SENSORS FOR ENVIRONMENTAL TESTING

PCB PIEZOTRONICS
AN AMPHENOL COMPANY

ENDEVCO
AN AMPHENOL COMPANY

pcb.com | endevco.com

ENVIRONMENTAL TEST

INTRODUCTION

PCB Piezotronics was founded in 1967 as a manufacturer of piezoelectric quartz sensors and associated electronics for the measurement of dynamic pressure, force, and acceleration. The unique expertise of the company was the incorporation of microelectronic signal conditioning circuitry within these sensors to make them easier to use and more environmentally compatible. These ICP® sensors gained wide popularity and became the foundation for the company's success.

Subsequent growth and steady investment in facilities, machinery, and equipment permitted a constant broadening of the product offering. Measurement capabilities expanded with the addition of piezoceramic, tourmaline, capacitive, piezoresistive, and metal strain gage sensing technologies. Ensuing products include industrial accelerometers, DC MEMS accelerometers, load cells, torque sensors, microphones, pressure transmitters, and calibration equipment.

Founded in 1947, Endevco is one of the most trusted brands in test and measurement sensors. It was acquired by PCB in 2019. Combining Endevco's world class innovation with PCB's world class Total Customer Satisfaction (TCS) enables us to provide products and service that are unmatched in the sensor market.

QUALITY SYSTEM CERTIFICATIONS

PCB® Quality Systems are certified to the requirements of the following International Standards:

AS9100:2016 QMS Certified by DQS, Inc.: Requirements for Aviation, Space and Defense

ISO 9001:2015 QMS Certified by DQS, Inc: Quality Management Systems requirements

ISO17025 and ANSI-Z-540-1: Requirements for Competence of Testing & Calibration Laboratories

EN13980 & Directive 94/9/EC: Quality Systems for Potentially Explosive Atmospheres

These standards strive for process consistency and provide a means for continuous improvement while covering the entire product cycle, which includes contracting, product design control, manufacturing process control and inspection and test. In-house calibration of PCB® sensors is conducted with full traceability to National and International Institutes of Standards and Technology (N.I.S.T., P.T.B). In addition, a complete listing of A2LA accredited calibration services is documented on PCB's "Scope of Calibration" document(s). Assurance of quality system conformity is provided by certifying bodies and through our internal auditing system. In addition, our system remains compliant with obsolete or superseded standards such as: ISO 10012-1 (former MIL-STD-45662A), Guide 25, MIL-Q-9858 and MIL-I-45208. PCB is also compliant to nuclear power plant specification 10CFR50 Appendix B. PCB sensors are capable of testing MIL-STD-810 and MIL-STD-461. If you require compliance to a product or application specific standard (such as RoHS, European CE Marking, or US test requirement MIL-STD-740-2) which was not mentioned, please contact the factory for additional information.

TABLE OF CONTENTS

HALT/HASS ICP® Test Accelerometers 4

High Temperature Accelerometers ..... 5 - 6

Filtered Accelerometers 7

High Amplitude ICP® Shock Accelerometers ..... 8 - 9

Piezoresistive Accelerometers ..... 10 - 13

Low Outgassing ICP® & Charge Mode Accelerometers and Cables ..... 14 - 19

High Temperature Charge Mode Accelerometers ..... 20 - 23

Cryogenic ICP® Accelerometers ..... 24 - 26

Extreme Environment ICP® & Charge Output Pressure Sensors ..... 27 - 29
- Water Cooled, Helium Bleed Pressure Sensors 27
- High Temperature Charge Output & Cryogenic ICP® Pressure Sensors ..... 28 - 29

Shakers for Modal Testing ..... 30 - 31

Force Limited Vibration Testing Systems ..... 32 - 35
- 3-Component ICP® & Charge Output Force Sensors ..... 32 - 34
- Signal Conditioning & Summing Amplifiers 35

Underwater Sensors ..... 36 - 38
- Rapidly Fluctuating Pressure, Flow, Screw Cavitation & Wave Slap 36
- Vibration 37
- Underwater Blast 38

Portable System Verification Instruments 39

HALT/HASS ICP® TEST ACCELEROMETERS

Environmental Stress Screening (ESS) is the practice of exposing primarily electronic products to environmental stresses in an attempt to create failures and expose defects. HALT and HASS represent two types of ESS:

Highly Accelerated Life Testing (HALT) is a design verification process, which exposes a product to very rapid and extreme changes in vibration in temperature in an effort to quickly uncover design and assembly flaws.

Highly Accelerated Stress Screening (HASS) is a weeding-out process that involves testing 100 percent of final products in an effort to identify those which may possess a higher probability of early failure.

ESS GENERAL PURPOSE QUARTZ SHEAR ICP® ACCELEROMETER

PCB MODEL 320C18

Sensitivity: 10 mV/g

Measurement Range: ±500 g pk

Frequency Range (±5%): 1 - 10k Hz

ESS GENERAL PURPOSE QUARTZ SHEAR ICP® ACCELEROMETER

PCB MODEL 320C03

Sensitivity: 10 mV/g

Measurement Range: ±500 g pk

Frequency Range (±5%): 1 - 6k Hz

ESS GENERAL PURPOSE QUARTZ SHEAR ICP® ACCELEROMETER

PCB MODEL 320C04

Sensitivity: 10 mV/g

Measurement Range: ±500 g pk

Frequency Range: (±5%): 1 - 6k Hz

ESS GENERAL PURPOSE QUARTZ SHEAR ICP® ACCELEROMETER

PCB MODEL 320C15

Sensitivity: 10 mV/g

Measurement Range: ±500 g pk

Frequency Range: (±5%): 1 - 10k Hz

ESS HIGH SENSITIVITY QUARTZ SHEAR ICP® ACCELEROMETER

PCB MODEL 320C20

Sensitivity: 10 mV/g

Measurement Range: ±500 g pk

Frequency Range: (±5%) 2 - 5k Hz

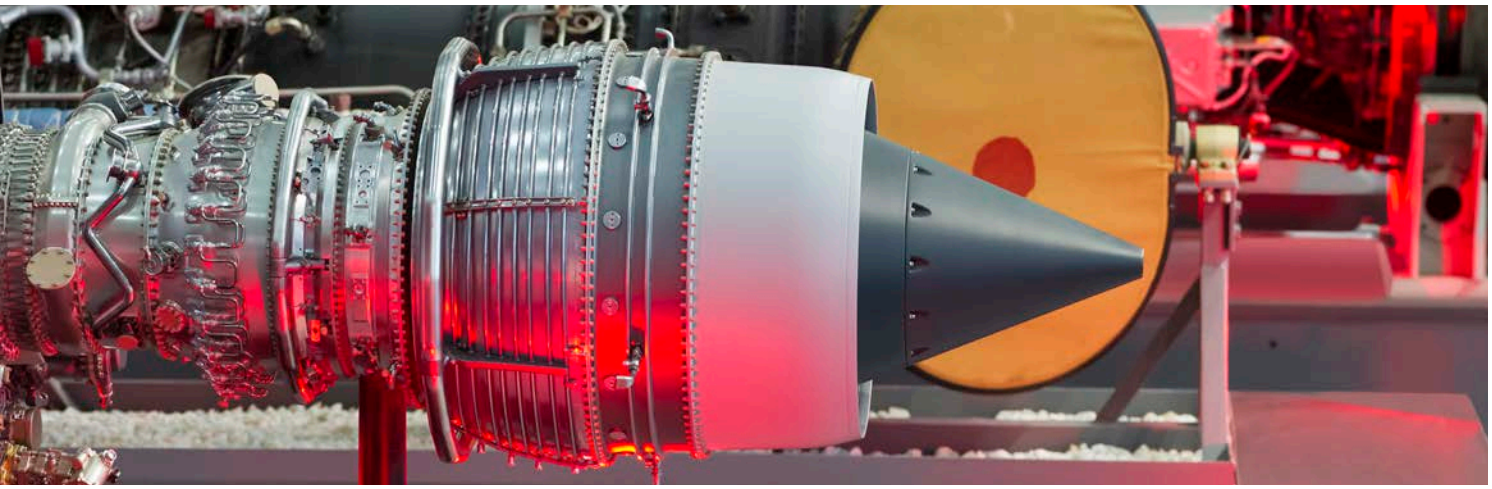
ESS HIGH SENSITIVITY QUARTZ SHEAR ICP® ACCELEROMETER

PCB MODEL 320C33

Sensitivity: 100 mV/g

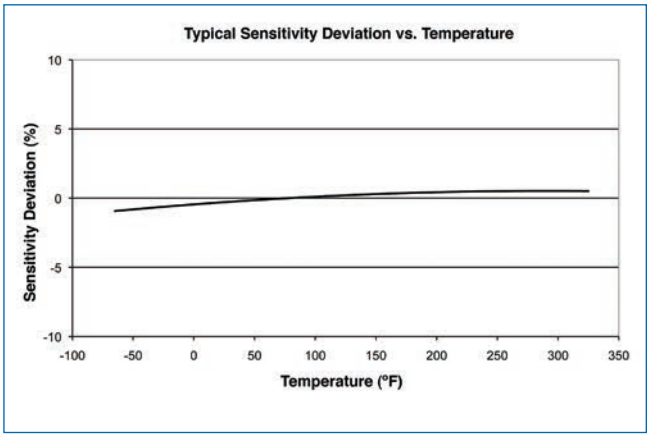
Measurement Range: ±50 g pk

Frequency Range: (±5%) 1 - 4k Hz



HIGH TEMPERATURE ICP® ACCELEROMETERS

PCB® single axis and triaxial ICP® accelerometers are designed with a temperature coefficient as low as 0.005% / °F (0.009% / °C), wide operating temperature range, and good broadband measurement resolution, making them ideal for any vibration measurement requiring tight control of amplitude sensitivity over a wide thermal gradient. To alleviate the effects of high frequency overloads some models have a low pass filter incorporated, ensuring accurate data in the frequency range of interest.



UHT-12™ MINIATURE ICP® ACCELEROMETER

PCB MODEL 320C52

Sensitivity: 10 mV/g

Measurement Range: ±500 g pk

Frequency Range: (±5%) 1 - 10k Hz

UHT-12™ MINIATURE ICP® ACCELEROMETER

PCB MODEL 320C53

Sensitivity: 1 mV/g

Measurement Range: ±5k g pk

Frequency Range: (±5%) 1 - 5k Hz

UHT-12™ TRIAXIAL ICP® ACCELEROMETER

PCB MODEL 339A30

Sensitivity: 10 mV/g

Measurement Range: ±500 g pk

Frequency Range: (±5%) 2 - 8k Hz

UHT-12™ TRIAXIAL ICP® ACCELEROMETER

PCB MODEL 339B31

Sensitivity: 10 mV/g

Measurement Range: ±500 g pk

Frequency Range: (±5%) 2 - 8k Hz

UHT-12™ LOW-PROFILE ICP® ACCELEROMETER

PCB MODEL 339B32

Sensitivity: 10 mV/g

Measurement Range: ±500 g pk

Frequency Range: (±5%) 2 - 10k Hz

UHT-12™ LOW-PROFILE ICP® ACCELEROMETER

PCB MODEL TLD339A34

Sensitivity: 50 mV/g

Measurement Range: ±100 g pk

Frequency Range: (±5%) 2 - 5k Hz

TRIAXIAL ICP® ACCELEROMETER WITH TEDS

PCB MODEL TLD339A36

Sensitivity: 10 mV/g

Measurement Range: ±500 g pk

Frequency Range: (±5%) 2 - 5k Hz

UHT-12™ TRIAXIAL ICP® ACCELEROMETER WITH TEDS

PCB MODEL TLD339A37

Sensitivity: 100 mV/g

Measurement Range: ±50 g pk

Frequency Range: (±5%) 0.3 - 4k Hz

UHT-12™ TRIAXIAL ICP® ACCELEROMETER

PCB MODEL HT356B01

Sensitivity: 5 mV/g

Measurement Range: ±1k g pk

Frequency Range: (±5%) 1 - 5k Hz

FILTERED ICP® ACCELEROMETERS

Impact testing of aerospace components often involves exposing the test specimen to dynamic stimuli, which include high levels of broadband excitation. This testing regiment can cause resonant behavior in brackets or other subassemblies that may be mounted to the component under test. A resonating component can cause vibration energy to be transmitted throughout the test structure, which can potentially corrupt or mask the measurement data of interest. Internal LP filtering is used to eliminate unwanted high magnitude high frequency signals that are above the structural frequency range of interest.

CERAMIC SHEAR ICP® ACCELEROMETER

PCB MODEL 352A60

Sensitivity: 10 mV/g

Measurement Range: ±500 g pk

Frequency Range (±5%): 5 to 60k Hz

MINIATURE LIGHTWEIGHT ICP® ACCELEROMETER

PCB MODEL 352A72

Sensitivity: 10 mV/g

Measurement Range: ±500 g pk

Frequency Range (±5%): 0.5 - 4.5k Hz

TRIAXIAL MINIATURE ICP® ACCELEROMETER

PCB MODEL 356A63

Sensitivity: 10 mV/g

Measurement Range: ±500 g pk

Frequency Range (±5%): 2 - 4k Hz

TRIAXIAL CERAMIC SHEAR ICP® ACCELEROMETER

PCB MODEL 356A66

Sensitivity: 10 mV/g

Measurement Range: ±500 g pk

Frequency Range (±5%): 2 - 4k Hz

SINGLE AXIS MINIATURE ICP® ACCELEROMETER

PCB MODEL 353B77

Sensitivity: 2 mV/g

Measurement Range: ±2500 g pk

Frequency Range: (±5%) 1 - 10k Hz

HIGH AMPLITUDE ICP® ACCELEROMETER

PCB MODEL 350B50

Sensitivity: 0.5 mV/g

Measurement Range: ±10k g pk

Frequency Range (±1dB): 3 - 10k Hz

HIGH AMPLITUDE ICP® ACCELEROMETER

ENDEVCO MODEL 65HTLPF

Sensitivity: 10 mV/g

Measurement Range: ±500 g pk

Frequency Range (±5dB): 1k / 5k Hz

HIGH AMPLITUDE ICP® SHOCK ACCELEROMETERS

Piezoelectric ICP® accelerometers afford a very high signal output (+/- 5 volts full scale) and the ease of two-wire electrical connectivity. Their inherent ruggedness enables them to be severely over ranged without damage. The addition of internal mechanical isolation minimizes the high frequency stress that is transferred to their sensing elements. This mechanical isolation, coupled with an internal 2-pole electrical filter built into the ICP® circuitry, tailors the overall accelerometer response to assure data quality to 10 kHz and up to 100k g's. Full scale linearity is verified through calibration in accordance with MIL-STD-810.

SHOCK ICP® ACCELEROMETER

PCB MODEL 350C23

Sensitivity: 0.5 mV/g

Measurement Range: ±10k g pk

Frequency Range (±1dB): 0.4 - 10k Hz

SHOCK ICP® ACCELEROMETER

PCB MODEL 350C24

Sensitivity: 1 mV/g

Measurement Range: ±5k g pk

Frequency Range (±1dB): 0.4 - 10k Hz

SHOCK ICP® ACCELEROMETER

PCB MODEL 350B01

Sensitivity: 0.05 mV/g

Measurement Range: ±100k g pk

Frequency Range (±1dB): 4 - 10k Hz

SHOCK ICP® ACCELEROMETER

PCB MODEL 350D02

Sensitivity: 0.1 mV/g

Measurement Range: ±50k g pk

Frequency Range (±1db): 4 - 10k Hz

TRIAXIAL SHOCK ICP® ACCELEROMETER

PCB MODEL 350B41

Sensitivity: 0.05 mV/g

Measurement Range: ±100k g pk

Frequency Range (±1dB): 0.4 - 10k Hz

TRIAXIAL SHOCK ICP® ACCELEROMETER

PCB MODEL 350B42

Sensitivity: 0.1 mV/g

Measurement Range: ±50k g pk

Frequency Range (±1dB): 0.4 - 10k Hz

TRIAXIAL SHOCK ICP® ACCELEROMETER

PCB MODEL 350B43

Sensitivity: 0.5 mV/g

Measurement Range: ±10k g pk

Frequency Range (±1dB): 0.4 - 10k Hz

TRIAXIAL SHOCK ICP® ACCELEROMETER

PCB MODEL 350B44

Sensitivity: 1 mV/g

Measurement Range: ±5k g pk

Frequency Range (±1dB): 0.4 - 10k Hz

PIEZORESISTIVE ACCELEROMETERS

Piezoresistive high g shock accelerometers are available in both undamped and lightly damped models to provide high-reliability shock and vibration measurements in extreme environments. With available measurement ranges from 2k to 200k g, these accelerometers feature rugged piezoresistive MEMS sensing elements.

Our in-house MEMS manufacturing techniques allow us to offer a product with compact size, high sensitivity, and exceptional overrange, while ensuring the repeatability and reliability required for mission critical applications. Product variations include single axis or triaxial configurations and screw, stud, and surface mounting options.

APPLICATIONS:

- Mechanical shock testing
- Shock wave monitoring
- Drop and impact testing
- Portable electronic device testing
- High-shock data recorders
- Near and far-field pyroshock testing
- Weapons and rocket testing
- Fuze/safe and arm

HIGHLIGHTS:

- Multiple mounting configurations
- Minimal zero shift after shock
- High survivability in overrange environments
- DC response for long duration transient events
- Ranges up to 200k g
- Undamped for broad frequency response or damped for exceptional survivability
- Miniature SMT versions for embedded applications

UNDAMPED PIEZORESISTIVE ACCELEROMETERS

The Endevco brand of undamped shock accelerometers dates back over four decades and are used on many long standing programs that require high frequency. They are used by our most experienced customers primarily engaged in research and development applications, where careful preparation of the experiment is performed and attention is given to minute instrumentation details such as sample rate, anti-aliasing filter selection and detailed post process analysis.

HIGH RESONANCE UNDAMPED PIEZORESISTIVE ACCELEROMETER

ENDEVCO MODEL 7270A

Sensitivity: 10 / 3 / 1 / .3 / .1 uV/V/g

Measurement Range:
±2K / ±6K / ±20K / ±60K / ±200K g

Frequency Range (+/-5%):
10 / 20 / 50 / 100/ 150 kHz

HIGH RESONANCE UNDAMPED PIEZORESISTIVE ACCELEROMETER

ENDEVCO MODEL 7270AM4

Sensitivity: 10 / 3 / 1 / .3 / .1 uV/V/g

Measurement Range:
±2K / ±6K / ±20K / ±60K / ±200K g

Frequency Range (+/-5%):
10 / 20 / 50 / 100/ 150 kHz

RUGGED UNDAMPED PIEZORESISTIVE ACCELEROMETER

ENDEVCO MODEL 7270AM6

Sensitivity: 10 / 3 / 1 / .3 uV/V/g

Measurement Range:
±2K / ±6K / ±20K / ±60K g

Frequency Range (+/-5%): 10 kHz

EXTREMELY RUGGED UNDAMPED PIEZORESISTIVE ACCELEROMETER

ENDEVCO MODEL 7270AM7

Sensitivity: 10 / 3 / 1 / .3 / .1 uV/V/g

Measurement Range:
±2K / ±6K / ±20K / ±60K / ±200K g

Frequency Range (+/-5%):
10 / 20 / 50 / 100/ 150 kHz

HIGH RESONANCE UNDAMPED PIEZORESISTIVE TRIAXIAL ACCELEROMETER

ENDEVCO MODEL 7274A

Sensitivity: 10 / 3 / 1 / .3 uV/V/g

Measurement Range:
±2K / ±6K / ±20K / ±60K g

Frequency Range (+/-5%):
18 / 36 / 70 / 140 kHz

UNDAMPED PIEZORESISTIVE SURFACE MOUNT ACCELEROMETERS

Endevco undamped surface mount configurations allow for use in circuit board OEM applications.

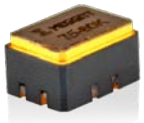
UNDAMPED PIEZORESISTIVE SURFACE MOUNT ACCELEROMETER

ENDEVCO MODEL 71M

Sensitivity: 10 / 3 / 1 / .3 uV/V/g

Measurement Range:
±2K / ±6K / ±20K / ±60K g

Frequency Range (+/-5%):
10 / 20 / 50 / 100 kHz



UNDAMPED PIEZORESISTIVE SURFACE MOUNT TRIAXIAL ACCELEROMETER

ENDEVCO MODEL 75

Sensitivity: 10 / 3 / 1 / .3 uV/V/g

Measurement Range:
±2K / ±6K / ±20K / ±60K g

Frequency Range (+/-5%):
18 / 36 / 70 / 140kHz

LIGHTLY DAMPED PIEZORESISTIVE SURFACE MOUNT SHOCK ACCELEROMETERS

The PCB and Endevco brands of lightly damped shock accelerometers feature over range stops for improved survivability. Damping also helps improve data recorder resolution compared to undamped versions.

LIGHTLY DAMPED PIEZORESISTIVE SURFACE MOUNT SHOCK ACCELEROMETER

PCB MODEL 3501A20XXKG

Sensitivity: 1 / .3 uV/V/g

Measurement Range: 20K / 60K g

Frequency Range (+/-5%): 10 / 20 kHz

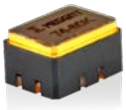
LIGHTLY DAMPED PIEZORESISTIVE SURFACE MOUNT SHOCK ACCELEROMETER

ENDEVCO MODEL 72

Sensitivity: 30 / 1.6 / .6 uV/V/g

Measurement Range: 2K / 20K / 60K g

Frequency Range (+/-5%):
10 / 10 / 20 kHz



LIGHTLY DAMPED PIEZORESISTIVE SURFACE MOUNT SHOCK ACCELEROMETER

ENDEVCO MODEL 74

Sensitivity: 30 / 1.6 / .5 uV/V/g

Measurement Range: 2K / 20K / 60K g

Frequency Range (+/-5%):
5 / 10 / 13 kHz

DAMPED PIEZORESISTIVE ACCELEROMETERS

The PCB and Endevco brands of damped shock accelerometers feature over range stops for improved survivability. Damping also helps improve data recorder resolution compared to undamped versions.

HIGH SENSITIVITY MULTI-MODE DAMPING PIEZORESISTIVE ACCELEROMETER

ENDEVCO MODEL 2262B

Sensitivity: 0.45 / 0.3 / 0.015 uV/V/g

Measurement Range:
±1K / ±2K / ±6K g

Frequency Range (+/-5%): 3000 kHz

LIGHTLY DAMPED STUD MOUNT PIEZORESISTIVE ACCELEROMETER

PCB MODEL 3501B12XXKG

Sensitivity: 1 / .3 uV/V/g

Measurement Range: ±20K / ±60K g

Frequency Range (+/-5%): 10/20 kHz

EXTREMELY RUGGED LIGHTLY DAMPED PIEZORESISTIVE ACCELEROMETER

ENDEVCO MODEL 7280AM4

Sensitivity: 30 / 1.6 / .5 uV/V/g

Measurement Range:
±2K / ±20K / ±60K g

Frequency Range (+/-5%):
5 / 10 / 13 kHz

LIGHTLY DAMPED THRU HOLE MOUNT PIEZORESISTIVE ACCELEROMETER

PCB MODEL 3991B12XXKG

Sensitivity: 1 / .3 uV/V/g

Measurement Range: ±20K / ±60K g

Frequency Range (+/-5%):
10 / 20 kHz

EXTREMELY RUGGED LIGHTLY DAMPED PIEZORESISTIVE ACCELEROMETER

ENDEVCO MODEL 7280AM7

Sensitivity: 30 / 1.6 / .5 uV/V/g

Measurement Range:
±2K / ±20K / ±60K g

Frequency Range (+/-5%):
5 / 10 / 13 kHz

LOW POWER LIGHTLY DAMPED PIEZORESISTIVE ACCELEROMETER

ENDEVCO MODEL 7280A

Sensitivity: 30 / 1.6 / .5 uV/V/g

Measurement Range:
±2K / ±20K / ±60K g

Frequency Range (+/-5%):
5 / 10 / 13 kHz

LIGHTLY DAMPED THRU HOLE MOUNT PIEZORESISTIVE ACCELEROMETER

PCB MODEL 3503A11XXKG

Sensitivity: 1 / .3 uV/V/g

Measurement Range: 20K / 60K g

Frequency Range (+/-5%):
10 / 20 kHz

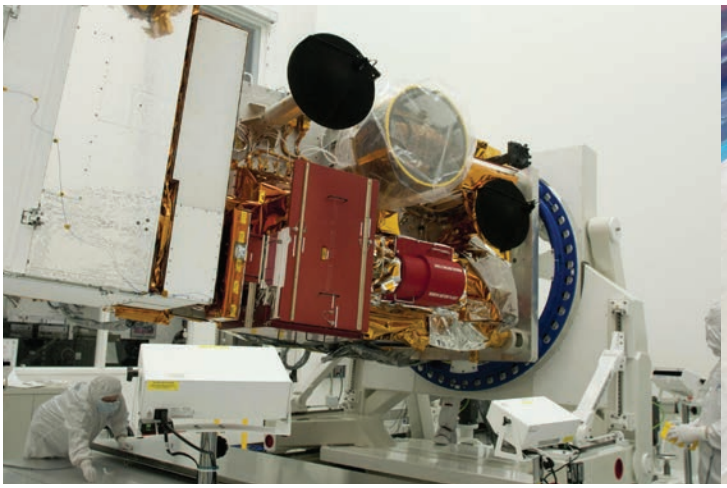
LIGHTLY DAMPED THRU HOLE MOUNT PIEZORESISTIVE ACCELEROMETER

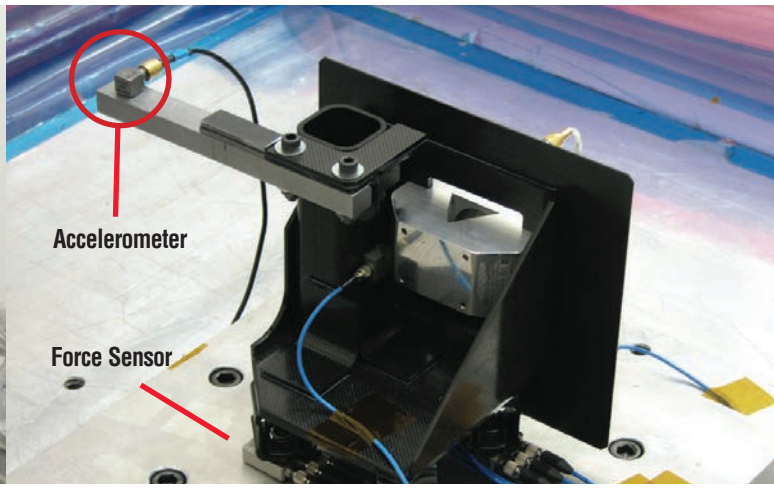
ENDEVCO MODEL 7284A

Sensitivity: 30 / 1.6 / .5 uV/V/g

Measurement Range:
2K / 20K / 60K g

Frequency Range (+/-5%):
10 / 10 / 20 kHz





PCB® Model 356M208 accelerometer & force sensors used during vibration testing of bracket assembly at Utah State Space Dynamics Lab

LOW OUTGASSING ICP® ACCELEROMETERS AND CABLES

PCB's low outgassing accelerometers and cables are standard products whose specifications are designed for use in high-vacuum applications such as satellite ground testing and in space.

THERMAL VACUUM VIBRATION TESTING

Exposure to the high vacuum level of a space environment induces material outgassing in ordinary accelerometers and cables. Any substance subjected to a vacuum has the potential to release trapped gasses. Contaminants from outgassing can condense onto nearby surfaces obscuring them, rendering them useless during their intended application.

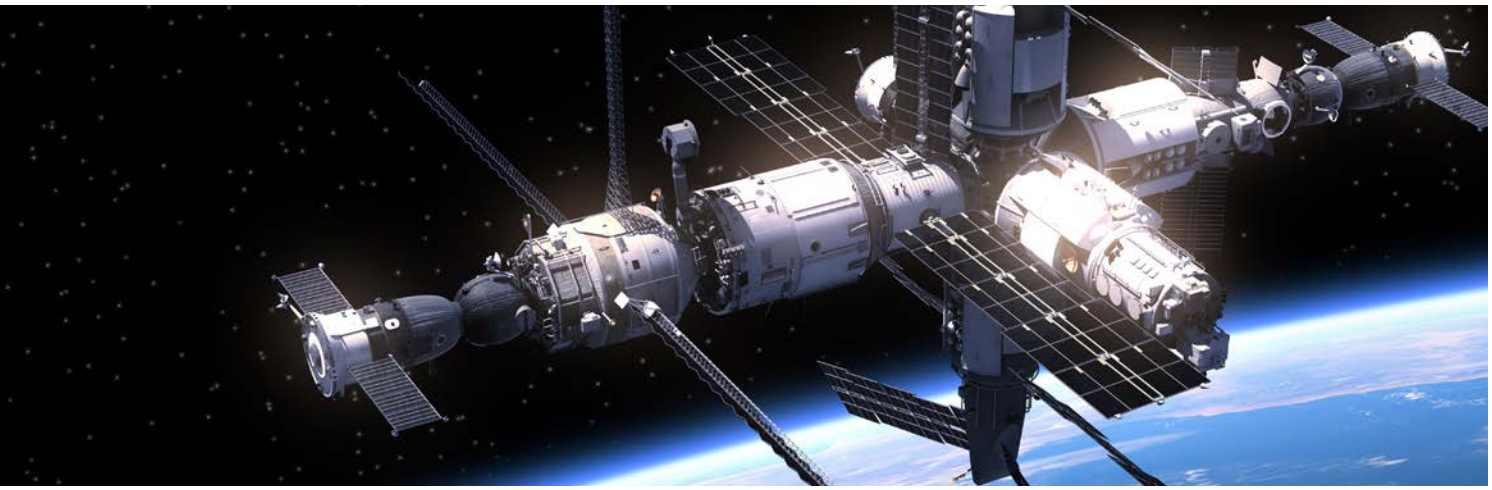
Many hermetic accelerometer designs have inherent low outgassing qualities. Cables with rubberized boots or shrink tubing typically do not have low outgassing qualities.

For all non-metallic materials outside of a hermetic package required for an application in a vacuum environment, PCB® verifies that the material has less than or equal to 1% TML (total mass loss) and a CVCM (collected volatile condensable mass material) less than or equal to 0.1%. This is verified either using NASA documentation or test results from an outside laboratory.

In any application involving a vacuum environment, the important things to consider when selecting low outgassing accelerometers and cables are: welded hermetic housings, polymers and epoxies that have low TML and CVCM values, and leak testing services for low outgas verification of accelerometers.

Highlights:

- Vibration measurements in thermal vacuum or space environment
- Welded hermetic accelerometer designs have low outgassing qualities
- Hermeticity testing is performed on all hermetic products at PCB®
- Cables with strain relief use polymers are verified for total mass loss and collected volatile condensable material
- Materials selected using NASA guidelines



LOW OUTGASSING ACCELEROMETERS

LOW OUTGASSING MINIATURE CHARGE OUTPUT ACCELEROMETER

PCB MODEL 357A07

Sensitivity: 1.7 pC/g

Measurement Range: ±2k g pk

Frequency Range (+5%): 15k Hz

MINIATURE CHARGE OUTPUT ACCELEROMETER WITH CABLE

PCB MODEL P357A09/030EK001PH

Sensitivity: 1.7 pC/g

Measurement Range: ±2k g pk

Frequency Range (+5%): 10k Hz

LOW OUTGASSING SHOCK ICP® ACCELEROMETER

PCB MODEL 350M88A

Sensitivity: 0.5 mV/g

Measurement Range: ±10k g pk

Frequency Range (±1dB): 0.4 - 10k Hz

LOW OUTGASSING TEARDROP ICP® ACCELEROMETER

PCB MODEL 352M212

Sensitivity: 10 mV/g

Measurement Range: ±500 g pk

Frequency Range (±5%): 0.5 - 10k Hz

LOW OUTGASSING MINIATURE ICP® TRIAXIAL ACCELEROMETER

PCB MODEL 356M57

Sensitivity: 10 mV/g

Measurement Range: ±500 g pk

Frequency Range (±5%):
2 - 10k Hz (y or z axis)
2 - 7k Hz (x axis)

LOW OUTGASSING MINIATURE LIGHTWEIGHT ICP® TRIAXIAL ACCELEROMETER

PCB MODEL 356A06/NC & 356A09/NC

Sensitivity: Available in 5 mV/g and 10 mV/g

Measurement Range:
±1k g pk

Frequency Range (±5%):
2 - 8k Hz (y or z axis)
2 - 5k Hz (x axis)

LOW OUTGASSING MINIATURE LIGHTWEIGHT ICP® TRIAXIAL ACCELEROMETER

PCB MODEL 356M208/NC & 356M239

Sensitivity: Available in 5 mV/g and 10 mV/g

Measurement Range:
±1k g pk

Frequency Range (±5%):
2 - 8k Hz (y or z axis)
2 - 5k Hz (x axis)

LOW OUTGASSING ICP® TRIAXIAL ACCELEROMETER WITH LOW MASS CABLE

PCB MODEL 356M234

Sensitivity: 5 mV/g

Measurement Range: ±1k g pk

Frequency Range (±5%):
2 - 8k Hz (y or z axis)
2 - 5k Hz (x axis)

HIGH AMPLITUDE ICP® TRIAXIAL ACCELEROMETER WITH LOW-PASS FILTER

PCB MODEL 350B50/XXXBZ/NC

Sensitivity: (±30%) 0.5 mV/g

Measurement Range: ±10k g pk

Frequency Range (±1 dB): 3 to 10k Hz

LOW OUTGASSING ICP® TRIAXIAL ACCELEROMETER

PCB MODEL TLD356M131

Sensitivity: 10 mV/g

Measurement Range: ±500 g pk

Frequency Range (±5%): 2 - 3k Hz

LOW OUTGASSING TITANIUM ICP® TRIAXIAL ACCELEROMETER

PCB MODEL 356M98

Sensitivity: 1k mV/g

Measurement Range: ±5 g pk

Frequency Range (±5%): 0.5 - 3k Hz

LOW OUTGASSING HIGH SENSITIVITY ICP® TRIAXIAL ACCELEROMETER

PCB MODEL 356M132

Sensitivity: 500 mV/g

Measurement Range: ±10 g pk

Frequency Range (±5%): 0.5 - 3k Hz

LOW OUTGASSING MINIATURE ICP® TRIAXIAL ACCELEROMETER

PCB MODEL 354M56

Sensitivity: 10 mV/g

Measurement Range: ±500 g pk

Frequency Range (±5%): 2 - 8k Hz

LOW OUTGASSING ICP® TRIAXIAL ACCELEROMETER WITH TEDS

PCB MODEL TLD356M155

Sensitivity: 2.5 mV/g

Measurement Range: ±2k g pk

Frequency Range (±5%):
1 - 10k Hz (y or z axis)
1 - 6k Hz (x axis)

LOW OUTGASSING ICP® TRIAXIAL ACCELEROMETER WITH TEDS

PCB MODEL 356A19

Sensitivity: 10 mV/g

Measurement Range: ±500 g pk

Frequency Range (±5%):
1 - 13k Hz (all axis)

LOW OUTGASSING CABLES FOR SINGLE AXIS ACCELEROMETERS

PCB MODEL 002A10

Sensor connecting cable for ICP®

General purpose, coaxial FEP

10-ft, 10-32 plug to 10-32 plug

PCB MODEL 003A10

Sensor connecting cable

Low-noise, coaxial TFE

10-ft, 10-32 plug to 10-32 plug

PCB MODEL 003M208

Sensor connecting cable

Low-noise, coaxial TFE

10-ft, 5-44 plug to 10-32 plug

PCB MODEL 003M269/010

Connecting cable

Low-noise, coaxial TFE

10-ft, 10-32 plug to BNC plug

PCB MODEL 030B10

Sensor connecting cable

Low-noise, coaxial FEP

10-ft, M3 plug to 10-32 jack

PCB MODEL 030A10

Sensor connecting cable

Low-noise, coaxial FEP

10-ft, 3-56 plug to 10-32 plug

PCB MODEL 030EK010PH

Sensor connecting cable

Low-noise, coaxial FEP

10-ft, 3-56 plug to 10-32 jack

PCB MODEL 098EB010EB

Extension cable

Low-noise, coaxial TFE

10-ft, 10-32 plug to 10-32 plug

PCB MODEL 098PW010PW

Connecting cable

Low-noise, green, coaxial, TFE cable with stranded conductor

10 ft, BNC plug to BNC plug (both with gold plated pins)

LOW OUTGASSING CABLES FOR TRIAXIAL ACCELEROMETERS

PCB MODEL 034M22

Sensor connecting cable

4-conductor shielded, FEP

20-ft, 4-pin 1/4-28 plug to
(3) BNC plugs

PCB MODEL 034M51

Extension cable

4-conductor shielded, FEP

40-ft, 4-pin 1/4-28 plug to
4-pin 1/4-28 plug

PCB MODEL 034M28/020

Sensor connecting cable

4-conductor shielded, FEP

20-ft, 4 pin 1/4-28 plug to
(3) 10-32 plugs

PCB MODEL 034M21

Sensor connecting cable

4-conductor shielded, FEP

10-ft, mini 4-pin 8-36 plug to
(3) BNC plugs

PCB MODEL 010M128/040

Extension cable

4-conductor shielded, FEP

40-ft, 4-pin 1/4-28 plug to
4-pin 1/4-28 jack

PCB MODEL 068M01/020

Sensor connecting cable

4-conductor, 85% shield for low mass

20-ft, 4 pin 1/4-28 plug to blunt cut

Also available to (3) BNC or
(3) 10-32 plugs

PCB MODEL 070B14

Hermetic bulkhead feed-thru adaptor

Low outgassing

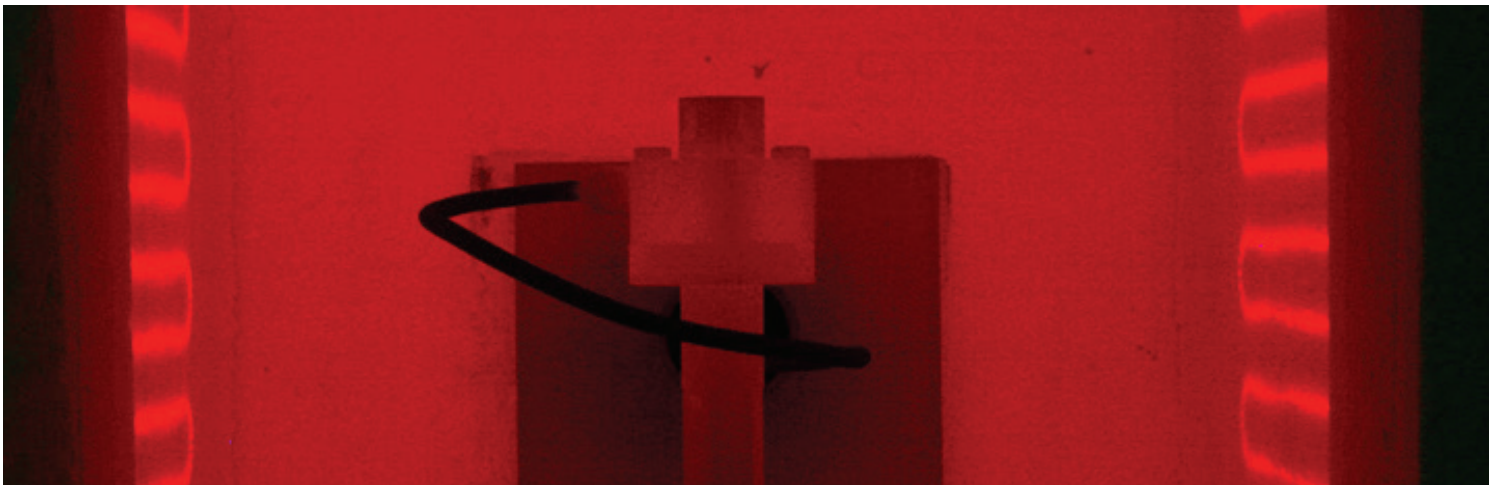
10-32 jack to 10-32 jack

PCB MODEL 080M233

Hermetic bulkhead feed-thru adaptor

Low outgassing

4-pin 1/4-28 jack to 1/4-28 jack



HIGH TEMPERATURE CHARGE MODE ACCELEROMETERS

Vibration testing of aircraft gas turbine engines, industrial turbines, rocket propulsion systems, and exhaust systems requires accelerometers that are designed to withstand very high temperature environments.

Because of its temperature and high/complex vibration environment, the turbine engine measurement environment is perhaps the most demanding application for accelerometers. With 30 years of high temperature measurement experience, PCB® has developed a range of piezoelectric materials and technologies that provide accurate, reliable measurements in this challenging environment. With the cost (and non-repeatability) of each turbine engine test, PCB®'s customers have come to expect and rely on this accuracy and reliability of our sensors.

UHT-12™ is a proprietary crystal designed for more accurate, lower noise measurements at elevated temperatures and trusted in the most demanding test environments. PCB® sensors made with UHT-12™ technology have an improved data quality compared to ceramic crystal designs.

The main technical advantages include:

- Absence of pyroelectric noise spikes up to 1200 °F (649 °C)
- Sensitivity that remains more consistent over a wide temperature change
- Shear mode crystals isolated from base strain & transverse measurement errors
- Proprietary crystal technology comes sealed in a hermetic package and has proven reliable performance in hundreds of gas turbine installations for research and monitoring

Applications:

- High temperature vibration measurements
- Engine compartment studies
- Exhaust component vibration tests
- Steam turbine testing
- Engine vibration analysis

MINIATURE TRIAXIAL CHARGE OUTPUT ACCELEROMETER

PCB MODEL 356A70 & 356A71

Temperature: -94 to +490 °F (-70 to +254 °C)

Sensitivity: 2.7 to 10 pC/g

Measuring range: 1500 g

Weight: 8 grams

MINIATURE RING-STYLE CHARGE OUTPUT ACCELEROMETER

PCB MODEL 357B06

Temperature: -65 to +500 °F (-54 to +260 °C)

Sensitivity: 5 pC/g

Measuring range: 500 g

Weight: 2.3 grams

HIGH TEMPERATURE MINIATURE CHARGE OUTPUT ACCELEROMETER

PCB MODEL 357B11

Temperature: -95 to +500 °F (-71 to +260 °C)

Sensitivity: 3 pC/g

Measuring range: 2300 g

Weight: 2 grams

CHARGE OUTPUT TRIAXIAL ACCELEROMETER WITH UHT-12™

PCB MODEL EX356A73

Temperature: -67 to +900 °F (-55 to +482 °C)

Sensitivity: 3.2 pC/g

Measuring range: ±500 g

Weight: 150 grams

UHT-12™ HIGH TEMPERATURE CHARGE OUTPUT ACCELEROMETER

PCB MODEL 357A63

Temperature: -65 to +900 °F (-54 to +482 °C)

Sensitivity: 0.53 pC/g

Measuring range: ±5000 g

Weight: 8.7 grams

HIGH TEMPERATURE CHARGE OUTPUT ACCELEROMETER

PCB MODEL 357B69

Temperature: -65 to +900 °F (-54 to +482 °C)

Sensitivity: 3.5 pC/g

Measuring range: ±500 g

Weight: 16.0 grams

MINIATURE CHARGE OUTPUT ACCELEROMETER

ENDEVCO MODEL 7240C

Temperature: -67 to +500 ºF

Sensitivity: 3 pC/g

Measuring range: 5k g pk

Weight: 4.8 grams

MINIATURE CHARGE OUTPUT ACCELEROMETER

ENDEVCO MODEL 2220E

Temperature: -67 to +500 ºF

Sensitivity: 3 pC/g

Measuring range: 5k g pk

Weight: 3.1 grams

MINIATURE CHARGE OUTPUT ACCELEROMETER

ENDEVCO MODEL 2230E

Temperature: -67 to +500 ºF

Sensitivity: 2.8 pC/g

Measuring range: 2kg pk

Weight: 17 grams

CHARGE OUTPUT ACCELEROMETER

ENDEVCO MODEL 2221F

Temperature: -67 to +500 ºF

Sensitivity: 10 pC/g

Measuring range: 2k g pk

Weight: 11 grams

CHARGE OUTPUT ACCELEROMETER

ENDEVCO MODEL 7201-10

Temperature: -67 to +500 ºF

Sensitivity: 10 pC/g

Measuring range: 2k g pk

Weight: 18 grams

CHARGE OUTPUT ACCELEROMETER

ENDEVCO MODEL 7221A

Temperature: -67 to +500 ºF

Sensitivity: 10 pC/g

Measuring range: 2k g pk

Weight: 0.37 grams

CHARGE OUTPUT ACCELEROMETER

ENDEVCO MODEL 7703A-50

Temperature: -67 to +550 ºF
(-55 to +288 °C)

Sensitivity: 300 pC/g

Measuring range: 2k g pk

Weight: 25 grams

CHARGE OUTPUT ACCELEROMETER

ENDEVCO MODEL 7704A-50

Temperature: -67 to +550 ºF
(-55 to +288 °C)

Sensitivity: 50 pC/g

Measuring range: 2k g pk

Weight: 0.9 grams

TRIAXIAL CHARGE OUTPUT ACCELEROMETER

ENDEVCO MODEL 2230EM1

Temperature: -67 to +500 ºF

Sensitivity: 3 pC/g

Measuring range: 2k g pk

Weight: 17 grams

900°F (482 °C)

HIGH TEMPERATURE CHARGE OUTPUT ACCELEROMETER

PCB MODEL 357B69

Sensitivity: 3 pC/g

Measurement Range: ±500 g pk

Frequency Response (+5%): 6k Hz

900°F (482 °C)

HIGH TEMPERATURE CHARGE OUTPUT ACCELEROMETER

PCB MODEL 357B61

Sensitivity: 10 pC/g

Measurement Range: ±1k g pk

Frequency Response (+5%): 5k Hz

1200°F (649 °C)

UHT-12™ CHARGE OUTPUT ACCELEROMETER

PCB MODELS 357E90/91/92/93

357E90/91 Sensitivity: 5.0 pC/g

357E92/93 Sensitivity: 2.3 pC/g

Measurement Range: ±1k g pk

Frequency Response (+5%): 3k Hz

900°F (482 °C)

UHT-12™ CHARGE OUTPUT ACCELEROMETER

PCB MODEL 357A63

Sensitivity: 0.53 pC/g

Measurement Range: ±5k g pk

Frequency Response (+10%): 10k Hz

1200°F (649 °C)

UHT-12™ CHARGE OUTPUT ACCELEROMETER

PCB MODEL 357A64

Sensitivity: 0.53 pC/g

Measurement Range: ±5k g pk

Frequency Response (+10%): 10k Hz

1200°F (649 °C)

UHT-12™ CHARGE OUTPUT DIFFERENTIAL ACCELEROMETER

PCB MODELS 357A94/95

Sensitivity: 3.3 pC/g

Measurement Range: ±1k g pk

Frequency Response (+5%): 3k Hz

CRYOGENIC ICP® ACCELEROMETERS

Cryogenic ICP® accelerometers are specifically designed to operate at temperatures below the typical -65 °F (-54 °C) temperature limit of most voltage mode sensors. The use of specialized, built-in, cryogenic ICP® circuitry and quartz shear sensing technology provides survivability in demanding environments such as liquid nitrogen. Each sensor is hermetically sealed and individually tested to determine the thermal coefficient of sensitivity at -320 °F (-196 °C) ensuring reliable operation and accurate measurements. Choose from a variety accelerometers ranging from lightweight units for minimizing mass loading effects to high sensitivity versions for sensing low-level vibrations.

CRYOGENIC ICP® ACCELEROMETERS					
Model Number	**PCB 351B03**	**PCB 351B04**	**PCB 351B31**	**PCB 351B41**	**PCB 351B42**
Performance					
Sensitivity	10 mV/g		50 mV/g	100 mV/g	
Measurement Range	±150 g pk		±30 g pk	±15 g pk	
Frequency Range (±5%)	1 - 6k Hz		1 - 4k Hz	1 - 2k Hz	
Options: Available with ground isolation	J351B03	J351B04	J351B31	J351B41	J351B42

CRYOGENIC MINIATURE ICP® ACCELEROMETERS			
Model Number	**PCB 351B11**	**PCB 351B14**	**PCB 351A15**
Performance			
Sensitivity	5 mV/g		5.5 mV/g
Measurement Range	±300 g pk		±1k g pk
Frequency Range	1 - 10k Hz	1 - 8k Hz	1.25 to 6.5k Hz
Options: Available with ground isolation	J351B11	J351B14	-
Options: Available in Metric	M351B11	M351B14	-

CRYOGENIC CHARGE OUTPUT PIEZOELECTRIC ACCELEROMETERS

Endevco® cryogenic piezoelectric accelerometers are built specifically for measuring vibration under cryogenic conditions down to -452 °F (-269 °C). Signal outputs of these units are very stable even at extremely low temperatures. Their rugged internal construction is designed to withstand multiple cycles of thermal shock with steep temperature gradient. The accelerometers are self-generating devices that require no external power source for operation and contain no electronics. This allows them to operate below the -320 °F (-196 °C) limit of ICP accelerometers, down to -452 °F (-269 °C).

CRYOGENIC CHARGE OUTPUT PIEZOELECTRIC ACCELEROMETERS			
Model Number	**Endevco 7722**	**Endevco 7724**	**Endevco 2271A / 2271AM20**
Performance			
Description	Immune to thermal transients, grounded design	Immune to thermal transients, isolated design	High sensitivity, side (2271A) or top exit (2271AM20) connector
Sensitivity (pC/g typical)	3.7	3.7	11.5
Sinusoidal Limit (g)	500	500	1k
Shock Limit (g)	2.5k	2.5k	10k
Frequency Response (±1 dB Hz)	1 - 6k	1 - 6k	1 - 8k

REMOTE CHARGER CONVERTERS WITH TEDS			
Model Number	**Endevco 2771C-01**	**Endevco 2771C-1**	**Endevco 2771C-5**
Performance			
Gain	.1 mV/pC	1 mV/pC	5 mV/pC
Input Type	Single-ended piezoelectric	Single-ended piezoelectric	Single-ended piezoelectric
Number of channels	1	1	1
Configuration	In-line	In-line	In-line

MINIATURE CRYOGENIC ICP® ACCELEROMETER

PCB MODEL 351A15

Sensitivity: 5.5 mV/g

Measurement Range: ±1k g pk

Frequency Range (±5%): 1.25 to 6.5k Hz

CRYOGENIC ICP® ACCELEROMETER

PCB MODEL 351B03

Sensitivity: 10 mV/g

Measurement Range: ±150 g pk

Frequency Range (±5%): 1 - 6k Hz

GROUND ISOLATED CRYOGENIC ICP® ACCELEROMETER

PCB MODEL J351B03

Sensitivity: 10 mV/g

Measurement Range: ±150 g pk

Frequency Range (±5%): 1 - 6k Hz

CRYOGENIC ICP® ACCELEROMETER

PCB MODEL 351B04

Sensitivity: 10 mV/g

Measurement Range: ±150 g pk

Frequency Range (±5%): 1 - 6k Hz

Available with ground isolation (J)

CRYOGENIC ICP® ACCELEROMETER

PCB MODEL 351B41

Sensitivity: 100 mV/g

Measurement Range: ±15 g pk

Frequency Range (±5%): 1 - 2k Hz

Available with ground isolation (J)

CRYOGENIC ICP® ACCELEROMETER

PCB MODEL 351B42

Sensitivity: 100 mV/g

Measurement Range: ±15 g pk

Frequency Range (±5%): 1 - 2k Hz

Available with ground isolation (J)

CRYOGENIC ICP® ACCELEROMETER

PCB MODEL 351B31

Sensitivity: 50 mV/g

Measurement Range: ±30 g pk

Frequency Range (±5%): 1 - 4k Hz

Available with ground isolation (J)

CRYOGENIC MINIATURE ICP® ACCELEROMETER

PCB MODEL 351B11

Sensitivity: 5 mV/g

Measurement Range: ±300 g pk

Frequency Range (±5%): 1 - 10k Hz

Available with ground isolation (J)

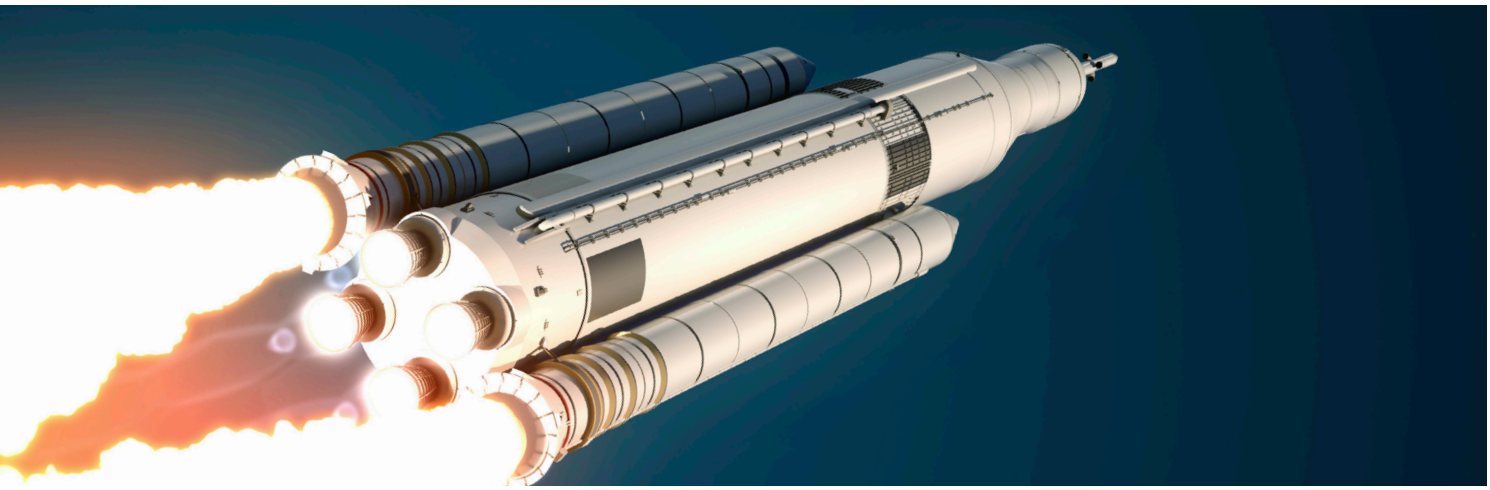
CRYOGENIC MINIATURE ICP® ACCELEROMETER

PCB MODEL 351B14

Sensitivity: 5 mV/g

Measurement Range: ±300 g pk

Frequency Range (±5%): 1 - 8k Hz



EXTREME ENVIRONMENT ICP® & CHARGE OUTPUT PRESSURE SENSORS

CE

ROCKET MOTOR ICP® PRESSURE SENSOR

PCB MODEL 123B22 / 23 / 24

Sensitivity: 1.0 / 0.5 / 5.0 mV/psi

Measurement Range:
3k / 10k / 1k psi

Temperature Range: -100 to +250 °F
(-73 to +121 °C)

CE

CHARGE OUTPUT ROCKET MOTOR PRESSURE SENSOR

PCB MODEL 123B

Sensitivity: 1.1 pC/psi

Measurement Range: 3k psi

Temperature Range
(with water cooling on):
-450 to +500 °F (-268 to +260 °C)

CE

ROCKET MOTOR ICP® PRESSURE SENSOR

PCB MODEL 124A24

Sensitivity: 5.0 mV/psi

Measurement Range: 1 kpsi

Temperature Range: -100 to +250 °F
(-73 to +121 °C)

PCB® HIGH TEMPERATURE CHARGE OUTPUT SENSORS

PCB® High Temperature quartz dynamic pressure sensors are designed for operation at the highest temperatures. They are structured with quartz crystals and operate, without cooling, up to 1200 °F (650 °C) on compressors and pumps. Special mounting adaptors can be supplied to fit existing mounting holes. Water cooled adaptors are available to provide a lower temperature thermally stable environment that allow sensors to operate in applications above their normal operating range.

Hard-line cables are recommended for operating temperatures above +500 °F (+260 °C). The cable can be welded to the sensor for operation in pressurized environments. All of these features ensure reliable operation in high temperature environments.

Highlights:

- Laser welded, hermetically sealed quartz sensing elements
- Fused ceramic insulation connectors
- Internal acceleration compensation minimizes vibration sensitivity
- Calibration supplied at room temperature with thermal coefficients up to 1200 °F (650 °C)

PCB® CRYOGENIC ICP® PRESSURE SENSORS

PCB® Cryogenic quartz dynamic pressure sensors are a high resolution ICP® pressure sensor design, specially made for cryogenic environments. They consistently follow dynamic events found in cryogenic turbo pumps for liquid fuel handling systems or biomedical research.

Highlights:

- Fast rise time of ≤ 2 µsec from quartz element, with high resonant frequency ≥ 250 kHz
- Welded, hermetically sealed, stainless steel construction
- Electrically ground isolated, which helps prevent ground loop challenges
- Calibration supplied at room temperature with thermal coefficients at -320 °F (-196 °C)

HIGH TEMPERATURE PRESSURE PROBE

PCB MODEL 112B05

Sensitivity: 1.1 pC/psi

Measurement Range: 5k psi

Temperature Range: -400 to +500 °F (-240 to +316 °C)

WATER-COOLED ADAPTOR

PCB MODEL 064B01

1/2-20 External thread

1.0” hex (for PCB Model 112A05)

PCB MODEL 064B06

M20 x 1.5 External thread

1.25” hex (for PCB Model 112B05)

HIGH TEMPERATURE PRESSURE SENSOR

PCB MODEL 116B

Sensitivity: 6 pC/psi

Measurement Range: 100 psi

Temperature Range: -400 to +650 °F (-240 to +345 °C)

CRYOGENIC ICP® PRESSURE SENSOR

PCB MODEL 102B10 / 102B11

Sensitivity: 50 / 5.0 mV/psi

Measurement Range: 100 psi / 1k psi

Temperature Range: -320 to +212 °F (-196 to +100 °C)

CRYOGENIC ICP® PRESSURE SENSOR

PCB MODEL 102B13 / 102B14

Sensitivity: 0.5 / 1 mV/psi

Measurement Range: 10k / 5k psi

Temperature Range: -320 to +212 °F (-196 to +100 °C)

CHARGE OUTPUT PRESSURE SENSOR

PCB MODEL 176A07

Sensitivity: 7 pC/psi

Measurement Range: 725 psi

Temperature Range: -94 to +1200 °F (-70 to +650 °C)

CHARGE DIFFERENTIAL OUTPUT PRESSURE SENSOR

PCB MODEL 176A31

Sensitivity: 6 pC/psi

Measurement Range: 3k psi

Temperature Range: -94 to +1400 °F (-70 to +760 °C)

CHARGE SINGLE ENDED OUTPUT PRESSURE SENSOR

PCB MODEL 176A33

Sensitivity: 6 pC/psi

Measurement Range: 3k psi

Temperature Range: -94 to +1400 °F (-70 to +760 °C)

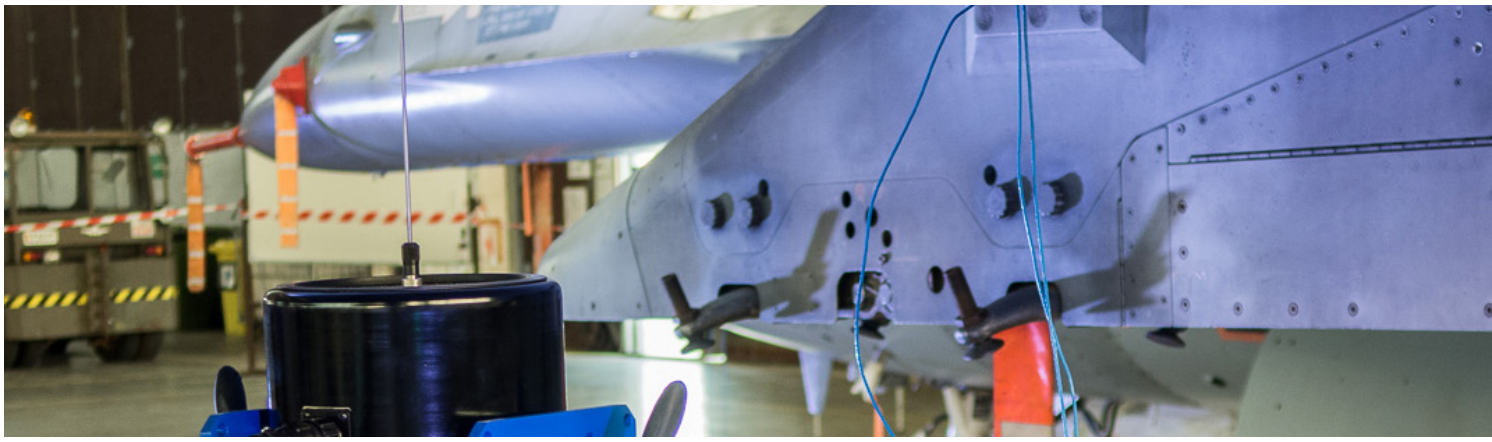
CHARGE OUTPUT PRESSURE SENSOR

PCB MODEL 176M47

Sensitivity: 15 pC/psi

Measurement Range: 500 psi

Temperature Range: -70 to +1200 °F (-57 to 650 °C)



THE MODAL SHOP
AN AMPHENOL COMPANY

The Modal Shop's family of shakers includes small-sized shakers rated from 2 lbf (9 N) to 500 lbf (2224 N). Available designs include the revolutionary SmartShaker™ with integrated power amplifier, the mini inertial shaker, a variety of mini, through-hole modal, dual purpose, and platform shakers. These exciters are ideal for applications ranging from experimental modal analysis to general vibration testing of small components and sub-assemblies. The shaker systems are also available through the TMS Rental Program in addition to accelerometers, force sensors, hammers, microphones and sound level meters. Visit www.modalshop.com for more information, or reach TMS at +1-513-351-9919 or info@modalshop.com.

SHAKERS FOR MODAL TESTING

The Modal Shop's modal shakers are a proven solution in test laboratories throughout the world. With force ratings from 2 to 60 lbf (9 to 133 N), these shakers are suitable for a wide range of modal analysis applications. When performing experimental modal analysis and structural testing, the choice of excitation function and system will make the difference between a good measurement and a poor one. For many applications, an electrodynamic shaker system is the ideal choice.

The Modal Shop's modal shakers are designed to be highly portable, rugged, and easy to set up in order to facilitate the best testing results. The smallest Model 2002E Inertial Shaker is well suited for testing applications in confined locations that a stinger or modal hammer could not normally be used. The compact, all-in-one Models K2007E01 and K2004E01 SmartShakers™ with built-in power amplifier makes modal test set up quick and easy, whether a single or multiple input (SIMO or MIMO) test. The Model 2060E shaker with extended 1.4 in (36 mm) stroke is particularly useful for GVT applications enhancing input levels at low frequencies. All shaker systems are supplied complete and ready to use with appropriate amplifier, trunnion base, cables, stingers, and other accessories.

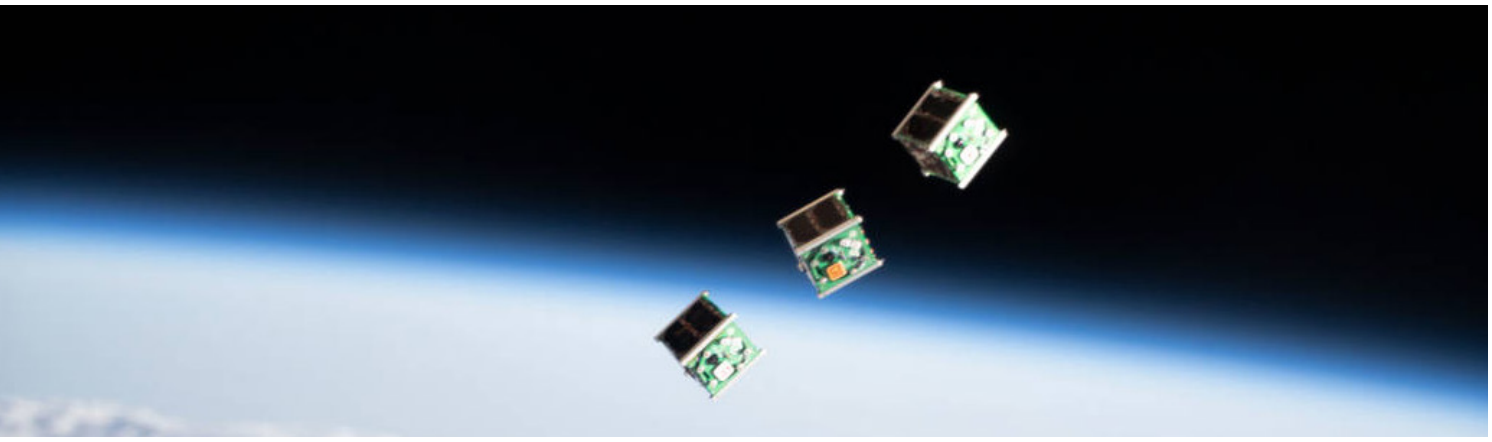
MODEL 2060E

MODEL 2025E

MODELS 2004E & 2007E

SMARTSHAKER™
MODELS K2004E01 & K2007E01

MODEL 2002E



CUBESAT VIBRATION TESTING WITH MODAL-POD™

Streamline your CubeSat vibration testing with The Modal Shop's Electrodynamic Shaker Model 2500E using the Modal-Pod™ Model 2000X15. The 2500E shaker is a 500 lbf pk since force shaker with a 6 in (15.2 cm) diameter mounting platform designed for general-purpose vibration testing of small components, as well as stress screening of electronic and mechanical sub-assemblies for R&D, reliability, and quality assurance applications.

The 2000X15 Modal-Pod™ is a CubeSat test fixture specific for use with the 2500E shaker providing a standard mounting fixture to meet the standardized sizing of 1U, 2U, and 3U CubeSats. The user can quickly mount up to 3U size satellites in horizontal or vertical configurations for critical vibration qualification and acceptance testing based on NASA or other standards to ensure survivability during launch.

Model 2500E Shaker with 2000X15 Mounted

SHAKERS FOR VIBRATION TESTING

Vibration shakers from The Modal Shop offer a wide range of options from miniature inertial shakers to large vibration test shakers. Designed for applications ranging from laboratory research to automotive and aerospace component testing, this versatile line of shakers offers force ratings from 4.5 lbf (20 N) to 500 lbf (2224 N).

The miniature SmartShaker™ Series, Models K2007E01 and K2004E01, serves as an all-in-one modal and vibration shaker with built-in power amplifier. The Model 2025E-HF with its 2.125 in (5.4 cm) diameter table offers an extended high frequency capability of 20 kHz. Dual Purpose Vibration Test Shaker Models 2075E and 2110E are designed with a 3.25 in (8.3 cm) diameter platform for vibration testing and through-hole armature for modal testing, delivering a unique solution for a variety of applications. The 2500E, 2075E, and 2110E shakers are also available with Head Expanders and in Horizontal Table configurations to support vibration testing of payloads that are not suitable for direct shaker attachment, or need to be tested in a specific orientation.

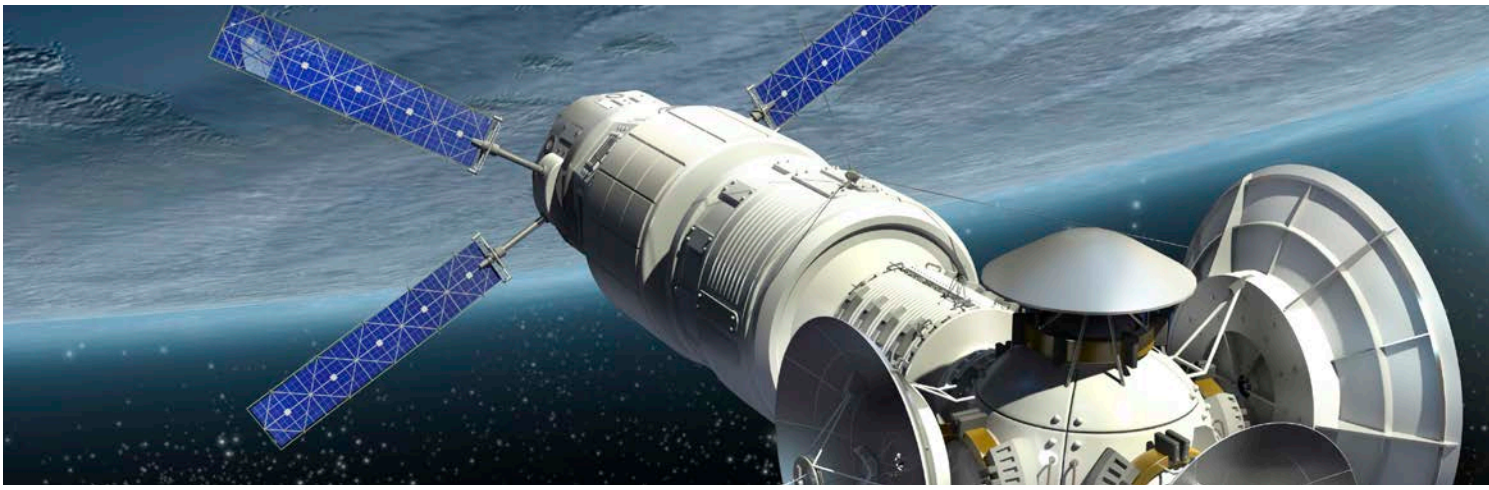
MODEL 2110E

MODEL 2075E

MODEL 2025E-HF

MODELS 2004E & 2007E

SMARTSHAKER™
MODELS K2004E01 & K2007E01



FORCE LIMITED VIBRATION TESTING SYSTEMS

Force limited vibration testing system for easy and accurate measurement of the input force. Optimizing 3 component force sensor installation for satellite force limited vibration testing.

Due to the high cost, long development times, and uniqueness of sophisticated aerospace and other high-tech equipment, it has become imperative to implement techniques that ensure the safety of such items during vibration qualification testing.

Conventional control using acceleration has been shown to cause significant over-testing that may result in damage to the unit under test (UUT). In force limited vibration testing, the total input force to the UUT is measured and controlled, thereby limiting the "quasi-static" acceleration of the center-of-gravity and ensuring the integrity of the equipment.

The PCB® Force Limited Vibration Testing System meets most requirements for limiting the reaction force between the shaker and unit under test in random vibration testing. The use of piezoelectric, 3-component force sensors facilitates easy and accurate measurement of the input force. This force relates directly, using Newton's Second Law, F=ma, to the "quasi-static" acceleration of the structure's center-of-gravity. Since design loads for aerospace equipment are often given in terms of the "quasi-static" acceleration, the use of force sensors represents an ideal measurement approach for this application.

Highlights:

- Minimizes over-testing
- Reduces risk of damage to critical structures
- Measures summed forces
- Measures force differences (moments)
- Simplifies and expedites the test process
- Convenient and easy to implement

3-COMPONENT ICP® & CHARGE OUTPUT QUARTZ FORCE RINGS

TRIAXIAL ICP® FORCE SENSOR

PCB MODEL 260A01

Sensitivity (z-axis): 2.5 mV/lb

Sensitivity (x or y axis): 10 mV/lb

Measurement Range (z-axis): 1k lb

Measurement Range (x or y axis): ±500 lb

Temperature Range: -65 to +250 °F (-54 to +121 °C)

TRIAXIAL ICP® FORCE SENSOR

PCB MODEL 260A02

Sensitivity (z-axis): 2.5 mV/lb

Sensitivity (x or y axis): 5 mV/lb

Measurement Range (z-axis): ±1k lb

Measurement Range (x or y axis): ±1k lb

Temperature Range: -65 to +250 °F (-54 to +121 °C)

TRIAXIAL ICP® FORCE SENSOR

PCB MODEL 260A03

Sensitivity (z-axis): 0.25 mV/lb

Sensitivity (x or y axis): 1.25 mV/lb

Measurement Range (z-axis): ±10k lb

Measurement Range (x or y axis): ±4k lb

Temperature Range: -65 to +250 °F (-54 to +121 °C)

TRIAXIAL CHARGE OUTPUT FORCE SENSOR

PCB MODEL 260A11

Sensitivity (z-axis): 15 pC/lb

Sensitivity (x or y axis): 32 pC/lb

Measurement Range (z-axis): ±1k lb

Measurement Range (x or y axis): ±500 lb

Temperature Range: -100 to +350 °F (-73 to +177 °C)

TRIAXIAL CHARGE OUTPUT FORCE SENSOR

PCB MODEL 260A12

Sensitivity (z-axis): 15 pC/lb

Sensitivity (x or y axis): 32 pC/lb

Measurement Range (z-axis): ±1k lb

Measurement Range (x or y axis): ±1k lb

Temperature Range: -100 to +350 °F (-73 to +177 °C)

TRIAXIAL CHARGE OUTPUT FORCE SENSOR

PCB MODEL 260A13

Sensitivity (z-axis): 15 pC/lb

Sensitivity (x or y axis): 32 pC/lb

Measurement Range (z-axis): ±10k lb

Measurement Range (x or y axis): ±4k lb

Temperature Range: -100 to +350 °F (-73 to +177 °C)

3-COMPONENT ICP® & CHARGE OUTPUT QUARTZ FORCE LINKS

TRIAXIAL ICP® FORCE LINK

PCB MODEL 261B01

Sensitivity (z-axis): 2.5 mV/lb

Sensitivity (x or y axis): 10 mV/lb

Measurement Range (z-axis): ±1k lb

Measurement Range (x or y axis): ±500 lb

Temperature Range: -65 to +250 °F (-54 to +121 °C)

TRIAXIAL ICP® FORCE LINK

PCB MODEL 261B02

Sensitivity (z-axis): 2.5 mV/lb

Sensitivity (x or y axis): 5 mV/lb

Measurement Range (z-axis): ±1k lb

Measurement Range (x or y axis): ±1k lb

Temperature Range: -65 to +250 °F (-54 to +121 °C)

TRIAXIAL ICP® FORCE LINK

PCB MODEL 261B03

Sensitivity (z-axis): 0.25 mV/lb

Sensitivity (x or y axis): 1.25 mV/lb

Measurement Range (z-axis): ±10k lb

Measurement Range (x or y axis): ±4k lb

Temperature Range: -65 to +250 °F (-54 to +121 °C)

TRIAXIAL CHARGE OUTPUT FORCE LINK

PCB MODEL 261B11

Sensitivity (z-axis): 15 pC/lb

Sensitivity (x or y axis): 32 pC/lb

Measurement Range (z-axis): ±1k lb

Measurement Range (x or y axis): ±500 lb

Temperature Range: -100 to +350 °F (-73 to +177 °C)

TRIAXIAL CHARGE OUTPUT FORCE LINK

PCB MODEL 261B12

Sensitivity (z-axis): 15 pC/lb

Sensitivity (x or y axis): 32 pC/lb

Measurement Range (z-axis): ±1k lb

Measurement Range (x or y axis): ±1k lb

Temperature Range: -100 to +350 °F (-73 to +177°C)

TRIAXIAL CHARGE OUTPUT FORCE LINK

PCB MODEL 261B13

Sensitivity (z-axis): 15 pC/lb

Sensitivity (x or y axis): 32 pC/lb

Measurement Range (z-axis): ±10k lb

Measurement Range (x or y axis): ±4k lb

Temperature Range: -100 to +350 °F (-73 to +177°C)

SIGNAL CONDITIONING SYSTEM COMPONENT SPECIFICATIONS

SUMMING BLOCK FOR CHARGE MODE SENSORS

PCB MODEL 070A15

Input: 4-Channels of charge input

Output: 1-Channel of summed charge output

DUAL-MODE CHARGE AMPLIFIER

PCB MODEL 443B102

1-channel

Voltage Gain (ICP® sensor mode): x0.1 to x1k

Voltage Gain (charge mode): x0.1 to 10k mV/pC

CHARGE SUMMATION NODE MODULE

PCB MODEL 070M70

Input: 8-Channels of charge mode

Output: 1-Channel of summed charge output

COMPUTATIONAL SIGNAL CONDITIONER

PCB MODEL 070M69

Input: 4 to 8-Channels of ICP® sensor or voltage signals

Output: 1-Channel

For summing or moment calculations

SUMMING AMPLIFIER FOR ICP® SENSORS

PCB MODEL 070M90

Input: 12-Channels of ICP® signals

Output: 1-Channel

Gain: x0.1, x1, x10

PE/IEPE SIGNAL CONDITIONER

ENDEVCO MODEL 2775C

Input: 1-Channel Piezoelectric (PE), Integrated Electronics PE (IEPE), or in-line Remote Charge Converter (RCC)

Output: AC, DC, or SERVO

Gain up to 10,000

RAPIDLY FLUCTUATING PRESSURE, FLOW, SCREW CAVITATION, & WAVE SLAP

Piezoelectric pressure & force sensors are suited for dynamic pressure measurements including turbulence and cavitation. These measurements require a fast response or rise time, ruggedness, and high stiffness in order to obtain a high frequency response.

HIGH RESOLUTION ICP® PRESSURE PROBE

PCB MODEL S112A22

- 100 mV/psi, 50 psi
- Stainless steel for corrosion protection
- Acceleration compensated

ICP® QUARTZ FORCE RINGS

PCB MODEL 202M44

- ±100 lbs
- Measures dynamic excitation or reaction forces
- Integral waterproof cable

VIBRATION

Shear mode accelerometers isolate the sensing crystals from the base and housing, lowering thermal transients and signal noise resulting from base bending effects. This is a very important feature when attaching them to relatively thin walled vessel hull models during wave slap applications.

ICP® UNDERWATER ACCELEROMETER

PCB MODEL 352M221

- 10 mV/g, ±500 g
- 2nd order LP filter
- Frequency response: 1 Hz to 6k Hz
- Integral waterproof cable

MINIATURE RING-STYLE, CERAMIC SHEAR CVLD ACCELEROMETER

PCB MODEL 355M87A

- 100 µA/g, ±50 g
- Frequency response: 7 Hz to 9k Hz
- Integral waterproof cable
- Case isolated

MINIATURE RING-STYLE, CERAMIC SHEAR ICP® ACCELEROMETER

PCB MODEL 355M73

- 100 mV/g, ±50 g range
- Frequency response: 7 Hz to 9k Hz
- Integral waterproof cable
- Case isolated

TEARDROP ICP® ACCELEROMETER WITH FLEXIBLE, INTEGRAL CABLE

PCB MODEL 352A74

- 100 mV/g, ±50 g range
- Frequency response: 1 Hz to 8k Hz
- Hermetic housing

RING-STYLE SEISMIC SHEAR CVLD ACCELEROMETER

PCB MODEL 631M21

- 1k µA/g, ±2.5 g range
- Frequency response: 1 Hz to 4k Hz
- Integral waterproof cable
- Case isolated

UNDERWATER BLAST

Piezoelectric pressure sensors measure shock waves and bubble energy associated with underwater explosion testing. Sensors structured with volumetrically sensitive, omnidirectional tourmaline crystal and ICP® microelectronics provide a high frequency, low impedance output in underwater test environments. Waterproof cables of customer requested lengths are factory installed.

TOURMALINE ICP® UNDERWATER BLAST SENSOR

PCB SERIES 138A

- ICP® underwater blast pressure probes
- Ranges from 1k to 50k psi
- Rise time 1.5 µ sec
- Resonant frequency ≥ 1 MHz
- Approximate max depth 1k ft.

Photo Courtesy of Siemens and Belgian Defense

PORTABLE SYSTEM VERIFICATION INSTRUMENTS

PCB® MODEL 394C06 HANDHELD SHAKER

The Model 394C06 Handheld Shaker from PCB Piezotronics is a small, self-contained, battery powered vibration exciter specifically designed to conveniently verify accelerometer and vibration system performance. It accepts sensors weighing up to 210 grams and delivers a controlled 1 g mechanical excitation.

ACCELEROMETER SIMULATOR ENDEVCO MODEL 4830B

The 4830B accelerometer simulator is a hand held battery operated signal generator designed specifically to simulate the electrical output of common types of accelerometers. The instrument contains a highly accurate oscillator with an adjustable output level and is ideal for setting up, testing and the diagnosis of faults within data acquisition systems, environmental test systems, or simply as a flexible signal generator.

PCB PIEZOTRONICS
AN AMPHENOL COMPANY

3425 Walden Avenue, Depew, NY 14043 USA

pcb.com | info@pcb.com | 800 828 8840 | +1 716 684 0001

ENDEVCO
AN AMPHENOL COMPANY

10869 NC Highway 903, Halifax, NC 27839 USA

endevco.com | sales@endevco.com | 866 363 3826

© 2024 PCB Piezotronics - all rights reserved. PCB Piezotronics is a wholly-owned subsidiary of Amphenol Corporation. Endevco is an assumed name of PCB Piezotronics of North Carolina, Inc., which is a wholly-owned subsidiary of PCB Piezotronics, Inc. Accumetrics, Inc. and The Modal Shop, Inc. are wholly-owned subsidiaries of PCB Piezotronics, Inc. IMI Sensors and Larson Davis are Divisions of PCB Piezotronics, Inc. Except for any third party marks for which attribution is provided herein, the company names and product names used in this document may be the registered trademarks or unregistered trademarks of PCB Piezotronics, Inc., PCB Piezotronics of North Carolina, Inc. (d/b/a Endevco), The Modal Shop, Inc. or Accumetrics, Inc. Detailed trademark ownership information is available at www.pcb.com/trademarkownership.

AD-Environmental-0424