



**Model EX615A42**

**High temperature, intrinsically safe, charge mode accelerometer, 100 pC/g sensitivity, 500 degree F, 10 ft integral cable.**

**Installation and Operating Manual**

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

**Toll-free: 800-959-4464  
24-hour SensorLine: 716-684-0001  
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## 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

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For a complete list of distributors, global offices and sales representatives, visit our website, [www.pcb.com](http://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.

**General**  
**OPERATING GUIDE**

for use with

**PIEZOELECTRIC CHARGE MODE ACCELEROMETERS**

SPECIFICATION SHEET, INSTALLATION DRAWING  
AND CALIBRATION INFORMATION ENCLOSED

PCB ASSUMES NO RESPONSIBILITY FOR DAMAGE CAUSED TO THIS PRODUCT AS A RESULT OF  
PROCEDURES THAT ARE INCONSISTENT WITH THIS OPERATING GUIDE.

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## INTRODUCTION

Congratulations on the purchase of a quality PCB charge mode accelerometer. In order to ensure the highest level of performance for this product, it is imperative that you properly familiarize yourself with the correct mounting and installation techniques before attempting to operate this device. If, after reading this manual, you have any additional questions concerning this sensor or its application, feel free to call an Application Engineer at 716-684-0001 or the closest PCB representative.

### 1.1 Cables in Explosive Atmospheres

The cable lengths (Integral and Cable and Cable Assemblies) INSTALLED IN AN EXPLOSIVE ATMOSPHERE IS DEFINED IN THE ATEX, IECEx, CSA, ETC. APPROVAL CERTIFICATES.

### 1.2 High Temperature Differential Charge Output Sensor

Ceramic or Single crystal shear-structured accelerometers offer high performance for precision vibration measurements in high-temperature environments. The use of ceramic or single crystal sensing crystals, operating in the shear mode, reduces erroneous output due to base strain, thermal transients, and transverse motion.

Charge mode accelerometers output a strong, high-impedance charge signal directly from their piezoelectric sensing element. They do not contain built-in signal conditioning electronics; the signal is conditioned externally by either a laboratory-style charge amplifier or in-line charge converter prior to being analyzed by a readout or recording device. The absence of built-in electronics permits operation to elevated temperatures of 500 °F (260 °C) for most models or up to 1300 °F (700 °C) for special applications.

These accelerometers are ideal for structural testing, machine monitoring, and vehicular shock, high temperature machinery and power generation turbine and other vibration measurement tasks where high temperatures preclude the use of accelerometers with built-in microelectronics.

Enclosed is a **Specification Sheet**, which lists the complete performance characteristics of the particular accelerometer.

## 2 CABLING

### 2.1 General Precautions and Considerations

#### 2.1.1 Proper Cable Type and Care

Ascertain that you have ordered the correct cable type. Due to the high-impedance nature of the output signal generated by charge mode accelerometers, several important precautionary measures must be followed. When using soft-line cable always use special low-noise PCB Series 045 Low-Noise Cable (or equivalent) for connecting to the input of the differential charge-output accelerometers. For extremely high temperature charge mode applications use mineral insulated (MI) hard-line.

Care and attention to installation is essential, as the reliability and accuracy of your system is no better than that of the output cable. Cables and connectors must be kept clean and dry to maintain high insulation resistance and low frequency response. In the event that the insulation resistance is compromised, inspect, clean, and bake cables and connectors to restore insulation resistance.

### 2.2 Softline Cable

Special high temperature low-noise, shielded cable 2-wire cable assembly is required with charge mode sensors for applications up to 500°F to connect the transducer to the charge amp. When additional mechanical protection is required a stainless steel armor can be used.

The shield acts as a Faraday cage to reduce electrical noise from corrupting the signals, and minimizes capacitively coupled noise from other electrical sources.

Standard, two-wire, or coaxial cable, when flexed, generates a charge between the conductors. This is referred to as triboelectric noise and cannot be distinguished from the sensor's charge output. Low-noise cables have a special graphite lubricant between the dielectric and the braided shield, which minimizes the triboelectric effect and improves the quality of the sensor's charge output signal.



When using separate cables connect the cable to the accelerometer. A small amount of thread-locking compound placed on the connector prior to attachment helps secure the cable during testing. In harsh environments, the connection can be sealed with silicone rubber, O-rings, and flexible heat-shrink tubing.

### 2.3 Integral Hardline Cable

For extremely high temperature (>500°F) charge mode applications use mineral insulated (MI) hardline. Keep cable clean to maintain insulation resistance and good low-frequency response

### 2.4 Hardline Connection Type

#### 2.4.1 PCB / Lemo type connector

The Lemo connector is PCA.0S.302.CLAC42 that is specially adapted for use with hardline cable. The connector is a self-latching system that allows the connector to be mated by simply pushing the plug axially into the socket. When required the connector is disengage by a single axial pull on the outer release sleeve.

#### 2.4.2 High Temperature 2 –pin 7/16-27 UNS connector

This connector is a Model GP, 2 Pin Jack, 7/16-27 thread. The connector is welded to the hardline to provide a high temperature, hermetic connection. The GP connector uses a threaded connection to mate with a GN or QY 2-Socket plug and torqued to 5 ft\*lbs +/- 1 ft\*lb

### 2.5 Differential Charge Amplifier

The differential charge amplifier is purchased separately

A conventional method for conditioning the high-impedance signal generated by a charge output sensor is to use a differential charge amplifiers operate from an ICP® signal conditioner. The unit employs a high gain amplifier to perform the impedance transformation. The charge output of the transducers may be scaled in terms of acceleration, pressure or force. The output is then mV/g, mV/psi or mV/lb, respectively.

## 3 INSTALLATION OVERVIEW

### 3.1 Equipment Inspection

Before installing the accelerometer, verify the insulation resistance (I/R) of the sensor is per specification. I/R can be out of specification due to mishandling and/or damage.

### 3.2 Polarity Test

Use this test to verify the proper polarity response. Improper polarity will adversely affect the use of the sensor for machinery diagnostics such as balancing.

Step 1 – Connect the sensor to a charge amp and any ICP® signal conditioner. Using standard cable, connect the powered sensor to an oscilloscope.

Step 2 – Set the time scale to 20 milliseconds/division

Step 3 – Hold the transducer in hand and tap the bottom. The waveform on the oscilloscope first goes positive as shown in Figure 1. If the waveform goes negative the wiring is reversed, contact PCB for technical support.

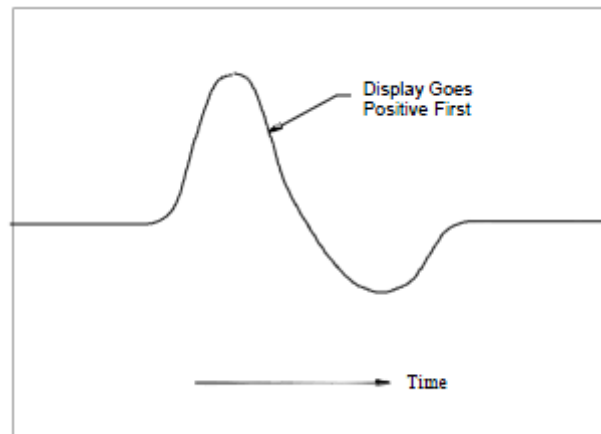


FIGURE 1

### 3.3 Sensor Location

*Characteristics like location, ruggedness, amplitude range, accessibility, temperature, and portability are extremely critical.*

For optimum performance and measurement find a rigid location on the machine casing that most accurately represents the vibration of the rotor, bearing, fan, etc. to be measured.).

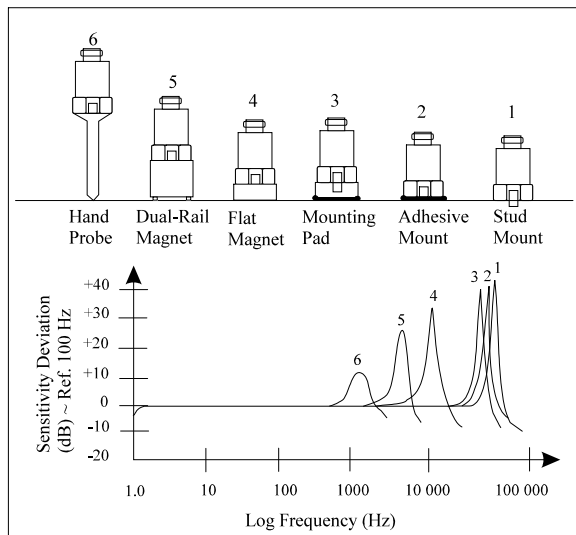
### 3.4 Mounting Sensor

When choosing a mounting method, consider closely both the advantages and disadvantages of each technique. Characteristics like location, ruggedness, amplitude range, accessibility, temperature, and portability are extremely critical. However, the most important and often overlooked consideration is the effect the mounting technique has on the high-frequency performance of the accelerometer.

Shown hereafter are six possible mounting techniques and their effects on the performance of a typical piezoelectric accelerometer. (Note that not all of the mounting methods may apply to your particular sensor.) The mounting configurations and corresponding graph demonstrate how the high-frequency response of the accelerometer may be compromised as mass is added to the system and/or the mounting stiffness is reduced.

**Note:** *The low-frequency response is unaffected by the mounting technique. Its roll-off behavior is dependent*

*upon the coupling type or time constant of the external charge amplifying device. This characteristic may be fixed or adjustable, depending on the charge amplifier. Please refer to the appropriate charge amplifier specification sheet for information on low-frequency characteristics.*

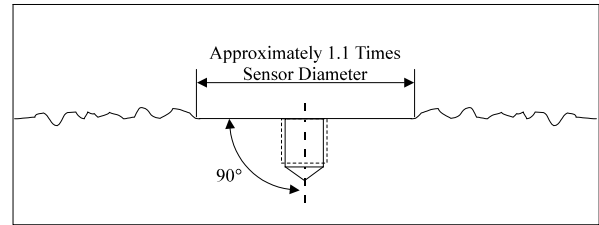


**Figure 1.** Assorted Mounting Configurations and Their Effects on High Frequency

#### 3.4.1 STUD MOUNT

This mounting technique requires smooth, flat contact surfaces for proper operation and is recommended for permanent and/or secure installations. Stud mounting is also recommended when testing at high frequencies.

**Note:** *Do NOT attempt mounting on curved, rough, or uneven surfaces, as the potential for misalignment and limited contact surface may significantly reduce the sensor's upper operating frequency range.*

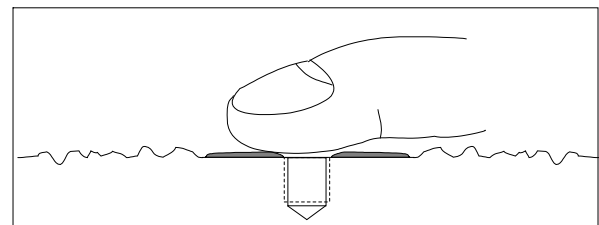


**Figure 2.** Mounting Surface Preparation

**STEP 1:** First, prepare a smooth, flat mounting surface, then drill and tap a mounting hole in the center of this area as shown in Figure 2 and in accordance with the **Installation Drawing** for the specific sensor that is being mounted.

A precision-machined mounting surface with a minimum finish of 63  $\mu\text{in}$  (0.00016 mm) is recommended. (If it is not possible to properly prepare the test structure mounting surface, consider adhesive mounting as a possible alternative.) Inspect the area, checking that there are no burrs or other foreign particles interfering with the contact surface.

**STEP 2:** Wipe clean the mounting surface and spread on a light film of grease, oil, or similar coupling fluid prior to installation.



**Figure 3.** Mounting Surface Lubrication

Adding a coupling fluid improves vibration transmissibility by filling small voids in the mounting surface and increasing the mounting stiffness. For semi-

permanent mounting, substitute epoxy or another type of adhesive.

**STEP 3:** Screw the mounting stud into the base of the accelerometer and hand-tighten. Then, screw the sensor/stud assembly into the prepared tapped hole and tighten to the recommended mounting torque as indicated on the **Installation Drawing**.

**Note:** *It is important to use a torque wrench during this step. Under-torquing the sensor may not adequately couple the device; over-torquing may result in stud failure.*

### 3.4.2 ADHESIVE MOUNT

Adhesive mounting is often used for temporary installation or when the test object surface cannot be adequately prepared for stud mounting. Adhesives like hot glue and wax work well for temporary mounts; two-part epoxies and quick-bonding gels provide a more permanent mount.

**Note:** *Adhesively mounted sensors often exhibit a reduction in high-frequency range. Generally, smooth surfaces and stiff adhesives provide the best frequency response.*

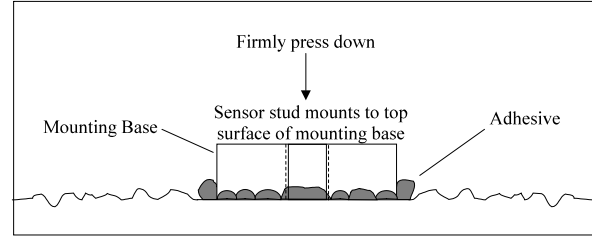
#### METHOD 1 - Adhesive Mounting Base

This method involves attaching a base to the test structure, then securing the sensor to the base. This allows for easy removal of the accelerometer. Also, since the bases are of a “hard-coated” aluminum design, they provide electrical isolation to eliminate ground loops and reduce electrical interference that may be present on the surface of the test object.

**STEP 1:** Prepare a smooth, flat mounting surface. A minimum surface finish of 63  $\mu\text{in}$  (0.00016 mm) generally works best.

**STEP 2:** Stud-mount the sensor to the appropriate adhesive mounting base according to the guidelines set forth in **STEPS 2** and **3** of the Stud Mount Procedure.

**STEP 3:** Place a small portion of adhesive on the underside of the mounting base. Firmly press down on the assembly to displace any extra adhesive remaining under the base.



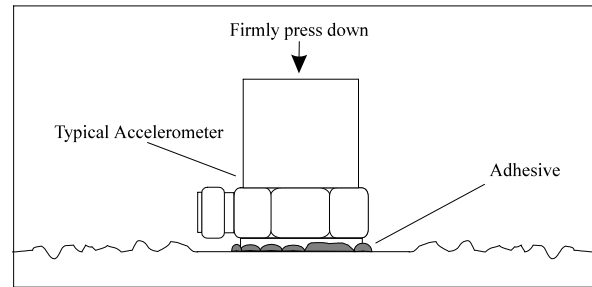
**Figure 4.** Mounting Base: Adhesive Installation

#### METHOD 2 - Direct Adhesive Mount

For restrictions of space or for convenience, most sensors (with the exception of integral stud models) can be adhesive-mounted directly to the test structure.

**STEP 1:** Prepare a smooth, flat mounting surface. A minimum surface finish of 63  $\mu\text{in}$  (0.00016 mm) generally works best.

**STEP 2:** Place a small portion of adhesive on the underside of the sensor. Firmly press down on the top of the assembly to displace any adhesive. Be aware that excessive amounts of adhesive can make sensor removal difficult.



**Figure 5.** Direct Adhesive Mounting

### 3.4.3 HANDHELD OR PROBE TIP MOUNT

This method is NOT recommended for most applications. It is generally used only for machinery monitoring and other portable trending applications. Both the accuracy and repeatability at low (<5 Hz) and high frequency (>1 kHz) ranges are questionable.

## 3.5 Route Mineral Insulated Hardline Cable

### 3.5.1 Care

Certain precautions should be used to avoid physical damage and minimize electrical noise. For instance, route the cables away from points that may exceed its

### 3.5.2 Bend Radius

The minimum bend radius ( $r$ ) for both soft-line and hardline cable is determined by the cable diameter as shown below:

Bends Allowed	Cable Diameter	Minimum Bending Radius
Total	$d$	$r$
1	0.125" (3.2 mm)	0.60" (16 mm)
20	0.125" (3.2 mm)	2.0" (50 mm)

### 3.5.3 Clamp Cable

To minimize triboelectric (motion-induced) noise from the cable interfering with the sensors high impedance charge output cable clamps must be used. Clamp the cable as close to the transducer as possible and should be attached to the same surface that the head is mounted (See Figure 3) taking care not to induce stress into the cable and possibly leading to intermittent or broken connections. Continue to clamp the cable at regular intervals of approximately 1.5 ft (0.5 m)

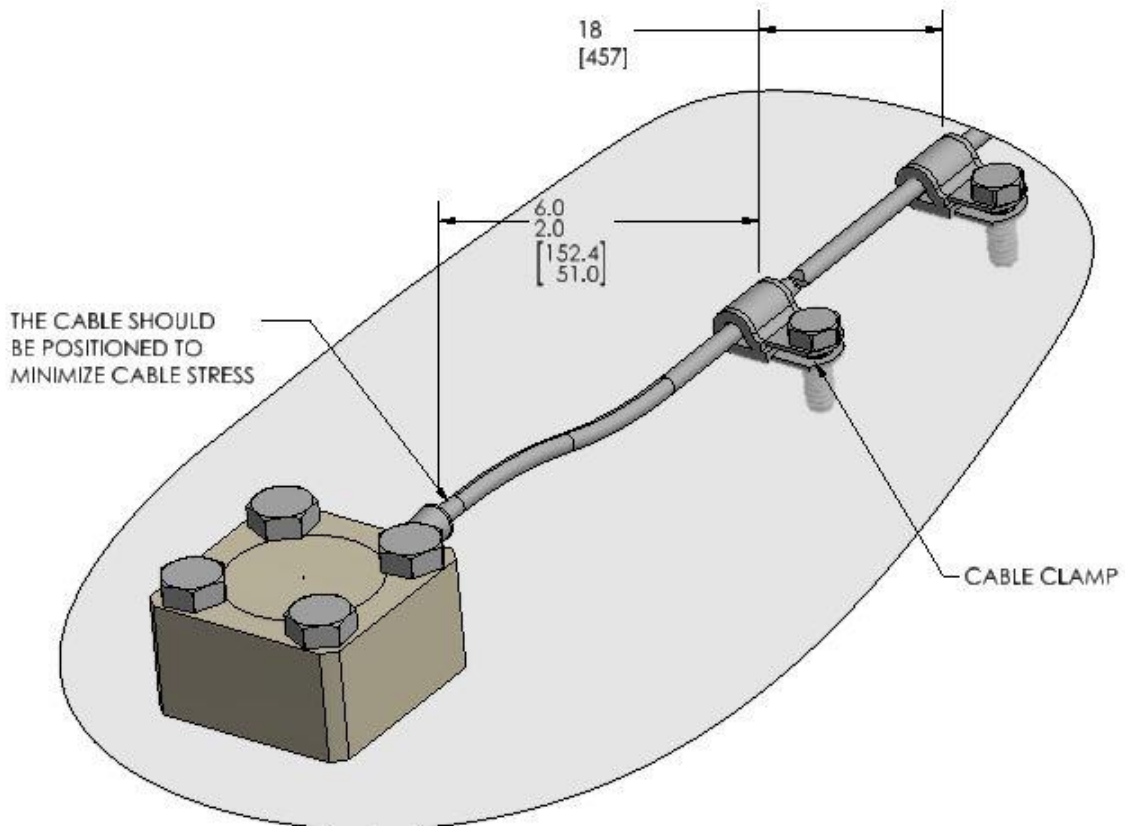
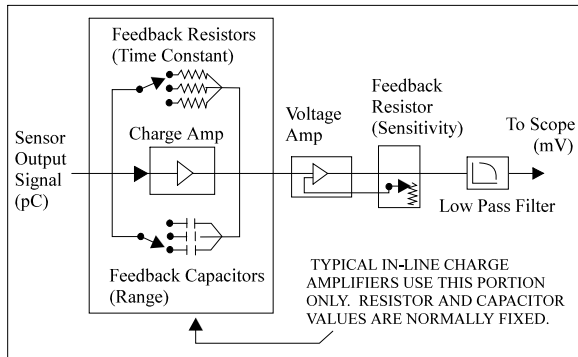


Figure 3

## 4 POWERING

### 4.1 Installation

Before connecting the low-noise cable from the accelerometer to the charge amplifier, be sure to ground both the charge amplifier and the cable. This ensures that an excessive static charge that may have accumulated across the accelerometer or cable is harmlessly discharged. Failure to observe this precaution can result in the destruction of the input FET of certain amplifiers.



Connect the transducer to the input of a PCB differential or equivalent charge amp using low noise cable. **Note:** For optimum noise performance, the cable length between the sensor and the charge AMP should be minimized.

Connect the output of the charge AMP to any ICP® signal conditioner using standard cable. Finally, the output of the signal conditioner may then be connected to an oscilloscope or other monitoring device. This output will be an AC signal (see **specification** for actual frequency response) with a DC bias. Many PCB signal conditioners remove the bias via an AC coupling circuit.

### 4.2 Operation

Once each element is connected, allow a few minutes for the system to thermally stabilize. Place the switch on the charge amplifier in the OPERATE position and proceed with the measurement.

It is often convenient to normalize the accelerometer and charge amplifier system to a precise sensitivity, such as 10.0 or 100.0 mV/g for ease of data analysis. This is accomplished with most PCB laboratory charge amplifiers and some miniature in-line units as well.

For fixed sensitivity charge converters, the system sensitivity (mV/g) is determined as the product of the charge amplifier sensitivity (mV/pC) and the charge sensitivity of the accelerometer (pC/g).

**Note:** When using charge-amplified systems, the noise floor of the system is dependent on the input capacitance to the charge amplifier. Since the cable adds to the capacitance and to minimize the noise threshold, keep the cable length between the accelerometer and the charge amplifier to a minimum. Cable length does not affect the system sensitivity of charge-amplified systems.

Since charge amplifier operation varies, please contact the respective signal conditioner manufacturer or check the product manual for additional information.

## 5 HIGH-TEMPERATURE OPERATION

### 5.1 Introduction

When subjected to elevated temperature, all piezoelectric sensors/hardline cable systems exhibit decreased insulation resistance, due in part to the piezoelectric element, but due mostly to the hardline cable necessary to withstand the high temperatures. This situation can cause serious voltage offset problems in direct-coupled charge amplifiers. To solve this problem, the user must AC couple (capacitor) the charge amplifier to the sensor/cable system. See 5.3 Solution to Reduced Resistance, for complete details, or use different amplifiers.

## 5.2 Reduced Resistance at Charge Amplifier Input

Figure 5.1 illustrates a simplified schematic of a typical direct-coupled charge amplifier where:

- $R_f$  = Feedback resistor (ohms)
- $R_i$  = Input leakage resistance (ohms)
- $E_o$  = Steady-state output voltage (volts)
- $e_i$  = Offset voltage: FET leakage (volts)
- $C_f$  = Feedback capacitor (farads)

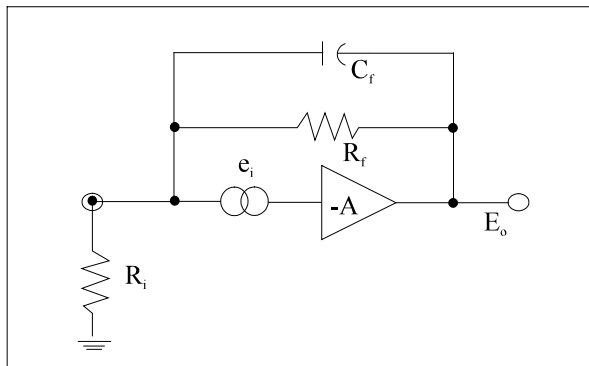


Figure 5.1 Typical Charge Amplifier Schematic

The feedback capacitor  $C_f$  comes into play only in the dynamic situation and its influence does not affect the steady-state situation. The voltage  $e_i$  is a DC offset voltage, usually very tiny (microvolts), that exists at the input gate of the MOSFET circuit. This minute leakage current exists in all real devices.

As demonstrated in Equation 1, the steady-state (DC) output voltage  $E_o$  is:

Equation 1

$$E_o = e_i \left( 1 + \frac{R_f}{R_i} \right)$$

This equation shows that if the input (leakage) resistance at the charge amplifier is extremely high (approaching infinity), the output DC voltage approaches  $e_i$ , usually a very tiny voltage. However, as  $R_i$  decreases, the term

$$1 + \frac{R_f}{R_i}$$

increases, such that the output voltage can, with large ratios of  $R_f/R_i$ , become large enough to result in a large  $E_o$ , perhaps large enough to be outside the normal output voltage range of the charge amplifier.

Because of the feedback capacitor  $C_f$ , this output voltage change usually does not occur rapidly but rather, it manifests itself as a slow drift in the output voltage level. If  $R_i$  is low enough with respect to  $R_f$ , the voltage drift may continue until saturation of the charge amplifier occurs.

## 5.3 Solution to Reduced Resistance

Since the drift or offset problem is caused by a static or steady-state imbalance at the input of the charge amplifier, the solution involves blocking this steady-state effect while allowing the desired dynamic phenomena to pass. This may be accomplished by installing a series capacitor at the input of the charge amplifier, between the offending sensor (or low-impedance hardline) and the input.

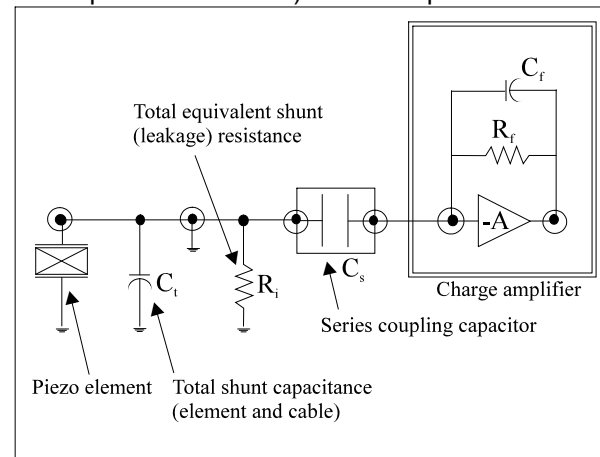


Figure 5.2 Piezoelectric System Block Diagram

Figure 5.2 illustrates a block diagram of the piezoelectric system where:

- $C_t$  = Shunt capacitor
- $C_s$  = Series blocking capacitor

With the series blocking capacitor  $C_s$  in place as shown, the dynamic charge (Q) generated by the sensor element is distributed across the two capacitors,  $C_t$  and  $C_s$ , in proportion to the size (capacitance) of each. If  $C_s$ , for example, is equal to 100 times  $C_t$ , 99% of the charge appears at the input of the charge amplifier, while 1% is across the shunt capacitor  $C_t$ . This results in a 1% decrease in apparent sensitivity of the system.

This therefore demonstrates the importance of selecting the series blocking capacitor at least two orders of magnitude higher than the total shunt capacitance  $C_t$  across the input of the charge amplifier.

It is also important that this capacitor be of high quality, with a leakage resistance of greater than  $10^{12}$  ohms, to avoid the DC offset discussed previously in 5.1, Introduction.

## 5.4 Low-Frequency Response Limitations

In a normal charge amplifier, the low-frequency response is set by the RC time constant, as established by the product of  $C_t$  and  $R_f$ . The system acts like a high-pass first order RC filter with a -3 dB frequency established by the relationship:

Equation 2

$$f_o = \frac{.16}{R_f C_t}$$

where:

- $f_o$  = -3 dB Frequency (Hz)
- $R_f$  = Feedback resistor (ohms)
- $C_t$  = Feedback capacitor (farads)

However, after the addition of the series blocking capacitor  $C_s$ , the system becomes the equivalent of two high-pass filters in series, one as previously mentioned and one comprised of series capacitor  $C_s$  and total equivalent shunt resistance  $R_i$ . This new cutoff frequency is:

Equation 3

$$f_o = \frac{.16}{R_i C_s}$$

To avoid compromise of the low-frequency response established by the charge amplifier parameters and illustrated by Equation 2, the product of  $R_i C_s$  should be several orders of magnitude higher than  $R_f C_t$ .

The approximate final system discharge time constant becomes:

Equation 4a

$$TC = \frac{1}{\frac{1}{R_i C_s} + \frac{1}{R_f C_t}} \quad \text{seconds}$$

If the input coupling time constant ( $R_i C_s$ ) is very much greater than the discharge time constant of the charge amplifier ( $R_f C_t$ ), Equation 4a then becomes:

Equation 4b

$$\frac{1}{R_i C_s} \Rightarrow 0 \text{ Seconds}$$

Equation 5

$$TC = R_f C_t$$

With the product  $R_i C_s$  chosen to be much greater than  $R_f C_t$ , the system discharge time constant is simply  $R_f C_t$  (seconds). The feedback parameters of the charge amplifier establish the low frequency characteristics of the system, unaffected by the degraded input resistance parameters of the test sensor and/or cable.

## 5.5 Other Precautions

Always remember to keep the OPR-GND switch on the charge amplifier in the GND position while connecting or disconnecting sensors, cable, or capacitor to the input connector. Stray or accumulated electrostatic charges may build to the point that they may saturate or even damage the input circuitry of the charge amplifier.

Operate the charge amplifier in the SHORT time constant while the sensor is subject to elevated or changing temperatures.

If it is not necessary to procure data during the transition from room temperature to operating temperature, place the OPR-GND switch in the

GND position to keep spurious, thermally generated charges grounded.

It is prudent to momentarily switch to the GND position even during the measurement period to ensure that excess charges do not accumulate at the input of the charge amplifier.

## 6 ACCELEROMETER CALIBRATION

Accelerometer calibration provides, with a definable degree of accuracy, the necessary link between the physical quantity being measured and the electrical signal generated by the sensor. In addition, other useful information concerning operational limits, physical parameters, electrical characteristics, or environmental influences may also be determined. Without this link, analyzing data becomes a nearly impossible task. PCB provides a calibration record that documents the exact characteristics of each sensor. (The type and amount of data varies depending on the sensor type, contractual regulations, and other special requirements.)

Under normal operating conditions, piezoelectric sensors are extremely stable, and their calibrated performance characteristics do not change over time. However, harsh environments or other unusual conditions that cause the sensor to experience dynamic phenomena outside of its specified operating range may temporarily or permanently affect the sensor. This change manifests itself in a variety of ways, including a shift of the sensor resonance due to a cracked crystal, or a temporary loss of low-frequency measuring capability due to a drop in insulation resistance.

For these reasons, it is recommended that a recalibration cycle be established for each accelerometer. This schedule is unique and is based on a variety of factors, such as extent of use, environmental conditions, accuracy requirements, trend information obtained from previous calibration records, contractual regulations, frequency of “cross-checking” against other equipment, manufacturer recommendation, and any risk associated with incorrect readings. International standards, such as ISO 10012-1, provide insight and suggested methods for determining recalibration intervals for most measuring equipment. With the above information in mind and under “normal” circumstances, PCB conservatively

suggests a 12- to 24-month recalibration cycle for most piezoelectric accelerometers.

**Note:** *It is good measurement practice to verify the performance of each accelerometer with a Handheld Shaker or other calibration device before and after each measurement. The PCB Model 394C06 Handheld Shaker operates at a fixed frequency and known amplitude (1.0 g) to provide a quick check of sensor sensitivity.*

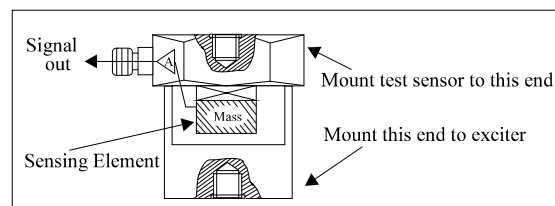
### 6.1.1 SENSOR RECALIBRATION

Accelerometer recalibration services are typically performed by PCB's internal metrology laboratory. (Other international and private laboratories are also available.) The PCB laboratory is certified to ISO 9001, accredited by A2LA to ISO 17025, complies with ISO 10012-1 (and former MIL-STD-45662A), and uses equipment directly traceable to N.I.S.T. This assures an accurate calibration of relevant specifications.

In addition, many companies choose to purchase the equipment necessary to perform the recalibration procedure themselves. While this may result in both a savings of time and money, it has also been attributed to incorrect readings and costly errors. Therefore, in an effort to prevent the common mistakes associated with customer-performed calibration, this document includes a broad overview of the Back-to-Back Calibration technique. This technique provides a quick and easy method for determining the sensitivity of a test accelerometer over a wide frequency range.

### 6.1.2 BACK-TO-BACK CALIBRATION THEORY

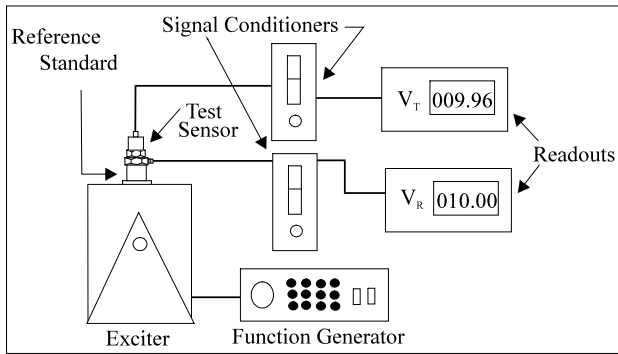
Back-to-Back Calibration is perhaps the most common method for determining the sensitivity of piezoelectric accelerometers. This method relies on a simple comparison to a previously calibrated accelerometer, typically referred to as a reference standard.





**Figure 1. Reference Standard Accelerometer**

These high-accuracy devices, which are directly traceable to a recognized standards laboratory, are designed for stability, as well as configured to accept a test accelerometer. By mounting a test accelerometer to the reference standard and then connecting this combination to a suitable vibration source, it is possible to vibrate both devices and compare the data as shown in Figure 2. (Test setups may be automated and vary, depending on the type and number of accelerometers being calibrated.)

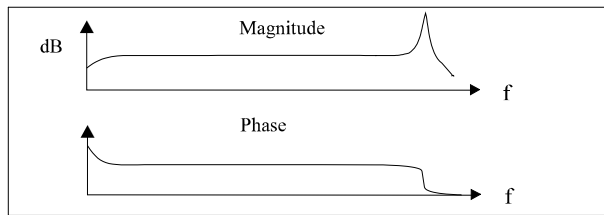


**Figure 2. Typical Back-to-Back Calibration System**

Because the acceleration is the same on both sensors, the ratio of their outputs ( $V_T/V_R$ ) must also be the ratio of their sensitivities. With the sensitivity of the reference standard ( $S_R$ ) known, the exact sensitivity of the test sensor ( $S_T$ ) is easily calculated by using the following equation:

$$S_T = S_R (V_T/V_R)$$

By varying the frequency of the vibration, the sensor may be calibrated over its entire operating frequency range. The typical response of an unfiltered accelerometer is shown in Figure 3.



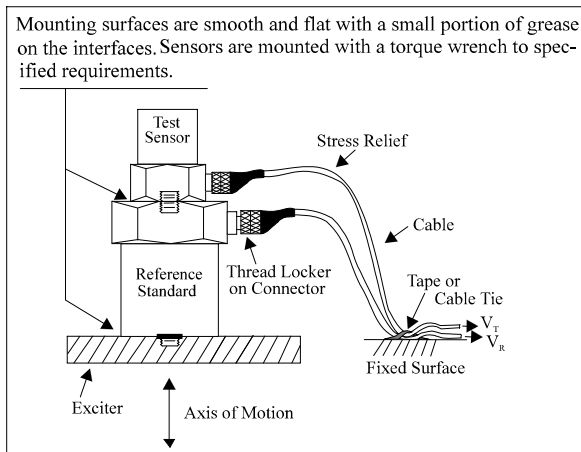
**Figure 3. Typical Test Accelerometer Response**

### 6.1.3 PCB CALIBRATION PROCEDURE

Numerous precautions are taken at PCB to insure accurate and repeatable results. This section provides a brief overview of the primary areas of concern.

Since the Back-to-Back Calibration technique relies on each sensor experiencing an identical acceleration level, proper mounting of the test sensor to the reference standard is imperative. Sensors with mounting holes are attached directly to the reference standard with a stud tightened to the recommended mounting torque. A shouldered mounting stud is typically used to prevent the stud from “bottoming out” in the hole.

Both mounting surfaces are precision-machined and lapped to provide a smooth, flat interface according to the manufacturer’s specification. A thin layer of silicone grease is placed between the mating surfaces to fill any imperfections and increase the mounting stiffness. The cables are stress-relieved by first routing them to the shaker head, securing them with tape or cable ties, then routing them to a nearby stationary location. This reduces cable motion, which is especially important when testing charge output sensors and helps to prevent extraneous noise or stresses from being imparted into the system. A typical set-up is shown in Figure 4.



**Figure 4.** Typical Calibration Set-Up

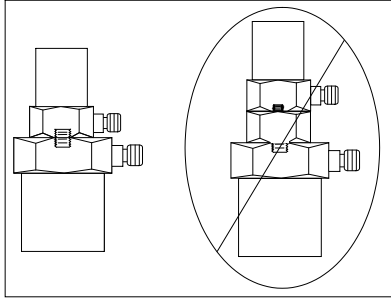
Adhesively mounted sensors use similar practices. However, in this case, a small portion of quick-bonding gel or similar temporary adhesive is used to attach the test sensor to a reference standard designed with a smooth, flat mounting surface.

In addition to mounting, the selection of the proper equipment is critical. Some of the more important considerations include: 1) the reference standard must be specified and previously calibrated over the frequency and/or amplitude range of interest; 2) the shaker should be selected to provide minimal transverse (lateral) motion and minimal distortion; and 3) the quality of the meters, signal generator, and other devices should be selected so as to operate within the limits of permissible error.

### 7.4 COMMON MISTAKES

Most calibration errors are caused by simply overlooking some of the fundamental principals of dynamics. This section attempts to address some of the more common concerns.

For stud-mount sensors, always mount the accelerometer directly to the reference standard. Ensure that the mounting surfaces are smooth, flat, and free of any burrs. Always use a coupling fluid, such as silicone grease, in the mounting interface to maintain a high mounting stiffness. Mount the sensor according to the manufacturer’s recommended mounting torque. DO NOT use any intermediate mounting adaptors, as the mounted resonant frequency may be reduced and thereby compromise the high-frequency performance. If necessary, use adaptor studs.



**Figure 5.** Stud Mounting

Understand Back-to-Back Calibration limitations. Do not expect the uncertainty of calibration to be any better than  $\pm 2\%$ . (In fact, the uncertainty may

be as high as  $\pm 3\%$  or  $\pm 4\%$  for frequencies  $< 10$  Hz or  $> 2$  kHz.) Since large sensors may affect high-frequency accuracy, verify that the test sensor does not mass load the reference standard. Validate your calibration system with another accelerometer prior to each calibration session. Check with the manufacturer for exact system specifications.

### 7.5 CONCLUSIONS

Without an adequate understanding of dynamics, determining what, when, and how to test a sensor is a difficult task. Therefore, each user must weigh the cost, time, and risk associated with self-calibration versus the services of an accredited laboratory.



3425 Walden Avenue,

Toll Free: 888-684-0013 • 24-hour SensorLine<sup>SM</sup>: 716-684-0001 • FAX: 716-685-3886

E-mail: [vibration@pcb.com](mailto:vibration@pcb.com) • Website: [www.pcb.com](http://www.pcb.com)

Depew, NY 14043

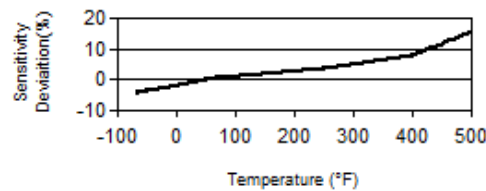
Model Number  
**EX615A42**

# HIGH TEMPERATURE INDUSTRIAL ACCELEROMETER

Revision: A  
ECN #: 47864

Performance	ENGLISH	SI	
Sensitivity(± 5 %)	100 pC/g	10.2 pC/(m/s <sup>2</sup> )	[2]
Measurement Range	+/-200 g pk	+/-2000 m/s <sup>2</sup> pk	
Frequency Range(± 5 %)	5 kHz	5 kHz	[3]
Frequency Range(± 10 %)	6 kHz	6 kHz	
Resonant Frequency	>20 kHz	>20 kHz	[1]
Non-Linearity(<200 g pk)	± 1 %	± 1 %	[4]
Transverse Sensitivity	<5 %	<5 %	[5]
<b>Environmental</b>			
Overload Limit(Shock)	1000 g pk	9800 m/s <sup>2</sup> pk	
Temperature Range	-65 to +500 °F	-54 to +260 °C	
Temperature Response	See Graph	See Graph	
Temperature Response	+ .03 %/°F	+ .06 %/°C	[1]
Temperature Response	See Graph	See Graph	
Base Strain Sensitivity	0.003 g/µε	0.03 (m/s <sup>2</sup> )/µε	[1]
Enclosure Rating	IP68	IP68	
<b>Electrical</b>			
Capacitance(Pin to Pin)	11,100 pF	11,100 pF	[1]
Capacitance(with integral cable)	35 pF/ft	115 pF/m	
Insulation Resistance(at 500F)	≥ 10 <sup>7</sup> Ohm	≥ 10 <sup>7</sup> Ohm	
Insulation Resistance(at room temp)	≥ 10 <sup>9</sup> Ohm	≥ 10 <sup>9</sup> Ohm	
Electrical Isolation(Case)	>10 <sup>8</sup> Ohm	>10 <sup>8</sup> Ohm	
<b>Physical</b>			
Sensing Element	Ceramic	Ceramic	
Sensing Geometry	Shear	Shear	
Housing Material	Stainless Steel	Stainless Steel	
Sealing	Welded Hermetic	Welded Hermetic	
Size (Height x Length x Width)	.89 in x 1.58 in x 1.58 in	23 mm x 40 mm x 40 mm	
Weight(without cable)	6.7 oz	190 gm	[1]
Mounting	Through Holes (4)	Through Holes (4)	
Cable Length	10 ft	3 m	
Cable Termination	Pigtail	Pigtail	
Cable Type	Armored 3-wire, low-noise PTFE cable	Armored 3-wire, low-noise PTFE cable	
Mounting Torque	11 ft-lb	15 Nm	

Typical Sensitivity Deviation vs Temperature



## 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.

## NOTES:

- [1] Typical.
- [2] Conversion Factor 1g = 9.81 m/s<sup>2</sup>.
- [3] 1Hz = 60 cpm (cycles per minute).
- [4] Zero-based, least-squares, straight line method.
- [5] Transverse sensitivity is typically ≤ 3%.

## SUPPLIED ACCESSORIES:

Model 081C108 Mounting Screw, 1/4-28x1, Inconel (4)  
Model ICS-1 NIST-traceable single-axis amplitude response calibration from 600 cpm (10 Hz) to upper 5% frequency (3)

Entered: LK	Engineer: JR	Sales: MC	Approved: JJB	Spec Number:
Date: 2/14/2018	Date: 2/14/2018	Date: 2/14/2018	Date: 2/14/2018	<b>58202</b>



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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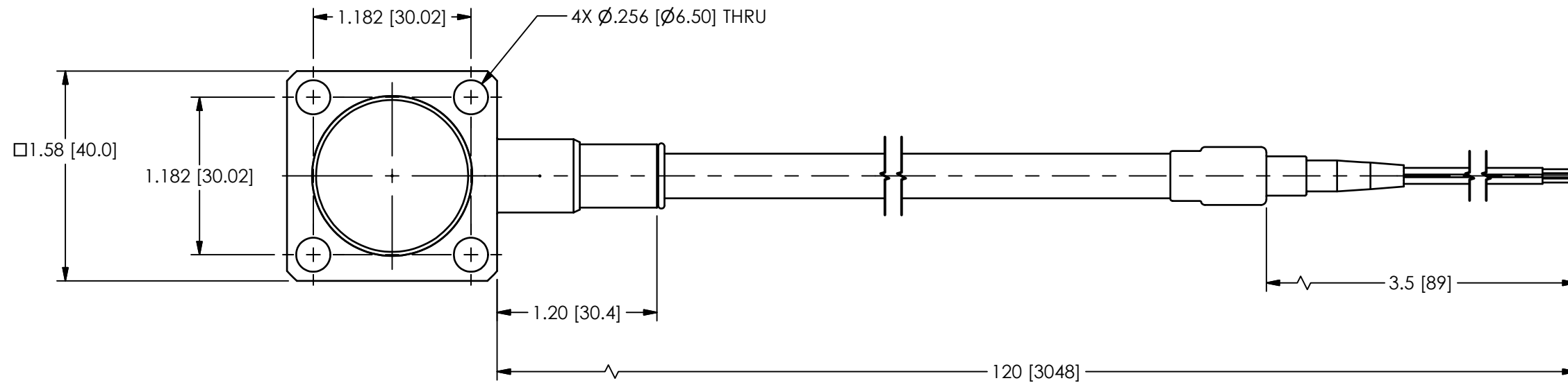
**IMI SENSORS**  
A PCB PIEZOTRONICS DIV.  
3425 Walden Avenue, Depew, NY 14043

Phone: 800-959-4464  
Fax: 716-684-3823  
E-Mail: imi@pcb.com

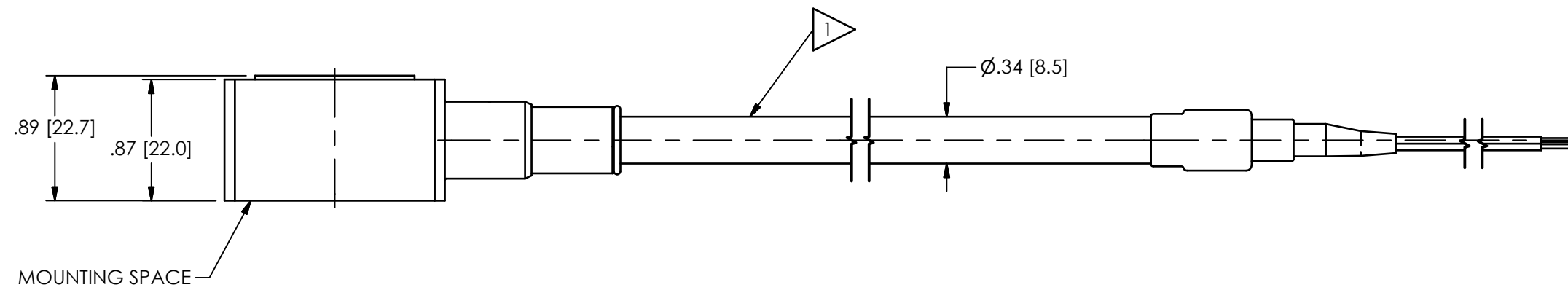
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58201

REVISIONS		
REV	DESCRIPTION	DIN
A	ADDED DELTA NOTE 1	49588



RED WIRE: SIGNAL POSITIVE (+)  
 GREEN WIRE: SHIELD  
 BLACK WIRE: SIGNAL NEGATIVE (-)



1 FLEXIBLE METAL CONDUIT MINIMUM BEND RADIUS IS 1.125" [28.58]

UNLESS OTHERWISE SPECIFIED TOLERANCES ARE:		DRAWN		CHECKED		ENGINEER	
DIMENSIONS IN INCHES	DIMENSIONS IN MILLIMETERS [IN BRACKETS]	JES	6/4/19	JDM	6/4/19	JJD	6/4/19
DECIMALS XX ±.03 XXX ±.010	DECIMALS X ±0.8 XX ±0.25	TITLE OUTLINE DRAWING MODEL EX615A42 HIGH TEMPERATURE ACCELEROMETER					
ANGLES ± 2 DEGREES	ANGLES ± 2 DEGREES						
FILLETS AND RADII .003 - .005	FILLETS AND RADII 0.07 - 0.13	CODE IDENT. NO. 52681		DWG. NO. 58201		SCALE: FULL SHEET 1 OF 1	

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

61680

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**SCHEDULE DRAWING**  
NO MODIFICATIONS PERMITTED WITHOUT REFERENCE TO THE NOTIFIED BODY

REVISIONS		
REV	DESCRIPTION	DIN
NR	RELEASED TO DRAFTING	43970

T-CODE	AMBIENT
T2	-55°C TO 260°C
T3	-55°C TO 195°C
T4	-55°C TO 130°C
T5	-55°C TO 95°C
T6	-55°C TO 80°C

5 Ci AND Li BASED ON CABLE WITH 30 pF/ft AND .33 μH/ft WITH A MAXIMUM CABLE LENGTH OF 100ft. Ci AND Li WILL BE DECREASED WITH SHORTER CABLE LENGTHS.

4 SHIELDS TO BE EARTHED AT BARRIER END.

3 THE INSTALLER SHALL INSURE THAT THE TRANSDUCER MOUNTING STRUCTURE IS AT THE SAME GROUNDING POTENTIAL AS THE BARRIER GROUND. TOTAL EARTH LOOP IMPEDANCE SHALL BE LESS THAN ONE OHM.

2 BARRIER WILL BE MOUNTED IN AN ENCLOSURE THE SUITABILITY OF WHICH WILL BE DETERMINED BY LOCAL AUTHORITIES.

1 ENTITY APPLICATION:

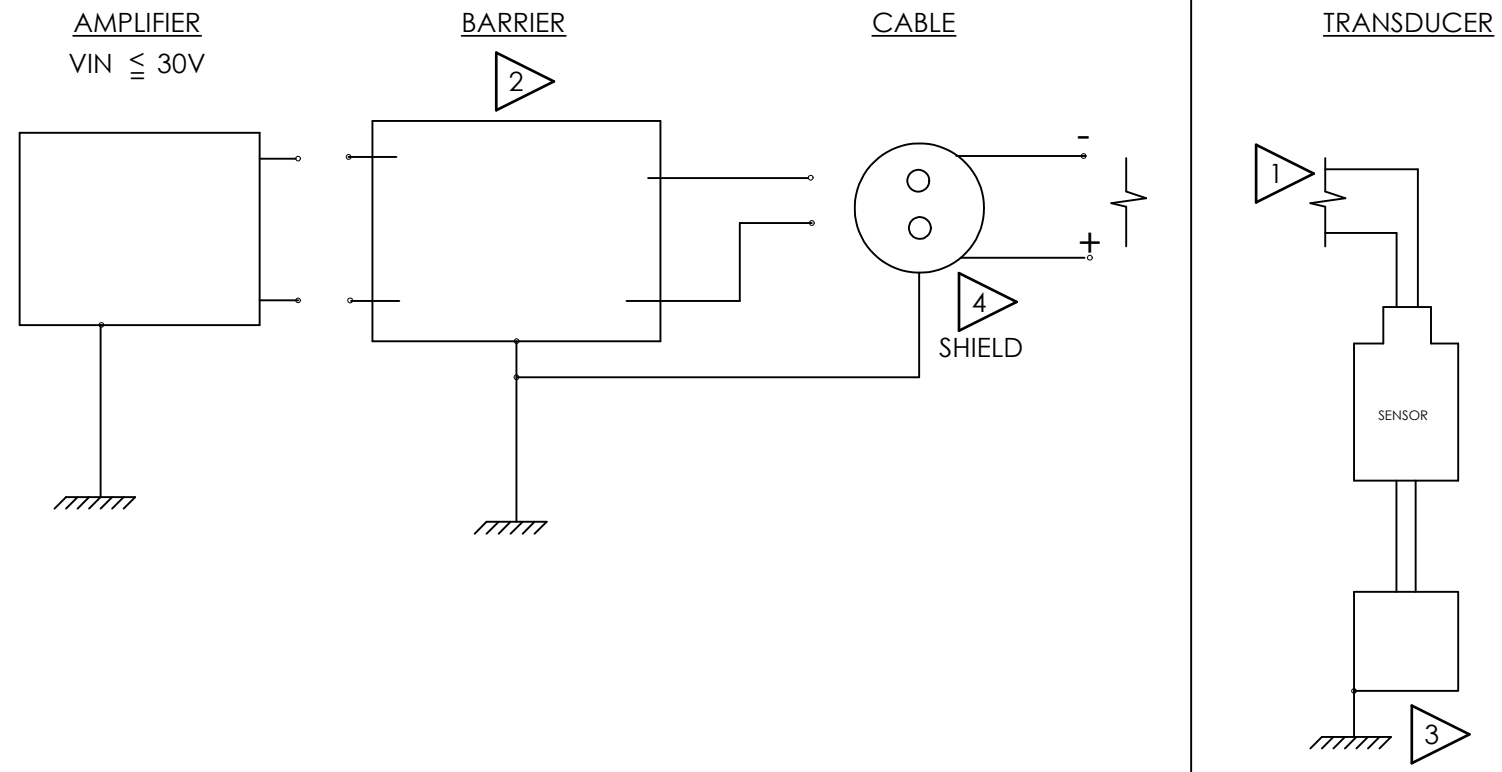
Barrier I.S. Apparatus  
 $V_{oc}/U_o < V / U_i$   
 $I_{sc}/I_o < I / I_i$   
 $C_a/C_o < C_i + C$   
 $L_a/L_o < L_i + L$

BARRIERS WITHIN THE SPECIFIED LIMITATIONS ARE PERMITTED.

ENTITY PARAMETERS:

$U_i \leq 30 \text{ V}$   
 $I_i \leq 100 \text{ mA}$   
 $P_i \leq 0.7 \text{ W}$   
 5  $C_i \leq 15 \text{ nF}$   
 5  $L_i \leq 30 \mu\text{H}$

CERTIFIED BY THE APPROPRIATE APPROVAL AUTHORITY FOR CONNECTION TO THE FOLLOWING AREAS:  
CLASS 1 DIVISION 2



UNLESS OTHERWISE SPECIFIED	
DIMENSIONS ARE IN INCHES	
DECIMALS	X ± .05
	XX ± .01
	XXX ± .005
	XXXX ± .0005
ANGLES ± 2 DEGREES	
FILLETS AND RADII .003 - .005	
HEX DIMENSIONS ARE:	
	≤ .5 + .000 / - .003
	> .5 + .000 / - .005
INTERNAL THREAD DEPTH MIN.	
REMOVE ALL BURRS	
SHARP = R.000 - R.003	



DRAWN	CHECKED		ENGINEER	
	BB	ECB	PML	
10/19/15	10/19/15	10/19/15		
TITLE				
CSA APPROVAL 615A42 INTERCONNECTIONS				

**PCB PIEZOTRONICS™**  
 3425 WALDEN AVE. DEPEW, NY 14043  
 (716) 684-0002 E-MAIL: sales@pcb.com

CODE IDENT. NO. 52681	DWG. NO. 61680
SCALE: NONE	SHEET 1 OF 1

bbbehinger 08:17 10/19/2015



**L C I E**

1 **ATTESTATION D'EXAMEN DE TYPE**  
**VOLONTAIRE**

2 **Appareil ou composant** destiné à être utilisé en  
atmosphères explosibles  
(Directive 94/9/CE)



**VOLUNTARY TYPE EXAMINATION**  
**CERTIFICATE**

**Equipment or component** intended for use in potentially  
explosive atmospheres  
(Directive 94/9/EC)

3 **Version : 00**

**LCIE 15 ATEX 1023 X**

**Issue : 00**

4 **Appareil :**  
Accéléromètre piézoélectrique

**Equipment:**  
Piezoelectronic accelerometer

**Type:** Model EX615A42/MNNZZ Series

5 **Demandeur - Fabricant**

**Applicant - Manufacturer**

**IMI Sensors,  
a PCB Piezotronics Division**

6 **Adresse :** 3425 Walden Avenue  
Depew, New York 14043 - USA

**Address :** 3425 Walden Avenue  
Depew, New York 14043 - USA

7 Cet appareil ou composant et ses variantes éventuelles  
acceptées sont décrits dans l'annexe de la présente  
attestation et dans les documents descriptifs cités en  
référence.

This equipment or component and any acceptable variation  
thereto are specified in the schedule to this certificate and  
the documents therein referred to.

8 Le LCIE certifie que cet appareil ou composant est conforme  
aux Exigences Essentielles de Sécurité et de Santé pour la  
conception d'appareils ou composants électriques de  
catégorie 3 ou non électriques de catégorie 2 et 3, destinés  
à être utilisés en atmosphères explosibles. Ces Exigences  
Essentielles de Sécurité et de Santé sont données dans  
l'annexe II de la directive 94/9/CE du Parlement européen et  
du Conseil du 23 mars 1994.

LCIE certifies that this equipment or component has been  
found to comply with the Essential Health and Safety  
Requirements that relates to the design, of category 3  
electrical or categories 2 and 3 non electrical equipment or  
component, which is intended for use in potentially  
explosive atmospheres. These Essential Health and Safety  
Requirements are given in Annex II of the Directive 94/9/EC  
of the European Parliament and the Council of 23 March  
1994.

Les résultats des vérifications et essais figurent dans le  
rapport confidentiel :

The examination and test results are recorded in  
confidential report:

N° 133179-667578-02.

9 Le respect des Exigences Essentielles de Sécurité et de  
Santé est assuré par la conformité à :

Compliance with the Essential Health and Safety  
Requirements has been assured by compliance with :

EN 60079-0:2012+A11:2013  
EN 60079-15:2010

10 Le signe X lorsqu'il est placé à la suite du numéro de  
l'attestation, indique que cet appareil est soumis aux  
conditions spéciales pour une utilisation sûre, mentionnées  
dans l'annexe de cette attestation.

If the sign X is placed after the certificate number, it  
indicates that the equipment is subject to special conditions  
for safe use specified in the schedule to this certificate.

11 Cette attestation d'examen de type volontaire concerne  
uniquement la conception et la construction de l'appareil ou  
composant spécifié conformément à la Directive 94/9/CE.

This voluntary type examination certificate relates only to  
the design, examination and tests of this specified  
equipment or component in accordance to the Directive  
94/9/EC.

Des exigences supplémentaires de la directive sont  
applicables pour la fabrication et la fourniture de l'appareil,  
système de protection ou composant. Ces dernières ne sont  
pas couvertes par la présente attestation.

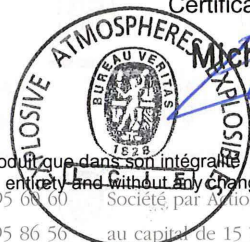
Further requirements of the directive apply to the  
manufacturing process and supply of this equipment or  
component. These are not covered by this certificate.

12 Le marquage de l'appareil ou composant est mentionné dans  
l'annexe de cette attestation.

The marking of the equipment or component is specified in  
the schedule to this certificate.

Fontenay-aux-Roses, le 29 septembre 2015

Responsable de Certification  
Certification Officer



**Michel EQUI**

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Laboratoire Central BP 8 Fax : +33 1 40 95 86 50 au capital de 15 745 984 €

des Industries Electriques 92266 Fontenay-aux-Roses cedex contact@lcie.fr RCS Nanterre B 408 363 174

Une société de Bureau Veritas France www.lcie.fr



LCIE

1 **ATTESTATION D'EXAMEN DE TYPE  
VOLONTAIRE**

2 **Appareil ou composant** destiné à être utilisé en  
atmosphères explosibles  
(Directive 94/9/CE)



**VOLUNTARY TYPE EXAMINATION  
CERTIFICATE**

**Equipment or component** intended for use in potentially  
explosive atmospheres  
(Directive 94/9/EC)

3 **Version : 00**

**LCIE 15 ATEX 1023 X**

**Issue : 00**

13

**ANNEXE**

**SCHEDULE**

15 **DESCRIPTION DE L'APPAREIL OU DU COMPOSANT**

L'appareil est un capteur de vibration principalement  
composé d'une enveloppe en acier inoxydable contenant un  
élément sensible et des fils de raccordement.  
Il peut être installé en zone 2.

Paramètres électriques :  
U = 28V ; P = 0.7W

**MARQUAGE**

Le marquage de l'appareil ou du composant doit  
comprendre :

IMI Sensors,  
a PCB Piezotronics Division  
Adresse : ...  
Type : Model EX615A42/MNNZZ  
N° de fabrication : ...  
Année de fabrication : ...

⊕ II 3G  
Ex nA IIC T6...T2 Gc  
LCIE 15 ATEX 1023 X

L'appareil doit également comporter le marquage  
normalement prévu par les normes de construction qui le  
concernent sous la responsabilité du fabricant.

16 **DOCUMENTS DESCRIPTIFS**

Dossier de certification N° 60730 rév.NR du 15/07/2015  
Ce dossier comprend 5 rubriques (9 pages).

**DESCRIPTION OF EQUIPMENT OR COMPONENT**

The apparatus is a vibration sensor mainly composed of a  
stainless steel enclosure containing a sensing element and  
a wire for connection.  
It can be installed in zone 2.

Electrical parameters :  
U = 28V ; P = 0.7W

**MARKING**

The marking of the equipment or component shall include  
the following :

IMI Sensors,  
a PCB Piezotronics Division  
Address : ...  
Type : Model EX615A42/MNNZZ  
Serial number : ...  
Year of construction : ...

⊕ II 3G  
Ex nA IIC T6...T2 Gc  
LCIE 15 ATEX 1023 X

The equipment shall also bear the usual marking required  
by the product standards applying to such equipment under  
the manufacturer responsibility.

**DESCRIPTIVE DOCUMENTS**

Certification file N° 60730 rev.NR dated 2015/07/15  
This file includes 5 items (9 pages).





LCIE

# ATTESTATION D'EXAMEN DE TYPE VOLONTAIRE

Appareil ou composant destiné à être utilisé en atmosphères explosibles (Directive 94/9/CE)



# VOLUNTARY TYPE EXAMINATION CERTIFICATE

Equipment or component intended for use in potentially explosive atmospheres (Directive 94/9/EC)

3 Version : 00

LCIE 15 ATEX 1023 X

Issue : 00

## 17 CONDITIONS SPECIALES POUR UNE UTILISATION SURE

## SPECIAL CONDITIONS FOR SAFE USE

Température ambiante	Classement en température
$-55^{\circ}\text{C} \leq T_{\text{amb}} \leq +75^{\circ}\text{C}$	T6
$-55^{\circ}\text{C} \leq T_{\text{amb}} \leq +90^{\circ}\text{C}$	T5
$-55^{\circ}\text{C} \leq T_{\text{amb}} \leq +125^{\circ}\text{C}$	T4
$-55^{\circ}\text{C} \leq T_{\text{amb}} \leq +190^{\circ}\text{C}$	T3
$-55^{\circ}\text{C} \leq T_{\text{amb}} \leq +260^{\circ}\text{C}$	T2

Ambient temperature	Temperature class
$-55^{\circ}\text{C} \leq T_{\text{amb}} \leq +75^{\circ}\text{C}$	T6
$-55^{\circ}\text{C} \leq T_{\text{amb}} \leq +90^{\circ}\text{C}$	T5
$-55^{\circ}\text{C} \leq T_{\text{amb}} \leq +125^{\circ}\text{C}$	T4
$-55^{\circ}\text{C} \leq T_{\text{amb}} \leq +190^{\circ}\text{C}$	T3
$-55^{\circ}\text{C} \leq T_{\text{amb}} \leq +260^{\circ}\text{C}$	T2

L'installation électrique à laquelle est connecté l'équipement doit être protégé contre les effets transitoires. Le dispositif de protection doit être réglé à un niveau n'excédant pas 140% de la tension assignée de crête aux bornes de l'alimentation du matériel (conformément au paragraphe 13.c de la norme EN 60079-15).

The electrical installation to which the apparatus is connected must be protected against transients. The protective device has to be set at a level not exceeding 140% of the peak rated voltage values at the power supply terminals (according to clause 13.c of standard EN 60079-15).

## 18 EXIGENCES ESSENTIELLES DE SECURITE ET DE SANTE

Couvertes par les normes listées au point 9.

## ESSENTIAL HEALTH AND SAFETY REQUIREMENTS

Covered by standards listed at 9.

## 19 INFORMATIONS COMPLEMENTAIRES

### Détails du type :

Model EX615A42/MNZZ

M : Présent seulement si l'unité métrique est utilisée  
NNN : spécifie la longueur du câble (jusqu'à trois chiffres)  
ZZ : spécifie le type de terminaison (deux lettres)

## ADDITIONAL INFORMATION

### Type details :

Model EX615A42/MNZZ

M : Present only if metric length units  
NNN : specifies cable length (up to three numbers)  
ZZ : specifies termination type (two letters)

### Lieu de fabrication supplémentaire :

PCB Piezotronics  
10869 Hwy 903  
Halifax, North Carolina 27839

### Additional manufacturing location :

PCB Piezotronics  
10869 Hwy 903  
Halifax, North Carolina 27839

### Essais individuels

Essai de rigidité diélectrique selon §23.2 de la norme EN 60079-15:2010. 500VAC devront être appliqués sur chaque appareil pendant 60 secondes sans claquage.

### Routine tests

Dielectric strength test according to §23.2 of EN 60079-15:2010. 500VAC shall be applied on each apparatus during 60 seconds without breakdown.

## 20 DETAILS DES MODIFICATIONS

Version 00 : Evaluation initiale selon les normes mentionnées en page 1.

## DETAILS OF CHANGES

Issue 00 : Initial assessment according to standards listed on page 1.



LCIE



1 ATTESTATION D'EXAMEN CE DE TYPE

EC TYPE EXAMINATION CERTIFICATE

Appareil, système de protection ou composant destiné à être utilisé en atmosphères explosibles (Directive 94/9/CE)

Equipment, protective system or component intended for use in potentially explosive atmospheres (Directive 94/9/EC)

3 Version : 00

LCIE 15 ATEX 3038 X

Issue : 00

4 Appareil : Accéléromètre piézoélectrique

Equipment: Piezoelectric accelerometer

Type: Model EX615A42/MNNZZ Series

5 Demandeur - Fabricant

Applicant - Manufacturer

IMI Sensors, a PCB Piezotronics Division

6 Adresse : 3425 Walden Avenue Depew, New York 14043 - USA

Address : 3425 Walden Avenue Depew, New York 14043 - USA

7 Cet appareil, système de protection ou composant et ses variantes éventuelles acceptées sont décrits dans l'annexe de la présente attestation et dans les documents descriptifs cités en référence.

This equipment, protective system or component and any acceptable variation thereto are specified in the schedule to this certificate and the documents therein referred to.

8 Le LCIE, organisme notifié sous la référence 0081 conformément à l'article 9 de la directive 94/9/CE du Parlement européen et du Conseil du 23 mars 1994, certifie que l'appareil, système de protection ou composant est conforme aux Exigences Essentielles de Sécurité et de Santé pour la conception et la construction d'appareil, système de protection ou composant destinés à être utilisés en atmosphères explosibles, données dans l'annexe II de la directive. Les résultats des vérifications et essais figurent dans le rapport confidentiel :

LCIE, notified body number 0081 in accordance with article 9 of the Directive 94/9/EC of the European Parliament and the Council of 23 March 1994 certifies that this equipment, protective system or component has been found to comply with the essential Health and Safety Requirements relating to the design and construction of equipment and protective systems intended for use in potentially explosive atmospheres, given in Annex II to the Directive.

The examination and test results are recorded in confidential report:

N° 133179-667578-01.

9 Le respect des Exigences Essentielles de Sécurité et de Santé est assuré par la conformité à :

Compliance with the Essential Health and Safety Requirements has been assured by compliance with :

EN 60079-0:2012+A11:2013 EN 60079-11:2012

10 Le signe X lorsqu'il est placé à la suite du numéro de l'attestation, indique que cet appareil est soumis aux conditions spéciales pour une utilisation sûre, mentionnées dans l'annexe de cette attestation.

If the sign X is placed after the certificate number, it indicates that the equipment is subject to special conditions for safe use specified in the schedule to this certificate.

11 Cette attestation d'examen CE de type concerne uniquement la conception et la construction de l'appareil, système de protection ou composant spécifié. Des exigences supplémentaires de la directive sont applicables pour la fabrication et la fourniture de l'appareil, système de protection ou composant. Ces dernières ne sont pas couvertes par la présente attestation.

This EC type examination certificate relates only to the design and construction of the specified equipment, protective system or component. Further requirements of the directive apply to the manufacturing process and supply of this equipment, protective system or component. These are not covered by this certificate.

12 Le marquage de l'appareil, système de protection ou composant est mentionné dans l'annexe de cette attestation.

The marking of the equipment, protective system or component is specified in the schedule to this certificate.

Fontenay-aux-Roses, le 29 septembre 2015

Responsable de Certification Certification Officer



Seul le texte en français peut engager la responsabilité du LCIE. Ce document ne peut être reproduit que dans son intégralité sans aucune modification.

The LCIE's liability applies only on the French text. This document may only be reproduced in its entirety and without any change.



LCIE

1 **ATTESTATION D'EXAMEN CE DE TYPE**

2 **Appareil, système de protection ou composant**  
destiné à être utilisé en atmosphères explosibles  
(Directive 94/9/CE)



**EC TYPE EXAMINATION CERTIFICATE**

**Equipment, protective system or component** intended  
for use in potentially explosive atmospheres  
(Directive 94/9/EC)

3 **Version : 00**

**LCIE 15 ATEX 3038 X**

**Issue : 00**

13

**ANNEXE**

15 **DESCRIPTION DE L'APPAREIL, DU SYSTEME DE PROTECTION OU DU COMPOSANT**

L'appareil est un capteur de vibration principalement composé d'une enveloppe en acier inoxydable contenant un élément sensible et des fils de raccordement. Il peut être installé en zone 0, 1 ou 2.

Paramètres électriques :

Ui: 28V; Ii: 0.1A; Pi: 0.7W; Ci: 15nF; Li: 30µH

**MARQUAGE**

Le marquage de l'appareil du système de protection ou du composant doit comprendre :

IMI Sensors,  
a PCB Piezotronics Division  
Adresse : ...  
Type : Model EX615A42/MNNZZ  
N° de fabrication : ...  
Année de fabrication : ...

Ex II 1G

Ex ia IIC T6... T2 Ga  
Ui: 28V; Ii: 0.1A; Pi: 0.7W; Ci: 15nF; Li: 30µH  
LCIE 15 ATEX 3038 X

L'appareil doit également comporter le marquage normalement prévu par les normes de construction qui le concernent sous la responsabilité du fabricant.

16 **DOCUMENTS DESCRIPTIFS**

Dossier de certification N° 60712 rev.NR du 15/07/2015  
Ce dossier comprend 5 rubriques (9 pages).

**SCHEDULE**

**DESCRIPTION OF EQUIPMENT, PROTECTIVE SYSTEM OR COMPONENT**

The apparatus is a vibration sensor mainly composed of a stainless steel enclosure containing a sensing element and a wire for connection. It can be installed in zone 0, 1 or 2.

Electrical parameters :

Ui: 28V; Ii: 0.1A; Pi: 0.7W; Ci: 15nF; Li: 30µH

**MARKING**

The marking of the equipment, protective system or component shall include the following :

IMI Sensors,  
a PCB Piezotronics Division  
Address : ...  
Type : Model EX615A42/MNNZZ  
Serial number : ...  
Year of construction : ...

Ex II 1G

Ex ia IIC T6... T2 Ga  
Ui: 28V; Ii: 0.1A; Pi: 0.7W; Ci: 15nF; Li: 30µH  
LCIE 15 ATEX 3038 X

The equipment shall also bear the usual marking required by the product standards applying to such equipment under the manufacturer responsibility.

**DESCRIPTIVE DOCUMENTS**

Certification file N° 60712 rev.NR dated 2015/07/15  
This file includes 5 items (9 pages).



LCIE



1 ATTESTATION D'EXAMEN CE DE TYPE

EC TYPE EXAMINATION CERTIFICATE

Appareil, système de protection ou composant destiné à être utilisé en atmosphères explosibles (Directive 94/9/CE)

Equipment, protective system or component intended for use in potentially explosive atmospheres (Directive 94/9/EC)

3 Version : 00

LCIE 15 ATEX 3038 X

Issue : 00

17 CONDITIONS SPECIALES POUR UNE UTILISATION SURE

SPECIAL CONDITIONS FOR SAFE USE

Température ambiante	Classement en température
- 55°C ≤ T <sub>amb</sub> ≤ +75°C	T6
- 55°C ≤ T <sub>amb</sub> ≤ +90°C	T5
- 55°C ≤ T <sub>amb</sub> ≤ +125°C	T4
- 55°C ≤ T <sub>amb</sub> ≤ +190°C	T3
- 55°C ≤ T <sub>amb</sub> ≤ +260°C	T2

Ambient temperature	Temperature class
- 55°C ≤ T <sub>amb</sub> ≤ +75°C	T6
- 55°C ≤ T <sub>amb</sub> ≤ +90°C	T5
- 55°C ≤ T <sub>amb</sub> ≤ +125°C	T4
- 55°C ≤ T <sub>amb</sub> ≤ +190°C	T3
- 55°C ≤ T <sub>amb</sub> ≤ +260°C	T2

Les matériels de sécurité intrinsèque ne doivent être raccordés qu'à des matériels de sécurité intrinsèque certifiés pour l'usage considéré. Cette association doit répondre aux exigences de la norme EN 60079-25.

The intrinsically safe apparatus shall only be connected to intrinsically safe apparatus certified for the intended use. This association shall comply with the requirements of the standard EN 60079-25.

18 EXIGENCES ESSENTIELLES DE SECURITE ET DE SANTE

ESSENTIAL HEALTH AND SAFETY REQUIREMENTS

Couvertes par les normes listées au point 9.

Covered by standards listed at 9.

19 INFORMATIONS COMPLEMENTAIRES

ADDITIONAL INFORMATION

Détails du type :  
Model EX615A42/MNZZ

Type details :  
Model EX615A42/MNZZ

M : Présent seulement si l'unité métrique est utilisée  
NNN : spécifie la longueur du câble (jusqu'à trois chiffres)  
ZZ : spécifie le type de terminaison (deux lettres)

M : Present only if metric length units  
NNN : specifies cable length (up to three numbers)  
ZZ : specifies termination type (two letters)

Lieu de fabrication supplémentaire :  
PCB Piezotronics  
10869 Hwy 903  
Halifax, North Carolina 27839

Additional manufacturing location :  
PCB Piezotronics  
10869 Hwy 903  
Halifax, North Carolina 27839

Essais individuels

Néant.

Routine tests

None.

Conditions de certification

Les détenteurs d'attestations d'examen CE de type doivent également satisfaire les exigences de contrôle de production telles que définies à l'article 8 de la directive 94/9/CE.

Conditions of certification

Holders of EC type examination certificates are also required to comply with the production control requirements defined in article 8 of directive 94/9/EC.

20 DETAILS DES MODIFICATIONS

DETAILS OF CHANGES

Version 00 : Evaluation initiale selon les normes mentionnées en page 1.

Issue 00 : Initial assessment according to standards listed on page 1.



# IECEX Certificate of Conformity

## INTERNATIONAL ELECTROTECHNICAL COMMISSION IEC Certification Scheme for Explosive Atmospheres

for rules and details of the IECEx Scheme visit [www.iecex.com](http://www.iecex.com)

Certificate No.: **IECEX LCIE 15.0033X** issue No.: **0** Certificate history: \_\_\_\_\_

Status: **Current**

Date of Issue: **2015-09-29** Page 1 of 3

Applicant: **IMI Sensors, a PCB Piezotronics Division**  
3425 Walden Avenue  
Depew, New York 14043  
**United States of America**

Electrical Apparatus: **Piezoelectronic accelerometer**  
Optional accessory: Type : Model EX615A42/MNNZZ series

Type of Protection: **Ex ia IIC ; Ex nA IIC**

Marking: **Ex ia IIC T6...T2 Ga**  
**Ui : 28V ; li : 0.1A ; Pi : 0.7W ; Ci : 15nF ; Li : 30µH**  
**Ex nA IIC T6...T2 Gc**  
**IECEX LCIE 15.0033 X**  
(The complete marking is available in Annex of this certificate).

Approved for issue on behalf of the IECEx  
Certification Body:

Michel Equi

Position:

Certification Officer

Signature:  
(for printed version)

Date:

2015/09/29

1. This certificate and schedule may only be reproduced in full.
2. This certificate is not transferable and remains the property of the issuing body.
3. The Status and authenticity of this certificate may be verified by visiting the [Official IECEx Website](http://www.iecex.com).

Certificate issued by:

**Laboratoire Central des Industries Electriques (LCIE)**  
**33 Avenue du General Leclerc**  
**FR-92260 Fontenay-aux-Roses**  
**France**

Documents relative to LCIE certification activities (Certificates, QARs,  
ExTRs) can be registered under the references "LCI" or "LCIE".





# IECEX Certificate of Conformity

Certificate No.: IECEx LCIE 15.0033X

Date of Issue: 2015-09-29

Issue No.: 0

Page 2 of 3

Manufacturer: **IMI Sensors, a PCB Piezotronics Division**  
3425 Walden Ave  
Depew, New York 14043  
United States of America

Additional Manufacturing location  
(s):

**PCB Piezoelectronics**  
10869 Hwy 903  
Halifax, North California 27839  
United States of America

This certificate is issued as verification that a sample(s), representative of production, was assessed and tested and found to comply with the IEC Standard list below and that the manufacturer's quality system, relating to the Ex products covered by this certificate, was assessed and found to comply with the IECEx Quality system requirements. This certificate is granted subject to the conditions as set out in IECEx Scheme Rules, IECEx 02 and Operational Documents as amended.

#### STANDARDS:

The electrical apparatus and any acceptable variations to it specified in the schedule of this certificate and the identified documents, was found to comply with the following standards:

<b>IEC 60079-0 : 2011</b> Edition: 6.0	Explosive atmospheres - Part 0: General requirements
<b>IEC 60079-11 : 2011</b> Edition: 6.0	Explosive atmospheres - Part 11: Equipment protection by intrinsic safety "i"
<b>IEC 60079-15 : 2010</b> Edition: 4	Explosive atmospheres - Part 15: Equipment protection by type of protection "n"

*This Certificate **does not** indicate compliance with electrical safety and performance requirements other than those expressly included in the Standards listed above.*

#### TEST & ASSESSMENT REPORTS:

*A sample(s) of the equipment listed has successfully met the examination and test requirements as recorded in*

Test Report:

[FR/LCIE/ExTR15.0052/00](#)

Quality Assessment Report:

[NL/DEK/QAR14.0004/01](#)



# IECEx Certificate of Conformity

Certificate No.: IECEx LCIE 15.0033X

Date of Issue: 2015-09-29

Issue No.: 0

Page 3 of 3

## Schedule

### EQUIPMENT:

*Equipment and systems covered by this certificate are as follows:*

The apparatus is a vibration sensor mainly composed of a stainless steel enclosure containing a sensing element and a wire for connection.

It can be installed in zone 0, 1 or 2 for Ex ia version.

It can be installed in zone 2 for Ex nA version.

#### Routine test (For non-sparking apparatus only) :

Dielectric strength test according to §23.2 of IEC 60079-15:2010. 500VAC shall be applied on each apparatus during 60 seconds without breakdown.

### CONDITIONS OF CERTIFICATION: YES as shown below:

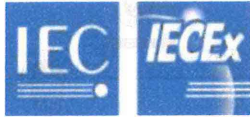
Ambient temperature	Temperature class
- 55°C ≤ Tamb ≤ +75°C	T6
- 55°C ≤ Tamb ≤ +90°C	T5
- 55°C ≤ Tamb ≤ +125°C	T4
- 55°C ≤ Tamb ≤ +190°C	T3
- 55°C ≤ Tamb ≤ +260°C	T2

#### Intrinsic safety device :

The intrinsically safe apparatus shall only be connected to intrinsically safe apparatus certified for the intended use. This association shall comply with the requirements of the standard IEC 60079-25.

#### Non sparking device :

The electrical installation to which the apparatus is connected must be protected against transients. The protective device has to be set at a level not exceeding 140% of the peak rated voltage values at the power supply terminals (according to clause 13.c of standard IEC 60079-15).



**Annex to Certificate  
IECEX LCIE 15.0033 X issue 00**



IMI Sensors,  
a PCB Piezotronics Division  
Address : .....  
Type : Model EX615A42/MNNZZ  
Model : .....  
Serial number : .....  
Year of construction : .....

Ex ia IIC T6... T2 Ga  
Ex nA IIC T6... T2 Gc  
IECEX LCIE 15.0033 X

Intrinsic safety device :  
Ui: 28V; Ii: 0.1A; Pi: 0.7W; Ci: 15nF; Li: 30µH

Non-sparking device :  
U = 28V ; P = 0.7W

Ambient temperature	Temperature class
$-55^{\circ}\text{C} \leq T_{\text{amb}} \leq +75^{\circ}\text{C}$	T6
$-55^{\circ}\text{C} \leq T_{\text{amb}} \leq +90^{\circ}\text{C}$	T5
$-55^{\circ}\text{C} \leq T_{\text{amb}} \leq +125^{\circ}\text{C}$	T4
$-55^{\circ}\text{C} \leq T_{\text{amb}} \leq +190^{\circ}\text{C}$	T3
$-55^{\circ}\text{C} \leq T_{\text{amb}} \leq +260^{\circ}\text{C}$	T2

Type details :

Model EX615A42/ MNNZZ

M : Present only if metric length units  
NNN : specifies cable length (three numbers)  
ZZ : specifies termination type (two letters)



## EU Declaration of Conformity PS190

*In Accordance with ISO/IEC 17050*

<b>Manufacturer:</b> PCB Piezotronics, Inc. 3425 Walden Avenue Depew, New York 14043 USA	<b>Authorized European Representative:</b> PCB Piezotronics Europe GmbH Porschestrasse 20-30 41836 Hückelhoven, Germany
--	---

**Certifies that type of equipment:** High Temperature Accelerometer

**Whose Product Models Include:** EX615A42/MNNZZ Series

Note: "M" is only present metric length units (optional)  
 "NNN" is a place holder for up to 3 numbers indicating cable length (optional)  
 "ZZ" is a place holder for up to two letters indicating termination type (optional)

For example: EX615A42

These letters and numbers are included in the model numbers of the series. For details see the related data sheets.

**This declaration is applicable to all EX615(s) of the above series which have the CE & (EX) ATEX mark on their data sheets and where those data sheets refer to this declaration of conformity. The data sheets for all model numbers referenced above, which include the CE & (EX) ATEX mark on such data sheets and refer to this Declaration of Conformity are hereby incorporated by reference into this Declaration.**

<b>Conform to the following EU Directive(s) when installed per product documentation:</b>	2014/34/EU 2011/65/EU w/2015/863/EU	ATEX Directive RoHS Directive
---	--	----------------------------------

### Standards to which Conformity is Declared:

<b>Harmonized Standards</b>	EN 60079-0 :2012+ A11:2013 EN 60079-11 2012 EN 60079-15:2010 EN 63000:2018	General Explosive Atmosphere  Explosive atmospheres — Part 11: Equipment protection by intrinsic safety 'i' Explosive atmospheres — Part 15: Equipment protection by type of protection 'n' Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances
<b>EC Type Examination</b>	ATEX Certification	LCIE 15 ATEX 3038 X Ex ia IIC T6...T2 Ga, II 1 G
<b>Voluntary Certification</b>	Supplemental ATEX Certification	LCIE 15 ATEX 1023 X Ex nA IIC T6...T2 Gc, II 3 G

<b>IEC Certification Scheme</b>	IECEX Certification	IECEX LCIE 15.0033X Ex ia IIC T6...T2 Ga Ex nA IIC T6...T2 Gc
<b>Notified Body Name</b>		Laboratoire Central des Industries Electriques (0081)
<b>Notified Body's Address</b>		<b>FONTENAY-AUX-ROSES (Head Office)</b> 33, avenue du Général Leclerc FR- 92260 Fontenay-aux-Roses Tel. : + 33 1 40 95 60 60 Fax : + 33 1 40 95 86 56

*I, the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s) Standard(s)*

**Place:** Depew, NY **Date:** 08/25/2021

Signature:



Name: Carrie Termin

Title: Regulatory Affairs and Product Certification Specialist