

TEST REPORT



DT&C Co., Ltd.

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Tel : 031-321-2664, Fax : 031-321-0220

1. Report No. : DRCREL1703-0135

2. Customer

- Name : LSIS Co., Ltd.
- Address : 127, LS-ro, Dongan-gu, Anyang-si, Gyeonggi-do, Korea

3. Use of Report : Validation


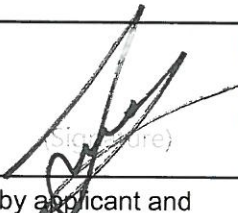
4. Product Name / Model Name : Vacuum Circuit Breaker / UVL-15P25A12

5. Test Method Used : IEEE-693™-2005

6. Date of Test : March 08, 2017

7. Testing Environment : Temperature (21 ± 2) °C, Humidity (30 ± 3) % R.H.

8. Test Result : Refer to the attached Test Result

Affirmation	Tested by	Technical Manager
	Name : YoungLock Lee  (Signature)	Name : JaeHan Jung  (Signature)

. The test results presented in this test report are limited only to the sample supplied by applicant and the use of this test report is inhibited other than its purpose. This test report shall not be reproduced except in full, without the written approval of DT&C Co., Ltd.

2017. 3. 17.

DT&C Co., Ltd.

If this report is required to confirmation of authenticity, please contact to report@dtnc.net

TABLE OF CONTENTS

	<u>Page</u>
1. Scope	4
2. Applicable Document	4
3. Specimen Identification	5
3.1 Specimen Description	5
3.2 Specimen Configuration	5
4. Test Requirements	6
5. Seismic Test Acceptance Criteria	7
6. Test Procedures	7
6.1 Initial Inspection	7
6.2 Test Setup	7
6.3 Functional Test Data.....	9
6.4 Test Requirements.....	11

Attachment

1. Resonant Search Test Data
2. Seismic Test Data
3. Sine Beat Test Data
4. Functional Monitoring Data
5. Photograph

※ Appendix

1. Seismic Test Data (ZPA 3 g Condition)

TABLE OF CONTENTS

(Continue)

<LIST OF TABLES>

Table 1. Specimen Description	5
Table 2. Required Response Spectrum	6
Table 3. (6 Degree of Freedom) Shaker Table Specification	8
Table 4. Measuring Instrument	9
Table 5. Measuring Instrument for Functional test	10
Table 6. Functional Check Criteria	10
Table 7. Resonant Frequency Search Test Result	11
Table 8. Maximum Acceleration of Seismic Test	12
Table 9. Sine Beat Input Value	12
Table 10. Test Results of Summary	13

<LIST OF FIGURES>

Fig. 1 Vacuum Circuit Breaker	5
Fig. 2 Required Response Spectrum (0.5 g, 2 % Damping)	6
Fig. 3 Vacuum Circuit Breaker Setup	7
Fig. 4 Dt&C's Seismic Table Configuration	8
Fig. 5 Functional Checking Diagram	10

1. Scope

Vacuum Circuit Breaker was supplied by LSIS Co., Ltd, described in section 3. The test specimen was subjected to seismic testing in accordance with the "IEEE-693™-2005". The test program step accomplished in the following sequence.

- Initial Inspection
- Test Setup
- Resonant Frequency Search Test (XYZ axis)
- Seismic Test(0.5 g, 2 % Damping)
- Resonant Frequency Search Test (XYZ axis)
- Sine Beat test (XYZ axis)
- Resonant Frequency Search Test (XYZ axis)
- Final Inspection

The tests were performed on March 8, 2017.

2. Applicable Document

IEEE-693™-2005

3. Specimen Identification

3.1 Specimen Description

The description of the specimen is shown in "Table 1".

Table 1. Specimen Description

Description	Specification
Equipment	Vacuum Circuit Breaker
Model Name	UVL-15P25A12
Manufacturer	LSIS Co., Ltd.
Mounting method	Base mounting
Frame Rack Size	(W) 450 mm x (H) 650 mm x (D) 523.2 mm
Weight	89 kg

3.2 Specimen Configuration

The test specimen layout for seismic test is shown in "Fig 1".

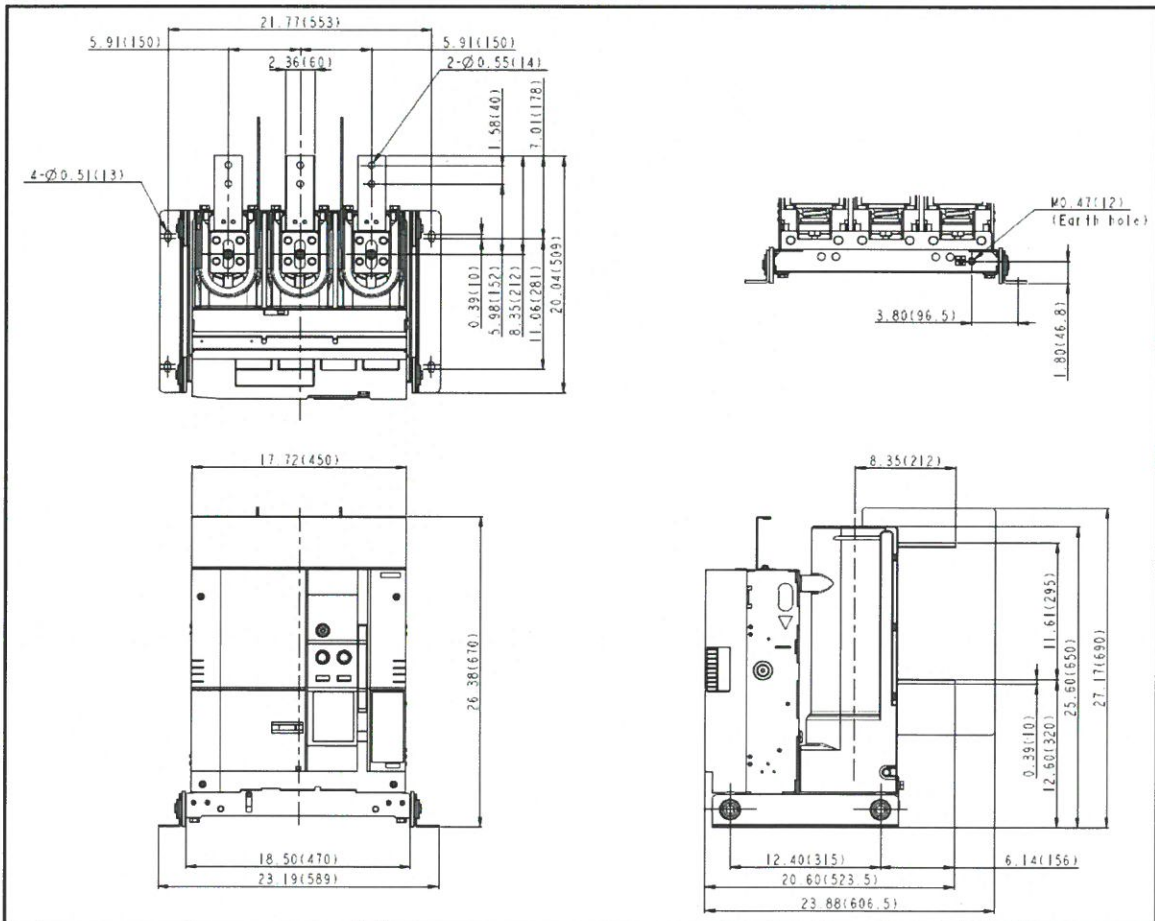


Fig.1 Vacuum Circuit Breaker

4. Test Requirements

Required Response Spectrum (RRS) was adopted by "IEEE-693™-2005". The applicable damping factor for the seismic test is 2 % damping. RRS are shown in "Fig 2" and "Table 2".

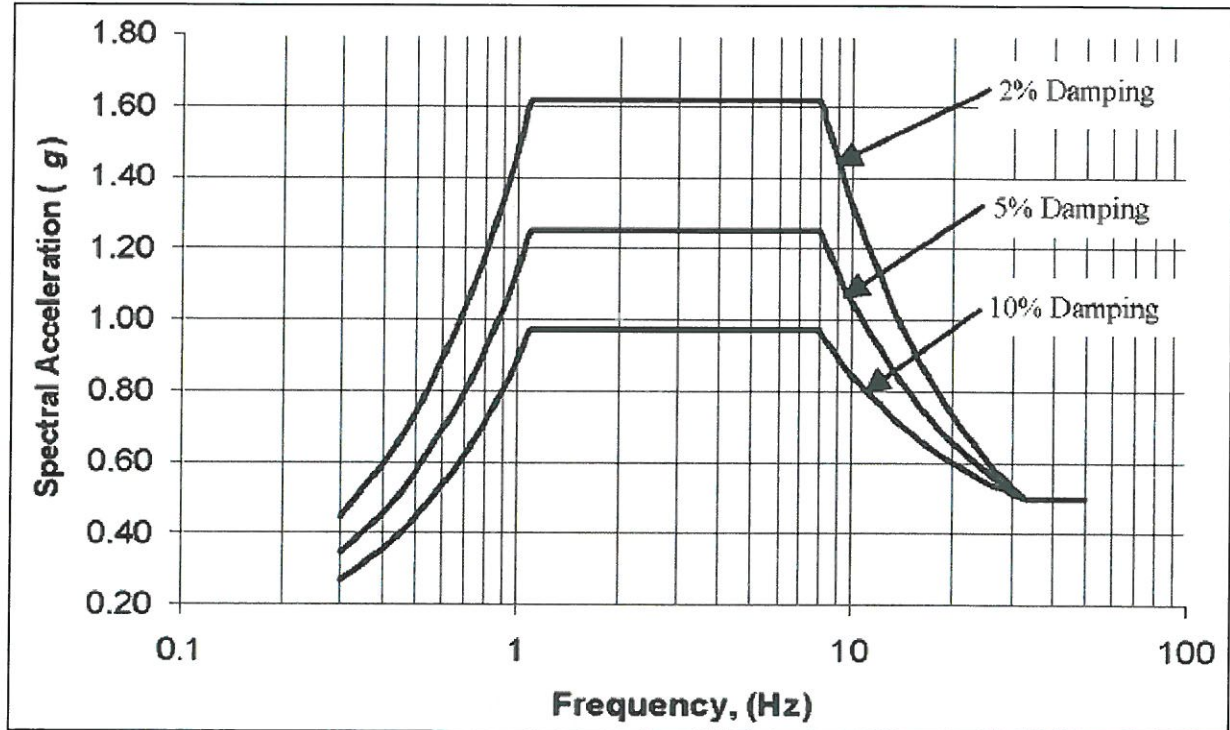


Fig. 2 Required Response Spectrum (0.5 g, 2 % Damping)

Table 2. Required Response Spectrum

Front to back (X)		Side to side (Y)		Vertical (Z)	
Frequency (Hz)	Acceleration (g)	Frequency (Hz)	Acceleration (g)	Frequency (Hz)	Acceleration (g)
0.3	0.45	0.3	0.45	0.3	0.45
1.0	1.43	1.0	1.43	1.0	1.43
1.1	1.62	1.1	1.62	1.1	1.62
8.0	1.62	8.0	1.62	8.0	1.62
33.0	0.50	33.0	0.50	33.0	0.50
50.0	0.50	50.0	0.50	50.0	0.50

5. Seismic Test Acceptance Criteria

The acceptance criteria are applied to the test results in accordance with physical and functional performance criteria.

- 1) Equipment and support shall not fail, crack, buckle, or show any other permanent distress.
- 2) The specified functions of the equipment shall be checked before and after the shake-table testing.

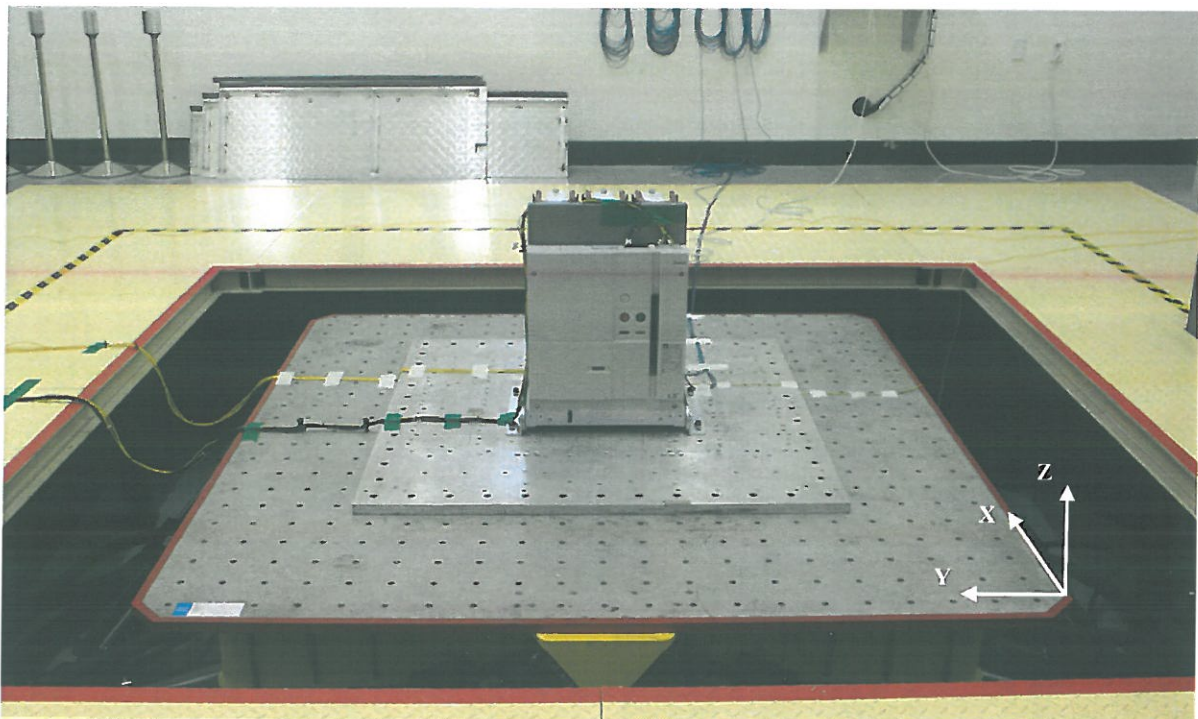
6. Test Procedures

6.1 Initial Inspection

The test specimen was visually inspected for any physical damages or defects. The initial inspection revealed no obvious physical damage or defect.

6.2 Test Setup

The table and base plate was mounted using forty-eight M12 bolts torque to 770 kgf-cm. The base plate and specimen was mounted using four M12 bolts. Accelerometers were installed on the table, top of specimen, housing side left, housing side right. The test setup is shown to "Fig. 3", "Attachment 5".



※ Note - X: Front to back, Y: Side to side, Z: Vertical

Fig. 3 Vacuum Circuit Breaker Setup

6.2.1 Test Facilities

Dt&C’s shaker table and measuring instrument are shown in “Table 3” and “Table 4”.

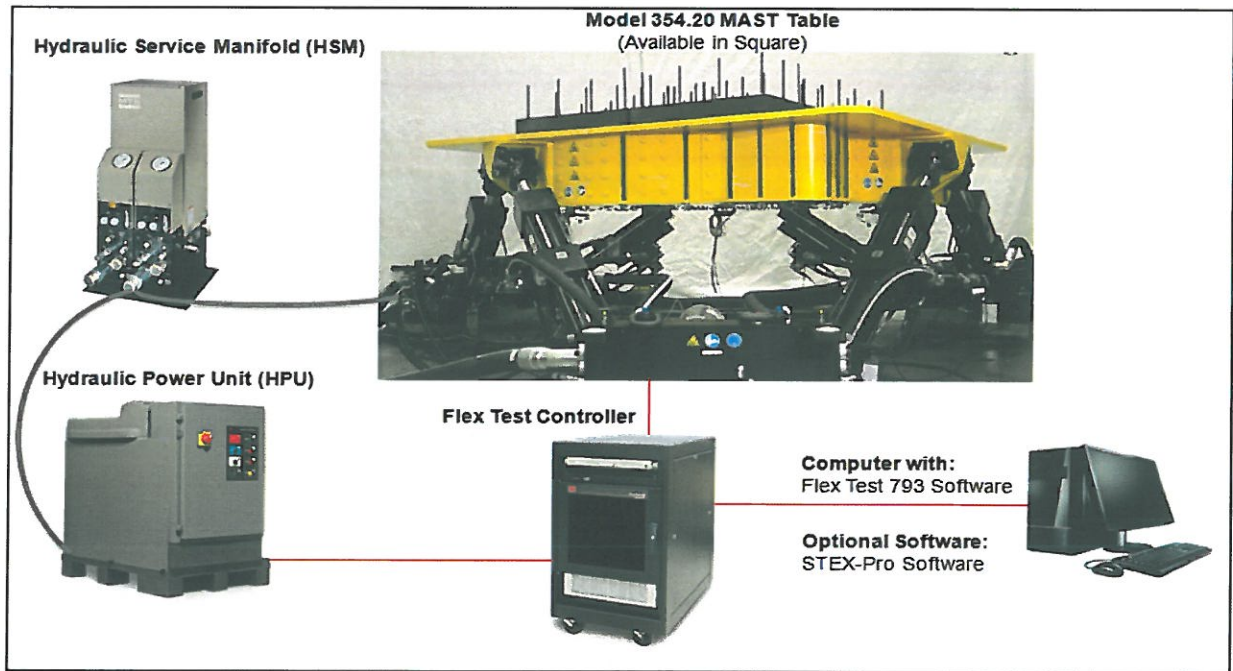


Fig. 4 Dt&C’s Seismic Table Configuration

Table 3. (6 Degree of Freedom) Shaker Table Specification

Description	Specification
Manufacturer	MTS systems Corporation
Table size	(2 200 x 2 200) mm
Max. Payload	2 000 kg
Excitation Axes	Translational 3axes, Rotational 3axes
Max Displacement	Ver.: ±140 mm, Lat.: ±110 mm, Long.: ±125 mm
Max. Acceleration, ZPA(2 000 kg)	Vertical: 6 g, Lateral: 4.6 g, Longitudinal: 4.9 g
Frequency Range	(1 ~ 100) Hz
Excitation Mechanism	Electro-hydraulic Servo, 3 Variable Control

Table 4. Measuring Instrument

Description	Model No. / Manufacturer	Serial No.	The Next Scheduled Calibration Date	Calibration Laboratory
Accelerometer	8395A050ATTA00 / KISTLER	4789925	2017. 05. 04.	KISTLER
		4768785	2017. 05. 04.	KISTLER
		4768787	2017. 05. 04.	KISTLER
	8315A050ATTA00 / KISTLER	4795582	2017. 05. 04.	KISTLER
		4795581	2017. 05. 04.	KISTLER
		4782867	2017. 05. 04.	KISTLER
Voltage & Current Meter	MX1601B / QUANTUMX	0009E5006856	2017. 04. 11.	HCT
DC Power Supply	DDPS20K / DIGITEK POWER	N12-106	2017. 07. 18.	HCT
TORQUE WRENCH	1800QL4-MH / TOHNICHI	113532E	2017. 06. 15.	HCT
THERMO HYGROMETER	BO-807 / BLUE BIRD	21493	2018. 01. 17.	HCT

6.3 Functional Test Data

The test specimen was subjected to the functional tests before, during and after each seismic testing. Functional checking diagram is shown in "Fig 5", Measuring Instrument for functional test and functional check criteria are shown in "Table 5", "Table 6".

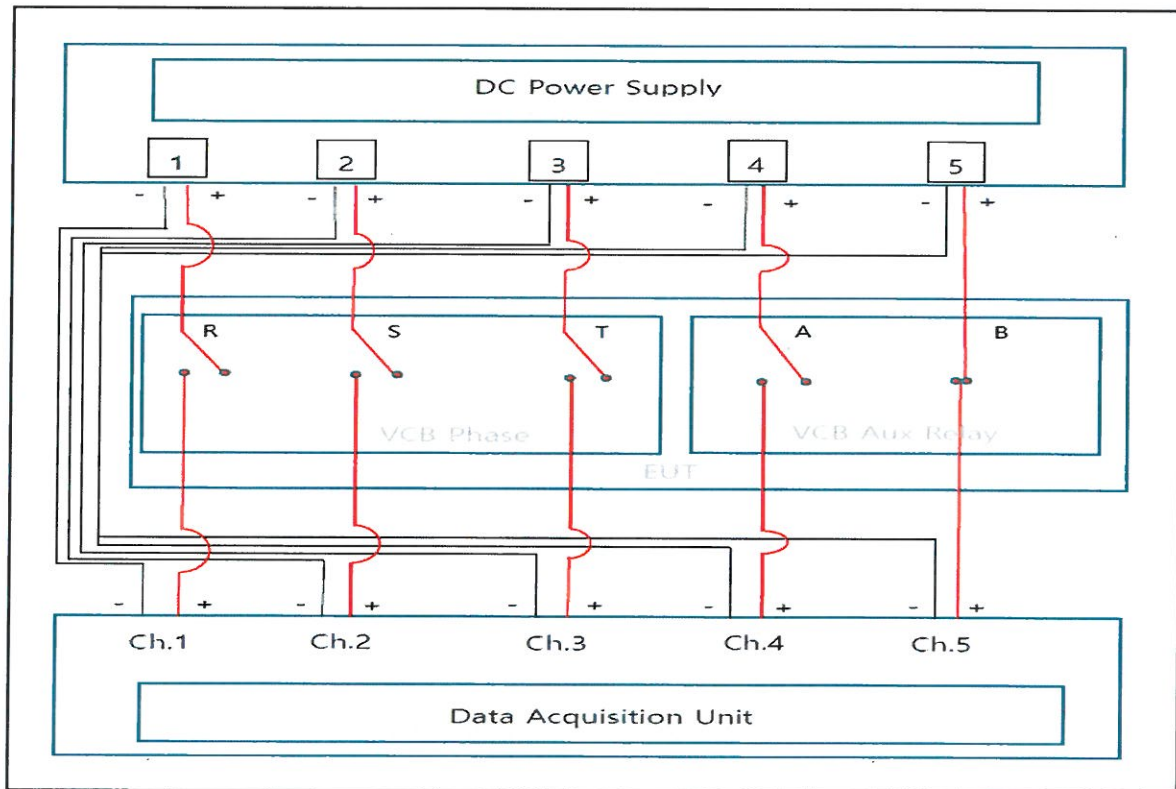


Fig. 5 Functional Checking Diagram

Table 5. Measuring Instrument for Functional test

Description	Model No.	Manufacturer	Remark
Voltage & Current Meter	MX1601B	QUANTUMX	

Table 6. Functional Check Criteria

Description	Requirements	Remark
Functional Check from the specimen	Continually monitored for electrical parameters	Refer to Attachment 4

6.4 Test Requirements

The test specimen was subjected to each testing as specified in the following sections.

6.4.1 Resonant frequency search test

The results of resonant frequency search test data are shown in "Table 7", "Attachment 1".

Table 7. Resonant Frequency Search Test Result

Description		Pre Seismic Test		Post Seismic Test		Post Sine beat	
		1st Resonance ¹⁾ (Hz)	Amplitude (g/g)	1st Resonance ¹⁾ (Hz)	Amplitude (g/g)	1st Resonance ¹⁾ (Hz)	Amplitude (g/g)
Long. - X (Front to back)	Top of Specimen	38.00	4.52	36.00	4.01	33.50	3.73
	Housing Side (Right)	38.00	3.68	36.00	3.40	33.50	2.95
	Housing Side (Left)	37.50	2.78	35.50	2.51	31.00	1.93
Lat. - Y (Side to side)	Top of Specimen	50.00	3.67	50.00	3.58	50.00	3.51
	Housing Side (Right)	50.00	4.67	50.00	4.63	50.00	4.53
	Housing Side (Left)	50.00	4.72	50.00	4.60	50.00	4.53
Vert. - Z (Up to Down)	Top of Specimen	No Resonance	-	No Resonance	-	No Resonance	-
	Housing Side (Right)	No Resonance	-	No Resonance	-	No Resonance	-
	Housing Side (Left)	No Resonance	-	No Resonance	-	No Resonance	-

¹⁾ Resonant frequency search test Result is 1st Mode Value

6.4.2 Seismic Test

The seismic test was performed by using the independent tri-axial test method. The test specimen was subjected to 30 seconds duration with a minimum of 20 seconds strong motion multi-frequency random motion which is amplitude-controlled in one-sixth octave band-widths, spaced one-sixth octave apart over the frequency range of (1 ~ 50) Hz. The input motions of each axis were proved as statistically independent of each other. Test Response Spectrum (TRS) for the shake table motions were analyzed at 2 % damping for The seismic test and plotted at one-sixth octave intervals over the frequency range of (1 ~ 50) Hz. The TRS were greater than the corresponding RRS, during and after seismic test, any noticeable damage and structural defects were not also observed. (After Sine beat testing, VCB was carried out once more to the seismic test – ZPA 3 g Condition. The detailed seismic test result is described in "Appendix 1") Maximum acceleration results are shown in "Table 8".

Table 8. Maximum Acceleration of Seismic Test

Description	Table (g)	Top of Specimen (g)	Housing Side (Right) (g)	Housing Side (Left) (g)
Longitudinal-X (Front to back)	0.66	5.38	4.24	11.41
Lateral-Y (Side to side)	0.70	7.73	21.21	9.27
Vertical-Z (Up to down)	0.96	30.03	9.03	7.42

6.4.3 Sine Beat Test

The sine beat test was performed to demonstrate the structural and integrity of the test specimen. A sine beat motion consisted of a sinusoid of the equipment resonant frequency modulated by a lower frequency sinusoid that provides over ten cycles and five such beats of resonant frequency, and carried out at the specified input value in the horizontal axes, vertical axis each simultaneously.

The detailed sine beat test result is described in "Table 9" and "Attachment 3".

Table 9. Sine Beat Input Value

Description	X (Front to back)	Y (Side to side)	Z (Vertical)
Input value for Testing ¹⁾	36 Hz	33 Hz	33 Hz

¹⁾ : If no resonant frequency is found in each axis, a test at 33 Hz shall be performed in that axis. ("IEEE Std 693-2005")

6.5 Final Inspection

Upon completion of the qualification testing, the test specimen was visually inspected for any physical damages or defects. No obvious physical damage or defect was found.

7. Test Result

Before, during and after seismic test, any obvious structural and functional failures were not observed. The test results of summary for Vacuum Circuit Breaker refers to the below "Table 10".

Table 10. Test Results of Summary

Description	Acceptance Criteria	Applied Test	Remark
TRS Envelop	(1 ~ 50) Hz (1/6 octave analysis)	Enveloped	Refer to Attachment 2
Resonant Frequency Search Test	No change of more than 20 %	Satisfied	Refer to Attachment 1
Structural Integrity	Physical damages or defects.	Satisfied	Refer to Attachment 1
Functional Integrity	Continually monitored for electrical parameters	Satisfied	Refer to Attachment 4

8. Conclusion

The Vacuum Circuit Breaker was proved that can perform its safety function without failure mechanism that could lead to common cause failures through the seismic test.

Attachment 1

Resonant Search Test Data

Table of Contents

Fig. 1 - 1 X Dir. Resonant Search before Seismic Test – Top of Specimen.....	16
Fig. 1 - 2 X Dir. Resonant Search after Seismic Test – Top of Specimen.....	16
Fig. 1 - 3 X Dir. Resonant Search after Sine beat – Top of Specimen.....	17
Fig. 1 - 4 X Dir. Resonant Search before Seismic Test – Housing Side (Right).....	17
Fig. 1 - 5 X Dir. Resonant Search after Seismic Test – Housing Side (Right).....	18
Fig. 1 - 6 X Dir. Resonant Search after Sine beat – Housing Side (Right).....	18
Fig. 1 - 7 X Dir. Resonant Search before Seismic Test – Housing Side (Left).....	19
Fig. 1 - 8 X Dir. Resonant Search after Seismic Test – Housing Side (Left).....	19
Fig. 1 - 9 X Dir. Resonant Search after Sine beat – Housing Side (Left).....	20
Fig. 1 - 10 Y Dir. Resonant Search before Seismic Test – Top of Specimen.....	20
Fig. 1 - 11 Y Dir. Resonant Search after Seismic Test – Top of Specimen.....	21
Fig. 1 - 12 Y Dir. Resonant Search after Sine beat – Top of Specimen.....	21
Fig. 1 - 13 Y Dir. Resonant Search before Seismic Test – Housing Side (Right).....	22
Fig. 1 - 14 Y Dir. Resonant Search after Seismic Test – Housing Side (Right).....	22
Fig. 1 - 15 Y Dir. Resonant Search after Sine beat – Housing Side (Right).....	23
Fig. 1 - 16 Y Dir. Resonant Search before Seismic Test – Housing Side (Left).....	23
Fig. 1 - 17 Y Dir. Resonant Search after Seismic Test – Housing Side (Left).....	24
Fig. 1 - 18 Y Dir. Resonant Search after Sine beat – Housing Side (Left).....	24
Fig. 1 - 19 Z Dir. Resonant Search before Seismic Test – Top of Specimen.....	25
Fig. 1 - 20 Z Dir. Resonant Search after Seismic Test – Top of Specimen.....	25
Fig. 1 - 21 Z Dir. Resonant Search after Sine beat – Top of Specimen.....	26
Fig. 1 - 22 Z Dir. Resonant Search before Seismic Test – Housing Side (Right).....	26
Fig. 1 - 23 Z Dir. Resonant Search after Seismic Test – Housing Side (Right).....	27
Fig. 1 - 24 Z Dir. Resonant Search after Sine beat – Housing Side (Right).....	27
Fig. 1 - 25 Z Dir. Resonant Search before Seismic Test – Housing Side (Left).....	28
Fig. 1 - 26 Z Dir. Resonant Search after Seismic Test – Housing Side (Left).....	28
Fig. 1 - 27 Z Dir. Resonant Search after Sine beat – Housing Side (Left).....	29

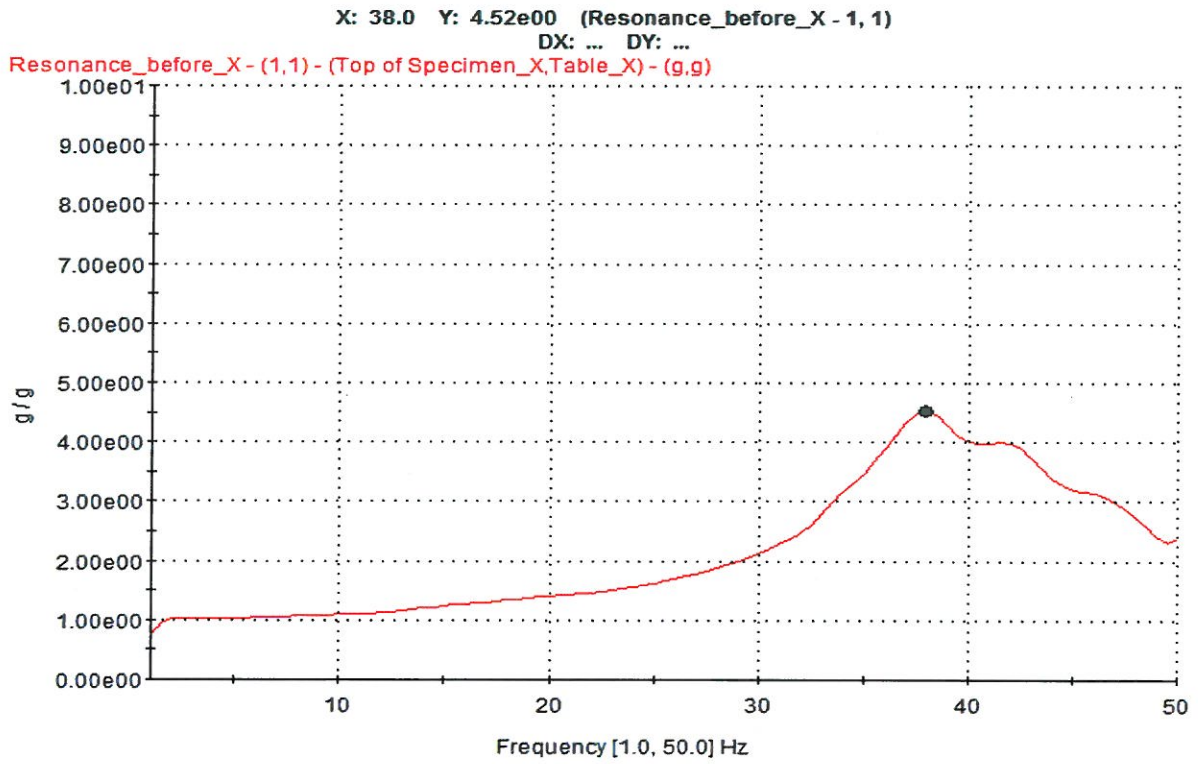


Fig. 1 - 1 X Dir. Resonant Search before Seismic Test – Top of Specimen

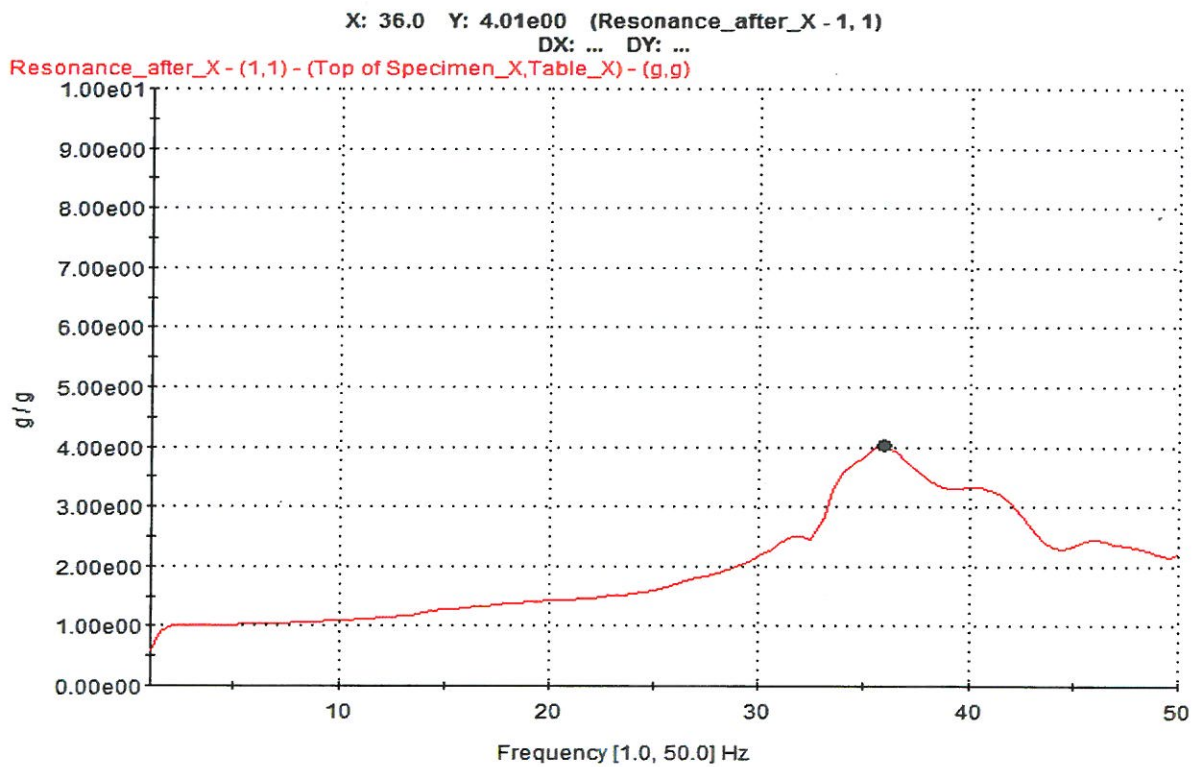
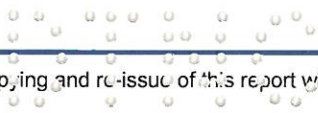


Fig. 1 - 2 X Dir. Resonant Search after Seismic Test – Top of Specimen



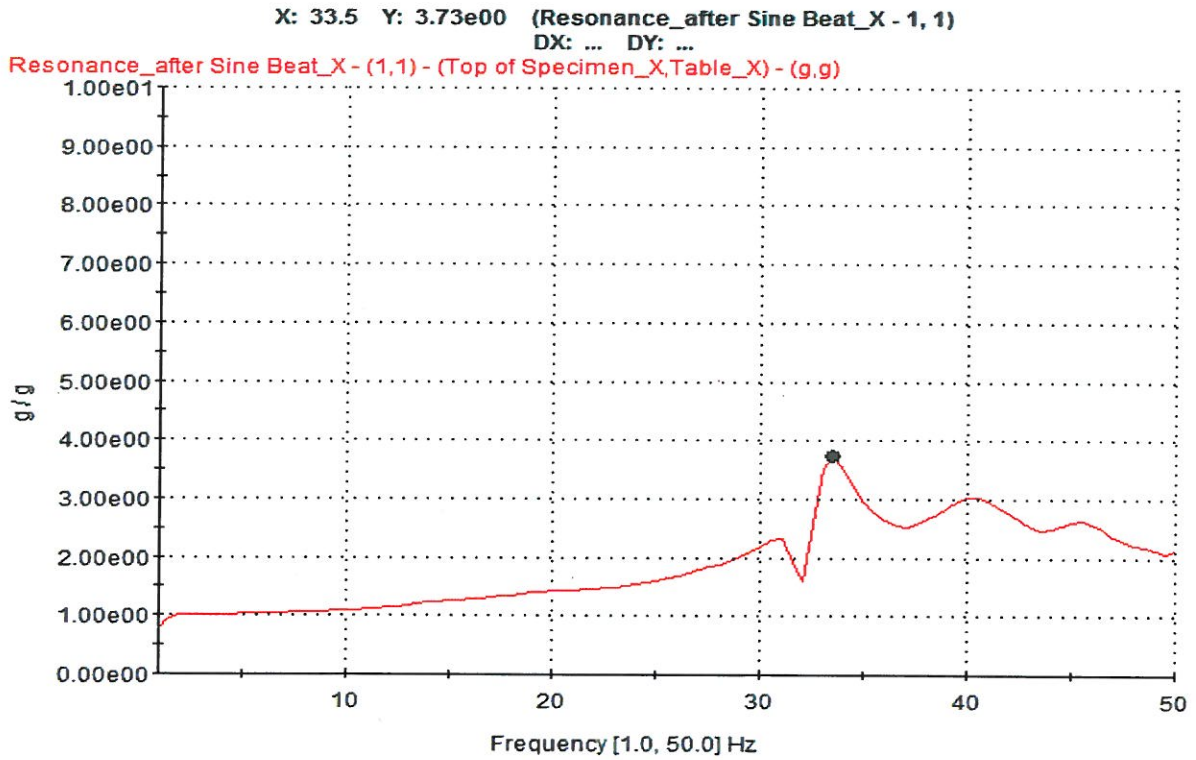


Fig. 1 - 3 X Dir. Resonant Search after Sine beat – Top of Specimen

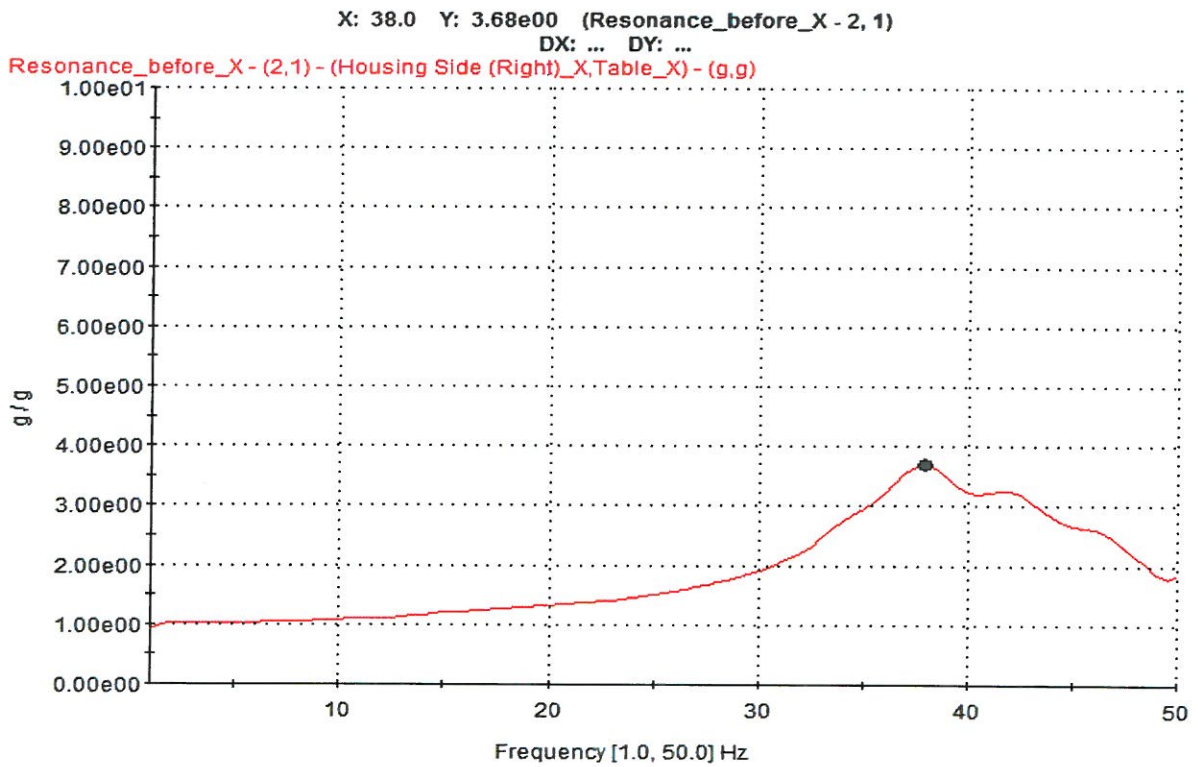


Fig. 1 - 4 X Dir. Resonant Search before Seismic Test – Housing Side (Right)

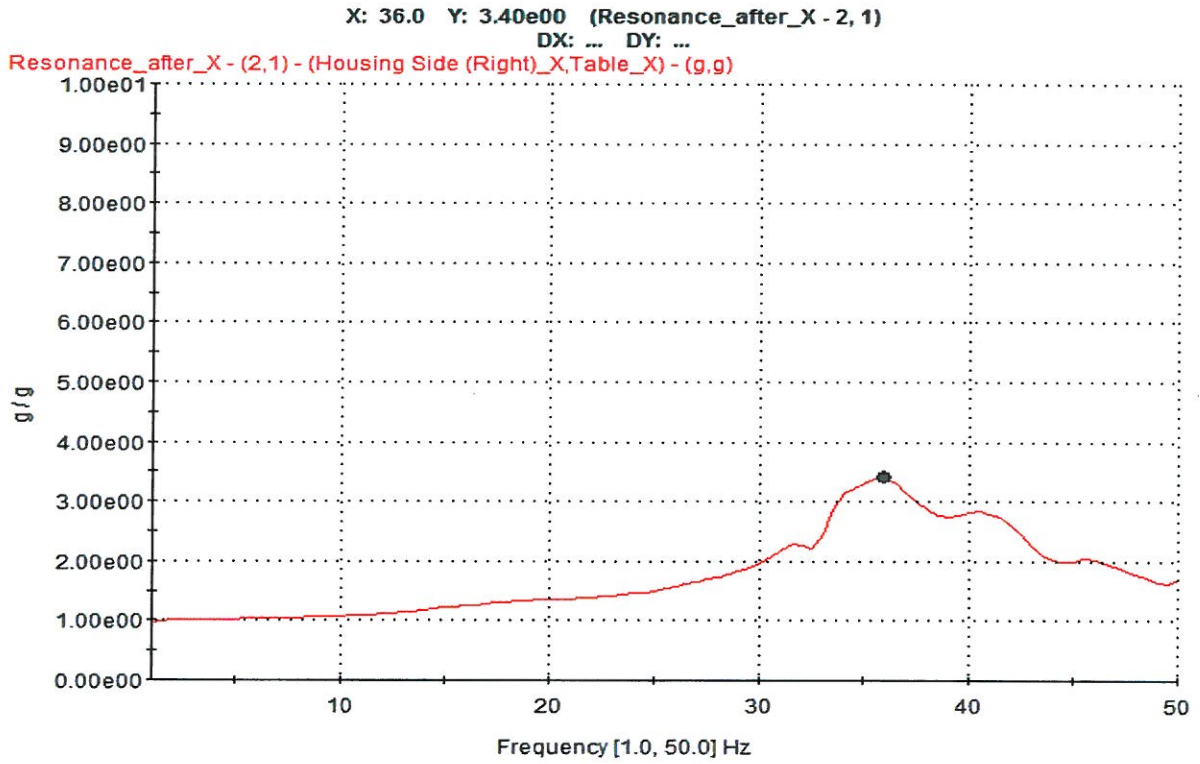


Fig. 1 - 5 X Dir. Resonant Search after Seismic Test – Housing Side (Right)

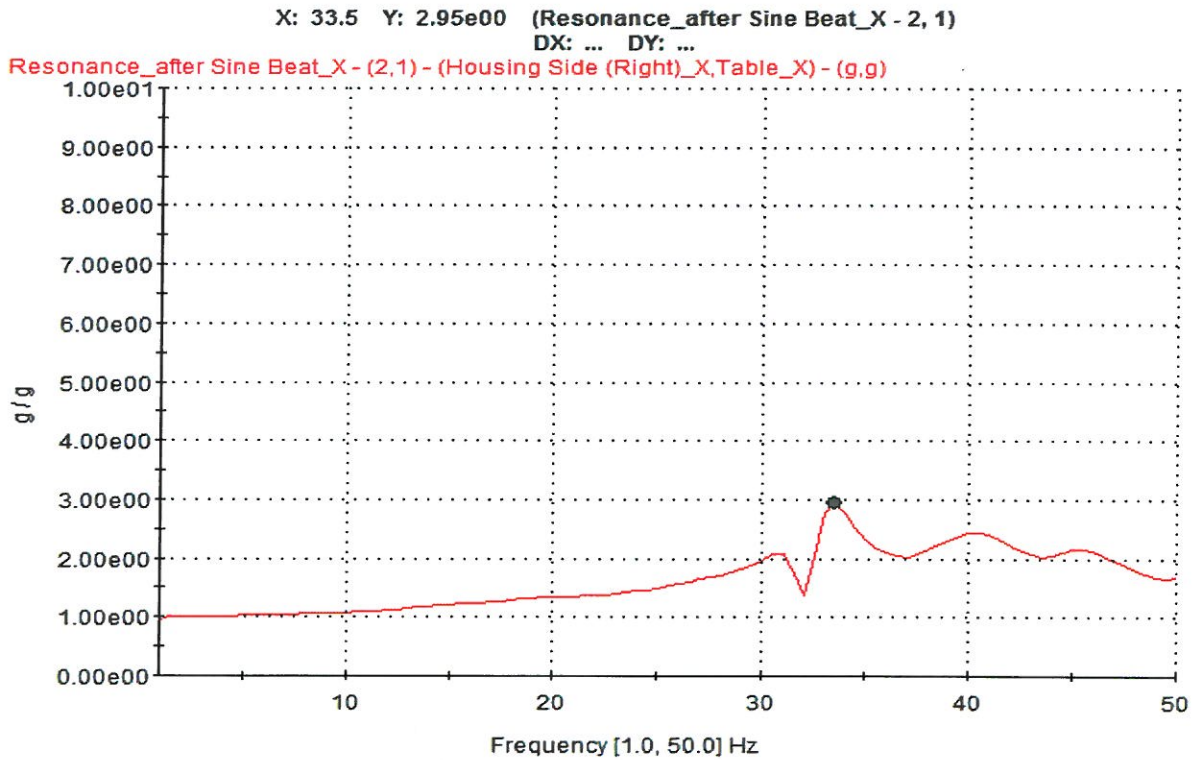


Fig. 1 - 6 X Dir. Resonant Search after Sine beat – Housing Side (Right)

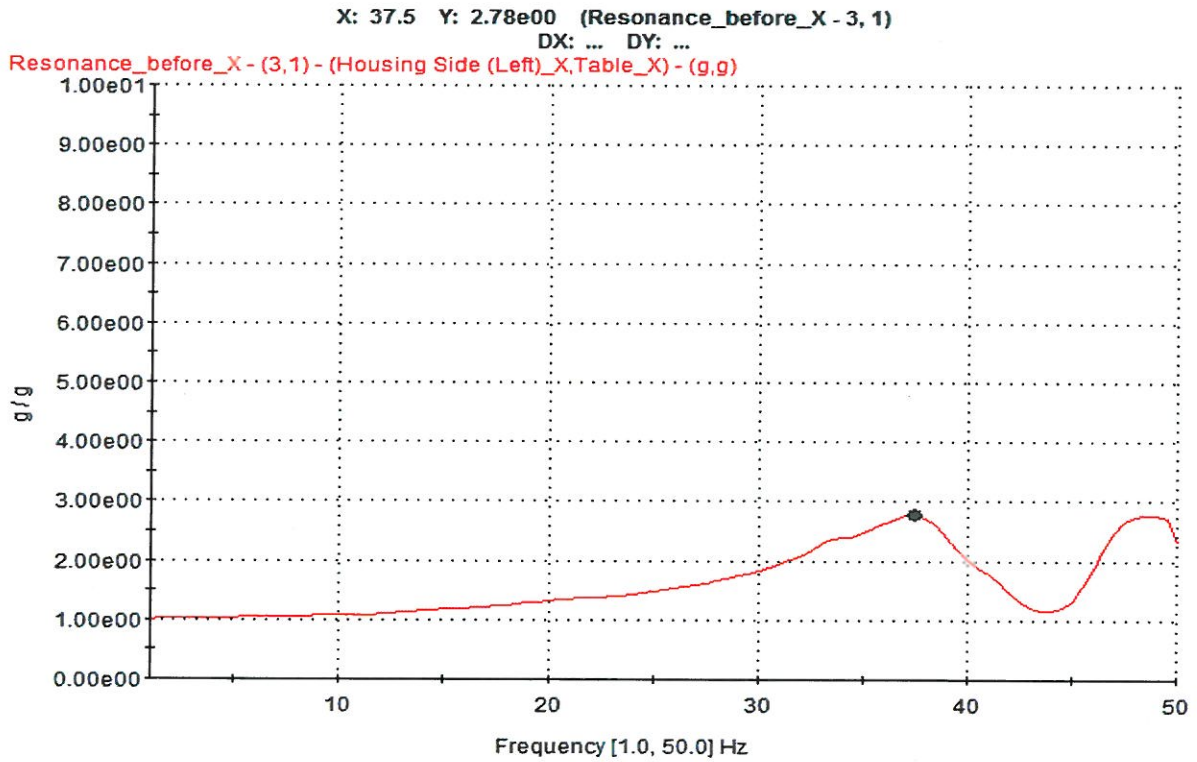


Fig. 1 - 7 X Dir. Resonant Search before Seismic Test – Housing Side (Left)

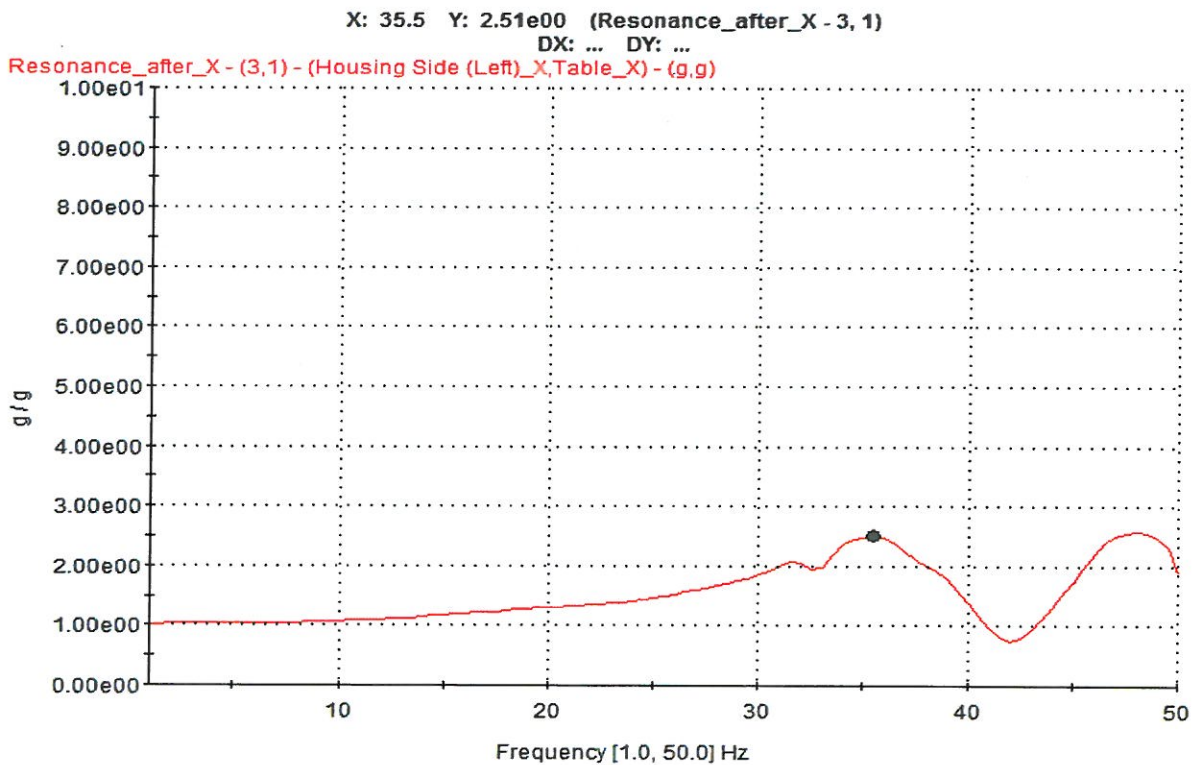


Fig. 1 - 8 X Dir. Resonant Search after Seismic Test – Housing Side (Left)

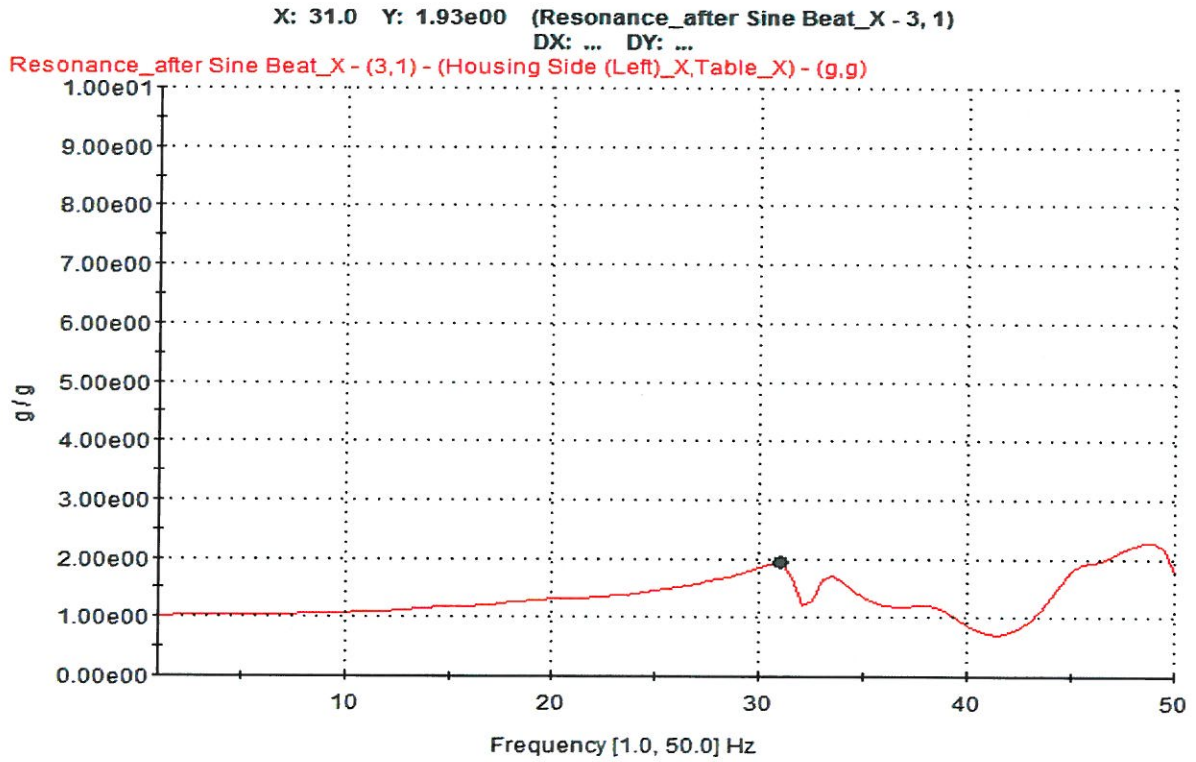


Fig. 1 - 9 X Dir. Resonant Search after Sine beat – Housing Side (Left)

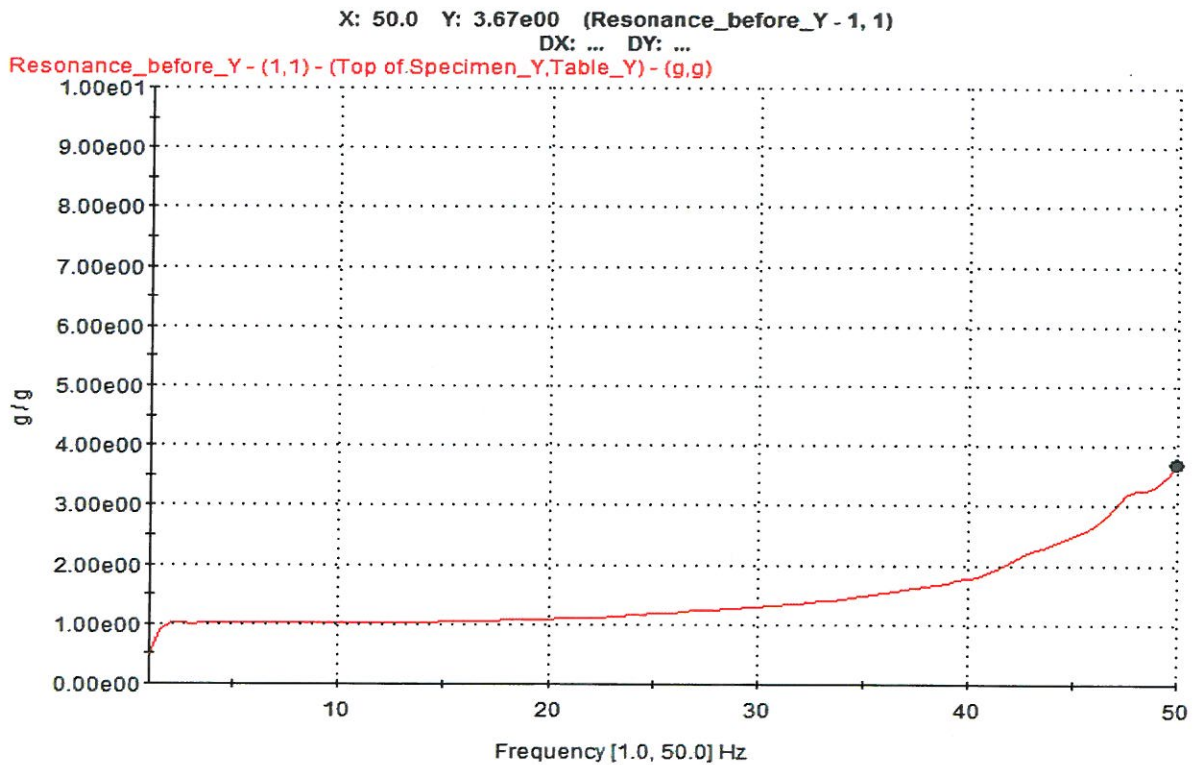


Fig. 1 - 10 Y Dir. Resonant Search before Seismic Test – Top of Specimen

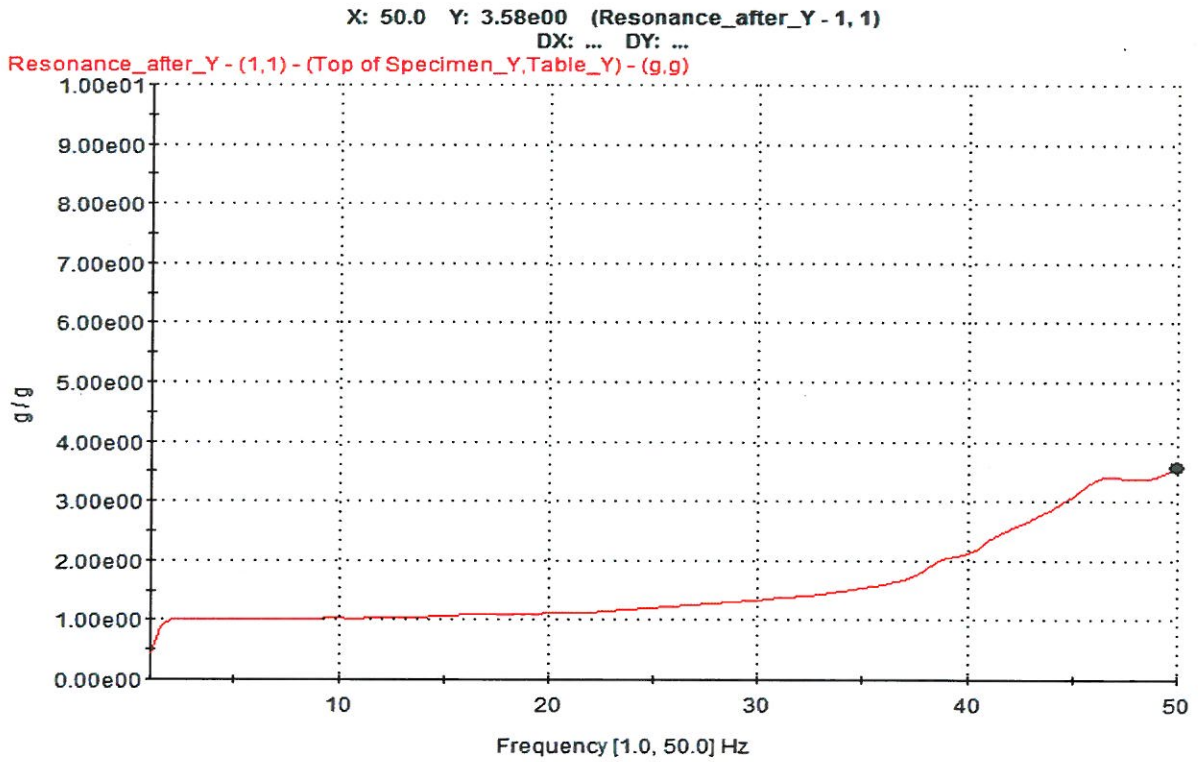


Fig. 1 - 11 Y Dir. Resonant Search after Seismic Test – Top of Specimen

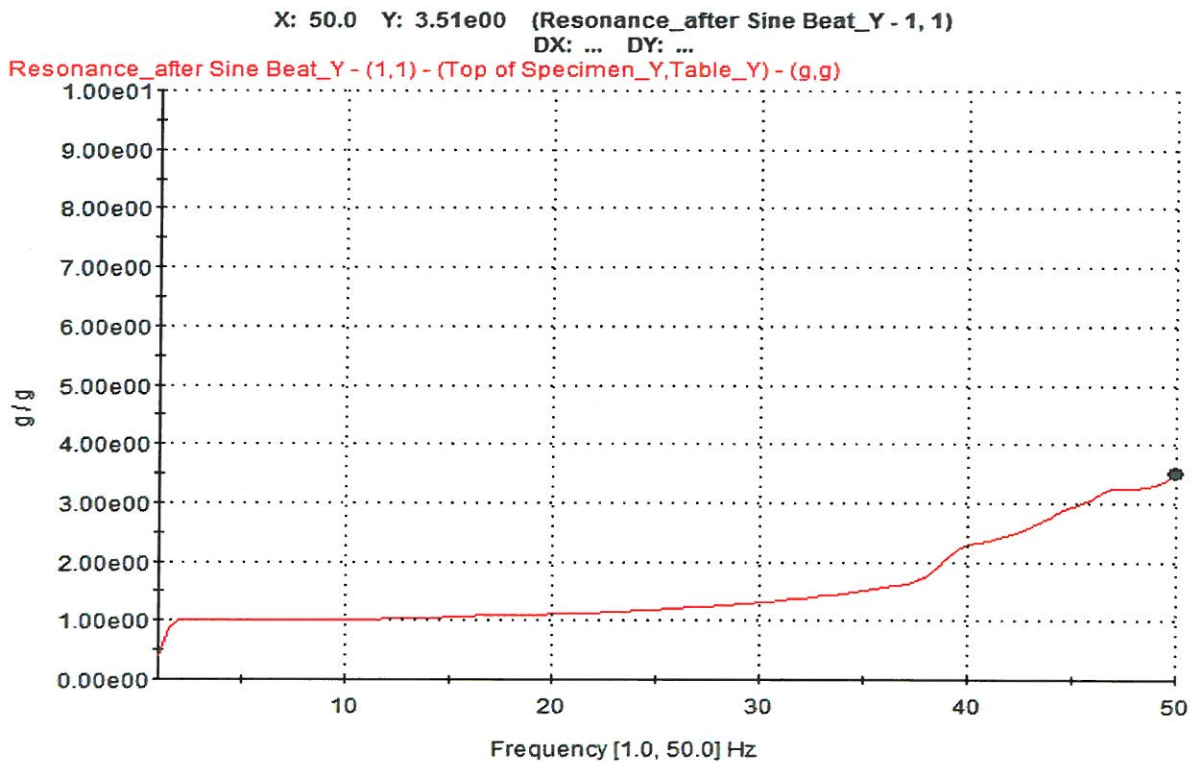


Fig. 1 - 12 Y Dir. Resonant Search after Sine beat – Top of Specimen

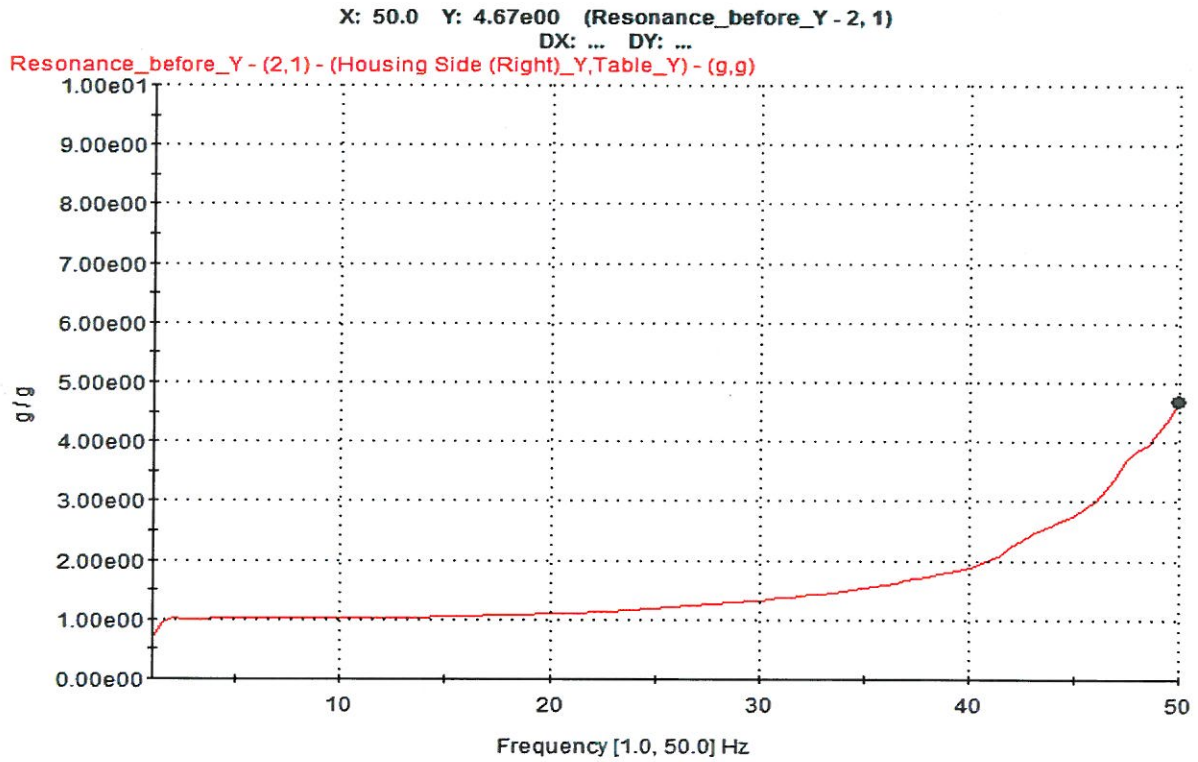


Fig. 1 - 13 Y Dir. Resonant Search before Seismic Test – Housing Side (Right)

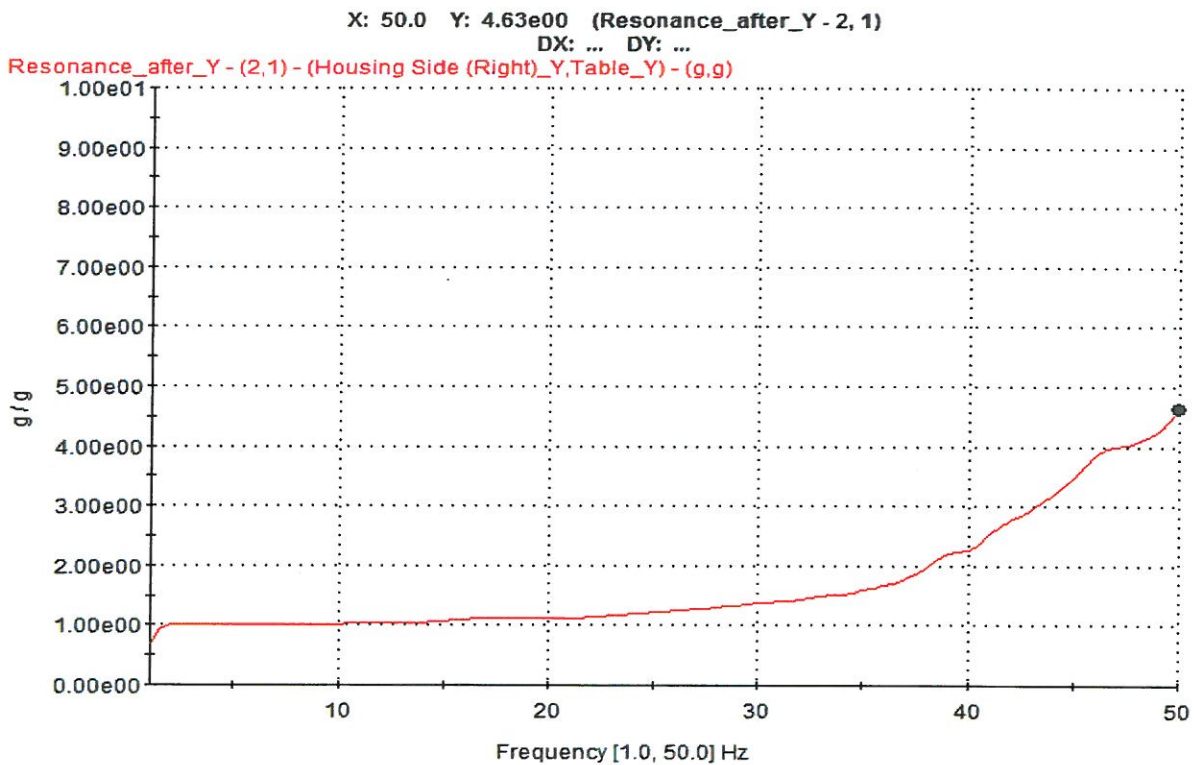


Fig. 1 - 14 Y Dir. Resonant Search after Seismic Test – Housing Side (Right)

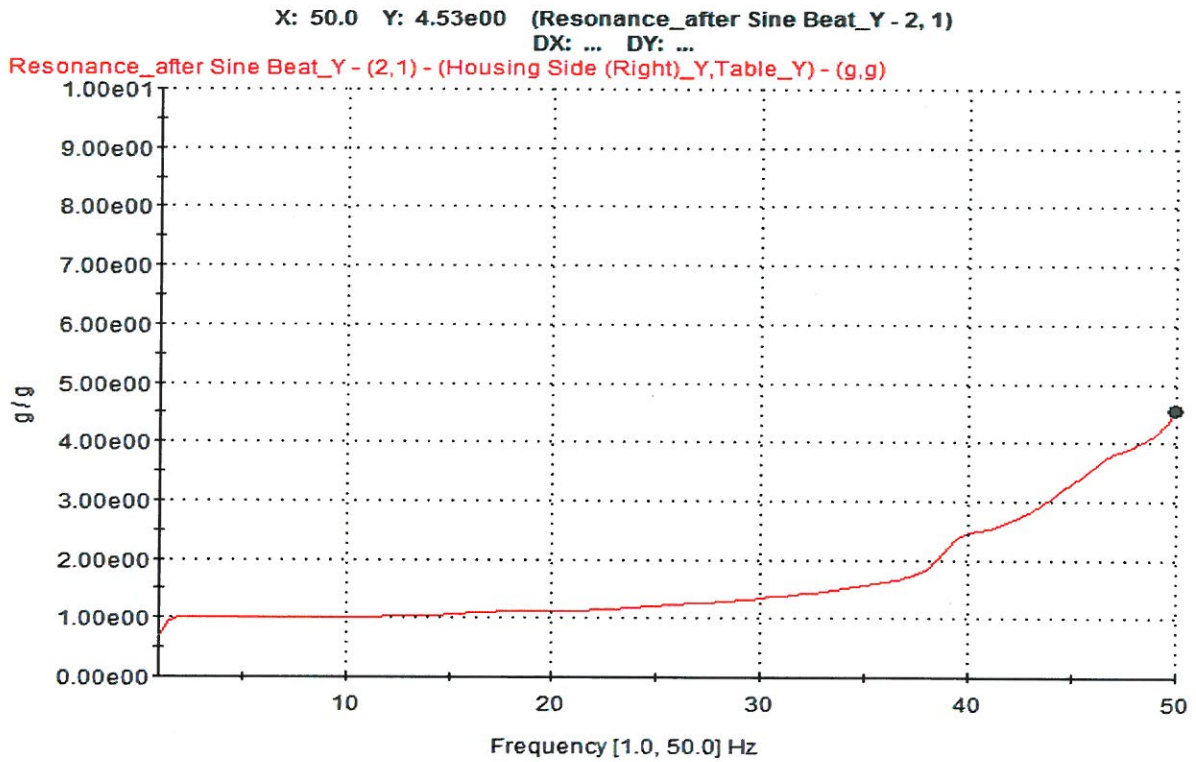


Fig. 1 - 15 Y Dir. Resonant Search after Sine beat – Housing Side (Right)

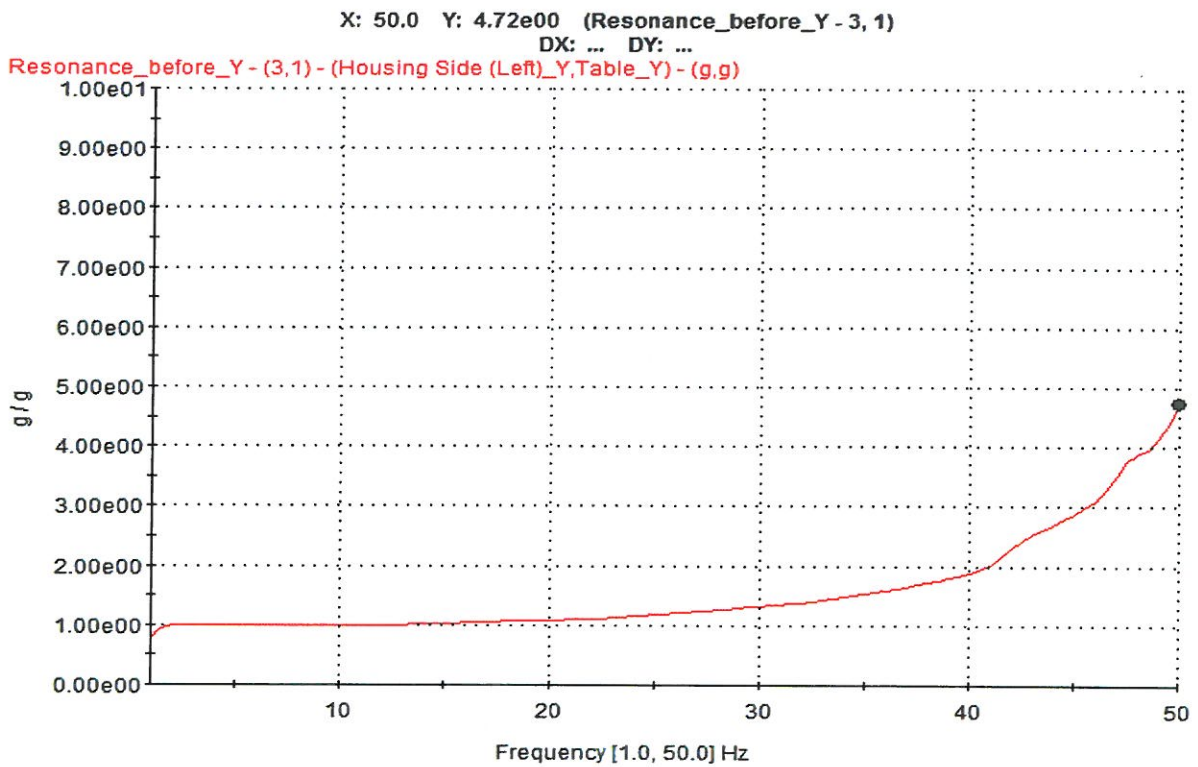


Fig. 1 - 16 Y Dir. Resonant Search before Seismic Test – Housing Side (Left)

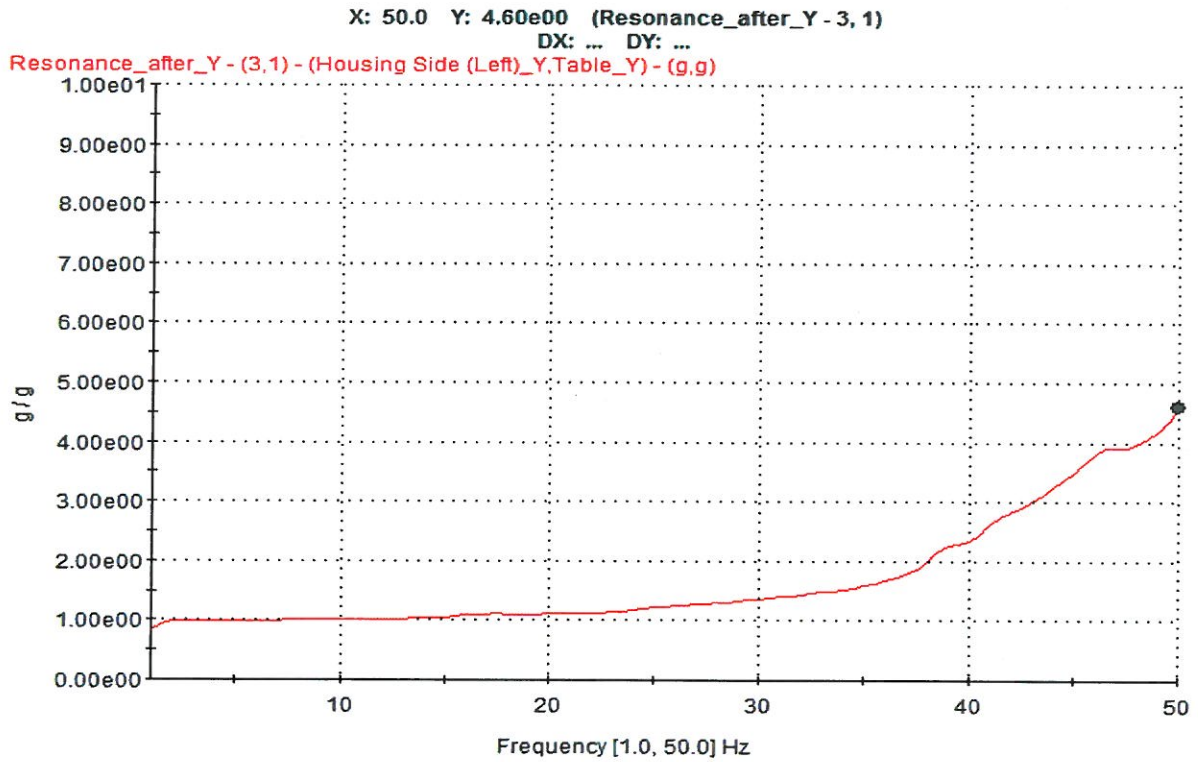


Fig. 1 - 17 Y Dir. Resonant Search after Seismic Test – Housing Side (Left)

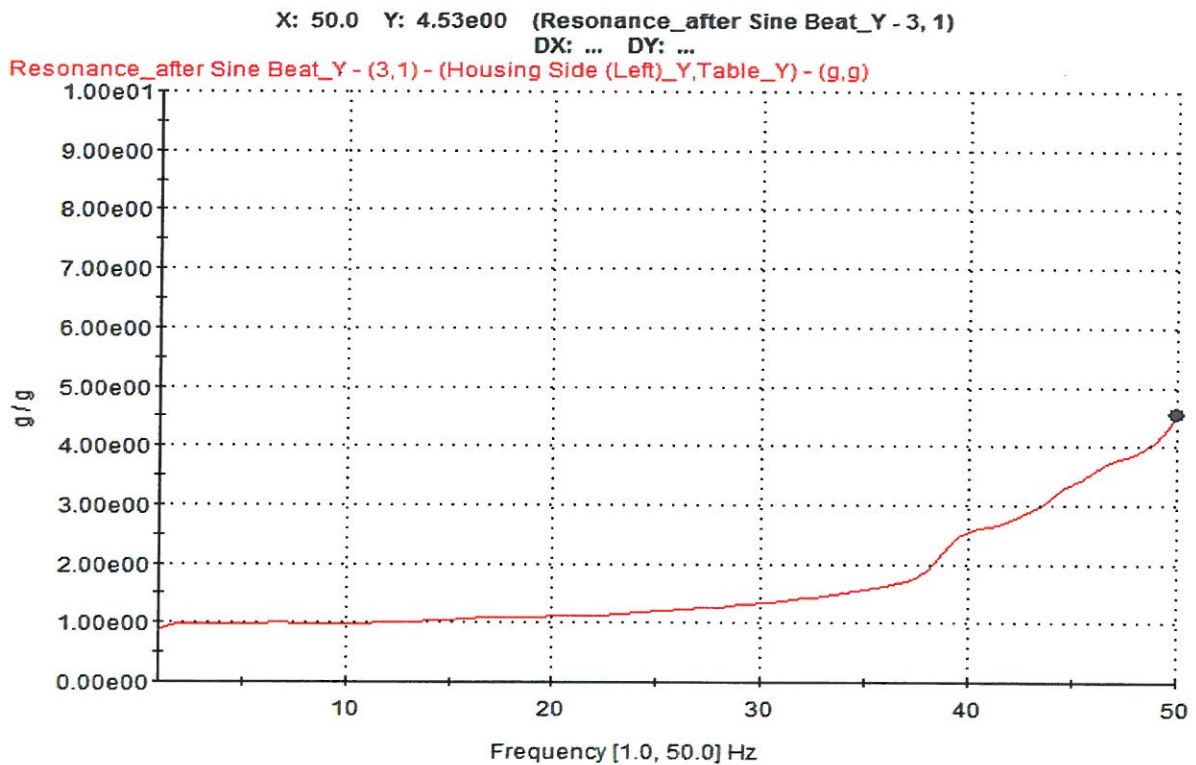


Fig. 1 - 18 Y Dir. Resonant Search after Sine beat – Housing Side (Left)

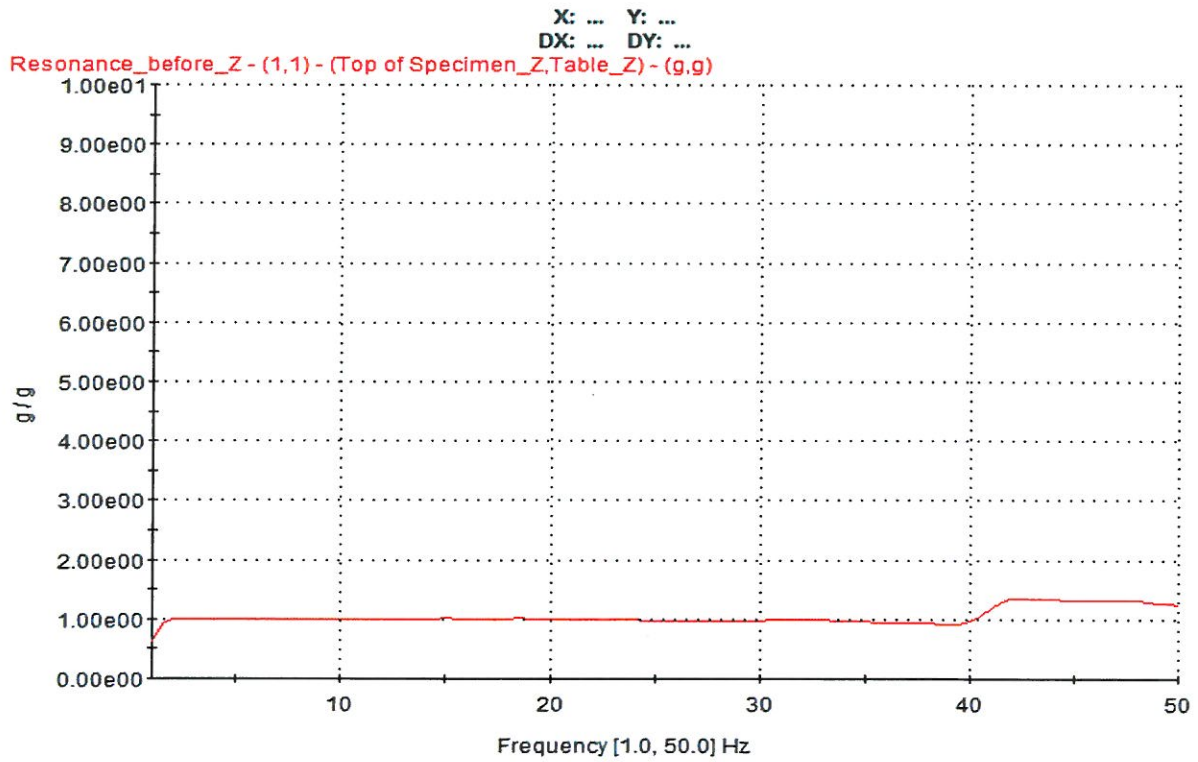


Fig. 1 - 19 Z Dir. Resonant Search before Seismic Test – Top of Specimen

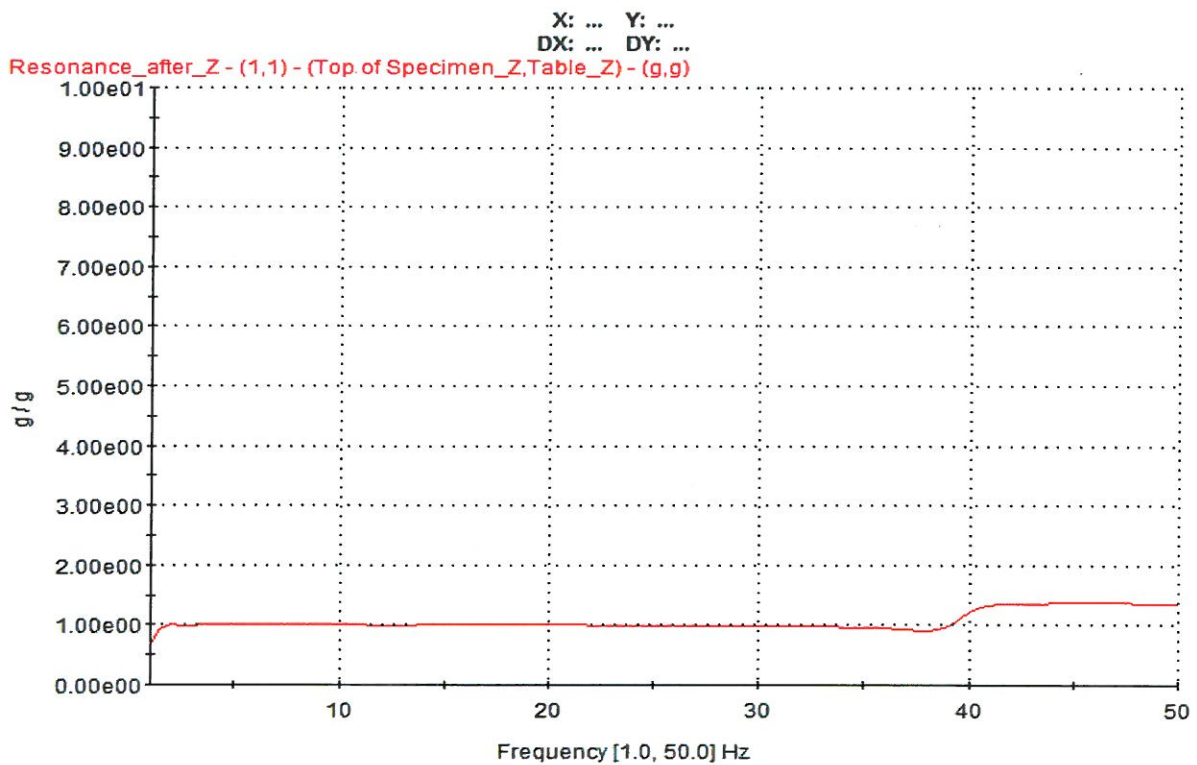


Fig. 1 - 20 Z Dir. Resonant Search after Seismic Test – Top of Specimen

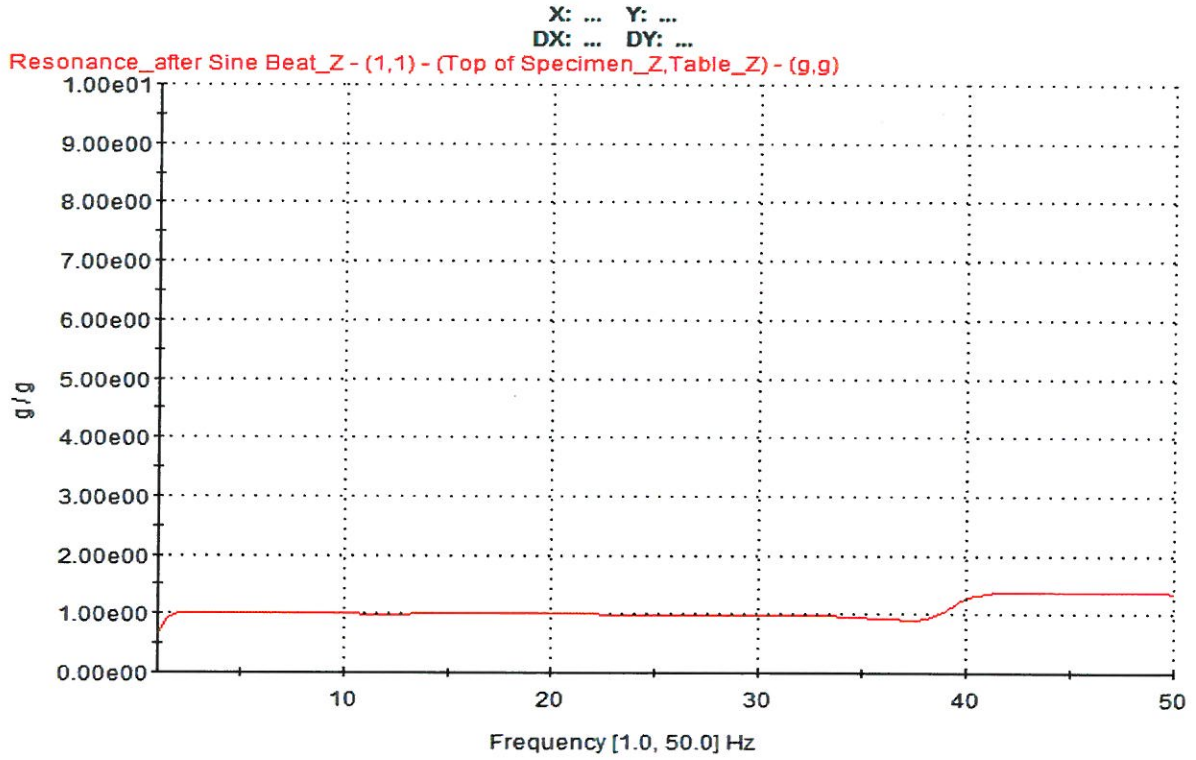


Fig. 1 - 21 Z Dir. Resonant Search after Sine beat – Top of Specimen

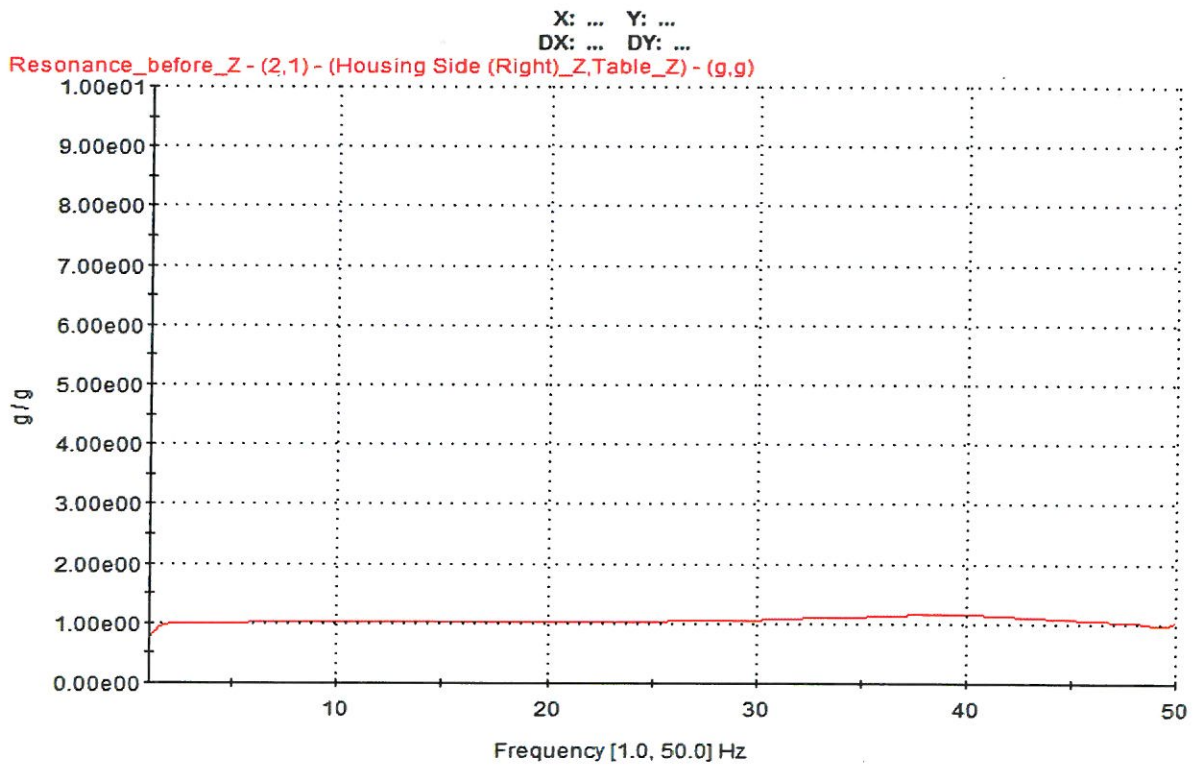


Fig. 1 - 22 Z Dir. Resonant Search before Seismic Test – Housing Side (Right)

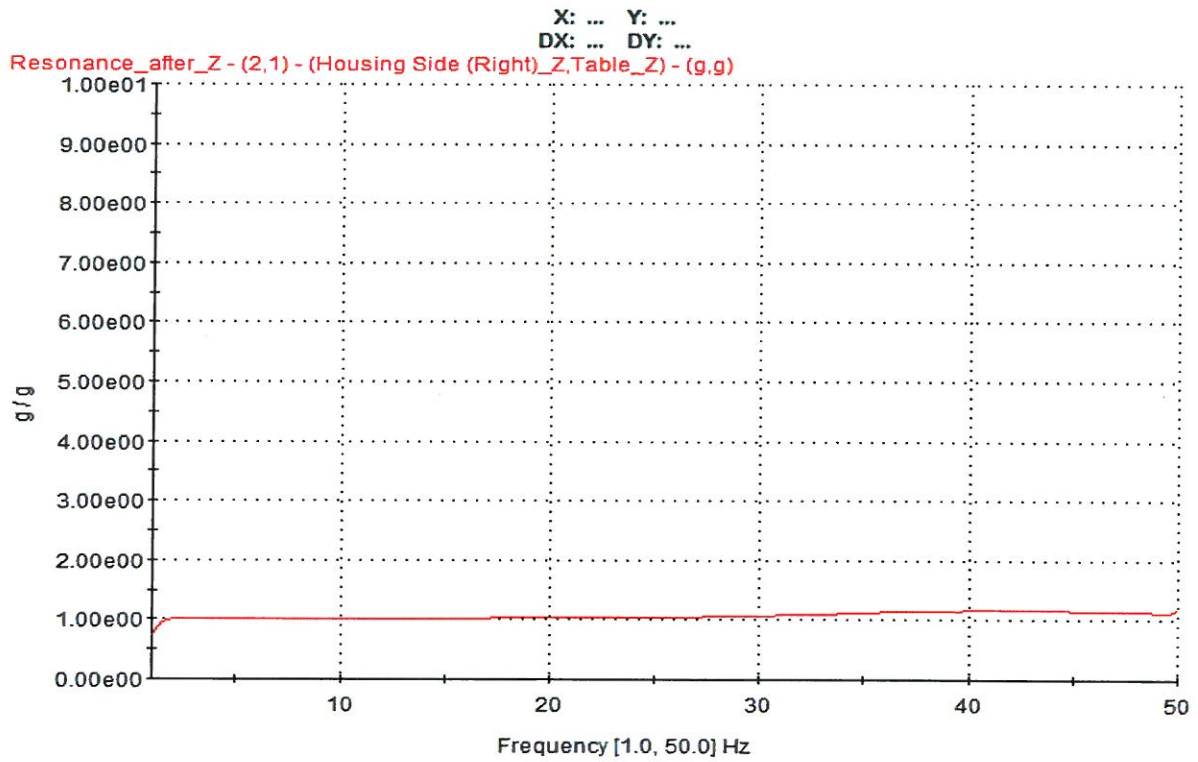


Fig. 1 - 23 Z Dir. Resonant Search after Seismic Test – Housing Side (Right)

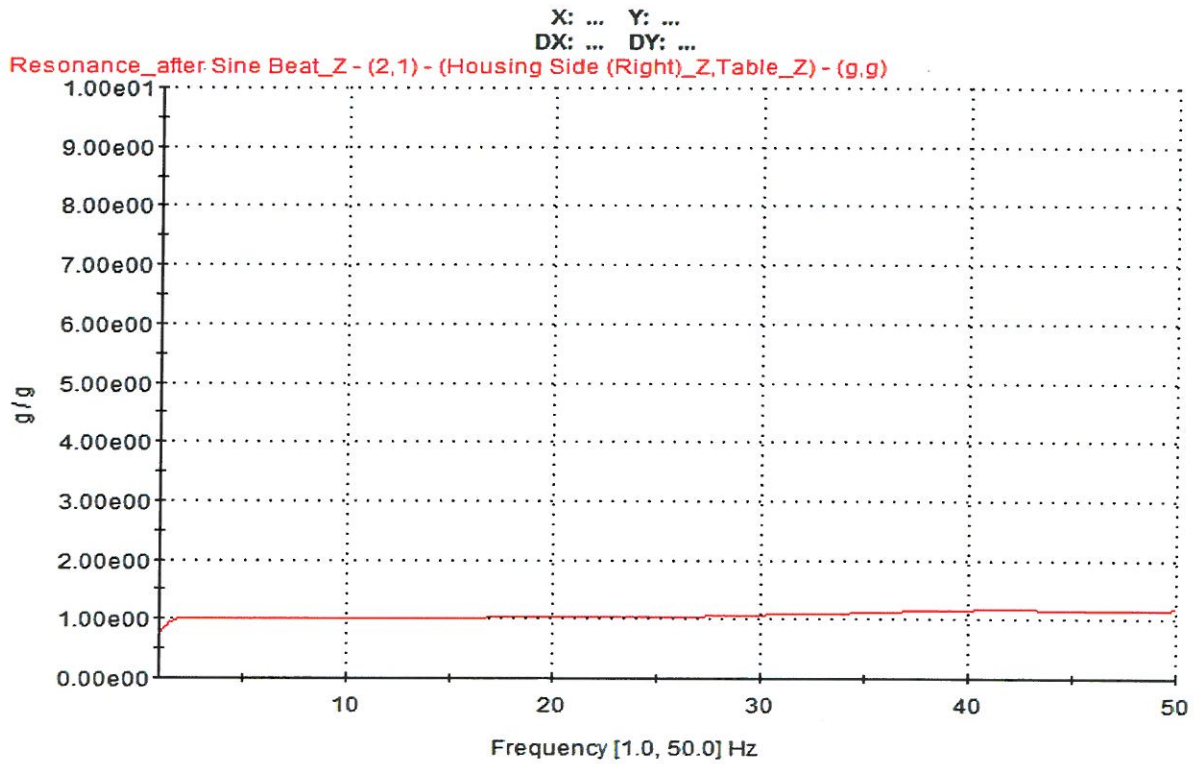


Fig. 1 - 24 Z Dir. Resonant Search after Sine beat – Housing Side (Right)

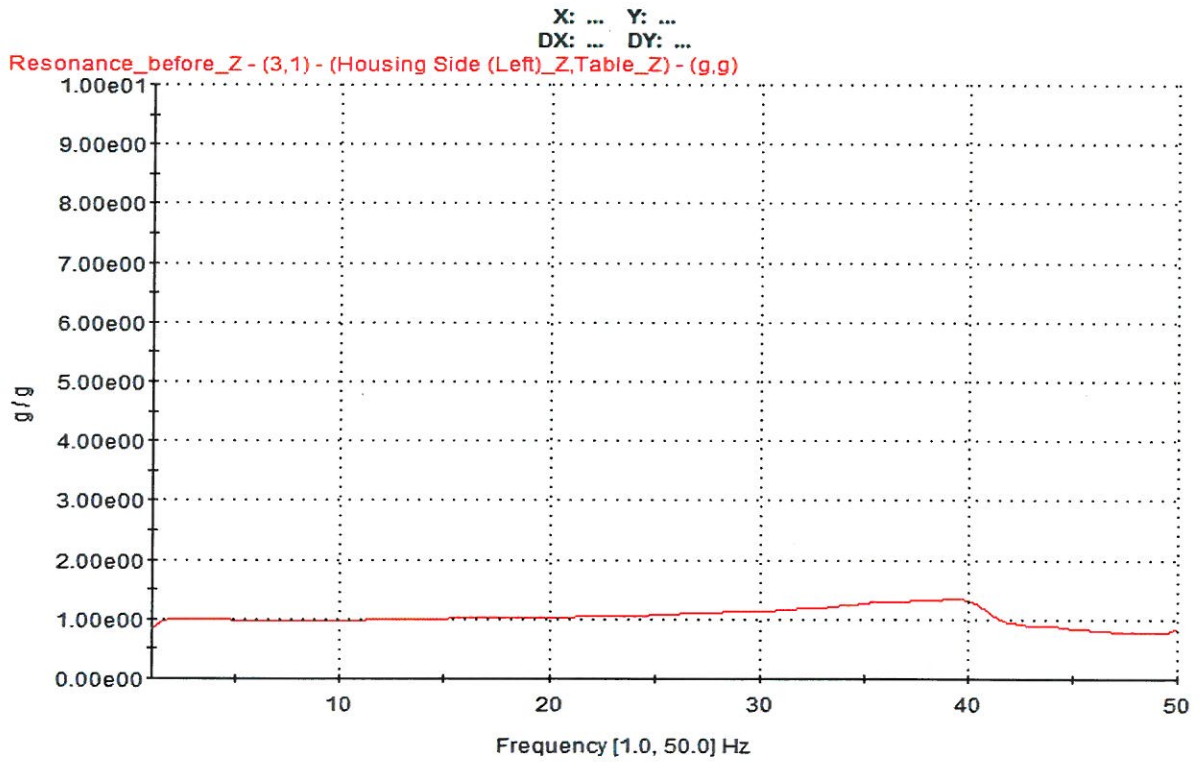


Fig. 1 - 25 Z Dir. Resonant Search before Seismic Test – Housing Side (Left)

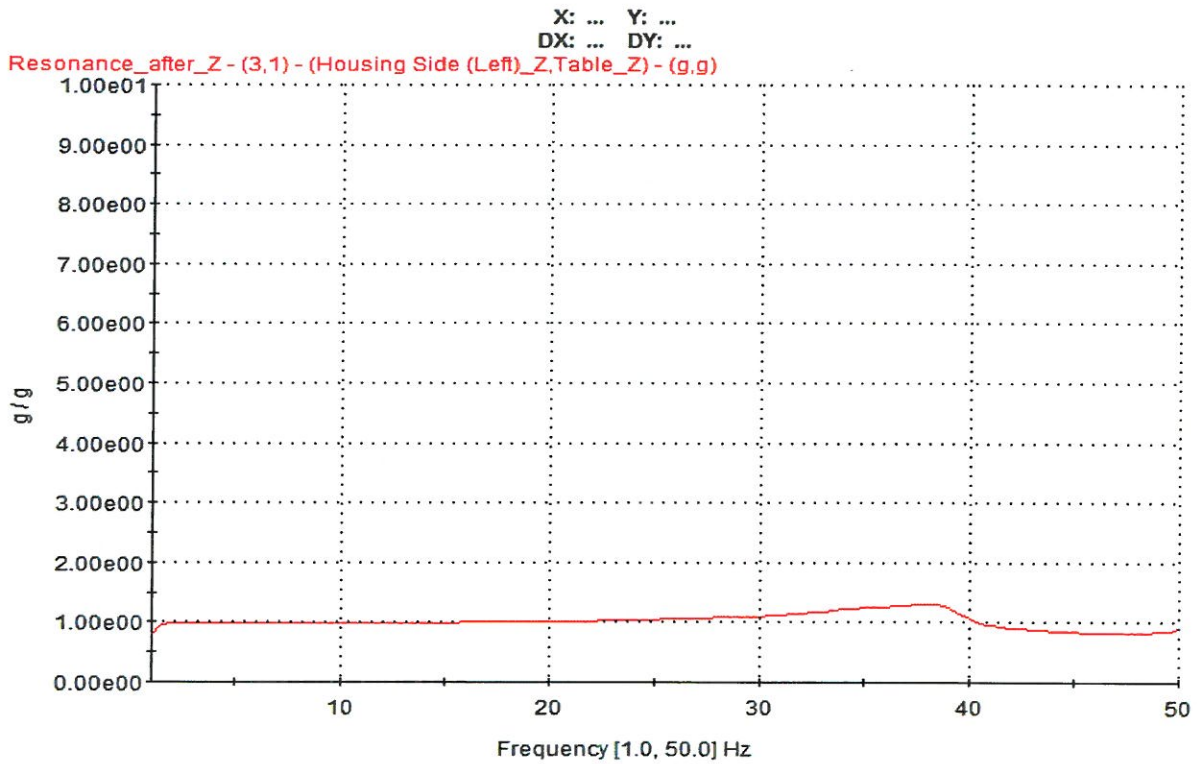


Fig. 1 - 26 Z Dir. Resonant Search after Seismic Test – Housing Side (Left)

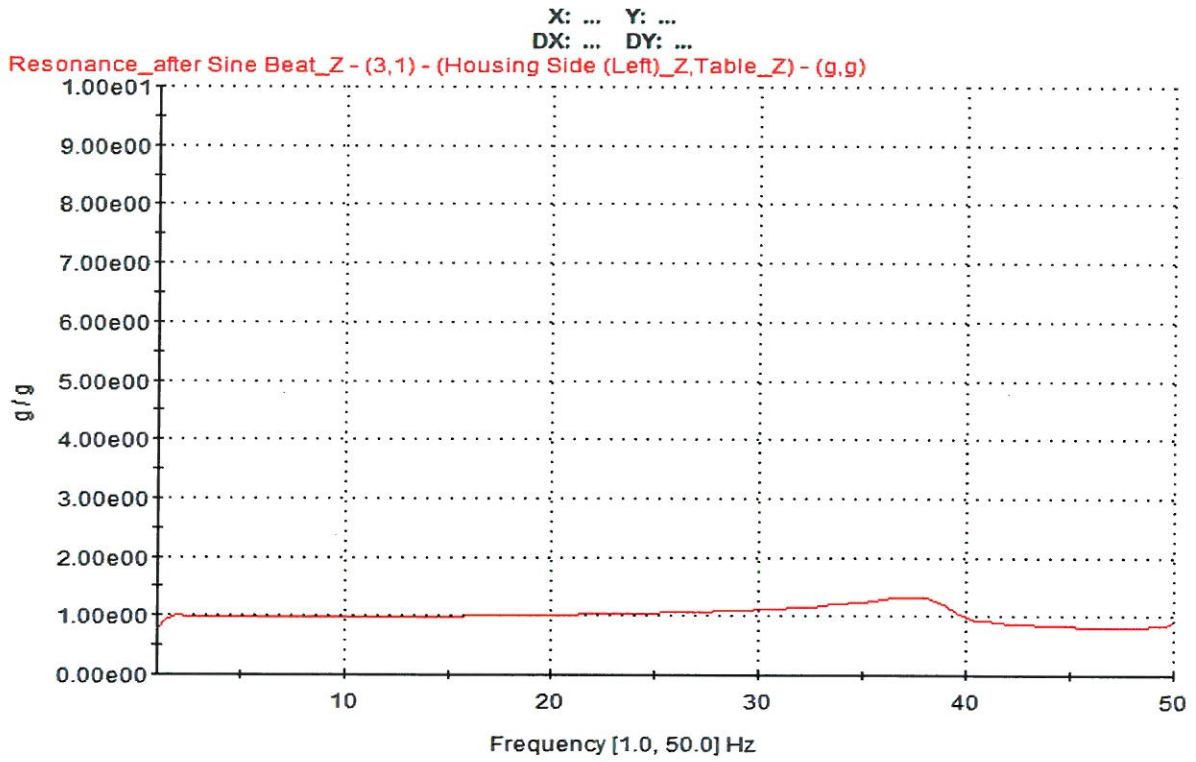


Fig. 1 - 27 Z Dir. Resonant Search after Sine beat – Housing Side (Left)

Attachment 2

Seismic Test Data

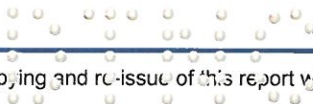


Table of Contents

Fig. 2 - 1 TRS (Table) with X Dir. of Seismic Test	32
Fig. 2 - 2 TRS (Top of Specimen) with X Dir. of Seismic Test.....	32
Fig. 2 - 3 TRS (Housing Side_Right) with X Dir. of Seismic Test.....	33
Fig. 2 - 4 TRS (Housing Side_Left) with X Dir. of Seismic Test.....	33
Fig. 2 - 5 TRS (Table) with Y Dir. of Seismic Test	34
Fig. 2 - 6 TRS (Top of Specimen) with Y Dir. of Seismic Test.....	34
Fig. 2 - 7 TRS (Housing Side_Right) with Y Dir. of Seismic Test.....	35
Fig. 2 - 8 TRS (Housing Side_Left) with Y Dir. of Seismic Test.....	35
Fig. 2 - 9 TRS (Table) with Z Dir. of Seismic Test	36
Fig. 2 - 10 TRS (Top of Specimen) with Z Dir. of Seismic Test	36
Fig. 2 - 11 TRS (Housing Side_Right) with Z Dir. of Seismic Test	37
Fig. 2 - 12 TRS (Housing Side_Left) with Z Dir. of Seismic Test	37
Fig. 2 - 13 Time History (Table) of Seismic Test	38
Fig. 2 - 14 Time History (Top of Specimen) of Seismic Test.....	38
Fig. 2 - 15 Time History (Housing Side_Right) of Seismic Test.....	39
Fig. 2 - 16 Time History (Housing Side_Left) of Seismic Test.....	39

IEEE 693 RRS (0.5 g, 2% Damping) - (1,1) - (Long Acc,Long Acc) - (g,g)
 Seismic Test_1_SRS - (1,1) - (Table_X,Col 1) - (g,)

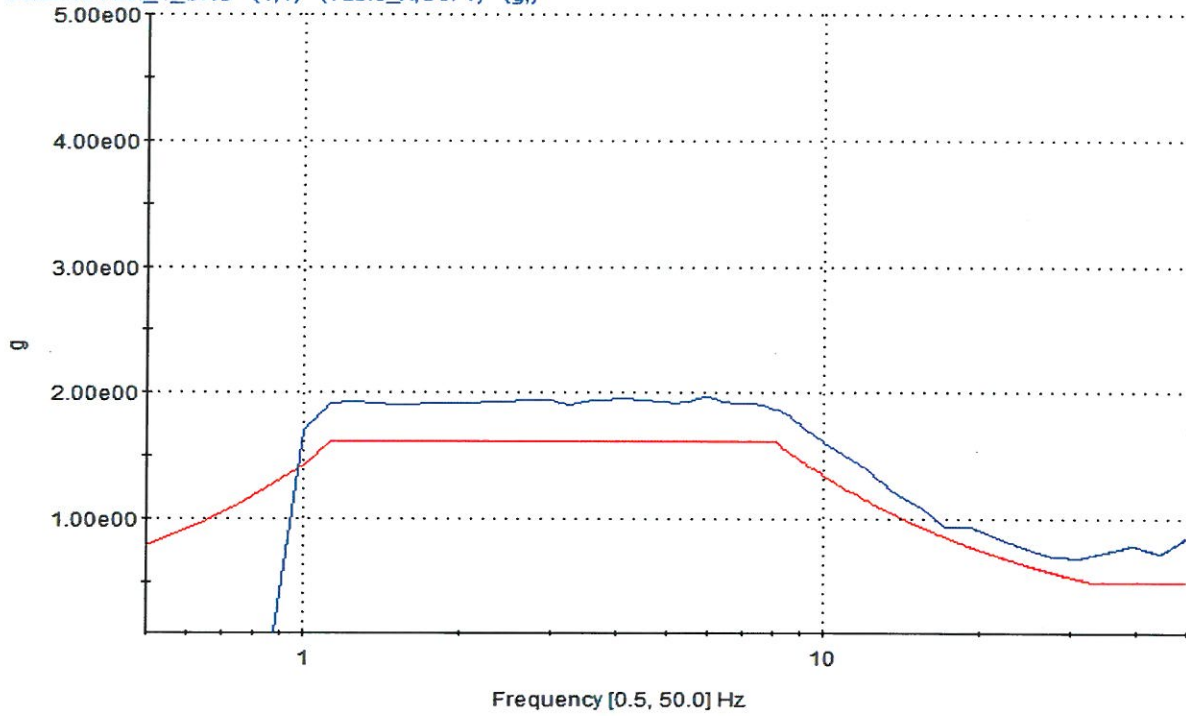


Fig. 2 - 1 TRS (Table) with X Dir. of Seismic Test

IEEE 693 RRS (0.5 g, 2% Damping) - (1,1) - (Long Acc,Long Acc) - (g,g)
 Seismic Test_1_SRS - (4,4) - (Top of Specimen_X,) - (g,)

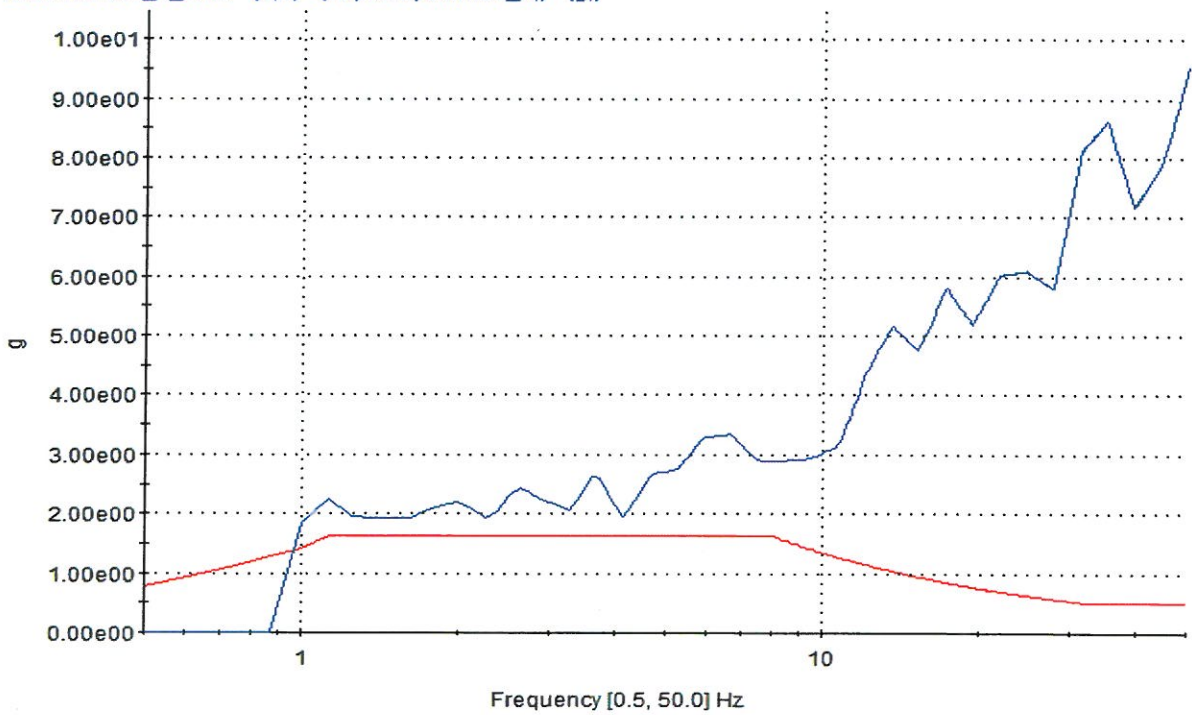


Fig. 2 - 2 TRS (Top of Specimen) with X Dir. of Seismic Test

IEEE 693 RRS (0.5 g, 2% Damping) - (1,1) - (Long Acc,Long Acc) - (g,g)
 Seismic Test_1_SRS - (7,7) - (Housing Side (Right)_X) - (g,)

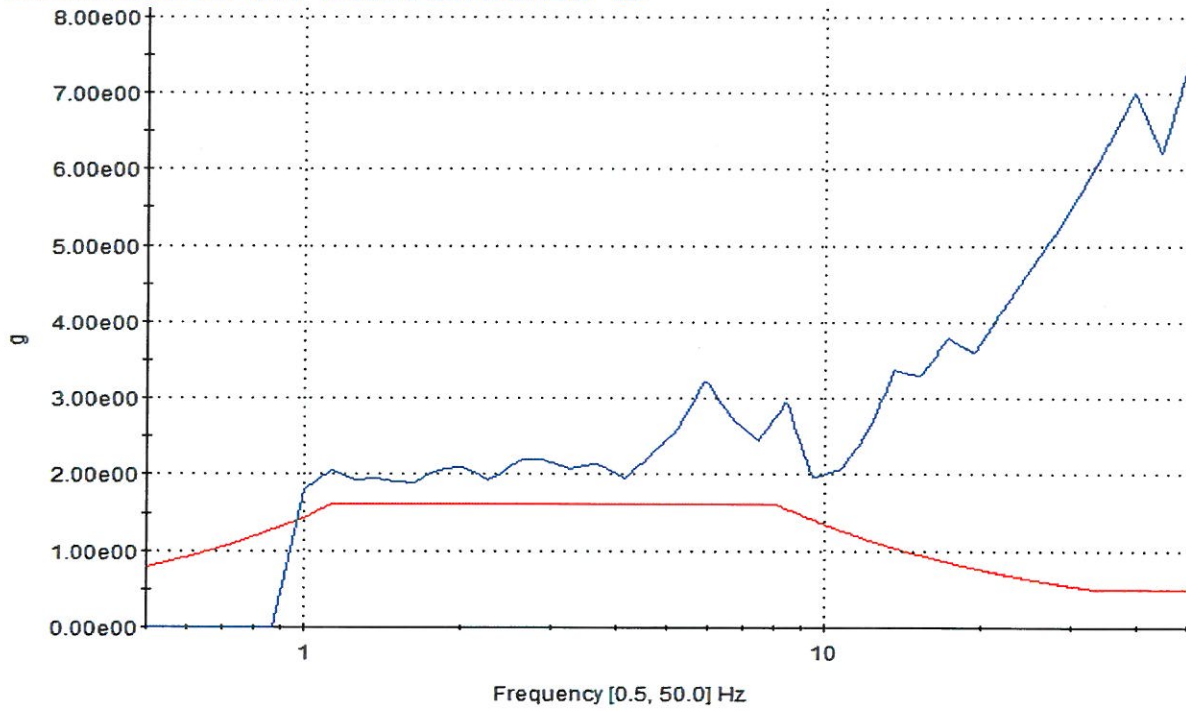


Fig. 2 - 3 TRS (Housing Side_Right) with X Dir. of Seismic Test

IEEE 693 RRS (0.5 g, 2% Damping) - (1,1) - (Long Acc,Long Acc) - (g,g)
 Seismic Test_1_SRS - (10,10) - (Housing Side (Left)_X) - (g,)

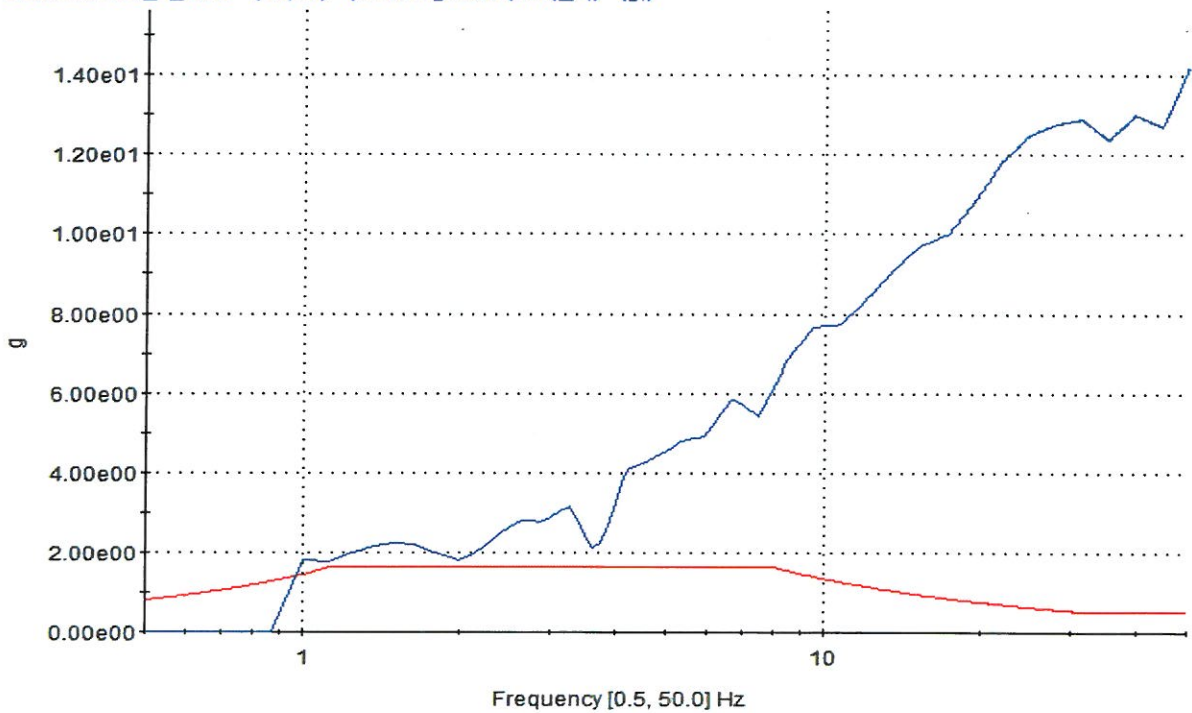


Fig. 2 - 4 TRS (Housing Side_Left) with X Dir. of Seismic Test

IEEE 693 RRS (0.5 g, 2% Damping) - (2,2) - (Lat Acc,Lat Acc) - (g,g)
 Seismic Test_1_SRS - (2,2) - (Table_Y,) - (g.)

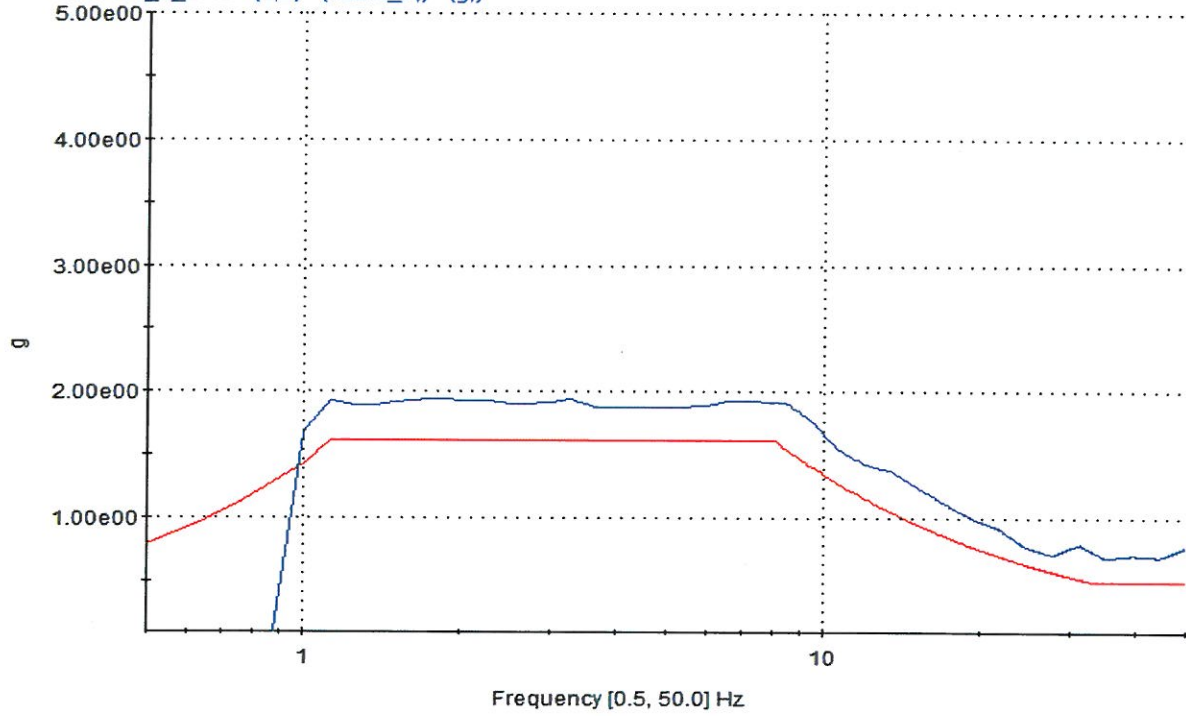


Fig. 2 - 5 TRS (Table) with Y Dir. of Seismic Test

IEEE 693 RRS (0.5 g, 2% Damping) - (2,2) - (Lat Acc,Lat Acc) - (g,g)
 Seismic Test_1_SRS - (5,5) - (Top of Specimen_Y,) - (g.)

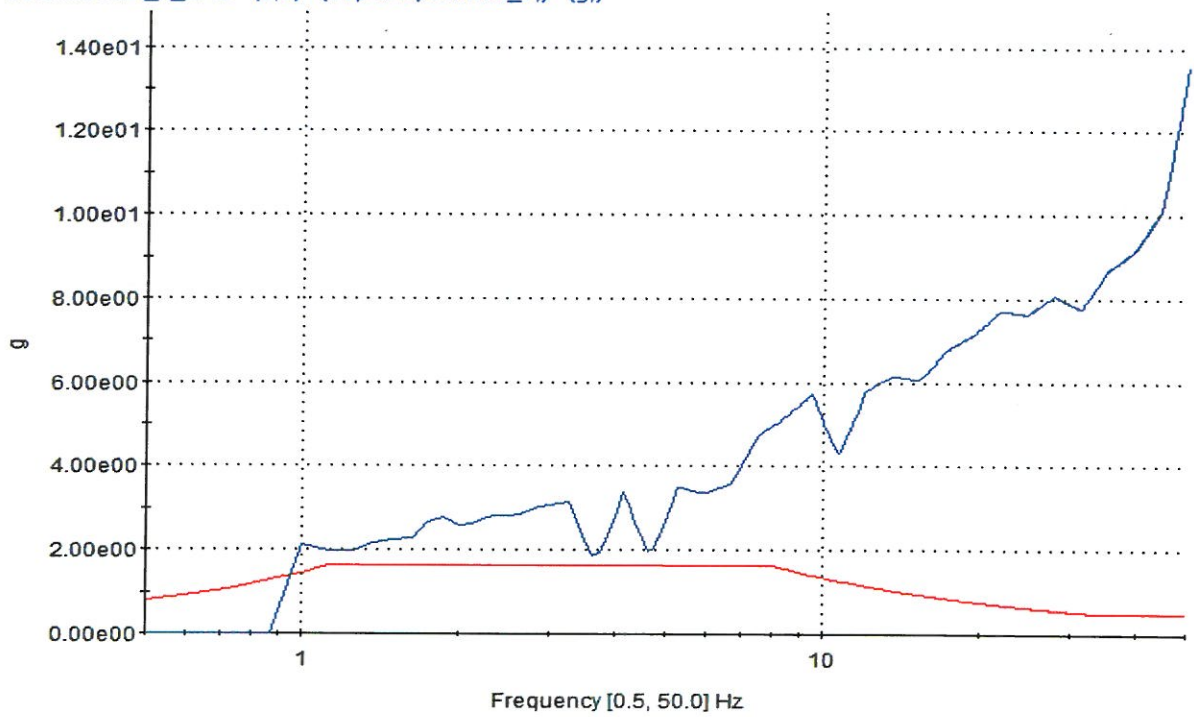


Fig. 2 - 6 TRS (Top of Specimen) with Y Dir. of Seismic Test

IEEE 693 RRS (0.5 g, 2% Damping) - (2,2) - (Lat Acc,Lat Acc) - (g,g)
 Seismic Test_1_SRS - (8,8) - (Housing Side (Right)_Y,) - (g.)

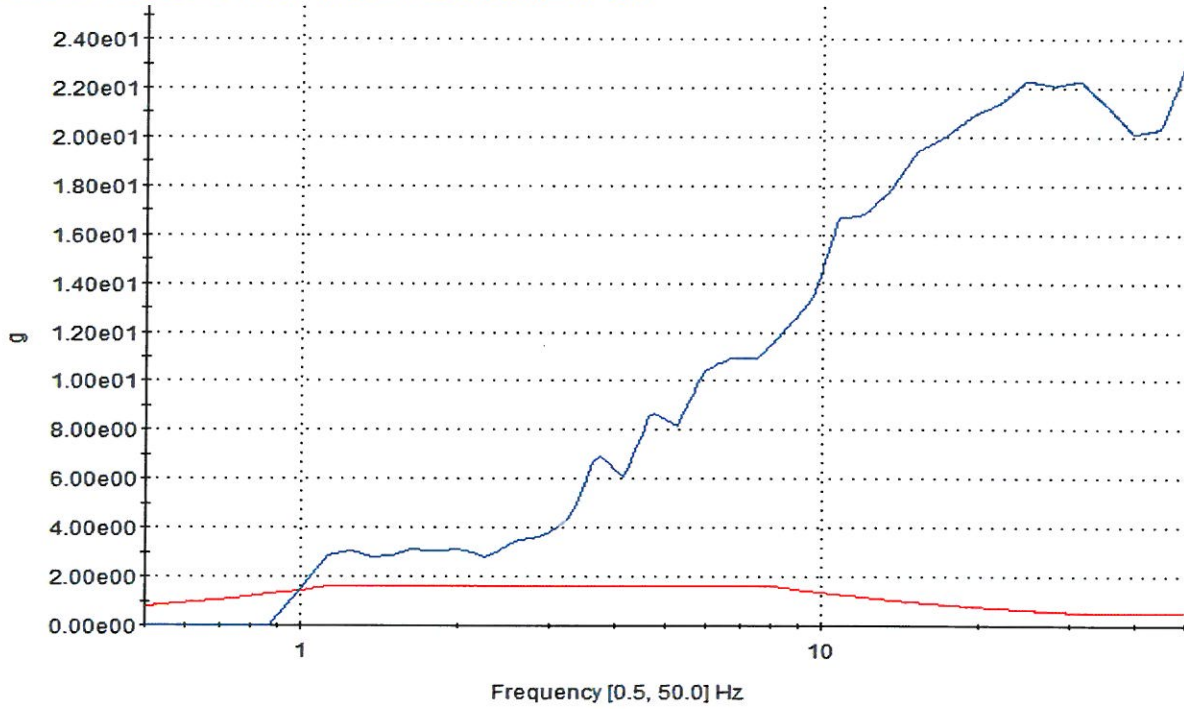


Fig. 2 - 7 TRS (Housing Side_Right) with Y Dir. of Seismic Test

IEEE 693 RRS (0.5 g, 2% Damping) - (2,2) - (Lat Acc,Lat Acc) - (g,g)
 Seismic Test_1_SRS - (11,11) - (Housing Side (Left)_Y,) - (g.)

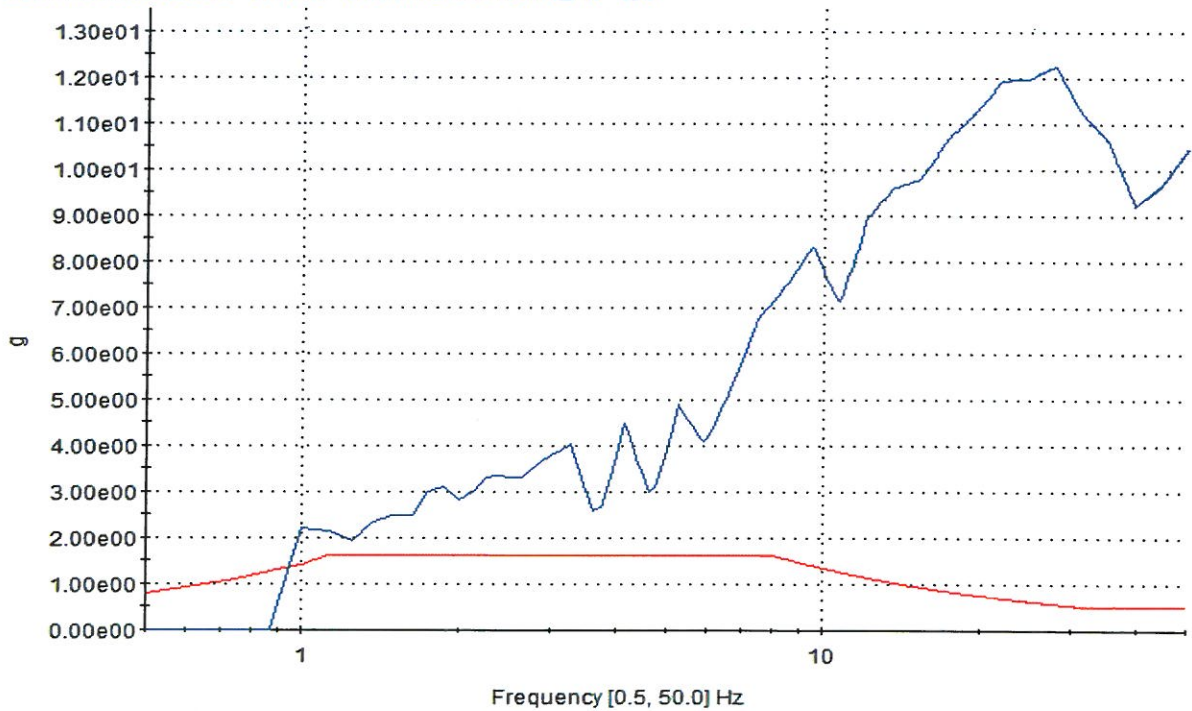


Fig. 2 - 8 TRS (Housing Side_Left) with Y Dir. of Seismic Test

IEEE 693 RRS (0.5 g, 2% Damping) - (3,3) - (Vert Acc,Vert Acc) - (g,g)
 Seismic Test_1_SRS - (3,3) - (Table_Z,) - (g.)

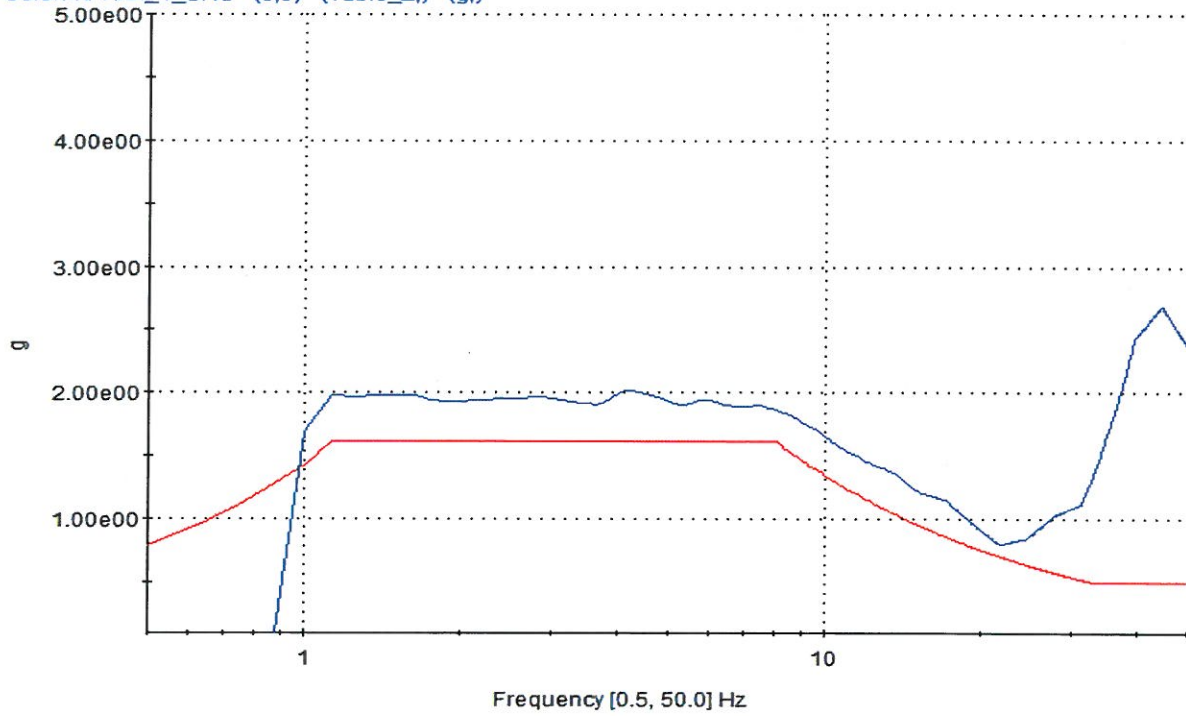


Fig. 2 - 9 TRS (Table) with Z Dir. of Seismic Test

IEEE 693 RRS (0.5 g, 2% Damping) - (3,3) - (Vert Acc,Vert Acc) - (g,g)
 Seismic Test_1_SRS - (6,6) - (Top of Specimen_Z,) - (g.)

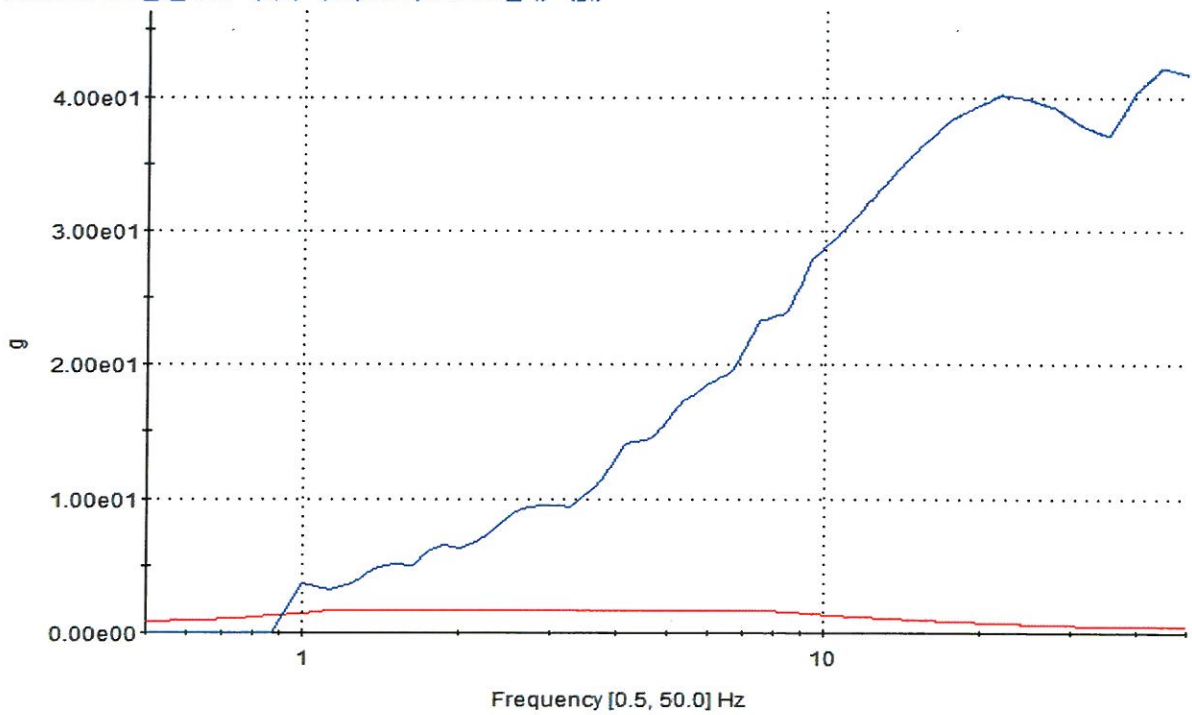


Fig. 2 - 10 TRS (Top of Specimen) with Z Dir. of Seismic Test

IEEE 693 RRS (0.5 g, 2% Damping) - (3,3) - (Vert Acc,Vert Acc) - (g,g)
 Seismic Test_1_SRS - (9,9) - (Housing Side (Right)_Z,) - (g,)

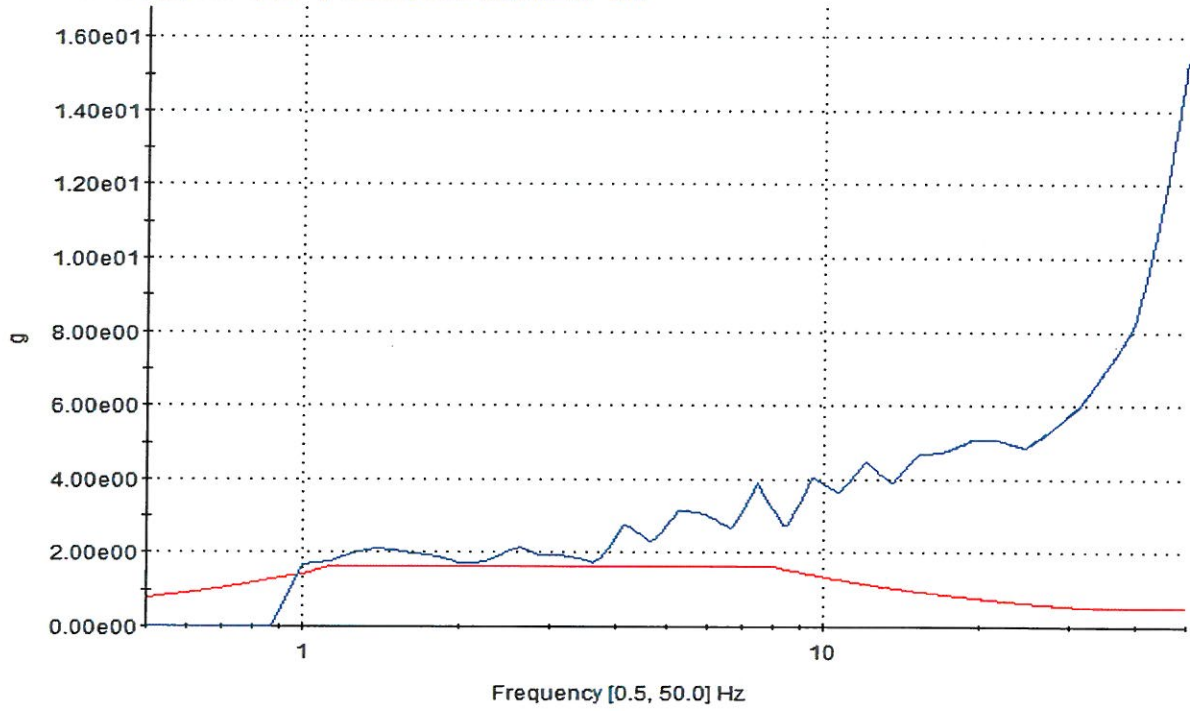


Fig. 2 - 11 TRS (Housing Side_Right) with Z Dir. of Seismic Test

IEEE 693 RRS (0.5 g, 2% Damping) - (3,3) - (Vert Acc,Vert Acc) - (g,g)
 Seismic Test_1_SRS - (12,12) - (Housing Side (Left)_Z,) - (g,)

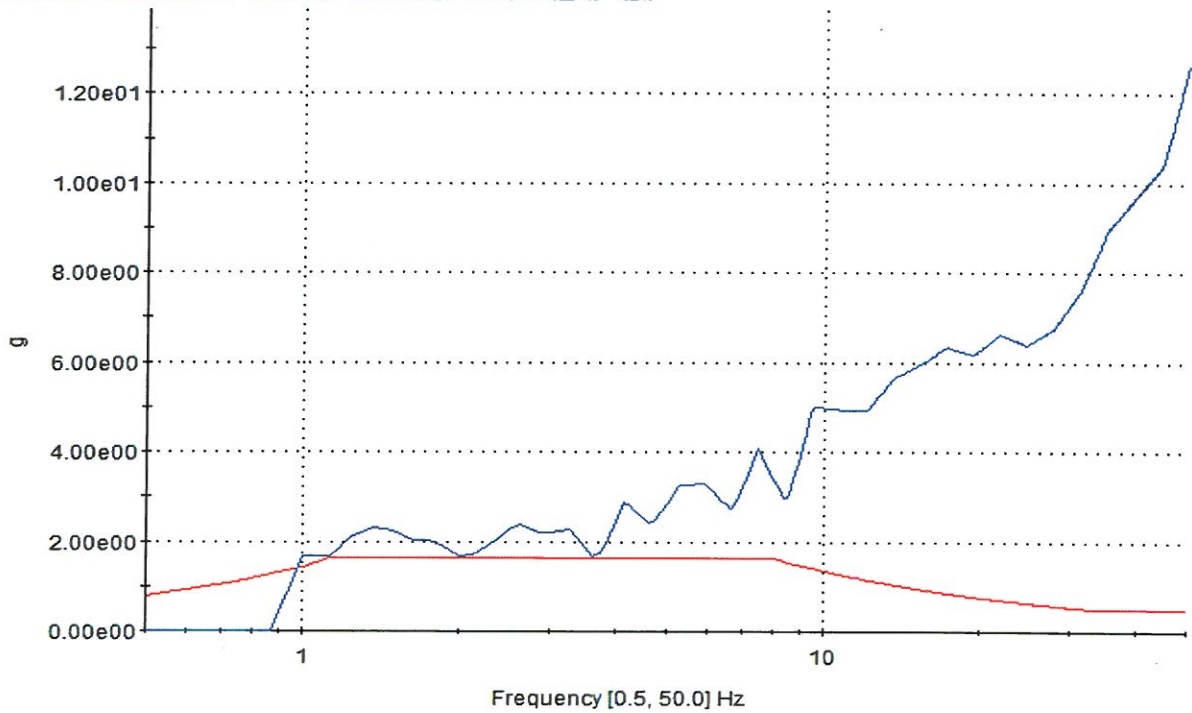


Fig. 2 - 12 TRS (Housing Side_Left) with Z Dir. of Seismic Test

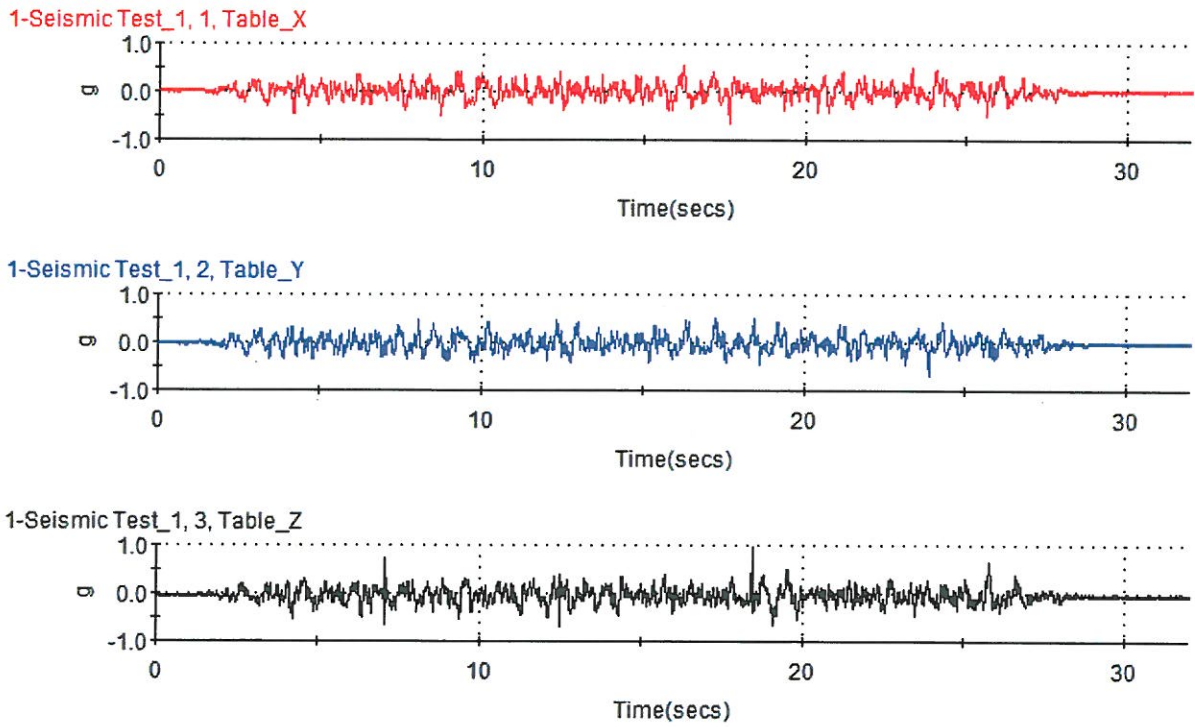


Fig. 2 - 13 Time History (Table) of Seismic Test

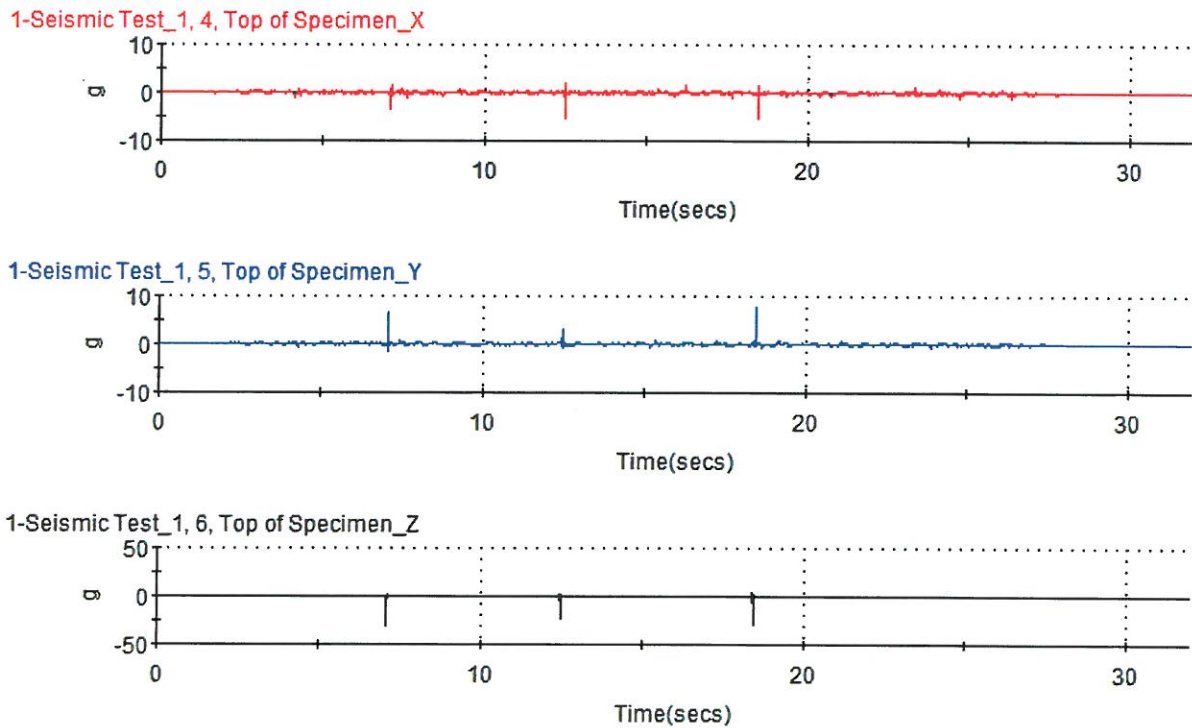


Fig. 2 - 14 Time History (Top of Specimen) of Seismic Test

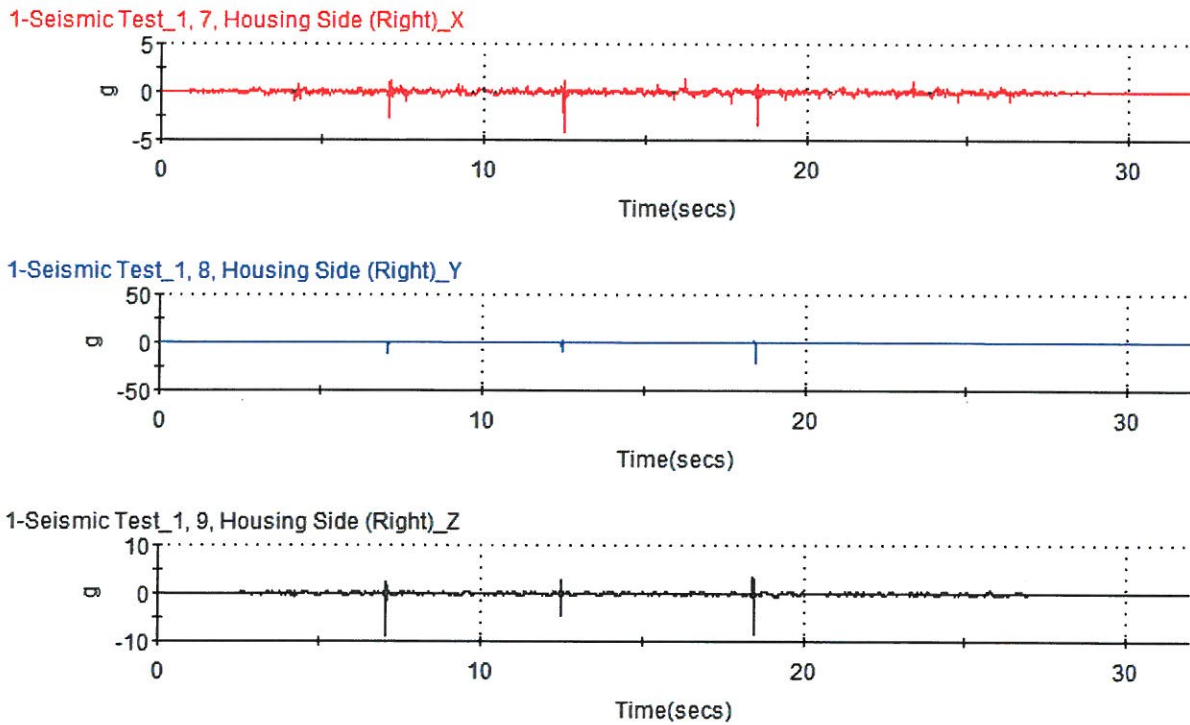


Fig. 2 - 15 Time History (Housing Side_Right) of Seismic Test

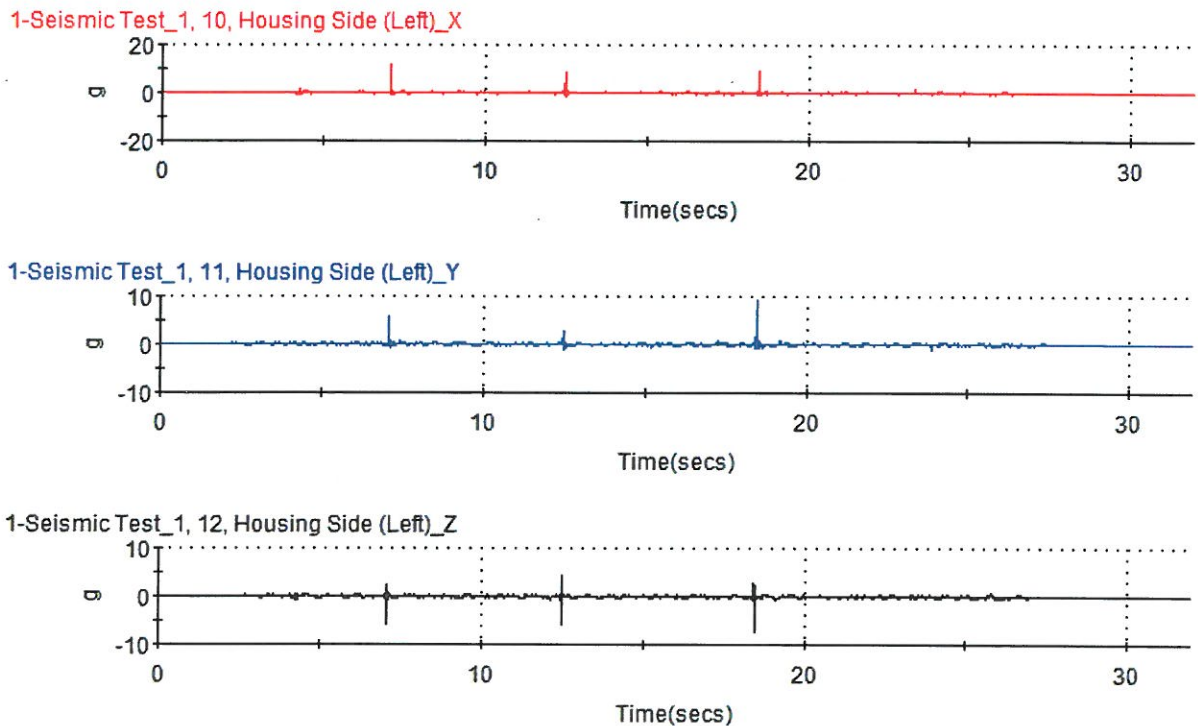


Fig. 2 - 16 Time History (Housing Side_Left) of Seismic Test

Attachment 3

Sine Beat Test Data

Table of Contents

Fig. 3 - 1 Time History (Table) of The Sine beat Test [X Direction, 36 Hz]	42
Fig. 3 - 2 Time History (Table) of The Sine beat Test [Y Direction, 33 Hz].....	42
Fig. 3 - 3 Time History (Table) of The Sine beat Test [Z Direction, 33 Hz].....	43

1-Sine Beat Test_X_1, 1, Table_X

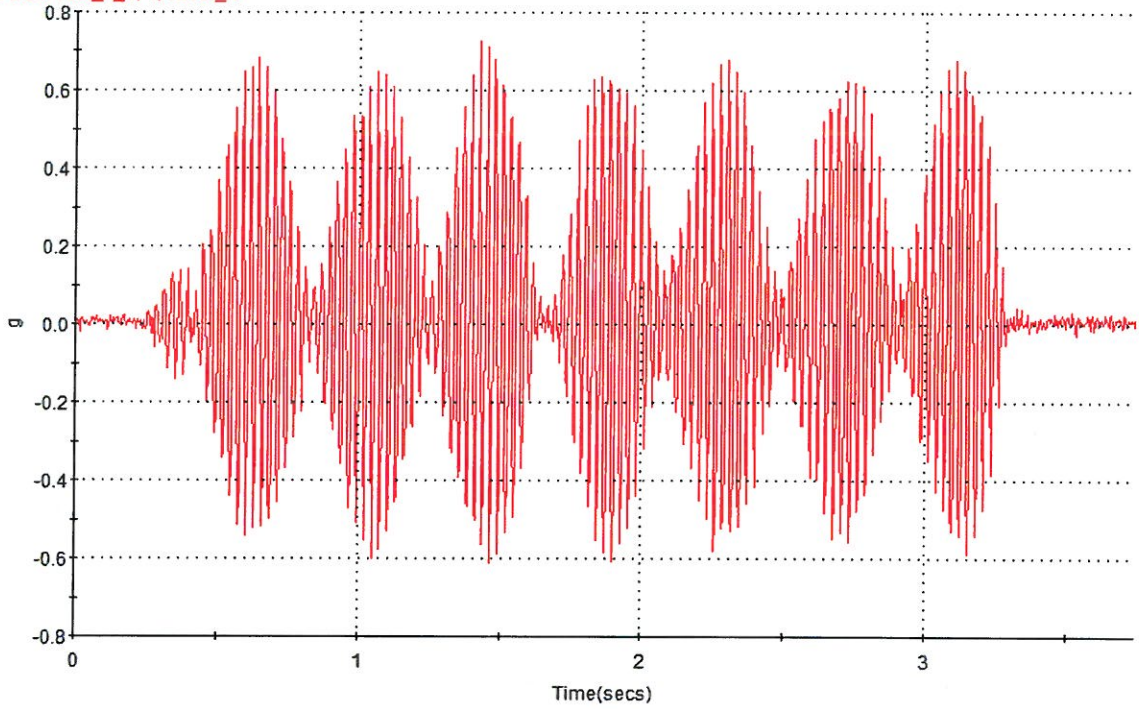


Fig. 3 - 1 Time History (Table) of The Sine beat Test [X Direction, 36 Hz]

1-Sine Beat Test_Y_2, Table_Y

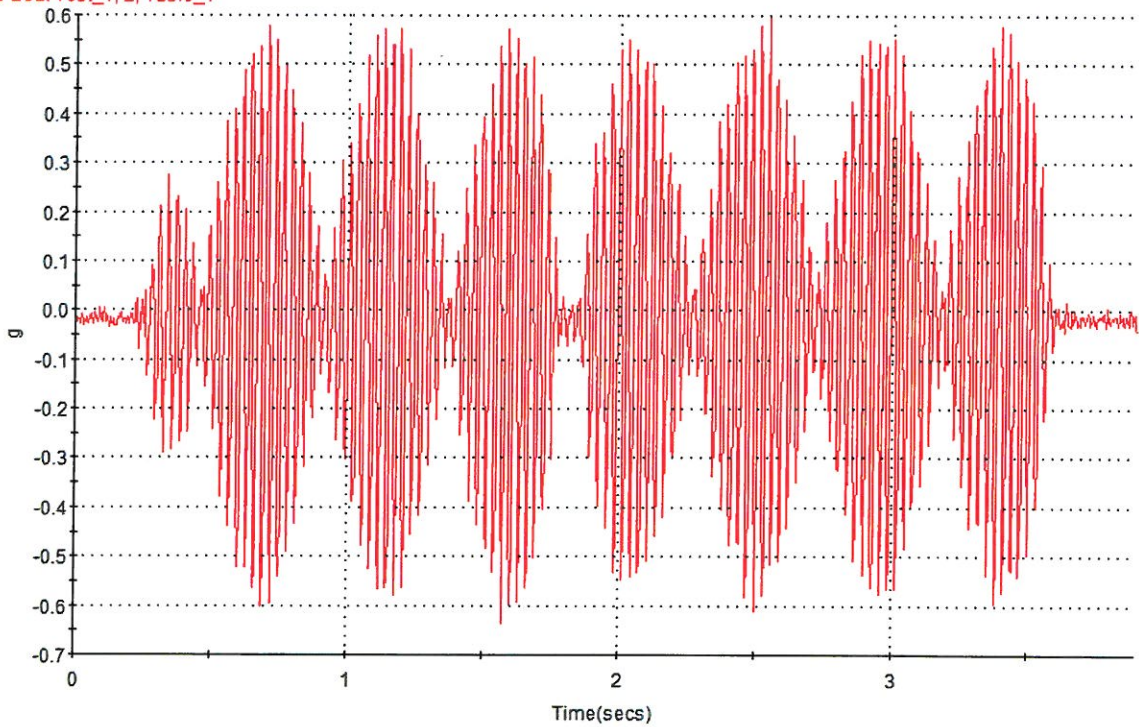


Fig. 3 - 2 Time History (Table) of The Sine beat Test [Y Direction, 33 Hz]

1-Sine Beat Test_Z, 3, Table_Z

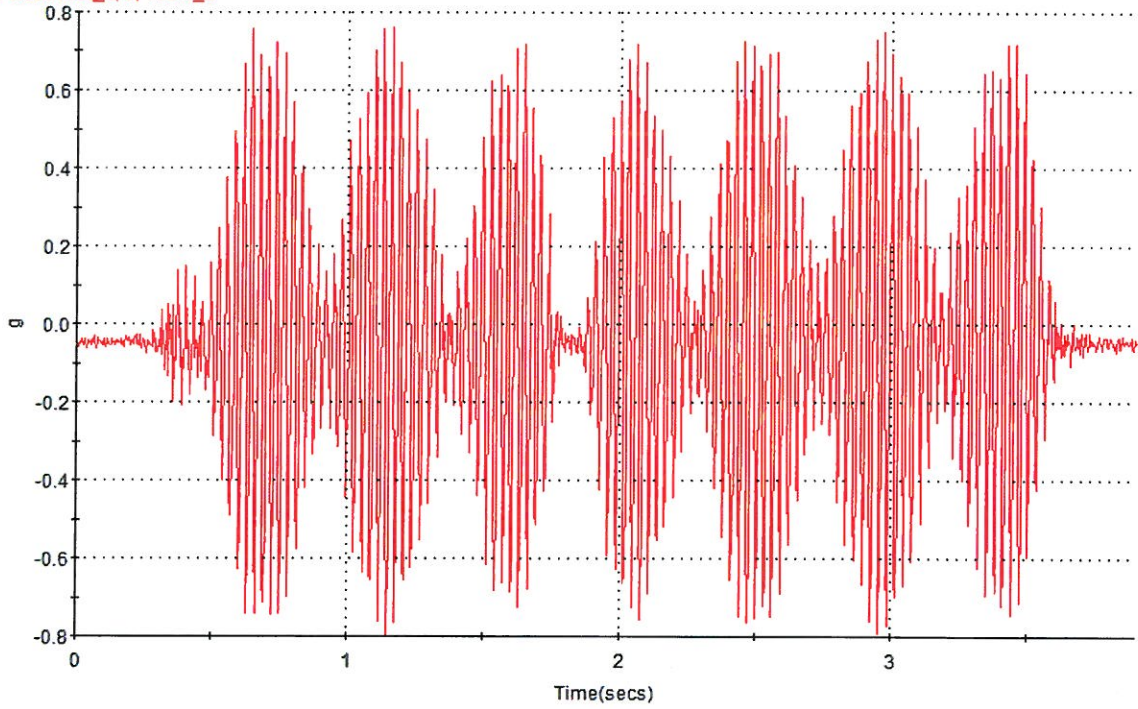


Fig. 3 - 3 Time History (Table) of The Sine beat Test [Z Direction, 33 Hz]

Attachment 4

Functional Monitoring Data

Table of Contents

Fig. 4-1 Pre Functional Test (Normal Close).....	46
Fig. 4-2 Pre Functional Test (Normal Open).....	46
Fig. 4-3 Pre Functional Test (Open – Close - Open)	47
Fig. 4-4 Seismic Test (Open – Close - Open).....	47
Fig. 4-5 X axis Sine beat Test (Normal Close).....	48
Fig. 4-6 Y axis Sine beat Test (Normal Close)	48
Fig. 4-7 Z axis Sine beat Test (Normal Close).....	49
Fig. 4-8 Post Functional Test (Normal Close).....	49
Fig. 4-9 Post Functional Test (Normal Open).....	50
Fig. 4-10 Post Functional Test (Open – Close - Open)	50

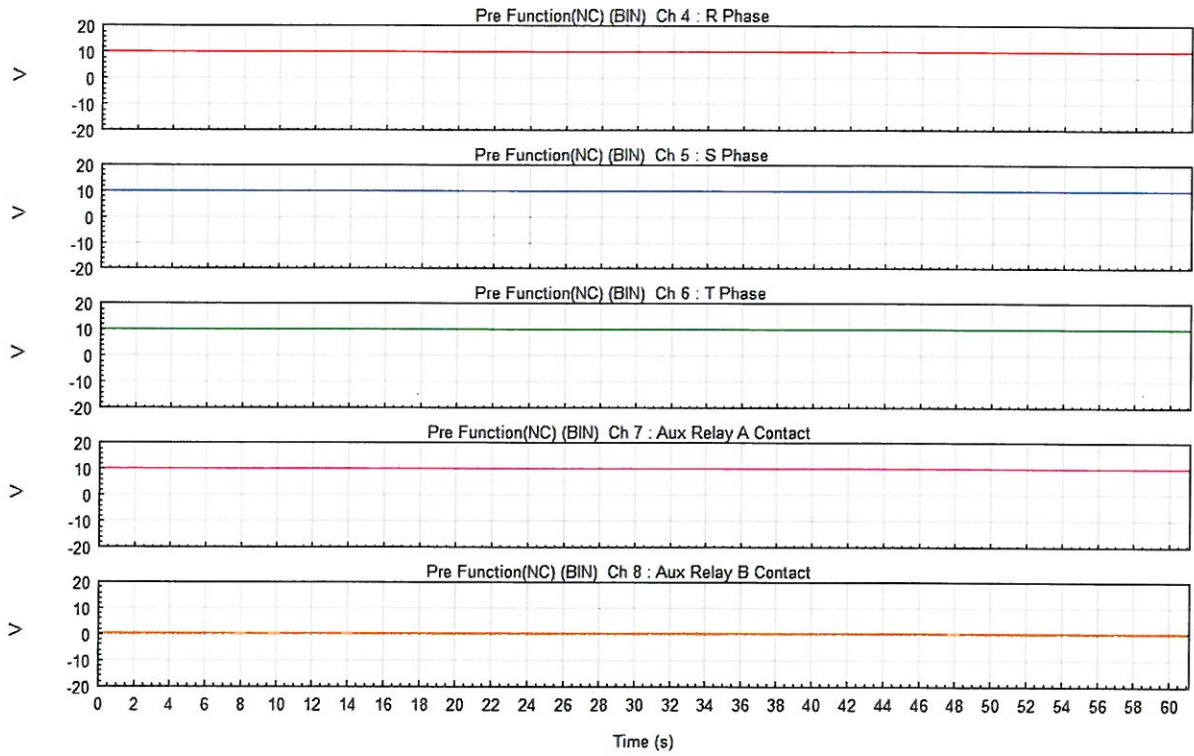


Fig. 4 - 1 Pre Functional Test (Main Close)

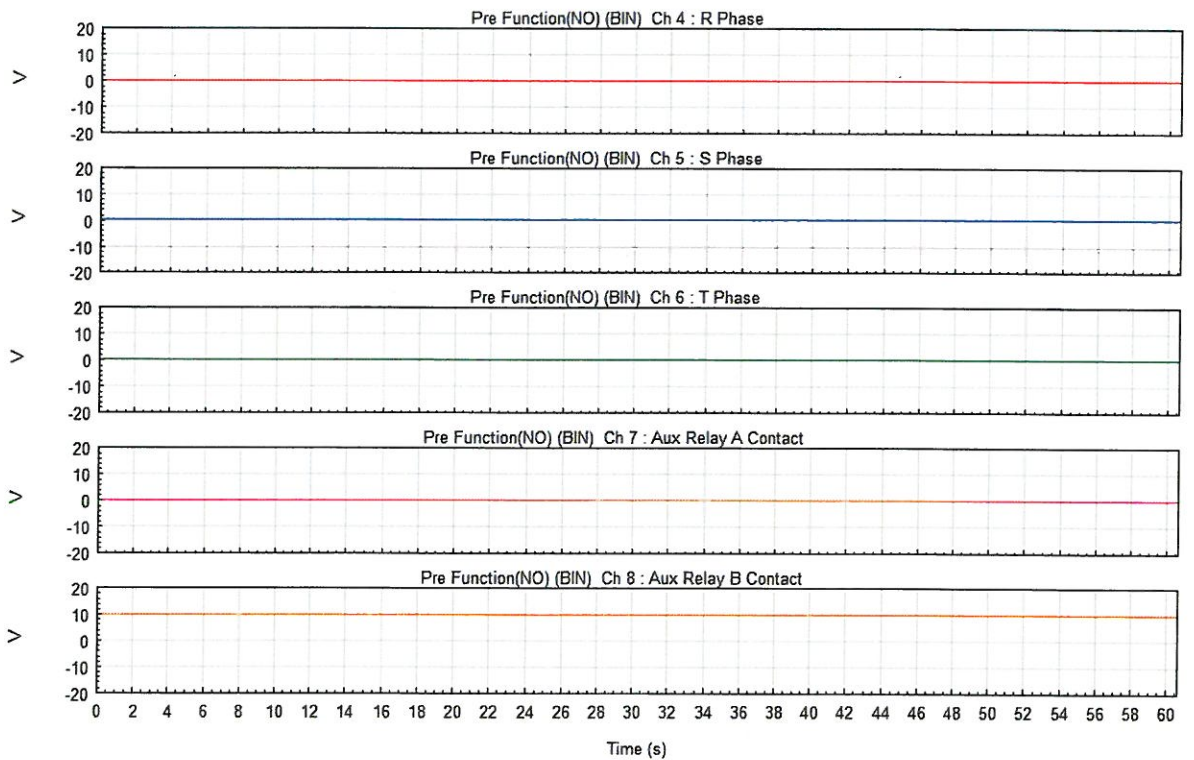


Fig. 4 - 2 Pre Functional Test (Main Open)

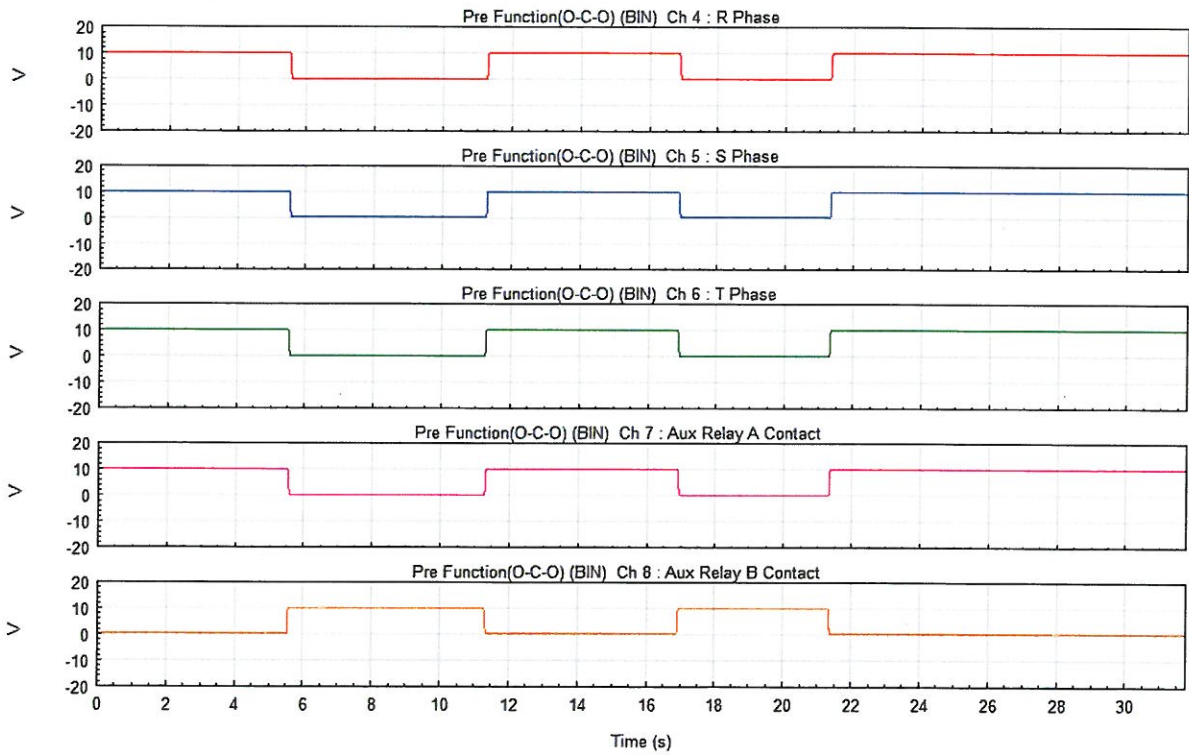


Fig. 4 - 3 Pre Functional Test (Main On-Off Cycle)

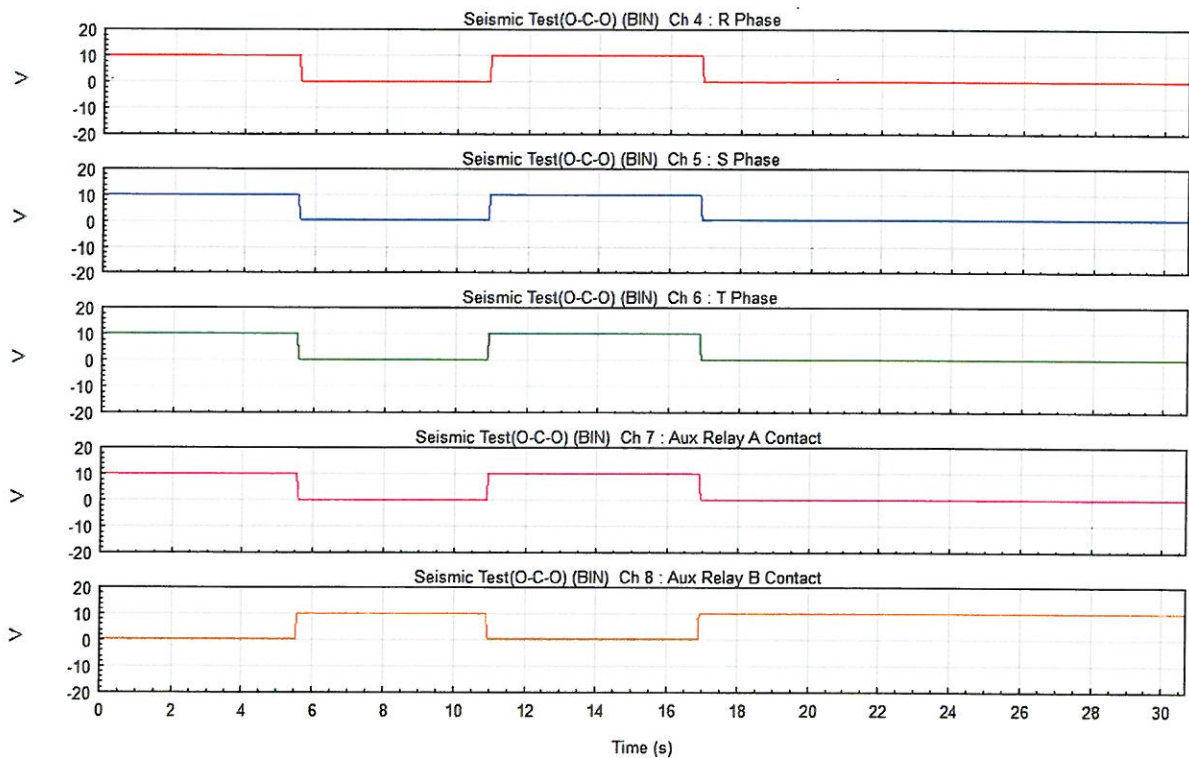


Fig. 4-4 Seismic Test (Main On-Off Cycle)

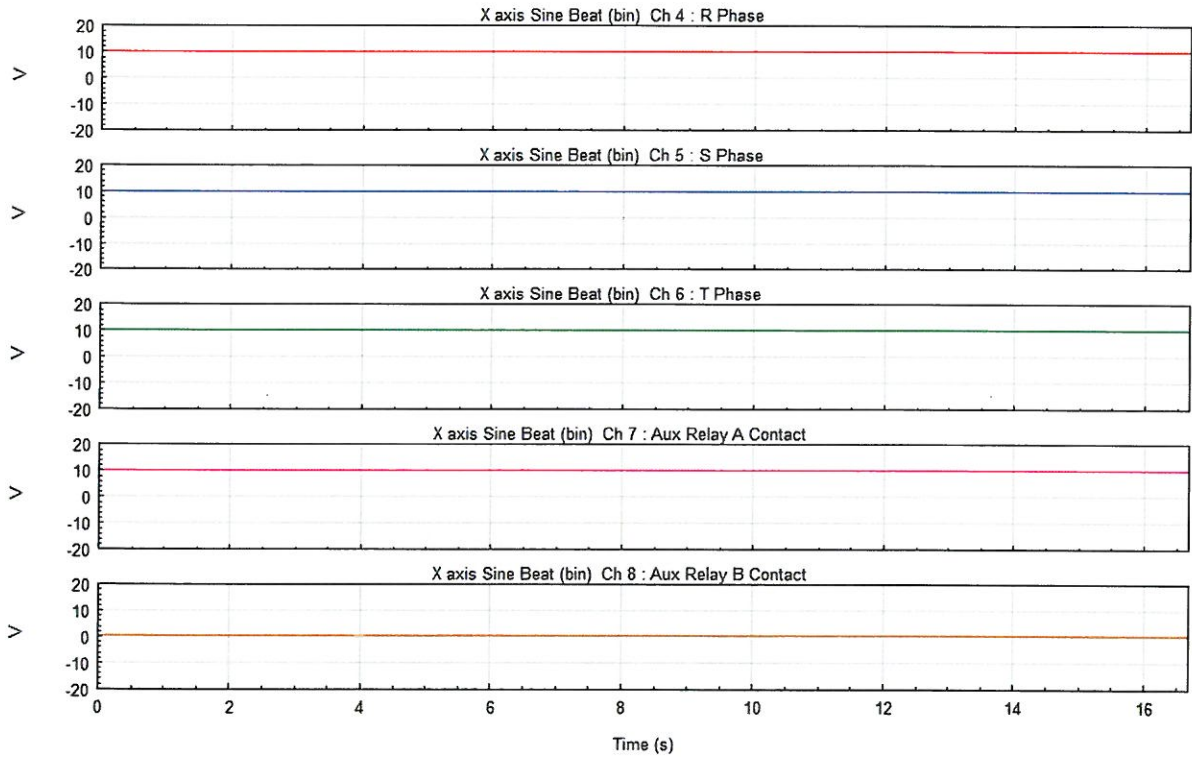


Fig. 4-5 X axis Sine beat Test (Main Close)

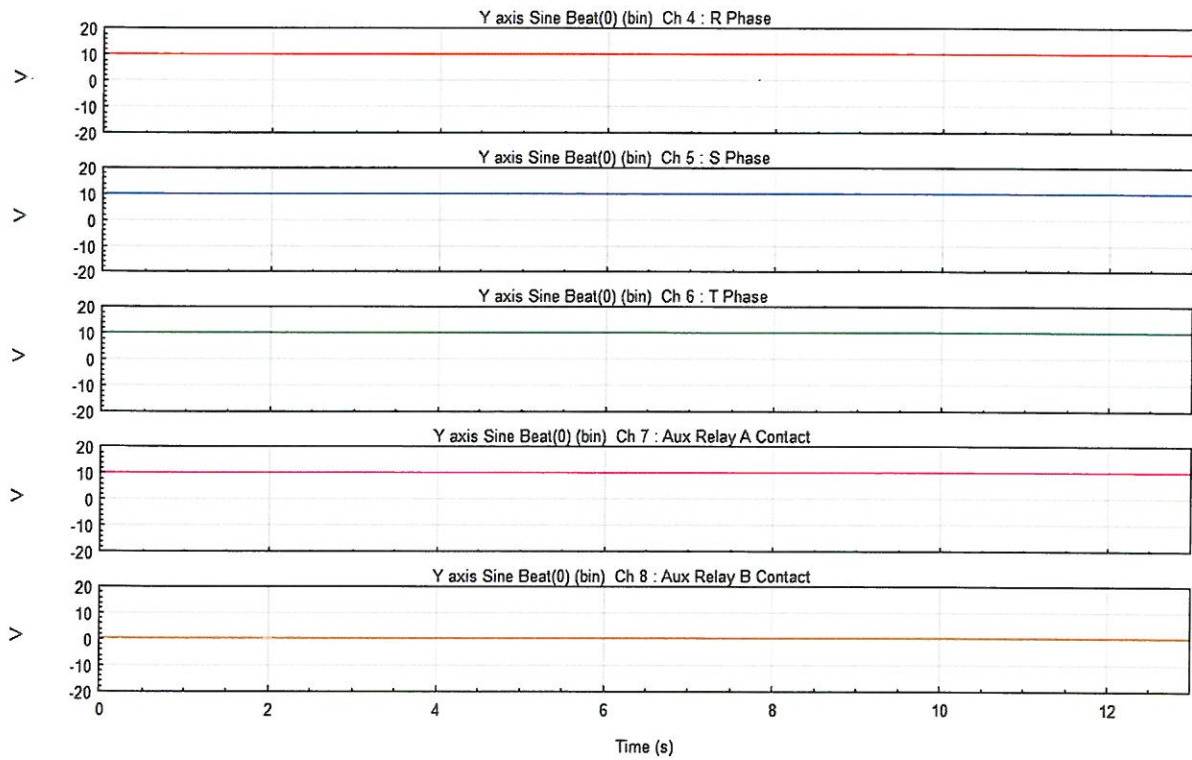


Fig. 4-6 Y axis Sine beat Test (Main Close)

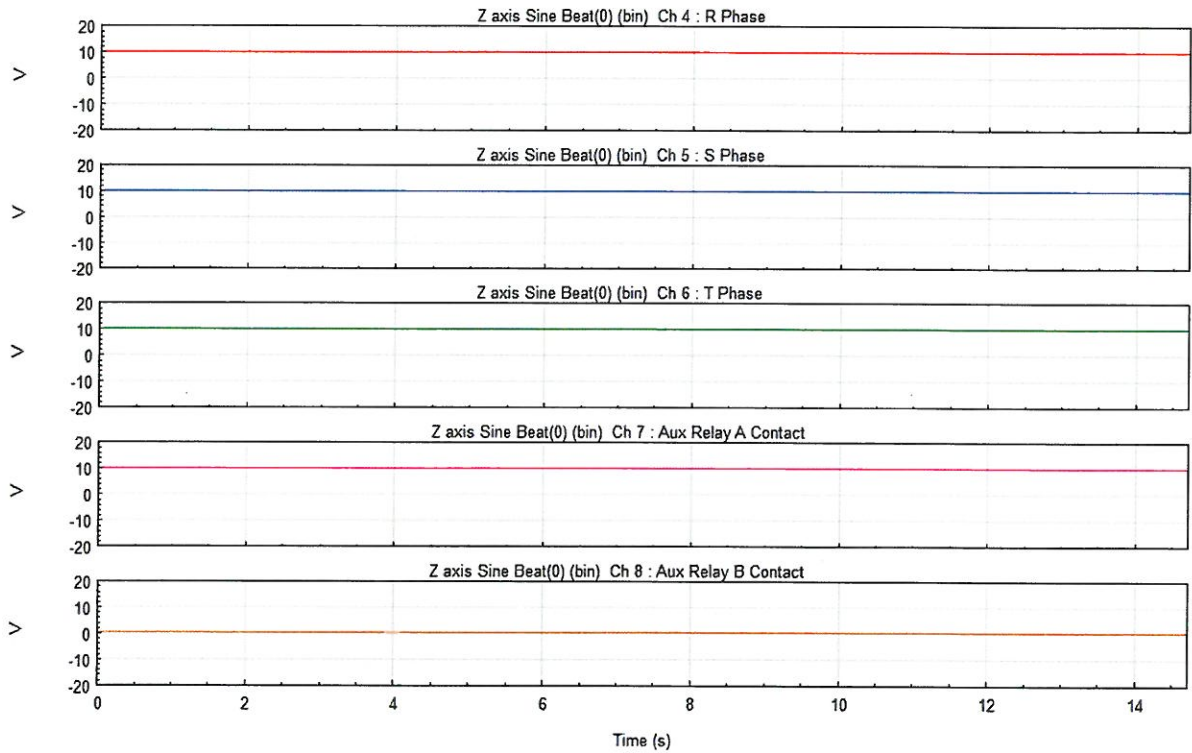


Fig. 4-7 Z axis Sine beat Test (Main Close)

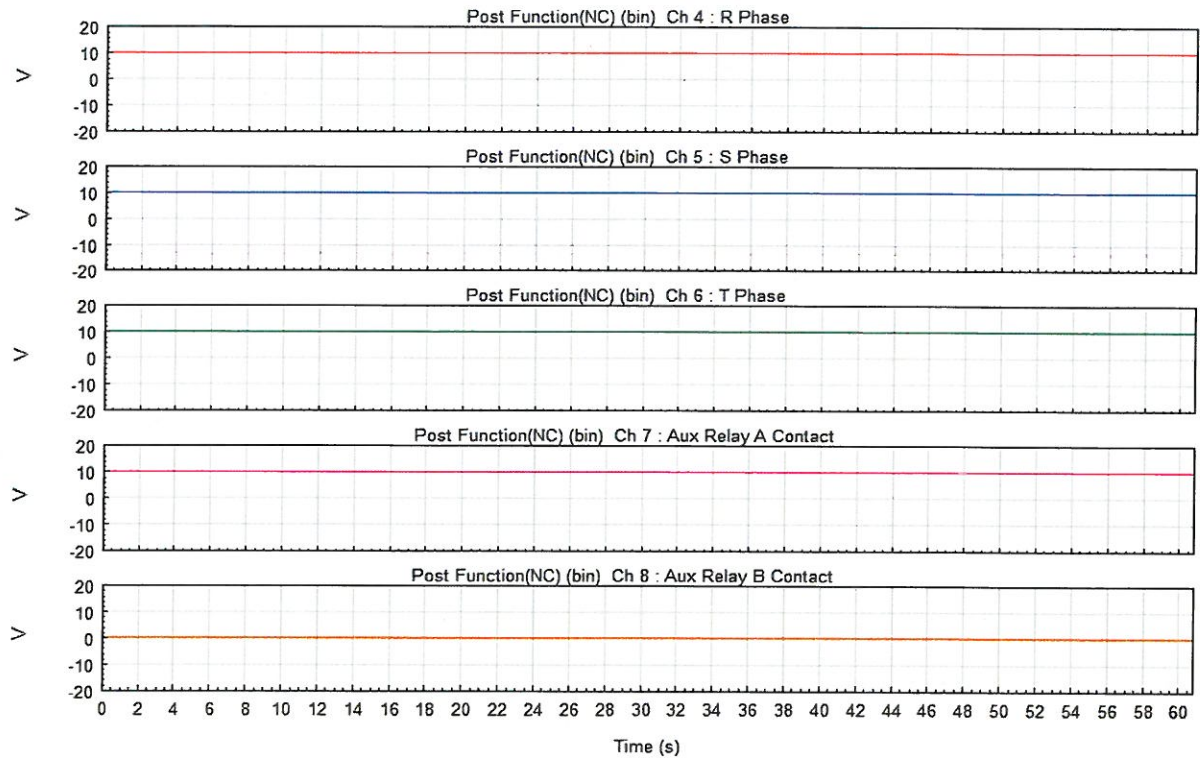


Fig. 4-8 Post Functional Test (Main Close)

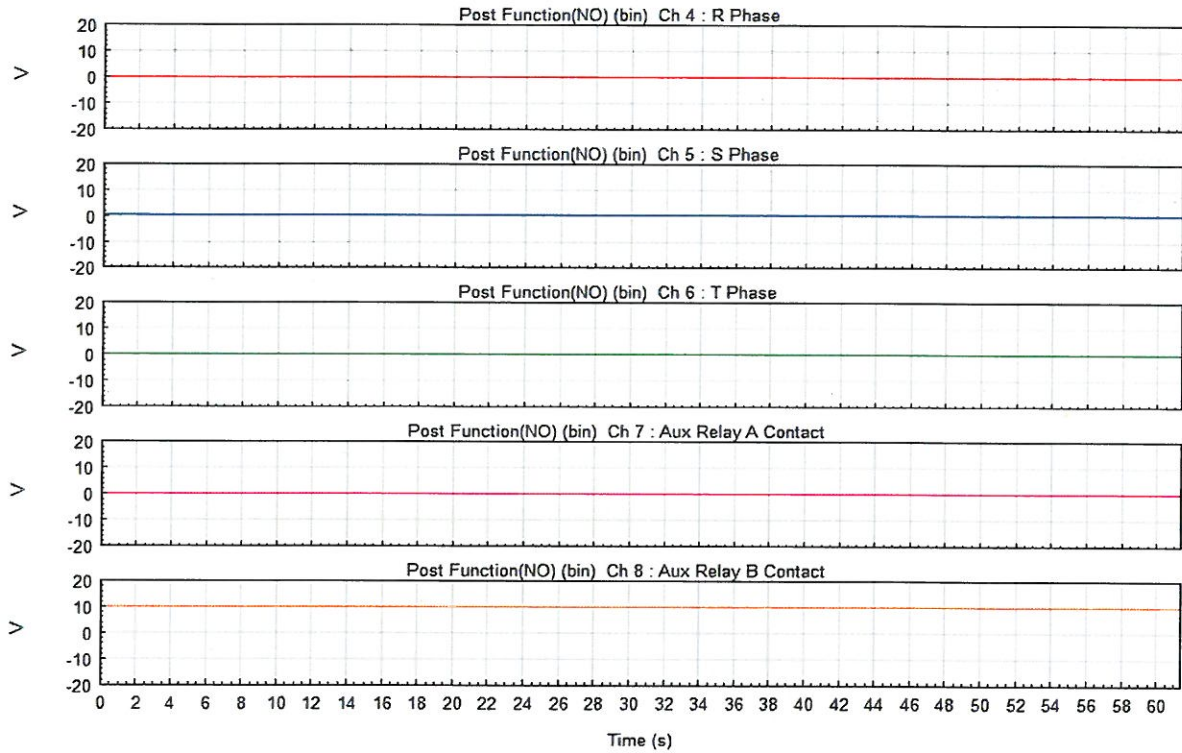


Fig. 4-9 Post Functional Test (Main Open)

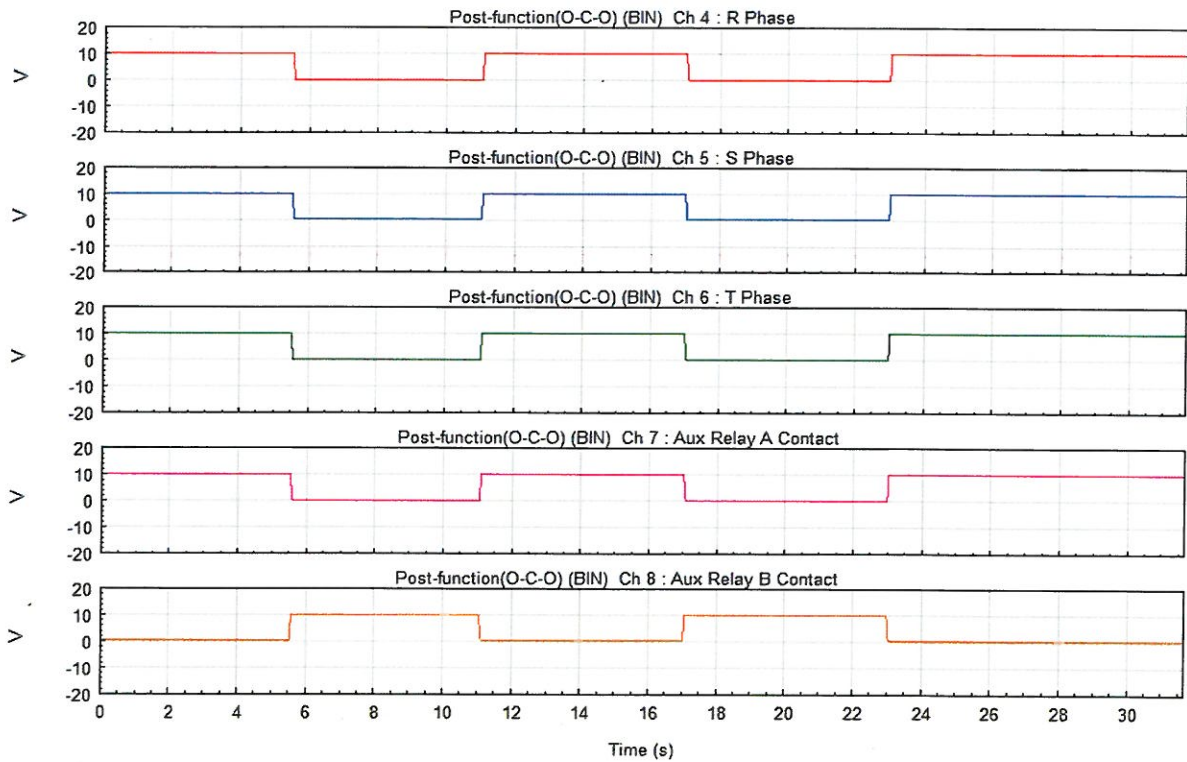


Fig. 4-10 Post Functional Test (Main On-Off Cycle)

Attachment 5

Photograph

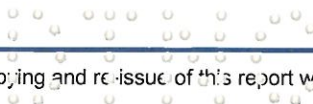


Table of Contents

Fig. 5 - 1 Test Setup (Front View)	53
Fig. 5 - 2 Test Setup (Side View)	53
Fig. 5 - 3 Test Setup (Back View)	54
Fig. 5 - 4 Test Setup (Top View).....	54
Fig. 5 - 5 Installed Accelerometer - Table	55
Fig. 5 - 6 Installed Accelerometer – Top of Specimen.....	55
Fig. 5 - 7 Installed Accelerometer – Housing Side (Right).....	56
Fig. 5 - 8 Installed Accelerometer – Housing Side (Left).....	56
Fig. 5 - 9 Monitoring Instruments Setup.....	57

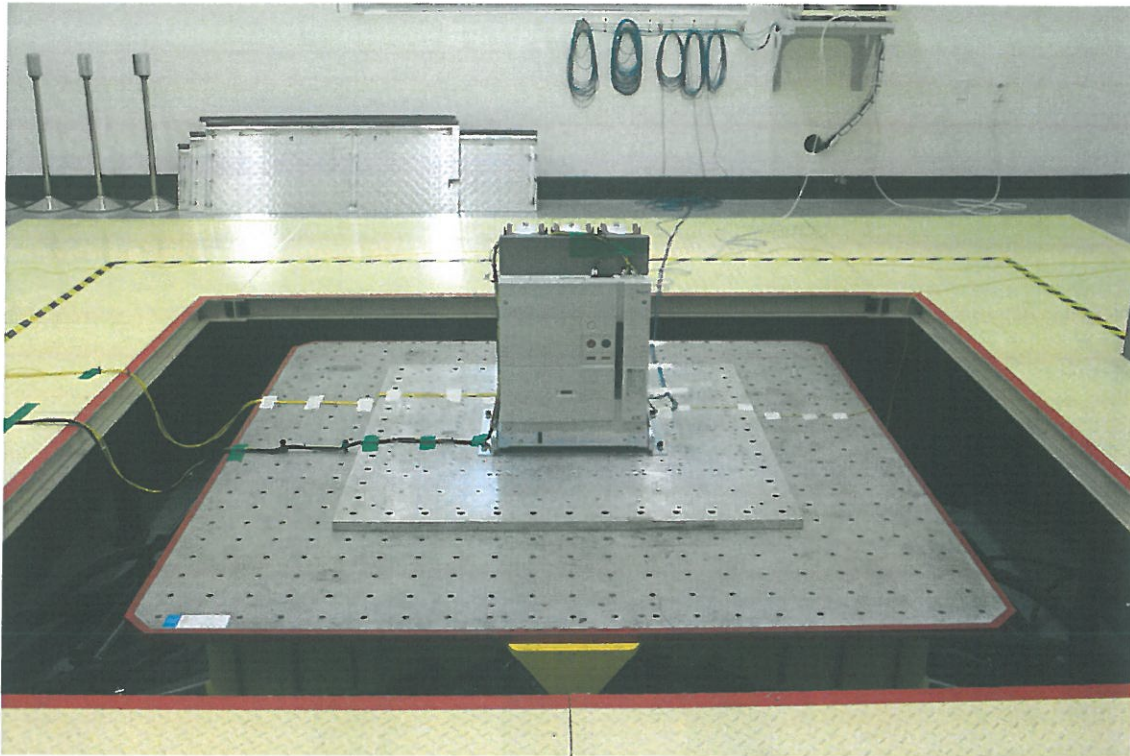


Fig. 5 - 1 Test Setup (Front View)

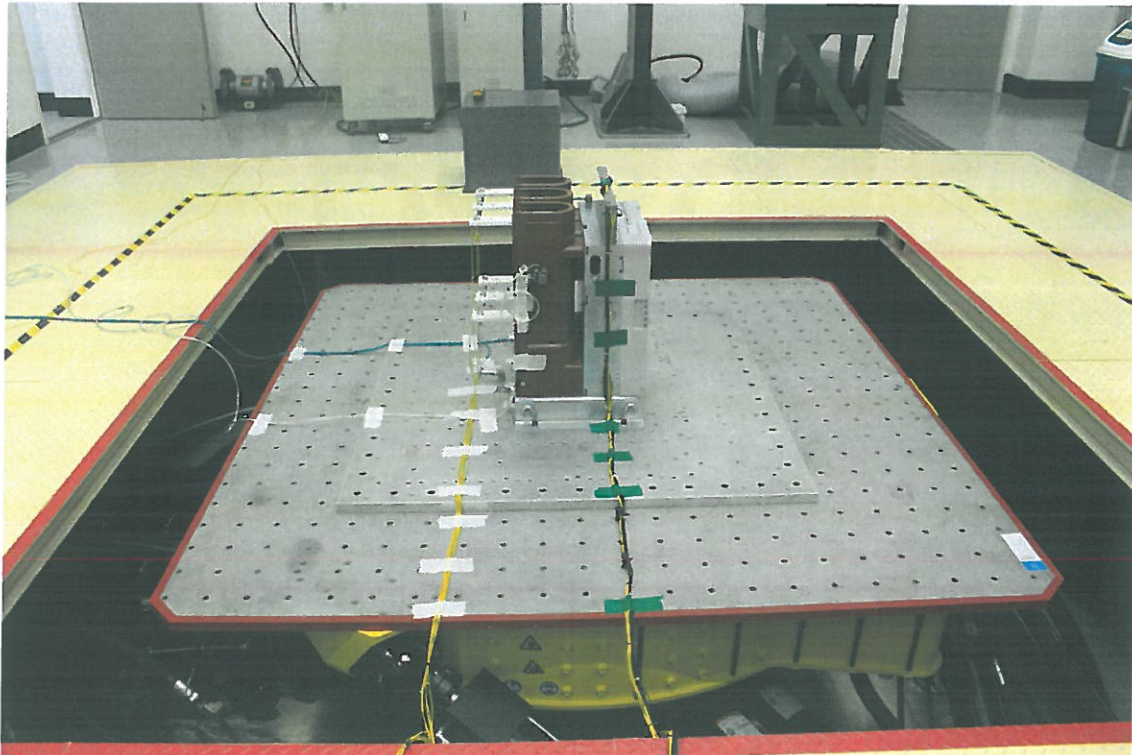


Fig. 5 - 2 Test Setup (Side View)



Fig. 5 - 3 Test Setup (Back View)

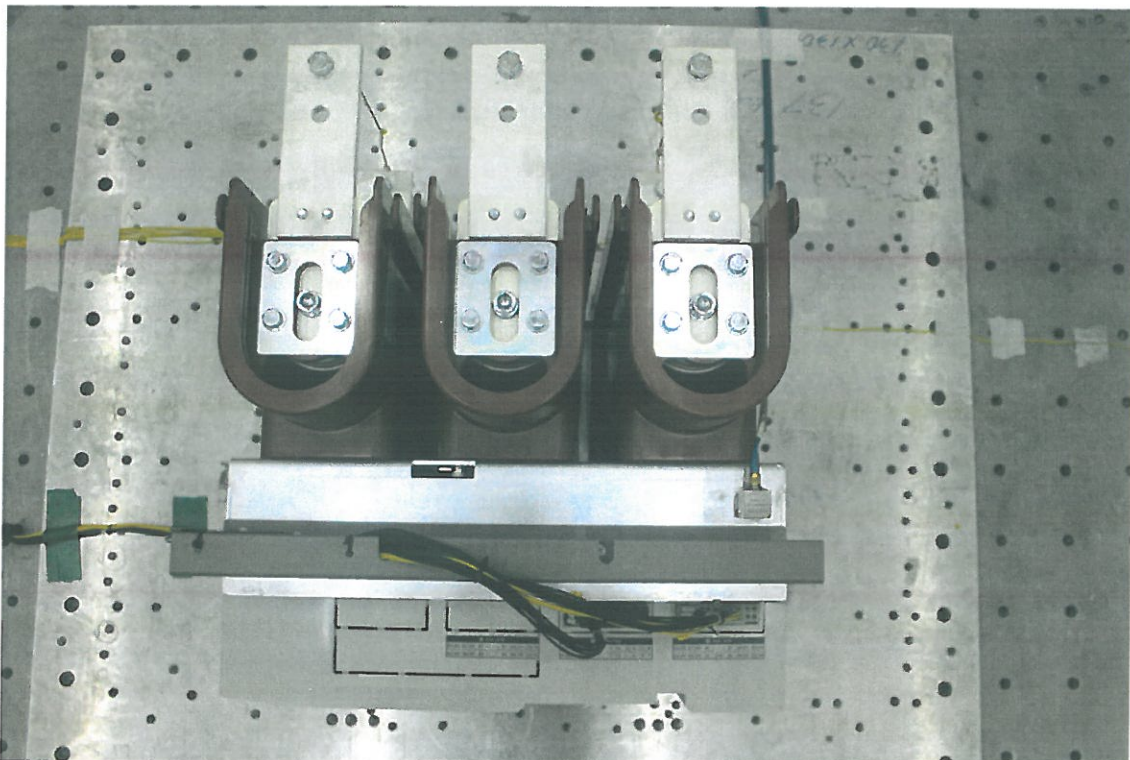


Fig. 5 - 4 Test Setup (Top View)

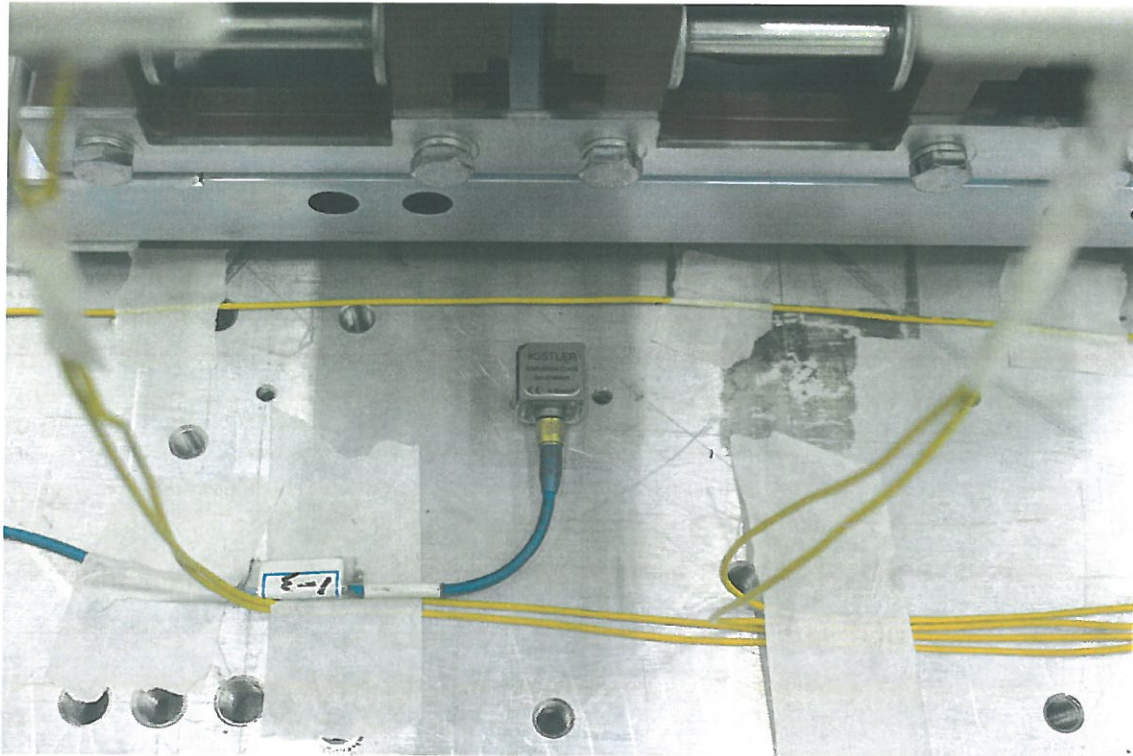


Fig. 5 - 5 Installed Accelerometer - Table

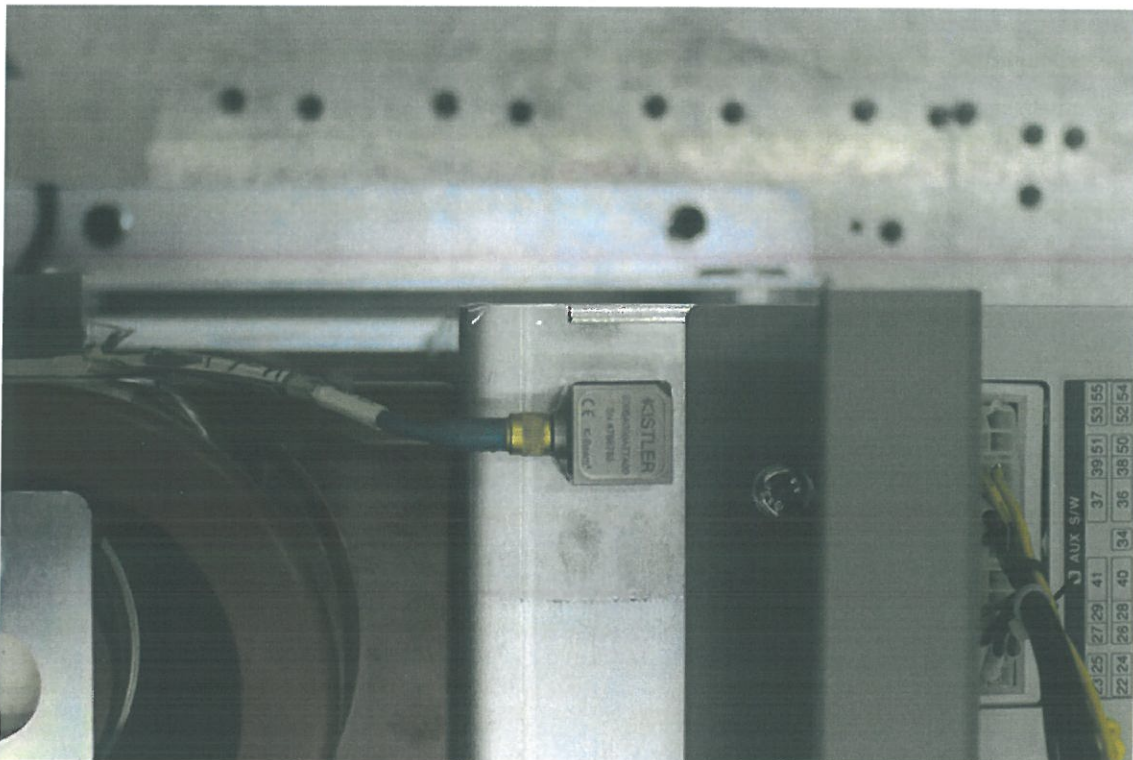


Fig. 5 - 6 Installed Accelerometer – Top of Specimen

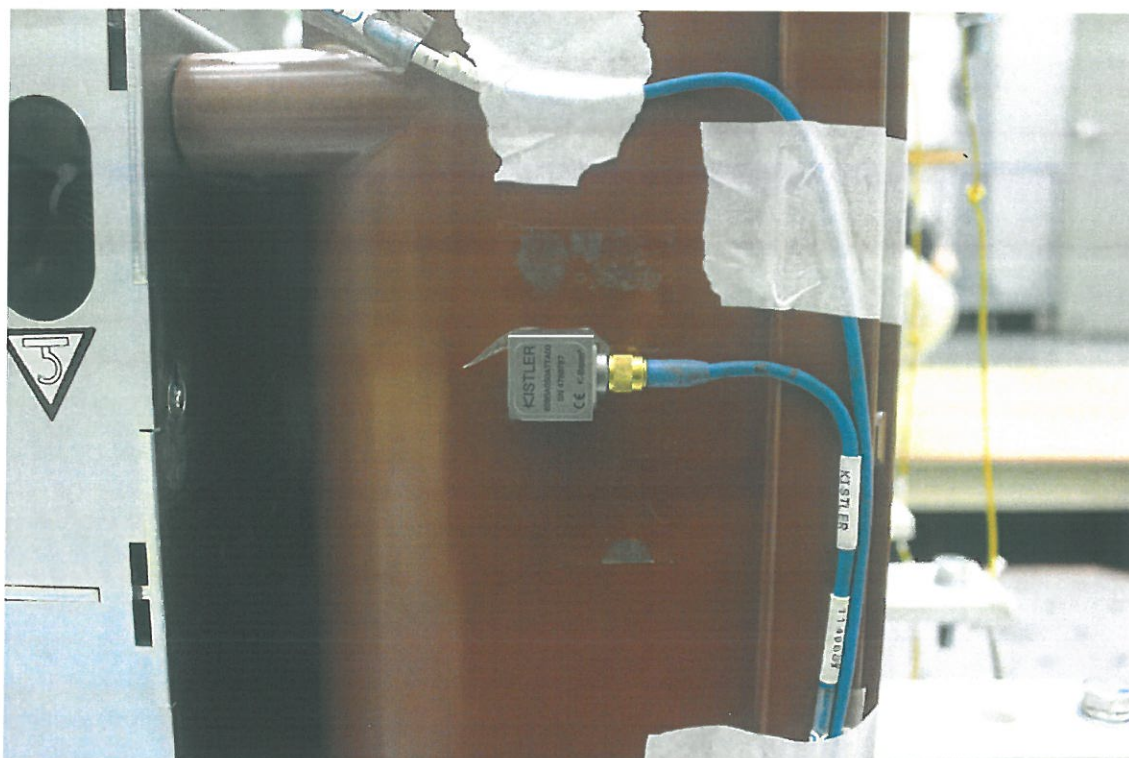


Fig. 5 - 7 Installed Accelerometer – Housing Side (Right)

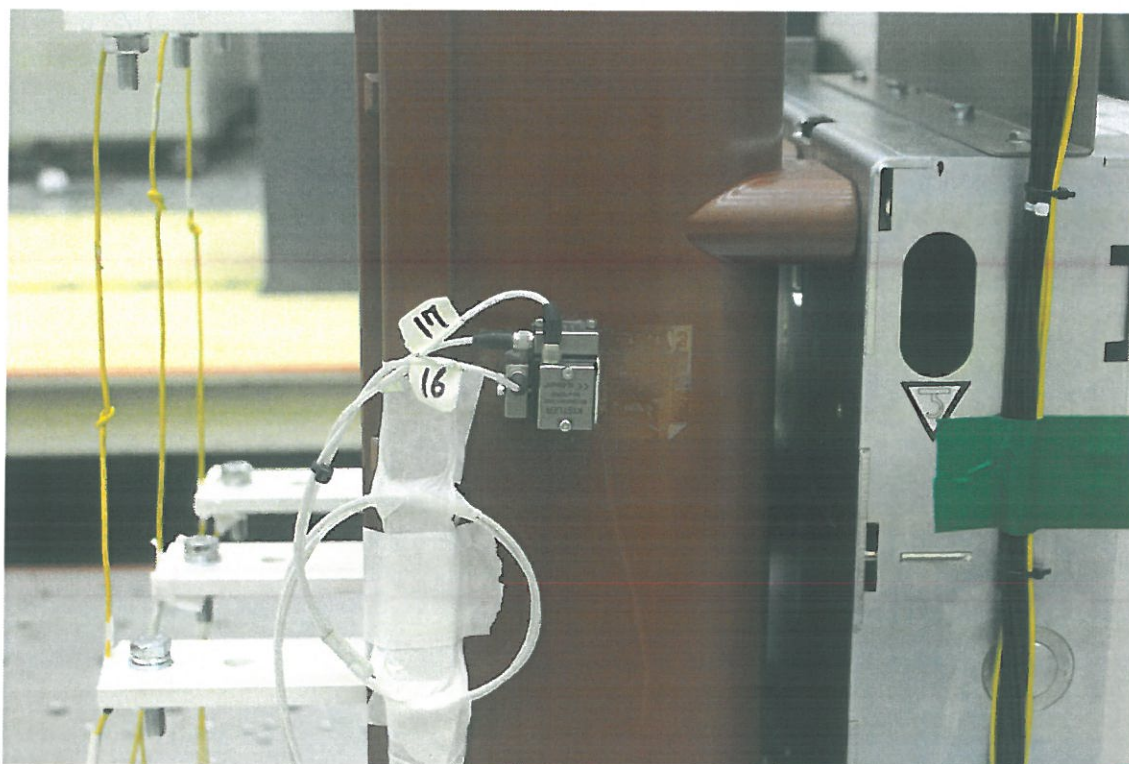


Fig. 5 - 8 Installed Accelerometer – Housing Side (Left)

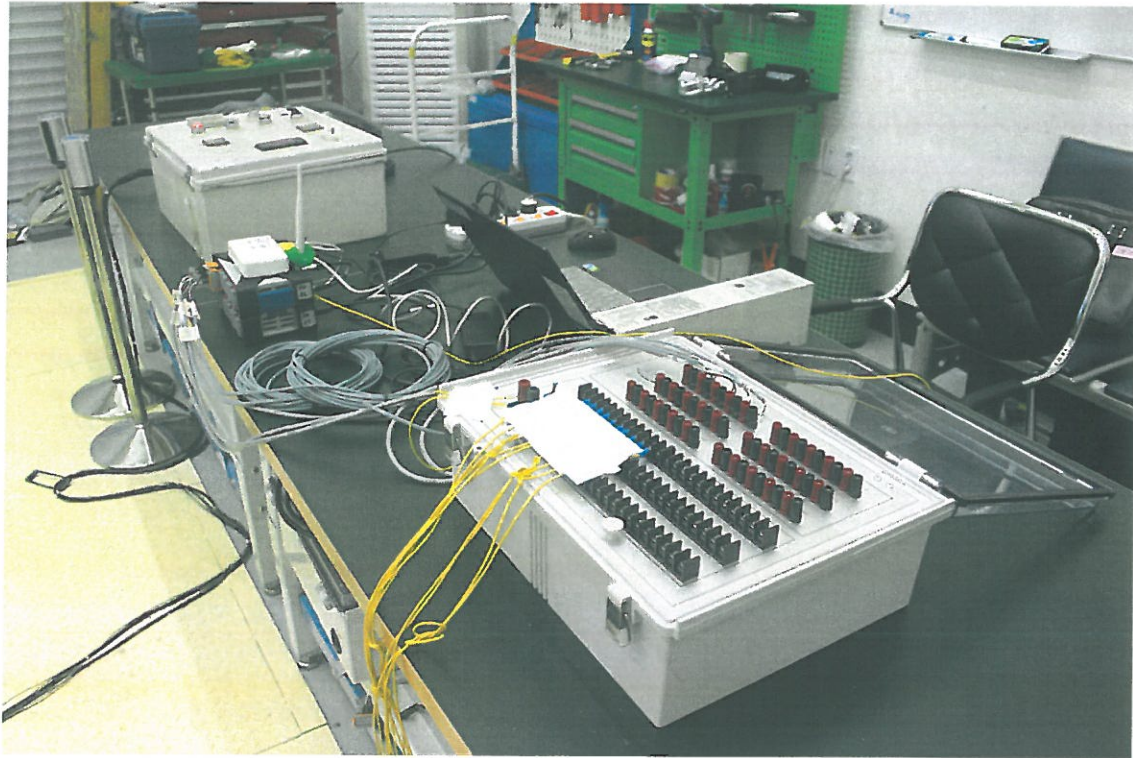


Fig. 5 - 9 Monitoring Instruments Setup

※ Appendix 1

Seismic Test Data (ZPA 3 g Condition)

Table of Contents

Fig. 1 - 1 TRS (Table) with X Dir. of Seismic Test	60
Fig. 1 - 2 TRS (Table) with Y Dir. of Seismic Test	61
Fig. 1 - 3 TRS (Table) with Z Dir. of Seismic Test	61
Fig. 1 - 4 X Dir. Resonant Search after seismic test (ZPA-3 g Condition) – Top of Specimen	62
Fig. 1 - 5 X Dir. Resonant Search after seismic test (ZPA-3 g Condition) – Housing Side (Right)	62
Fig. 1 - 6 X Dir. Resonant Search after seismic test (ZPA-3 g Condition) – Housing Side (Left)	63
Fig. 1 - 7 Y Dir. Resonant Search after seismic test (ZPA-3 g Condition) – Top of Specimen	63
Fig. 1 - 8 Y Dir. Resonant Search after seismic test (ZPA-3 g Condition) – Housing Side (Right)	64
Fig. 1 - 9 Y Dir. Resonant Search after seismic test (ZPA-3 g Condition) – Housing Side (Left)	64
Fig. 1 - 10 Z Dir. Resonant Search after seismic test (ZPA-3 g Condition) – Top of Specimen.....	65
Fig. 1 - 11 Z Dir. Resonant Search after seismic test (ZPA-3 g Condition) – Housing Side (Right).....	65
Fig. 1 - 12 Z Dir. Resonant Search after seismic test (ZPA-3 g Condition) – Housing Side (Left).....	66

1. Seismic Test Data (ZPA 3 g Condition)

After sine beat testing, VCB was carried out once more to the seismic test (ZPA-3 g Condition), as required by LSIS Co., Ltd.

There are no obvious structural failure, based upon the results of the seismic testing, it is regarded that the VCB possesses sufficient structural integrity against the stress due to the given seismic condition.

The detailed results refer to the below "Fig 1" through "Fig 12"

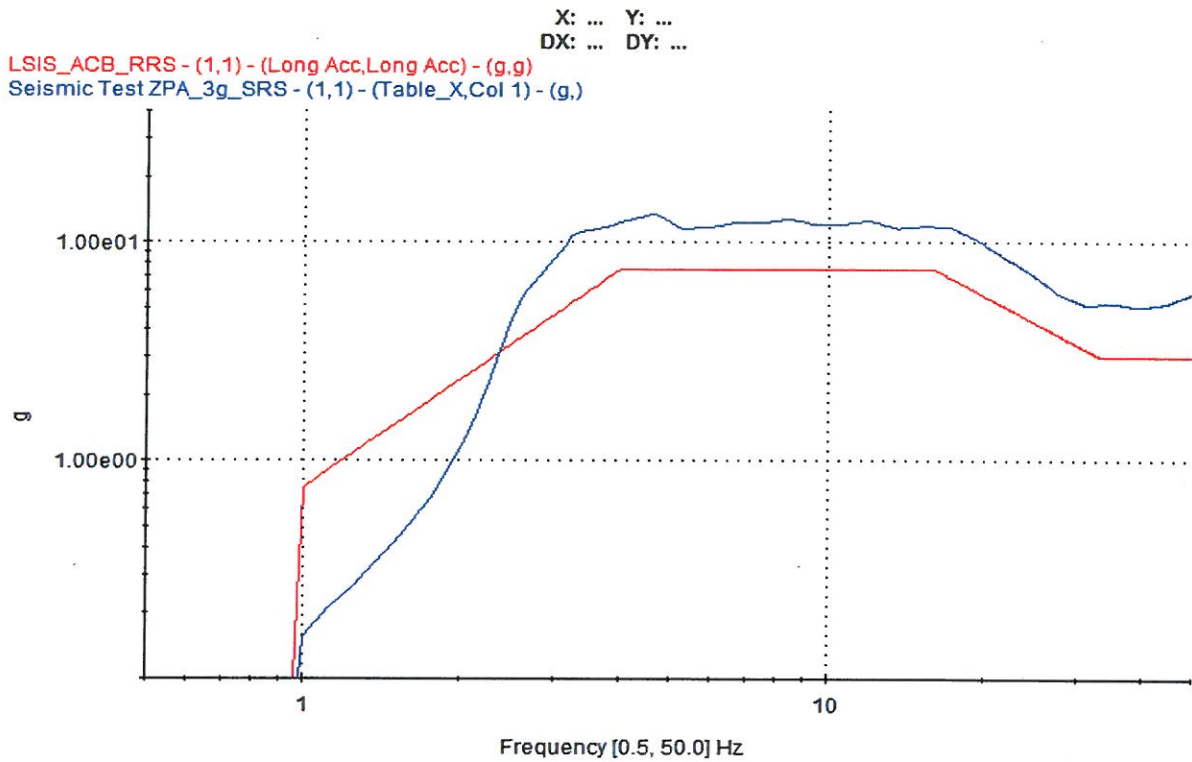


Fig. 1 - 1 TRS (Table) with X Dir. of Seismic Test

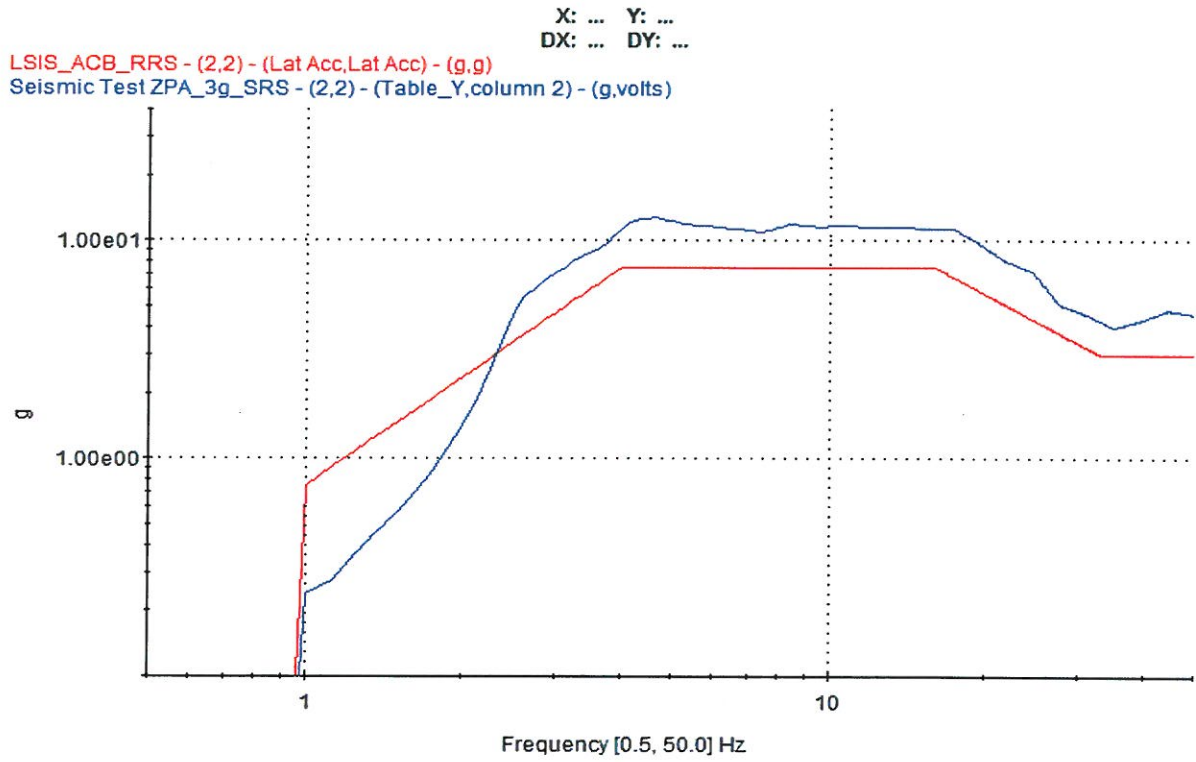


Fig. 1 - 2 TRS (Table) with Y Dir. of Seismic Test

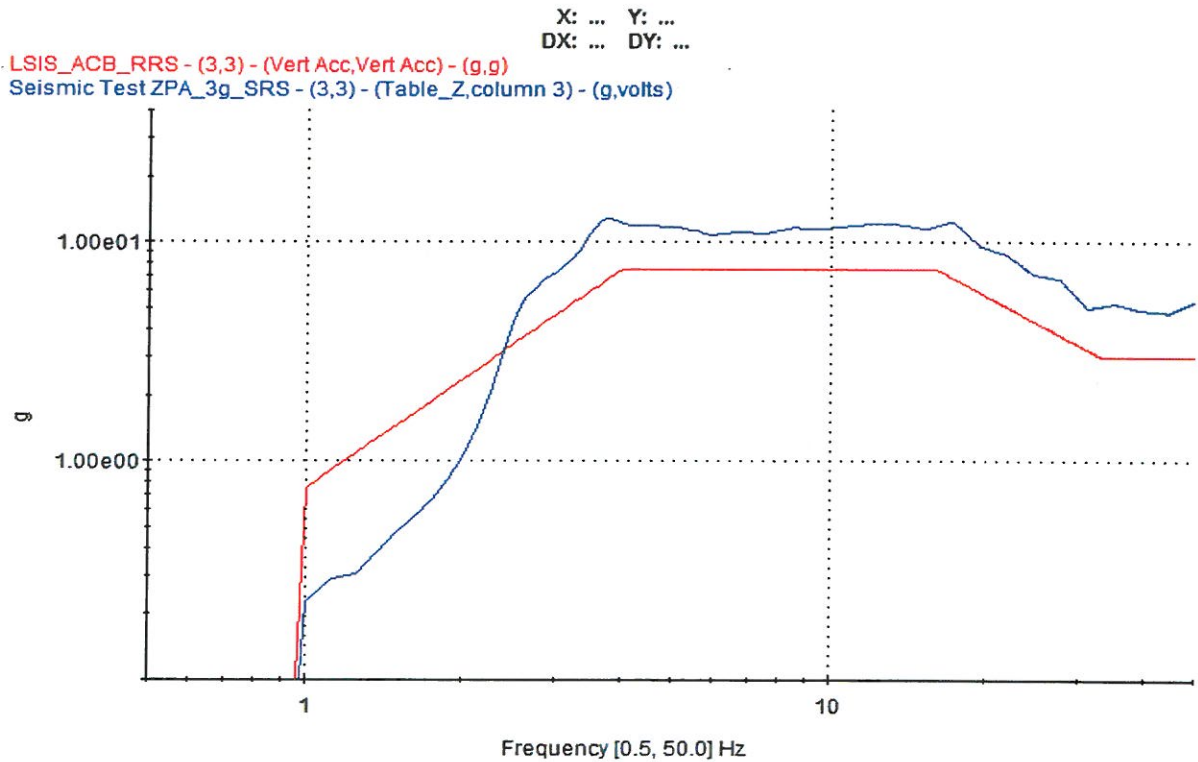


Fig. 1 - 3 TRS (Table) with Z Dir. of Seismic Test

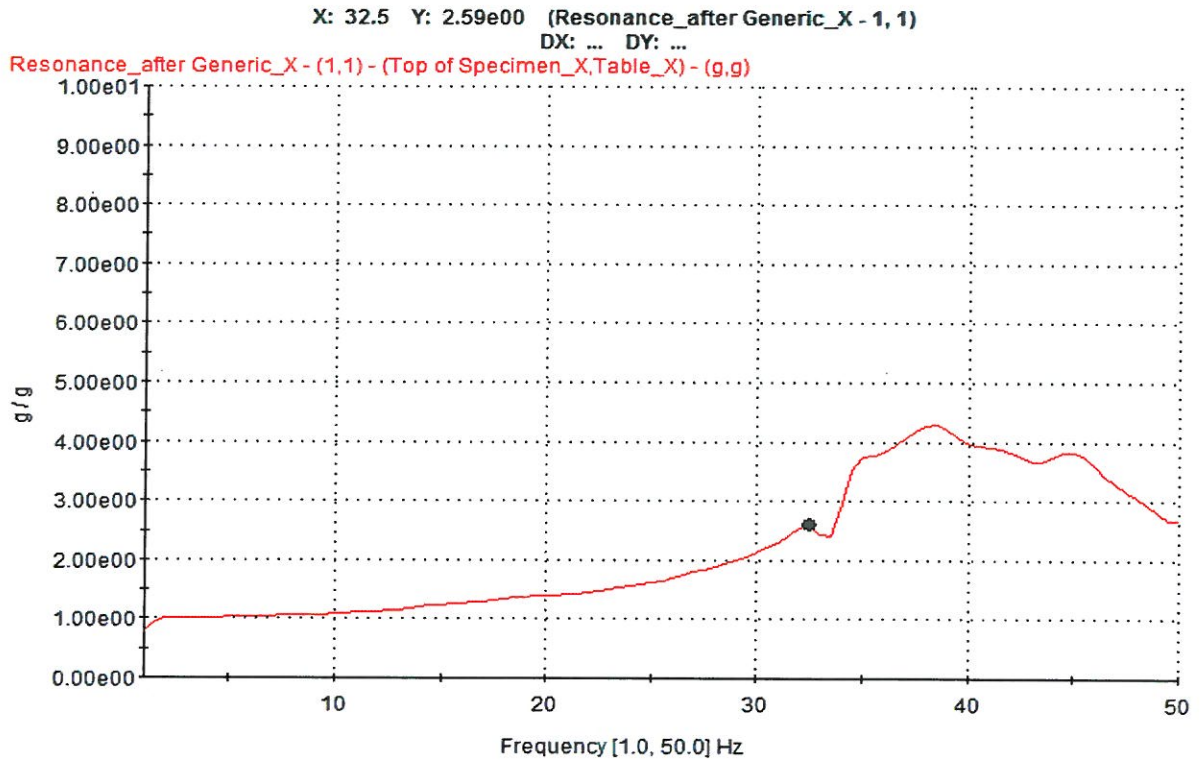


Fig. 1 - 4 X Dir. Resonant Search after seismic test (ZPA-3 g Condition) – Top of Specimen

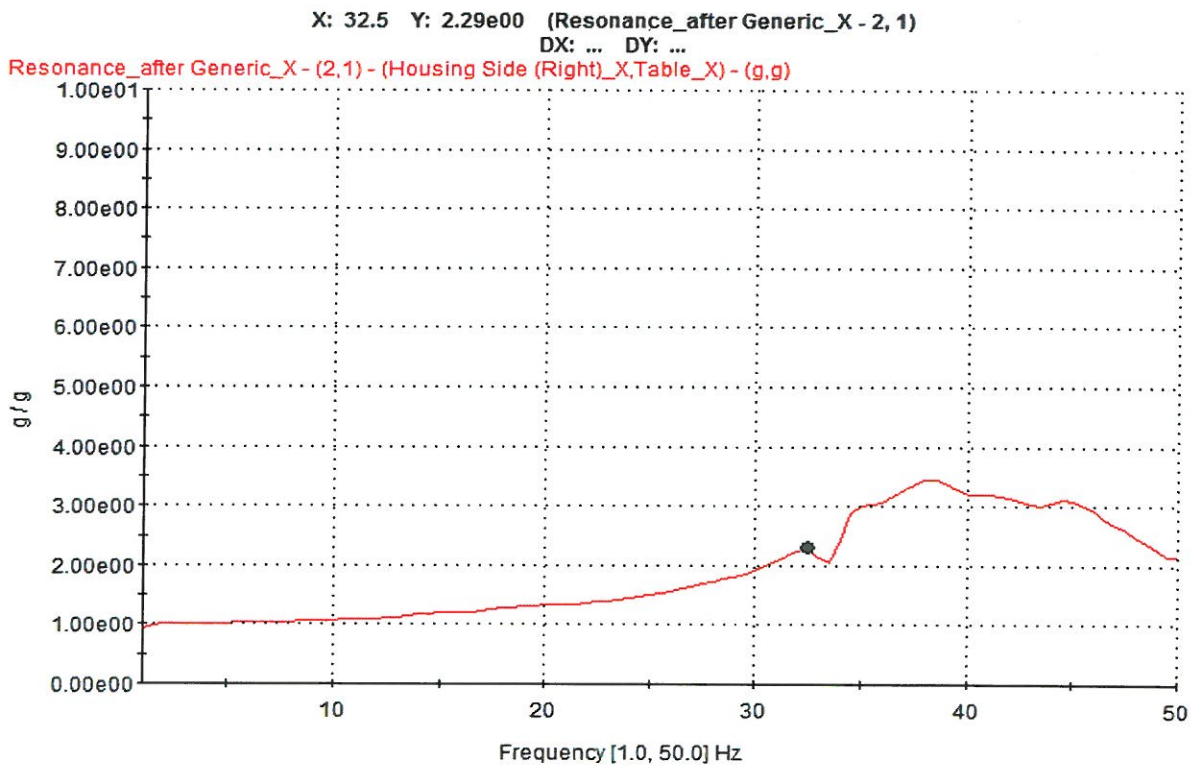


Fig. 1 - 5 X Dir. Resonant Search after seismic test (ZPA-3 g Condition) – Housing Side (Right)

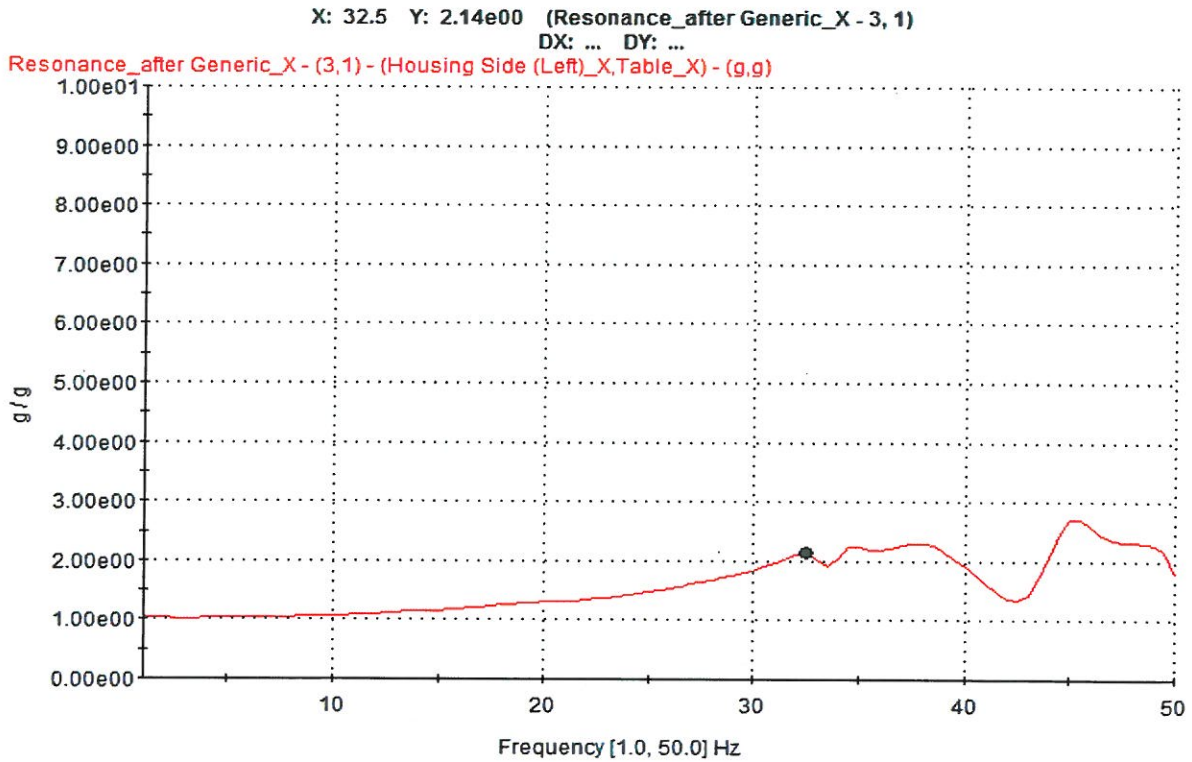


Fig. 1 - 6 X Dir. Resonant Search after seismic test (ZPA-3 g Condition) – Housing Side (Left)

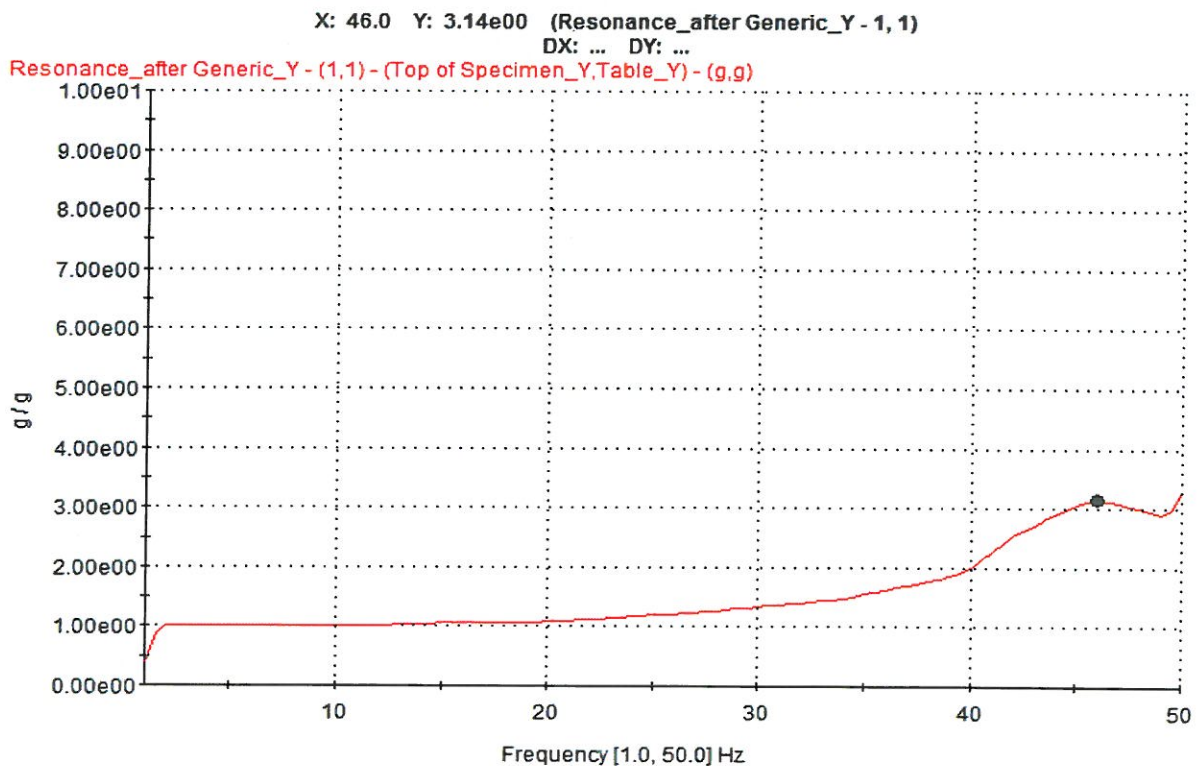


Fig. 1 - 7 Y Dir. Resonant Search after seismic test (ZPA-3 g Condition) – Top of Specimen

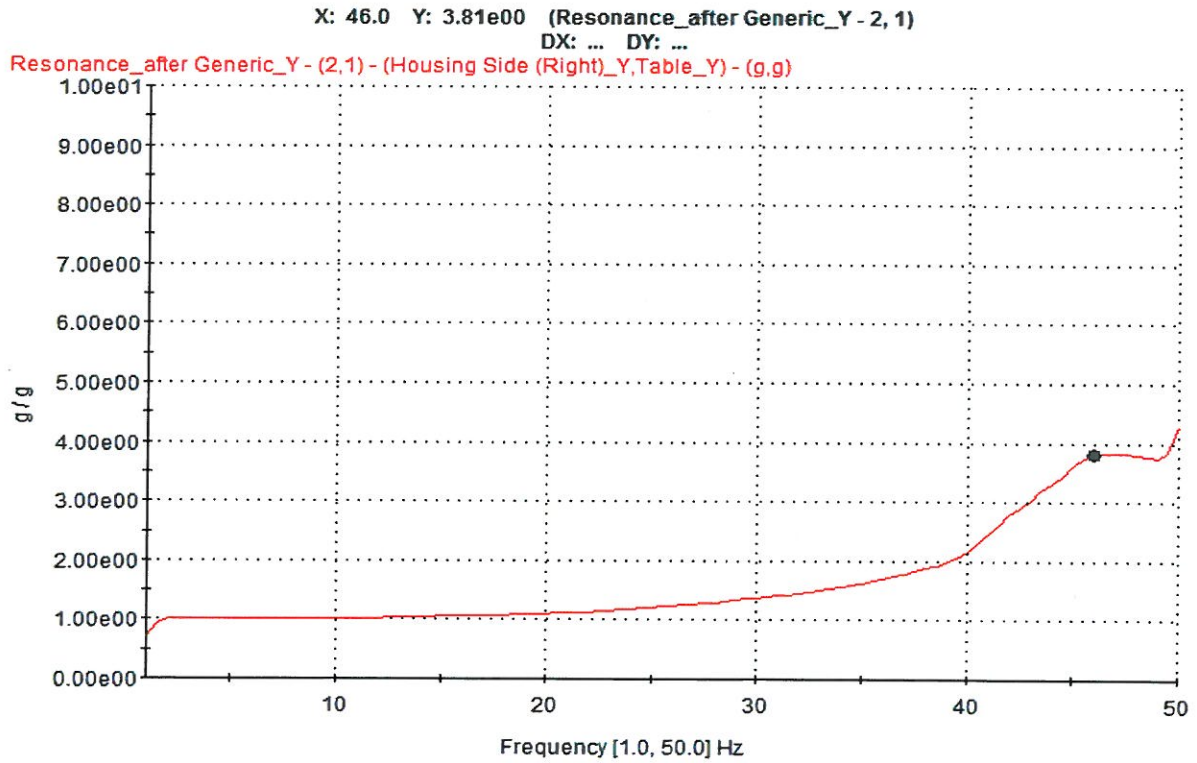


Fig. 1 - 8 Y Dir. Resonant Search after seismic test (ZPA-3 g Condition) – Housing Side (Right)

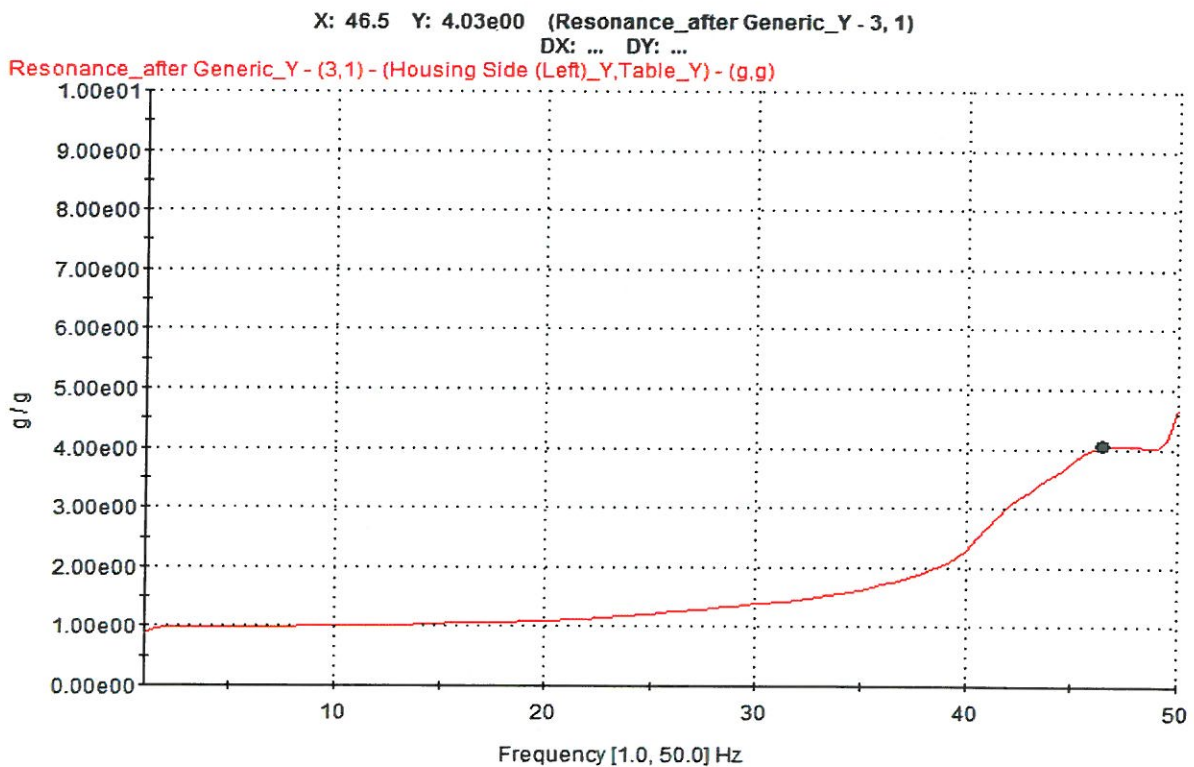


Fig. 1 - 9 Y Dir. Resonant Search after seismic test (ZPA-3 g Condition) – Housing Side (Left)

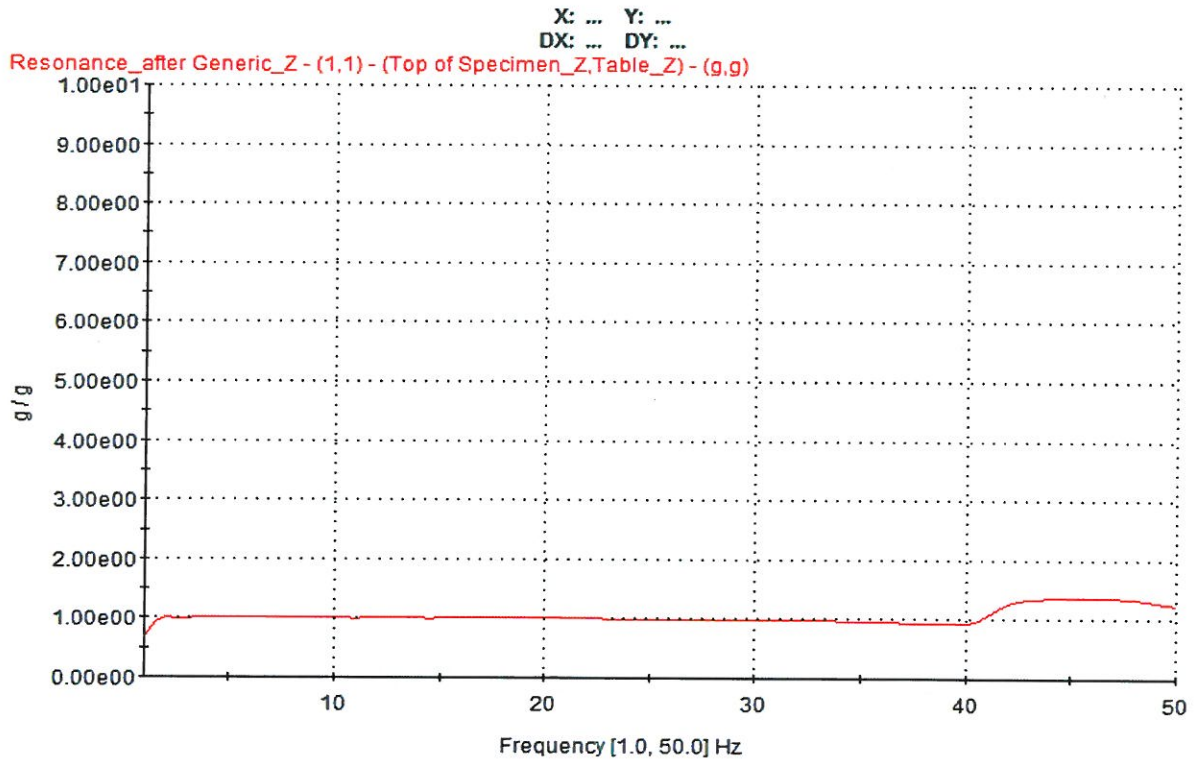


Fig. 1 - 10 Z Dir. Resonant Search after seismic test (ZPA-3 g Condition) – Top of Specimen

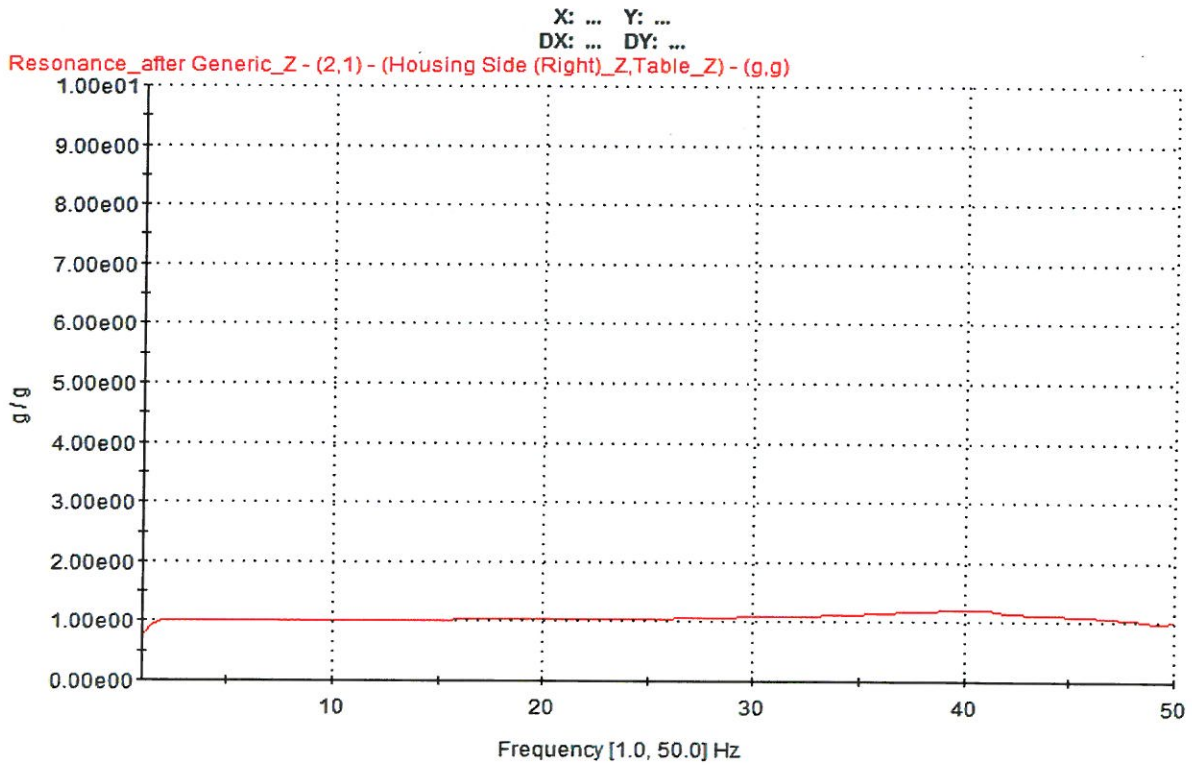


Fig. 1 - 11 Z Dir. Resonant Search after seismic test (ZPA-3 g Condition) – Housing Side (Right)

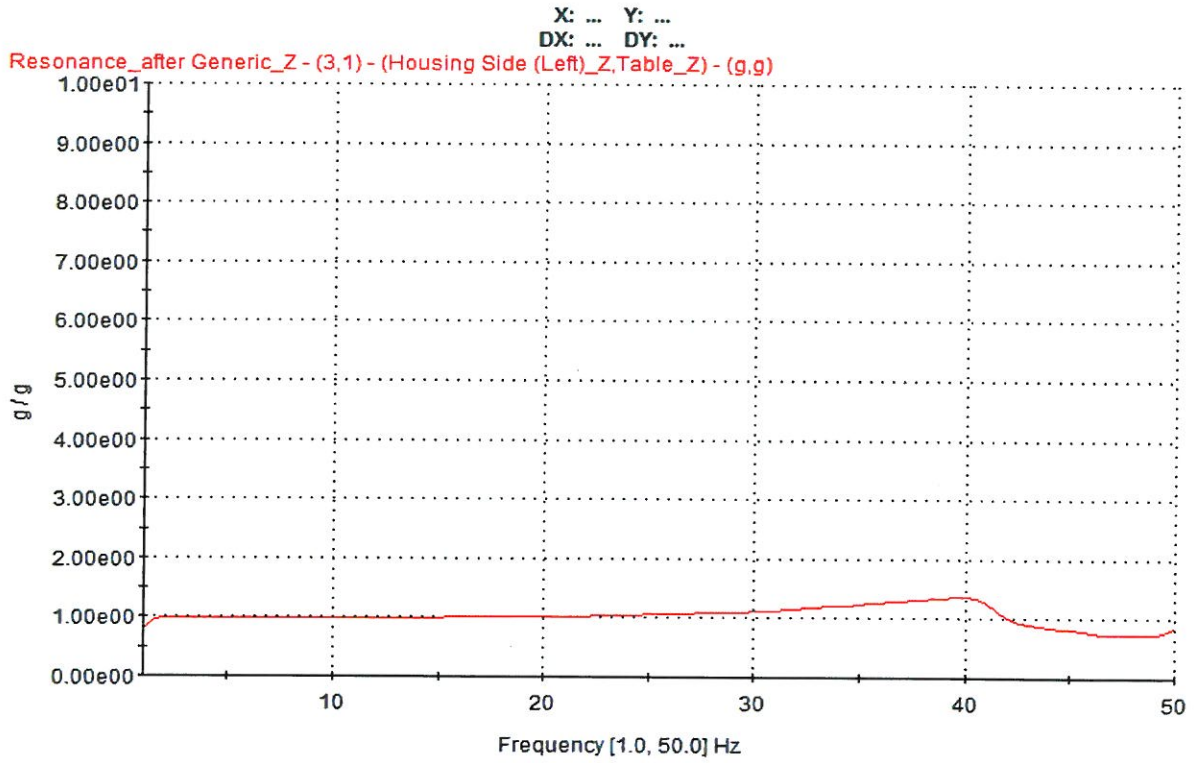


Fig. 1 - 12 Z Dir. Resonant Search after seismic test (ZPA-3 g Condition) – Housing Side (Left)

- END -