Model 108A02

Hydraulic pump ICP® pressure sensor, 10k psi, 0.5 mV/psi (long life

Installation and Operating Manual

For assistance with the operation of this product,
contact PCB Piezotronics, Inc.

Toll-free: 800-828-8840
24-hour SensorLine: 716-684-0001
Fax: 716-684-0987
E-mail: info@pcb.com
Web: www.pcb.com

Service, Repair, and Return Policies and Instructions

The information contained in this document supersedes all similar information that may be found elsewhere in this manual.

Service – Due to the sophisticated nature of the sensors and associated instrumentation provided by PCB Piezotronics, user servicing or repair is not recommended and, if attempted, may void the factory warranty. Routine maintenance, such as the cleaning of electrical connectors, housings, and mounting surfaces with solutions and techniques that will not harm the physical material of construction, is acceptable. Caution should be observed to ensure that liquids are not permitted to migrate into devices that are not hermetically sealed. Such devices should only be wiped with a dampened cloth and never submerged or have liquids poured upon them.

Repair – In the event that equipment becomes damaged or ceases to operate, arrangements should be made to return the equipment to PCB Piezotronics for repair. User servicing or repair is not recommended and, if attempted, may void the factory warranty.

Calibration – Routine calibration of sensors and associated instrumentation is recommended as this helps build confidence in measurement accuracy and acquired data. Equipment calibration cycles are typically established by the users own quality regimen. When in doubt about a calibration cycle, a good "rule of thumb" is to recalibrate on an annual basis. It is also good practice to recalibrate after exposure to any severe temperature extreme, shock, load, or other environmental influence, or prior to any critical test.

PCB Piezotronics maintains an ISO-9001 certified metrology laboratory and offers calibration services, which are accredited by A2LA to ISO/IEC 17025, with full traceability to SI through N.I.S.T. In addition to the normally supplied calibration, special testing is also available, such as: sensitivity at elevated or cryogenic temperatures, phase response, extended high or low frequency response, extended range, leak testing, hydrostatic pressure testing, and others. For information on standard recalibration services or special testing, contact your local PCB Piezotronics distributor, sales representative, or factory customer service representative.

Returning Equipment – *Following these procedures will ensure that your returned materials are handled in the most expedient manner*. Before returning any equipment to PCB Piezotronics, contact your local distributor, sales representative, or factory customer service representative to obtain a Return **Warranty, Service, Repair, and Return Policies and Instructions** Materials Authorization (RMA) Number. This RMA number should be clearly marked on the outside of all package(s) and on the packing

list(s) accompanying the shipment. A detailed account of the nature of the problem(s) being experienced with the equipment should also be included inside the package(s) containing any returned materials.

A Purchase Order, included with the returned materials, will expedite the turn-around of serviced equipment. It is recommended to include authorization on the Purchase Order for PCB to proceed with any repairs, as long as they do not exceed 50% of the replacement cost of the returned item(s). PCB will provide a price quotation or replacement recommendation for any item whose repair costs would exceed 50% of replacement cost, or any item that is not economically feasible to repair. For routine calibration services, the Purchase Order should include authorization to proceed and return at current pricing, which can be obtained from a factory customer service representative.

Contact Information – International customers should direct all inquiries to their local distributor or sales office. A complete list of distributors and offices can be found at www.pcb.com. Customers within the United States may contact their local sales representative or a factory customer service representative. A complete list of sales representatives can be found at www.pcb.com. Toll-free telephone numbers for a factory customer service representative, in the division responsible for this product, can be found on the title page at the front of this manual. Our ship to address and general contact numbers are:

PCB Piezotronics, Inc.
3425 Walden Ave.
Depew, NY14043 USA
Toll-free: (800) 828-8840
24-hour SensorLine^{SM}: (716) 684-0001
Website: www.pcb.com
E-mail: info@pcb.com

PCB工业监视和测量设备 - 中国RoHS2公布表

PCB Industrial Monitoring and Measuring Equipment - China RoHS 2 Disclosure Table

部件名称	有害物质					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
住房	O	O	O	O	O	O
PCB板	X	O	O	O	O	O
电气连接器	O	O	O	O	O	O
压电晶体	X	O	O	O	O	O
环氧	O	O	O	O	O	O
铁氟龙	O	O	O	O	O	O
电子	O	O	O	O	O	O
厚膜基板	O	O	X	O	O	O
电线	O	O	O	O	O	O
电缆	X	O	O	O	O	O
塑料	O	O	O	O	O	O
焊接	X	O	O	O	O	O
铜合金/黄铜	X	O	O	O	O	O
本表格依据 SJ/T 11364 的规定编制。						
O： 表示该有害物质在该部件所有均质材料中的含量均在 GB/T 26572 规定的限量要求以下。						
X： 表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T 26572 规定的限量要求。 铅是欧洲RoHS指令2011/65/ EU附件三和附件四目前由于允许的豁免。						

CHINA RoHS COMPLIANCE

Component Name	Hazardous Substances					
	Lead (Pb)	Mercury (Hg)	Cadmium (Cd)	Chromium VI Compounds (Cr(VI))	Polybrominated Biphenyls (PBB)	Polybrominated Diphenyl Ethers (PBDE)
Housing	O	O	O	O	O	O
PCB Board	X	O	O	O	O	O
Electrical Connectors	O	O	O	O	O	O
Piezoelectric Crystals	X	O	O	O	O	O
Epoxy	O	O	O	O	O	O
Teflon	O	O	O	O	O	O
Electronics	O	O	O	O	O	O
Thick Film Substrate	O	O	X	O	O	O
Wires	O	O	O	O	O	O
Cables	X	O	O	O	O	O
Plastic	O	O	O	O	O	O
Solder	X	O	O	O	O	O
Copper Alloy/Brass	X	O	O	O	O	O

This table is prepared in accordance with the provisions of SJ/T 11364.

O: Indicates that said hazardous substance contained in all of the homogeneous materials for this part is below the limit requirement of GB/T 26572.

X: Indicates that said hazardous substance contained in at least one of the homogeneous materials for this part is above the limit requirement of GB/T 26572.
Lead is present due to allowed exemption in Annex III or Annex IV of the European RoHS Directive 2011/65/EU.

DOCUMENT NUMBER: 21354
*DOCUMENT REVISION: **D***
ECN: 46162

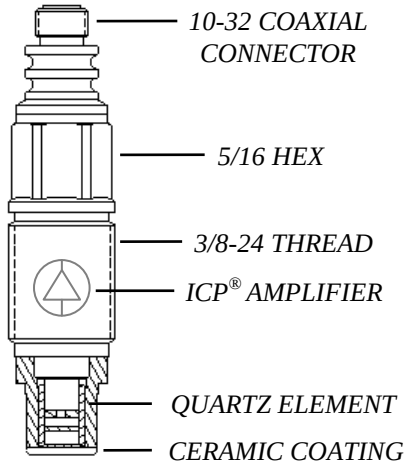
OPERATION MANUAL FOR ICP® HIGH PRESSURE SENSORS Series 108 & 109

1.0 INTRODUCTION

The 108 & 109 Series are acceleration-compensated, high pressure, ICP® (Integrated Circuit Piezoelectric) sensors primarily developed to measure ballistics chamber pressures for R & D and production testing of ammunition. They may also be used for explosive air blast and other high pressure measurements in extreme shock environments where ultra-fast, micro-second response is required. These types of tests are usually accompanied by large acceleration pulses, which can add considerable error to output signals of un-compensated sensors.

The shoulder seal design features a one-piece diaphragm machined integral with the housing for ruggedness. A ceramic coating is applied to the diaphragm to minimize flash temperature effects.

For applications where strain sensitivity from stress within the mounting port is a concern, the 108A1X, 108B1X, 109B1X and 109C1X utilize a floating clamp-nut design to reduce the effects, where "X" denotes pressure range.



2.0 DESCRIPTION

The 108 & 109 Series contain an acceleration-compensated piezo element, which is coupled to a microelectronic amplifier. The quartz element contains an integral seismic mass that counteracts the acceleration effects of the end piece and diaphragm. This compensation acts to extend the frequency characteristics and enhance the transient response of the sensor.

The machined diaphragm is made from maraging steel, selected because of its high strength and durability. The combination of the short, rigid element and stiff diaphragm give these sensors a high natural frequency and linearity.

The microelectronic amplifier converts the high-impedance voltage from the quartz package into a low-impedance, high-level output signal. See the Technical Information section of our website for more complete coverage of ICP® instruments.

3.0 INSTALLATION

With a 3/8-24 (M10x1.0 for metric mount) mounting thread and flush diaphragm design, the 108 & 109 Series transducers mount directly in existing ports machined for PCB Series 118 & 119.

Unlike conventional diaphragm type sensors, the 108 & 109 Series are pressure sensitive over the entire frontal area. Extra care should be exercised to avoid bottoming in the mounting hole when recess mounted or when mounting into existing ports.

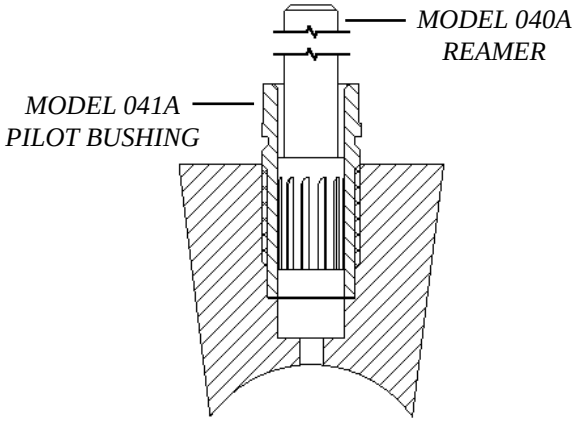
Install the sensor, using only one of the seals provided, with the aid of a torque wrench to monitor the mounting torque value. The recommended torque range can be found on the installation drawing. Seals should be replaced each time the sensor is re-installed.

3.1 MOUNTING IN EXISTING RECESSED PORTS

Before installing the sensor in previously used mounting ports, clean out the residue from previous tests. The port can be cleaned by hand reaming the ¼ inch diameter hole using a PCB Model 040A end cutting reamer (040A07 for metric mount) guided by PCB Model 041A pilot bushing (M041A for metric mount).

Pay particular attention to the sealing surface, keeping it free from tool chatter marks, nicks and other imperfections that could adversely affect the seal. If the sealing surface requires re-machining after prolonged use, refer to the installation drawing to ensure that the ¼ inch hole is deepened to avoid bottoming of the sensor when re-installed.

Drawing Number: 21113
Revision: A



Existing Recessed Ports

If waveform distortion occurs during prolonged testing, remove the sensor and clean the residue as illustrated above.

3.2 PREPARING NEW MOUNTING PORTS

Refer to the installation drawing provided in this manual for instructions on mounting hole preparation. For best results, do not deviate from the steps outlined in this drawing.

To assist new mounting port preparation, PCB offers the 040B20 Tooling Kit (040B21 for metric mount). These installation kits provide all of the necessary tooling required to drill, ream, and tap the mounting ports for proper installation of the 108, 109, 118 and 119 Series transducers.

Use good machining practice in preparation of the mounting port, paying particular attention to the seal surface. It is important that this surface be perfectly smooth and free from tool chatter marks, nicks and other imperfections which might cause leaks at high pressures.

3.3 RECESSED MOUNT

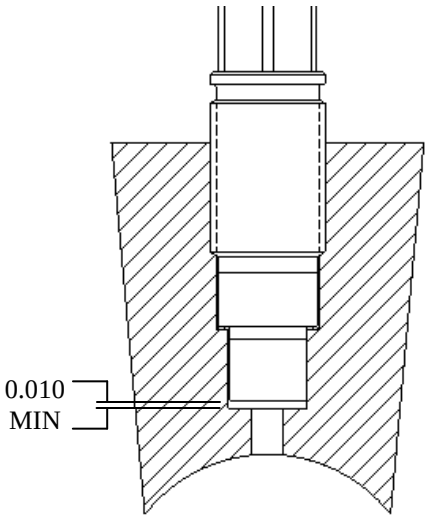
The recessed installation is shown in the Recessed Mount figure. This type of mounting protects the sensor diaphragm from the effects of high-flash temperatures and particle impingement due to blast effects, thereby prolonging sensor life.

The recommended range of passage diameters is 0.090 to 0.125 inch (2.29 to 3.18 mm) diameter.

The limitation in this type of installation lies in the frequency-limiting effects of the passage due to its length.

The passage behaves like an underdamped second order system; the resonant frequency being determined by the passage length. The length may have a limiting effect on pressure pulse rise time and cause passage ringing in cases where the passage is too long.

Recessed Mount



The following relationship approximates this resonant frequency (f_r):

$$f_r = \frac{V}{4L} \quad (Hz) \qquad \text{(EQ. 1)}$$

Where: f_r = Resonant frequency of passage (Hz)

V = Velocity of sound in air (ft/sec)

L = Length of column (ft)

For air at room temperature, (EQ. 1) becomes:

$$f_r = \frac{3300}{L} \qquad \text{(EQ. 2)}$$

Where: L = Passage length (in)

The natural frequency and approximate fastest pressure step rise time for various length passages is shown in the following chart. (Medium, air at 25°C).

PASSAGE LENGTH (in)	PASSAGE RESONANCE (kHz)	APPROX. FASTEST PULSE RISE TIME (μsec)
.050	66	5
.100	33	10
.200	16.5	20
.50	6.6	50
1.0	3.3	100

Passage Resonance vs. Passage Length

Actual resonant frequencies measured in practice may differ slightly from the chart values. These differences are due to variations in the velocity of propagation of sound in air caused by changes in temperature and pressure of the air in the passage.

For best matching of passage to diaphragm, maintain the 0.010 inch (0.254 mm) clearance ahead of the diaphragm as shown in the Recessed Mount figure on the previous page.

3.4 FLUSH MOUNT

In the flush mount installation, there is no reduced area passage from the sensor diaphragm to the test chamber; rather the sensor diaphragm is mounted flush with (or slightly recessed from) the inside surface of the test chamber.

Use this type of installation only if space or rise time considerations preclude the use of recessed installation.

In severe pyrotechnic environments, sensor life may be severely limited with flush installation.

3.5 FLASH TEMPERATURE EFFECTS

The ceramic coating on the diaphragm of these sensors should render the flash thermal effect insignificant in most cases, especially when recessed mounted.

However, if more protection from flash thermal effects is required with the recessed mount, the passage can be filled with silicone grease (DC-4 or equivalent). Several layers of black vinyl electrical tape directly on the diaphragm have proven effective in many cases as well.

Flash temperature effects are usually longer term and will show up as a baseline shift long after the event to be measured has passed.

For flush mount installations, a silicone rubber coating approximately 0.010 inch thick can be effective; GE RTV type 106 is recommended, and is available from PCB as Model 065A67. Follow manufacturer's instructions to apply. It is best to recess the diaphragm 0.010 inch for this type of protection.

3.6 INSTALLING CABLES

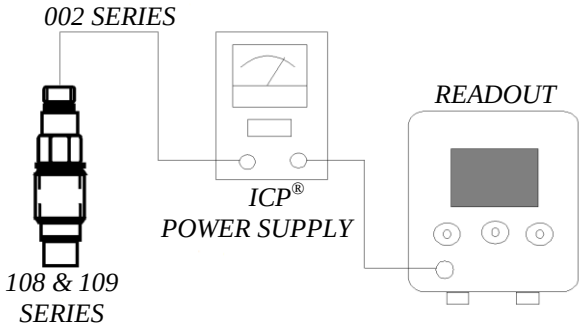
It is convenient, though not necessary, to use coaxial cable, such as PCB 002 Series, to connect the transducer to the power unit. Cable need not be low-noise treated.

If the use of lighter, more flexible cable is desired, PCB Model 070B09 solder connector adaptors may be used to employ twisted pair or other types of two-wire cable.

3.7 CIRCUIT CONNECTIONS

The figures below show two typical circuit connections normally used to connect the 108 & 109 Series to power units.

The first figure is the connection scheme used for most applications. In this set up, the signal is AC-coupled from the bias voltage meaning the voltage at the "scope" terminal will be at a zero volt bias level.

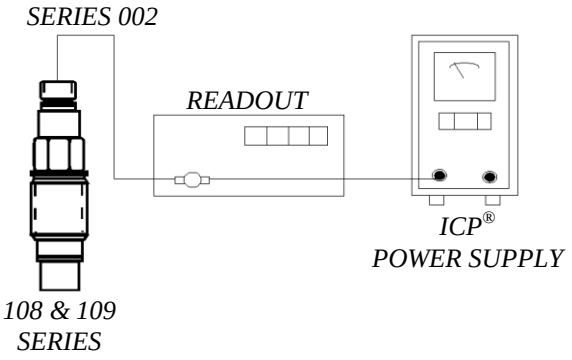


Normal Connection AC-Coupled Output

In this case, the system discharge time constant will be determined by the input resistance and capacitance of the power unit. Most PCB power units have approximately a 10 second discharge time constant.

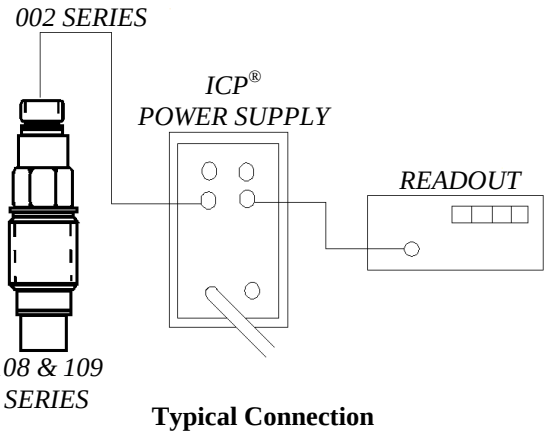
Alternate Connection to take Advantage of Sensor Discharge TC

The second figure illustrates an optional connection scheme which can be used during calibration to take full advantage of the sensor's discharge time constant.



With this arrangement, the readout is direct-coupled to the sensor and the output signal will be added to the DC bias voltage (11 VDC nominal).

The discharge time constant will then be determined only by the sensor and should be in the order of 2000 seconds; this is sufficient for most types of static calibration methods. (See Calibration Section 4.0)



Typical Connection

The figure above shows the 108 & 109 Series connected to a PCB Model 484B06 power unit. The 484B06 is a power unit that can be AC or DC-coupled.

In the DC-couple mode, a level-shifting circuit removes the bias level and provides a zero adjust feature at the front panel. The system's discharge time constant is determined by the sensor in this mode.

An AC-coupled mode is provided for normal AC-coupled operation.

4.0 CALIBRATION

PCB 108 & 109 Series sensors are supplied with a calibration certification from the factory. Recalibration services are provided at the factory for a nominal fee.

Static calibration methods may be employed using the set-up shown in the Alternate Connection figure or by use of the Model 484B06 Power Unit as shown in the figure above – use the 484B06 in DC mode.

Following thermal stabilization of the sensor, use a high pressure pump with dial reference sensor or a dead weight tester to apply pressure in desired increments to full scale. Release pressure after taking the reading and before proceeding to the next higher pressure level.

With a 2000 second discharge time constant, 1% of the signal will be lost in 20 seconds, so it is imperative that the pressure setting and recording of output be accomplished quickly.

A calibration graph can be plotted using output voltage vs. input pressure to determine sensitivity and linearity.

5.0 OPERATION

Select desired mode of circuit connection and turn power unit on.

Observe fault monitor meter at the front panel of the power unit.

Normal operation is indicated by an approximate midscale reading. Shorted cable or connections are indicated by a zero reading (red area).

Open cable or connections are indicated by a full-scale (yellow area) reading.

Allow instrument several minutes to warm up and thermally stabilize.

When output from the power unit is connected to readout equipment, a drift in the voltage signal will be noticed; this is normal. This voltage signal drift is caused by the charging of the coupling capacitor in the power unit and will cease within several minutes.

6.0 POLARITY

The 108 & 109 Series are designed to produce a positive output voltage for increasing pressure at the diaphragm.

7.0 MAINTENANCE

The small size and sealed construction of the 108 & 109 Series precludes field maintenance and repair. Contact the factory for further assistance.

ICP® is a registered trademark of PCB Piezotronics

Model Number	ICP® PRESSURE SENSOR	Revision: C
108A02		ECN #: 25662

Performance	ENGLISH	SI	
Measurement Range(for ±5V output)	10 kpsi	68,950 kPa	
Useful Overrange(for ± 10V output)	20 kpsi	137,900 kPa	[1]
Sensitivity(± 15 %)	0.5 mV/psi	0.073 mV/kPa	
Maximum Pressure(static)	50 kpsi	344,750 kPa	
Resolution	200 mpsi	1.4 kPa	
Resonant Frequency	≥ 250 kHz	≥ 250 kHz	
Rise Time(Reflected)	≤ 2 µ sec	≤ 2 µ sec	
Low Frequency Response(-5 %)	0.01 Hz	0.01 Hz	
Non-Linearity	≤ 2 % FS	≤ 2 % FS	[2]
Environmental			
Acceleration Sensitivity	≤ 0.05 psi/g	≤ 0.035 kPa/(m/s²)	
Temperature Range(Operating)	-100 to +275 °F	-73 to +135 °C	
Temperature Coefficient of Sensitivity	≤ 0.10 %/°F	≤ 0.18 %/°C	
Maximum Vibration	2000 g pk	19,614 m/s² pk	
Maximum Shock	20,000 g pk	196,140 m/s² pk	
Electrical			
Output Polarity(Positive Pressure)	Positive	Positive	
Discharge Time Constant(at room temp)	≥ 50 sec	≥ 50 sec	
Excitation Voltage	20 to 30 VDC	20 to 30 VDC	
Constant Current Excitation	2 to 20 mA	2 to 20 mA	
Output Impedance	≤ 100 ohm	≤ 100 ohm	
Output Bias Voltage	8 to 14 VDC	8 to 14 VDC	
Physical			
Sensing Geometry	Compression	Compression	
Sensing Element	Quartz	Quartz	
Housing Material	C-300	C-300	
Diaphragm	C-300	C-300	
Sealing	Welded Hermetic	Welded Hermetic	
Electrical Connector	10-32 Coaxial Jack	10-32 Coaxial Jack	
Weight	0.42 oz	12 gm	

CE [3]

All specifications are at room temperature unless otherwise specified.
In the interest of constant product improvement, we reserve the right to change specifications without notice.

ICP® is a registered trademark of PCB Group, Inc.

OPTIONAL VERSIONS

Optional versions have identical specifications and accessories as listed for the standard model except where noted below. More than one option may be used.

M - Metric Mount

N - Negative Output Polarity

W - Water Resistant Cable

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] See PCB Declaration of Conformance PS023 for details.

SUPPLIED ACCESSORIES:

Model 065A06 Seal ring 0.318" OD x 0.250" ID x 0.010" thk 316L SS material (3)

Entered: BLS	Engineer: RF	Sales: DPC	Approved: NJL	Spec Number:
Date: 1-16-07	Date: 1/16/07	Date: 1/16/07	Date: 1/16/07	6913

PCB PIEZOTRONICS
PRESSURE DIVISION
3425 Walden Avenue, Depew, NY 14043

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E-Mail: pressure@pcb.com

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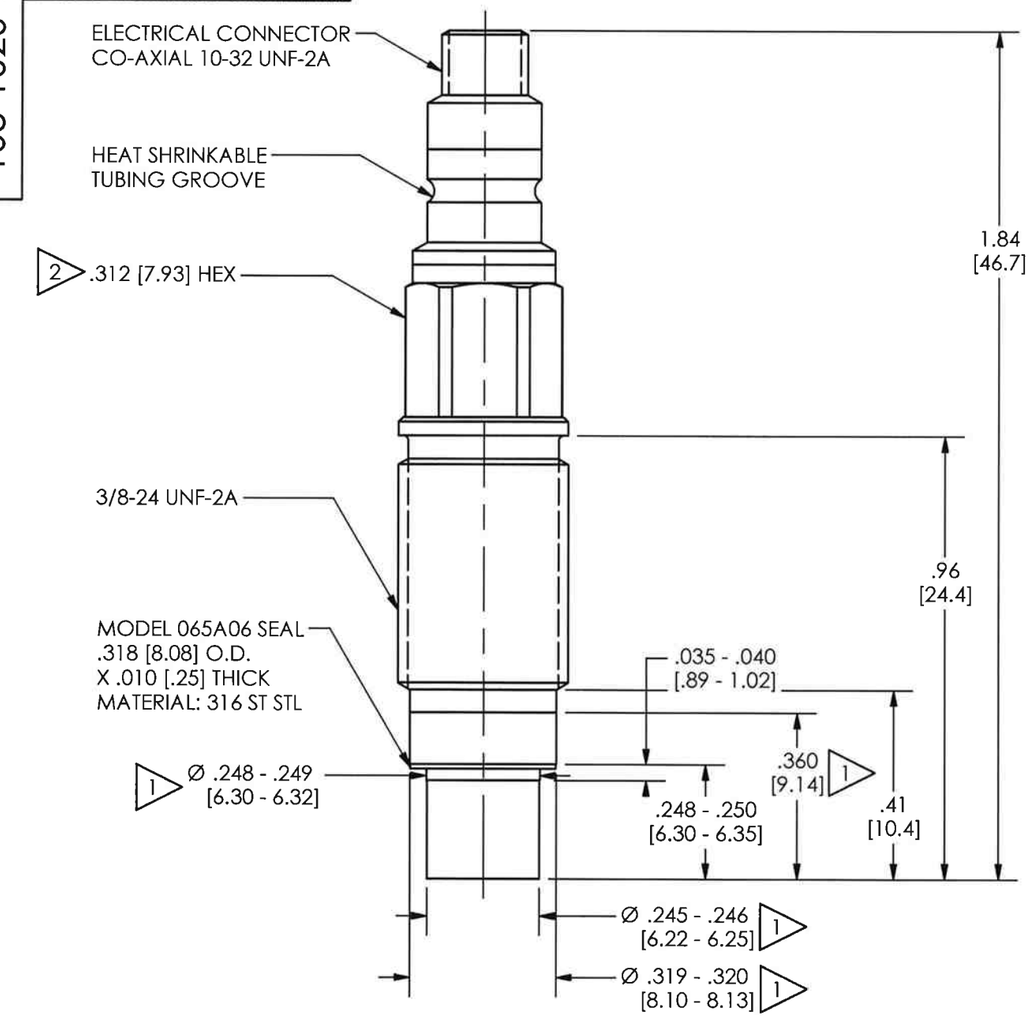
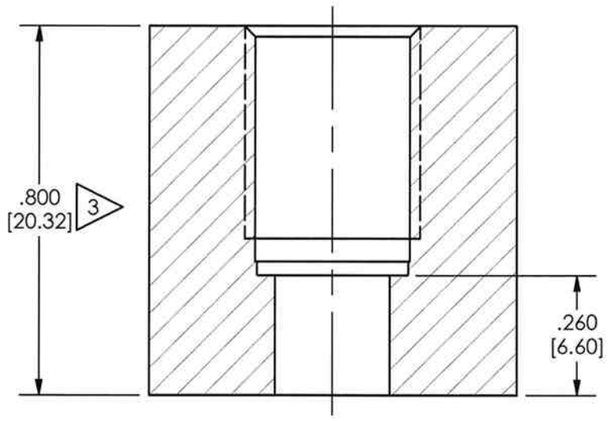
108-1020-90

REVISIONS		
REV	DESCRIPTION	ECO
F	ADD MODEL TO TITLE BLOCK	23185
G	UPDATE MOUNTING HOLES	29412



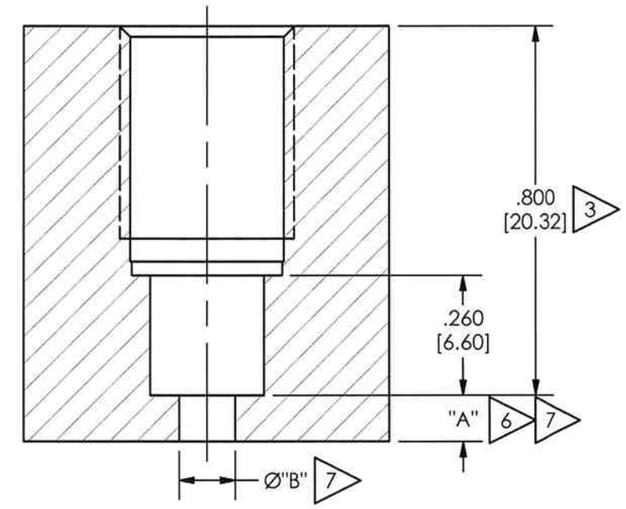
FLUSH INSTALLATION



MOUNTING HOLE DIMENSIONS

3 5 Ø.252 ±.001 [6.40 ±.03]
THRU
4 5 ⌴ Ø.332 ±.001 [8.43 ±.03]
(X .540 [13.72] ↧)
8 3/8-24 UNF-2B
X .460 [11.68] ↧ PERFECT THREAD

RECESSED INSTALLATION



MOUNTING HOLE DIMENSIONS

3 5 ⌴Ø.252 ±.001 [6.40 ±.03]
X .800 [20.3] ↧
4 5 ⌴ Ø.332 ±.001 [8.43 ± .03]
(X .540 [13.72] ↧)
8 3/8-24 UNF-2B
X .460 [11.68] ↧ PERFECT THREAD

8 CAUTION: DO NOT TOUCH SEAL SURFACE WITH TAP WHEN TAPPING HOLE.

7 DIMENSION "A" & "B" TO SUIT USER REQUIREMENTS.

6 KEEP "A" AS SHORT AS POSSIBLE, SEE OPERATING GUIDE FOR OPTIMUM PASSAGE LENGTH.

5 THESE DIAMETERS TO BE CONCENTRIC WITHIN .001 [.03] TIR.

4 SEAL SURFACE SHOULD BE FLAT AND FREE OF TOOL MARKS WITH A MINIMUM 63[1.6] √ FINISH FOR BEST RESULTS.

3 DIMENSIONS SHOWN ARE FOR .800 [20.32] WALL THICKNESS. COUNTERBORE FOR THICKER WALL.

2 RECOMMENDED MOUNTING TORQUE ON .312 [7.93] HEX: 20-25 FT-LB [27-34 N-M].

1 MATERIAL: C-300 MARAGING STEEL

UNLESS OTHERWISE SPECIFIED TOLERANCES ARE:	
DIMENSIONS IN INCHES	DIMENSIONS IN MILLIMETERS [IN BRACKETS]
DECIMALS XX ±.01, XXX ±.005	DECIMALS X ± 0.3, XX ± 0.13
ANGLES ± 2 DEGREES	ANGLES ± 2 DEGREES
FILLETS AND RADII .003 - .005	FILLETS AND RADII [0.07 - 0.13]

DRAWN	MCG	5/19/09	MFG	PRR	5/19/09
CHK'D	ECB	5/20/09	ENGR	APB	5/19/09
APP'D	EB	5/19/09	SALES	RWM	5/19/09

TITLE
INSTALLATION DRAWING
MODEL 108A02, 108A04
HERMETICALLY SEALED PRESSURE SENSOR

PCB PIEZOTRONICS INC.
3425 WALDEN AVE. DEPEW, NY 14043
(716) 684-0001 E-MAIL: sales@pcb.com

CODE IDENT. NO. 52681 | DWG. NO. 108-1020-90 | SCALE: 3X | SHEET 1 OF 1