DynaQual Test Labs

Where being stressed is a good thing

PJLA Testing Accreditation # 79999

ISO 17025: 2017 ACCREDITED

Test Report

Vibration, Thermal and Pneumatic Shock Testing

TR-030624-2 March 6th – May 25th, 2024

COMPANY: [redacted]

COMPANY REP(s): [redacted]

DYNAQUAL TEST TECH: Zak Hausler, Ken Dimick

PRODUCT(S) TESTED: [redacted]

The undersigned have produced and reviewed the data collected and presented in the following report. By signing below, DynaQual Test Labs technical staff verifies that the data is accurate and obtained from functioning and calibrated equipment. Also, the undersigned determine that all data collection techniques are authentic, and the observations and conclusions are true results of the tests performed on the dates indicated above. This report shall not be reproduced except in full without the approval of the laboratory. Lastly, the report's results apply only to the sample(s) received for this test.

APPROVAL SIGNATURE SECTION:

Testing Performed By:

Zachary Hausler, Lab Technician

Ken Dimick, Lab Technician

Approved By:

Bill Burt, Sr. Technical Writer

07/03/2024
Date

PROJECT SCOPE

[redacted] requested the services of DynaQual Test Labs to perform vibration, thermal and pneumatic shock testing on two (2) of their [redacted] assemblies. The testing consisted of sine on random vibration at ambient and while heated, one-hundred-hour thermal soaks, ten thermal cycles, and pneumatic shock testing.

The following test report covers the test program and describes the tests performed, with any associated input/output profiles. The testing was performed at DynaQual's vibration and thermal labs. All equipment and sensor measurements were performed with calibrated equipment and trained, qualified personnel.

Definitions

UUT – Units Under Test
SoR – Sine on Random
TC – Thermocouple
SP – Set Point of Apparatus

UUT Identification

The UUT and dates the unit was subjected to testing is shown in Table 1.

Table 1 – Product Identifiers

UUT	Description	Dates Tested
1	[redacted]	04/12/2024 – 05/25/2024
2	[redacted]	04/12/2024 – 05/25/2024

VIBRATION TESTING PARAMETERS/SETUP

Table 2 – Description of Test Equipment

Description	Manufacturer	Model	S/N	Cal Due
Vibration System	ETS-714 Shaker	MPA714	SH1204115	N/A
Vibration Controller	Vibration Research	VR9500	9511B7F2	06/20/2024
Vibration Controller	Vibration Research	VR9500	950E43A0	06/20/2024
Control accelerometer	Dytran Instruments	3035B1	17935	09/08/2024
Control accelerometer	Dytran Instruments	3305A1	10766	04/26/2025
Response accelerometer	Dytran Instruments	3225F5	22443	06/16/2024
Thermocouple Data Logger	Pico Technology	USB TC-08	A0082/551	02/28/2025
Heater Controller	Watlow	EZ-Zone	193212	12/29/2025
Heater Controller	Watlow	EZ-Zone	193210	12/29/2025
Voltage Data Logger	Dataq	DI-149	5167F3D3	Verified
Multimeter	Fluke	115	29330388WS	06/30/2024
Power Supply	KORAD	KD3005P	08250131672	Verified

Vibration System: ETS MPA714 15,400 lbf shaker was used to perform the testing. (Figure 1)

Figure 1: ETS-714, 15,400 lbf Shaker with 2'x5' slip table

Testing Program – Sine and Random Vibration

The UUT were subjected to testing per the following test plan:

1. Sine on Random, random from 5-1200Hz at 23.74G_{rms}, with sine from 80-500Hz at 25G_{peak}, at 16Hz per minute, for 6 hours on UUT-1 in the X, Y and Z axes. One hour at ambient temperature and +110°C, four hours at +175°C.
2. Sine on Random, random from 5-1200Hz at 23.74G_{rms}, with sine from 80-500Hz at 25G_{peak}, at 16Hz per minute, for 6 hours on UUT-2 in the X and Y axes. One hour at ambient temperature and +110°C, four hours at +175°C.
3. Sine on Random, random from 5-1200Hz at 7.4G_{rms}, with sine from 80-500Hz at 3.5G_{peak}, 16Hz per minute, for 6 hours on UUT-2 in the Z axis. One hour at ambient temperature and +110°C, four hours at +175°C.

The vibration profiles are shown below in Figures 2-7.

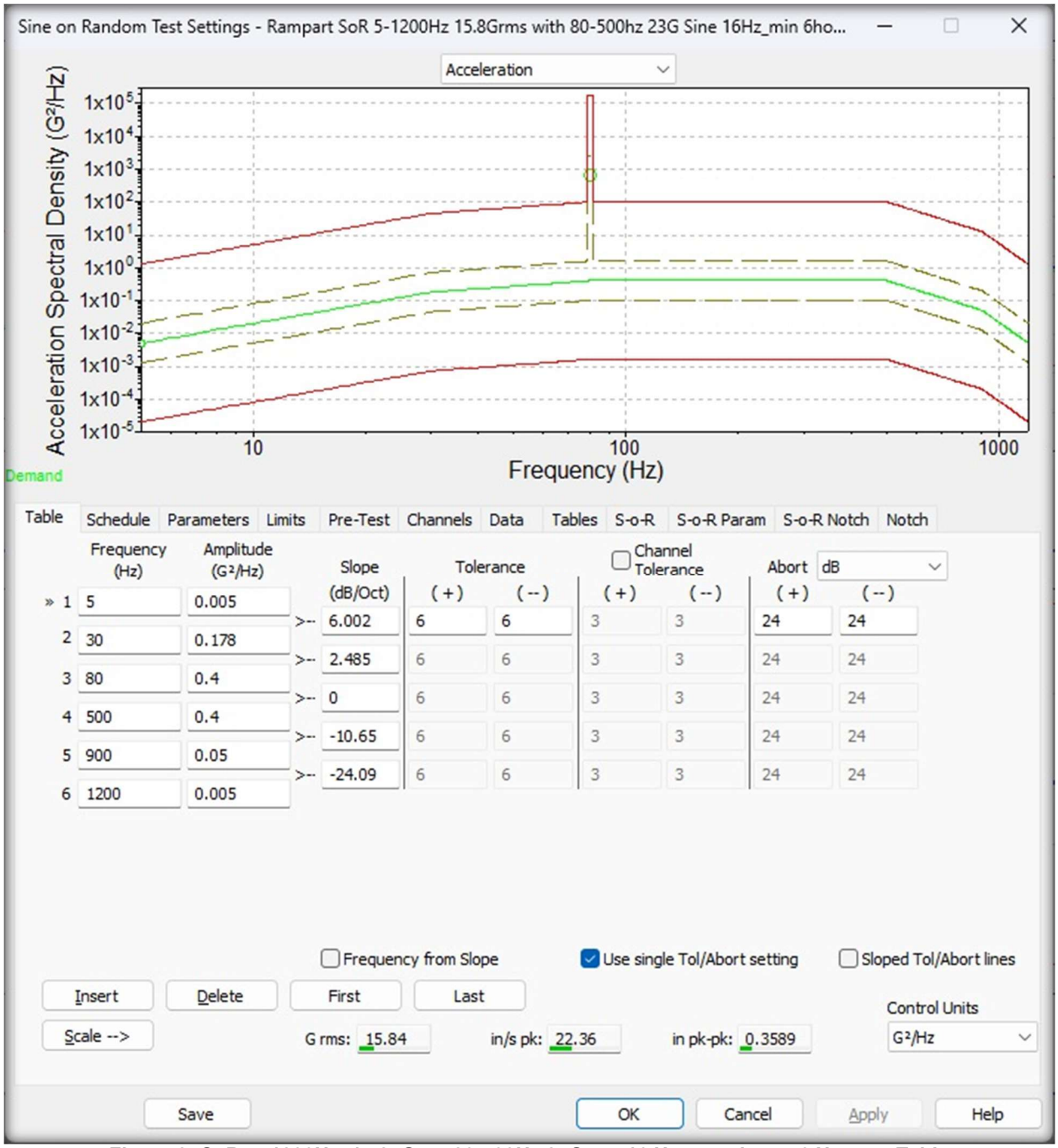


Figure 2: SoR, 5-1200Hz, 15.84G_{rms}, 80-500Hz 25G_{peak}, 16 Hz per minute, 6 Hours – Table

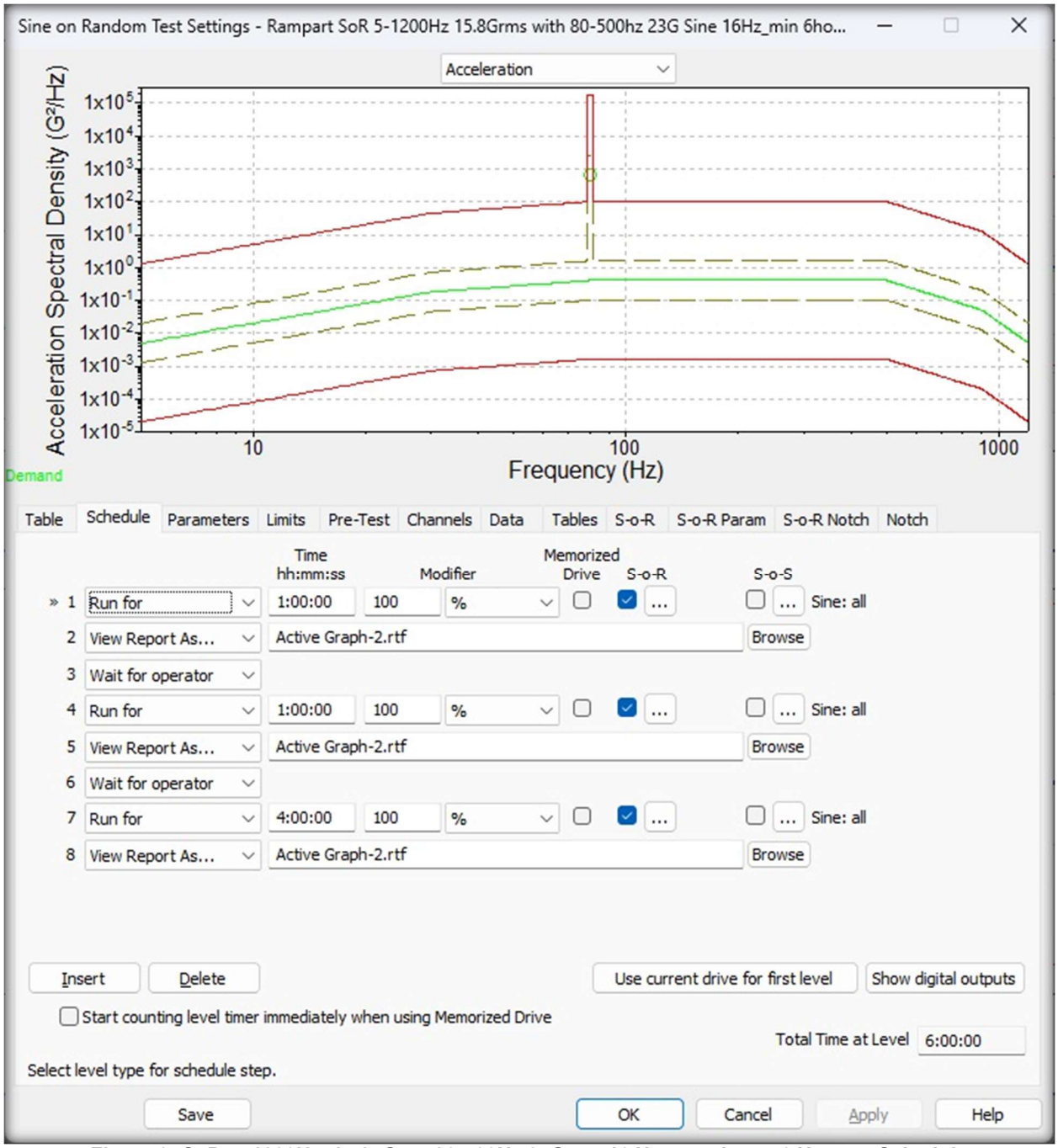


Figure 3: SoR, 5-1200Hz, 15.84G_{rms}, 80-500Hz 25G_{peak}, 16 Hz per minute, 6 Hours – Schedule

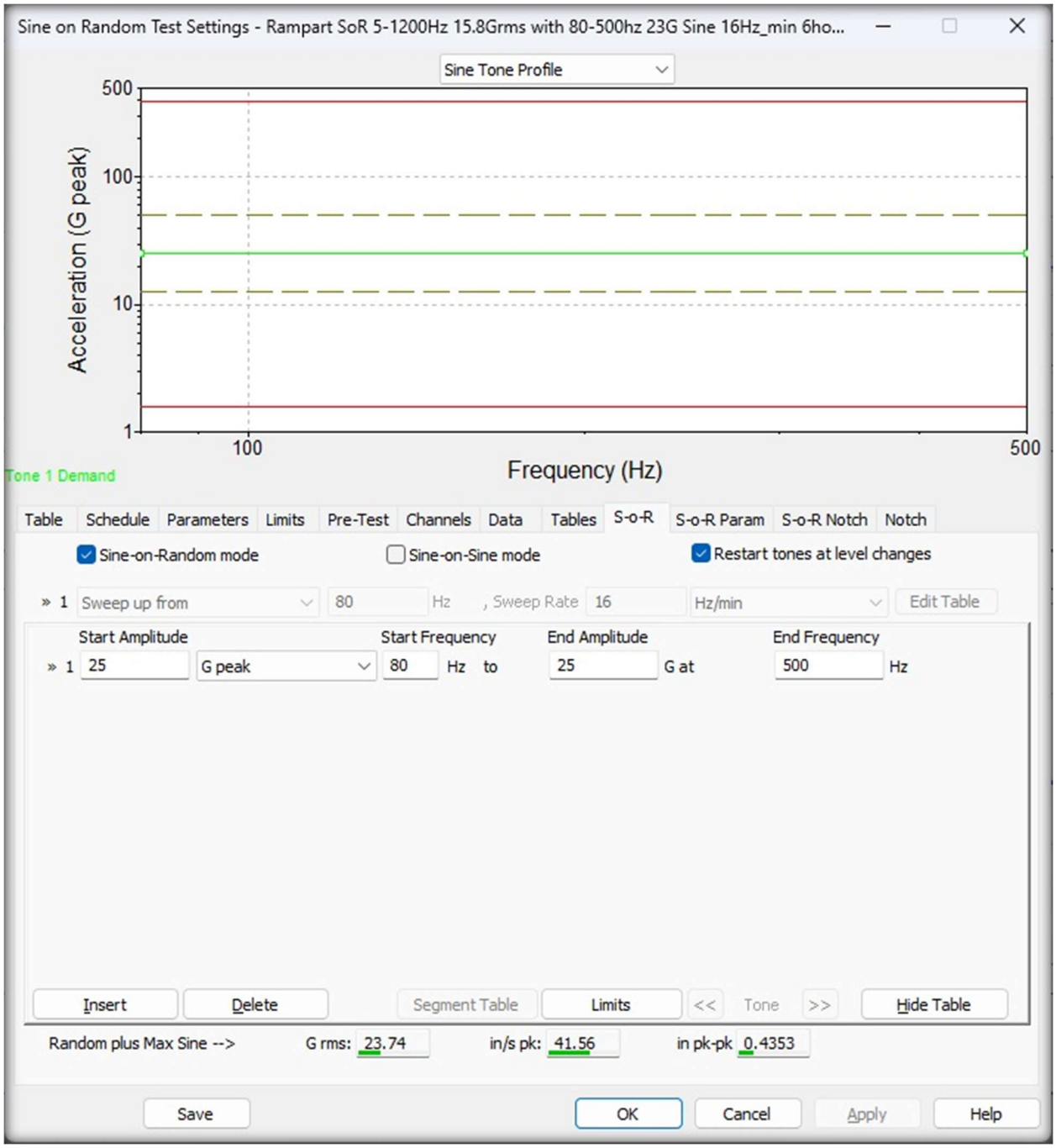


Figure 4: SoR, 5-1200Hz, 15.84G_{rms}, 80-500Hz 25G_{peak}, 16 Hz per minute, 6 Hours – Tone

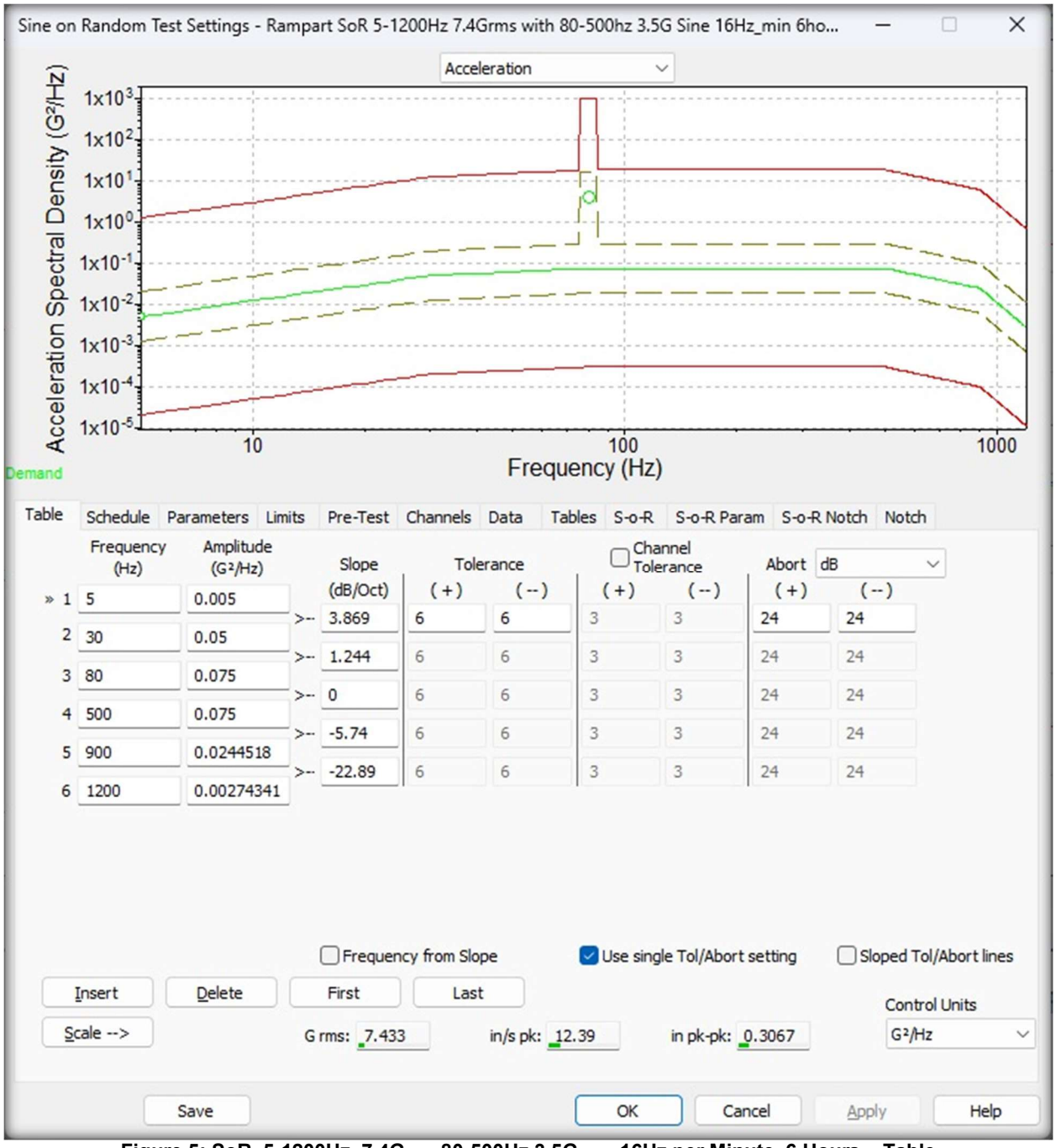


Figure 5: SoR, 5-1200Hz, 7.4G_{rms}, 80-500Hz 3.5G_{peak}, 16Hz per Minute, 6 Hours – Table

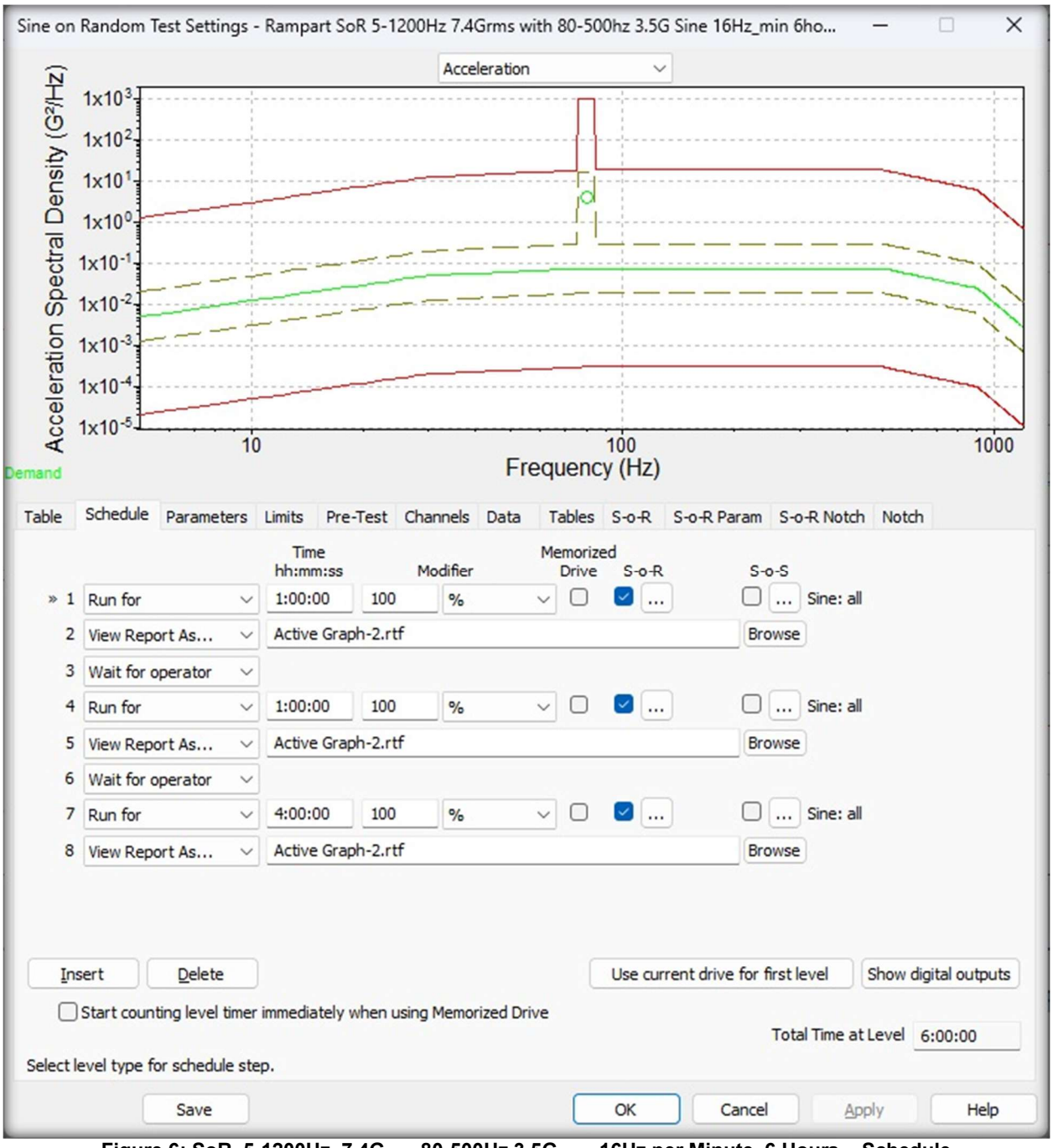


Figure 6: SoR, 5-1200Hz, 7.4G_{rms}, 80-500Hz 3.5G_{peak}, 16Hz per Minute, 6 Hours – Schedule

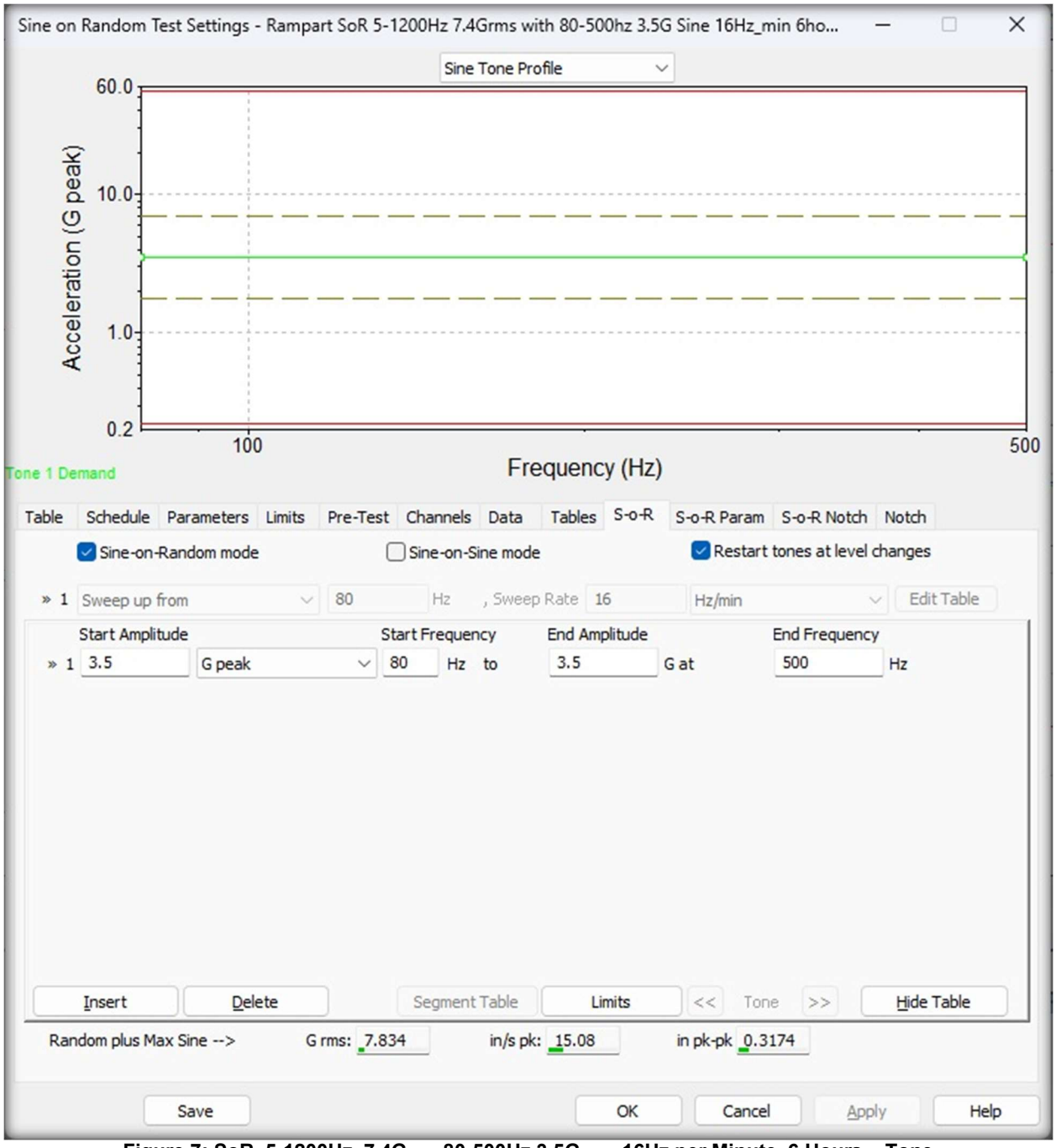


Figure 7: SoR, 5-1200Hz, 7.4G_{rms}, 80-500Hz 3.5G_{peak}, 16Hz per Minute, 6 Hours – Tone

Fixturing

Testing started with UUT-1 in the X axis with the ETS shaker configured in the vertical position. The UUT were mounted to the shaker table using 2 sets of 1.875” split radius clamps. To differentiate between the X and Y axes, the UUT were rotated 90° in the split radius clamps. For Z axis testing and L-bracket was secured to the shaker table and the split radius clamps were secured to the L-bracket to hold the UUT in the vertical position. Heater wraps and a portable heater controller were used for the heated portions of the vibration testing. See Figures 8-15 below for illustrations of the UUT fixtured on the slip table along with a view of the control accelerometer location.

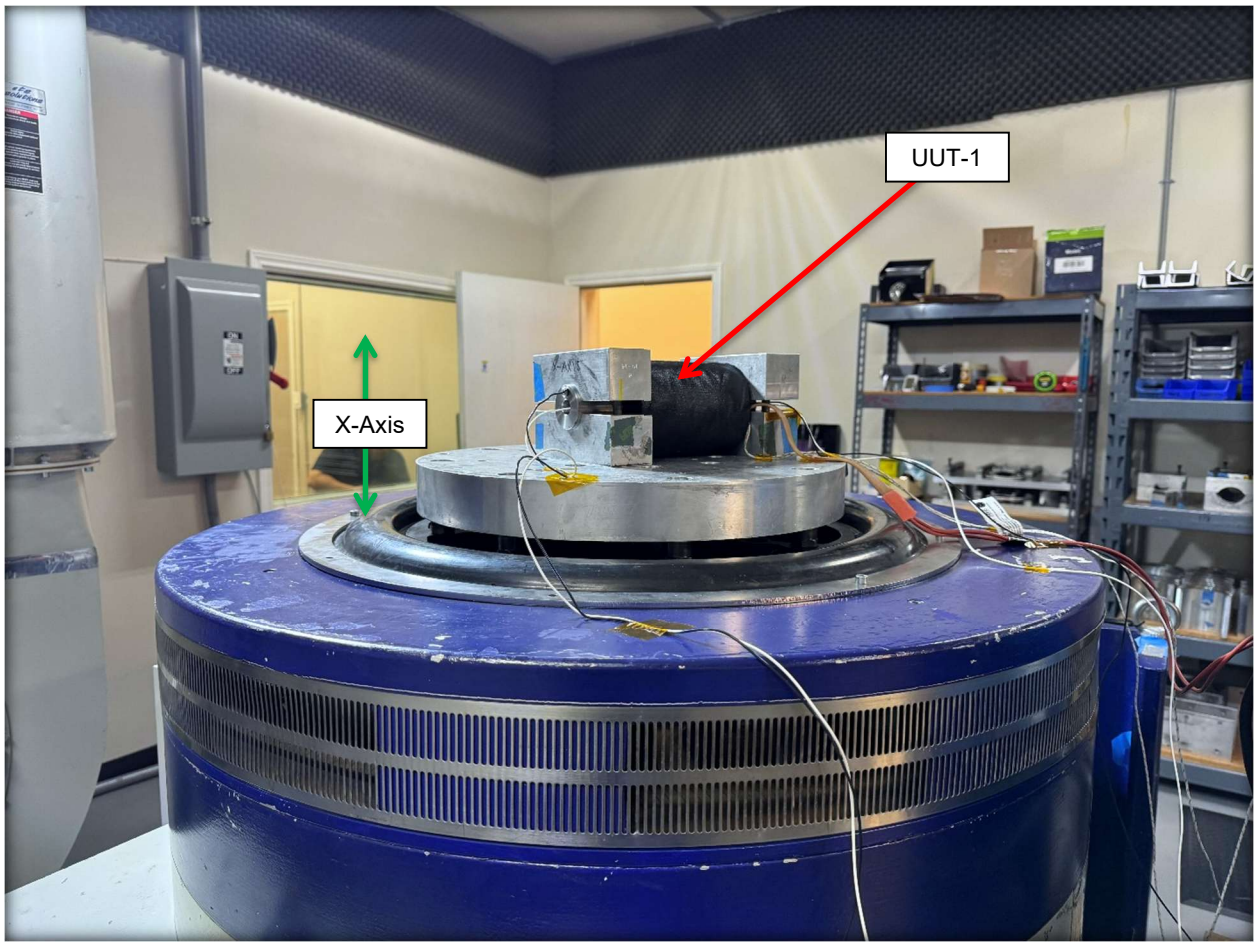


Figure 8: UUT-1 shown fixtured for X Axis testing

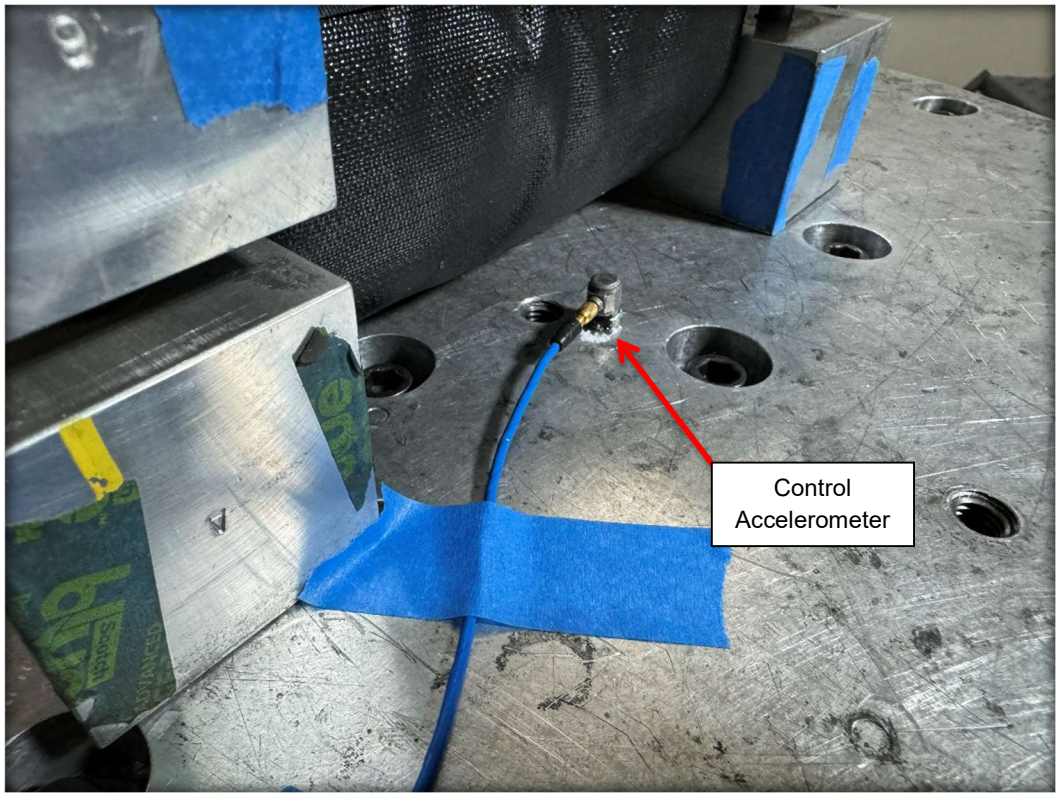


Figure 9: Detailed view of the control accelerometer location for UUT-1 X/Y axes testing

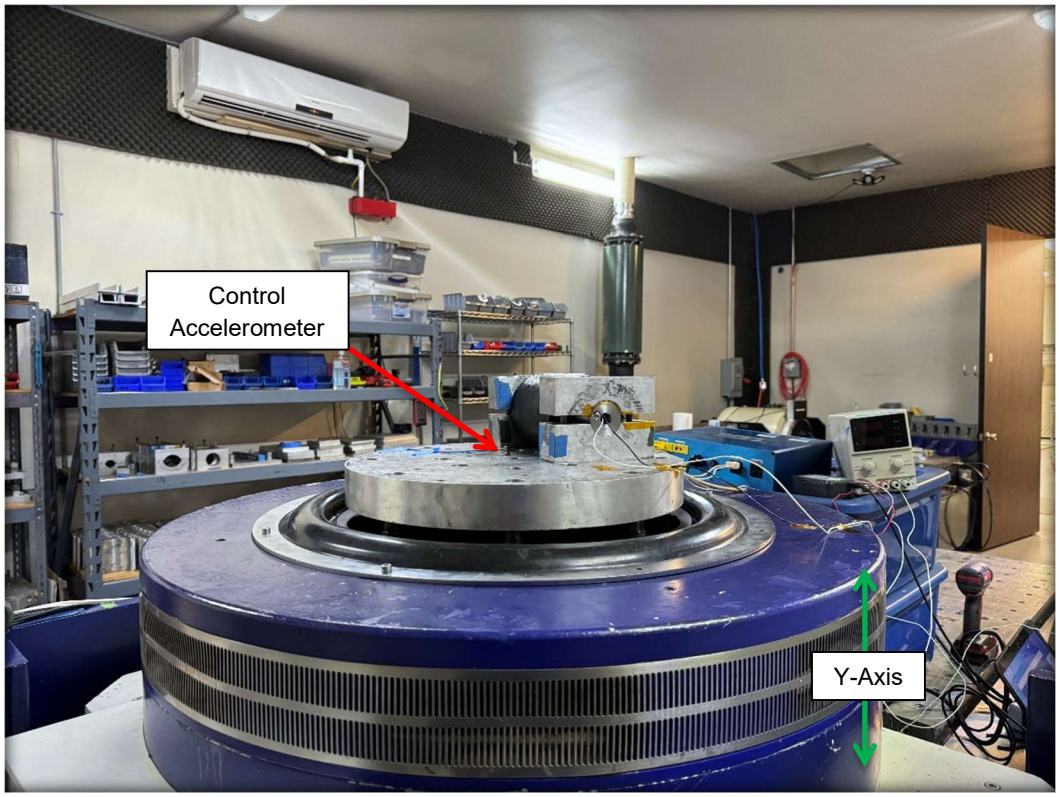


Figure 10: UUT-1 shown fixtured for *Y* Axis testing

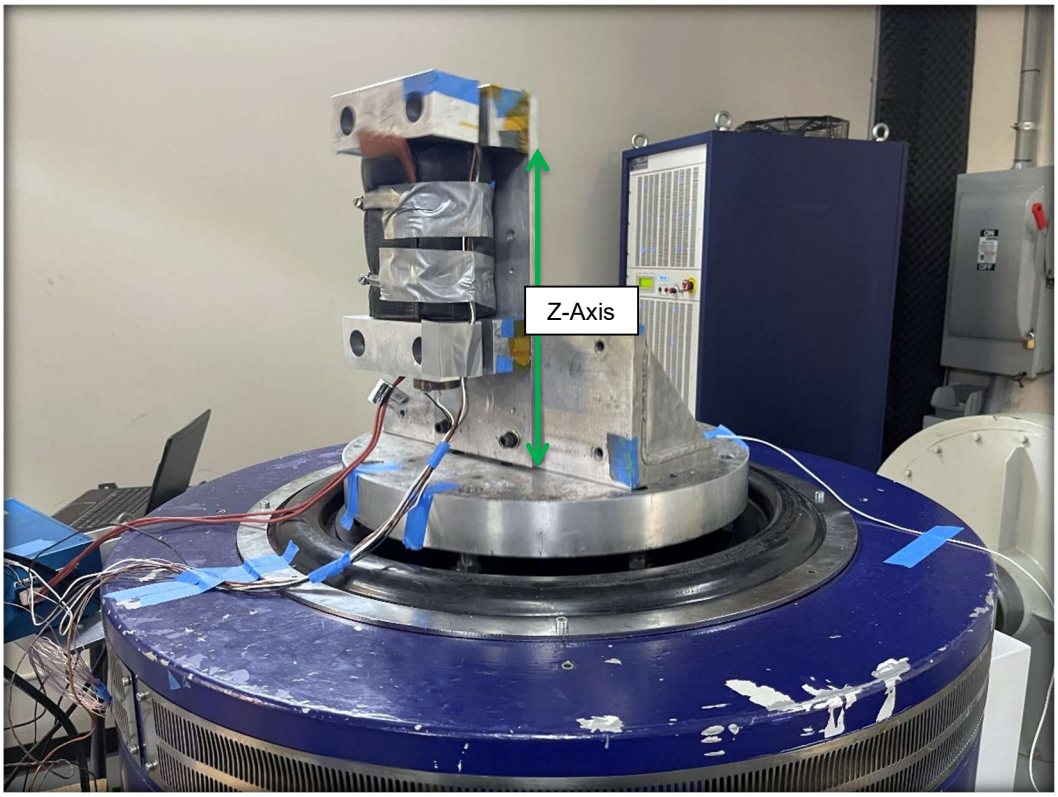


Figure 11: UUT-1 shown fixtured for Z Axis testing

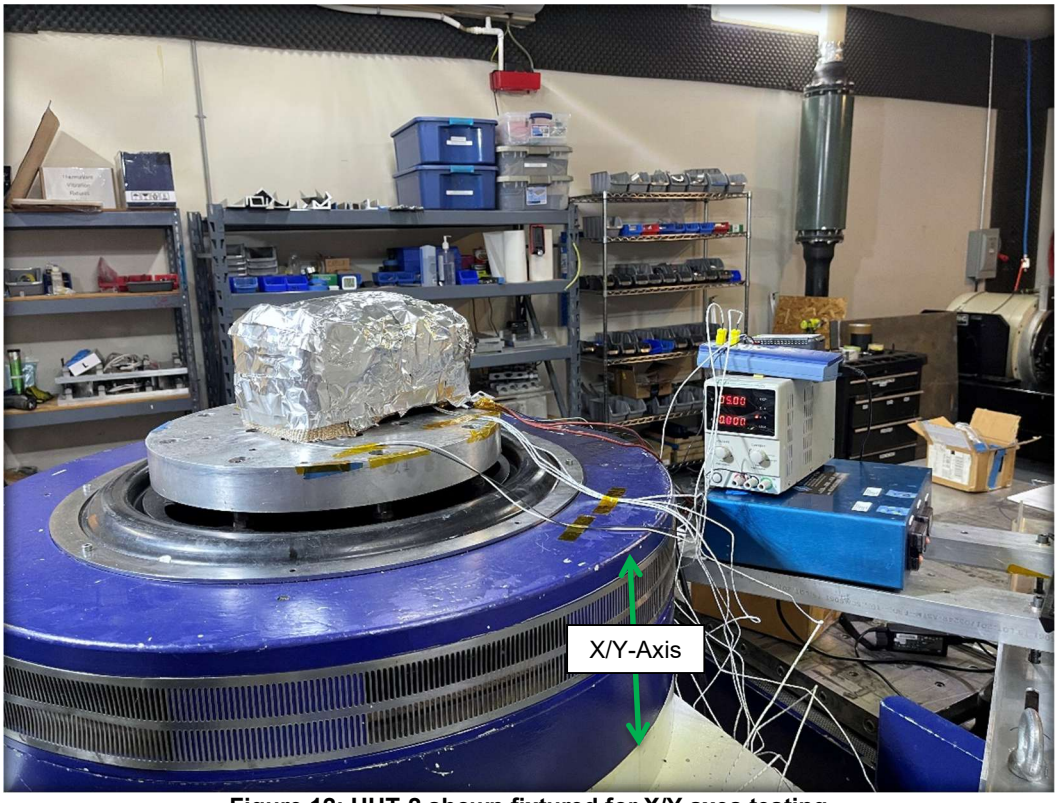


Figure 12: UUT-2 shown fixtured for X/Y axes testing

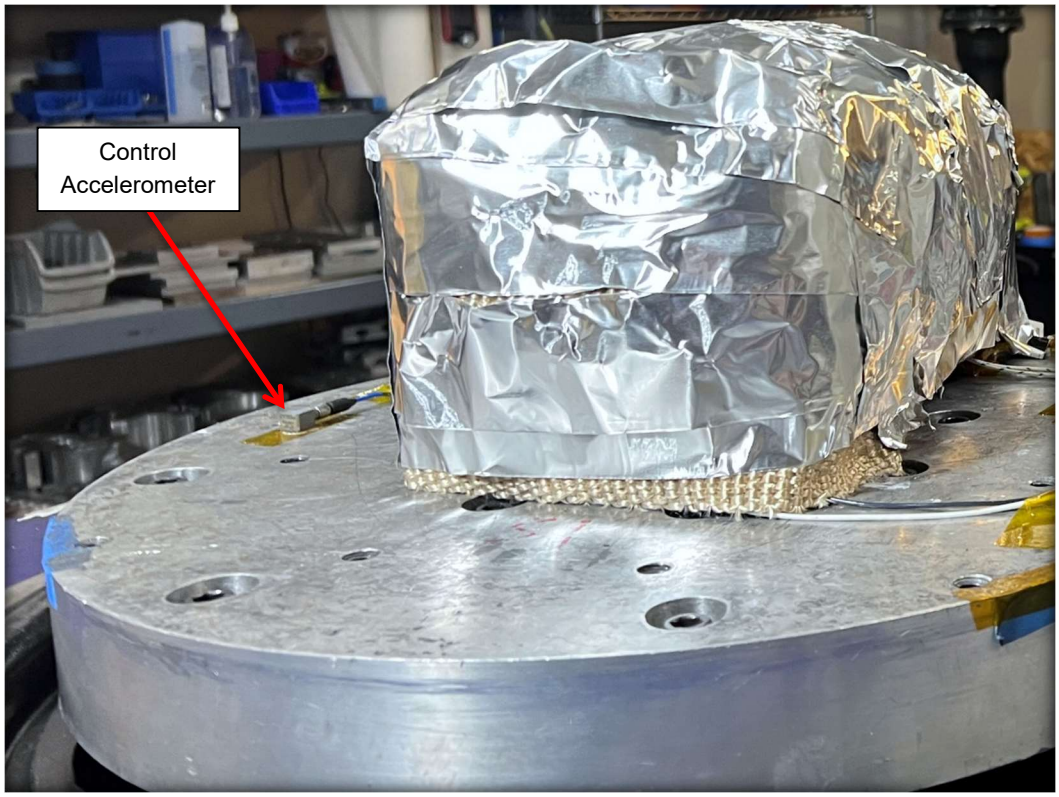


Figure 13: Detailed view of the control accelerometer location for UUT-2 X/Y axes testing

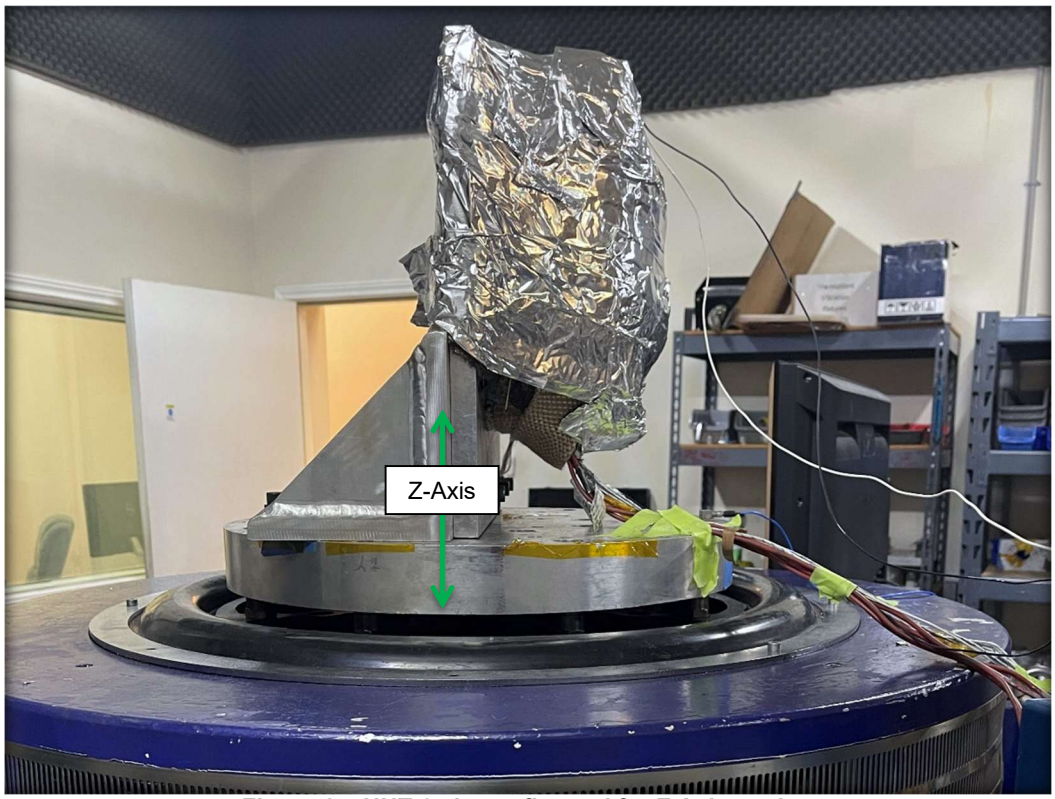


Figure 14: UUT-2 shown fixtured for Z Axis testing

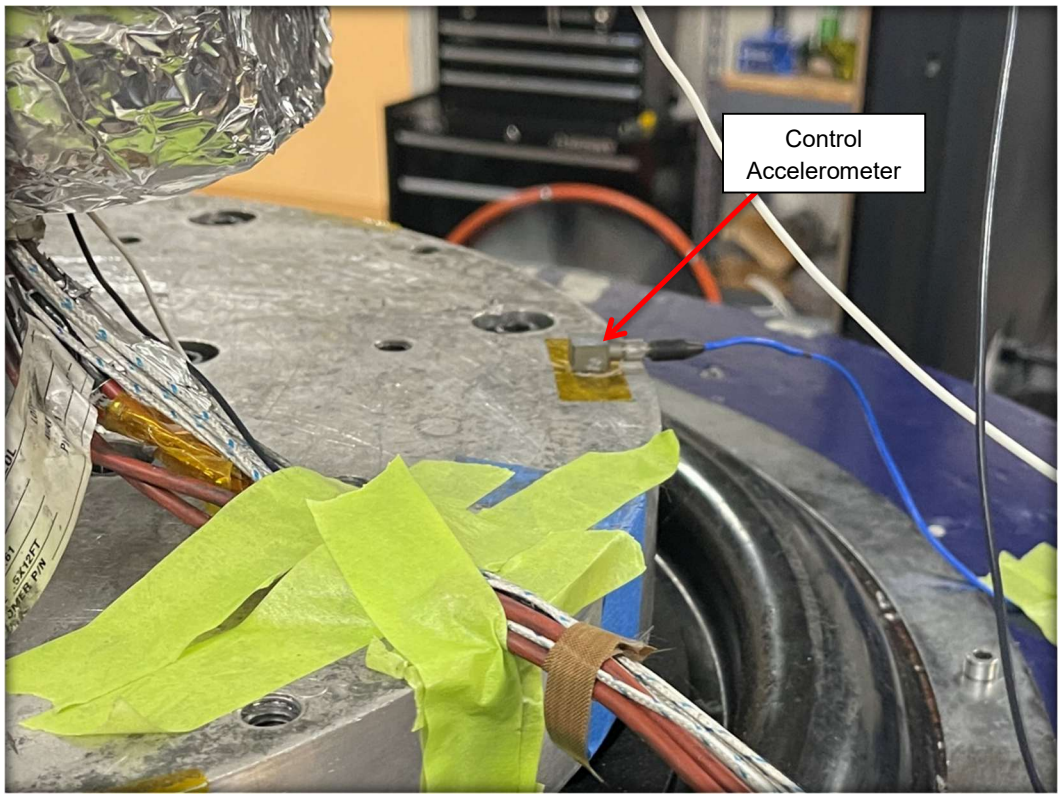


Figure 15: Detailed view of the control accelerometer location for UUT-2 Z axis testing

Product Functional Testing

The UUT were functionally tested during the vibration testing using a DC power supply to supply approximately 5 volts through the connector that was logged via a Dataq datalogger connected to a laptop. Any break in the connector circuit would be recorded on the datalogger graph. The datalogger files were included with the customer data files made available with the distribution of this report. A continuity check was also done manually following each axis of testing with the results shown in Table 3 notes below.

Vibration Testing Program

Table 3 summarizes the vibration test steps for the UUT, showing the type of test, with input parameters, any associated notes referencing the data collected, and observations or changes noted. Software generated reports for each test performed, are shown below Table 3, and are also provided in the customer data file made available after the conclusion of testing. A Pico log TC datalogger was used to record the outside housing temperature during the testing with the exported data and graphs included in the customer data files.

Table 3 – Vibration Testing Program

Test #	Date	UUT	Temp	Axis	Test	Freq.	Amplitude	Duration	Notes
1	3/06/2024	1	Ambient	X	SoR	5-1200Hz	23.74G_{rms} 25G_{peak}	1 Hour	
2	3/06/2024	1	+110°C	X	SoR	5-1200Hz	23.74G_{rms} 25G_{peak}	1 Hour	
3	3/06/2024	1	+175°C	X	SoR	5-1200Hz	23.74G_{rms} 25G_{peak}	4 Hours	1
4	3/08/2024	1	Ambient	Y	SoR	5-1200Hz	23.74G_{rms} 25G_{peak}	1 Hour	
5	3/08/2024	1	+110°C	Y	SoR	5-1200Hz	23.74G_{rms} 25G_{peak}	1 Hour	
6	3/08/2024	1	+175°C	Y	SoR	5-1200Hz	23.74G_{rms} 25G_{peak}	2.5 Hours	2
7	3/13/2024	1	+175°C	Y	SoR	5-1200Hz	23.74G_{rms} 25G_{peak}	1.5 Hours	1
8	3/13/2024	1	Ambient	Z	SoR	5-1200Hz	23.74G_{rms} 25G_{peak}	1 Hour	3
9	3/13/2024	1	+110°C	Z	SoR	5-1200Hz	23.74G_{rms} 25G_{peak}	56 Mins	
10	3/23/2024	1	+175°C	Z	SoR	5-1200Hz	23.74G_{rms} 25G_{peak}	4 Hours	1, 4
11	5/21/2024	2	Ambient	X	SoR	5-1200Hz	23.74G_{rms} 25G_{peak}	1 Hour	5
12	5/21/2024	2	Ambient	Y	SoR	5-1200Hz	23.74G_{rms} 25G_{peak}	1 Hour	
13	5/21/2024	2	+110°C	Y	SoR	5-1200Hz	23.74G_{rms} 25G_{peak}	1 Hour	
14	5/21/2024	2	+175°C	Y	SoR	5-1200Hz	23.74G_{rms} 25G_{peak}	4 Hours	1
15	5/22/2024	2	+110°C	X	SoR	5-1200Hz	23.74G_{rms} 25G_{peak}	1 Hour	
16	5/22/2024	2	+175°C	X	SoR	5-1200Hz	23.74G_{rms} 25G_{peak}	4 Hours	1
17	5/23/2024	2	+110°C	Z	SoR	5-1200Hz	7.4G_{rms} 3.5G_{peak}	1 Hour	
18	5/23/2024	2	+175°C	Z	SoR	5-1200Hz	7.4G_{rms} 3.5G_{peak}	4 Hours	
19	5/23/2024	2	Ambient	Z	SoR	5-1200Hz	7.4G_{rms} 3.5G_{peak}	1 Hour	1, 6

Notes:

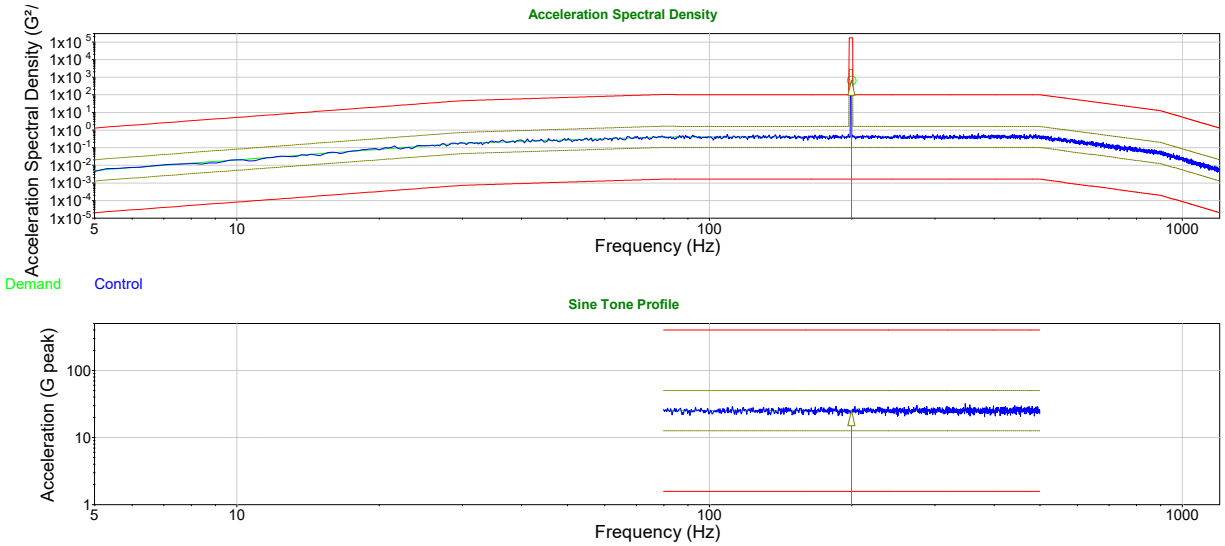
1. Following this axis, the continuity test and the Dataq data log showed no UUT failures.

2. The heater wrap broke and the remaining 1.5 hours was finished after getting new wraps.
3. UUT-1 Z axis testing was inadvertently done at the X/Y axes level. A decision was made not to retest due to the X/Y level being an over-test for the Z axis.
4. Both UUT were moved to the thermal testing prior to continuing with UUT-2 vibration testing.
5. Vibration testing continued with the initial test on UUT-2 in the X axis.
6. Vibration testing concluded with no UUT failures noted.

Test 1: X Axis, 3/06/2024 UUT-1

Test Mode: Sine on Random
Frequency: 5-1200Hz Random, 80-500Hz Sine
Duration: 1 Hour with Sine at 16 Hz per Minute
Amplitude: 23.74 G_{rms} Random and 25 G_{peak} Sine
Temp: Ambient

Data: C:\VibrationVIEW\Data\2024-03\2024Mar06-1410-0004.vrd
Test: C:\VibrationVIEW\Profiles\[redacted] SoR 5-1200Hz 15.8Grms with 80-500hz 23G Sine 16Hz_min 6hours.vrp
Data stored on Mar 06, 2024 15:12:52



Test level schedule:

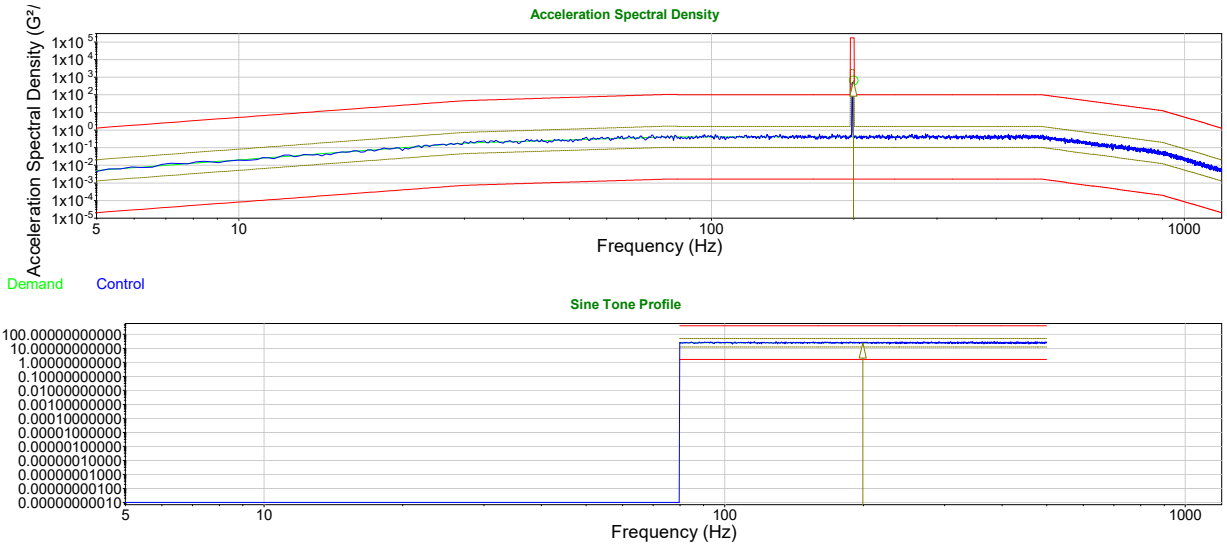
	Duration	Level	
1)	1:00:00	100 %	(SoR)
2)	View Report (prompt)		
3)	Wait for operator		
4)	1:00:00	100 %	(SoR)
5)	View Report (prompt)		
6)	Wait for operator		
7)	4:00:00	100 %	(SoR)
8)	View Report (prompt)		

** Test started Mar 06, 2024 14:10:13, running for 1:02:27
** Current level: 1, running at 100 % for 1:00:00 of 1:00:00

Test 2: X Axis, 3/06/2024 UUT-1

Test Mode: Sine on Random
Frequency: 5-1200Hz Random, 80-500Hz Sine
Duration: 1 Hour with Sine at 16 Hz per Minute
Amplitude: 23.74 G_{rms} Random and 25 G_{peak} Sine
Temp: +110°C

Data: C:\VibrationVIEW\Data\2024-03\2024Mar06-1410-0008.vrd
Test: C:\VibrationVIEW\Profiles\Customers Profiles\[redacted] SoR 5-1200Hz 15.8Grms with 80-500hz 23G Sine 16Hz_min 6hours.vrp
Data stored on Mar 06, 2024 17:04:23



Test level schedule:

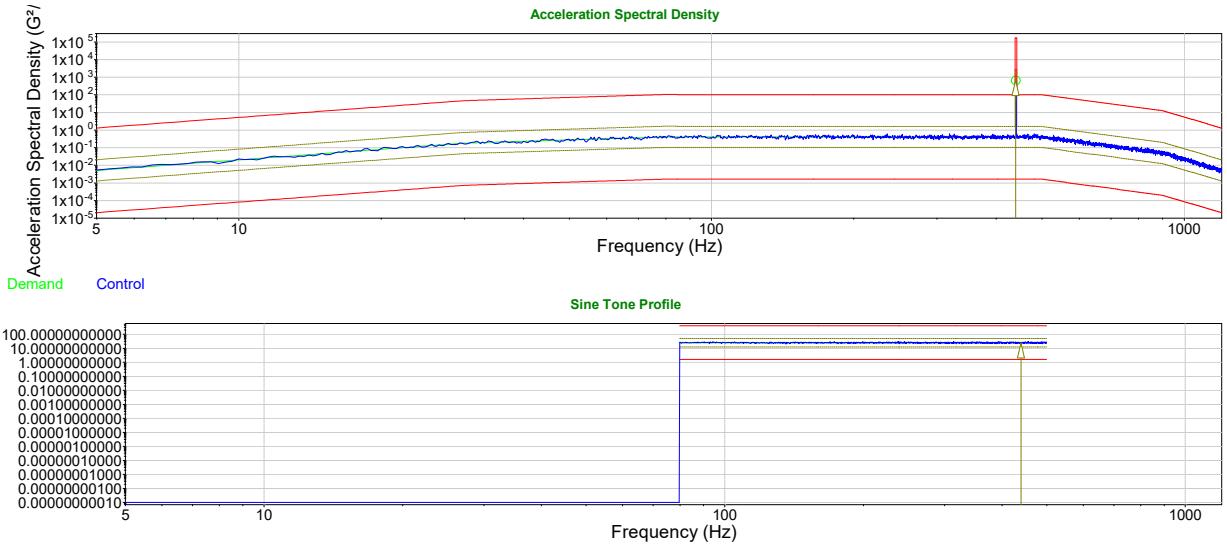
	Duration	Level	
1)	1:00:00	100 %	(SoR)
2)	View Report (prompt)		
3)	Wait for operator		
4)	1:00:00	100 %	(SoR)
5)	View Report (prompt)		
6)	Wait for operator		
7)	4:00:00	100 %	(SoR)
8)	View Report (prompt)		

** Test started Mar 06, 2024 14:10:13, running for 2:03:03
** Current level: 4, running at 100 % for 1:00:00 of 1:00:00

Test 3: X Axis, 3/06/2024 UUT-1

Test Mode: Sine on Random
Frequency: 5-1200Hz Random, 80-500Hz Sine
Duration: 4 Hours with Sine at 16 Hz per Minute
Amplitude: 23.74 G_{rms} Random and 25 G_{peak} Sine
Temp: +175°C

Data: C:\VibrationVIEW\Data\2024-03\2024Mar06-1410-0021.vrd
Test: C:\VibrationVIEW\Profiles\Customers Profiles\[redacted] SoR 5-1200Hz 15.8Grms with 80-500hz 23G Sine 16Hz_min 6hours.vrp
Data stored on Mar 07, 2024 15:58:50



Test level schedule:

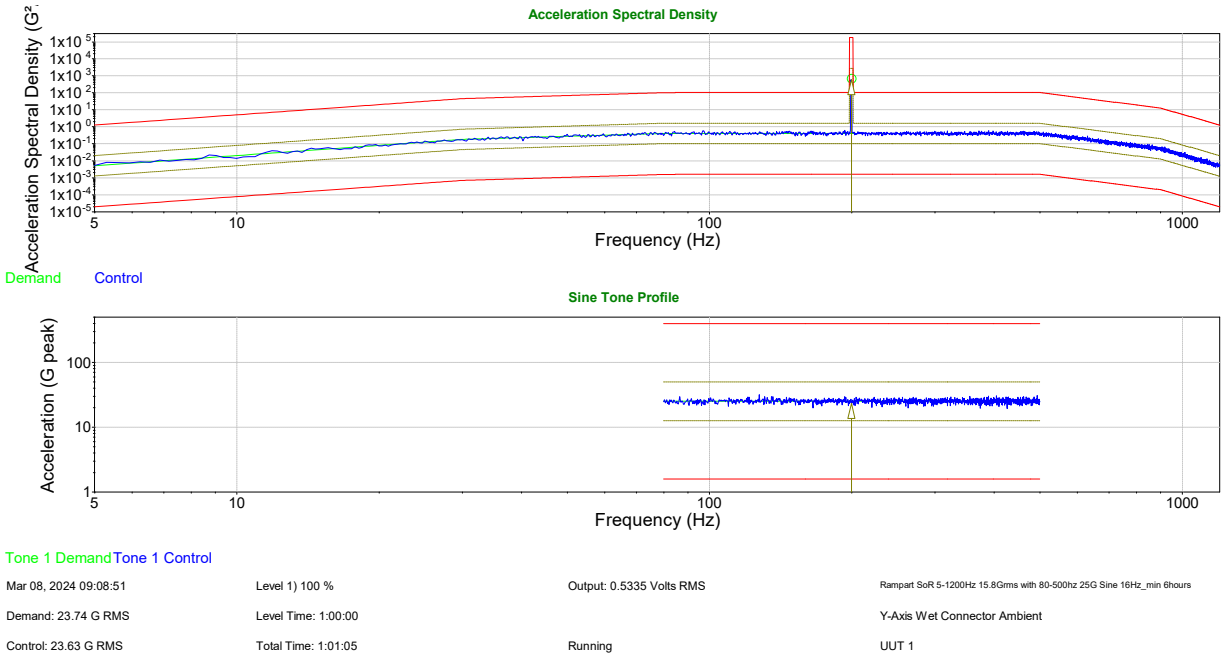
	Duration	Level	
1)	1:00:00	100 %	(SoR)
2)	View Report (prompt)		
3)	Wait for operator		
4)	1:00:00	100 %	(SoR)
5)	View Report (prompt)		
6)	Wait for operator		
7)	4:00:00	100 %	(SoR)
8)	View Report (prompt)		

** Test started Mar 06, 2024 14:10:13, running for 6:05:40
** Current level: 7, running at 100 % for 4:00:00 of 4:00:00

Test 4: Y Axis, 3/08/2024 UUT-1

Test Mode: Sine on Random
Frequency: 5-1200Hz Random, 80-500Hz Sine
Duration: 1 Hour with Sine at 16 Hz per Minute
Amplitude: 23.74 G_{rms} Random and 25 G_{peak} Sine
Temp: Ambient

Data: C:\VibrationVIEW\Data\2024-03\2024Mar08-0807-0003.vrd
Test: C:\VibrationVIEW\Profiles\Customers Profiles[redacted] SoR 5-1200Hz 15.8Grms with 80-500hz 25G Sine 16Hz_min 6hours.vrp
Data stored on Mar 08, 2024 09:08:51



Test level schedule:

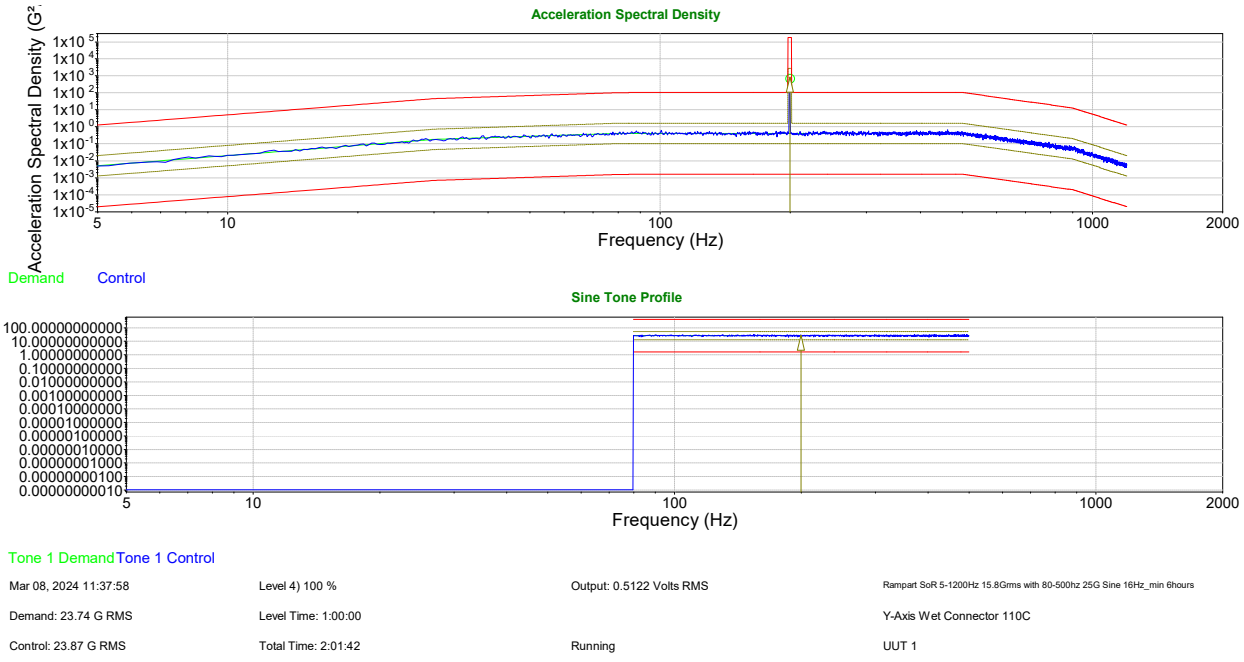
	Duration	Level	
1)	1:00:00	100 %	(SoR)
2)	View Report (prompt)		
3)	Wait for operator		
4)	1:00:00	100 %	(SoR)
5)	View Report (prompt)		
6)	Wait for operator		
7)	4:00:00	100 %	(SoR)
8)	View Report (prompt)		

** Test started Mar 08, 2024 08:07:46, running for 1:01:05
** Current level: 1, running at 100 % for 1:00:00 of 1:00:00

Test 5: Y Axis, 3/08/2024 UUT-1

Test Mode: Sine on Random
Frequency: 5-1200Hz Random, 80-500Hz Sine
Duration: 1 Hour with Sine at 16 Hz per Minute
Amplitude: 23.74 G_{rms} Random and 25 G_{peak} Sine
Temp: +110°C

Data: C:\VibrationVIEW\Data\2024-03\2024Mar08-0807-0007.vrd
Test: C:\VibrationVIEW\Profiles\[redacted] SoR 5-1200Hz 15.8Grms with 80-500hz 25G Sine 16Hz_min 6hours.vrp
Data stored on Mar 08, 2024 11:37:58



Test level schedule:

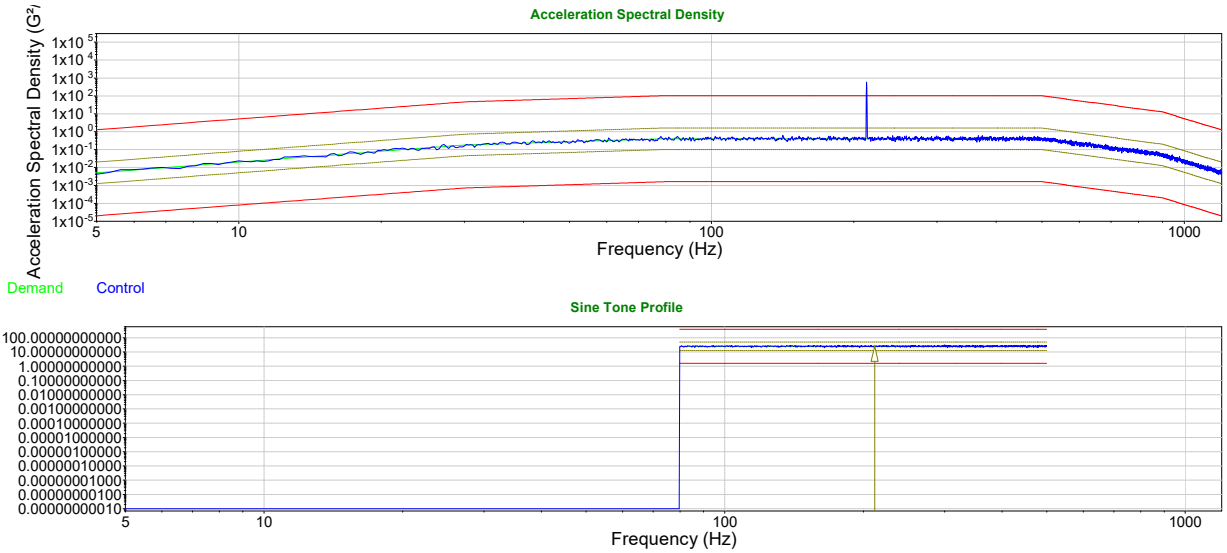
	Duration	Level	
1)	1:00:00	100 %	(SoR)
2)	View Report (prompt)		
3)	Wait for operator		
4)	1:00:00	100 %	(SoR)
5)	View Report (prompt)		
6)	Wait for operator		
7)	4:00:00	100 %	(SoR)
8)	View Report (prompt)		

** Test started Mar 08, 2024 08:07:46, running for 2:01:42
** Current level: 4, running at 100 % for 1:00:00 of 1:00:00

Test 6: Y Axis, 3/08/2024 UUT-1

Test Mode: **Sine on Random**
Frequency: **5-1200Hz Random, 80-500Hz Sine**
Duration: **2.5 Hours with Sine at 16 Hz per Minute**
Amplitude: **23.74 G_{rms} Random and 25 G_{peak} Sine**
Temp: **+175°C**

Data: C:\VibrationVIEW\Data\2024-03\2024Mar08-0807-0015.vrd
Test: C:\VibrationVIEW\Profiles\Customers Profiles\[redacted] SoR 5-1200Hz 15.8Grms with 80-500hz 25G Sine 16Hz_min 6hours.vrp
Data stored on Mar 11, 2024 11:59:16



Test level schedule:

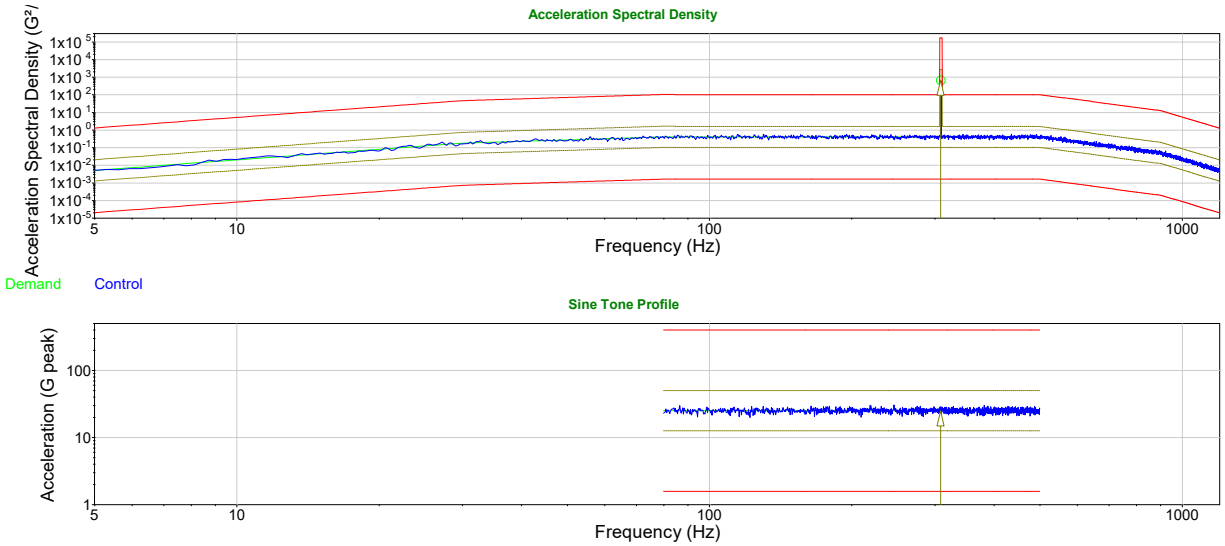
	Duration	Level	
1)	1:30:44	100 %	(SoR)
2)	View Report (prompt)		

** Test started Mar 08, 2024 08:07:46, running for 4:32:05
** Current level: 2, running at View Report (prompt) for 2:29:16 of (Report level)

Test 7: Y Axis, 3/13/2024 UUT-1

Test Mode: **Sine on Random**
Frequency: **5-1200Hz Random, 80-500Hz Sine**
Duration: **1.5 Hours with Sine at 16 Hz per Minute**
Amplitude: **23.74 G_{rms} Random and 25 G_{peak} Sine**
Temp: **+175°C**

Data: C:\VibrationVIEW\Data\2024-03\2024Mar13-1159-0004.vrd
Test: C:\VibrationVIEW\Profiles[redacted] SoR 5-1200Hz 15.8Grms with 80-500hz 25G Sine 16Hz_min 6hours.vrp
Data stored on Mar 13, 2024 13:31:31



Test level schedule:

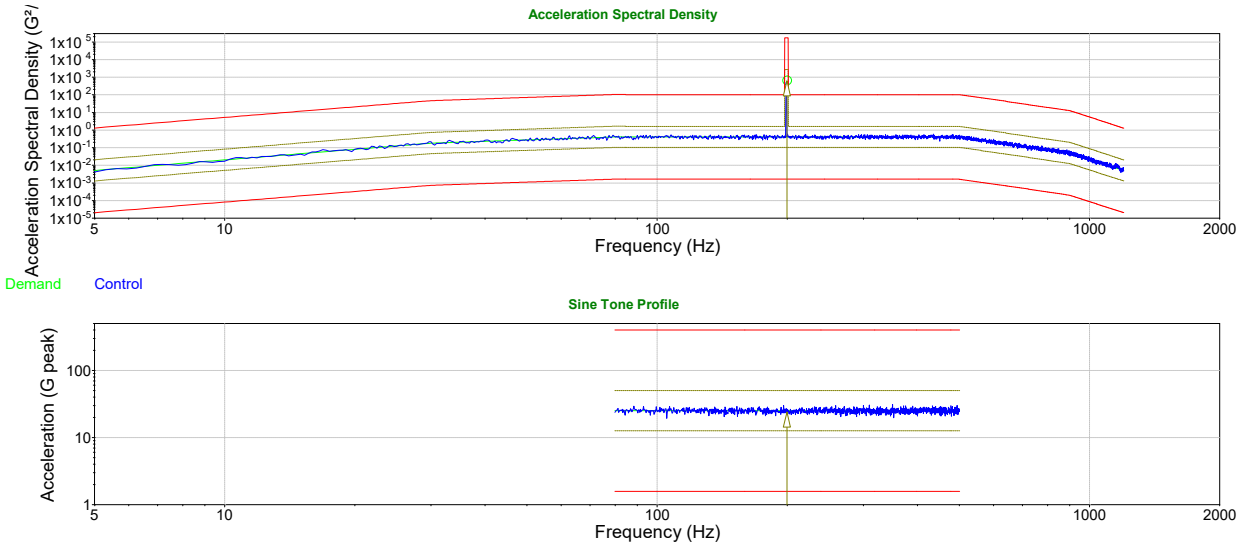
	Duration	Level	
1)	1:30:44	100 %	(SoR)
2)	View Report (prompt)		

** Test started Mar 13, 2024 11:59:55, running for 1:31:37
** Current level: 1, running at 100 % for 1:30:44 of 1:30:44

Test 8: Z Axis, 3/13/2024 UUT-1

Test Mode: Sine on Random
Frequency: 5-1200Hz Random, 80-500Hz Sine
Duration: 1 Hour with Sine at 16 Hz per Minute
Amplitude: 23.74 G_{rms} Random and 25 G_{peak} Sine
Temp: Ambient

Data: C:\VibrationVIEW\Data\2024-03\2024Mar13-1506-0004.vrd
Test: C:\VibrationVIEW\Profiles\[redacted] SoR 5-1200Hz 15.8Grms with 80-500hz 25G Sine 16Hz_min 6hours.vrp
Data stored on Mar 13, 2024 16:09:23



Test level schedule:

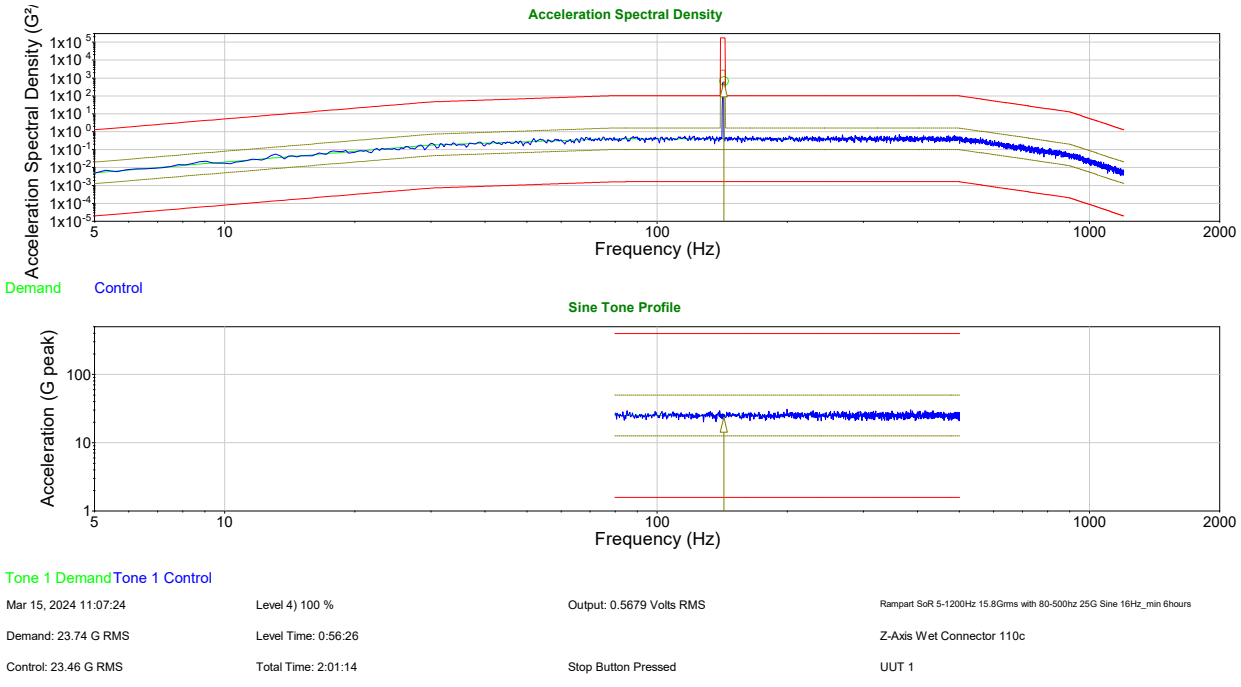
	Duration	Level	
1)	1:00:00	100 %	(SoR)
2)	View Report (prompt)		
3)	Wait for operator		
4)	1:00:00	100 %	(SoR)
5)	View Report (prompt)		
6)	Wait for operator		
7)	4:00:00	100 %	(SoR)
8)	View Report (prompt)		

** Test started Mar 13, 2024 15:06:07, running for 1:01:54
** Current level: 1, running at 100 % for 1:00:00 of 1:00:00

Test 9: Z Axis, 3/13/2024 UUT-1

Test Mode: **Sine on Random**
Frequency: **5-1200Hz Random, 80-500Hz Sine**
Duration: **1 Hour with Sine at 16 Hz per Minute**
Amplitude: **23.74 G_{rms} Random and 25 G_{peak} Sine**
Temp: **+110°C**

Data: C:\VibrationVIEW\Data\2024-03\2024Mar13-1506-0011.vrd
Test: C:\VibrationVIEW\Profiles\[redacted] SoR 5-1200Hz 15.8Grms with 80-500hz 25G Sine 16Hz_min 6hours.vrp
Data stored on Mar 15, 2024 11:07:24



Test level schedule:

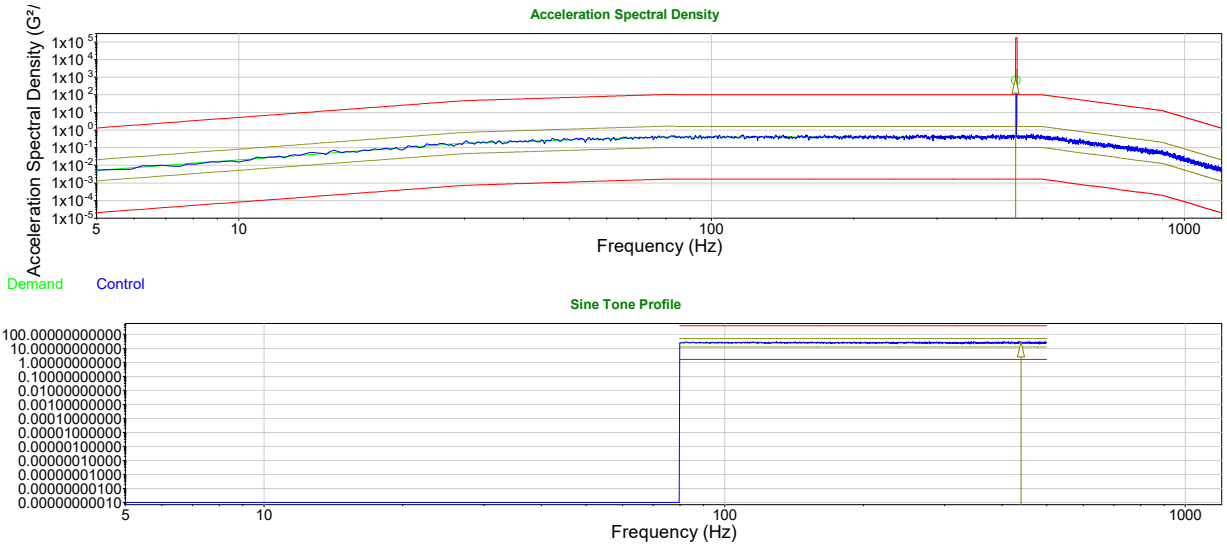
	Duration	Level	
1)	1:00:00	100 %	(SoR)
2)	View Report (prompt)		
3)	Wait for operator		
4)	1:00:00	100 %	(SoR)
5)	View Report (prompt)		
6)	Wait for operator		
7)	4:00:00	100 %	(SoR)
8)	View Report (prompt)		

** Test started Mar 13, 2024 15:06:07, running for 2:01:14
** Current level: 4, running at 100 % for 0:56:26 of 1:00:00

Test 10: Z Axis, 3/23/2024 UUT-1

Test Mode: Sine on Random
Frequency: 5-1200Hz Random, 80-500Hz Sine
Duration: 4 Hours with Sine at 16 Hz per Minute
Amplitude: 23.74 G_{rms} Random and 25 G_{peak} Sine
Temp: +175°C

Data: C:\VibrationVIEW\Data\2024-03\2024Mar23-0954-0017.vrd
Test: C:\VibrationVIEW\Profiles\[redacted] SoR 5-1200Hz 15.8Grms with 80-500hz 25G Sine 16Hz_min 6hours.vrp
Data stored on Mar 23, 2024 18:43:10



Test level schedule:

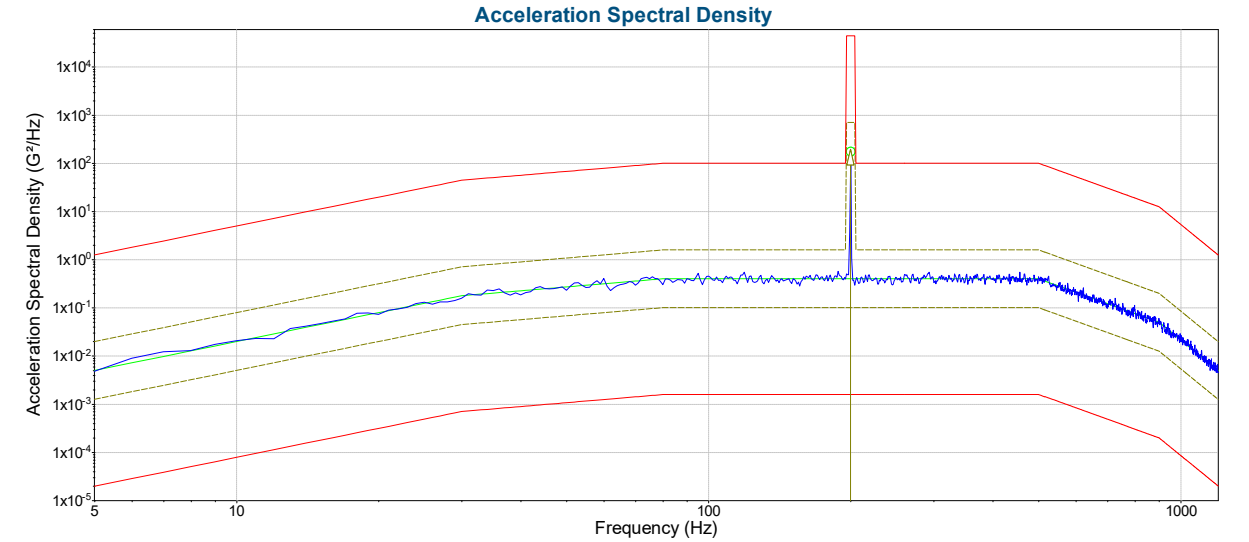
	Duration	Level	
1)	0:03:34	100 %	(SoR)
2)	View Report (prompt)		
3)	Wait for operator		
4)	4:00:00	100 %	(SoR)
5)	View Report (prompt)		

** Test started Mar 23, 2024 09:54:52, running for 4:12:52
** Current level: 4, running at 100 % for 4:00:00 of 4:00:00

Test 11: X Axis, 5/21/2024 UUT-2

Test Mode: **Sine on Random**
Frequency: **5-1200Hz Random, 80-500Hz Sine**
Duration: **1 Hour with Sine at 16 Hz per Minute**
Amplitude: **23.74 G_{rms} Random and 25 G_{peak} Sine**
Temp: **Ambient**

Data: C:\VibrationVIEW\Data\2024-05\2024May21-0929-0004.vrd
Test: C:\VibrationVIEW\Profiles\[redacted]Rampart SoR 5-1200Hz 15.8Grms with 80-500hz 23G Sine 16Hz_min 6hours.vrp
Data stored on May 21, 2024 10:32:26



Test level schedule:

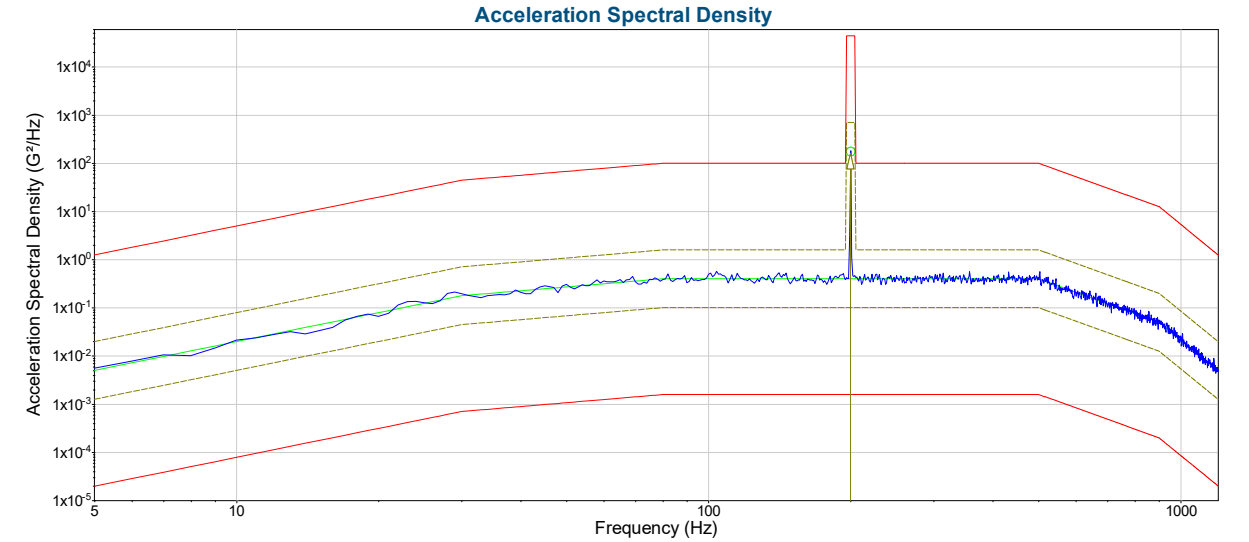
	Duration	Level	
1)	1:00:00	100 %	(SoR)
2)	View Report (prompt)		
3)	Wait for operator		
4)	1:00:00	100 %	(SoR)
5)	View Report (prompt)		
6)	Wait for operator		
7)	4:00:00	100 %	(SoR)
8)	View Report (prompt)		

** Test started May 21, 2024 09:29:22, running for 1:01:39
** Current level: 1, running at 100 % for 1:00:00 of 1:00:00

Test 12: Y Axis, 5/21/2024 UUT-2

Test Mode: Sine on Random
Frequency: 5-1200Hz Random, 80-500Hz Sine
Duration: 1 Hour with Sine at 16 Hz per Minute
Amplitude: 23.74 G_{rms} Random and 25 G_{peak} Sine
Temp: Ambient

Data: C:\VibrationVIEW\Data\2024-05\2024May21-0929-0007.vrd
Test: C:\VibrationVIEW\Profiles\[redacted] SoR 5-1200Hz 15.8Grms with 80-500hz 23G Sine 16Hz_min 6hours.vrp
Data stored on May 21, 2024 11:41:14



Test level schedule:

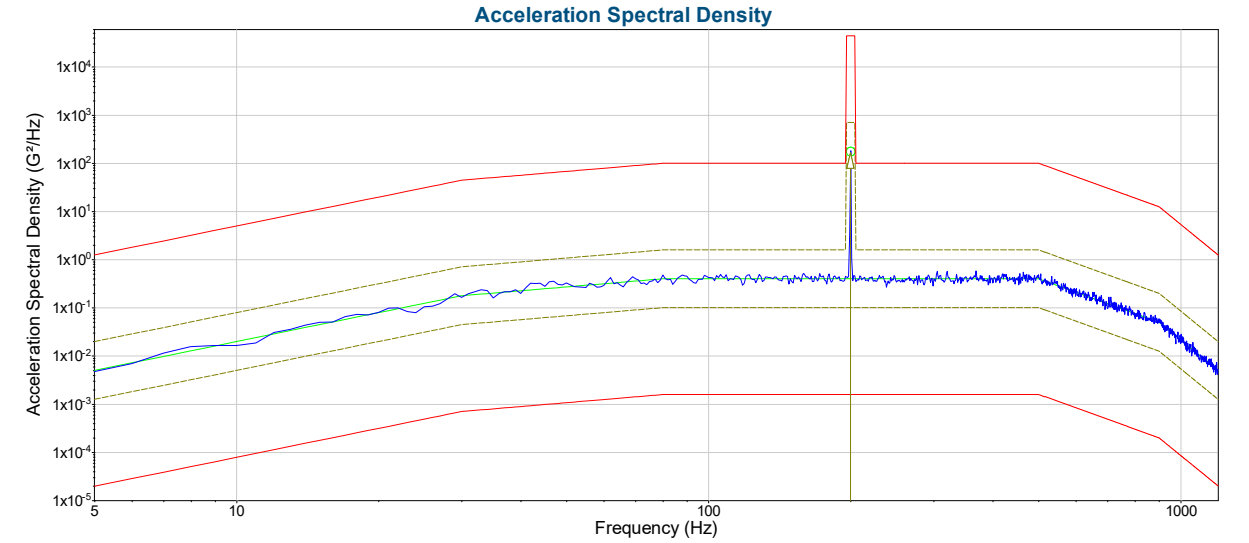
	Duration	Level	
1)	1:00:00	100 %	(SoR)
2)	View Report (prompt)		
3)	Wait for operator		
4)	1:00:00	100 %	(SoR)
5)	View Report (prompt)		
6)	Wait for operator		
7)	4:00:00	100 %	(SoR)
8)	View Report (prompt)		

** Test started May 21, 2024 09:29:22, running for 2:01:55
** Current level: 4, running at 100 % for 1:00:00 of 1:00:00

Test 13: Y Axis, 5/21/2024 UUT-2

Test Mode: **Sine on Random**
Frequency: **5-1200Hz Random, 80-500Hz Sine**
Duration: **1 Hour with Sine at 16 Hz per Minute**
Amplitude: **23.74 G_{rms} Random and 25 G_{peak} Sine**
Temp: **+110°C**

Data: C:\VibrationVIEW\Data\2024-05\2024May21-1249-0003.vrd
Test: C:\VibrationVIEW\Profiles\[redacted] SoR 5-1200Hz 15.8Grms with 80-500hz 23G Sine 16Hz_min 6hours.vrp
Data stored on May 21, 2024 13:50:02



Test level schedule:

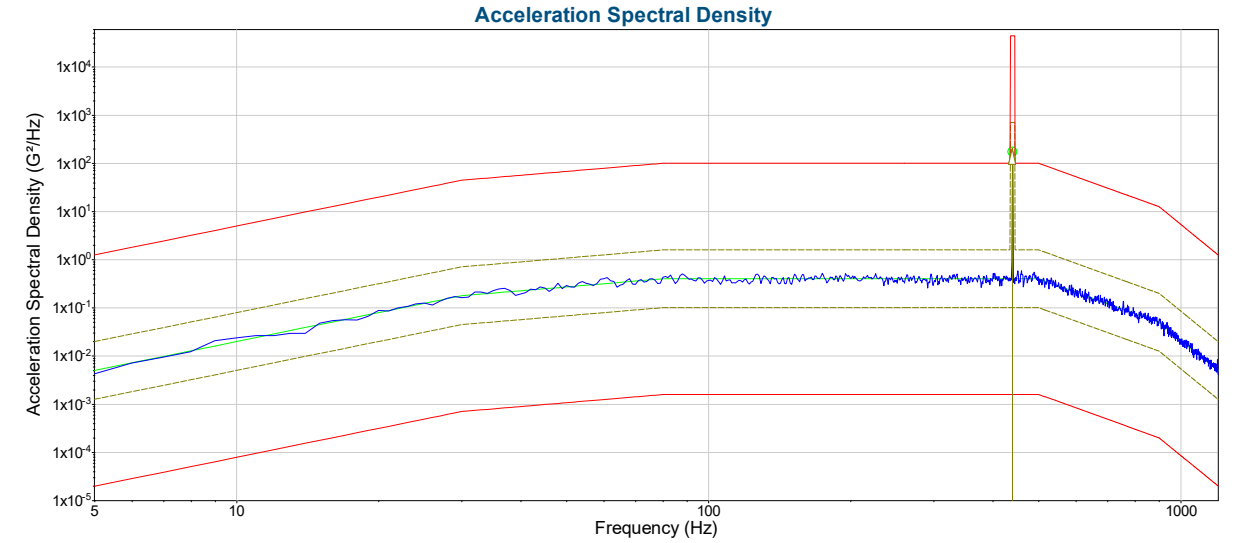
	Duration	Level	
1)	1:00:00	100 %	(SoR)
2)	View Report (prompt)		
3)	Wait for operator		
4)	1:00:00	100 %	(SoR)
5)	View Report (prompt)		
6)	Wait for operator		
7)	1:00:00	100 %	(SoR)
8)	View Report (prompt)		

** Test started May 21, 2024 12:49:21, running for 1:00:41
** Current level: 1, running at 100 % for 1:00:00 of 1:00:00

Test 14: Y Axis, 5/21/2024 UUT-2

Test Mode: **Sine on Random**
Frequency: **5-1200Hz Random, 80-500Hz Sine**
Duration: **4 Hours with Sine at 16 Hz per Minute**
Amplitude: **23.74 G_{rms} Random and 25 G_{peak} Sine**
Temp: **+175°C**

Data: C:\VibrationVIEW\Data\2024-05\2024May21-1610-0010.vrd
Test: C:\VibrationVIEW\Profiles\[redacted] SoR 5-1200Hz 15.8Grms with 80-500hz 23G Sine 16Hz_min 6hours.vrp
Data stored on May 21, 2024 20:16:45



Test level schedule:

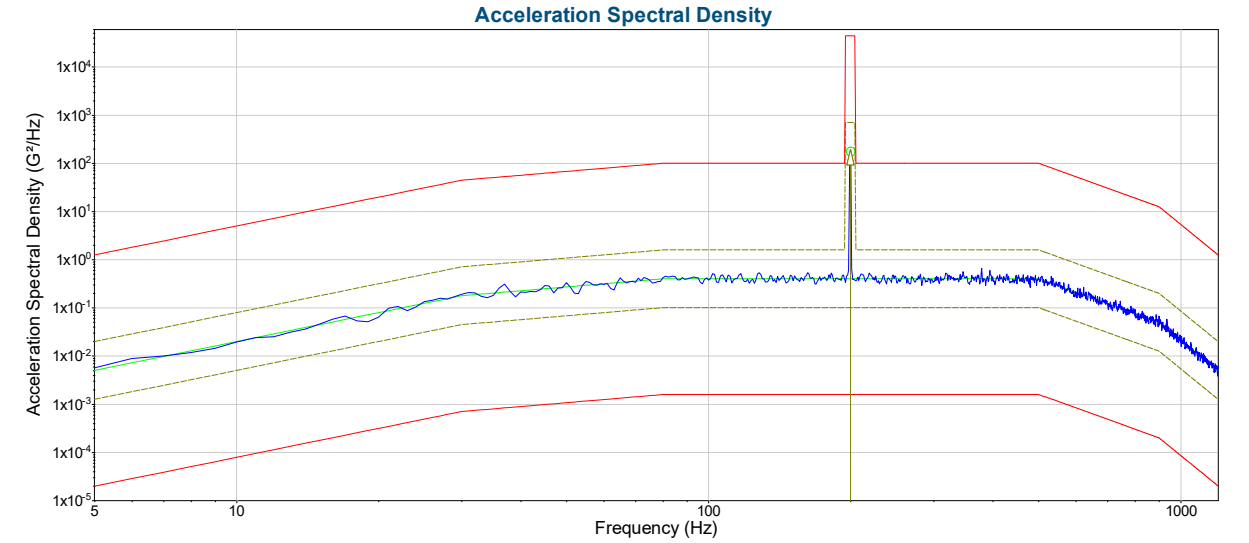
	Duration	Level	
1)	4:00:00	100 %	(SoR)
2)	View Report (prompt)		
3)	Wait for operator		
4)	4:00:00	100 %	(SoR)
5)	View Report (prompt)		
6)	Wait for operator		
7)	1:00:00	100 %	(SoR)
8)	View Report (prompt)		

** Test started May 21, 2024 16:10:12, running for 4:01:20
** Current level: 1, running at 100 % for 4:00:00 of 4:00:00

Test 15: X Axis, 5/22/2024 UUT-2

Test Mode: Sine on Random
Frequency: 5-1200Hz Random, 80-500Hz Sine
Duration: 1 Hour with Sine at 16 Hz per Minute
Amplitude: 23.74 G_{rms} Random and 25 G_{peak} Sine
Temp: +110°C

Data: C:\VibrationVIEW\Data\2024-05\2024May22-0910-0003.vrd
Test: C:\VibrationVIEW\Profiles\[redacted] SoR 5-1200Hz 15.8Grms with 80-500hz 23G Sine 16Hz_min 6hours.vrp
Data stored on May 22, 2024 10:11:35



Test level schedule:

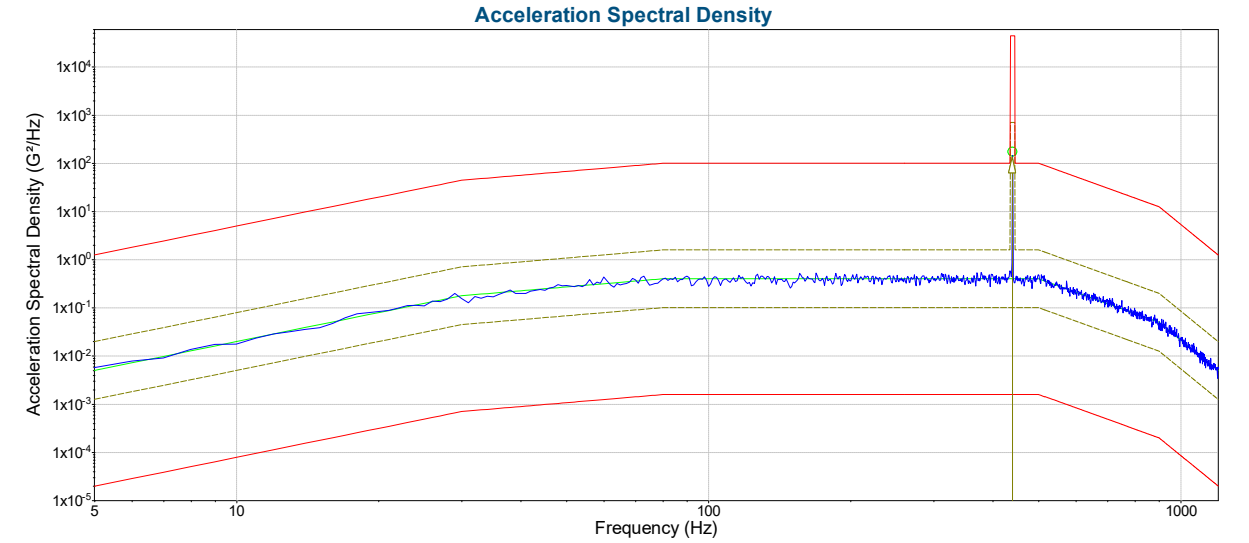
	Duration	Level	
1)	1:00:00	100 %	(SoR)
2)	View Report (prompt)		
3)	Wait for operator		
4)	4:00:00	100 %	(SoR)
5)	View Report (prompt)		
6)	Wait for operator		
7)	1:00:00	100 %	(SoR)
8)	View Report (prompt)		

** Test started May 22, 2024 09:10:00, running for 1:01:35
** Current level: 1, running at 100 % for 1:00:00 of 1:00:00

Test 16: X Axis, 5/22/2024 UUT-2

Test Mode: **Sine on Random**
Frequency: **5-1200Hz Random, 80-500Hz Sine**
Duration: **4 Hours with Sine at 16 Hz per Minute**
Amplitude: **23.74 G_{rms} Random and 25 G_{peak} Sine**
Temp: **+175°C**

Data: C:\VibrationVIEW\Data\2024-05\2024May22-0910-0016.vrd
Test: C:\VibrationVIEW\Profiles\[redacted] SoR 5-1200Hz 15.8Grms with 80-500hz 23G Sine 16Hz_min 6hours.vrp
Data stored on May 22, 2024 17:34:30



Test level schedule:

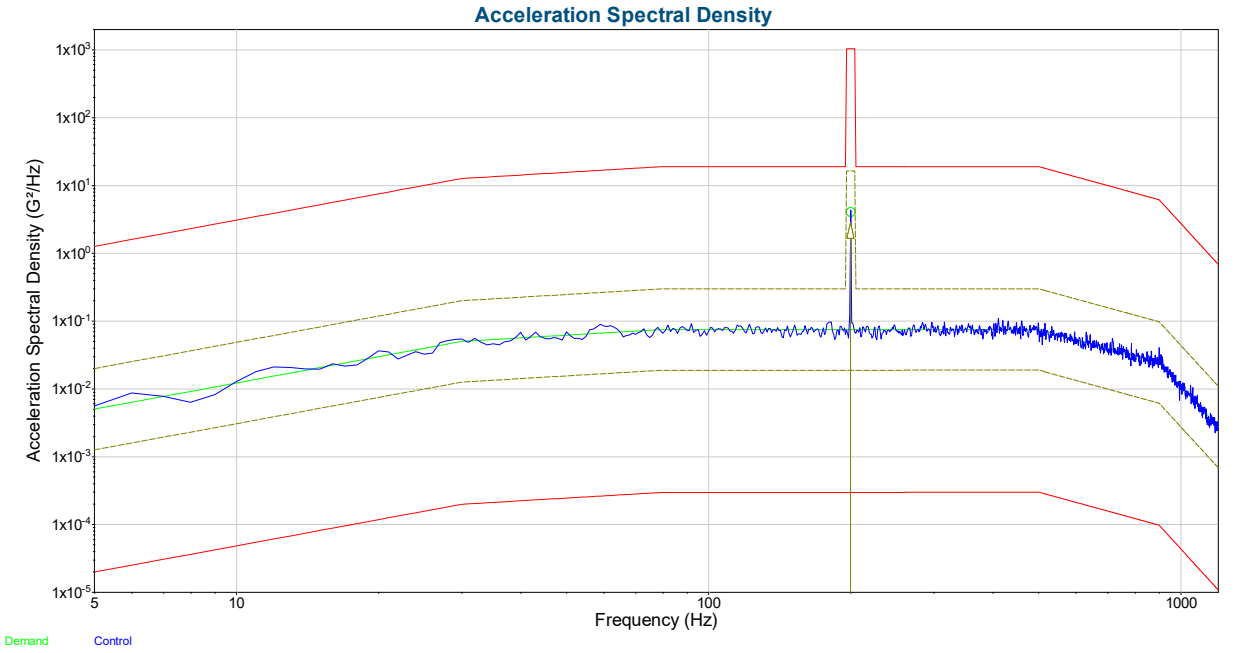
	Duration	Level	
1)	1:00:00	100 %	(SoR)
2)	View Report (prompt)		
3)	Wait for operator		
4)	4:00:00	100 %	(SoR)
5)	View Report (prompt)		
6)	Wait for operator		
7)	1:00:00	100 %	(SoR)
8)	View Report (prompt)		

** Test started May 22, 2024 09:10:00, running for 5:03:58
** Current level: 4, running at 100 % for 4:00:00 of 4:00:00

Test 17: Z Axis, 5/23/2024 UUT-2

Test Mode: Sine on Random
Frequency: 5-1200Hz Random, 80-500Hz Sine
Duration: 1 Hour with Sine at 16 Hz per Minute
Amplitude: 7.4 G_{rms} Random and 3.5 G_{peak} Sine
Temp: +110°C

Data: C:\VibrationVIEW\Data\2024-05\2024May23-1101-0003.vrd
Test: C:\VibrationVIEW\Profiles\[redacted] SoR 5-1200Hz 7.4Grms with 80-500hz 3.5G Sine 16Hz_min 6hours Z axis.vrp
Data stored on May 23, 2024 12:04:39



May 23, 2024 12:04:39	Level 1) 100 %	Output: 0.3328 Volts RMS	Rampart SoR 5-1200Hz 7.4Grms with 80-500hz 3.5G
Demand: 7.834 G RMS	Level Time: 1:00:00	Remaining 0:00:00	UUT #2 110°C 1 Hour
Control: 7.69 G RMS	Total Time: 1:02:49	Running	

Test level schedule:

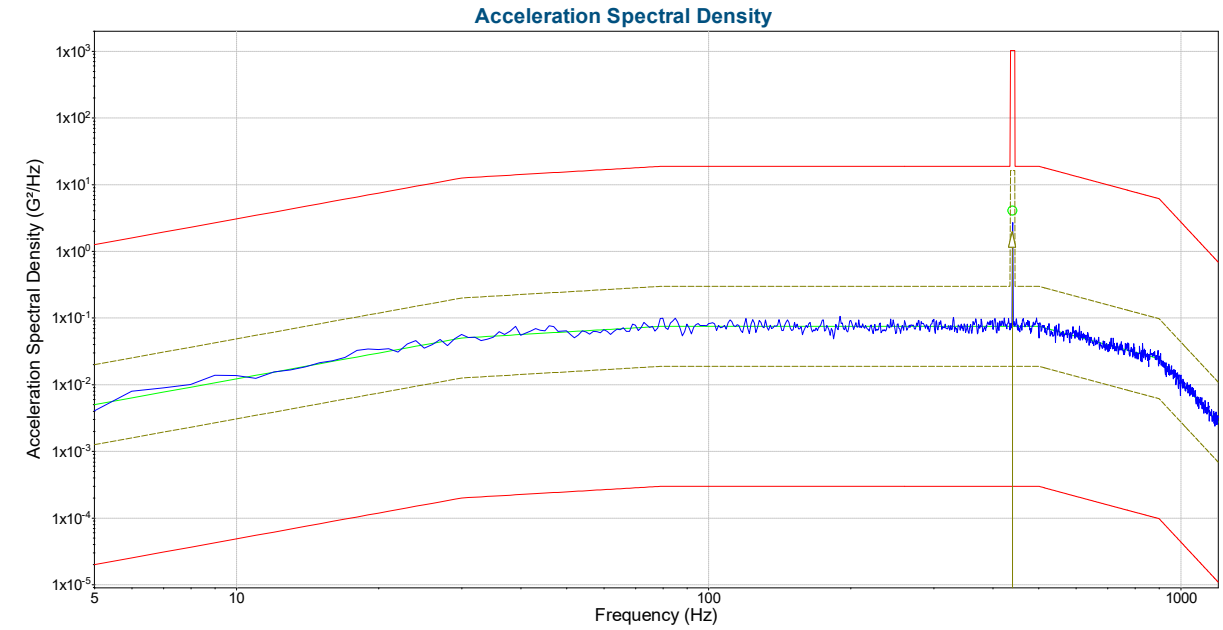
	Duration	Level	
1)	1:00:00	100 %	(SoR)
2)	View Report (prompt)		
3)	Wait for operator		
4)	1:00:00	100 %	(SoR)
5)	View Report (prompt)		
6)	Wait for operator		
7)	4:00:00	100 %	(SoR)
8)	View Report (prompt)		

** Test started May 23, 2024 11:01:50, running for 1:02:49
** Current level: 1, running at 100 % for 1:00:00 of 1:00:00

Test 18: Z Axis, 5/23/2024 UUT-2

Test Mode: **Sine on Random**
Frequency: **5-1200Hz Random, 80-500Hz Sine**
Duration: **4 Hours with Sine at 16 Hz per Minute**
Amplitude: **7.4 G_{rms} Random and 3.5 G_{peak} Sine**
Temp: **+175°C**

Data: C:\VibrationVIEW\Data\2024-05\2024May23-1101-0014.vrd
Test: C:\VibrationVIEW\Profiles\[redacted] SoR 5-1200Hz 7.4Grms with 80-500hz 3.5G Sine 16Hz_min 6hours Z axis.vrp
Data stored on May 23, 2024 17:05:14



May 23, 2024 17:05:14	Level 4) 100 %	Output: 0.3251 Volts RMS	Rampart SoR 5-1200Hz 7.4Grms with 80-500hz 3.5G Sine 16Hz_min 6hours Z axis
Demand: 7.834 G RMS	Level Time: 4:00:00	Remaining 0:00:00	UUT #2 175°C 4 Hour
Control: 7.794 G RMS	Total Time: 5:03:51	Running	

Test level schedule:

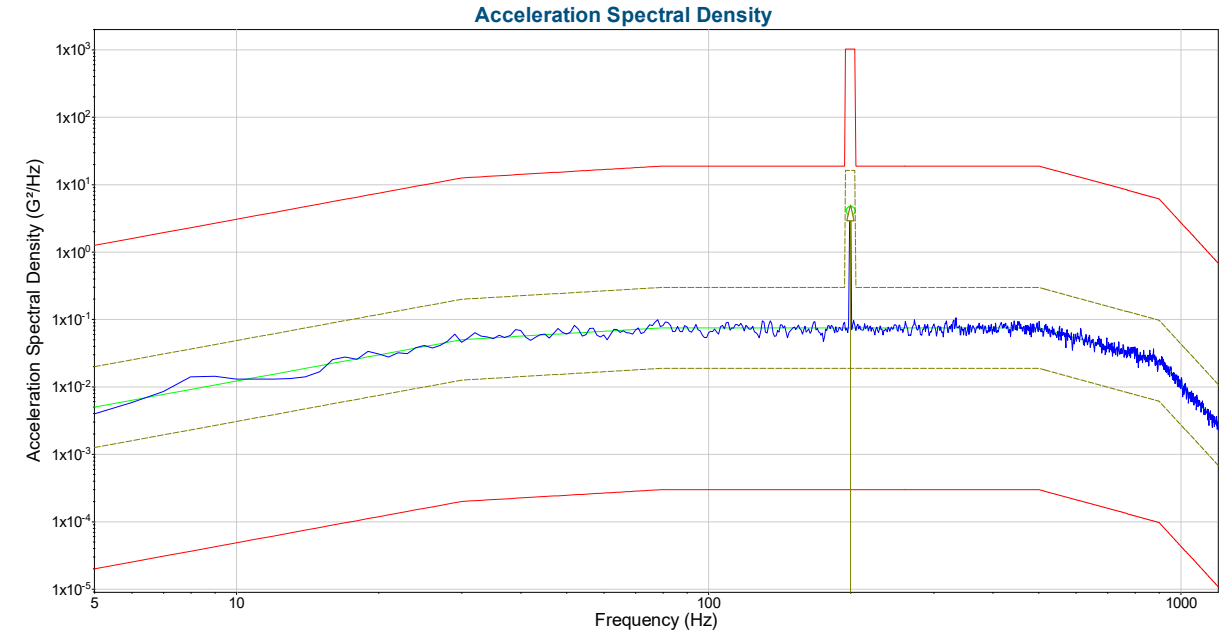
	Duration	Level	
1)	1:00:00	100 %	(SoR)
2)	View Report (prompt)		
3)	Wait for operator		
4)	4:00:00	100 %	(SoR)
5)	View Report (prompt)		
6)	Wait for operator		
7)	4:00:00	100 %	(SoR)
8)	View Report (prompt)		

** Test started May 23, 2024 11:01:50, running for 5:03:51
** Current level: 4, running at 100 % for 4:00:00 of 4:00:00

Test 19: Z Axis, 5/23/2024 UUT-2

Test Mode: Sine on Random
Frequency: 5-1200Hz Random, 80-500Hz Sine
Duration: 1 Hour with Sine at 16 Hz per Minute
Amplitude: 7.4 G_{rms} Random and 3.5 G_{peak} Sine
Temp: Ambient

Data: C:\VibrationVIEW\Data\2024-05\2024May23-1101-0019.vrd
Test: C:\VibrationVIEW\Profiles\[redacted] SoR 5-1200Hz 7.4Grms with 80-500hz 3.5G Sine 16Hz_min 6hours Z axis.vrp
Data stored on May 24, 2024 07:46:08



May 24, 2024 07:46:08	Level 7) 100 %	Output: 0.3542 Volts RMS	Rampart SoR 5-1200Hz 7.4Grms with 80-500hz 3.5G Sine 16Hz_min 6hours Z axis
Demand: 7.834 G RMS	Level Time: 1:00:00	Remaining 0:00:00	UUT #2 RT 1 Hour
Control: 7.841 G RMS	Total Time: 6:04:53	End of Test	

Test level schedule:

	Duration	Level	
1)	1:00:00	100 %	(SoR)
2)	View Report (prompt)		
3)	Wait for operator		
4)	1:00:00	100 %	(SoR)
5)	View Report (prompt)		
6)	Wait for operator		
7)	1:00:00	100 %	(SoR)
8)	View Report (prompt)		

** Test started May 23, 2024 11:01:50, running for 6:04:53
** Current level: 7, running at 100 % for 1:00:00 of 1:00:00

THERMAL TESTING PARAMETERS/SETUP

Description of Test Equipment

Table 4 – Test Equipment

Description	*Manufacturer*	*Model*	*S/N*	*Cal Due*
Thermal Chamber	Cincinnati	Sub Zero	Z0043520	04/02/2025
Voltage Data Logger	Dataq	DI-149	5167F3D3	Verified
Multimeter	Fluke	115	29330388WS	06/30/2024
Power Supply	KORAD	KD3005P	08250131672	Verified

Fixturing and Airflow

The UUT were placed in the chamber on the bottom shelf on v-block bottoms. The fixturing is illustrated below in Figure 16 taken during previous testing of the same type UUT. Note that photos were inadvertently not taken during the thermal portion of the testing.

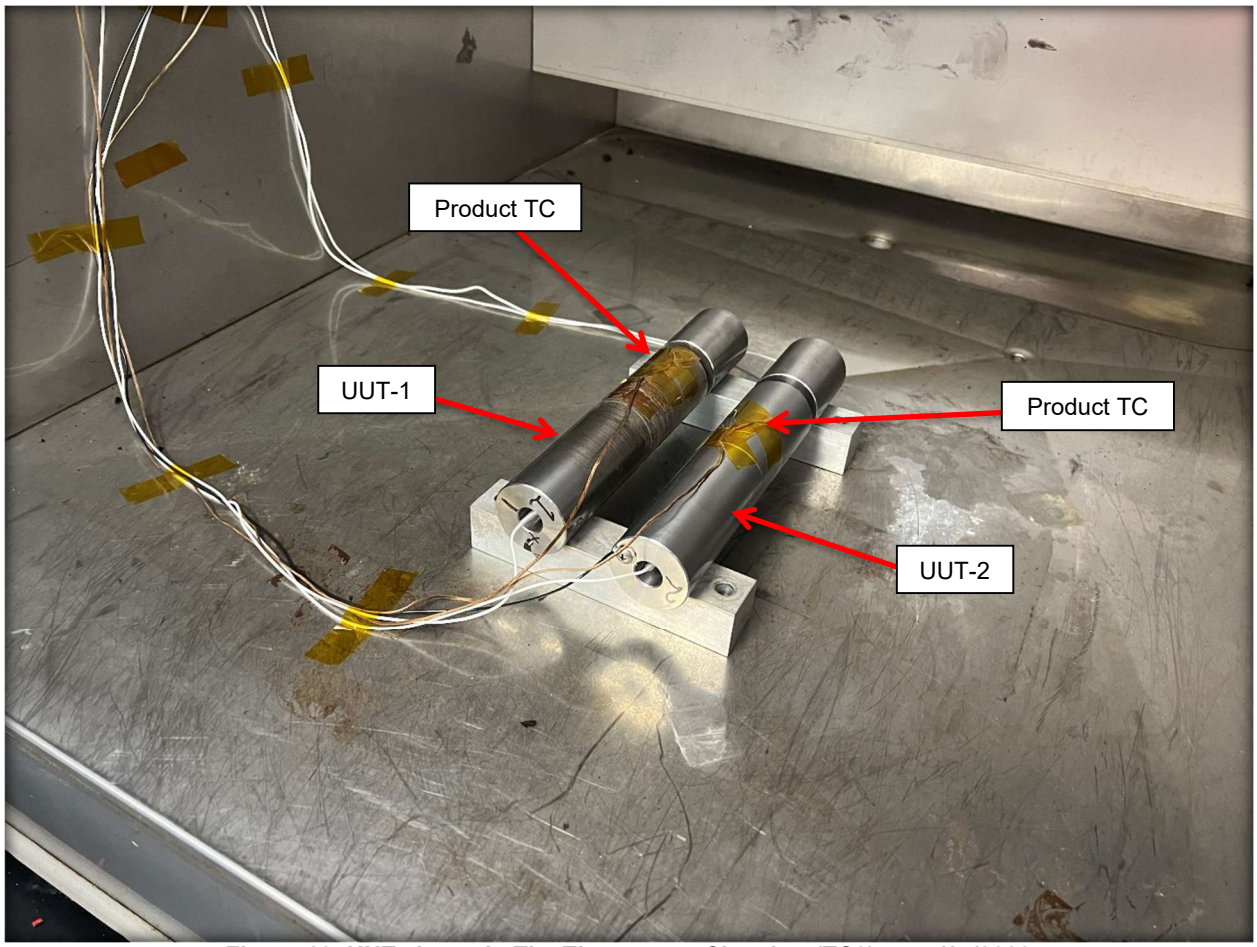


Figure 16: UUT shown in The Thermotron Chamber (TC3), on 4/14/2023

Data Collection

A PicoLog TC datalogger was used to capture and monitor the air and select product temperatures during testing. Kapton tape was used to hold them in place. The thermocouples were utilized throughout the testing.

Product Function Tests

The UUT were functionally tested during the thermal testing using a DC power supply to supply approximately 5 volts through the [redacted] that was logged via a Dataq datalogger connected to a laptop. Any continuity break in the connector would be recorded on the datalogger graph. The datalogger files were included with the customer data files made available with the distribution of this report. A continuity check was also done manually following the thermal testing with the results shown in Table 5 notes below. The test equipment used is shown below in Figure 17 taken during previous testing of the same type UUT.

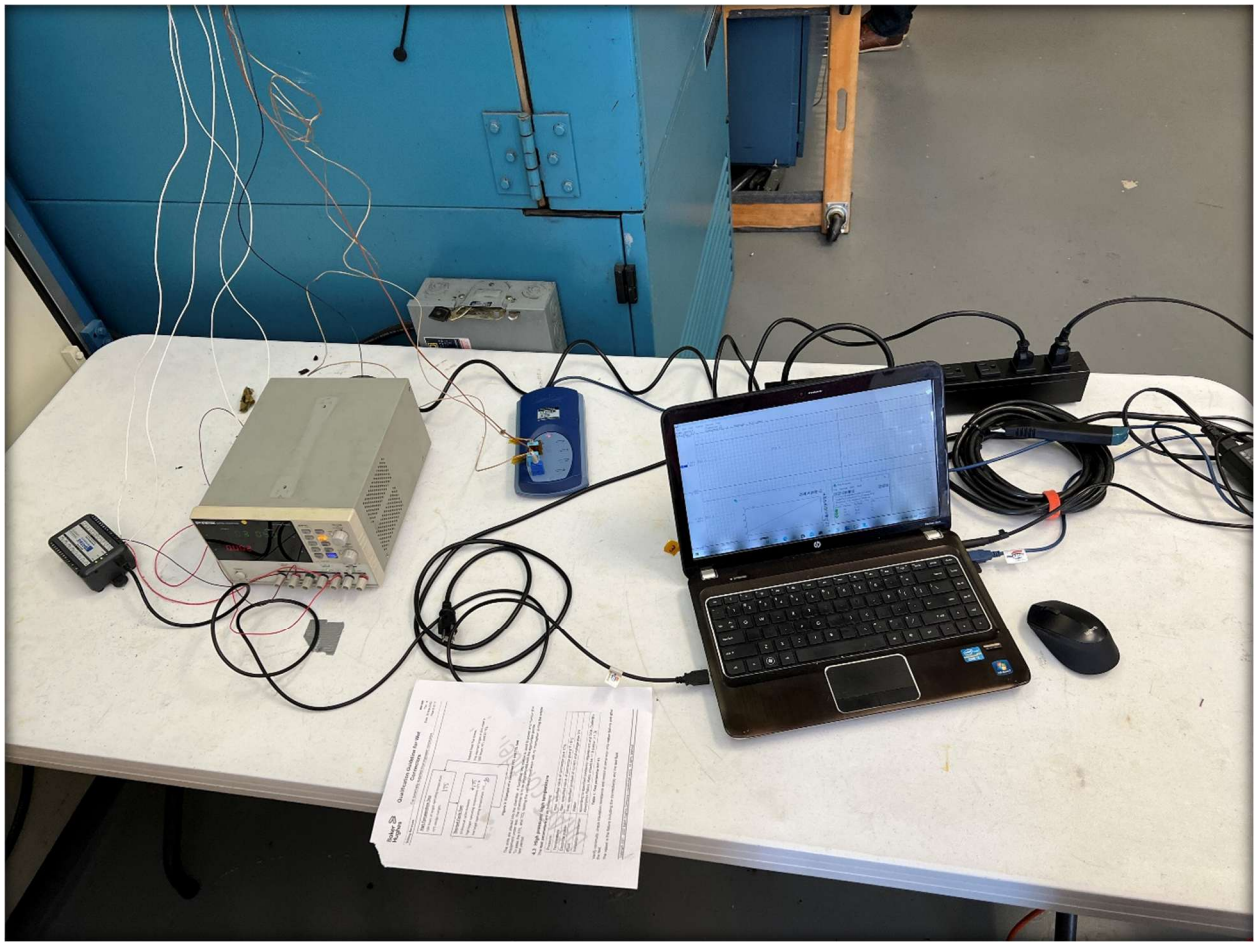


Figure 17: Test equipment used to monitor the UUT for thermal testing

Thermal Testing

The UUT were to be subjected to a 100-hour soak at +180°C, immediately followed by ten thermal cycles from -25°C to +180°C with thermal transition rates set to maximum of the Thermal chamber. This cycle was repeated four more times for a total of 50 thermal cycles and 500 hours of soak time. The chamber temperature was controlled via the chamber air TC. The results of the testing, along with any notes or observations, are summarized below in Table 5. The PicoLog graphs for the testing are provided below in Figures 18 and 19 and were included in the customer datafiles.

Table 5 – Thermotron Chamber Thermal Testing

Dates	Test #	Description	Notes
3/25 – 3/30/2024	1	100 Hour soak at +180°C	1
3/30 – 3/31/2024	1	10 Thermal cycles, -25°C to +180°C	1
3/31 – 4/05/2024	2	100 Hour soak at +180°C	1
4/05 – 4/06/2024	2	10 Thermal cycles, -25°C to +180°C	1
4/06 – 4/12/2024	3	100 Hour soak at +180°C	1, 2
4/12 – 4/13/2024	3	10 Thermal cycles, -25°C to +180°C	1
4/16 – 4/21/2024	4	100 Hour soak at +180°C	1, 3
5/06 – 5/07/2024	4	10 Thermal cycles, -25°C to +180°C	1
5/07 – 5/11/2024	5	100 Hour soak at +180°C	1
5/11 – 5/12/2024	5	10 Thermal cycles, -25°C to +180°C	1, 4

Notes:

1. No UUT failure was noted during this test.
2. After the third set of 10 thermal cycles, it was discovered that the PicoLog datalogger had stopped recording during the third 100-hour soak. Once it was discovered, the datalogger was reset and started recording again.
3. Following the 10 thermal cycles on 4/13/2024, the heater element fuse blew, and testing resumed on 4/16/2024.
4. Following the thermal testing, the UUT passed a continuity check. UUT-2 was then subjected to vibration testing, see section above, followed by pneumatic shock for UUT-2 only.

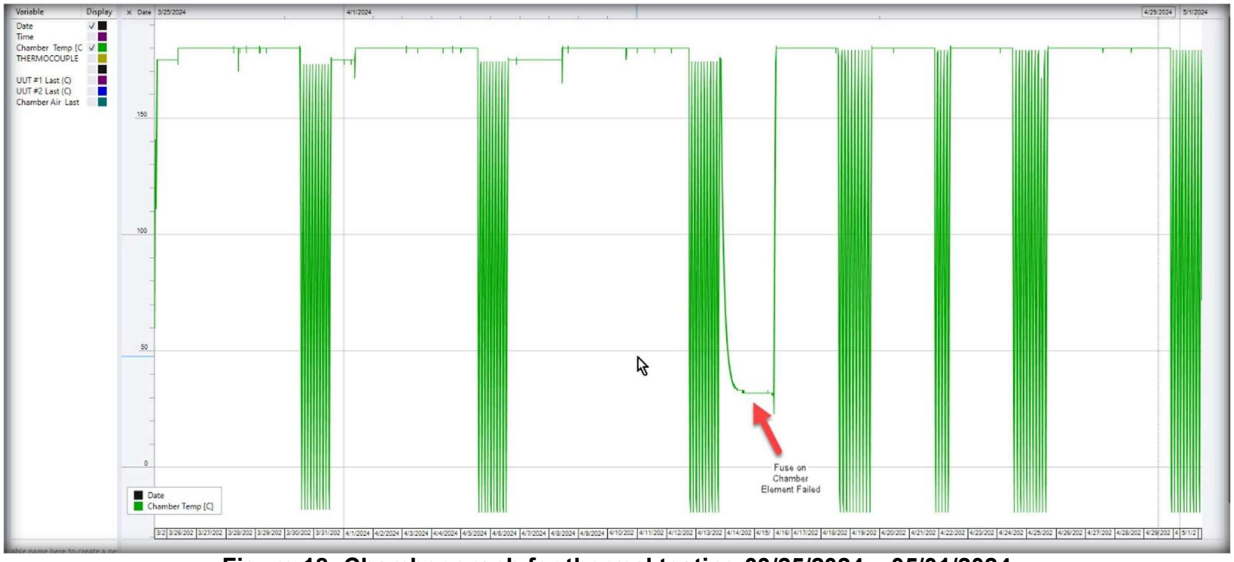


Figure 18: Chamber graph for thermal testing 03/25/2024 – 05/01/2024

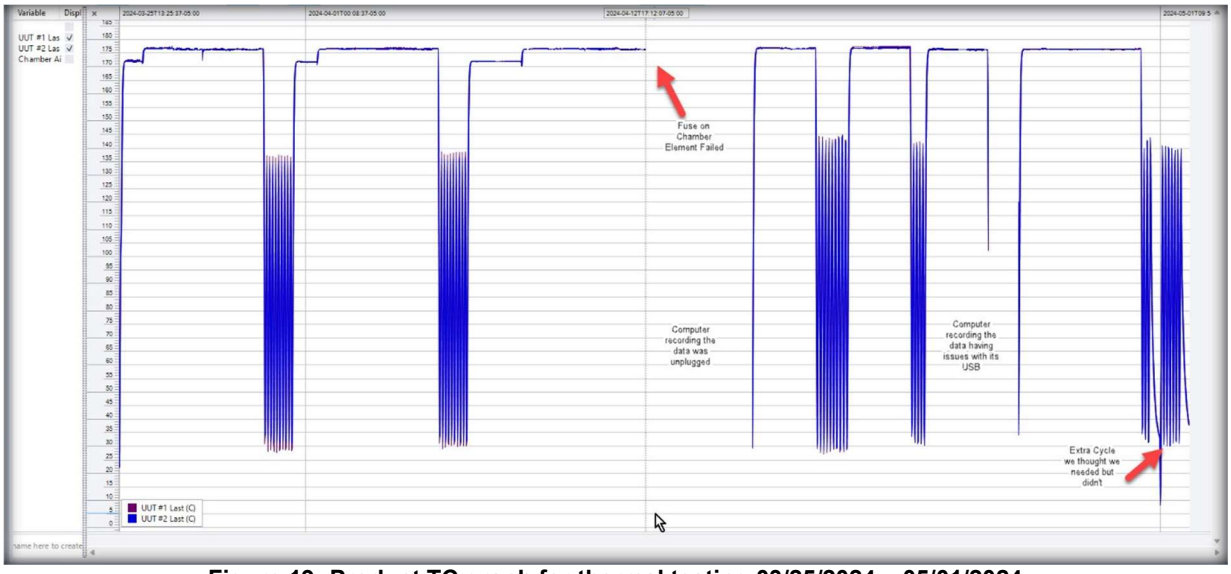


Figure 19: Product TC graph for thermal testing 03/25/2024 – 05/01/2024

PNEUMATIC SHOCK TESTING PARAMETERS/SETUP

Description of Test Equipment

Table 6 – Test Equipment

Description	*Manufacturer*	*Model*	*S/N*	*Cal Due*
VST DAQ	VST	DAS8U	367681	10/22/2025
Control Accelerometer (SH1)	Dytran	3200B52	14913	02/20/2025
Response Accelerometer (HG2)	PCB	352B01	173451	04/05/2025
Voltage Data Logger	Dataq	DI-149	5167F3D3	Verified
Multimeter	Fluke	115	29330388WS	06/30/2024
Power Supply	KORAD	KD3005P	08250131672	Verified

Shock System: VST Pneumatic Shock Machine PSM600HP-3030 with an eight-channel acquisition system was used to perform the pneumatic shock, Figure 20.

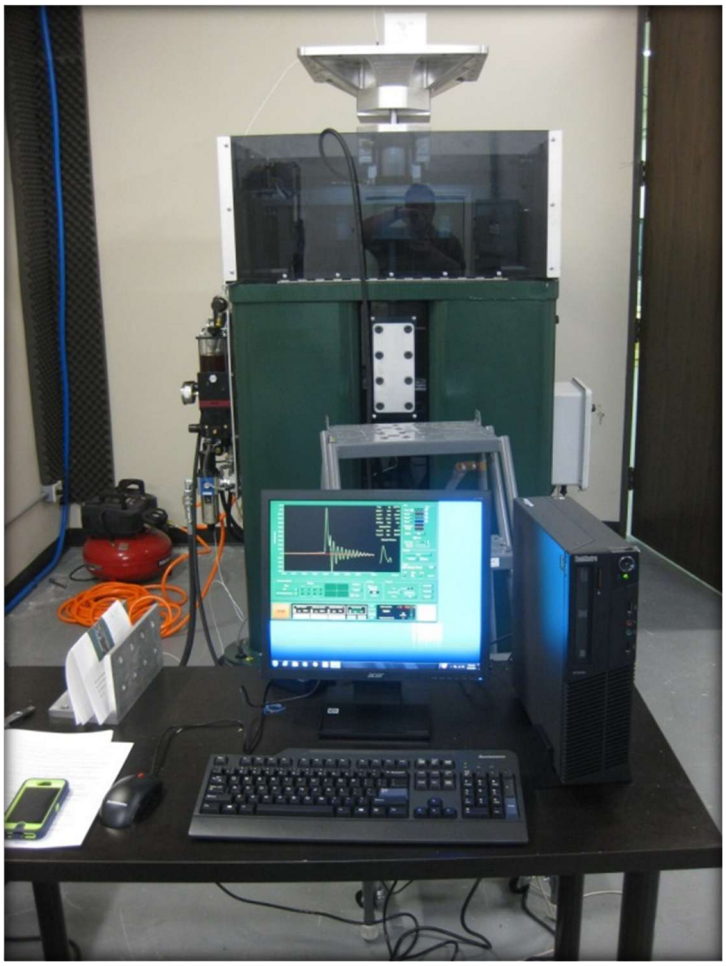


Figure 20: Shock control workstation

Fixturing

The UUT was fixtured using the same split radius clamps as used in the vibration testing. An L-bracket was fixtured to the shock machine carriage using 3/8-16 socket head screws for all axes tested. Testing started in the +X axis, to differentiate between the axes tested, the UUT was rotated in 90° increments in the clamps. For ±Z axes testing, the split radius clamps were rotated 90° to configure the UUT in the vertical position. To differentiate between the ±Z axes, the UUT was rotated 180° vertically in the clamps. See Figures 21-29 below for illustrations of the UUT fixturing to the pneumatic shock machine along with detailed views of the accelerometer locations. Note that photos were not taken of each axis tested, however the fixturing is the same for all axis with just the rotation of the UUT in the split radius clamps to change the axis tested.

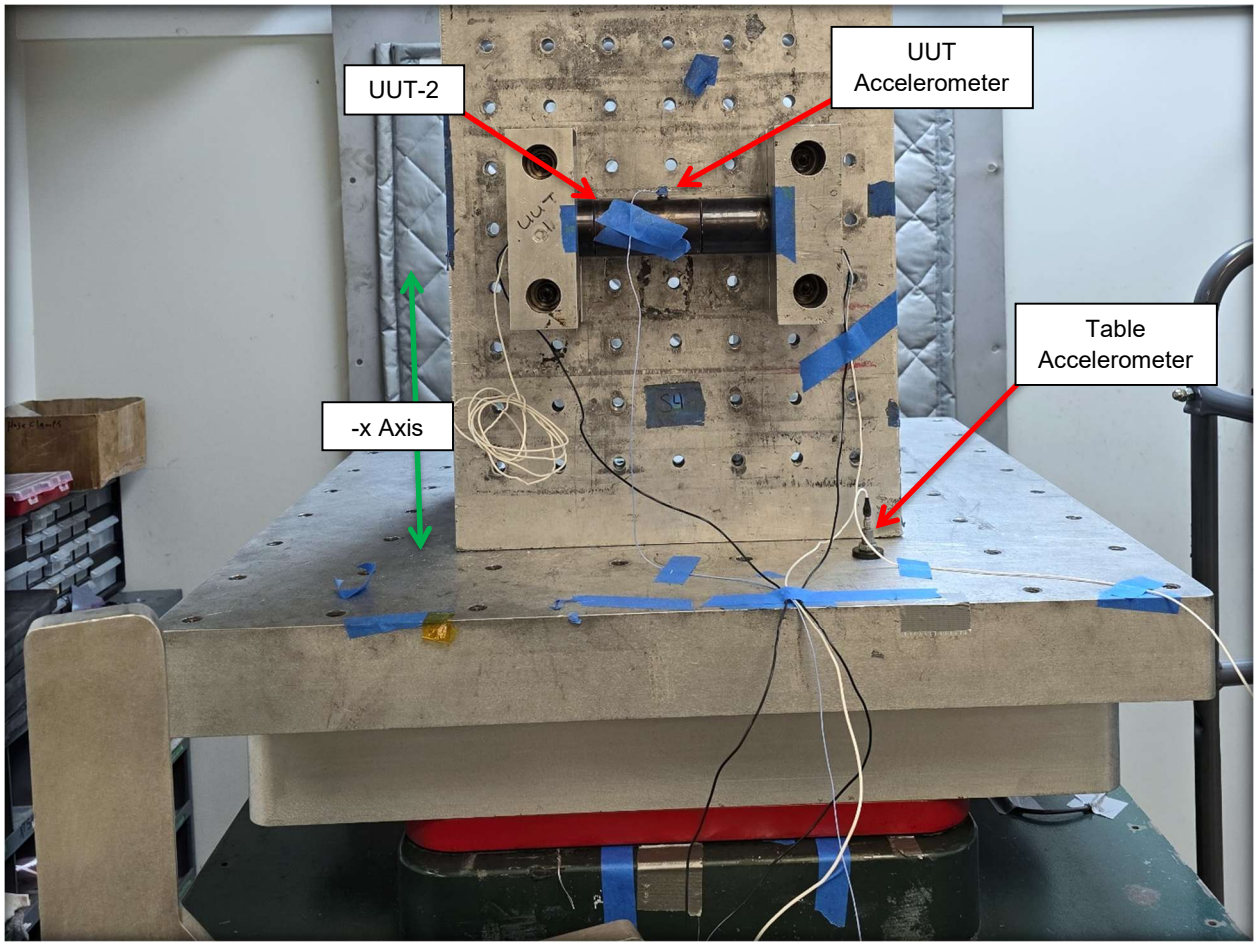


Figure 21: UUT-2 shown fixtured for -X axis testing – 05/23/2024

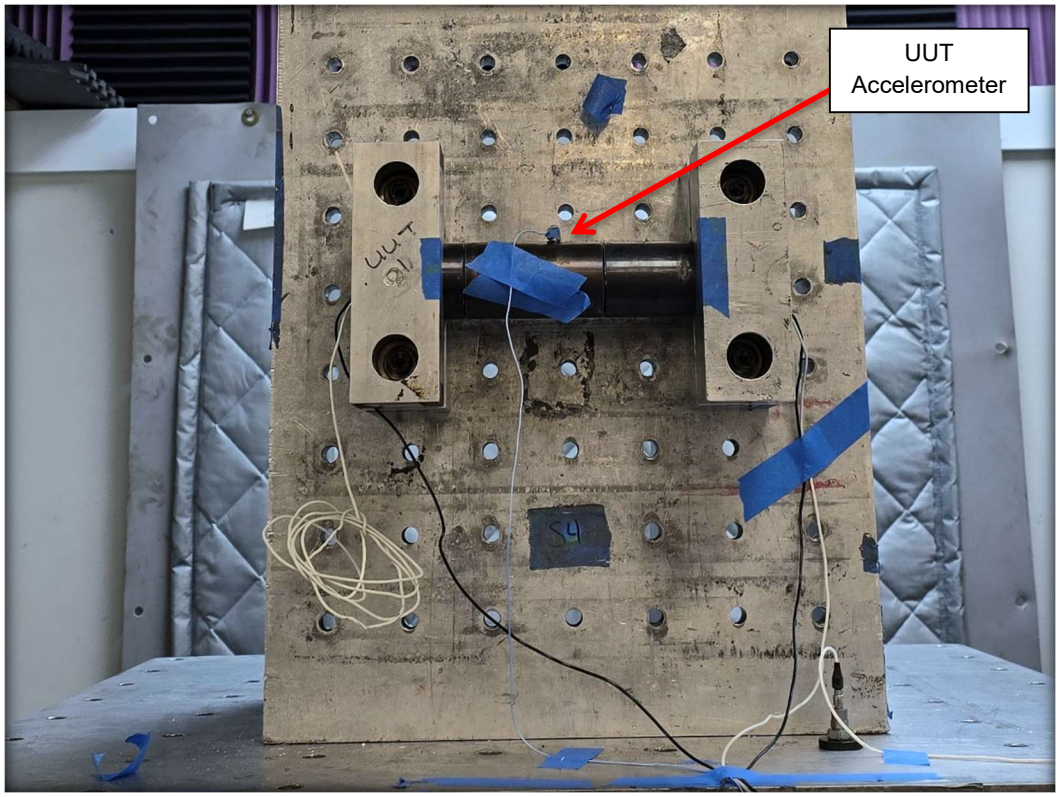


Figure 22: Detailed view of "UUT" accelerometer location shown for -X axis testing

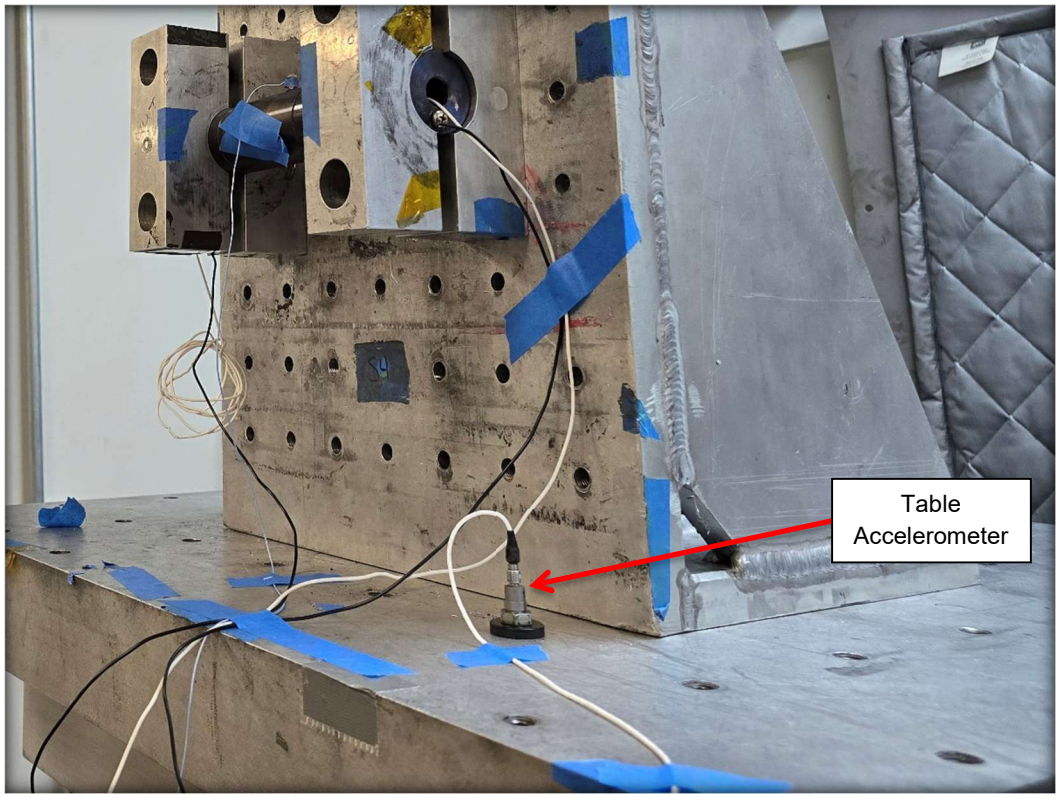


Figure 23: Detailed view of Table accelerometer location for all axes testing

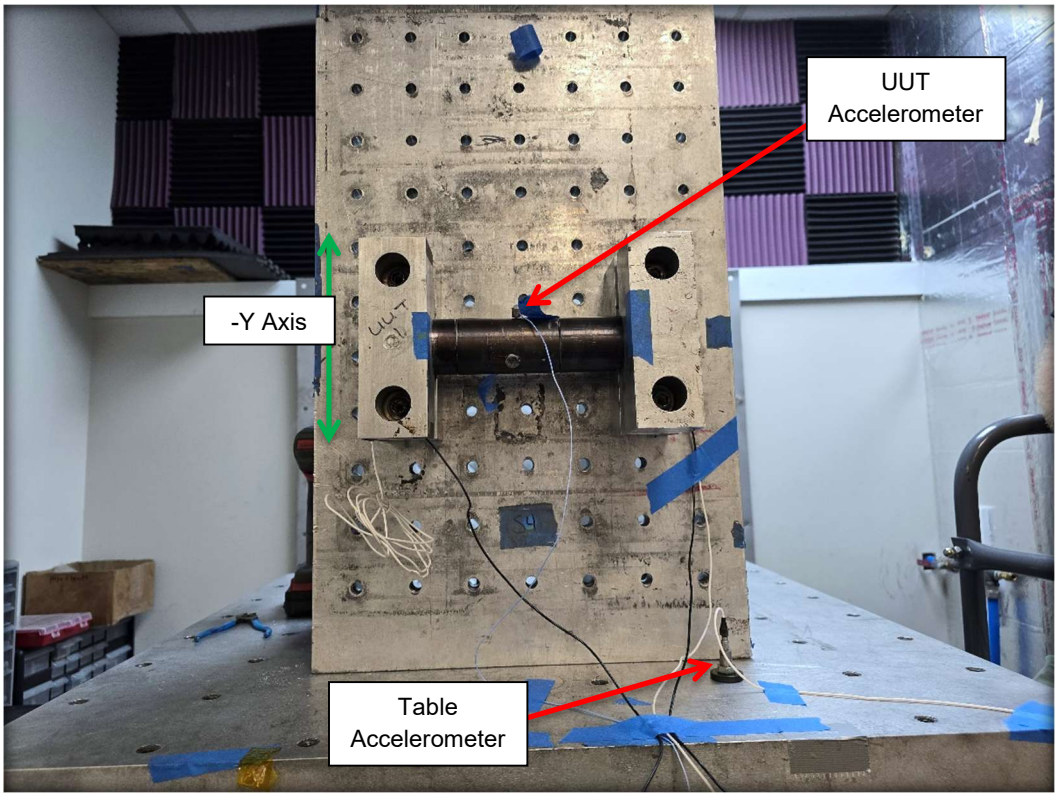


Figure 24: UUT-2 shown fixtured for -Y axis testing – 5/23/2024

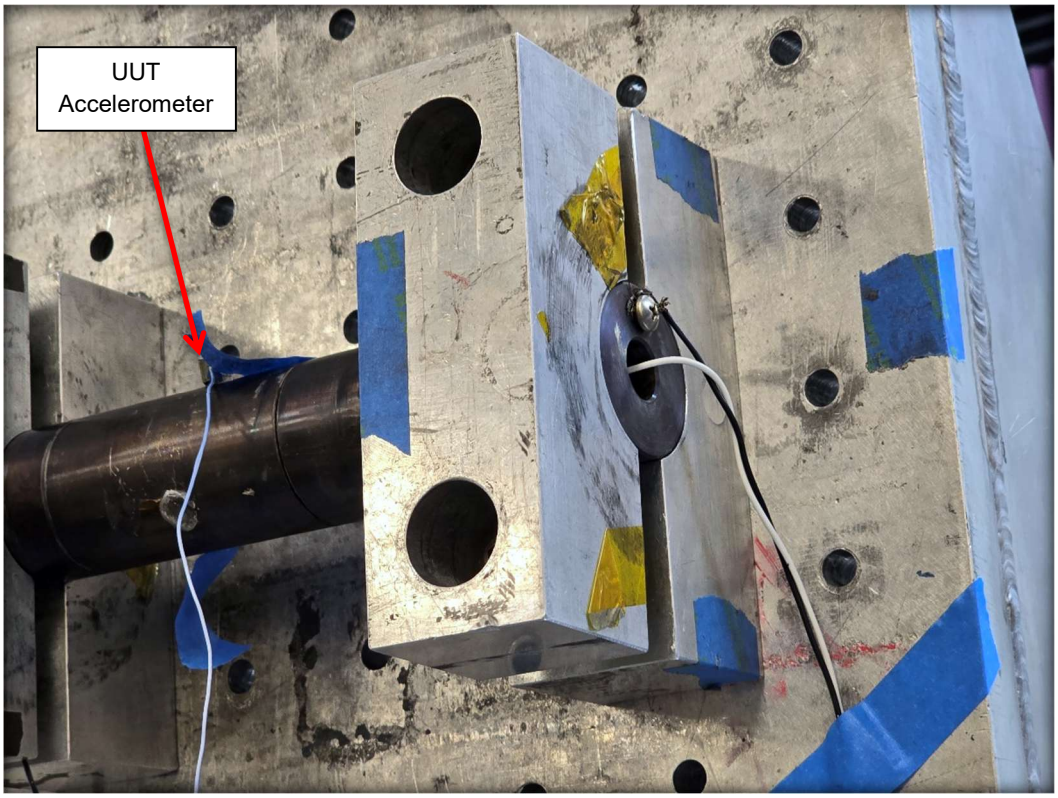


Figure 25: Detailed view of "UUT" accelerometer location shown in -Y axis testing

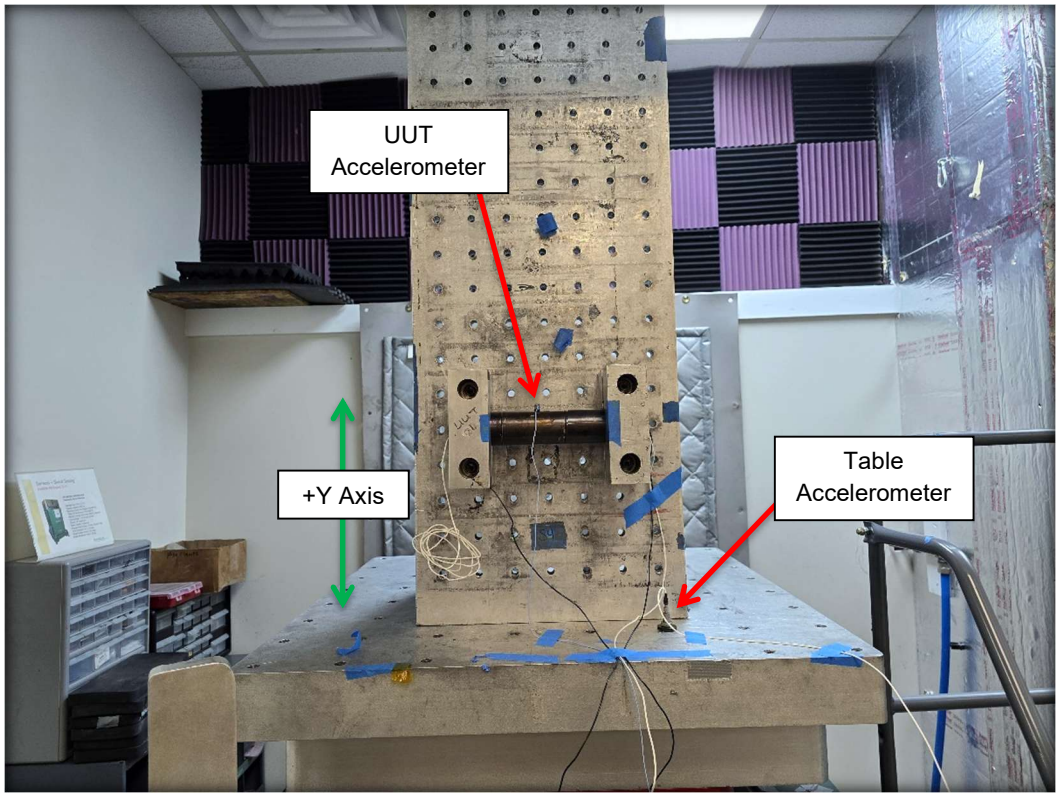


Figure 26: UUT-2 shown fixtured for +Y axis testing – 5/23/2024

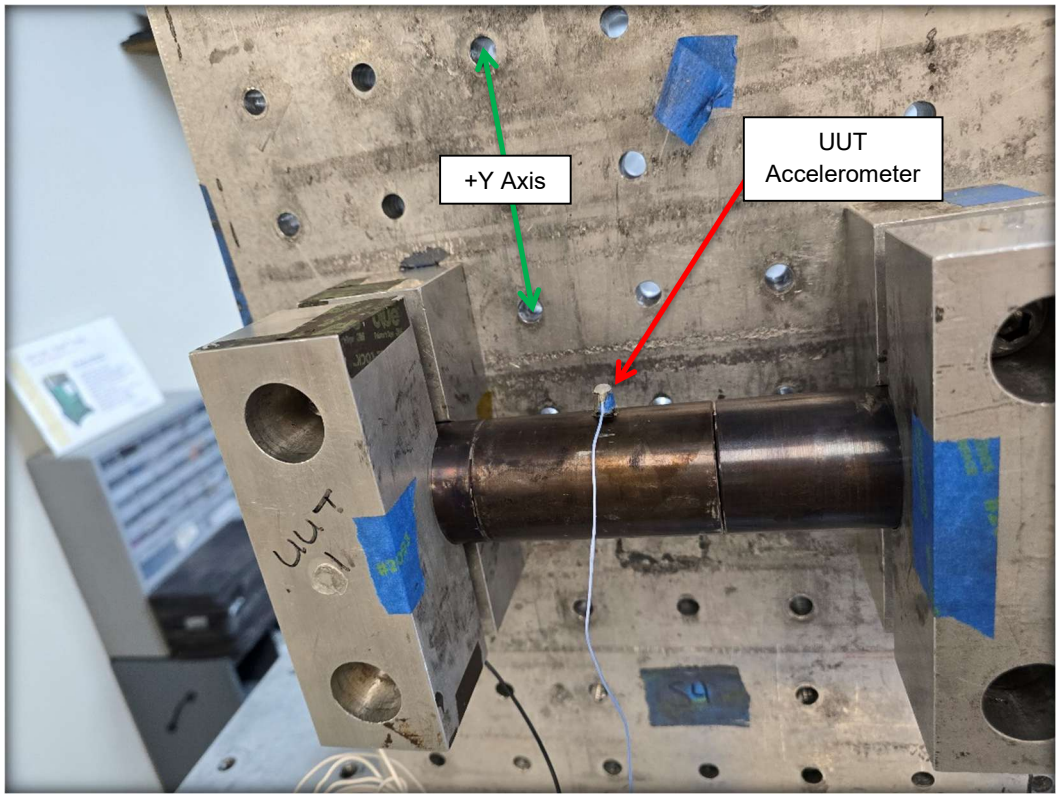


Figure 27: Detailed view of "UUT" accelerometer location shown for +Y axis testing

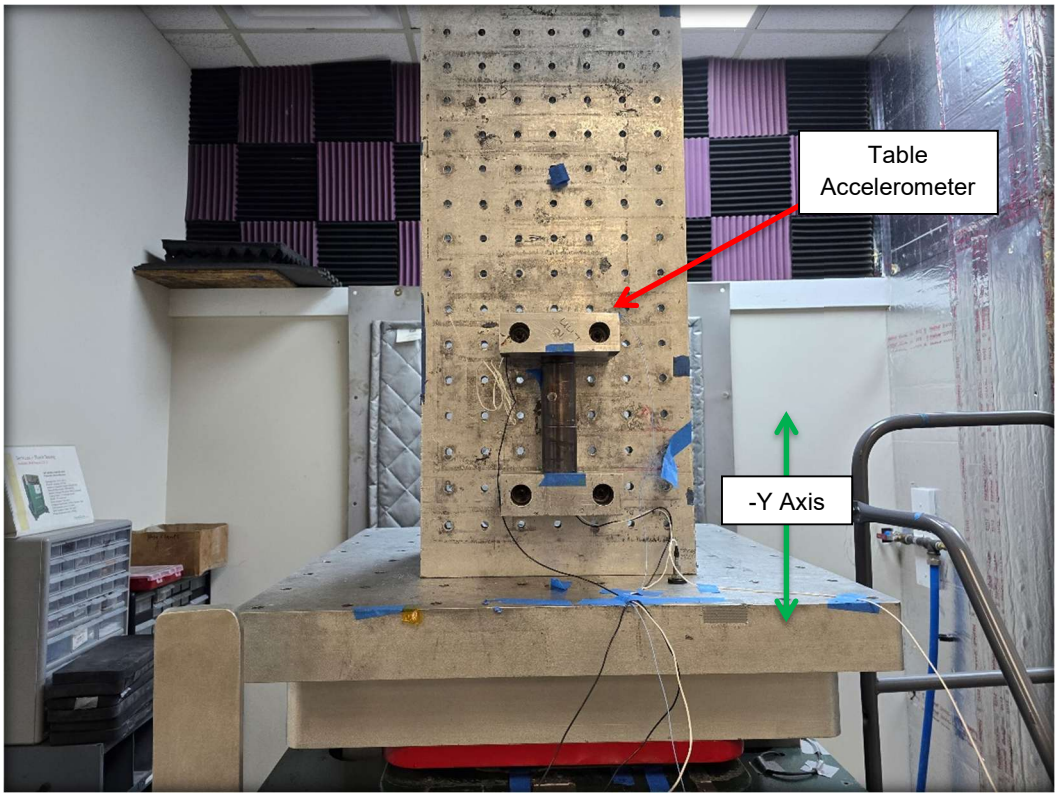


Figure 28: UUT-2 shown fixtured for +Z axis testing – 5/24/2024

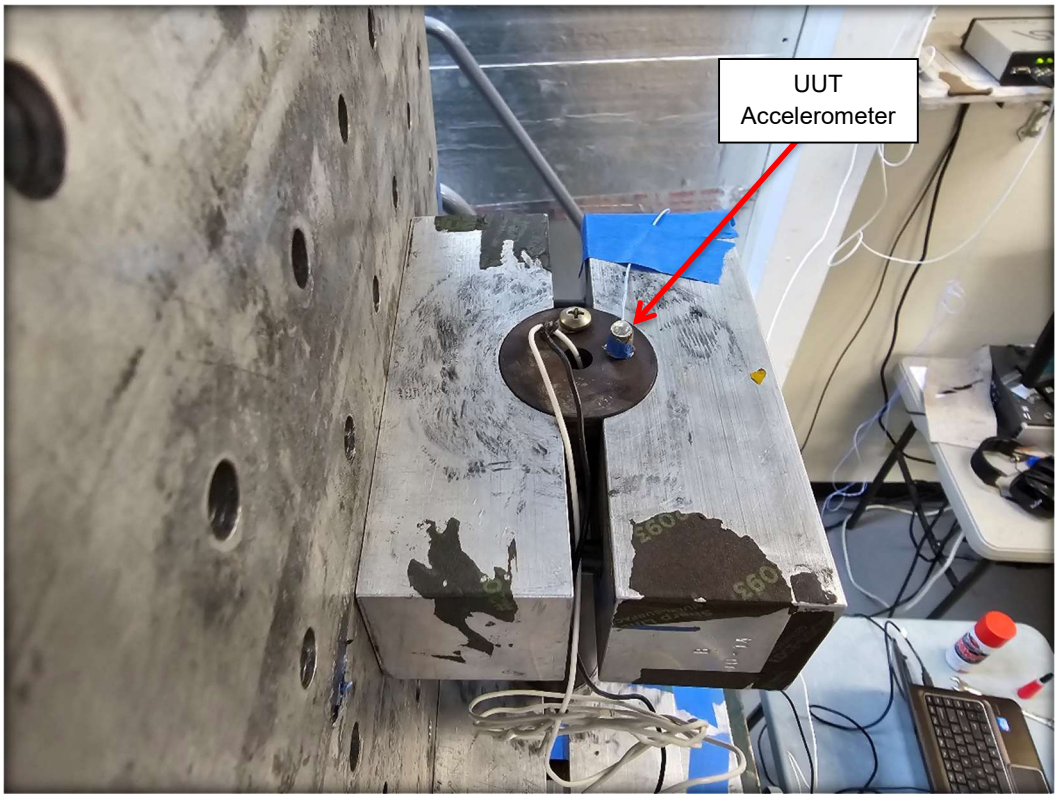


Figure 29: Detailed view of "UUT" accelerometer location shown for +Z axis testing

Product Function Tests

The UUT was functionally tested during the shock testing using a DC power supply to supply approximately 5 volts through the [redacted] that was logged via a Dataq datalogger connected to a laptop. Any continuity break in the connector would be recorded on the datalogger graph. The datalogger files were included with the customer data files made available with the distribution of this report. A continuity check was also done manually following each axis of shock testing with the results shown in Table 5 notes below. The test equipment used is shown below in Figure 30.

Figure 30: Test equipment used to monitor the UUT for shock testing

Pneumatic Shock Testing

The UUT was to be subjected to 50 shocks in the ± X, Y, and Z axes, with a target level of approximately 800 G_{peak} at .5mS duration. Table height, pressure, and felt pads were used to dial in these parameters as close as possible. See Table 7 below for the G_{peak} and duration averages as measured by the shock control system. A sample report from each axis tested is shown below in Figures 31-36. The raw data files for each manual and logged drops were included in the customer data files along with a spreadsheet listing the individual drops.

Table 7 – Pneumatic Shock Testing

Drop #s	Axis	Table (G_{peak})	Table (mS)	UUT (G_{peak})	UUT (mS)	Notes
1-65	+X	845.5	0.4	731.7	0.50	1, 2
66-121	+Y	522.2	0.72	800.4	0.42	3, 2
122-172	-X	513.8	0.39	867.1	0.44	4, 2
173-223	-Y	442.6	0.62	785.4	0.41	1, 2
224-278	+Z	860.7	0.32	775.2	0.83	1, 2
279-344	-Z	594.2	1.42	899.3	0.32	3, 2, 5

Note:

1. The first five drops in this axis were manual, and the remaining drops were automated and recorded in a log file.
2. The UUT passed a continuity check following this axis of shock testing.
3. The first ten drops in this axis were manual, and the remaining drops were automated and recorded in a log file.
4. The first two drops in this axis were manual, and the remaining drops were automated and recorded in a log file.
5. The pneumatic shock testing concluded with no continuity checks failing.

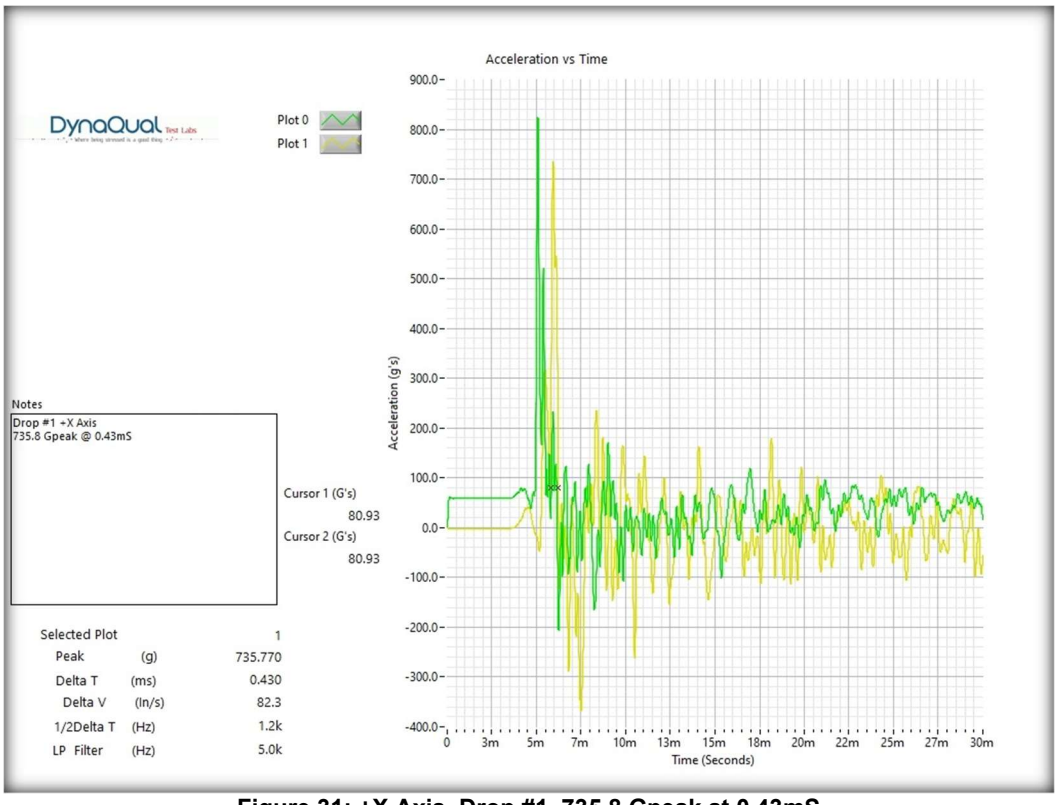


Figure 31: +X Axis, Drop #1, 735.8 Gpeak at 0.43mS

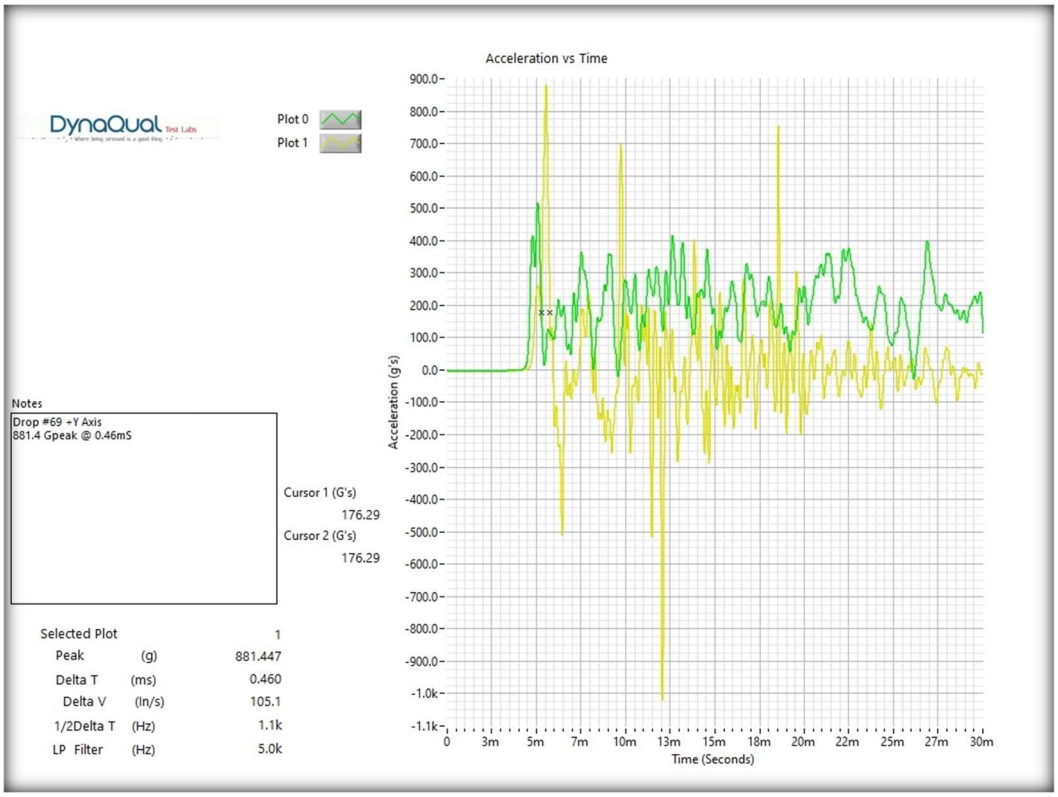


Figure 32: +Y Axis, Drop #69, 881.4 G_{peak} at 0.46mS

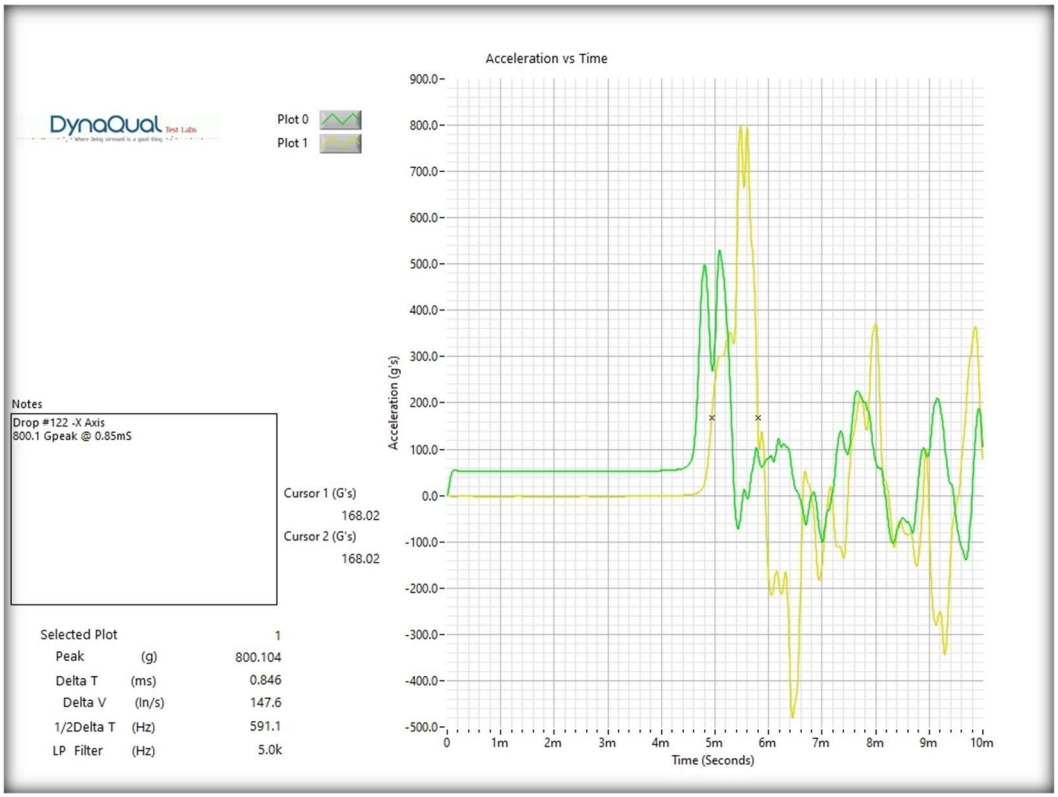


Figure 33: -X Axis, Drop #122, 800.1 G_{peak} at 0.85mS

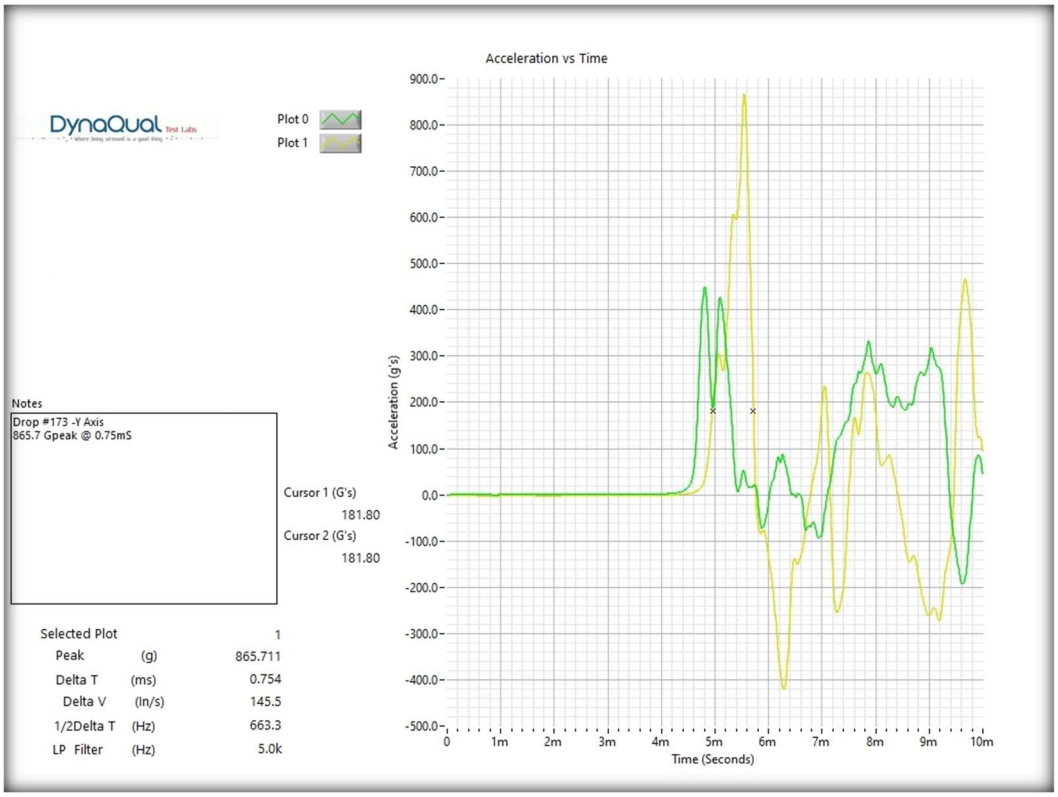


Figure 34: -Y Axis, Drop #173, 865.7 G_{peak} at 0.75mS

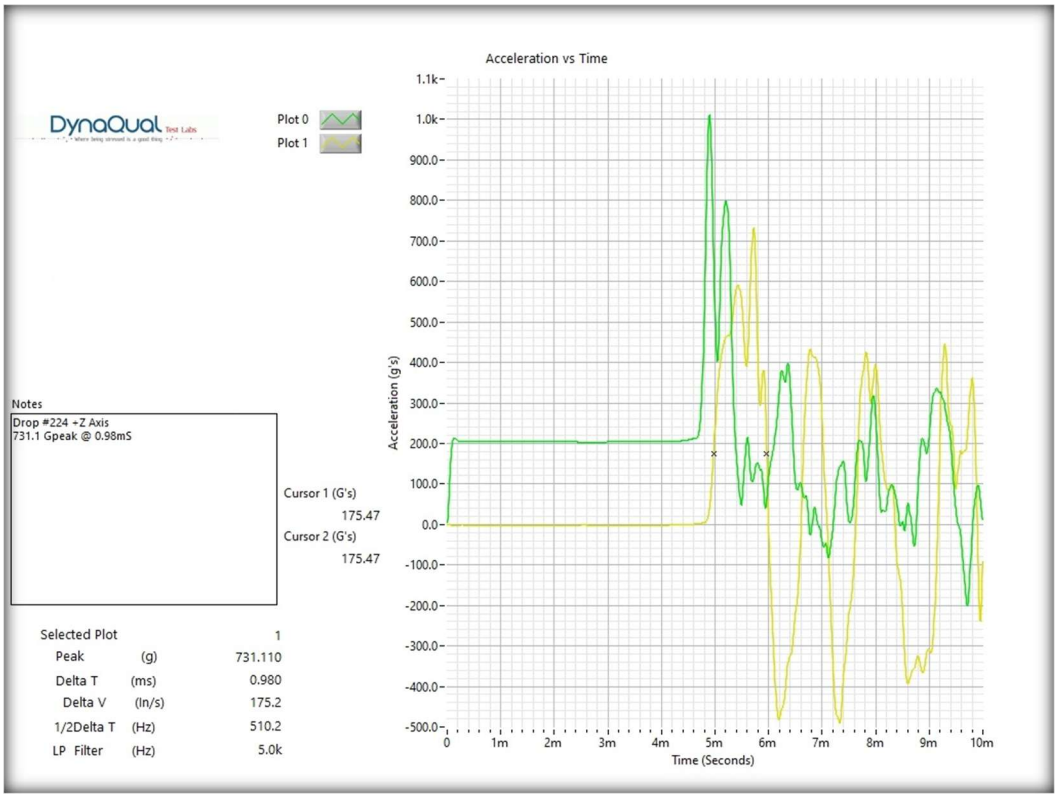


Figure 35: +Z Axis, Drop #224, 731.1 G_{peak} at 0.98mS

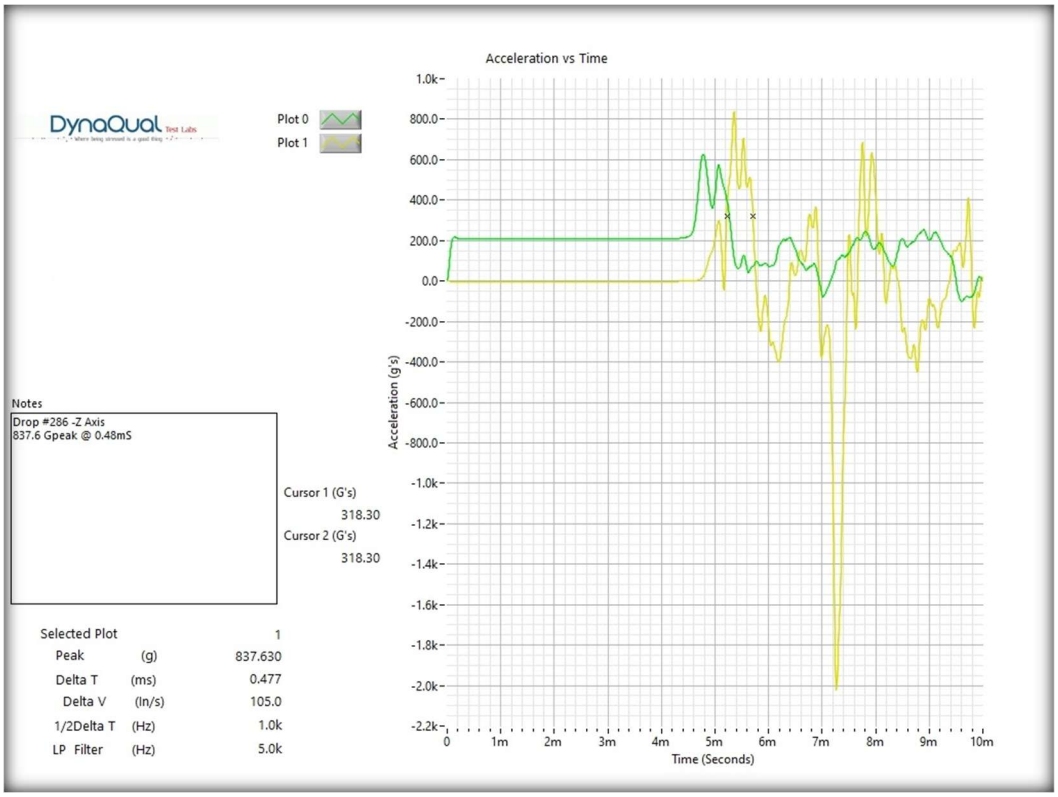


Figure 36: -Z Axis, Drop #286, 837.6 G_{peak} at 0.48mS

TESTING SUMMARY/CONCLUSIONS

The following summarizes the vibration, thermal, and pneumatic shock testing performed for [redacted] between March 6th and May 25th, 2024.

1. [redacted] DynaQual Test Labs performed sine on random vibration testing along with thermal and pneumatic shock testing [redacted] assemblies [redacted]
2. The UUT were functionally tested during the vibration and thermal portions of the testing at DynaQual. During the pneumatic shock testing, only a continuity test was performed following each axis of testing.
3. Sine on Random, random from 5-1200Hz at 23.74G_{rms}, with sine from 80-500Hz at 25G_{peak}, at 16Hz per minute, for 6 hours was performed on UUT-1 in the X, Y and Z axes. One hour at ambient temperature and +110°C, four hours at +175°C.
4. Sine on Random, random from 5-1200Hz at 23.74G_{rms}, with sine from 80-500Hz at 25G_{peak}, at 16Hz per minute, for 6 hours was performed on UUT-2 in the X and Y axes. One hour at ambient temperature and +110°C, four hours at +175°C.
5. Sine on Random, random from 5-1200Hz at 7.4G_{rms}, with sine from 80-500Hz at 3.5G_{peak}, 16Hz per minute, for 6 hours was performed on UUT-2 in the Z axis. One hour at ambient temperature and +110°C, four hours at +175°C.
6. Thermal testing was performed in DynaQual's Cincinnati Sub Zero chamber.
7. The UUT were subjected to a one-hundred-hour soak at +180°C followed immediately by 10 thermal cycles from -25°C to +180°C with thermal transition rates of approximately 4.5°C per minute and no dwell time. This process was done a total of five times for a total of 500 hours of soak time and 50 thermal cycles.
8. During the vibration and thermal testing, the UUT were functionally tested using a DC power supply and running a 5-volt DC signal through the connector and logging this voltage using a Dataq datalogger. No UUT failures occurred during this period. The UUT also had a continuity check done following each axis of vibration testing and the at the conclusion of the thermal testing.
9. Pneumatic shock testing was done on DynaQual's VST shock machine with a target level of 800 G_{peak} with duration of .5mS. A minimum of 50 drops was to be done in each of the ±X, Y, and Z axes.
10. UUT-2 only was subjected to pneumatic shock testing and was tested for continuity during the shock testing using the same equipment as during the vibration testing. A continuity check was also performed following each axis of testing with no failures occurring.
11. All the Dataq data used to check the continuity during testing, were checked for failures with no failures occurring. These files will be stored at DynaQual and are available upon request.
12. The testing provided quality data for further analysis by [redacted] personnel.

Data File Provided to Customer
(Profile Screen Shots, Graphs, Test Data, Pictures of set up)