



# MEMS High-G Shock Accelerometers

State-of-the-Art MEMS Design and Fabrication

## Highlights

- Packaged and OEM configurations
- Single axis and triaxial arrangements
- Titanium housing with integral cable for packaged configurations
- Surface mount, wire bond and flip chip technologies available for OEM configurations
- Wide band frequency response
- No zero-shift
- Mechanical over-range stops improves survivability
- Slight damping reduces resonance amplification
- Low transverse sensitivity
- Excellent amplitude linearity
- 20 KG and 60 KG ranges available
- Low power consumption

## Applications

- Consumer electronics testing
- Pile drivers
- Down-hole oil exploration
- Shot counting for rifles and handguns
- Jack hammer manufacturers
- Golf driver head measurements



Series 3501 & 3503  
MEMS High-G Shock Accelerometers



Series 3501 and 3503 MEMS high-amplitude shock accelerometers, from PCB Piezotronics (PCB®), represent state-of-the-art industry technology for miniature, high amplitude, DC response acceleration sensors. This series is capable of measuring long duration transient motion, as well as, responding to and surviving extremely fast rise times, typical of a high-G shock event. Both a packaged and an OEM configuration are offered, to fulfill a variety of installation requirements.

The air-damped acceleration sensing element, micromachined from silicon, is manufactured with the latest advances in etching techniques and equipment. This tiny element measures just 2.5 x 1.7 x 0.9 mm (L x W x H), and incorporates a seismic mass, protective over-range stops and a full-active, piezoresistive Wheatstone bridge.

Series 3501 and 3503 are intended to fulfill the most demanding aerospace, industrial and commercial application requirements. Their design concepts were born from more than 20 years of PCB® expertise in very high-G shock ( $\geq 20,000$  G) measurement applications and sensor development. Our design team has the most experience in the world for these applications. Our process engineers utilized the latest and most sophisticated techniques and equipment to achieve the desired performance levels that previously have not been attainable.

Utilizing deep reactive ion etching (DRIE) equipment and techniques, PCB® can micromachine in-house, from extremely strong single crystal silicon, the industry's smallest, most accurate and durable shock accelerometer.

As with all PCB® instrumentation, these sensors are complemented with toll-free applications assistance, 24-hour customer service and are backed by our Total Customer Satisfaction no risk policy.



# SERIES 3501 and 3503 MEMS HIGH-G SHOCK ACCELEROMETERS

## MEMS High Amplitude Shock Accelerometers

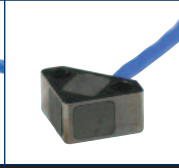
### Series 3501 and 3503



### Surface Mount



### Packaged



Model Number	3501A2020KG Single Axis	3503A2020KG Triaxial	3501A1220KG Single Axis	3503A1020KG Triaxial
Sensitivity ( $\pm 20\%$ ) (@ typical excitation)	0.010 mV/g	0.010 mV/g	0.010 mV/g	0.010 mV/g
Sensitivity	0.001 mV/V/g	0.001 mV/V/g	0.001 mV/V/g	0.001 mV/V/g
Measurement Range	$\pm 0$ to 20,000 g	$\pm 0$ to 20,000 g	$\pm 0$ to 20,000 g	$\pm 0$ to 20,000 g
Frequency Range ( $\pm 1$ dB)	10 kHz	10 kHz	10 kHz	10 kHz
Resonant Frequency	> 60 kHz	> 60 kHz	> 60 kHz	> 60 kHz
Overload Limit (Shock)	$\pm 60,000$ g pk	$\pm 60,000$ g pk	$\pm 60,000$ g pk	$\pm 60,000$ g pk
Overload Limit (Mechanical Stops)	$\geq 30$ kg	$\geq 30$ kg	$\geq 30$ kg	$\geq 30$ kg
Temperature Range (Operating)	-65 to +250 °F -54 to +121 °C	-65 to +250 °F -54 to +121 °C	-65 to +250 °F -54 to +121 °C	-65 to +250 °F -54 to +121 °C
Excitation Voltage (Typical)	10 VDC	10 VDC	10 VDC	10 VDC
Excitation Voltage	3.3 to 15 VDC	3.3 to 15 VDC	3.3 to 15 VDC	3.3 to 15 VDC
Bridge Resistance ( $\pm 2k$ ohms)	6k ohms	6k ohms	6k ohms	6k ohms
<b>Physical</b>				
Size (Height x Length x Width)	0.085 x 0.236 x 0.138 in 2.16 x 3.5 x 6 mm	0.12 x 0.15 x 0.15 in 3 x 3.8 x 3.8 mm	0.5 x 0.375 hex in 12.7 x 9.5 hex mm	0.25 x 0.47 x 0.47 in 6.35 x 11.8 x 11.8 mm
Weight	0.005 oz (0.15 gm)	0.003 oz (0.1 gm)	0.11 oz (3 gm)	0.09 oz (2.8 gm)
Mounting	Adhesive Mount	Adhesive Mount	1/4-28 stud	(2) Through-holes
Housing	Alumina	Alumina	Titanium	Titanium
Cable Length	N/A	N/A	10 ft (3m)	10 ft (3m)
Electrical Connection	Surface Mount (SMT)	Surface Mount (SMT)	034 FEP, Integral Cable	Integral Cable (8 conductor)
Cable Termination	N/A	N/A	Pigtails	Pigtails
<b>Supplied Accessories</b>				
Mounting Screw	N/A	N/A	Integral Stud	(2) Model 081Axxx (4-40 x 3/8" SHCS)
Calibration Certificate	ACS-62 Shock Calibration	ACS-62 Shock Calibration	ACS-62 Shock Calibration	ACS-62 Shock Calibration
<b>Additional Versions</b>				
Metric Mount (M6 x 0.75-6H)	—	—	M3501A1220KG	—

Model Number	3501A2060KG Single Axis	3503A2060KG Triaxial	3501A1260KG Single Axis
Sensitivity ( $\pm 20\%$ ) (@ typical excitation)	0.003 mV/g	0.003 mV/g	0.003 mV/g
Sensitivity	0.0003 mV/V/g	0.0003 mV/V/g	0.0003 mV/V/g
Measurement Range	$\pm 0$ to 60,000 g	$\pm 0$ to 60,000 g	$\pm 0$ to 60,000 g
Frequency Range ( $\pm 1$ dB)	20 kHz	20 kHz	20 kHz
Resonant Frequency	>120 kHz	>120 kHz	>120 kHz
Overload Limit (Shock)	$\pm 100,000$ g pk	$\pm 100,000$ g pk	$\pm 100,000$ g pk
Overload Limit (Mechanical Stops)	$\geq 80$ kg	$\geq 80$ kg	$\geq 80$ kg
Temperature Range (Operating)	-65 to +250 °F -54 to +121 °C	-65 to +250 °F -54 to +121 °C	-65 to +250 °F -54 to +121 °C
Excitation Voltage (Typical)	10 VDC	10 VDC	10 VDC
Excitation Voltage (Max)	3.3 to 15 VDC	3.3 to 15 VDC	3.3 to 15 VDC
Bridge Resistance ( $\pm 2k$ ohms)	6k ohms	6k ohms	6k ohms
<b>Physical</b>			
Size (Height x Length x Width)	0.085 x 0.236 x 0.138 in 2.16 x 3.5 x 6 mm	0.12 x 0.15 x 0.15 in 3 x 3.8 x 3.8 mm	0.5 x 0.375 hex in 12.7 x 9.5 hex mm
Weight	0.005 oz (0.15 gm)	0.003 oz (0.1 gm)	0.11 oz (3 gm)
Mounting	Adhesive Mount	Adhesive Mount	1/4-28 Stud
Housing	Alumina	Alumina	Titanium
Cable Length	N/A	N/A	10 ft (3m)
Electrical Connection	Surface Mount (SMT)	Surface Mount (SMT)	034 FEP, Integral Cable
Cable Termination	N/A	N/A	Pigtails
<b>Supplied Accessories</b>			
Mounting Screw	N/A	N/A	Integral Stud
Calibration Certificate	ACS-62 Shock Calibration	ACS-62 Shock Calibration	ACS-62 Shock Calibration
<b>Additional Versions</b>			
Metric Mount (M6 x 0.75-6H)	—	—	M3501A1260KG



**Model Numbering System for Series 3501 and 3503 MEMS High-Amplitude Shock Accelerometers**

**Single Axis Series 3501**

3501A Single axis, MEMS DC response shock accelerometer

1) Configurations

- 12 Titanium housing, mounted with integral 1/4-28 thread stud, side cable exit
- 20 Housed in a SMT leadless chip carrier to facilitate surface mount installation
- 21 "Flip chip", utilizes solder balls to attach to the substrate

2) Measurement Range

- 20KG ±20,000 G
- 60KG ±60,000 G

3) Integral Cable Length for configuration 3501A12XXG and 3501A13XXG (add only if other than standard length shown above)

/ XXX Specify XXX, as desired in feet

4) Cable Termination (add only if selecting other than pigtail connection)

- LN Mini 8-pin DIN connector
- AY 4-pin plug

**Triaxial Series 3503 (Q309)**

3503A Triaxial, MEMS DC response shock accelerometer

1) Configurations

- 10 Titanium housing, two through-holes for 4-40 mounting bolts
- 20 Incorporates three flip chip elements attached to a SMT leadless chip carrier to facilitate surface mount installation

2) Measurement Range

- 20KG ±20,000 G

3) Integral Cable Length for configuration 3503A10XXG only (add only if other than standard length shown above)

/ XXX Specify XXX, as desired in feet

4) Cable Termination (add only if selecting other than pigtail connection)

- LY (3) LN Mini 8-pin DIN connectors in a triple splice

**Examples**

3501A	12	60KG			Single axis, titanium housing, mounted with integral 1/4-28 thread stud, side cable exit, 60,000 G range
3503A	10	20KG	/020	LY	Triaxial, titanium housing, two through-holes for 4-40 mounting bolts, 20,000 G range, 20 ft (6.1m) cable terminating with (3) LN mini 8-pin DIN connectors

**LN Mini 8-Pin DIN Connector**



**Bridge input mating connector**



**MEMS Sensor Signal Conditioner**

<b>Model Number</b>	<b>482C27</b>
Channels	4
Sensor Input Types	Differential/Single-ended MEMS/Bridge, ICP®/Voltage
Compatible Sensor Series	350X, 360X, 371X, 374X, 3991, load cells
Gain	x0.1 to x2000; x0.1 to x200 [1]
Gain Increment	0.1
Output Range	±10 V
Frequency Response	DC to 100k Hz (-3dB)
Temperature Range (Operating)	+32 to +122 °F 0 to +50 °C
Excitation Voltage	0 to 12 VDC unipolar or bipolar [2]
Computer Controller	Ethernet/RS-232
Power Required	9 to 18 VDC [3]
Input Connectors	(4) 8-socket mini DIN, (4) BNC Jacks
Output Connectors	BNC Jacks
Size (Height x Width x Depth)	3.2 in x 8.0 in x 5.9 in 8.1 cm x 20 cm x 15 cm
Weight	2.25 lb 1.021 kg

**Supplied Accessories**

(1) 017AXX Power Cord; (1) 488A14 Universal Power Adaptor; (1) MCSC Control Software

**Additional Accessories**

Auto Lighter Adaptor	488A13
Input Mating Connector(s)	8-pin mini DIN, AC

**Additional Versions**

8-channel 19" rack mount version, computer control only	483C28
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**Notes**

- [1] Maximum gain for bridge/MEMS input is x2000 and for ICP®/voltage input is x200.
- [2] In bipolar mode, +Vexc and -Vexc track each other. They are equal and opposite.
- [3] Supplied with 85 to 264 VAC, 47 to 400 Hz Universal Power Adaptor.



**Typical Rear Panel**

The Model 482C27 four-channel, benchtop signal conditioner is full-featured and cost effective. It offers low noise operation and simplicity of use. Each channel is selectable between two input types: Bridge/MEMS or ICP®/Voltage.

For the bridge inputs, this model offers 0 to 12 VDC unipolar or bipolar excitation voltage for use with single-ended or differential MEMS and bridge sensors, like load cells and reaction torque sensors. This model features incremental gain of x0.1 to x2000, auto zero, auto balance, AC/DC coupling, normalization and shunt calibration. The bridge inputs are compatible with full bridge sensors as well as 1/2 and 1/4 bridge sensors, with internal switchable bridge completion resistors.

For the ICP® inputs, the model offers 0 to 20 mA of constant current excitation, to power ICP® sensors or in-line ICP® charge converters. This model features incremental gain of x.1 to x200, normalization and AC/DC coupling.

The base unit of this model is powered from 9 to 18 VDC, however, it is supplied with a universal voltage, AC power adaptor. Optional auto lighter adaptor, Model 488A13, is also available.

As with all PCB® instrumentation, this model is complemented with toll-free application assistance, 24-hour customer service and is backed by a no-risk policy that guarantees satisfaction or your money refunded.



**483C28**  
**8-channel version, computer control only**



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