



**Model 108A04**  
**ICP® Pressure Sensor**  
**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](mailto:info@pcb.com)**  
**Web: [www.pcb.com](http://www.pcb.com)**



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

**Total Customer Satisfaction** – PCB Piezotronics guarantees Total Customer Satisfaction. If, at any time, for any reason, you are not completely satisfied with any PCB product, PCB will repair, replace, or exchange it at no charge. You may also choose to have your purchase price refunded in lieu of the repair, replacement, or exchange of the product.

**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 insure 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 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 insure 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

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.

**Warranty** – All equipment and repair services provided by PCB Piezotronics, Inc. are covered by a limited warranty against defective material and workmanship for a period of one year from date of original purchase. Contact

PCB for a complete statement of our warranty. Expendable items, such as batteries and mounting hardware, are not covered by warranty. Mechanical damage to equipment due to improper use is not covered by warranty. Electronic circuitry failure caused by the introduction of unregulated or improper excitation power or electrostatic discharge is not covered by warranty.

**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](http://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](http://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, NY 14043 USA  
Toll-free: (800) 828-8840  
24-hour SensorLine<sup>SM</sup>: (716) 684-0001  
Website: [www.pcb.com](http://www.pcb.com)  
E-mail: [info@pcb.com](mailto:info@pcb.com)

# OPERATION MANUAL FOR ICP<sup>®</sup> HIGH PRESSURE SENSOR Series 108B

## 1.0 INTRODUCTION

The Model 108B is the ICP<sup>®</sup> (Integrated Circuit Piezoelectric) version of the Model 118B11 Ballistics Sensor. These models were developed primarily to measure ballistics chamber pressures for R & D and production testing of ammunition. Both models share the same quartz pressure element.

The design features a one-piece diaphragm, machined integral with the housing for ruggedness. The diaphragms are coated with flame-sprayed ceramic to minimize flash temperature effects.

The high-impedance voltage signal produced by the quartz element in the Model 108B is impressed across the input of a built-in microelectronic amplifier (actually an impedance converter with unity voltage gain) which converts the signal to a low-impedance level voltage ( $< 100 \Omega$ ) able to drive long lines and be fed directly into readout instruments such as oscilloscopes, peak meters, etc.

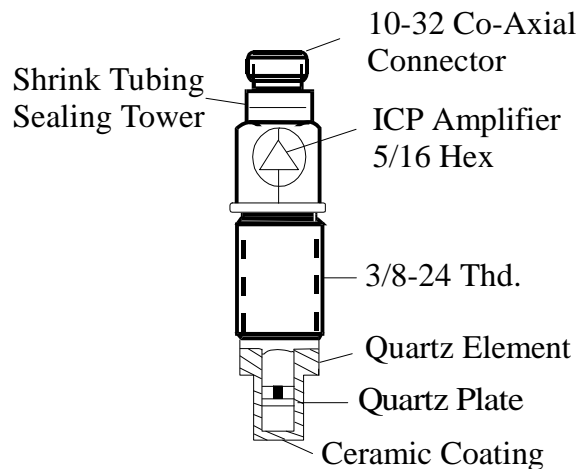


Figure 1: Model 108B Pressure Sensor

## 2.0 DESCRIPTION

The figure 1 above shows the internal construction of the Model 108B.

The machined diaphragm is made from maraging steel because of its high strength and toughness.

The 3/8-24 thread and flush diaphragm design are conventional, providing direct interchangeability with existing welded diaphragm-type piezoelectric sensors.

The simple, rigid piezo element (containing only quartz, steel and ceramic) gives the 108B a very high natural frequency and good linearity, even below 100 psi.

The microelectronic impedance converter is located just below the connector and is fully potted to withstand up to 100,000 g shocks. The signal at the output of this amplifier is superimposed on a +11 V bias level. This bias is removed in all PCB power units. (See the PCB publication "Guide to ICP<sup>®</sup> Instrumentation" G0001B for a complete treatment of the ICP<sup>®</sup> concept.)

## 3.0 INSTALLATION

The Model 108B Sensor mounts directly in existing ports machined for PCB Models 118B01, 109B01 and 119A.

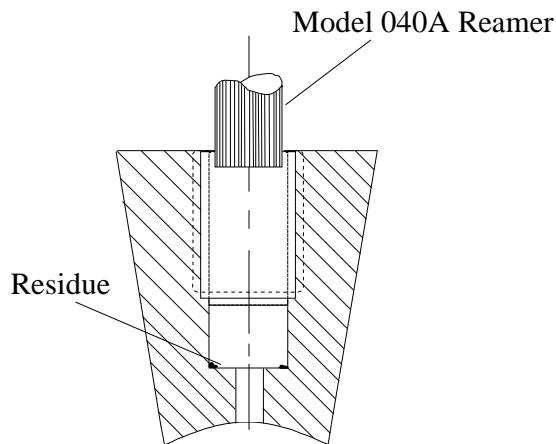
Unlike conventional diaphragm type sensors, the 108B is pressure sensitive over the entire frontal area. For this reason, extra care should be exercised to avoid bottoming in mounting hole when recessed mounted and especially when mounting into existing mounting ports.

A torque wrench should be used to monitor the mounting torque value when installing the Series 108B. The recommended range is given on the installation drawing.

### 3.1 MOUNTING IN EXISTING RECESSED PORTS

Before installing the sensor in previously used mounting ports, clean off residue from previous tests as shown in figure 2.

This can be accomplished by hand reaming the 1/4" diameter hole using a PCB Model 040A end cutting reamer (or equivalent).



**Figure 2: Existing Recessed Ports Mount**

During prolonged testing, should waveform distortion occur, remove sensor and remove residue as shown.

It is important to note that, should the seal surface require re-machining to clean up after prolonged use, don't forge to deepen the 1/4" diameter hole by the same amount. Otherwise, the sensor may bottom when installed.

### 3.2 PREPARING NEW MOUNTING PORTS

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

Use good machining practice in preparation of the mounting port, paying particular attention to the seal surface (.323 diameter), and keeping it free from tool chatter marks.

**NOTE:** It is important that this surface be perfectly smooth and free from nicks or other discontinuities which might cause leaks at high pressures.

### 3.3 RECESSED MOUNT

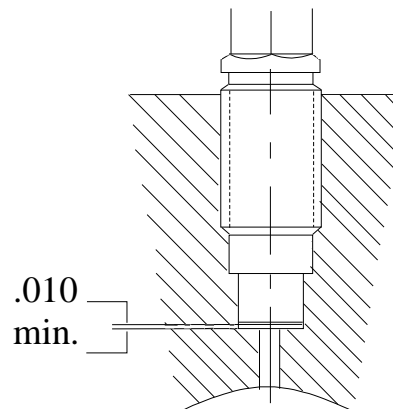
The recessed installation is shown in figure 3.

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 .090 to .125.

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. This can have a limiting effect on pressure pulse rise time while causing passage ringing in cases where the passage is too long.



**Figure 3**

The following relationship determines this resonant frequency ( $f_r$ ):

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

Where:  $f_r$  = resonant frequency of passage (Hz)

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

$L$  = Length of column (ft)

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

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

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 (u Sec)
.050	66	5
.100	33	10
.200	16.5	20
.50	6.6	50
1.0	3.3	100

Actual resonant frequencies measured in practice may differ slightly from the chart values 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 .010" clearance ahead of the diaphragm as shown in previous figure.

### 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 the 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.

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

For flush mount installations, a silicone rubber coating approximately .010" thick can be effective. General Electric RTV type 106 silicone rubber is recommended. Follow manufacturer's instructions to apply. It is best to recess the diaphragm .010" for this type of protection.

### 3.6 INSTALLING CABLES

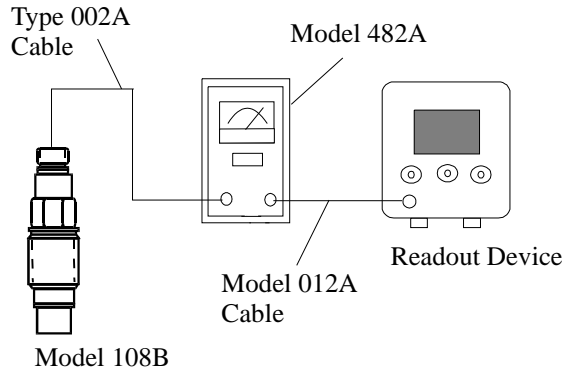
It is convenient, though not necessary, to use co-axial cable such as PCB Model 002A to connect sensor to power unit.

Cable need not be low-noise treated and in fact, if it is desired to use lighter, more flexible cable, 070A09 solder connector adaptors may be used to employ twisted pair or other types of two-wire cable.

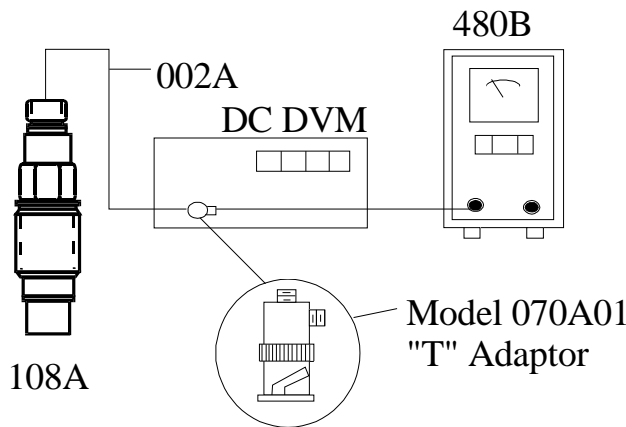
### 3.7 CIRCUIT CONNECTIONS

Figures 5a and 5b show two typical circuit connections normally used with the 108B Series to connect to the power units.

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**Figure 5a: Normal Connection AC-Coupled Output**



**Figure 5b: Alternate Connection to take Advantage of Sensor Discharge TC**

Figure 5 (a) is the most often used connection scheme for most applications. In this set-up, the signal is AC-coupled from the bias voltage by a 10  $\mu$ F capacitor located in the power unit.

The voltage at the "scope" terminal will be at a " 0" volt bias level.

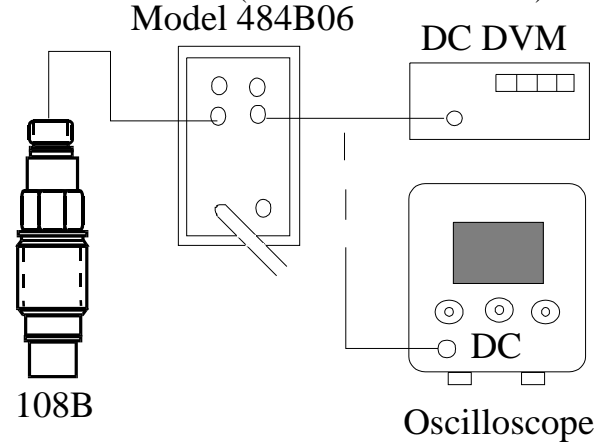
In this case, the system discharge time constant will be determined by the value of the input resistance (R) of the readout device and the 10  $\mu$ F capacitor (C) in accordance with the following relationship:

$$TC \text{ (seconds)} = R \text{ (ohms)} C \text{ (farads)}$$

Figure 5 (b) illustrates an optional connection scheme which can be used during calibration to take full advantage of the sensor discharge time constant.

With this arrangement, the readout is direct-coupled to the sensor and the output signal will be added to the +11 volt (Nom) bias level.

The discharge time constant will now 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.)



**Figure 6: Typical Connection**

The above figure shows the 108B connected to the Model 484B06 Power Unit. The 484B06 is a dual-mode power unit, i.e. the output signal can be AC- or DC-coupled from the sensor.

In the DC mode, a level-shifting circuit removes the bias level and provides a zero adjust feature at the front panel.

In the DC mode, the system discharge time constant is determined by the sensor.

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

## 4.0 CALIBRATION

Static calibration methods may be employed using the set-up shown in Figure 5 (b) or by use of the Model 484B06 Power Unit as shown in Figure 6. Use 484B06 in DC mode.

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Use a high pressure pump with dial reference gage or a dead weight tester to apply pressure in desired increments to full scale. Dump pressure after taking the reading and before proceeding to the next higher pressure level.

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With a 2000 second discharge TC, 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 then be plotted using output voltage vs. input pressure.

## **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 power unit is connected to readout equipment, a drifting of the voltage signal will be noticed. This is normal. It is due to the charging of the coupling capacitor in the power unit and will cease within several minutes.


## **6.0 POLARITY**

The series 108B produces a positive-going output voltage for increasing pressure at the diaphragm.

## **7.0 MAINTENANCE**

The small size and sealed construction of the series 108B precludes field maintenance and repair.



Performance	ENGLISH	SI	OPTIONAL VERSIONS	
Measurement Range (for $\pm 4.5V$ output)	30 kpsi	207,000 kPa	Optional versions have identical specifications and accessories as listed for the standard model except where noted below. More than one option may be used.	
Sensitivity ( $\pm 15\%$ )	0.15 mV/psi	0.022 mV/kPa	<b>M</b> - Metric Mount	
Maximum Pressure	50 kpsi	344,750 kPa	<b>N</b> - Negative Output Polarity	
Resolution	500 mpsi	3.5 kPa	<b>W</b> - Water Resistant Cable	
Resonant Frequency	$\geq 250$ kHz	$\geq 250$ kHz		
Rise Time (Reflected)	$\leq 2 \mu$ sec	$\leq 2 \mu$ sec		
Low Frequency Response (-5%)	0.002 Hz	0.002 Hz		
Non-Linearity	$\leq 2\%$ FS	$\leq 2\%$ FS		
<b>Environmental</b>				
Acceleration Sensitivity	$\leq 0.05$ psi/g	$\leq 0.035$ kPa/(m/s <sup>2</sup> )		
Temperature Range (Operating)	-100 to +275 °F	-73 to +135 °C		
Temperature Coefficient of Sensitivity	$\leq 0.10\%$ /°F	$\leq 0.18\%$ /°C		
Maximum Vibration	2000 g pk	19,614 m/s <sup>2</sup> pk		
Maximum Shock	20,000 g pk	196,140 m/s <sup>2</sup> pk		
<b>Electrical</b>				
Output Polarity (Positive Pressure)	Positive	Positive		
Discharge Time Constant (at room temp)	$\geq 250$ sec	$\geq 250$ sec		
Excitation Voltage	20 to 30 VDC	20 to 30 VDC		
Constant Current Excitation	2 to 20 mA	2 to 20 mA		
Output Impedance	$\leq 100$ ohm	$\leq 100$ ohm		
Output Bias Voltage	8 to 14 VDC	8 to 14 VDC		
<b>Physical</b>				
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	0.48 oz	13.6 gm		
			<b>NOTES:</b>	
			[1] Zero-based, least-squares, straight line method.	
			[2] See PCB Declaration of Conformance PS023 for details.	
			<b>SUPPLIED ACCESSORIES:</b>	
			Model 065A06 Seal ring 0.318" OD x 0.250" ID x 0.010" thk 316L SS material (3)	
			Entered: <i>BLS</i>	Engineer: <i>NJL</i>
			Sales: <i>DPC</i>	Approved: <i>RF</i>
			Date: <i>4-4-05</i>	Date: <i>4/4/05</i>
			Date: <i>4/4/05</i>	Spec Number: <i>28544</i>
			 <b>PCB PIEZOTRONICS™</b> <b>PRESSURE DIVISION</b> Phone: 716-684-0001 Fax: 716-686-9129 E-Mail: pressure@pcb.com 3425 Walden Avenue, Depew, NY 14043	



[2]

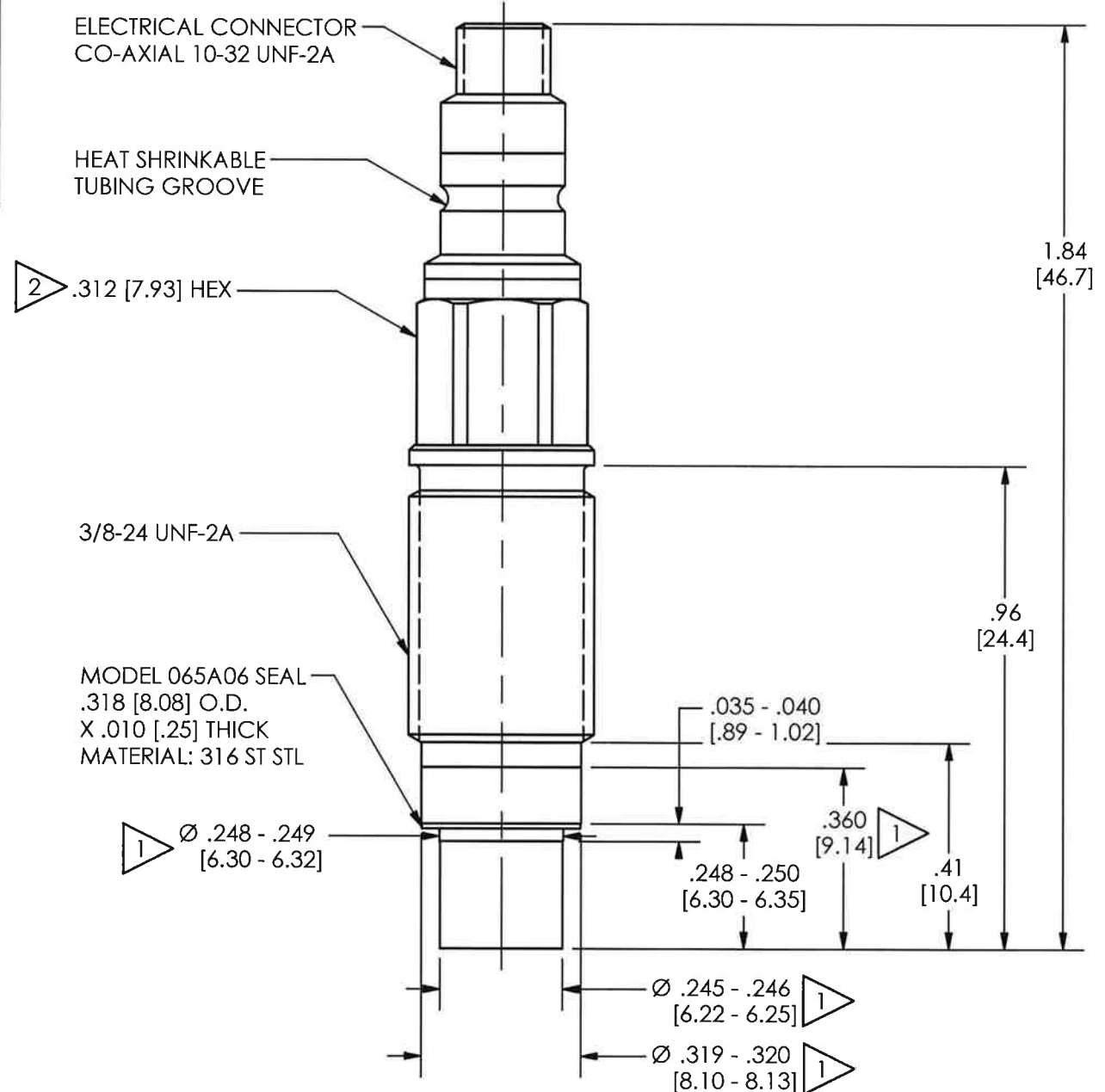
All specifications are at room temperature unless otherwise specified.  
 In the interest of constant product improvement, we reserve the right to change specifications without notice.

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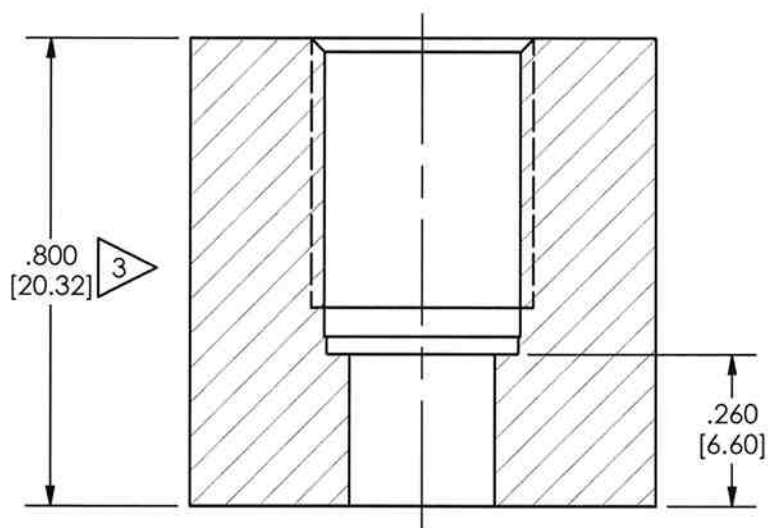
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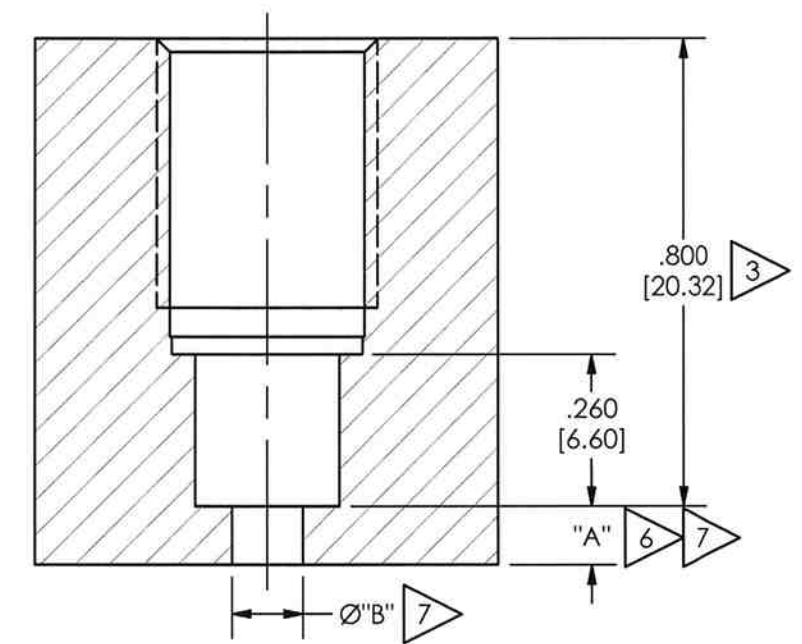
REVISIONS		
REV	DESCRIPTION	ECO
F	ADD MODEL TO TITLE BLOCK	23185
G	UPDATE MOUNTING HOLES	29412



**FLUSH INSTALLATION**



**RECESSED INSTALLATION**



**MOUNTING HOLE DIMENSIONS**

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

**MOUNTING HOLE DIMENSIONS**

- 3 5  $\varnothing$ .252 ±.001 [6.40 ±.03] X .800 [20.3]  $\nabla$
- 4 5  $\varnothing$ .332 ±.001 [8.43 ±.03] (X .540 [13.72]  $\nabla$ )
- 8 3/8-24 UNF-2B (X .460 [11.68]  $\nabla$  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  $\sqrt{63[1.6]}$  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:		DRAWN	MCG	5/19/09	MFG	PRR	5/19/09	 3425 WALDEN AVE. DEPEW, NY 14043 (716) 684-0001 E-MAIL: sales@pcb.com
DIMENSIONS IN INCHES	DIMENSIONS IN MILLIMETERS [IN BRACKETS]	CHK'D	ECB	5/20/09	ENGR	APB	5/19/09	
DECIMALS XX ±.01 XXX ±.005	DECIMALS X ±.03 XX ±.013	APP'D	EB	5/19/09	SALES	RWM	5/19/09	
ANGLES ± 2 DEGREES	ANGLES ± 2 DEGREES	TITLE		INSTALLATION DRAWING MODEL 108A02, 108A04 HERMETICALLY SEALED PRESSURE SENSOR				
FILLETS AND RADII .003 - .005	FILLETS AND RADII [0.07 - 0.13]	CODE IDENT. NO.		DWG. NO.		SCALE:		SHEET 1 OF 1
		52681		108-1020-90		3X		