



# MEMS High-G Shock Accelerometers

State-of-the-Art MEMS Design and Fabrication

## Highlights

- Packaged and SMT configurations
- Single axis and triaxial
- Mechanical over-range stops improve survivability
- Slight damping reduces resonance amplification
- Excellent amplitude linearity
- Low power consumption

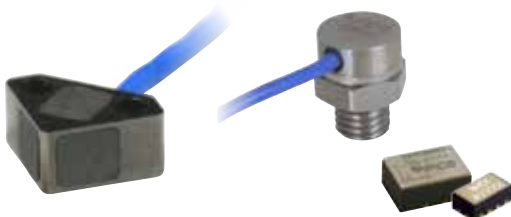
## Applications

- Metal-to-metal impact & pyroshock
- Data recorders, penetrator & launch tests
- Consumer electronics drop testing
- Sporting goods and impact tool testing
- Blast loading & survivability of structures
- Fuze, safe and arm



Series 3501 and 3503 Piezoresistive MEMS high-amplitude shock accelerometers represent state-of-the-art industry technology for miniature, high amplitude, DC response 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 as found in explosive, gun and impact testing. Both packaged and OEM configurations are offered, to fulfill a variety of installation requirements.

The hermetically sealed sensing element is air-damped with over range stops intended to improve survivability and is a full active Wheatstone bridge with high input resistance for low power consumption. It is micromachined from single crystal silicon and manufactured with the latest advances in etching techniques and equipment using deep reactive ion etching (DRIE).



Series 3501 & 3503  
MEMS High-G Shock Accelerometers



# SERIES 3501 and 3503 MEMS HIGH-G SHOCK ACCELEROMETERS

## MEMS High Amplitude Shock Accelerometers

Series 3501 and 3503	Surface Mount	Integral Stud	Through Holes (2)

2 KG				
Model Number	3501A202KG	3503C202KG	3501B122KG	3503A112KG
<b>Performance</b>				
Sensitivity ( $\pm 50\%$ ) (at 10VDC)	0.2 mV/g 0.02 mV/(m/s <sup>2</sup> )	0.10 mV/g 0.01 mV/(m/s <sup>2</sup> )	0.20 mV/g 0.02 mV/(m/s <sup>2</sup> )	0.20 mV/g 0.02 mV/(m/s <sup>2</sup> )
Sensitivity (raw)	0.02 mV/V/g 0.002 mV/V/(m/s <sup>2</sup> )	0.02 mV/V/g 0.002 mV/V/(m/s <sup>2</sup> )	0.02 mV/V/g 0.002 mV/V/(m/s <sup>2</sup> )	0.02 mV/V/g 0.002 mV/V/(m/s <sup>2</sup> )
Measurement Range	$\pm 2000$ g $\pm 19610$ m/s <sup>2</sup> pk	$\pm 2000$ g $\pm 19613$ m/s <sup>2</sup> pk	$\pm 2000$ g $\pm 19620$ m/s <sup>2</sup> pk	$\pm 2000$ g $\pm 19620$ m/s <sup>2</sup> pk
Frequency Range ( $\pm 1$ dB)	0-10000 Hz	0-10000 Hz	0-10000 Hz	0-10000 Hz
Resonant Frequency	>20 kHz	>20 kHz	>20 kHz	$\geq 20$ kHz
Damping Ratio	0.7 % Critical	—	70 % Critical	0.7 % Critical
Non-Linearity	$\pm 1$ %	—	$\pm 1$ %	$\pm 1$ %
Non-Linearity (per 1000 g, 9810 m/s <sup>2</sup> )	—	$\pm 1$ %	—	—
Transverse Sensitivity	$\leq 3$ %	$\leq 3$ %	$\leq 3$ %	$\leq 3$ %
<b>Environmental</b>				
Temperature Range (Operating)	-65-250 °F -54-121 °C	-65-150 °F -54-65 °C	-65-250 °F -54-121 °C	-65-250 °F -54-121 °C
<b>Electrical</b>				
Excitation Voltage (Maximum)	15.0 VDC	12 VDC	15.0 VDC	15.0 VDC

20 KG				
Model Number	3501A2020KG	3503C2020KG	3501B1220KG	3503A1120KG
<b>Performance</b>				
Sensitivity ( $\pm 50\%$ ) (at 10VDC)	0.010 mV/g 0.001 mV/(m/s <sup>2</sup> )	0.005 mV/g 0.0005 mV/(m/s <sup>2</sup> )	0.010 mV/g 0.001 mV/(m/s <sup>2</sup> )	0.010 mV/g 0.001 mV/(m/s <sup>2</sup> )
Sensitivity (raw)	0.001 mV/V/g 0.0001 mV/V/(m/s <sup>2</sup> )	0.001 mV/V/g 0.0001 mV/V/(m/s <sup>2</sup> )	0.001 mV/V/g 0.0001 mV/V/(m/s <sup>2</sup> )	0.001 mV/V/g 0.0001 mV/V/(m/s <sup>2</sup> )
Measurement Range	$\pm 20000$ g $\pm 196100$ m/s <sup>2</sup> pk	$\pm 20000$ g $\pm 196133$ m/s <sup>2</sup> pk	$\pm 20000$ g $\pm 196100$ m/s <sup>2</sup> pk	$\pm 0-20000$ g $\pm 0-196100$ m/s <sup>2</sup> pk
Frequency Range (1dB)	0-10000 Hz	0-10000 Hz	0-10000 Hz	0-10000 Hz
Resonant Frequency	>60 kHz	>60 kHz	>60 kHz	>60 kHz
Damping Ratio	5 % Critical	5 % Critical	5 % Critical	5 % Critical
Non-Linearity (per 10,000 g (98,100 m/s <sup>2</sup> ))	$\pm 1$ %	$\pm 1$ %	$\leq 1$ %	$\pm 1$ %
Transverse Sensitivity	$\leq 3$ %	$\leq 3$ %	$\leq 3$ %	$\leq 3$ %
<b>Environmental</b>				
Temperature Range (Operating)	-65-250 °F -54-121 °C	-65-150 °F -54-65 °C	-65-250 °F -54-121 °C	-65-250 °F -54-121 °C
<b>Electrical</b>				
Excitation Voltage (Maximum)	15.0 VDC	15.0 VDC	12 VDC	15.0 VDC

60 KG				
Model Number	3501A2060KG	3503C2060KG	3501B1260KG	3503A1160KG
<b>Performance</b>				
Sensitivity ( $\pm 50\%$ ) (at 10VDC)	.003 mV/g .0003 mV/(m/s <sup>2</sup> )	0.0015 mV/g 0.00015 mV/(m/s <sup>2</sup> )	0.003 mV/g 0.0003 mV/(m/s <sup>2</sup> )	0.003 mV/g .0003 mV/(m/s <sup>2</sup> )
Sensitivity (raw)	0.0003 mV/V/g 0.00003 mV/V/(m/s <sup>2</sup> )	0.0003 mV/V/g 0.00003 mV/V/(m/s <sup>2</sup> )	0.0003 mV/V/g 0.00003 mV/V/(m/s <sup>2</sup> )	0.0003 mV/V/g 0.00003 mV/V/(m/s <sup>2</sup> )
Measurement Range	$\pm 60000$ g $\pm 588400$ m/s <sup>2</sup> pk	$\pm 60000$ g $\pm 588400$ m/s <sup>2</sup> pk	$\pm 60000$ g $\pm 588400$ m/s <sup>2</sup> pk	$\pm 60000$ g $\pm 588400$ m/s <sup>2</sup> pk
Frequency Range (1dB)	0-20000 Hz	0-10000 Hz	0-20000 Hz	0-10000 Hz
Resonant Frequency	>120 kHz	>150 kHz	>120 kHz	$\geq 120$ kHz
Damping Ratio	2 % Critical	2 % Critical	2 % Critical	2 % Critical
Non-Linearity (per 10,000 g (98,100 m/s <sup>2</sup> ))	$\pm 1$ %	$\pm 1$ %	$\leq 1$ %	$\pm 1$ %
Transverse Sensitivity	$\leq 3$ %	$\leq 3$ %	$\leq 3$ %	$\leq 3$ %
<b>Environmental</b>				
Temperature Range (Operating)	-65-250 °F -54-121 °C	-65-150 °F -54-65 °C	-65-250 °F -54-121 °C	-65-250 °F -54-121 °C
<b>Electrical</b>				
Excitation Voltage (Maximum)	15.0 VDC	12 VDC	15.0 VDC	15.0 VDC



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

**Single Axis Series 3501**

3501	Single axis, MEMS DC response shock accelerometer				
	1) Configurations				
B12 A20	Titanium housing, mounted with integral 1/4-28 thread stud, side cable exit Housed in a SMT leadless chip carrier to facilitate surface mount installation				
	2) Measurement Range				
	2KG	±2000 G			
	20KG	±20,000 G			
	60KG	±60,000 G			
	3) Integral Cable Length for configuration 3501B12XXG (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			
	CA	4-pin jack			

**Triaxial Series 3503 (Q309)**

3503	Triaxial, MEMS DC response shock accelerometer				
	1) Configurations				
A11 C20	Titanium housing, two through-holes for 4-40 mounting bolts Triaxial MEMS accelerometer, surface mount technology				
	2) Measurement Range				
	2KG	±2,000 G			
	20KG	±20,000 G			
	60KG	±60,000 G			
	3) Integral Cable Length for configuration 3503A11XXG 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**

<b>3501</b>	<b>B12</b>	<b>60KG</b>			<b>Single axis, titanium housing, mounted with integral 1/4-28 thread stud, side cable exit, 60,000 G range</b>
<b>3503</b>	<b>A11</b>	<b>2KG</b>	<b>1020</b>	<b>LY</b>	<b>Triaxial, titanium housing, two through-holes for 4-40 mounting bolts, 2,000 G range, 20 ft (6.1m) cable terminating with (3) LN mini 8-pin DIN connectors</b>

For complete specifications visit [www.pcb.com/mems](http://www.pcb.com/mems).

**LN Mini 8-Pin DIN Connector**



**Bridge input mating connector**



## MEMS Sensor Signal Conditioner

Model Number	482C27	483C28
Channels	4	8
Sensor Input Types	Differential & Single-ended MEMS/Bridge, ICP®, Voltage	Differential & Single-ended MEMS/Bridge, ICP®, Voltage
Compatible Sensor Series	3501, 3503, 3711 3713, 3741, 3991	3501, 3503, 3711 3713, 3741, 3991
Gain	x0.1 to x2000; x0.1 to x200 [1]	x0.1 to x2000; x0.1 to x200 [1]
Gain Increment	0.1	0.1
Output Range	±10 V	±10 V
Frequency Response	DC to 100k Hz (-3dB) [2]	DC to 100k Hz (-3dB) [2]
Temperature Range (Operating)	+32 to +120 °F 0 to +50 °C	+32 to +120 °F 0 to +50 °C
Excitation Voltage	-12 VDC to +12 VDC [3]	-12 VDC to +12 VDC [3]
Computer Control	Ethernet/RS-232	Ethernet
Power Required	9 to 18 VDC [4]	100 to 240 VAC (47 to 63 Hz)
Input Connectors	(4) 8-socket mini DIN (4) BNC Jacks	(8) 8-socket mini DIN (8) BNC Jacks
Output Connectors	BNC Jacks	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	1.75 in x 19.0 in x 13.7 in 44.5 cm x 482.6 cm x 348 cm
Weight	2.5 lb 1.134 kg	7.0 lb 3.18 kg

### Supplied Accessories

482C27: (1) 017AXX Power Cord; (1) 488B14/NC Universal Power Adaptor; (1) MCSC Control Software  
483C28: (1) 017AXX Power Cord; (1) MCSC Control Software

### Additional Accessories

Auto Lighter Adaptor 488A13 —

### Notes

- [1] Maximum gain for Bridge/MEMS input is x2000 and for ICP®/Voltage input is x200.
- [2] Low frequency response is 0.05 Hz when AC coupled.
- [3] In bipolar mode, +Vexc and -Vexc track each other. They are equal and opposite.
- [4] Supplied with 100 to 240 VAC, 50 to 60 Hz Universal Power Adaptor.

Models 482C27 (4-channels, bench top) and 483C28 (8-channels, rack mount) are full-featured signal conditioners. They offer low noise operation and are simple to use. Each channel is selectable between several input types: MEMS/Bridge, MEMS/Single-ended, ICP® and Voltage.

The models offer a -12 VDC to +12 VDC excitation voltage for MEMS/Bridge and MEMS/Single-ended sensors. Additional features are incremental gain from x0.1 to x2000, auto zero, auto balance, AC/DC coupling, normalization and shunt calibration. The bridge inputs are compatible with full, half and quarter bridge sensors.

The ICP® inputs offer 24 VDC and 2 to 20 mA of constant current excitation for powering ICP® sensors and in-line ICP® charge convertors. Additional features are incremental gain from x0.1 to x200, normalization and AC/DC coupling.

The 482C27 is powered from 9 to 18 VDC, but is supplied with a universal AC power adaptor. An optional auto lighter adaptor is also available (model 488A13). The 483C28 is line powered only.



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

CE



**482C27 Front Panel**



**482C27 Rear Panel**



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