Model GK291D50

Impact Hammer Kit

Installation and Operating Manual

This manual contains the 086D50, 353B33, 393A03, 480E09 installation and operating manuals that comprise a Model GK291D50 Impact Hammer Kit.

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

PCB PIEZOTRONICS INC.

Service, Repair, and Return Policies and Instructions

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Depew, NY14043 USA
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24-hour SensorLine^SM: (716) 684-0001
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E-mail: info@pcb.com

PCB工业监视和测量设备 - 中国RoHS2公布表

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

部件名称	有害物质					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
住房	O	O	O	O	O	O
PCB板	X	O	O	O	O	O
电气连接器	O	O	O	O	O	O
压电晶体	X	O	O	O	O	O
环氧	O	O	O	O	O	O
铁氟龙	O	O	O	O	O	O
电子	O	O	O	O	O	O
厚膜基板	O	O	X	O	O	O
电线	O	O	O	O	O	O
电缆	X	O	O	O	O	O
塑料	O	O	O	O	O	O
焊接	X	O	O	O	O	O
铜合金/黄铜	X	O	O	O	O	O

本表格依据 SJ/T 11364 的规定编制。

O： 表示该有害物质在该部件所有均质材料中的含量均在 GB/T 26572 规定的限量要求以下。

X： 表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T 26572 规定的限量要求。

铅是欧洲RoHS指令2011/65/ EU附件三和附件四目前由于允许的豁免。

CHINA RoHS COMPLIANCE

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

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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.

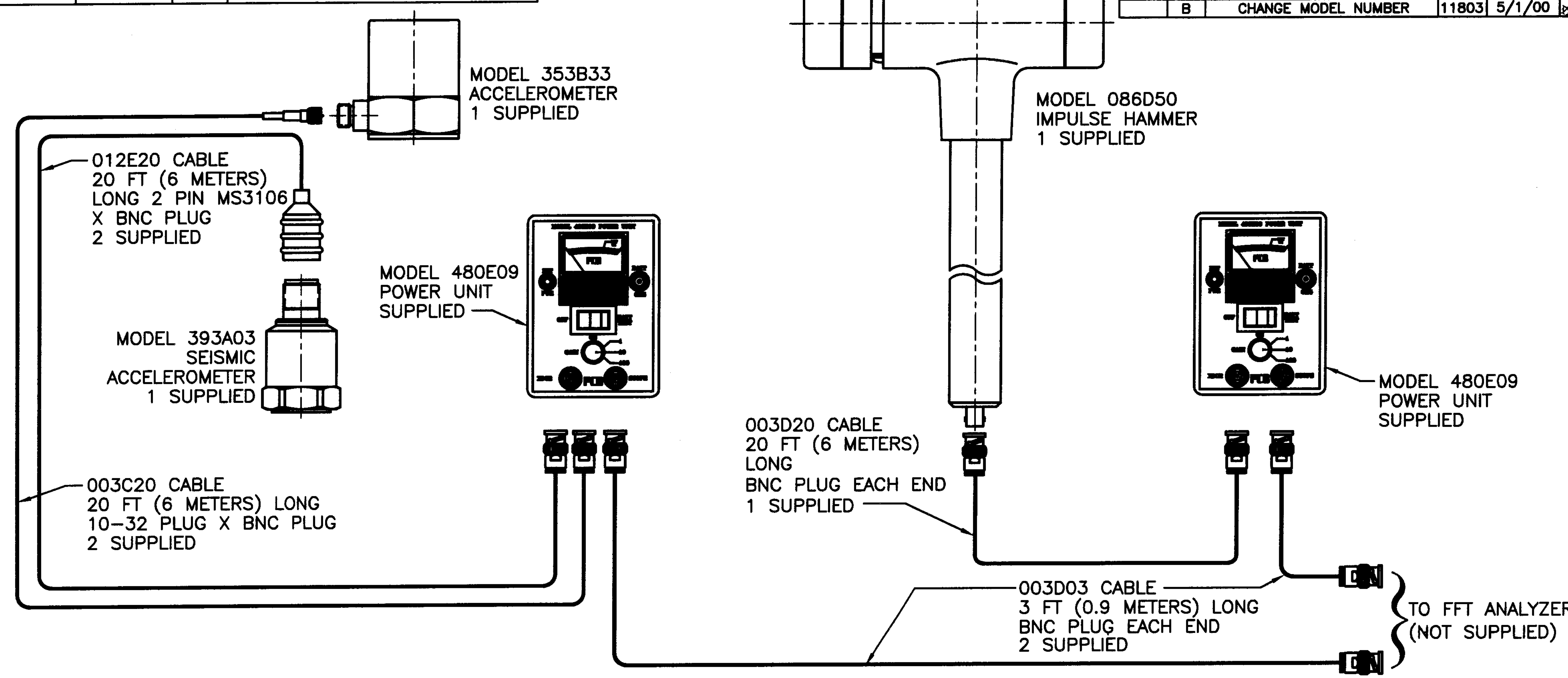
DOCUMENT NUMBER: 21354
DOCUMENT REVISION: D
ECN: 46162

APPLICATION		
NEXT ASS'Y	USED ON	VAR

5054

REVISIONS

ZONE	REV	DESCRIPTION	ECN	DATE	APP'D
	A	REVISED PER ECR	9368	7/30/98	
	B	CHANGE MODEL NUMBER	11803	5/1/00	DMM 5/1/00



THE FOLLOWING ACCESSORIES ARE SUPPLIED IN ADDITION TO THOSE SHOWN:

QTY	DESCRIPTION	MODEL
1	QUICK BONDER	080A80
1	PETRO WAX	080A109
1	ADHESIVE MOUNTING BASE	080A12
2	MOUNTING STUD	081B05
2	MOUNTING STUD	081B20
1	SPARE CABLE	012E20
1	THERMAL JACKET	085A31
1	SUPER SOFT TIP (GRAY)	084A30
1	SOFT TIP (BROWN)	084A31
1	MEDIUM TIP (RED)	084A32
1	HARD TIP (BLACK)	084A33
1	CASE	001A16

UNLESS SPECIFIED TOLERANCES	
DIMENSIONS IN INCHES	DIMENSIONS IN MILLIMETERS (IN PARENTHESIS)
DECIMALS XX ±.01 XXX ±.005 ANGLES ±2 DEGREES	DECIMALS XX ±0.3 XXX ±0.13 ANGLES ±2 DEGREES
FILLETS AND RADII .003 – .005	FILLETS AND RADII (0.07 – 0.13)
DD012 REV. B 03/13/98	

DRAWN	DRM	5/1/00	MFG	CSO	5/1/00
CHK'D	BMM	5/1/00	ENGR	APC	5/1/00
APP'D	[illegible]	5/1/00		AL	5/1/00

TITLE: OUTLINE DRAWING MODEL GK291D50 IMPACT HAMMER KIT

PCB PIEZOTRONICS
3425 WALDEN AVE. DEPEW, NY 14043
(716) 684-0001 EMAIL: SALES@PCB.COM

CODE IDENT. NO. 52681 | DWG. NO. 5054

SCALE: NONE | SHEET 1 OF 1

5054

REVISIONS

ZONE	REV	DESCRIPTION	ECN	DATE	APP'D
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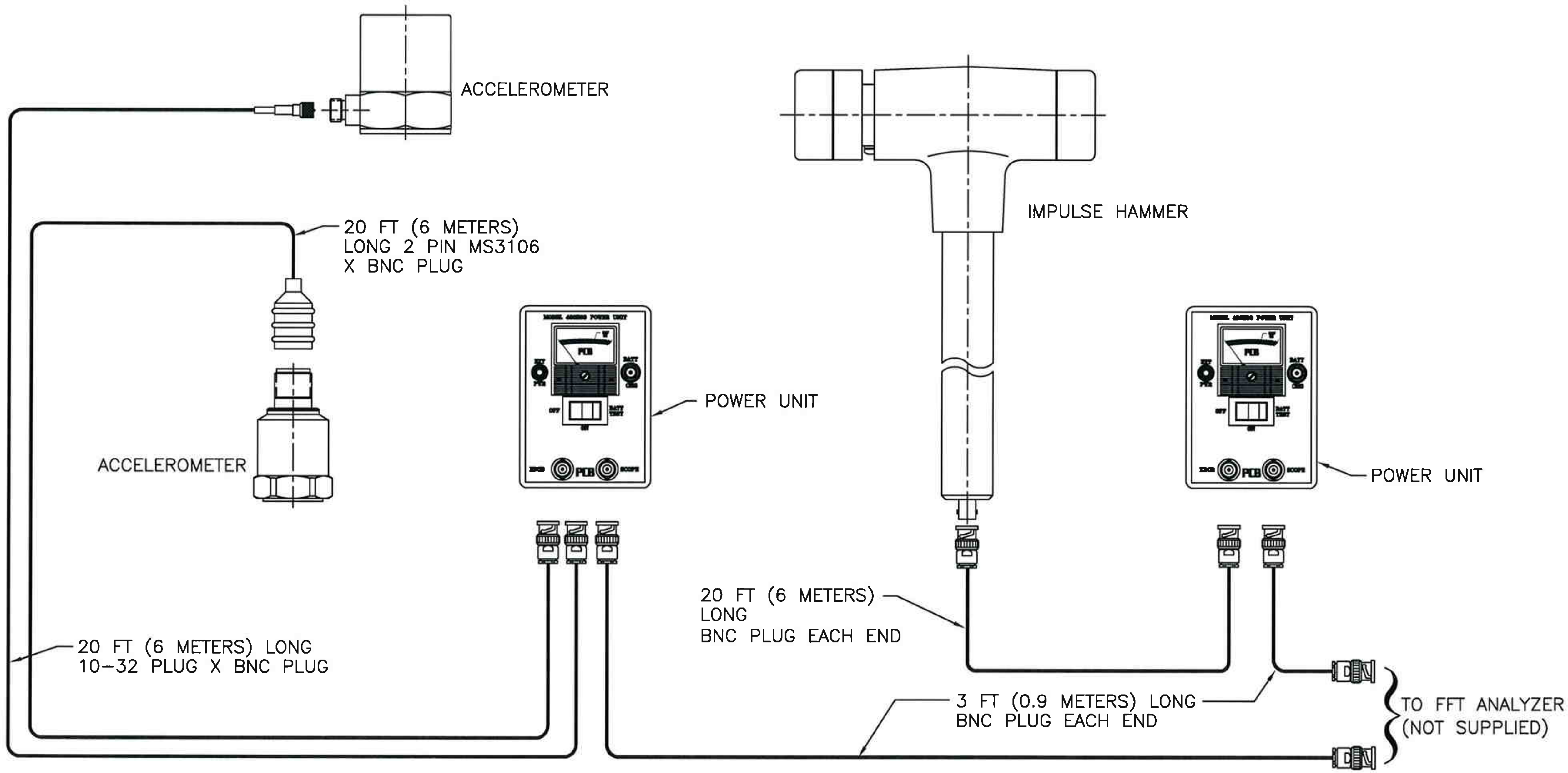
	D	GENERALIZE DRAWING	26451	5/14/07	



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DD012 REV. B 03/13/98	

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CHK'D		5/17/07	ENGR	5/17/07
APP'D		5/17/07		5/17/07

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SCALE: NONE

SHEET 1 OF 1

Model 086D50

Large-sledge Impulse Hammer w/force sensor & tips, 0 to 5k lbf, 1 mV/lbf

Installation and Operating Manual

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电线	O	O	O	O	O	O
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PCB PIEZOTRONICS INC

VIBRATION DIVISION

Installation and Operating Manual ICP® Impulse Force Test Hammer

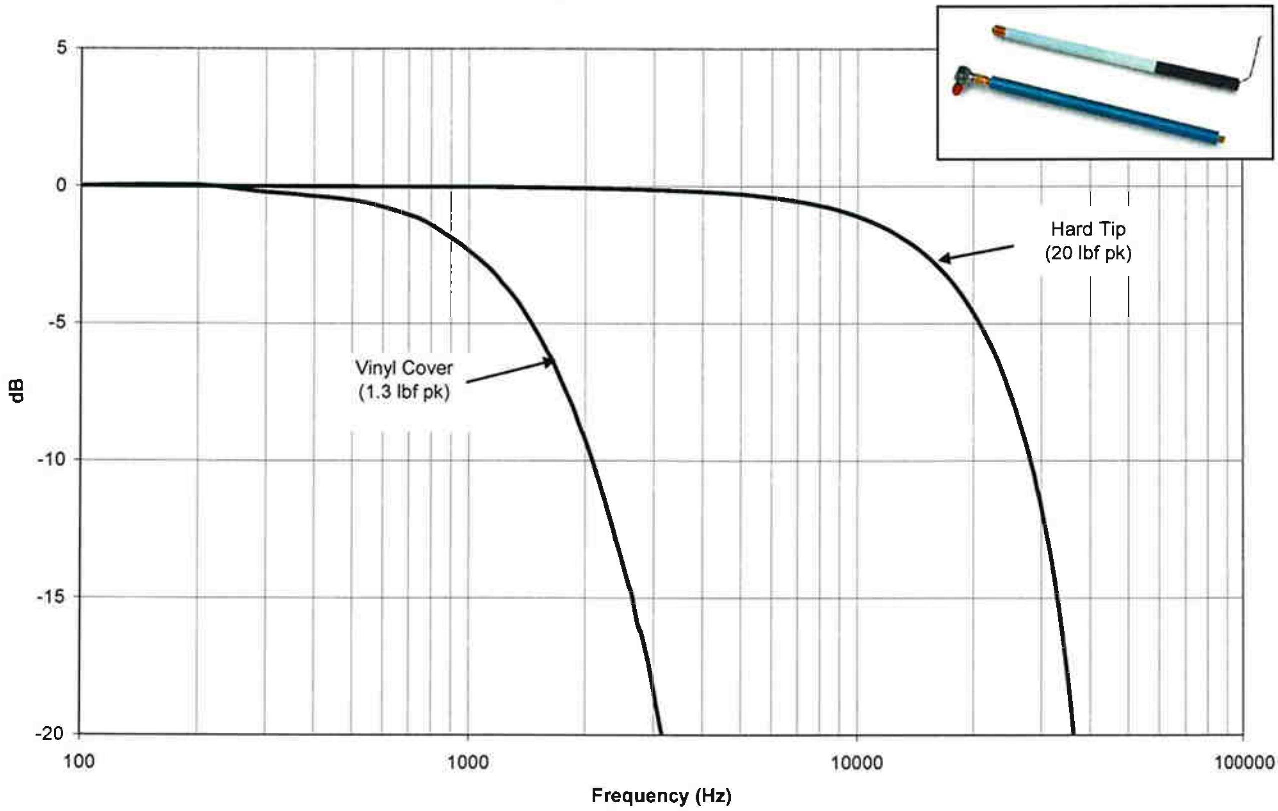
Contents:

1.0 INTRODUCTION

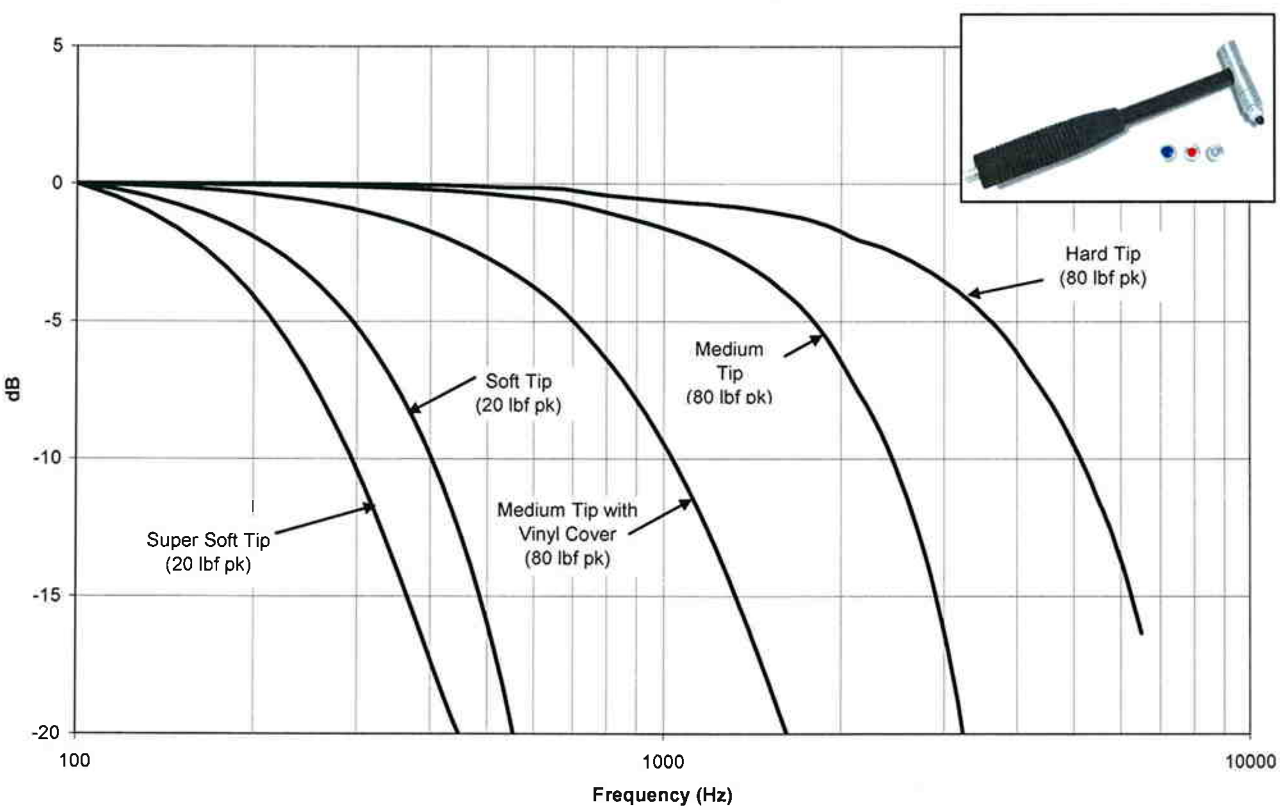
The ICP® Impulse Force Test Hammer adapts your FFT analyzer for structural behavior testing. Impulse testing of the dynamic behavior of mechanical structures involves striking the test object with the force-instrumented hammer, and measuring either the resultant motion with an accelerometer or the acoustic signature with a microphone. Structures generally respond as (1) rigid or elastic bodies, (2) finite elements, lumped constant models, and (3) distributed parameter models conducting stress-strain (sound) waves.

Testing the functional transfer and transactional characteristics of a mechanical structure involves mounting the accelerometer at one location of interest, and striking the test object with the hammer. Modal analysis and modeling involves fixing the accelerometer(s) at one location, impacting the structure at one point, and then moving the accelerometer(s) to other points of interest. Integration of the acceleration signal yields velocity compliance, impedance, and mobility. The hammer impulse consists of a nearly-constant force over a broad frequency range, and is therefore capable of exciting all resonances in that range. The hammer, size, length, material, and velocity at impact determine the amplitude and frequency content (wave shape) of the force impulse. The impact cap material generally determines energy content. The force spectrums of an impact on a stiff steel mass for hammers with their available tips are shown below.

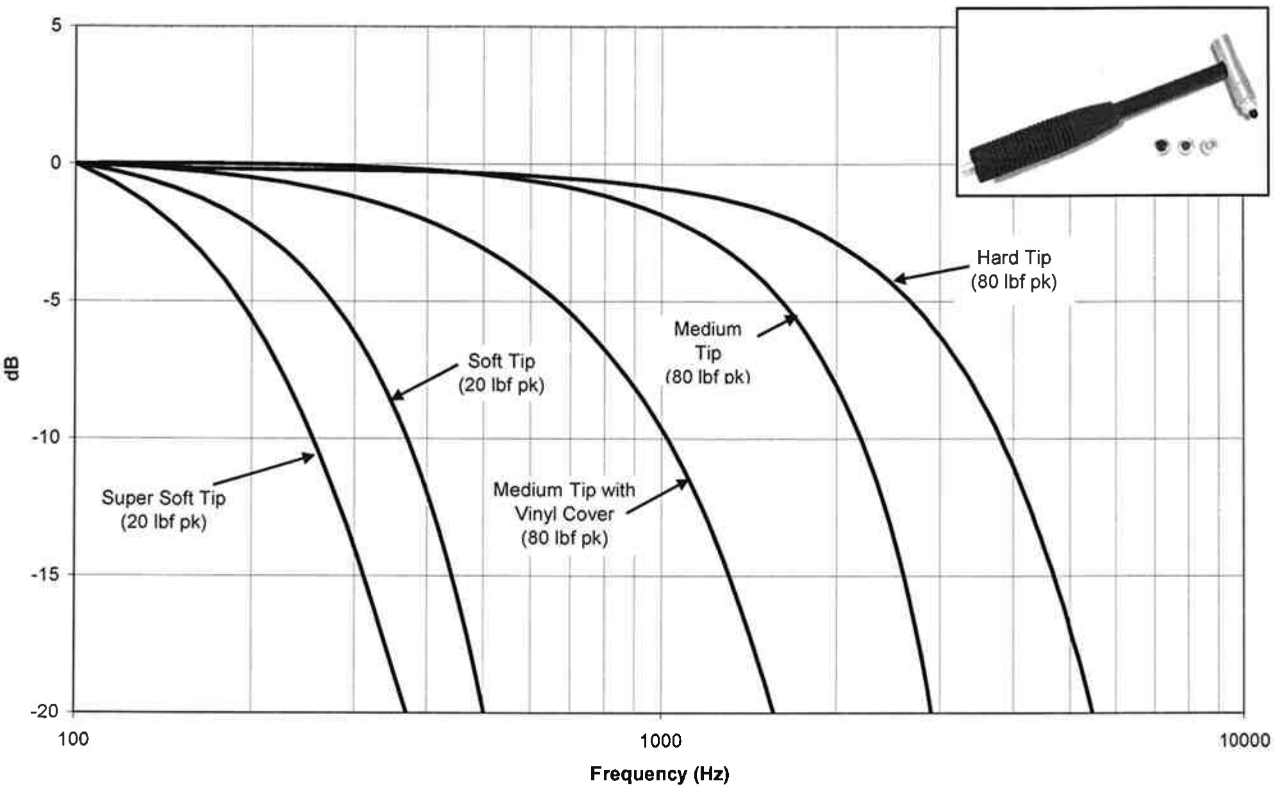
086E80 Family Impulse Hammer Response Curves



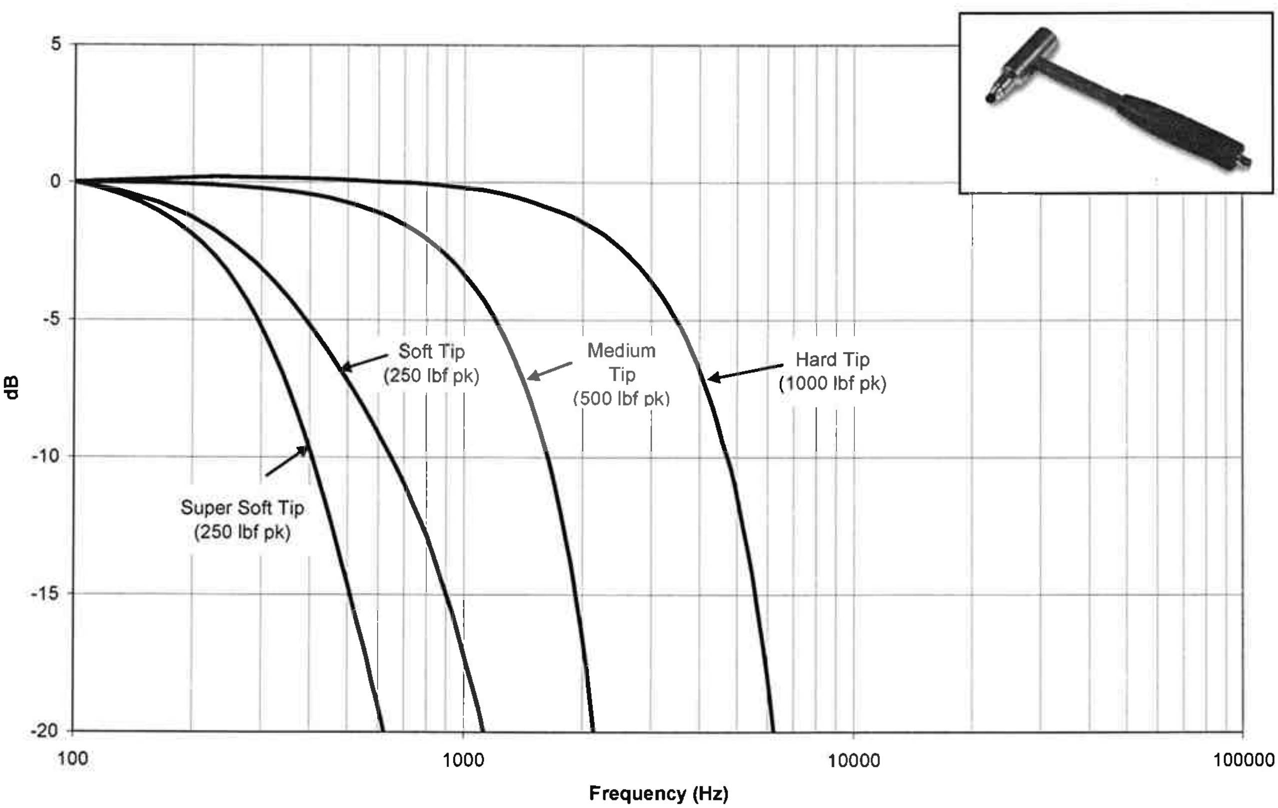
086C01 Family Impulse Hammer Response Curve



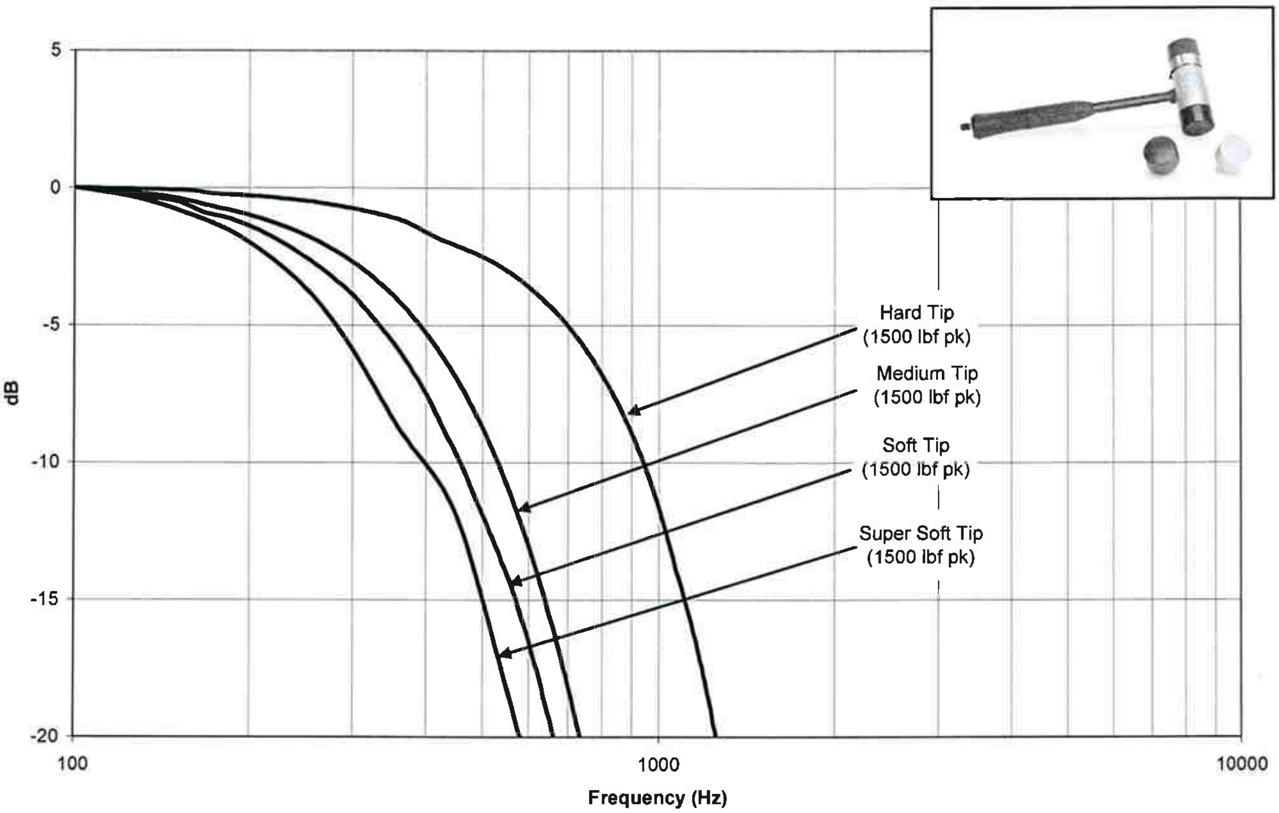
086C02, C03, C04, C40 Family Impulse Hammer Response Curves



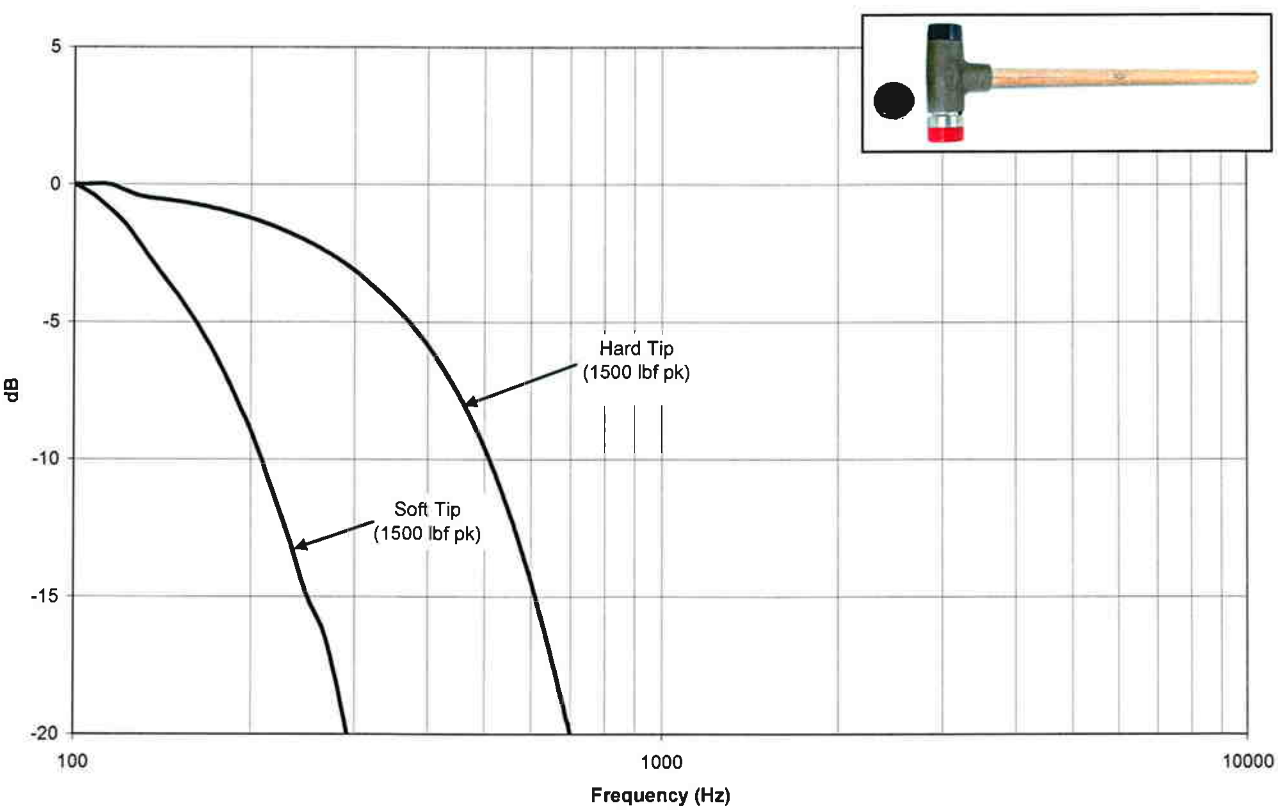
086D05 Family Impulse Hammer Response Curves



086D20, C41 Family Impulse Hammer Response Curves



086D50, C42 Family Impulse Hammer Response Curves



PCB® impulse hammers are available in sizes ranging from the mini-impulse hammer to the 12 lb sledgehammer. All sensors in this system are classified as ICP® (Integrated Circuit Piezoelectric), low impedance, voltage-mode sensors. Microelectronic, built-in amplifiers standardize sensitivities within a few percent of nominal value, which is adequate for most dynamic applications.

Hammer model selection involves determining the size and mass of the hammer structure which will provide the force amplitude and frequency content required for proper excitation of the structure under test. Large, heavy structures like locomotive frames, tanks, and bridges require an instrumented sledgehammer; small structures like compressor blades often require mini-hammers. Some very large structures may require a massive mechanical ram instrumented with a force-sensing impact head.

2.0 DESCRIPTION

The hammer consists of an integral, ICP® quartz force sensor mounted on the striking end of the hammer head. The sensing element functions to transfer impact force into electrical signal for display and analysis. It is structured with rigid quartz crystals and a built-in, micro-electronic, unity gain amplifier. The cable is connected to the end of the handle for convenience, and to avoid connector damage in the event of a "miss hit."

The ICP® sensor operates over a standard two-wire cable from a PCB® power unit. For reasons of safety, the easily-repairable ribbon wire cable is intended to be the weak link in larger hammer design. The ICP® signal conditioner supplies constant current excitation to the sensor over the signal lead and AC couples the output signal. Many FFT analyzers and data acquisition systems have ICP® power supply built in.

The hammer is a single, integral unit. Laser-welded construction of the sensor element insures reliable operation in adverse environments. The mechanical assembly is locked together with a structural epoxy adhesive so it should not be taken apart except at the factory.

The striking end of the hammer has a threaded hole for installation of a variety of impact tips. The tip functions to transfer the force of impact to the sensor, and protects the sensor face from damage. Tips of different stiffness allow you to vary the pulse width and frequency content of the force. The specific frequency range can be found in the datasheet supplied with hammer. An extender mass, supplied with most hammers, allows further tuning by concentrating more energy at lower frequencies.

3.0 INSTALLATION AND OPERATION

The hammer is assembled and locked together with structural adhesive at the factory. Tips and extender mass install at opposite ends of the hammer via 10-32 threaded studs. In the case of the model 086E80 mini impulse hammer, the handle is removable.

1. With cables supplied, connect the hammer to an ICP® signal conditioner, and then to your analyzer, as shown in the system and power unit operation guide.
2. Tighten the cable connectors securely by hand to insure good electrical contact.
3. Switch power on, and wait a minute or two for the sensor amplifier to turn on, and for the coupling capacitor to fully charge. Check the power unit meter for normal operation (meter pointer pointing in green area).

4. If meter pointer points in the red area, look for shorted cables or connections. If meter pointer points in the yellow area, look for open cables or connections.
5. Connect accelerometer(s) in similar manner referring to the appropriate operating guides for the accelerometer(s) and power unit. When all power unit meters indicate normal operation (green), proceed with tests, following all sensor, power unit, and analyzer operating instructions.

4.0 TESTING

Generally speaking, the impact tips affect the hammer impulse frequency content, and the extender affects the signal energy level. Frequency content and energy level are interrelated, so both will be affected by different hammer structures. Hammer velocity at impact will also affect both. In general, massive structures with lower stiffness require the use of the extender and soft impact tip to adequately excite low frequency resonances.

The frequency range of the hammer can be varied by changing the type of tip used. The following guidelines can be used to determine the ideal hammer configuration for a particular test setup:

1. For a higher frequency response, use a stiffer tip without the extender mass.
2. For a lower frequency response, use a softer tip and install the extender mass.
3. To increase motion signal energy, increase the impact velocity and/or hammer mass.

When using the model 086E80 mini impact hammer, the model 084A17 handle is designed for use in frequency ranges lower than those reached when using the model 084A14 handle. When using the model 084A17 handle, best results are achieved by mounting the model 084A13 extender mass to the back of the hammer as shown on the outline drawing. This will improve the low frequency content of the force input to the structure, as well as improve the "feel" of the hammer by offsetting any effective mass added to the handle base by an attached cable.

To test the behavior of your structure, and to tailor the frequency bandwidth of the force, follow the following procedure:

1. Strike the test object with the hammer and process the results. Always take several averages to reduce the effects of spurious noise.

   CAUTION: *Never impact without a hammer tip properly installed on the sensor element. In the case of the model 086E80 mini impact hammer, the sensor element is pre-installed with a steel tip.*

2. Check the measured results for signal quality (adequate signal-to-noise), no overloads (overload lights or sharp flattening of time history peaks), and no double impacts.
3. Analyze results for frequency content, and check to insure that the reasonably flat portion of the force spectrum is sufficient to cover the structural resonances present in the acceleration spectrum. Often signal energy is sufficient to excite structural resonances at 20 dB below initial low frequency force levels.

During testing, occasionally check and tighten the electrical and mechanical connections. Repeated impacting tends to loosen them, which may result in erratic and noisy signals.

Although modal tuning has done much to eliminate this possibility, bouncing (multiple impacts) or penetration may still occur when using too heavy a hammer on too light a structure, or section of a structure. This will appear as an oscillatory component superimposed on the spectrum in your data. Reject such data. Some skill and practice may still be required when testing lighter structures.

PCB's newest ICP® power units providing greater than 10 volts positive signal range (three x 9 volt batteries) prevent undetected overloads in the power unit. Distortion, undershoot, and oscillation of the impulse time history as viewed on the analyzer display is caused by ringing of the analyzer's anti-aliasing filters, which is their normal behavior. To view the correct impulse waveform, switch the analyzer to a high-frequency range.

When configuring your oscilloscope or data acquisition system, it is recommended that the input be set to DC coupled. This is because, in some cases, the time constant associated with the equipment's AC coupling circuit is less then that of the impulse hammer and PCB ICP® power units. This will cause a small offset in the output voltage of the hammer after impact, which will appear as a negative dip in the response on the down slope of the response with a gradual rise back to zero over a period of time.

5.0 CALIBRATION

Calibration involves testing the functional transfer behavior (sensitivity) of the sensor structure in controlled transactions and environments.

Different hammer structures have different sensitivities, because the test structure experiences a force greater than the crystal-sensing elements. The force of impact on the test structure is a function of the total mass of the hammer, while the force on the crystals is a function of only the mass behind them (the impact tip is in front of the crystal-sensing element). Their differences, which depend on the ratio of the tip mass to the head mass, is automatically compensated for when the hammer is properly calibrated, since the extender mass is behind the sensing element. When used, it results in a slight increase in voltage sensitivity (as shown on calibration certificate). Each hammer structure can be easily calibrated to ensure the most accurate data.

A hammer can be calibrated by hitting a freely-suspended mass instrumented with a reference accelerometer. According to Newton's second law of motion, at any instant in time, the force experienced by the mass is simply the mass multiplied by the measured acceleration. On a storage oscilloscope, dividing the peak output signal of the hammer (mV) by the mass (lb or kg), times the peak acceleration (g), gives the hammer sensitivity directly in mV/lb or mV/kg.

Calibration on a FFT analyzer produces the same result as a function of frequency. Since the transfer function of a mass behaving as a rigid body is a consistent (1/M) ratio, the force and the acceleration signals produces a calibration constant (ideally 1/M) for each discrete frequency. The effects of a non-modally tuned hammer will be readily apparent when performing this calibration.

The mass, pendulously suspended or placed on a piece of foam rubber, will behave as a rigid body. Hitting such an instrumented mass is also a good way of checking the normal operation of the hammer and instruments prior to testing. This procedure builds confidence in data results.

6.0 MAINTENANCE

The sealed construction of the sensing element and the bonded construction of the hammer preclude field maintenance. Should service be required, first replace the cables (cables are often the source of trouble) and test operation again. If necessary, return the unit to the factory with a note describing the problem.

7.0 PRECAUTIONS

Although hammers are very rugged in construction, damage can result from misuse. When observed, the following precautions can ensure long life and accurate data.

1. Do not attempt to dismantle sensor element from hammer structure. All service should be performed at the factory.
2. Never generate more than 5 times the rated impact force range with any hammer. Generally, observe the force rating for five volts output. Excessive impact force may destroy the built-in miniature electronics.
3. Never strike an object without an impact tip properly installed in front of the force-sensing element. Damaging the precision-lapped surface of the hammer sensor can affect its behavior.
4. During testing, periodically check and tighten tip, extender and cable connections to ensure continued proper operation. Machined flats in the tips and extender facilitate tightening and removal.
5. Do not apply voltage to unit without constant current protection.
6. Do not apply more than 20 mA of current.
7. Do not exceed 30 volts supply voltage.
8. Do not subject units to temperatures above 250 degrees F (121 degrees C).

8.0 WARRANTY AND SERVICE

All equipment and repair services provided by PCB Piezotronics, Inc. are covered by a warranty against defective material and workmanship under a **Total Customer Satisfaction** policy. See the supplemental sheet, contained with this manual, for information on our service, repair and return policies, procedures and instructions. When unexpected problems arise, call our 24-Hour SensorLine℠ to discuss your immediate dynamic instrumentation needs with a factory representative. PCB guarantees **Total Customer Satisfaction**. If, at any time, for any reason, you are not completely satisfied with any PCB product, PCB will repair, replace, or exchange it at no charge. You may also choose to have your purchase price refunded. Contact PCB for a complete statement of our warranty.

3425 Walden Avenue, Depew, NY 14043-2495
E-Mail: vibration@pcb.com
Website: www.pcb.com

24-hour SensorLine℠: 716-684-0001
Fax: 716-685-3886
Vibration Division toll-free: 888-684-0013

A PCB GROUP COMPANY ISO 9001 CERTIFIED A2LA ACCREDITED to ISO 17025

Manual Number: 19198
Manual Revision: A
ECO 27899

PCB PIEZOTRONICS
VIBRATION DIVISION

VIB-086 Manual – 12/07
Printed in the U.S.A.

Model Number	ICP® IMPACT HAMMER	Revision: H
086D50		ECN #: 46036

Performance	ENGLISH	SI	
Sensitivity(± 15 %)	1 mV/lbf	0.23 mV/N	
Measurement Range	± 5000 lbf pk	± 22,240 N pk	
Resonant Frequency	≥ 5 kHz	≥ 5 kHz	
Non-Linearity	≤ 1 %	≤ 1 %	
Electrical			
Excitation Voltage	20 to 30 VDC	20 to 30 VDC	
Constant Current Excitation	2 to 20 mA	2 to 20 mA	
Output Impedance	<100 Ohm	<100 Ohm	[1]
Output Bias Voltage	8 to 14 VDC	8 to 14 VDC	
Discharge Time Constant	≥ 2000 sec	≥ 2000 sec	[1]
Physical			
Sensing Element	Quartz	Quartz	
Sealing	Hermetic	Hermetic	
Hammer Mass	12.1 lb	5.5 kg	
Head Diameter	3.0 in	7.6 cm	
Tip Diameter	3.0 in	7.6 cm	
Hammer Length	35 in	89 cm	
Electrical Connection Position	Bottom of Handle	Bottom of Handle	
Electrical Connector	BNC Jack	BNC Jack	

CE [2]

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

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.

TLD - TEDS Capable of Digital Memory and Communication Compliant with IEEE 1451.4

Output Bias Voltage	8.5 to 15 VDC	8.5 to 15 VDC

NOTES:

[1] Typical.
[2] See PCB Declaration of Conformance PS136 for details.

SUPPLIED ACCESSORIES:

Model 084A31 Tip - soft plastic, brown (1)
Model 084A32 Tip - hard plastic, red (1)
Model HCS-2 Calibration of Series 086 instrumented impact hammers (1)

Entered: LK	Engineer: BAM	Sales: WDC	Approved: BAM	Spec Number:
Date: 10/11/2016	Date: 10/11/2016	Date: 10/11/2016	Date: 10/11/2016	**12993**

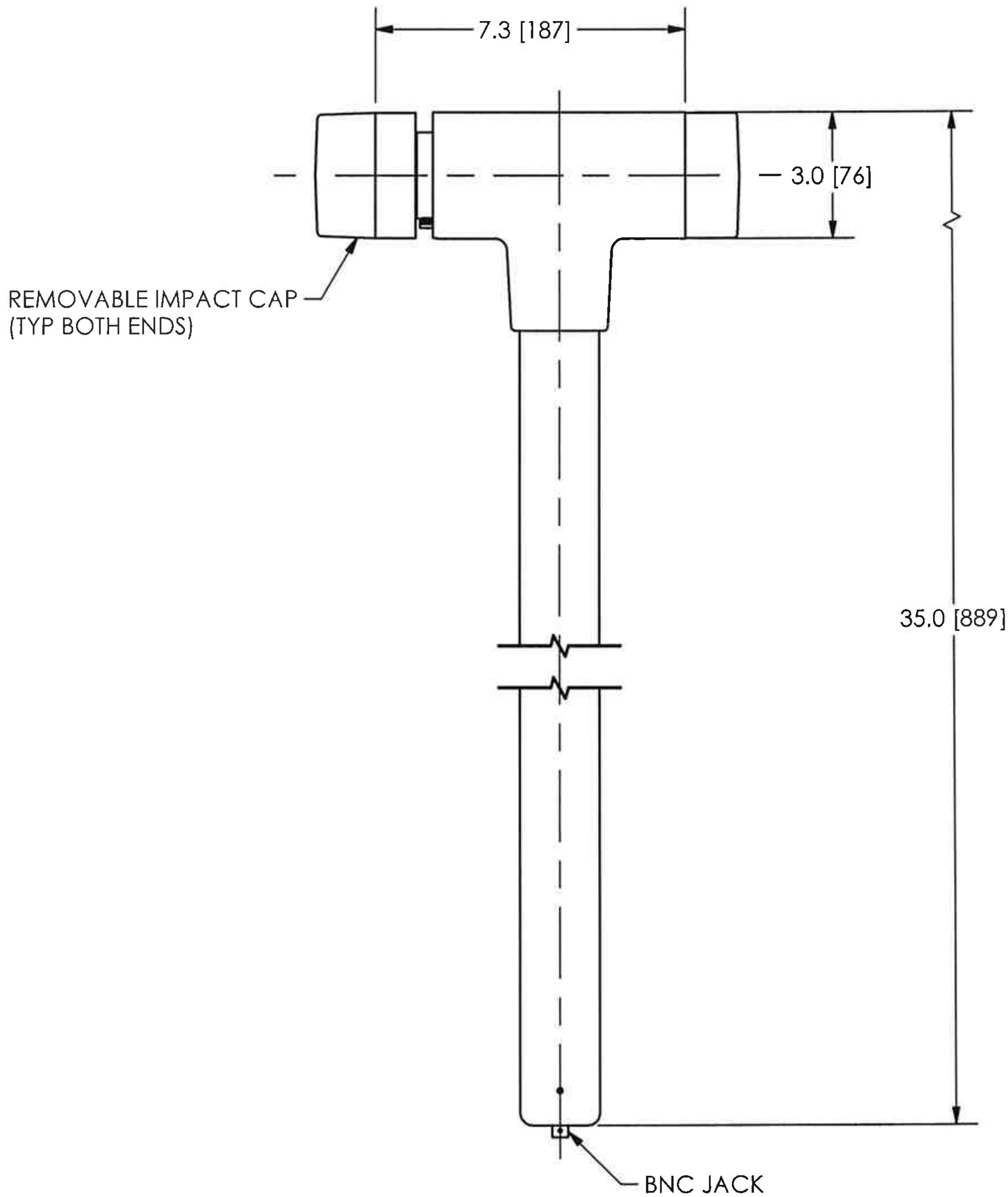
PCB PIEZOTRONICS
3425 Walden Avenue, Depew, NY 14043
Phone: 716-684-0001
Fax: 716-684-0987
E-Mail: info@pcb.com

12782

PCB Piezotronics Inc. claims proprietary rights in the information disclosed hereon. Neither it nor any reproduction thereof will be disclosed to others without the written consent of PCB Piezotronics Inc.

REVISIONS

REV	DESCRIPTION	ECN	APP'D
NR	RELEASED TO DRAFTING		DM 2/00
A	REMOVE TIP CHART	27899	



UNLESS OTHERWISE SPECIFIED TOLERANCES ARE:	
DIMENSIONS IN INCHES	DIMENSIONS IN MILLIMETERS [IN BRACKETS]
DECIMALS XX ± .03 XXX ± .010 ANGLES ± 2 DEGREES	DECIMALS X ± 0.8 XX ± 0.25 ANGLES ± 2 DEGREES
FILLETS AND RADII .003 - .005	FILLETS AND RADII [0.07 - 0.13]

DRAWN	ECB	1/11/08	MFG	DC	1/11/08
CHK'D	DM	1/11/08	ENGR	CL	1/11/08
APP'D	EB	1/11/08	SALES	RJL	1/11/08

TITLE

OUTLINE DRAWING
MODEL 086D50
IMPULSE HAMMER

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

CODE IDENT. NO.	DWG. NO.
52681	12782

SCALE: .5X SHEET 1 OF 1

Model 353B33

Platinum Stock Products; High sensitivity, quartz shear ICP® accel., 100

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**

PCB PIEZOTRONICS INC.

Service, Repair, and Return Policies and Instructions

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

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

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

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

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

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

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

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

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

PCB Piezotronics, Inc.
3425 Walden Ave.
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24-hour SensorLine℠: (716) 684-0001
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E-mail: info@pcb.com

PCB工业监视和测量设备 - 中国RoHS2公布表

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

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

CHINA RoHS COMPLIANCE

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

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

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

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

DOCUMENT NUMBER: 21354
DOCUMENT REVISION: D
ECN: 46162

General
OPERATING GUIDE

for use with

PIEZOELECTRIC ICP® 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.

1.0 INTRODUCTION

Congratulations on the purchase of a quality, ICP® acceleration sensor. 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 a factory Application Engineer at 716-684-0001 or your nearest PCB sales representative.

2.0 ICP® ACCELEROMETERS

Powered by simple, inexpensive, constant-current signal conditioners, these sensors are easy to operate and interface with signal analysis, data acquisition and recording instruments. The following features further characterize ICP® sensors:

- Fixed voltage sensitivity, regardless of cable type or length.
- Low-impedance output signal, which can be transmitted over long cables in harsh environments with virtually no loss in signal quality.
- Two-wire operation with low cost coaxial cable, two-conductor ribbon wire or twisted-pair cabling.
- Low-noise, voltage-output signal compatible with standard readout, signal analysis, recording, and data acquisition equipment.
- Low cost per-channel - ICP® accelerometers require only an inexpensive, constant-current signal conditioner to operate.
- Intrinsic self-test feature – monitoring the sensor's output bias voltage provides an indication of proper operation, faulty condition, and bad cables.

In the rear of this manual you will find a **Specification Sheet**, which provides the complete performance characteristics of your particular sensor.

3.0 OPTIONAL FEATURES

Many sensors are supplied with standard, optional features. When listed before the model number, the following prefix letters indicate that the sensor is manufactured or supplied with a particular optional feature: **"A"** option: adhesive mount; **"HT"** option: extended high temperature range; **"J"** option: electrically ground isolated; **"M"** option: metric mounting thread; **"Q"** option: extended discharge time constant; **"T"** option: built-in transducer electronic data sheet (TEDS); and **"W"** option: attached, water-resistant cabling. Other prefix letters, such as **"K"**, **"KR"**, **"GK"**, **"GKR"**, **"KL"**, and **"GKL"**, indicate that the sensor is ordered in kit form, including interconnect cabling and signal conditioner. If you have any questions or concerns regarding optional features, consult the Vibration Division's product catalog or contact a PCB factory representative.

4.0 INSTALLATION OVERVIEW

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.

® ICP is a registered trademark of PCB Group, Inc., which uniquely identifies PCB sensors that incorporate built-in microelectronics.

Shown in figure 1 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. This roll-off behavior is typically fixed by the sensor's built-in electronics. However, when operating AC-coupled signal conditioners with readout devices having an input impedance of less than one megohm, the low frequency range may be affected. If necessary, contact a factory representative for further assistance.*

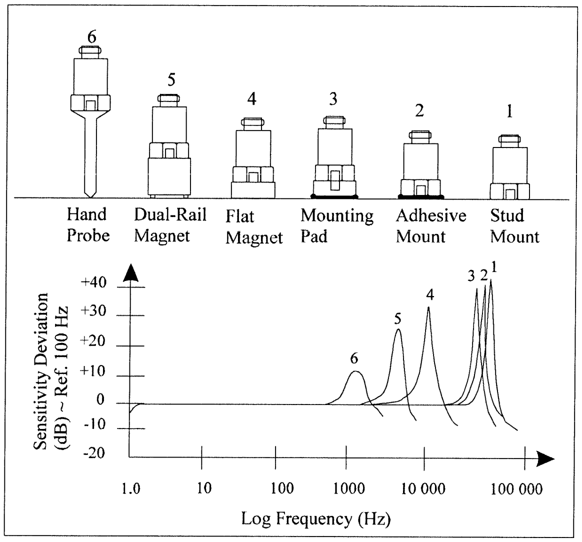


Figure 1. Assorted Mounting Configurations and Their Effects on High Frequency

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.*

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 enclosed **Installation Drawing**.

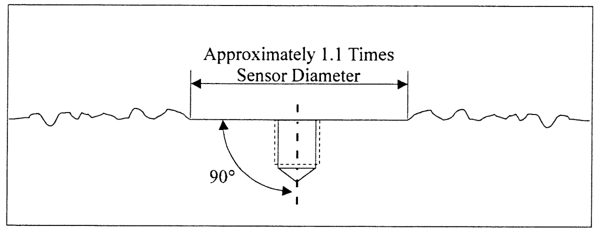


Figure 2. Mounting Surface Preparation

A precision-machined mounting surface with a minimum finish of 63 μin (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.

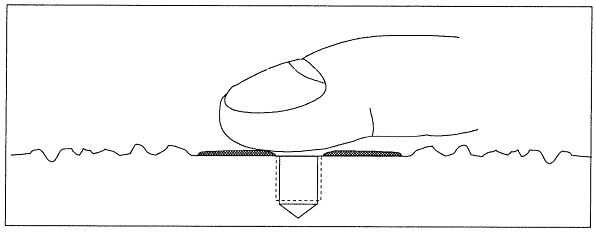


Figure 3. Mounting Surface Lubrication

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 accelerometer and hand-tighten (this step is unnecessary for units having an integral mounting stud). Then, screw the sensor into the tapped hole that was prepared in the test object. Tighten the unit in place by applying, with a torque wrench, the recommended mounting torque, as listed on the enclosed **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.*

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 perform well for temporary installations whereas two-part epoxies and quick-bonding gels (super glue) provide a more permanent installation. Two techniques are used for adhesive mounting; they are via an adhesive mounting base (method 1 below) or direct adhesive mounting (method 2 below).

NOTE: *Adhesively mounted sensors often exhibit a reduction in high-frequency range. Generally, smooth surfaces and stiff adhesives provide the best high 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 many bases are manufactured of "hard-coated" aluminum, they provide electrical isolation to eliminate ground loops and reduce electrical interference that may propagate from the surface of the test object.

STEP 1: Prepare a smooth, flat mounting surface. A minimum surface finish of 63 μin (0.00016 mm) generally works best.

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

STEP 3: Place a small portion of adhesive on the underside of the mounting base (the underside is discernable by the concentric grooves which are designed to accept the adhesive). Firmly press down on the assembly to displace any extra adhesive remaining under the base.

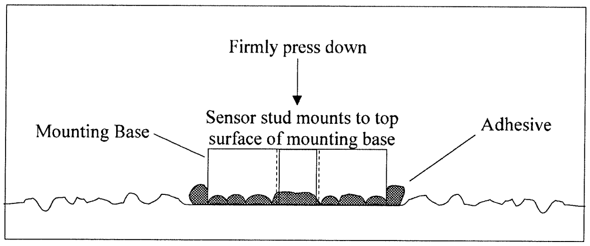


Figure 4. Mounting Base: Adhesive Installation

METHOD 2 - Direct Adhesive Mount

For restrictions of space or for convenience, most sensors can be adhesive-mounted directly to the test structure (an exception being units having integral mounting studs).

STEP 1: Prepare a smooth, flat mounting surface. A minimum surface finish of 63 μin (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. Also, adhesive that may invade the tapped mounting hole in the base of the sensor will compromise future ability to stud mount the unit.

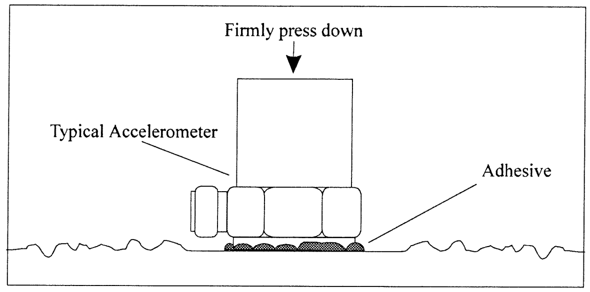


Figure 5. Direct Adhesive Mounting

4.2-1 ADHESIVE MOUNT REMOVAL (other than wax)

NOTE: *A debonder should always be used to avoid sensor damage.*

To avoid damaging the accelerometer, a debonding agent must be applied to the adhesive prior to sensor removal. With so many adhesives in use (everything from super glues, dental cement, epoxies, etc), there is no universal debonding agent available. The debonder for the Loctite 454 adhesive that PCB offers is Acetone. If you are using anything other than Loctite 454, you will have to check with the individual manufacturers for their debonding recommendations. The debonding agent must be allowed to penetrate the surface in order to properly react with the adhesive, so it is advisable to wait a few minutes before removing the sensor.

After the debonding agent has set, you can use an ordinary open-end wrench if the accelerometer has a hex base or square base, or the supplied removal tool for teardrop accelerometers. After attaching either, use a gentle shearing (or twisting) motion (by hand only) to remove the sensor from the test structure.

4.3 MAGNETIC MOUNT

Magnetic mounting provides a convenient means for making quick, portable measurements and is commonly used for machinery condition monitoring, predictive maintenance, spot checks, and vibration trending applications.

NOTE: *The correct magnet choice and an adequately prepared mounting surface are critical for obtaining reliable measurements, especially at high frequencies. Poor installations can cause as much as a 50% drop in the sensor frequency range.*

Not every magnet is suitable for all applications. For example, rare earth magnets are commonly used because of their high strength. Flat magnets work well on smooth, flat surfaces, while dual-rail magnets are required for curved surfaces such as motor housings and pipes. In the case of non-magnetic or rough surfaces, it is recommended that the user first weld, epoxy, or otherwise adhere a steel mounting pad to the test surface. This provides a smooth location for mounting and a target to insure that subsequent measurements for trending purposes are taken at the same location.

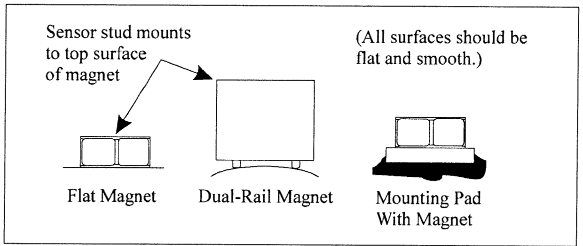


Figure 6. Magnet Types

STEP 1: Prepare a smooth, flat mounting surface. A minimum surface finish of 63 μin (0.00016 mm) generally works best. After cleaning the surface and checking for burrs, apply a light film of silicone grease, machine oil, or similar-type coupling fluid.

STEP 2: After choosing the correct magnet type, inspect the magnet, verifying that its mounting surfaces are flat and smooth.

STEP 3: Stud-mount the accelerometer to the appropriate magnet according to the guidelines set forth in **STEP 3** of the above Stud Mount Procedure.

STEP 4: To avoid damage to the sensor, install the magnet/sensor assembly to the prepared test surface by gently "rocking" or "sliding" it into place.

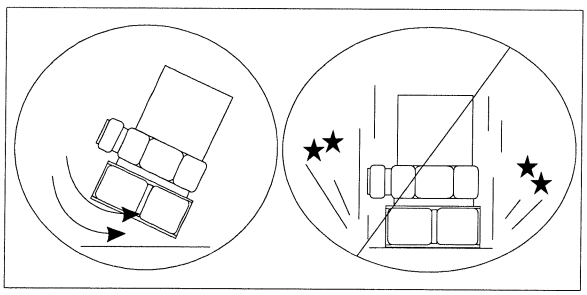


Figure 7. Magnet Mounting

CAUTION: *Magnetically mounting of an accelerometer has the potential to generate very high (and very damaging) acceleration (g) levels. To prevent such damage, exercise caution and install the assembly gently by rocking it into place. If shock is expected to be a particular concern, use a sensor with built-in shock protection. For further assistance, contact a factory representative.*

4.4 HANDHELD OR PROBE TIP MOUNT

This method is NOT recommended for most applications. Both the accuracy and repeatability at low (<5 Hz) and high frequency (>1 kHz) ranges are questionable. It is generally used only for machinery condition monitoring, when installation space is restricted, or other portable trending applications. The technique, however, can be useful for initially determining locations of greatest vibration to establish a permanent sensor installation point.

5.0 CABLING

Care and attention to cable installation and cable condition is essential as the reliability and accuracy of any measurement system is no better than that of its weakest link. Do to the nature of vibration measurements, all sensor cables will ultimately fatigue and fail. Good installation practice will extend the life of a cable, however, it is highly recommended to keep spare cables on hand to enable continuation of the test in the event of a cable failure.

STEP 1: Ascertain that you have the correct cable type.

One cable type cannot satisfy all applications. ICP® sensors can be operated with any ordinary two-wire or coaxial cable. Special, low-noise cables that are typically recommended for use with high-impedance, charge-output sensors can also be used. For applications requiring conformity to CE, low noise cables are essential. Industrial applications often require shielded, twisted-pair cables to reduce the effects of EMI and RFI that is present near electrical motors and machinery. Teflon-jacketed cabling may be necessary to withstand corrosive environments and higher temperatures. Consult the Vibration Division's product catalog for more information about cables or feel free to contact a factory representative for a specific recommendation on cables that are best suited for your application.

STEP 2: Connect the cable to the accelerometer.

A small amount of thread-locking compound placed on the connector threads prior to attachment helps secure the cable during testing. In wet, oily, or dirty environments, the connection can be sealed with silicone rubber sealant, O-rings, and flexible, heat-shrink tubing.

Coaxial Cables: Make connection by inserting the cable's connector pin into the sensor's mating socket. Then thread the connector into place by turning the cable connector's outer shell onto the accelerometer's electrical connector.

NOTE: *Do not spin the accelerometer while holding the cable connector stationary, as this will cause undue* *friction on the center pin of the cable connector and lead to premature fatigue.*

Multi-pin connectors: Make connection by inserting the sensor's mating pins onto the cable connector's mating sockets. Then thread the connector into place by turning the cable connector's outer shell onto the accelerometer's electrical connector.

Pigtail Connections: Certain miniature accelerometers and shock sensors are provided with lightweight cables attached to "Pigtail" connections. This type of connection reduces overall weight and incidence of connection intermittency under shock conditions. In the event of a cable or connection failure, the cables may be repaired in the field simply by re-soldering the stripped leads to the exposed pins on the sensor. (Check the **Installation Drawing** to determine signal and ground pins). In many cases, it is also helpful to protect the solder joint with heat-shrink tubing or epoxy.

NOTE: *If you do not have the experience or resources to attach pigtail leads, consult PCB to discuss factory attachment. Damage to internal electronics may be caused by excessive heat during soldering and such failure is not covered by warranty.*

STEP 3: Route the cable to the signal conditioner, making certain to relieve stress on the sensor/cable connection. Also, minimize cable motion by securing it with tape, clamps or ties at regular intervals.

Common sense should be used to avoid physical damage and minimize electrical noise. For instance, avoid routing cables near high-voltage wires. Do not route cables along floors or walkways where they may be stepped on or become contaminated. To avoid ground loops, shielded cables should have the shield grounded at one end only, typically at the signal conditioner.

STEP 4: Finally, connect the remaining cable end to the signal conditioner. It is good practice to dissipate any electrical charge that may have accumulated in the cable by shorting the signal pin to the ground pin or shell prior to attachment.

6.0 POWERING

All ICP® sensors require constant current excitation for proper operation. For this reason, use only PCB constant-current signal conditioners or other approved constant-current sources. A typical system schematic is shown in Figure 8.

NOTE: *Damage to the built-in electronics resulting from the application of incorrect power, or the use of an unapproved power source, is NOT covered by warranty.*

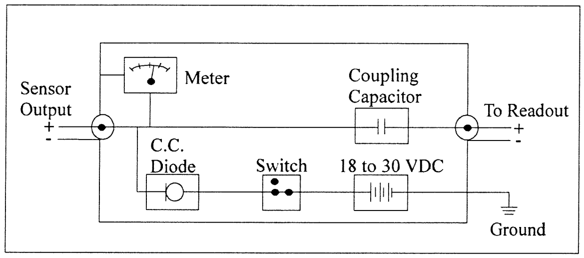


Figure 8. Typical System Schematic

The power supply consists of a current-regulated, 18 to 30 VDC source. This power is regulated by a current-limiting circuit, which provides the constant-current excitation required for proper operation of ICP® sensors. In general, battery-powered devices offer versatility for portable, low-noise measurements, whereas line-powered units provide the capability for continuous monitoring. Consult the Vibration Division's product catalog for more information about signal conditioners.

NOTE: *Under no circumstances should a voltage be supplied to an ICP® accelerometer without a current-regulating diode or equivalent electrical circuit. This may include ohmmeters, multi-meters and continuity testers.*

Meters or LEDs are used on PCB signal conditioners to monitor the bias voltage on the sensor output signal, to check sensor operation, and detect cable faults. Normally, a "yellow" reading indicates an open circuit; "green" indicates normal operation; and "red" indicates either a short or overload condition. Finally, a capacitor at the output stage of the device removes the sensor output bias voltage from the measurement signal. This provides a zero-based, AC-coupled output signal that is compatible with most standard readout devices.

NOTE: *Units having a low bias voltage may be in the "red," when actually they are working properly. If suspect, the bias voltage can be checked with a voltmeter attached to a "T" connector installed on the input connector to the signal conditioner.*

Note: *For readout devices having an input impedance near one gigohm (as encountered with some A to D converters), it may be necessary to place a one megohm resistor in parallel to the readout input to eliminate slow turn-on and signal drift.*

Today, many FFT analyzers, data acquisition modules, and data collectors have the proper constant-current excitation built-in for direct use with ICP® sensors. Before using this feature, however, check that the supply voltage and constant current are within acceptable limits for use with your particular sensor. (Check enclosed **Specification Sheet**). Please contact the respective signal conditioner manufacturer or check the product manual for more information.

7.0 OPERATING

After completing the system setup, switch on the signal conditioner and allow 1 to 2 minutes for the system to stabilize. The meter (or LED) on the signal conditioner should be reading "green." This indicates proper operation and you may begin taking measurements. If a faulty condition is indicated (red or yellow reading), first check all system connections, then check the functionality of the cable and signal conditioner. If the system still does not operate properly, consult a PCB factory representative.

NOTE: *Always operate the accelerometer within the limitations listed on the enclosed* ***Specification Sheet****. Operating the device outside these parameters can cause temporary or permanent damage to the sensor.*

8.0 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. Fortunately, most sensor manufacturers provide a calibration record that documents the exact characteristics of each sensor. (The type and amount of data varies depending on the manufacturer, sensor type, contractual regulations, and other special requirements).

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

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 suggest 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 Handheld Shaker operates at a fixed frequency and known amplitude (1.0 g) to provide a quick check of sensor sensitivity.*

8.1 RECALIBRATION SERVICE

PCB offers recalibration services for our piezoelectric accelerometers, as well as units produced by other manufacturers. Our internal metrology laboratory is certified to ISO 9001, accredited by A2LA to ANSI/IEC 17025 and ANSI/NCSL Z540-1, complies with ISO 10012-1 (and former MIL-STD-45662A), and uses equipment directly traceable to NIST. Our investment in equipment, traceability and conformance to industry standards ensures accurate calibration against relevant specifications, in a timely fashion.

8.2 BACK-TO-BACK CALIBRATION THEORY

Many companies choose to purchase the equipment necessary to perform the recalibration procedure in house. 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.

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.

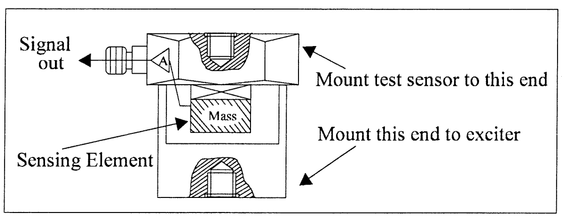


Figure 9. Reference Standard Accelerometer

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 10. (Test set-ups may be automated and vary, depending on the type and number of accelerometers being calibrated).

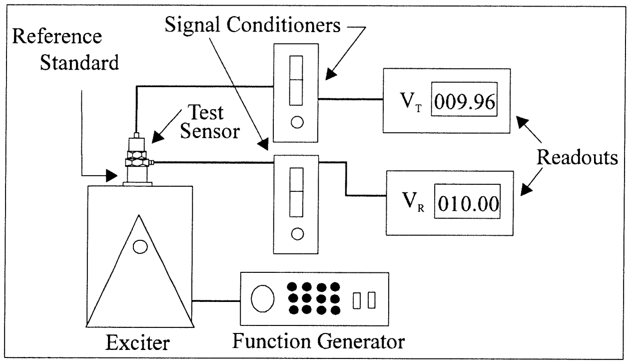


Figure 10. Typical Back-to-Back Calibration System

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 11.

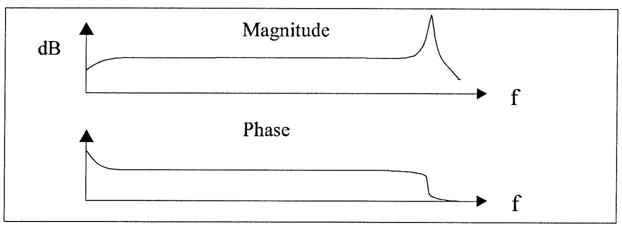


Figure 11. Typical Test Accelerometer Response

8.3 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, then to a nearby stationary location. This reduces cable motion, which is especially important when testing charge output sensors, and helps to prevent extraneous motion or stresses from being imparted into the system. A typical set-up is shown in Figure 12.

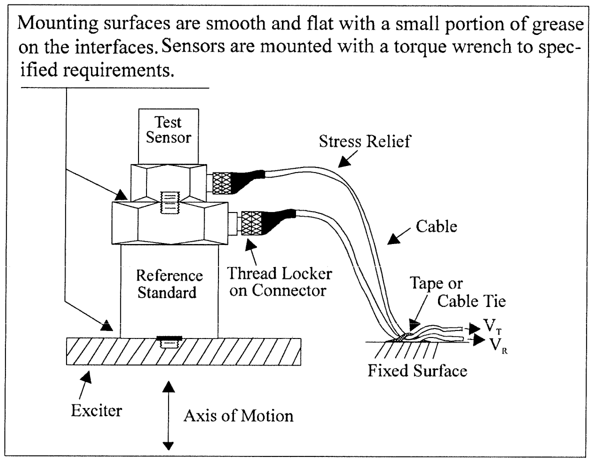


Figure 12. Typical Calibration Set-Up

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.

8.4 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.

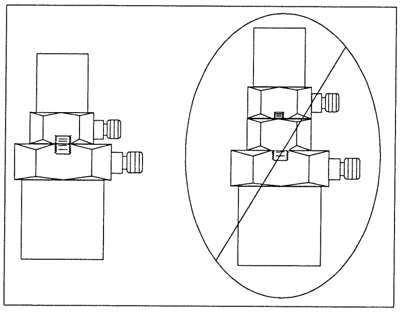


Figure 13. Stud Mounting

For adhesive mount sensors, use a thin, stiff layer of temporary adhesive such as quick-bonding gel or superglue. DO NOT use excessive amounts of glue or epoxy, as the mounting stiffness may be reduced and compromise high-frequency performance. It may also damage the sensor during removal.

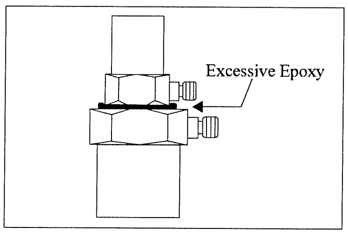


Figure 14. Incorrect Adhesive Mounting

Triaxial accelerometers should always be mounted directly to the reference standard. Unless absolutely required, DO NOT use adaptors to re-orient the sensor along the axis of motion, as the mounting stiffness may be altered. The vibration at the test sensor's sensing element may differ from the vibration at the reference standard due to a "cantilever" effect, seen in Figure 15.

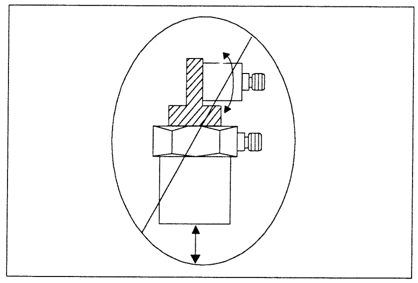


Figure 15. Mounting Triaxial Sensors (Incorrect)

Understand Back-to-Back Calibration limitations. Do not expect the uncertainty of calibration to be any better than ±2%. (In fact, the uncertainty may be as high as ±3% or ±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.

8.5 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 utilizing the services of an accredited laboratory.

9.0 SERVICE

See the supplement sheet, contained in this manual, for information on our warranty, service, repair, and return policies and instructions.

When unexpected measurement problems arise, call our 24-hour SensorLine^{SM} to discuss your immediate dynamic instrumentation needs with a factory representative.
Dial 716-684-0001.

PCB PIEZOTRONICS INC
VIBRATION DIVISION

3425 Walden Avenue, Depew, NY 14043-2495 USA **Vibration Division toll-free** 888-684-0013
24-hour SensorLineSM 716-684-0001 **FAX** 716-685-3886 **E-mail** vibration@pcb.com **Website** www.pcb.com

A PCB GROUP COMPANY ISO 9001 CERTIFIED A2LA ACCREDITED to ISO 17025

Manual Number: 18292
Manual Revision: B
ECN Number: 19829

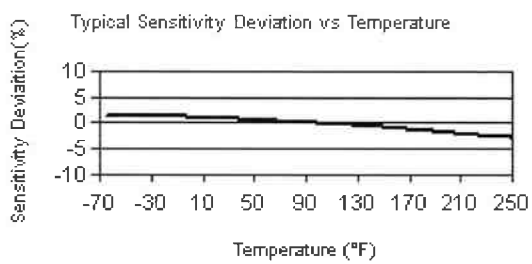
VIB-ICPMANUAL-0

Printed in U.S

Model Number 353B33	ICP® ACCELEROMETER	Revision: N ECN #: 26810

Performance	ENGLISH	SI	
Sensitivity(± 5 %)	100 mV/g	10.19 mV/(m/s²)	[2]
Measurement Range	± 50 g pk	± 491 m/s² pk	
Frequency Range(± 5 %)	1 to 4000 Hz	1 to 4000 Hz	
Frequency Range(± 10 %)	0.7 to 6500 Hz	0.7 to 6500 Hz	
Frequency Range(± 3 dB)	0.35 to 12,000 Hz	0.35 to 12,000 Hz	
Resonant Frequency	≥ 22 kHz	≥ 22 kHz	
Broadband Resolution(1 to 10,000 Hz)	0.0005 g rms	0.005 m/s² rms	[1]
Non-Linearity	≤ 1 %	≤ 1 %	[3]
Transverse Sensitivity	≤ 5 %	≤ 5 %	[4]
Environmental			
Overload Limit(Shock)	± 10,000 g pk	± 98,100 m/s² pk	
Temperature Range(Operating)	-65 to +250 °F	-54 to +121 °C	
Temperature Response	See Graph	See Graph	[1]
Base Strain Sensitivity	0.0002 g/με	0.002 (m/s²)/με	[1]
Electrical			
Excitation Voltage	18 to 30 VDC	18 to 30 VDC	
Constant Current Excitation	2 to 20 mA	2 to 20 mA	
Output Impedance	≤ 100 ohm	≤ 100 ohm	
Output Bias Voltage	7.5 to 11.5 VDC	7.5 to 11.5 VDC	
Discharge Time Constant	0.5 to 2.0 sec	0.5 to 2.0 sec	
Settling Time(within 10% of bias)	<25 sec	<25 sec	
Spectral Noise(1 Hz)	320 μg/√Hz	3139 (μm/s²)/√Hz	[1]
Spectral Noise(10 Hz)	70 μg/√Hz	687 (μm/s²)/√Hz	[1]
Spectral Noise(100 Hz)	18 μg/√Hz	177 (μm/s²)/√Hz	[1]
Spectral Noise(1 kHz)	6.4 μg/√Hz	63 (μm/s²)/√Hz	[1]
Physical			
Sensing Element	Quartz	Quartz	
Sensing Geometry	Shear	Shear	
Housing Material	Titanium	Titanium	
Sealing	Welded Hermetic	Welded Hermetic	
Size (Hex x Height)	0.75 in x 0.93 in	19.1 mm x 23.6 mm	
Weight	0.95 oz	27 gm	[1]
Electrical Connector	10-32 Coaxial Jack	10-32 Coaxial Jack	
Electrical Connection Position	Side	Side	
Mounting Thread	10-32 Female	10-32 Female	

[5]



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

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

OPTIONAL VERSIONS

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

B - Low bias electronics			[2]
Output Bias Voltage	4.5 to 7.5 VDC	4.5 to 7.5 VDC	
Excitation Voltage	12 to 30 VDC	12 to 30 VDC	
Constant Current Excitation	1 to 20 mA	1 to 20 mA	
Measurement Range	± 30 g pk	± 294 m/s² pk	
J - Ground Isolated			
Frequency Range(± 5 %)	1 to 4000 Hz	1 to 4000 Hz	
Frequency Range(± 10 %)	0.7 to 6000 Hz	0.7 to 6000 Hz	
Resonant Frequency	≥ 18 kHz	≥ 18 kHz	
Electrical Isolation(Base)	≥ 10^8 ohm	≥ 10^8 ohm	
Size - Hex x Height	0.75 in x 0.98 in	19.1 mm x 24.9 mm	
Q - Extended discharge time constant			[2]
Frequency Range(± 5 %)	0.1 to 4000 Hz	0.1 to 4000 Hz	
Frequency Range(± 10 %)	0.07 to 6500 Hz	0.07 to 6500 Hz	
Discharge Time Constant	≥ 10 sec	≥ 10 sec	
Settling Time(within 10% of bias)	<120 sec	<120 sec	

Supplied Accessory : Model ACS-4 Single-axis, low frequency phase and amplitude response calibration. (1)

W - Water Resistant Cable		
Electrical Connector	Sealed Integral Cable	Sealed Integral Cable
Electrical Connection Position	Side	Side

NOTES:

[1] Typical.
[2] B and Q options supplied with a sensitivity tolerance of ± 10 %.
[3] Zero-based, least-squares, straight line method.
[4] Transverse sensitivity is typically ≤ 3%.
[5] See PCB Declaration of Conformance PS023 for details.

SUPPLIED ACCESSORIES:

Model 080A109 Petro Wax (1)
Model 080A12 Adhesive Mounting Base (1)
Model 081B05 Mounting Stud (10-32 to 10-32) (1)
Model ACS-1 NIST traceable frequency response (10 Hz to upper 5% point). (1)
Model M081B05 Mounting Stud 10-32 to M6 X 0.75 (1)

Entered: BLS	Engineer: BAM	Sales: WDC	Approved: EB	Spec Number:
Date: 7-10-07	Date: 7-2-07	Date: 7-2-07	Date: 7-5-07	353-2330-80

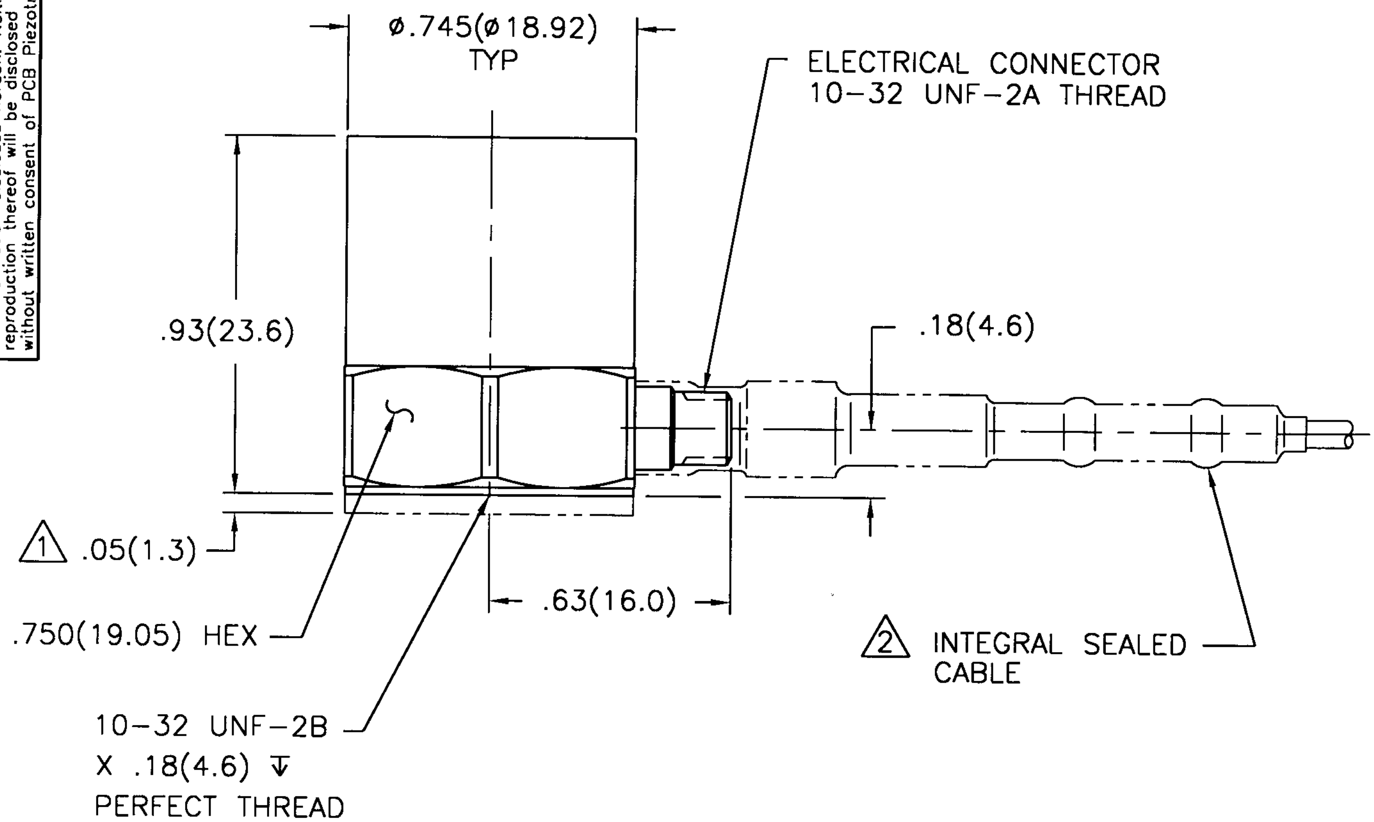
PCB PIEZOTRONICS
VIBRATION DIVISION
3425 Walden Avenue, Depew, NY 14043

Phone: 716-684-0001
Fax: 716-685-3886
E-Mail: vibration@pcb.com

APPLICATION		
NEXT ASS'Y	USED ON	VAR

REVISIONS				
REV	DESCRIPTION	ECN	DATE	APP'D
	REFERENCE ECN # 7617			

5921



2 ADD CABLE FOR TRANSDUCER WITH WATER RESISTANT OPTION.

1 ADD DIMENSION FOR TRANSDUCER WITH GROUND ISOLATED OPTION.

UNLESS SPECIFIED TOLERANCES	
DIMENSIONS IN INCHES	DIMENSIONS IN MILLIMETERS (IN PARENTHESIS)
DECIMALS XX ±.01 XXX ±.005 ANGLES ±2 DEGREES	DECIMALS XX ±0.3 XXX ±0.13 ANGLES ±2 DEGREES
FILLETS AND RADII .003 - .005	FILLETS AND RADII (0.07 - 0.13)
DD011 REV. A 05/26/95	

DRAWN	[illegible]	[illegible]	MFG	JBS	2/20/97
CHK'D	[illegible]	2/20/97	ENGR	[illegible]	2/20/97
APP'D	KJS	2/20/97		[illegible]	[illegible]

TITLE: OUTLINE DRAWING
MODEL 353B33
ACCELEROMETER

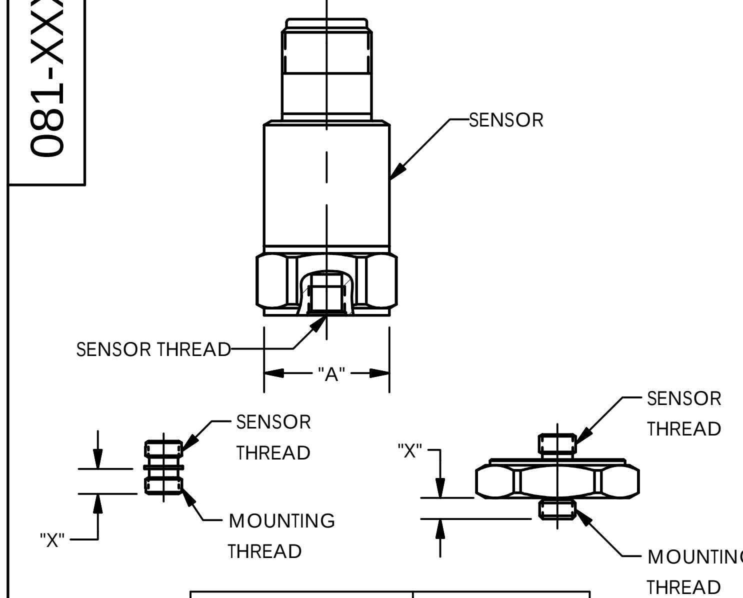
PCB PIEZOTRONICS, INC.
3425 WALDEN AVE. DEPEW, NEW YORK 14043
PHONE: (716) 684-0001

CODE IDENT. NO.	DWG. NO.
52681	5921
SCALE: 2X	SHEET 1 OF 1

081-XXXX-90

REVISIONS		
REV	DESCRIPTION	DIN
P	UPDATE DRAWING	25686

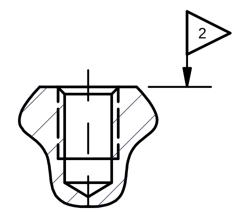
STANDARD STUD MOUNT



MOUNTING THREAD	SEE DRAWING
5-40	A
M3 X 0.50	B
10-32	C
M5 X 0.80	D
1/4-28	E
M6 X 1.00	F

"A" 5-40 MOUNTING INSTRUCTIONS

(METRIC DIMENSIONS IN BRACKETS)



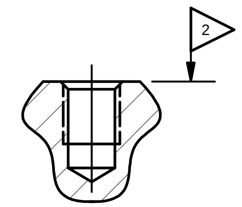
MOUNTING HOLE PREPARATION:

1 Ø.101[Ø2.57]
X .20[5.1]↧ MIN.
5-40 UNC-2B
X .15[3.8]↧ MIN.

4.) RECOMMENDED MOUNTING TORQUE, 4-5 INCH POUNDS [45-55 NEWTON CENTIMETERS].

"B" M3 X 0.50 MOUNTING INSTRUCTIONS

(ENGLISH DIMENSIONS IN BRACKETS)



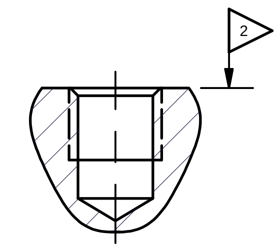
MOUNTING HOLE PREPARATION:

1 Ø2.5[Ø.099]
X 4.6 [1.8]↧ MIN.
M3 X 0.50-6H
X 3.3[.13]↧ MIN.

4.) RECOMMENDED MOUNTING TORQUE, 45-55 NEWTON CENTIMETERS [4-5 INCH POUNDS].

"C" 10-32 MOUNTING INSTRUCTIONS

(METRIC DIMENSIONS IN BRACKETS)



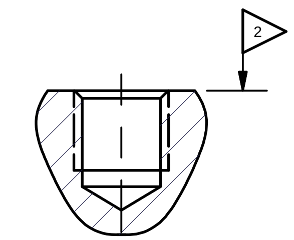
MOUNTING HOLE PREPARATION:

1 Ø.159[Ø4.04]
X .23[5.8]↧ MIN.
10-32 UNF-2B
X .15[3.8]↧ MIN.

4.) RECOMMENDED MOUNTING TORQUE, 10-20 INCH POUNDS [113-225 NEWTON CENTIMETERS].

"D" M5 X 0.80 MOUNTING INSTRUCTIONS

(ENGLISH DIMENSIONS IN BRACKETS)

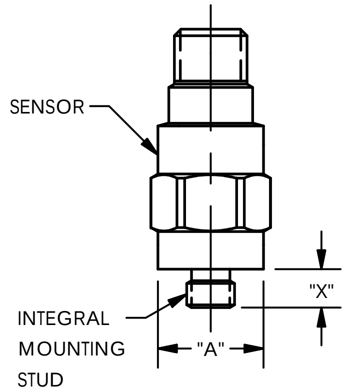


MOUNTING HOLE PREPARATION:

1 Ø4.22[Ø.166]
X 7.62 [.300]↧ MIN.
M5 X 0.8-6H
X 5.08[.200]↧ MIN.

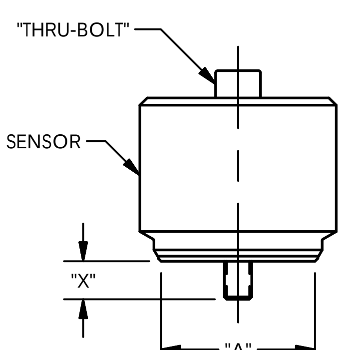
4.) RECOMMENDED MOUNTING TORQUE, 113-225 NEWTON CENTIMETERS [10-20 INCH POUNDS].

INTEGRAL STUD MOUNT



MOUNTING THREAD	SEE DRAWING
5-40	A
M3 X 0.50	B
10-32	C
M5 X 0.80	D
1/4-28	E
M6 X 1.00	F

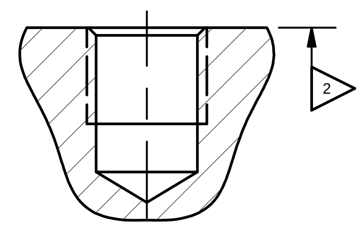
"THRU-BOLT" STUD MOUNT



BOLT THREAD	SEE DRAWING
10-32	C
M5 X 0.80	D
1/4-28	E
M6 X 1.00	F
M8 X 1.25	F

"E" 1/4-28 MOUNTING INSTRUCTIONS

(METRIC DIMENSIONS IN BRACKETS)



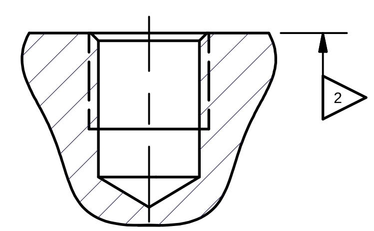
MOUNTING HOLE PREPARATION:

1 Ø.218[Ø5.54]
X .300[7.62]↧ MIN.
1/4-28 UNF-2B
X .200[5.08]↧ MIN.

4.) RECOMMENDED MOUNTING TORQUE, 2-5 FOOT POUNDS [3-7 NEWTON METERS].

"F" M6 X 0.75, M6 X 1.00, M8 X 1.25 MOUNTING INSTRUCTIONS

(ENGLISH DIMENSIONS IN BRACKETS)



M6 X 0.75 MOUNTING HOLE PREPARATION:

1 Ø5.31[Ø.209]
X 7.62 [.300]↧ MIN.
M6 X 0.75-6H
X 5.08[.200]↧ MIN.

M6 X 1.0 MOUNTING HOLE PREPARATION:

1 Ø5.05[Ø.199]
X 8.10 [.320]↧ MIN.
M6X 1.0-6H
X 6.35[.250]↧ MIN.

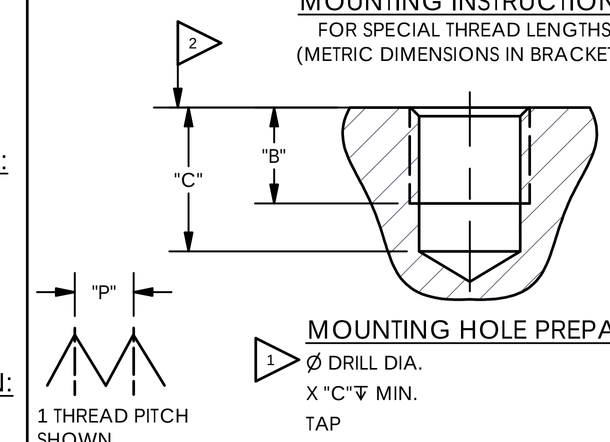
M8 X 1.25 MOUNTING HOLE PREPARATION:

1 Ø6.75[Ø.266]
X 8.64 [.340]↧ MIN.
M8 X 1.25-6H
X 5.00[.197]↧ MIN.

4.) RECOMMENDED MOUNTING TORQUE, 3-7 NEWTON METERS [2-5 FT POUNDS].

"G" MOUNTING INSTRUCTIONS

FOR SPECIAL THREAD LENGTHS
(METRIC DIMENSIONS IN BRACKETS)



MOUNTING HOLE PREPARATION:

1 Ø DRILL DIA.
X "C"↧ MIN.
TAP
X "B"↧ MIN.

THREAD DEPTH : B= X + 1 THREAD PITCH
DRILL DEPTH : C= B + 3 THREAD PITCH
SEE A-F FOR APPROPRIATE DRILL AND TAP
THREAD PITCH= 1/TPI [P]

3.) FOR BEST RESULTS, PLACE A THIN LAYER OF SILICONE GREASE (OR EQUIVALENT) ON INTERFACE PRIOR TO MOUNTING.

2 MOUNTING SURFACE SHOULD BE FLAT TO WITHIN .001(0.03) TIR OVER DIM 'A' WITH A 63[1.61] √ OR BETTER FINISH FOR BEST RESULTS.

1 DRILL PERPENDICULAR TO MOUNTING SURFACE TO WITHIN ± 1˚.

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

DRAWN		CHECKED		ENGINEER	
JDM	3/9/07	ECB	3/9/07	JJD	3/9/07

TITLE: INSTALLATION DRAWING FOR STANDARD 081 SERIES MOUNTING

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

CODE IDENT. NO. 52681 | DWG. NO. 081-XXXX-90

SCALE: N.T.S. SHEET 1 OF 1

Model 393A03

Seismic, ceramic shear ICP® accel., 1 V/g, 0.5 to 2k Hz, 2-pin top conn.

Installation and Operating Manual

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

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

Service, Repair, and Return Policies and Instructions

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

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

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

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

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

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

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

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

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

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

PCB工业监视和测量设备 - 中国RoHS2公布表

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

部件名称	有害物质					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
住房	O	O	O	O	O	O
PCB板	X	O	O	O	O	O
电气连接器	O	O	O	O	O	O
压电晶体	X	O	O	O	O	O
环氧	O	O	O	O	O	O
铁氟龙	O	O	O	O	O	O
电子	O	O	O	O	O	O
厚膜基板	O	O	X	O	O	O
电线	O	O	O	O	O	O
电缆	X	O	O	O	O	O
塑料	O	O	O	O	O	O
焊接	X	O	O	O	O	O
铜合金/黄铜	X	O	O	O	O	O

本表格依据 SJ/T 11364 的规定编制。

O： 表示该有害物质在该部件所有均质材料中的含量均在 GB/T 26572 规定的限量要求以下。

X： 表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T 26572 规定的限量要求。

铅是欧洲RoHS指令2011/65/ EU附件三和附件四目前由于允许的豁免。

CHINA RoHS COMPLIANCE

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

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

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

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

DOCUMENT NUMBER: 21354
DOCUMENT REVISION: D
ECN: 46162

General
OPERATING GUIDE

for use with

PIEZOELECTRIC ICP® 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.

1.0 INTRODUCTION

Congratulations on the purchase of a quality, ICP® acceleration sensor. 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 a factory Application Engineer at 716-684-0001 or your nearest PCB sales representative.

2.0 ICP® ACCELEROMETERS

Powered by simple, inexpensive, constant-current signal conditioners, these sensors are easy to operate and interface with signal analysis, data acquisition and recording instruments. The following features further characterize ICP® sensors:

- Fixed voltage sensitivity, regardless of cable type or length.
- Low-impedance output signal, which can be transmitted over long cables in harsh environments with virtually no loss in signal quality.
- Two-wire operation with low cost coaxial cable, two-conductor ribbon wire or twisted-pair cabling.
- Low-noise, voltage-output signal compatible with standard readout, signal analysis, recording, and data acquisition equipment.
- Low cost per-channel - ICP® accelerometers require only an inexpensive, constant-current signal conditioner to operate.
- Intrinsic self-test feature – monitoring the sensor's output bias voltage provides an indication of proper operation, faulty condition, and bad cables.

In the rear of this manual you will find a **Specification Sheet**, which provides the complete performance characteristics of your particular sensor.

3.0 OPTIONAL FEATURES

Many sensors are supplied with standard, optional features. When listed before the model number, the following prefix letters indicate that the sensor is manufactured or supplied with a particular optional feature: **"A"** option: adhesive mount; **"HT"** option: extended high temperature range; **"J"** option: electrically ground isolated; **"M"** option: metric mounting thread; **"Q"** option: extended discharge time constant; **"T"** option: built-in transducer electronic data sheet (TEDS); and **"W"** option: attached, water-resistant cabling. Other prefix letters, such as **"K"**, **"KR"**, **"GK"**, **"GKR"**, **"KL"**, and **"GKL"**, indicate that the sensor is ordered in kit form, including interconnect cabling and signal conditioner. If you have any questions or concerns regarding optional features, consult the Vibration Division's product catalog or contact a PCB factory representative.

4.0 INSTALLATION OVERVIEW

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.

® ICP is a registered trademark of PCB Group, Inc., which uniquely identifies PCB sensors that incorporate built-in microelectronics.

Shown in figure 1 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. This roll-off behavior is typically fixed by the sensor's built-in electronics. However, when operating AC-coupled signal conditioners with readout devices having an input impedance of less than one megohm, the low frequency range may be affected. If necessary, contact a factory representative for further assistance.*

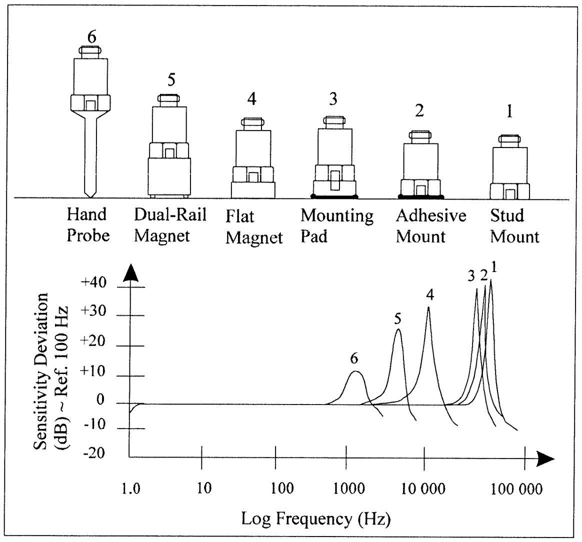


Figure 1. Assorted Mounting Configurations and Their Effects on High Frequency

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.*

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 enclosed **Installation Drawing**.

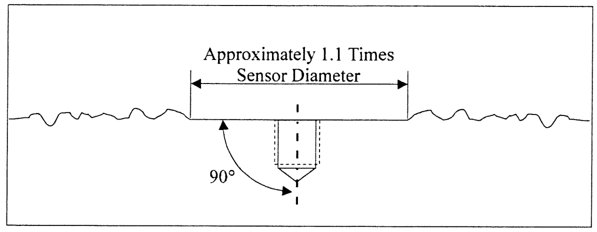


Figure 2. Mounting Surface Preparation

A precision-machined mounting surface with a minimum finish of 63 µin (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.

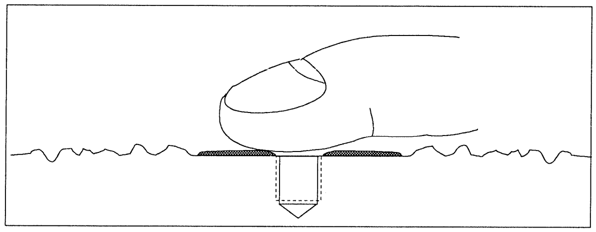


Figure 3. Mounting Surface Lubrication

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 accelerometer and hand-tighten (this step is unnecessary for units having an integral mounting stud). Then, screw the sensor into the tapped hole that was prepared in the test object. Tighten the unit in place by applying, with a torque wrench, the recommended mounting torque, as listed on the enclosed **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.*

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 perform well for temporary installations whereas two-part epoxies and quick-bonding gels (super glue) provide a more permanent installation. Two techniques are used for adhesive mounting; they are via an adhesive mounting base (method 1 below) or direct adhesive mounting (method 2 below).

NOTE: *Adhesively mounted sensors often exhibit a reduction in high-frequency range. Generally, smooth surfaces and stiff adhesives provide the best high 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 many bases are manufactured of "hard-coated" aluminum, they provide electrical isolation to eliminate ground loops and reduce electrical interference that may propagate from the surface of the test object.

STEP 1: Prepare a smooth, flat mounting surface. A minimum surface finish of 63 μin (0.00016 mm) generally works best.

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

STEP 3: Place a small portion of adhesive on the underside of the mounting base (the underside is discernable by the concentric grooves which are designed to accept the adhesive). Firmly press down on the assembly to displace any extra adhesive remaining under the base.

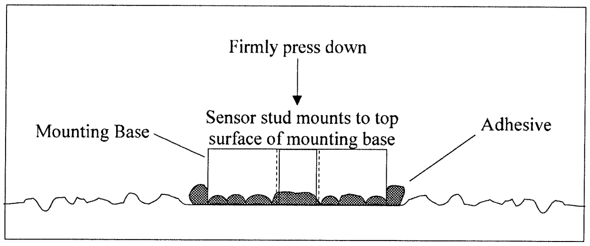


Figure 4. Mounting Base: Adhesive Installation

METHOD 2 - Direct Adhesive Mount

For restrictions of space or for convenience, most sensors can be adhesive-mounted directly to the test structure (an exception being units having integral mounting studs).

STEP 1: Prepare a smooth, flat mounting surface. A minimum surface finish of 63 μin (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. Also, adhesive that may invade the tapped mounting hole in the base of the sensor will compromise future ability to stud mount the unit.

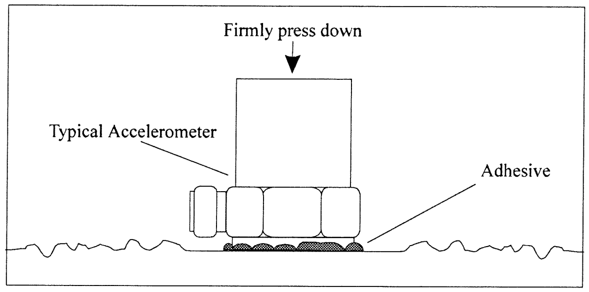


Figure 5. Direct Adhesive Mounting

4.2-1 ADHESIVE MOUNT REMOVAL (other than wax)

NOTE: *A debonder should always be used to avoid sensor damage.*

To avoid damaging the accelerometer, a debonding agent must be applied to the adhesive prior to sensor removal. With so many adhesives in use (everything from super glues, dental cement, epoxies, etc), there is no universal debonding agent available. The debonder for the Loctite 454 adhesive that PCB offers is Acetone. If you are using anything other than Loctite 454, you will have to check with the individual manufacturers for their debonding recommendations. The debonding agent must be allowed to penetrate the surface in order to properly react with the adhesive, so it is advisable to wait a few minutes before removing the sensor.

After the debonding agent has set, you can use an ordinary open-end wrench if the accelerometer has a hex base or square base, or the supplied removal tool for teardrop accelerometers. After attaching either, use a gentle shearing (or twisting) motion (by hand only) to remove the sensor from the test structure.

4.3 MAGNETIC MOUNT

Magnetic mounting provides a convenient means for making quick, portable measurements and is commonly used for machinery condition monitoring, predictive maintenance, spot checks, and vibration trending applications.

NOTE: *The correct magnet choice and an adequately prepared mounting surface are critical for obtaining reliable measurements, especially at high frequencies. Poor installations can cause as much as a 50% drop in the sensor frequency range.*

Not every magnet is suitable for all applications. For example, rare earth magnets are commonly used because of their high strength. Flat magnets work well on smooth, flat surfaces, while dual-rail magnets are required for curved surfaces such as motor housings and pipes. In the case of non-magnetic or rough surfaces, it is recommended that the user first weld, epoxy, or otherwise adhere a steel mounting pad to the test surface. This provides a smooth location for mounting and a target to insure that subsequent measurements for trending purposes are taken at the same location.

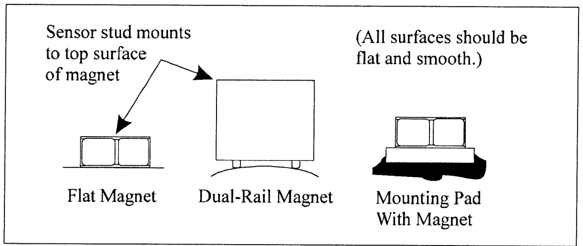


Figure 6. Magnet Types

STEP 1: Prepare a smooth, flat mounting surface. A minimum surface finish of 63 μin (0.00016 mm) generally works best. After cleaning the surface and checking for burrs, apply a light film of silicone grease, machine oil, or similar-type coupling fluid.

STEP 2: After choosing the correct magnet type, inspect the magnet, verifying that its mounting surfaces are flat and smooth.

STEP 3: Stud-mount the accelerometer to the appropriate magnet according to the guidelines set forth in **STEP 3** of the above Stud Mount Procedure.

STEP 4: To avoid damage to the sensor, install the magnet/sensor assembly to the prepared test surface by gently "rocking" or "sliding" it into place.

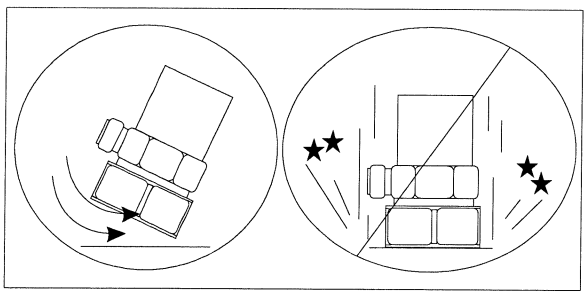


Figure 7. Magnet Mounting

CAUTION: *Magnetically mounting of an accelerometer has the potential to generate very high (and very damaging) acceleration (g) levels. To prevent such damage, exercise caution and install the assembly gently by rocking it into place. If shock is expected to be a particular concern, use a sensor with built-in shock protection. For further assistance, contact a factory representative.*

4.4 HANDHELD OR PROBE TIP MOUNT

This method is NOT recommended for most applications. Both the accuracy and repeatability at low (<5 Hz) and high frequency (>1 kHz) ranges are questionable. It is generally used only for machinery condition monitoring, when installation space is restricted, or other portable trending applications. The technique, however, can be useful for initially determining locations of greatest vibration to establish a permanent sensor installation point.

5.0 CABLING

Care and attention to cable installation and cable condition is essential as the reliability and accuracy of any measurement system is no better than that of its weakest link. Do to the nature of vibration measurements, all sensor cables will ultimately fatigue and fail. Good installation practice will extend the life of a cable, however, it is highly recommended to keep spare cables on hand to enable continuation of the test in the event of a cable failure.

STEP 1: Ascertain that you have the correct cable type.

One cable type cannot satisfy all applications. ICP® sensors can be operated with any ordinary two-wire or coaxial cable. Special, low-noise cables that are typically recommended for use with high-impedance, charge-output sensors can also be used. For applications requiring conformity to CE, low noise cables are essential. Industrial applications often require shielded, twisted-pair cables to reduce the effects of EMI and RFI that is present near electrical motors and machinery. Teflon-jacketed cabling may be necessary to withstand corrosive environments and higher temperatures. Consult the Vibration Division's product catalog for more information about cables or feel free to contact a factory representative for a specific recommendation on cables that are best suited for your application.

STEP 2: Connect the cable to the accelerometer.

A small amount of thread-locking compound placed on the connector threads prior to attachment helps secure the cable during testing. In wet, oily, or dirty environments, the connection can be sealed with silicone rubber sealant, O-rings, and flexible, heat-shrink tubing.

Coaxial Cables: Make connection by inserting the cable's connector pin into the sensor's mating socket. Then thread the connector into place by turning the cable connector's outer shell onto the accelerometer's electrical connector.

NOTE: *Do not spin the accelerometer while holding the cable connector stationary, as this will cause undue* *friction on the center pin of the cable connector and lead to premature fatigue.*

Multi-pin connectors: Make connection by inserting the sensor's mating pins onto the cable connector's mating sockets. Then thread the connector into place by turning the cable connector's outer shell onto the accelerometer's electrical connector.

Pigtail Connections: Certain miniature accelerometers and shock sensors are provided with lightweight cables attached to "Pigtail" connections. This type of connection reduces overall weight and incidence of connection intermittency under shock conditions. In the event of a cable or connection failure, the cables may be repaired in the field simply by re-soldering the stripped leads to the exposed pins on the sensor. (Check the **Installation Drawing** to determine signal and ground pins). In many cases, it is also helpful to protect the solder joint with heat-shrink tubing or epoxy.

NOTE: *If you do not have the experience or resources to attach pigtail leads, consult PCB to discuss factory attachment. Damage to internal electronics may be caused by excessive heat during soldering and such failure is not covered by warranty.*

STEP 3: Route the cable to the signal conditioner, making certain to relieve stress on the sensor/cable connection. Also, minimize cable motion by securing it with tape, clamps or ties at regular intervals.

Common sense should be used to avoid physical damage and minimize electrical noise. For instance, avoid routing cables near high-voltage wires. Do not route cables along floors or walkways where they may be stepped on or become contaminated. To avoid ground loops, shielded cables should have the shield grounded at one end only, typically at the signal conditioner.

STEP 4: Finally, connect the remaining cable end to the signal conditioner. It is good practice to dissipate any electrical charge that may have accumulated in the cable by shorting the signal pin to the ground pin or shell prior to attachment.

6.0 POWERING

All ICP® sensors require constant current excitation for proper operation. For this reason, use only PCB constant-current signal conditioners or other approved constant-current sources. A typical system schematic is shown in Figure 8.

NOTE: *Damage to the built-in electronics resulting from the application of incorrect power, or the use of an unapproved power source, is NOT covered by warranty.*

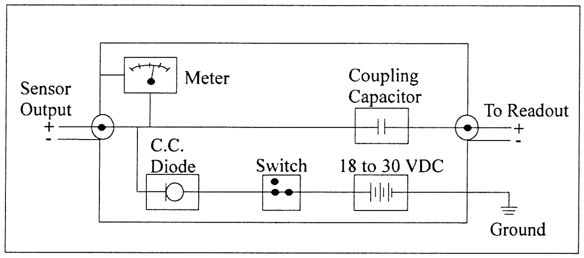


Figure 8. Typical System Schematic

The power supply consists of a current-regulated, 18 to 30 VDC source. This power is regulated by a current-limiting circuit, which provides the constant-current excitation required for proper operation of ICP® sensors. In general, battery-powered devices offer versatility for portable, low-noise measurements, whereas line-powered units provide the capability for continuous monitoring. Consult the Vibration Division's product catalog for more information about signal conditioners.

NOTE: *Under no circumstances should a voltage be supplied to an ICP® accelerometer without a current-regulating diode or equivalent electrical circuit. This may include ohmmeters, multi-meters and continuity testers.*

Meters or LEDs are used on PCB signal conditioners to monitor the bias voltage on the sensor output signal, to check sensor operation, and detect cable faults. Normally, a "yellow" reading indicates an open circuit; "green" indicates normal operation; and "red" indicates either a short or overload condition. Finally, a capacitor at the output stage of the device removes the sensor output bias voltage from the measurement signal. This provides a zero-based, AC-coupled output signal that is compatible with most standard readout devices.

NOTE: *Units having a low bias voltage may be in the "red," when actually they are working properly. If suspect, the bias voltage can be checked with a voltmeter attached to a "T" connector installed on the input connector to the signal conditioner.*

Note: *For readout devices having an input impedance near one gigohm (as encountered with some A to D converters), it may be necessary to place a one megohm resistor in parallel to the readout input to eliminate slow turn-on and signal drift.*

Today, many FFT analyzers, data acquisition modules, and data collectors have the proper constant-current excitation built-in for direct use with ICP® sensors. Before using this feature, however, check that the supply voltage and constant current are within acceptable limits for use with your particular sensor. (Check enclosed **Specification Sheet**). Please contact the respective signal conditioner manufacturer or check the product manual for more information.

7.0 OPERATING

After completing the system setup, switch on the signal conditioner and allow 1 to 2 minutes for the system to stabilize. The meter (or LED) on the signal conditioner should be reading "green." This indicates proper operation and you may begin taking measurements. If a faulty condition is indicated (red or yellow reading), first check all system connections, then check the functionality of the cable and signal conditioner. If the system still does not operate properly, consult a PCB factory representative.

NOTE: *Always operate the accelerometer within the limitations listed on the enclosed **Specification Sheet**. Operating the device outside these parameters can cause temporary or permanent damage to the sensor.*

8.0 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. Fortunately, most sensor manufacturers provide a calibration record that documents the exact characteristics of each sensor. (The type and amount of data varies depending on the manufacturer, sensor type, contractual regulations, and other special requirements).

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

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 suggest 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 Handheld Shaker operates at a fixed frequency and known amplitude (1.0 g) to provide a quick check of sensor sensitivity.*

8.1 RECALIBRATION SERVICE

PCB offers recalibration services for our piezoelectric accelerometers, as well as units produced by other manufacturers. Our internal metrology laboratory is certified to ISO 9001, accredited by A2LA to ANSI/IEC 17025 and ANSI/NCSL Z540-1, complies with ISO 10012-1 (and former MIL-STD-45662A), and uses equipment directly traceable to NIST. Our investment in equipment, traceability and conformance to industry standards ensures accurate calibration against relevant specifications, in a timely fashion.

8.2 BACK-TO-BACK CALIBRATION THEORY

Many companies choose to purchase the equipment necessary to perform the recalibration procedure in house. 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.

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.

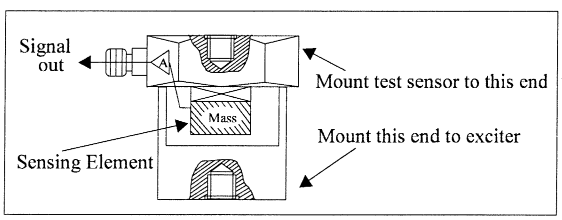


Figure 9. Reference Standard Accelerometer

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 10. (Test set-ups may be automated and vary, depending on the type and number of accelerometers being calibrated).

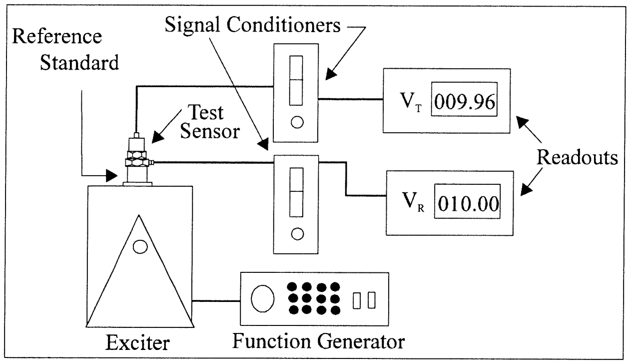


Figure 10. Typical Back-to-Back Calibration System

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 11.

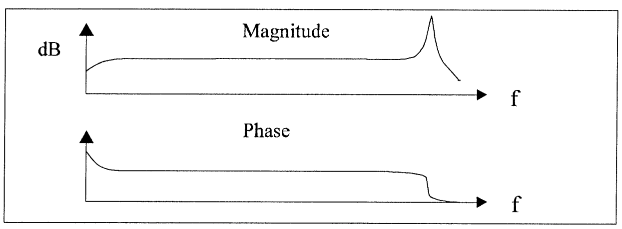


Figure 11. Typical Test Accelerometer Response

8.3 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, then to a nearby stationary location. This reduces cable motion, which is especially important when testing charge output sensors, and helps to prevent extraneous motion or stresses from being imparted into the system. A typical set-up is shown in Figure 12.

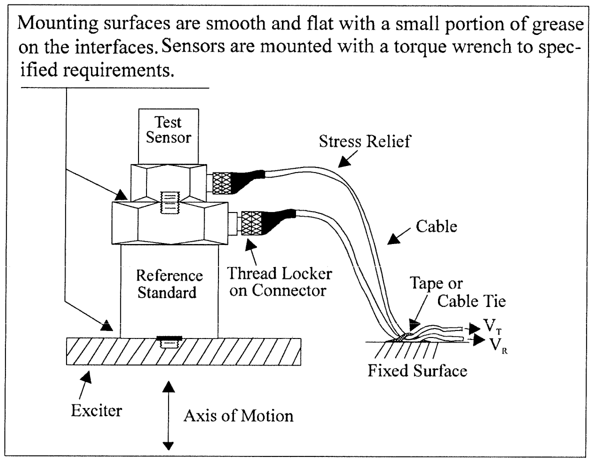


Figure 12. Typical Calibration Set-Up

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.

8.4 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.

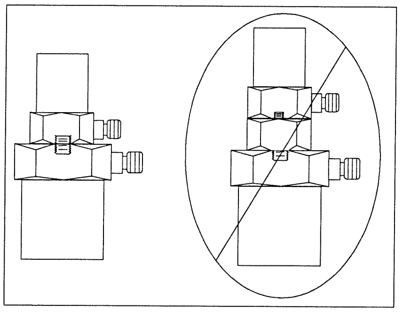


Figure 13. Stud Mounting

For adhesive mount sensors, use a thin, stiff layer of temporary adhesive such as quick-bonding gel or superglue. DO NOT use excessive amounts of glue or epoxy, as the mounting stiffness may be reduced and compromise high-frequency performance. It may also damage the sensor during removal.

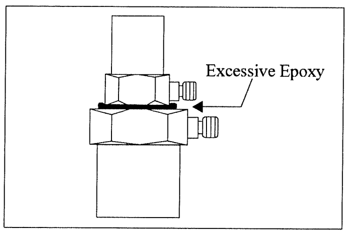


Figure 14. Incorrect Adhesive Mounting

Triaxial accelerometers should always be mounted directly to the reference standard. Unless absolutely required, DO NOT use adaptors to re-orient the sensor along the axis of motion, as the mounting stiffness may be altered. The vibration at the test sensor's sensing element may differ from the vibration at the reference standard due to a "cantilever" effect, seen in Figure 15.

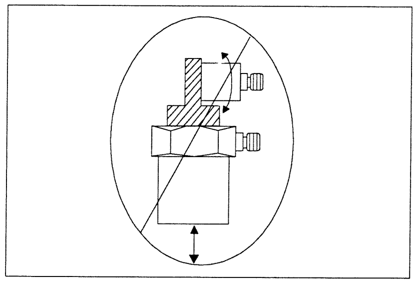


Figure 15. Mounting Triaxial Sensors (Incorrect)

Understand Back-to-Back Calibration limitations. Do not expect the uncertainty of calibration to be any better than ±2%. (In fact, the uncertainty may be as high as ±3% or ±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.

8.5 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 utilizing the services of an accredited laboratory.

9.0 SERVICE

See the supplement sheet, contained in this manual, for information on our warranty, service, repair, and return policies and instructions.

When unexpected measurement problems arise, call our 24-hour SensorLine^{SM} to discuss your immediate dynamic instrumentation needs with a factory representative.
Dial 716-684-0001.

PCB PIEZOTRONICS INC
VIBRATION DIVISION

3425 Walden Avenue, Depew, NY 14043-2495 USA **Vibration Division toll-free** 888-684-0013
24-hour SensorLineSM 716-684-0001 **FAX** 716-685-3886 **E-mail** vibration@pcb.com **Website** www.pcb.com

A PCB GROUP COMPANY ISO 9001 CERTIFIED A2LA ACCREDITED to ISO 17025

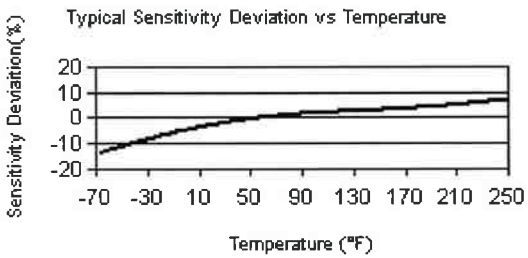
Manual Number: 18292
Manual Revision: B
ECN Number: 19829

VIB-ICPMANUAL-0

Printed in U.S

Model Number		Revision: H
393A03	**SEISMIC ICP® ACCELEROMETER**	ECN #: 29751

Performance	ENGLISH	SI	
Sensitivity(± 5 %)	1000 mV/g	102 mV/(m/s²)	
Measurement Range	± 5 g pk	± 49 m/s² pk	
Frequency Range(± 5 %)	0.5 to 2000 Hz	0.5 to 2000 Hz	
Frequency Range(± 10 %)	0.3 to 4000 Hz	0.3 to 4000 Hz	
Frequency Range(± 3 dB)	0.2 to 6000 Hz	0.2 to 6000 Hz	
Resonant Frequency	≥ 10 kHz	≥ 10 kHz	
Broadband Resolution(1 to 10,000 Hz)	0.00001 g rms	0.0001 m/s² rms	[1]
Non-Linearity	≤ 1 %	≤ 1 %	[2]
Transverse Sensitivity	≤ 7 %	≤ 7 %	
Environmental			
Overload Limit(Shock)	± 5000 g pk	± 49,050 m/s² pk	
Temperature Range	-65 to +250 °F	-54 to +121 °C	
Temperature Response	See Graph	See Graph	
Base Strain Sensitivity	≤ 0.0005 g/με	≤ 0.005 (m/s²)/με	[1]
Electrical			
Excitation Voltage	18 to 30 VDC	18 to 30 VDC	
Constant Current Excitation	2 to 20 mA	2 to 20 mA	
Output Impedance	<250 ohm	<250 ohm	
Output Bias Voltage	8 to 12 VDC	8 to 12 VDC	
Discharge Time Constant	1 to 3 sec	1 to 3 sec	
Settling Time	<15 sec	<15 sec	
Spectral Noise(1 Hz)	2 μg/√Hz	20 (μm/sec²)/√Hz	[1]
Spectral Noise(10 Hz)	0.5 μg/√Hz	5 (μm/sec²)/√Hz	[1]
Spectral Noise(100 Hz)	0.2 μg/√Hz	2 (μm/sec²)/√Hz	[1]
Spectral Noise(1 kHz)	0.1 μg/√Hz	1 (μm/sec²)/√Hz	[1]
Electrical Isolation(Case)	≥ 10^8 ohm	≥ 10^8 ohm	
Physical			
Sensing Element	Ceramic	Ceramic	
Sensing Geometry	Shear	Shear	
Housing Material	Stainless Steel	Stainless Steel	
Sealing	Hermetic	Hermetic	
Size (Hex x Height)	1 3/16 in x 2 3/16 in	30.2 mm x 55.6 mm	
Weight	7.4 oz	210 gm	[1]
Electrical Connector	2-Pin MIL-C-5015	2-Pin MIL-C-5015	
Electrical Connection Position	Top	Top	
Mounting Thread	1/4-28 Female	1/4-28 Female	
Mounting Torque	2 to 5 ft-lb	3 to 7 N-m	



CE [3]

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

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

OPTIONAL VERSIONS

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

T - TEDS Capable of Digital Memory and Communication Compliant with IEEE P1451.4

Output Bias Voltage	8.5 to 12.5 VDC	8.5 to 12.5 VDC

NOTES:

[1] Typical.
[2] Zero-based, least-squares, straight line method.
[3] See PCB Declaration of Conformance PS023 for details.

SUPPLIED ACCESSORIES:

Model 081B20 Mounting Stud, with shoulder (1/4-28 to 1/4-28) (1)
Model 085A31 Protective Thermal Jacket (1)
Model ACS-1 NIST traceable frequency response (10 Hz to upper 5% point). (1)
Model ACS-4 Single axis, low frequency phase and amplitude response cal from 0.5 to 10 Hz (1)
Model M081B20 Mounting Stud 1/4-28 to M6 X 0.75 (1)

Entered: JH	Engineer: [illegible]	Sales: WDC	Approved: EB	Spec Number:
Date: 12-2-08	Date: 11-24-08	Date: 11-24-08	Date: 12-1-08	393-1030-80

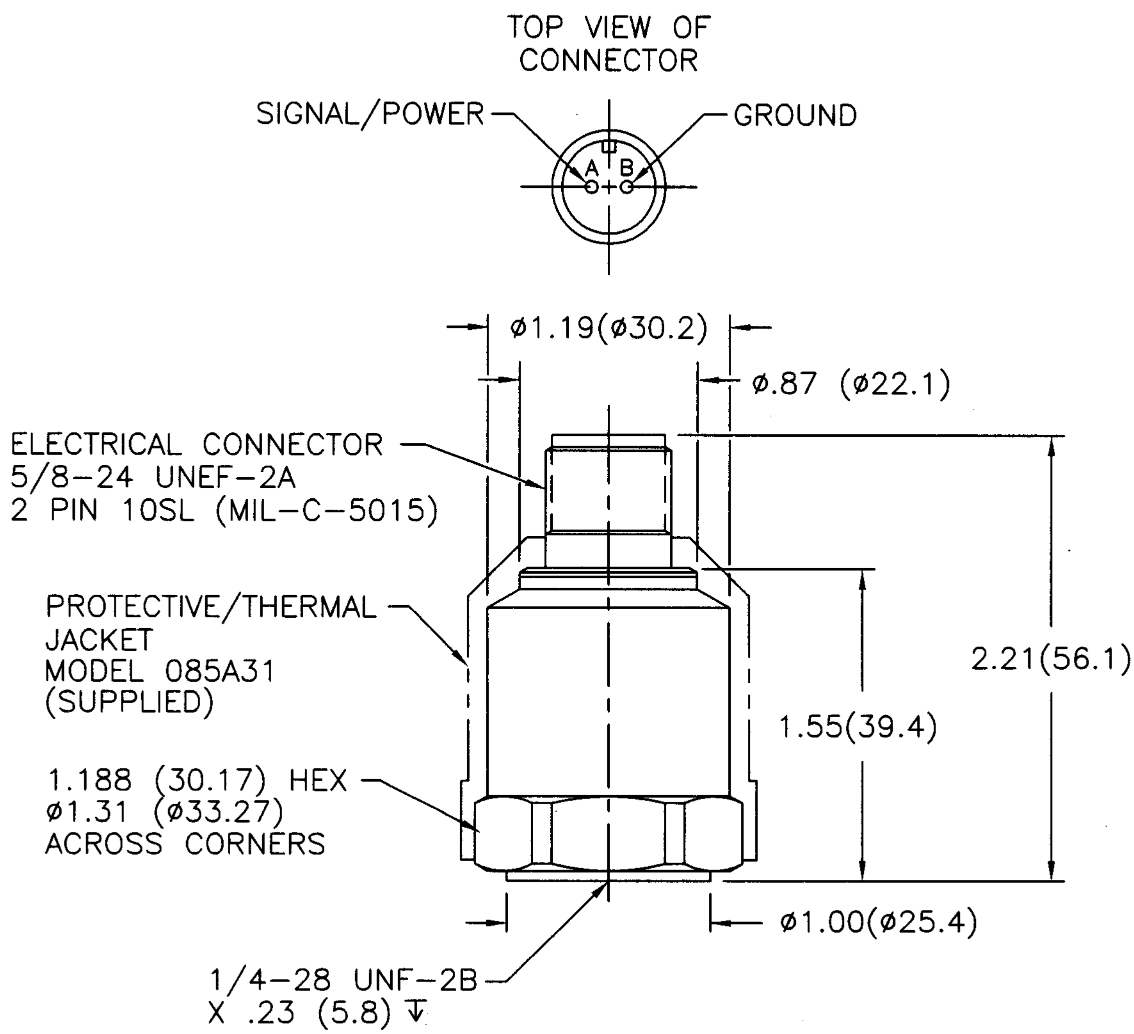
PCB PIEZOTRONICS
VIBRATION DIVISION
3425 Walden Avenue, Depew, NY 14043

Phone: 716-684-0001
Fax: 716-685-3886
E-Mail: vibration@pcb.com

22634

APPLICATION		
NEXT ASS'Y	USED ON	VAR

REVISIONS				
REV	DESCRIPTION	ECN	DATE	APP'D
NR	RELEASED TO DRAFTING		4/15/03	4/16/03



UNLESS SPECIFIED TOLERANCES	
DIMENSIONS IN INCHES	DIMENSIONS IN MILLIMETERS [IN BRACKETS]
DECIMALS XX ±.01 XXX ±.005 ANGLES ±2 DEGREES	DECIMALS X ±0.3 XX ±0.13 ANGLES ±2 DEGREES
FILLETS AND RADII .003 - .005	FILLETS AND RADII [0.07 - 0.13]
DD011 REV. C 01/21/03	

DRAWN	DM	4/15/03	MFG	AL	4/16/03
CHK'D	DM	4/16/03	ENGR	DJS	4/16/03
APP'D	BAS	4/18/03	SALES		

TITLE: OUTLINE DRAWING MODEL 393A03 ACCELEROMETER

PCB PIEZOTRONICS™
3425 WALDEN AVE. DEPEW, NY 14043
(716) 684-0001 EMAIL: SALES@PCB.COM

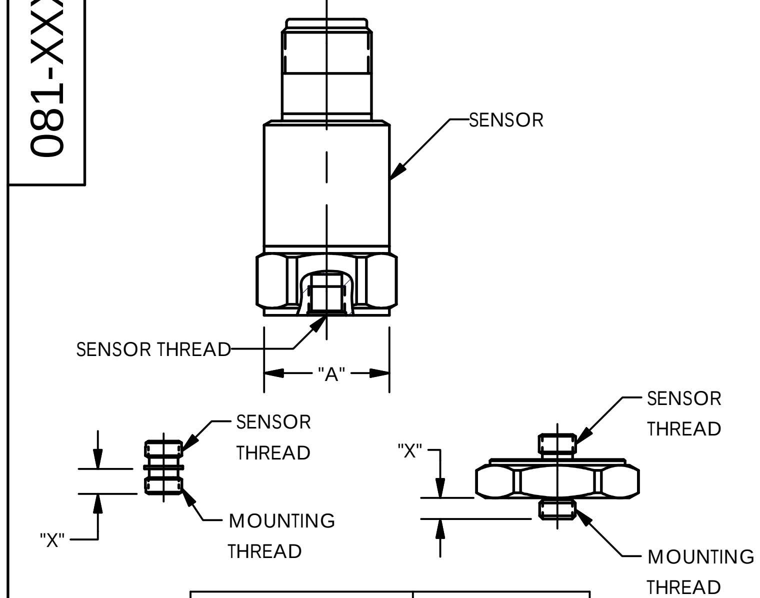
CODE IDENT. NO.	DWG. NO.
52681	22634

SCALE: FULL | SHEET 1 OF 1

081-XXXX-90

REVISIONS		
REV	DESCRIPTION	DIN
P	UPDATE DRAWING	25686

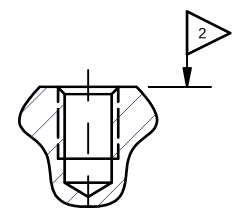
STANDARD STUD MOUNT



MOUNTING THREAD	SEE DRAWING
5-40	A
M3 X 0.50	B
10-32	C
M5 X 0.80	D
1/4-28	E
M6 X 1.00	F

"A" 5-40 MOUNTING INSTRUCTIONS

(METRIC DIMENSIONS IN BRACKETS)



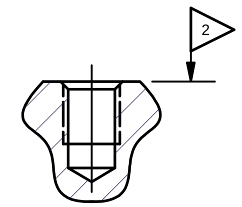
MOUNTING HOLE PREPARATION:

1 Ø.101[Ø2.57]
X .20[5.1]↧ MIN.
5-40 UNC-2B
X .15[3.8]↧ MIN.

4.) RECOMMENDED MOUNTING TORQUE, 4-5 INCH POUNDS [45-55 NEWTON CENTIMETERS].

"B" M3 X 0.50 MOUNTING INSTRUCTIONS

(ENGLISH DIMENSIONS IN BRACKETS)



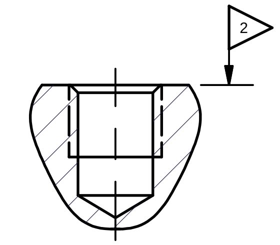
MOUNTING HOLE PREPARATION:

1 Ø2.5[Ø.099]
X 4.6 [1.8]↧ MIN.
M3 X 0.50-6H
X 3.3[.13]↧ MIN.

4.) RECOMMENDED MOUNTING TORQUE, 45-55 NEWTON CENTIMETERS [4-5 INCH POUNDS].

"C" 10-32 MOUNTING INSTRUCTIONS

(METRIC DIMENSIONS IN BRACKETS)



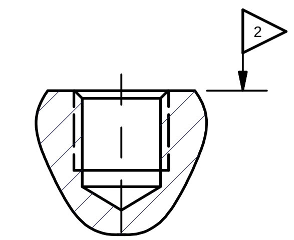
MOUNTING HOLE PREPARATION:

1 Ø.159[Ø4.04]
X .23[5.8]↧ MIN.
10-32 UNF-2B
X .15[3.8]↧ MIN.

4.) RECOMMENDED MOUNTING TORQUE, 10-20 INCH POUNDS [113-225 NEWTON CENTIMETERS].

"D" M5 X 0.80 MOUNTING INSTRUCTIONS

(ENGLISH DIMENSIONS IN BRACKETS)

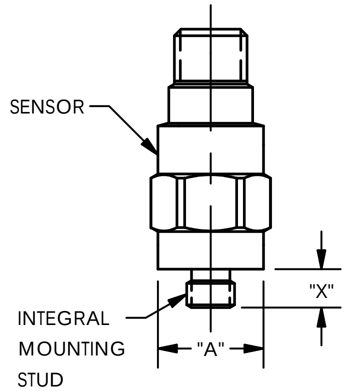


MOUNTING HOLE PREPARATION:

1 Ø4.22[Ø.166]
X 7.62 [.300]↧ MIN.
M5 X 0.8-6H
X 5.08[.200]↧ MIN.

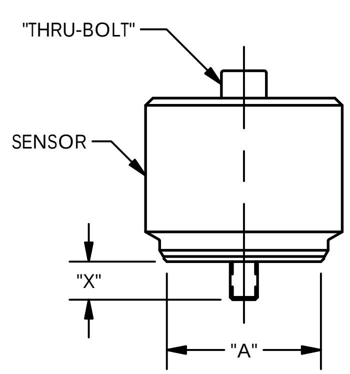
4.) RECOMMENDED MOUNTING TORQUE, 113-225 NEWTON CENTIMETERS [10-20 INCH POUNDS].

INTEGRAL STUD MOUNT



MOUNTING THREAD	SEE DRAWING
5-40	A
M3 X 0.50	B
10-32	C
M5 X 0.80	D
1/4-28	E
M6 X 1.00	F

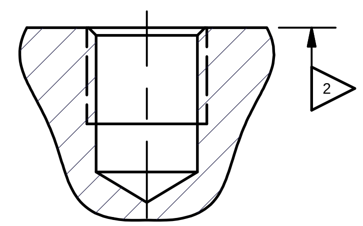
"THRU-BOLT" STUD MOUNT



BOLT THREAD	SEE DRAWING
10-32	C
M5 X 0.80	D
1/4-28	E
M6 X 1.00	F
M8 X 1.25	F

"E" 1/4-28 MOUNTING INSTRUCTIONS

(METRIC DIMENSIONS IN BRACKETS)



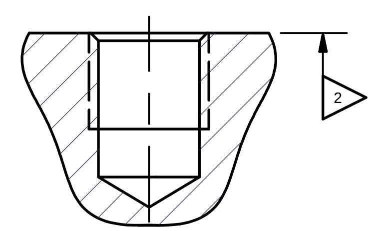
MOUNTING HOLE PREPARATION:

1 Ø.218[Ø5.54]
X .300[7.62]↧ MIN.
1/4-28 UNF-2B
X .200[5.08]↧ MIN.

4.) RECOMMENDED MOUNTING TORQUE, 2-5 FOOT POUNDS [3-7 NEWTON METERS].

"F" M6 X 0.75, M6 X 1.00, M8 X 1.25 MOUNTING INSTRUCTIONS

(ENGLISH DIMENSIONS IN BRACKETS)



M6 X 0.75 MOUNTING HOLE PREPARATION:

1 Ø5.31[Ø.209]
X 7.62 [.300]↧ MIN.
M6 X 0.75-6H
X 5.08[.200]↧ MIN.

M6 X 1.0 MOUNTING HOLE PREPARATION:

1 Ø5.05[Ø.199]
X 8.10 [.320]↧ MIN.
M6X 1.0-6H
X 6.35[.250]↧ MIN.

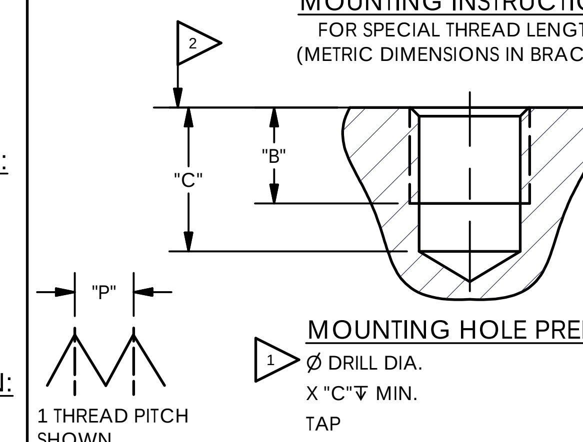
M8 X 1.25 MOUNTING HOLE PREPARATION:

1 Ø6.75[Ø.266]
X 8.64 [.340]↧ MIN.
M8 X 1.25-6H
X 5.00[.197]↧ MIN.

4.) RECOMMENDED MOUNTING TORQUE, 3-7 NEWTON METERS [2-5 FT POUNDS].

"G" MOUNTING INSTRUCTIONS

FOR SPECIAL THREAD LENGTHS
(METRIC DIMENSIONS IN BRACKETS)



MOUNTING HOLE PREPARATION:

1 Ø DRILL DIA.
X "C"↧ MIN.
TAP
X "B"↧ MIN.

THREAD DEPTH : B= X + 1 THREAD PITCH
DRILL DEPTH : C= B + 3 THREAD PITCH
SEE A-F FOR APPROPRIATE DRILL AND TAP
THREAD PITCH= 1/TPI [P]

3.) FOR BEST RESULTS, PLACE A THIN LAYER OF SILICONE GREASE (OR EQUIVALENT) ON INTERFACE PRIOR TO MOUNTING.

2 MOUNTING SURFACE SHOULD BE FLAT TO WITHIN .001(0.03) TIR OVER DIM 'A' WITH A 63[1.61]√ OR BETTER FINISH FOR BEST RESULTS.

1 DRILL PERPENDICULAR TO MOUNTING SURFACE TO WITHIN ± 1˚.

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

DRAWN		CHECKED		ENGINEER	
JDM	3/9/07	ECB	3/9/07	JJD	3/9/07

TITLE: INSTALLATION DRAWING FOR STANDARD 081 SERIES MOUNTING

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

CODE IDENT. NO. 52681
DWG. NO. 081-XXXX-90
SCALE: N.T.S. SHEET 1 OF 1

Model 480E09

Short sledge Impact Hammer kit, 0 to 5k lbf, 1 mV/lbf, 2.4-lb head, with 2 ea.

Installation and Operating Manual

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

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

Service, Repair, and Return Policies and Instructions

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

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

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

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

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

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

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

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

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

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

PCB工业监视和测量设备 - 中国RoHS2公布表

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

部件名称	有害物质					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
住房	O	O	O	O	O	O
PCB板	X	O	O	O	O	O
电气连接器	O	O	O	O	O	O
压电晶体	X	O	O	O	O	O
环氧	O	O	O	O	O	O
铁氟龙	O	O	O	O	O	O
电子	O	O	O	O	O	O
厚膜基板	O	O	X	O	O	O
电线	O	O	O	O	O	O
电缆	X	O	O	O	O	O
塑料	O	O	O	O	O	O
焊接	X	O	O	O	O	O
铜合金/黄铜	X	O	O	O	O	O

本表格依据 SJ/T 11364 的规定编制。

O： 表示该有害物质在该部件所有均质材料中的含量均在 GB/T 26572 规定的限量要求以下。

X： 表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T 26572 规定的限量要求。

铅是欧洲RoHS指令2011/65/ EU附件三和附件四目前由于允许的豁免。

CHINA RoHS COMPLIANCE

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

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

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

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

DOCUMENT NUMBER: 21354
DOCUMENT REVISION: D
ECN: 46162

1.0 INTRODUCTION

The Models 480E09/E06 are ICP® Battery Power Units with gain. The voltage gain switch offers amplification factors of 1, 10, and 100.

NOTE: The only difference between the models is that the 480E09 unit features BNC connectors while the 480E06 unit features microdot connectors.

2.0 DESCRIPTION

Refer to Drawings and Specifications in the front of this manual. Also see Figure 1 for Schematic Diagram, common for both Models 480E09 and 480E06.

The 480E09/E06 models operate from three self-contained 9-volt transistor radio batteries and supply constant-current power to the built-in transducer amplifier in ICP® transducers or in-line and adaptor amplifiers such as the 401 and 402 series. (See Guide G-0001 for a comprehensive coverage of the ICP® concept).

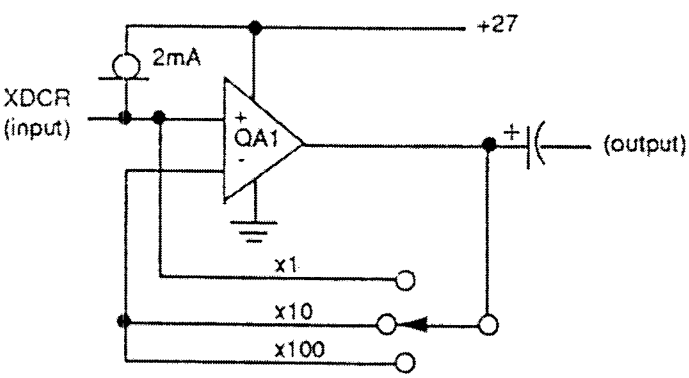


Figure 1
Schematic Diagram Model 480E09 or 480E06

A transducer ("XDCR") jack is located at the front panel as well as a signal output jack labeled "SCOPE". These jacks are both female BNC jacks (for the 480E09) which mate directly with the PCB Model 002C cable.

Both units use easy-to-change batteries (see Section 3.3) and are physically easy to operate.

The units are small enough to be easily carried in the field and, being battery operated, are especially noise-free and unaffected by ground loops. The low battery drain affords good battery life. An additional connector for battery charging permits use of rechargeable batteries.

Also, the gain amplifier is "unpowered" in the gain of "1" position for extended battery life.

A notable feature common to these units is the low-frequency response. (See Specification Sheets).

Another feature common to these units is a front panel meter which serves as fault monitor check for circuit connections and, when used in connection with a front panel momentary battery test rocker switch, can also check the condition of the batteries. Another refinement is a small phone jack on the front panel which can be used as an external DC power source with inputs up to 27 volts.

The front panel meter referred to above is color-coded to monitor circuit faults and to check battery conditions. Subsequent sections of this manual will describe these functions in detail.

3.0 OPERATION

With no transducer connected to the Models 480E09/E06, move the rotary switch to the desired gain position. The front panel voltmeter will read the battery voltage. (+27 volts for fresh batteries). The voltmeter is scaled to read 27-volts full scale without the transducer in the system. (see figure 2).

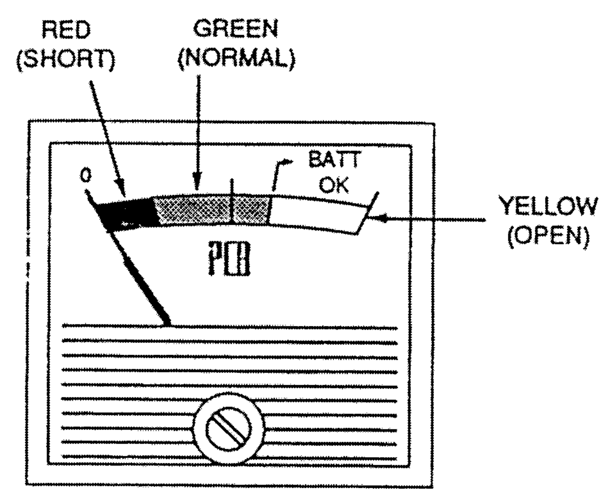


Figure 2
Fault Monitor Meter

When an ICP® transducer is connected to the input "transducer" jack, the meter will indicate approximately mid-scale (+11V nominal) if the transducer's built-in amplifier is functioning properly and cables are intact. (Certain special ICP® transducers such as low-noise or cryogenic units have lower turn-on voltage. Consult specification sheet).

In this manner, the meter can be used to continuously monitor the system for normal operation.

Immediately after connecting readout instrument (oscilloscope, meter, recorder, etc.) to the "output" jack, the 22µF coupling capacitor will begin charging through the input resistance of the readout instrument. This charging will cause an apparent "drifting" of the output signal until the capacitor is fully charged. Such drifting is perfectly normal.

3.1 OUTPUT VOLTAGE LIMITATIONS

Certain ICP® transducers are capable of a 10-volt output voltage swing. The Models 480E09/E06 with 27V supply will allow the positive-going side of the signal to go to ±14 volts. The negative-going side of the signal is capable of -8 volts assuming a 10-volt turn-on for the transducer.

3.2 CURRENT DRIVE LIMITATIONS

In the interest of battery life, the current output of Models 480E09/E06 is fixed at 2mA. This current will adequately handle high-frequency signals in cables up to approximately 100 ft. long. Longer cables can be driven, but with sacrifice of high-frequency response.

3.3 CHANGING THE BATTERIES

Should the batteries require changing, as indicated by the front panel voltmeter, proceed as follows:

Remove the one screw at the rear panel of both the 480E09/E06 and remove the unit from its plastic case.

Unsnap battery from connectors and remove batteries. Connect new 9-volt batteries in place, replace rear cover and re-screw. Be sure the insulator between the PC board and the battery is in place.

In normal use, the life expectancy of the batteries is in excess of 40 hours of operation when gain is in the x10 or x100 position. When gain switch is in unity position, battery life is approximately 80 hours. Turn unit off when not in use to conserve battery life.

NOTE: Use Mallory Duracell Mn 1604 or equivalent NEDA 1604A battery.

3.4 BATTERY TEST

The Models 480E09/E06 Power Units incorporate a momentary battery test rocker switch as part of the ON/OFF switch.

Depressing this rocker switches the meter from the "XDCR" jack to the battery high side.

Normal circuit operation is not affected by this action and releasing the rocker returns the meter to the transducer bias monitor function.

Replace batteries if meter pointer does not move to "BATT OK" mark on the meter when power is "ON", and "BATT TEST" rocker is depressed.

3.5 BATTERY CHARGING

Plug 488A02 charger into front panel jack and with unit off, recharge for 14 hours. Full charge supplies 10 mA constant current to batteries. (With unit "ON" only a trickle charge of about 2mA is available for the batteries). The standard 488A02 operates on 110V; the prefix "F" indicates 220V operation (F488A02).

CAUTION
Do not use recharger unless unit has rechargeable batteries installed (Varta TR7/8 or Eveready N88).

3.6 EXTERNAL BATTERY CONNECTION

The external battery connector (which takes a #750 switchcraft phone plug) is intended for use when longer battery life is desired. Model 073A05 Long Life Battery Pack uses 6V lantern batteries connected in series to provide 24 volts to the unit.

4.0 MAINTENANCE AND REPAIR

Aside from battery replacement, no maintenance is required for these units. It is suggested, should trouble occur, that you contact the factory for assistance.

If the unit must be returned, please describe the problem in a brief note.

A quotation for repair of out-of-warranty equipment should be requested.

MANUAL NUMBER: 18782
MANUAL REVISION: NR

Model Number 480E09	BATTERY-POWERED SIGNAL CONDITIONER	Revision: V ECN #: 45339

Performance	ENGLISH	SI	
Channels	1	1	
Frequency Range(-5 %)(x1, x10 Gain)	0.15 to 100,000 Hz	0.15 to 100,000 Hz	[6]
Frequency Range(-10 %)(x100 Gain)	0.15 to 50,000 Hz	0.15 to 50,000 Hz	[7]
Voltage Gain(± 2 %)	1:1	1:1	
Voltage Gain(± 2 %)	1:10	1:10	
Voltage Gain(± 2 %)	1:100	1:100	
Fault/Bias Monitor/Meter(± 1 V)(midscale)	13 VDC	13 VDC	
Environmental			
Temperature Range	32 to 120 °F	0 to 50 °C	
Electrical			
Excitation Voltage(To Sensor)	25 to 29 VDC	25 to 29 VDC	[1]
Constant Current Excitation(To Sensor)	2.0 to 3.2 mA	2.0 to 3.2 mA	[2]
Discharge Time Constant	>7 sec	>7 sec	[3][4]
DC Offset(Maximum)	<30 mV	<30 mV	[3]
Spectral Noise(1 Hz)(Gain 1)	.25 µV/√Hz	-132 dB	
Spectral Noise(10 Hz)(Gain 1)	.07 µV/√Hz	-143 dB	
Spectral Noise(100 Hz)(Gain 1)	.05 µV/√Hz	-146 dB	
Spectral Noise(1 kHz)(Gain 1)	.04 µV/√Hz	-148 dB	
Spectral Noise(10 kHz)(Gain 1)	.03 µV/√Hz	-150 dB	
Broadband Electrical Noise(1 to 10,000 Hz)(Gain x1)	3.25 µV rms	-110 dB/rms	
Spectral Noise(1 Hz)(Gain 10)	2.2 µV/√Hz	-113 dB	
Spectral Noise(10 Hz)(Gain 10)	2.0 µV/√Hz	-114 dB	
Spectral Noise(100 Hz)(Gain 10)	1.1 µV/√Hz	-119 dB	
Spectral Noise(1 kHz)(Gain 10)	.55 µV/√Hz	-125 dB	
Spectral Noise(10 kHz)(Gain 10)	.3 µV/√Hz	-130 dB	
Broadband Electrical Noise(1 to 10,000 Hz)(Gain x10)	49 µV/rms	-86 dB/rms	
Spectral Noise(1 Hz)(Gain 100)	20 µV/√Hz	-94 dB	
Spectral Noise(10 Hz)(Gain 100)	19 µV/√Hz	-94 dB	
Spectral Noise(100 Hz)(Gain 100)	12 µV/√Hz	-98 dB	
Spectral Noise(1 kHz)(Gain 100)	5.5 µV/√Hz	-105 dB	
Spectral Noise(10 kHz)(Gain 100)	2 µV/√Hz	-114 dB	
Broadband Electrical Noise(1 to 10,000 Hz)(Gain x100)	569 µV/rms	-65 dB/rms	
Power Required(Standard)	Internal Battery	Internal Battery	
Internal Battery(Type)	9V	9V	
Battery Life(Standard Alkaline)	50 hours	50 hours	
Power Required(Alternate)	DC power	DC power	
DC Power	15 mA	15 mA	[5]
Internal Battery(Quantity)	3	3	
DC Power	18 to 30 VDC	18 to 30 VDC	[5][1]
Physical			
Electrical Connector(Input, sensor)	BNC Jack	BNC Jack	
Electrical Connector(Output, scope)	BNC Jack	BNC Jack	
Electrical Connector(External Power, DC)	3.5 mm Diameter Miniature Jack	3.5 mm Diameter Miniature Jack	
Electrical Connector(Battery Charger)	#722 Switchcraft Jack	#722 Switchcraft Jack	
Size (Depth x Height x Width)	2.4 in x 4.0 in x 2.9 in	6.1 cm x 10 cm x 7.4 cm	
Weight(Including Batteries)	0.7 lb	0.3 kg	

CE [8]

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.

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]Excitation voltage to sensor limited by optional DC power voltage.
[2]Through internal current limiting regulator.
[3]With 1M ohm load.
[4]Un-buffered output, read out device input impedance affects discharge time constant and low frequency response of unit.
[5]Provided by optional external DC power supply.
[6]Low frequency response specified into 1M ohm load.
[7]After Serial Number 24699, previously HFR was 100kHz.
[8]See PCB Declaration of Conformance PS024 for details.

Entered: LK	Engineer: CPH	Sales: ML	Approved: JWH	Spec Number:
Date: 5/23/2016	Date: 5/23/2016	Date: 5/23/2016	Date: 5/23/2016	480-5090-80

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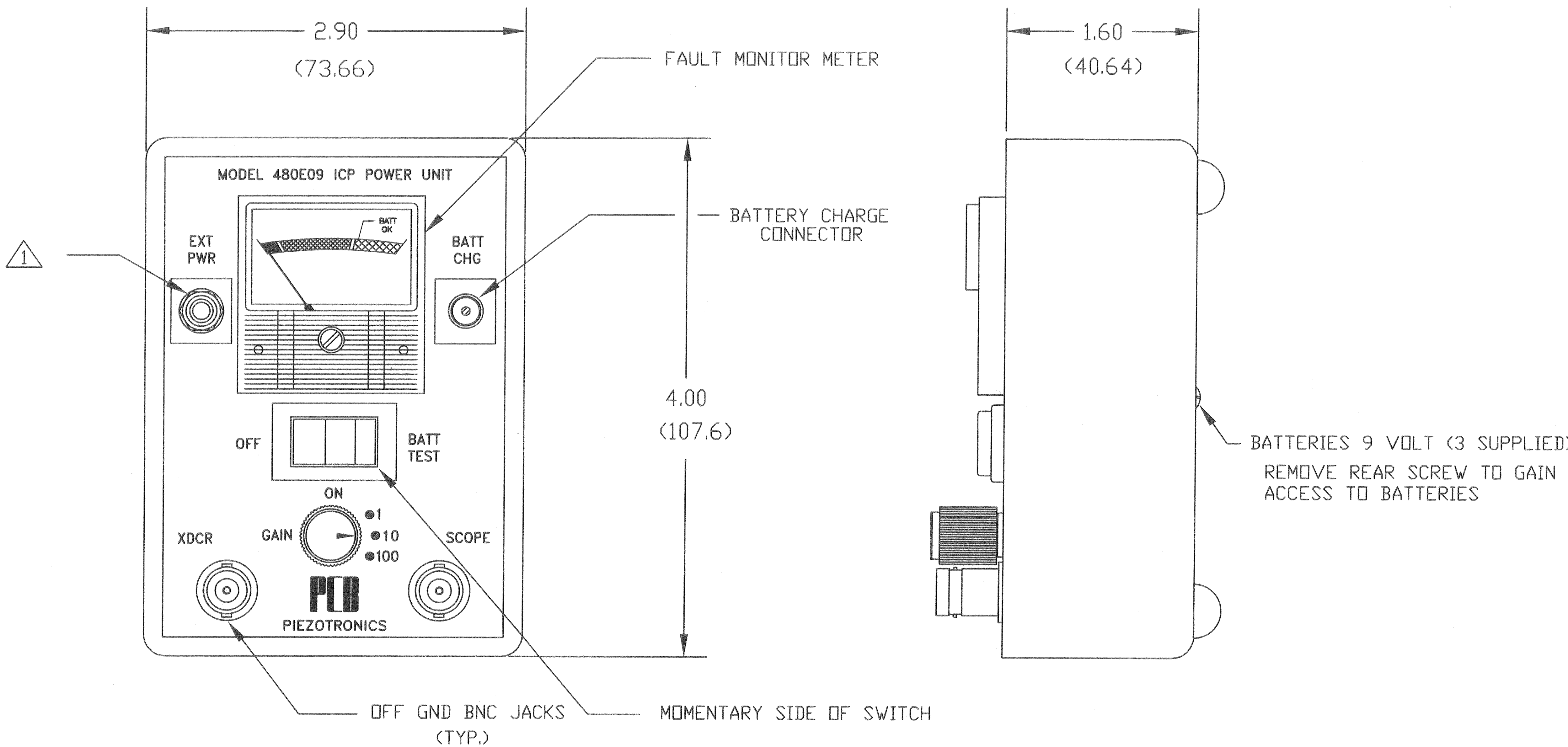
480-5090-95

APPLICATION		
NEXT ASS'Y	USED ON	VAR

REVISIONS					
ZONE	REV	DESCRIPTION	ECN	DATE	APP'D
	A	CHANGED NOTE	17892	7/7/03	DM 7/03



⚠1 FOR USE WITH 488A03 AC POWER SOURCE

UNLESS SPECIFIED TOLERANCES	MATERIAL
DIMENSIONS ARE IN INCHES DECIMALS XX ±.01 XXX ±.005 ANGLES ±2 DEGREES	FINISH
FILLETS AND RADII .003 – .005	

DRAWN	TC	7-8-03	MFG	BD	7/10/03
CHK'D	DM	7/10/03	ENGR	CMK	7/10/03
APP'D	RJV	7/10/03			

TITLE: OUTLINE DRAWING MODEL 480E09 ICP POWER UNIT

PCB PIEZOTRONICS, INC.
3425 WALDEN AVE. DEPEW, NEW YORK 14043
PHONE: (716) 684-0001

CODE IDENT. NO.	DWG. NO.
52681	480-5090-95

SCALE: FULL | SHEET 1 OF 1