



Model 090B243
CALIBRATION ADAPTOR
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



Repair and Maintenance

PCB guarantees Total Customer Satisfaction through its “Lifetime Warranty Plus” on all Platinum Stock Products sold by PCB and through its limited warranties on all other PCB Stock, Standard and Special products. Due to the sophisticated nature of our sensors and associated instrumentation, **field servicing and repair is not recommended and, if attempted, will void the factory warranty.**

Beyond routine calibration and battery replacements where applicable, our products require no user maintenance. Clean electrical connectors, housings, and mounting surfaces with solutions and techniques that will not harm the material of construction. Observe caution when using liquids near devices that are not hermetically sealed. Such devices should only be wiped with a dampened cloth—never saturated or submerged.

In the event that equipment becomes damaged or ceases to operate, our Application Engineers are here to support your troubleshooting efforts 24 hours a day, 7 days a week. Call or email with model and serial number as well as a brief description of the problem.

Calibration

Routine calibration of sensors and associated instrumentation is necessary to maintain measurement accuracy. We recommend calibrating on an annual basis, after exposure to any extreme environmental influence, or prior to any critical test.

PCB Piezotronics is an ISO-9001 certified company whose calibration services are accredited by A2LA to ISO/IEC 17025, with full traceability to SI through N.I.S.T. In addition to our standard calibration services, we also offer specialized tests, including: sensitivity at elevated or cryogenic temperatures, phase response, extended high or low frequency response, extended range, leak testing, hydrostatic pressure testing, and others. For more information, contact your local PCB Piezotronics distributor, sales representative, or factory customer service representative.

Returning Equipment

If factory repair is required, our representatives will provide you with a Return Material Authorization (RMA) number, which we use to reference any information you have already provided and expedite the repair process. This number should be clearly marked on the outside of all returned package(s) and on any packing list(s) accompanying the shipment.

Contact Information

PCB Piezotronics, Inc.
3425 Walden Ave.
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General inquiries: info@pcb.com
Repair inquiries: rma@pcb.com

For a complete list of distributors, global offices and sales representatives, visit our website, www.pcb.com.

Safety Considerations

This product is intended for use by qualified personnel who recognize shock hazards and are familiar with the precautions required to avoid injury. While our equipment is designed with user safety in mind, the protection provided by the equipment may be impaired if equipment is used in a manner not specified by this manual.

Discontinue use and contact our 24-Hour Sensorline if:

- Assistance is needed to safely operate equipment
- Damage is visible or suspected
- Equipment fails or malfunctions

For complete equipment ratings, refer to the enclosed specification sheet for your product.

Definition of Terms and Symbols

The following symbols may be used in this manual:



DANGER

Indicates an immediate hazardous situation, which, if not avoided, may result in death or serious injury.

**CAUTION**

Refers to hazards that could damage the instrument.

**NOTE**

Indicates tips, recommendations and important information. The notes simplify processes and contain additional information on particular operating steps.

The following symbols may be found on the equipment described in this manual:



This symbol on the unit indicates that high voltage may be present. Use standard safety precautions to avoid personal contact with this voltage.



This symbol on the unit indicates that the user should refer to the operating instructions located in the manual.



This symbol indicates safety, earth ground.



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	0	0	0	0	0	0
PCB板	X	0	0	0	0	0
电气连接器	0	0	0	0	0	0
压电晶体	X	0	0	0	0	0
环氧	0	0	0	0	0	0
铁氟龙	0	0	0	0	0	0
电子	0	0	0	0	0	0
厚膜基板	0	0	X	0	0	0
电线	0	0	0	0	0	0
电缆	X	0	0	0	0	0
塑料	0	0	0	0	0	0
焊接	X	0	0	0	0	0
铜合金/黄铜	X	0	0	0	0	0
本表格依据 SJ/T 11364 的规定编制。						
0：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.

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Lead is present due to allowed exemption in Annex III or Annex IV of the European RoHS Directive 2011/65/EU.

**OPERATION MANUAL FOR
BALLISTICS PRESSURE SENSOR CALIBRATION ADAPTOR
FOR AMMUNITION TESTING
Model 090B**

1.0 INTRODUCTION

The Series 090B Calibration Adaptors are designed to facilitate calibration of the Model 117B Conformal Pressure.

An actual empty cartridge case is pressurized with precisely known hydraulic pressure and the corresponding output of the sensor is read at each pressure point to full scale.

2.0 DESCRIPTION

Refer to Drawing No. 090-2 -90 included as part of this manual.

The Model 090B Adaptor Assembly consists of a pressure chamber (Item 1) a pressure chamber adaptor (Item 2), a cartridge case retainer (Item 3), and a retaining nut (Item 4).

The pressure chamber adaptor (Item 2) contains an O-ring to affect a pressure seal when the adaptor is pushed into the cartridge case mouth. The opposite end of this item is designed to mount directly into a standard mounting port for the PCB Models 118A, 108A, 119A and 109A pressure sensors. This feature precludes the need for high pressure fitting, tubing, etc. thereby, keeping the total pressurized volume to a minimum.

3.0 INSTALLING THE SENSOR

The sensor is installed in the empty pressure chamber (Item 1) so that the flushness of the curved diaphragm with the I.D. of the test chamber can be observed.

Before installing the sensor into the Model 090B Adaptor, read the installation instructions supplied with the specific sensor for which this adaptor is designed.

Follow these instructions carefully paying particular attention to the depth adjustment. The rotational alignment is automatically controlled by the alignment device incorporated in all 117B Conformal Sensors.

4.0 INSTALLATION OF THE CARTRIDGE CASE

(Refer to Installation Dwg. No. 090-2 -90)

It is important that cartridge case selected for calibration be identical in all respects including material, to the lot of ammunition undergoing test. It is advisable that the test unit be selected from the same lot as the ammunition under test for greatest accuracy of test results.

For small arms cartridge cases, it is necessary to use a case with the primer in place, but fired.

Note: Do not use a cartridge case with an unfired primer or a case which has drilled holes.

If a sample cartridge is a loaded round, remove bullet and powder, then fire the primer.

On certain calibers an O-ring is provided in the cartridge case retainer (Item 3) to effect a pressure seal at the boltface end of the case.

Inspect the boltface surface for irregularities or imperfections in the area of this O-ring, which could preclude a pressure seal.

Note: For shotshell installation, consult enclosed drawing for necessary modification to the empty shotshell case. The case must be cut to a specified overall length to fit properly into the calibration fixture due to inconsistencies in the designs of the various makes of ammunition.

4.1 STEP-BY-STEP INSTALLATION PROCEDURE

1. Remove Items 2, 3, and 4 from chamber body (Item 1).

Note: For metallic cartridges, it is extremely important that the mouth of the cartridge case be chamfered to allow easy entry of the O-ring on the pressure chamber adaptor. This operation is easily performed with a hand held 90° countersink or a sharp de-burring tool. If this is not done, O-ring life will be drastically shortened.

**OPERATION MANUAL FOR
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Insert the empty cartridge case into the chamber body (Item 1) as shown. Inspect the cartridge case retainer (Item 3) for an O-ring groove, which will be found on certain calibrators. If an O-ring groove is found, an O-ring must be used with this item. Lubricate O-ring with silicone grease or equivalent and install on to the cartridge case retainer (Item 3).

Install the cartridge case retainer (Item 3) and tighten until its shoulder bottoms snugly against the chamber body.

- Slide the retaining nut (Item 4) over chamber adaptor (Item 2), with the threaded portion first, facing the o-ring groove. See drawing 090-2 - 90. Install this chamber adaptor/retaining nut assembly into the test port of a high pressure hydraulic source (dead weight tester or pressure pump with reference pressure gage) using 065A06 seal ring. Using the hex flats on the chamber adaptor, tighten the chamber adaptor/retaining nut assembly to approx. 20 ft. lbs. of torque.

Note: Do not over torque as chamber or seal could be damaged.

- Lubricate the O-ring on the chamber adaptor (Item 2) with silicone grease or hydraulic oil. Insert the open end of the chamber body (Item 1) onto the chamber adaptor (Item 2). Insert fully until end of chamber body meets large diameter seat on the chamber adaptor.

Thread the retaining nut (Item 4) over the chamber adaptor, snugly. It will not be necessary to use large amounts of torque on this nut to affect a pressure seal.

- Connect 117B to an electrostatic charge amplifier (such as PCB Model 462A or 462B52) on "long time constant".

Zero the system electrically by moving front panel toggle to "gnd" position momentarily.

5.0 COLLECTING THE DATA

It is important to proceed carefully while performing the calibration to avoid procedures which could lend inherent error to the results.

The recommended procedure is as follows:

- Allow at least 15 minutes for test equipment to warm-up and stabilize after connecting sensor to charge amplifier and charge amplifier to digital volt meter.
- Since the end result of the sensor calibration is a determination of sensor slope (in units of picocoulombs/psi) it will be convenient to range the charge amplifier so that the output charge can be read directly in picocoulombs.

To facilitate this, choose the 1000 units/volt range for the miniature versions of the Model 117B (for pressure to 40,000 psi) and 10,000 units/volt for the standard versions (for pressure to 80,000 psi).

Set the dial gain pot to 10.00 and verify, by calibration that the transfer function of the Charge Amplifier is precisely 1000 pC/volt and/or 10,000 pC/volt.

- Set the charge amplifier time constant switch to "long", switch to "gnd" position and zero the charge amplifier. Switch to operate and observe the zero for 15 seconds. No drift should be observed.

If excessive drift is observed, check for faulty cable or contamination on connector of sensor.

- Apply pressure, increasing to 10,000 psi. Set pressure precisely, using reference gage and allow pressure to remain at this level for approximately 5 seconds. Readjust pressure if necessary and record voltage reading.

**OPERATION MANUAL FOR
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5. Without dropping pressure, immediately proceed to next pressure level, set pressure and record reading.

NOTE: For sensors with full scale range of 40,000 psi or less, calibration increments of 5,000 psi are used. For sensors with full scale range above 40,000 psi, increments of 10,000 psi are used.

Proceed in this manner to full scale.

6. It is important to note that the test pressure must always be approached from below, i.e. by increasing pressure, never decreasing.

Use only unfired cases since the hardness of fired cases may have been altered.

Do not cycle case before calibrating. Take one set of readings on each case, then discard the case.

If the test pressure at any point is exceeded by more than 5%, discard the case and the data and start over with another case.

8. Repeat procedure for each case to be calibrated.

6.0 ORGANIZING THE DATA

Since the family of values of output charge at each calibration point follows a random distribution about a mean value, the standard deviation at each point is a valid indication as to the preciseness of the calibration at that point.

A convenient format for tabulating this data and calculating the standard deviation is shown in figures 1 and 2.

7.0 UTILIZING THE DATA

See "An Improved Technique for Utilization of Conformal Ballistics Sensor Calibration Data", attached.

8.0 OPERATION

Apply pressure slowly, starting with the lowest pressure working toward the highest, set the pressure to specific values precisely and read corresponding voltage output at each point. Do not dump pressure at each point.

Due to the fact that a certain amount of pressure is necessary to expand the cartridge case, a severe non-linearity will be noticed at the low end of the calibration curve.

A special technique has been developed to handle this problem. Refer to the enclosed paper "An Improved Technique for Utilization of Conformal Sensor Calibration Data" for instructions in collecting and using the conformal calibration data.

Also, read the operating guide supplied with the sensor for further pertinent information regarding use of the 090B Calibrator.

9.0 PRESSURE LIMITS

It is very important that maximum pressures are not exceeded for the safety of operating personnel.

For pistol calibrators, and 22 rimfire, the maximum pressure is 40,000 psi. For center fire rifle cartridges, the maximum hydraulic pressure is 60,000 psi.

Do not exceed these pressures. The units were tested at the factory only to the pressures stated here. Exceeding these pressures may endanger personnel operating this equipment.

OPERATION MANUAL FOR
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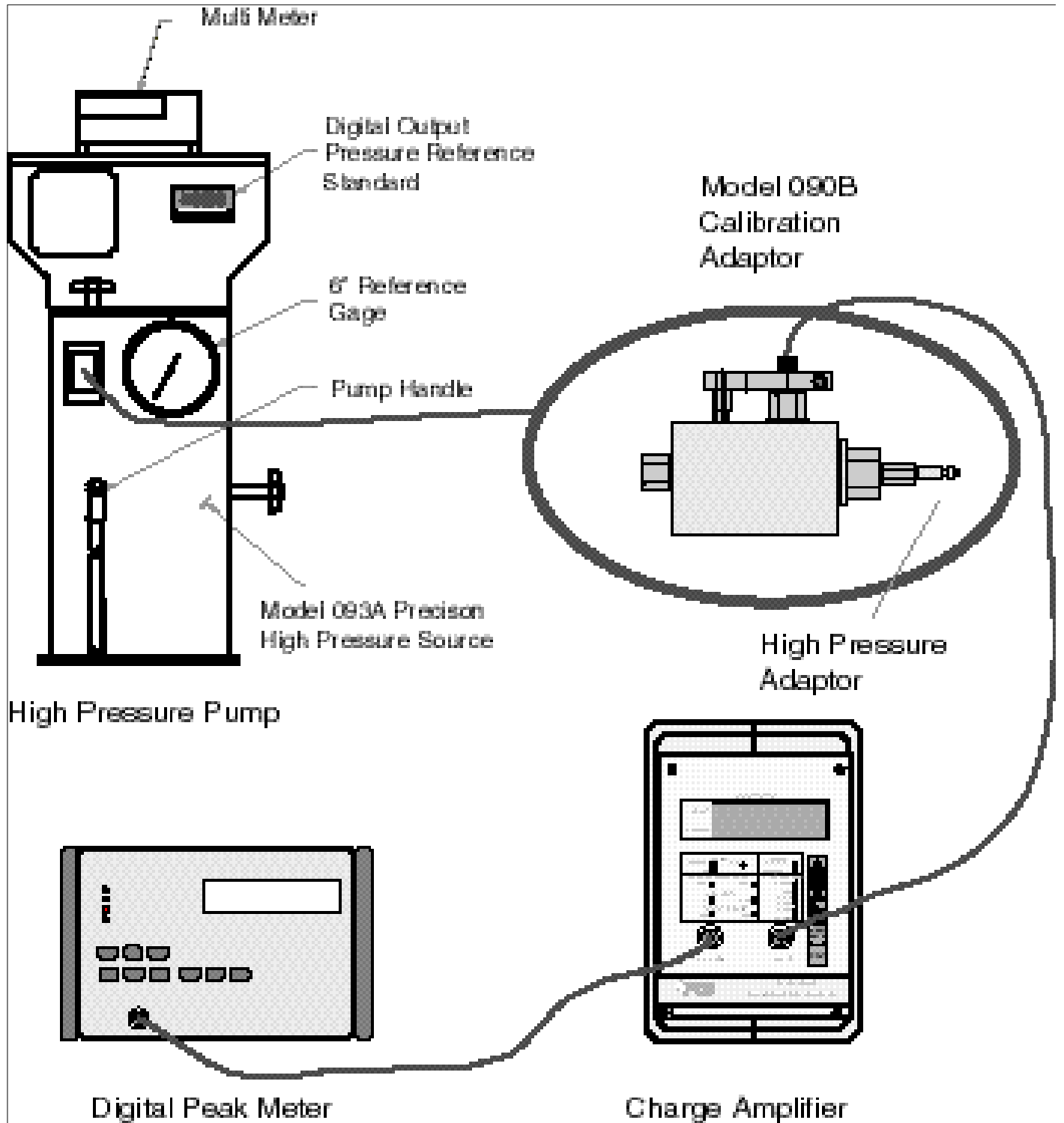


Figure 1

OPERATION MANUAL FOR
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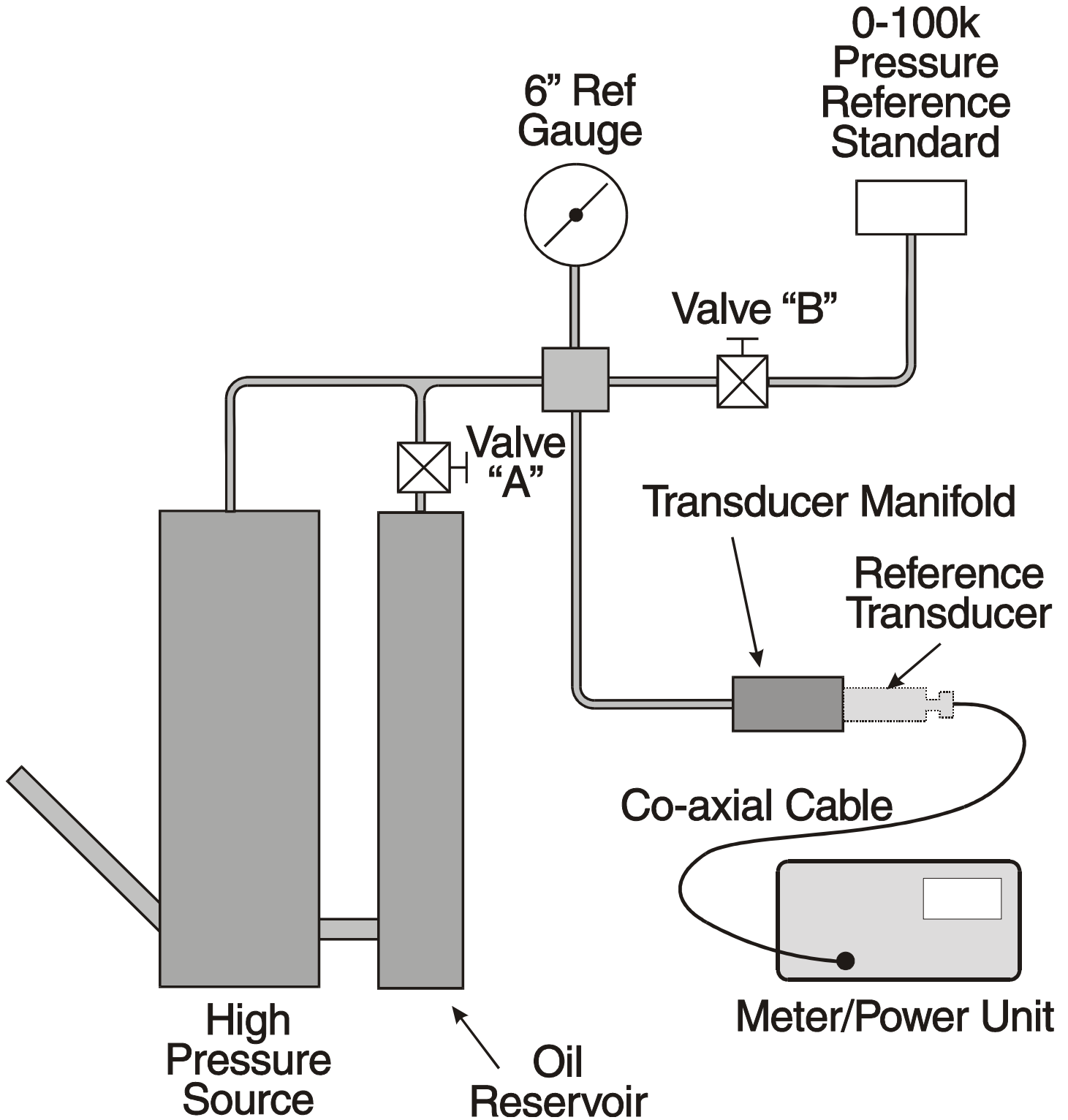


Figure 2



Model 117B12

CONFORMAL BALLISTICS PRESSURE SENSOR

Installation and Operating Manual

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Indicates tips, recommendations and important information. The notes simplify processes and contain additional information on particular operating steps.

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This symbol indicates safety, earth ground.



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

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电气连接器	0	0	0	0	0	0
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环氧	0	0	0	0	0	0
铁氟龙	0	0	0	0	0	0
电子	0	0	0	0	0	0
厚膜基板	0	0	X	0	0	0
电线	0	0	0	0	0	0
电缆	X	0	0	0	0	0
塑料	0	0	0	0	0	0
焊接	X	0	0	0	0	0
铜合金/黄铜	X	0	0	0	0	0
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CHINA RoHS COMPLIANCE

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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

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**OPERATION MANUAL FOR
CONFORMAL BALLISTICS PRESSURE SENSOR
Series 117B**

1.0 INTRODUCTION

The Model 117B Conformal Sensor measures pressure inside metallic cartridges and paper or plastic shotshell, during firing of the round, without drilled holes in the round.

The sensor is mounted flush with the chamber walls, matching the curvature exactly. The expanded cartridge or shotshell transmits forces through the thin wall to the sensor.

The Model 117B is a conventional charge output type sensor using synthetic quartz as the piezoelectric sensing material.

An alignment guide now standard on all 117B Models, simplifies installation by automatically controlling rotational alignment of the sensor, leaving only the depth adjustment consideration.

2.0 DESCRIPTION

Refer to enclosed installation drawing for outline dimensions and physical description.

The basic sensor is a probe design with captivated hollow clamp nut. The clamp nut rotates independently of the probe body and serves to lift the sensor out of the mounting port as it is unscrewed.

The alignment device consists of a pin and slotted clamp assembly which fits tightly over the collar of the sensor.

The hardened steel pin is accurately aligned with the axis of the diaphragm curvature and when assembled into a precisely drilled mating hole in the barrel or calibration chamber, achieves near perfect rotational alignment of sensor diaphragm.

The slotted clamp arrangement allows for tolerance in the location of the guide pin hole in an axial direction on the test barrel or calibration adaptor.

The precise depth adjustment is obtained by the use of the correct thickness spacer selected from a set of 9 spacers of various thicknesses supplied with each sensor.

Once the proper thickness spacer is found, removal and re-installation now becomes a routine matter.

3.0 INSTALLATION

3.1 PORT PREPARATION

Prepare mounting port in accordance with installation drawing 117-20 (XX)-90 supplied as part of this manual.

NOTE: The installation port for the 117B is identical to that for the 117A.

Drill guide pin hole as shown in installation drawing, paying particular attention to locating C/L of hole exactly on C/L of barrel.

Do not use a drill that is worn, as this may cause the hole to be slightly undersized and the guide pin may bind as it is drawn into the hole.

It is extremely important that the guide pin hole be drilled parallel to the sensor mounting port to permit the guide pin to move freely into the hole.

NOTE: Each model variation of the 117B is designed to fit in a specific location (measured from the bolt face) on a specific ammunition caliber. Changing location and/or caliber will cause a mismatch of diaphragm curvature with cartridge case diameter since most cartridge cases are tapered.

3.2 INSTALLING THE SENSOR

After mounting holes have been prepared, proceed with installation as follows:

1. On most models of 117B, it is not important which side of the sensor is mounted toward the muzzle.

However, on certain types of ammunition (such as 20 mm cannon) which have a severe taper, the diaphragm has a matching taper in

**OPERATION MANUAL FOR
CONFORMAL BALLISTICS PRESSURE SENSOR
Series 117B**

the curvature. In these latter cases, the sensor forward side is identified with the legend "FWD" etched on the guide collar to which the slotted clamp is attached. The clamp must be removed to find this legend. If it does not appear, the sensor may be mounted with either side toward the muzzle.

2. Loosen slotted clamp, but do not remove clamp.
3. Select the middle thickness (.014) spacer from the set of nine (065A19) supplied and place it around sensor barrel.
4. Begin threading the sensor clamp nut into the threaded mounting port, sliding slotted clamp fore and aft as needed to allow guide pin to fully enter hole.

Continue to turn clamp nut into hole by hand or using 5/16 open end wrench.

Do not tighten when sensor bottoms.

5. Now tighten the screw closing slotted clamp.
6. Using open end wrench, tighten sensor clamp nut.

NOTE: It is not necessary to put large amounts of torque on this nut since a pressure seal is not necessary. Approximately 5 to 10 ft. lbs. is sufficient.

7. Now inspect flushness of diaphragm with inside surface of chamber. This can be accomplished visually in most cases.

If the diaphragm extends too deeply into the chamber, select a thicker spacer and repeat mounting procedure.

If the diaphragm is too deeply recessed, select a thinner spacer and remount.

Once the proper thickness is found for perfect flushness, the sensor may be removed and reinstalled using this same spacer and the proper depth will be achieved each time.

NOTE: For best accuracy of results, use same charge amplifier for calibration and for actual operation. Use long TC for calibration, medium or short TC for best drift free operation.

4.0 POLARITY

Polarity of the Model 117B is negative i.e., the charge output is negative for increasing pressure input, making it compatible with inverting type charge amplifiers.

5.0 CALIBRATION

Calibration of the Models 117B is facilitated by a calibration adaptor which exactly matches the chamber dimensions of the cartridge under test. An actual cartridge case is hydraulically pressurized with reference pressure to obtain a point-by-point sensor calibration.

These calibration adaptors can be fabricated by the user or can be purchased from PCB as our Model 090B calibration adaptor. Simply specify caliber and longitudinal location of sensor.

For most rimfire applications, the sensor is located .25 inches forward of the boltface.

For center fire cartridges a location .175 inches back from the cartridge shoulder is preferred. Consult PCB for recommendations on sensor locations if questions arise.

Since most cartridge cases are tapered and diameter is dependent upon longitudinal location, this location may not be changed after the sensor is fabricated since it is essential for proper operation that the sensor curvature exactly match chamber curvature.

**OPERATION MANUAL FOR
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Series 117B**

5.1 LOW-END NONLINEARITY

It will be noticed during calibration, especially with metallic cartridges, that a certain amount of pressure is necessary before linear output is attained from the conformal sensor.

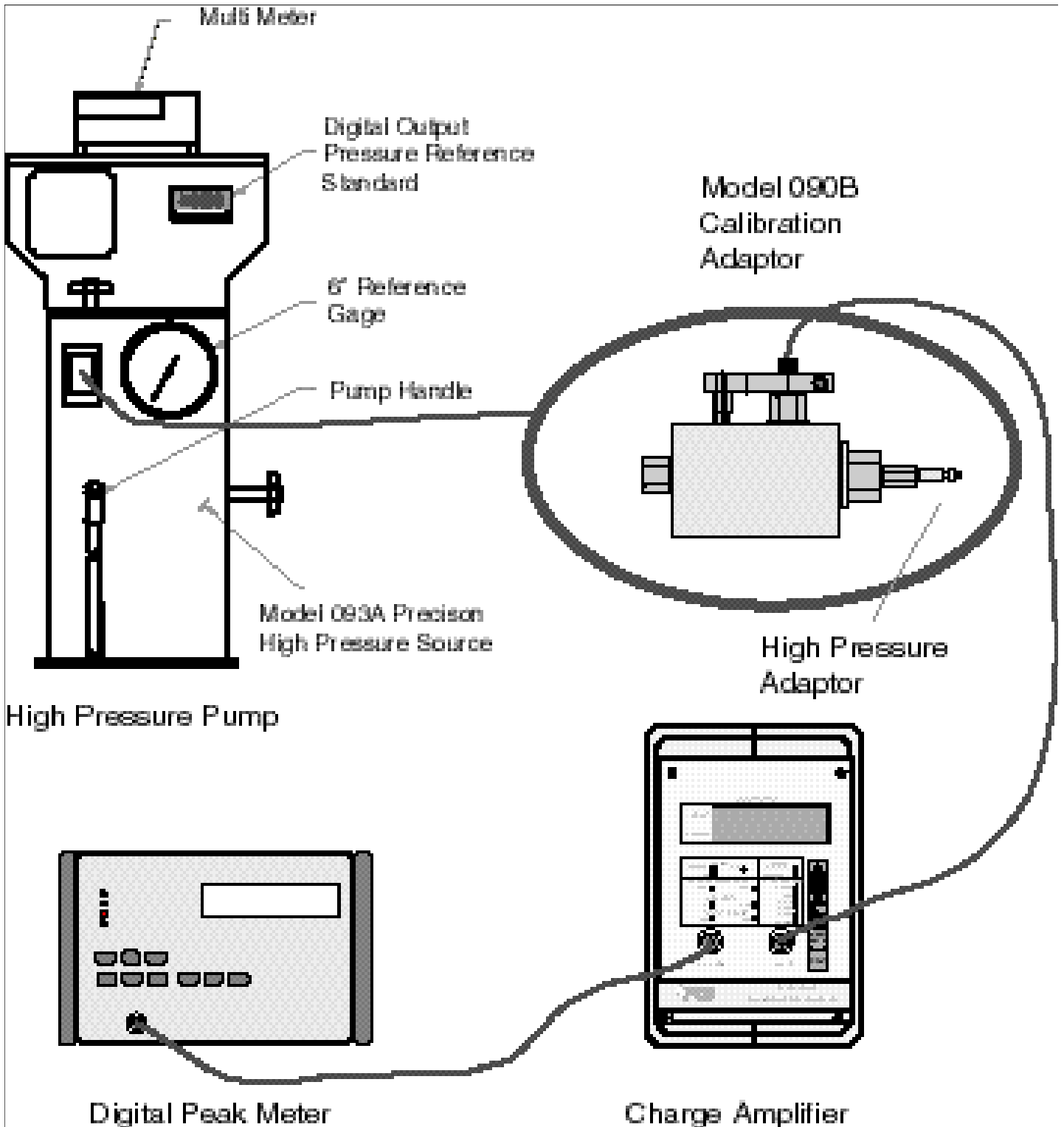
This is due to the fact that since the cartridge cases are made nominally smaller in diameter than the chamber to allow easy insertion and extraction, the case must be expanded slightly by the internal pressure before force can be transmitted to the sensor.

See the enclosed guide "An Improved Technique for Utilization of Conformal Ballistics Sensor Calibration Data" for methods of dealing with this topic.

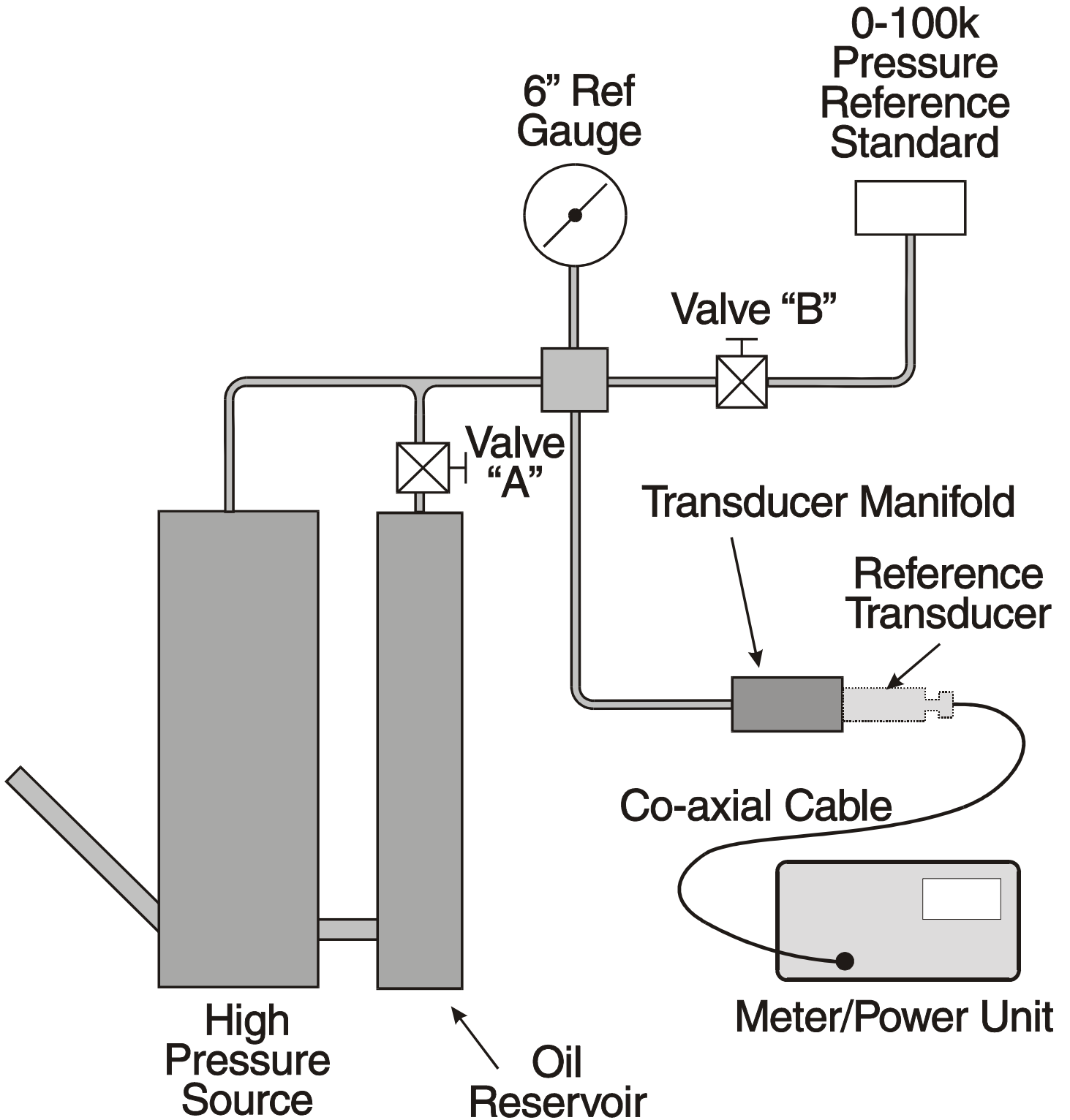
6.0 MAINTENANCE

It is essential for normal operation of the Model 117B that the insulation resistance be maintained above 10^{12} ohms. If insulation resistance should deteriorate, wipe connector with clean cloth or paper wipe dipped in a solvent compatible with Teflon[®] such as isopropyl alcohol, then bake in oven at 250°F for ½ hour.

OPERATION MANUAL FOR
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OPERATION MANUAL FOR
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AN IMPROVED TECHNIQUE FOR UTILIZATION OF CONFORMAL BALLISTICS SENSOR CALIBRATION DATA

The PCB Series 117B Conformal Ballistics Sensor (patented) measures chamber pressure in a novel manner.

The sensitive surface of the sensor, when properly installed in the gun chamber, conforms or blends in precisely with the inside surface of the chamber actually forming a portion of the wall adjacent to the cartridge case.

When the round is fired, the pressure builds up rapidly inside the case, obturating the case outward against the chamber. The force, transmitted through the thin cartridge case wall stresses the sensor crystals producing an output charge analogous to chamber pressure.

An exclusive calibration technique has been developed in conjunction with the conformal sensor, consisting of a simulated gun chamber which positions the sensor at the same location as in the test barrel and provides for hydraulic pressurizations of an actual cartridge case.

Using this system and a reference standard pressure source, a point by point calibration is performed on samples of the actual lot of ammunition under test to take into account transmissibility characteristics of the cartridge case for each lot of ammunition.

Because a certain amount of pressure is required to fully obturate the cartridge case in the test chamber, a rather severe non-linearity is exhibited over the first several thousand psi of input pressure, i.e. until the cartridge case is pressed firmly against the inside chamber walls.

Figure 1 illustrates a typical calibration result with .22 caliber rimfire ammunition.

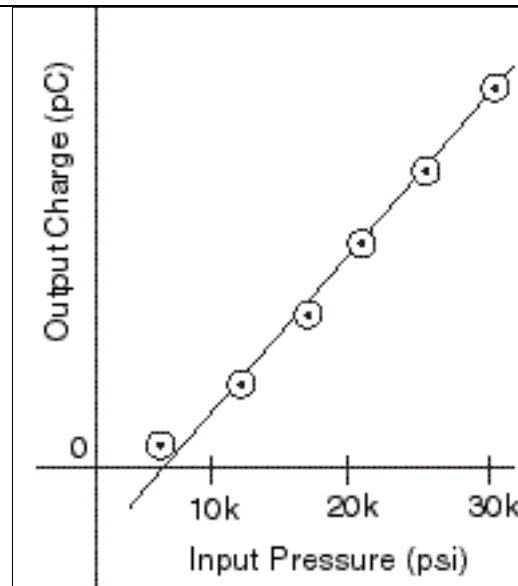


Figure 1: Typical calibration graph Conformal sensor with .22 caliber rimfire.

As shown in figure 1, the best straight line that can be drawn through the majority of the data points in the linear portion of the curve, does not pass through the origin.

Because of this, the widely accepted zero based best straight line method of linearity determination cannot be applied to the conformal sensor. Also, the actual sensitivity of this sensor may only be specified at one input pressure level since the sensitivity is not a constant, but varies with input pressure level.

This paper outlines a simple alternative approach to utilization of conformal sensor data.

The most universally accepted method of defining conventional sensor nonlinearity is the full scale error band method used in conjunction with the zero based best straight line.

AN IMPROVED TECHNIQUE FOR UTILIZATION OF CONFORMAL BALLISTICS SENSOR CALIBRATION DATA

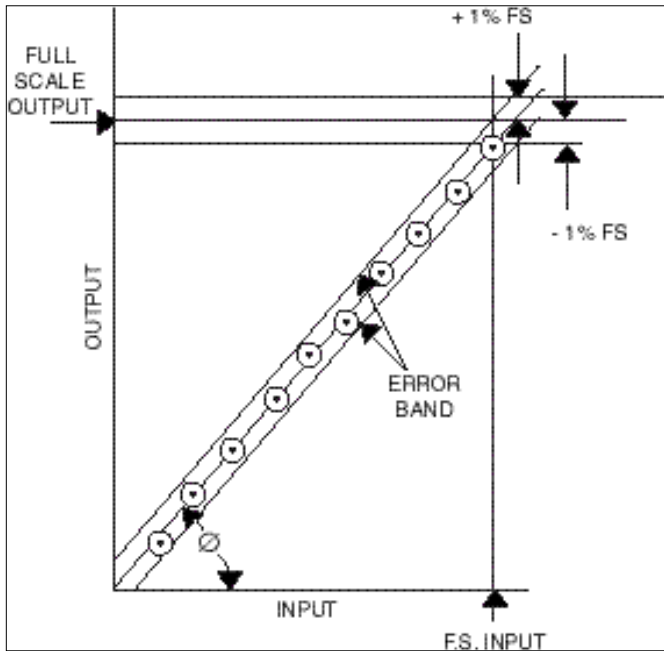


Figure 2: Zero based best straight line method of linearity determination.

To utilize the zero based best straight line method, the corresponding value of the sensor output is plotted for each value of input measurand up to full scale as shown in Figure 2.

A straight line, intercepting the origin as shown, is fitted to the data points by equalizing the error between the points below the line and the points above the line.

Error bands, as delineated by the instrument specification are constructed as shown in figure 2. Typically, plus and minus one or two percent of full scale is specified for quartz sensors.

An acceptable instrument is then defined as one whose data points all fall within this error band.

The "sensitivity" of an instrument so calibrated is simply the full scale output (charge or voltage) divided by full scale input pressure, where F.S. output is determined by the straight line as defined above.

$$\text{Sensitivity} = \frac{\text{F.S. output}}{\text{F.S. input}} \quad (\text{Eq. 1})$$

The units for sensitivity are commonly pC/psi or mV/psi.

Note that in this case, the sensitivity is identical to the slope of the line, since the line does intersect the origin by previous definition.

The general equation for a straight line in terms of the dependent variable is:

$$y = mx + b \quad (\text{Eq. 2})$$

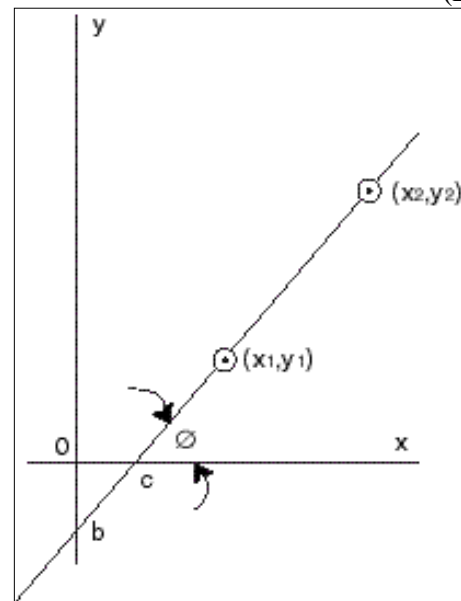


Figure 3

b in equation 2 is the y axis intercept.
m is the slope of the line defined as:

$$m = \tan\theta = \frac{y_2 - y_1}{x_2 - x_1} \quad (\text{Eq. 3})$$

Equation 2, expressed in terms of the independent variable x is:

AN IMPROVED TECHNIQUE FOR UTILIZATION OF CONFORMAL BALLISTICS SENSOR CALIBRATION DATA

$$x = \frac{y}{m} + C \quad (\text{Eq. 4})$$

Where C is the X-axis intercept.

Equation 4 is directly applicable to the conformal sensor even through the X variable (psi) becomes the dependent variable when using the sensor output to determine pressure.

Consider again the calibration graph of a typical conformal sensor, shown in figure 4.

To calibrate a conformal sensor, the input pressure is increased in discrete steps from 0 psi to full scale with the corresponding output recorded at each step. The information must be taken only once and only with increasing pressure. A repeat run on the same cartridge case will not yield the same values as the initial run due to work hardening of the cartridge case metal.

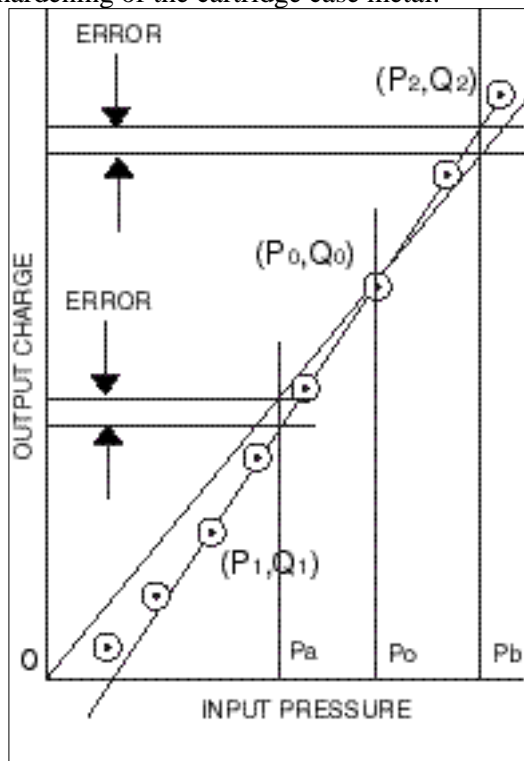


Figure 4

At the lower pressures, the sensor has very little output because there is a certain amount of clearance between the cartridge case and the chamber wall. Obturation of the cartridge occurs in this region.

However, when obturation is complete, the sensor output is then linear with pressure from this point up to maximum rated pressure.

In the past, a common procedure has been to calibrate the conformal at the expected nominal pressure, deriving a sensitivity at this point, e.g. point P_0, Q_0 in figure 4.

The sensitivity determined by dividing output Q_0 by corresponding pressure input P_0 , would then yield the exact result if the input pressure was always exactly P_0 .

However, should the input pressure change to P_a , it is clear that the reading would be in error, as shown in Fig. 4, since the actual sensitivity of the instrument is not the same at P_0 , as it is at P_a .

A solution to this problem lies in utilization of equation 4.

$$x = \frac{y}{m} + C \quad (\text{Eq. 4})$$

Expressed in terms of sensor transfer parameters, input pressure and output charge

$$\text{Indicated pressure (psi)} = \frac{\text{indicated charge (pC)}}{\text{slope (pC/psi)}} + \text{intercept} \quad (\text{Eq. 5})$$

Where the slope of the line is defined as:

$$\text{Slope} = \frac{Q_2 - Q_1}{P_2 - P_1} \frac{\text{pC}}{\text{psi}} \quad (\text{Eq. 6})$$

and the intercept is the pressure axis intercept.

**AN IMPROVED TECHNIQUE FOR
UTILIZATION OF CONFORMAL BALLISTICS
SENSOR CALIBRATION DATA**

The straight line is the best line that can be constructed through the linear portion of the curve as shown in Figure 4 and the pressure intercept (or offset) is the point at which this line crosses the pressure axis, in psi.

Instead of establishing the sensitivity parameter (which has been shown to have little meaning for this sensor) the user now determines the slope as defined in Eq. 6

and the accompanying pressure offset by constructing the best straight line as described previously.

Pressures P1 and P2 are arbitrarily established at some point well above and well below the expected nominal pressure of the test.

The corresponding outputs at these pressures should be an average of at least 20 cartridges taken from the same lot of ammunition as is under test.

The main difference between utilization of the data with this method is that now a constant (pressure offset) must be added to each reading. However, this can be easily handled by most data reduction methods in use today.

Example:

In actual practice, this is how a conformal sensor/charge amplifier system could be utilized:

Assume that averaging the data from 20 consecutive calibration runs performed on a conformal sensor yielded a slope of .04 pC/psi and an intercept of 7,500 psi, determined by constructing the best fitting straight line as described previously.

Assume also that average expected peak pressure is 25,000 psi.

Approximate full scale charge output is:

$$25,000 \text{ psi} \times .04 \text{ pC/psi} = 1000 \text{ pC}$$

Set range of charge amplifier output to 1000 pC/volt (or other desired range).

Read peak output voltage of .800 volts during test.

Peak indicated charge is then:

$$1000 \text{ pC/volt} \times .80 \text{ volts} = 800 \text{ pC}$$

Indicated peak pressure is:

$$\text{Pressure (pk)} = \frac{\text{peak charge}}{\text{slope}} + \text{offset}$$

$$P = \frac{800 \text{ pC}}{.04 \text{ pC/psi}} + 7,500 \text{ psi}$$

$$P = 20,000 \text{ psi} + 7500 = 27,500 \text{ Psi}$$

As previously stated, this method will yield accurate results anywhere within the linear portion of the sensor calibration curve without inherent errors due to variability of sensitivity with pressure level.

Accuracy should be close to that expected for standard piezoelectric sensors within the limitation of transmissibility variations in the cartridge cases.

Simplified standardization techniques for Conformal Sensor

The technique described by the previous example outlines one basic method of output signal utilization. This method in actual practice may be cumbersome for repeated testing because of the conversions that must be made from measured charge output to indicated peak pressure.

Other system scaling methods exist which further simplify signal utilization.

AN IMPROVED TECHNIQUE FOR UTILIZATION OF CONFORMAL BALLISTICS SENSOR CALIBRATION DATA

Dial Gain Standardization

Many charge amplifiers feature a calibrated gain pot for dialing in sensor sensitivity for the purpose of setting system sensitivity to standardized unit of output voltage (PCB Model 462A).

To utilize such amplifiers, dial in the actual value of slope as determined by the calibration graph for the particular ammunition lot.

Using the slope value effectively displaces the calibration curve to pass through the origin (0) of the calibration graph.

See Figure 5.

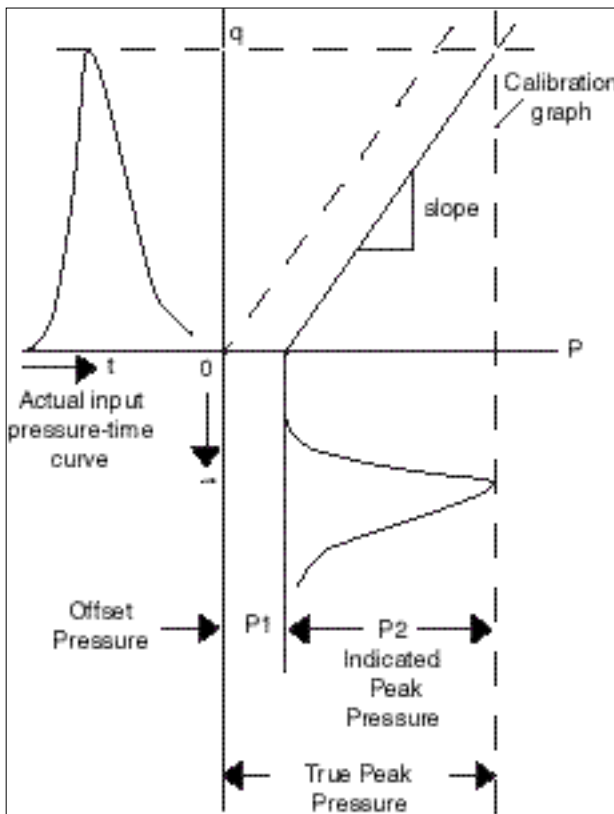


Figure 5

The indicated peak pressure P2 from the conformal, which through scale factoring can be read to read directly in psi (on a digital peak meter for example) is simply added to the offset pressure to arrive at true peak pressure, $P1 + P2$

This process can be further refined to, include a variable voltage source as a bias in series with the output of the charge amplifier. This voltage bias can be set to simulate the offset pressure, and then the true peak pressure can be read directly. (See figure 6 on the next page)

Example:

Assume a 20 round calibration lot and attendant graph yield a slope of .250 pC/psi and an offset of 5,000 psi.

Proceed as follows:

Dial the slope (.250) into the dial gain pot and select a convenient full scale range over which to operate.

For example, for an expected full scale range of 40,000 psi, select 10,000 units/volt.

Now the indicated peak pressure can be read directly from a digital peak holding meter such as the PCB Model 451B.

If the offset supply is not used, simply add the offset pressure (5,000 psi) to the indicated pressure to arrive at true peak pressure.

If an offset supply is used as in figure 6 simply dial in the offset voltage equivalent to offset pressure. Now the offset will be automatically added and the true peak pressure can be read directly from the peak meter.

**AN IMPROVED TECHNIQUE FOR
UTILIZATION OF CONFORMAL BALLISTICS
SENSOR CALIBRATION DATA**

Calibrate Signal Insertion

Another method that is useful especially when utilizing a storage oscilloscope readout is to use a charge calibrator to inject a full scale charge signal into the charge amplifier. Multiply the sensor slope value by full scale pressure to find full scale picocoulombs.

$$40,000 \text{ psi} \times .250 \text{ pC/psi} = 10,000 \text{ pC}$$

Set the charge calibrator for 10,000 pC and apply this signal to the input of the amplifier. Now adjust the gain of the oscilloscope (or charge amplifier if gain adjust is available) to make full scale equal to a selected number of oscilloscope divisions.

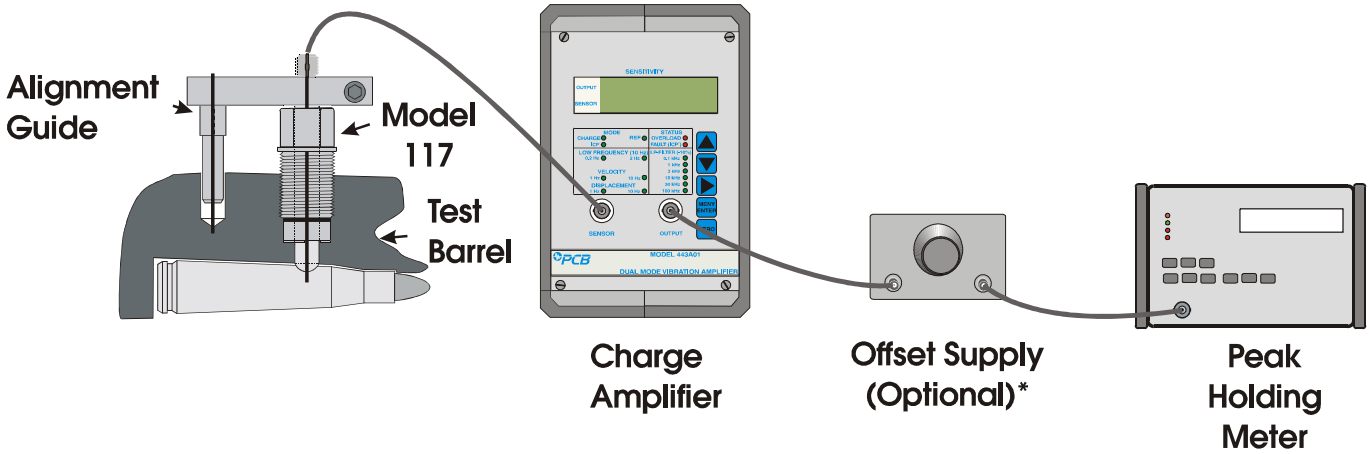
For example: 6 Div = 40,000 psi

Now the peak value can be determined from the oscilloscope face or scope photo using a variable scale or other interpolative methods.

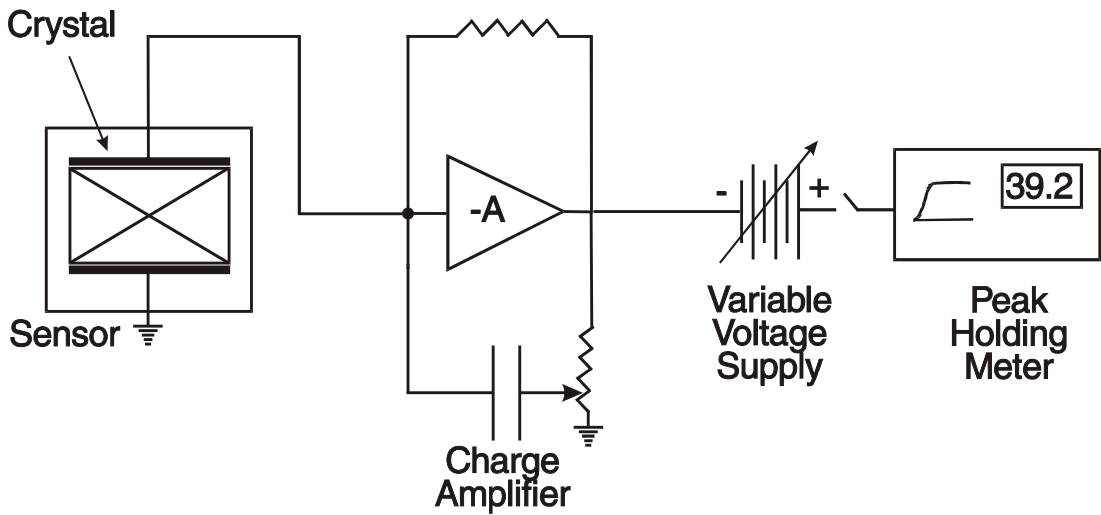
Then, add the offset pressure to this value to determine true peak pressure.

AN IMPROVED TECHNIQUE FOR UTILIZATION OF CONFORMAL BALLISTICS SENSOR CALIBRATION DATA

* Adds offset pressure (not available from PCB).



+ -



Model Number 117B-80K	CHARGE OUTPUT PRESSURE SENSOR	Revision: R ECN #: 46956
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	<u>ENGLISH</u>	<u>SI</u>	
Performance			
Sensitivity(± 20 %)(for straight oil)	0.14 pC/psi	0.021 pC/kPa	[2][3]
Measurement Range	20 to 60 kpsi	138,000 to 414,000 kPa	[4]
Maximum Pressure	80 kpsi	552,000 kPa	
Resolution	2 psi	14 kPa	[5]
Resonant Frequency	≥ 200 kHz	≥ 200 kHz	
Rise Time(Reflected)	≤ 2 μ sec	≤ 2 μ sec	
Non-Linearity	≤ 2 % FS	≤ 2 % FS	
Environmental			
Acceleration Sensitivity	≤ 0.02 psi/g	≤ 0.14 kPa/(m/s ²)	
Temperature Range(Operating)	-100 to +400 °F	-73 to +204 °C	
Temperature Coefficient of Sensitivity	≤ 0.03 %/°F	≤ 0.054 %/°C	
Maximum Flash Temperature	3000 °F	1650 °C	
Maximum Shock	20,000 g pk	196 200 m/s ² pk	
Electrical			
Output Polarity(Positive Pressure)	Negative	Negative	[1]
Capacitance	9 pF	9 pF	
Insulation Resistance(at room temp)	≥ 10 ¹² Ohm	≥ 10 ¹² Ohm	
Physical			
Housing Material	17-4 Stainless Steel	17-4 Stainless Steel	
Diaphragm	17-4 Stainless Steel	17-4 Stainless Steel	
Sealing	Epoxy	Epoxy	
Electrical Connector	10-32 Coaxial Jack	10-32 Coaxial Jack	
Weight	0.45 oz	13 gm	

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

NOTES:

[1] Typical.
 [2] Actual slope is dependent upon material properties of cartridge case.
 [3] For conformal cal. sensitivity will be ±40%.
 [4] Calibrated range to 60,000 psi.
 [5] Resolution dependent on range setting and cable length used in charge system.
 [6] See PCB Declaration of Conformance PS158 for details.

SUPPLIED ACCESSORIES:

Model 045B Alignment Guide
 Model 065A19 Spacer set, 0.250" ID

Entered: LK	Engineer: BAM	Sales: WDC	Approved: BAM	Spec Number:
Date: 8/8/2017	Date: 8/8/2017	Date: 8/8/2017	Date: 8/8/2017	117-2010-80



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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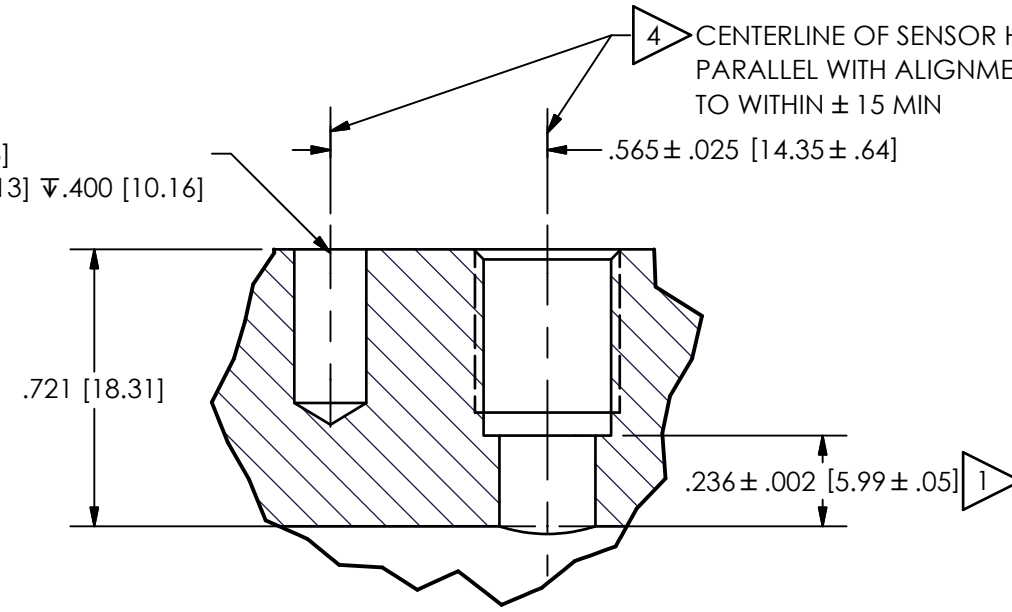
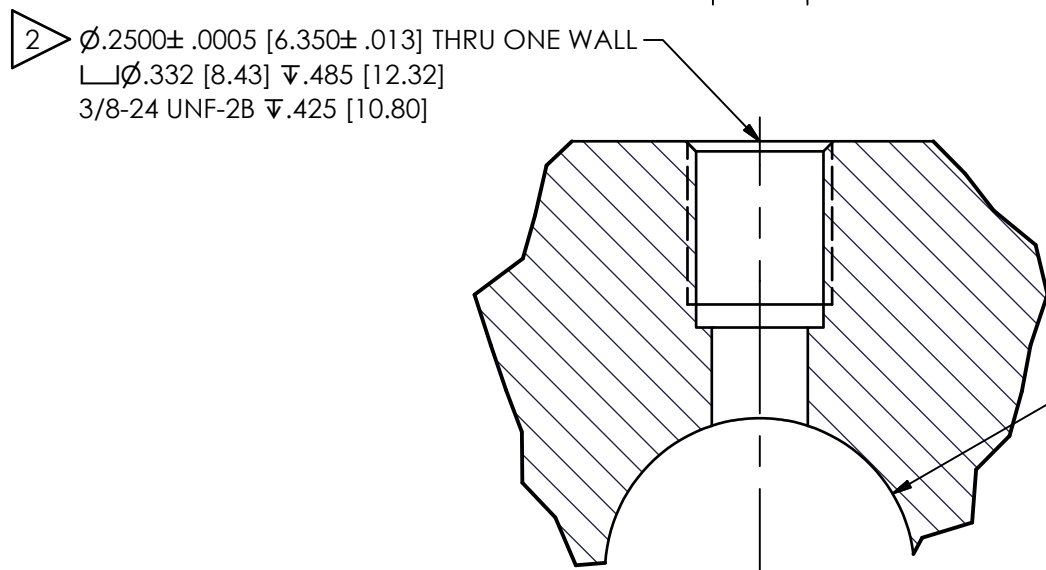
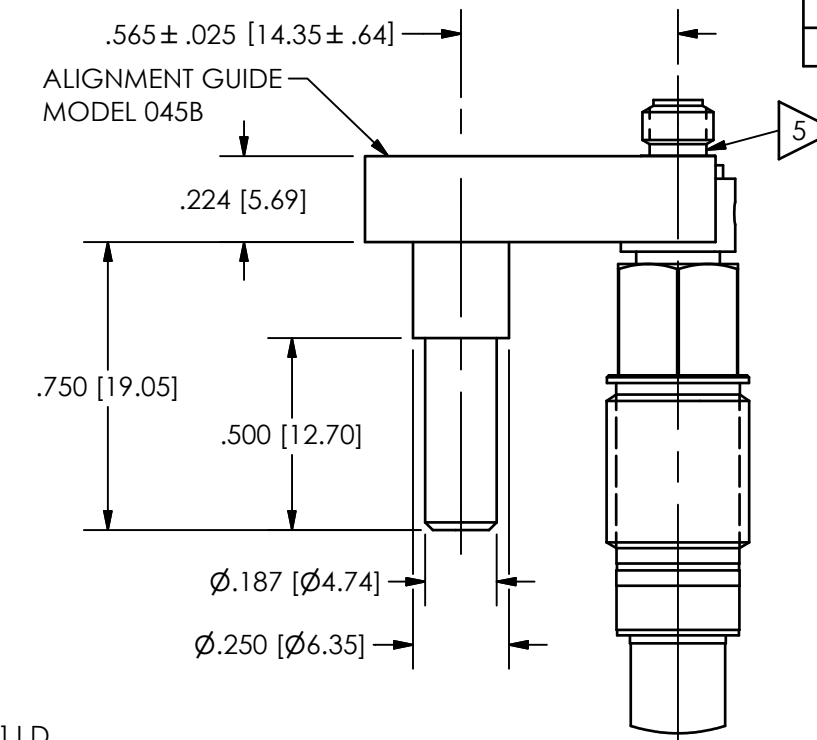
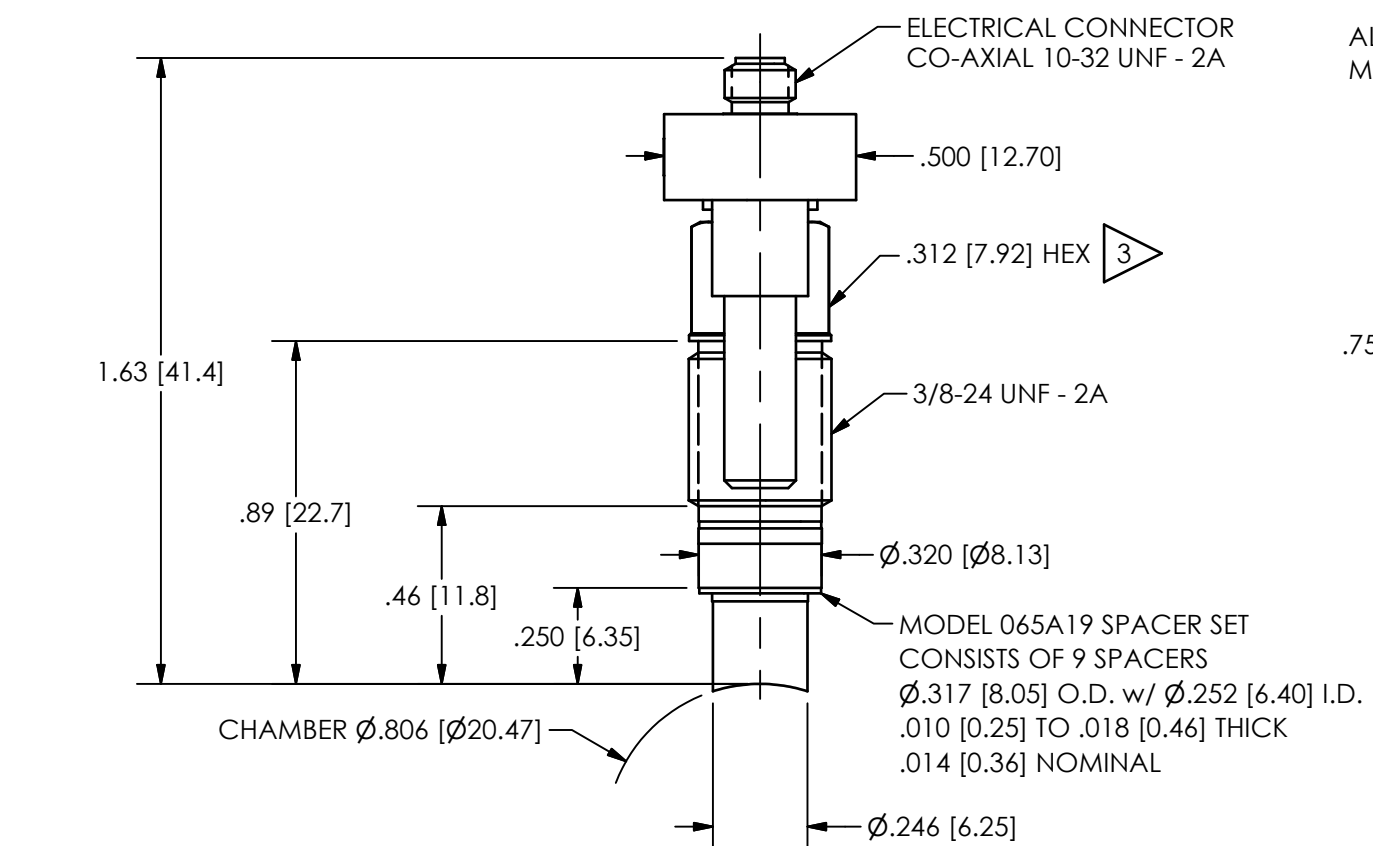


Phone: 716-684-0001
Fax: 716-684-0987
E-Mail: info@pcb.com

117-2120-90

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REVISIONS		
REV	DESCRIPTION	DIN
C	UPDATED 065A19 NOTE	50698



- $\triangle 5$ LOCATE YELLOW DOT TOWARD CASE MOUTH
- $\triangle 4$ ALIGNMENT HOLE MAY BE LOCATED EITHER FORE OR AFT OF SENSOR MOUNTING HOLE
- $\triangle 3$ MOUNTING TORQUE ON .312 [7.92] HEX: 5-10 FT LBS [6.8-13.6 NEWTON METERS]
- $\triangle 2$ CENTERLINE OF $\phi .2500$ [6.350] HOLE MUST INTERSECT CENTERLINE OF CHAMBER BORE WITHIN .001 [.23]
- $\triangle 1$ HOLD THIS DIMENSION TO OBTAIN FLUSH MOUNT

UNLESS OTHERWISE SPECIFIED TOLERANCES ARE:		DRAWN		CHECKED		ENGINEER	
DIMENSIONS IN INCHES	DIMENSIONS IN MILLIMETERS [IN BRACKETS]	KSR	2/15/21	KSR	2/15/21	MJK	2/15/21
DECIMALS XX \pm .01 XXX \pm .005	DECIMALS X \pm 0.3 XX \pm 0.13	TITLE					
ANGLES ± 2 DEGREES	ANGLES ± 2 DEGREES	INSTALLATION DRAWING MODEL 117B12 CONFORMAL BALLISTIC SENSOR					
FILLETS AND RADII .003 - .005	FILLETS AND RADII 0.07 - 0.13	CODE IDENT. NO. 52681		DWG. NO. 117-2120-90		3425 WALDEN AVE. DEPEW, NY 14043 (716) 684-0001 E-MAIL: sales@pcb.com	
		SCALE: 2X		SHEET 1 OF 1			



Model 090B243
CALIBRATION ADAPTOR
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



Repair and Maintenance

PCB guarantees Total Customer Satisfaction through its “Lifetime Warranty Plus” on all Platinum Stock Products sold by PCB and through its limited warranties on all other PCB Stock, Standard and Special products. Due to the sophisticated nature of our sensors and associated instrumentation, **field servicing and repair is not recommended and, if attempted, will void the factory warranty.**

Beyond routine calibration and battery replacements where applicable, our products require no user maintenance. Clean electrical connectors, housings, and mounting surfaces with solutions and techniques that will not harm the material of construction. Observe caution when using liquids near devices that are not hermetically sealed. Such devices should only be wiped with a dampened cloth—never saturated or submerged.

In the event that equipment becomes damaged or ceases to operate, our Application Engineers are here to support your troubleshooting efforts 24 hours a day, 7 days a week. Call or email with model and serial number as well as a brief description of the problem.

Calibration

Routine calibration of sensors and associated instrumentation is necessary to maintain measurement accuracy. We recommend calibrating on an annual basis, after exposure to any extreme environmental influence, or prior to any critical test.

PCB Piezotronics is an ISO-9001 certified company whose calibration services are accredited by A2LA to ISO/IEC 17025, with full traceability to SI through N.I.S.T. In addition to our standard calibration services, we also offer specialized tests, including: sensitivity at elevated or cryogenic temperatures, phase response, extended high or low frequency response, extended range, leak testing, hydrostatic pressure testing, and others. For more information, contact your local PCB Piezotronics distributor, sales representative, or factory customer service representative.

Returning Equipment

If factory repair is required, our representatives will provide you with a Return Material Authorization (RMA) number, which we use to reference any information you have already provided and expedite the repair process. This number should be clearly marked on the outside of all returned package(s) and on any packing list(s) accompanying the shipment.

Contact Information

PCB Piezotronics, Inc.
3425 Walden Ave.
Depew, NY14043 USA
Toll-free: (800) 828-8840
24-hour SensorLine: (716) 684-0001
General inquiries: info@pcb.com
Repair inquiries: rma@pcb.com

For a complete list of distributors, global offices and sales representatives, visit our website, www.pcb.com.

Safety Considerations

This product is intended for use by qualified personnel who recognize shock hazards and are familiar with the precautions required to avoid injury. While our equipment is designed with user safety in mind, the protection provided by the equipment may be impaired if equipment is used in a manner not specified by this manual.

Discontinue use and contact our 24-Hour Sensorline if:

- Assistance is needed to safely operate equipment
- Damage is visible or suspected
- Equipment fails or malfunctions

For complete equipment ratings, refer to the enclosed specification sheet for your product.

Definition of Terms and Symbols

The following symbols may be used in this manual:



DANGER

Indicates an immediate hazardous situation, which, if not avoided, may result in death or serious injury.

**CAUTION**

Refers to hazards that could damage the instrument.

**NOTE**

Indicates tips, recommendations and important information. The notes simplify processes and contain additional information on particular operating steps.

The following symbols may be found on the equipment described in this manual:



This symbol on the unit indicates that high voltage may be present. Use standard safety precautions to avoid personal contact with this voltage.



This symbol on the unit indicates that the user should refer to the operating instructions located in the manual.



This symbol indicates safety, earth ground.



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	0	0	0	0	0	0
PCB板	X	0	0	0	0	0
电气连接器	0	0	0	0	0	0
压电晶体	X	0	0	0	0	0
环氧	0	0	0	0	0	0
铁氟龙	0	0	0	0	0	0
电子	0	0	0	0	0	0
厚膜基板	0	0	X	0	0	0
电线	0	0	0	0	0	0
电缆	X	0	0	0	0	0
塑料	0	0	0	0	0	0
焊接	X	0	0	0	0	0
铜合金/黄铜	X	0	0	0	0	0
本表格依据 SJ/T 11364 的规定编制。						
0：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.

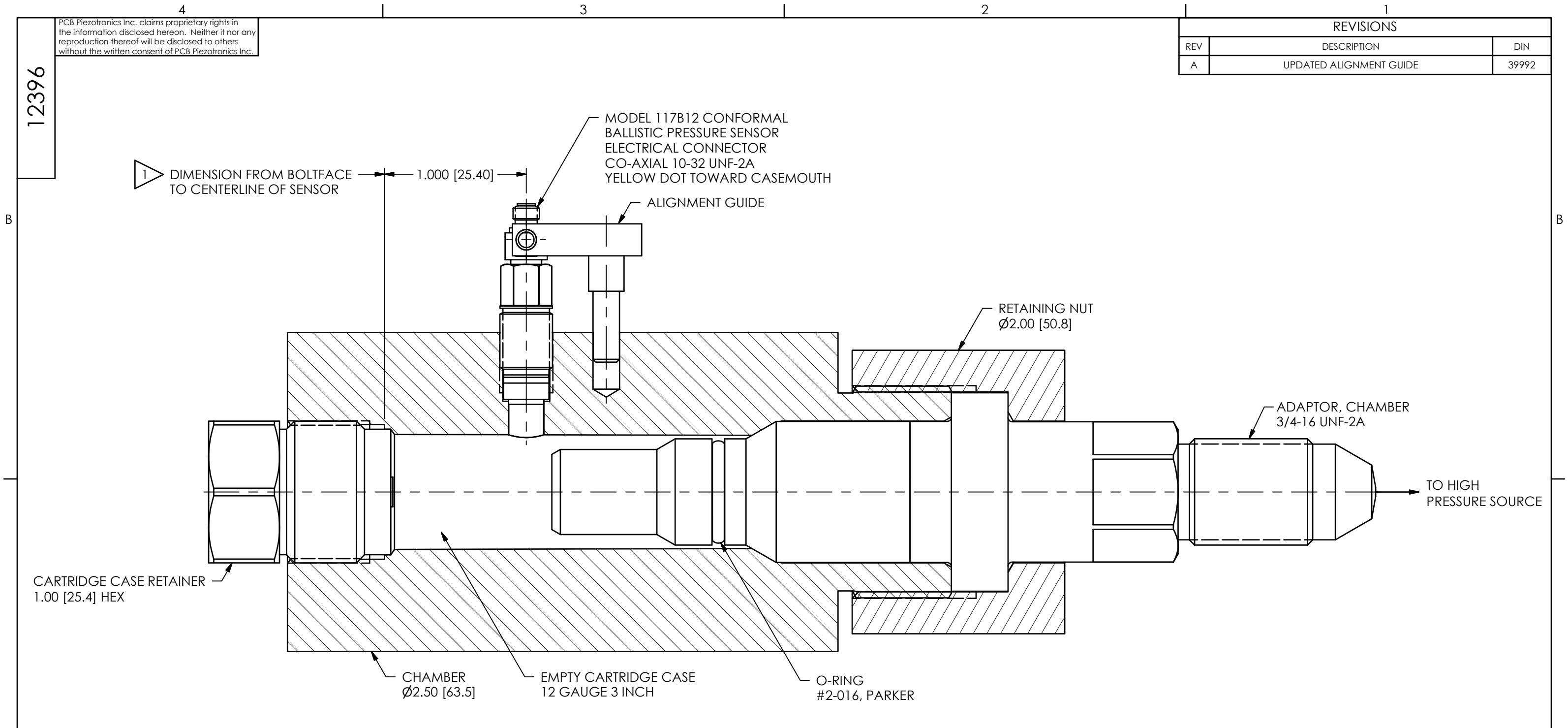
X: Indicates that said hazardous substance contained in at least one of the homogeneous materials for this part is above the limit requirement of GB/T 26572.

Lead is present due to allowed exemption in Annex III or Annex IV of the European RoHS Directive 2011/65/EU.

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12396

REVISIONS		
REV	DESCRIPTION	DIN
A	UPDATED ALIGNMENT GUIDE	39992



MODEL 090B243
12 GAUGE 3 INCH

2.) TRIM CASE TO 2.8 [71] BEFORE CALIBRATING.
 1) ACTUAL DIAMETER AT THIS LOCATION IS .806 [20.47].

UNLESS OTHERWISE SPECIFIED TOLERANCES ARE:		DRAWN		CHECKED		ENGINEER	
DIMENSIONS IN INCHES	DIMENSIONS IN MILLIMETERS [IN BRACKETS]	JDM	12/3/14	JDM	12/3/14	SMB	12/3/14
DECIMALS XX ±.03 XXX ±.010	DECIMALS X ±0.8 XX ±0.25	TITLE OUTLINE DRAWING MODEL 090B243 CALIBRATION ADAPTOR					
ANGLES ± 2 DEGREES	ANGLES ± 2 DEGREES						
FILLETS AND RADII .003 - .005	FILLETS AND RADII 0.07 - 0.13	CODE IDENT. NO. 52681		DWG. NO. 12396		SCALE: 1.5X SHEET 1 OF 1	

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