitors all of the calibration centers accredited to EN 45000 and is authorized to issue internationally recognized calibration certificates.

Numerous companies have their own calibration centers with reference standards traceable to national standards. For example, several Kistler Group companies operate such centers in order to minimize downtime for the customer. At the bottom of the hierarchy is the customer's measuring and test equipment.

The measurement uncertainty approximately quadruples with each level lower down the hierarchy. However, costs are also drastically reduced. It is necessary, therefore, to strike a careful balance between unnecessary costs and an acceptable level of measurement uncertainty.



Only a few of the countries involved are listed. Please ask Kistler about the institutions in your country.

Calibration services from Kistler

In Switzerland, Kistler is accredited as a calibration centre for pressure, force, acceleration and electrical charge measurands. Our calibration facilities and methods are regularly checked and audited.

Recalibration
Our products can be recalibrated or tested at any time. All records are kept and made available to our customers. This allows complete traceability of calibration and repairs.

Calibration service
We offer an on-site calibration service for equipment that cannot be transported or for cases where downtime has to be minimized.

Sensor quality and calibration

All of our products are manufactured to ISO 9001:2001/EN ISO 13485: 2000 and MIL-I-45208A. Testing, calibration and data acquisition are all computer-assisted and state of the art. Our calibration system conforms to MIL-STD-45662A, ANSI/NCSL Z540 and ISO/IE 17025/SN EN 45001.

Our calibrations can be traced through three different national institutes. On the other hand, many leading test laboratories and national calibration laboratories use Kistler products as primary standards.

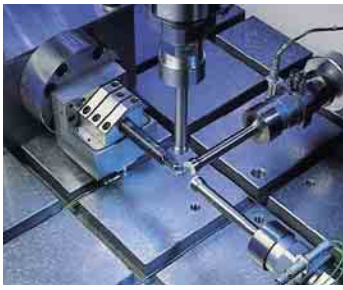
Kistler calibration methods

Pressure sensors
The sensor under test and the reference sensor are subjected to the same pressure regime and compared in parallel. Calibration pressures are increased incrementally (in the case of piston-type pressure gauge standards) or continuously (piezoelectric standards). Additional factory calibrations are performed in accordance with the requirements for the sensor and under certain ambient conditions, such as high temperatures.

Force sensors
The force for calibrating the sensor is produced with a hydraulic press. Our factory force standard is traceably calibrated against a national standard.

Accelerometers
The instruments are calibrated with sinusoidal excitation produced by an electrodynamic vibration exciter. This involves mounting the accelerometer directly on the working standard, a back-to-back method that guarantees minimum measuring errors.

SCS calibration



Recalibration

Calibration service

Products for calibration laboratories

Glossary

Absolute pressure
Pressure measured with respect to a vacuum.

Acceleration sensitivity
Undesirable signal from the sensor caused by acceleration. Units: bar/g.

ATEX
Explosion Protection Directive.

Bursting pressure
Pressure at which the sensor or the measuring element is damaged.

Change in sensitivity (Temperature Coefficient of Sensitivity, TCS)
The percentage change in sensitivity that must be taken into account when there are changes in temperature at the installation site. The individual change in sensitivity is shown on the calibration sheet.

Charge amplifier
Part of a measuring system that amplifies the sensor signal and converts the charge into a proportional voltage signal.

Charge meter
Charge amplifier with measurement display.

Coulomb
Symbol: C. Unit of electrical charge. 1 coulomb corresponds to 1 ampere second (1 C = 1 As).

Coupler
Electronic unit that supplies constant current excitation to sensors with voltage output and decouples the measurement signal from the subsequent output bias voltage.

Degree of protection
Protection of electrical equipment with suitable enclosures, covers, etc, to EN 60529. The degree of protection is indicated with IP (international protection) followed by two digits. The first of these stands for the degree of protection against contact and penetration.

Dual mode charge amplifier
Charge amplifier with additional input for sensors with voltage output.

Dynamic pressure measurement
Measurement of constantly changing pressures, such as those in the cylinder of an engine.

FSO
Full Scale Output. Difference in output signal between the zero and upper limit of the measuring range.

Full scale output (FSO)
Calibrated measuring range of the sensor, also called FS.

High pressure indication
Measurement of the pressure in the cylinder of an engine, typically performed with piezoelectric sensors.

Hysteresis
The maximum difference in output signal at any measurand value within the range of a sensor when the value is reached first with increasing and then decreasing measurand.

Linearity
The closeness of a calibration curve to a specified straight line. The "best straight line through zero" is often used. This is defined as the median line between two parallels that are as close together as possible but enclose the entire calibration curve. In addition, the median parallel must pass through zero (measurand zero, output signal zero). The slope of this median parallel is the sensitivity of the sensor. The linearity (maximum positive or negative deviation of the calibration curve from the best straight line) is expressed as a percentage of full scale output (FSO).

Low pass filter
An electronic circuit that transmits signals up to certain upper cut-off frequency. Plug-in types are available for Kistler charge amplifiers, couplers and power supplies.

Measuring system
Several individual components interconnected for measurement purposes. A measuring system usually consists of sensors, amplifiers, indicator and analysis units, and a recording device such as a printer.

Measurement uncertainty
This is an indication of the anticipated maximum deviation of a measurement from the actual (physical) value.

Natural frequency
The frequency of free (not forced) oscillation of the entire sensor. In practice, the generally lower natural frequency of the entire mounting determines the frequency response.

Operating temperature
Range of ambient temperatures in which the sensor should be operated. The specified, temperature-dependent tolerances only apply within this range. Higher temperatures can result in irreparable damage to the sensor.

Output bias voltage
DC output voltage of a sensor with voltage output supplied with constant current when the measurand is zero.

Overload
Levels above the measuring range, within which the sensor can be loaded without suffering damage. It is a safety reserve rather than an extended measuring range. The specified measurement tolerances only apply in the measuring range and are no longer guaranteed in the overload range.

Piezoelectric
Property of quartz crystals that causes them to develop a proportional electrical charge under mechanical stress.

Piezoelectric sensor
Sensor with a measuring element made of a piezoelectric material that yields an electrical charge under mechanical stresses.

Piezoresistive
Property of resistors that causes change in the resistance of a Wheatstone bridge proportionally under tensile and compressive mechanical stress.

Piezoresistive sensor
Sensor with a measuring element made of a Wheatstone bridge that changes the resistance proportionally under mechanical stress.

PiezoSmart®
Sensor identification system developed by Kistler and based on IEEE 1451.4.

Piezotron®
Patented Kistler sensors with built-in miniature impedance converter.

Relative pressure
The difference between an absolute pressure and the particular atmospheric pressure.

Resonant frequency
The measurand frequency at which a sensor responds with maximum output signal amplitude.

Rise time
The length of time needed for the output signal of a sensor to rise from 10 to 90% of its final value as a result of a step change in the measurand.

SCP
Signal conditioning platform; unit for conditioning measurement signals.

Sensitivity
Nominal value or calibrated value specified on the calibration certificate of the ratio of the change in sensor output signal to a change in the value of the measurand.

Static pressure
Permanent pressure that does not change or only varies slightly (atmospheric pressure, for example).

TEDS
Transducer (sensor) Electronic Data Sheet. Characteristic data is stored digitally in the sensor in conformity with IEEE 1451.4.

Thermal shock
Thermal shock, also called short-term drift, is a short term measuring error arising periodically with each combustion stroke. It is caused by thermal stresses in the sensor diaphragm induced by hot combustion gases, which can reach temperatures of 2 000 (to 3 000) °C for a few milliseconds.

Threshold
The smallest change in the measurand that will result in a measurable change in sensor signal. In practice, it is possible to apply the rule of thumb that the threshold is about twice to three times as large as the typical noise signal of an amplifier.

ZMO
(zero measurement output) value of offset for unloaded sensor.

Kistler – Made to Measure Service

The selection of services from Kistler is as comprehensive as the range of products

We support our customers with a whole series of services to enable them to get the best possible results with our products.

Technical advice

Experienced specialists for all applications are available to support our customers with functional expertise. Kistler's consulting services focus on identifying and defining the measurement problem, developing a solution and selecting the right measuring system, as well as installation planning.

Repair service

Our experts work around the clock to minimize machine and production line downtime in the event of a measuring system failure.

Calibration

We offer our customers a calibration service for periodic checking of measuring accuracy. We fully document and archive details of what sensor was calibrated when. We also support calibration laboratories with a series of calibration instruments.

Information

To keep our customers up to date, we disseminate the latest technical expertise at exhibitions, conferences, symposia, website and customer seminars.

We also offer our customers a wealth of information in hardcopy and electronic form, including data sheets, brochures, catalogs, reprints, instruction manuals and application descriptions.

Training

We hold regular seminars for our customers on special topics of interest. Our engineers are comprehensively trained in our own training center to ensure that they are abreast of the latest developments.

Experienced specialists are available to support our customers.

Our efficient repair service keeps downtime to a minimum.

For maximum accuracy, Kistler measuring systems should be periodically recalibrated.

A high proportion of our products is available ex-stock.

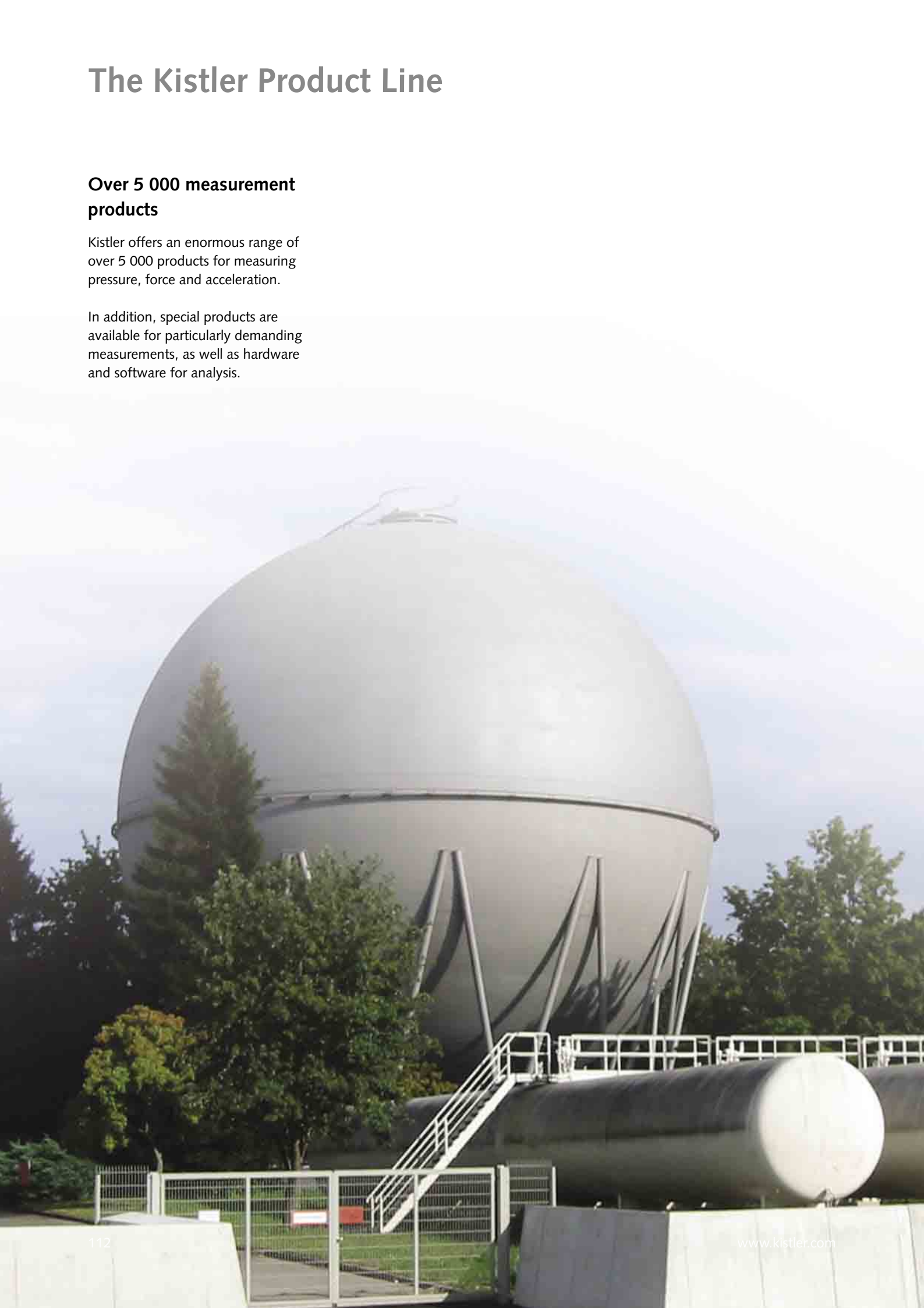
Our engineers are always abreast of the latest developments.

The Kistler Product Line

Over 5 000 measurement products

Kistler offers an enormous range of over 5 000 products for measuring pressure, force and acceleration.

In addition, special products are available for particularly demanding measurements, as well as hardware and software for analysis.



Pressure

In addition to manufacturing the sensors and systems for measuring all types of pressure presented in this catalog, Kistler is active in three other product areas.

Force

Kistler has been developing and producing force sensors for almost 50 years. These are used for the dynamic and quasi-static measurement of forces ranging from minute to enormous. Kistler force sensors are particularly effective where precise results are required under extreme conditions.

Acceleration

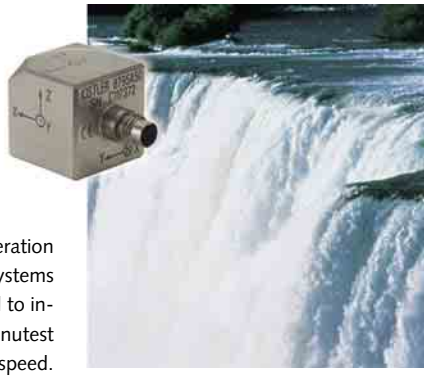
Kistler accelerometers cover the entire spectrum from static through to high-frequency acceleration. To name but a few, their applications include vehicle suspension systems, aircraft wings and railroad trucks.

Electronics & Software

Kistler high-precision electronics and sophisticated software serve to store, condition and analyze sensor signals, revealing even the smallest changes in pressure, force or acceleration. The level of analysis achieved is ideal for use in controlling processes of all kinds.

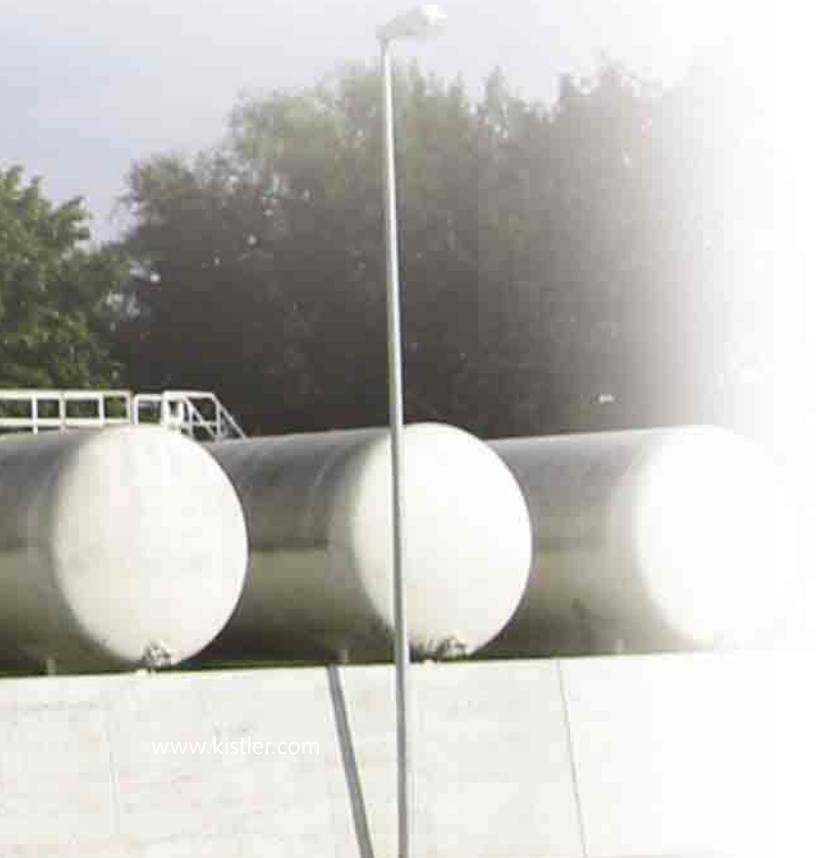
Kistler piezoelectric and piezoresistive sensors are capable of measuring almost every type of pressure.

Kistler measuring systems serve to acquire forces, torques or strains.



Kistler acceleration measuring systems can be used to indicate the minutest changes in speed.

Kistler electronics and software permit measurement-based control and regulation of processes.



Kistler – Applications

On land, on the sea and in the air, Kistler measuring instruments are conquring new data challenges every day.

Combustion engines

Engine developers are forever striving to achieve the impossible combination of maximum efficiency and minimum emissions. Kistler measuring instrumentation provides them with invaluable information to optimize engine operation.

Vehicles

Kistler sensors serve not only to make automobiles safer and more comfortable but also help to cut the costs of road maintenance. They are used to measure an extremely wide variety of forces in chassis, bodywork, wheels and road surface.

Manufacturing

Constant monitoring makes volume production more cost-effective without sacrificing quality. The necessary processes have to be determined and optimized in a series of trials. Kistler supplies the measuring technology for both applications.
Process controllers operate from sensors to maximize uniformity thus increasing yield.

Machinery and equipment

Kistler pressure sensors, force sensors and accelerometers are to be found in countless machines and items of electrical equipment for industrial applications. They support the control and regulation of a wide variety of processes.

Plastics processing

The quality of the processing involved in the manufacture of plastic components can be enhanced by pressure sensors and control technology from Kistler. While maintaining the same high production quality, rejection rates and start-up losses are cut while the bottom line is improved.

Biomechanics

Gait can measured extremely accurately on Kistler force plates. The results help doctors to achieve an even better understanding of the underlying mechanisms and to reduce physical loads. Technique monitoring guides athletic performance development.

Acceleration

Kistler accelerometers can perform even the most demanding measurements. Miniaturized sensors add little mass yet generate signals that allow meaningful measurements. These highly sensitive devices measure movements with small amplitudes and frequencies down to 0 Hz.

Making combustion engines more efficient and easier on the environment.

Making automobiles safer and more comfortable.

Making mass production more cost-effective.

Making industrial processes more precisely controllable.

Improving the quality of plastic parts.

Enhancing athletic performance.

Making rail travel more comfortable.

Kistler in brief

Kistler Instrumente AG ranks as a world leader in measuring instrumentation. Sensors from Kistler measure pressure, forces and acceleration using piezoelectric, piezoresistive or capacitive methods.

Our mission

Kistler's top priority is to satisfy the needs and requirements of our customers. This includes developing leading-edge products and advising customers how to get the best possible results from their applications.

Our philosophy

Our success continues to be based on innovative technologies, precise knowledge of the market and a comprehensive range of services.

measure. analyze. innovate.

Our slogan is also our range:

measure.
Our core strength lies in accurately measuring physical quantities with sensors under the most adverse conditions.

analyze.
We develop electronics and software for measuring, processing and analyzing measurement signals.

innovate.
We are entirely focused on ensuring that our customers are always able to bring innovation into the market.

Successful research

At Kistler, innovation is not left to chance: it is the natural outcome of intensive research and development. This explains the company's ability to develop revolutionary ideas time and again such as the world's first commercial quartz sensor or the first high temperature (350 °C) pressure sensor, based on our polystable quartz cut or the first 3-component force sensor or automatic sensor identification. And so on, and so on. Kistler's ongoing achievements will always be a talking point!

Comprehensive service

The services available from Kistler include technical advice for all applications, calibration, repairs and regular in-service technical training.

Kistler today

Kistler Instrumente AG is one of the leading providers of measuring instrumentation. 17% of our worldwide workforce of over 700 is involved in research and development. With 18 Group companies and more than 30 distributors throughout the world, we are always within easy reach of our customers.

www.kistler.com

Our history

1955
Kistler Instruments begins operations in western New York State in the design, development and manufacture of quartz instrumentation.

1957
Kistler Instruments established in Winterthur, Switzerland.

1958
First miniature quartz pressure sensor, a device which is to set the standard for pressure measurement.

1959
Kistler Instruments becomes Kistler Instrumente AG.

1963
Establishment of a German group company in Ostfildern near Stuttgart.

1965
Kistler introduces the world's first quartz force sensor.

1966
Kistler moves into its new Winterthur-Wülflingen premises; establishment of a group company in England.

1968
Kistler introduces another world innovation: force sensors capable of measuring all three components of a force and their exact direction.

1973
Kistler launches the first sensors based on the piezoresistive principle.

1974
Introduction of quartz sensor for temperatures above 350 °C.

1980
Kistler announces another world first: the quartz strain sensor, an instrument that, even today, offers unrivalled sensitivity.

1983
Introduction of Kistler's unique quartz wheel force dynamometer.

1986
Establishment of a Japanese group company.

1987
Launch of a new generation of ultra-light, super-sensitive accelerometers.

1989
Another world first from Kistler – a high temperature sensor with a diameter of only 5 mm for use in combustion engine measurements.

1993 to 1996
Founding of group companies in France, Italy and Singapore.

1998
Kistler begins with its own growth of the PiezoStar® crystals.

1999
Setting up of a group company in Korea.

2002
Kistler takes over all of the activities of IgeL GmbH.

2003
Kistler takes over all of the activities of Velos Messsysteme GmbH. Establishment of a group company for Scandinavia. Delivery of the first PiezoSmart sensors with automatic sensor identification for combustion engine measurements.

Paramount research objective: ultra-modern, market- and customer-oriented solutions.

Innovative solutions developed in close conjunction with users.

Quartz sensors one of the many world firsts from Kistler.

Kistler at home in over 50 countries.

Kistler Instrumente AG, Winterthur, Switzerland

Kistler Instrument Corp., Amherst, NY, USA

Technical Literature

Reprints and application brochures

Engines

Inertia Compensated Force and Pressure 920-221

New Methods of Low Pressure Indication for Optimizing Gas Exchange in Directly Injected Multivalve Engines 20.189

Low Pressure Indication – Optimization of Gas Exchange Through Suitable Combination of Pressure Indication, Analysis and Simulation 920-246

Higher Precision in Measurement – the Key to Optimum Engine Performance 65.201

Innovation, Precision and Quality – the Engines of the Future 65.204

Optimization of gas exchange by a suitable Combination of Pressure Indicating, Analysis and Simulation 920-246

Pressure Indication with Measuring Spark Plugs on a DI Petrol Engine – State of the Art 920-333

Pressure – General

Kistler Sensor and Transmitter Solution in Oil and Gas Exploration 400-304

Pressure Transmitters for High-End Applications 400-311

Fundamentals

Piezoelectric Measurement and its Applications 20.116

Measuring with Crystals (book; publisher: Moderne Industrie, ISBN 3-478-93269-6) 900-335

Combustion Engine Measurements (book; publisher: Vogel Buchverlag, ISBN 3-8023-1553-7) 900-334

PiezoStar® Crystals – A New Dimension in Sensor Technology 920-240

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Artist's impression of
International Space Station
ESA – D. Ducros

Product index

(in order of type numbers)

* See Plastics Catalogue 500-510

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measure. analyze. innovate.