



KISTLER

measure. analyze. innovate.

Pressure Sensors for Test and Measurement

**For Precise Pressure
Measurement in
Static and Dynamic
Applications**



Piezoelectric Pressure



Quartz and PiezoStar® crystals are the heart of Kistler piezoelectric dynamic pressure sensors. Their characteristics of long-term stability, high rigidity and strength, wide measuring ranges and extended temperature range make them the ideal sensing element for dynamic pressure sensors. PiezoStar® is a Kistler proprietary Piezoelectric crystal which has higher sensitivity and operating temperature range compared to quartz. Pressure measurements with ranges up to 150,000 psi, temperature up to 660 °F, rise times of 1 µsec, and resonant frequencies up to 500 kHz are all possible with Kistler piezoelectric pressure sensors. There are two types of piezoelectric pressure sensors: 1) Charge mode with output in pico-Coulomb (pC) per mechanical unit (MU) and 2) Integrated Electronics Piezo Electric (IEPE) with output in mV per MU.

Piezoelectric pressure sensors are tailored for a particular application by using a specific housing and diaphragm type together with a suitable technique for preloading the sensing elements. This packaging technique distributes the load from the sensor's diaphragm to

the preloaded element and ultimately determines its measuring range. While these pressure sensors are ideally suited for measuring dynamic events, they cannot perform truly static measurements. Although the electrical charge delivered under a static load can be recorded, it cannot be measured for an indefinite period of time. This is sometimes referred to as, "quasi-static."

Piezoelectric pressure sensors are also referred to as "gage" or "relative" because they produce an output only when they sense a change in pressure. Since most measurements originate at atmospheric pressures, this point is often referred to as "zero" pressure when using piezoelectric systems. Other types of pressure measurements are absolute and differential. Absolute pressure measurements are made with respect to vacuum, while differential pressure is measured between two different points. Piezoresistive pressure sensors (sometimes referred to as PRT sensors) can measure both static and dynamic events in all three modes mentioned above (relative, absolute and differential). See the information below.

Piezoresistive Pressure



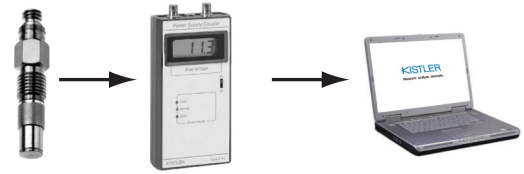
Piezoresistive pressure (PRT) sensors are based upon proven Kistler piezoresistive sensing technology that has been continually developed and refined since the early 1970's. A silicon sensing element is mounted within a high integrity seal assembly that is fully isolated from the pressure media by a welded 316L stainless steel or Hastelloy™ diaphragm. The silicon sensing element exhibits high performance for stability and repeatability, extremely important parameters for the test engineer.

The pressure sensing assembly also features a unique sealing method that enables the sensor to withstand multiple cycles without fatigue. This is especially

useful in cyclic applications. This unique design (U.S. Patent 7.373.827) enables flexibility in choice of pressure connections without the use of adaptors or O-rings.

Surface Mount Electronics, internal to the sensor, condition the output from the silicon sensing element and provide temperature compensation. Additional electronic circuit boards can be added to configure the electrical output for a wide choice of voltage and mA outputs. As a result, Type 4260/62/64... series can be quickly configured at the factory to the customer's choice of electrical output to suit a variety of data acquisition systems.

Piezoelectric Technology



High impedance piezoelectric system (charge mode)

- Wide measuring range
- One sensor can be used over its entire measuring range by selecting an appropriate charge amplifier range
- Push-button, electronic or computer controlled resetting of charge amplifier; Instantly zeros out last measurement
- Operational temperature range -320 °F ... 660 °F or higher
- Charge amplifier for setting of range, filtering and time constant
- Frequency response \approx 0 Hz ... 180 kHz or higher
- Quartz and PiezoStar® sensing elements

Low impedance piezoelectric system (IEPE)




- Low output impedance, $<100 \Omega$
- Low noise output signal
- Fixed sensor range and voltage sensitivity
- Simple two-wire system for power and signal with no special cable conductor requirements
- Lower cost per channel
- Simple and inexpensive signal conditioning; power supply/coupler and standard cables
- Coupler for setting of gain, range, filtering and time constant
- Frequency response 0.07 Hz... 60 kHz
- Operational temperature ranges of -320 °F ... 330 °F
- Quartz and PiezoStar® sensing elements

Piezoresistive Technology

Pressure	Range	Type
Absolute (psia)	0 ... 15 to 0 ... 5,000	4260A
Relative (psig)	0 ... 1.5 to 0 ... 500	4262A
Relative (psis sealed)	0 ... 750 to 0 ... 5,000	4262A
Differential (psid unidirectional)	0 ... 1.5 to 0 ... 150	4264A
Differential (psid bidirectional)	0 ... 1.5 to 0 ... 15	4264A
Barometric and compound ranges available		4260A, 4264A

Features

- 0.05% FS accuracy available
- 0.1% FS stability per year
- Temperature compensated -40 °F ... 250 °F
- 300% proof pressure
- mV, V and mA electrical output options
- 4 ... 20 mA, mV/V and voltage outputs
- Intrinsically safe sensors available
- Continued on page 6

Sensors	Requires external signal conditioning for excitation and output	
Transducers	Requires external signal conditioning for excitation and output	
Transmitters	Self-contained, fully compensated with various output signals	

Piezoelectric Pressure Sensors







Piezoelectric Pressure Sensors (General Purpose)

Specification	Unit	211B1	211B2	211B3	211B4	211B5	211B6	601B1	603B1	
Range	psi	10,000	5,000	500	200	100	50	15,000	15,000	
Sensitivity	mV/psi	0.5	1.0	10	25	50	100	—	—	
Sensitivity	pC/psi	—	—	—	—	—	—	-1.0	-0.35	
Threshold	psi (rms)	0.1	0.05	0.005	0.002	0.001	0.0005	0.003	0.009	
Natural Freq. nom.	kHz	500	500	300	500	300	250	300	500	
Rise Time	µs	1	1	2	1	2	2	2	1	
Time Constant nom.	sec	700	340	100	15	20	30	—	—	
Linearity & Hysteresis	%FSO	<1	<1	<1	<1	<1	<1	<1	<1	
Acceleration Sensitivity	psi/g	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	
Operating Temperature	°F	-65 ... 250	-65 ... 250	-65 ... 250	-65 ... 250	-65 ... 250	-65 ... 250	-450 ... 500	-450 ... 500	
Weight	g	7	7	7	7	7	7	7	7	
Description		General purpose IEPE quartz pressure sensors that measure transient and repetitive dynamic events in a mV/psi output and in a wide variety of applications						General purpose, charge, quartz pressure sensors that measure transient and repetitive dynamic events in a wide variety of applications		

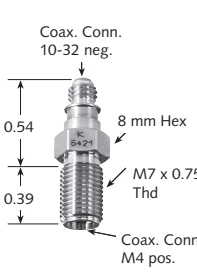

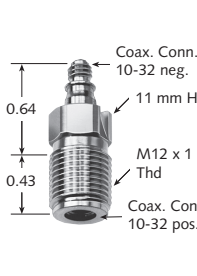
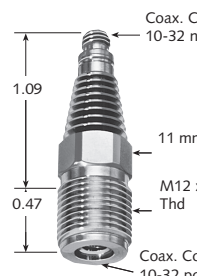
Quick Change Series of Pressure Adaptors for 211B, 601B1, and 603B1

Types 220... A Flush B Recessed P Passage	Types 221... A Flush B Recessed	Types 222P Passage	Types 223... A Flush B Recessed P Passage
Types 228P Passage	Types 223D Gnd. Iso. Passage	Types 253D Gnd. Iso. Flush	Types 225P Passage

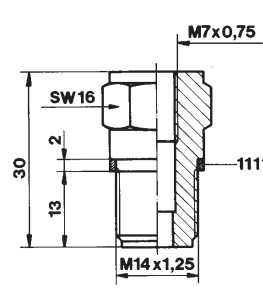
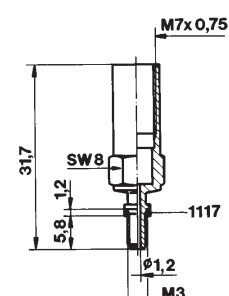
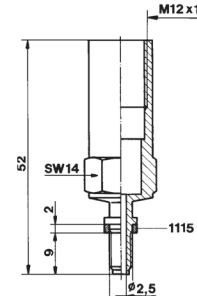
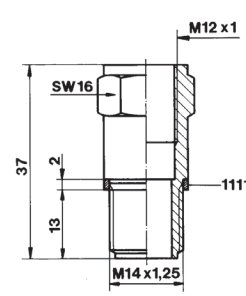
Piezoelectric Pressure Sensors

Piezoelectric Pressure Sensors (General Purpose and High Temperature)							
							
Specification	Unit	7261	6229A	6001	7001	601A	701A
Range	psi	-14.5 ... 145	72,000	3,625	3,625	3,625	3,625
Sensitivity	pC/psi	-150	-0.17	-1.0	-5.5	-1.1	-5.5
Threshold	psi (rms)	0.00001	0.18	0.03	0.006	0.03	0.006
Natural Freq. nom.	kHz	13	200	150	70	150	70
Rise Time	µs	3	1	3	6	3	6
Linearity & Hysteresis	%FSO	≤±0.8	≤±1	≤±0.8	≤±0.8	≤±0.5	≤±0.5
Acceleration Sensitivity	psi/g	<0.015	<0.06	<0.015	<0.03	<0.015	<0.015
Operating Temperature	°F	-40 ... 465	-60 ... 395	-320 ... 660	-320 ... 395	-320 ... 395	-320 ... 395
Weight	g	180	12	1.8	9.0	1.8	8.5
Description		Low pressure, high-sensitivity quartz design from vacuum to 145 psi. Measures sound, air, & other pressures. Very robust.	Designed for fast, cyclic events; fuel injection, hydraulics and more. Long cycle life. Patented anti-strain design.	Quartz pressure sensors for measuring dynamic and quasistatic pressures up to 3625 psi at temperatures up to 660 °F		Small dimensions, wide temperature range, high natural frequency	Versatile, wide temperature range, high-sensitivity

Sensor Connector Adapters for 60xx, 70xx Sensors (use with compatible adapters below and on page 4)

Types 6421...	Types 6461...	Types 7421	Type 7461
 <p>Coax. Conn. 10-32 neg. 0.54 8 mm Hex M7 x 0.75 Thd 0.39 Coax. Conn. M4 pos.</p>	 <p>Coax. Conn. 10-32 neg. 0.95 8 mm Hex 0.39 M7 x 0.75 Thd Coax. Conn. M4 pos.</p>	 <p>Coax. Conn. 10-32 neg. 0.64 11 mm Hex 0.43 M12 x 1 Thd Coax. Conn. 10-32 pos.</p>	 <p>Coax. Conn. 10-32 neg. 1.09 11 mm Hex 0.47 M12 x 1 Thd Coax. Conn. 10-32 pos.</p>

Adapters for 60xx, 70xx Sensors (use with connector adapters above)

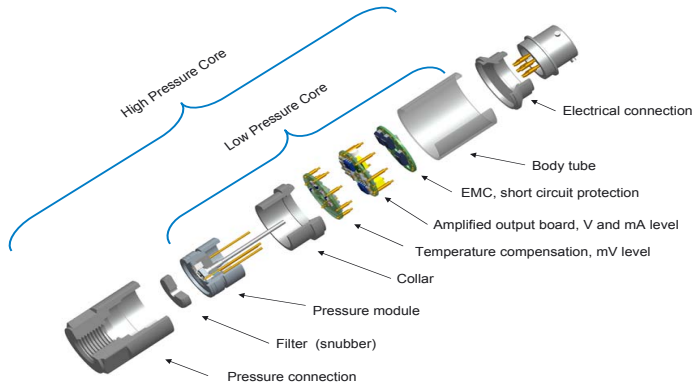
Types 6501	Types 6507	Types 7501	Types 7503
 <p>M7x0,75 SW16 30 2 13 1111 M14 x 1,25</p>	 <p>M7x0,75 SW8 31,7 5,8 1,2 1117 Ø1,2 M3</p>	 <p>M12x1 SW14 52 2 9 1115 Ø2,5 M5</p>	 <p>M12x1 SW16 37 2 13 1111 M14 x 1,25</p>

Piezoresistive Pressure Sensors

4260A/4262A/4264A (426X Series) PRT Sensors

This series of pressure cores are stocked in popular types and pressure ranges. Prior to shipping, the sensor is adjusted to suit the required pressure range and engineering units, the zero and span are checked and the sensor is then completed with a choice of electrical and pressure connections. Contact Kistler for complete details or assistance with part number configuration.

Flexible, Modular Design



Calibration data is available for all Type 426X... series sensors and is supplied as standard with all premium accuracy sensors. The information provided on the calibration sheet is a comprehensive summary of the actual performance of the sensor compared to its specifications.

Type 426X... series sensors are fully tested over both pressure and temperature to ensure compliance to the specifications. This data is available for each sensor and is traceable to ISO 17025 and NIST. Kistler can also provide custom calibrations for specific applications.

Typical Applications

Type 4260A/4262A/4264A... series of PRT sensors are well-suited for demanding pressure applications in R&D, Automotive, Aerospace, Rail, Marine and Industrial markets.

Engine and powertrain test

- Engine oil and coolant pressures
- Engine fuel
- Inlet and exhaust pressures
- Air conditioning
- Brakes and hydraulics
- Crankcase pressure

Component and sub-system testing

- Auxiliary power units
- Air conditioning systems
- Fuel, water and oil pumps
- Leak testing
- Flight test – avionics cooling, cabin conditioning

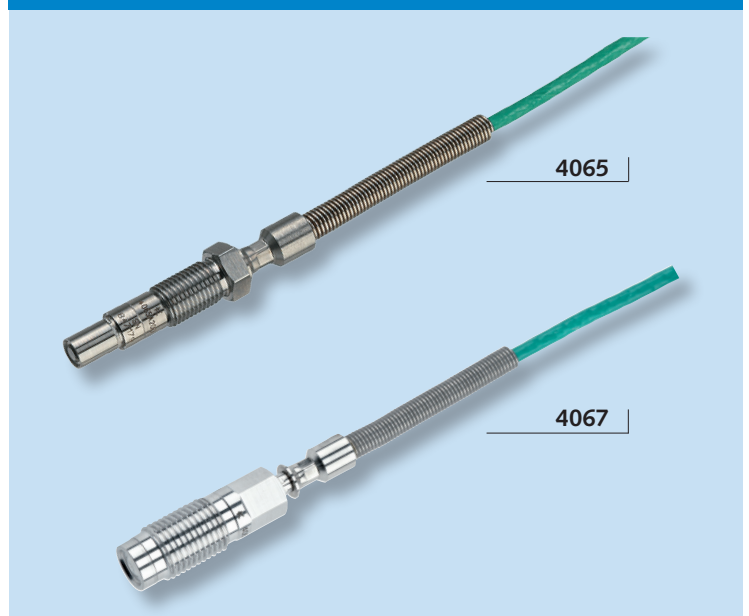
Industrial

- Air or hydraulic assembly machines
- Injection molding machines
- Leak detection and testing
- Critical pressure processes
- Factory floor, pumps, compressors
- Rail-brake control systems

Research and development





- Critical pressure measurements
- High accuracy, high proof pressure
- HAST/HALT testing
- Cyclic, long-term, rugged design
- Prototype to OEM capabilities for engineered solutions

4065 and 4067 High Pressure Sensors



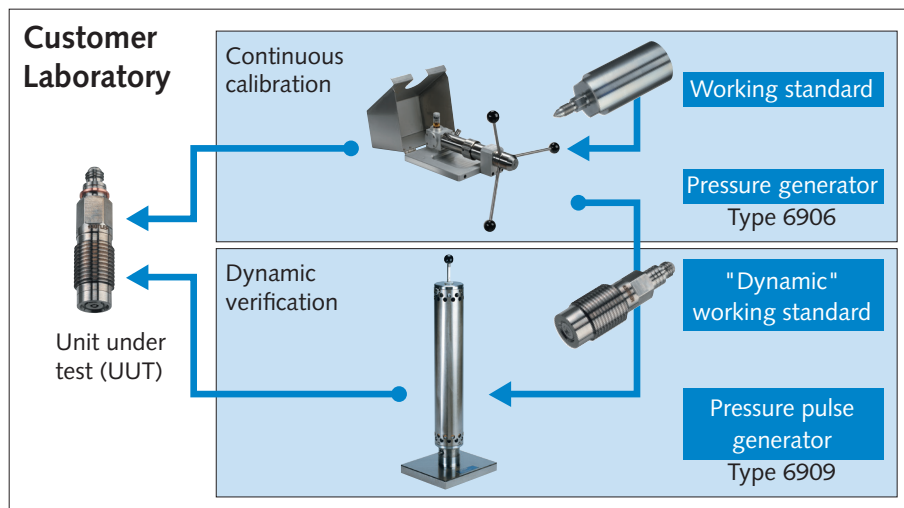
High pressure sensors designed for static and dynamic measurements. They feature a rugged diaphragm for measuring cyclic events during hydraulic, gas and fuel injection applications. Their small dimensions allow for easy clamp adaptor mounting on fuel lines. Each model is available in various pressure ranges. Units are calibrated and supplied with the 4618A signal conditioner. Optional version includes temperature output (10 mV/°C) - call Kistler for details or obtain multi-page data sheets.

Specification	Unit	Type 4065A(X)	Type 4067(X)
Ranges (full-scale)	bar	200, 500, 1k	1k, 2k, 3k, 5k
Sensitivity	mV/bar	50, 20, 10	10, 5, 3.3, 2
Natural frequency	kHz	40, 50, 100	100, 100, 200, 200
Linearity	%FSO	≤±0.5	≤±0.5
Compensated temp. range	°F	70 to 250	
Output pressure signal	mA or V	4...20 or 0...10	
Power excitation (4618A)	VDC	18 to 36	
Dimensions	in	1.6L x SW8 Hex.	
Thread size	mm	M7 x 0.75	M10 x 1

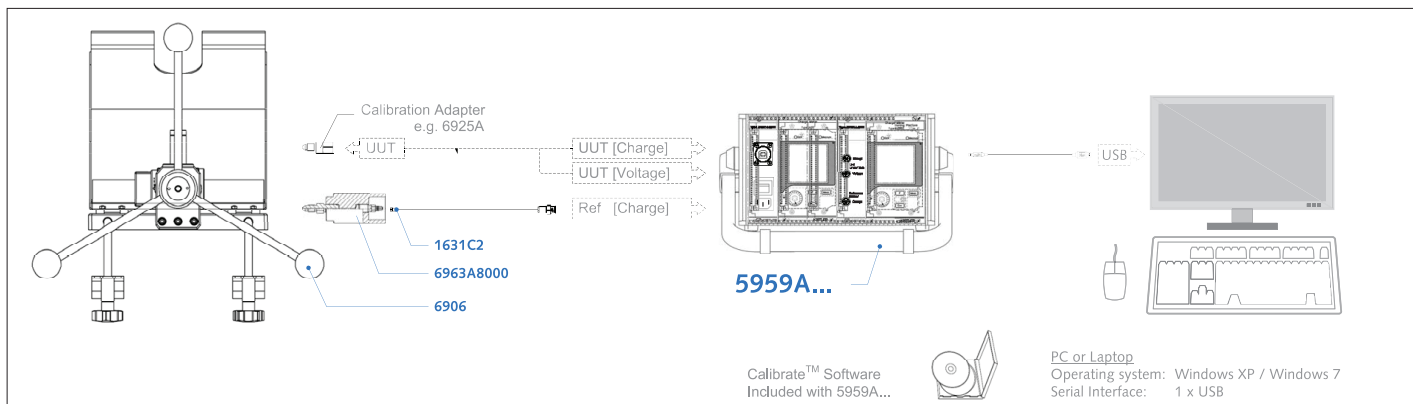
Technical Data					
					
Specification	Unit	Type 5010B	Type 5015A	Type 5114	Type 5118B2
Technology		Dual Mode Charge/IEPE	Charge (IEPE option)	IEPE	IEPE
Measuring Range	pC	±10 ... 999,000	±2 ... 2,200,000		
Sensor Supply Current	mA	4	4	2	2
Frequency Response, ±5	Hz	≈0 ... 180,000	≈0 ... 200,000	0.07 ... 60,000	0.02 ... 40,000
Output Voltage	V	±10	±10 ... ±2	±20 p-p	±20 p-p
Accuracy	%	<±0.5	<±0.5 ... <±3		
Gain				1	1, 10, 100
Power		115 VAC	115/230 VAC	1 x 9 V or Ext.	4 x 1.5 V (AA) or Ext.
Properties		For Charge (pC) and IEPE piezoelectric sensors; Dynamic and quasi-static measurement, automatic zero adjustment, RS-232C interface, ultra high accuracy.	Single-channel charge amplifier, LCD menu as well as read-out for signal evaluation, peak hold display, statistical capture, built-in IEPE filters, optional Piezotron (IEPE) input, CE compliant	Provides constant current excitation, monitors condition of sensor and cables, 3.5" digital LCD display AC-DC or battery powered, CE compliant	Selectable gain and low pass, plug-in filters, panel selectable, high pass filtering, exclusive "Rapid Zero" feature AC-DC or battery powered, CE compliant

Calibration

Kistler calibration hardware and sensors enable testing locations to effectively and efficiently test and calibrate their sensors. The output from the unit under test (UUT) is compared with that of a Kistler reference sensor (a/k/a working standard) while the applied pressure is continuously ramped from zero to full-scale and back using the 6906 pressure generator. An additional dynamic verification with a pressure pulse generator 6909 ensures a sensor's functionality under application-specific conditions.



Typical Calibration System



Applications (Examples)

	Application Description	Sensor Features	Technology: Charge, IEPE, PR
General Purpose	Pumps, compressors, multi-vane	High dynamic, cyclic measurement accuracy	Charge, IEPE
	Flow/fluids with acoustic events	High frequency, low acceleration sensitivity	Charge, IEPE
	Pneumatic, hydraulic fluctuations	High sensitivity, robust diaphragm construction	Charge, PR
	Underwater to high altitude	Hermetic sealing, low sensitivity to thermal changes	Charge, IEPE
	EMI/RF, electrical noise environments	Ground isolation	Charge, IEPE
	Turbo pumps, cryogenic, space applications	Low temperature (cryo-rated), low thermal sensitivity	Charge, IEPE
Automotive	Motoring, valve train applications	High frequency, low acceleration sensitivity	Charge, IEPE
	Fluid dynamics (oils, hydraulics, air, other)	High sensitivity, robust diaphragm construction	Charge, IEPE, PR
	Turbo charger performance testing	High dynamic, cyclic measurement accuracy	Charge, IEPE
	Airbag initiator and inflator testing	High frequency response, robust diaphragm design	Charge, IEPE, PR
	Single combustion event studies	Low thermal shock and low acceleration sensitivity	Charge
	Fuel studies	High dynamic, cyclic measurement accuracy	Charge, IEPE, PR
Aerospace	Flight test air/altitude pressure testing	High sensitivity, high accuracy	IEPE, PR
	Aircraft component tests	High frequency, low acceleration sensitivity	Charge, IEPE, PR
	Auxiliary Power Unit (APU) studies	High dynamic, cyclic measurement accuracy	Charge, IEPE
	Hydraulic control pulsation events	High dynamic and static pressure accuracy	Charge, IEPE, PR
	Flow control valve (open, close) tests	High frequency, low acceleration sensitivity	Charge, IEPE, PR
Other	Explosive, ballistics propellant events	High frequency, robust diaphragm construction	Charge, IEPE
	Closed bomb/closed vessel	High frequency, robust diaphragm construction	Charge, IEPE
	Blast - near-mid-far field explosions	High sensitivity output with low acceleration sensitivity	Charge IEPE
	Sound and wave studies (very low pressure)	High sensitivity output with low acceleration sensitivity	Charge, IEPE, PR
	Marine applications	High sensitivity, high accuracy	Charge, IEPE, PR
	Rail applications	Robust construction, high accuracy	Charge, IEPE, PR

NOTE: Charge = Piezoelectric (pC/MU) IEPE = Integrated Electronics Piezo Electric (mV/MU) PR = Piezoresistive (mV/V, mA, V out)
 MU = Mechanical Unit (i.e. psi, bar, other)

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KISTLER
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