



# Engine Health Monitoring Sensors

## Highlights

- Qualified to RTCA/DO-160 & MIL-STD-810
- Case isolated to reduce EMI & ground loop interference
- High temperature environments
- ICP® & charge output operations
- Numerous form factors
- Custom designed monitoring sensors

## Applications

- Mechanical diagnostics
- Engine balance
- Engine health monitoring
- Combustion instability monitoring



### High Temperature Turbine Instrumentation Overview

Most people have either forgotten or never experienced the pre-turbine engine levels of vibration in reciprocating engine aircraft. The smooth operation of turbine engines belies the complexity of their operating environment.

Turbine engines' numerous rotating components create a multitude of high amplitude oscillatory and impulsive forces across a broad band of frequencies. Certainly, catastrophic events are indicated by sudden increases in vibration, but the early symptoms of many maintenance problems are also marked by identifiable vibration signatures. Similarly, relatively small amounts of combustion pressure oscillation can cause catastrophic failure of critical downstream engine components. Thus, the turbine engine operating environment presents a multitude of measurement challenges and opportunities.

But turbine engines also pose instrumentation reliability problems. Coupled with the engine vibratory environment and challenging flight conditions, engine case temperatures can be in excess of 1200 °F or 649 °C, with internal engine temperatures far exceeding these.

Each of PCB's accelerometers, dynamic pressure sensors and associated signal conditioning routinely sustain thousands of trouble-free hours of operation, while accurately measuring minute changes in pressures and accelerations. This has translated to a record of 10's of millions of trouble free operating hours for our customers.

This catalog contains a sample of the turbine engine monitoring instrumentation that PCB® has developed and proven in the field. These products are typically custom designed for each application using PCB's field-proven subsystems. This document will give you an idea of our experience, but is far from exhaustive. We therefore invite you to contact PCB® at the email address or telephone numbers on the back of this catalog to discuss how we can support your turbine engine sensing efforts.





## Engine Health Monitoring Sensors



The precursor to implementing monitoring solutions is extensive test and development. The instrumentation requirements for such programs are decidedly different from those of engine health monitoring. To that end, PCB® supplies high temperature accelerometers and dynamic pressure sensors that are tailored to engine test and development programs. Responding to the highly constrained spaces and high temperatures within which these sensors must reliably operate, PCB® has developed a line of small, high temperature, high frequency range sensors specifically designed for test and measurement applications. The models pictured below are just a sample of the scores of models available.

### Test & Measurement Accelerometers



#### Model 357C90

- 5 pC/g [0.51 pC/(m/s<sup>2</sup>)] sensitivity
- ±1000 g pk measurement range
- 2.5 kHz frequency range (±5%)
- 1200 °F (649 °C) temperature range
- Welded hermetic seal
- Inconel housing
- 10-32 Coaxial jack rated to 900 °F (482 °C) on end of Integral hardline cable
- Electrical case isolated
- 0.66 x 1.26 x 0.66 in  
16.7 x 32.0 x 16.7 mm (Height x Length x Width)



#### Model 357B61

- 10 pC/g [1.02 pC/(m/s<sup>2</sup>)] sensitivity
- ±3000 g pk measurement range
- 5 kHz frequency range (+5%)
- -65 to +900 °F (-54 to +482 °C) temperature range
- Welded hermetic seal
- Inconel housing
- 10-32 Coaxial jack
- 1.0 x 5/8 in  
25.4 mm x 5/8 in (Height x Hex)



#### Model 357B69

- 3 pC/g [0.31 pC/(m/s<sup>2</sup>)] sensitivity
- ± 500 g pk measurement range
- 6 kHz frequency range (+5%)
- - 65 to + 900 °F (-54 to +482 °C) temperature range
- Welded hermetic seal
- Inconel housing
- 10-32 Coaxial jack
- 0.875 x 0.45 in  
22.2 x 11.4 mm (Height x Diameter)



#### Model 357M46

- 3 pC/g [0.31 pC/(m/s<sup>2</sup>)] sensitivity
- ± 2300 g pk measurement range
- 12 kHz frequency range (+5%)
- - 95 to + 500 °F (-71 to +260 °C) temperature range
- Welded hermetic seal
- Titanium housing
- 5-44 Coaxial jack
- 0.43 x 0.30 in  
10.9 x 7.6 mm (Height x Hex)

### Engine Vibration Monitoring High Temperature Accelerometers

#### 550 °F (288 °C)



#### Model 357B81

- 20 pC/g [2.04 pC/(m/s<sup>2</sup>)] sensitivity
- ± 2000 g pk measurement range
- 9000 Hz frequency range (±5%)
- -65 to +550 °F (-54 to + 288 °C) temperature range
- Welded hermetic seal
- Stainless steel housing
- 7/16-27 2-Pin connector
- Electrical case isolation
- 1.0 in x 0.75 in  
25.4 mm x 19.1 mm (H x D)

#### Model 357B82

- 50 pC/g [5.1 pC/(m/s<sup>2</sup>)] sensitivity
- ± 1000 g pk measurement range
- 6000 Hz frequency range (±5%)
- -65 to +550 °F (-54 to + 288 °C) temperature range
- Welded hermetic seal
- Stainless steel housing
- 7/16-27 2-Pin connector
- Electrical case isolation
- 1.0 in x 0.75 in  
25.4 mm x 19.1 mm (H x D)

#### Model 357B83

- 100 pC/g [10.2 pC/(m/s<sup>2</sup>)] sensitivity
- ± 500 g pk measurement range
- 6000 Hz frequency range (±5%)
- -65 to +550 °F (-54 to + 288 °C) temperature range
- Welded hermetic seal
- Stainless steel housing
- 7/16-27 2-Pin connector
- Electrical case isolation
- 1.0 in x 0.75 in  
25.4 mm x 19.1 mm (H x D)

#### 900 °F (482 °C)

While most engine monitoring applications dictate custom designed accelerometers, some engine health monitoring requirements can be met by catalog sensors. These case isolated sensors feature differential electrical output and mount on ARINC standard structural interfaces. PCB® also supplies hard line mineral insulated cables and connectors to complement this line of catalog accelerometers. The capabilities of a few of these models are summarized below.

#### Model 357C71

- 10 pC/g [1.02 pC/(m/s<sup>2</sup>)] sensitivity
- ± 1000 g pk measurement range
- 4000 Hz frequency range (±5%)
- -65 to +900 °F (-54 to + 482 °C) temperature range
- Welded hermetic seal
- Inconel housing
- 7/16-27 2-Pin connector
- Electrical case isolation
- 1.0 in x 0.75 in  
25.4 mm x 19.1 mm (H x D)

#### Model 357C72

- 50 pC/g [5.1 pC/(m/s<sup>2</sup>)] sensitivity
- ± 500 g pk measurement range
- 2500 Hz frequency range (±5%)
- -65 to +900 °F (-54 to + 482 °C) temperature range
- Welded hermetic seal
- Inconel housing
- 7/16-27 2-Pin connector
- Electrical case isolation
- 1.25 in x 0.75 in  
31.8 mm x 19.1 mm (H x D)

#### Model 357C73

- 100 pC/g [10.2 pC/(m/s<sup>2</sup>)] sensitivity
- ± 300 g pk measurement range
- 2000 Hz frequency range (±5%)
- -65 to +900 °F (-54 to + 482 °C) temperature range
- Welded hermetic seal
- Inconel housing
- 7/16-27 2-Pin connector
- Electrical case isolation
- 1.48 in x 0.75 in  
37.6 mm x 19.1 mm (H x D)



# Customize-it!

## Custom Designed Engine Health Monitoring Instrumentation

As mentioned on the front cover, the majority of Engine Health Monitoring instrumentation is custom designed to the application. This page illustrates some of the accelerometers and dynamic pressure sensors that are in current use in Engine Health Monitoring applications. PCB's custom sensors operate in temperature environments from cryogenic to 1200 °F (649 °C), under severe vibration loads, and provide many thousands of hours of reliable operation while meeting highly specialized measurement requirements.

### 900 °F Custom Accelerometers



900 °F/482 °C Rocket Engine Health Monitoring Accelerometer used in environments from cryogenic to high temperatures

#### Model 357M119

- 15 pC/g [1.53 pC/(m/s<sup>2</sup>)] sensitivity
- ±2000 g pk Measurement range
- 10 kHz frequency range (±5%)
- -420 to +900 °F (-251 to +482 °C) Operating temperature range
- Hermetically sealed
- Inconel housing
- MI Hardline cable with SS braid
- Signal isolated from case
- 1.0 x 5/8 in  
25.4 mm x 5/8 in (H x Hex)



900 °F/482 °C accelerometer selected for its order of magnitude better reliability than existing competitors

#### Model 357M79

- 10 pC/g [1.02 pC/(m/s<sup>2</sup>)] sensitivity
- ±1000 g pk Measurement range
- 4 kHz frequency range (±5%)
- -65 to +900 °F (-54 to +482 °C) Operating temperature range
- Hermetically sealed
- Inconel housing
- MI hardline cable with SS braid, 7/16-27 2-pin termination
- (3) Through holes
- 1.25 x 0.75 in  
31.7 x 19.05 mm (H x D)



986 °F/530 °C combustion dynamics monitoring pressure sensor with hundreds of thousands of hours of reliable usage

#### Model 176M03

- 17pC/psi (2.47 pC/kPa) sensitivity
- 20 psi Measurement range
- 50 kHz resonant frequency
- -65 to +986 °F (-54 to 530 °C) Operating temperature range
- Hermetically sealed
- Inconel housing
- Sealed integral cable, 2 pin termination
- (2) Through holes
- 1.6 x .475 in  
40.6 12.1 mm (H x D)

### Up to 550 °F Custom Accelerometers

#### 500 °F (260 °C) Differential Charge Output Accelerometers – Ideal for Bearing Monitoring

#### Model 357M132

- 50 pC/g Sensitivity
- ± 40 g Measurement range
- 1000 Hz Frequency range
- -65 to 500 °F (-54 to 260 °C) Operating temperature range
- Hermetically sealed
- Stainless steel housing
- Sealed integral cable
- (2) Through holes
- 0.71 x 40.33 x 08.80 in  
18 x 1024.4 x 20.3 mm (D x L x W)

#### Model 357M133

- 100 pC/g Sensitivity
- ± 40 g Measurement range
- 1000 Hz Frequency range
- -65 to 500 °F (-54 to 260 °C) Operating temperature range
- Hermetically sealed
- Stainless steel housing
- Sealed integral cable
- (2) Through holes
- 0.71 x 40.33 x 08.80 in  
18 x 1024.4 x 20.3 mm (D x L x W)



#### 550 °F (288 °C) Charge Output Accelerometers – General Purpose Monitoring

#### Model 357M134

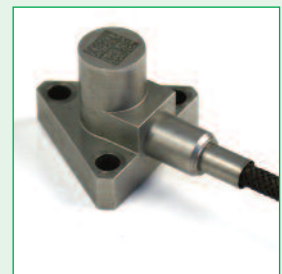
- 20 pC/g Sensitivity
- 9 k Hz Frequency range
- -65 to 550 °F (-54 to 288 °C) Operating temperature range
- Hermetically sealed
- Stainless steel housing
- Sealed integral cable
- (3) Through holes
- 1.01 x 0.75 in  
24.4 x 19.1 mm (H x D)

#### Model 357M135

- 50 pC/g Sensitivity
- 6 k Hz Frequency range
- -65 to 550 °F (-54 to 288 °C) Operating temperature range
- Hermetically sealed
- Stainless steel housing
- Sealed integral cable
- (3) Through holes
- 1.01 x 0.75 in  
24.4 x 19.1 mm (H x D)

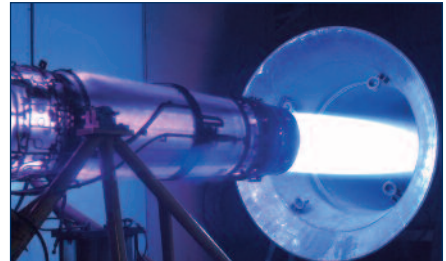
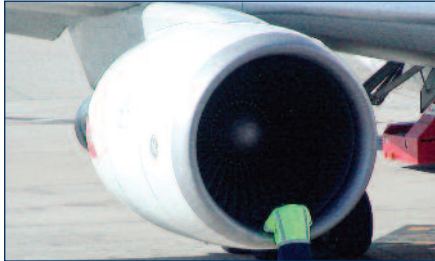
#### Model 357M136

- 100 pC/g Sensitivity
- 6 k Hz Frequency range
- -65 to 550 °F (-54 to 288 °C) Operating temperature range
- Hermetically sealed
- Stainless steel housing
- Sealed integral cable
- (3) Through holes
- 1.01 x 0.75 in  
24.4 x 19.1 mm (H x D)





## Engine Health Monitoring Sensors



The **Aerospace & Defense** division of PCB Piezotronics serves the Turbine Engine, Helicopter Health and Usage Monitoring (HUMS), Ground Vibration Test, Flight Test, Wind Tunnel Test, Fuze/Safe and Arm, Spacecraft and Aerospace Systems design and development communities with sensors and associated signal conditioning for measurement of acceleration (vibration, shock and rigid body); acoustics; pressure; force; strain; and torque. Sensor technologies employed include piezoelectric, piezoresistive (both strain gauge and MEMS) and variable capacitive (both MEMS and microphone). Manufacturing operations are certified to AS9100 and ISO 9001, with calibration procedures accredited by A2LA to ISO 17025. Products can be manufactured to meet specific aerospace environmental standards, with program design requirements to meet RTCA-DO-160 and MIL-STD-810, and low outgassing designs available for specific applications.

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