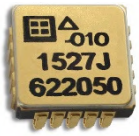
REPORT SUMMARY:

TOTAL DOSE GAMMA RADIATION TESTING OF SDI MODEL 1527 ACCELEROMETERS



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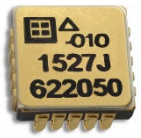
SUMMARY

This report documents tests conducted on Silicon Designs, Inc. (SDI) Model 1527 MEMS accelerometers to determine their sensitivity to total dose gamma radiation. The Model 1527 was chosen for this test is because this one accelerometer model, once qualified, can perform the functions of all SDI analog accelerometers. In particular the Model 1527 has the performance needed for tactical navigation, but it also shares the same architecture as SDI's Model 1521, which was previously built and qualified for a military space application.



SDI develops and manufactures miniature accelerometers useful in a wide range of military and commercial systems, including measuring shock, vibration, impulse and other changes in velocity of aircraft, spacecraft and weapons. SDI accelerometers are used on more than 13 US and NATO missiles, and the Model 1527 can be made in full scale ranges of 2, 5, 10, 25, 50, 100, 200 and 400g, all of which are expected to have similar performance after exposure to gamma radiation and are pin compatible allowing easy range changes during development.

The tests consisted of six steps:

1) Fabricate a lot of 1527 accelerometers using current standard production methods;
2) Measure their pre-radiation performance;
3) Divide the units into six groups of three parts each;
4) Expose each group at Oregon State University to six different total-dose levels of gamma radiation: 10K, 25K, 50K, 100K, 200K and 350K rads (Si);
5) Measure the post-radiation performance of the Model 1527 accelerometers for general instrumentation uses; and
6) Measure the post-radiation performance of the Model 1527 accelerometers for tactical navigation uses.

Three tests were intended to concentrate on measuring the adverse effects of gamma radiation to the accelerometers. First, the standard production calibration test was run to measure each unit's normal characteristics as general-purpose instrumentation accelerometers. The second test evaluated each unit's performance for navigation use at +1 and -1g to calculate bias and scale factor shifts, measured its output for eight hours at a constant 30°C temperature. The third test measured each accelerometer's output at +1 and -1 g over a temperature scan from 25 to 85°C, then to -40°C, and then back to 25°C to calculate bias and scale factor over temperature. Plots of the output compensated for temperature were then generated to compare with the actual applied accelerations.

The test results show that all the units met all requirements as instrumentation accelerometers before and after radiation. The two navigation performance tests show that the scale factor is only slightly affected by radiation. All but one of the units showed a bias that remained within specification for all radiation levels. Only one unit produced a bias shift of approximately 6 mg, about 0.024% of full scale, after 350K rads of radiation, and the unit retained its prior performance for tactical navigation.

OBJECTIVES

Accelerometers are important sensors used to measure changes in motion, shock and vibration for many applications. In space systems they are vital to detect and measure rocket firing impulse, determine velocity changes for guidance and navigation, detect the direction and magnitude of gravity or centripetal forces, measure vibration and shocks, and detect stage sequencing. They must be robust to operate in the harsh radiation and thermal environment of space and after nuclear events.

Electronic parts are sensitive to a range of high energy particles in space that penetrate many materials. It is important to identify those parts early in a project that are likely to operate in spite of the environments. Small, light-weight accelerometers commonly used for commercial applications are generally not suitable for such applications. The objective of this report is to describe the radiation test performed on an accelerometer model, similar to another model previously used in such applications, to determine if the current accelerometer model will likely operate after exposure to various levels of gamma radiation expected in future projects.

In 2016, Orbital Sciences tested SDI's Model 1521 general-purpose accelerometers for radiation hardness, and SDI built some special units for their use, presumably, in GMD. However, Orbital did not share the test results, the radiation levels tested to, or any changes caused by the radiation. Although some of SDI's accelerometer components have changed in the last six years, this testing led SDI to believe that its newest products should have the same level of radiation hardness. The objective of this test was to determine if this belief is well founded.

TEST PLAN

1) Fabricate a lot of 1527 accelerometers using standard production methods;
2) Measure their pre-radiation performance;
3) Divide the parts into six groups of three units each;
4) Expose each group at Oregon State University to six different total-dose levels of gamma radiation: 10K, 25K, 50K, 100K, 200K and 350K rads (Si);
5) Measure the post-radiation performance of the accelerometers for general instrumentation uses; and
6) Measure the post-radiation performance of the accelerometers for tactical navigation uses.

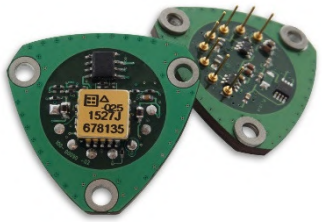
TEST PROCEDURE

A lot of approximately 35 production Model 1527-025 accelerometers were built using the latest traveler and procedures. The 25g range unit was selected because it is the range most commonly used in military applications.

All parts were screened in accordance with SDI's standard production processes used for both 1521s and 1527s. The first 24 parts in serial number sequence that passed all production tests were selected for radiation testing. The standard production testing on a computer-controlled shaker system is used on all of SDI's production parts to verify that the parts meet SDI's specified performance for instrumentation applications.

All 24 parts were then screened for navigation performance with two additional tests in a temperature tumble test system, recording each unit's output. First, the parts were run for eight hours at 30°C, periodically rotating the parts through +/- 1g positions. Second, the parts spent four hours sweeping over a -40°C to +85°C range, periodically rotating between +/- 1g positions. The purpose of these two tests is to verify that all units met the requirement for navigation. All of the parts passed these tests.

The parts were then allocated to the six different radiation levels in sequence, in four-unit groups, with three units for testing as individual accelerometers and the fourth unit assembled into SDI's Model 2227 Q-modules, which are configured for applications utilizing industry-standard quartz closed-loop accelerometers, the results of which will be analyzed later.



The six groups of three Model 1527 accelerometers and one Model 2227 Q-module accelerometer were packaged each in 2½ x 2½ x ½-inch static-resistant plastic boxes sandwiched between two layers of black conductive foam, and sealed with tape, which were then taped to cardboard rectangles (and labeled with the test level) so as to position the parts near the center of the Oregon State University (OSU) Gamma-cell test chamber.

The plastic boxes were sent by common carrier to OSU, where each box was irradiated to a different amount of gamma radiation based on the time in the Gamma-cell. The levels applied were 10K, 25K, 50K, 100K, 200K and 350K Rads (Si). Each group of parts was exposed individually at a dose rate of 348.45 K Rads per hour, with the total dose determined by the amount of time each group remained in the test chamber. The units remained sealed in the plastic boxes at all times while out of the SDI facility. The unopened boxes were then returned to SDI.

When received, the boxes were opened and the parts were again tested using the same program and test stations as before where possible. The same analysis was performed on the pre- and post-radiation results and compared with the original results. NOTE: The pre-radiation temperature tests were declared a no-test because the A/D converter was replaced on the test system between the pre- and post-radiation testing.

RESULTS

All accelerometers passed the production room-temperature test conducted on the computer-controlled shaker, showing that all the parts met all requirements as instrumentation accelerometers before and after radiation.

While no parts failed during the post-exposure testing, small changes to behavior were identified:

- The tests showed that the radiated accelerometers may have developed a small increase in current consumption.
- Some parts exposed to 200+ K Rads appear to have developed about 1 mg of temperature hysteresis.
- The bias, scale factor, linearity and frequency response appeared to be generally unaffected by gamma radiation up to 350K Rads, with bias showing only a minor shift.

The bias/scale factor repeatability tests show that the scale factor is only slightly affected by radiation. All but one of the parts showed a bias that remained within specification for all radiation levels. After 350K rads of radiation one part produced a bias shift of approximately 6 mg, about 0.024% of full scale.

Temperature tumble tests found that all the parts met the requirements for tactical navigation after radiation at all levels. The one part with a 6 mg bias shift, after the bias correction was made the part, recovered its prior performance for tactical navigation.

See the Appendices to view the production test reports for all 18 parts.

CONCLUSIONS

Preliminary radiation testing found that the SDI Model 1527 MEMS accelerometers are a good candidate for instrumenting shock and vibration measurements during tests and for arming and fuzing operations with the potential of gamma radiation. In addition, the Model 1527 accelerometers can be considered reliable before and after exposure to gamma radiation for measuring varying accelerations to compute velocity changes for tactical navigation.

ACCELEROMETER DESIGN

The current accelerometers are designed for ruggedness, reliability and technical performance over a military temperature range, -55 to 125 degrees C. Space applications and new missiles for hypersonic offensive and defensive weapons now need also to operate in severe temperature environments.

All SDI MEMS accelerometers are about 9 mm on a side and 3 mm high with a mass less than 1g, consisting of the following six major components: 1) one of eight different silicon sense elements that determine the g-level, 2) one of four similar CMOS application-specific integrated circuits (ASICs) that determine the output, accuracy and stability, 3) one of three different 20-pin ceramic chip carrier packages based on the intended application, 4) either gold or aluminum wire bonds, 5) a solder-sealed, gold-plated kovar lid and 6) an adhesive. The sense element and ASIC are the main accelerometer components.

Closed-loop accelerometers can offer excellent bias stability, good linearity and low noise. However, many closed- and open-loop designs, are designed for one or two specific ranges of operation. When fielded in applications with peak accelerations less than the designed range, their gain is often increased, giving instability and noise higher than it would be if the accelerometers were redesigned for that g-level. Better system performance can be obtained from a family of interchangeable models of accelerometers, each of which is optimized for a particular g-level and together cover a wide range of g-levels needed for navigation. The optimum g-range of SDI accelerometers can be modified for different hypersonic or other military applications by simply using sense elements for that range. SDI makes pin-compatible accelerometers with full scale ranges of 2, 5, 10, 25, 50,100, 200 and 400g, and it can make optimum units for any specific value between 2 and 400g for special applications.

Fig. 1 shows a microphotograph of the sense element die. On each sensor dice are located two pendulous, capacitive, MEMS sense elements. Each sense element consists of a flat plate of silicon supported above the substrate surface by a rugged but sensitive flexure attached to a central pedestal. The structure is asymmetrically shaped so that one side is larger than the other, resulting in a center of mass that is offset from the flexure axis. Some g-levels have an additional mass on the larger end. When an acceleration perpendicular to the substrate produces a moment around the flexure axis, the plate is free to rotate around that axis, constrained only by the tensional spring constant of the flexure.

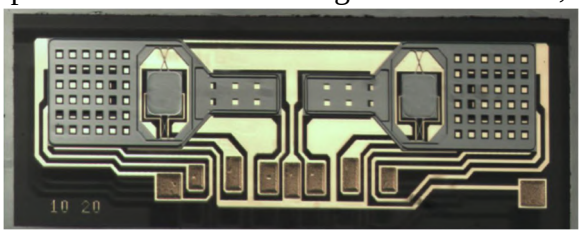


Figure 1: Microphotograph of SDI Sensor Die

On the substrate beneath each sense element are two equal-sized capacitor plates, one on each side of the flexure axis. The sense element structure and the air gap with the equal-sized capacitor plates on the substrate form two nominally equal, differential, variable capacitors, with the sense element forming a common connection. Under acceleration the average distance between the sense element and one surface plate decreases, increasing its capacitance, while the distance to the other plate increases, decreasing its capacitance. The two sense elements on the

sensor die, each with their two differential capacitors, together form a fully active capacitance bridge. Sense elements are about 2200 by 1000 microns in size and about 10 microns thick. The sense elements are spaced about 8-12 microns from the fixed capacitor plates on the substrate, forming a capacitor with the sense element to each plate of about 150 femtofarads. For different g-levels the sensitivity of the sense elements, the ratio of deflection to acceleration, is determined mainly by the flexure stiffness and the substrate spacing. Squeeze-film damping is controlled by the substrate spacing and the holes in the sense element control the damping ratio. The number and spacing of holes are designed to give near critical damping. The two identical sense elements are laid out rotated 180 degrees relative to each other to convert any cross-axis acceleration into a common mode signal that is cancelled out in the ASIC.

The ASIC is designed and currently built with a bulk CMOS process. SDI's ASICs are designed for minimum risk of latch-up, and their relatively large gate lengths (1-5 microns) make them relatively insensitive to single event bit upset. If it does occur, however, they are designed to recover quickly (in less than 100 microseconds).

To achieve the ASICs high stability, the ASIC architecture also takes advantage of fully differential and chopper-stabilization techniques, that cancel out much of the drift, temperature effects, component mismatch and 1/f noise present in all silicon parts.

ABOUT SILICON DESIGNS, INC.

SDI was founded in 1983 and is a veteran-owned small business that specializes in MEMS accelerometers, the designs of which were originally developed under SBIR projects throughout SDI's first 20 years. During the last 15 years, SDI has improved and expanded the family to include other g-ranges for other applications up to and including tactical navigation. Today SDI offers a family of micro-electro-mechanical system (MEMS) accelerometers used in a wide range of industrial and military applications, including two models designed for tactical navigation.

Although SDI supplies accelerometers for over 13 US and NATO tactical missiles, it is not a traditional defense contractor. We have a unique business model; we build a single, common family of dual-use accelerometers for both military and high-end industrial applications. Although we have licensed the technology for automotive air-bags, SDI does not produce any accelerometers for commercial grade applications. All accelerometers are built to MIL-PRF-38534 standards in a facility certified to ISO-9001:2015. Because industry needs products with high quality similar to the military, SDI sells about half of their accelerometers for high value industrial applications, such as down-hole drilling, bridge and other infrastructure monitoring, launch support, commercial low-earth orbit instrumentation and bullet train control. Many missile programs, including commercial rockets, now buy "commercial off-the-shelf" (COTS) accelerometers without any additional testing and at the same price as industrial users pay.

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APPENDICES

Model 1527 Accelerometer Profile

Design Specifications

Design specifications are inherent in the design and not tested during manufacturing.

PARAMETER	Typical Value/Range +/- 10G	Typical Value/Range +/-25G	Typical Value/Range +/-50G	Units
Vibration Rectification, typical Random, 10-50 Hz Random, 50-200 Hz	 20 50	 35 100	 50 150	µg/g² rms
Velocity Random Walk	0.007	0.012	0.025	m/s√Hr½
Bias, Long Term Repeatability (1σ)	1.25	1.50	3.0	mg
In Run Bias Stability at +1g, 2-40,000 sec. (AV Min)	12	30	60	µg
Scale Factor Long Term Repeatability (1σ)	300	300	300	PPM
Output White Noise	18	25	50	µg/√Hz½ rms
Temperature Sensor Sensitivity (IT Pin 7)	1.2 to 1.8	1.2 to 1.8	1.2 to 1.8	uA/°C
Temperature Sensor Noise	0.33 RMS typ	0.33 RMS typ	0.33 RMS typ	C
Turn-On Time < 150 ppm of FS	0.5	0.5	0.5	msec
Operating Voltage	4.75 to 5.25	4.75 to 5.25	4.75 to 5.25	Volts
Input Axis Misalignment, typical	4	4	4	mrad
Peak Vibration (Operating and Non-operating)	200%	200%	200%	FS

Tested Performance Specifications

Parameter	Limit +/-10G	Limit +/-25G	Limit +/-50G	Units
Bias	+/- 0.5	+/- 0.5	+/- 0.5	% of FS
Bias Temperature Coefficient	±25	±15	±15	PPM of FS/ºC
Scale Factor Sensitivity, +/-0.5%	400	160	80	mV/g
Scale Factor Temperature Coefficient	±25	±25	±25	PPM/ ºC
Frequency Response, DC to -3 dB, Minimum*	420	660	1050	Hz
RMS Model Residual (+/- 1g, -40, +25, +85ºC)	30	25	25	PPM of FS

*Frequency Response reported as performance once soldered. Simulating Frequency Response with the DV pin will report lower values than actual performance once soldered.

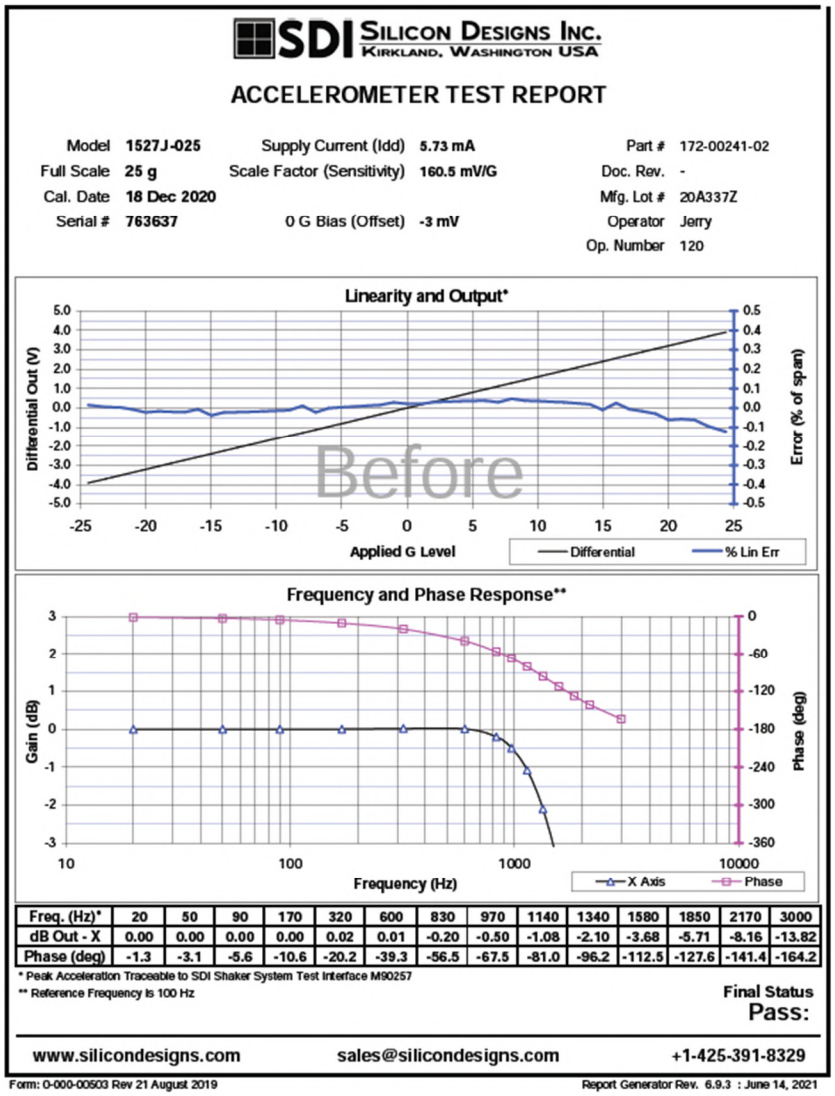
Max Operating Limits

Parameter	Minimum	Maximum	Units
Differential Output	-4.0	+4.0	Volts
Operating Voltage	4.75	5.25	Volts
Quiescent Operating Current at +5V	----	6.5	mA
Operating / Storage Temperature	-55	+125	ºC
Applied Voltage on Digital Pins	-0.5	5.5	Volts
Mechanical Shock (0.1 ms)	----	5,000	g-peak
Peak Vibration (Operating and Non-operating)	----	200	% of FS

FS = Full Scale = 4V absolute differential output = 4000 mV

Before and After Production Test Reports

10k Rads Exposure: Part #1



SDI Silicon Designs Inc.
Kirkland, Washington USA

ACCELEROMETER TEST REPORT

Model	1527J-025	Supply Current (Idd)	5.73 mA	Part #	172-00241-02
Full Scale	25 g	Scale Factor (Sensitivity)	160.5 mV/G	Doc. Rev.	-
Cal. Date	18 Dec 2020			Mfg. Lot #	20A337Z
Serial #	763637	0 G Bias (Offset)	-3 mV	Operator	Jerry
				Op. Number	120

Freq. (Hz)*	20	50	90	170	320	600	830	970	1140	1340	1580	1850	2170	3000
dB Out - X	0.00	0.00	0.00	0.00	0.02	0.01	-0.20	-0.50	-1.08	-2.10	-3.68	-5.71	-8.16	-13.82
Phase (deg)	-1.3	-3.1	-5.6	-10.6	-20.2	-39.3	-56.5	-67.5	-81.0	-96.2	-112.5	-127.6	-141.4	-164.2

* Peak Acceleration Traceable to SDI Shaker System Test Interface M90257
** Reference Frequency is 100 Hz

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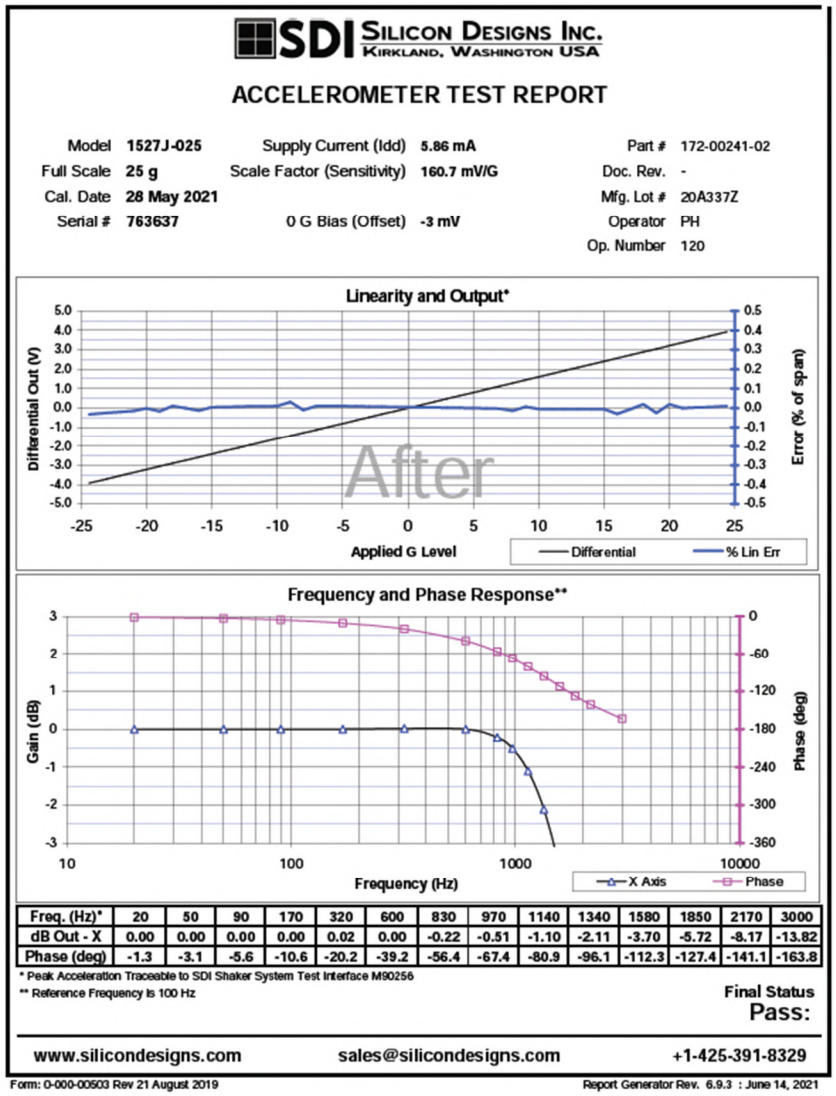
Form: 0-000-00503 Rev 21 August 2019 Report Generator Rev. 6.9.3 : June 14, 2021



SDI Silicon Designs Inc.
Kirkland, Washington USA

ACCELEROMETER TEST REPORT

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Full Scale	25 g	Scale Factor (Sensitivity)	160.7 mV/G	Doc. Rev.	-
Cal. Date	28 May 2021			Mfg. Lot #	20A337Z
Serial #	763637	0 G Bias (Offset)	-3 mV	Operator	PH
				Op. Number	120

Freq. (Hz)*	20	50	90	170	320	600	830	970	1140	1340	1580	1850	2170	3000
dB Out - X	0.00	0.00	0.00	0.00	0.02	0.00	-0.22	-0.51	-1.10	-2.11	-3.70	-5.72	-8.17	-13.82
Phase (deg)	-1.3	-3.1	-5.6	-10.6	-20.2	-39.2	-56.4	-67.4	-80.9	-96.1	-112.3	-127.4	-141.1	-163.8

* Peak Acceleration Traceable to SDI Shaker System Test Interface M90256
** Reference Frequency is 100 Hz

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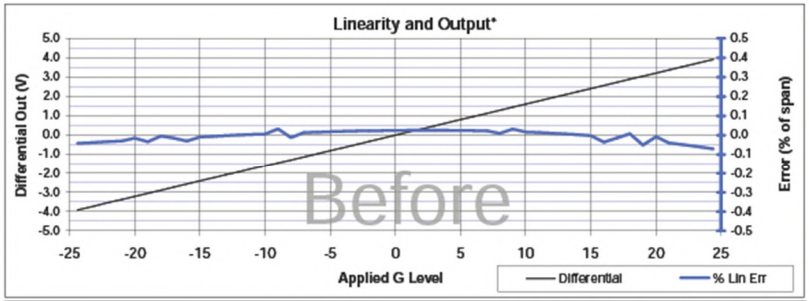
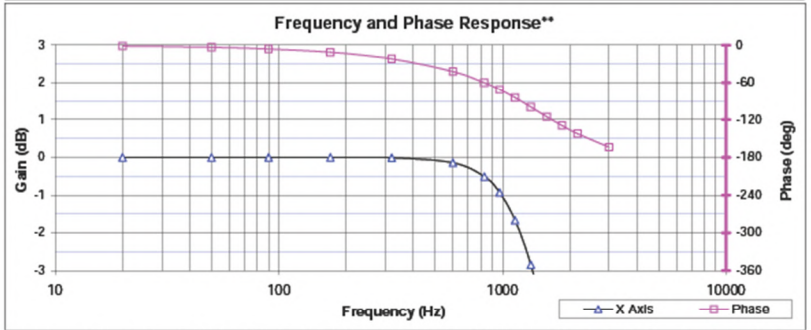
10k Rads Exposure: Part #2

SDI Silicon Designs Inc.
Kirkland, Washington USA

ACCELEROMETER TEST REPORT

Model	1527J-025	Supply Current (Idd)	5.65 mA	Part #	172-00241-02
Full Scale	25 g	Scale Factor (Sensitivity)	160.5 mV/G	Doc. Rev.	-
Cal. Date	18 Dec 2020			Mfg. Lot #	20A337Z
Serial #	763638	0 G Bias (Offset)	-1 mV	Operator	Jerry
				Op. Number	120





Freq. (Hz)*	20	50	90	170	320	600	830	970	1140	1340	1580	1850	2170	3000
dB Out - X	0.00	0.00	0.00	0.00	-0.01	-0.14	-0.51	-0.93	-1.67	-2.85	-4.56	-6.65	-9.10	-14.67
Phase (deg)	-1.4	-3.4	-6.0	-11.4	-21.7	-42.1	-60.1	-71.4	-84.9	-99.7	-115.3	-129.3	-142.2	-163.7

* Peak Acceleration Traceable to SDI Shaker System Test Interface M90257
** Reference Frequency is 100 Hz

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SDI Silicon Designs Inc.
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ACCELEROMETER TEST REPORT

Model	1527J-025	Supply Current (Idd)	5.79 mA	Part #	172-00241-02
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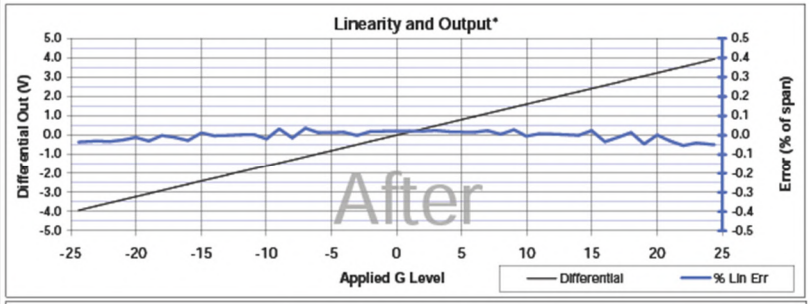
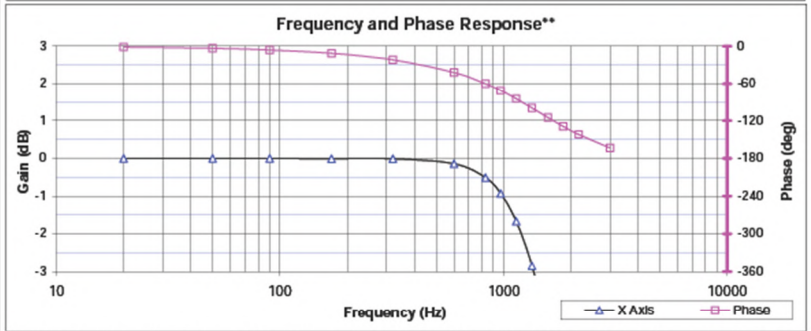
Cal. Date	28 May 2021			Mfg. Lot #	20A337Z
Serial #	763638	0 G Bias (Offset)	-2 mV	Operator	PH
				Op. Number	120





Freq. (Hz)*	20	50	90	170	320	600	830	970	1140	1340	1580	1850	2170	3000
dB Out - X	0.00	0.00	0.00	-0.01	-0.01	-0.14	-0.51	-0.93	-1.67	-2.85	-4.56	-6.65	-9.10	-14.67
Phase (deg)	-1.4	-3.4	-6.0	-11.4	-21.6	-42.0	-60.0	-71.3	-84.8	-99.6	-115.1	-129.1	-142.0	-163.5

* Peak Acceleration Traceable to SDI Shaker System Test Interface M90256
** Reference Frequency is 100 Hz

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10k Rads Exposure: Part #3

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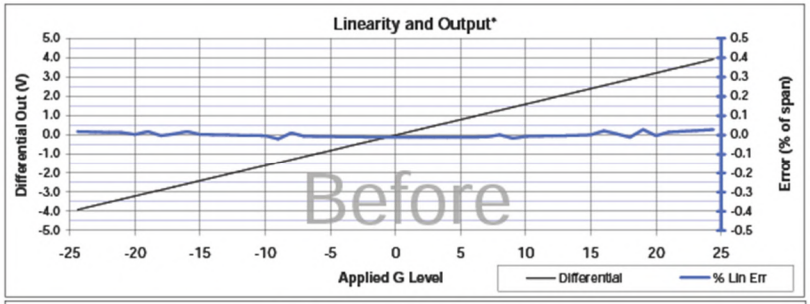
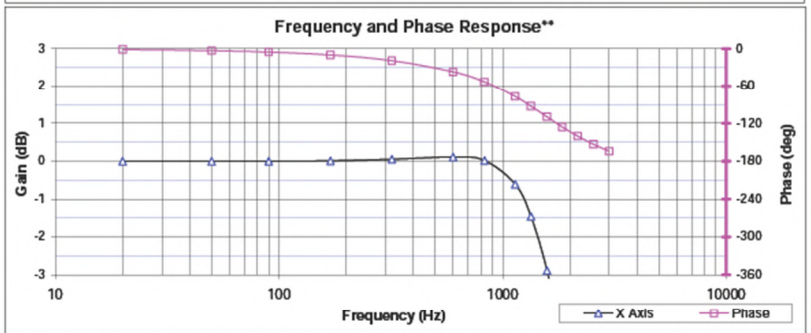
Kirkland, Washington USA

ACCELEROMETER TEST REPORT

Model	1527J-025	Supply Current (Idd)	6.02 mA	Part #	172-00241-02
Full Scale	25 g	Scale Factor (Sensitivity)	160.3 mV/G	Doc. Rev.	-
Cal. Date	18 Dec 2020			Mfg. Lot #	20A337Z
Serial #	763639	0 G Bias (Offset)	-2 mV	Operator	Jerry
				Op. Number	120





Freq. (Hz)*	20	50	90	170	320	600	830	1140	1340	1580	1850	2170	2550	3000
dB Out - X	0.00	0.00	0.00	0.01	0.05	0.11	0.02	-0.61	-1.46	-2.89	-4.84	-7.27	-10.04	-12.98
Phase (deg)	-1.2	-3.0	-5.3	-9.9	-18.9	-36.9	-53.2	-77.2	-92.6	-109.6	-125.7	-140.4	-153.3	-164.4

* Peak Acceleration Traceable to SDI Shaker System Test Interface M90257
** Reference Frequency is 100 Hz

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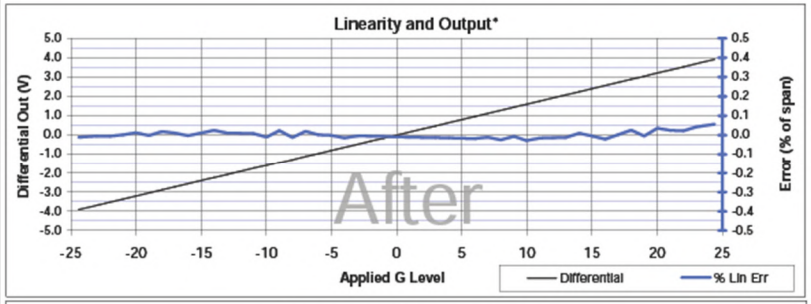
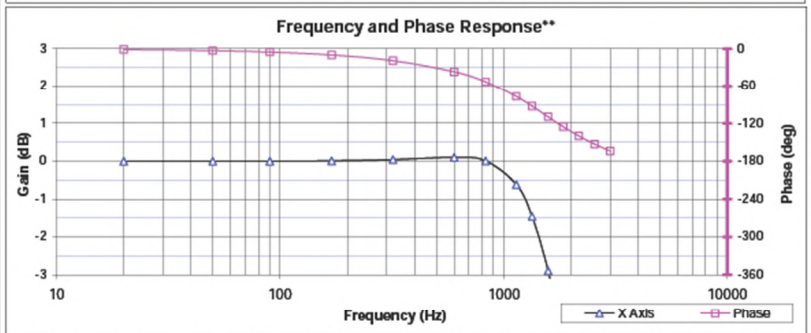
Kirkland, Washington USA

ACCELEROMETER TEST REPORT

Model	1527J-025	Supply Current (Idd)	6.14 mA	Part #	172-00241-02
Full Scale	25 g	Scale Factor (Sensitivity)	160.0 mV/G	Doc. Rev.	-
Cal. Date	28 May 2021			Mfg. Lot #	20A337Z
Serial #	763639	0 G Bias (Offset)	-2 mV	Operator	PH
				Op. Number	120





Freq. (Hz)*	20	50	90	170	320	600	830	1140	1340	1580	1850	2170	2550	3000
dB Out - X	0.00	0.00	0.00	0.01	0.04	0.10	0.01	-0.62	-1.46	-2.90	-4.84	-7.27	-10.03	-12.97
Phase (deg)	-1.2	-2.9	-5.3	-9.9	-18.9	-36.8	-53.1	-77.0	-92.5	-109.4	-125.4	-140.1	-153.0	-164.1

* Peak Acceleration Traceable to SDI Shaker System Test Interface M90256
** Reference Frequency is 100 Hz

Final Status
Pass:

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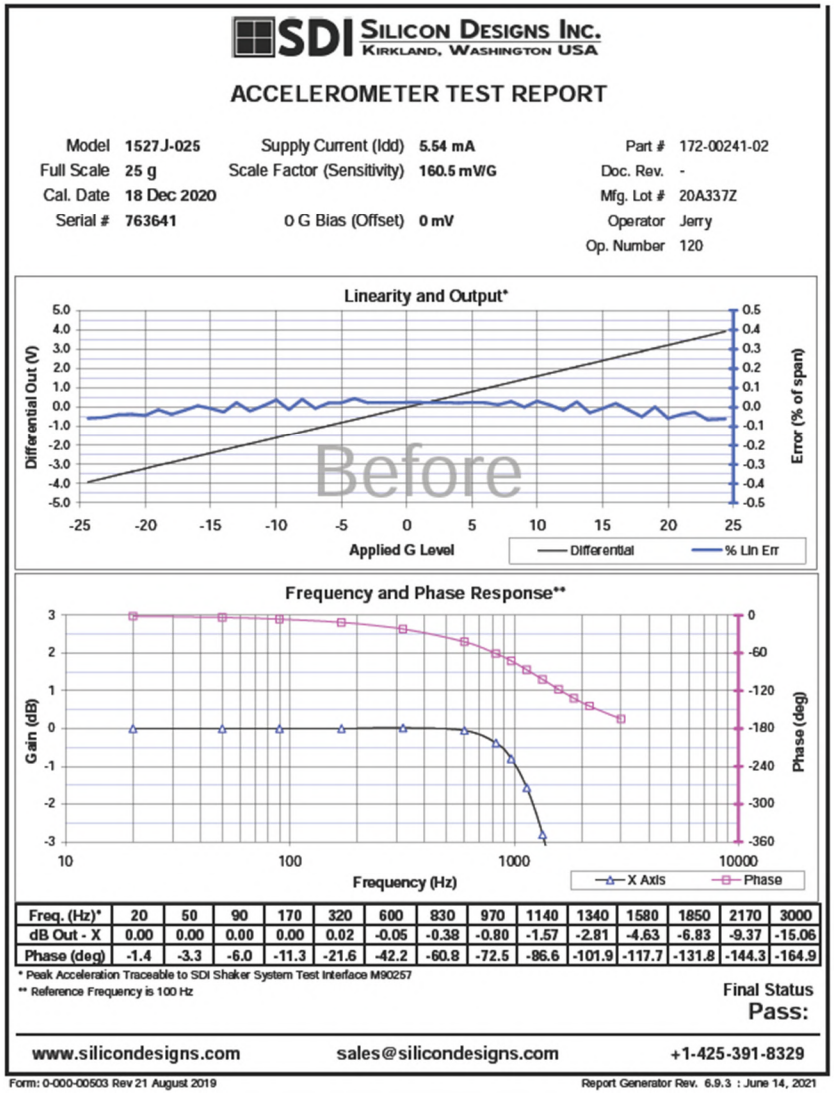
Form: 0-000-00503 Rev 21 August 2019 Report Generator Rev. 6.9.3 : June 14, 2021

25k Rads Exposure: Part #1



SDI Silicon Designs Inc.
Kirkland, Washington USA

ACCELEROMETER TEST REPORT

Model	1527J-025	Supply Current (Idd)	5.54 mA	Part #	172-00241-02
Full Scale	25 g	Scale Factor (Sensitivity)	160.5 mV/G	Doc. Rev.	-
Cal. Date	18 Dec 2020			Mfg. Lot #	20A337Z
Serial #	763641	0 G Bias (Offset)	0 mV	Operator	Jerry
				Op. Number	120

Freq. (Hz)*	20	50	90	170	320	600	830	970	1140	1340	1580	1850	2170	3000
dB Out - X	0.00	0.00	0.00	0.00	0.02	-0.05	-0.38	-0.80	-1.57	-2.81	-4.63	-6.83	-9.37	-15.06
Phase (deg)	-1.4	-3.3	-6.0	-11.3	-21.6	-42.2	-60.8	-72.5	-86.6	-101.9	-117.7	-131.8	-144.3	-164.9

* Peak Acceleration Traceable to SDI Shaker System Test Interface M90257
** Reference Frequency is 100 Hz

Final Status
Pass:

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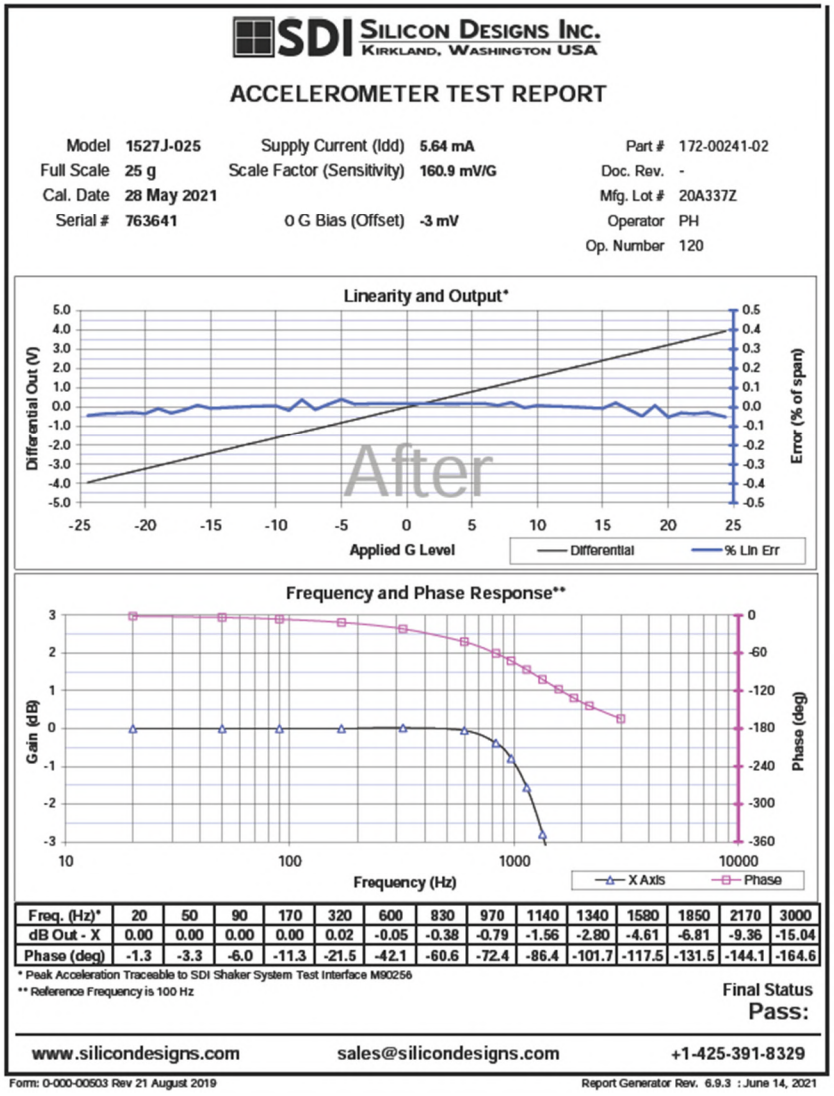
Form: 0-000-00503 Rev 21 August 2019 Report Generator Rev. 6.9.3 : June 14, 2021



SDI Silicon Designs Inc.
Kirkland, Washington USA

ACCELEROMETER TEST REPORT

Model	1527J-025	Supply Current (Idd)	5.64 mA	Part #	172-00241-02
Full Scale	25 g	Scale Factor (Sensitivity)	160.9 mV/G	Doc. Rev.	-
Cal. Date	28 May 2021			Mfg. Lot #	20A337Z
Serial #	763641	0 G Bias (Offset)	-3 mV	Operator	PH
				Op. Number	120

Freq. (Hz)*	20	50	90	170	320	600	830	970	1140	1340	1580	1850	2170	3000
dB Out - X	0.00	0.00	0.00	0.00	0.02	-0.05	-0.38	-0.79	-1.56	-2.80	-4.61	-6.81	-9.36	-15.04
Phase (deg)	-1.3	-3.3	-6.0	-11.3	-21.5	-42.1	-60.6	-72.4	-86.4	-101.7	-117.5	-131.5	-144.1	-164.6

* Peak Acceleration Traceable to SDI Shaker System Test Interface M90256
** Reference Frequency is 100 Hz

Final Status
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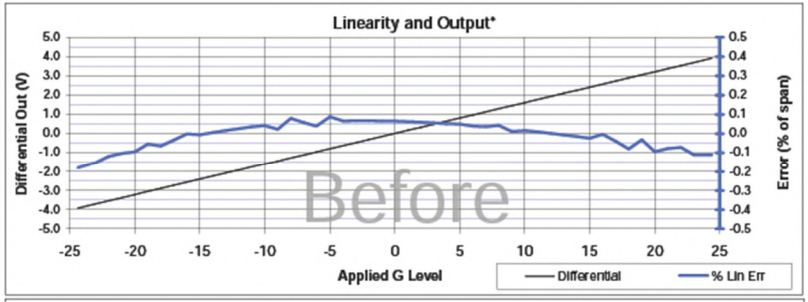
Form: 0-000-00503 Rev 21 August 2019 Report Generator Rev. 6.9.3 : June 14, 2021

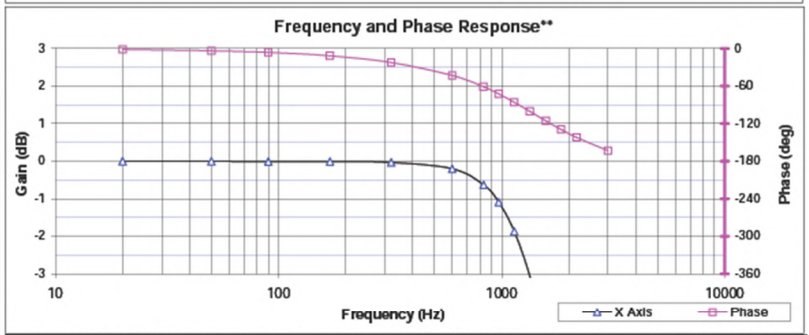
25k Rads Exposure: Part #2

SDI Silicon Designs Inc.
Kirkland, Washington USA

ACCELEROMETER TEST REPORT

Model	1527J-025	Supply Current (Idd)	4.55 mA	Part #	172-00241-02
Full Scale	25 g	Scale Factor (Sensitivity)	160.5 mV/G	Doc. Rev.	-
Cal. Date	18 Dec 2020			Mfg. Lot #	20A337Z
Serial #	763642	0 G Bias (Offset)	3 mV	Operator	Jerry
				Op. Number	120





Freq. (Hz)*	20	50	90	170	320	600	830	970	1140	1340	1580	1850	2170	3000
dB Out - X	0.00	0.00	-0.01	-0.01	-0.03	-0.20	-0.63	-1.09	-1.87	-3.08	-4.80	-6.88	-9.32	-14.82
Phase (deg)	-1.4	-3.5	-6.2	-11.7	-22.2	-43.0	-61.2	-72.5	-85.9	-100.5	-115.7	-129.5	-142.1	-163.2

* Peak Acceleration Traceable to SDI Shaker System Test Interface M90257
** Reference Frequency is 100 Hz

Final Status
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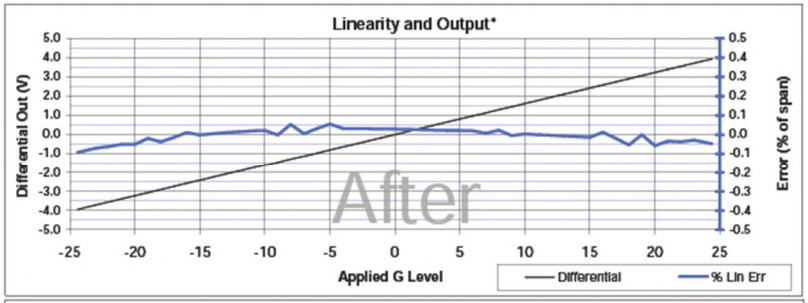
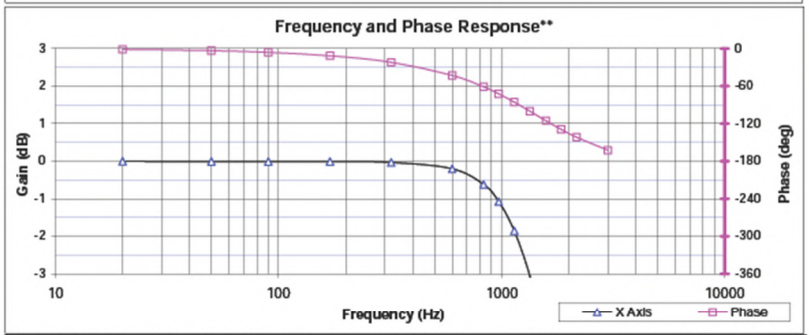
Form: 0-000-00503 Rev 21 August 2019 Report Generator Rev. 6.9.3 : June 14, 2021

SDI Silicon Designs Inc.
Kirkland, Washington USA

ACCELEROMETER TEST REPORT

Model	1527J-025	Supply Current (Idd)	4.74 mA	Part #	172-00241-02
Full Scale	25 g	Scale Factor (Sensitivity)	161.0 mV/G	Doc. Rev.	-
Cal. Date	28 May 2021			Mfg. Lot #	20A337Z
Serial #	763642	0 G Bias (Offset)	2 mV	Operator	PH
				Op. Number	120





Freq. (Hz)*	20	50	90	170	320	600	830	970	1140	1340	1580	1850	2170	3000
dB Out - X	0.00	-0.01	-0.01	-0.01	-0.03	-0.20	-0.62	-1.08	-1.86	-3.07	-4.79	-6.87	-9.30	-14.79
Phase (deg)	-1.4	-3.4	-6.2	-11.6	-22.1	-42.8	-61.0	-72.3	-85.7	-100.3	-115.4	-129.2	-141.8	-162.7

* Peak Acceleration Traceable to SDI Shaker System Test Interface M90256
** Reference Frequency is 100 Hz

Final Status
Pass:

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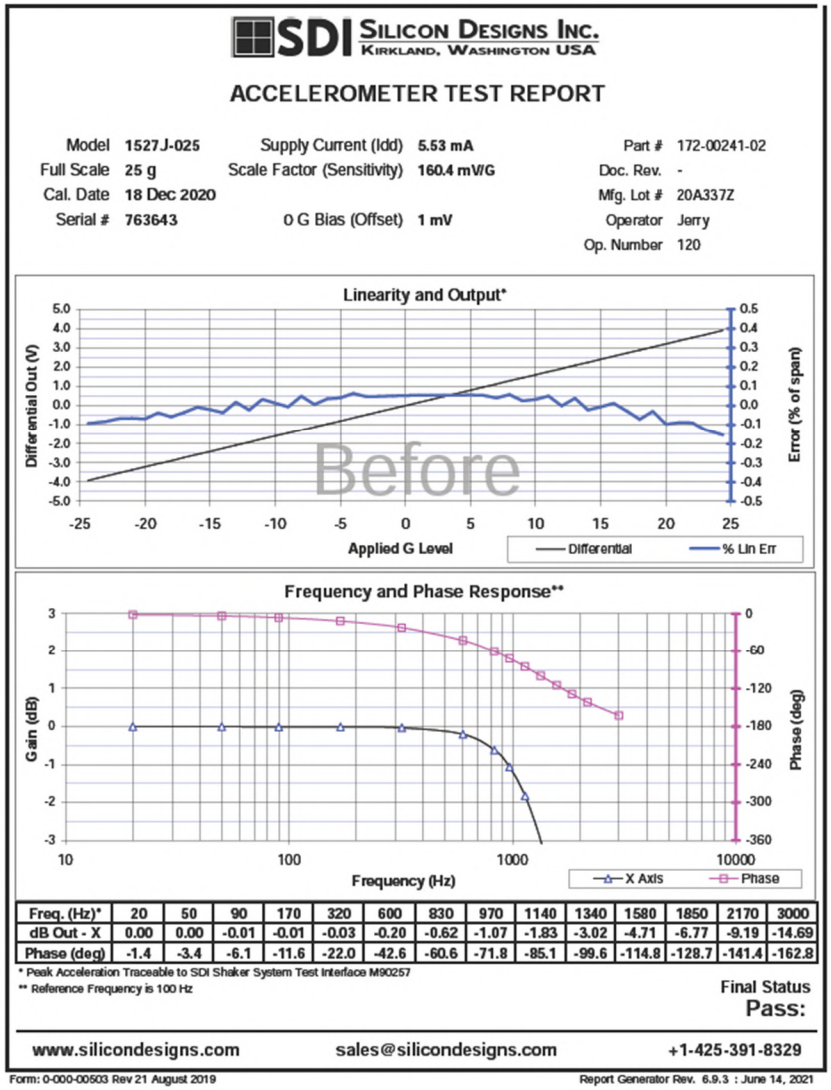
Form: 0-000-00503 Rev 21 August 2019 Report Generator Rev. 6.9.3 : June 14, 2021

25k Rads Exposure: Part #3



SDI Silicon Designs Inc.
Kirkland, Washington USA

ACCELEROMETER TEST REPORT

Model	1527J-025	Supply Current (Idd)	5.53 mA	Part #	172-00241-02
Full Scale	25 g	Scale Factor (Sensitivity)	160.4 mV/G	Doc. Rev.	-
Cal. Date	18 Dec 2020			Mfg. Lot #	20A337Z
Serial #	763643	0 G Bias (Offset)	1 mV	Operator	Jerry
				Op. Number	120

Freq. (Hz)*	20	50	90	170	320	600	830	970	1140	1340	1580	1850	2170	3000
dB Out - X	0.00	0.00	-0.01	-0.01	-0.03	-0.20	-0.62	-1.07	-1.83	-3.02	-4.71	-6.77	-9.19	-14.69
Phase (deg)	-1.4	-3.4	-6.1	-11.6	-22.0	-42.6	-60.6	-71.8	-85.1	-99.6	-114.8	-128.7	-141.4	-162.8

* Peak Acceleration Traceable to SDI Shaker System Test Interface M90257
** Reference Frequency is 100 Hz

Final Status
Pass:

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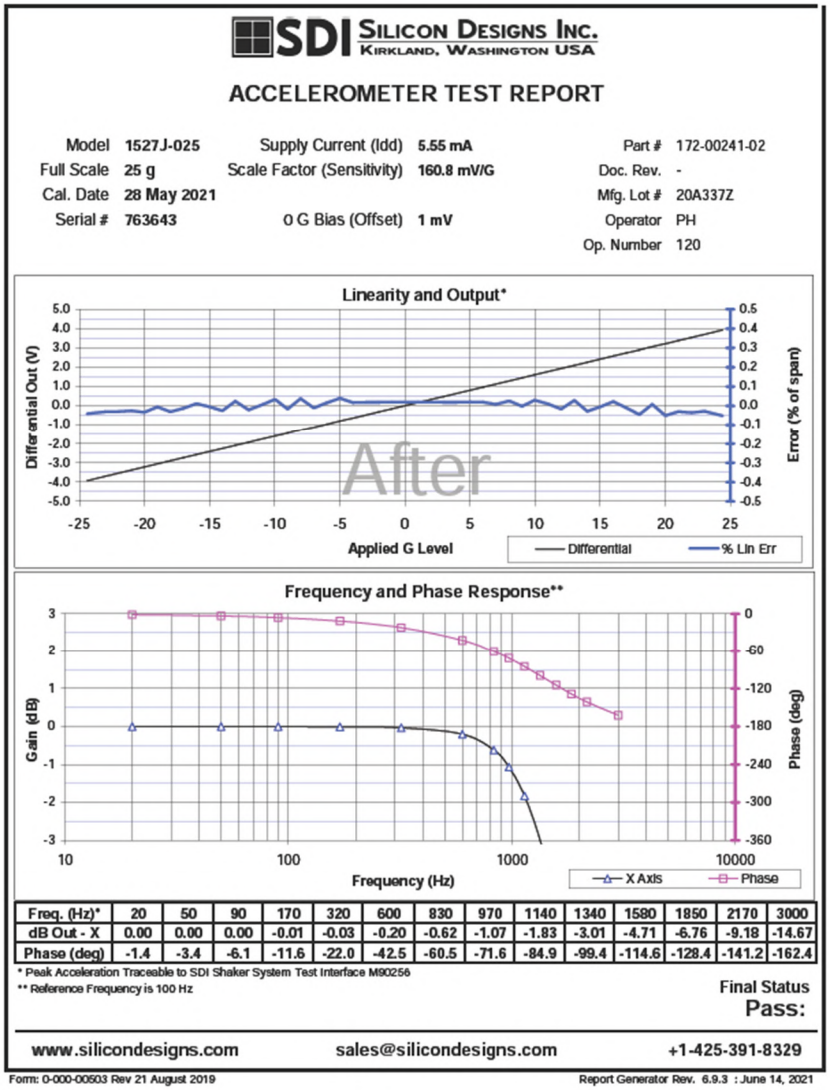
Form: 0-000-00503 Rev 21 August 2019 Report Generator Rev. 6.9.3 : June 14, 2021



SDI Silicon Designs Inc.
Kirkland, Washington USA

ACCELEROMETER TEST REPORT

Model	1527J-025	Supply Current (Idd)	5.55 mA	Part #	172-00241-02
Full Scale	25 g	Scale Factor (Sensitivity)	160.8 mV/G	Doc. Rev.	-
Cal. Date	28 May 2021			Mfg. Lot #	20A337Z
Serial #	763643	0 G Bias (Offset)	1 mV	Operator	PH
				Op. Number	120

Freq. (Hz)*	20	50	90	170	320	600	830	970	1140	1340	1580	1850	2170	3000
dB Out - X	0.00	0.00	0.00	-0.01	-0.03	-0.20	-0.62	-1.07	-1.83	-3.01	-4.71	-6.76	-9.18	-14.67
Phase (deg)	-1.4	-3.4	-6.1	-11.6	-22.0	-42.5	-60.5	-71.6	-84.9	-99.4	-114.6	-128.4	-141.2	-162.4

* Peak Acceleration Traceable to SDI Shaker System Test Interface M90256
** Reference Frequency is 100 Hz

Final Status
Pass:

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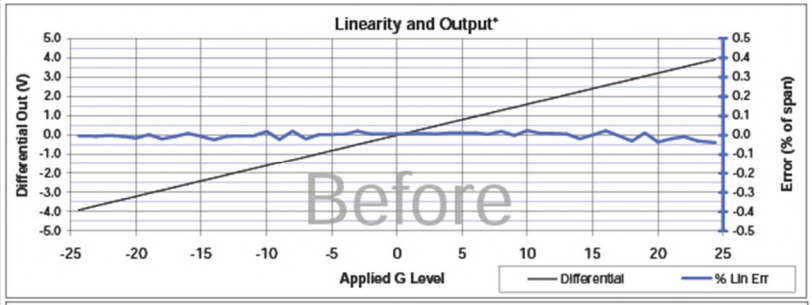
Form: 0-000-00503 Rev 21 August 2019 Report Generator Rev. 6.9.3 : June 14, 2021

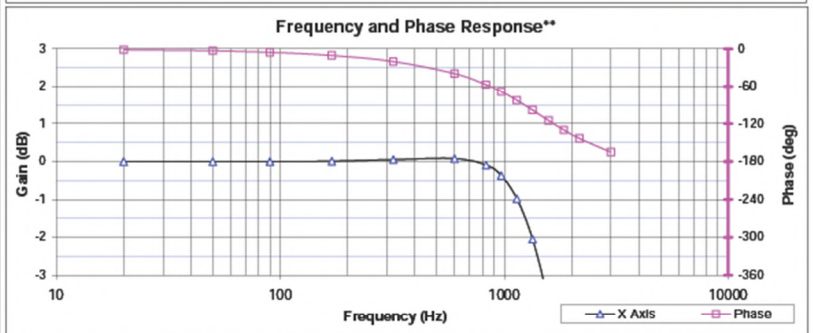
50k Rads Exposure: Part #1

SDI Silicon Designs Inc. Kirkland, Washington USA

ACCELEROMETER TEST REPORT

Model	1527J-025	Supply Current (Idd)	5.52 mA	Part #	172-00241-02
Full Scale	25 g	Scale Factor (Sensitivity)	160.3 mV/G	Doc. Rev.	-
Cal. Date	18 Dec 2020			Mfg. Lot #	20A337Z
Serial #	763646	0 G Bias (Offset)	-2 mV	Operator	Jerry
				Op. Number	120





Freq. (Hz)*	20	50	90	170	320	600	830	970	1140	1340	1580	1850	2170	3000
dB Out - X	0.00	0.00	0.00	0.01	0.05	0.08	-0.09	-0.37	-0.98	-2.05	-3.74	-5.88	-8.42	-14.17
Phase (deg)	-1.3	-3.1	-5.6	-10.6	-20.1	-39.4	-57.1	-68.5	-82.5	-98.3	-114.9	-130.0	-143.4	-165.2

* Peak Acceleration Traceable to SDI Shaker System Test Interface M90257
** Reference Frequency is 100 Hz

Final Status
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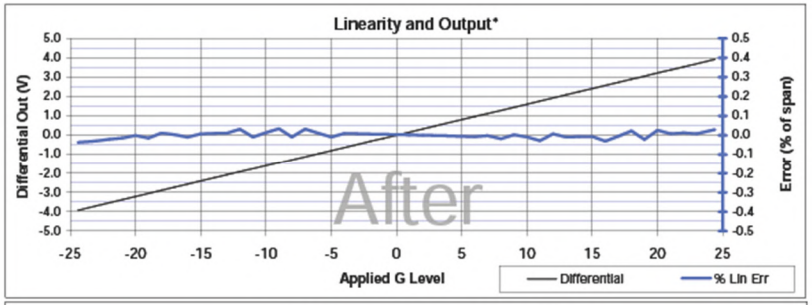
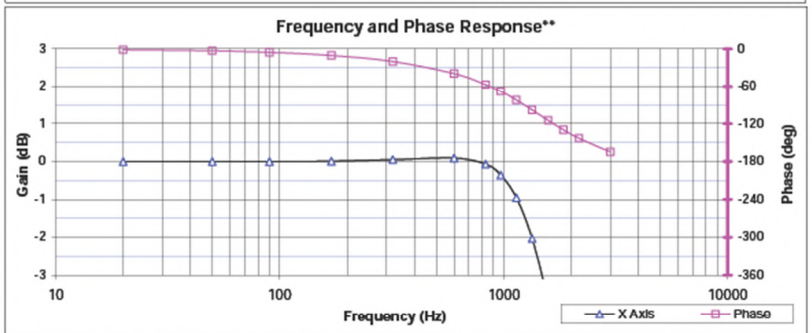
Form: 0-000-00503 Rev 21 August 2019 Report Generator Rev. 6.9.3 : June 14, 2021

SDI Silicon Designs Inc. Kirkland, Washington USA

ACCELEROMETER TEST REPORT

Model	1527J-025	Supply Current (Idd)	5.71 mA	Part #	172-00241-02
Full Scale	25 g	Scale Factor (Sensitivity)	160.5 mV/G	Doc. Rev.	-
Cal. Date	28 May 2021			Mfg. Lot #	20A337Z
Serial #	763646	0 G Bias (Offset)	-2 mV	Operator	PH
				Op. Number	120





Freq. (Hz)*	20	50	90	170	320	600	830	970	1140	1340	1580	1850	2170	3000
dB Out - X	0.00	0.00	0.00	0.01	0.05	0.09	-0.07	-0.36	-0.96	-2.03	-3.71	-5.85	-8.40	-14.15
Phase (deg)	-1.3	-3.1	-5.6	-10.5	-20.0	-39.2	-56.9	-68.3	-82.2	-98.0	-114.6	-129.7	-143.1	-164.8

* Peak Acceleration Traceable to SDI Shaker System Test Interface M90256
** Reference Frequency is 100 Hz

Final Status
Pass:

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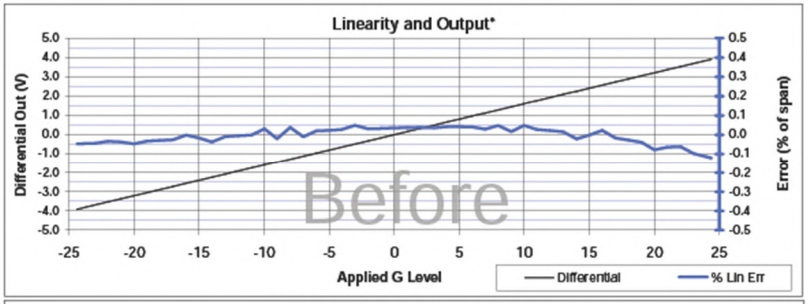
Form: 0-000-00503 Rev 21 August 2019 Report Generator Rev. 6.9.3 : June 14, 2021

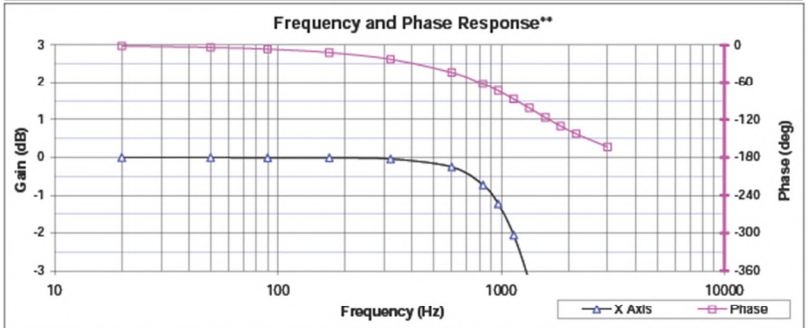
50k Rads Exposure: Part #2

SDI Silicon Designs Inc.
Kirkland, Washington USA

ACCELEROMETER TEST REPORT

Model	1527J-025	Supply Current (Idd)	4.97 mA	Part #	172-00241-02
Full Scale	25 g	Scale Factor (Sensitivity)	160.5 mV/G	Doc. Rev.	-
Cal. Date	18 Dec 2020			Mfg. Lot #	20A337Z
Serial #	763647	0 G Bias (Offset)	1 mV	Operator	Jerry
				Op. Number	120





Freq. (Hz)*	20	50	90	170	320	600	830	970	1140	1340	1580	1850	2170	3000
dB Out - X	0.00	0.00	-0.01	-0.01	-0.04	-0.25	-0.73	-1.23	-2.06	-3.32	-5.09	-7.20	-9.65	-15.17
Phase (deg)	-1.4	-3.5	-6.3	-11.9	-22.7	-43.9	-62.3	-73.7	-87.2	-101.7	-116.7	-130.2	-142.6	-163.4

* Peak Acceleration Traceable to SDI Shaker System Test Interface M90257
** Reference Frequency is 100 Hz

Final Status
Pass:

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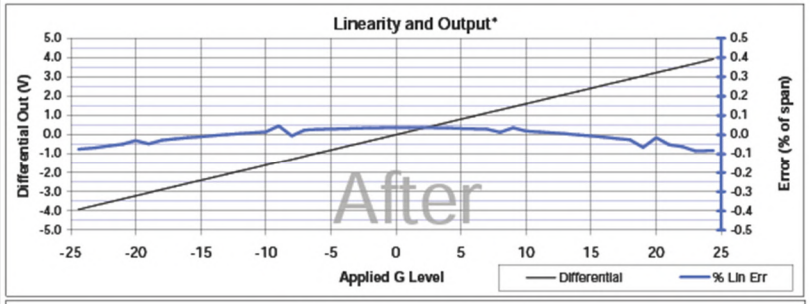
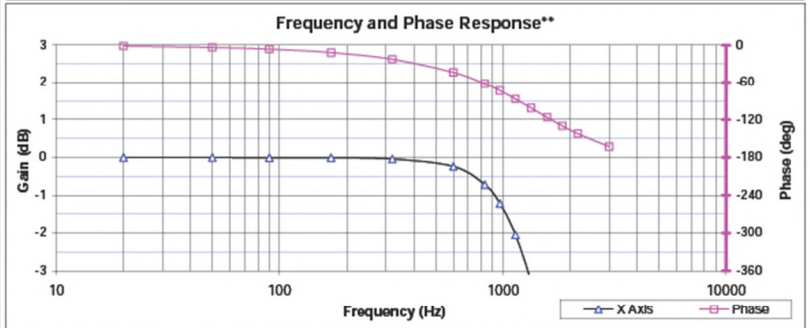
Form: 0-000-00503 Rev 21 August 2019 Report Generator Rev. 6.9.3 : June 14, 2021

SDI Silicon Designs Inc.
Kirkland, Washington USA

ACCELEROMETER TEST REPORT

Model	1527J-025	Supply Current (Idd)	5.28 mA	Part #	172-00241-02
Full Scale	25 g	Scale Factor (Sensitivity)	160.5 mV/G	Doc. Rev.	-
Cal. Date	28 May 2021			Mfg. Lot #	20A337Z
Serial #	763647	0 G Bias (Offset)	-1 mV	Operator	PH
				Op. Number	120





Freq. (Hz)*	20	50	90	170	320	600	830	970	1140	1340	1580	1850	2170	3000
dB Out - X	0.00	0.00	-0.01	-0.01	-0.04	-0.24	-0.72	-1.22	-2.05	-3.31	-5.07	-7.18	-9.63	-15.14
Phase (deg)	-1.4	-3.5	-6.3	-11.9	-22.6	-43.7	-62.1	-73.5	-86.9	-101.4	-116.4	-129.9	-142.2	-162.9

* Peak Acceleration Traceable to SDI Shaker System Test Interface M90256
** Reference Frequency is 100 Hz

Final Status
Pass:

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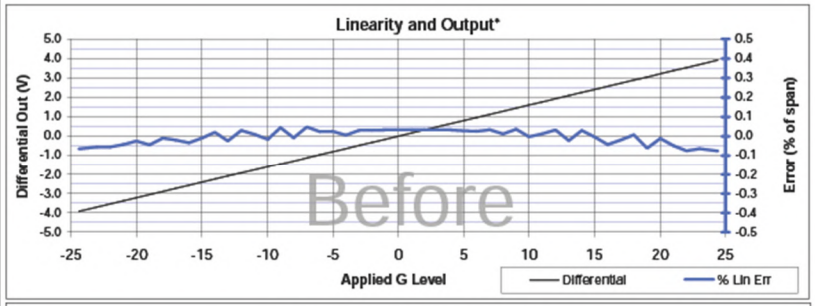
Form: 0-000-00503 Rev 21 August 2019 Report Generator Rev. 6.9.3 : June 14, 2021

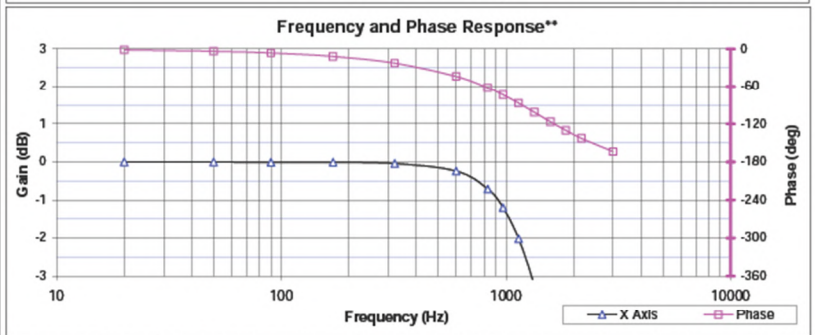
50k Rads Exposure: Part #3

SDI Silicon Designs Inc.
Kirkland, Washington USA

ACCELEROMETER TEST REPORT

Model	1527J-025	Supply Current (Idd)	4.67 mA	Part #	172-00241-02
Full Scale	25 g	Scale Factor (Sensitivity)	160.6 mV/G	Doc. Rev.	-
Cal. Date	18 Dec 2020			Mfg. Lot #	20A337Z
Serial #	763648	0 G Bias (Offset)	1 mV	Operator	Jerry
				Op. Number	120





Freq. (Hz)*	20	50	90	170	320	600	830	970	1140	1340	1580	1850	2170	3000
dB Out - X	0.00	0.00	-0.01	-0.01	-0.04	-0.24	-0.71	-1.20	-2.02	-3.27	-5.03	-7.13	-9.58	-15.11
Phase (deg)	-1.4	-3.5	-6.3	-11.9	-22.6	-43.7	-62.1	-73.5	-86.9	-101.5	-116.6	-130.2	-142.8	-163.8

* Peak Acceleration Traceable to SDI Shaker System Test Interface M90257
** Reference Frequency is 100 Hz

Final Status
Pass:

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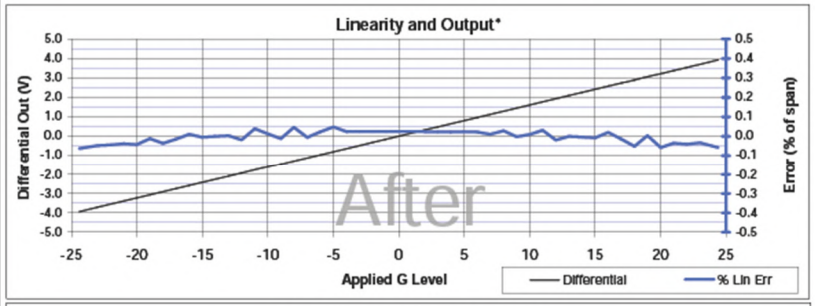
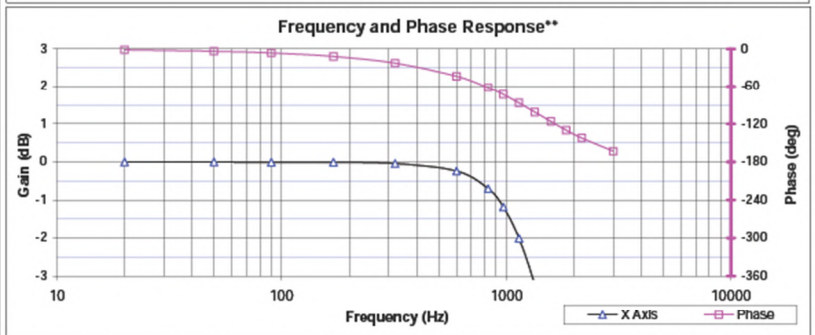
Form: 0-000-00503 Rev 21 August 2019 Report Generator Rev. 6.9.3 : June 14, 2021

SDI Silicon Designs Inc.
Kirkland, Washington USA

ACCELEROMETER TEST REPORT

Model	1527J-025	Supply Current (Idd)	4.88 mA	Part #	172-00241-02
Full Scale	25 g	Scale Factor (Sensitivity)	160.9 mV/G	Doc. Rev.	-
Cal. Date	28 May 2021			Mfg. Lot #	20A337Z
Serial #	763648	0 G Bias (Offset)	-1 mV	Operator	PH
				Op. Number	120





Freq. (Hz)*	20	50	90	170	320	600	830	970	1140	1340	1580	1850	2170	3000
dB Out - X	0.00	0.00	-0.01	-0.01	-0.04	-0.24	-0.70	-1.19	-2.01	-3.25	-5.01	-7.11	-9.55	-15.08
Phase (deg)	-1.4	-3.5	-6.3	-11.8	-22.5	-43.5	-61.9	-73.3	-86.7	-101.2	-116.3	-129.9	-142.3	-163.3

* Peak Acceleration Traceable to SDI Shaker System Test Interface M90256
** Reference Frequency is 100 Hz

Final Status
Pass:

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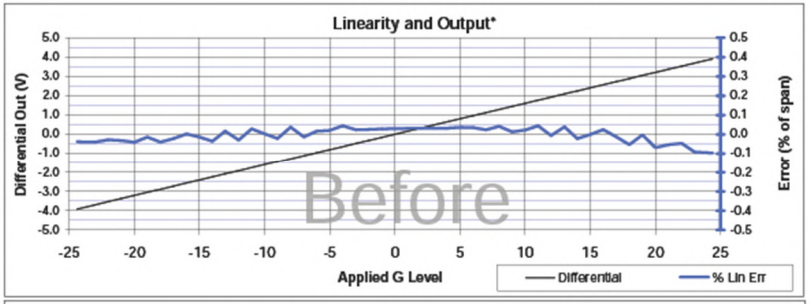
Form: 0-000-00503 Rev 21 August 2019 Report Generator Rev. 6.9.3 : June 14, 2021

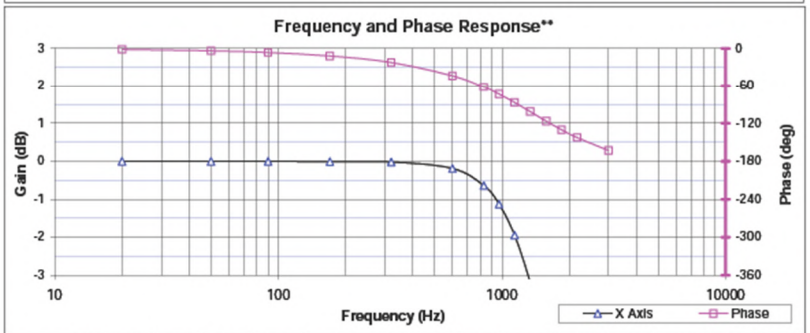
100k Rads Exposure: Part #1

SDI Silicon Designs Inc.
Kirkland, Washington USA

ACCELEROMETER TEST REPORT

Model	1527J-025	Supply Current (Idd)	5.9 mA	Part #	172-00241-02
Full Scale	25 g	Scale Factor (Sensitivity)	160.5 mV/G	Doc. Rev.	-
Cal. Date	18 Dec 2020			Mfg. Lot #	20A337Z
Serial #	763651	0 G Bias (Offset)	1 mV	Operator	Jerry
				Op. Number	120





Freq. (Hz)*	20	50	90	170	320	600	830	970	1140	1340	1580	1850	2170	3000
dB Out - X	0.00	0.00	0.00	-0.01	-0.02	-0.19	-0.64	-1.13	-1.95	-3.22	-5.01	-7.13	-9.61	-15.16
Phase (deg)	-1.4	-3.5	-6.2	-11.8	-22.4	-43.4	-61.9	-73.4	-87.0	-101.6	-116.7	-130.2	-142.5	-163.0

* Peak Acceleration Traceable to SDI Shaker System Test Interface M90257
** Reference Frequency is 100 Hz

Final Status
Pass:

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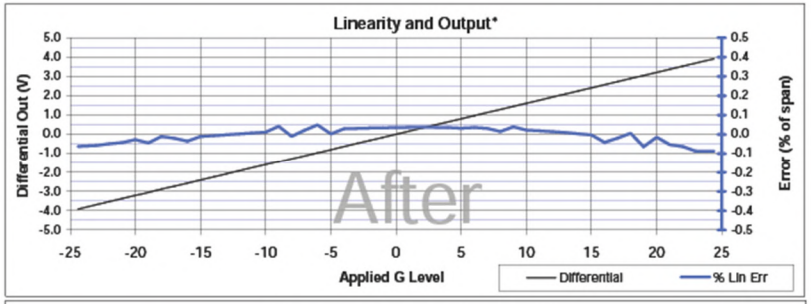
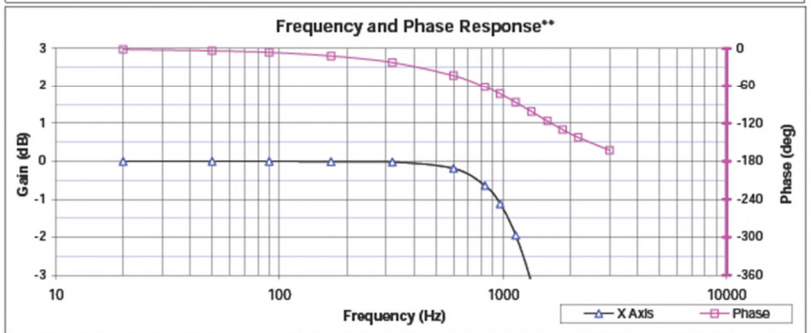
Form: 0-000-00503 Rev 21 August 2019 Report Generator Rev. 6.9.3 : June 14, 2021

SDI Silicon Designs Inc.
Kirkland, Washington USA

ACCELEROMETER TEST REPORT

Model	1527J-025	Supply Current (Idd)	6.3 mA	Part #	172-00241-02
Full Scale	25 g	Scale Factor (Sensitivity)	160.4 mV/G	Doc. Rev.	-
Cal. Date	28 May 2021			Mfg. Lot #	20A337Z
Serial #	763651	0 G Bias (Offset)	1 mV	Operator	PH
				Op. Number	120





Freq. (Hz)*	20	50	90	170	320	600	830	970	1140	1340	1580	1850	2170	3000
dB Out - X	0.00	0.00	0.00	-0.01	-0.02	-0.19	-0.64	-1.12	-1.95	-3.21	-5.00	-7.12	-9.59	-15.14
Phase (deg)	-1.4	-3.5	-6.2	-11.7	-22.3	-43.2	-61.7	-73.2	-86.7	-101.3	-116.3	-129.9	-142.2	-162.6

* Peak Acceleration Traceable to SDI Shaker System Test Interface M90256
** Reference Frequency is 100 Hz

Final Status
Pass:

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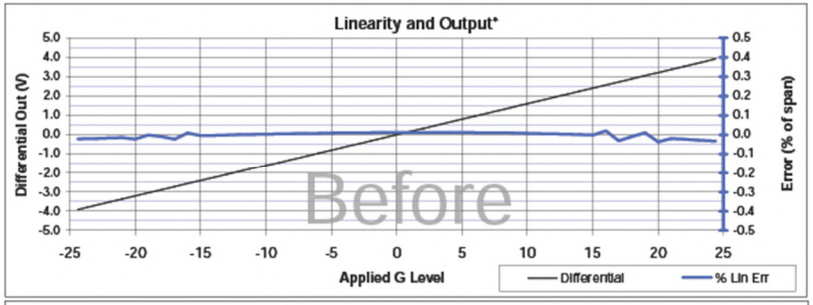
Form: 0-000-00503 Rev 21 August 2019 Report Generator Rev. 6.9.3 : June 14, 2021

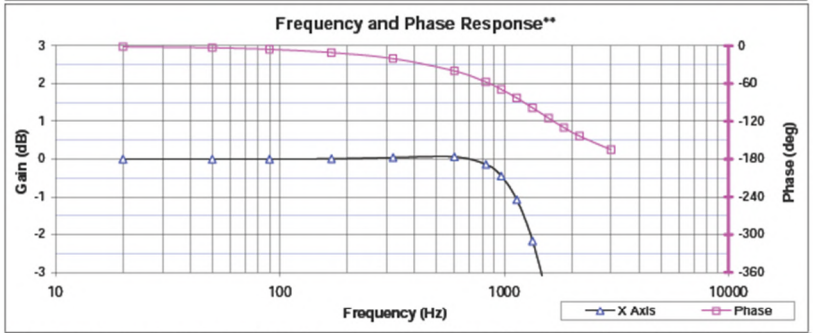
100k Rads Exposure: Part #2

SDI Silicon Designs Inc.
Kirkland, Washington USA

ACCELEROMETER TEST REPORT

Model	1527J-025	Supply Current (Idd)	5.43 mA	Part #	172-00241-02
Full Scale	25 g	Scale Factor (Sensitivity)	160.3 mV/G	Doc. Rev.	-
Cal. Date	18 Dec 2020			Mfg. Lot #	20A337Z
Serial #	763652	0 G Bias (Offset)	1 mV	Operator	Jerry
				Op. Number	120





Freq. (Hz)*	20	50	90	170	320	600	830	970	1140	1340	1580	1850	2170	3000
dB Out - X	0.00	0.00	0.00	0.01	0.04	0.06	-0.14	-0.45	-1.08	-2.17	-3.86	-6.00	-8.53	-14.26
Phase (deg)	-1.3	-3.2	-5.6	-10.7	-20.4	-39.8	-57.6	-69.0	-83.0	-98.6	-115.1	-130.0	-143.4	-165.2

* Peak Acceleration Traceable to SDI Shaker System Test Interface M90257
** Reference Frequency is 100 Hz

Final Status
Pass:

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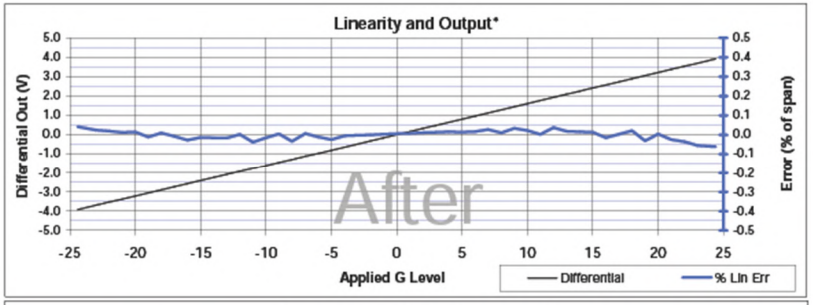
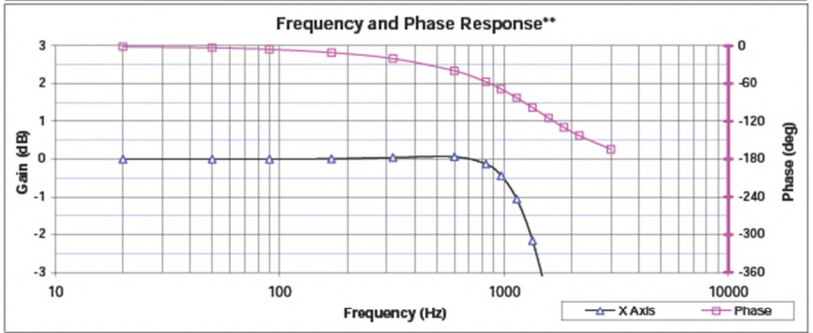
Form: 0-000-00503 Rev 21 August 2019 Report Generator Rev. 6.9.3 : June 14, 2021

SDI Silicon Designs Inc.
Kirkland, Washington USA

ACCELEROMETER TEST REPORT

Model	1527J-025	Supply Current (Idd)	5.64 mA	Part #	172-00241-02
Full Scale	25 g	Scale Factor (Sensitivity)	160.6 mV/G	Doc. Rev.	-
Cal. Date	28 May 2021			Mfg. Lot #	20A337Z
Serial #	763652	0 G Bias (Offset)	2 mV	Operator	PH
				Op. Number	120





Freq. (Hz)*	20	50	90	170	320	600	830	970	1140	1340	1580	1850	2170	3000
dB Out - X	0.00	0.00	0.00	0.01	0.04	0.06	-0.13	-0.44	-1.06	-2.16	-3.85	-5.98	-8.51	-14.24
Phase (deg)	-1.3	-3.1	-5.6	-10.6	-20.3	-39.7	-57.4	-68.7	-82.7	-98.3	-114.7	-129.6	-143.0	-164.7

* Peak Acceleration Traceable to SDI Shaker System Test Interface M90256
** Reference Frequency is 100 Hz

Final Status
Pass:

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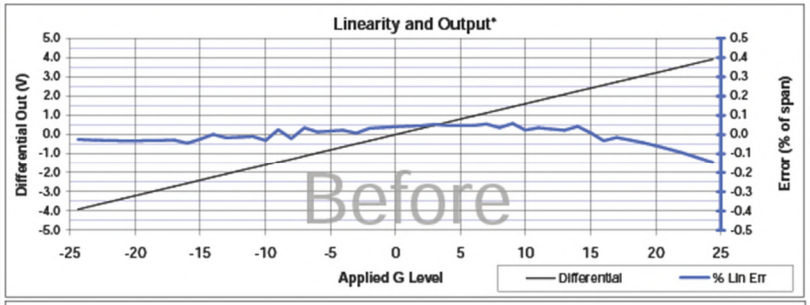
Form: 0-000-00503 Rev 21 August 2019 Report Generator Rev. 6.9.3 : June 14, 2021

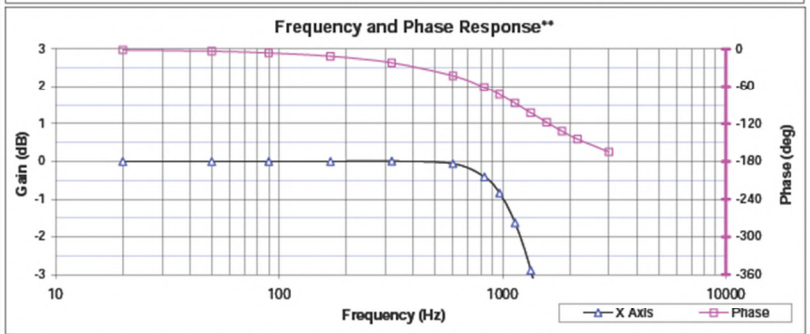
100k Rads Exposure: Part #3

SDI Silicon Designs Inc.
Kirkland, Washington USA

ACCELEROMETER TEST REPORT

Model	1527J-025	Supply Current (Idd)	5.25 mA	Part #	172-00241-02
Full Scale	25 g	Scale Factor (Sensitivity)	160.5 mV/G	Doc. Rev.	-
Cal. Date	18 Dec 2020			Mfg. Lot #	20A337Z
Serial #	763653	0 G Bias (Offset)	0 mV	Operator	Jerry
				Op. Number	120





Freq. (Hz)*	20	50	90	170	320	600	830	970	1140	1340	1580	1850	2170	3000
dB Out - X	0.00	0.00	0.00	0.00	0.01	-0.06	-0.41	-0.84	-1.63	-2.89	-4.72	-6.92	-9.46	-15.12
Phase (deg)	-1.4	-3.4	-6.0	-11.4	-21.8	-42.5	-61.2	-73.0	-87.0	-102.3	-117.9	-131.9	-144.4	-164.9

* Peak Acceleration Traceable to SDI Shaker System Test Interface M90257
** Reference Frequency is 100 Hz

Final Status
Pass:

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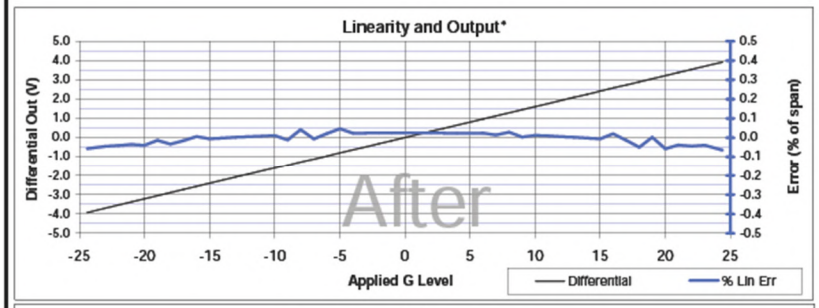
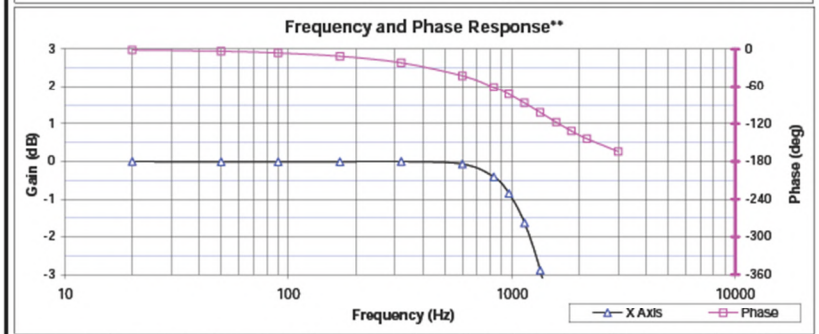
Form: 0-000-00503 Rev 21 August 2019 Report Generator Rev. 6.9.3 : June 14, 2021

SDI Silicon Designs Inc.
Kirkland, Washington USA

ACCELEROMETER TEST REPORT

Model	1527J-025	Supply Current (Idd)	5.64 mA	Part #	172-00241-02
Full Scale	25 g	Scale Factor (Sensitivity)	160.7 mV/G	Doc. Rev.	-
Cal. Date	28 May 2021			Mfg. Lot #	20A337Z
Serial #	763653	0 G Bias (Offset)	0 mV	Operator	PH
				Op. Number	120





Freq. (Hz)*	20	50	90	170	320	600	830	970	1140	1340	1580	1850	2170	3000
dB Out - X	0.00	-0.01	-0.01	-0.01	0.00	-0.07	-0.41	-0.85	-1.63	-2.89	-4.71	-6.90	-9.45	-15.11
Phase (deg)	-1.4	-3.4	-6.0	-11.4	-21.7	-42.4	-61.0	-72.7	-86.7	-102.0	-117.6	-131.5	-144.0	-164.4

* Peak Acceleration Traceable to SDI Shaker System Test Interface M90256
** Reference Frequency is 100 Hz

Final Status
Pass:

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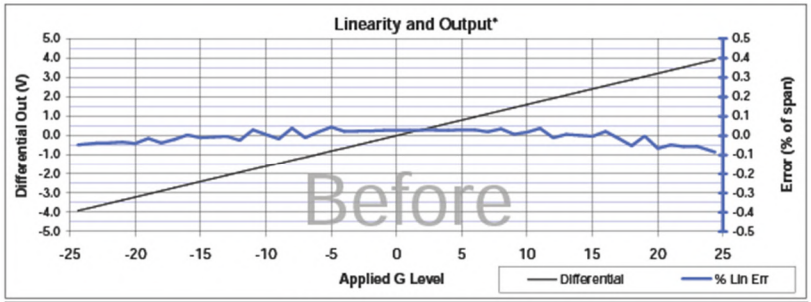
Form: 0-000-00503 Rev 21 August 2019 Report Generator Rev. 6.9.3 : June 14, 2021

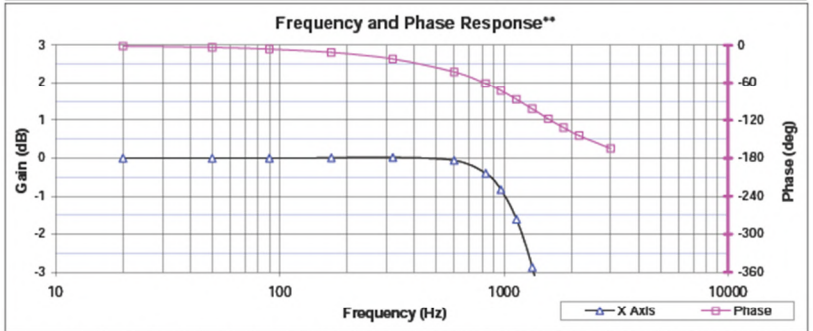
200k Rads Exposure: Part #1

SDI Silicon Designs Inc.
Kirkland, Washington USA

ACCELEROMETER TEST REPORT

Model	1527J-025	Supply Current (Idd)	5.25 mA	Part #	172-00241-02
Full Scale	25 g	Scale Factor (Sensitivity)	160.4 mV/G	Doc. Rev.	-
Cal. Date	18 Dec 2020			Mfg. Lot #	20A337Z
Serial #	763655	0 G Bias (Offset)	-2 mV	Operator	Jerry
				Op. Number	120





Freq. (Hz)*	20	50	90	170	320	600	830	970	1140	1340	1580	1850	2170	3000
dB Out - X	0.00	0.00	0.00	0.01	0.02	-0.06	-0.40	-0.83	-1.61	-2.87	-4.70	-6.90	-9.45	-15.13
Phase (deg)	-1.4	-3.4	-6.0	-11.4	-21.7	-42.5	-61.1	-72.9	-86.9	-102.2	-117.9	-131.9	-144.5	-165.0

* Peak Acceleration Traceable to SDI Shaker System Test Interface M90257
** Reference Frequency is 100 Hz

Final Status
Pass:

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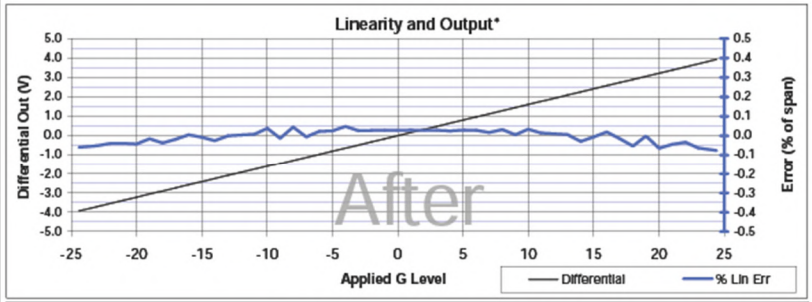
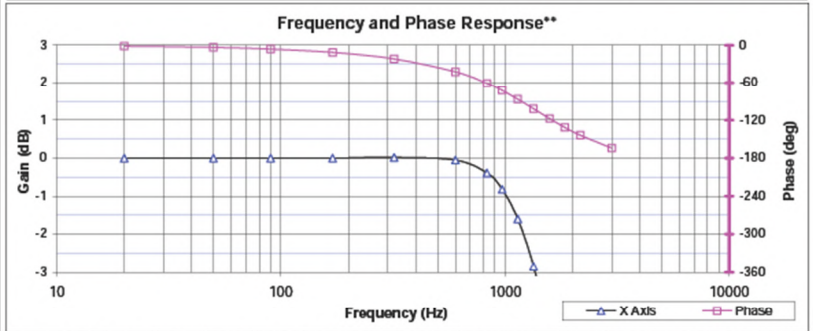
Form: 0-000-00503 Rev 21 August 2019 Report Generator Rev. 6.9.3 : June 14, 2021

SDI Silicon Designs Inc.
Kirkland, Washington USA

ACCELEROMETER TEST REPORT

Model	1527J-025	Supply Current (Idd)	5.28 mA	Part #	172-00241-02
Full Scale	25 g	Scale Factor (Sensitivity)	160.8 mV/G	Doc. Rev.	-
Cal. Date	28 May 2021			Mfg. Lot #	20A337Z
Serial #	763655	0 G Bias (Offset)	-1 mV	Operator	PH
				Op. Number	120





Freq. (Hz)*	20	50	90	170	320	600	830	970	1140	1340	1580	1850	2170	3000
dB Out - X	0.00	0.00	0.00	0.00	0.02	-0.05	-0.39	-0.82	-1.60	-2.85	-4.68	-6.87	-9.42	-15.09
Phase (deg)	-1.4	-3.4	-6.0	-11.4	-21.6	-42.3	-60.9	-72.6	-86.6	-101.9	-117.6	-131.5	-144.0	-164.4

* Peak Acceleration Traceable to SDI Shaker System Test Interface M90256
** Reference Frequency is 100 Hz

Final Status
Pass:

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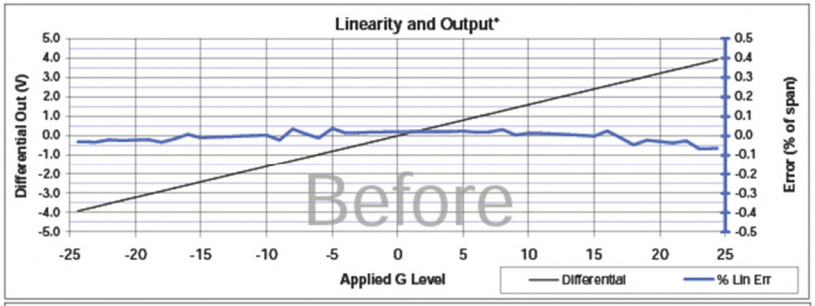
Form: 0-000-00503 Rev 21 August 2019 Report Generator Rev. 6.9.3 : June 14, 2021

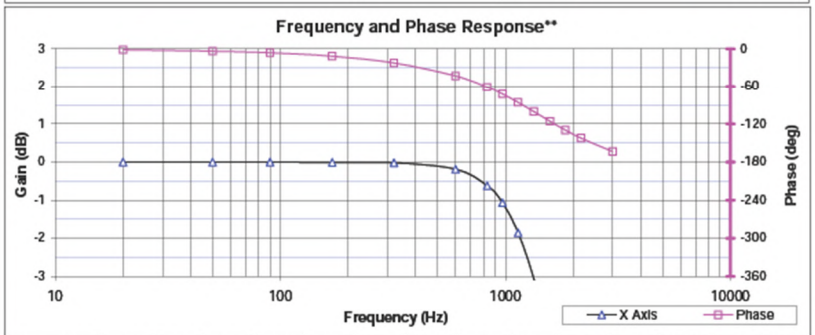
200k Rads Exposure: Part #2

SDI Silicon Designs Inc.
Kirkland, Washington USA

ACCELEROMETER TEST REPORT

Model	1527J-025	Supply Current (Idd)	5 mA	Part #	172-00241-02
Full Scale	25 g	Scale Factor (Sensitivity)	160.5 mV/G	Doc. Rev.	-
Cal. Date	18 Dec 2020			Mfg. Lot #	20A337Z
Serial #	763657	0 G Bias (Offset)	0 mV	Operator	Jerry
				Op. Number	120





Freq. (Hz)*	20	50	90	170	320	600	830	970	1140	1340	1580	1850	2170	3000
dB Out - X	0.00	0.00	0.00	-0.01	-0.02	-0.19	-0.62	-1.07	-1.86	-3.08	-4.80	-6.89	-9.34	-14.87
Phase (deg)	-1.4	-3.5	-6.2	-11.7	-22.2	-42.9	-61.2	-72.5	-85.9	-100.6	-115.7	-129.6	-142.2	-163.4

* Peak Acceleration Traceable to SDI Shaker System Test Interface M90257
** Reference Frequency is 100 Hz

Final Status
Pass:

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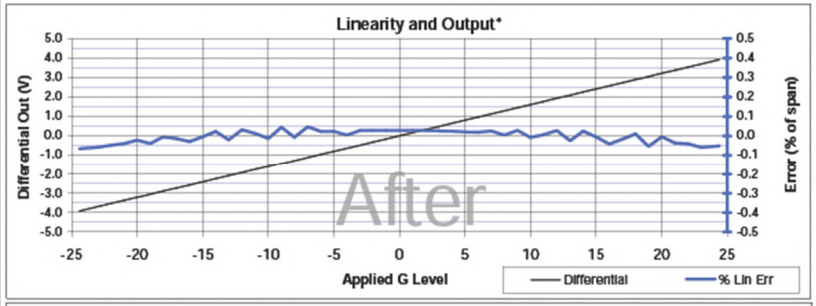
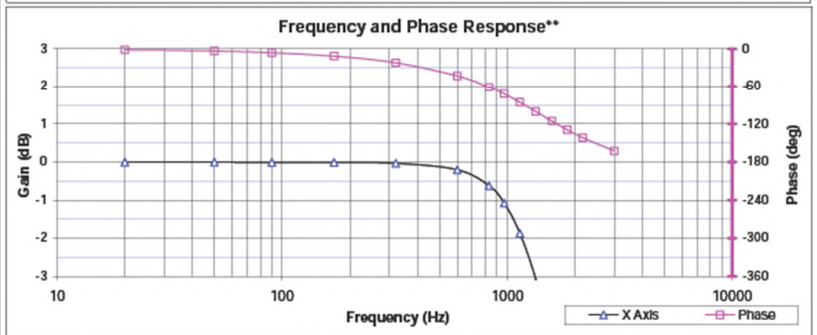
Form: 0-000-00503 Rev 21 August 2019 Report Generator Rev. 6.9.3 : June 14, 2021

SDI Silicon Designs Inc.
Kirkland, Washington USA

ACCELEROMETER TEST REPORT

Model	1527J-025	Supply Current (Idd)	5.22 mA	Part #	172-00241-02
Full Scale	25 g	Scale Factor (Sensitivity)	160.4 mV/G	Doc. Rev.	-
Cal. Date	28 May 2021			Mfg. Lot #	20A337Z
Serial #	763657	0 G Bias (Offset)	1 mV	Operator	PH
				Op. Number	120





Freq. (Hz)*	20	50	90	170	320	600	830	970	1140	1340	1580	1850	2170	3000
dB Out - X	0.00	0.00	-0.01	-0.01	-0.03	-0.20	-0.62	-1.08	-1.87	-3.08	-4.80	-6.89	-9.32	-14.85
Phase (deg)	-1.4	-3.4	-6.2	-11.6	-22.1	-42.8	-61.0	-72.2	-85.6	-100.2	-115.4	-129.2	-141.7	-162.8

* Peak Acceleration Traceable to SDI Shaker System Test Interface M90256
** Reference Frequency is 100 Hz

Final Status
Pass:

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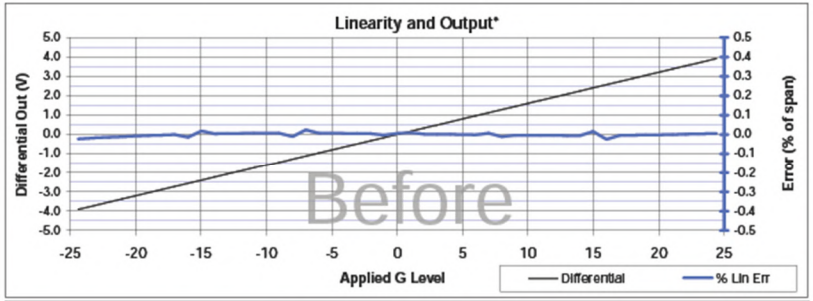
Form: 0-000-00503 Rev 21 August 2019 Report Generator Rev. 6.9.3 : June 14, 2021

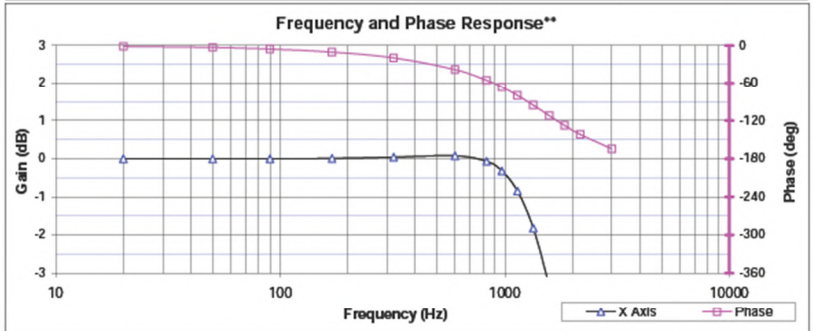
200k Rads Exposure: Part #3

SDI Silicon Designs Inc. Kirkland, Washington USA

ACCELEROMETER TEST REPORT

Model	1527J-025	Supply Current (Idd)	4.97 mA	Part #	172-00241-02
Full Scale	25 g	Scale Factor (Sensitivity)	160.3 mV/G	Doc. Rev.	-
Cal. Date	18 Dec 2020			Mfg. Lot #	20A337Z
Serial #	763658	0 G Bias (Offset)	2 mV	Operator	Jerry
				Op. Number	120





Freq. (Hz)*	20	50	90	170	320	600	830	970	1140	1340	1580	1850	2170	3000
dB Out - X	0.00	0.00	0.00	0.01	0.04	0.08	-0.07	-0.32	-0.85	-1.82	-3.39	-5.42	-7.89	-13.59
Phase (deg)	-1.2	-3.1	-5.5	-10.3	-19.7	-38.4	-55.4	-66.4	-80.0	-95.5	-112.2	-127.6	-141.6	-164.6

* Peak Acceleration Traceable to SDI Shaker System Test Interface M90257
** Reference Frequency is 100 Hz

Final Status
Pass:

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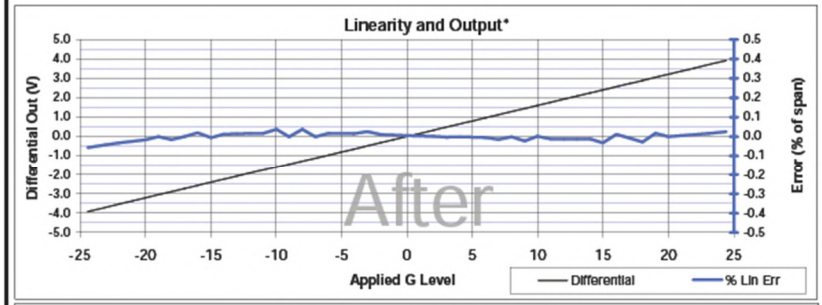
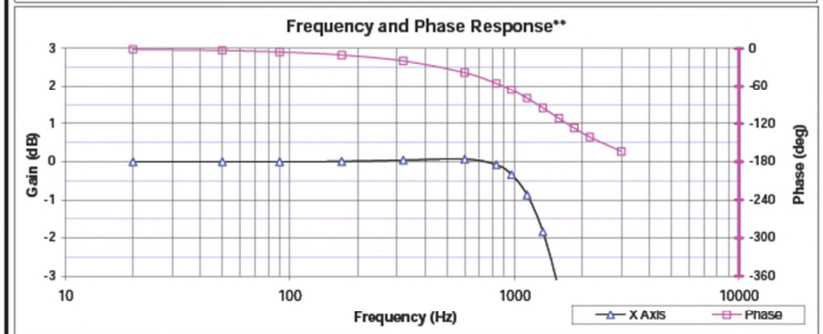
Form: 0-000-00503 Rev 21 August 2019 Report Generator Rev. 6.9.3 : June 14, 2021

SDI Silicon Designs Inc. Kirkland, Washington USA

ACCELEROMETER TEST REPORT

Model	1527J-025	Supply Current (Idd)	5.3 mA	Part #	172-00241-02
Full Scale	25 g	Scale Factor (Sensitivity)	160.4 mV/G	Doc. Rev.	-
Cal. Date	28 May 2021			Mfg. Lot #	20A337Z
Serial #	763658	0 G Bias (Offset)	0 mV	Operator	PH
				Op. Number	120





Freq. (Hz)*	20	50	90	170	320	600	830	970	1140	1340	1580	1850	2170	3000
dB Out - X	0.00	0.00	0.00	0.01	0.04	0.07	-0.08	-0.34	-0.87	-1.84	-3.40	-5.43	-7.90	-13.58
Phase (deg)	-1.3	-3.0	-5.5	-10.3	-19.6	-38.3	-55.2	-66.2	-79.7	-95.2	-111.8	-127.1	-141.1	-164.0

* Peak Acceleration Traceable to SDI Shaker System Test Interface M90256
** Reference Frequency is 100 Hz

Final Status
Pass:

www.silicondesigns.com sales@silicondesigns.com +1-425-391-8329

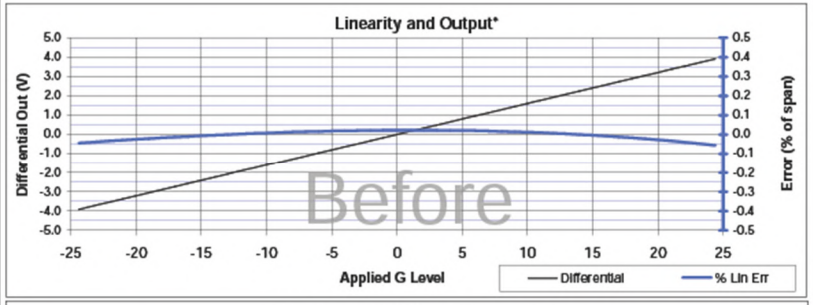
Form: 0-000-00503 Rev 21 August 2019 Report Generator Rev. 6.9.3 : June 14, 2021

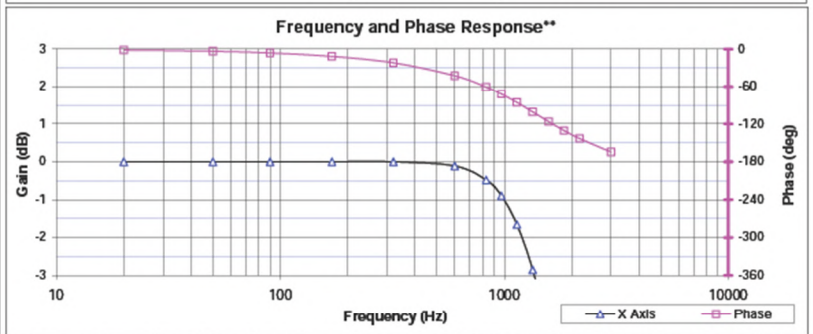
350k Rads Exposure: Part #1

SDI Silicon Designs Inc. Kirkland, Washington USA

ACCELEROMETER TEST REPORT

Model	1527J-025	Supply Current (Idd)	5.03 mA	Part #	172-00241-02
Full Scale	25 g	Scale Factor (Sensitivity)	160.4 mV/G	Doc. Rev.	-
Cal. Date	18 Dec 2020			Mfg. Lot #	20A337Z
Serial #	763660	0 G Bias (Offset)	0 mV	Operator	Jerry
				Op. Number	120





Freq. (Hz)*	20	50	90	170	320	600	830	970	1140	1340	1580	1850	2170	3000
dB Out - X	0.00	0.00	0.00	0.00	0.00	-0.11	-0.48	-0.90	-1.66	-2.86	-4.61	-6.74	-9.23	-14.84
Phase (deg)	-1.4	-3.4	-6.1	-11.4	-21.7	-42.3	-60.6	-72.0	-85.7	-100.8	-116.3	-130.4	-143.2	-164.5

* Peak Acceleration Traceable to SDI Shaker System Test Interface M90257
** Reference Frequency is 100 Hz

Final Status
Pass:

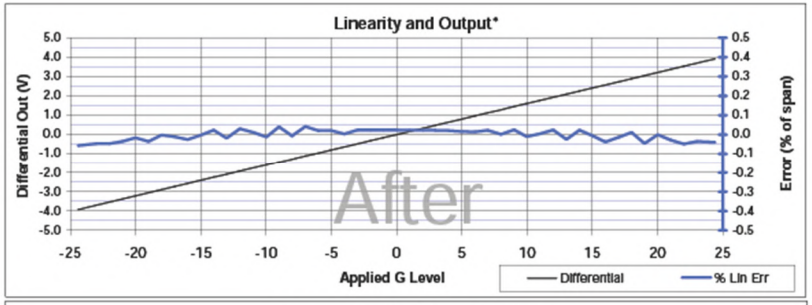
www.silicondesigns.com sales@silicondesigns.com +1-425-391-8329

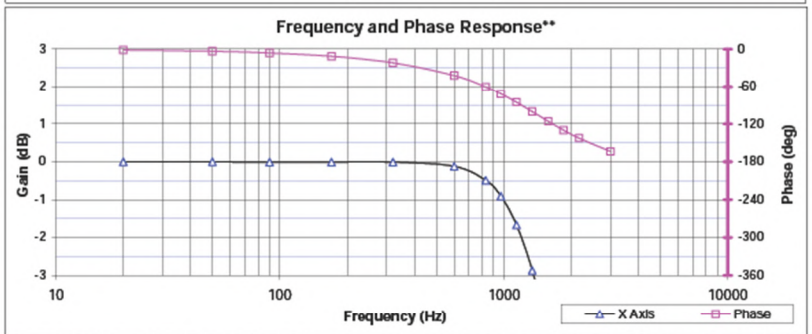
Form: 0-000-00503 Rev 21 August 2019 Report Generator Rev. 6.9.3 : June 14, 2021

SDI Silicon Designs Inc. Kirkland, Washington USA

ACCELEROMETER TEST REPORT

Model	1527J-025	Supply Current (Idd)	5.43 mA	Part #	172-00241-02
Full Scale	25 g	Scale Factor (Sensitivity)	160.4 mV/G	Doc. Rev.	-
Cal. Date	28 May 2021			Mfg. Lot #	20A337Z
Serial #	763660	0 G Bias (Offset)	-3 mV	Operator	PH
				Op. Number	120





Freq. (Hz)*	20	50	90	170	320	600	830	970	1140	1340	1580	1850	2170	3000
dB Out - X	0.00	0.00	-0.01	-0.01	-0.01	-0.12	-0.49	-0.91	-1.67	-2.87	-4.61	-6.73	-9.22	-14.83
Phase (deg)	-1.4	-3.4	-6.0	-11.4	-21.7	-42.1	-60.3	-71.7	-85.4	-100.3	-115.8	-129.9	-142.7	-163.9

* Peak Acceleration Traceable to SDI Shaker System Test Interface M90256
** Reference Frequency is 100 Hz

Final Status
Pass:

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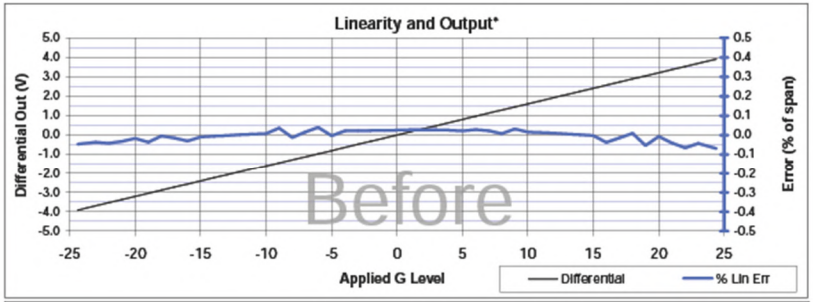
Form: 0-000-00503 Rev 21 August 2019 Report Generator Rev. 6.9.3 : June 14, 2021

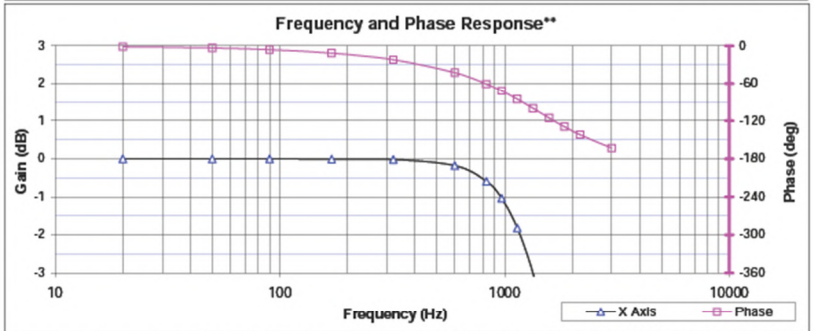
350k Rads Exposure: Part #2

SDI Silicon Designs Inc. Kirkland, Washington USA

ACCELEROMETER TEST REPORT

Model	1527J-025	Supply Current (Idd)	5.69 mA	Part #	172-00241-02
Full Scale	25 g	Scale Factor (Sensitivity)	160.4 mV/G	Doc. Rev.	-
Cal. Date	18 Dec 2020			Mfg. Lot #	20A337Z
Serial #	763662	0 G Bias (Offset)	1 mV	Operator	Jerry
				Op. Number	120





Freq. (Hz)*	20	50	90	170	320	600	830	970	1140	1340	1580	1850	2170	3000
dB Out - X	0.00	0.00	0.00	-0.01	-0.02	-0.18	-0.59	-1.04	-1.82	-3.02	-4.75	-6.85	-9.30	-14.83
Phase (deg)	-1.4	-3.4	-6.1	-11.6	-22.0	-42.7	-60.9	-72.2	-85.6	-100.3	-115.6	-129.4	-142.0	-163.1

* Peak Acceleration Traceable to SDI Shaker System Test Interface M90257
** Reference Frequency is 100 Hz

Final Status
Pass:

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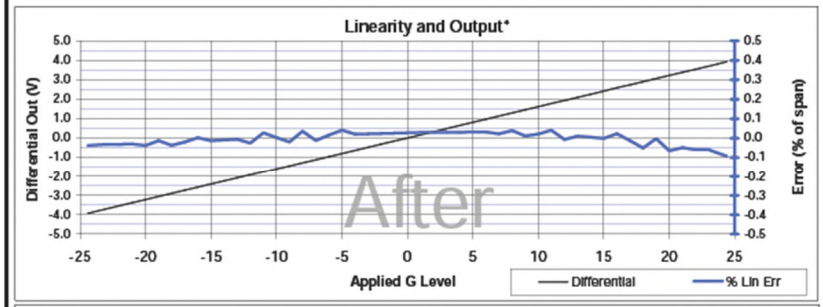
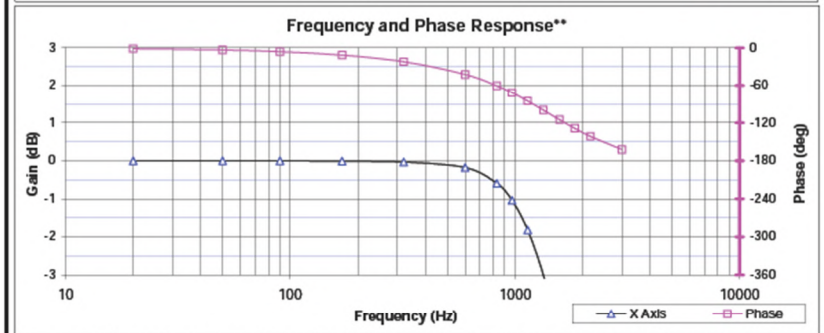
Form: 0-000-00503 Rev 21 August 2019 Report Generator Rev. 6.9.3 : June 14, 2021

SDI Silicon Designs Inc. Kirkland, Washington USA

ACCELEROMETER TEST REPORT

Model	1527J-025	Supply Current (Idd)	6.49 mA	Part #	172-00241-02
Full Scale	25 g	Scale Factor (Sensitivity)	160.8 mV/G	Doc. Rev.	-
Cal. Date	28 May 2021			Mfg. Lot #	20A337Z
Serial #	763662	0 G Bias (Offset)	5 mV	Operator	PH
				Op. Number	120





Freq. (Hz)*	20	50	90	170	320	600	830	970	1140	1340	1580	1850	2170	3000
dB Out - X	0.00	0.00	0.00	-0.01	-0.03	-0.18	-0.59	-1.04	-1.82	-3.02	-4.74	-6.83	-9.26	-14.77
Phase (deg)	-1.4	-3.4	-6.1	-11.6	-21.9	-42.5	-60.6	-71.9	-85.3	-99.9	-115.0	-128.8	-141.4	-162.3

* Peak Acceleration Traceable to SDI Shaker System Test Interface M90256
** Reference Frequency is 100 Hz

Final Status
Pass:

www.silicondesigns.com sales@silicondesigns.com +1-425-391-8329

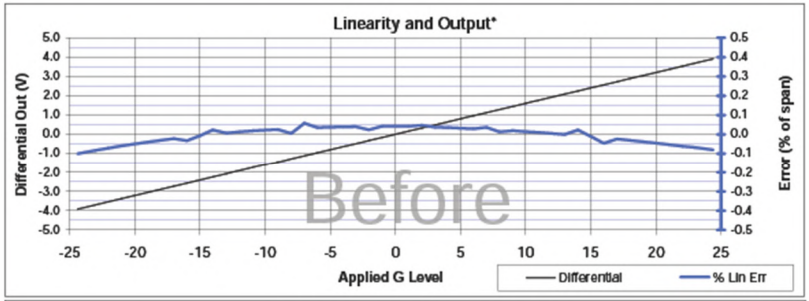
Form: 0-000-00503 Rev 21 August 2019 Report Generator Rev. 6.9.3 : June 14, 2021

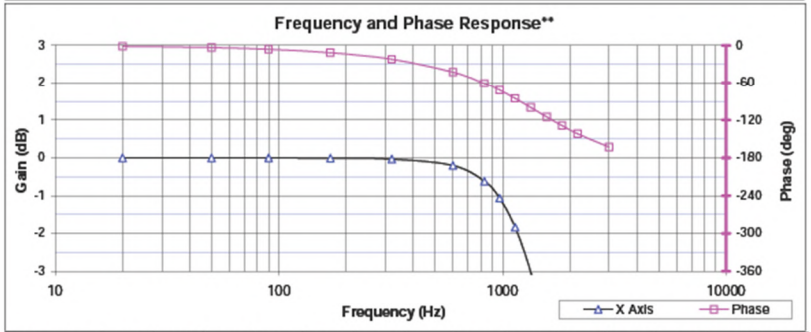
350k Rads Exposure: Part #3

SDI Silicon Designs Inc.
Kirkland, Washington USA

ACCELEROMETER TEST REPORT

Model	1527J-025	Supply Current (Idd)	5.84 mA	Part #	172-00241-02
Full Scale	25 g	Scale Factor (Sensitivity)	160.4 mV/G	Doc. Rev.	-
Cal. Date	18 Dec 2020			Mfg. Lot #	20A337Z
Serial #	763663	0 G Bias (Offset)	-1 mV	Operator	Jerry
				Op. Number	120





Freq. (Hz)*	20	50	90	170	320	600	830	970	1140	1340	1580	1850	2170	3000
dB Out - X	0.00	0.00	0.00	-0.01	-0.03	-0.20	-0.62	-1.07	-1.84	-3.04	-4.75	-6.82	-9.25	-14.77
Phase (deg)	-1.4	-3.4	-6.1	-11.6	-22.1	-42.7	-60.7	-72.0	-85.3	-99.9	-115.1	-128.9	-141.6	-162.9

* Peak Acceleration Traceable to SDI Shaker System Test Interface M90257
** Reference Frequency is 100 Hz

Final Status
Pass:

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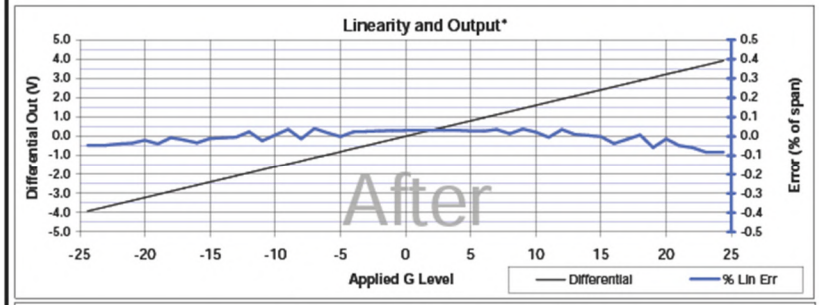
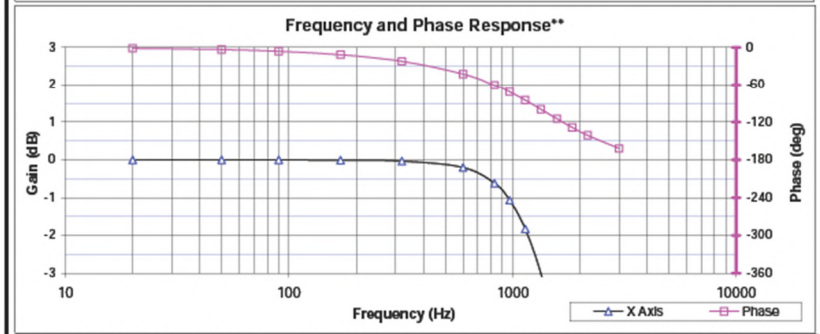
SDI Silicon Designs Inc.
Kirkland, Washington USA

ACCELEROMETER TEST REPORT

Model	1527J-025	Supply Current (Idd)	6.29 mA	Part #	172-00241-02
Full Scale	25 g	Scale Factor (Sensitivity)	160.5 mV/G	Doc. Rev.	-
Cal. Date	28 May 2021			Mfg. Lot #	20A337Z
Serial #	763663	0 G Bias (Offset)	0 mV	Operator	PH
				Op. Number	120





Freq. (Hz)*	20	50	90	170	320	600	830	970	1140	1340	1580	1850	2170	3000
dB Out - X	0.00	0.00	0.00	-0.01	-0.03	-0.20	-0.62	-1.07	-1.83	-3.02	-4.73	-6.79	-9.22	-14.71
Phase (deg)	-1.4	-3.4	-6.1	-11.5	-22.0	-42.5	-60.5	-71.7	-85.0	-99.5	-114.7	-128.5	-141.1	-162.2

* Peak Acceleration Traceable to SDI Shaker System Test Interface M90256
** Reference Frequency is 100 Hz

Final Status
Pass:

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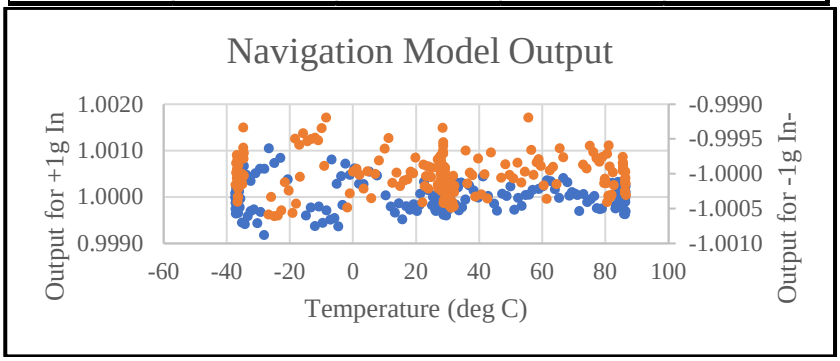
Radiation Induced Bias and Scale Factor Changes

				Before Radiation					After Radiation					Change with Radiation				
Rad (Si)	SN	Socket	g-Level	+1g Out (mV)	-1g Out (mV)	Bias (mV)	SF (mV/g)	SN	+1g Out (mV)	-1g Out (mV)	Bias (mV)	SF (mV/g)		Radiation Level	Bias Chng mV	SF Chng mV/g	Bias Chng ppm FS	SF Chng ppm
10 Krad	963637	1	25	155.272	-164.470	-4.599	159.871	963637	155.896	-163.836	-3.970	159.866		10 Krad	0.629	-0.005	157	-31
10 Krad	963638	2	25	156.181	-163.811	-3.815	159.996	963638	156.488	-163.533	-3.523	160.011		10 Krad	0.292	0.015	73	92
10 Krad	963639	3	25	155.183	-164.690	-4.754	159.936	963639	155.807	-164.091	-4.142	159.949		10 Krad	0.611	0.012	153	78
10 Krad	963640	4	25	156.438	-163.209	-3.385	159.823	This part was used to build Q-modules for Rad Test										
25 Krad	763641	5	25	157.408	-162.232	-2.412	159.820	763641	155.667	-163.918	-4.125	159.793		25 Krad	-1.713	-0.027	-428	-172
25 Krad	763642	6	25	159.992	-160.139	-0.074	160.065	763642	160.037	-160.055	-0.009	160.046		25 Krad	0.065	-0.019	16	-120
25 Krad	763643	7	25	158.551	-161.230	-1.339	159.890	763643	159.455	-160.290	-0.417	159.872		25 Krad	0.922	-0.018	231	-110
25 Krad	763644	8	25	154.514	-165.596	-5.541	160.055	This part was used to build Q-modules for Rad Test										
50 Krad	763646	1	25	154.513	-164.669	-5.078	159.591	763646	156.030	-163.079	-3.524	159.555		50 Krad	1.554	-0.036	389	-226
50 Krad	763647	2	25	159.437	-160.007	-0.285	159.722	763647	157.966	-161.391	-1.713	159.679		50 Krad	-1.428	-0.043	-357	-269
50 Krad	763648	3	25	159.115	-160.663	-0.774	159.889	763648	157.971	-161.734	-1.882	159.853		50 Krad	-1.108	-0.036	-277	-228
50 Krad	763649	4	25	156.785	-162.772	-2.994	159.778	This part was used to build Q-modules for Rad Test										
100 Krad	763651	5	25	157.751	-162.042	-2.145	159.897	763651	158.117	-161.591	-1.737	159.854		100 Krad	0.408	-0.043	102	-268
100 Krad	763652	6	25	158.428	-161.025	-1.299	159.726	763652	160.145	-159.191	0.477	159.668		100 Krad	1.776	-0.058	444	-365
100 Krad	763653	7	25	157.631	-161.791	-2.080	159.711	763653	158.683	-160.654	-0.986	159.668		100 Krad	1.095	-0.043	274	-266
100 Krad	763654	8	25	156.738	-162.615	-2.939	159.676	This part was used to build Q-modules for Rad Test										
200 Krad	763655	1	25	154.874	-164.455	-4.791	159.665	763655	157.309	-161.956	-2.324	159.632		200 Krad	2.467	-0.033	617	-203
200 Krad	763657	2	25	157.460	-162.520	-2.530	159.990	763657	159.763	-160.114	-0.175	159.939		200 Krad	2.355	-0.051	589	-319
200 Krad	763658	3	25	159.235	-160.145	-0.455	159.690	763658	159.750	-159.569	0.090	159.659		200 Krad	0.545	-0.031	136	-194
200 Krad	763659	4	25	156.889	-162.701	-2.906	159.795	This part was used to build Q-modules for Rad Test										
350 Krad	763660	5	25	156.328	-163.257	-3.464	159.793	763660	154.873	-164.692	-4.909	159.783		350 Krad	-1.445	-0.010	-361	-63
350 Krad	763662	6	25	158.701	-161.338	-1.318	160.019	763662	163.702	-156.281	3.710	159.992		350 Krad	5.028	-0.028	1257	-174
350 Krad	763663	7	25	156.745	-163.375	-3.315	160.060	763663	159.288	-160.777	-0.745	160.033		350 Krad	2.570	-0.027	643	-170
350 Krad	763664	8	25	157.816	-161.957	-2.070	159.887	This part was used to build Q-modules for Rad Test										

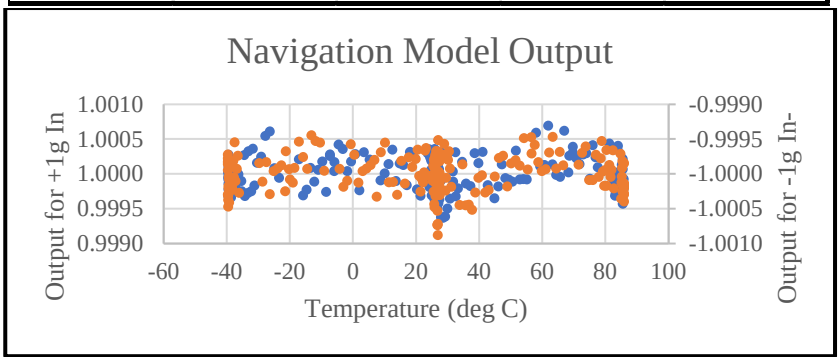
Post Radiation Navigation Performance

Performance After 10k Rads Exposure

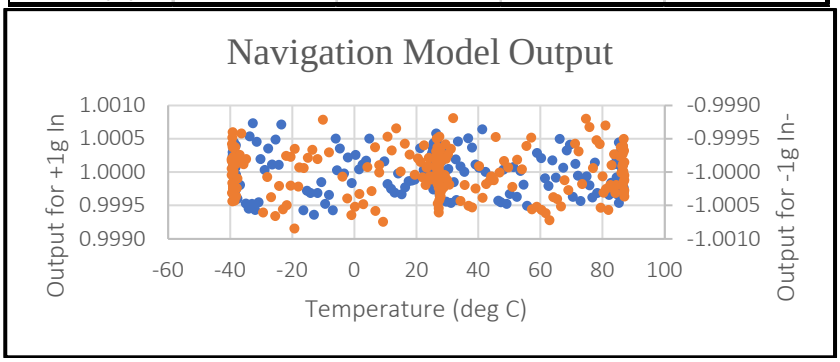
Serial No:	763637			
Coefficients	3	2	1	0
Nav Bias (B)	-6.362E-09	1.542E-06	-2.226E-04	0.031074
Nav SF (C)	3.249E-12	-5.436E-10	-3.813E-08	0.006257



Serial No:	763638			
Coefficients	3	2	1	0
Nav Bias (B)	-3.226E-09	4.906E-07	1.475E-05	0.021037
Nav SF (C)	-1.105E-12	-2.365E-10	-1.547E-09	0.006250



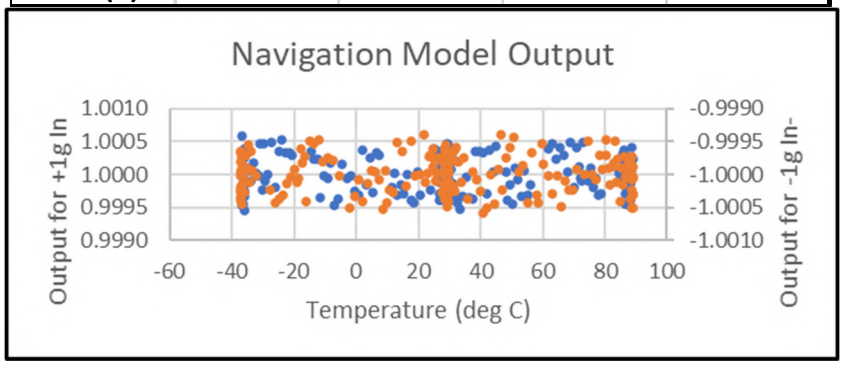
Serial No:	763639			
Coefficients	3	2	1	0
Nav Bias (B)	-6.094E-09	7.785E-07	-1.560E-04	0.030286
Nav SF (C)	1.532E-12	-5.060E-10	6.437E-09	0.006253



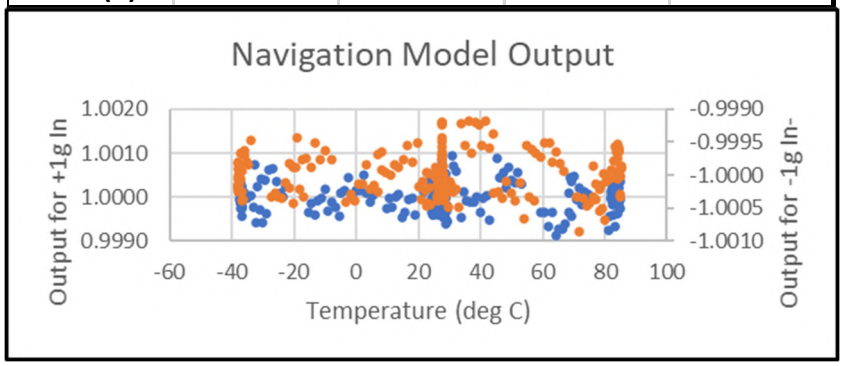
Navigation Performance Over -40 to +85C After 10K Rads

Performance After 25k Rads Exposure

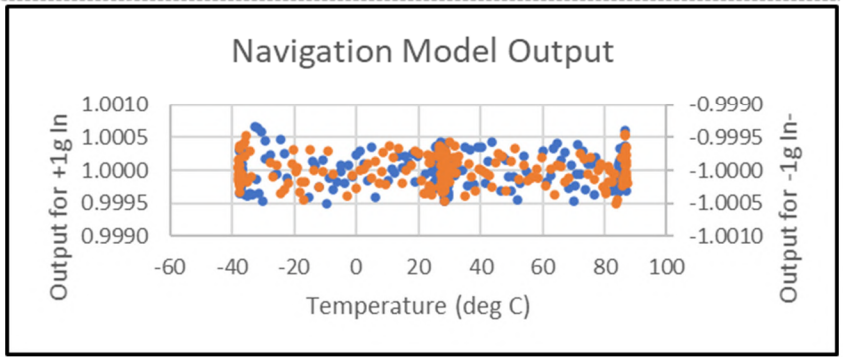
Serial No:	763641			
Coefficients	3	2	1	0
Nav Bias (B)	-2.067E-09	2.308E-07	-1.049E-04	0.028725
Nav SF (C)	1.350E-12	-3.476E-10	-1.559E-08	0.006259



Serial No:	763642			
Coefficients	3	2	1	0
Nav Bias (B)	-4.125E-09	8.972E-07	-1.829E-04	0.005878
Nav SF (C)	-1.472E-12	-1.995E-10	-4.377E-08	0.006250



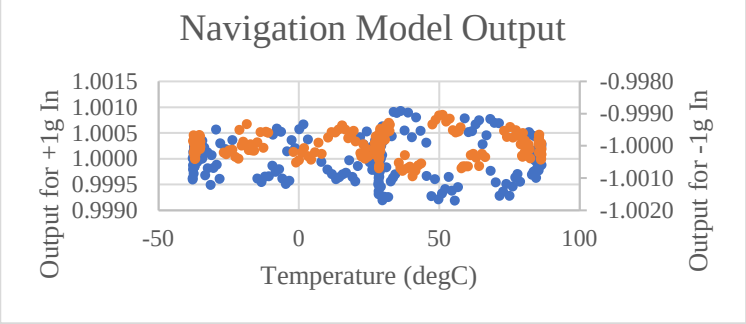
Serial No:	763643			
Coefficients	3	2	1	0
Nav Bias (B)	-6.138E-09	1.232E-06	-1.395E-04	0.006788
Nav SF (C)	7.657E-13	-3.199E-10	-1.674E-08	0.006256



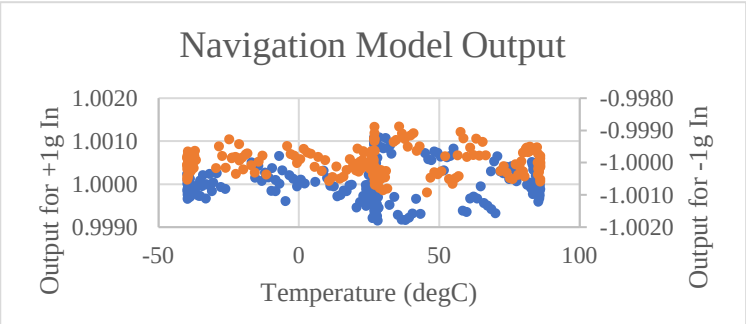
Navigation Performance Over -40 to +85C After 25K Rads

Performance After 50k Rads Exposure

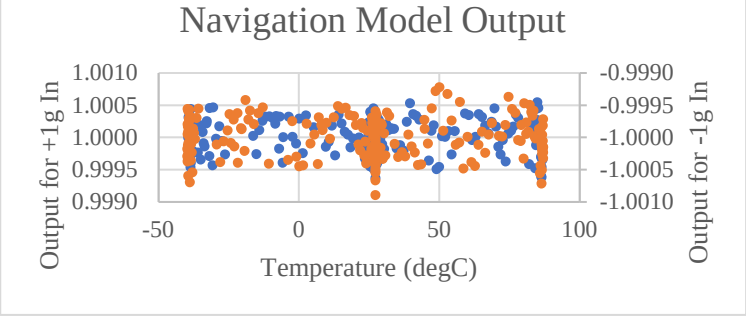
Serial No.	763646			
Coefficients	3	2	1	0
Nav Bias (B)	-5.839E-10	-8.077E-08	-1.335E-04	0.025774
Nav SF (C)	2.260E-12	-4.047E-10	-7.408E-09	0.006268



Serial No.	763647			
Coefficients	3	2	1	0
Nav Bias (B)	7.028E-10	-1.265E-07	-1.559E-06	0.013740
Nav SF (C)	-1.674E-12	-1.546E-10	-9.716E-09	0.006263



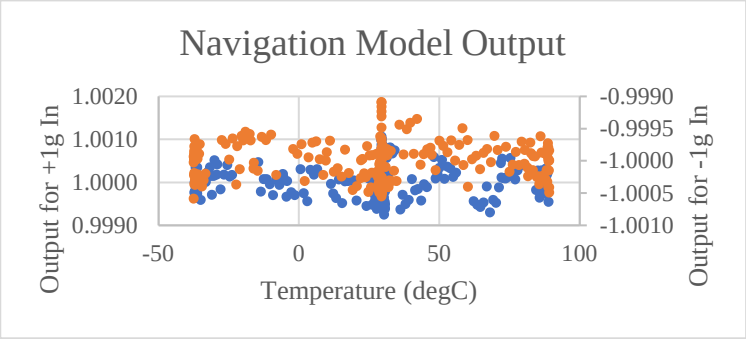
Serial No.	763648			
Coefficients	3	2	1	0
Nav Bias (B)	-2.986E-09	4.859E-07	-5.270E-06	0.011831
Nav SF (C)	-3.498E-14	-4.170E-10	-1.180E-08	0.006257



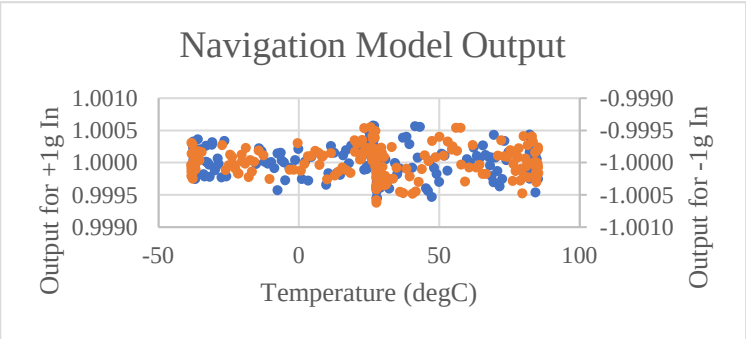
Navigation Performance Over -40 to +85C After 50K Rads

Performance After 100k Rads Exposure

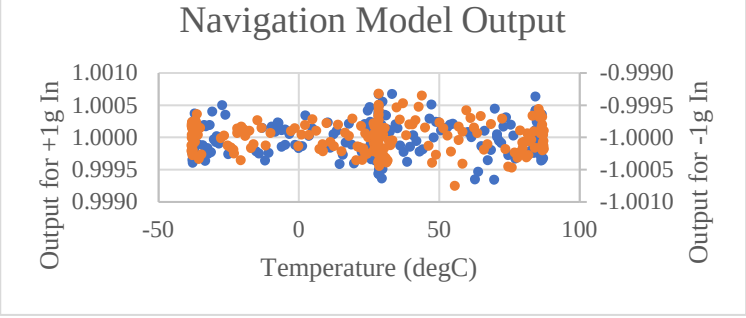
Serial No.	763651			
Coefficients	3	2	1	0
Nav Bias (B)	4.983E-10	-2.611E-08	-1.260E-04	0.016048
Nav SF (C)	-2.262E-13	-1.403E-10	-3.408E-08	0.006257



Serial No.	763652			
Coefficients	3	2	1	0
Nav Bias (B)	-2.851E-09	3.327E-07	-3.576E-05	0.000015
Nav SF (C)	-5.536E-13	-2.944E-10	-1.703E-08	0.006264



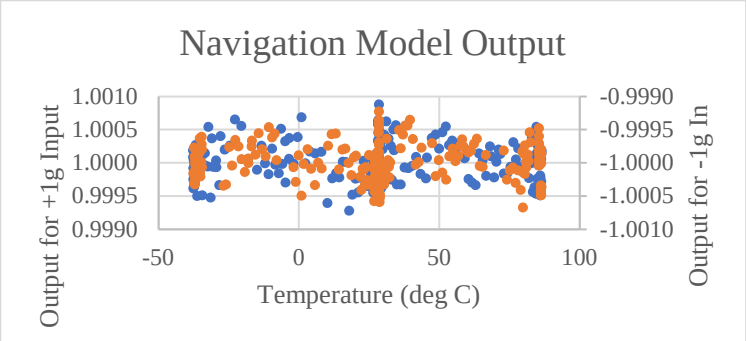
Serial No.	763653			
Coefficients	3	2	1	0
Nav Bias (B)	7.464E-10	1.197E-07	-1.480E-04	0.011067
Nav SF (C)	2.913E-12	-4.469E-10	-1.348E-08	0.006264



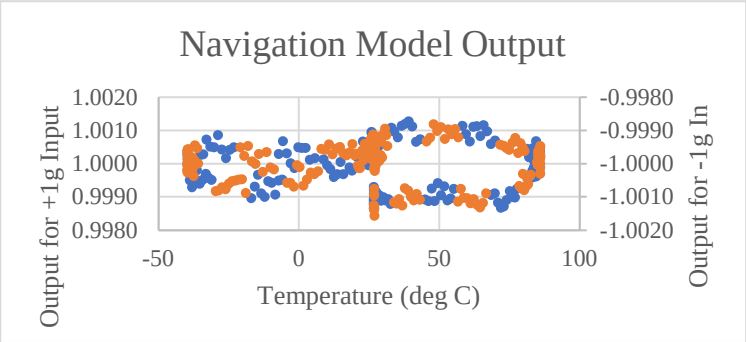
Navigation Performance Over -40 to +85C After 100K Rads

Performance After 250k Rads Exposure

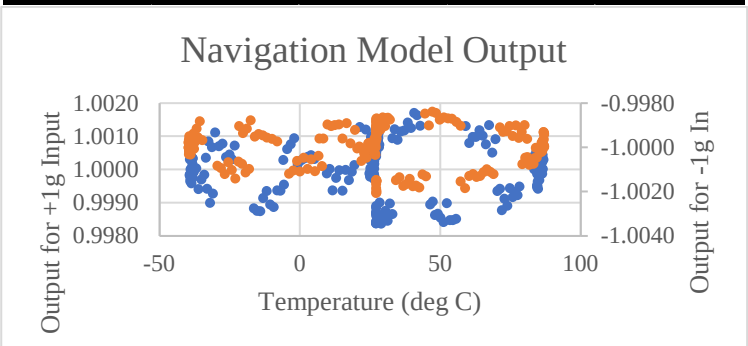
Serial No.	763655			
Coefficients	3	2	1	0
Nav Bias (B)	5.208E-10	1.936E-07	-3.737E-05	0.019185
Nav SF (C)	5.438E-12	-5.022E-10	-1.420E-08	0.006265



Serial No.	763657			
Coefficients	3	2	1	0
Nav Bias (B)	-9.996E-09	1.859E-06	-2.091E-04	0.009372
Nav SF (C)	4.636E-12	-4.795E-10	-4.420E-08	0.006254



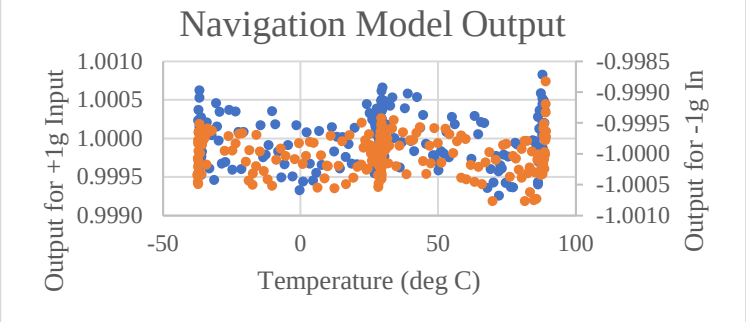
Serial No.	763658			
Coefficients	3	2	1	0
Nav Bias (B)	-1.201E-08	2.168E-06	-1.868E-04	0.003566
Nav SF (C)	2.045E-13	-3.363E-10	-1.065E-08	0.006265



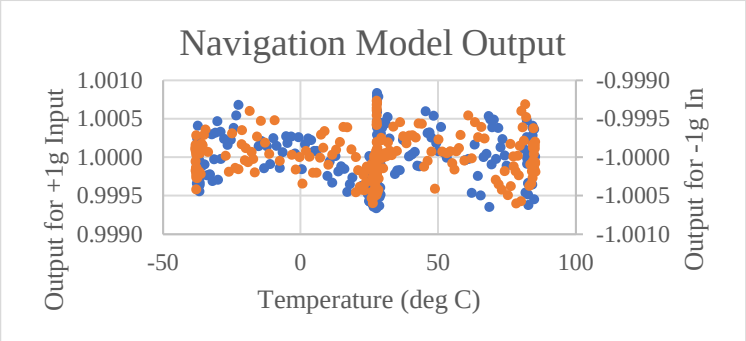
Navigation Performance over -40 to +85C After 200K Rads

Performance After 350k Rads Exposure

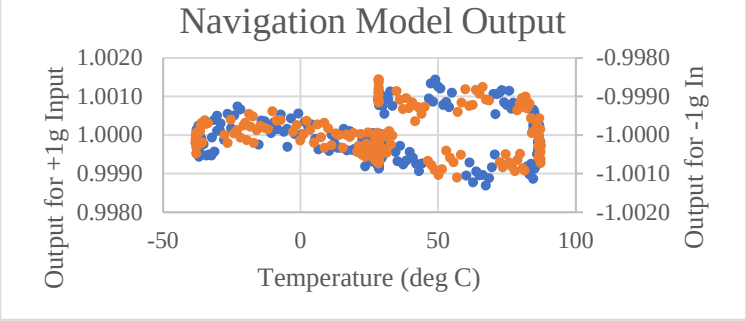
Serial No.	763660			
Coefficients	3	2	1	0
Nav Bias (B)	-1.025E-08	5.130E-07	-2.545E-05	0.032265
Nav SF (C)	-1.347E-13	-6.365E-11	2.564E-09	0.006259



Serial No.	763662			
Coefficients	3	2	1	0
Nav Bias (B)	-4.484E-09	4.080E-07	-1.494E-04	-0.014796
Nav SF (C)	5.441E-12	-2.208E-10	-2.668E-08	0.006251



Serial No.	763663			
Coefficients	3	2	1	0
Nav Bias (B)	7.193E-09	1.380E-06	-9.808E-05	0.005902
Nav SF (C)	6.432E-12	-3.430E-10	-9.116E-09	0.006249



Navigation Performance over -40 to +85C After 350K Rads