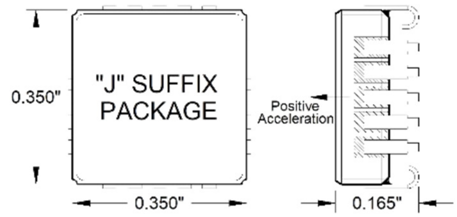
SDI's Highest-Performance Industrial Surface-Mount Accelerometer

- Individually Thermally Characterized, Calibrated, and Verified
- Bias Temperature Coefficient: ±25 ppm of span/°C
- Scale Factor Temperature Coefficient: -50/+25 ppm/°C
- -55°C to +125°C Operating Temperature Range
- Continuous Response to 0 Hz DC
- Low-Noise Differential Analog Output
- Hermetically Sealed Ceramic Package
- Individually Serialized
- Individual Calibration Report Included

AVAILABLE G-RANGES

FULL SCALE ACCELERATION	20 PIN J-LEAD
± 10 g	1523J-010
± 25 g	1523J-025
± 50 g	1523J-050



Tighter Thermal Performance for Precision Industrial Measurement

The Model 1523 is the highest-performing accelerometer in SDI's industrial surface-mount family. It is designed for applications where temperature-related changes in bias and scale factor represent a significant part of the measurement error budget.

Each Model 1523 undergoes individual thermal characterization and calibration during production, followed by climate-chamber verification of bias and scale-factor performance over temperature. Bias temperature coefficient is specified at ±25 ppm of span/°C, and scale-factor temperature coefficient is specified at -50/+25 ppm/°C across the -55°C to +125°C operating range.

The 1523 combines SDI's capacitive MEMS sensing element with analog signal conditioning to provide a low-noise differential output with continuous response to 0 Hz DC. Each device is serialized and supplied with an individual calibration report documenting measured bias, scale factor, linearity, operating current, and frequency response.

ZERO (DC) TO MEDIUM FREQUENCY APPLICATIONS

PERFORMANCE

INPUT RANGE	SENSITIVITY, DIFFERENTIAL	FREQUENCY RESPONSE (TYPICAL, 3 DB)	FREQUENCY RESPONSE (MINIMUM, 3 DB)	OUTPUT NOISE, DIFFERENTIAL (RMS, TYPICAL)	MAX. MECHANICAL SHOCK (0.1 MS)
g	mV/g	Hz	Hz	µg/(root Hz)	g (peak)
±10	400	0 – 1100	0 – 750	18	
±25	160	0 – 1400	0 – 1200	25	5000
±50	80	0 – 1400	0 – 1200	50	

By Model: *V_{DD}=V_R=5.0 VDC, T_C=25°C* *Single ended sensitivity is one-half of the values shown.*

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

PERFORMANCE - ALL VERSIONS

All Models: Unless otherwise specified V_{DD}=V_R=5.0 VDC, T_C=25°C, Differential. Span = ±g range = 8000 mV

PARAMETER	MIN	TYP	MAX	UNITS
Bias Calibration Error (mV)		16	40	± mV
Bias Calibration Error (Span)		0.2	0.5	± % of span
Bias Temperature Coefficient (T_C= -55 to +125°C)	**-25**	**0**	**+25**	**ppm of span/°C**
Scale Factor Calibration Error		0.5	1	± %
Scale Factor Temperature Coefficient (T_C= -55 to +125°C)	**-50**	**0**	**+25**	**ppm/°C**
Non-Linearity (-90 to +90% of Full Scale)		0.10	0.25	± % of span
Long Term Bias Stability		1000	2000	± PPM of span
Long Term Scale Factor Stability		500	1000	± PPM
Cross Axis Sensitivity		2	3	± %
Input Axis Misalignment		5	10	± mrad
Turn-On Transient (in less than 0.5ms)		75		± PPM of FS
Output Impedance		90		Ohms
Operating Voltage [1]	4.75	5.0	5.25	volts
Operating Current (IDD+IVR)		5.5	6.5	mA
Mass: ‘J’ package		0.68		grams

Case Operating Temperature	-55 to +125°C	Voltage on V_{DD} to GND	-0.5V to 6.0V
Storage Temperature	-55 to +125°C	Voltage on Any Pin (except DV) to GND	-0.5V to V_{DD}+0.5V
Max Reflow Solder Temperature	+239°C	Voltage on DV to GND (Self-Test)	±15V
	Power Dissipation	35 mW	

Note 1: Voltages on pins other than DV, GND or V_{DD} may exceed 0.50 volt above or below the supply voltages provided max current is <1 mA.
NOTICE: Minimize exposure above 125°C for maximum lifespan. Stresses greater than those listed above may cause permanent damage to the device. These are maximum stress ratings only. Functional operation of the device at or above these conditions is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability and lifespan.

UNDERSTANDING BIAS & SCALE FACTOR TEMPERATURE COEFFICIENTS

Changes in temperature can affect both accelerometer bias and scale factor. In applications operating over a narrow temperature range, these effects may represent only a small portion of the total measurement error. As the operating temperature range increases, bias and scale-factor temperature coefficients become more important to overall measurement accuracy. Each Model 1523 undergoes individual thermal characterization and calibration during production. Climate-chamber verification then confirms bias and scale-factor performance over temperature.

Bias	The accelerometer output when no acceleration is present. For SDI differential-output analog accelerometers, bias is a signed quantity expressed in acceleration units or differential output voltage and is ideally zero g, or zero differential volts.
Scale Factor	The ratio of change in output to change in input acceleration, expressed in millivolts per g (mV/g). Because accelerometer output is not perfectly linear, SDI defines scale factor as the slope of the least-squares-fit line through the acceleration-versus-output data over the specified measurement range.
Bias Temperature Coefficient	The change in accelerometer bias resulting from a change in temperature, expressed in ppm of span/°C. For example, a Model 1523 with a ±25 ppm of span/°C bias temperature coefficient subjected to a 55°C temperature increase has a maximum calculated bias change of: 25 / 1,000,000 × 55 × 100% = 0.1375% of span For a ±25 g device, total span is 50 g, corresponding to a maximum calculated bias change of: 50 g × 0.001375 = 0.069 g
Scale Factor Temperature Coefficient	The change in scale factor resulting from a change in temperature, expressed in ppm/°C. The Model 1523 scale-factor temperature coefficient is specified from -50 to +25 ppm/°C. Over a 60°C temperature change, the maximum calculated change is therefore -0.30% to +0.15%. For a ±10 g Model 1523 with nominal differential sensitivity of 400 mV/g, this corresponds to approximately 398.8 to 400.6 mV/g.

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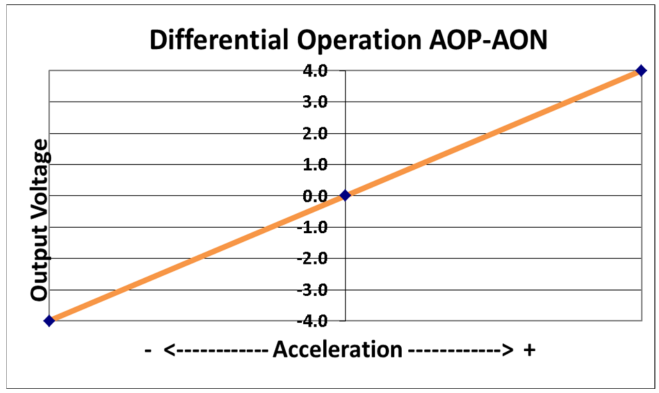
OPERATION

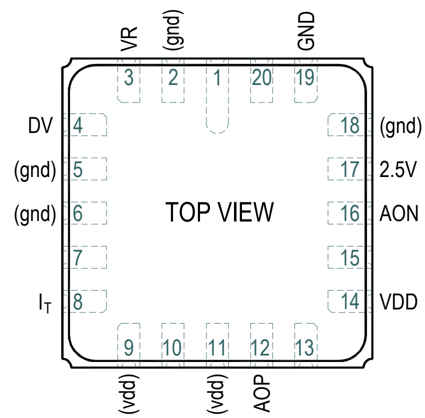
The Model 1523 sensitive axis is perpendicular to the bottom of the package, with positive acceleration resulting from a positive force pushing on the bottom of the package. The seismic center is located on a centerline through the dual sense elements and halfway between them.



The Model 1523 produces a differential ±4 V output that varies with acceleration as shown in the figure. Errors caused by rotation about the seismic center are effectively cancelled by the internal electronics.

Two reference voltages are required: +5.0 V and +2.5 V nominal. Scale factor is ratiometric to the +5.0 V reference relative to GND, and both outputs at zero acceleration are nominally equal to the +2.5 V input.

SIGNAL DESCRIPTIONS



<u>V_{DD} and GND (power):</u> Pins 14 and 19, respectively. Apply +5 VDC to VDD and connect GND to system ground.

<u>AOP and AON (Analog Outputs):</u> Pins 12 and 16, respectively. AOP and AON provide complementary analog output voltages proportional to acceleration. With positive acceleration, AOP increases while AON decreases. At zero acceleration, both outputs are nominally equal to the +2.5 V reference input.

The device experiences positive (+1 g) acceleration with the lid facing upward in Earth's gravitational field. Differential operation is recommended for lowest noise and best measurement accuracy. Output may be measured ratiometrically to VR for improved repeatability without requiring a separate precision reference for the A/D converter.

<u>DV (Deflection Voltage Input):</u> Pin 4. DV is an electrostatic test input that applies force to the sensing element to simulate positive acceleration. Its nominal open-circuit voltage is 1/2 VDD. For normal operation, connect DV to the +2.5 V reference input. Applying a voltage greater than that required to drive the output to positive full scale may damage the ±10 g device.

<u>VR (input):</u> Pin 3. Voltage Reference. Tie to a good reference (not directly to V_{DD}) for best scale factor repeatability. A 0.1uF bypass capacitor is recommended at this pin. The current is less than 100 µA.

<u>2.5 V Input:</u> Pin 17. Sets the internal and output common-mode voltage. Connect this pin to a resistive divider from +5 V as shown in the recommended circuit. A 0.1 µF bypass capacitor is recommended. Input current is less than 50 µA.

<u>IT (Temperature Output):</u> Pin 8. Provides a temperature-dependent current output for monitoring the accelerometer's internal temperature. IT may be tied to VDD or left unconnected when the temperature output is not used.

<u>Special Use Pins:</u> Connect pins 9 and 11 to VDD. Connect pins 2, 5, 6, and 18 to GND.

Pins 1, 7, 10, 13, 15, and 20 are reserved for future use and should remain unconnected

OPTIONAL INTERNAL TEMPERATURE SENSING

The Model 1523 includes a temperature-dependent current source on pin 8 for monitoring the accelerometer's internal temperature. This output can be used with previously characterized device behavior to support additional correction of bias and scale-factor variation over temperature, if required by the application.

At 25°C, the nominal output current is approximately 500 µA ±200 µA, with a nominal temperature sensitivity of 1.5 µA/°C ±0.5 µA/°C. Variations in VDD and VR have little effect on the temperature output. Reducing both VDD and VR by 0.10 V changes the output current by approximately 1 µA, corresponding to less than a 1°C change in indicated temperature.

With a 2 kΩ resistor between IT (pin 8) and GND, the output voltage VT varies from approximately +0.76 V to +1.3 V over the -55°C to +125°C operating range, corresponding to a nominal sensitivity of approximately +3 mV/°C.

$$V_T \approx R_T\left[(500\,\mu A) + \left[(1.5\,\mu A)(T-25)\right]\right]$$

$$\frac{\Delta V_T}{\Delta T} = R_T(1.5\mu A)$$

$$V_T \approx -R_G\left[\frac{V_{OFF}}{R_{OFF}} + (500\mu A) + \left[(1.5\mu A)(T-25)\right]\right]$$

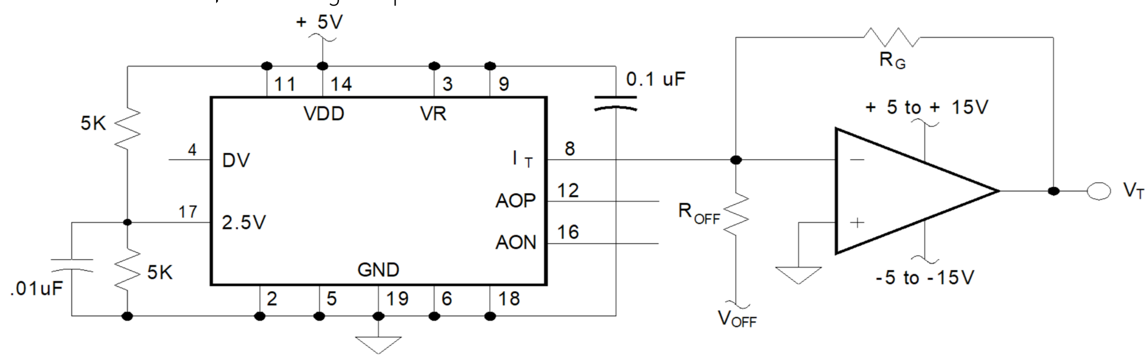
$$R_{OFF} = \frac{-V_{OFF}}{\left(V_T/R_G\right) + (500\mu A) + \left[(1.5\mu A)(T-25)\right]}$$

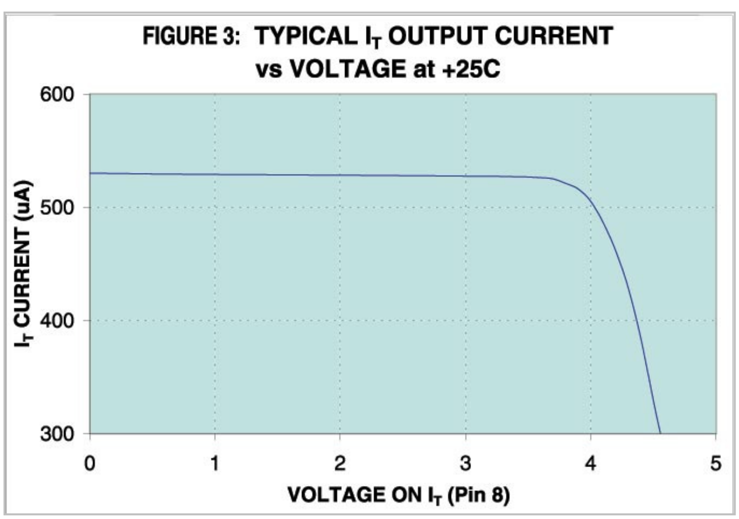
$$R_G = \frac{-\Delta V_T}{(1.5\mu A)(\Delta T)} \qquad \frac{\Delta V}{\Delta T} = -R_G(1.5\mu A)$$

If greater voltage change with temperature or lower source impedance is required, use the amplifier configuration shown in Figure 2. With VOFF = -5 V, RG = 15.0 kΩ, and ROFF = 7.32 kΩ, VT varies from approximately +4.5 V to +0.5 V over the -55°C to +125°C operating range, corresponding to a nominal sensitivity of approximately -29 mV/°C.

Figure 3 shows the voltage compliance of the temperature-dependent current source, IT, at 25°C. For valid temperature measurements, the voltage at pin 8 should remain between 0 and +3 V.

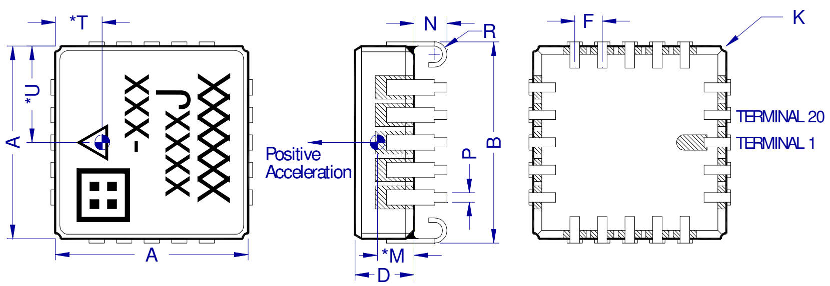
Figure 2





PACKAGE DIMENSIONS

1. *Dimensions "M," "T," and "U" locate sensing element's center of mass.
2. Lid is electrically tied to terminal 19 (GND).
3. Controlling dimension: Inch.
4. Terminals are plated with 60 microinches min gold over 80 microinches min nickel. This plating specification does not apply to the Pin-1 identifier mark on the bottom of the J-lead package version.
5.
6. Package: 90% min alumina (black), lid: solder sealed kovar.



Dim	Inches		Millimeters	
	Min	Max	Min	Max
A	0.342	0.358	8.69	9.09
B	0.346	0.378	8.79	9.60
C	0.055 TYP		1.40 TYP	
D	0.095	0.115	2.41	2.92
E	0.085 TYP		2.16 TYP	
F	0.050 BSC		1.27 BSC	
G	0.025 TYP		0.64 TYP	
H	0.050 TYP		1.27 TYP	
J	0.004 x 45°		0.10 x 45°	
K	0.010 R TYP		0.25 R TYP	
L	0.016 TYP		0.41 TYP	
* M	0.066 TYP		1.68 TYP	
N	0.050	0.070	1.27	1.78
P	0.017 TYP		0.43 TYP	
R	0.023 R TYP		0.58 R TYP	
* T	0.085 TYP		2.16 TYP	
* U	0.175 TYP		4.45 TYP	

RECOMMENDED CONNECTIONS

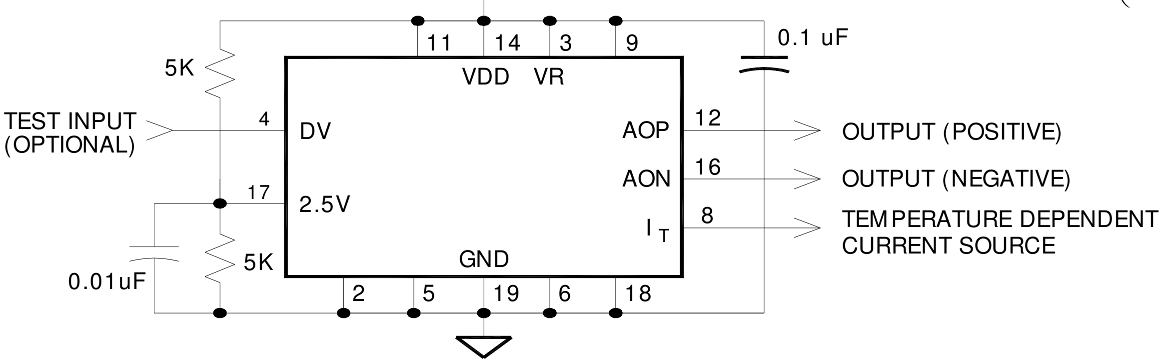
DEFLECTION VOLTAGE (DV) TEST INPUT: The DV input applies an electrostatic force to the sensing element to simulate positive acceleration. It has a nominal input impedance of 32 kΩ and a nominal open-circuit voltage of 1/2 VDD. For normal operation, DV may be left unconnected or connected to a voltage source equal to 1/2 VDD.

The change in differential output voltage (AOP - AON) is proportional to the square of the difference between the applied DV voltage and 1/2 VDD. Only positive shifts in output can be generated through the DV input. On the ±10 g device, apply DV gradually and do not exceed the voltage required to drive the output to positive full scale, as higher voltage may damage the device. The proportionality constant, k, varies from device to device and is not characterized.

ESD AND LATCH-UP CONSIDERATIONS: The Model 1523 is a CMOS device and can be damaged by large electrostatic discharges. Input and output diode protection is provided, but standard ESD handling precautions should be followed. Personnel, tools, and work surfaces should be properly grounded before contact with the device.

The Model 1523 is resistant to latch-up; however, inserting or removing the device from a powered socket may cause damage.

$$\Delta(AOP - AON) \approx k\left(V_{DV} - \frac{1}{2}V_{DD}\right)^2$$



SOLDERING RECOMMENDATIONS

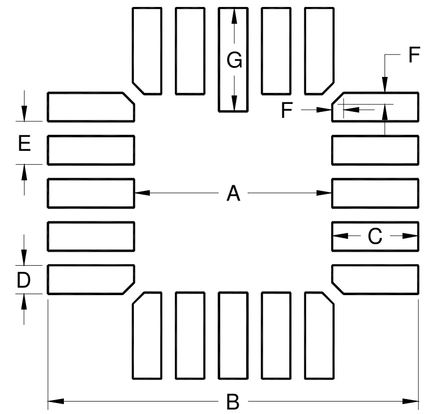
RoHS Compliance: The Model 1523 contains no elemental lead and is RoHS compliant.

Soldering: Solder reflow temperature should not exceed 239°C. Higher temperatures may permanently damage the device.

Pre-Tinning of Accelerometer Leads: Pre-tinning is recommended to reduce the risk of gold embrittlement in solder joints.

J-Lead Solder Contact Plating Information: The plating composition and thickness for the solder pads and castellations on the J-Lead package top layer are 100 to 225 microinches thick of 99.7% gold (Au) over 80 to 350 microinches thick of electroplated nickel (Ni).

Recommended Solder Pad Pattern: The recommended solder pad size and shape is shown in the diagram and table below. These dimensions are recommendations only and may or may not be optimum for your particular soldering process.



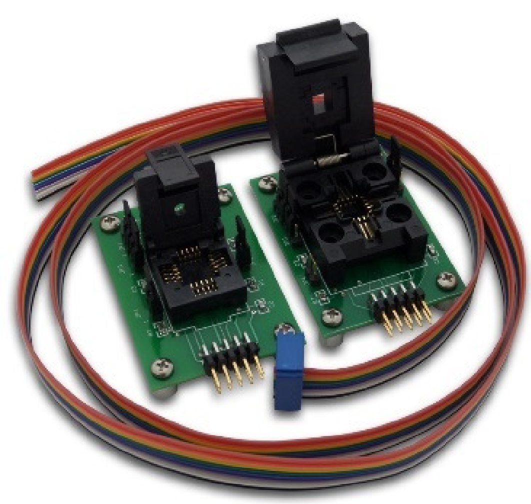
DIM	Inch	mm
A	.230	5.84
B	.430	10.92
C	.100	2.54
D	.033	0.84
E	.050	1.27
F	.013	0.33
G	.120	3.05

Do not use ultrasonic cleaners. Ultrasonic cleaning may break internal wire bonds and will void the warranty.

COMPANION ACCESSORY

The Model EB-J Test Set provides a convenient way to test and evaluate SDI Model 1523 surface-mount accelerometers. The board includes a pre-installed zero-insertion-force socket and configurable jumpers for supported accelerometer functions. A 10-pin connector and ribbon cable provide connections to external test equipment.

The Model EB-J Test Set and Model 1523 accelerometers are sold separately.



TEST REPORT EXAMPLE: LINEARITY, PHASE & FREQUENCY RESPONSE

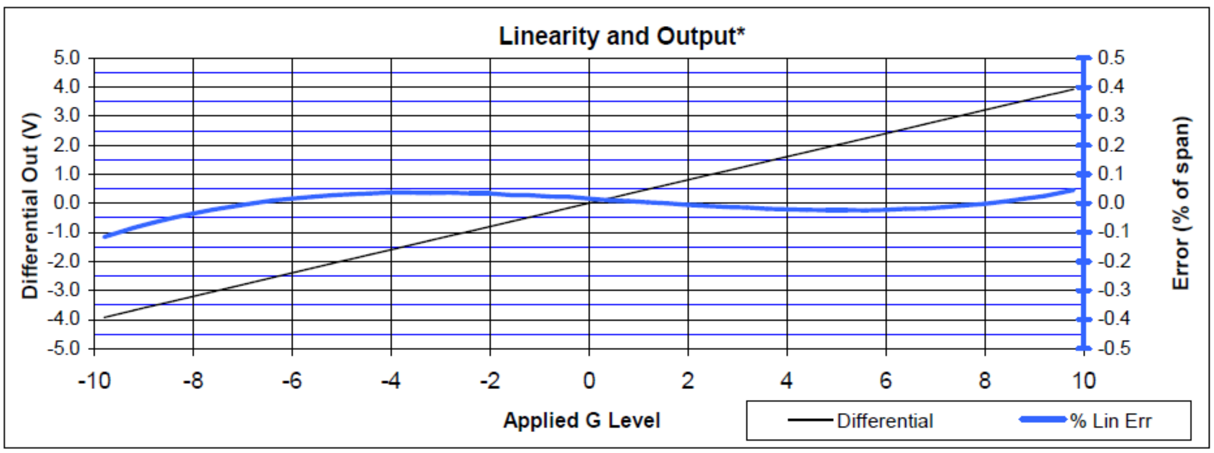
Each Model 1523 is supplied with an individual 1523-TST test report documenting measured linearity, output, phase, and frequency response. The example below shows a representative report for the available acceleration ranges.

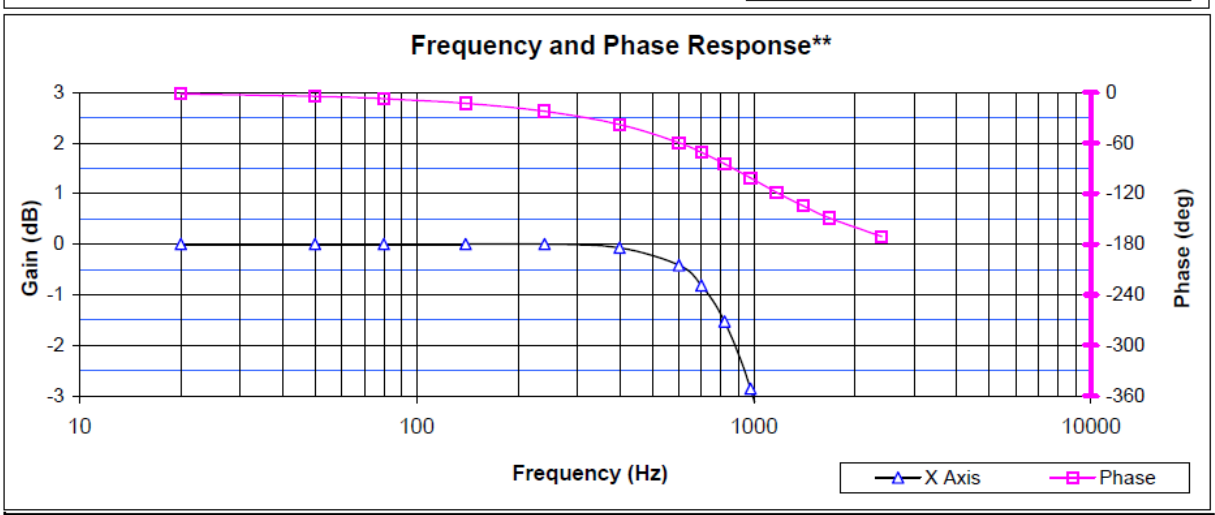
NOTE: Frequency response shown on the test report is measured using the DV input to simulate acceleration. Because this method does not replicate the final installed mechanical condition, the reported frequency response may be lower than the response achieved after the accelerometer is soldered or otherwise permanently mounted to a circuit board.

EXAMPLE 10G: 1523J-010

ACCELEROMETER TEST REPORT

Model **1523J-010**
Supply Current (Idd) **4.81 mA**
Full Scale **10 g**
Scale Factor (Sensitivity) **400.4 mV/G**
Cal. Date **06 Jul 2026**
Mfg. Lot # 26A161A
Serial # XXXXX
0 G Bias (Offset) **-1 mV**
Operator Rina
Op. Number 120





Freq. (Hz)*	20	50	80	140	240	400	600	700	820	980	1170	1400	1680	2400
dB Out - X	0.00	0.00	0.00	0.00	0.00	-0.07	-0.42	-0.82	-1.53	-2.86	-4.81	-7.36	-10.35	-16.77
Phase (deg)	-1.8	-4.6	-7.3	-12.9	-22.3	-38.2	-59.8	-71.2	-84.7	-101.6	-118.6	-134.7	-148.9	-171.2

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