Nuclear Power Instrumentation

Sensors with radiation hardened approvals
for nuclear power environments

IMI SENSORS
A PCB PIEZOTRONICS DIV.

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Energy & Power Generation

Nuclear Power Instrumentation

- High temperature vibration measurements
- Steam turbine testing
- Monitoring of boiling water reactors

PCB®'s charge accelerometers utilize piezo ceramic sensing elements to directly output an electrostatic charge signal that is proportional to applied acceleration. Charge accelerometers do not contain built-in signal conditioning electronics. As a result, external signal conditioning is required to interface their generated measurement signals to readout or recording instruments. The sensor's charge output signals can be conditioned with an in-line, fixed charge amplifier.

Since there are no electronics built into charge accelerometers, they can operate and survive exposure to very high temperatures (up to +1200 °F/+649 °C for some models). In addition, charge accelerometers are used for thermal cycling requirements or to take advantage of existing charge amplifier signal conditioning equipment. It is important to note that measurement resolution and low frequency response for charge acceleration sensing systems are dependent upon the noise floor and discharge time constant characteristics of the signal conditioning and readout devices used.

Radiation Hardened High Temperature Charge Accelerometers

- Survives integrated gamma flux to 10^8 rads
- Survives integrated neutron flux to 10^{10} N/cm^2

High Temperature Charge Accelerometer
Model 357B53

- Sensitivity: 100 pC/g
- Measurement Range: ±150 g pk
- Frequency Range: 3 kHz pk
- Electrical Connector: 10-32 coaxial jack

High Temperature Charge Accelerometer
Model 357B54

- Sensitivity: 100 pC/g
- Measurement Range: ±150 g pk
- Frequency Range: 3 kHz pk
- Electrical Connector: 10-32 coaxial jack

Hardline Cable, Radiation Hardened

10-32 Coaxial Plug
Model FZ

Coaxial Hardline Cable
Model 023XXX

10-32 Coaxial Plug
Model FZ

In-line Charge Amplifiers, Radiation Hardened

In-line Charge Amplifier
Model 422E65/A

- Sensitivity: 1 mV/pC
- Voltage Output: ±5 V pk
- Temperature Range (Operating): -65 to +250 °F

In-line Charge Amplifier
Model 422E66/A

Sensitivity: 10 mV/pC

Voltage Output: ±5 V pk

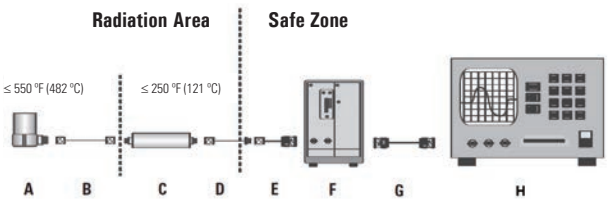
Temperature Range (Operating): -65 to +250 °F

Tips From Techs

Recommended Components for a Typical Installation

A Model 357B53 or 357B54 – Charge accelerometer
B Model 023FZXXXFZ – Cable with 10-32 plug to 10-32 plug
C Model 422E65/A or 422E66/A – In-line charge amplifier
D Model 023FZXXXGA – Cable with 10-32 plug to 10-32 jack
E Model 003C03 – Cable with 10-32 plug to BNC plug
F ICP® sensor signal conditioner
G Model 012A03 – Cable with BNC plug to BNC plug
H Readout, recording, or data acquisition device

XXX = Denote cable length, 010 = 10 feet (Metric lengths available)



Energy & Power Generation

Nuclear Power Instrumentation

Radiation Hardened Very High Temperature Charge Accelerometers

900°F (482 °C)

Very High Temperature Charge Accelerometer

Model 357B61

- Sensitivity: 10 pC/g
- Measurement Range: ±1000 g pk
- Frequency Range: 5 kHz pk
- Electrical Connector: 10-32 coaxial jack

CE

900°F (482 °C)

Very High Temperature Charge Accelerometer

Model 357B69

- Sensitivity: 3.5 pC/g
- Measurement Range: ±500 g pk
- Frequency Range: 6 kHz pk
- Electrical Connector: 10-32 coaxial jack

CE

Hardline Cable, Radiation Hardened

Note: 10 ft. length (Model 023A10) included as accessory with 357B61 & 357B69

10-32 Coaxial Plug

Model FZ

Coaxial Hardline Cable

Model 023XXX

10-32 Coaxial Plug

Model FZ

In-line Charge Amplifier, Radiation Hardened

In-line Charge Amplifier

Model 422E65/A

- Sensitivity: (±2%) 1 mV/pC
- Voltage Output: ±5 V pk
- Temperature Range (Operating): -65 to +250 °F

In-line Charge Amplifier

Model 422E66/A

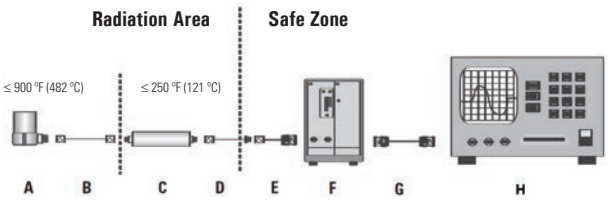
- Sensitivity: (±2%) 10 mV/pC
- Voltage Output: ±5 V pk
- Temperature Range (Operating): -65 to +250 °F

Tips From Techs

Recommended Components for a Typical Installation

A Model 357B61 or 357B69 – Charge accelerometer
B Model 023FZXXXFZ – Cable with 10-32 plug to 10-32 plug
C Model 422E65/A or 422E66/A – In-line charge amplifier
D Model 023FZXXXGA – Cable with 10-32 plug to 10-32 jack
E Model 003C03 – Cable with 10-32 plug to BNC plug
F ICP® sensor signal conditioner
G Model 012A03 – Cable with BNC plug to BNC plug
H Readout, recording, or data acquisition device

XXX = Denote cable length, 010 = 10 feet (Metric lengths available)



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Radiation Hardened Very High Temperature Charge Accelerometers

Very High Temperature Charge Accelerometer
Model 357A100

- Sensitivity: 5 pC/g
- Measurement Range: ±200 g pk
- Frequency Range: 5 kHz pk
- Electrical Connector: 7/16-27 2-pin

Very High Temperature Charge Accelerometer
Model 357C71

- Sensitivity: 10 pC/g
- Measurement Range: ±1000 g pk
- Frequency Range: 4 kHz pk
- Electrical Connector: 7/16-27 2-pin

Very High Temperature Charge Accelerometer
Model 357C72

- Sensitivity: 50 pC/g
- Measurement Range: ±500 g pk
- Frequency Range: 2.5 kHz pk
- Electrical Connector: 7/16-27 2-pin

Very High Temperature Charge Accelerometer
Model 357C73

- Sensitivity: 100 pC/g
- Measurement Range: ±300 g pk
- Frequency Range: 2 kHz pk
- Electrical Connector: 7/16-27 2-pin

Hardline Cable, Radiation Hardened

2-socket Plug, 7/16-27 Thd
Model GN

2-conductor Hardline Cable
Model 013XXX

2-pin Jack, 7/16-27 Thd
Model GP

PTFE Jacketed Cable

PTFE Jacketed Cable with 2-socket Plug, 7/16-27 Thd to 2-socket Plug, 5/8-24 Thd (25 ft cable)
045M19A Cabling

Differential Charge Amplifiers

Differential Charge Amplifier
Model 422M182

- Sensitivity: 4 mV/pC
- Voltage Output: ±5 V pK
- Temperature Range (Operating): -60 to +185 °F

Differential Charge Amplifier
Model 422M183

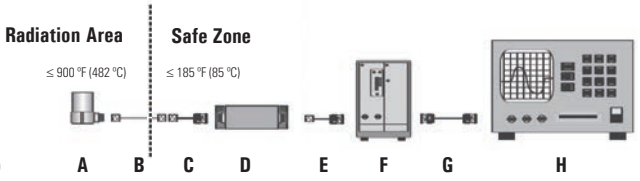
- Sensitivity: 6 mV/pC
- Voltage Output: ±5 V pK
- Temperature Range (Operating): -60 to +185 °F

Tips From Techs

Recommended Components for a Typical Installation

A Model 357A100 or 357C71 or 357C72 or 357C73 – Charge accelerometer
B Model 013GNXXXGP – Cable with 2 socket plug to 2 pin jack
C Model 045M19A – Cable with PY connector to BP connector
D Model 422M182 or Model 422M183 – Charge amplifier
E Model 003D03 – Cable with BNC plug to BNC plug
F ICP® sensor signal conditioner
G Model 012A03 – Cable with BNC plug to BNC plug
H Readout, recording, or data acquisition device

XXX = Denote cable length, 010 = 10 feet (Metric lengths available)



Energy & Power Generation

Nuclear Power Instrumentation

Radiation Hardened Very High Temperature Charge Accelerometers

900 °F (482 °C) CE

Very High Temperature Charge Accelerometer

Model 357A100

- Sensitivity: 5 pC/g
- Measurement Range: ±200 g pk
- Frequency Range: 5 kHz pk
- Electrical Connector: 7/16-27 2-pin

900 °F (482 °C) CE

Very High Temperature Charge Accelerometer

Model 357C71

- Sensitivity: 10 pC/g
- Measurement Range: ±1000 g pk
- Frequency Range: 4 kHz pk
- Electrical Connector: 7/16-27 2-pin

900 °F (482 °C) CE

Very High Temperature Charge Accelerometer

Model 357C72

- Sensitivity: 50 pC/g
- Measurement Range: ±500 g pk
- Frequency Range: 2.5 kHz pk
- Electrical Connector: 7/16-27 2-pin

900 °F (482 °C) CE

Very High Temperature Charge Accelerometer

Model 357C73

- Sensitivity: 100 pC/g
- Measurement Range: ±300 g pk
- Frequency Range: 2 kHz pk
- Electrical Connector: 7/16-27 2-pin

Hardline Cable, Radiation Hardened

2-socket Plug, 7/16-27 Thd

Model GN

2-conductor Hardline Cable

Model 013

2-pin Jack, 7/16-27 Thd

Model GP

PTFE Jacketed Cable

PTFE Jacketed Cable with 2-socket Plug, 7/16-27 Thd to Pigtails (25 ft cable)

045M21A Cabling

Differential Charge Amplifiers

Differential Charge Amplifier

Model 421A3X

- Configurable sensitivity
- Voltage Output: ±5 V pk
- Temperature Range (Operating): -22 to +185 °F

CE CSA

Differential Charge Amplifier

Model EX682A40

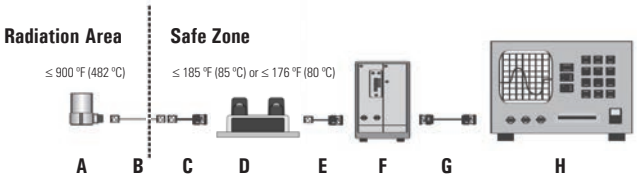
- Sensitivity: 10 mV/pC
- Voltage Output: ± 2.5 V pk
- Temperature Range (Operating): -40 to +176 °F

Tips From Techs

Recommended Components for a Typical Installation

A	Model 357A100 or 357C71 or 357C72 or 357C73 – Charge accelerometer
B	Model 013GNXXXGP – Cable with 2 socket plug to 2 pin jack
C	Model 045M21A – Cable with PY connector to pigtails
D	Model 421A3X or model EX682A40 – Charge amplifier
E	Model 003ACXXXAD – Cable with pigtails to BNC plug
F	ICP® sensor signal conditioner
G	Model 012A03 – Cable with BNC plug to BNC plug
H	Readout, recording, or data acquisition device

XXX = Denote cable length, 010 = 10 feet (Metric lengths available)



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Radiation Hardened Extreme Temperature Charge Accelerometers

Axis of Measurement
Models 357E90 and 357E92

Axis of Measurement
Models 357E91 and 357E93

Extreme Temperature Charge Accelerometer
Model 357E90

- Sensitivity: 5 pC/g
- Measurement Range: ±1000 g pk
- Frequency Range: 2.5kHz pk
- Output into sensor base

Extreme Temperature Charge Accelerometer
Model 357E92

- Sensitivity: 2.3 pC/g
- Measurement Range: ±1000 g pk
- Frequency Range: 2.5kHz pk
- Output into sensor base

Extreme Temperature Charge Accelerometer
Model 357E91

- Sensitivity: 5 pC/g
- Measurement Range: ±1000 g pk
- Frequency Range: 2.5kHz pk
- Output perpendicular to sensor base with sensitivity in the transverse direction

Extreme Temperature Charge Accelerometer
Model 357E93

- Sensitivity: 2.3 pC/g
- Measurement Range: ±1000 g pk
- Frequency Range: 2.5kHz pk
- Output perpendicular to sensor base with sensitivity in the transverse direction

PTFE Jacketed Cable

PTFE Cable with 10-32 Plug to 10-32 Plug
Model 003EBXXXEB

XXX = Denote cable length, 010 = 10 feet (Metric lengths available)

In-Line Charge Amplifiers

In-line Charge Amplifier
Model 422E35

- Sensitivity: 1 mV/pC
- Voltage Output: ±2.5 V pk
- Temperature Range (Operating): -65 to +250 °F

In-line Charge Amplifier
Model 422E36

- Sensitivity: 10 mV/pC
- Voltage Output: ±2.5 V pk
- Temperature Range (Operating): -65 to +250 °F

Tips From Techs

Recommended Components for a Typical Installation

A Model 357E90 or 357E91 or 357E92 or 357E93 – Charge accelerometer
B Model 003EBXXXEB – Cable with 10-32 plug to 10-32 plug
C Model 422E35 or 422E36 – In-line charge amplifier
D 003DXX – Cable with BNC plug to BNC plug
E ICP® sensor signal conditioner.
F Model 012A03 – Cable with BNC plug to BNC plug
G Readout, recording, or data acquisition device

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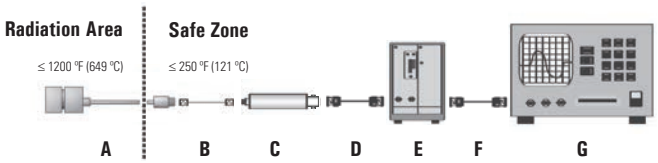

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IMI-App-Nuclear-0217

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