

SMALL SAT 2026
EXTENDED ABSTRACT

SATELLITE SENSORS
by Dr. Ing. Carmine Salzano

Abstract

Satellite Testing Sensors

New accelerometers design advancements for spacecrafts vibration testing:
“from microg to pyroshock testing”

The role of measurement sensors plays a fundamental role in various development tests and is also mandatory for all types of small satellites. In these pages, we will summarize some of the latest results achieved in the development of technologies to achieve increasingly advanced performance for satellite test accelerometers. We will evaluate three type of vibration testing, from microG to high G pyroshock testing.

Agenda/Index

1. Microvibration triaxial accelerometer
2. Low outgassing and vibration stress screening accelerometer
3. New accelerometers technology for pyroshock testing

Extended Abstract

Sensors for Satellite Testing

New accelerometers design advancements for spacecrafts vibration testing “from microg to pyroshock testing”

1. Content:

- Overview of satellite testing sensors
- Microvibration new design
- Low outgassing accelerometers
- Shock & pyroshock state of the art measurement technologies
- Errors in shock measurements



2. Overview of Sensors for Satellite Testing

Prima di presentare le nuove soluzioni e tecnologie degli accelerometri per misure da microvibrazioni a pyroshock, risulta opportuno presentare un breve riassunto dei sensori per diversi tipi di test dinamici su satelliti.

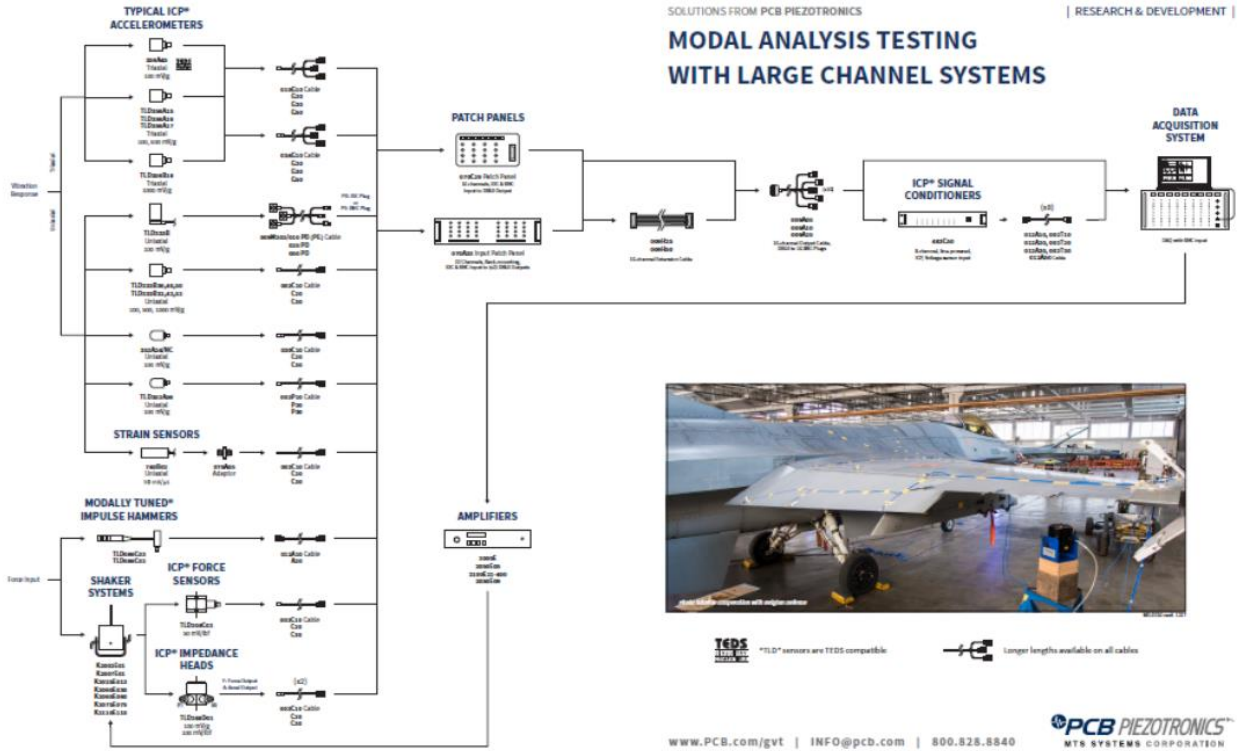
- a. Structural analysis**
- b. Microvibration**
- c. ENV Test- Vibration stress screening**
- d. PyroShock**
- e. Low Outgassing Accels and Cables**
- f. Force Limited Vibration (FLV)**
- g. Acoustic stress**
- h. Satellite propulsion & cryogenic**

3. Structural Test sensors

Structural tests are among the first tests conducted on satellites as they provide useful information right from the design and prototyping phase. The system includes an excitation phase performed with instrumented hammers (for quick and preliminary measurements) and electrodynamic shakers to provide different excitation waveforms. Accelerometers are used to measure the response of the satellite (or its component) following excitation and are typically cubic in shape for easier and faster assembly, yet still precise due to features such as the "shear" design, which offers significant advantages in measurement accuracy and reliability, as well as a precise phase response useful for the use of a large number of sensors that must all measure simultaneously.

In the following figure we find an overview of these sensors and accessories as well as a reusable strain sensor, unique on the market, which according to available literature offers the possibility, used in conjunction with accelerometers, to identify other modes that may escape a pure accelerometer measurement.

MODAL ANALYSIS TESTING WITH LARGE CHANNEL SYSTEMS

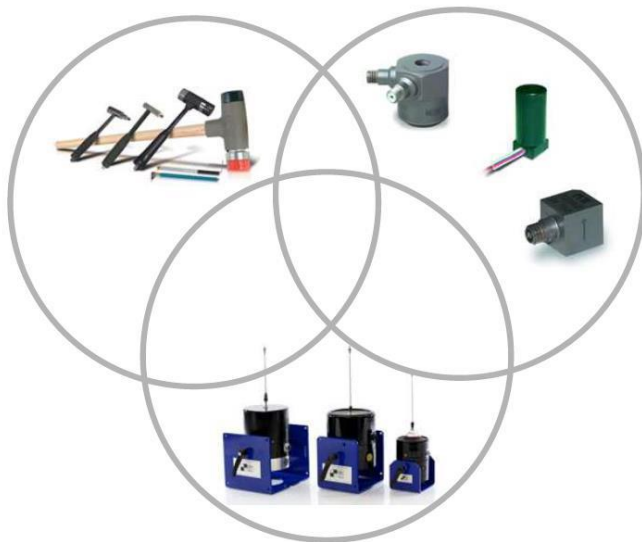


4. Modal Testing Sensing Technologies

Therefore, below we report a list of the sensors used for structural tests with related accessories and which we will not discuss in detail as they are beyond the scope of this extended abstract.

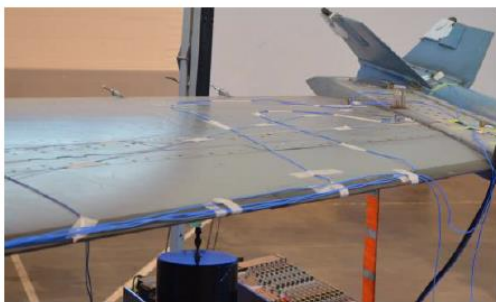
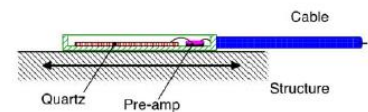
- a. Accelerometers:
 - i. Piezoelectric
 - ii. DC Capacitive
- b. Excitation inputs:
 - i. Impact hammers
 - ii. Modal shakers, stingers and accessories
 - iii. Force Transducers & Impedance heads
- c. Cable management
 - i. Structural test systems
 - ii. TEDS technology

In the following figure we report a series of examples of such sensors summarized above.



5. Unique Dynamic Reusable Strain Sensors

The reusable strain sensor, as previously mentioned, is useful for structural testing when used in conjunction with an accelerometer. The main benefit for dynamic strain testing is its simple reusability, which allows the sensor to be easily and quickly attached and removed from the test article without damaging the test article's structure, a particularly important feature for satellites.



Pictures courtesy of Siemens and Belgium Defense (Air Force)

All other types of sensors and tests summarized above will not be mentioned as in the following pages we will focus the exposition on the 3 types of tests and related new examples of technologies.

Part 1. Microvibration sensors

As per the title, "From microG to pyroshock," we now begin to discuss accelerometer solutions for microvibration testing. These tests are essential to the life and function of some vital satellite components, which, if subjected to even minimal vibrations during operation, can impair their performance once in orbit.

High sensitivity accelerometers overview

Below in the image is a series of so-called "seismic" accelerometers, as they measure even at microG levels. They are not as small as other test accelerometers, precisely because of their high sensitivity.



Sensors for seismic test



MODELS 354A12, 393B03, 393B04, 393B05, 393C31, & 393C12

SENSORS FOR SEISMIC TESTING



LOW FREQUENCY, HIGH OUTPUT ICP® ACCELEROMETERS

Earth tremors, foot, track and automobile, road and bridge traffic loads or other seismic events impart low frequency vibration on foundations intended to support these daily activities. These vibratory loads accumulate as stress and may degrade the structure. Smart infrastructure includes active measurement with real-time data logging that informs operators on structural integrity, critical during unforeseen loading scenarios. Cities of the future will monitor not only new structures but those with critical or historical value reducing potential for catastrophic failure.

PCB® is supporting advancements in sensor technology to take low frequency measurements to micro-g levels with ICP® accelerometers. In doing so, structural integrity data can be obtained on a real-time, real-time basis. Permanently installed, high-output accelerometers are being mounted on bridges, walkways, highways, buildings, and other large structures to capture important loading data. Information gathered will aid engineers in evaluating structural integrity and alert communities where safety thresholds are approaching. This type of preventive maintenance can warn engineers that structural repair is necessary before a major catastrophic occurs.

- Piezoelectric ICP® single axis and triaxial accelerometers
- High sensitivity output
- Extended low frequency measurement capability
- Resolution down to 1.0 µg rms
- Hermetically sealed, stainless steel or titanium housings
- Durable, water resistant connectors

TYPICAL APPLICATIONS

- Smart infrastructure - foundation, floor vibration, and security monitoring
- Earthquake detection / sway fatigue analysis
- Structural testing of bridges and foundations
- Process monitoring inside machinery that is susceptible to low level vibration

SPECIFICATIONS						
Model Number	393B03	393B04	393C12	393B05	393C31	354A12
	Single Axis	Single Axis	Single Axis	Single Axis	Single Axis	Triaxial
Performance						
Sensitivity	1.0 V/g	1.0 V/g	10 V/g	10 V/g	10 V/g	10 V/g
Measurement Range	±5.0 g pk	±5.0 g pk	±0.5 g pk	±0.5 g pk	±0.5 g pk	±0.5 g pk
Frequency Range (±5%)	0.5 to 2,000 Hz	0.06 to 400 Hz	0.15 to 1,000 Hz	0.7 to 450 Hz	0.1 to 200 Hz	0.17 to 700 Hz
Resonant Frequency	>10,000 Hz	≥2,500 Hz	>10,000 Hz	≥2,500 Hz	≥950 Hz	≥9000 Hz
Broadband Resolution	0.00001 g rms	0.00003 g rms	0.000008 g rms	0.00004 g rms	0.00002 g rms	0.00001 g rms
Non-Linearity	≤1 %	≤1 %	≤1 %	≤1 %	≤1 %	≤1 %
Transverse Sensitivity	≤7 %	≤5 %	≤7 %	≤5 %	≤3 %	≤7 %
Overload Limit (Shock)	±5000 g pk	±300 g pk	±5000 g pk	±300 g pk	±250 g pk	±1500 g pk
Base Strain Sensitivity	±0.0005 g/µε	±0.0005 g/µε	±0.0005 g/µε	±0.0005 g/µε	±0.0002 g/µε	±0.0005 g/µε
Temperature Range	-65 to +250 °F	-15 to +176 °F	-50 to +180 °F	-15 to +176 °F	-15 to +150 °F	-15 to +150 °F
Electrical						
Excitation Voltage	18 to 30 VDC	18 to 30 VDC	18 to 30 VDC	18 to 30 VDC	18 to 28 VDC	18 to 30 VDC
Constant Current Excitation	2 to 20 mA	2 to 10 mA	2 to 20 mA	2 to 10 mA	2 to 10 mA	2 to 20 mA
Output Impedance	<250 Ohm	<500 Ohm	<1500 Ohm	<500 Ohm	<500 Ohm	<500 Ohm
Output Bias Voltage	8 to 12 VDC	7 to 12 VDC	8 to 12 VDC	7 to 12 VDC	8 to 12 VDC	8.7 to 12.7 VDC
Discharge Time Constant	1 to 3 sec	5 to 15 sec	≥3.5 sec	0.5 to 2.0 sec	≥5 sec	2.9 to 7 sec
Settling Time	<15 sec	<100 sec	<80 sec	<100 sec	80 sec	<80 sec
Spectral Noise (1 Hz) (Typical)	2 µg/√Hz	0.30 µg/√Hz	1.50 µg/√Hz	0.50 µg/√Hz	0.038 µg/√Hz	1.30 µg/√Hz
Spectral Noise (10 Hz) (Typical)	0.5 µg/√Hz	0.10 µg/√Hz	0.6 µg/√Hz	0.10 µg/√Hz	0.012 µg/√Hz	0.40 µg/√Hz
TEDS 1.0 version available (TLD)	-	Yes	-	Yes	-	Yes
Physical						
Sensing Element	Ceramic					
Sensing Geometry	Shear	Flexural	Shear	Flexural	Flexural	Shear
Housing Material	Stainless Steel	Titanium	Stainless Steel	Titanium	Stainless Steel	Stainless Steel
Size - Diameter / Hex	1.18 in	0.99 in	1.18 in	0.99 in	2.25 in	2.25 in
Size - Height	2.30 in	1.22 in	2.30 in	1.22 in	2.76 in	1.26 in
Weight	199 gm (7.0 oz)	50 gm (1.8 oz)	199 gm (7.0 oz)	50 gm (1.8 oz)	748 gm (26.4 oz)	845 gm (22.7 oz)
Electrical Connector	2-Pin MIL-C-5015	10-32 Coaxial Jack	2-Pin MIL-C-5015	10-32 Coaxial Jack	2-Pin MIL-C-5015	4-Pin
Mounting Thread	1/4-28 Female	10-32 Female	1/4-28 Female	10-32 Female	1/4-28 Female	1/4-28 Female

An example of the use of these types of sensors is reported below and explained in a dedicated paper where the use of these seismic sensors in space orbit on this satellite is explained.

PCB® Piezotronics, Inc. Supplies Accelerometers for the GOES R Series Weather Satellites.

Piezoelectric accelerometers ensure accurate dynamic, environment measurements in flight of GOES 16 spacecraft.



GOES-R illustration courtesy of Lockheed Martin

The problem with this application and others was to keep the size of these sensors small, a problem now solved with the advent of this new solution, still piezoelectric, but this time triaxial, which, by allowing simultaneous measurement on three axes, significantly reduces the space required to house these accelerometers.

354A12 New Triaxial microG accelerometer

Below we highlight the main features of this new and unique technological solution, particularly useful for small satellites where microvibration tests were strongly affected by the size of the accelerometer.

Key Technical Features:

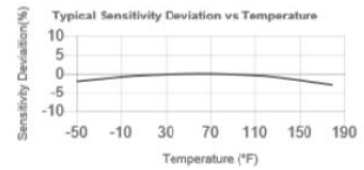
- Triaxial package designed for installation in structures or machinery
- Very Low noise. Resolution 10 μ g rms
- Frequency range from 0.17 to 700 Hz (@5%)
- Case Isolated / Hermetic stainless steel housing

Model 354A12 as our first triaxial, seismic accelerometer complementing our existing 393 Family of single axis, seismic / high sensitivity accelerometers. This model has significant size/mass (22.7 oz, 645 gm), designed for installation in structures and machine bases. The size is driven by the large, individual ceramic elements that provide high piezoelectric output, requiring less amplification to provide the cleanest possible output. The elements are laser welded into the housing and wired to the PCB ¼-28 4-pin connector. Mounting will be via two through-bolts for good coupling with the object under measurement and hermetic sealing allows installation in damp locations or locations under vacuum.

Model 354A12 adds a triaxial model to PCB's family of Seismic Accelerometers with onboard TEDS 1.0 and individually case isolated elements in a rugged package.



Performance	ENGLISH	SI
Sensitivity(± 10 %)	10,000 mV/g	1019.4 mV/(m/s ²)
Measurement Range	0.5 g pk	4.9 m/s ² pk
Frequency Range(± 5 %)	0.17 to 700 Hz	0.17 to 700 Hz
Frequency Range(± 10 %)	0.12 to 1,400 Hz	0.12 to 1,400 Hz
Frequency Range(± 3 dB)	0.06 to 2,500 Hz	0.06 to 2,500 Hz
Resonant Frequency	9 kHz	9 kHz [1]
Phase Response(± 5 °)	1 to 700 Hz	1 to 700 Hz
Electrical Filter Corner Frequency	13.5 kHz	13.5 kHz [1]
Electrical Filter Roll-off	6 dB/octave	6 dB/octave [1]
Broadband Resolution(1 to 10,000 Hz)	10 µg rms	98 µm/sec ² rms [1]
Non-Linearity	± 1 %	± 1 % [2]
Transverse Sensitivity	± 7.0 %	± 7.0 % [2]
TEDS Compliant(Per IEEE 1451.4)	Yes	Yes
Environmental		
Overload Limit(Shock)	± 1,500 g pk	± 14,715 m/s ² pk
Temperature Range	-50 to +180 °F	-45 to +82 °C
Temperature Response	See Graph	See Graph [1]
Electrical		
Excitation Voltage	18 to 30 VDC	18 to 30 VDC
Constant Current Excitation	2 to 20 mA	2 to 20 mA
Output Impedance	≈ 500 Ohm	≈ 500 Ohm
Output Bias Voltage	8.7 to 12.7 VDC	8.7 to 12.7 VDC
Discharge Time Constant	2.9 to 7 sec	2.9 to 7 sec
Settling Time(within 10% of bias)	< 60 sec	< 60 sec
Spectral Noise(1 Hz)	130 µg/√Hz	12.7 (µm/sec ²)/√Hz [1]
Spectral Noise(10 Hz)	0.40 µg/√Hz	0.40 (µm/sec ²)/√Hz [1]
Spectral Noise(100 Hz)	0.15 µg/√Hz	0.15 (µm/sec ²)/√Hz [1]
Spectral Noise(1 kHz)	0.10 µg/√Hz	0.10 (µm/sec ²)/√Hz [1]
Electrical Isolation(Case)	≥ 10 ⁸ Ohm	≥ 10 ⁸ Ohm
Physical		
Sensing Element	Ceramic	Ceramic
Sensing Geometry	Shear	Shear
Housing Material	Stainless Steel	Stainless Steel
Sealing	Hermetic	Hermetic
Size - Height	1.26 in	32 mm
Weight	22.7 oz	645 gm [1]
Electrical Connector	1/4-28 4-Pin	1/4-28 4-Pin
Electrical Connection Position	Side	Side
Mounting	Through Hole	Through Hole



~ Calibration Certificate ~
Per ISO 10063:21

Model Number: 306M133
Serial Number: 3365 (x axis)
Description: ICP® Accelerometer
Manufacturer: PCB Method: Back-to-Back Comparison AT401-12

Calibration Data

Sensitivity @ 100 Hz: 9.81 V/g Output Bias: 10.9 VDC
(1.001 V/m/s²) Transverse Sensitivity: 2.0 %
Discharge Time Constant: 5.11 seconds

Sensitivity Plot

Temperature: 72 °F (22 °C) Relative Humidity: 37 %

Frequency (Hz)	Dev. (%)	Frequency (Hz)	Dev. (%)	Frequency (Hz)	Dev. (%)
0.5	-0.5	10	1.2	70	-0.2
1	1.5	15	0.9	REF. FREQ.	0.0
2	1.7	20	0.8	200	0.6
5	1.4	30	0.3	500	0.3
7	1.3	50	0.4	700	-2.7

Condition of Unit
As Found: N/A
As Left: New Unit, In Tolerance

Notes
1. Calibration is traceable to one or more of the following: PTB 10065, PTB 10066 and NIST 683/283498.
2. This certificate shall not be reproduced, except in full, without written approval from PCB Piezotronics, Inc.
3. Calibration is performed in compliance with ISO 10012-1, ANSI Z540.3 and ISO 17025.
4. See Manufacturer's Specification Sheet for a detailed listing of performance specifications.
5. Measurement uncertainty (95% confidence level with coverage factor of 2) for frequency ranges tested during calibration are as follows: 0.5-0.99 Hz: +/- 1.8%, 1-30 Hz: +/- 1.0%, 30.01-199 Hz: +/- 1.5%, 200-1 kHz: +/- 3.0%.

Technician: Jesse J. Johnson Date: 5/7/2020

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The figure above shows a photo, specifications, and an example calibration paper for this triaxial seismic accelerometer, which once again certifies the accuracy of each unit produced.

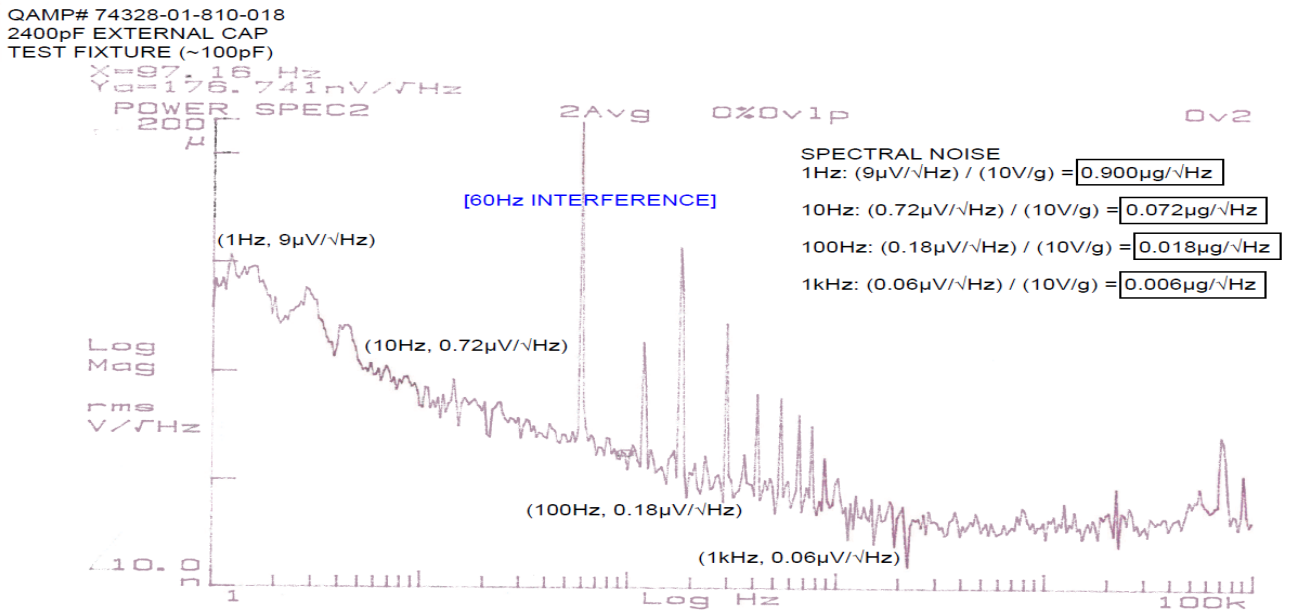


Fig. 354A12 Spectral Noise Validation Testing

The figure above shows a photo, specifications, and an example calibration paper for this triaxial seismic accelerometer, which once again certifies the accuracy of each unit produced.

2. Satellite test: low outgassing sensors

One of the challenges of satellite testing is avoiding disruption to their functionality once in orbit, and in this case, appropriate technologies are used. One of these concerns is the potential leakage of the accelerometer-cable system, which could obscure the satellites' optical components, rendering them inoperable. To this end, accelerometers and cables made of suitable, very low-loss materials are used, in compliance with aerospace standards such as those of NASA.

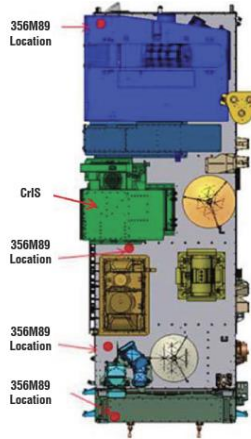
Below is a paper on this topic and an example of low outgassing accelerometers mounted on a satellite under test.



Case Study

How Low Outgassing Accelerometers Facilitate Thermal Vacuum Testing and Permanent Satellite Installation

Meeting NASA Requirements for the Suomi National Polar-Orbiting Partnership (NPP) Satellite



LOW OUTGASSING TRIAXIAL ACCELEROMETER
MODEL 356M98

THE PCB ADVANTAGE IN THERMAL VACUUM TESTING	
Testing Challenge	PCB Model 356M98 Solution
Contamination risk from sensor outgassing	Fully protects sensitive instruments by meeting NASA RP-1124 and ASTM E595 low outgassing standards
Reliable data collection in extreme conditions	Shear-mode piezoelectric element delivers stable measurements under random vibration, shock, and thermal stress
Long-term reliability after spacecraft integration	Ensures maintenance-free installation with hermetically sealed titanium construction
Installation in tight or critical areas	Simplifies integration with compact, lightweight sensor design

This table summarizes the main benefits of that example of a low outgassing accelerometer in the face of each testing challenge.

Accelerometers, connectors & cables low outgassing



Accelerometer 357A09, P357A09

Drawing/Item Number	Description	Material	Secondary finish
Element Assembly	Crystal Mass Memory Ring	PZT Ceramic Tungsten Nickel - Titanium	Gold over Nickel
Housing Assembly	Housing Contact Insulator	Ti6AL4V BeCu Torlon	Gold plate over Nickel plate
Cover	Epoxy	Ti6AL4V	
Epoxy		H20E	
Wire		104A/B	
Solder		44AWG Copper SN63/37	




030BK01PH Materials List

030 Cable	Teflon (PTFE Tapes)
Jack	40 AWG Silver Plated Copper Wire
Shield	Geophils
Low Noise Barrier	Teflon (Extruded PTFE)
Insulator	34 AWG (7x0.003) Silver Plated Copper
Conductor	
PH	
Connector Shell	SS 304L
Insulator	99913 Glass
Contact/Socket	SS 430, Nickel Sulfamate Plate per SAE AMS-QQ-N-290 Class 2, Grade G
Backshell	SS 304L
Lock Ring	Brass, Gold Plate per MIL-K-45204 Type B, Grade C, Class 1 over Nickel Plate per QQ-N-290
Strain Relief	Viton
Pin Retaining Ring	Teflon (PTFE 15% Glass)
Wiring	Teflon
Solder	SN10PB88AG2
EK	
Coupling Nut	6061-T6 Al with gold plate over nickel plate
Housing	6061 Al with gold plate over nickel plate
Insulator	Torlon
Socket	BeCu with gold plate over nickel plate
Strain Relief	Torlon
Solder	SN10PB88AG2

This figure shows examples of accelerometers and cables that meet the low-outgassing conditions and standard. Specifically, for miniaturized cables and accelerometers, in compliance with the NASA standard, a list of the materials used to make the accelerometer and cable must be provided. For other hermetic accelerometers and their connectors, specific tests must be performed in accordance with the standard. One of the challenges concerns connectors that can meet the standard with a specific design and production process for glass-to-metal bonds.

Leak Testing

On such accelerometers and hermetic connectors the bubble test is the coarsest and the test in the mass spectrometer is the finest test to test for very low levels of low outgassing as summarized below:

- Bubble test is visual in heated fluoro inert (picture below left)
 - 110 °C fluoro inert
- Fine leak test subjects accelerometers and connectors to pressurized helium
- Mass spectrometer vacuum leak detector verifies leak flow rate of $<2 \times 10^{-8}$ cc/sec (picture center)
- 3 tests: Hermetic connectors, Finished sensor assembly, Weld joints 'sniff' (two picture on right side below)



Accelerometers Low Outgassing

Here is an overview of low outgassing accelerometers and cables that are a derivative of standard accelerometers and cables but comply with NASA standards.



Low Outgassing Posters

Finally, below are two posters: an older one presented at an international conference on cubesats and, on the right, the updated version of this poster summarizing the solutions presented.

3rd IAA Latin American CubeSat Workshop - Florianopolis - SC, Brazil
IAA-BR-16-0P Low Outgassing Accelerometers & Cables
 Bob Metz, Carmine Salzano
 PCB Piezotronics, Inc.

Introduction

- Exposure to vacuum of space or Thermal Vacuum (TVAC) environments induces material outgassing. Components can outgas on to nearby surfaces and in process devices, resulting in damage.
- Non-harmless outgassing and residual outgases are not suited for this environment.
- Minimum Outgassing
 - Pre-flight ground chamber testing is performed.
 - Quality Test chamber conditions.
 - Quality Test chamber procedures.
 - Quality Test chamber after flight.
 - Quality Test chamber after flight.
 - Quality Test chamber after flight.
 - Quality Test chamber after flight.

Specifications

- Developed and tested for use in TVAC test chambers.
- Compliant with the CubeSat Operator (CSO) test chamber as required in U.S.
- Quantity of outgassing under test conditions.
- Compliant with the CubeSat Operator (CSO) test chamber as required in U.S.
- Quality Test chamber after flight.
- Quality Test chamber after flight.
- Quality Test chamber after flight.
- Quality Test chamber after flight.

Hermetic Connector Assembly

- Designs with complete hermetic seal to provide electrical isolation and hermetic seal.
- Designs with complete hermetic seal to provide electrical isolation and hermetic seal.
- Designs with complete hermetic seal to provide electrical isolation and hermetic seal.
- Designs with complete hermetic seal to provide electrical isolation and hermetic seal.

Hermetic Connectors

- Example of a hermetic seal with good adhesion for TVAC test chamber as required in U.S.

Conclusion

- Quality Test chamber after flight.
- Quality Test chamber after flight.
- Quality Test chamber after flight.
- Quality Test chamber after flight.

LOW OUTGASSING ACCELEROMETERS & CABLES **PCB PIEZOTRONICS**
 400 WESTERN AVENUE, WESTFIELD, MA 01095

INTRODUCTION

OBJECTIVES

DEVELOP ACCELEROMETERS AND CABLES THAT MEET ASTM TEST STANDARDS

- Developed and tested for use in TVAC test chambers.
- Compliant with the CubeSat Operator (CSO) test chamber as required in U.S.
- Quantity of outgassing under test conditions.
- Compliant with the CubeSat Operator (CSO) test chamber as required in U.S.

HERMETIC CONNECTOR ANATOMY

NON-HERMETIC SENSORS

CABLE DESIGN

REFERENCES

CONCLUSIONS

CASE STUDY

MEASUREMENT POINTS

SOLUTION PROVIDED

LEARN TESTING TO VALIDATE HERMETIC ACCELEROMETERS

SUMMARY

3. Pyroshock Test Sensor Technologies: Mechanically Isolated & Electrically Filtered ICP pyroshock Accelerometers

In this final part of this extended abstract, we report the state of the art of sensors for pyroshock testing for satellites. Here an example of such shock accelerometers.



Pyroshock test

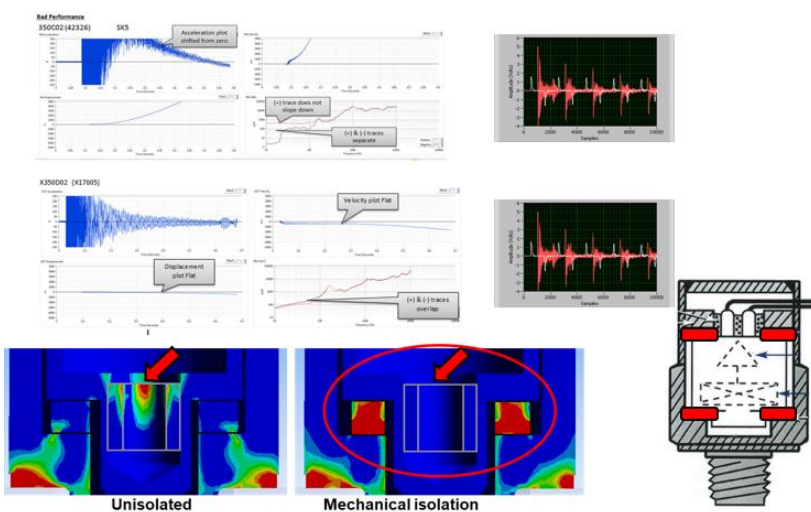
A typical live explosive pyroshock simulation can be performed by using either (as in picture):

- a detonation cord
- a pendulous impact
- Or Air hammer



Detonation cord on back side of plate

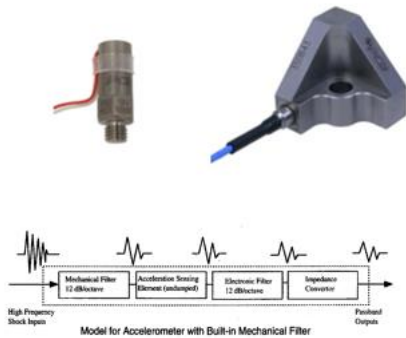
The technological challenges for such pyroshock sensors for measurements up to 100,000 G lie especially in the following 3 typical measurement errors that affect such tests: amplifier saturation, zero shift and ringing. With Mechanical Isolation, zero shift and ringing are avoided, while an electronic low-pass filter prevents amplifier saturation. Below is a finite element simulation of mechanical isolation and the pre- and post-effects with plots over time, as well as a schematic of the accelerometer with this mechanical isolation.



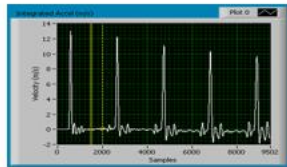
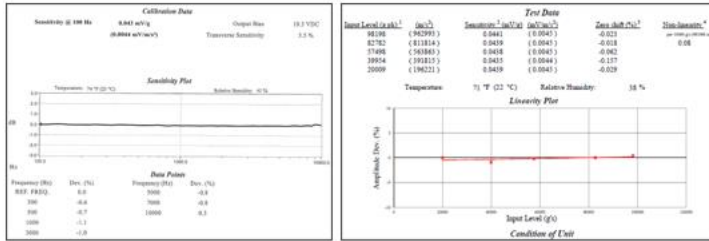
Piezoelectric Shock Accelerometers

These accelerometers represent the state of the art for pyroshock measurements and the unique features resulting from this design are summarized below:

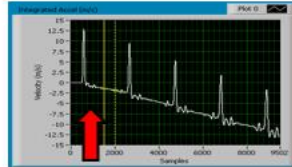
- Uniquely Designed for Pyroshock
 - They contain mechanical isolation and an electrical LP filter
- Mechanical Isolation
 - Removes out band energy above 45 kHz
 - Reduces strain effects and zero shift of the element
 - Ensures the survivability of the accelerometer from over-shock
- Electronic LP filter
 - Located between the sensor and the amplifier input stage
 - Reduces resonant effect of mechanical isolation
- High Signal-to-noise Ratio
 - 50 kG sensor has **0.5 g** resolution



Shock Accelerometer Calibration. These accelerometers are obviously calibrated using appropriate calibration systems and the certificates demonstrate that the residual zershift is almost zero with these innovative technological solutions.



Low Zero shift



High Zero Shift (~300G equivalent)
(0.3% of 100kG)

New unique Triaxial ICP® Shock Accelerometer (350B4X)

Below are summarized the features of the only triaxial pyroshock accelerometer currently available on the market that has electronic filtering and mechanical isolation on each axis and is available for ranges up to 100,000G.

Series 350B4x are mechanically isolated, electrically filtered triaxial ICP® shock accelerometers developed specifically for pyro-shock applications. Additional features include electrical isolation and thru-hole mount.

PRODUCT APPLICATION

- Model 350B4x is designed to withstand pyro-shock.
- Improved design over 3 single axis sensors on a triax block:
 - Weight reduced more than 50%
 - Center of gravity closer to mounting
 - Thru-hole mount for easy installation

350B4x
Triaxial ICP® Shock Sensor

- ✓ Mechanical and electrical isolation
- ✓ 2nd order electrical low pass filter
- ✓ Eliminates need for mounting block

PRODUCT SPECIFICATION

	350B41	350B42	350B43	350B44
Sensitivity (mV/g):	0.05	0.1	0.5	1
Measurement Range (g pk):	±100k	±50k	±10k	±5k
Frequency Range (± 1 dB):	4 Hz to 10 kHz		0.4 Hz to 10 kHz	
Resonant Frequency:	> 50 kHz			
Elec. Filter Corner Freq. (-3 dB):	17 kHz			
Operating Temperature Range:	0 to +150 °F (-18 to +66 °C)			
Weight (without cable):	0.95 oz (27 gm)			
Housing Material:	Titanium			

PRODUCT FAMILY

350B01 **350C23**
350C24 **350D02**

Mechanically isolated and Electrically Filtered Single Axis ICP® Shock Sensors in ranges of 15kg, 10kg, 50kg & 100kg

PRODUCT PERFORMANCE

Combines the features of existing ICP® shock sensors into a simplified and cost effective solution

350B60
(Electrical Filter Only)

350C23 w/ triax block
(Mechanical Isolation)