Explosive, Gun & Impact Testing

Accelerometers, Pressure Sensors, Force & Strain Sensors, Cables/Connectors, and Signal Conditioning for Blast, Ballistics and Shock Measurement

PCB PIEZOTRONICS INC.

Aerospace & Defense Division ☎ Toll-Free in USA 866-816-8892 ☎ 716-684-0001 www.pcb.com

Explosive, Gun & Impact Testing

Introduction

PCB® provides shock accelerometers and pressure sensors for explosive, gun and impact testing. High amplitude shock accelerometers represent state-of-the-art industry technology for miniature, high amplitude, and DC response, capable of measuring long duration transient motion, as well as responding to and surviving extremely fast rise times typical of a high-G shock event. Pressure sensors are designed for a broad range of explosion, gun pressure, air and under water blast, and shock wave testing. They are frequency tailored to capture both peak pressure and total impulse measurements.

Measuring Pressure from Explosives

An explosion is a rapid release of energy (detonation) that results in gas formation and intense heat. The energy source can be anything that generates a violent reaction when initiated. This includes chemicals, gas-storage vessels, electrical spark gap, or nuclear materials. The most common source is unstable chemical compounds, which rapidly transform themselves to a more stable form, with a resultant release of energy.

The properties of air cause the pressure wave resulting from an explosion to "shock up" or steepen as its front moves outward from the source. This shock front moves supersonically with discontinuities in pressure, temperature, density, and particle velocity across it. In contrast to an explosion (high explosive) is deflagration (low explosive): i.e., a subsonic combustion that propagates through thermal conductivity, where hot burning material heats the next layer of cold material and ignites it. Deflagration is easier to control than detonation, and therefore is more useful when employing the force of the expanding gas to move an object such as a bullet in a gun barrel.

Some of the more important characteristics of explosives are sensitivity (ease of detonation), stability (ability to be stored without deterioration), performance (ability to do work), brisance (indicated by how fast it reaches peak pressure), density of loading, volatility (readiness with which it vaporizes – undesired), and hygroscopicity (moisture absorbing tendencies – undesired).

The primary civilian applications of explosives are in mining and construction. Many coal mines use explosives to loosen the rock and coal. In surface mining, holes are drilled through the rock overburden, loaded with explosives, and discharged, shattering the rock in the overburden. In addition to coal mining, many other minerals must also be mined. Other uses of explosives include but are not limited to: aerospace (ejection seats, explosive bolts), seismic exploration, pyrotechnics, breaking ice jams or avalanche prevention, projecting life lines to ships in distress, demolition, and more.

When considering the military application of explosives, a basic property by which a weapon's effectiveness is measured is the quantity of energy and thus damage potential it delivers to the target. Modern weapon systems use both kinetic energy and potential energy to achieve maximum lethality. Kinetic energy systems rely on the conversion of kinetic energy into work, while potential energy systems use explosive energy directly in the form of heat and blast or by accelerating case fragments to increase their kinetic energy and damage volume. Some of the more important characteristics of military explosives, aside from availability and cost, are sensitivity (ease of detonation), stability (ability to be stored without deterioration), performance (ability to do work), brisance (indicated by rapidity with which it reaches its peak pressure), density of loading, volatility (readiness with which it vaporizes – undesired), hygroscopicity (moisture absorbing tendencies – undesired), and toxicity (also undesired). Most, if not all of these, are also important in civilian applications. Adoption of an explosive for a particular military use is based upon proving ground, arena, and service testing.

Low explosives are used as propellants that impart motion to something like a missile, artillery round, shoulder launched munitions, or bullet. Ammunition testing is required to support development activities, lot acceptance, and reliability of stored munitions. Live fire ammunition testing typically involves measurements of chamber pressures and muzzle velocities. For ammunition testing, while response times are more moderate, depending on caliber, chamber pressure levels can be anywhere between thousands and tens of thousands of psi or hundreds to thousands of bars. Quartz sensing technology also satisfies this requirement being capable of operating from acoustic levels to over 100,000 psi (8000 bar).

The measurement of underwater explosions, such as are encountered in naval testing or water filled bore holes associated with mining, require tourmaline as the sensing technology due to its unique piezoelectric properties that enable a hydrostatic response.

Common to all of these requirements are unique transducer mounting requirements. Pencil-shaped probes are required for static overpressure measurements in air. Tourmaline crystals are mounted in a non-conductive oil encased by a mechanically impedance matched sleeve to successfully measure underwater explosions. Coatings, placed on transducer faces, are required to mitigate transient thermal induced errors encountered in explosive environments. PCB® air-blast sensors are 100% in-process tested for resonant frequency, rise time, and acceleration compensation prior to shipment, and include a dynamic calibration certificate, to ensure the best measurement possible.

Measuring Shock from Impacts

Shock Accelerometers are available in two technologies; ICP® Piezoelectric and full-bridge, single crystal silicon MEMS. PCB's Series 350 ICP® Piezoelectric shock accelerometers have long been a staple for shock measurements because their benefit is integral signal-conditioning electronics (ICP or IEPE), and when measuring mechanical shock, ICP® signal conditioning enhances the measurement system's signal-to-noise ratio. High amplitude shock accelerometers represent state-of-the-art industry technology for miniature, high amplitude, and DC response, capable of measuring long duration transient motion, as well as responding to and surviving extremely fast rise times typical of a high-G shock event. Both packaged and OEM configurations are offered to fulfill a variety of installation requirements.

Shock occurs when two or more objects collide, where responses of the individual objects depend on their mass, geometry, material, directionality of impact, and velocity at impact. If the impact occurs over a short period of time it is usually more severe and results in higher forces and accelerations on the colliding masses. Shock is a common occurrence found in sports helmet testing, automobile crash testing, aircraft landings, pile drivers, machine tools, package drop testing, and more. Defense interest in shock encompasses some of the above, with a principal focus in penetrating and damaging a target or mitigating the damage effects to an object encountering impact. Projectiles (e.g., bullets, cannons, mortars) encounter shock during launch and again on reaching their intended target. Penetrating weapons are first impacted by the media through which they travel and then by the object responsible for their detonation.

To assure mechanical reliability of a system and components under impact conditions, operational tests are performed to both verify proper system performance and acquire mechanical shock measurements to validate design models. Once these component responses are measured, and the structural model is validated, component specific impact or mechanical shock test specifications can be generated. These specifications enable testing to be performed over the life of a program at the component level providing assurance that the component will operate reliably under the operational conditions. This testing is dependent on acceleration measurements from accelerometers.

Some of the larger challenges associated with shocks measurement are those associated with pyroshock, which is the decaying, oscillatory response of a structure to high-amplitude and high frequency mechanical excitation. Frequencies that comprise this oscillatory response can extend to thousands of Hertz and beyond. The aerospace industry first recognized the potentially destructive effect of pyroshock when firing explosive bolts, cutters, and other similar devices. Other environments (e.g., the sudden release of strain energy and metal-to-metal impact), produce effects similar to pyroshock. Electrical and optical components integrated into aerospace structures have become increasingly more miniature, resulting in the resonant frequencies of these components to increasing, making them susceptible to damage by pyroshock. Pyroshock simulation testing of components involves metal-on-metal impact of tuned plates and/or actual explosive stimulation.

When measuring severe shock, such as is encountered in many of the described applications, a number of concerns must be addressed. First, the measuring accelerometers must often remain linear to many thousands or tens of thousands of Gs. While shock spectra requirements are typically less than 10,000 Hz, the resonant frequency of the accelerometer can be excited and its range must be accommodated to enable data filtering. To acquire these high frequency response measurements, accelerometer attachment to the test item must be carefully designed, and the accelerometer cable/connector interface must also be ruggedized. All shock sensors are calibrated on a pneumatically generated half-sine pulse shock calibration system, and are available with a Hopkinson Bar test as an option. Born from decades of expertise in very high-G shock (≥ 20,000 G) measurement applications and sensor development, PCB® sensors will meet the demands of your shock test requirement.

Summary

In this catalog, you will find a listing of PCB's most popular high-G shock and pressure sensors. Gun pressure and sound level meters plus a wide variety of cable and signal conditioning offer maximum flexibility when developing a new test plan. Dynamic calibration systems are also presented offering rapid self-service.

Sensors for Blast Measurements

Shock Accelerometers: Our high amplitude shock accelerometers represent state-of-the-art industry technology for miniature, high amplitude, DC response acceleration sensors, capable of measuring long duration transient motion, as well as responding to and surviving extremely fast rise times typical of a high-G shock event. Both a packaged and an OEM configuration are offered to fulfill a variety of installation requirements.

Pressure Sensors: Our pressure sensors are designed for a broad range of explosion, blast, and shock wave testing. They are frequency tailored to capture both peak pressure and total impulse measurements. Applications include measuring air-blast pressure in free-field or closed bunker arenas to obtain peak pressure, total impulse, shock wave and time-of-arrival measurements often used to study blast effects on structures, vehicles, or other objects.

In this catalog, you will find a listing of PCB®'s most popular blast, high-G shock sensors and other hardware for these applications. Please log onto www.pcb.com, and search the model series for detailed specifications. You can also contact us at 866-816-8892, or aerosales@pcb.com, to discuss your specific requirement with an Application Engineer.

Applications:

Civilian applications of various types of chemical explosives include:

- Mining
- Construction
- Demolition
- Pyrotechnics

Defense applications of explosives encompass:

- Aerial Bombs
- Mines
- Torpedoes
- Breeching Operations
- Ballistics
- Tactical Missiles & More

AEROSPACE & DEFENSE
A PCB PIEZOTRONICS DIV.

MEMS High-G Shock Accelerometers

Four-wire Full Bridge

MEMS high-amplitude shock accelerometers, from PCB Piezotronics (PCB®), represent state-of-the-art industry technology for miniature, high amplitude, DC response acceleration sensors, capable of measuring long duration transient motion, as well as, responding to and surviving extremely fast rise times, typical of a high-G shock event. Both a packaged and an OEM configuration are offered, to fulfill a variety of installation requirements.

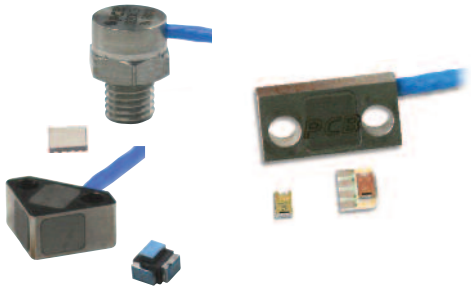
The air-damped acceleration sensing element, which is micromachined from silicon, is manufactured with the latest advances in etching techniques and equipment. This tiny element measures just 2.5 x 1.7 x 0.9 mm (L x W x H), and incorporates a seismic mass, protective over-range stops, and a full-active, piezoresistive Wheatstone bridge.

These Series are intended to fulfill the most demanding aerospace, industrial, and commercial application requirements. Their design concepts were born from more than 20 years of PCB® expertise in very high-G shock (≥ 20,000 G) measurement applications and sensor development. Our design team has the most experience in the world for these applications. Our process engineers utilized the latest and most sophisticated techniques and equipment to achieve the desired performance levels that previously have not been attainable.

Utilizing deep reactive ion etching (DRIE) equipment and techniques, PCB® can micromachine in-house, from extremely strong single crystal silicon, the industry's smallest, most accurate and durable shock accelerometer.

Highlights:

- Packaged and OEM Configurations
- Single axis and triaxial arrangements
- Titanium housing with integral cable for packaged configurations
- Surface mount, wire bond and flip chip technologies available for OEM configurations
- Wide band frequency response
- No zero-shift
- Mechanical over-range stops improves survivability
- Slight damping reduces resonance amplification
- Low transverse sensitivity
- Excellent amplitude linearity
- 20 KG and 60 KG ranges available
- Low power consumption



Series 3501, 3503 & 3991 MEMS High-G Shock Accelerometers

Series 3501 & 3503

MEMS High-G Shock Accelerometers/Commercial

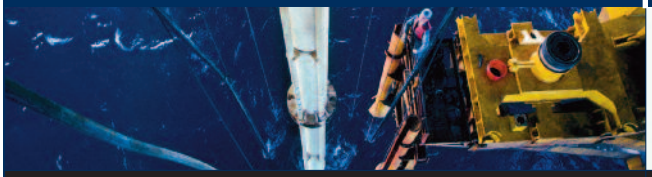
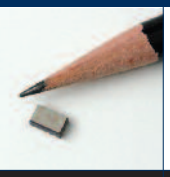
Applications

- Consumer Electronics Testing
- Pile Drivers (e.g. piles for a pier into the ocean)
- Down-hole Oil Exploration
- Shot Counting for Rifles and Handguns
- Jack Hammer Manufacturers
- Golf Driver Head Measurements
- Not Restricted Under ITAR

Model Numbering System for Series 3501 and 3503 MEMS High-Amplitude Shock Accelerometers

Single Axis Series 3501					
3501A	Single axis, MEMS DC response shock accelerometer				
	1.) Configurations				
	12	Titanium housing, mounted with integral 1/4-28 thread stud, side cable exit			
	13	Titanium housing, mounted with integral 1/4-28 thread stud, top cable exit			
	20	Housed in a SMT leadless chip carrier to facilitate surface mount installation			
	21	"Flip chip", utilizes solder balls to attach to the substrate			
		2.) Measurement Range			
		20KG	±20,000 G		
		60KG	±60,000 G		
			3.) Integral Cable Length for configuration 3501A12XXG and 3501A13XXG (add only if other than standard length shown above)		
			/ XXX	Specify XXX, as desired in feet	
				4.) Cable Termination (add only if selecting other than pigtail connection)	
				LN	Mini 8-pin DIN connector
				AY	4-pin plug
Triaxial Series 3503					
3503A	Triaxial, MEMS DC response shock accelerometer				
	1.) Configurations				
	10	Titanium housing, two through-holes for 4-40 mounting bolts			
	20	Incorporates three flip chip elements attached to a SMT leadless chip carrier to facilitate surface mount installation			
		2.) Measurement Range			
		20KG	±20,000 G		
		60KG	±60,000 G **Note:** not available in 3503A1060KG version		
			3.) Integral Cable Length for configuration 3503A10XXG only (add only if other than standard length shown above)		
			/ XXX	Specify XXX, as desired in feet	
				4.) Cable Termination (add only if selecting other than pigtail connection)	
				LY	(3) LN Mini 8-pin DIN connectors in a triple splice
Examples					
3501A	**12**	**20KG**			**Single axis, titanium housing, mounted with integral 1/4-28 thread stud, side cable exit, 20,000 G range**
3503A	**10**	**60KG**	**/020**	**LY**	**Triaxial, titanium housing, two through-holes for 4-40 mounting bolts, 60,000 G range, 20 ft (6.1m) cable terminating with (3) LN mini 8-pin DIN connectors**

MEMS High-Amplitude Shock Accelerometers

Series 3501 and 3503	Surface Mount		Packaged	
				
Model Number	**3501A2020KG Single Axis**	**3503A2020KG Triaxial**	**3501A1220KG Single Axis**	**3503A1020KG Triaxial**
Sensitivity (± 20%) (@ typical excitation)	0.010 mV/g	0.010 mV/g	0.010 mV/g	0.010 mV/g
Sensitivity	0.001 mV/V/g	0.001 mV/V/g	0.001 mV/V/g	0.001 mV/V/g
Measurement Range	± 0 to 20,000 g	± 0 to 20,000 g	± 0 to 20,000 g	± 0 to 20,000 g
Frequency Range (± 1dB)	10k Hz	10k Hz	10k Hz	10k Hz
Resonant Frequency	> 60k Hz	> 60k Hz	> 60k Hz	> 60k Hz
Overload Limit (Shock)	± 60,000 g pk	± 60,000 g pk	± 60,000 g pk	± 60,000 g pk
Overload Limit (Mechanical Stops)	≥ 30 kg	≥ 30 kg	≥ 30 kg	≥ 30 kg
Excitation Voltage (Typical)	10 VDC	10 VDC	10 VDC	10 VDC
Excitation Voltage (Max)	15 VDC	15 VDC	15 VDC	15 VDC
Temperature Range (Operating)	-65 to +250 °F -54 to +121 °C	-65 to +250 °F -54 to +121 °C	-65 to +250 °F -54 to +121 °C	-65 to +250 °F -54 to +121 °C
Physical				
Size (Height x Length x Width)	0.085 x 0.236 x 0.138 in 2.16 x 3.5 x 6 mm	0.12 x 0.15 x 0.15 in 3 x 3.8 x 3.8 mm	0.5 x 0.375 hex in 12.7 x 9.5 hex mm	0.25 x 0.47 x 0.47 in 6.35 x 11.8 x 11.8 mm
Weight	0.005 oz (0.15 gm)	0.003 oz (0.1 gm)	0.11 oz (3 gm)	0.09 oz (2.8 gm)
Mounting	Adhesive Mount	Adhesive Mount	1/4-28 stud	(2) Through-holes
Housing	Alumina	Alumina	Titanium	Titanium
Cable Length	N/A	N/A	10 ft (3m)	10 ft (3m)
Electrical Connection	Surface Mount (SMT)	Surface Mount (SMT)	034 Teflon, Integral Cable	Integral Cable (8 conductor)
Cable Termination	N/A	N/A	Pigtails	Pigtails
Supplied Accessories				
Mounting Screw	N/A	N/A	Integral Stud	(2) Model 081Axxx (4+40 x 3/8" SHCS)
Calibration Certificate	ACS-62 Shock Calibration	ACS-62 Shock Calibration	ACS-62 Shock Calibration	ACS-62 Shock Calibration
Additional Versions				
Metric Mount	—	—	M3501A1220KG	—

Model Number	**3501A2060KG Single Axis**	**3503A2060KG Triaxial**	**3501A1260KG Single Axis**
Sensitivity (± 20%) (@ typical excitation)	0.003 mV/g	0.003 mV/g	0.003 mV/g
Sensitivity	0.0003 mV/V/g	0.0003 mV/V/g	0.0003 mV/V/g
Measurement Range	± 0 to 60,000 g	± 0 to 60,000 g	± 0 to 60,000 g
Frequency Range (± 1dB)	20k Hz	20k Hz	20k Hz
Resonant Frequency	>120k Hz	>120k Hz	>120k Hz
Overload Limit (Shock)	± 100,000 g pk	± 100,000 g pk	± 100,000 g pk
Overload Limit (Mechanical Stops)	≥ 100 kg	≥ 100 kg	≥ 100 kg
Excitation Voltage (Typical)	10 VDC	10 VDC	10 VDC
Excitation Voltage (Max)	15 VDC	15 VDC	15 VDC
Temperature Range (Operating)	-65 to +250 °F -54 to +121 °C	-65 to +250 °F -54 to +121 °C	-65 to +250 °F -54 to +121 °C
Physical			
Size (Height x Length x Width)	0.085 x 0.236 x 0.138 in 2.16 x 3.5 x 6 mm	0.12 x 0.15 x 0.15 in 3 x 3.8 x 3.8 mm	0.5 x 0.375 hex in 12.7 x 9.5 hex mm
Weight	0.005 oz (0.15 gm)	0.003 oz (0.1 gm)	0.11 oz (3 gm)
Mounting	Adhesive Mount	Adhesive Mount	1/4-28 Stud
Housing	Alumina	Alumina	Titanium
Cable Length	N/A	N/A	10 ft (3m)
Electrical Connection	Surface Mount (SMT)	Surface Mount (SMT)	034 Teflon, Integral Cable
Cable Termination	N/A	N/A	Pigtails
Supplied Accessories			
Mounting Screw	N/A	N/A	Integral Stud
Calibration Certificate	ACS-62 Shock Calibration	ACS-62 Shock Calibration	ACS-62 Shock Calibration
Additional Versions			
Metric Mount	—	—	M3501A1260KG

Series 3991

MEMS High-G Shock Accelerometers/ITAR

Applications

- Safe and Arm
- Smart Fuzes
- Penetrator Tests
- Weapons Data Recorders / Launch Characteristics
- Explosive Environments (pyroshock)
- Metal-to-metal Impact / Armor Piercing
- Blast Loading of Structures / Nuclear Blast Survivability

Model Numbering System for Series 3991 High-Amplitude Shock Accelerometers

1.) Single Axis Series 3991					
3991A	Single axis, MEMS DC response shock accelerometer (revision A)				
	2.) Configurations				
	10	Titanium housing, 3 ft (0.9 m) integral cable, 4-conductor Kevlar® cable, terminating pigtails, two through-bolt mounting holes			
	11	Titanium housing, 10 ft (3m) integral cable, 4 conductor Teflon cable, terminating in pigtails, two through-bolt mounting holes			
	30	Substrate package, adhesive mount with solder tabs for electrical hook up, (internal component to Model 3991A1020KG and 3991A1120KG)			
		3.) Measurement Range			
		20KG	±20,000 G		
		60KG	±60,000 G		
			4.) Integral Cable Length (add only if selecting integral cable and other than standard length shown above)		
			/ XXX	Specify XXX as desired in feet	
				5.) Cable Termination (add only if selecting integral cable with other than pigtail connection	
				LN	Mini 8-pin DIN connector
Examples					
3991A	**10**	**20KG**			**Single axis, titanium housing, 3 ft (0.9m) integral cable, 4 conductor Kevlar® cable, terminating in pigtails, 20,000 G range**
3991A	**11**	**60KG**	**/020**	**LN**	**Single axis, titanium housing, integral 4 conductor Teflon cable, 60,000 G range with 20 ft (6.1m) cable terminating with Mini 8-Pin DIN connector**

Model 427A0X

The Best of Both Worlds–DC Response with ICP® Signal Conditioning

The PCB® Series 427A represents a revolutionary advance in transducer conditioning. A patent is pending on the circuit, which combines the best features of the low impedance two wire interface of ICP®, with the advantages of DC-coupled piezoresistive transducers–the best of both worlds. The Series 427A takes the conventional current supply of any ICP® conditioner, and provides a highly regulated 5V excitation for a Wheatstone bridge transducer, then amplifies the differential output of the bridge with wide-band frequency response, and adds that DC-coupled output to the ICP® bias voltage. For the first time with ICP® circuitry it is possible to make truly static measurements. The Series 427A includes members with different gain settings, an optional 4-pole filter, and TEDS capability.

MEMS High-Amplitude Shock Accelerometers

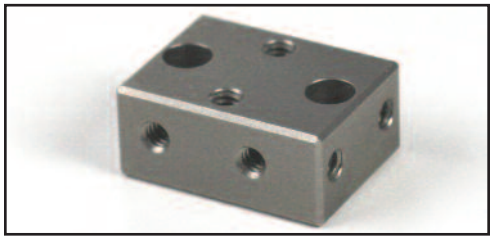



MEMS High-Amplitude Shock Accelerometers

Model Number	3991A1020KG	3991A1060KG	3991A1120KG	3991A1160KG	3991A3020KG	3991A3060KG
Sensitivity (± 20%) (@ 10VDC excitation)	0.010 mv/g	0.003 mV/g	0.010 mv/g	0.003 mV/g	0.010 mv/g	0.003 mV/g
Sensitivity	0.001 mV/V/g	0.0003 mV/V/g	0.001 mV/V/g	0.0003 mV/V/g	0.001 mV/V/g	0.0003 mV/V/g
Measurement Range	± 0 to 20,000 g	± 0 to 60,000 g	± 0 to 20,000 g	± 0 to 60,000 g	± 0 to 20,000 g	± 0 to 60,000 g
Frequency Range (± 1 db)	10,000 Hz	20,000 Hz	10,000 Hz	20,000 Hz	10,000 Hz	20,000 Hz
Resonant Frequency	> 60k Hz	>120k Hz	> 60k Hz	>120k Hz	> 60k Hz	>120k Hz
Overload Limit (Shock)	± 60,000 g pk	± 100,000 g pk	± 60,000 g pk	± 100,000 g pk	± 60,000 g pk	± 100,000 g pk
Overload Limit (Mechanical Stops)	≥ 30 kg	≥ 100 kg	≥ 30 kg	≥ 100 kg	≥ 30 kg	≥ 100 kg
Excitation Voltage (Typical)	10 VDC	10 VDC	10 VDC	10 VDC	10 VDC	10 VDC
Excitation Voltage (Max)	15 VDC	15 VDC	15 VDC	15 VDC	15 VDC	15 VDC
Temperature Range (Operating)	-65 to +250 °F -54 to +121 °C	-65 to +250 °F -54 to +121 °C	-65 to +250 °F -54 to +121 °C	-65 to +250 °F -54 to +121 °C	-65 to +250 °F -54 to +121 °C	-65 to +250 °F -54 to +121 °C
Physical						
Size (Height x Length x Width)	0.11 x 0.56 x 0.28 in 2.79 x 14.22 x 7.11 mm	0.11 x 0.56 x 0.28 in 2.79 x 14.22 x 7.11 mm	0.11 x 0.56 x 0.28 in 2.79 x 14.22 x 7.11 mm	0.11 x 0.56 x 0.28 in 2.79 x 14.22 x 7.11 mm	0.052 x 0.170 x 0.160 in 1.32 x 4.32 x 4.06 mm	0.052 x 0.170 x 0.160 in 1.32 x 4.32 x 4.06 mm
Weight	0.045 oz 1.28 gm	0.045 oz 1.28 gm	0.045 oz 1.28 gm	0.045 oz 1.28 gm	0.0013 oz 0.04 gm	0.0013 oz 0.04 gm
Mounting	(2) Through-holes / Screws	(2) Through-holes / Screws	(2) Through-holes / Screws	(2) Through-holes / Screws	Adhesive Mount	Adhesive Mount
Housing	Titanium	Titanium	Titanium	Titanium	Substrate	Substrate
Cable Length	3 ft 0.91 m	3 ft 0.91 m	10 ft 3 m	10 ft 3 m	N/A	N/A
Electrical Connection	094 Kevlar, Integral Cable	094 Kevlar, Integral Cable	034 Teflon, Integral Cable	034 Teflon, Integral Cable	N/A	N/A
Cable Termination	Pigtails	Pigtails	Pigtails	Pigtails	N/A	N/A
Supplied Accessories						
Mounting Screw	(2) Model 081A110 (4-40 x 1/4" SHCS)	(2) Model 081A110 (4-40 x 1/4" SHCS)	(2) Model 081A110 (4-40 x 1/4" SHCS)	(2) Model 081A110 (4-40 x 1/4" SHCS)	N/A	N/A
Calibration Certificate	ACS-62 Shock Calibration	ACS-62 Shock Calibration	ACS-62 Shock Calibration	ACS-62 Shock Calibration	ACS-62 Shock Calibration	ACS-62 Shock Calibration

This product is a controlled item under the International Traffic in Arms Regulations (ITAR), administered by the Office of Defense Trade Controls. Any export of this product from the United States, including any item in which this product may be incorporated, requires appropriate authorization from the U.S. State Department. Diversion contrary to U.S. law is prohibited.

Model 080A213



Triaxial mounting block for Models 3991A10X0KG and 3991A11X0KG

LN Mini 8-Pin DIN Connector

Bridge input mating connector

Piezoelectric Shock Accelerometers

Series 660

Low Cost, Embeddable Accelerometers

Series 660 accelerometers are ideal for continuous vibration monitoring in high-volume and commercial OEM applications.

The Series 660 low cost accelerometers offer an affordable solution for vibration and shock measurements in high-volume and commercial OEM applications. The units are particularly well suited for shock and impact detection of packages or components, as well as bearing and gear mesh vibration measurements in predictive maintenance and condition monitoring requirements. The compact designs may be imbedded into machinery at the OEM level to provide value-added monitoring protection.

The units employ field-proven, solid-state, piezoelectric sensing elements for durability and broadband performance. Choose from either charge mode types, which achieve high operating temperatures or voltage mode ICP® types, with built-in signal conditioning microelectronics, for simplified operation and connectivity to data acquisition and vibration monitoring instrumentation.

Highlights:

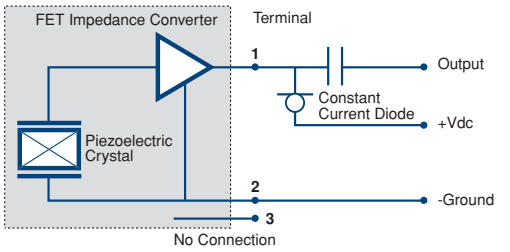
- Choice of standard TO-5 or TO-8 transistor-style packages
- Choice of charge mode piezoelectric, voltage mode ICP®, and 3-wire low power varieties
- Mountable via adhesive or soldering and choice of either integral cable or solder pin electrical connections
- Variety of sensitivities to accommodate a wide variety of applications
- Broad bandwidth, high shock survivability, wide operating temperature range, high resolution, and large dynamic range

Options:

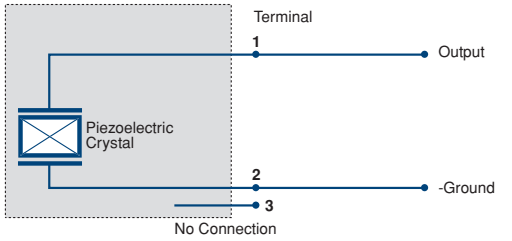
- Low Output Bias Voltage
- High Temperature Operation to 365 °F (185 °C)
- High Range (less sensitivity)
- Temperature Output Signal

Specifications Package Size	Low Profile TO-5	TO-5
2-Wire ICP Configuration		
Primary Model Sensitivity (± 20%)	10 mV/g 1.02 mV/m/s²	100 mV/g 10.2 mV/m/s²
Measurement Range	500 g 5000 m/s²	50 g 500 m/s²
Frequency Range (± 3 dB)	0.4 to 10 k Hz	0.32 to 10k Hz
Resonant Frequency	>30 kHz	>25 kHz
Broadband Resolution	0.003 g pk	0.0003 g pk
Excitation Voltage	18 to 28 VDC	18 to 28 VDC
Excitation Constant Current	2 to 20 mA	2 to 20 mA
Output Impedance	<100 ohm	<100 ohm
Output Bias Voltage	8 to 12 VDC	8 to 12 VDC
Discharge Time Constant	≥0.4 sec	≥0.5 sec
Settling Time	2 sec	2.5 sec
Operating Temperature Range	-65 to +185 °F -54 to +85 °C	-65 to +185 °F -54 to +85 °C
Weight	0.08 oz 2.2 gm	0.1 oz 3 gm
Other Available Sensitivities	1 mV/g 0.102 mV/m/s²	N/A
3-Wire, Low-Power Configuration		
Primary Model Sensitivity (± 20%)	10 mV/g 1.02 mV/m/s²	100 mV/g 10.2 mV/m/s²
Measurement Range *	200 g 2000 m/s²	20 g 200 m/s²
Frequency Range (± 3 dB)	0.32 to 10k Hz	0.32 to 10k Hz
Resonant Frequency	>30 kHz	>25 kHz
Broadband Resolution	0.003 g pk 0.03 m/s² pk	0.001 g pk 0.01 m/s² pk
Excitation Voltage	3 to 5 VDC	3 to 5 VDC
Current Draw	0.75 mA	0.75 mA
Output Impedance	< 100 ohm	< 100 ohm
Output Bias Voltage (±10%)	0.5 × Excitation Voltage	0.5 × Excitation Voltage
Discharge Time Constant	≥0.5 sec	≥0.5 sec
Settling Time	2.5 sec	2.5 sec
Operating Temperature Range	-65 to +185 °F -54 to +85 °C	-65 to +185 °F -54 to +85 °C
Weight	0.08 oz 2.2 gm	0.1 oz 3 gm
Charge Mode Configuration		
Sensitivity (± 20%)	5 pC/g 0.51 pC/m/s²	11 pC/g 1.12 pC/ms²
Measurement Range	500 g	50 g
Frequency Range (± 3 dB)	10 kHz	10 kHz
Resonant Frequency	>30 kHz	>25 kHz
Operating Temperature Range	-65 to +185 °F -54 to +85 °C	-65 to +185 °F -54 to +85 °C
Capacitance	350 pF	350 pF
Weight	0.08 oz 2.2 gm	0.1 oz 3 gm
Common Specifications		
Transverse Sensitivity	≤ 5%	≤ 5%
Non-Linearity	≤1%	≤1%
Temperature Coefficient	0.10 %/°F 0.18 %/°C	0.10 %/°F 0.18 %/°C
Shock Limit	7000 g pk 70k m/s² pk	7000 g pk 70k m/s² pk
Housing Material	Stainless Steel	Stainless Steel
Mounting	Adhesive or Solder	Adhesive or Solder
Sealing (welded)	Hermetic	Hermetic
Size	0.36 × 0.26 in 9.1 × 6.6 mm	0.36 × 0.38 in 9.1 × 9.7 mm
Note:		
* Measurement range achieved is dependent upon excitation voltage supplied, i.e.: Measurement Range = $\frac{(0.5 \times \text{Excitation Voltage}) - 0.5\ \text{V}}{\text{Sensitivity (V/g)}}$		

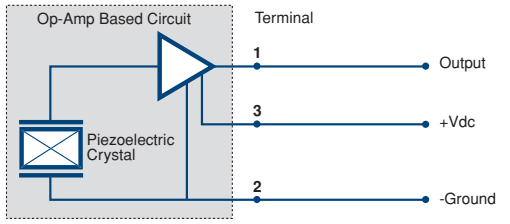
2-Wire ICP Mode



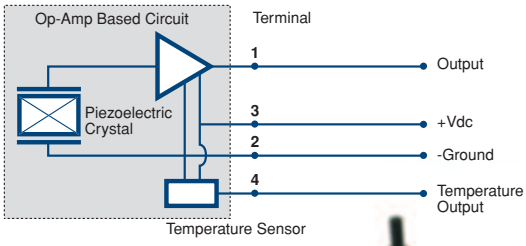
2-Wire Charge Mode

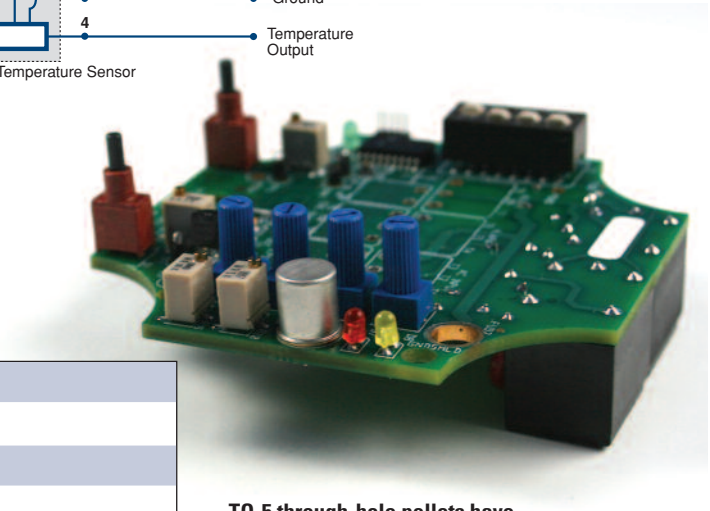


3-Wire Voltage Mode



4-Wire Voltage Mode with Temperature Output



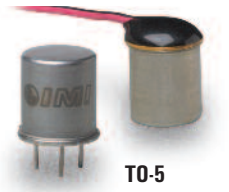


TO-5 through-hole pellets have been used in high volume shock measurement applications at levels above 7,000 g's.

How to Order

Style						
66	Low Cost, Embeddable Accelerometer					
	Package Size and Sensitivity					
	10	Low-profile TO-5 with 10 mV/g sensitivity				
	16	Low-profile TO-5 with 1 mV/g sensitivity — must select configuration 2A below				
	19	Low-profile TO-5 with 5 pC/g sensitivity — must select configuration 2C below				
	29	TO-5 with 11 pC/g sensitivity — must select configuration 2C below				
		Sensor Configuration and Excitation Scheme				
		2A	2-wire ICP® voltage mode (pwr/sgnl, gnd), current regulated power			
		2C	2-wire charge mode (sgnl, gnd) — for size and sensitivity 19, 29 or 39 only			
		3L	3-wire voltage mode (pwr, sgnl, gnd), low power			
		4T	4-wire voltage mode with temperature output (pwr, sgnl, gnd, temp)			
			Orientation / Polarity			
			PZ	Positive output for acceleration along z-axis (in upward direction when pin mounted)		
			NZ	Negative output for acceleration along z-axis (in upward direction when pin mounted)		
				Electrical Connection		
				1	Header Pins	
				2	Integral 1 ft. (0.3 m) cable	
					Options	
					XX	Overall integral cable length in "XX" ft. (other than standard 1 ft.)
					MXX	Overall integral cable length in "XX" meters (other than standard 0.3 m)
Example						
66	21	2A	PZ	1		Low-cost, TO-5 size, 100 mV.g, 2-wire, ICP accelerometer with positive polarity and header pin connections

Low Profile TO-5



TO-5

Series 350

High Amplitude ICP® Shock Accelerometers

Shock accelerometers are specifically designed to withstand and measure extreme, high-amplitude, short-duration, transient accelerations. Such accelerations characteristically exceed the 1000 g boundary imposed on other typical accelerometer designs. Shock acceleration events may reach 100,000 g or more with pulse durations of less than 10 microseconds. The extremely fast transient and volatile nature of a shock event imposes special demands on the design of a shock accelerometer.

PCB® shock accelerometers represent extensive research in materials, assembly techniques, and testing techniques to insure survivability and faithful representation of the shock event. An automated Hopkinson Bar Calibration Station is utilized to evaluate shock sensor performance by simulating actual, high amplitude measurement conditions. This investment allows PCB® to assess and improve upon individual sensor characteristics, such as zero shift, ringing, and non-linearity.

Highlights:

- Mechanically and electrically filtered avoids ringing and minimizes zero shift
- Lightweight titanium construction
- Hermetically sealed for harsh environments

Applications:

- Simulated Pyroshock Events
- Recoil and Penetration
- Impact Press Monitoring
- Explosive Studies
- Shaker Impact Monitoring

Models
350B23
350C02
350B21

Model 350B50

Shock Accelerometers				
Model Number	**350B23**	**350C02**	**350B21**	**350B50**
Sensitivity	0.5 mV/g	0.1 mV/g	0.05 mV/g	0.05 mV/g
Measurement Range	± 10,000 g pk	50,000 g pk	± 100,000 g pk	± 10,000 g pk
Broadband Resolution	0.04 g rms	0.5 g rms	0.3 g rms	0.03 g rms
Frequency Range (± 1 dB)	0.4 to 10k Hz	4 to 10k Hz	1 to 10k Hz	3 to 10k Hz
Electrical Filter Corner	13 kHz (-3dB)	13 kHz	—	—
Mechanical Filter Resonance	23 kHz	23 kHz	—	—
Resonant Frequency	≥ 100 kHz	≥ 100 kHz	≥ 200 kHz	≥ 60 kHz
Temperature Range	0 to +150 °F -18 to +66 °C	0 to +150 °F -18 to +66 °C	-65 to +200 °F -54 to +93 °C	-65 to +250 °F -54 to +121 °C
Sensing Element	Ceramic/Shear	Ceramic/Shear	Ceramic/Shear	Ceramic/Shear
Electrical Connector	Integral Cable	Integral Cable	Integral Cable	Integral Cable
Electrical Ground Isolation	Yes	Yes	Yes	Isolation Base
Housing Material	Titanium	Titanium	Titanium	Titanium
Sealing	Hermetic	Hermetic	Hermetic	Hermetic
Weight	4.5 gm	4.2 gm	4.4 gm	8.6 gm
Size	3/8 x 0.75 in 3/8 in x 19.1 mm	3/8 x 0.75 in 3/8 in x 19.1 mm	3/8 x 0.73 in 3/8 in x 18.5 mm	0.33 x 0.69 x 0.69 in 8.4 x 17.5 x 17.5 mm
Mounting	1/4-28 Stud	1/4-28 Stud	1/4-28 Stud	Through Hole
Supplied Accessories				
Cable	—	—	—	034G05
Insulated Cap Screw	—	—	—	(4) 081A112
Adhesive Mounting Base	—	—	—	080A197
Additional Accessories				
Adhesive Mounting Base	080M217, M080M217	080M217, M080M217	080M217, M080M217	—
Triaxial Mounting Adaptor	080A180, M080A180	080A180, M080A180	080A180, M080A180	—
Mating Cable Connectors	AL	AL	AL	—
Connector Adaptor	070A02	070A02	070A02	—
Additional Versions				
Metric Mounting Thread	M350B23	M350C02	M350B21	—

Pressure Products for Blast Testing

Measuring Explosions and Propellant Burns

Pressure sensors with quartz, ceramic and tourmaline sensing elements are used for a wide variety of shock wave, blast and explosive testing. Typical applications include measurement of shock and blast waves, combustion or detonation in closed bombs, projectile velocity, free field or underwater explosive testing, and squib lot acceptance testing. All of these applications require high frequency response and durability, ability to drive long cables, and operate in adverse environments.

In applications involving long input cables to data acquisition systems, care must be exercised to assure the measurement system has adequate frequency response. Capacitance associated with the long cables can act as a low pass filter. Sensor output voltage, cable capacitance and constant current are factors to be considered. More current is required to drive higher voltages over longer cables. PCB® signal conditioners can be easily field-adjusted up to 20 mA to drive long cables. Selecting a sensor to provide about 1 V full scale for the expected pressure to be measured, rather than 5V, will provide 5 times greater frequency response for a given current and cable length.

Most of the sensors listed in this section incorporate acceleration-compensating sensing elements with integral electronics, which provide a frequency-tailored, non-resonant response. Frequency tailored sensors have microsecond rise time and suppressed resonance to faithfully follow shock wave events without the characteristic "ringing" common in other sensors

Applications:

- Air Blast Measurement
- Underwater Explosion Measurement
- Peak and Total Impulse
- Explosive Research and Structural Loading
- Shock Tube or Closed Bomb Testing
- Wave Velocity and/or Time of Arrival Determinations
- Explosive Component (e.g., Squib) Lot Acceptance


Series 113B are ideal for measuring blast "over-pressure."

Series 113B

High Frequency, General Purpose Pressure Sensors

PCB® Series 113B dynamic pressure sensors set the standard for extremely fast, micro-second response and a wide amplitude and frequency range that allows them to excel in high-frequency applications where minimum sensor diameter is required. Typical applications include combustion studies, explosive component testing (e.g. detonators, explosive bolts), airbag testing, and measurement of air blast shock waves resulting from explosions.

Highlights

- Fast rise time ≤ 1 µsec from quartz element
- Ultra-high resonant frequency of ≥ 500 kHz
- Frequency-tailored output without the "ringing" characteristic of most other sensors
- Internal acceleration compensation minimizes shock and vibration sensitivity

Dynamic Pressure Sensors for High Frequency


Model Number	113B28	113B27	113B21	113B26	113B24	113B22	113B23	113B03
Measurement Range (+/- 5 Volt Output)	50 psi 345 kPa	100 psi 690 kPa	200 psi 1380kPa	500 psi 3450 kPa	1 kpsi 6895 kPa	5 kpsi 34,475 kPa	10 kpsi 68,950 kPa	15 kpsi 103,420 kPa
Useful Overrange (+/- 10 Volt Output)	100 psi [1] 690 kPa [1]	200 psi [1] 1380 kPa [1]	400 psi [1] 2758 kPa [1]	1 kpsi [1] 6895 kPa [1]	2 kpsi [1] 13,790 kPa [1]	10 kpsi [1] 68,950 kPa [1]	—	—
Sensitivity	100 mV/psi 14.5 mV/kPa	50 mV/psi 7.25 mV/kPa	25 mV/psi 3.6 mV/kPa	10 mV/psi 1.45 mV/kPa	5 mV/psi 0.725 mV/kPa	1 mV/psi 0.145 mV/psi	0.5 mV/psi 0.073 mV/kPa	0.44 pC/psi 0.064 pC/kPa
Maximum Pressure	1 kpsi 6895 kPa	1 kpsi 6895 kPa	1 kpsi 6895 kPa	10 kpsi 68,950 kPa	10 kpsi 68,950 kPa	15 kpsi 103,420 kPa	15 kpsi 103,420 kPa	15 kpsi 103,420 kPa
Resolution	0.5 mpsi 0.0034 kPa	1 mpsi 0.007 kPa	1 mspi 0.007 kPa	2 mpsi 0.014 kPa	20 mpsi 0.138 kPa	20 mpsi 0.138 kPa	40 mpsi 0.28 kPa	10 mpsi [3] 0.07 kPa [3]
Resonant Frequency	≥ 500k Hz	≥ 500k Hz	≥ 500k Hz	≥ 500k Hz	≥ 500k Hz	≥ 500k Hz	≥ 500k Hz	≥ 500k Hz
Rise Time (Reflected)	≤ 1 µsec	≤ 1 µsec	≤ 1 µsec	≤ 1 µsec	≤ 1 µsec	≤ 1 µsec	≤ 1 µsec	≤ 1 µsec
Low Frequency Response (-5 %)	0.5 Hz	0.5 Hz	0.5 Hz	0.01 Hz	0.005 Hz	0.001 Hz	0.0005 Hz	—
Non-linearity	≤ 1 % [2]	≤ 1 % [2]	≤ 1 % [2]	≤ 1 % [2]	≤ 1 % [2]	≤ 1 % [2]	≤ 1 % [2]	≤ 1 % [2]
Acceleration Sensitivity	≤ 0.002 psi/g ≤ 0.0014 kPa/(m/s²)	≤ 0.002 psi/g ≤ 0.0014 kPa/(m/s²)	≤ 0.002 psi/g ≤ 0.0014 kPa/(m/s²)	≤ 0.002 psi/g ≤ 0.0014 kPa/(m/s²)	≤ 0.002 psi/g ≤ 0.0014 kPa/(m/s²)	≤ 0.002 psi/g ≤ 0.0014 kPa/(m/s²)	≤ 0.002 psi/g ≤ 0.0014 kPa/(m/s²)	≤ 0.002 psi/g ≤ 0.0014 kPa/(m/s²)
Temperature Range	-100 to +275 °F -73 to +135 °C	-100 to +275 °F -73 to +135 °C	-100 to +275 °F -73 to +135 °C	-100 to +275 °F -73 to +135 °C	-100 to +275 °F -73 to +135 °C	-100 to +275 °F -73 to +135 °C	-100 to +275 °F -73 to +135 °C	-400 to +400 °F -240 to +204 °C
Discharge Time Constant (at room temp)	≥ 1 sec	≥ 1 sec	≥ 1 sec	≥ 50 sec	≥ 100 sec	≥ 500 sec	≥ 1000 sec	—
Electrical Connector	10-32 Jack	10-32 Jack	10-32 Jack	10-32 Jack	10-32 Jack	10-32 Jack	10-32 Jack	10-32 jack
Housing Material	17-4 Stainless	17-4 Stainless	17-4 Stainless	17-4 Stainless	17-4 Stainless	17-4 Stainless	17-4 Stainless	17-4 Stainless
Diaphragm Material	Invar	Invar	Invar	Invar	Invar	Invar	Invar	Invar
Sealing	Welded Hermetic	Welded Hermetic	Welded Hermetic	Welded Hermetic	Welded Hermetic	Welded Hermetic	Welded Hermetic	Welded Hermetic

Mounting Adaptors


061A01 (3/8-24)
061A10 (M10)
062A01 (1/8-NPT)


061A59 (3/8-24 Delrin, Ground Isolated)

Series 113B
Dynamic Pressure Sensors for High Frequency

Supplied Accessories

Seal Rings: (3) 065A02 brass, 0.015 in. thick, (1) 065A05 stainless steel, 0.240 in. thick.

Clamp Nuts: (1) 060A03 English 5/16-24 thread, (1) 060A05 metric M7 thread

Notes

[1] For +10 volt output, minimum 24 VDC supply voltage required. Negative 10 volt output may be limited by output bias.

[2] Zero-based, least-squares, straight line method.

[3] Resolution dependent on signal conditioning and cable length used in charge system.

Series 102B

Ground Isolated Version of the Series 113B

These sensors have all of the same features and benefits of the Series 113B, plus the added benefit of having their output electrically isolated from ground, which helps prevent ground loop problems. This series can accomodate an optional ablative coating (Prefix: CA) to protect the diaphram from thermal shock in flash-temperature applications.

Tips from Techs

Ablative Coating Option 'CA' Available for Flash Temperature Protection

Highlights

- Ultra-high frequency > 500 kHz
- Fast rise time < 1 µsec
- Peak pressure and total impulse

Applications

- Shock Tubes and Closed Bombs
- Time-of-arrival Measurements
- Explosion, Blast, and Shock Wave

Ground Isolated, Dynamic Pressure Sensors for High Frequency

Model Number	102B18	102B16	102B15	102B06	102B04	102B	102B03
Measurement Range (+/- 5 Volt Output)	50 psi 345 kPa	100 psi 690 kPa	200 psi 1380 kPa	500 psi 3450 kPa	1 kpsi 6895 kPa	5 kpsi 34,475 kPa	10 kpsi 68,950 kPa
Useful Overrange (+/- 10 Volt Output)	100 psi [1] 690 kPa [1]	200 psi [1] 1380 kPa [1]	400 psi [1] 2758 kPa [1]	1 kpsi [1] 6895 kPa [1]	2 kpsi [1] 13,790 kPa [1]	10 kpsi [1] 68,950 kPa [1]	—
Sensitivity	100 mV/psi 14.5 mV/kPa	50 mV/psi 7.25 mV/kPa	25 mV/psi 3.6 mV/kPa	10 mV/psi 1.45 mV/kPa	5 mV/psi 0.725 mV/kPa	1 mV/psi 0.145 mV/psi	0.5 mV/psi 0.073 mV/kPa
Maximum Pressure	1 kpsi 6895 kPa	1 kpsi 6895 kPa	1 kpsi 6895 kPa	10 kpsi 68,950 kPa	10 kpsi 68,950 kPa	15 kpsi 103,420 kPa	15 kpsi 103,420 kPa
Resolution	0.5 mpsi 0.0034 kPa	1 mpsi 0.007 kPa	1 mspi 0.007 kPa	2 mpsi 0.014 kPa	20 mpsi 0.138 kPa	20 mpsi 0.138 kPa	40 mpsi 0.28 kPa
Resonant Frequency	≥ 500k Hz	≥ 500k Hz	≥ 500k Hz	≥ 500k Hz	≥ 500k Hz	≥ 500k Hz	≥ 500k Hz
Rise Time (Reflected)	≤ 1 µsec	≤ 1 µsec	≤ 1 µsec	≤ 1 µsec	≤ 1 µsec	≤ 1 µsec	≤ 1 µsec
Low Frequency Response (-5 %)	0.5 Hz	0.5 Hz	0.5 Hz	0.01 Hz	0.005 Hz	0.001 Hz	0.0005 Hz
Non-linearity	≤ 1 % [2]	≤ 1 % [2]	≤ 1 % [2]	≤ 1 % [2]	≤ 1 % [2]	≤ 1 % [2]	≤ 1 % [2]
Acceleration Sensitivity	≤ 0.002 psi/g ≤ 0.0014 kPa/(m/s²)	≤ 0.002 psi/g ≤ 0.0014 kPa/(m/s²)	≤ 0.002 psi/g ≤ 0.0014 kPa/(m/s²)	≤ 0.002 psi/g ≤ 0.0014 kPa/(m/s²)	≤ 0.002 psi/g ≤ 0.0014 kPa/(m/s²)	≤ 0.002 psi/g ≤ 0.0014 kPa/(m/s²)	≤ 0.002 psi/g ≤ 0.0014 kPa/(m/s²)
Temperature Range	-100 to +275 °F -73 to +135 °C	-100 to +275 °F -73 to +135 °C	-100 to +275 °F -73 to +135 °C	-100 to +275 °F -73 to +135 °C	-100 to +275 °F -73 to +135 °C	-100 to +275 °F -73 to +135 °C	-100 to +275 °F -73 to +135 °C
Discharge Time Constant (at room temp)	≥ 1 sec	≥ 1 sec	≥ 1 sec	≥ 50 sec	≥ 100 sec	≥ 500 sec	≥ 1000 sec
Electrical Connector	10-32 Jack	10-32 Jack	10-32 Jack	10-32 Jack	10-32 Jack	10-32 Jack	10-32 Jack
Housing Material	17-4 Stainless	17-4 Stainless	17-4 Stainless	17-4 Stainless	17-4 Stainless	17-4 Stainless	17-4 Stainless
Diaphragm Material	Invar	Invar	Invar	Invar	Invar	Invar	Invar
Sealing	Welded Hermetic	Welded Hermetic	Welded Hermetic	Welded Hermetic	Welded Hermetic	Welded Hermetic	Welded Hermetic
Additional Versions							
Metric Mounting Thread	M102B18	M102B16	M102B15	M102B06	M102B04	M102B	M102B03

This is a sample of PCB's Pressure Sensor offerings. Refer to PCB's Test & Measurement catalog or search "Pressure" at www.pcb.com.

Series 102B
Ground Isolated, Dynamic Pressure Sensors for High Frequency

Supplied Accessories
Seal Rings: (3) 065A03 brass 0.030 in. thick.
Notes
[1] For +10 volt output, minimum 24 VDC supply voltage required. Negative 10 volt output may be limited by output bias.
[2] Zero-based, least-squares, straight line method.

Models
106B52 & 106B50

Model 106B

Series 106B

ICP® High Intensity, Acoustic Pressure Sensors

Model 106B and 106B50 are high sensitivity, acceleration-compensated, ICP® quartz pressure sensors suitable for measuring intense acoustic phenomena. In fact, the series is widely used for measuring acoustic fields in operating launch vehicles and their associated payloads. The Series 106 family range spans from acoustic pressures of less than 80 dB to several psi. Similar piezoelectric technology is employed in PCB's complete range of hermetically sealed dynamic pressure sensors. These products measure pressure fluctuations from acoustic levels to tens of thousands of psi and frequencies from nearly DC to tens of kHz. Their ability to measure only pressure fluctuations above a specified frequency imposed on large static pressure fields makes them uniquely suited for such applications as combustion instability monitoring.

High Sensitivity, ICP® Acoustic Pressure Sensors

Model Number	106B52	106B50	106B
Measurement Range (± 2 V output)	1 psi 6.89k Pa [1]	5 psi 34.45k Pa	8.3 psi 57.2k Pa
Sensitivity	5000 mV/psi 725 mV/kPa	500 mV/psi 72.5 mV/kPa	300 mV/psi 43.5 mV/psi
Maximum Dynamic Pressure Step	10 psi 68.9k Pa	100 psi 690k Pa	200 psi 1379k Pa
Maximum Static Pressure	50 psi 345k Pa	500 psi 3448k Pa	2 kpsi 13,790k Pa
Resolution	0.02 mpsi 0.00013k Pa	0.07 mpsi 0.00048k Pa	0.1 mpsi 0.00069k Pa
Resonant Frequency	≥ 40k Hz	≥ 40k Hz	≥ 60k Hz
Low Frequency Response (-5 %)	2.5 Hz	0.5 Hz	0.5 Hz
Acceleration Sensitivity	≤ 0.002 psi/g ≤ 0.0014 kPa/(m/s²)	≤ 0.002 psi/g ≤ 0.0014 kPa/(m/s²)	≤ 0.002 psi/g ≤ 0.0014 kPa/(m/s²)
Temperature Range	-65 to +250 °F -54 to +121 °C	-65 to +250 °F -54 to +121 °C	-65 to +250 °F -54 to +121 °C
Discharge Time Constant (at room temp)	≥ 0.2 sec	≥ 1 sec	≥ 1 sec
Electrical Connector	10-32 Coaxial Jack	10-32 Coaxial Jack	10-32 Coaxial Jack
Housing Material	17-4 Stainless Steel	17-4 Stainless Steel	304/304L Stainless Steel
Diaphragm Material	316L Stainless Steel	316L Stainless Steel	316L Stainless Steel
Sealing	Welded Hermetic	Welded Hermetic	Welded Hermetic
Supplied Accessories			
English Clamp Nuts	(1) 060A11, 3/4-16, Delrin	(1) 060A11, 3/4-16, Delrin	(1) 060A12, 9/16-18 thd
Metric Clamp Nuts	(1) 060A13, M20x1.25, Delrin	(1) 060A13, M20x1.25, Delrin	(1) 060A14, M14 x 1.25 thd
Seal Rings	(3) 065A36 Delrin, 0.060 in thk	(3) 065A36 Delrin, 0.060 in thk	(1) 065A37, brass, 0.025 in thk
Additional Accessories			
Pipe Thread Adaptor	062A07, 1/2 NPT	062A07, 1/2 NPT	062A06, 1/2 NPT
English Thread Adaptor	—	—	061A60, 3/4-16 thd
Ground Isolated Adaptor, English Thread	061A65, 1.0-12 thd, Delrin	061A65, 1.0-12 thd, Delrin	061A61, 3/4-16 thd, Delrin
Water Cooled Adaptor	064A07	064A07	064B06
Mating Cable Connectors	EB	EB	EB
Recommended Stock Cables	002 Low Cost, 003 CE	002 Low Cost, 003 CE	002 Low Cost, 003 CE
Notes			
[1] For ± 5 V output			

This is a sample of PCB's Quartz ICP Pressure Sensors. Refer to PCB's Test & Measurement catalog or search "106" at www.pcb.com.

Series 132

Time of Arrival, ICP® Micro-pressure Sensors

High-Sensitivity Micro-Pressure Sensors are well suited for short wavelength acoustic and shock wave measurements associated with high-frequency projectile detection systems. Incorporating a 1mm diameter sensing element and integral microelectronics in a 3mm housing, these sensors have very high sensitivity and microsecond response capable of identifying the bow and stern wave from a passing projectile. An internal 8 kHz high-pass filter eliminates low-frequency inputs. Series 132 Microsensors are available in five different physical configurations to accommodate a wide range of application requirements.

Series 132A30 Microsensors all have a sensitivity of 100 mV/psi and come in a variety of external configurations to suit your specific application.

Highlights

- Shock wave time-of-arrival ICP® microsensors
- 50 psi (344 kPa) range
- Rise time <3 µsec
- Resonant frequency >1M Hz
- 0.124" (3.15 mm) diameter diaphragm

ICP® Micro-pressure Sensors for Time of Arrival

Model Number	132A31	132A35	132A36	132A37
Measurement Range	50 psi 345 kPa	50 psi 345 kPa	50 psi 345 kPa	50 psi 345 kPa
Sensitivity	140 mV/psi 20 mV/kPa	240 mV/psi 34.8 mV/kPa	140 mV/psi 20 mV/kPa	140 mV/psi 20 mV/kPa
Maximum Dynamic Pressure Step	800 psi 5515 kPa	800 psi 5515 kPa	800 psi 5515 kPa	800 psi 5515 kPa
Resolution	1 mpsi 0.007 kPa	1 mpsi 0.007 kPa	1 mpsi 0.007 kPa	1 mpsi 0.007 kPa
Resonant Frequency	> 1000 kHz	> 1000 kHz	> 1000 kHz	> 1000 kHz
Rise Time (Incident)	< 3 µsec	< 3 µsec	< 3 µsec	< 3 µsec
Rise Time (Reflected)	< 0.5 µsec	< 0.5 µsec	< 0.5 µsec	< 0.5 µsec
Low Frequency Response (-5 %)	11 kHz	11 kHz	11 kHz	11 kHz
Temperature Range	0 to +175 °F -18 to +79 °C	0 to +175 °F -18 to +79 °C	0 to +175 °F -18 to +79 °C	0 to +175 °F -18 to +79 °C
Discharge Time Constant(at room temp)	> 0.000045 sec	> 0.000045 sec	> 0.000045 sec	> 0.000045 sec
Electrical Connector	Integral Cable	Integral Cable	10-32 Coaxial Jack	Integral Cable
Housing Material	Stainless Steel	Stainless Steel	Delrin	Stainless Steel
Sealing	Epoxy	Epoxy	Epoxy	Epoxy
Supplied Accessories				
English Clamp Nut	060A28	060A28	—	—
10-32 Plug Solder Adaptor	070B09	070B09	—	070B09
Spanner Wrench	—	—	061A30	—
O-Rings	—	—	—	160-0238-00

Series 134

Tourmaline Pressure Bar

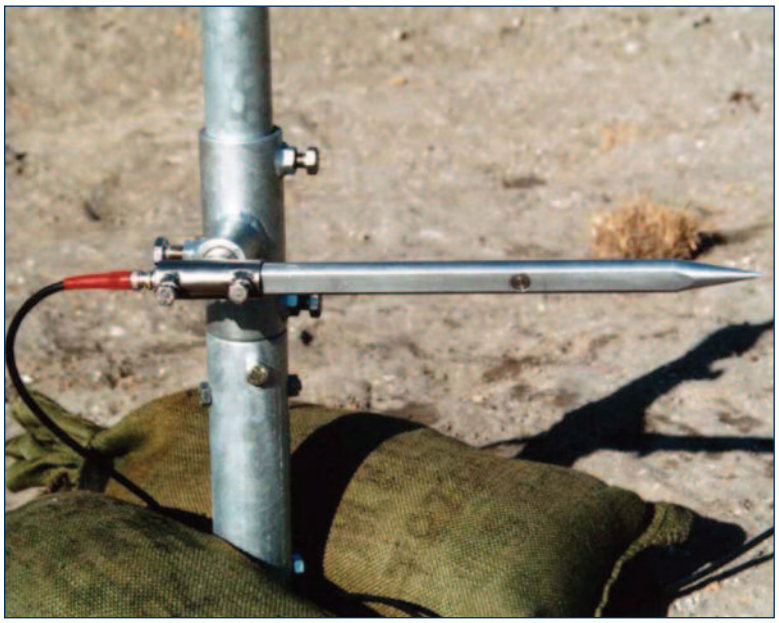
This unique non-resonant sensor is designed for instantaneous, reflected (face-on) shock wave pressure measurements. A shock wave pressure impacting the very thin tourmaline crystal which operates into a silver alloyed "pressure bar", eliminates sensor structure response. The sensor has a 0.2-microsecond rise time. Since the sensor diaphragm end is coated with a conductive silver epoxy, the sensor should not be used in water or chemical environments.

Highlights

- Designed for reflected shock wave pressure measurement
- Unique non-resonating design, Tourmaline sensing element
- Pressure ranges from 1000 to 20k psi (6894 to 137,900 kPa)
- Rise time ≤ 0.2 µsec

Tourmaline ICP® Pressure Bar for Instantaneous Reflected (face-one) Shock Wave Measurements

Series Number	134A
Measurement Range (+/- 5 Volt Output unless noted)	1000 psi to 20 kpsi 6895 kPa to 137900 kPa
Sensitivity	5 mv/psi to 0.25 mV/psi 0.73 mV/kPa to 0.04 mV/kPa
Resolution	20 mpsi to 300 mpsi 0.14 kPa to 2.1 kPa
Resonant Frequency	> 1500 kHz
Rise Time (Reflected)	< 0.2 µsec
Low Frequency Response (-5 %)	0.25 kHz
Non-linearity	< 2% [1]
Temperature Range	+32 to +120 °F 0 to +49 °C
Discharge Time Constant(at room temp)	> 1 sec
Electrical Connector	10-32 Coaxial Jack
Housing Material	Stainless Steel
Diaphragm Material	Epoxy
Sealing	Epoxy
Supplied Accessories	
Spanner Wrench	061A30
Additional Accessories	
Mating Cable Connectors	EB
Recommended Stock Cables	Low Noise, 003 CE
Additional Versions	
Charge Output	134A, 134A02
Notes	
[1] Zero-based, least-squares, straight line method.	



Series 137

ICP® Free-Field Blast Pressure "Pencil" Probe

Series 137 incorporates acceleration-compensated quartz elements and integral microelectronics for long cable driving, improved stability and low thermal sensitivity.

Highlights

- ICP® free-field blast pencil probes
- Ranges from 50 to 5000 psi (344 to 34,475 kPa)
- Rise time <4 µsec
- Resonant frequency >500k Hz

Model Number	137B23B	137B24B	137B22B	137B21B
Measurement Range	50 psi 345 kPa	250 psi 1725 kPa	500 psi 3450 kPa	1 kpsi [3] 6895 kPa [3]
Useful Overrange	100 psi [1] 690 kPa [1]	500 psi [1] 3450 kPa [1]	1 kpsi [1] 6895 kPa [1]	—
Sensitivity	100 mV/psi 14.5 mV/kPa	20 mV/psi 2.9 mV/kPa	10 mV/psi 1.45 mV/kPa	1 mV/psi 0.145 mV/kPa
Maximum Pressure	1 kpsi 6895 kPa	5 kpsi 34,475 kPa	1 kpsi 6895 kPa	5 kpsi 34,475 kPa
Resolution	10 mpsi 0.069 kPa	2 mpsi 0.001 kPa	10 mpsi 0.069 kPa	100 mpsi 0.69 kPa
Resonant Frequency	> 500 kHz	> 500 kHz	> 500 kHz	> 500 kHz
Rise Time (Incident)	< 4 µsec	< 4 µsec	< 4 µsec	< 4 µsec
Non-linearity	< 1 % [2]	< 1 % [2]	< 1 % [2]	< 1 % [2]
Temperature Range	-100 to +275 °F -73 to +135 °C	-100 to +275 °F -73 to +135 °C	-100 to +275 °F -73 to +135 °C	-100 to +275 °F -73 to +135 °C
Discharge Time Constant(at room temp)	> 0.2 sec	> 0.2 sec	> 0.2 sec	> 0.2 sec
Electrical Connector	BNC Coaxial Jack	BNC Coaxial Jack	BNC Coaxial Jack	BNC Coaxial Jack
Housing Material	Aluminum	Aluminum	Aluminum	Aluminum
Diaphragm Material	Invar	Invar	Invar	Invar
Sealing	Epoxy	Epoxy	Epoxy	Epoxy
Additional Accessories				
Mating Cable Connectors	AC	—	—	—
Recommended Stock Cables (29 pF/ft, 95 pF/m)	002 Multi-strand for Blast, 003 CE	—	—	—
Additional Versions				
10-32 Coaxial Jack Connector with Protection	137B23A	137B24A	137B22A	137B21A
Notes				
[1] For +10 volt output, minimum 24 VDC supply voltage required. Negative 10 volt output may be limited by output bias. [2] Zero-based, least-squares, straight line method. [3] For +/- 1V output.				

Series 138

ICP® Tourmaline Underwater Blast Sensor

Series 138 Sensors measure shock wave pressures associated with underwater explosion testing. The sensors are structured with a volumetrically sensitive tourmaline crystal, suspended and sealed in an insulating, oil-filled vinyl tube. They have integral microelectronics. These underwater shock wave sensors provide a clean, non-resonant, high-voltage output through long cables in adverse underwater environments. They can be supplied with a sealed cable of appropriate length, ready to operate. Two physical configurations are available.

Highlights

- ICP® underwater blast explosion pressure probes
- Ranges from 1000 to 50k psi (6894 to 344,740 kPa)
- Rise time <1.5 µsec
- Resonant frequency >1M Hz

CE

Underwater Tourmaline Blast Sensors for Peak, Overpressure and High-pressure Bubble Energy Measurements

Series 138A Model Numbering System

1) Connector Type			
Default	10-32 Coaxial Jack		
W	Attached Waterproof Cable		
	2A) ICP® Output Pressure Range and Tube Length / Configuration		
	138A01	Measurement Range: 1000 psi (6895 kPa) with 7.6 in.(193 mm) Length and Sinker Hole for Vertical Mounting	
	138A02	Measurement Range: 1000 psi (6895 kPa) with 4.7 in. (120 mm) Length for Horizontal Mounting	
	138A05	Measurement Range: 5000 psi (34,475 kPa) with 7.6 in.(193 mm) Length and Sinker Hole for Vertical Mounting	
	138A06	Measurement Range: 5000 psi (34,475 kPa) with 4.7 in. (120 mm) Length for Horizontal Mounting	
	138A10	Measurement Range: 10 kpsi (68,950 kPa) with 7.6 in.(193 mm) Length and Sinker Hole for Vertical Mounting	
	138A11	Measurement Range: 10 kpsi (68,950 kPa) with 4.7 in. (120 mm) Length for Horizontal Mounting	
	138A25	Measurement Range: 25 kpsi (172,375 kPa) with 7.6 in.(193 mm) Length and Sinker Hole for Vertical Mounting	
	138A26	Measurement Range: 25 kpsi (172,375 kPa) with 4.7 in. (120 mm) Length for Horizontal Mounting	
	138A50	Measurement Range: 50 kpsi (344,750 kPa) with 7.6 in.(193 mm) Length and Sinker Hole for Vertical Mounting	
	138A51	Measurement Range: 50 kpsi (344,750 kPa) with 4.7 in. (120 mm) Length for Horizontal Mounting	
	2B) Charge Output Pressure Range and Tube Length / Configuration		
	138A	Measurement Range: 25 kpsi (172,375 kPa) with 7.6 in.(193 mm) Length and Sinker Hole for Vertical Mounting	
	138A24	Measurement Range: 25 kpsi (172,375 kPa) with 4.7 in. (120 mm) Length for Horizontal Mounting	
		3) Attached Model 038 Cable Length (add only if ordering the W option)	
		/038CYxxxAC	Specify total length xxx in feet. Cable is terminated with BNC plug connector.
		/M038CYxxxAC	Specify total length xxx in meters. Cable is terminated with BNC plug connector.
Example			
W	**138A05**	**/038CY300AC**	**Attached 300 ft. 038 cable, 5000 psi measurement range, 7.6 in. length, sinker hole, BNC plug termination.**

Pressure Products for Ballistic Testing

Ballistic Pressure Sensors

PCB® has supplied high frequency, durable, Quartz ballistics pressure sensors in both charge and ICP® voltage mode versions for over forty years. The Series 109 ICP® ballistic pressure sensors are acceleration compensated, and have a ceramic coated integral diaphragm to attenuate thermal shock associated with burning propellants. This series also features a floating clamp nut that reduces strain sensitivity on the sensor body due to mounting torque. The ICP® integral electronics are protected from shock such as that found in gun test applications. Series 119 charge output versions are also available.

In the early 1970's PCB® worked with members of the Sporting Arms and Ammunition Manufacturers' Institute (SAAMI) to develop an accurate, durable, standard test method for sporting arms ammunition. Pressure sensors suitable for implementation into a standardized test method for rapid-fire production testing of ammunition were required. This method involved a sensor with a machined curved diaphragm that measures pressure directly through the shell case. Based on this success, the conformal sensor became a SAAMI/ANSI "National Standard" for ammunition testing.

Applications

- Ammunition and Gun Testing
- Explosives Testing
- Closed Bombs
- Recoil Mechanisms
- Ultra High-frequency Detonation

Series 117B conformal pressure sensors measure true gun chamber pressure directly through an unmodified shell case. Since the sensor diaphragm is machined to conform flush to the specific chamber diameter, the measurement process is not altered or changed in any way. There are no cartridges to be drilled or troublesome gas passages to be cleaned when using the conformal method. Conformal sensors have proven to be rugged, stable instruments, lasting thousands of rounds. Since the same sensor may outlast the life of many barrels, it is possible to start and finish ammunition batch qualification testing without experiencing sensor failure during the test.

Keeping with our tradition, PCB® continues to offer a complete line of sensors for conformal and case mouth ballistic measurements. All PCB® sensors are provided with NIST traceable calibration. For pre-calibration stabilization purposes, all ballistic pressure sensors are hydraulically cycled at high pressures and most are test fired in the PCB® ballistic firing range. PCB® also offers a high pressure static calibration system, Model 905C, for on-site use in ballistic labs. Side-by-side dynamic/static comparison calibration services are offered for PCB® and competitors' ballistic sensors.

Series 109C

Series 109
ICP® Ballistic Sensors

PCB® offers a complete line of high pressure ballistic sensors with integral electronics. They operate from a PCB® constant-current signal conditioner and provide a high-voltage, low-impedance output. ICP® sensors are well suited for applications involving long cables and operation in dirty factory or field environments.

These sensors incorporate a captivated floating clamp nut and a more stable structure for improved accuracy, reliability, and lower thermal transient sensitivity. They are structured with quartz sensing elements, built-in microelectronics, and an integral machined ceramic-coated diaphragm for greater durability, overrange capability, high-frequency response, and improved linearity.

Models 109C11 and 109C12 are acceleration-compensated ICP® sensors for high-energy, high-frequency applications, such as detonation, closed bomb combustion, and explosive blast measurements under extreme shock conditions.

Series 119
Charge Mode Ballistic Sensors

Charge Mode Pressure Sensors are well suited for high-pressure ballistics, detonation, and explosive research and test applications.

These sensors incorporate stable quartz-sensing elements, a durable-machined ceramic-coated integral diaphragm and floating clamp nut.

Models 119B11 and 119B12 are unique, acceleration-compensated, high resolution ballistic sensors designed for high-pressure, high-energy ballistics, detonation, and explosive applications under high-shock conditions, such as those that might be encountered in howitzer and liquid-propellant weapons. Two dynamic ranges of 80,000 and 100,000 psi are available.

Series 119B

High Pressure Acceleration Compensated Sensors				
Model Number	**109C11**	**109C12**	**119B11**	**119B12**
Measurement Range	80 kpsi 552,000 kPa	100 kpsi 690,000 kPa	80 kpsi 552,000 kPa	100 kpsi 690,000 kPa
Useful Overrange	100 kpsi 690,000 kPa	120 kpsi 827,370 kPa	—	—
Sensitivity	0.07 mV/psi 0.01 mV/kPa	0.07 mV/psi 0.01 mV/kPa	0.25 pC/psi 0.036 pC/kPa	0.25 pC/psi 0.036 pC/kPa
Maximum Pressure	125 kpsi 862,000 kPa	125 kpsi 862,000 kPa	100 kpsi 690,000 kPa	125 kpsi 862,000 kPa
Resolution	2 psi 13.8 kPa	2 psi 13.8 kPa	1 psi 7 kPa	1 psi 7 kPa
Resonant Frequency	> 400 kHz	> 400 kHz	> 400 kHz	> 400 kHz
Rise Time (Reflected)	< 2 µsec	< 2 µsec	< 2 µsec	< 2 µsec
Non-linearity	< 2 % [1]	< 2 % [1]	< 2 % [1]	< 2 % [1]
Acceleration Sensitivity	< 0.02 psi/g < 0.015 kPa/(m/s²)	< 0.02 psi/g < 0.015 kPa/(m/s²)	< 0.02 psi/g < 0.015 kPa/(m/s²)	< 0.02 psi/g < 0.015 kPa/(m/s²)
Temperature Range	-100 to +275 °F -73 to +135 °C	-100 to +275 °F -73 to +135 °C	-300 to +400 °F -184 to +204 °C	-300 to +400 °F -184 to +204 °C
Discharge Time Constant(at room temp)	> 2000 sec	> 2000 sec	–	–
Electrical Connector	10-32 Coaxial Jack	10-32 Coaxial Jack	10-32 Coaxial Jack	10-32 Coaxial Jack
Housing Material	C-300 Vascomax	C-300 Vascomax	C-300 Vascomax	C-300 Vascomax
Diaphragm Material	C-300 Vascomax	C-300 Vascomax	C-300 Vascomax	C-300 Vascomax
Diaphragm Coating	Ceramic	Ceramic	Ceramic	Ceramic
Sealing	Epoxy	Epoxy	Epoxy	Epoxy
Supplied Accessories				
Seals	065A06	065A06	065A06	065A06
Additional Accessories				
English Installation Tool Kits	040A20	040A20	040A20	040A20
Metric Installation Tool Kits	040A21	040A21	040A21	040A21
Mating Cable Connectors	EB	EB	EB	EB
Recommended Stock Cables	002 Low Cost, 003 CE	002 Low Cost, 003 CE	003	003
Additional Versions				
Metric Mount	M	M	M	M
Integral Threads	109B11	109B12	119B01	119B02
Hermetic Sealing	—	—	H	H
Notes				
[1] Zero-based, least-squares, straight line method.				

Series 117B

Charge Mode Conformal Ballistic Sensors

Conformal ballistic sensors measure true gun chamber pressure directly through the cartridge case. The diaphragm of the conformal sensor is contoured to match a specific chamber diameter. An alignment guide and spacers help the user to install the sensor flush with the gun chamber walls.

The conformal ballistic sensor, when correctly installed, has a proven life expectancy of hundreds of thousands of rounds, outlasting many test barrels. Rapid-fire testing is possible since there are no cartridges to drill and align, no diaphragm ablatives to apply, and no gas passages to clean. The conformal sensor does not affect operation of the test barrel, nor change the measurement process.

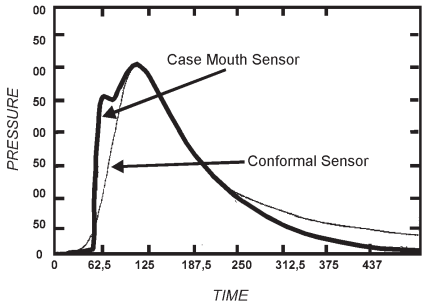
Developed in cooperation with members of SAAMI to provide an accurate rapid-fire electronic production test method to replace the mechanical "copper crusher," the conformal sensor has experienced 20 years of proven performance.

Conformal calibration through an unfired, unmodified empty cartridge shell case with PCB® Series 090B Calibration Adaptor accounts for the effects of the cartridge case. Output from the conformal sensor is compatible with any charge amplifier. The PCB® Model 443A53 Digital Peak Holding System with a charge amplifier and auto-reset peak meter facilitates rapid-fire testing of production ammunition.

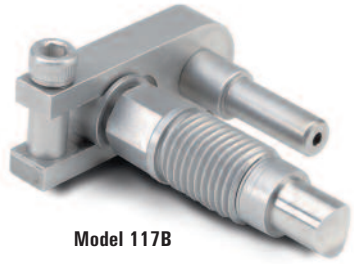
The two machined flats near the connector end, an alignment guide, and a captive retaining nut facilitate installation. The nut automatically extracts the sensor when it is unscrewed. Series 090B Calibration Adaptor permits static calibration of the Model 117B Sensor, with pressures to be applied to the empty cartridge case. Spacer set is supplied to facilitate flush installation of the sensor.

Highlights

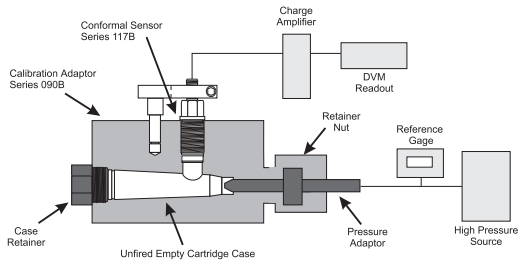
- Proven long life
- Outlasts life of many barrels
- SAAMI "standard" test method
- Allows rapid-fire testing
- No drilled cases or recessed passages
- Cost effective



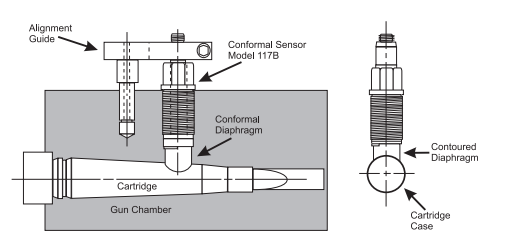
Conformal vs. Standard Case Mouth Installation



Model 117B



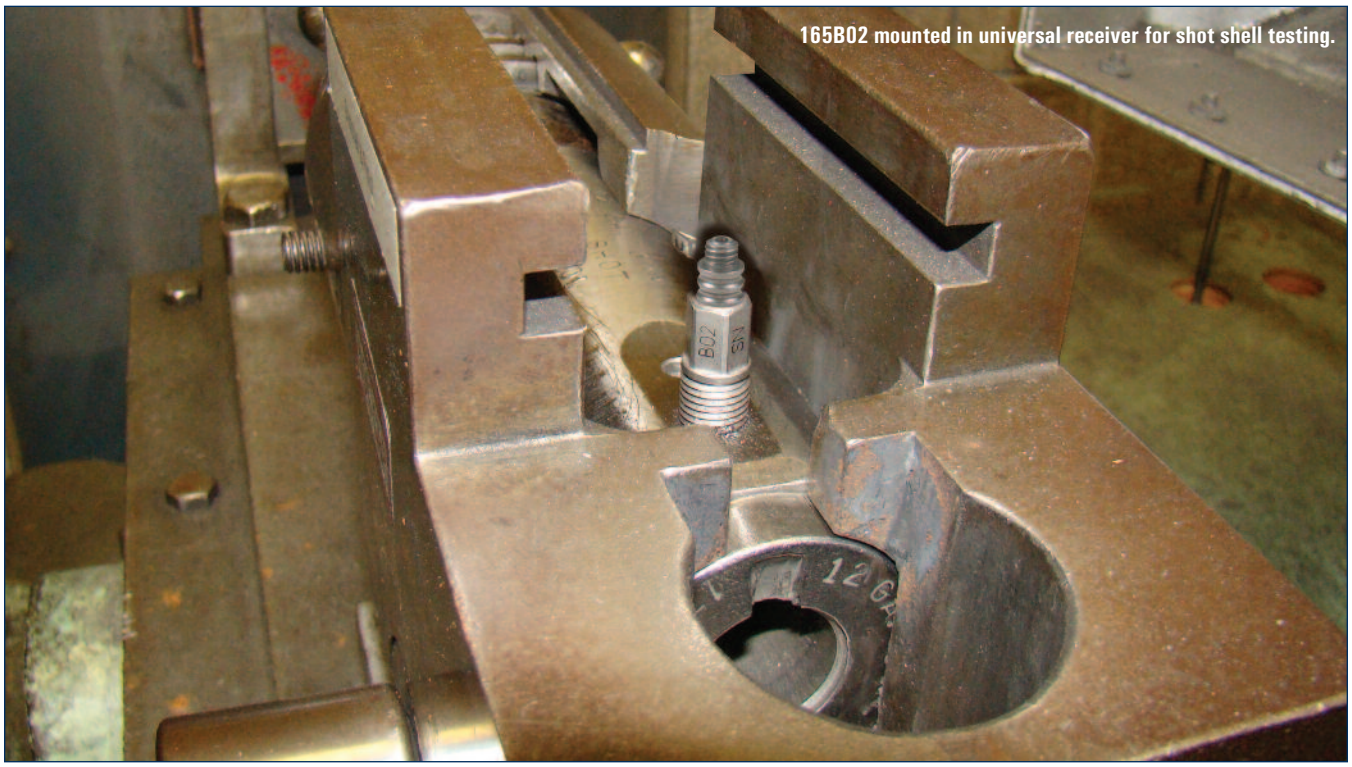
Typical Conformal Calibration Adaptor System



Typical Conformal Sensor Installation in Universal Receiver

Ballistic Pressure Sensors Small Arms Testing

	Conformal Gages	
	Contact factory for proper model number to match the caliber of ammunition under test	
Model Number	**117B Small Caliber**	**117B Large Caliber**
Measurement Range	35 kpsi 241 kPa	60 kpsi 414 kPa
Sensitivity	0.110 pC/psi 0.016 pC/kPa	0.140 pC/psi 0.021 pC/kPa
Maximum Pressure	40 kpsi 275 kPa	80 kpsi 552 kPa
Resolution	2 psi 14 kPa	2 psi 14 kPa
Resonant Frequency	> 300 kHz	> 300 kHz
Rise Time (Reflected)	< 2 µsec	< 2 µsec
Non-linearity	< 2 % [1]	< 2 % [1]
Acceleration Sensitivity	<0.02 psi/g <0.014 psi/(m/s²)	<0.02 psi/g <0.014 psi/(m/s²)
Temperature Range	-100 to +400 °F -73 to +204 °C	-100 to +400 °F -73 to +204 °C
Electrical Connector	10-32 Coaxial Jack	10-32 Coaxial Jack
Housing Material	17-4SS	17-4SS
Diaphragm Material	17-4SS	17-4SS
Additional Accessories		
Conformal Calibration Adaptors	090B	090B
Brass Calibration	Contact factory for assistance, requires customer supplied brass casings and conformal adaptor	
Mating Cable Connectors	EB	EB
Recommended Stock Cables	003	003
Notes		
[1] Zero-based, least-squares, straight line method.		


165B02 mounted in universal receiver for shot shell testing.

Ballistic Pressure Sensors Small Arms Testing	
	Shot Shell Sensor
Model Number	**165B02**
Measurement Range	30 kpsi 206,840 kPa
Sensitivity	0.2 pC/psi 0.029 pC/kPa
Maximum Pressure	70 kpsi 482,700 kPa
Resolution	10 mpsi 0.069 kPa
Resonant Frequency	> 175 kHz
Rise Time (Reflected)	< 2.5 µsec
Non-linearity	< 2 % [1]
Acceleration Sensitivity	< 0.03 psi/g < 0.015 kPa/(m/s²)
Temperature Range	-50 to +325 °F -46 to +163 °C
Electrical Connector	10-32 Coaxial Jack
Housing Material	C-300 Vascomax
Diaphragm Material	C-300 Vascomax
Additional Accessories	
Mating Cable Connectors	EB
Recommended Stock Cables	003
Additional Versions	
Floating clamp nut	167A11 [3]
Notes	
[1] Zero-based, least-squares, straight line method.	

Model 165B02

Charge Mode Shot Shell Sensor

For production testing of shotshell ammunition per SAAMI recommendations, this upgraded sensor measures chamber pressure through the case wall of an unmodified cartridge. The number of rounds capability has increased due to a recently modified design.


Model 165B02

Recommended Ballistic Peak Pressure Monitoring System


Model 444A53
Ballistic Peak Pressure Monitoring System
See Details on page 29.

Force & Strain Products for Structural Impact

Impact Force Sensors

Quartz, piezoelectric force and strain sensors are durable measurement devices, which possess exceptional characteristics for the measurement of dynamic force and strain events.

Applications

- Crash Testing
- Crushing
- Drop Testing
- Fatigue Testing
- Fracture Testing
- Materials Testing
- Penetration Testing
- Dynamic Tension & Compression
- Impact & Repetitive Applications
- Drop Testing
- Materials Testing

Series 208C

General Purpose Quartz Force Sensors	
Series	**208C**
Measurement Range (Compression)	10 - 5000 lb 44.5 -22.24 kN
Measurement Range (Tension)	10 - 500 lb 44.5 - 2.224 kN
Sensitivity	500 - 1 mV/lb 112.41 - 0.2248 mV/N
Maximum Static Force (Compression)	60 - 8000 lb 270 - 35.59 kN
Maximum Static Force (Tension)	60 - 500 lb 270 - 2.224 kN
Broadband Resolution	0.0001 - 0.05 lb-rms 0.00045 - 0.222 N-rms
Upper Frequency Limit	36 kHz
Low Frequency Response (-5%)	0.0003 - 0.01 Hz
Discharge Time Constant	≥ 50 sec - ≥ 2000 sec
Non-linearity	≤ 1%
Temperature Range	-65 to +250 °F -54 to +121 °C
Stiffness	6 lb/µin 1.05 kN/µm
Housing Material	Stainless Steel
Sealing	Hermetic
Electrical Connector	10-32 Coaxial Jack
Size (Hex x Height)	0.625 x 0.625 in 15.88 x 15.88 mm
Weight	22.7 gm
Mounting Thread	10-32 Thread
Supplied Accessories	
Impact Cap	084A03
Mounting Stud	081B05, M081A62
Thread Locker	080A81
Additional Accessories	
Mating Cable Connectors	EB
Recommended Cables	002 Low Cost, 003 CE

Series 201B

ICP® Quartz Force Ring for Performance Applications	
Series	**201B**
Sensitivity	50 to 1 mV/lb 11,240 to 224.8 mV/kN
Measurement Range (Compression)	100 to 5000 lb 0.4448 to 22.24 kN
Maximum Static Force (Compression)	600 to 8000 lb 2.67 to 35.59 kN
Broadband Resolution	0.002 to 0.10 lb-rms 0.00089 - 0.4448 N-rms
Low Frequency Response (-5 %)	0.006 to 0.0003 Hz
Temperature Range	-65 to +250 °F -54 to +121 °C
Preload	100 to 1000 lb 0.445 to 4.448 kN
Electrical Connector	10-32 Coaxial Jack
Sealing	Hermetic
Housing Material	Stainless Steel
Weight	10 gm
Size [1]	0.65 x 0.31 x 0.25 x 0.50 in 16.5 x 7.9 x 6.0 x 12.7 mm
Size (OD) (Sensor)	0.650 in 16.51 mm
Mounting	10-32 Thread
Supplied Accessories	
Assembly Lubricant	080A82
Mounting Stud	081A11
Anti-Friction Washer	082B01
Pilot Bushing	083B01
Notes	
[1] Diameter x Height x Bolt Diameter x Sensing Surface	

Model 740B02
Dynamic ICP® Strain Sensors

Highlights

- Measures small strain on top of large static loads
- Provides high resolution and wide dynamic range
- Designed with low profile and integral cable
- Contains built-in microelectronic circuitry
- Detects wave propagation for material velocity characterization

Structured with a quartz sensing element and microelectronic circuitry in a low-profile titanium housing, this sensor is ideal for high-resolution measurements of dynamic strain. This unit is compatible with PCB's ICP® Sensor signal conditioners and is capable of driving long cables. Typical applications include: active vibration control, noise-path analysis, modal testing, and use on aircraft and marine hulls, composite materials, and "smart" structures.

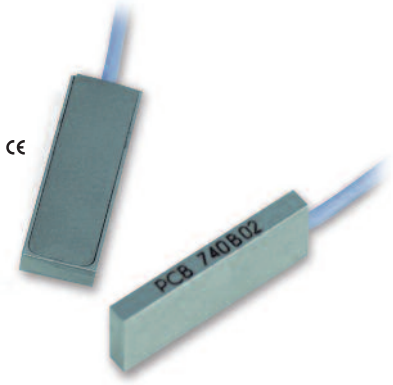
This product is CE-marking compliant to European Union EMC Directive, based upon conformance testing to the following European norms:

- EN 50081-1: 1992 Emissions
- EN 50082-1: 1992 Immunity

TYPICAL APPLICATION: An epoxy-bonded Model 740B02 Strain Sensor provides a control signal for an actively damped flexible robot manipulator, illustrated above. The electronic controller, with vibration feedback from the strain sensor, provides a signal to the amplifier, such that vibration amplitude is minimized. The active control system permits rapid settling time for a step rotation of the manipulator arm.

Model 740B02 Dynamic ICP® Piezoelectric Strain Sensor	
Dynamic Performance	
Sensitivity[1]	50 mV/με
Amplitude Range[1]	±100 με pk
Environmental	
Temperature Range	-65 to +250 °F -54 to +121 °C
Overload Limit (Shock)	±10,000 g pk
Acceleration Sensitivity	0.0001 με/g
Electrical	
Low Frequency Response	0.5 Hz
Excitation Voltage	20 to 30 VDC
Constant Current Excitation	2 to 20 mA
Output Bias	9 to 13 VDC
Mechanical	
Weight	0.02 oz 0.5 gm
Size (W x L x H)	0.2 x 0.6 x 0.07 in 5.1 x 15.2 x 1.8 mm
Mounting	Adhesive
Cable	Integral/Coaxial, 10 ft (3 m) Terminates in 10-32 threaded plug
Housing	Titanium
Sensing Element	Quartz

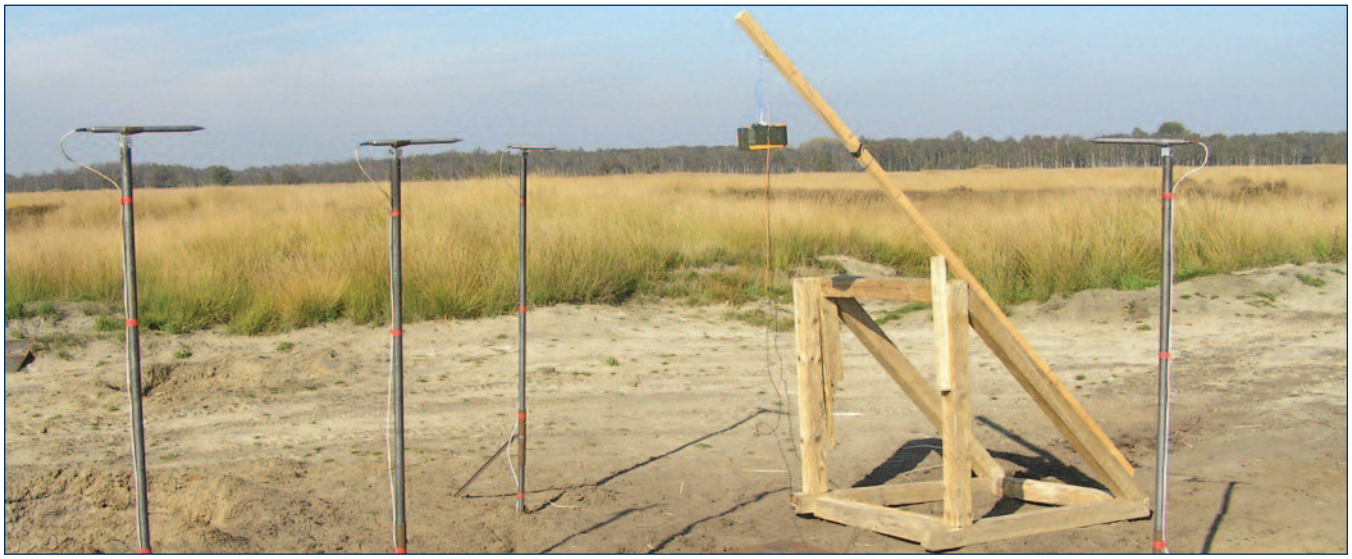
[1] Actual value depends upon thickness and stiffness of sensor structure interface.



Model 740B02

Placebo Transducers

A Tool for Data Validation



Placebo Transducers

For any testing in which the environmental operating conditions of a transducer vary with time and/or location, several requirements must be fulfilled before measurement uncertainty analysis is justified. Included among the requirements are good measurement system design practices, such as adequate low- and high-frequency response and data-sampling rates, appropriate anti-aliasing filter selection, proper grounding and shielding, and much more.

In addition to these requirements, data validation must be performed to establish that each transducer responds only to the environmental stimulus for which it is intended. For piezoelectric and piezoresistive transducers, "placebo" (IEST-RP-DTE011.1) transducers enable data validation to be accomplished. The referenced IEST standard defines a placebo transducer as 'identical to a "live" unit in every parameter except for mechanical sensitivities.' The placebo transducer should respond only to extraneous "environmental factors." Ideally, its output would be zero. Any signal output from it would indicate that signals from the "live" transducers could be corrupted.

Every transducer responds to its environment in every way it can. For example, accelerometer specifications include their response to thermal, acoustic, strain, and radiation stimuli, to name a few. While accelerometers must have their response to acoustic pressure specified, pressure transducers must have their response to acceleration specified. Thus, one transducer's desired response becomes another's undesired response.

These undesired responses can cause a change in transducer sensitivity or can result in additive, spurious signals at the transducer's output attributable to thermoelectric, electromagnetic, triboelectric and other self-generating noise phenomena. Since the test or instrumentation engineer has the best understanding of the test environment, he/she becomes responsible for data validation. The transducer manufacturer can assist by supplying "placebo" transducers to support this validation process.

Model 137APB0

Model 102BPB0

Model 113B22PB0

Model 356A32PB0

Model 350B21PB0

Model 354C03PB0

Model 356A33PB0

Model 3991A10PB0

Other models available upon special request. Contact your local Sale Representative for more information.

Calibration Products

Pressure Calibration Systems

In addition to the products listed below, PCB® is also able to perform a number of special calibration and testing services, upon request. These include acceleration sensitivity; Ballistics firing range; cold gas shock tube; discharge time constant; temperature effects from –320 to +1,000 °F (-196 to +535 °C); hydrostatic and hermeticity; mechanical shock; and PIND (Particle Impact Noise Detection).

Dynamic Pressure Sensor Calibration Systems

Pneumatic Pulse Calibrator Model 903B02

Manually actuated poppet valve exposes sensor under test (installed in a small volume manifold) to the step reference pressure, contained & regulated within a much larger storage cavity

- Strain gage pressure sensor reference
- 0 to 100 psi (0 to 0.7 MPa) range
- Accuracy to 0.8% FS

Aronson Step Pressure Calibrator Model 907A07

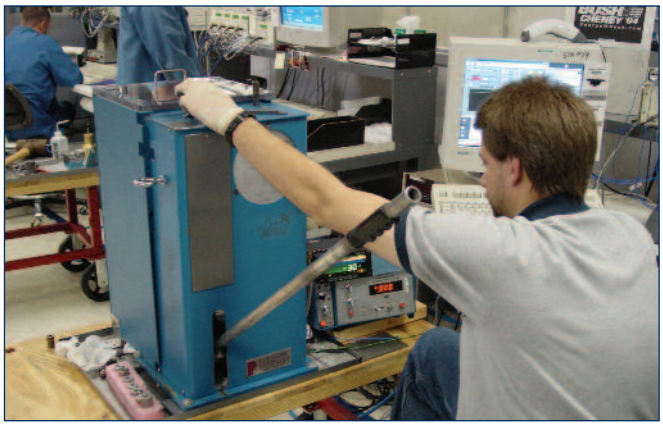
A guided mass impacts a plate, which opens a poppet valve with extreme quickness. This exposes the sensor under test (installed in a small volume manifold) to the step reference pressure, which is contained & regulated within a much larger storage cavity.

- Strain gage pressure sensor reference
- 0 to 1000 psi (0 to 7 MPa) range
- Accuracy to 1.3% FS

Pistonphone Kit Model 915A01

Generates a constant 134dB sound pressure level of at a controlled frequency of 250 Hz for calibrating high-intensity acoustic sensors in the field. Adaptors included for ICP® series 103B, 106B, 106B50, and 1-inch microphones.

Special Purpose Calibrators



Hydraulic Step Pressure Calibrator Model 905C

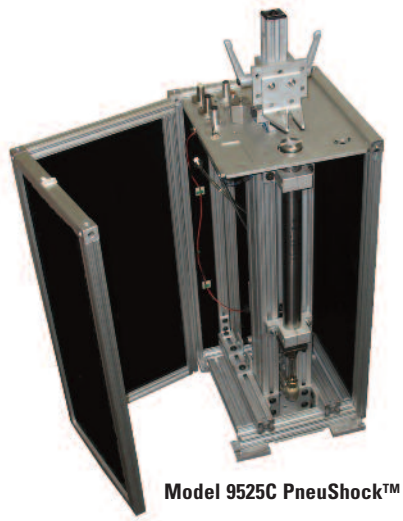
A high-pressure pump exposes the unit under test to graduated pressure steps with dump valve for rapid, pressure release.

- Strain gage pressure sensor reference
- 0 to 100k psi (0 to 690 MPa) range
- Accuracy to 1.7% FS

Shock Tube Model 901A10

A gas shock wave is generated past a burst diaphragm to create sub-microsecond pressure steps for evaluating various sensor performance characteristics such as rise time & resonant frequency.

- Reflected pressure to 1000psi (7MPa)
- Incident pressure to 180 psi (1.2 MPa)
- Includes time of arrival sensor with 0.5 µsec rise time



Model 9525C PneuShock™

Model 9525C

Shock Accelerometer Calibration

The PneuShock™ Model 9525C provides shock inputs for accurate and consistent sensitivity calibrations at high acceleration levels. Shocks are created at accelerations from 20g to 10,000g using a pneumatically operated projectile to strike an anvil and excite the sensor. By controlling both the level and the duration of the air pressure applied, the user gains greater control and consistency of the impacts. The system can be used manually in stand-alone mode or fully computer-controlled.

PneuShock works by pneumatically forcing a projectile to impact an anvil to which the sensor under test and the back-to-back reference accelerometer are mounted. Pressure is regulated either manually via a precision pressure regulator or optionally via an electrically controlled regulator that allows remote control of the pressure. When the impact occurs, the anvil lifts off a rubber mount, flies a short distance, and is captured by a cushioned fixture. Desired accelerations and pulse durations are produced using combinations of five anvils with different padding material, one optional supplemental mass, and continuously adjustable pressure settings. PneuShock's electronics are rack mountable and vibration isolated from the shock exciter. Also, the PneuShock poppet is shock isolated from the structure of the exciter to prevent false triggering by the poppet action during low level accelerations.

PneuShock provides verification and linearity check from 20g to 10,000g allowing accurate calibration of shock accelerometers at amplitude levels used in actual testing.

Highlights:

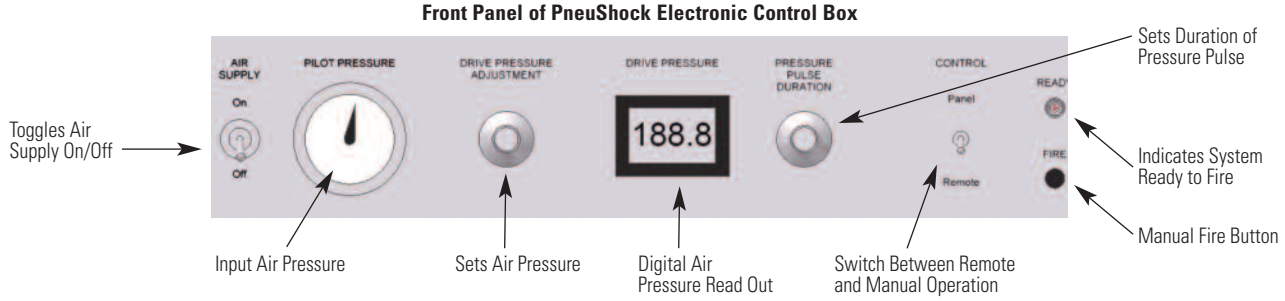
- Easy amplitude linearity calibration of shock and crash sensors from 20 g to 10,000 g
- Controlled and consistent impacts using state-of-the-art pneumatically actuated exciter
- Easy refinement of impulse shape and frequency content using a wide variety of impact anvils
- Superior impact control through drive pressure and duration control
- Precise adjustment of impact through use of digital pressure gauge

PneuShock™	
Model Number	**9525C**
Acceleration Range	20g - 10,000g [196 - 98,000 m/s²]
Sensor Mounting	1/4-28 UNF Thread Size
Air Supply Pressure	90 - 150 psi [6.2 - 10.3 bar]
Air Supply Quality Class	4 (ISO 8573.1 Compressed Air Standard)
Air Filter Requirements Dirt (Particle Size) Water Pressure Dewpoint (100 psi gauge) Oil (including vapor)	 15 micron 37 °F [3 °C] (128 ppm vol.) 5 mg/m³

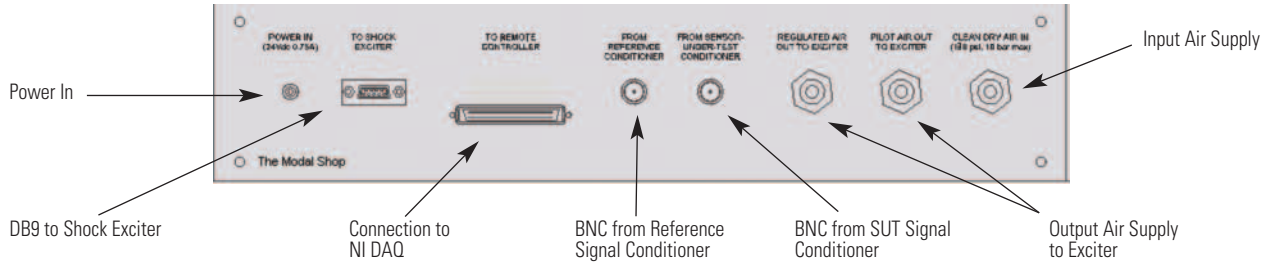
For complete specifications on the PneuShock™, please visit www.modalshop.com

Achieve	Using these settings				
Shock Level (g)	**Pulse Duration (ms)**	**Anvil Material**	**Padding**	**Drive Pressure (psi)**	**Pressure Pulse Range**
<100	1.0-2.0	Steel+mass	1/8 in felt	15-25	1.0-0.5
100-1k	0.2-1.5	Steel	1/8 in rubber	15-35	1.0-0.5
1k-5k	0.2-0.7	Alum.	1/16 in rubber	15-40	1.0-0.5
5k-10k	0.4-0.1	Alum.	Lexan + 1/8 in felt	25-45	0.6-0.4

Front Panel of PneuShock Electronic Control Box



Back Panel of PneuShock Electronic Control Box



Shock Calibration is also available as an option (9155C-525) to The Modal Shop's Model 9155C Accelerometer Calibration Workstation.

Specialized Instrumentation

Model 831

Firearms Detection Systems

Model 831 handheld sound level meter features a small, lightweight ergonomic design; real-time 1/1 and 1/3 octave spectra, and comes standard with a 120 dB dynamic range. Ten customizable markers are provided to annotate time history data. The sound level meter also has audio and voice recording with replay, supported by up to 2 GB of on-board memory and optional USB 2.0 data stick. The unit features one-hand operation, and has an easy-to-read backlit display. Plus, when used with a PC, the USB cable provides instrument power and recharges batteries. A full line of accessories is available including software, sound level calibrators, outdoor microphone systems with electrostatic actuators, weatherproof enclosures for short and long-term monitoring and a variety of tripods and tilt-down poles.

For complete specifications on Model 831, please visit Larson Davis at www.larsondavis.com/model831.htm.

As a division of PCB Piezotronics, Inc., Larson Davis provides complete solutions for noise and vibration measurement and analysis.

Model 444A53

Ballistic Peak Pressure Monitoring System

The Model 444A53 is a modular-style signal conditioner that combines a dual-mode amplifier module (443B102), a peak voltage monitoring module (444A152), and an AC power supply module (441A101) into one, integrated device. The unit connects directly with an ICP® or charge output pressure sensor, normalizes sensor sensitivity, and displays peak transient measurement signals in voltage or pressure units.

Unlike a digitizing peak detector, which is limited in accuracy by the sampling rate, the 444A152 peak monitoring module captures the true peak voltage of the transient event. Additionally, the module incorporates a 20 kHz low pass filter, offers reset capability between events, and delivers an analog output signal to profile the entire pressure event.

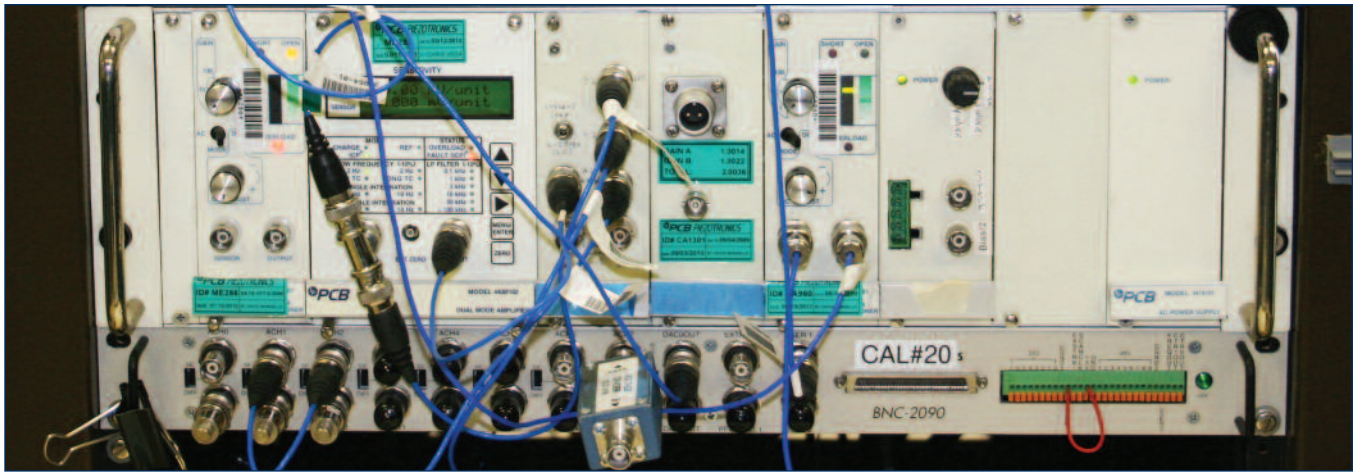
This device is ideal for barrel chamber pressure testing, lot testing of ammunition, and cartridge load studies. Two alternative versions (Models 444A51 and 444A52) eliminate the dual mode amplifier module and are intended for direct connection to ICP® pressure sensors, any direct voltage input, or for existing systems that already utilize a separate charge amplifier.

As with all PCB® instrumentation, this equipment is complemented with toll-free applications assistance, 24-hour customer service, and is backed by a no-risk policy that guarantees satisfaction or your money refunded.

Model 444A53
Ballistic Peak Pressure Monitoring System
Captures and Compares Peak Output from Piezoelectric Ballistic Pressure Sensors

Specifications	
Model	**444A53**
Performance	
Channels	1
Input Sensor Type (selectable)	ICP®, charge, voltage
Input Sensitivity Adjustment (normalization)	0.001 to 9999 (pC or mV per unit)
Excitation Supplied (ICP® mode)	24 VDC @ 0 to 20 mA
Voltage Gain (ICP® or voltage mode)	0.1 to 1000
Charge Converter (charge mode)	0.1 to 10,000 mV/pC
Charge Input Limit	100,000 pC
Drift (long DTC mode)	<0.03 pC/sec
Discharge Time Constant (selectable)	0.18, 1.8, 10, 100, 1000, >100,000 sec
Peak / DVM Display	4-digit LCD
Peak Voltage Display Range (infinite hold)	± 10 V
Accuracy	± 1%
Display Mode	Peak, DVM, Bias Test (for ICP® sensors)
Rise Time	<1 µsec
Low Pass Filter	20 kHz
Peak Reset	Manual, Remote, or Auto (1 to 99 sec)
Environmental	
Temperature Range	+32 to +120 °F 0 to +50 °C
Electrical	
Power Required	100 to 240 VAC, 50 to 60 Hz
Relays (2 Form C each with HI or LOW setpoint)	1 A @ 30 VDC, 1/2 A @ 125 VAC
Physical	
Size (h x w x d)	6.2 x 6.06 x 10.2 in 157.5 x 153.9 x 259.1 mm
Electrical Connectors (input, peak/DVM output, analog output, remote reset)	BNC Jack

Signal Conditioning & Converters



PCB® Signal Conditioning

Series 440 Modular Signal Conditioners

The Series 440 of modular signal conditioners is a flexible, compact solution for acceleration, sound pressure, and force sensor signal conditioning. The modular architecture allows great flexibility and scalability for users who may add or change testing capabilities in the future. The system adds or varies capability by the selection of signal conditioning modules that conform to the Series 440 standard for form factor, power consumption, and digital communication. Chassis themselves can be linked together, further expanding the system's scalability.

442B116	CE	16-channel basic ICP® signal conditioner

Multi-channel Signal Conditioners

Multi-channel, piezoelectric sensor signal conditioners, are cost-effective instruments which prepare multiple measurement signals for recording or analysis. Versions to accommodate either ICP® sensors, or both charge output and ICP® sensors, are available. Each unit is housed in a standard, 19-inch, rack-mountable chassis. The building-block design easily permits configuring a unit with appropriate features to suit a particular requirement. Several pre-configured models include some of the more popular features and are available for quick delivery.

Series 481A20	CE	16-Channel, line powered, ICP® and charge output, preconfigured or custom models

Four-channel Multi-purpose Signal Conditioners

These four-channel, benchtop signal conditioners are feature packed and cost effective. They offer low noise operation, simplicity of use, and compatibility with a wide range of sensor types. The 482C Series offers ICP® sensor excitation, incremental gain of x0.1 to x200, and computer control. The advanced unit adds built-in charge converters for connection to charge output sensors, lowpass filters, TEDS and Ethernet control. All versions may also be used to condition voltage signals from alternative sensor types.

482C05	CE	4-channel, line powered, ICP® /voltage sensor signal conditioner, unity gain, BNC input/output connections
482C16	CE	4-channel, line powered, ICP® /voltage sensor signal conditioner, incremental gain x0.1 to x200, RS-232
482C64	CE	4-channel, line powered, ICP®/voltage/charge sensor signal conditioner, incremental gain x0.1 to x200, RS-232, TEDS, Ethernet
482C27	CE	4-Channel, line powered, ICP/voltage, differential MEMS/bridge sensor, signal conditioner, incremental gain, x0.1, RS-232, Ethernet.

Battery & Line Powered ICP® Signal Conditioners

480C02	CE	Single-channel, battery powered, unity gain
480E09	CE	Single-channel, battery powered, gain x1, x10, x100
480B21	CE	3-Channel, battery powered, gain x1, x10, x100
482A21	CE	Single-Channel, AC/DC powerable, unity gain
482B11		Single-channel AC power, gain x1, x10, x100

Selectable Ground Isolation

483C30	CE	8-channel, line powered, ICP®/Charge sensor signal cond., gain, Xport, external calibration
		Sensor Input Type(s): ICP®, Voltage, Charge
		Channels: 8
		Voltage Gain: x0.1 to x200
		TEDS Sensor Support: Yes
		Power Required: (direct input to unit) 100 to 240 VAC / 47 to 63 Hz

DC Accelerometer Signal Conditioners

482C27	CE	For Series 3741 DC response accelerometers, four channel, incremental gain, 9 to18 VDC power required, provides two input options, Bridge/MEMS or ICP®/voltage

Series 422

In-Line, ICP®-Powered Charge Converters				
				
Model Number	**422E12**	**422E11**	**422E35 [1]**	**422E36 [1]**
Gain (Charge Conversion Sensitivity)	10 mV/pC ±2%	100 mV/pC ±2%	1 mV/pC ±2%	10 mV/pC ±2%
Input Range	±250 pC	±25 pC	±2500 pC	±250 pC
Output Voltage Range	±2.5 V	±2.5 V	±2.5 V	±2.5 V
Frequency Response (+/-5%) [2]	5 to 100k Hz	5 to 110k Hz	5 to 100k Hz	5 to 100k Hz
Broadband Electrical Noise	20 µV rms	60 µV rms	14 µV rms	26 µV rms
Temperature Range	-65 to +250 °F -54 to +121 °C	-65 to +250 °F -54 to +121 °C	-65 to +250 °F -54 to +121 °C	-65 to +250 °F -54 to +121 °C
Excitation Voltage	18 to 28 VDC	18 to 28 VDC	18 to 28 VDC	18 to 28 VDC
Constant Current Excitation	2.2 to 20 mA	2.2 to 20 mA	2.2 to 20 mA	2.2 to 20 mA
Input Connector	10-32 Jack	10-32 Jack	10-32 Jack	10-32 Jack
Output Connector	BNC Jack	BNC Jack	BNC Jack	BNC Jack
Size (Length x Diameter)	3.4 x 0.52 in 86 x 13 mm	3.4 x 0.52 in 86 x 13 mm	3.4 x 0.52 in 86 x 13 mm	3.4 x 0.52 in 86 x 13 mm
Weight	1.1 oz 31 gm	1.1 oz 31 gm	1.1 oz 31 gm	1.1 oz 31 gm
Additional Versions				
TEDS Addressable, On-board EEPROM	Included	Included	T422E35	T422E36
Notes				
[1] Specifically designed for use with sensors operating in elevated temperatures >+400°F (+204°C) [2] High frequency response may be limited by supply current and output cable length				

Series 402

Impedance Converters and In-Line Voltage Follower Amplifiers

Series 402A In-line voltage follower amplifiers, similar to the Series 422E charge converters, serve to convert charge output sensor signals to low-impedance voltage signals. They are recommended for applications requiring high frequency response up to 1 MHz, and for applications where sensor output (pC/unit) exceeds the maximum input range (pC) allowed in the Series 422E.

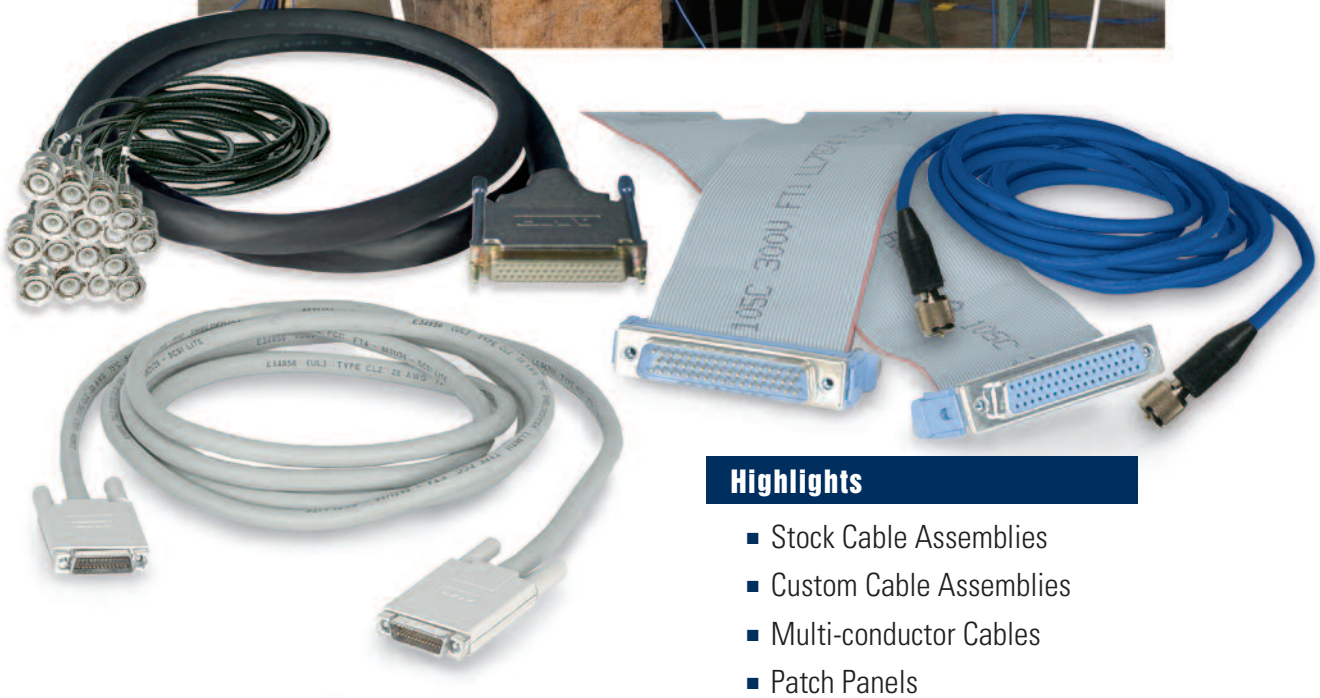
The voltage sensitivity, V, of a system including a charge output sensor, low-noise cable and voltage follower amplifier can be determined mathematically by the equation V=Q/C where Q is the charge sensitivity of the sensor in Coulombs and C is the total system capacitance in Farads. The total system capacitance is the result of the sum of the capacitance of the sensor, the capacitance of the interconnect cable, and the input capacitance of the voltage amplifier. Choose a voltage follower amplifier with an input capacitance that provides the sensitivity desired, while keeping the total output voltage (range x sensitivity) within the ±10 volt limit. Voltage follower amplifiers do not invert the polarity of the measurement signal.

Non-Inverting Voltage Follower Amplifiers and Impedance Converters for Use with Charge Output Sensors			
Voltage Follower Models	**402A**	**402A02**	**402A03**
Voltage gain (± 2%)	0.98	0.98	0.98
Output Range	± 10 V	± 10 V	± 10 V
Input Capacitance	< 8.0 pF	100 ± 10% pF	1000 ± 10% pF
Discharge Time Constant	1.0 second	10 second	100 second
Frequency Response (± 5%) [1]	0.5 to 1M Hz	0.05 to 1M Hz	0.005 to 1M Hz
Broadband Noise	43 µV rms	43 µV rms	43 µV rms
Output Bias	8 to 13 V	8 to 13 V	8 to 13 V
Temperature Range	-65 to +250 °F -54 to +121 °C	-65 to +250 °F -54 to +121 °C	-65 to +250 °F -54 to +121 °C
Power Required	18 to 28 VDC	18 to 28 VDC	18 to 28 VDC
Constant Current Required	2 to 20 mA	2 to 20 mA	2 to 20 mA
Input Connector	10-32 jack	10-32 jack	10-32 jack
Output Connector	10-32 jack	10-32 jack	10-32 jack
Size (Length x Diameter)	1.17 x 0.25 in 30 x 6 mm	1.17 x 0.25 in 30 x 6 mm	1.17 x 0.25 in 30 x 6 mm

Series 402

Note: [1] High frequency achieved at 20 mA excitation

Cables & Adaptors



Highlights

- Stock Cable Assemblies
- Custom Cable Assemblies
- Multi-conductor Cables
- Patch Panels
- Connector Adaptors

Coaxial Cable Assemblies

Coaxial Cable Assemblies

Base Model	1 ft (0.3 m)	3 ft (0.9 m)	5 ft (1.5 m)	10 ft (3.0 m)	20 ft (6.1 m)	30 ft (9.1 m)	50 ft (15.2 m)	Construct cable assembly model by combining base model with desired length, e.g., 002C10.	
030A		03	05	10	20	30	50	PTFE, Low Noise, Miniature	3-56 Plug to 10-32 Plug
030C			05	10	20	30	50	PTFE, Low Noise, Miniature	3-56 Plug to BNC Plug
018G		03	05	10	20	30		PVC, Miniature	5-44 Plug to 10-32 Plug
003G		03	05	10	20	30		TFE, Low Noise	5-44 Plug to 10-32 Plug
002P		03	05	10	20	30		FEP	5-44 Plug to BNC Plug
003P		03	05	10	20	30		TFE, Low Noise	5-44 Plug to BNC Plug
018C		03	05	10	20	30		PVC, Miniature	5-44 Plug to BNC Plug
030B			05	10	20			PTFE, Low Noise, Miniature	M3 Plug to 10-32 Plug
003R			05	10	20			TFE, Low Noise	M3 Plug to 10-32 Plug
002A		03	05	10	20	30	50	FEP	10-32 Plug to 10-32 Plug
003A	01	03	05	10	20	30	50	TFE, Low Noise	10-32 Plug to 10-32 Plug
023A				10				Hardline	10-32 Plug to 10-32 Jack
002C		03	05	10	20	30	50	FEP	10-32 Plug to BNC Plug
003C		03	05	10	20	30	50	TFE, Low Noise	10-32 Plug to BNC Plug
002B	01	03						FEP	10-32 Plug to BNC Jack
003B	01	03						TFE, Low Noise	10-32 Plug to BNC Jack
003U				10				TFE, Low Noise	SMB Female Plug to SMB Female Plug
003V				10				TFE, Low Noise	SMB Female Plug to BNC Plug
002T		03	05	10	20	30		FEP	BNC Plug to BNC Plug
003D		03		10	20			TFE, Low Noise	BNC Plug to BNC Plug
012A		03	05	10	20	30	50	PVC, RG58/U	BNC Plug to BNC Plug
012E				10	20		50	PVC, RG58/U	2-Socket Env. Sealed to BNC Plug
012R				10	20		50	PVC, RG58/U	2-Socket MIL to BNC Plug

3-56 Plug

5-44 Plug

10-32 Plug

10-32 Jack

BNC Plug

BNC Jack

M3 Plug

SMB Plug

2-Socket Plug

2-Socket
Env. Sealed Plug

Series 018C

Model 023A10

Series 002C

Series 003A

Series 012A

Coaxial Cable Specifications

Model	002	003	012	018	030
Cable Style	General Purpose	Low Noise	General Purpose	General Purpose	Low Noise
Temperature Range	-130 to +400 °F -90 to +204 °C	-320 to +500 °F -196 to +260 °C	-40 to +176 °F -40 to +80 °C	-22 to +221 °F -30 to +105 °C	-130 to +500 °F -90 to +260 °C
Impedance	50 Ohm	50 Ohm	52 Ohm	32 Ohm	50 Ohm
Capacitance	29 pF/ft 95 pF/m	30 pF/ft 98 pF/m	29 pF/ft 95 pF/m	55 pF/ft 180 pF/m	30 pF/ft 98 pF/m
Cable Jacket Material	FEP	TFE	PVC	PVC	PTFE
Cable Jacket Diameter	0.075 in 1.9 mm	0.079 in 2.01 mm	0.193 in 4.9 mm	0.054 in 1.37 mm	0.042 in 1.09 mm

Other Coaxial Cable Specifications

Model	005	006	023	038	098
Cable Style	Ruggedized	Low Noise Ruggedized	Hardline	Low Noise	Low Noise Flexible
Temperature Range	-67 to +275 °F -55 to +135 °C	-67 to +275 °F -55 to +135 °C	-300 to +1200 °F -184 to +650 °C	-58 to +250 °F -50 to +121 °C	-130 to +500 °F -90 to +260 °C
Impedance	50 Ohm	50 Ohm	—	50 Ohm	50 Ohm
Capacitance	29 pF/ft 95 pF/m	30 pF/ft 98 pF/m	100 pF/ft 328 pF/m	30 pF/ft 100 pF/m	35 pF/ft 115 pF/m
Cable Jacket Material	Polyolefin over Steel Braid	Polyolefin over Steel Braid	Stainless Steel	Polyurethane	TFE
Cable Jacket Diameter	0.200 in 5.08 mm	0.200 in 5.08 mm	0.059 in 1.5 mm	0.119 in 3.02 mm	0.079 in 2.01 mm

4-Conductor Cable Assemblies

4-Conductor Cable Assemblies

Base Model	5 ft (1.5 m)	10 ft (3.0 m)	15 ft (4.6 m)	20 ft (6.1 m)	25 ft (7.6 m)	30 ft (9.1 m)	50 ft (15.2 m)	Construct cable assembly model by combining base model with desired length, e.g., 034G20.	
034H	05	10		20		30	50	FEP, Lightweight	Mini 4-Socket Plug to (3) 10-32 Plugs
034K	05	10		20		30	50	FEP, Lightweight	Mini 4-Socket Plug to (3) BNC Plugs
019B	05	10	15	20		30		Silicone, Flexible, Lightweight	Mini 4-Socket Plug to (3) BNC Plugs
010P	05	10		20		30	50	FEP, General Purpose	4-Socket Plug to Pigtails
034A	05	10		20		30	50	FEP, Lightweight	4-Socket Plug to Pigtails
010D	05	10	15	20	25	30		FEP, General Purpose	4-Socket Plug to 4-Socket Plug
034D	05	10		20		30	50	FEP, Lightweight	4-Socket Plug to 4-Socket Plug
078D	05	10		20		30	50	Polyurethane, Flexible	4-Socket Plug to 4-Socket Plug
010F	05	10	15	20	25	30	50	FEP, General Purpose	4-Socket Plug to (3) 10-32 Plugs
034F	05	10		20		30	50	FEP, Lightweight	4-Socket Plug to (3) 10-32 Plugs
078F		10	15		25			Polyurethane, Flexible	4-Socket Plug to (3) 10-32 Plugs
010G	05	10	15	20	25	30	50	FEP, General Purpose	4-Socket Plug to (3) BNC Plugs
034G	05	10	15	20	25	30	50	FEP, Lightweight	4-Socket Plug to (3) BNC Plugs
036G	05	10	15	20	25	30		Silicone, Flexible	4-Socket Plug to (3) BNC Plugs
078G	05	10	15	20	25	30	50	Polyurethane, Flexible	4-Socket Plug to (3) BNC Plugs


Mini 4-Socket Plug


4-Socket Plug


BNC Plug


10-32 Plug


Series 034D


Series 010F


Series 034K


Series 010G

4-Conductor Cable Specifications

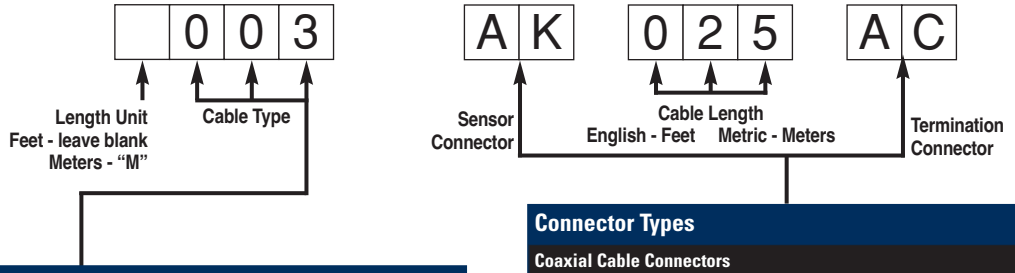
Model	010	034	019	036	078
Cable Style	General Purpose	Low Noise	Flexible Lightweight	Flexible	Flexible
Temperature Range	-130 to +392 °F -90 to +200 °C	-130 to +392 °F -90 to +200 °C	-76 to +500 °F -60 to +260 °C	-76 to +392 °F -60 to +200 °C	-58 to +185 °F -50 to +85 °C
Capacitance	16 pF/ft 52.4 pF/m	14 pF/ft 46 pF/m	15 pF/ft 49.2 pF/m	15 pF/ft 48 pF/m	25 pF/ft 81 pF/m
Cable Jacket Material	FEP	FEP	Silicone	Silicone	Polyurethane
Cable Jacket (Diameter)	0.1 in 2.54 mm	0.077 in 1.96 mm	0.070 in 1.77 mm	0.104 in 2.64 mm	0.119 in 3.02 mm

Custom Cable Assemblies

How to Configure Custom Cable Models:

1. Choose the cable length format desired, either English (ft) or Metric (m) unit lengths.
2. Choose the desired raw cable type.
3. Choose desired sensor connector type.
4. Determine the cable length required in English (ft) or Metric (m) unit lengths.
5. Choose desired termination connector type.

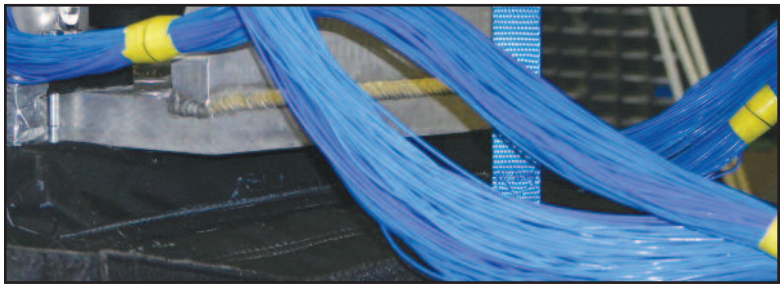
Example:
Model 003AK025AC defines a 25 ft, low-noise cable with right angle 10-32 plug sensor connector, BNC plug termination connector.



Raw Cable Type

			Diameter		Max. Temp.	
Coaxial Cables						
002	General Purpose, White FEP Jacket	CE	0.075 in	1.9 mm	400°F	204°C
003	Low Noise, Blue TFE Jacket	CE	0.079 in	2.0 mm	500°F	260°C
005	Ruggedized 002 Type, General Purpose	CE	0.2 in	5.08 mm	275°F	135°C
006	Ruggedized 003 Type, Low Noise	CE	0.2 in	5.08 mm	275°F	135°C
012	RG-58/U, Black Vinyl Jacket	CE	0.193 in	4.90 mm	176°F	80°C
018	Lightweight, Black PVC Jacket		0.054 in	1.37 mm	221°F	105°C
030	Low Noise, Mini, PTFE Jacket	CE	0.043 in	1.1 mm	500°F	260°C
038	Low Noise, Blue Polyurethane Jacket	CE	0.119 in	3.02 mm	250°F	121°C
098	Flexible, Low Noise, Green TFE Jacket	CE	0.079 in	2.06 mm	500°F	260°C
Twisted/Shielded Pair Cable						
024	General Purpose, Black Polyurethane Jacket	CE	0.250 in	6.35 mm	250°F	121°C
032	Lightweight, FEP Jacket		0.085 in	2.16 mm	392°F	200°C
045	High Temperature, Red PFA Jacket	CE	0.204 in	5.18 mm	250°F	121°C
053	High Temperature, Red FEP Jacket	CE	0.157 in	3.99 mm	392°F	200°C
Shielded 4-Conductor Cable						
010	General Purpose, FEP Jacket	CE	0.1 in	2.54 mm	392°F	200°C
034	Lightweight, FEP Jacket	CE	0.077 in	1.96 mm	392°F	200°C
019	Lightweight, Blue Silicon Jacket	CE	0.068 in	1.73 mm	500°F	260°C
036	General Purpose, Blue Silicon Jacket	CE	0.104 in	2.64 mm	392°F	200°C
078	General Purpose, Blue Polyurethane Jacket	CE	0.119 in	3.02 mm	185°F	85°C
Hardline Cable						
013	Hardline, 2-conductor, Inconel Jacket		0.125 in	3.20 mm	1200 °F	650 °C
023	Hardline, Coaxial, 304L Stainless Steel Jacket		0.059 in	1.5 mm	1200 °F	650 °C
Miscellaneous Cable						
031	Red/White Twisted Pair, PTFE Jacket		0.03 in*	0.8 mm*	392°F	200°C
037	10-cond. Shielded, Black Poly Jacket		0.024 in	0.61 mm	250°F	121°C

* diameter of each conductor
The combination of cables and connectors listed are only recommended configurations; other configurations may be available. Consult PCB® before ordering.
CE designates that cable maintains CE conformance



Connector Types

Coaxial Cable Connectors	
EB	10-32 Plug
EJ	10-32 Plug (Spring Loaded)
AH	10-32 Plug (Hex)
AK	10-32 Plug (Right-Angle)
AW	10-32 Plug (Solder Adaptor)
FZ	10-32 Plug (for 023 Hardline Cabling)
AL	10-32 Jack
GA	10-32 Jack (for 023 Hardline Cabling)
AG	5-44 Plug
AF	5-44 Plug (Right-Angle)
EK	3-56 Plug
EP	M3 Plug
AC	BNC Plug
AB	BNC Jack
FW	SMB Plug
FX	SMB Jack
Multi-Lead Connectors (For Triaxial Sensors)	
AY	4-Socket Plug
CA	4-Pin Jack
EH	4-Socket Miniature Plug
HJ	4-Pin Miniature Jack
EN	9-Socket Plug
GJ	9-Pin Plug
JY	Splice Assembly to (3) EB Connectors
LA	Splice Assembly to (3) EJ Connectors
JZ	Splice Assembly to (3) AL Connectors
JW	Splice Assembly to (3) AC Connectors
JX	Splice Assembly to (3) AB Connectors
JS	Splice Assembly to (3) AY Connectors
Miscellaneous Connectors	
AE	2-Socket Plug MS3106 5/8-24 thd (with Environmental Boot)
AM	2-Socket Plug MS3106 5/8-24 thd
AP	2-Socket Plug MS3106 5/8-24 thd (with Strain Relief)
BP	2-Socket Plug MS3106 5/8-24 thd (High Temperature)
ET	2-Socket Plug MIL 7/16-27 thd (High Temperature)
GN	2-Socket Plug MIL 7/16-27 thd (for 013 Hardline Cabling)
GP	2-Pin Jack MIL 7/16-27 thd (for 013 Hardline Cabling)
LN	8-Pin Mini DIN (for 4-Wire Bridge)
BZ	Blunt Cut
DZ	Pigtail (Leads Stripped and Tinned for 3711/3713 Series)
JJ	Pigtail (Leads Stripped and Tinned for 3741 Series)
AD	Pigtail (Leads Stripped and Tinned for all Others)

Cable Connectors

AB **BNC Jack**
Max Temp 329 °F (165 °C)

AC **BNC Plug**
Max Temp 329 °F (165 °C)

AD **Pigtail** (leads stripped and tinned)
Max Temp 490 °F (254 °C)*

AE **2-Socket MS3106 Plug** (with environmental boot)
Max Temp 325 °F (163 °C)

AF **5-44 Coaxial Plug** (right angle)
Max Temp 392 °F (200 °C)

AG **5-44 Coaxial Plug** (straight)
Max Temp 500 °F (260 °C)

AH **10-32 Coaxial Plug** (straight, with wire locking hex)
Max Temp 450 °F (232 °C)

AK **10-32 Coaxial Plug** (right angle)
Max Temp 329 °F (165 °C)

AL **10-32 Coaxial Jack** (straight)
Max Temp 500 °F (260 °C)

AP **2-Socket MS3106 Plug** (with strain relief)
Max Temp 257 °F (125 °C)

AW **10-32 Coaxial Plug / Solder Adaptor** (user repairable)
Max Temp 500 °F (260 °C)*

AY **4-Socket Plug, 1/4-28 Thread** (for triaxial sensors)
Max Temp 325 °F (163 °C)

CA **4-Pin Jack, 1/4-28 Thread** (for triaxial sensors)
Max Temp 325 °F (163 °C)

EB **10-32 Coaxial Plug** (straight)
Max Temp 500 °F (260 °C)

EH **4-Socket Mini Plug, 8-36 Thread** (for triaxial sensors)
Max Temp 356 °F (180 °C)

EJ **10-32 Coaxial Plug** (straight, o-ring seal, spring loaded)
Max Temp 500 °F (260 °C)

EK **3-56 Coaxial Plug**
Max Temp 500 °F (260 °C)

EN **9-Socket Plug** (for triaxial capacitive accelerometers)
Max Temp 275 °F (135 °C)

EP **M3 Coaxial Plug**
Max Temp 500 °F (260 °C)

ET **2-Socket Plug, 7/16-27 Thread**
Max Temp 500 °F (260 °C)

FZ **10-32 Coaxial Plug** (for hardline cable)
Max Temp 900 °F (482 °C)

GA **10-32 Coaxial Jack** (for hardline cable)
Max Temp 550 °F (288 °C)

GN **2-Socket Plug, 7/16-27 Thread** (high temperature)
Max Temp 900 °F (482 °C)

GP **2-Pin Jack, 7/16-27 Thread** (high temperature)
Max Temp 900 °F (482 °C)

*Max Temp may be less depending upon cable application.

Custom Cable Assemblies

PCB® offers many standard cable assemblies, however, in the event that a standard cable assembly will not fulfill the requirements of the application, the ability to configure a custom cable assembly is offered. Start by ensuring compatibility of the connector type with the cable type desired from the chart below, and then configure the custom cable model number from the steps on the previous page.

Cable - Connector Compatibility Matrix

The following table provides compatibility information for cables and cable connectors. A "✓" denotes compatibility of the connector type shown in the rows going down the table with the cable type of the intersecting column going across the table.

Coaxial Custom Cable Assemblies

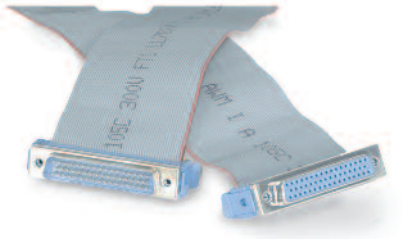
Cable	002	003	005	006	012	013	018	023	024	030	031	032	038	045	053	098
Connector																
AB	✔	✔	✔	✔	✔		✔		✔	✔	✔	✔	✔	✔	✔	✔
AC	✔	✔	✔	✔	✔		✔		✔	✔	✔	✔	✔	✔	✔	✔
AD	✔	✔	✔	✔	✔		✔		✔	✔	✔	✔	✔	✔	✔	✔
AE		✔			✔				✔						✔	
AF	✔	✔	✔	✔			✔			✔						
AG	✔	✔	✔	✔			✔			✔	✔	✔	✔			✔
AH	✔	✔	✔	✔			✔			✔		✔				
AK	✔	✔	✔	✔			✔			✔		✔	✔			✔
AL	✔	✔	✔	✔			✔			✔	✔	✔				✔
AP	✔	✔	✔	✔	✔				✔			✔	✔	✔	✔	
AW											✔					
BP	✔	✔		✔									✔	✔	✔	✔
BZ	✔	✔	✔	✔	✔		✔		✔	✔	✔	✔	✔	✔	✔	✔
EB	✔	✔	✔	✔			✔			✔	✔	✔	✔			✔
EJ	✔	✔	✔	✔			✔			✔		✔	✔			✔
EK										✔						
EP	✔	✔	✔	✔			✔			✔						
ET														✔	✔	
FW	✔	✔	✔	✔			✔			✔						
FX	✔	✔														
FZ								✔								
GA								✔								
GN						✔										
GP						✔										

Multi-conductor Custom Cable Assemblies

Cable	010	019	034	036	037	078
Connector						
AD	✔	✔	✔	✔	✔	✔
AY	✔	✔	✔	✔		✔
BZ	✔	✔	✔	✔	✔	✔
CA	✔	✔	✔	✔		✔
DZ	✔		✔		✔	✔
EH		✔	✔			
EN					✔	
GJ					✔	
HJ			✔			
JJ	✔					
JS					✔	
JW	✔	✔	✔	✔		✔
JX	✔	✔	✔	✔		✔
JY	✔	✔	✔	✔		✔
JZ	✔	✔	✔	✔		✔
LA	✔	✔	✔	✔		✔

Multi-conductor Cables

Multi-conductor cables minimize tangles and reduce overall cable costs. They also offer numerous cable/termination variations to suit a particular transmission requirement, as well as the ability to consolidate several cables into one.



Model 009F "xx"
Flat ribbon cable
DB50 female to DB50 male
Specify "xx" length in feet

Model 009H "xx"
Shielded ribbon cable
DB50 female to DB50 male
Specify "xx" length in feet

Model 009L05
Multi-conductor cable
VXI to 4 BNC plugs
5 ft (1.5 m) length

Model 009S05
Multi-conductor cable
VXI to VXI
5 ft (1.5 m) length

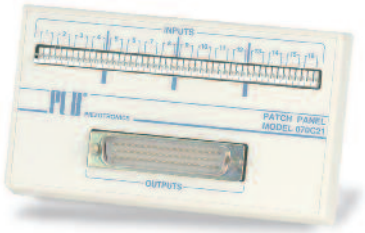
Model 009B "xx"
Ruggedized
Shielded multi-conductor cable
DB50 female to DB50 male
Specify "xx" length in feet

Model 009A "xx"
Ruggedized
Multi-conductor cable
DB50 female to 16 BNC Plugs
Specify "xx" length in feet

Patch Panels

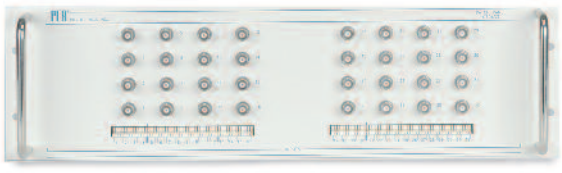
Input patch panels serve as a central collection point for individual sensor cables installed in multi-channel measurement arrays. The sensor signal paths are then consolidated and transmission to readout or data acquisition equipment is accomplished by a single, multi-conductor cable.

Output patch panels connect via multi-conductor cables to the output connectors on high density rack or modular signal conditioners. The sensor signal paths are then expanded to individual BNC's for each channel for subsequent connection to data acquisition equipment.



Model 070C21
16-channel input patch panel
16 IDC pin inputs
DB50 male output

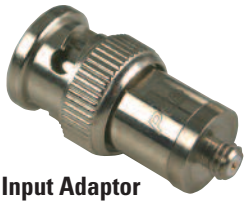
Model 070C29
16-channel input patch panel
16 BNC jack and
16 IDC pin inputs
DB50 male output



Model 070A33
32-channel input patch panel
32 BNC jack and 32 IDC pin inputs
2 DB50 male outputs
Rack mount

Model 070A34
32-channel output patch panel
2 DB37 male inputs
4 DB37 female servo inputs
4 DB50 male HP outputs
32 BNC jack outputs
Rack mount

Connector Adaptors



070A02

Scope Input Adaptor

10-32 coaxial jack to BNC plug. For adapting BNC connectors for use with 10-32 coaxial plugs.

070A03

Connector Adaptor

10-32 coaxial plug to BNC jack. Converts 10-32 connectors for use with BNC plugs. Do not use on sensor connectors.

070A05

10-32 Coaxial Coupler

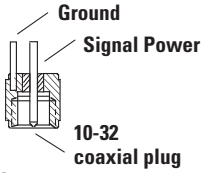
10-32 coaxial jack to 10-32 coaxial jack. Joins two cables terminating in 10-32 coaxial plugs.

070A08

Cable Adaptor

10-32 coaxial jack to BNC jack. Joins cables terminating in a BNC plug and a 10-32 coaxial plug.

070B09



Solder Connector Adaptor

10-32 coaxial plug to solder terminals. Excellent for high-shock applications. User-repairable.

BNC T Connector 070A11

BNC plug to two BNC jacks. Used as a cable splitter.

BNC Coupler 070A12

BNC jack to BNC jack. Joins two cables terminating in BNC plugs.

1/8 in max wall thickness
1/2 in mtg thd

Feed-thru Adaptor 070A13

10-32 coaxial jack to BNC jack. Bulkhead connects BNC plug to 10-32 coaxial jack.

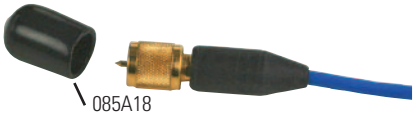
1/4 in max wall thickness
5/16-32 in mtg thd

10-32 Hermetic Feed-thru 070A14

10-32 coaxial jack to 10-32 coaxial jack.

10-32 Coaxial Right Angle Adaptor 070A20

10-32 coaxial jack to 10-32 coaxial plug. For use in confined locations. For ICP® sensors only.



085A18

Plastic Protective Cap

Provides strain relief for solder connector adaptors, as well as protects 10-32 cable ends.

085A40

10-32 Coaxial Shorting Cap

Used to short charge output sensor connectors during storage and transportation.

076A05

10-32 Coaxial Plug

Microdot connector, screw-on type.

076A25

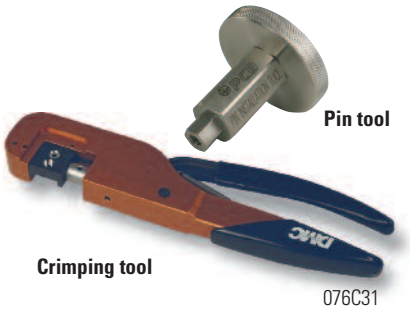
Connector Tool

Used to install 076A05 screw-on type microdot connector.

EB

Coaxial Connector

10-32 crimp-on style coaxial connector. Requires tools contained in Model 076C31 kit.



076C31

10-32 Coaxial Crimp-on Connector Kit

Includes 1 pin insertion tool, 1 sleeve-crimping tool, and 20 Model "EB" connectors with cable strain reliefs. (Wire stripper and soldering iron not included).

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PCB Piezotronics corporate headquarters,
located at 3425 Walden Avenue, Depew, NY, USA

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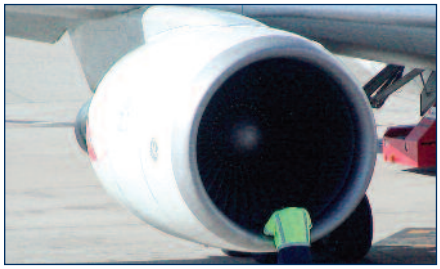

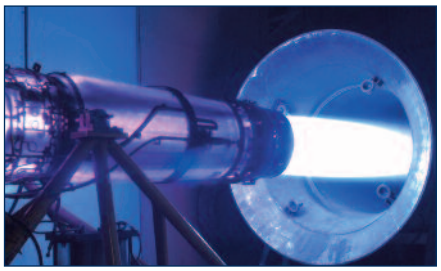

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