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Low Outgassing Accelerometers & Cables

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For Thermal Vacuum Vibration Testing





## Low Outgassing Accelerometers and Cables for 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 such as photo-optic devices and obscure them, rendering them useless during their intended application.

During random vibration or shock testing prior to flight, space craft payloads are often fitted with accelerometers in hard to reach mounting locations. As the space structure is built up around them, it can become impossible to remove the accelerometers. Sensors installed for ground vibration testing (GVT) must therefore remain on the structure even if they are no longer needed for testing purposes.

Many hermetic accelerometer designs naturally have 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) less than or equal to 0.1%. This is verified either using NASA documentation or test results from an outside laboratory.

Leak testing on hermetic sensors can be performed. PCB® incorporates two levels of testing dependent on the required level of hermeticity documentation.

**Stage 1** – A gross bubble test is provided on all hermetic accelerometers. The test verifies  $<1 \times 10^{-3}$  cc/sec flow. This is a quick bubble-out test with a heated fluid. The heated fluid causes any internal gasses to bubble out and be visible during the test. Refer to Figure 1 for a schematic of the heated bubble test.

**Stage 2** – A fine helium test uses a helium tank to pressurize the sensors. Refer to Figure 2 for a schematic of the Helium tank test set up. The fine leak test is a vacuum test, where the Helium tank is pressurized to 300 psi for a minimum of 30 minutes. A mass spectrometer vacuum leak detector then verifies a leak flow rate of  $<2 \times 10^{-8}$  cc/sec.

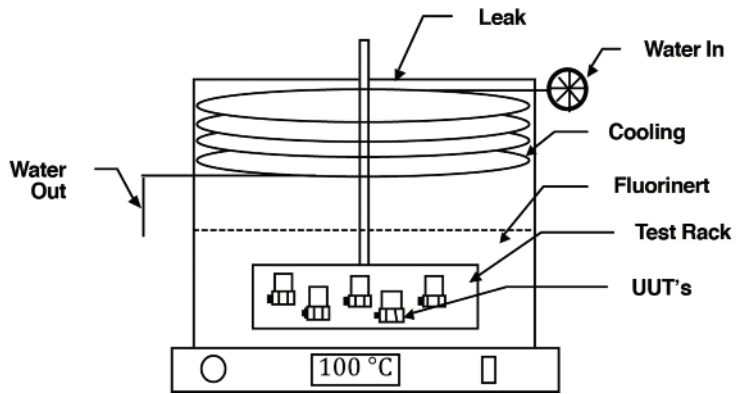


Figure 1  
Heated Bubble Test Set-up

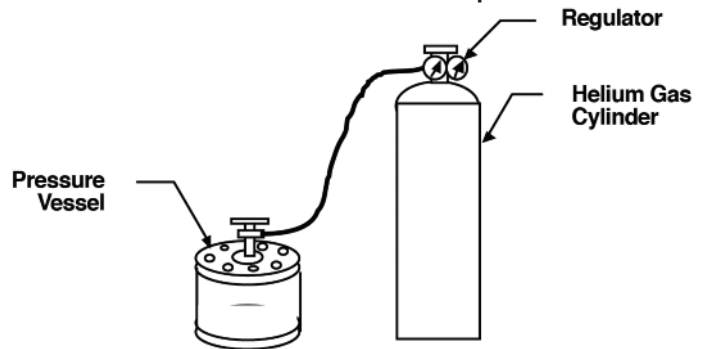


Figure 2  
Helium Tank Test Set-up

Four basic categories: miniature, triaxial, shock, and high-temperature. Popular models from PCB® are shown below, but are certainly not limited to the designs shown.

## Accelerometers

### Triaxial



#### 356M208

- Sensitivity 5 mV/g
- Measurement Range  $\pm 1,000$  g pk
- Frequency 2 to 8k Hz
- Weight 1.0 gm
- Hermetic 0.25 inch cube Titanium housing
- 5-ft integral cable
- 4-pin, 1/4-28 jack electrical termination
- 034M22 Low outgassing cable supplied



#### 356M57

- Sensitivity 10 mV/g
- Measurement Range  $\pm 500$  g pk
- Frequency 2 to 7k Hz
- Weight 4.0 gm
- Hermetic 0.4 inch cube titanium housing
- 5-ft integral cable
- 4-pin, 1/4-28 jack electrical termination



#### 354M56

- Sensitivity 10 mV/g
- Measurement Range  $\pm 500$  g pk
- Frequency 2 to 8k Hz
- Weight 5.0 gm
- Ground isolated
- Hermetic, titanium housing
- 5-ft Integral cable
- 4-pin, 1/4-28 jack electrical termination
- 034M22 Low outgassing cable supplied



#### 356M132

- High sensitivity 500 mV/g
- Measurement Range  $\pm 10$  g pk
- Frequency 0.5 to 3k Hz
- Weight 11.8 gm
- Hermetic 0.55 inch cube titanium housing
- 4-pin, 1/4-28 jack electrical termination



#### 356M98

- High sensitivity 1 V/g
- Measurement Range  $\pm 5$  g pk
- Frequency 2 to 3k Hz
- Mass 39.0 gm
- Hermetic 0.86 inch cube titanium housing
- 4-pin, 1/4-28 jack electrical termination



## Mini-triaxial applications

Space craft structures are often made of thin, light-weight materials and require low mass accelerometers. Full-scale space craft random vibration responses are three-dimensional, so the combination of a triaxial, low-mass accelerometer with low outgassing properties is recommended. PCB® Model 356M208 meets this requirement with a low mass of one gram and low outgassing characteristics. It is supplied with a low outgassing cable Model 034M22. Figure 3 shows a unit in action.

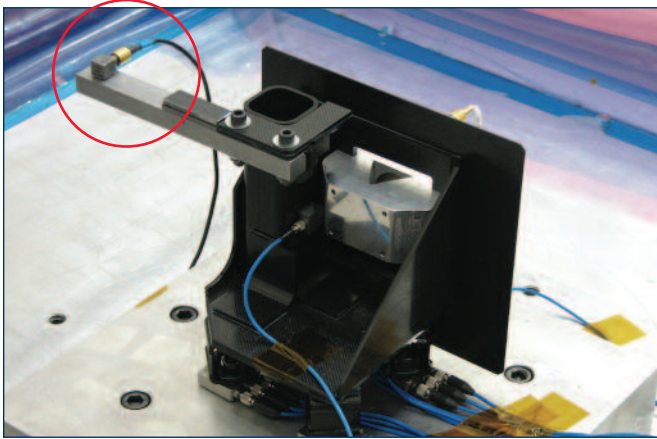


Figure 3

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

## Shock applications

Separation of booster stages cause shock events that may be transmitted to the spacecraft payload. Low outgassing accelerometers such as PCB® Model 350M72 may be launched with the payload or used in vacuum chamber to simulate launch conditions.

## Miniature and Hi-temp applications

Environmental stress screening is often performed in thermal vacuum chambers (see Figure 4) to verify operating characteristics at the component level rather than on a full-scale vehicle. PCB® Model 357A07 offers a hermetic, low-mass package with a wide operating temperature range from -100 to +500 °F (-73 to +260 °C) and is supplied with a low outgassing cable.

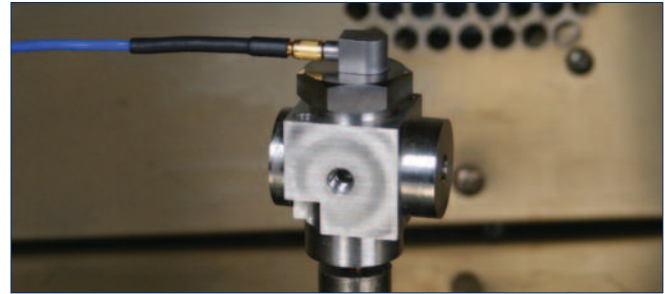


Figure 4

**PCB® Model 357A07 shown in an environmental chamber**

## Circuit Manufacturing

Today's technology requires precision, micro-circuitry to be designed, tested, and manufactured in clean room environments. Equipment incorporated into these manufacturing processes often operate at very minimal vibration levels to ensure both accuracy of the circuit and accuracy of a finished circuits installation into another component. Surrounding structures and foundations are also monitored to ensure vibration is kept to a minimum. Low frequency, high output sensors with low out-gassing characteristics provide the necessary protection to prevent unwanted contamination from spreading into the clean-room environment while, at the same time, providing the tight tolerance monitoring required.

## Cables

Ordinary output cables used for signal transmission are the greatest source of outgassing contamination. There are multiple cable options from PCB® and all materials are verified for TML and CVCM. Insulation and strain relief at each connector end are the largest contributors of outgassing contamination in cable design. Some examples of cables (shown on the back page of this brochure) use materials such as FKM, FEP and PTFE, which are known to have low TML and CVCM values.

## Summary

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 finally, leak testing services for low outgas verification of accelerometers.

## Shock



### 350M72

- Sensitivity 0.5 mV/g
- Measurement Range ± 10,000 g pk
- Frequency 0.4 to 10k Hz
- Electrical filter 13k Hz (-3 dB)
- Mechanical filter 23k Hz
- Hermetic, titanium housing
- 10-ft Integral cable
- 10-32 plug electrical termination

### 350M77

- Sensitivity 0.25 mV/g
- Measurement Range ± 20,000 g pk
- Frequency 1 to 15k Hz
- Electrical filter 23k Hz, -12 dB/octave
- Hermetic, stainless steel housing
- 10-32 jack electrical termination

## Miniature Single Axis



### 352M208

- Sensitivity 10 mV/g
- Measurement Range ± 500 g pk
- Frequency 2 to 10k Hz
- Weight 0.7 gm
- Hermetic, titanium housing
- 10-ft integral cable
- 10-32 plug electrical termination

### 352M212

- Sensitivity 10 mV/g
- Measurement Range ± 500 g pk
- Frequency 2 to 10k Hz
- Weight 0.64 gm
- 10-ft integral cable
- Hermetic, titanium housing
- 10-32 plug electrical termination

## High-temperature

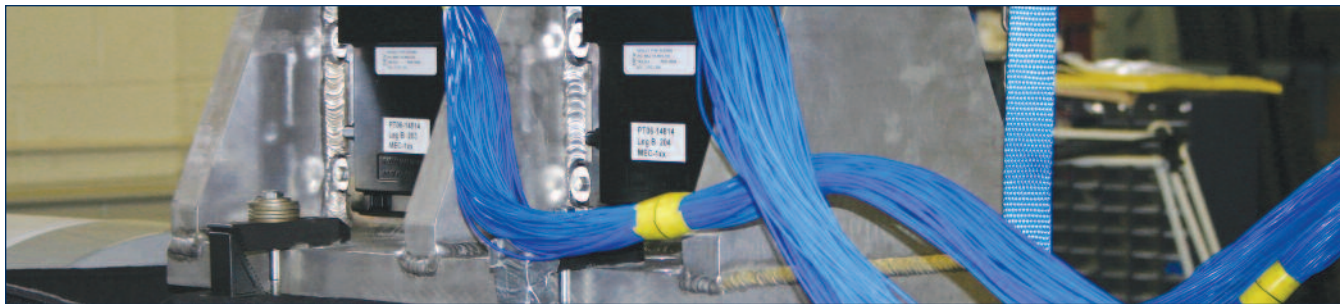


### 357A07

- Charge sensitivity 1.7 pC/g
- Measurement Range ± 2,000 g pk
- Frequency 15k Hz
- Weight 0.96 gm
- High temperature 500° F (260° C)
- Hermetic, titanium housing
- M3 jack electrical termination

### 357A09

- Charge sensitivity 1.7 pC/g
- Measurement Range ± 2,000 g pk
- Frequency 10k Hz
- Weight 0.6 gm
- High temperature 350° F (177° C)
- Titanium housing
- 3-56 jack electrical termination



## Cables

Contact the factory for additional cable lengths

### Cables for Single Axis Accelerometers



- 003M208**
- Connecting cable
  - Low-noise, coaxial TFE
  - 10-ft, 5-44 plug to 10-32 plug



- 003A10**
- Connecting cable
  - Low-noise, coaxial TFE
  - 10-ft, 10-32 plug to 10-32 plug



- 003M269/010**
- Connecting cable
  - Low-noise, coaxial TFE
  - 10-ft, 10-32 plug to BNC plug



- 003M252**
- Low-noise, coaxial TFE
  - 2-meter, 2-socket MS3106 to BNC plug
  - For 2-pin MIL connectors



- 003M204**
- Low-noise, coaxial TFE
  - 5-ft, 2-socket MS3106 to pigtails
  - For 2-pin MIL connectors



- 030A10**
- Connecting cable
  - Low-noise, coaxial FEP
  - 10-ft, 3-56 plug to 10-32 plug



- 030B10**
- Connecting cable
  - Low-noise, coaxial FEP
  - 10-ft, M3 plug to 10-32 jack



- 030EK010PH**
- Connecting cable
  - Low-noise, coaxial FEP
  - 10-ft, 3-56 plug to 10-32 jack

### Cables for Triaxial Accelerometers



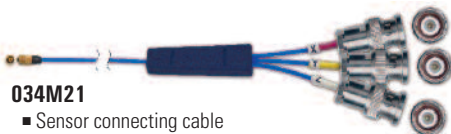
- 034M22**
- Sensor connecting cable
  - 4-conductor shielded, FEP
  - 20-ft, 4-pin 1/4-28 plug to (3) BNC plugs



- 034M51**
- Extension cable
  - 4-conductor shielded, FEP
  - 40 ft, 4-pin 1/4-28 plug to 4-pin 1/4-28 plug



- 010M128/040**
- Extension cable
  - 4-conductor shielded, FEP
  - 40-ft, 4-pin 1/4-28 plug to 4-pin 1/4-28 jack



- 034M21**
- Sensor connecting cable
  - 4-conductor shielded, FEP
  - 20-ft, mini 4-pin 3-36 plug to (3) BNC plugs



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