Model 134A27

Tourmaline ICP® pressure bar, 20k psi, 0.25 mV/psi, 0.2 microsecond rise

Installation and Operating Manual

This manual contains the 402A17 installation and operating manuals that comprise a Model 134A27 Tourmaline ICP® pressure bar, 20k psi, 0.25 mV/psi, 0.2 microsecond rise time kit.

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

Toll-free: 800-828-8840
24-hour SensorLine: 716-684-0001
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Web: www.pcb.com

PCB PIEZOTRONICS
A PCB GROUP COMPANY

Warranty, 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.

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.

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PCB Piezotronics maintains an ISO-9001 certified metrology laboratory and offers calibration services, which are accredited by A2LA to ISO/IEC 17025, with full traceablility to 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.

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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. 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:

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E-mail: info@pcb.com

1.0 INTRODUCTION

Series 134A20 Tourmaline Pressure Bar with In-Line Amplifier consists of a Series 134A Tourmaline Pressure Bar connected to a three-inch, low-noise cable that connects into Series 402 In-Line Source Follower Voltage Amplifier. See Figure 1.

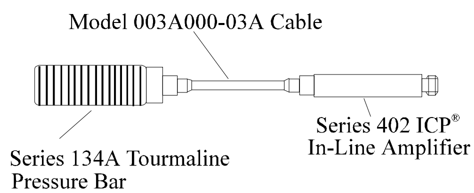


Figure 1. Series 134A20 Tourmaline Pressure Bar with In-Line Amplifier

The Tourmaline Pressure Bars is a high-pressure, fast rise time, suppressed-resonance blast sensor ideal for single-shot, high-frequency measurements of incident or reflected shock wave pressures found in studies of plasma physics and hyper-sonics. Ranges up to 20,000 psi are available.

The Series 134A20 is typically powered by a PCB Series 480 ICP® Power Conditioner (constant current) or equivalent. Power and signal is conducted over a single-conductor coaxial cable with the shield serving as a signal return. Output from the power conditioner is usually fed into a high-speed readout instrument, such as a digital oscilloscope.

2.0 DESCRIPTION

The Series 134A20 Tourmaline Pressure Bar with In-Line Amplifier consists of three components attached together and calibrated as a system. The Series 134A Tourmaline Pressure Bar senses and transduces a pressure/shock wave into a high-impedance, electrostatic charge. This charge is sent through the three-inch, low-noise cable into the Series 402A In-Line Amplifier, where it is converted into a low-impedance voltage with less than 100 ohms output impedance. See Figure 2.

The circuit in the in-line amplifier consists of a MOSFET input IC with a very high trans-conductance, resulting in a voltage gain that is very close to unity. The source terminal "follows" the gate voltage instantaneously, without a shift in phase (i.e., the amplifier is non-inverting).

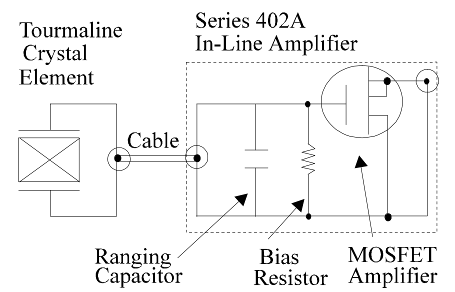


Figure 2. System Schematic (Typical)

2.1 SYSTEM OUTPUT

The system output of Series 134A20 is a low-impedance output governed by the following equation:

$$V = \frac{Q}{C1 + C2 + C3}$$

where:

- V = voltage sensitivity of system (V/psi)
- Q = charge output of Tourmaline Bar (pC/psi), Model 134A
- C1 = capacitance of Tourmaline Bar (pF), Series 134A
- C2 = capacitance of three-inch cable (pF), Model 003A000-03
- C3 = capacitance of input of in-line amplifier (pF), Series 402A

A system calibration is supplied with Series 134A20 that shows the system output in mV/psi.

3.0 INSTALLATION

See the Installation Drawing included in the back of this manual for a description of the Tourmaline Bar and its installation. *Install in a gas medium where the measurement is to be taken. The sensor can not be normally used in a liquid medium.*

Connect the Series 134A20 Tourmaline Pressure Bar with In-Line Amplifier to a PCB power conditioner. Connect the output of the power conditioner to an appropriate readout instrument.

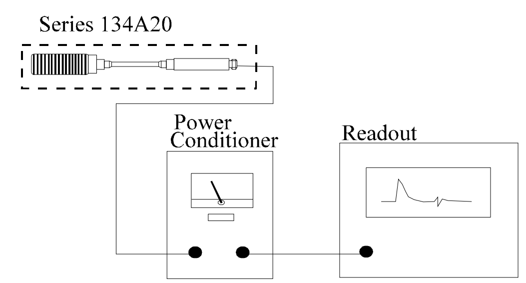


Figure 3. Typical System Layout

Tie the three-inch, low-noise cable to a rigid structure to prevent excessive motion and noise. Allow for strain relief.

Caution

If the tourmaline pressure bar or the three-inch cable become disconnected from the in-line amplifier, take caution to momentarily electrically short out the cable and tourmaline pressure bar before reconnecting the cable to the in-line amplifier. This prevents any unusual high charge buildup from damaging the input stage of the in-line amplifier.

Black vinyl tape is supplied on the sensing end of the tourmaline bar to dampen heat transfer into the sensing crystal. This tape can be removed and replaced if damaged.

4.0 OPERATION

Switch on the (PCB) power conditioner and observe the bias monitoring voltmeter (or LED) on the front panel.

If the indicator reads proper bias (green area on the meter, approximately 11 volts), the connections from the Series 402A In-Line Amplifier are correct and the in-line amplifier is operational. If the meter reads in the red or yellow areas, the system is shorted or open. The short or open circuit may be in the in-line amplifier, the cable connecting the in-line amplifier to the power conditioner, or in the power conditioner.

Allow the system to stabilize for a minute. A signal drift may occur when connecting the power conditioner to the readout instrument. This should stabilize as components in the power conditioner and readout instrument charge.

If long cables between the Series 134A20 and the power conditioner are used, impedance matching of the long cable and increase of the constant current in the power conditioner may be required because of the high-speed response of the sensor. Check with PCB if there are questions.

5.0 CALIBRATION

The tourmaline pressure bar must be calibrated *dynamically*. The tourmaline pressure bar does not measure static pressures. In addition, application of high static pressure to the tourmaline bar may cause damage.

Two methods are used at PCB to calibrate the Series 134A20: a shock tube and a hydraulic pulse tester. The shock tube is used primarily to check the sub-microsecond response of the tourmaline pressure bar.

The hydraulic pulse tester is used to generate a known, short-duration pressure pulse at five different pressure levels to determine the average sensitivity of the sensor.

Recalibration services are offered by PCB. In addition, the shock tube and hydraulic pulse calibrator are offered as standard products by PCB.

6.0 USE OF CHARGE MODE TOURMALINE PRESSURE BAR

The tourmaline pressure bar is a charge output piezoelectric sensor that can be used without the in-line source follower amplifier for certain applications. Calibration information is supplied showing (charge) output sensitivity of the tourmaline bar alone, along with its crystal capacitance.

Note that the Series 402A In-Line Amplifier features a frequency response of greater than 1 MHz. A charge amplifier used with the tourmaline pressure bar may limit the upper frequency response of the system.

Connecting the Series 134A Tourmaline Pressure Bar directly to a readout instrument without the use of the Series 402A In-Line Amplifier or other impedance-converting device can be done with some limitations. The input impedance of the readout instrument may be significantly low to create a very high-pass filtering effect. This can affect measurement of pulse duration or amplitude of a slow-rising pulse. Also, the voltage sensitivity of the output of the tourmaline bar into the readout instrument is affected by the cable capacitance and input capacitance of the readout instrument.

Contact the factory with any questions regarding use of the sensor in the charge output mode.

6.1 USE OF THE IN-LINE AMPLIFIER

The Series 402A In-Line Amplifier is used to convert the high-impedance output of the tourmaline pressure bar into a low-impedance output. The in-line amplifier may also be used as a unity gain amplifier for checking system frequency response. A signal generator is connected to the input of the in-line amplifier and fed through the system.

7.0 MAINTENANCE AND REPAIR

The electrical connectors on the tourmaline pressure bar, the input of the in-line amplifier, and the three-inch, low-noise cable must be kept clean and dry, especially if they are operating in a dusty or wet environment. This is to prevent drift due to low insulation resistance. Also, note the following precautions:

1. Do not exceed maximum levels.

2. Constant temperatures around the tourmaline bar should be limited to 150°F. Short-term exposure to higher temperatures, such as that found in a blast wave, do not cause damage.

3. Use only PCB power conditioners or approved alternative.

4. Current to the in-line amplifier must be limited to not more than 20 mA to avoid damage.

5. If the tourmaline pressure bar and in-line amplifier are to be left outside overnight or in humid or rainy environments, they should be coated with silicone oil and covered.

Model Number 134A27	ICP® PRESSURE SENSOR	Revision: G ECN #: 29109

Performance	ENGLISH	SI	
Measurement Range(for ±5V output)	20 kpsi	137,900 kPa	
Sensitivity(± 15 %)	0.25 mV/psi	0.04 mV/kPa	[1]
Maximum Pressure(static)	20 kpsi	137,900 kPa	
Resolution	300 mpsi	2.1 kPa	[2]
Resonant Frequency	≥ 1500 kHz	≥ 1500 kHz	
Rise Time(Reflected)	≤ 0.2 μ sec	≤ 0.2 μ sec	
Low Frequency Response(-5 %)	1 Hz	1 Hz	
Non-Linearity	≤ 2 % FS	≤ 2 % FS	[3]
Environmental			
Temperature Range(Operating)	+32 to +120 °F	0 to +49 °C	
Maximum Flash Temperature	5000 °F	2760 °C	
Electrical			
Output Polarity(Positive Pressure)	Positive	Positive	
Discharge Time Constant(at room temp)	≥ 0.5 sec	≥ 0.5 sec	
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	
Output Bias Voltage	8 to 14 VDC	8 to 14 VDC	
Physical			
Sensing Element	Tourmaline	Tourmaline	
Housing Material	Stainless Steel	Stainless Steel	
Diaphragm	Epoxy	Epoxy	
Sealing	Epoxy	Epoxy	
Electrical Connector	10-32 Coaxial Jack	10-32 Coaxial Jack	
Weight	1.4 oz	39 gm	

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.

OPTIONAL VERSIONS

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

M - Metric Mount

N - Negative Output Polarity

NOTES:

[1] Calibrated as a system using (3 inch) type 003 cable and 402A series in-line amplifier.
[2] Typical.
[3] Zero-based, least-squares, straight line method.
[4] See PCB Declaration of Conformance PS023 for details.

SUPPLIED ACCESSORIES:

Model 061A30 Spanner Wrench, 2 Pin (1)

Entered: BJS	Engineer: RF	Sales: RWM	Approved: BJH	Spec Number:
Date: 7/16/08	Date: 7/16/08	Date: 7/16/08	Date: 7/16/08	**6617**

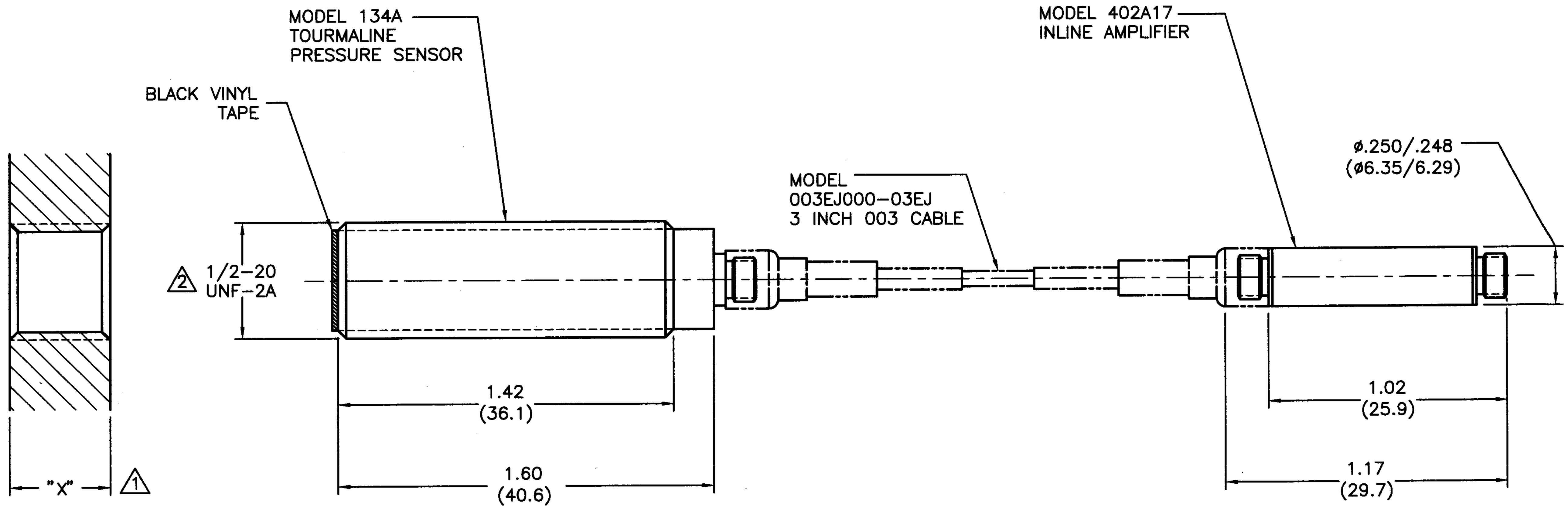
PCB PIEZOTRONICS™
PRESSURE DIVISION
3425 Walden Avenue, Depew, NY 14043

Phone: 716-684-0001
Fax: 716-686-9129
E-Mail: pressure@pcb.com

APPLICATION		
NEXT ASS'Y	USED ON	VAR

REVISIONS					
ZONE	REV	DESCRIPTION	ECN	DATE	APP'D

14377



MOUNTING HOLE PREPARATION:
ø.453
THRU
TAP 1/2-20 UNF-2B

2 TEFLON TAPE OR OTHER THREAD SEALANT IS RECOMMENDED

1 "X" DIMENSION TO SUIT USER REQUIREMENTS

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	DBJ	9/15/00	MFG	Dec	10/2/00
CHK'D	em	9/22/00	ENGR	WSH	9/27/00
APP'D	RJV	10/2/00	SALES	Jmm	10/3/00

TITLE INSTALLATION DRAWING
MODEL 134A27
PRESSURE SENSOR

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

CODE IDENT. NO.	DWG. NO.
52681	14377
SCALE: 2x	SHEET 1 OF 1

PCB PIEZOTRONICS INC.

Model 402A17

In-line Amplifier

Installation and Operating Manual

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E-mail: info@pcb.com

OPERATING GUIDE

SERIES 401A & 402A

ICP SOURCE FOLLOWER AMPLIFIERS

CONNECTOR TYPE
401A Voltage-Follower

IN-LINE TYPE
402A Voltage-Follower

1.0 INTRODUCTION

The series 401Aand 402A are miniature, unity gain, impedance converting voltage amplifiers which operate from constant current power units in a 2-wire mode.

These epoxy potted amplifiers are designed to convert the high impedance voltage from piezoelectric transducers to a low impedance voltage able to drive most readout instruments directly.

The input impedance of these amplifiers is extremely high (10^9 & 10^{11} ohms) while the output impedance is less than 100 ohms.

Except for mechanical configuration, the 401A series is identical to the 402A series.

See Guide G-0001 for a complete coverage of the ICP (Integrated Circuit Piezoelectric) concept.

2.0 DESCRIPTION

The series 401A is the "connector" series, i.e. it is designed to attach directly to the 10-32 co-axial connector of piezoelectric transducers as shown in Figure 1.

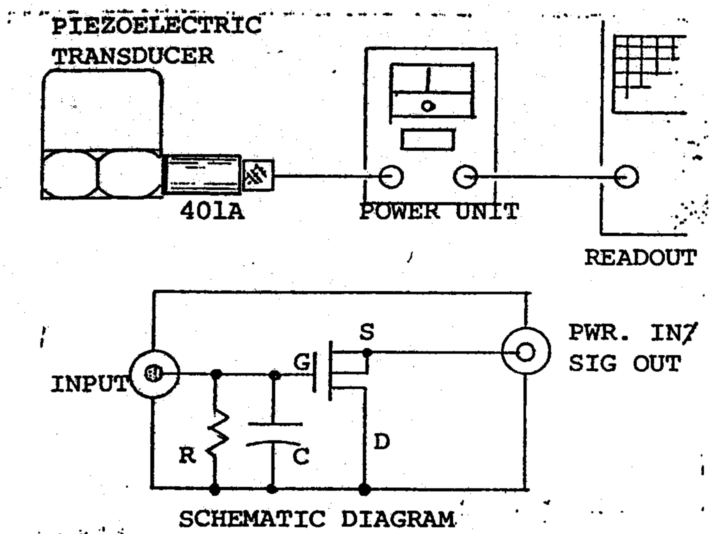

Figure 1
Typical Application
Series 401A

When used as in Figure 1, the piezoelectric transducer is converted to ICP operation.

The series 402A "in-line" series is designed to be used in a co-axial line as shown in Figure 2.

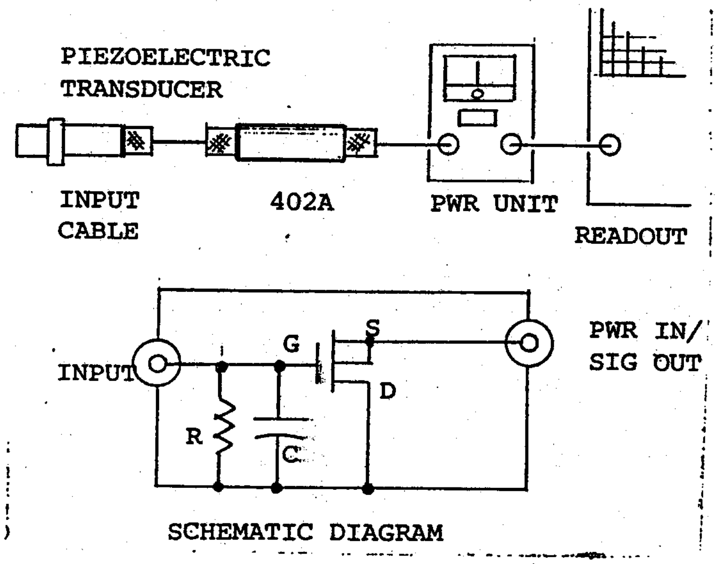

Figure 2
Typical Application
Series 402A

The series 402A is useful in field applications where high temperature or other severe environmental factors precludes the use of transducers with built-in amplifiers.

2.1 THEORY OF OPERATION

These impedance converting amplifiers utilize a MOSFET input integrated circuit as shown in Figures 1 & 2.

The circuit consists of a MOSFET input IC with a very high transconductance (gm) resulting in a voltage gain of very close to unity. The source terminal "follows" the gate voltage instantaneously and without a shift in phase, i.e. the amplifiers are non-inverting.

The input resistor, R serves 2 functions.

It biases the gate at drain potential for proper operation of the IC device and : it drains off spurious long term charge that exists at the input terminal from thermal effects on crystal transducer elements.

Because of the lowered insulation resistance of ceramic and non-quartz crystal transducers, this input resistance should be 10^9 ohms when used with such transducers. Consult our data sheets for the appropriate model numbers. (See section 7.0)

Quartz transducers on the other hand, have very high internal resistance and low capacitance, thus, the 10^{11} value of input resistance should be used for this type of transducer.

In both models, the outer case is at electrical ground potential.

2.2 INPUT DISCHARGE TIME CONSTANT

The input time constant is dependent upon two parameters, 1) the input resistor value 2) the total input capacitance.

The input capacitance value is the sum of all capacitance across the input connector, including transducer capacitance, cable capacitance (if used) and input ranging capacitor (C).

The input resistance is either 10^9 ohm or 10^{11} ohms depending upon exact model ordered.

To calculate the resultant discharge time constant (Sec), simply multiply the input resistor value (ohms) by the total shunt capacitance (farads).

Refer to Guide G0001 for effect of discharge TC on low frequency response.

2.3 RANGING

The voltage sensitivity of the transduction system varies inversely with the total input shunt capacitance and directly with the transducer charge sensitivity as follows:

$$V = \frac{Q}{C_t} \qquad \text{(Eq. 1)}$$

where:

Q = charge sensitivity of transducer in pC/mech. unit.

C_t = Total shunt capacitance in pF.

V = Voltage sensitivity in volts/mech. unit.

To obtain rough value of system sensitivity, simply divide the transducer charge sensitivity by total capacitance at the amplifier input as shown in Eq. 1.

Note: Don't forget to include input cable capacitance when using the series 402A.

To increase the range of a transducer i.e. to decrease system voltage sensitivity, select a 401A or 402A with larger value of input capacitor. 3 values are available; 10, 100 and 1000 pf.

Final system sensitivity should always be determined by calibration with known inputs.

3.0 INSTALLATION

The Model 401A is simply threaded directly on to the 10-32 coaxial connector of most transducers.

To exclude moisture from this high impedance input connection, protect joint with shrink tubing, RTV rubber coating or other suitable means.

Connect the power/signal connector to an ICP Power Unit such as the Model 480B, 482A, 484B, 483A etc. Using co-axial cable or solder connector adaptors (Model 070A09) and ordinary 2-wire cable.

In vibratory environments, clamp 402A to surface to prevent damage due to excessive shock motion. A plastic clamp is provided for this purpose.

Connect the power/signal connector to power unit as previously described for Model 401A.

Caution: Before connecting inputs to both models, short out cable and/or transducer to dissipate any accumulated charges.

4.0 OPERATION

Operation of these amplifiers is very similar to operation of ICP transducers.

All PCB Power Units have fault monitor meters on the front panel to monitor operation of the built-in amplifiers in ICP transducers. Since the Models 401A and 402A utilize the identical circuit as ICP transducers, use of the fault monitor meter is similar.

A mid-scale reading on the meter (green area) indicates proper bias level for the amplifier.

A zero reading (red area) indicates a shorted condition in the built-in amplifier or in the cable connecting amplifier to power unit.

A full scale reading (yellow area) indicates an open circuit condition in amplifier or interconnecting cable.

5.0 FREQUENCY RESPONSE

The low frequency response of these amplifiers when used with piezoelectric transducers is dependent upon the discharge time constant (or coupling time constant of power unit, if shorter than the discharge TC) in accordance with the following relationship:

$$f_o = \frac{.16}{RC} \qquad \text{(Eq 2)}$$

where:

f_o = -3db low freq. cut-off, (Hz)

RC = input discharge TC

See section 6.1.1 of Guide G-0001 for a more thorough discussion of this topic.

The high frequency response of these amplifiers, for small signals and driving short cables is better than 1 megahertz.

For optimum frequency response when driving long cables at maximum output voltages, use maximum allowable input current (20mA).

Many PCB Power Units such as 482A & 484B have adjustable output current to facilitate driving long lines at high voltage levels.

In most cases, high frequency response in actual use will be limited by transducer parameters.

6.0 MAINTENANCE

The miniature size and epoxy encapsulation precludes most maintenance. Should input connectors become dirty, reducing input time constant, clean with lint free wipes dipped in freon TF (R) or other suitable solvent. Avoid solvent containing ketones.

Caution: Avoid touching the input terminal directly with the fingers since accumulated static charge can destroy the input MOSFET.

After wiping input connector, dry in oven at 200°F for several hours. Do not heat beyond +250°F.

7.0 CAUTION - HIGH OUTPUT, THERMALLY SENSITIVE TRANSDUCERS

Certain ceramic transducers are capable of generating huge quantities of charge (and voltage) when affected by relatively small thermal transients such as when picked up by hand.

In recent tests at PCB, a ceramic accelerc meter, when picked up and held in the hand produced over 100,000 pC of charge resulting in over 100 volts into a high impedance load, over a period of several seconds.

High voltages like this can destroy the input mosfet in the 401A and 402A if not drained away fast enough.

For transducers such as these, it may be necessary to reduce the input resistor below 1×10^9 ohms (1×10^8 or 1×10^7) to rapidly dissipate such spurious outputs. Generally, internal capacitances of these types of transducers are extremely high ($>$ 1000 pF) resulting in adequate low frequency response, even with the low value input resistance. Consult factory if it is decided this problem exists in your installation.

MANUAL NUMBER: 1842
MANUAL REVISION: NR

.2674

Model Number	IN-LINE AMPLIFIER	Revision: D
402A17		ECN #: 29854

Performance	ENGLISH	SI	
Input Range	± 5.0 V	± 5.0 V	
Overrange	± 10 V	± 10 V	[2]
Output Range(AC)	± 5.0 V	± 5.0 V	
Voltage Gain(± 2 %)(non-inverting)	0.98	0.98	
Low Frequency Cutoff(-5 %)	1.0 Hz	1.0 Hz	[3]
High Frequency Response	1000 kHz	1000 kHz	[4]
Environmental			
Temperature Range(Operating)	-65 to +250 °F	-54 to +121 °C	
Maximum Shock	5000 g pk	49,050 m/s² pk	
Maximum Vibration(5 to 2000 Hz)	1000 g pk	9810 m/s² pk	
Electrical			
Excitation Voltage	18 to 28 VDC	18 to 28 VDC	
Constant Current Excitation	2 to 20 mA	2 to 20 mA	
Output Bias Voltage	8 to 14 VDC	8 to 14 VDC	
Input Resistance(± 20 %)	10^9 ohm	10^9 ohm	
Input Capacitance(± 10 %)	500 pF	500 pF	
Maximum Input Voltage(without damage)	100 V	100 V	
Discharge Time Constant(± 30 %)	0.5 sec	0.5 sec	[1]
Output Impedance	<100 ohm	<100 ohm	
Broadband Electrical Noise(1 to 10 kHz)	43.0 µV	43.0 µV	
Physical			
Housing Material	Stainless Steel	Stainless Steel	
Sealing	Welded Hermetic	Welded Hermetic	
Electrical Connector(Input)	10-32 Coaxial Jack	10-32 Coaxial Jack	
Electrical Connector(Output)	10-32 Coaxial Jack	10-32 Coaxial Jack	
Size (Diameter x Length)	0.25 in x 1.17 in	6.4 mm x 29.7 mm	
Weight	0.132 oz	3.75 gm	

CE [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.

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] Actual Discharge Time Constant is the product between the Input Resistance and the Total Input Capacitance (including cable capacitance and sensor capacitance).
[2] For +10 volt output, minimum 24 VDC supply voltage required. Negative 10 volt output may be limited by output bias.
[3] Actual Low Frequency Cutoff is approximately 0.5 ÷ Actual Discharge Time Constant.
[4] High frequency response may be limited by supply current and output cable length.
[5] See PCB Declaration of Conformance PS024 for details.

Entered: BLS	Engineer: BSH	Sales: RWM	Approved: EB	Spec Number:
Date: 12/18/08	Date: 12/16/08	Date: 12/16/08	Date: 12/18/08	402-1170-80

PCB PIEZOTRONICS™
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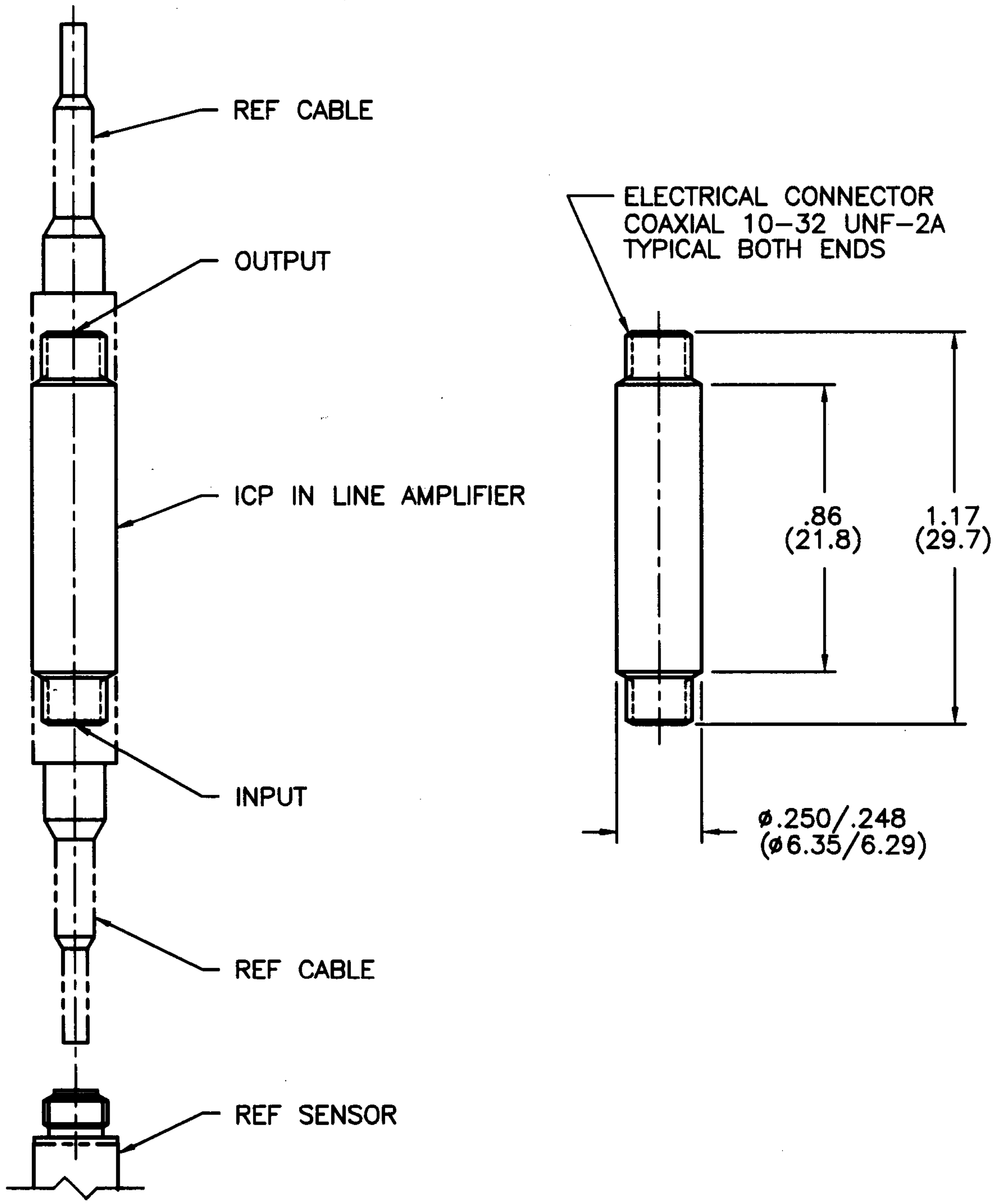
402-1010-90

APPLICATION		
NEXT ASS'Y	USED ON	VAR

REVISIONS				
REV	DESCRIPTION	ECN	DATE	APP'D
E	REVISED PER ECN	12019	6/16/00	DM 6/00



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. B 03/13/98	

DRAWN	MDP	6/16/00	MFG	TDS	6/20/00
CHK'D	DM	6/20/00	ENGR	RF	6/23/00
APP'D	RJV	7/13/00	SMO	RRR	7/13/00

TITLE INSTALLATION DRAWING
MODEL SERIES 402A ICP
IN LINE AMPLIFIER

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

CODE IDENT. NO.	DWG. NO.
52681	402-1010-90
SCALE: 2X	SHEET 1 OF 1