



**Model 422E21**  
**In-Line Charge Converter**  
**Installation and Operating Manual**

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

**Toll-free: 800-828-8840**  
**24-hour SensorLine: 716-684-0001**  
**Fax: 716-684-0987**  
**E-mail: [info@pcb.com](mailto:info@pcb.com)**  
**Web: [www.pcb.com](http://www.pcb.com)**





<b>Warranty, Service, Repair, and Return Policies and Instructions</b>
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**The information contained in this document supersedes all similar information that may be found elsewhere in this manual.**

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

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

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

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

PCB Piezotronics maintains an ISO-9001 certified metrology laboratory and offers calibration services, which are accredited by A2LA to ISO/IEC 17025, with full traceability to 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 insure that your returned materials are handled in the most expedient manner.* Before

returning any equipment to PCB Piezotronics, contact your local distributor, sales representative, or factory customer service representative to obtain a Return **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.

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

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

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

PCB Piezotronics, Inc.  
3425 Walden Ave.  
Depew, 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: C

ECN: 45605

***The Model 422E In-Line Charge Converter***

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***Operating Guide with Enclosed Warranty Information***

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***MANUAL NUMBER: 18882  
MANUAL REVISION: A  
ECN: 24741***

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### ***introduction***

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The 422E series in-line charge converters are designed to convert the high impedance of a charge mode piezoelectric transducer to a low-impedance voltage by means of an ICP® signal conditioner. These units may be used with either quartz or ceramic charge-mode piezoelectric sensors.

### ***description***

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The 422E series in-line charge amplifiers operate from an ICP® signal conditioner. The unit employs a high gain amplifier to perform the impedance transformation. The charge output of the transducers may be scaled in terms of acceleration, pressure or force. The output is then mV/g, mV/psi or mV/lb, respectively.

### ***installation***

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Connect the 422E series to the transducer with low-noise cable (003A) only. Standard coaxial or two-wire cable may be used between the amplifier and the signal conditioner, and between the signal conditioner and the readout device.

**Note:** *For optimum noise performance, the cable length between the sensor and the 422E should be minimized.*

### ***operation***

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To operate, simply connect the input of the 422E to the transducer using low-noise (003A) cable and the output to any ICP® signal conditioner using standard cable. The output of the signal conditioner may then be connected to an oscilloscope or other monitoring device. This output will be an AC signal (see **specification** for actual frequency response) with a DC bias. Many PCB signal conditioners remove the bias via an AC coupling circuit.



### ***calculation of output scaling***

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The 422E contains a high-gain, low-noise amplifier connected in a charge amplifier configuration. The charge output of the transducer is transferred to the feedback capacitor of the amplifier to develop a voltage which may be calculated using the following equation.

$$V_{out} = 422E \text{ Scaling (mV/pC)} \times \text{Transducer Sensitivity (pC/Engineering Unit)}$$

**where:**

$$V_{out} = \text{Output of 422E in mV/Engineering Unit}$$

*the Engineering Unit may be g's, Newtons, psi, etc., depending on the sensor*

**Example:** A 357A12 (3 pC/g) is used with a 422E02 (10 mV/pC). Calculate the output in mV/g.

**Answer:** 10 mV/pC x 3 pC/g = 30 mV/g

### ***TEDS functionality***

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422E units with a "T" prefix incorporate TEDS (Transducer Electronic Data Sheet) technology. Using a TEDS capable signal conditioner, or TEDS reader, the user is able to read calibration data stored in the sensor. Some systems allow the user to also write user data and calibration information to the 422E. All data is formatted in accordance with IEEE 1451.4.

### ***special considerations***

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High source capacitance may degrade the performance of the 422E (source capacitance is the input capacitance defined as transducer capacitance + cable capacitance). In particular, noise may increase and high frequency response may decrease if source capacitance exceeds the recommended level. In some cases, low frequency oscillation of the output may occur. The maximum recommended level in pF's is determined using the following formula:

$$\text{maximum recommended source capacitance} = 10,000 / 422E \text{ sensitivity in mV/pC}$$

For example, the level for a 422E02/E12 would be  $10,000/10 \text{ pF} = 1,000 \text{ pF}$ , and the level for a 422E03/E13 would be  $10,000 \text{ pF}$ . If PCB 003 type low noise cable is used, these values correspond to 10 meters and 100 meters of length respectively.

### ***422E series models for use with high temperature sensors***

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The 422E35 (1 mV/pC) and 422E36 (10 mV/pC) have been specifically designed to operate with the lower insulation resistance values which piezoelectric sensors may exhibit when subjected to very high temperatures (generally greater than 500° F). Both units will operate with insulation resistances as low as 10kΩ.

**Note:** *Because of the special circuitry required, the 422E35 and 422E36 have somewhat higher noise and longer turn on time than the equivalent units designed for use with sensors with high insulation resistance (the 422E03 and 422E02 respectively). Consult the **specifications** for details.*

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

**422E series models for use in radioactive environments**

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The 422E65 (1mV/pC) and 422E66 (10mV/pC) were designed to offer resistance to the effects of radiation exposure up to 1 Mrad Integrated Gamma Flux or  $10^{10}$  N/cm<sup>2</sup> of Integrated Neutron Flux. They are also designed to operate with lower insulation values which piezoelectric sensors may exhibit when subjected to the high temperatures that generally accompany high levels of radioactivity.

**warning 1 – ESD sensitivity**

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**The power supply/signal conditioner should not be opened by anyone other than qualified service personnel.** 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**

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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**

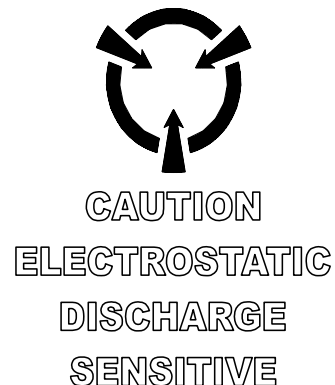
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**Cables can kill your equipment.** High voltage electrostatic discharge (ESD) can damage electrical devices. Similar to a capacitor, a cable can hold a charge caused by triboelectric transfer, such as that which occurs in the following:

- *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.*

**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**

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**ESD considerations should be made prior to performing any internal adjustments on the equipment.** Any piece 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**

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PCB instrumentation is warranted against defective material and workmanship for 1 year unless otherwise expressly specified. Damage to instruments caused by incorrect power or misapplication, is not covered by warranty. *If there are any questions regarding power, intended application, or general usage, please consult with your local sales contact or distributor.* Batteries and other expendable hardware items are not covered by warranty.

**service**

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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 as certain problems can often be corrected with simple on-site procedures.

**return procedure**

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*To expedite returned instrumentation, contact a factory PCB applications engineer for a RETURN MATERIAL AUTHORIZATION (RMA) NUMBER.* Please have information available such as model and serial number. Also, to insure efficient service, *provide a written description of the symptoms and problems with the equipment to a local sales representative or distributor, or contact PCB if none are located in your area.*

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 [electronics@pcb.com](mailto:electronics@pcb.com) or visit our web site at [www.pcb.com](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 at 716 684-0001**, and an application specialist will assist you.



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**PCB** [www.PCB.com](http://www.PCB.com) **IMI** [www.IMI-Sensors.com](http://www.IMI-Sensors.com) **Key** [www.KeyTransducers.com](http://www.KeyTransducers.com)

**ISO 9001 Certified**

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## IN-LINE CHARGE CONVERTER

**Performance**  
Sensitivity ( $\pm 5\%$ ) (Charge Conversion)  
Input Range  
Overrange

Low Frequency Response ( $-5\%$ )  
High Frequency Response (2.2 mA)  
High Frequency Response (4 mA)  
High Frequency Response (20 mA)  
Non-Linearity

**Environmental**  
Temperature Range (Operating)  
Temperature Response (Sensitivity Deviation)  
Maximum Shock

**Electrical**  
Excitation Voltage  
Constant Current Excitation  
Output Voltage (at specified measurement range)  
Output Impedance  
Output Bias Voltage  
Output Polarity  
Maximum Input Voltage  
Broadband Electrical Noise (1 to 10,000 Hz)  
Spectral Noise (1 Hz)  
Spectral Noise (10 Hz)  
Spectral Noise (100 Hz)  
Spectral Noise (1 kHz)  
Spectral Noise (10 kHz)  
Resistance (Minimum required at input)  
Discharge Time Constant  
Source Capacitance Loading

**Physical**  
Housing Material  
Sealing  
Size (Diameter x Length)  
Weight  
Electrical Connector (Input)  
Electrical Connector (Output)

**ENGLISH**  
0.4 mV/pC  
6250 pC  
 $\pm 3$  V  
1 Hz  
50 kHz  
75 kHz  
100 kHz  
 $\leq 1.0\%$  FS

-65 to +250 °F  
 $<1\%$   
1000 g pk

+18 to 28 VDC  
2.2 to 20 mA  
 $\pm 2.5$  V  
 $<10$  ohm  
+12.75 to 14.25 VDC  
Inverted  
30 V  
15  $\mu$ V  
10  $\mu$ V/√Hz  
0.8  $\mu$ V/√Hz  
0.2  $\mu$ V/√Hz  
0.07  $\mu$ V/√Hz  
0.07  $\mu$ V/√Hz  
5,000,000 ohm  
 $\geq 0.5$  sec  
0.0005 %/pF

Stainless Steel  
Welded Hermetic  
0.62 in x 3.62 in  
2.46 oz  
2-Pin MIL-C-26482  
2-Pin MIL-C-5015

**SI**  
0.4 mV/pC  
6250 pC  
 $\pm 3$  V  
1 Hz  
50 kHz  
75 kHz  
100 kHz  
 $\leq 1.0\%$  FS

-54 to +121 °C  
 $<1\%$   
9810 m/s<sup>2</sup> pk

+18 to 28 VDC  
2.2 to 20 mA  
 $\pm 2.5$  V  
 $<10$  ohm  
+12.75 to 14.25 VDC  
Inverted  
30 V  
-96 dB  
-100 dB  
-122 dB  
-134 dB  
-143 dB  
-143 dB  
5,000,000 ohm  
 $\geq 0.5$  sec  
0.0005 %/pF

Stainless Steel  
Welded Hermetic  
16 mm x 92.0 mm  
69.7 gm  
2-Pin MIL-C-26482  
2-Pin MIL-C-5015

**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  
Temperature Range (Operating) -40 to +185 °F -40 to +85 °C  
Output Bias Voltage 13.35 to 14.85 VDC 13.35 to 14.85 VDC

**NOTES:**

[1] Tested using voltage source and input capacitor equal to the feedback capacitor, to simulate a charge output sensor.  
[2] Not to be used with low values of source resistance such as charge mode sensors at elevated temperatures or contaminated sensor cables (preventing low frequency peaking and/or output bias problems).  
[3] Above stated frequency, the amplifier becomes slew rate limited.  
[4] See PCB Declaration of Conformance PS024 for details.

Entered: <b>BLS</b>	Engineer: <b>BA</b>	Sales: <b>MRA</b>	Approved: <b>CM</b>	Spec Number:
Date: <b>10/20/05</b>	Date: <b>10-11-05</b>	Date: <b>10/21/05</b>	Date: <b>10/21/05</b>	<b>13117</b>



**CE** [4]

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

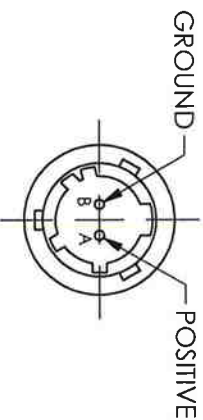
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12115

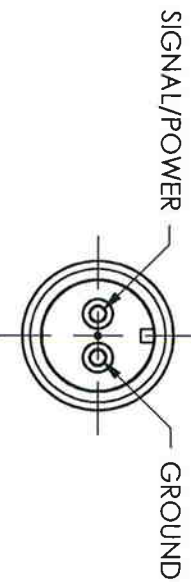
REVISIONS		ECCO
REV	DESCRIPTION	
A	ADDED ETCHING	31390
B	CHANGED PIN OUT	31968

TOP VIEW OF CONNECTOR



INPUT CONNECTOR  
2 PIN (MIL-C-26482)

OUTPUT CONNECTOR  
2 PIN (MIL-C-5015)



UNLESS OTHERWISE SPECIFIED TOLERANCES ARE:		DRAWN		CHECKED		ENGINEER	
DIMENSIONS IN INCHES		DIMENSIONS IN MILLIMETERS [ IN BRACKETS ]		CPH		12/18/09	
DECIMALS XX ±.03	XXX ±.010	DECIMALS X ±0.8	XXX ±0.25	TITLE			
ANGLES ± 2 DEGREES		ANGLES ± 2 DEGREES		OUTLINE DRAWING MODEL 422E20 IN-LINE AMPLIFIER			
FILLET AND RADI .003 - .005		FILLET AND RADI 0.07 - 0.13		CODE IDENT. NO. 52681			
				DWG. NO. 12115			
				SCALE: 1.25X SHEET 1 OF 1			

**PCB PIEZOTRONICS**  
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