



<b>Service, Repair, and Return Policies and Instructions</b>
--

**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](http://www.pcb.com). Customers within the United States may contact their local sales representative or a factory customer service representative. A complete list of sales representatives can be found at [www.pcb.com](http://www.pcb.com). Toll-free telephone numbers for a factory customer service representative, in the division responsible for this product, can be found on the title page at the front of this manual. Our ship to address and general contact numbers are:

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



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

## ***Series 421B3X Differential Input Charge Amplifier***

---



### ***Installation and Operating Manual***

---

PCB Piezotronics, Inc.

3425 Walden Avenue, Depew, New York 14043-2495

24-Hour SensorLine<sup>SM</sup> 716 684-0001

Fax 716 684-0987

***Toll Free (USA) 1-800-828-8840***

***E-Mail [info@pcb.com](mailto:info@pcb.com)***



## **Table of Contents**

---

Introduction .....	3
Description .....	3
Installation .....	3
Wiring and Operation .....	4
Calculation of Gain .....	5
Structural Diagram .....	6
Ordering Information .....	7
Special Considerations .....	7
Use with High Temperature Sensors .....	7
ESD Warning Information .....	8
Warning 1 – ESD sensitivity .....	8
Warning 2 – ESD sensitivity .....	8
Caution 1 – ESD sensitivity .....	8
Caution 2 – ESD sensitivity .....	8
Warranty .....	9
Service .....	9
Return Procedure .....	10
Customer Service .....	10

## Introduction

---

The 421B3X-Series Differential Charge Amplifiers are designed to convert the high-impedance output of a differential, charge-mode piezoelectric sensor to a low-impedance voltage output. These amplifiers may be used with either quartz or ceramic, differential charge-mode piezoelectric sensors.

## Description

---

The amplifier operates on a 22 to 28 VDC power supply. The amplifier employs a high gain amplifier to perform the impedance transformation. The output of the amplifier may be in voltage (mV) or current ( $\mu$ A) and may be scaled in terms of acceleration (g), pressure (psi or mbar) or velocity (in/s or mm/s). The electronic circuitry of the amplifier is incorporated into a molded aluminum enclosure. The amplifier has factory-configurable high-pass and low-pass filters. Furthermore, RFI filters protect the input and output against radio-frequency interference and other electromagnetic influences.

The amplifier is available in three variations, as noted in the table below.

Model	Sensor Type	Input	Output	High Pass Filter (-3dB)	Low Pass Filter (-1dB)
421B30	Pressure Sensor	17 pC/psi	350 mV/psi or $\mu$ A/psi	10 Hz	5 kHz
421B31	Accelerometer	10 pC/g	100 mV/g or $\mu$ A/g	10 Hz	1 kHz
421B3X	Pressure Sensor or Accelerometer	Configurable	Configurable	Configurable	Configurable

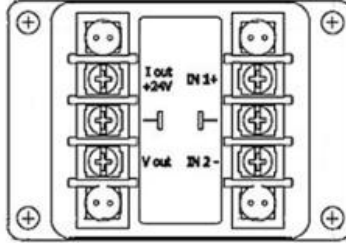
## Installation

---

Mount the base of the amplifier to a flat surface near the sensor, with the amplifier's input as close to the sensor as possible. The cable length between the sensor and the amplifier should be as short as possible to reduce the introduction of triboelectric noise into the system.

The 421B3X-Series housing is connected to the common (-) terminals. Therefore, the amplifier must be mounted so that the housing is isolated from ground.

## Wiring and Operation



Terminal	Current Output	Voltage Output
I out +24V	Current Output/Power Input	Power Input
⊥	Common	
V out	No Connection	Voltage Output
IN 1+	Sensor Positive Input Signal	
⊥	Sensor Shield	
IN 2-	Sensor Negative Input Signal	

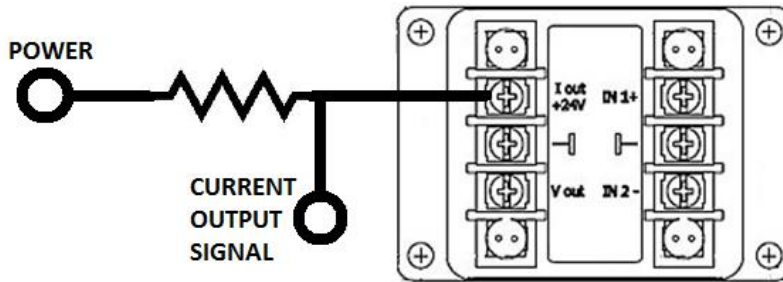
### Input Signal:

- Differential Piezoelectric Sensor: Connect the sensor's positive charge output to the positive input (IN1+) and the sensor's negative charge output to negative input (IN2-) using low-noise cable.
- Non-Differential Piezoelectric Sensor: Connect the sensor output to the negative input (IN2-) and short the positive input (IN1+) and common (⊥) using low-noise cable. The output signal will be inverted when operating with a non-differential sensor.

### Output Signal:

- Voltage Output (mV): The output of the amplifier (V out) should be routed to any readout device using standard coaxial or two-wire cable. The readout device may be an oscilloscope or other monitoring device. The output from the amplifier will be an AC signal proportional to the signal seen by the sensor.
- Current Output ( $\mu\text{A}$ ): A CVLD power supply that provides a voltage within the specified required supply voltage of the amplifier should be used for current mode operation. The output of the CVLD receiver will be a voltage proportional to the V/mA sensitivity of the receiver. A CVLD receiver is the preferred current mode configuration. Alternatively, a current sense resistor can be placed in series on the standard coaxial or two-wire cable running from the output of the amplifier (I out/+24V) to the power supply. The resistor must be less than or equal to 250  $\Omega$ . See diagram below of the current mode operation with series resistor. From this resistor, a voltage output can be routed to any readout device. The voltage output across the resistor is proportional to the current output per Ohm's law ( $V = IR$ ). In this configuration the measured voltage will be inverted relative to the current output of the amplifier. For both configurations the readout device may be an oscilloscope or other monitoring device. The output from the amplifier will be an AC signal proportional to the signal seen by the sensor.





## Calculation of Gain

An amplifier is selected by specifying an input sensitivity and an output sensitivity. As a result, the gain is inherently determined without specifically calling it out. The gain of the amplifier can be calculated using one of the following equations:

		Input Sensitivity Units		
		pC/bar	pC/psi	pC/g
Output Sensitivity Units	mV/mbar	$\frac{(\text{Output} \times 1000)}{\text{Input}}$	$\frac{(\text{Output} \times 68.9475)}{\text{Input}}$	N/A
	mV/psi	$\frac{(\text{Output} \times 14.5037)}{\text{Input}}$	$\frac{\text{Output}}{\text{Input}}$	N/A
	mV/g	N/A	N/A	$\frac{\text{Output}}{\text{Input}}$
	mV/mm/s	N/A	N/A	$\frac{(\text{Output} \times 9806.6) / (2 \times \pi \times f)}{\text{Input}}$
	mV/ips	N/A	N/A	$\frac{(\text{Output} \times 386.1) / (2 \times \pi \times f)}{\text{Input}}$

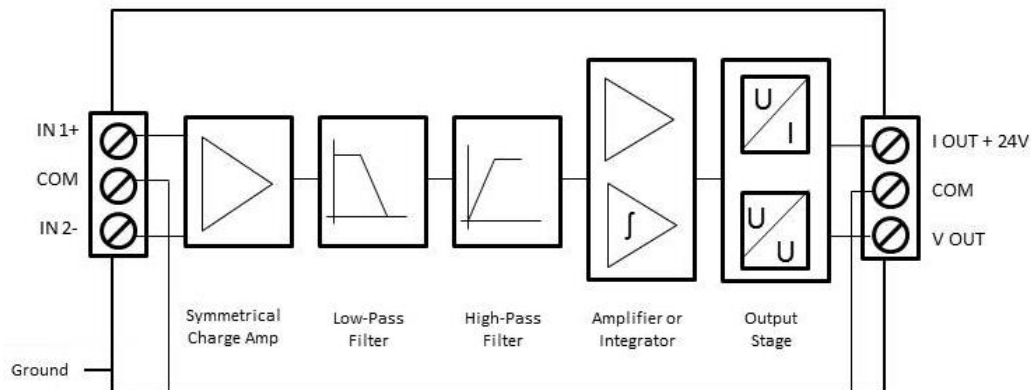
Note:

- Current output in  $\mu\text{A}$  always equals voltage output in mV.
- For velocity output models, the gain of the amplifier is frequency (f) dependent.

**Example:** An amplifier ordered with 10 pC/g input sensitivity and a 100 mV/g output sensitivity would have a gain of  $100 \text{ mV/g} / 10 \text{ pC/g} = 10 \text{ mV/pC}$ .

## Structural Diagram

The amplifier structural diagram is shown below:



The amplifier converts the charge-based signal from a piezoelectric transducer into a current and voltage signal.

- **Current Output:** The current signal is transmitted to the processing electronics via a 2-wire transmission cable. Two-wire current output is provided by power input/current output (Iout/+24V) and common (I-) terminals. The current output allows transmission over a maximum distance of 3,000 feet. A CVLD power supply as described in the Wiring and Operation section is recommended for this configuration.
- **Voltage Output:** The voltage signal is transmitted to the processing electronics via a 3-wire transmission cable. Three-wire voltage output is provided by power input/current output (Iout/+24V), common (I-) and voltage output (Vout) terminals. The voltage output allows transmission over a maximum distance of 100 feet (without analysis of cable capacitance).

## Ordering Information

To configure a 421B3X-Series amplifier, construct a full model number according to the below scheme.

MODEL	INPUT SENSITIVITY					OUTPUT SENSITIVITY					FILTERS				
	Value				Units	Value				Units	High-Pass		Low-Pass		
	A	A	A	A	B	C	C	C	C	D	E	E	F	F	F
421B3X	0001-1000				G/B/P	0001-2000				G/I/M/P/B	X5-10		002-200		
	0001-0200 pC/g 0001-1000 pC/bar 0001-0100 pC/psi				G=g B=bar P=psi	0010-2000 mV/g 0001-0005 mV/in/s 0010-0100 mV/mm/s 0001-1000 mV/psi 0001-0010 mV/mbar				G=g I=in/s M=mm/s P=psi B=mbar	X5=0.5 Hz 01=1 Hz 02=2 Hz 05=5 Hz 10=10 Hz		002=200 Hz 005=500 Hz 010=1 kHz 020=2 kHz 050=5 kHz 100=10 kHz 200=20 kHz		

Full Model Number for Pre-Configured Models:

- 421B30 for Use with Pressure Sensor = 421B3X-0017-P-0350-P-10-050
- 421B31 for Use with Accelerometer = 421B3X-0010-G-0100-G-10-010

## Special Considerations

High source capacitance may degrade the performance of the amplifier. Source capacitance is the input capacitance to the amplifier defined as transducer capacitance plus cable capacitance. If the source capacitance is increased due to a long length of cable, amplifier noise will increase and frequency response will decrease.

## Use with High Temperature Sensors

The amplifier is specifically designed for use with piezoelectric sensors with an operating temperature range of greater than 500 °F (260 °C), which typically have lower insulation resistance values. The amplifier will operate with insulation resistances as low as 50 kOhm.

**Note:** When using the 421B3X series differential charge amplifier with high temperature sensors, the unit may have a longer turn-on time than typical charge amplifiers which are designed for use with sensors with high insulation resistance.

**Caution!** Excessive accumulated charges on the input cables can destroy the field effect transistor (FET) in the amplifier. These charges can be grounded before connection by shorting the center pin on the cable connector plug to its knurled nut with any metallic object.

## ESD Warning Information

---

### **Warning 1 – ESD sensitivity**

---

**The 421B3X Series Differential Charge Amplifier should be opened by PCB factory-qualified personnel only.** This product is intended for use by qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid injury.

### **Warning 2 – ESD sensitivity**

---

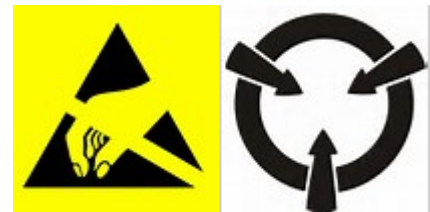
This equipment is designed with user safety in mind; however, the protection provided by the equipment may be impaired if the equipment is used in a manner not specified by PCB Piezotronics, Inc.

### **Caution 1 – ESD sensitivity**

---

**Cables can kill your equipment.** Although 421 series differential charge amplifiers have protection, they can still be damaged by high level voltage from electrostatic discharge (ESD). Similar to a capacitor, a cable can hold a charge caused by triboelectric transfer, such as that which occurs in the following:

- Laying on and moving across a rug,
- Any movement through air,
- The action of rolling out a cable, and/or
- Contact with a non-grounded person.



**CAUTION ELECTROSTATIC  
DISCHARGE SENSITIVE**

The PCB solution for product safety:

- Connect the cables only with the AC power off.
- Temporarily "short" the end of the cable before attaching it to any signal input or output.

### **Caution 2 – ESD sensitivity**

---

**ESD considerations should be made prior to performing any internal adjustments on the equipment.** Any item of electronic equipment is vulnerable to ESD when opened for adjustments. Internal adjustments should therefore be done **ONLY** at an ESD-safe work area. Many products have ESD protection, but the level of protection may be exceeded by extremely high voltage.

## Warranty

---

**A. Total Customer Satisfaction.** PCB guarantees **Total Customer Satisfaction** through its “Lifetime Warranty Plus” on all Platinum Stock Products sold by PCB and through its Limited Warranties on all other PCB Stock, Standard and Special products.

**B. Platinum Stock Products – Lifetime Warranty Plus.** Under PCB’s Lifetime Warranty Plus, if any PCB Platinum Stock Product ever fails, PCB will repair, replace or exchange the product at no charge. As a further benefit under PCB’s Lifetime Warranty Plus, PCB will, for a one (1) year period following the delivery date of any PCB Platinum Stock product, refund 100% of the customer’s purchase price paid for any such Product with which the original purchaser is not completely satisfied. This option of a refund may be selected in lieu of the repair, replacement or exchange of the product. “Platinum Stock Product” is defined as any PCB Stock Product designated by PCB from time-to-time as a “Platinum” model.

**C. Stock Products – Limited Warranty.** PCB warrants that all PCB Stock Products will be free from defects in materials and workmanship for a period of two (2) years from the date of original purchase. If any Stock Product shall fail during the warranty period, PCB will repair, replace or exchange it without charge. As a further benefit under PCB’s Limited Warranty for Stock Products, PCB will, for a (1) year period following the delivery date of any PCB Stock Product, refund 100% of the customer’s purchase price for any PCB Stock Product with which the original purchaser is not completely satisfied. “Stock Product” is defined to mean any product designated by PCB from time-to-time as a “Stock Product”. This is generally a product on which PCB customarily maintains finished goods inventory.

**D. Standard Products, Special Products and Test and Measurement Cables – Limited Warranty.** PCB warrants that all PCB Standards, PCB Specials and test and measurement cables will be free from defects in materials and workmanship for a period of one (1) year from the date of original purchase. If any PCB Standard or PCB Special shall fail during the warranty period, PCB will repair, replace or exchange it without charge. “PCB Standard” is a product regularly manufactured by PCB for which PCB does not customarily maintain finished goods inventory. “PCB Special” is defined as any customized or modified PCB product for which PCB does not customarily maintain finished goods inventory, or any other product PCB classifies as a special from time to time.

## Service

---

Because of the sophisticated nature of PCB instrumentation, field repair is typically not recommended and may void any warranty. If factory service is required, return the instrumentation according to the "Return Procedure" stated below. A repair and/or replacement quotation will be provided prior to servicing at no charge. Before returning the unit, please consult a factory PCB applications engineer concerning the situation because certain problems can often be corrected with simple on-site procedures.

## Return Procedure

---

To expedite returned instrumentation, contact a factory PCB Customer Service Representative for a RETURN MATERIAL AUTHORIZATION (RMA) NUMBER. When calling, please have information such as model, serial number and description of the problem available. When preparing the package for return, it is helpful to provide a written description of the symptoms and problems experienced with the equipment.

Customers outside the U.S. should consult their local PCB distributor for information on returning equipment. For exceptions, please contact the International Sales department at PCB to request shipping instructions and an RMA. For assistance, please call (716) 684-0003, or fax us at (716) 684-3823. You may also receive assistance via e-mail at <mailto:imi@pcb.com> or visit our web site at <http://www.pcb.com/>.

## Customer Service

---

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, within the warranty period, to have your purchase price refunded.

PCB offers to all customers, at no charge, 24-hour phone support. This service makes product or application support available to our customers, day or night, seven days a week. When unforeseen problems or emergency situations arise, call the **24 Hour SensorLine<sup>SM</sup> at 716 684-0001**, and an application specialist will assist you.



3425 Walden Avenue, Depew, NY 14043-2495  
**Phone** 716 684-0001 **Fax** 716 684-0987 **E-Mail** [info@pcb.com](mailto:info@pcb.com)  
**PCB** [www.PCB.com](http://www.PCB.com) **IMI** [www.IMI-Sensors.com](http://www.IMI-Sensors.com)

Certified to ISO 9001, AS-9100, ISO/IEC 17025

© 2013 PCB Group, Inc. In the interest of constant product improvement, specifications are subject to change without notice. All prices are subject to change without notice. PCB, ICP and Modally Tuned are registered trademarks of PCB Group, Inc. IMI and SensorLine are service marks of PCB Group, Inc. All other trademarks are properties of their respective owners.