DynaQual Test Labs

Where being stressed is a good thing

PJLA

ISO 17025: 2017 ACCREDITED (#79999)

Test Report

Pneumatic Shock

TR-032221-1 March 22-26, 2021

COMPANY: AT Controls
12840 Sugar Ridge Blvd
Stafford, Texas 77477

COMPANY REP(s): Pete Vezey, Celso Siado

DYNAQUAL TEST TECH(s): Eric Allen, Zachary Hausler

PRODUCT(S) TESTED: Actuators

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.

APPROVAL SIGNATURE SECTION:

Testing Performed By:

Eric Allen, Business Development Manager

Zachary Hausler, Lab Technician

Approved By:

Bill Burt, Sr. Lab Technician

4/12/2021
Date

PROJECT SCOPE

AT Controls requested the services of DynaQual Test Labs to perform pneumatic shock testing on nine, (9) Actuator assemblies and three mass models per IEC 60068-2-27 standard.

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

Definitions

UUT – Unit(s) under Test

UUT Identification

The UUT and date the units were subjected to testing is shown in Table 1.

Table 1 – Product Identifiers

UUT	Description	Type/Configuration	S/N	Dates Tested
0	Actuator	KER-440 Mass Model	N/A	
1	Actuator	KER-440	56546-2	
2	Actuator	WER/SER-690 Mass Model	N/A	
3	Actuator	WER-690	56546-3	
4	Actuator	SER-690	56546-8	
5	Actuator	WER-1350	56546-4	
6	Actuator	SER-1350	56546-9	
7	Actuator	WER/SER-4400 Mass Model	N/A	
8	Actuator	SER-4400	56546-10	
9	Actuator	WER-4400	56546-6	
10	Actuator	WER-2640	56546-5	
11	Actuator	WER-10500	56546-7	

PNEUMATIC SHOCK TESTING PARAMETERS/SETUP

Description of Test Equipment

Table 2 – Test Equipment

Description	*Manufacturer*	*Model*	*S/N*	*Cal Due*
VST DAQ	VST	DAS4U	DAS4U-367681	8/16/2021
Table Accelerometer	PCB	350C04	62843	10/26/2021
Response Accelerometer	PCB	353B11	164921	6/1/2022

Shock System: VST Pneumatic Shock Machine PSM600HP-3030 with a four channel acquisition system was used to perform the pneumatic shock, Figure 1.

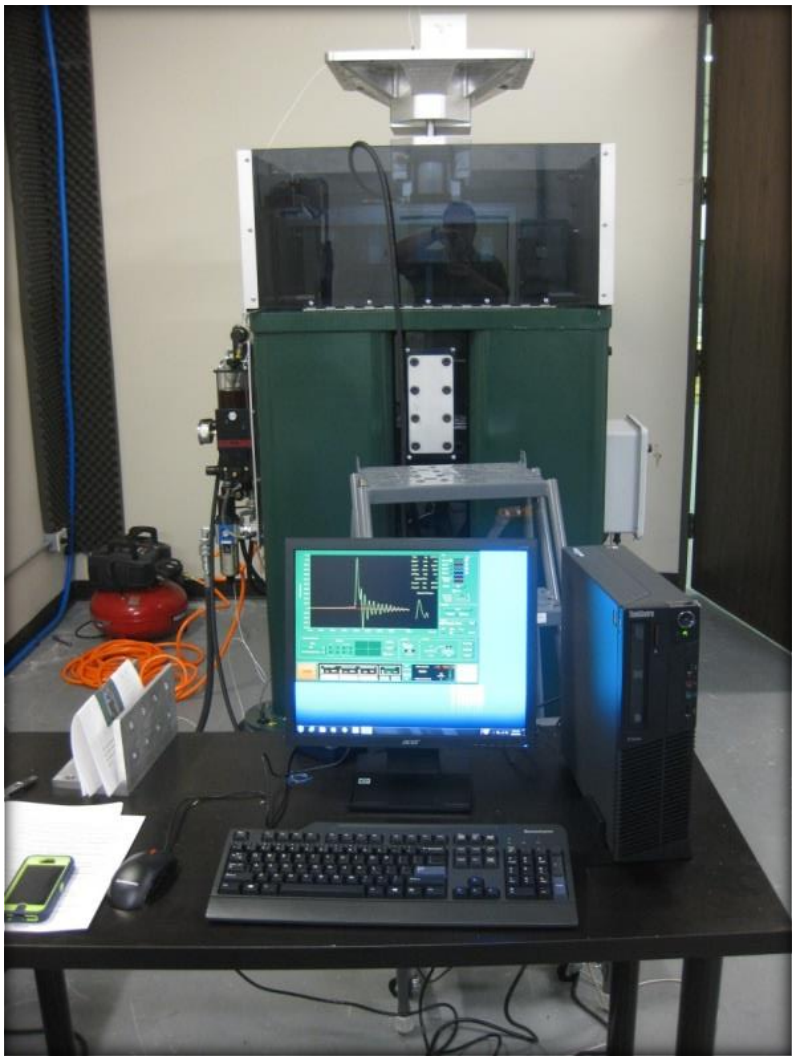

Figure 1: Shock control workstation

Fixturing

The UUT were tested individually and were secured to a single transfer plate for testing. For Z positive testing the transfer plate was secured directly to the shock machine carriage. For Z negative testing the transfer plate was secured to a small L-bracket that was secured to a large L-bracket to suspend the UUT 180° from the Z positive configuration. For the +/- X and Y axes testing, the small L-bracket was removed, and the transfer plate was secured to the large L-bracket. To differentiate between the +/- X and Y axes, the UUT were rotated in 90° increments on the transfer plate. See Figures 2-43 below for illustrations of the UUT fixturing to the pneumatic shock machine along with detailed views of the control and response accelerometer locations. Note that several of the UUT were the same type and therefore illustrations of fixturing are not provided for all the UUT, but their photos are included with the customer data files made available along with this report.

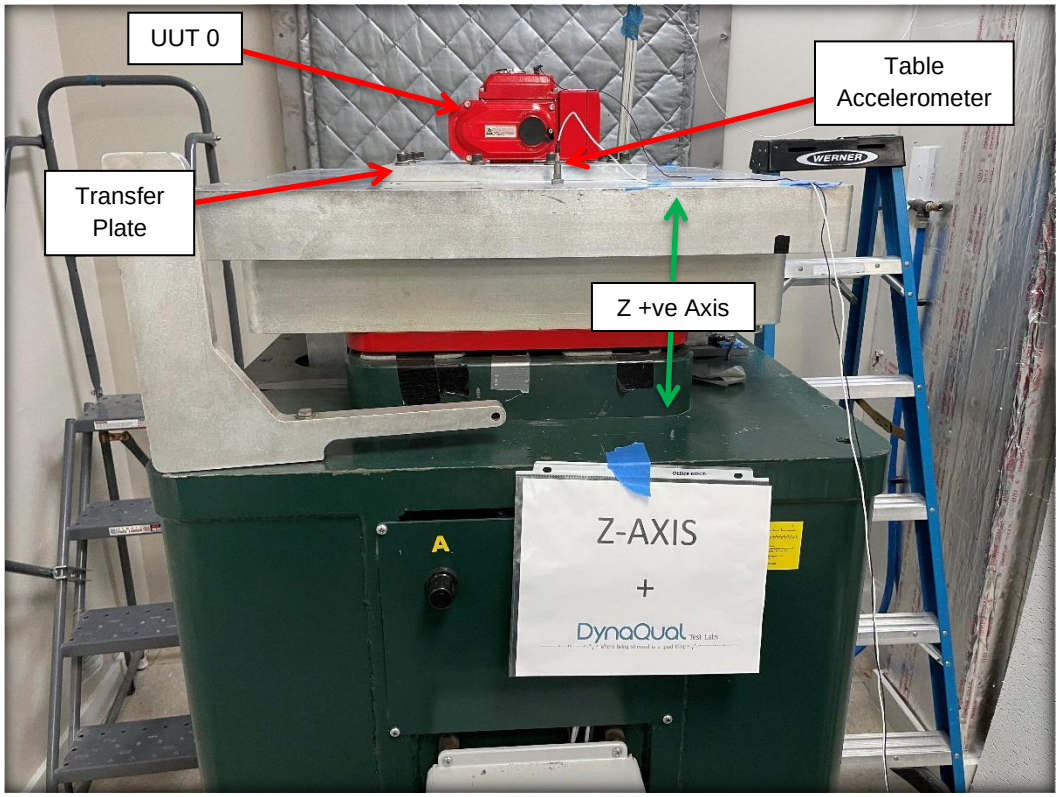

Figure 2: UUT 0 (Mass Model) shown fixtured for Z +ve axis testing – Type "KER" units

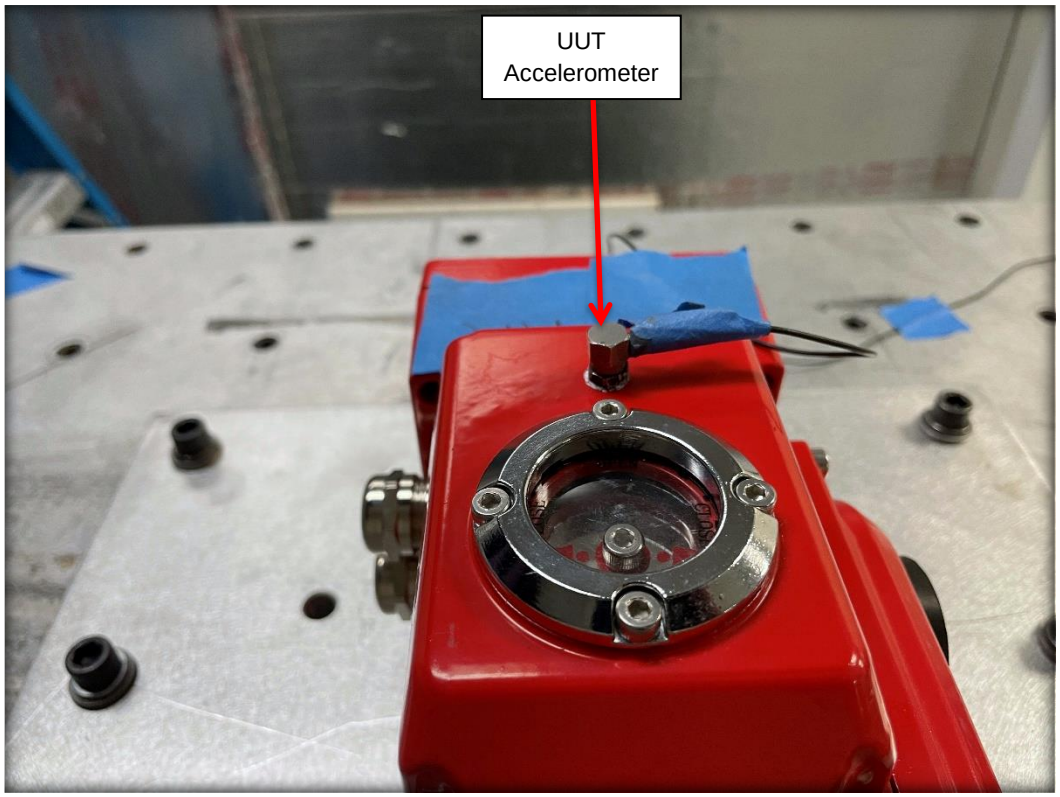

Figure 3: Detailed view of UUT accelerometer location for Z +ve axis testing – Type "KER" units

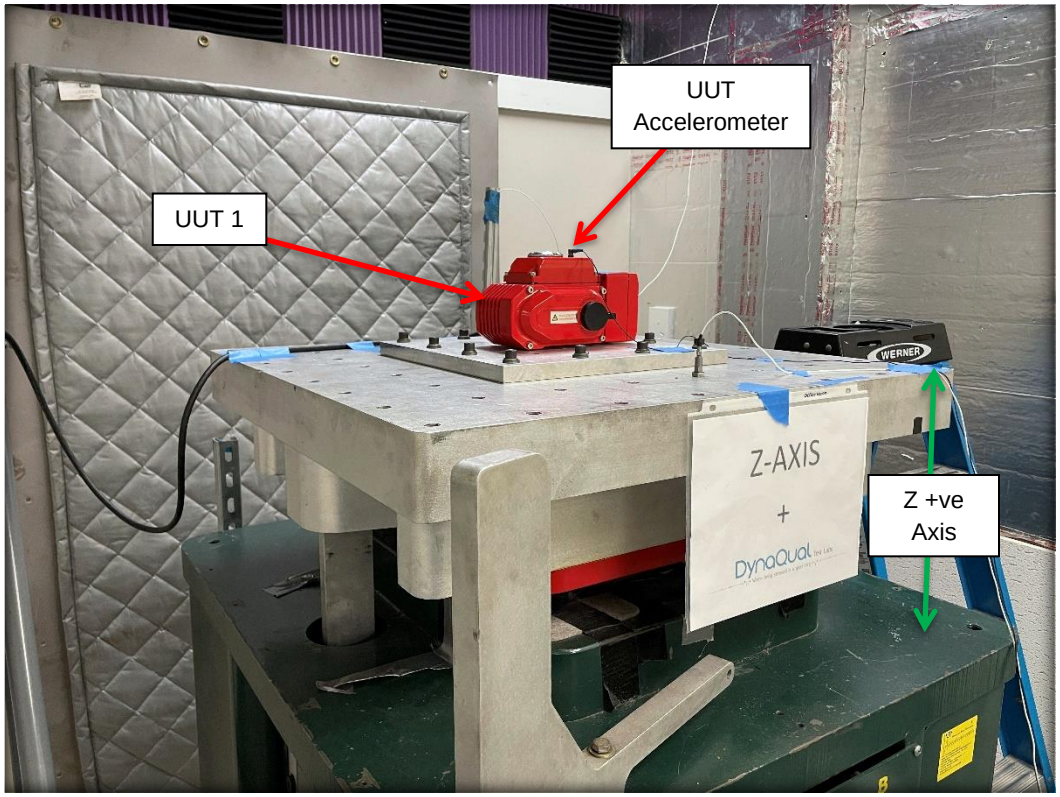

Figure 4: UUT 1 shown fixtured for Z +ve axis testing

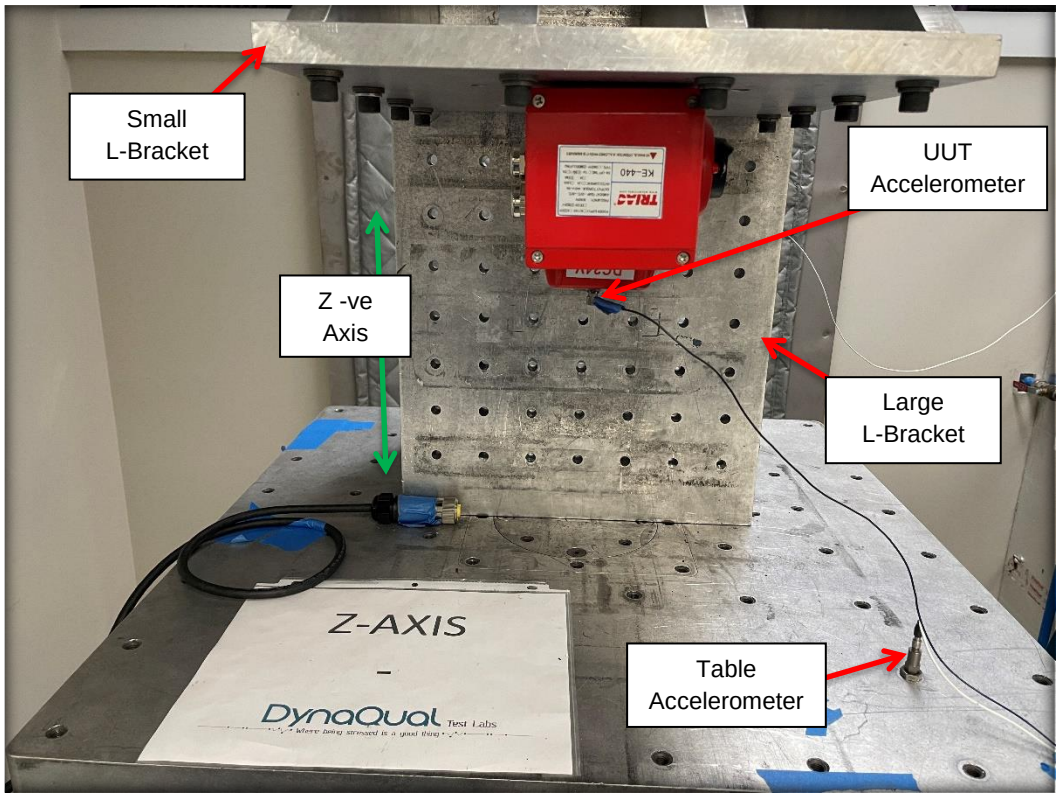

Figure 5: UUT 0 (Mass Model) shown fixtured for Z -ve axis testing – Type "KER" units

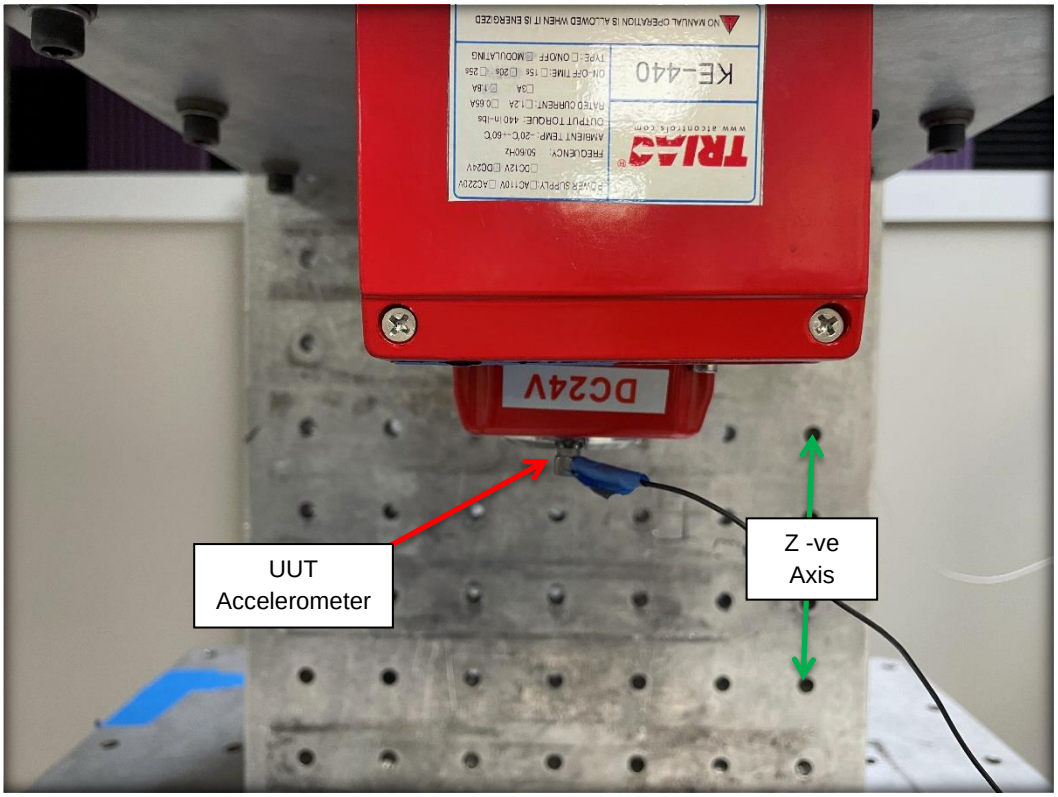

Figure 6: Detailed view of UUT accelerometer location for Z -ve axis testing – Type "KER" units

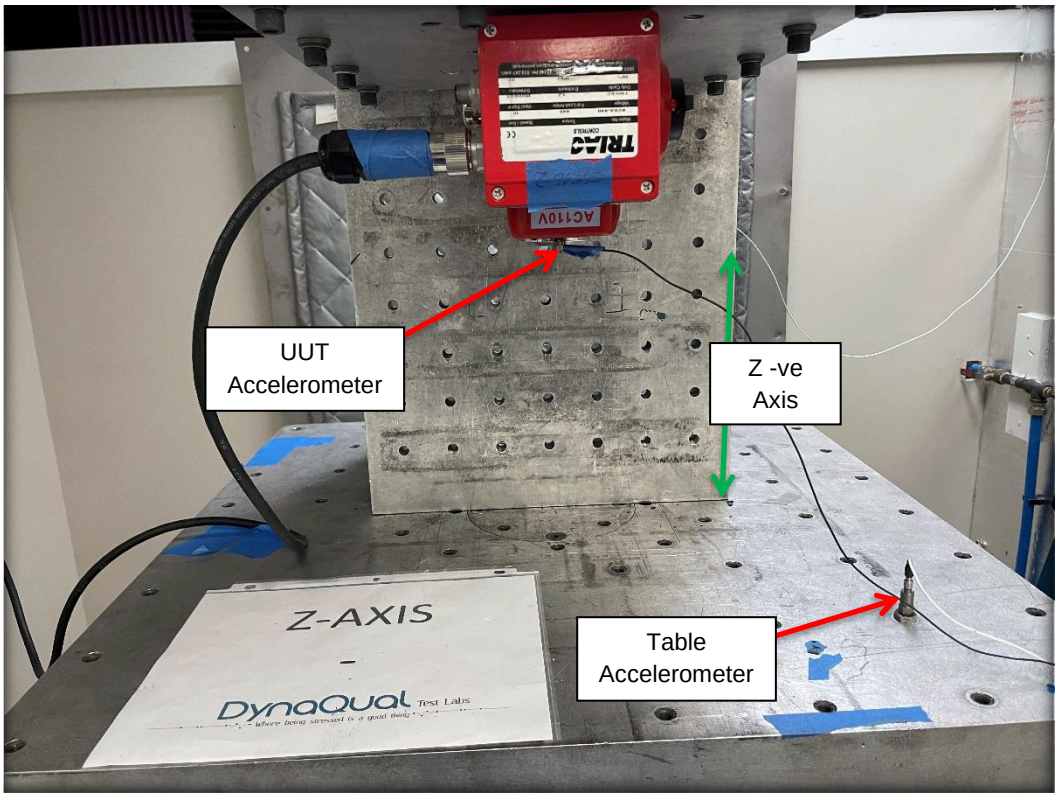

Figure 7: UUT 1 shown fixtured for Z -ve axis testing

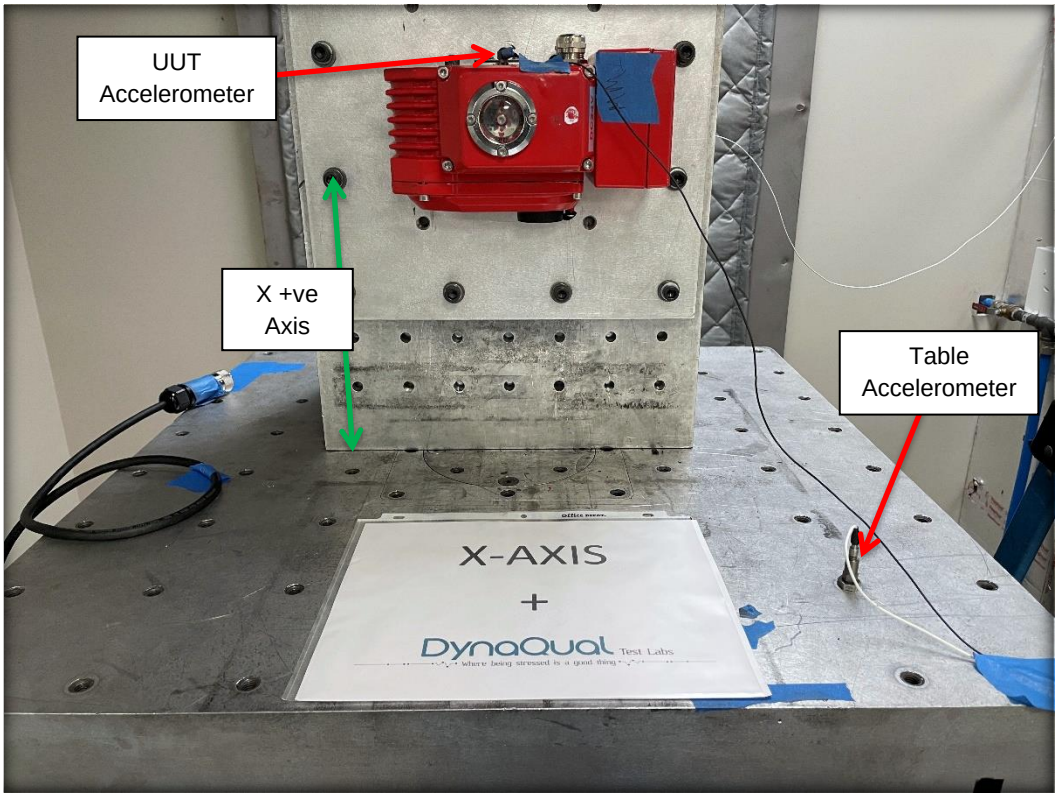

Figure 8: UUT 0 (Mass Model) shown fixtured for X +ve axis testing – Type "KER" units

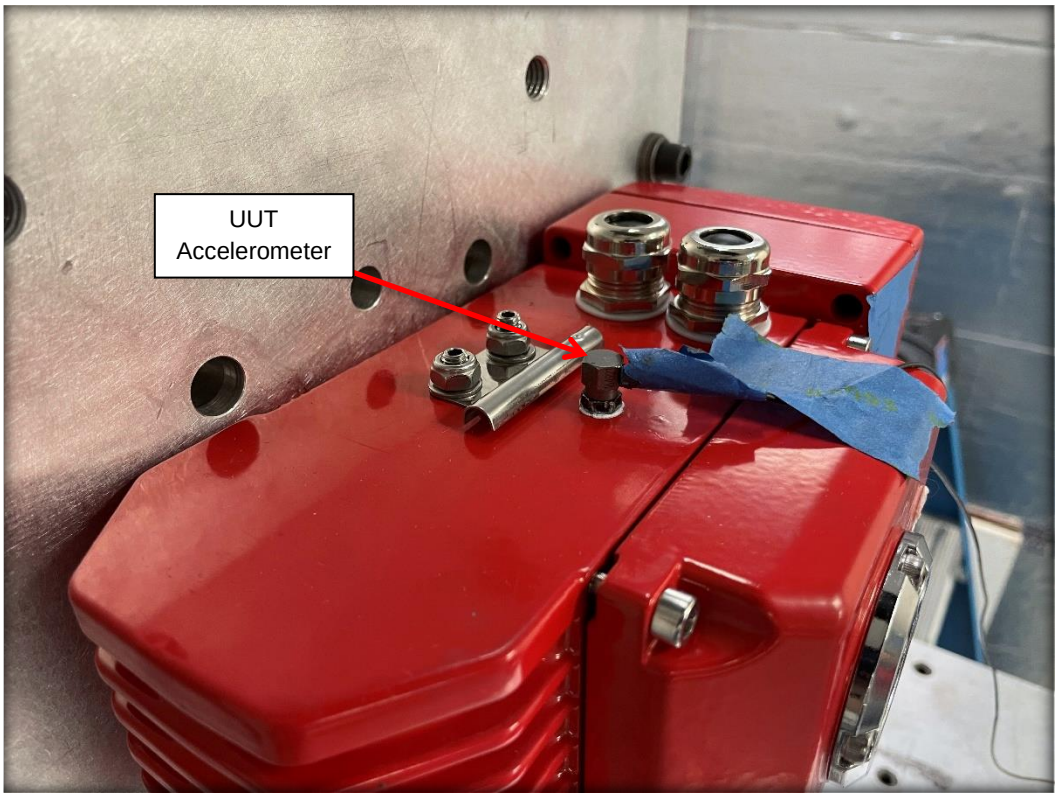

Figure 9: Detailed view of UUT accelerometer location for X +ve axis testing – Type "KER" units

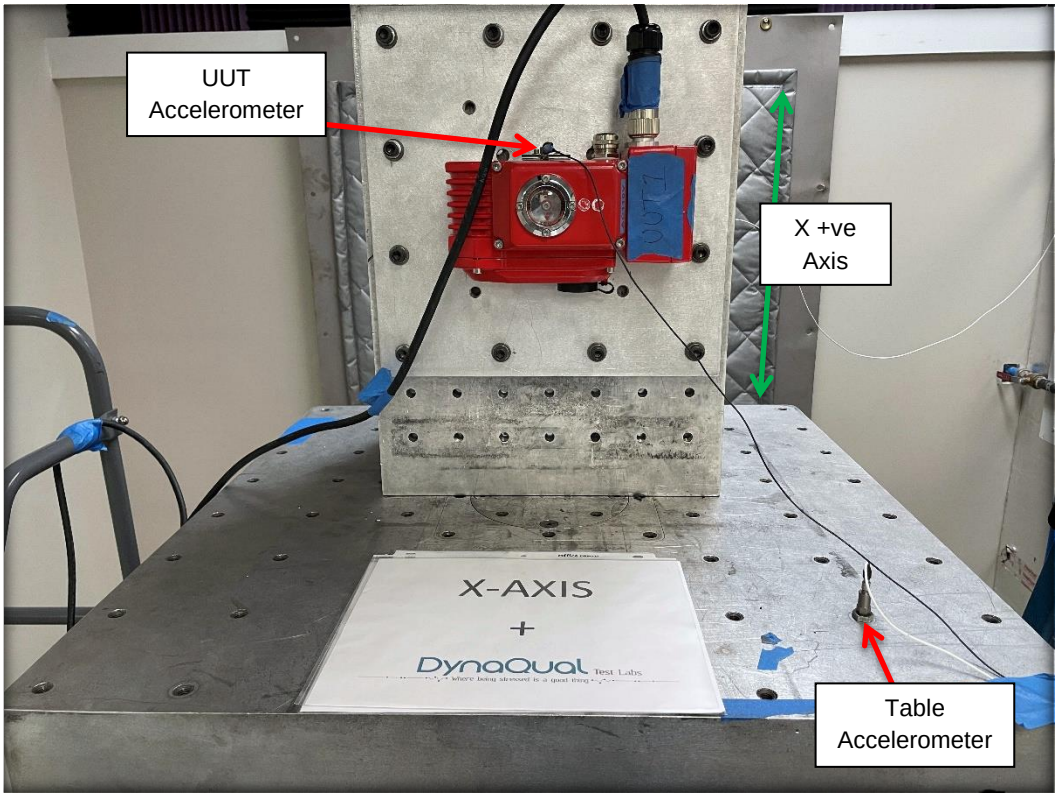

Figure 10: UUT 1 shown fixtured for X +ve axis testing

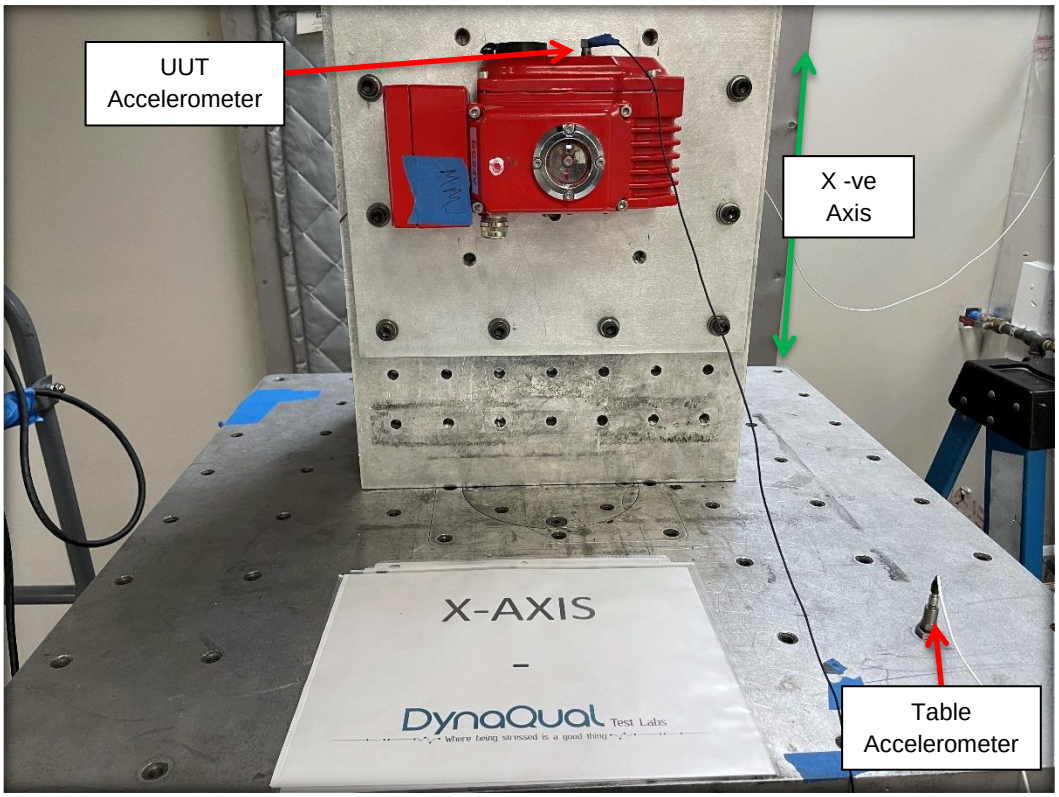

Figure 11: UUT 0 (Mass Model) shown fixtured for X -ve axis testing – Type "KER" units

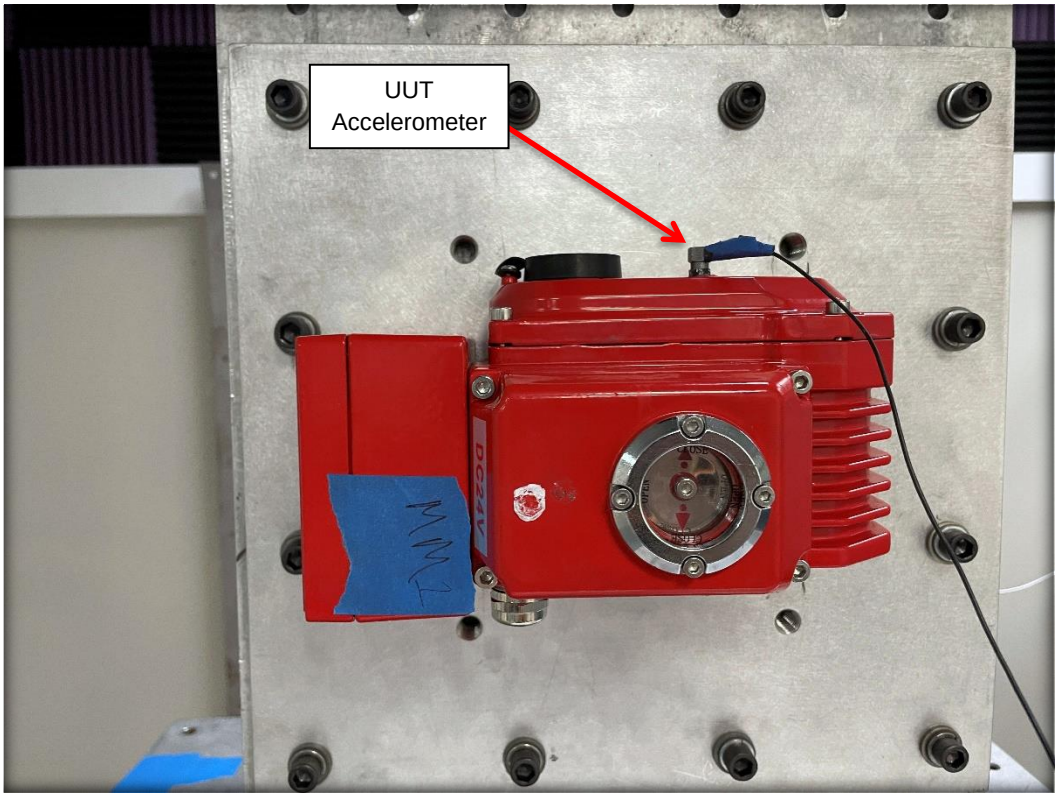

Figure 12: Detailed view of UUT accelerometer location for X -ve axis testing – Type "KER" units

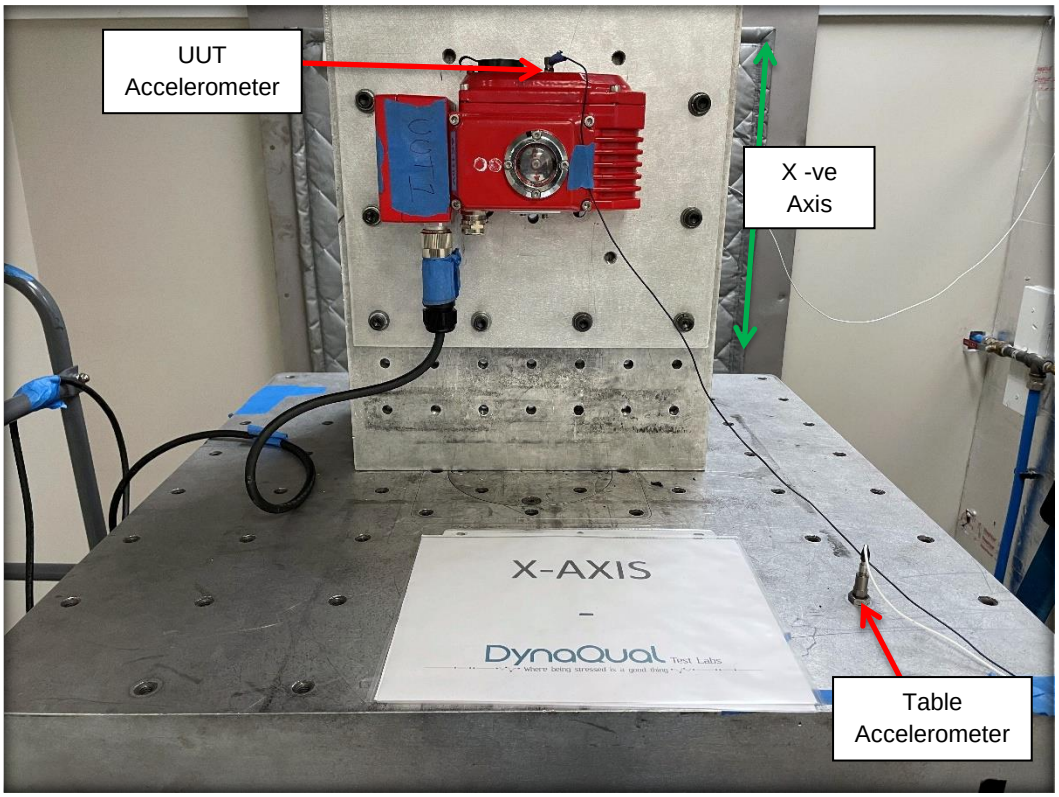

Figure 13: UUT 1 shown fixtured for X -ve axis testing

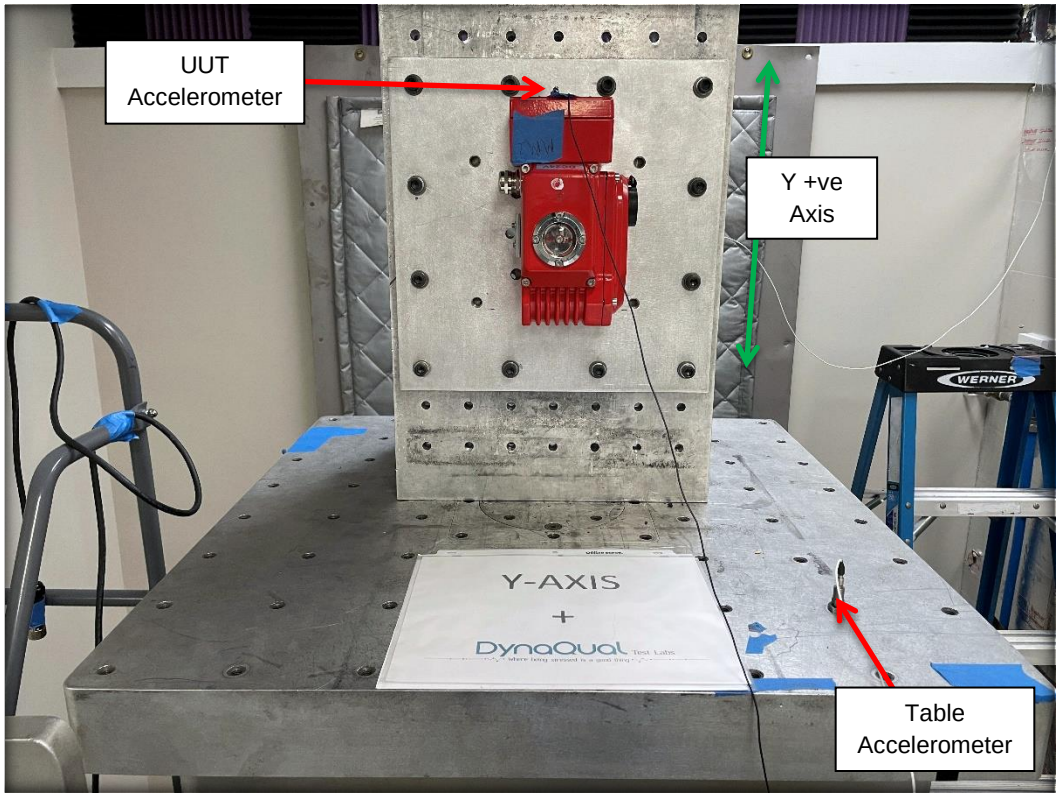

Figure 14: UUT 0 (Mass Model) shown fixtured for Y +ve axis testing – Type "KER" units

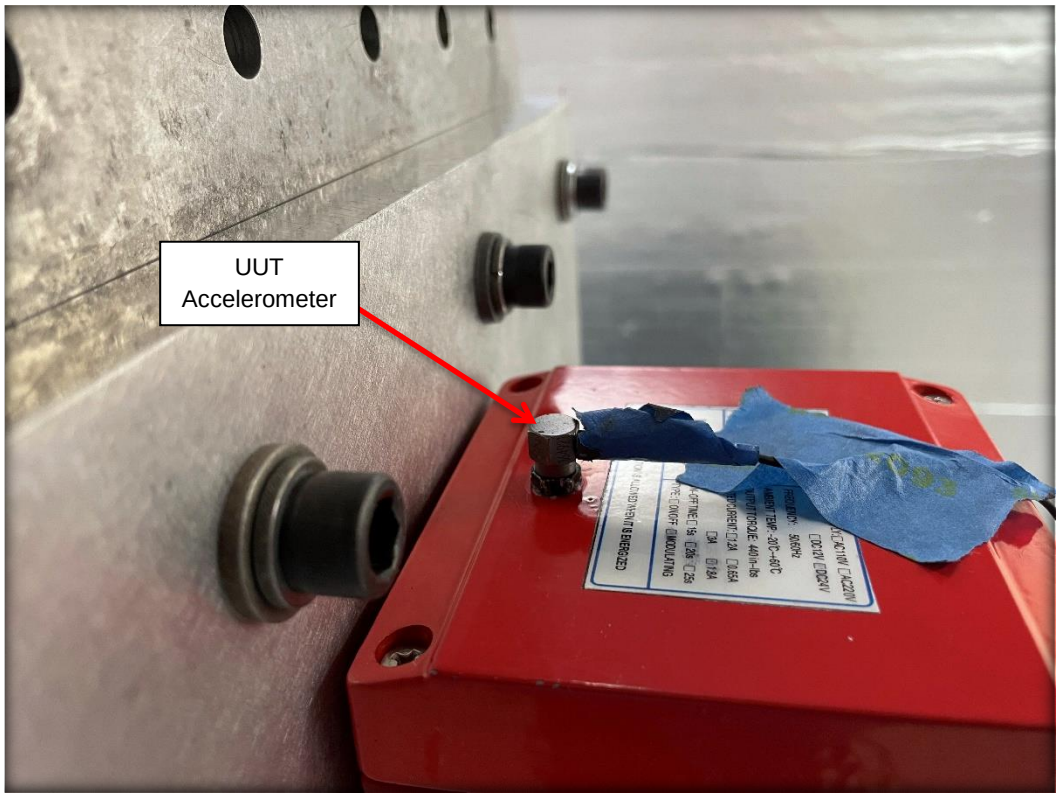

Figure 15: Detailed view of UUT accelerometer location for Y +ve axis testing – Type "KER" units

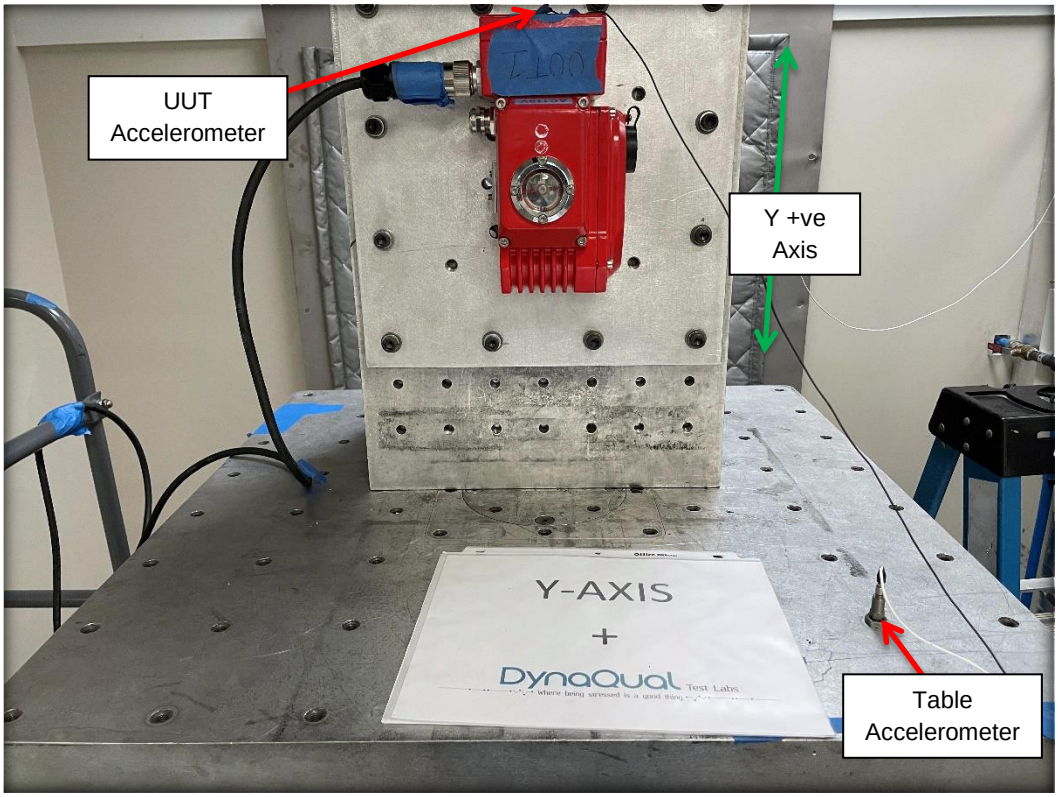

Figure 16: UUT 1 shown fixtured for Y +ve axis testing

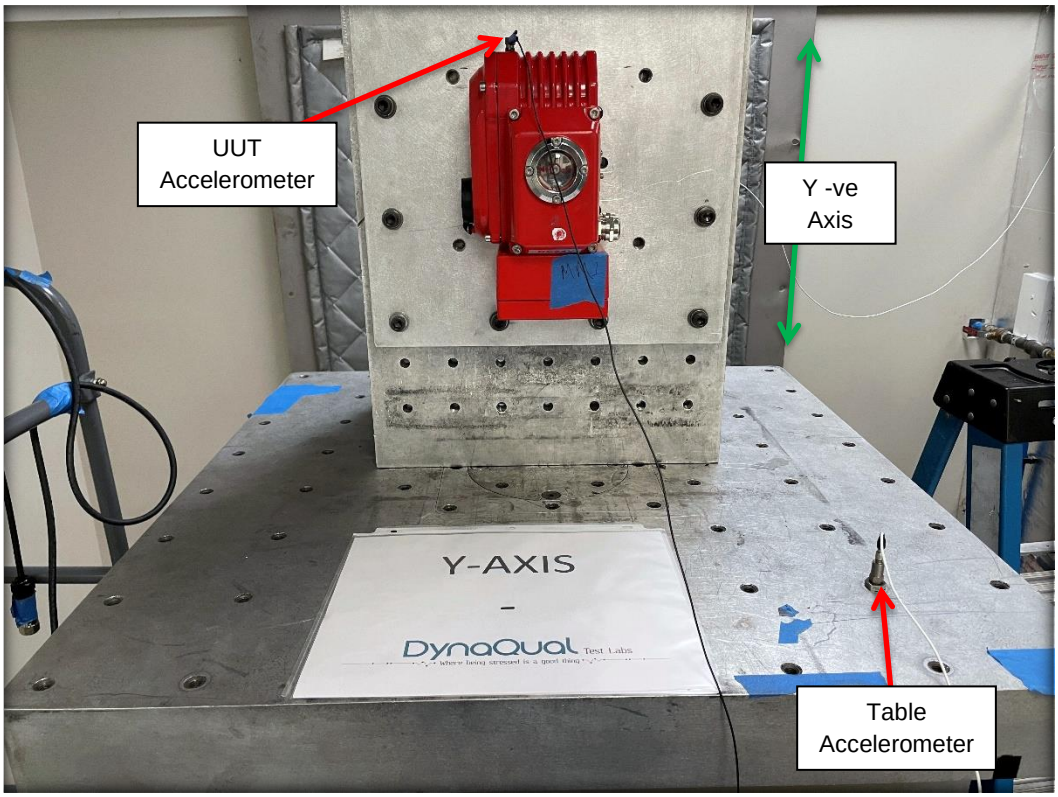

Figure 17: UUT 0 (Mass Model) shown fixtured for Y -ve axis testing – Type "KER" units

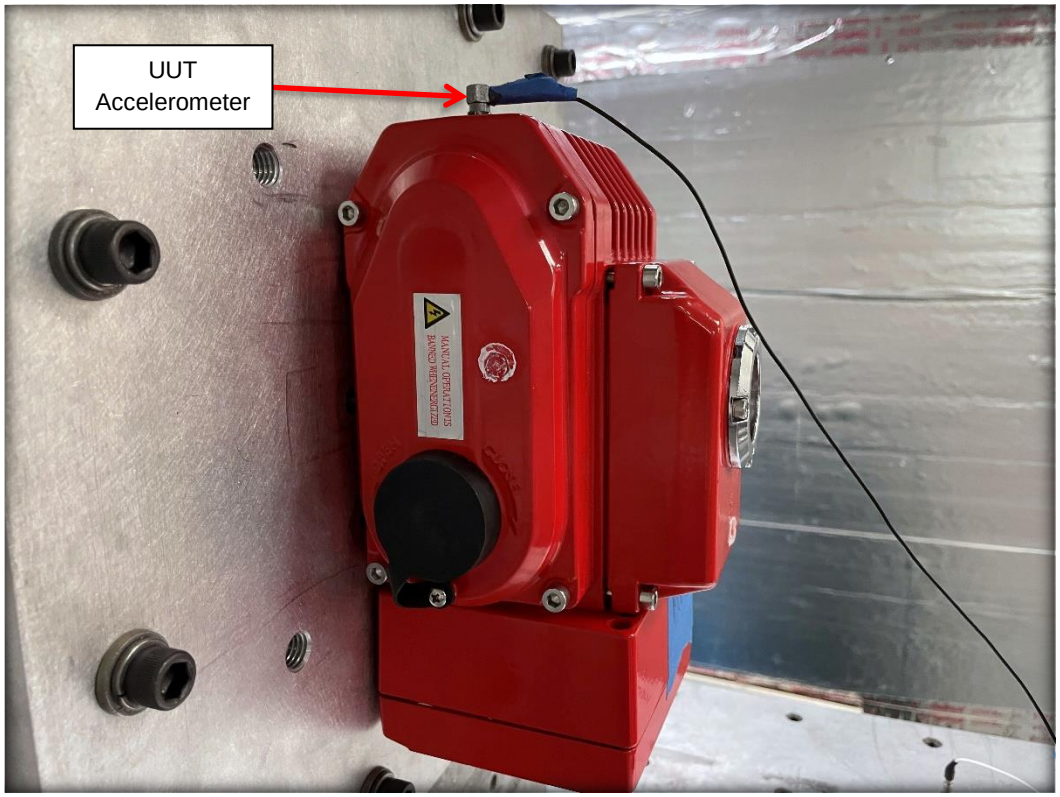

Figure 18: Detailed view of UUT accelerometer location for Y -ve axis testing – Type "KER" units

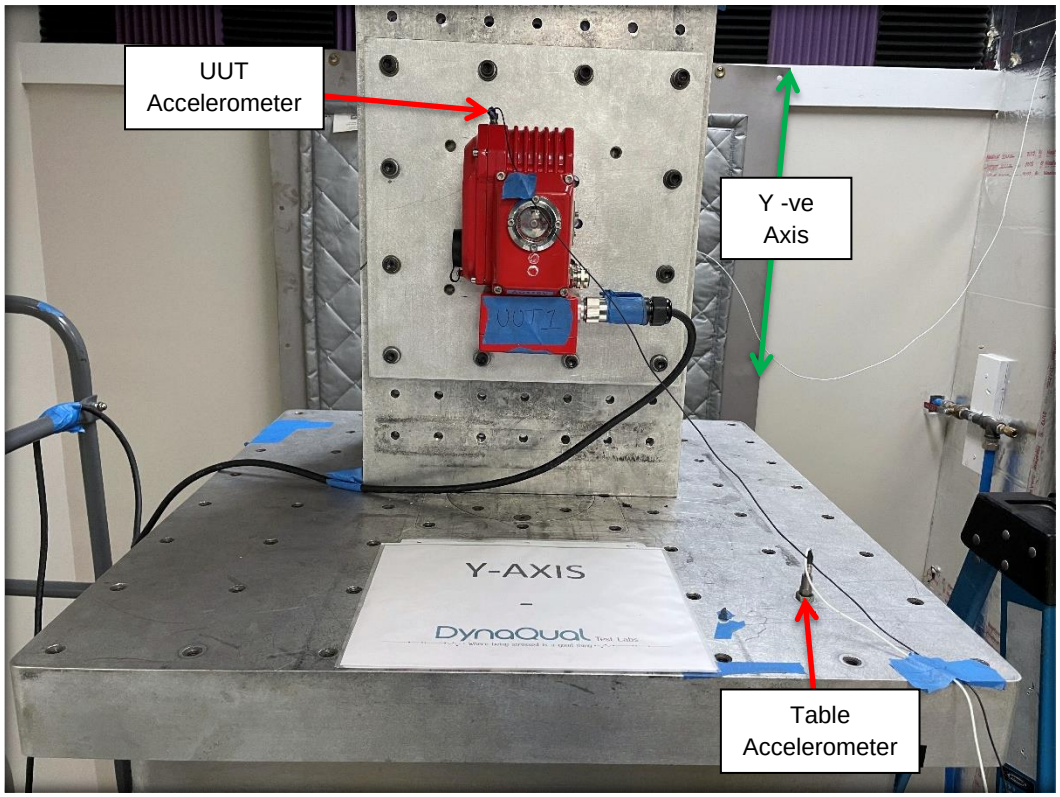

Figure 19: UUT 1 shown fixtured for Y -ve axis testing

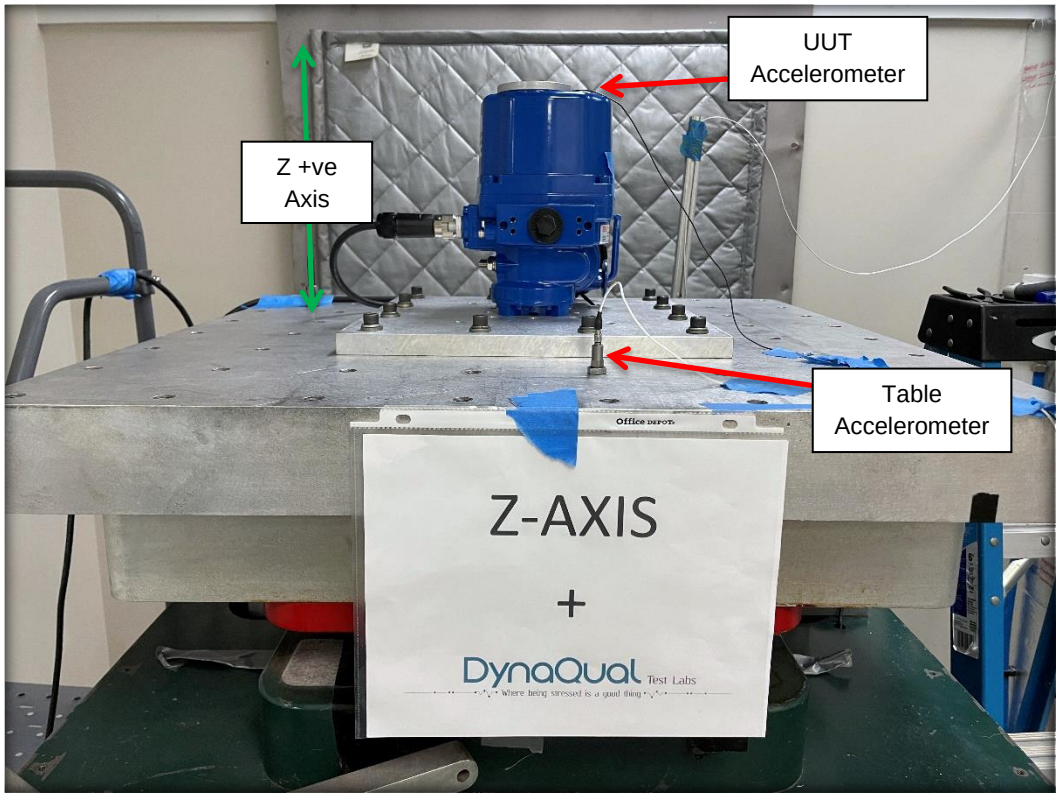

Figure 20: UUT 4 shown fixtured for Z +ve axis testing

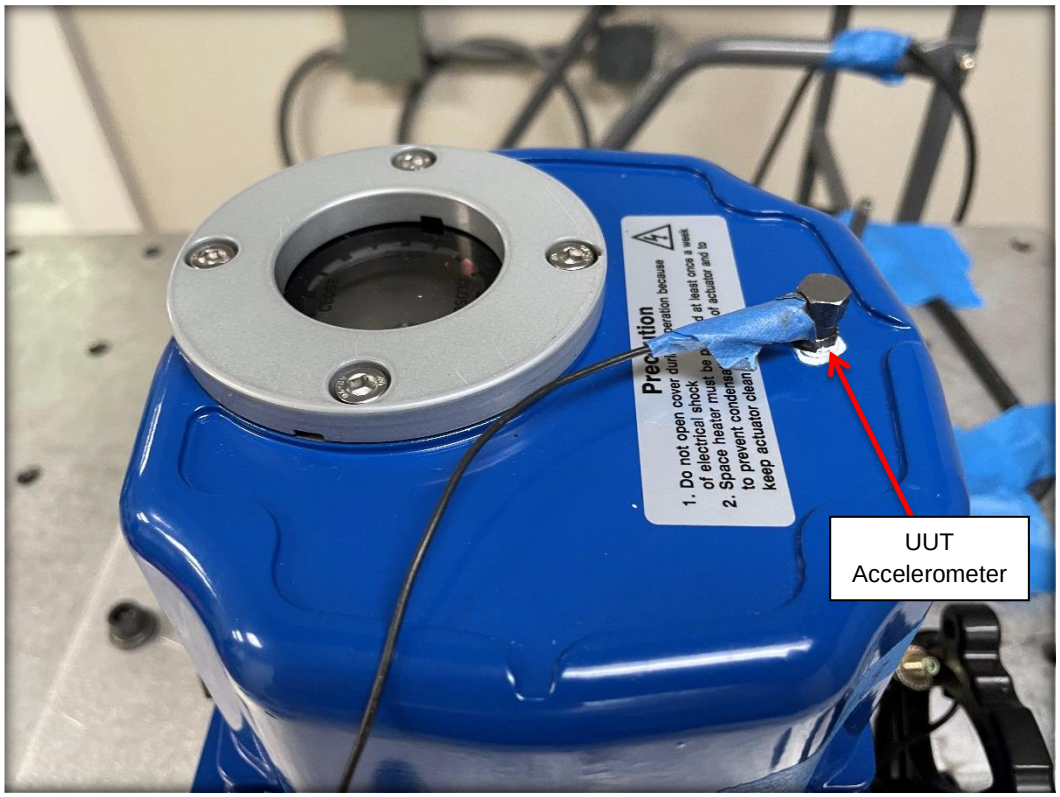

Figure 21: Detailed view of UUT accelerometer location for Z +ve axis testing – Type "SER" units

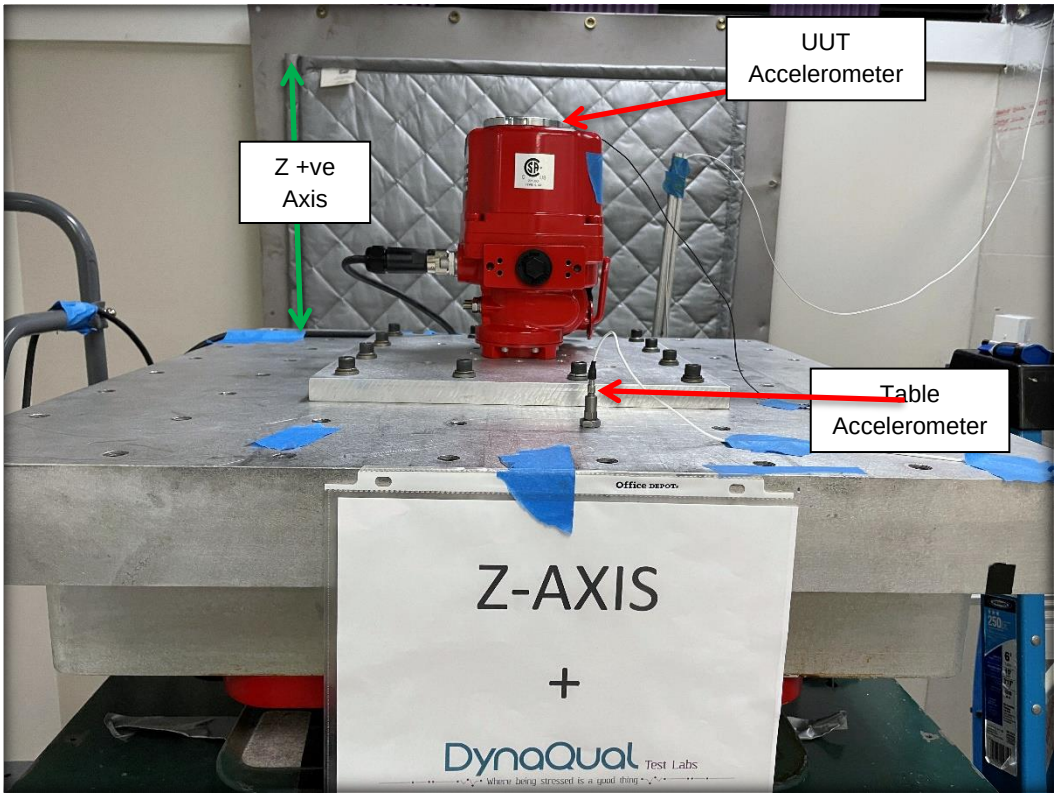

Figure 22: UUT 3 shown fixtured for Z +ve axis testing

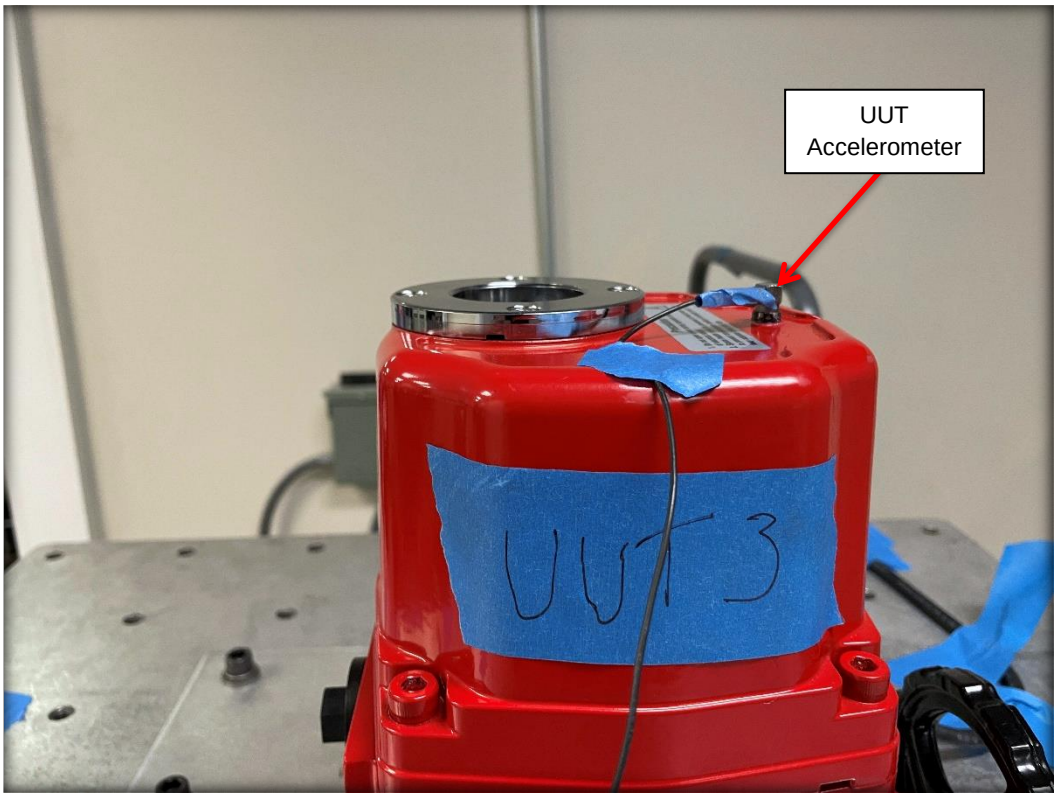

Figure 23: Detailed view of UUT accelerometer location for Z +ve axis testing – Type "WER" units

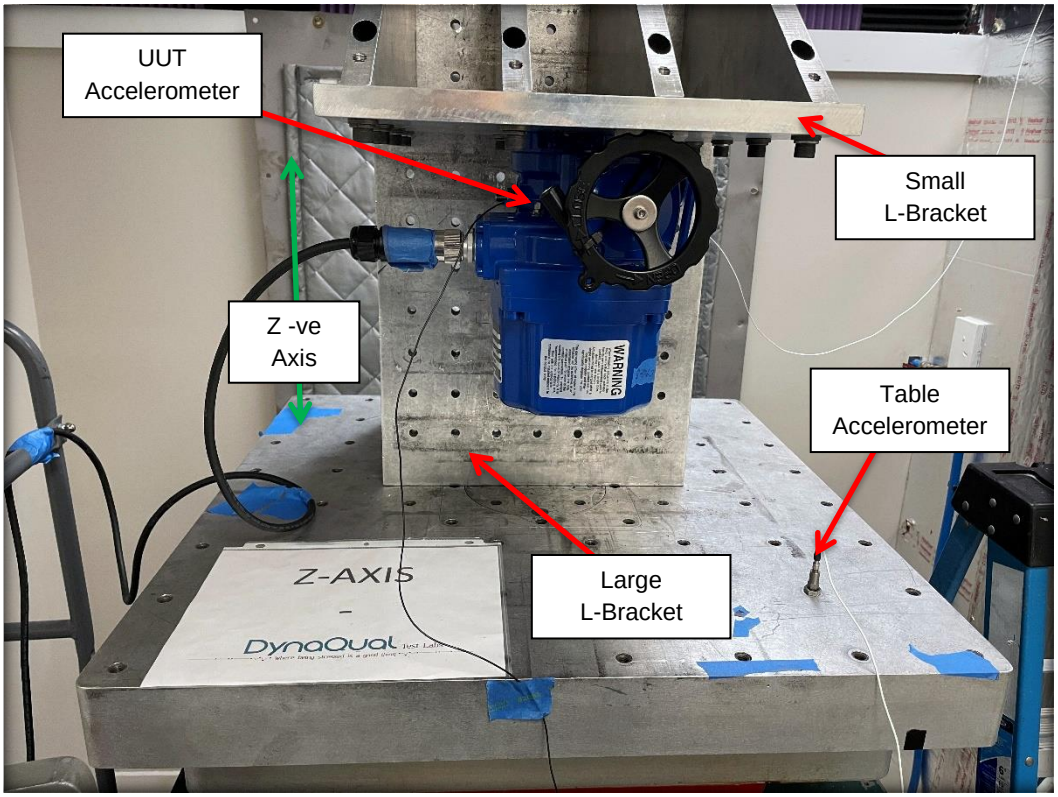

Figure 24: UUT 4 shown fixtured for Z -ve axis testing

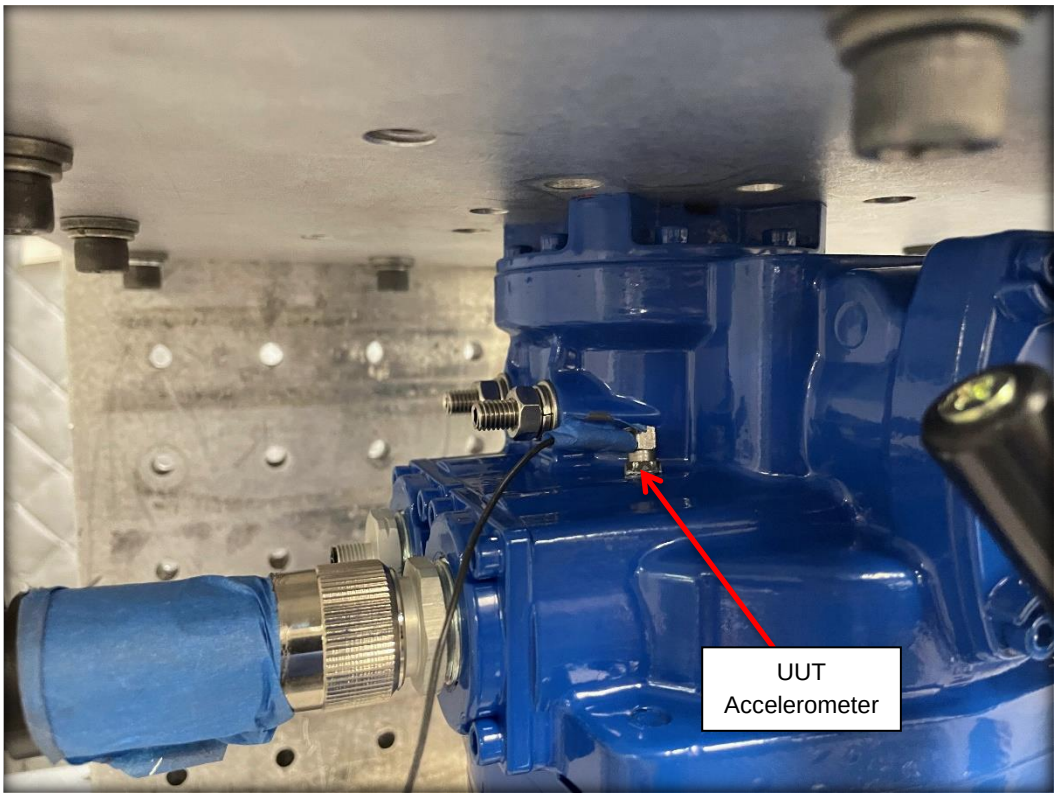

Figure 25: Detailed view of UUT accelerometer location for Z -ve axis testing – Type "SER" units

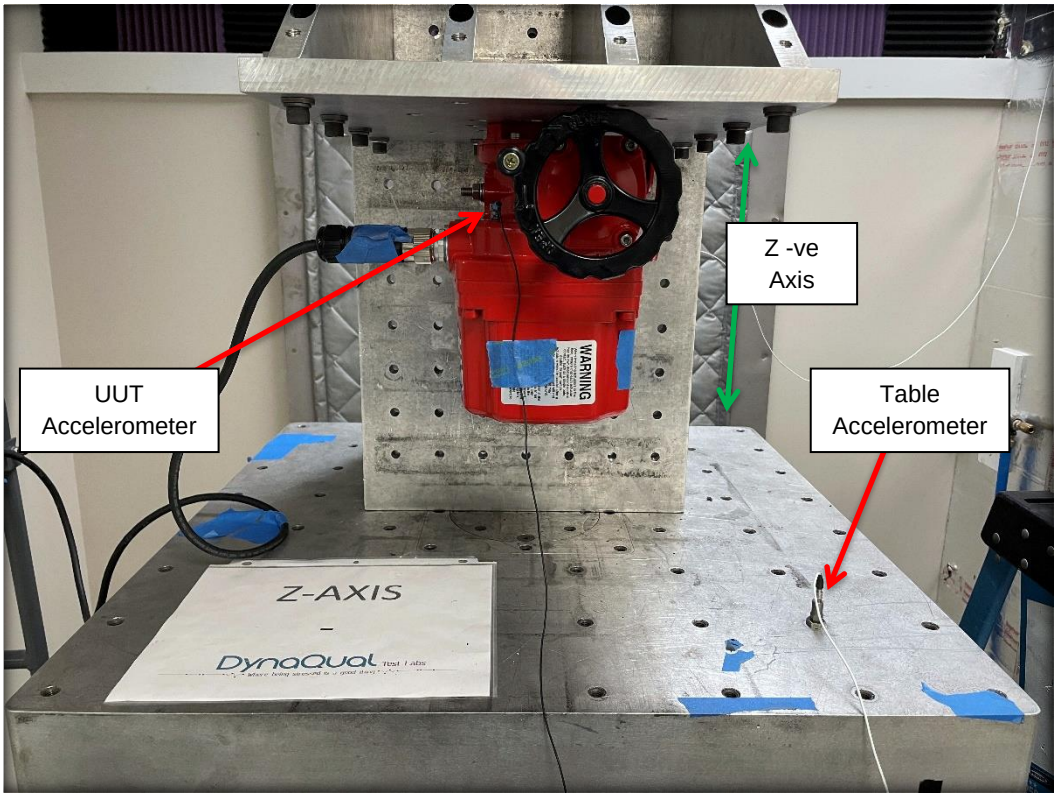

Figure 26: UUT 3 shown fixtured for Z -ve axis testing

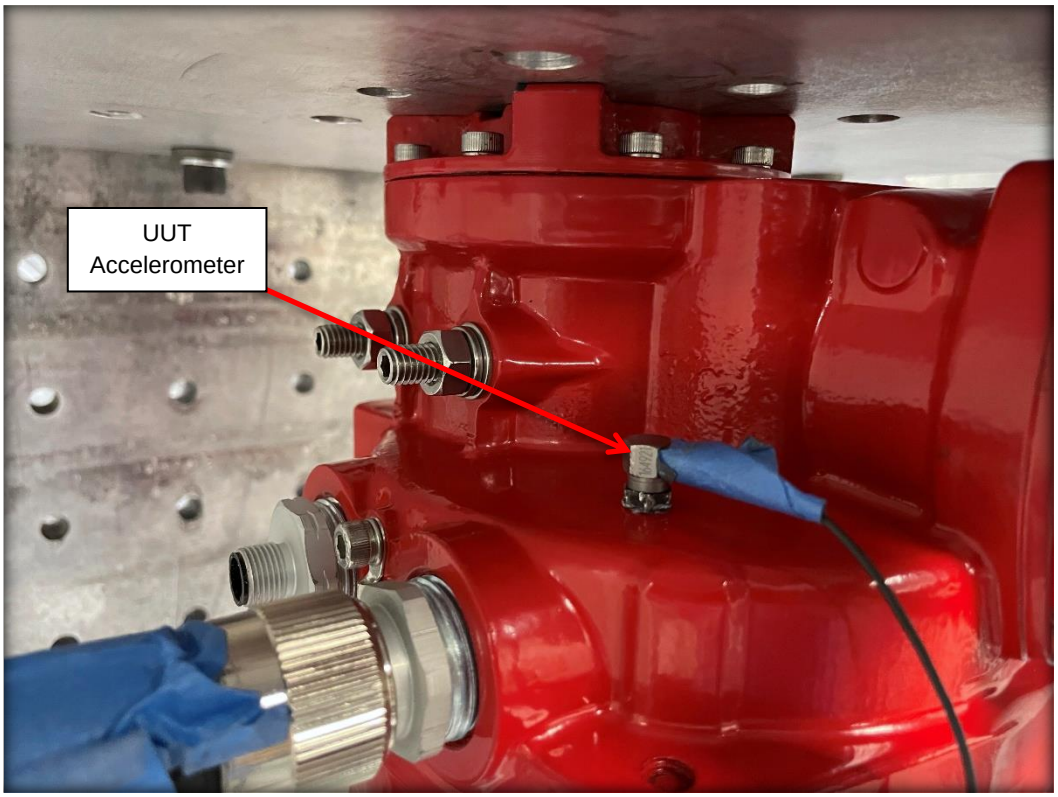

Figure 27: Detailed view of UUT accelerometer location for Z -ve axis testing – Type "WER" units

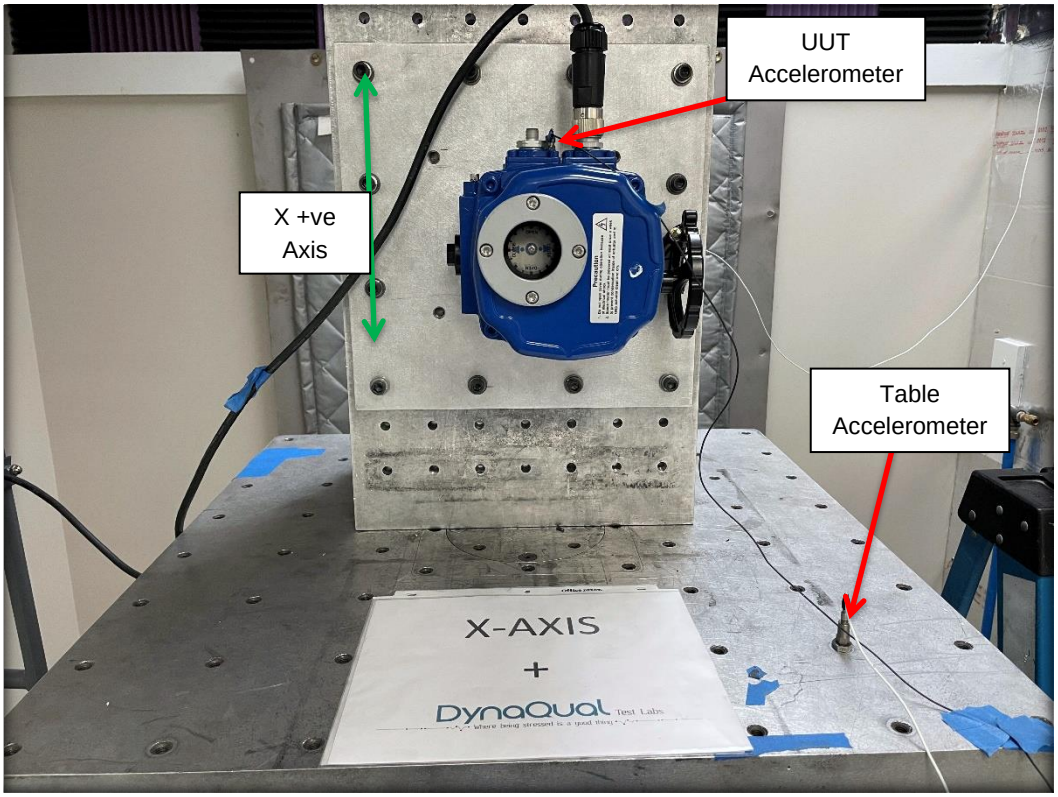

Figure 28: UUT 4 shown fixtured for X +ve axis testing

Figure 29: Detailed view of UUT accelerometer location for X +ve axis testing – Type "SER" units

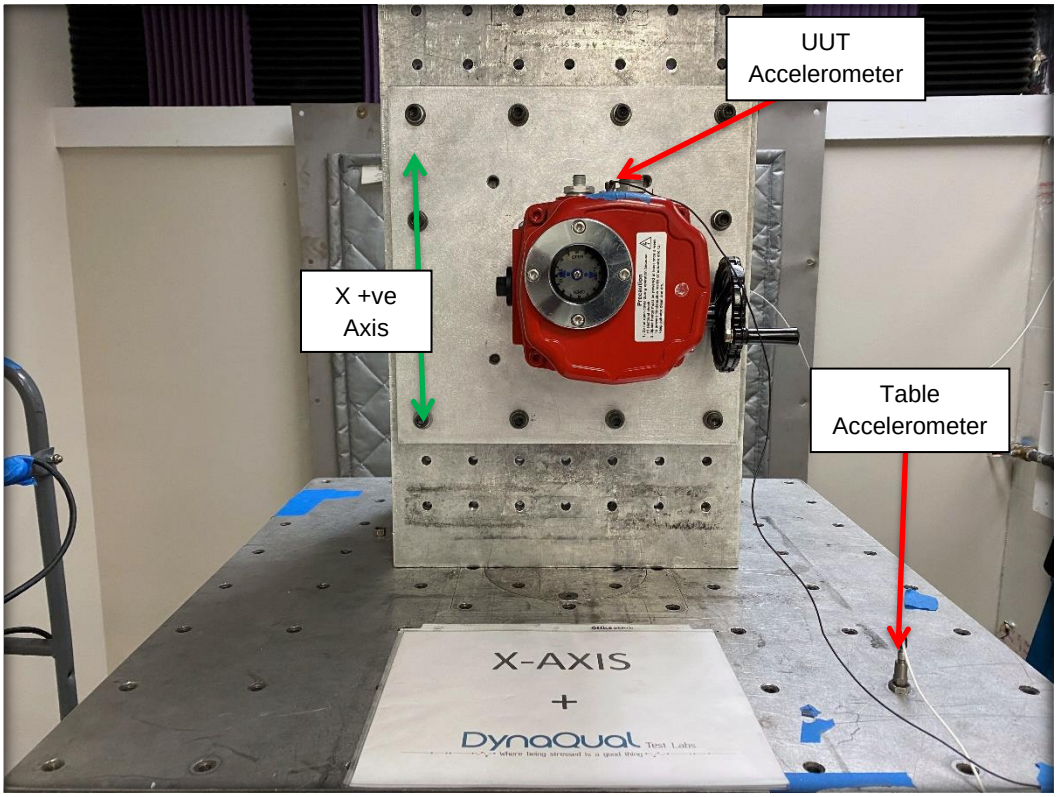

Figure 30: UUT 3 shown fixtured for X +ve axis testing

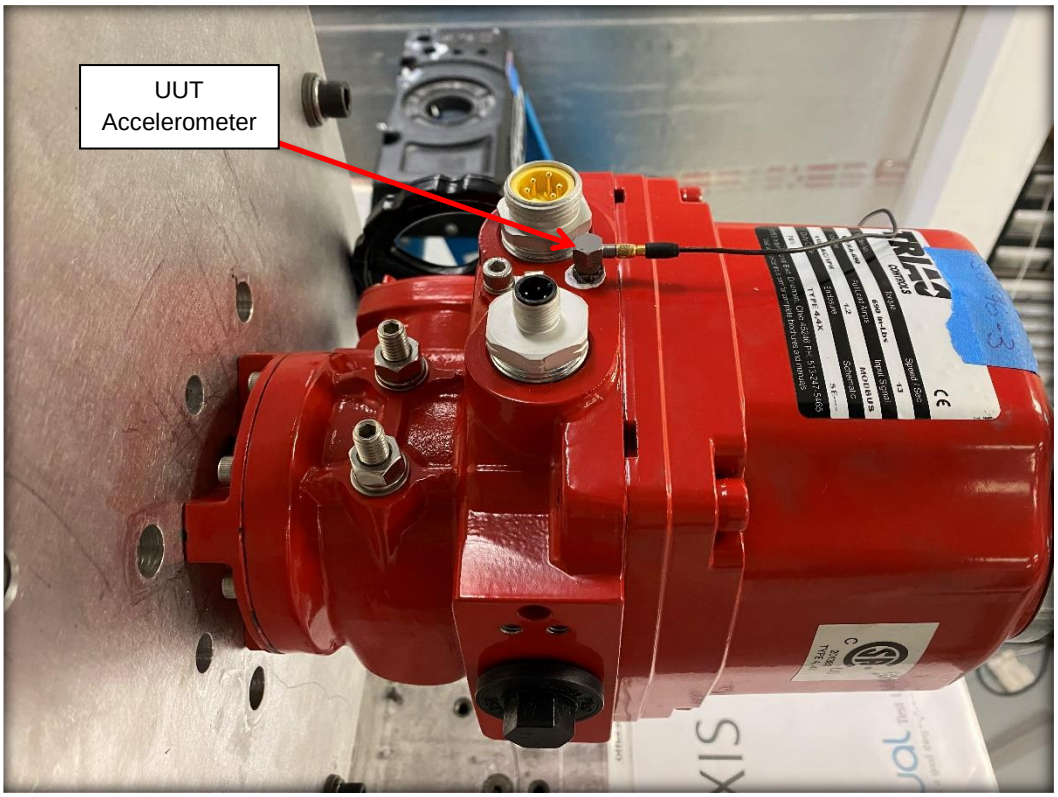

Figure 31: Detailed view of UUT accelerometer location for X +ve axis testing – Type "WER" units

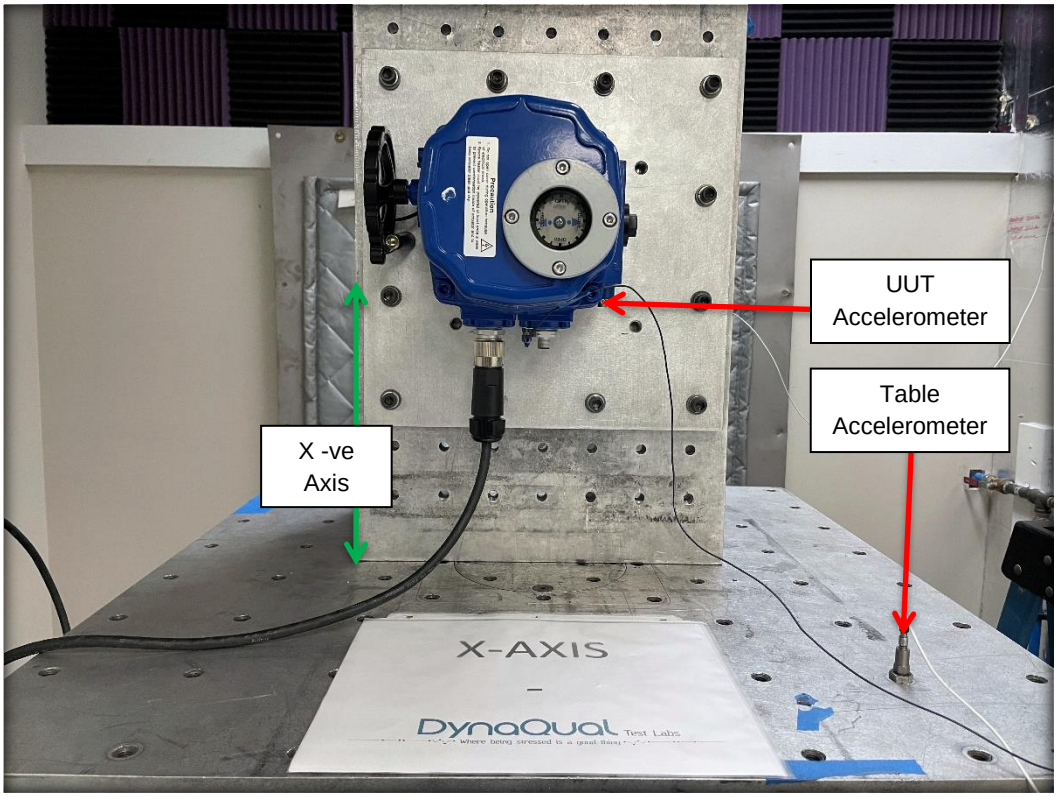

Figure 32: UUT 4 shown fixtured for X -ve axis testing

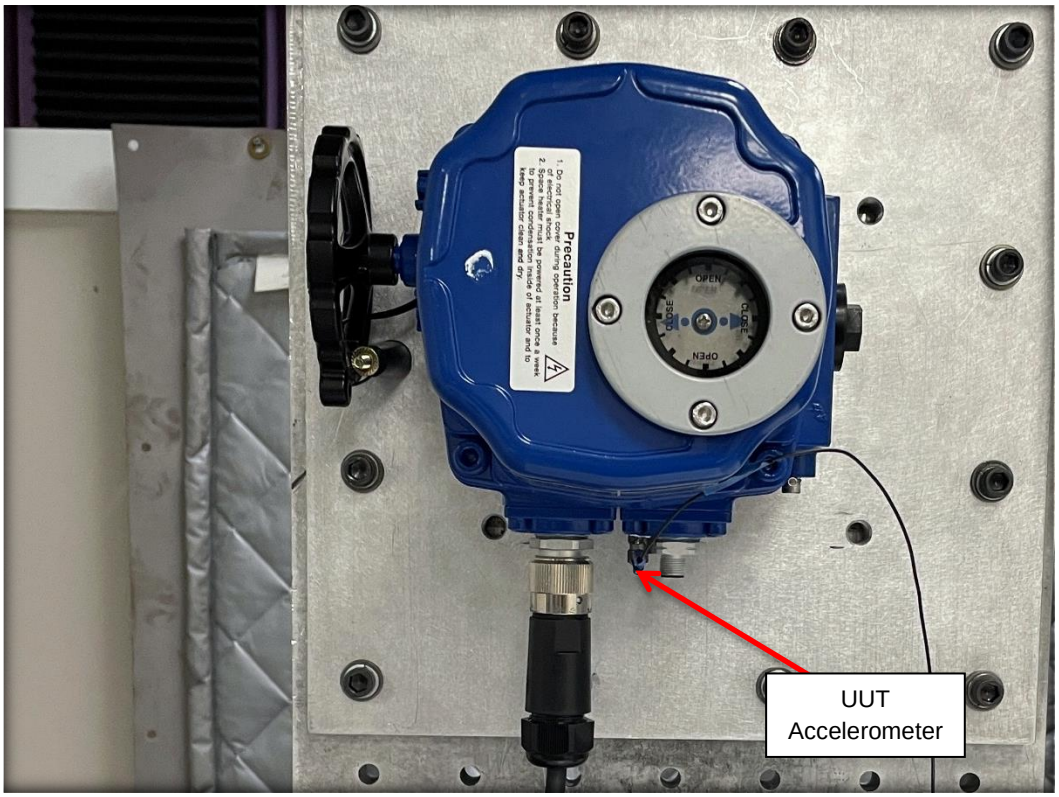

Figure 33: Detailed view of UUT accelerometer location for X -ve axis testing – Type "SER" units

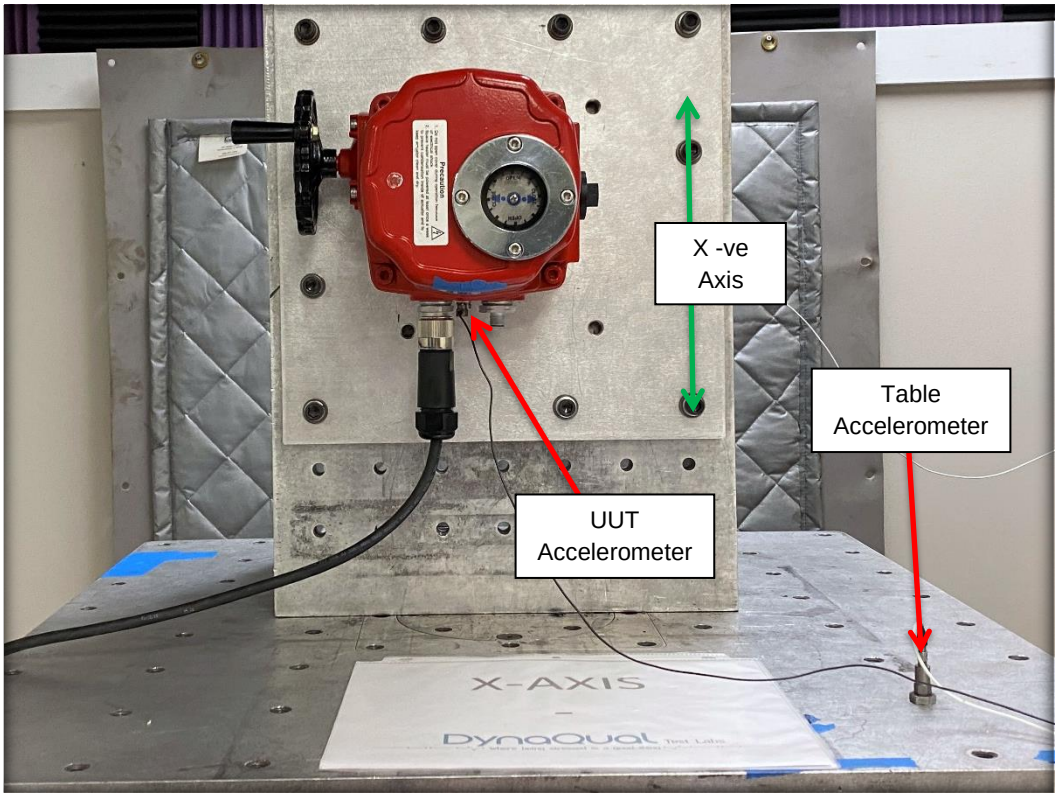

Figure 34: UUT 3 shown fixtured for X -ve axis testing

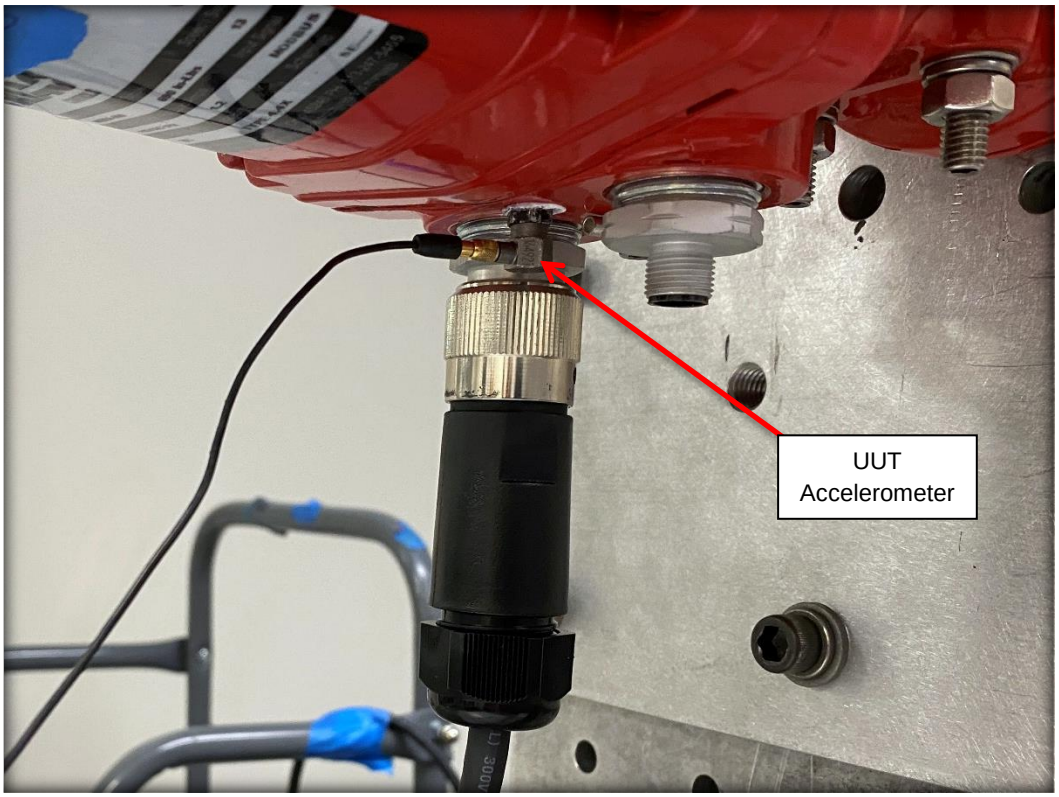

Figure 35: Detailed view of UUT accelerometer location for X -ve axis testing – Type "WER" units

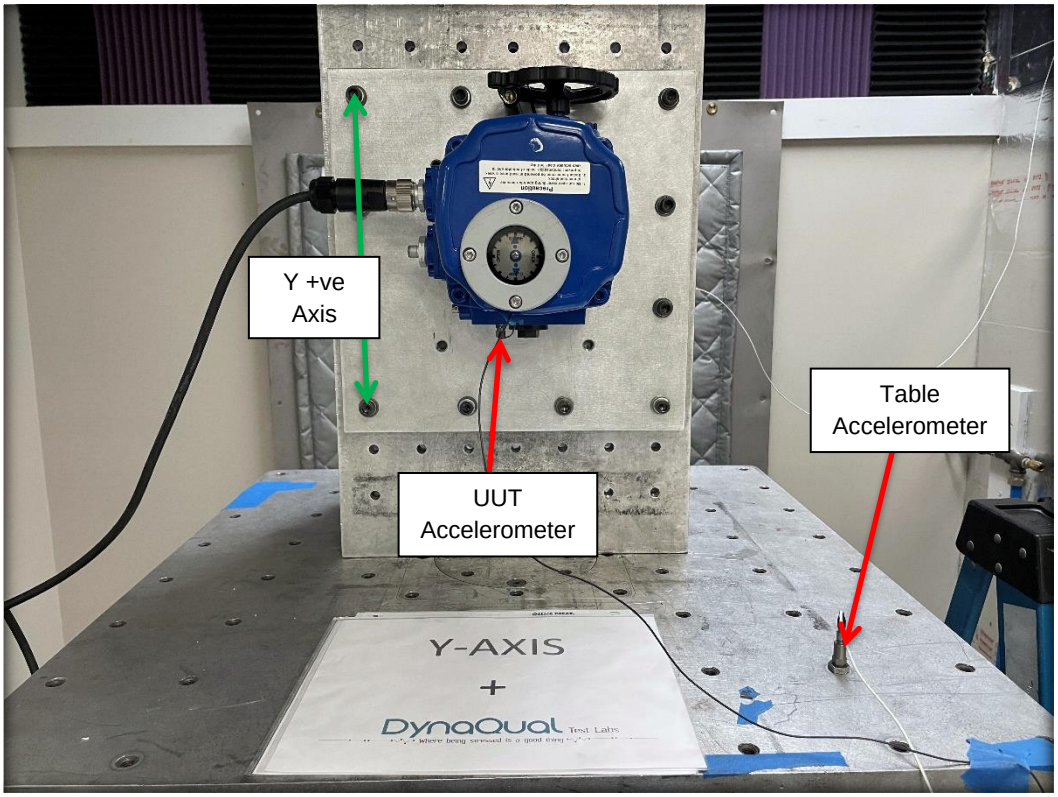

Figure 36: UUT 4 shown fixtured for Y +ve axis testing

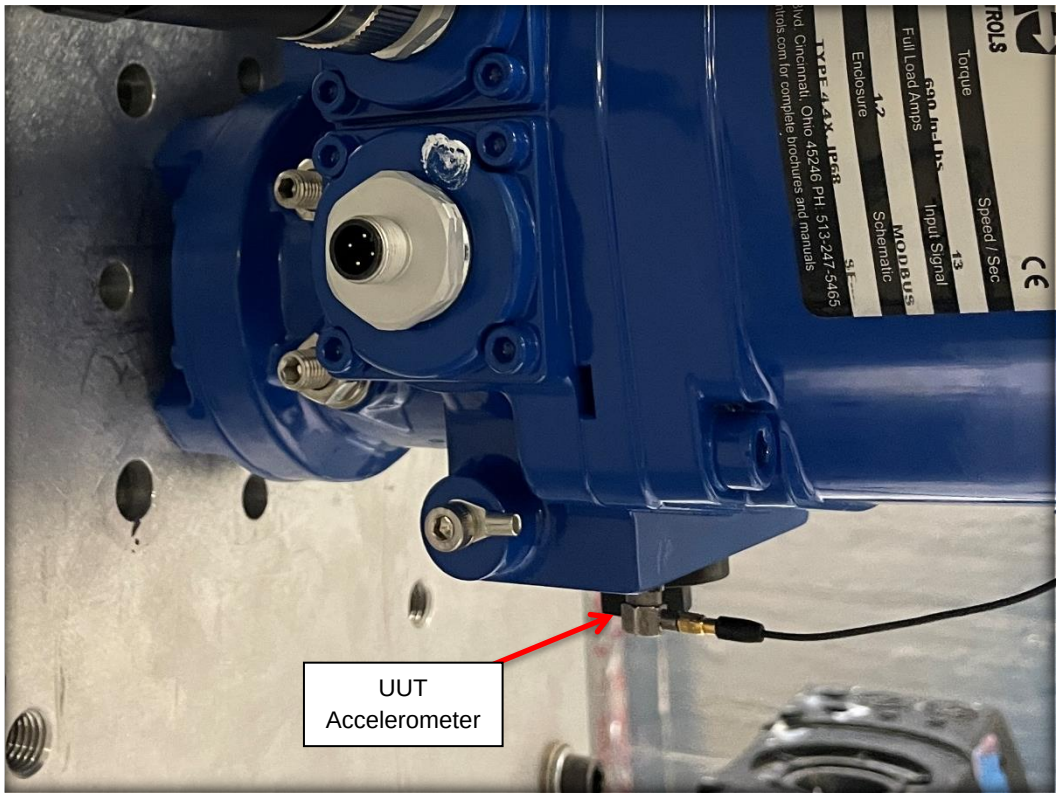

Figure 37: Detailed view of UUT accelerometer location for Y +ve axis testing – Type "SER" units

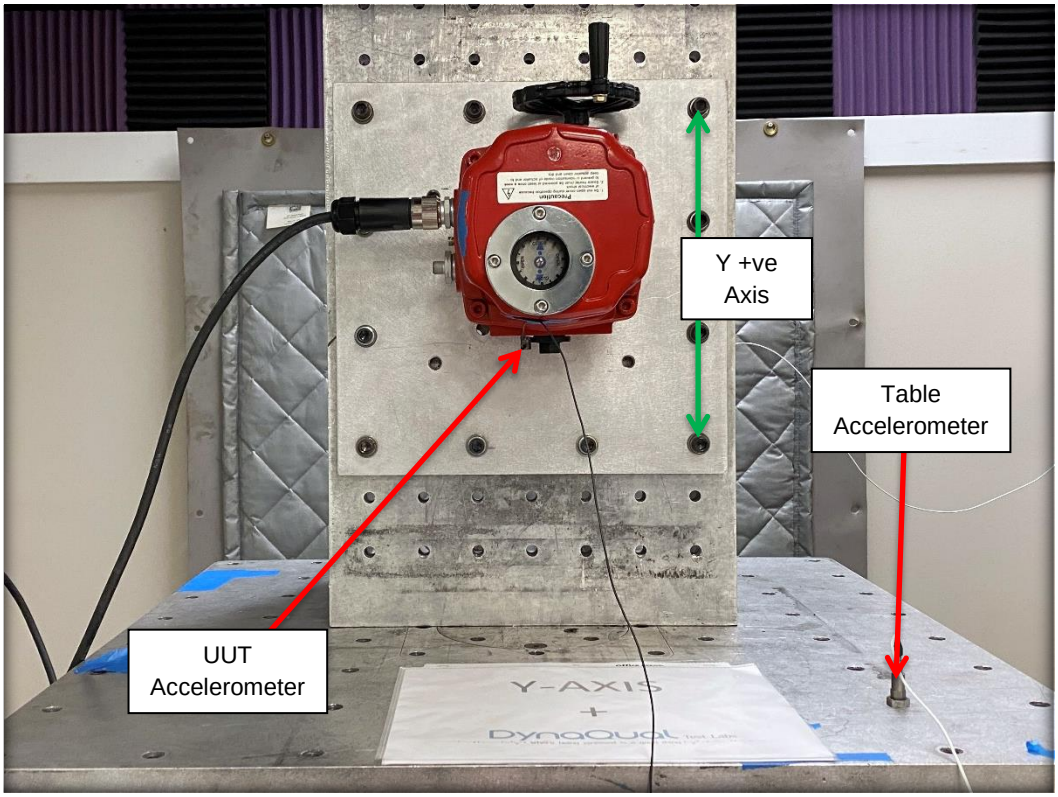

Figure 38: UUT 3 shown fixtured for Y +ve axis testing

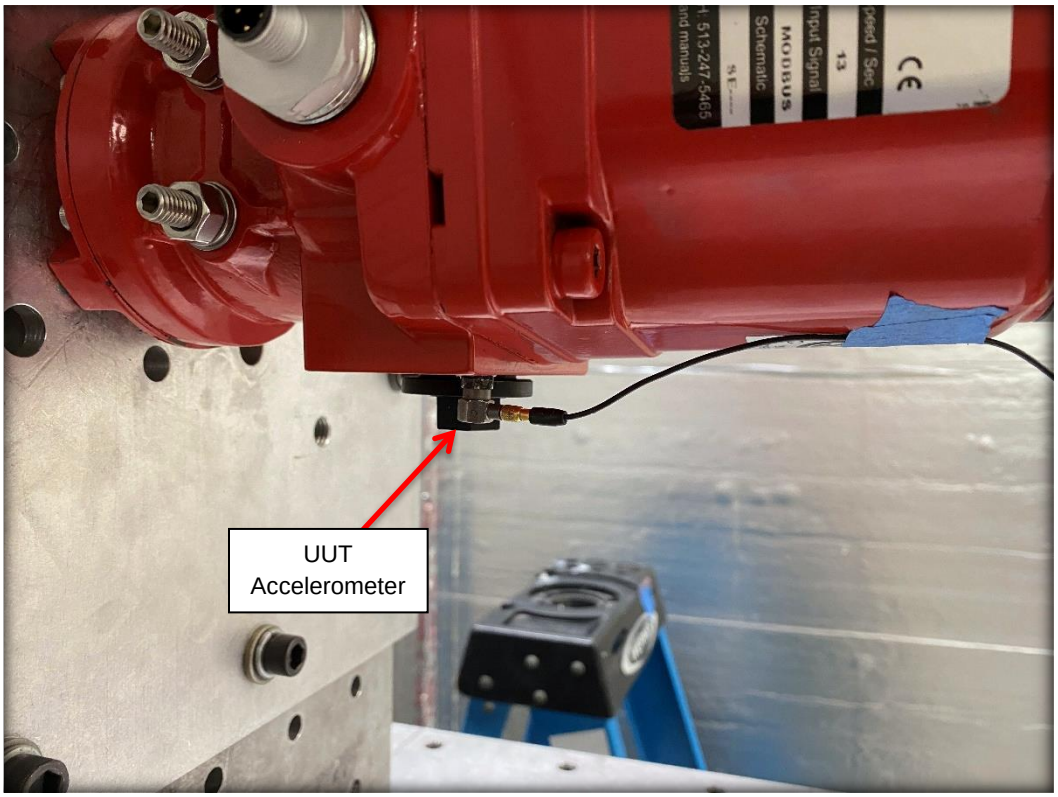

Figure 39: Detailed view of UUT accelerometer location for Y +ve axis testing – Type "WER" units

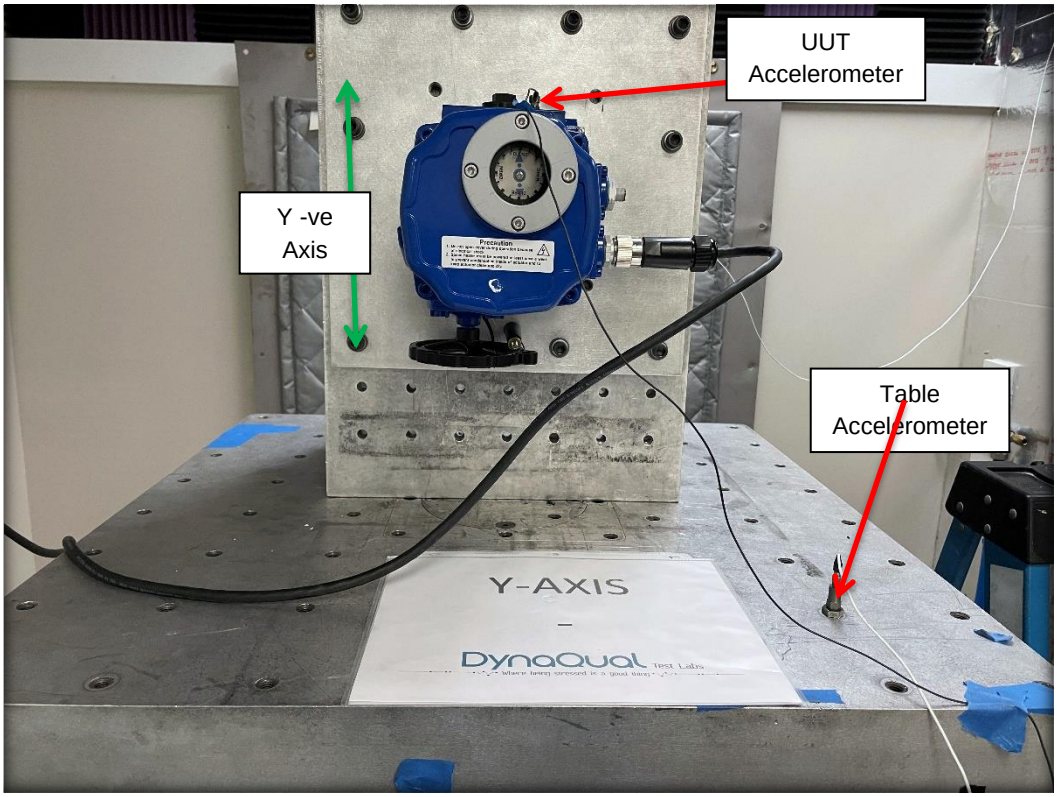

Figure 40: UUT 4 shown fixtured for Y -ve axis testing

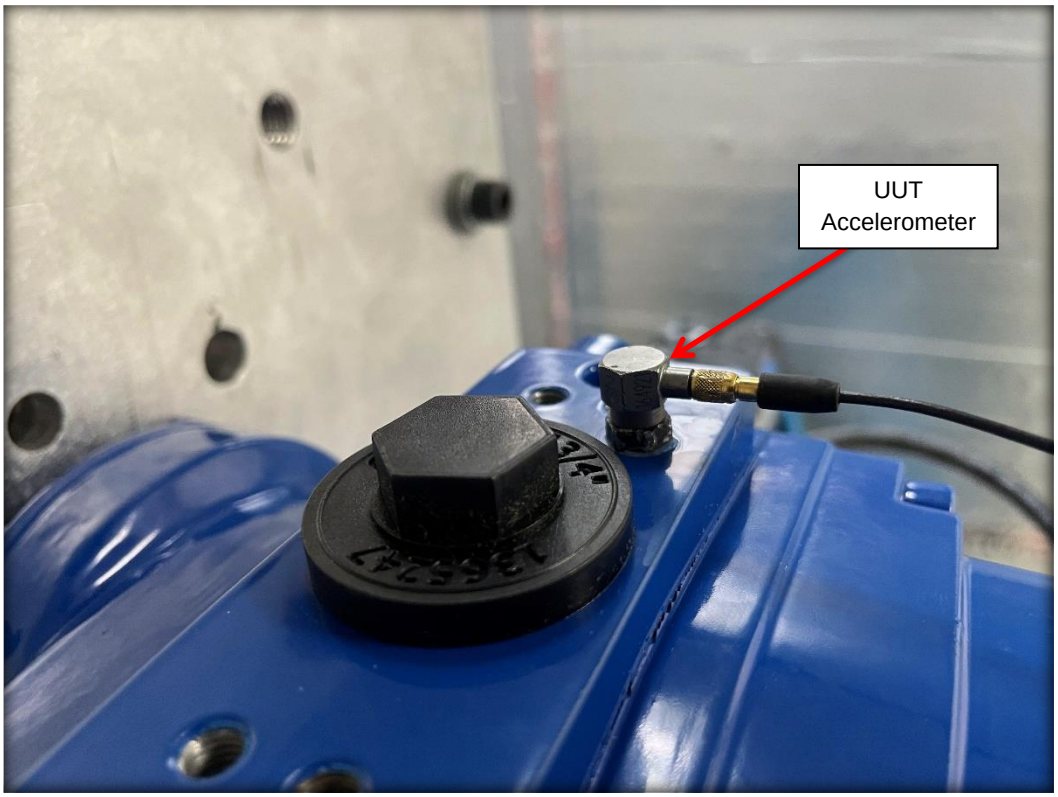

Figure 41: Detailed view of UUT accelerometer location for Y -ve axis testing – Type "SER" units

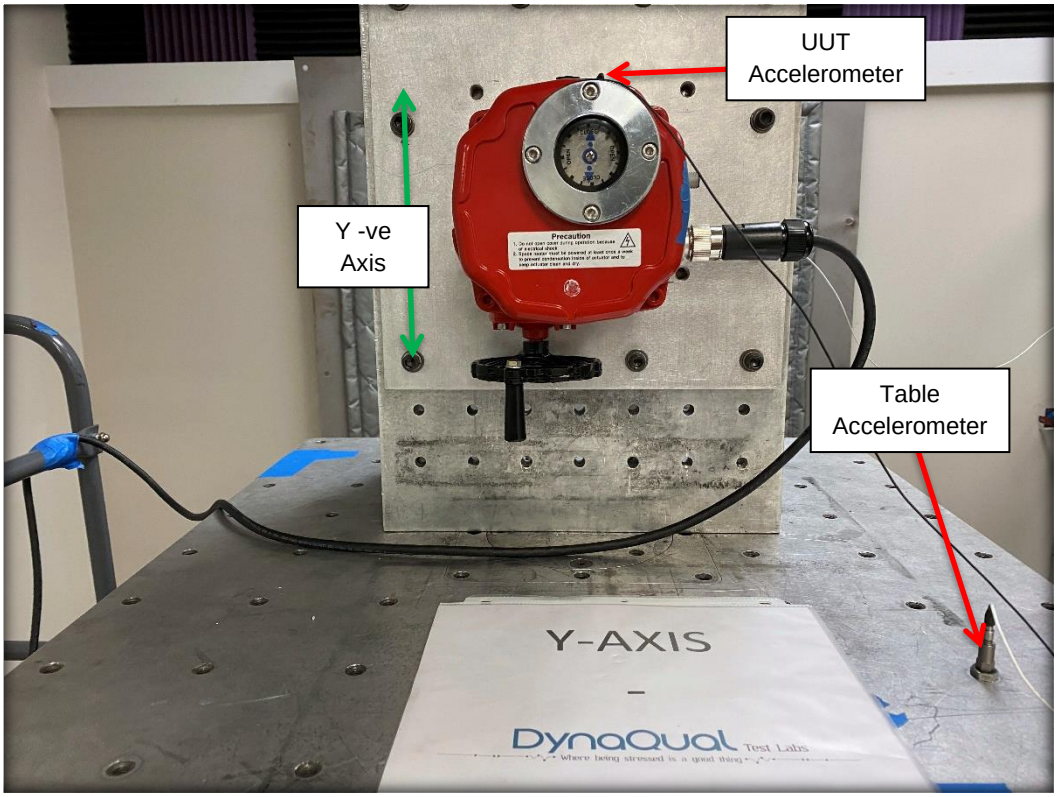

Figure 42: UUT 3 shown fixtured for Y -ve axis testing

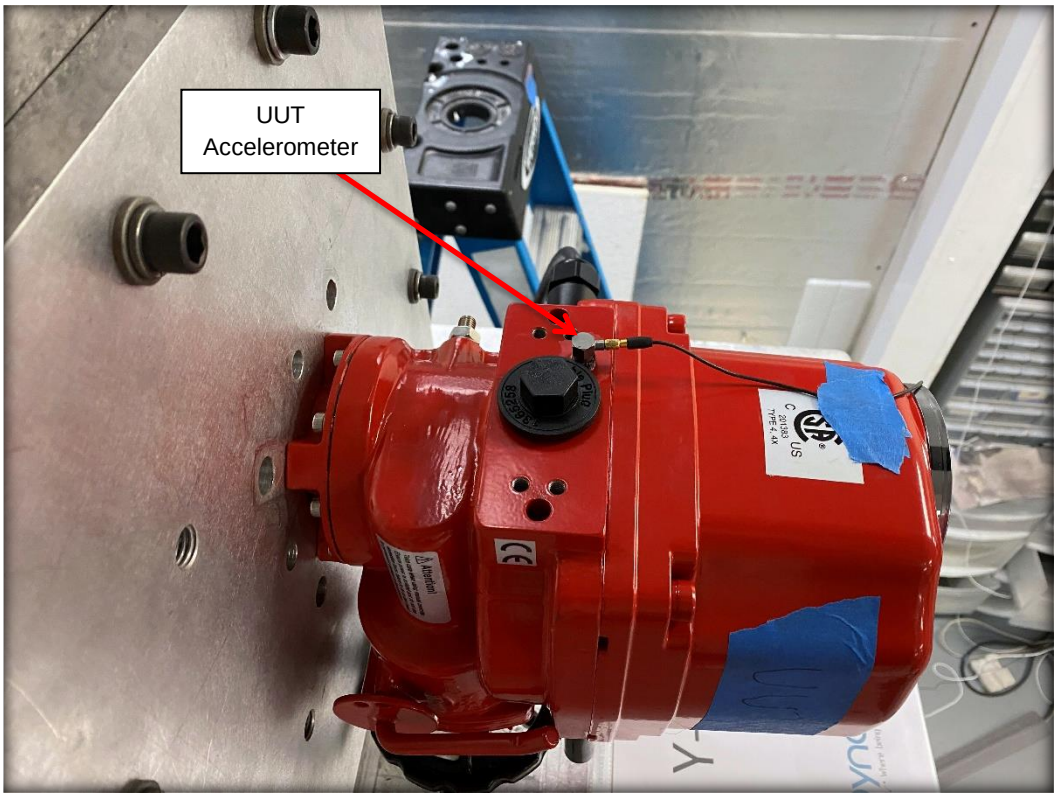

Figure 43: Detailed view of UUT accelerometer location for Y -ve axis testing – Type "WER" units

Product Function Tests

The UUT were powered and monitored for functionally during the pneumatic shock. They were checked to see that they were actuating after each drop or axis. The equipment used to power and monitor the UUT is shown below in Figures 44 and 45.

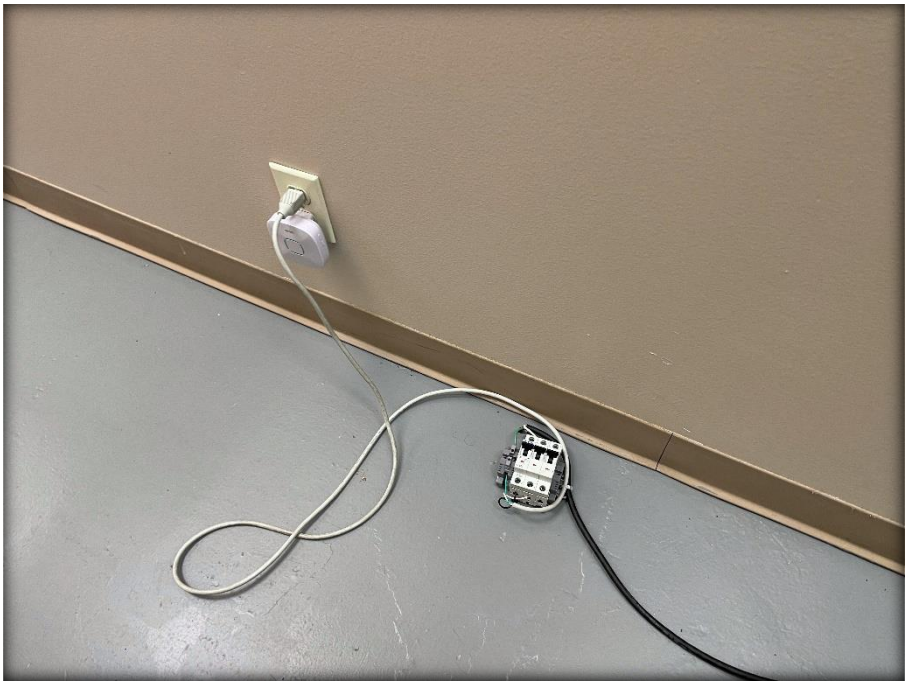

Figure 44: UUT power and monitoring equipment – 1 of 2

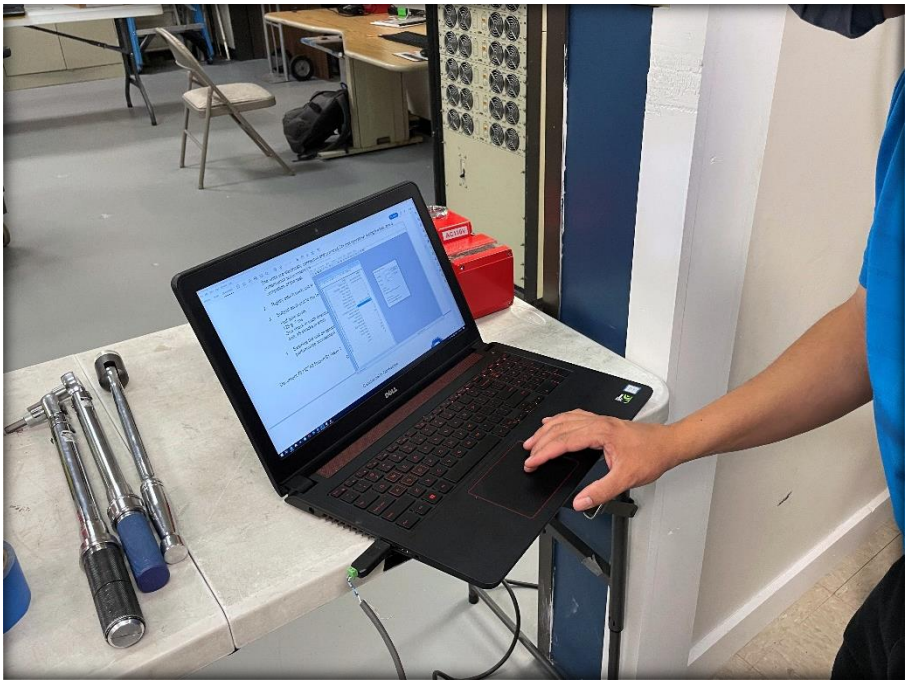

Figure 45: UUT power and monitoring equipment – 2 of 2

Pneumatic Shock Testing

The UUT were to be subjected to one shock in the +/- Z, X, and Y axes, with a target level minimum of 125 G_{peak} with a duration of approximately 5mS. Table height, pressure, felt, and rubber pads were used to dial in these parameters as close as possible. See Table 3 below for the G_{peak} levels and durations recorded by the shock control system for each UUT drop. A sample report from each axis tested is shown below in Figures 44-49. The raw data files for each drop were included in the customer data files.

Table 3 – Pneumatic Shock Testing

Drop #	UUT	Axis	Table	Table	UUT	UUT	Notes
1	0	Z +ve	130.5	5.74	131.3	5.01	
2	1	Z +ve	126.9	4.91	125.0	5.06	
3	1	Z +ve	133.7	5.16	132.1	5.12	
4	2	Z +ve	123.8	5.68	129.6	5.00	
5	3	Z +ve	N/A	N/A	125.4	5.07	1
6	4	Z +ve	124.7	5.94	132.7	5.11	
7	5	Z +ve	111.8	6.5	122.1	5.00	
8	5	Z +ve	124.6	6.91	140.9	5.00	
9	6	Z +ve	122.4	5.80	134.2	5.82	
10	7	Z +ve	119.9	6.2	131.4	5.00	
11	8	Z +ve	114.6	7.12	140.2	5.00	
12	9	Z +ve	114.6	6.35	132.4	5.13	
13	10	Z +ve	114.7	5.47	126.4	5.10	
14	11	Z +ve	108.2	6.57	129.6	5.09	
15	7	Z -ve	114.4	3.74	128.3	5.07	
16	11	Z -ve	130.8	3.10	121.8	5.07	
17	11	Z -ve	141.5	3.15	135.7	5.00	
18	9	Z -ve	122.8	3.62	131.3	5.55	
19	8	Z -ve	121.4	3.66	125.4	5.62	
20	10	Z -ve	135.3	3.51	138.2	5.67	
21	6	Z -ve	149.5	3.47	159.6	5.48	
22	5	Z -ve	136.6	3.58	145.2	5.56	
23	2	Z -ve	119.4	4.17	131.6	5.03	
24	4	Z -ve	121.8	3.97	128.0	5.14	
25	3	Z -ve	124.8	4.00	136.8	5.03	
26	0	Z -ve	96.1	5.26	133.3	5.04	
27	1	Z -ve	102.9	5.13	133.7	5.00	
28	0	X +ve	126.8	5.44	130.6	5.48	
29	0	Y +ve	117.1	5.82	135.7	4.58	
30	0	X -ve	127.1	5.62	131.6	4.47	
31	0	Y -ve	133.6	5.53	137.6	4.35	
32	1	X +ve	124.6	5.22	131.3	4.46	
33	1	Y +ve	124.4	5.20	128.8	4.54	
34	1	X -ve	124.8	5.49	134.1	4.49	
35	1	Y -ve	123.8	5.51	129.4	3.94	
36	2	X +ve	103.9	5.10	134.0	5.12	
37	2	Y +ve	104.1	5.84	135.9	5.12	
38	2	X -ve	108.4	5.88	135.7	5.03	
39	2	Y -ve	108.6	5.76	132.1	4.23	
40	4	X +ve	101.2	5.47	124.7	4.85	

Drop #	UUT	Axis	Table	Table	UUT	UUT	Notes
41	4	X -ve	119.8	6.65	140.5	4.91	
42	4	Y -ve	116.4	6.46	150.8	4.76	
43	4	Y +ve	106.2	6.81	130.2	5.04	
44	3	X +ve	128.6	6.20	152.3	5.85	
45	3	X -ve	N/A	N/A	153.9	5.00	1
46	3	Y -ve	119.2	5.21	146.1	5.03	
47	3	Y +ve	111.1	5.39	135.3	5.02	
48	5	X +ve	116.1	5.07	130.3	5.41	
49	5	X -ve	133.4	4.35	166.2	5.19	
50	5	Y -ve	119.3	5.37	147.3	5.20	
51	5	Y +ve	122.0	5.29	149.4	5.15	
52	6	X +ve	113.0	4.98	139.4	5.17	
53	6	X -ve	112.3	4.91	131.7	5.09	
54	6	Y -ve	113.2	4.93	137.8	5.14	
55	6	Y +ve	112.2	4.97	134.3	5.12	
56	7	X +ve	140.4	5.03	134.0	5.53	
57	7	Y -ve	148.1	4.66	137.1	5.58	
58	7	X -ve	131.5	5.80	128.1	5.72	
59	7	Y -ve	111.1	5.21	164.3	6.36	
60	9	X +ve	129.0	4.65	138.7	5.27	
61	9	X -ve	127.1	4.44	167.9	5.25	
62	9	Y -ve	126.2	5.26	129.3	5.31	
63	9	Y +ve	114.3	4.50	130.4	5.62	
64	8	X +ve	118.8	4.69	127.9	5.11	
65	8	X -ve	123.0	4.69	128.3	5.02	
66	8	Y -ve	120.4	4.59	145.4	5.05	
67	8	Y +ve	120.2	4.60	127.2	5.27	
68	10	X +ve	120.6	4.62	148.6	5.03	
69	10	X -ve	120.2	4.41	135.4	5.06	
70	10	Y -ve	118.4	4.59	146.2	5.00	
71	10	Y +ve	116.7	4.19	131.8	5.01	
72	11	X +ve	125.4	4.56	151.0	5.02	2
73	11	X +ve	N/A	N/A	134.7	5.02	1
74	11	X -ve	114.1	4.61	128.6	5.46	
75	11	Y -ve	112.6	4.50	136.9	5.45	
76	11	Y +ve	N/A	N/A	127.4	5.08	1, 3

Note:

1. The shock machine data file was corrupt so the UUT values were obtained from the written notes taken during the job. The table values were not recorded in the notes.
2. Following this drop, it was discovered that UUT 11, (WER 10500), was not actuating. The customer removed the casing and found the slot screw had disengaged causing the gears to separate. The screw was replaced, the UUT casing was put back on, and the UUT was tested with no failures occurring.
3. Pneumatic shock concluded with no other issues noted.

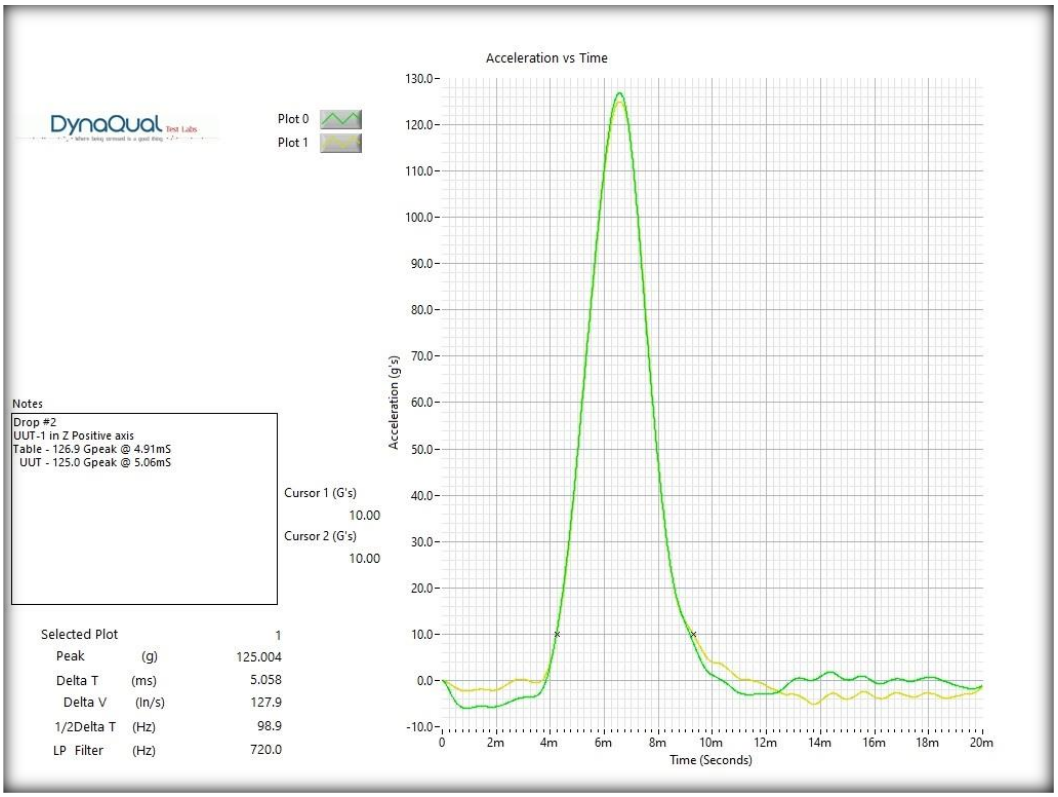

Figure 46: UUT-1, Z +ve Axis, Drop #2, 125.0 G_{peak} at 5.06mS

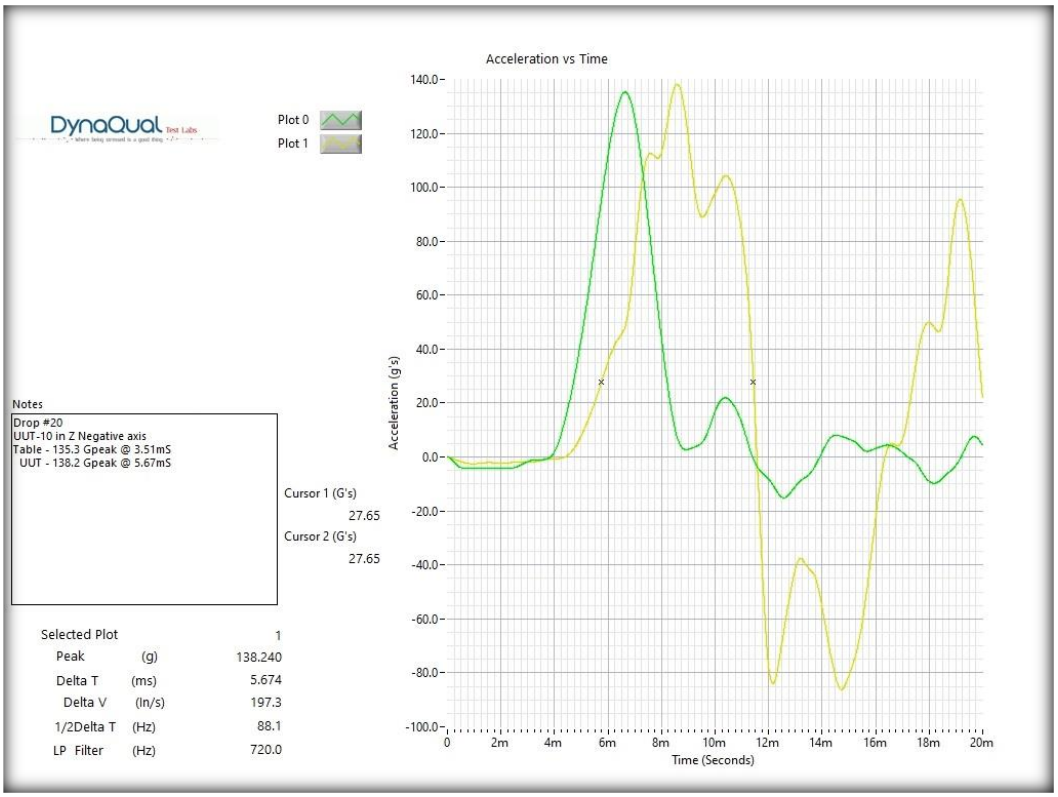

Figure 47: UUT-10, Z -ve Axis, Drop #20, 138.2 G_{peak} at 5.67mS

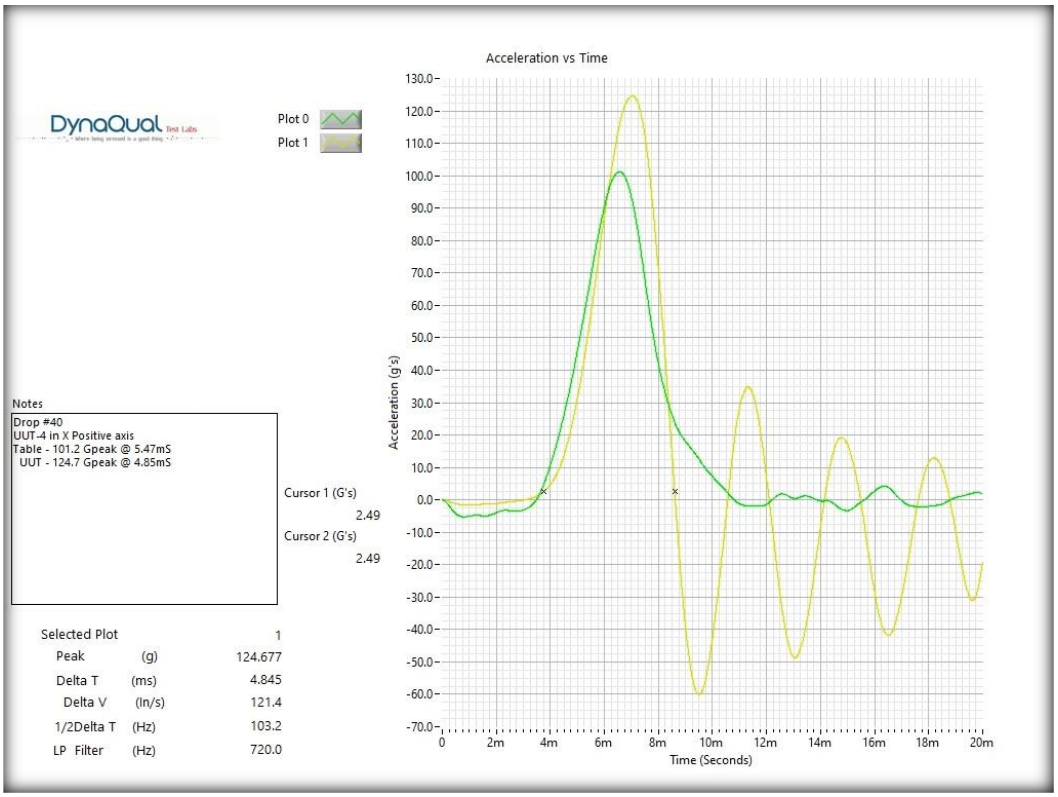

Figure 48: UUT-4, X +ve Axis, Drop #40, 124.7 G_{peak} at 4.85mS

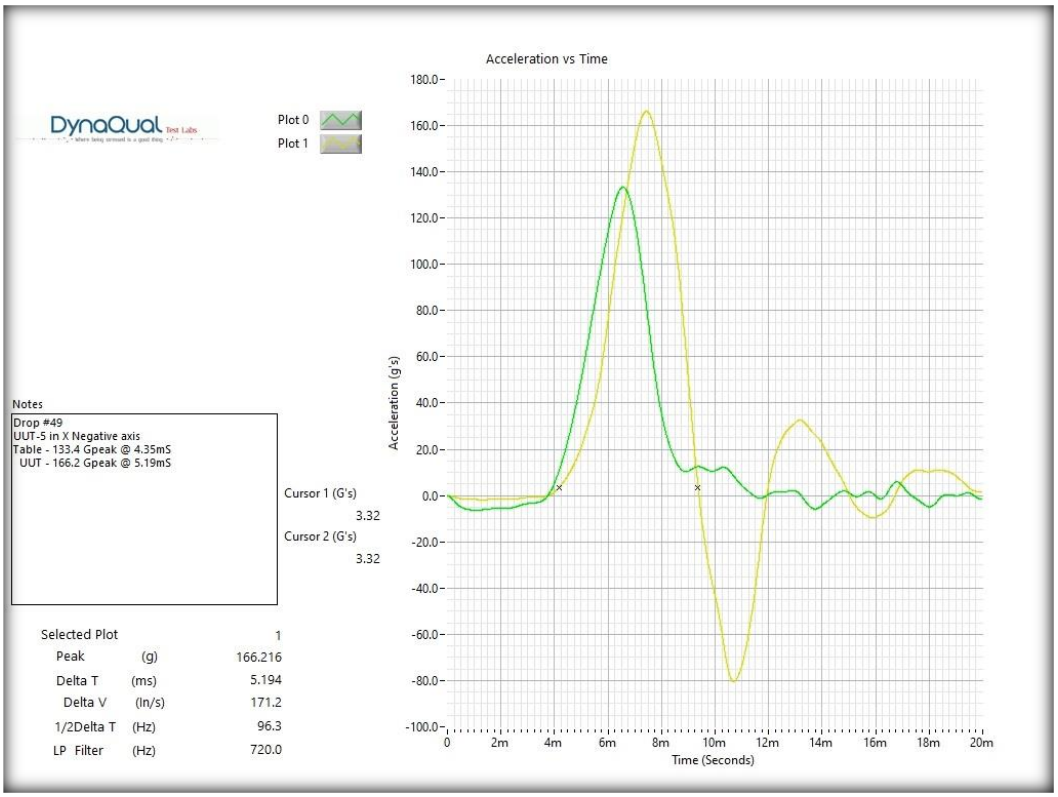

Figure 49: UUT-5, X -ve Axis, Drop #49, 166.2 G_{peak} at 5.19mS

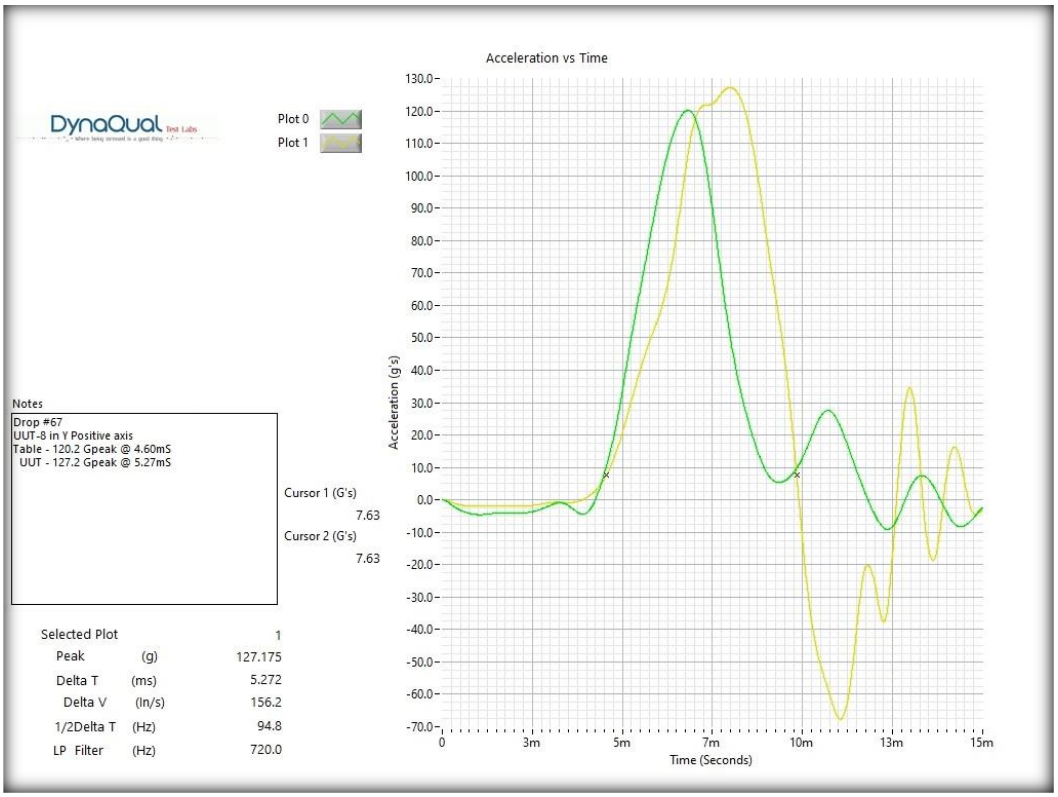

Figure 50: UUT-8, Y +ve Axis, Drop #67, 127.2 G_{peak} at 5.27mS

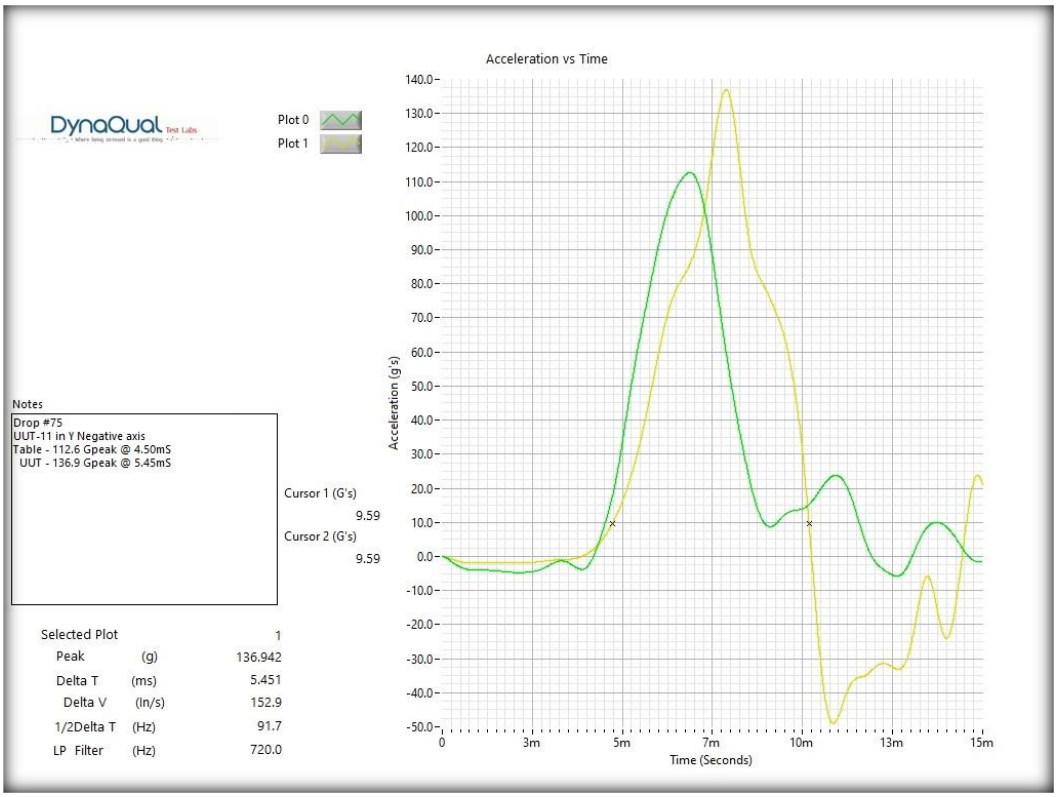

Figure 51: UUT-11, Y -ve Axis, Drop #75, 136.9 G_{peak} at 5.45mS

TESTING SUMMARY/CONCLUSIONS

The following summarizes the pneumatic shock testing performed for AT Controls on March 22-26, 2021:

1. DynaQual Test Labs performed pneumatic shock testing on nine (9) Actuator assemblies and three (3) Mass Models for AT Controls during March 22-26, 2021.
2. Pneumatic shock testing was performed with a target of 125 Gpeak with a duration periods of 5mS. Pneumatic shock was done in the positive and negative directions of the Z, X, and Y axes.
3. The UUT were powered and tested for functionality following each drop.
4. Following drop number 72, it was discovered that UUT 11, (WER 10500), was not actuating. An inspection of the UUT revealed the slot screw had disengaged causing the gears to separate. The gears were placed in their normal position and the screw was reinserted, and the UUT was tested with no failures occurring.
5. No other issues occurred during the shock testing.
6. The testing provided good data for further analysis by AT Controls personnel at their facility.

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