



S14 W33511 Highway 18 • Delafield, WI 53018 • 262 968-4003 • Fax: 262 968-3050 • 800 969-4050

**GR-63-CORE SEISMIC TESTING**

**OF A**

**TITAN Z4 CABINET**

**FOR**

**IMS ENGINEERED PRODUCTS**

**TEST DATE:**

**OCTOBER 15, 2015**

**DATASYST PROJECT NUMBER:**

**I31-17065**

**REVISION: A**

**PREPARED FOR:**

**VICTOR BERISTANY  
IMS ENGINEERED PRODUCTS  
1 INNOVATION DRIVE  
DES PLAINES, IL 60016**

**PREPARED BY:**

**EDWARD HANUS  
DATASYST ENGINEERING &  
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33511 HIGHWAY 18  
DELAFIELD, WI 53018**

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## **1.0 INTRODUCTION**

IMS Engineered Products, of Des Plaines, IL contracted DATASYST Engineering & Testing Services, Inc. (DATASYST) of Delafield, WI to perform GR63-CORE testing of a Titan Z4 (47U24-42) cabinet. The objective of the testing was to demonstrate compliance to the GR-63-CORE, Zone 4 seismic requirement and GR-63-CORE mechanical natural frequency requirement.

All testing was performed at the DATASYST facility in Delafield, WI and witnessed by IMS personnel.

## **2.0 CONCLUSIONS**

The Titan Z4 cabinet was exposed to the GR-63-CORE, Issue 4, Sine Survey and the GR-63-CORE, Issue 4, Zone 4 Earthquake Test in all three axes.

In all tests there were no visual structural failures and no liberated components from the structure.

The lowest natural frequency, of all three axes, was 8.3 Hz which is above the 2.0 Hz requirement and above the 6.0 Hz optional requirement. The maximum load washer value during the zone 4 waveform testing was 5,310 Lbs, which is within the 9,560 Lb limit of a 12 mm anchor in 3,000 psi concrete. The maximum relative deflection at the top of the rack was 1.00 inches which is within the 3.0 inch requirement.

## **3.0 TEST PROCEDURES**

IMS Engineered Products provided the Titan Z4 (47U24-42) cabinet with simulated front shelves. As tested, the cabinet was 24” wide x 42” deep x 88.625” high and contained a bottom level fixed shelf and five adjustable shelves with simulated fronts. The total cabinet weight was 1455 Lbs, which included the cabinet weight of 246



Lbs, the shelves weight of 279 Lbs; 630 Lbs of additional weight on the bottom fixed shelf and 300 Lbs of additional weight on the lowest adjustable shelf.

The weighted Titan Z4 cabinet was fastened to a 38" x 38" fixture plate with four ½-13 screws, and 20,000 pound capacity load washers. These four screws were tightened to a clamp load of approximately 5,000 pounds, which is the target preload for a 12 mm anchor in 3,000 psi concrete.

A displacement potentiometer, attached to the top of the cabinet, along with the displacement data from the shaker table, were used to measure the relative deflection at the top of the cabinet.

Two response accelerometers, one at the top of the cabinet and one at mid height, were used to measure the resonant natural frequency of the system during the sine survey test.

Testing was initiated by completing both test steps in the side/side axis followed by the front/back axis and finishing in the vertical axis.

The parameters for the tests performed, in each axis, were as follows:

- Sine Survey- One sweep from 1 to 50 Hz, 0.2g amplitude with response accelerometers at top and middle of rack. The sweep rate was 1.5 octave / minute from 1 – 20 Hz and 1.0 octave / minute from 20 – 50 Hz.
- Zone 4 Earthquake Test – One, 30 second, VERTEQII Zone 4 transient time history waveform.



## 4.0 PLOTS AND DATA SUMMARY

### DATA SUMMARY FOR GR-63-CORE CRITERIA

#### Anchor Bolt Data

Bolt type	Hilti 12 mm in 3000 psi concrete
Max Allowable Load	9560 pounds
Working Load	2740 pounds
Target Preload	4100 to 5500 pounds
Pass / Fail Criteria	Load cannot exceed Max Allowable Load During any Waveform test

#### Front to Back Seismic Waveform

Max Load During Test (Lbs)

	Load Washer 1	Load Washer 2	Load Washer 3	Load Washer 4
Zone 3	-	-	-	-
Zone 4	<b>4821</b>	<b>4742</b>	<b>4973</b>	<b>4952</b>

#### Side to Side Seismic Waveform

Max Load During Test (Lbs)

Zone 3	-	-	-	-
Zone 4	<b>5109</b>	<b>5202</b>	<b>5284</b>	<b>4845</b>

#### Vertical Seismic Waveform

Max Load During Test (Lbs)

Zone 3	-	-	-	-
Zone 4	<b>5002</b>	<b>4979</b>	<b>5310</b>	<b>4939</b>

#### Displacement Data

Pass / Fail Criteria

Displacement at top of cabinet cannot exceed 3.0 inches, relative to the fixed base.

#### Max relative displacement (inches)

##### Front to Back Seismic Waveform

Zone 3	-
Zone 4	<b>0.16</b>

##### Side to Side Seismic Waveform

Zone 3	-
Zone 4	<b>1.00</b>

#### Natural Frequency Data

Pass / Fail Criteria

Lowest natural frequency required to be above 2 Hz and desired to be above 6 Hz.

#### Lowest Natural Frequency (Hz)

##### Front to Back Seismic Sine Survey

##### Side to Side Seismic Sine Survey

##### Vertical Seismic Sine Survey

<b>10.8</b>
<b>8.3</b>
-



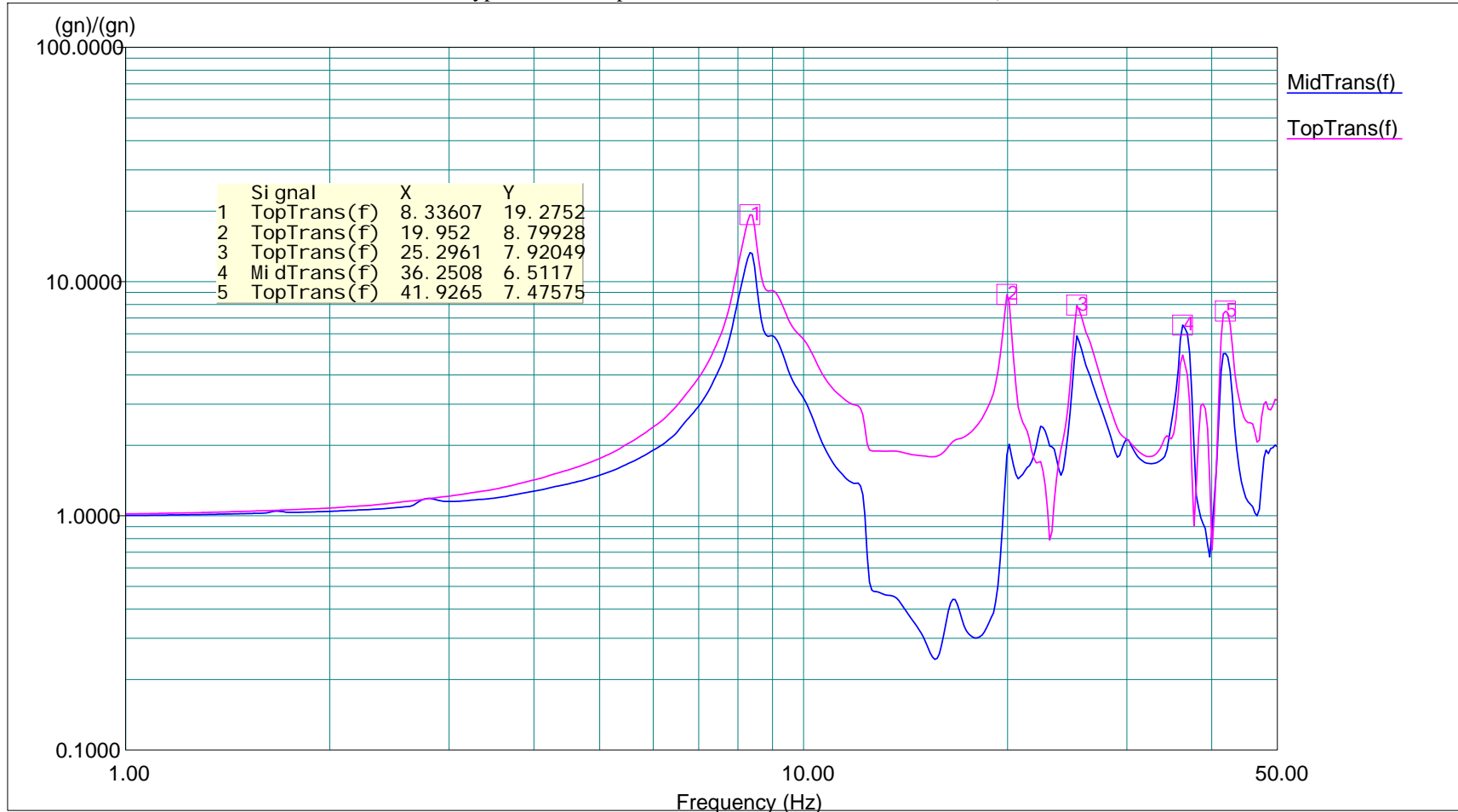
### Side / Side Axis Sine Survey, Transmissibility Plot

Project File Name: Sine Survey.prj

Profile Name: Low Level

Test Type: Swept Sine

Run Folder: .\RunDefault Oct 15, 2015 10-40-04

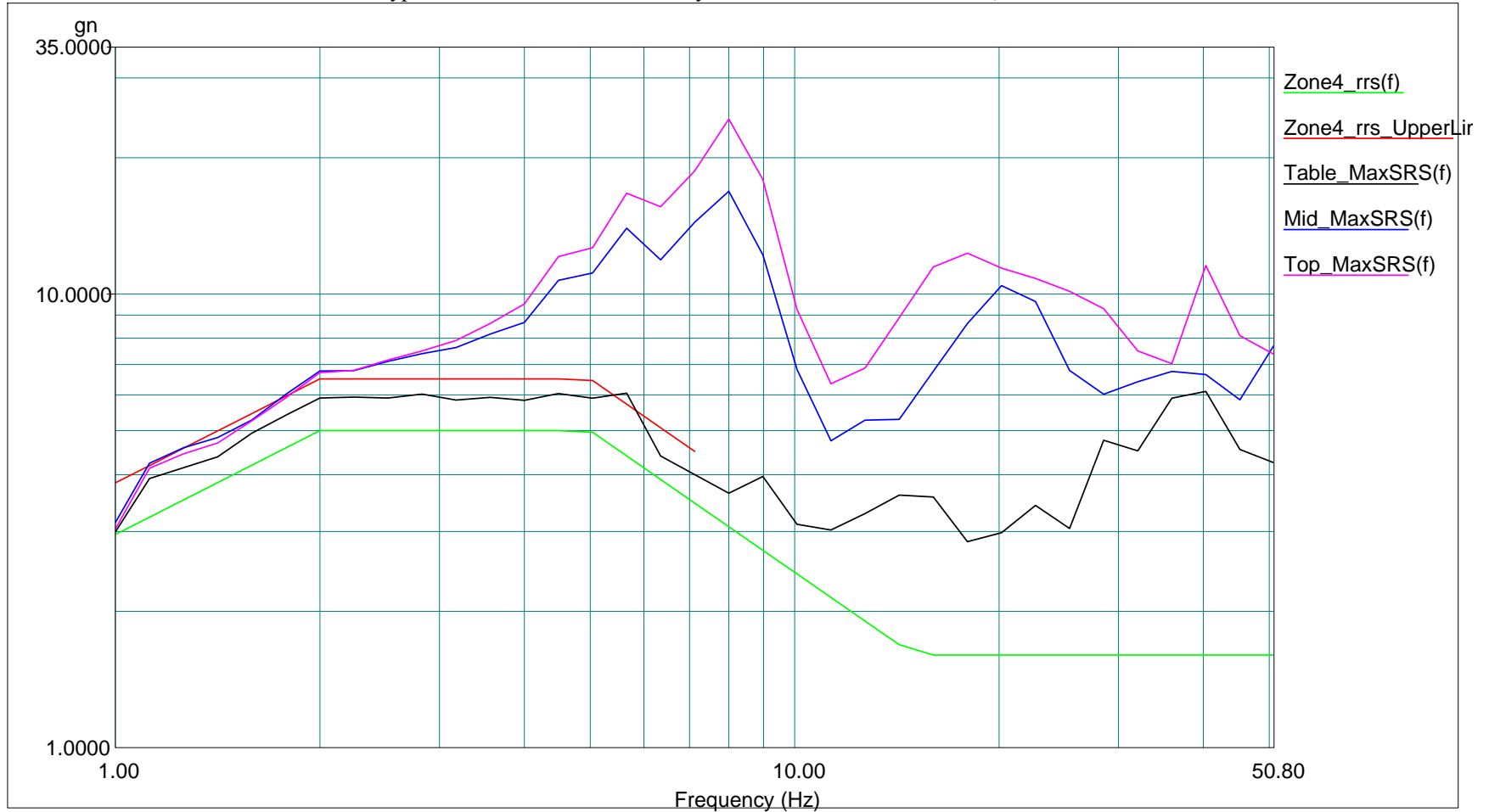


Level: 100 % Full Level Time: 00:05:39 Sweep Type: Logarithmic  
 Frequency: 49.986034 Hz Time Remaining: 00:00:00 Sweep Rate: 1 Oct/Min  
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### Side / Side Axis Zone 4 Waveform Test, Spectral Plot

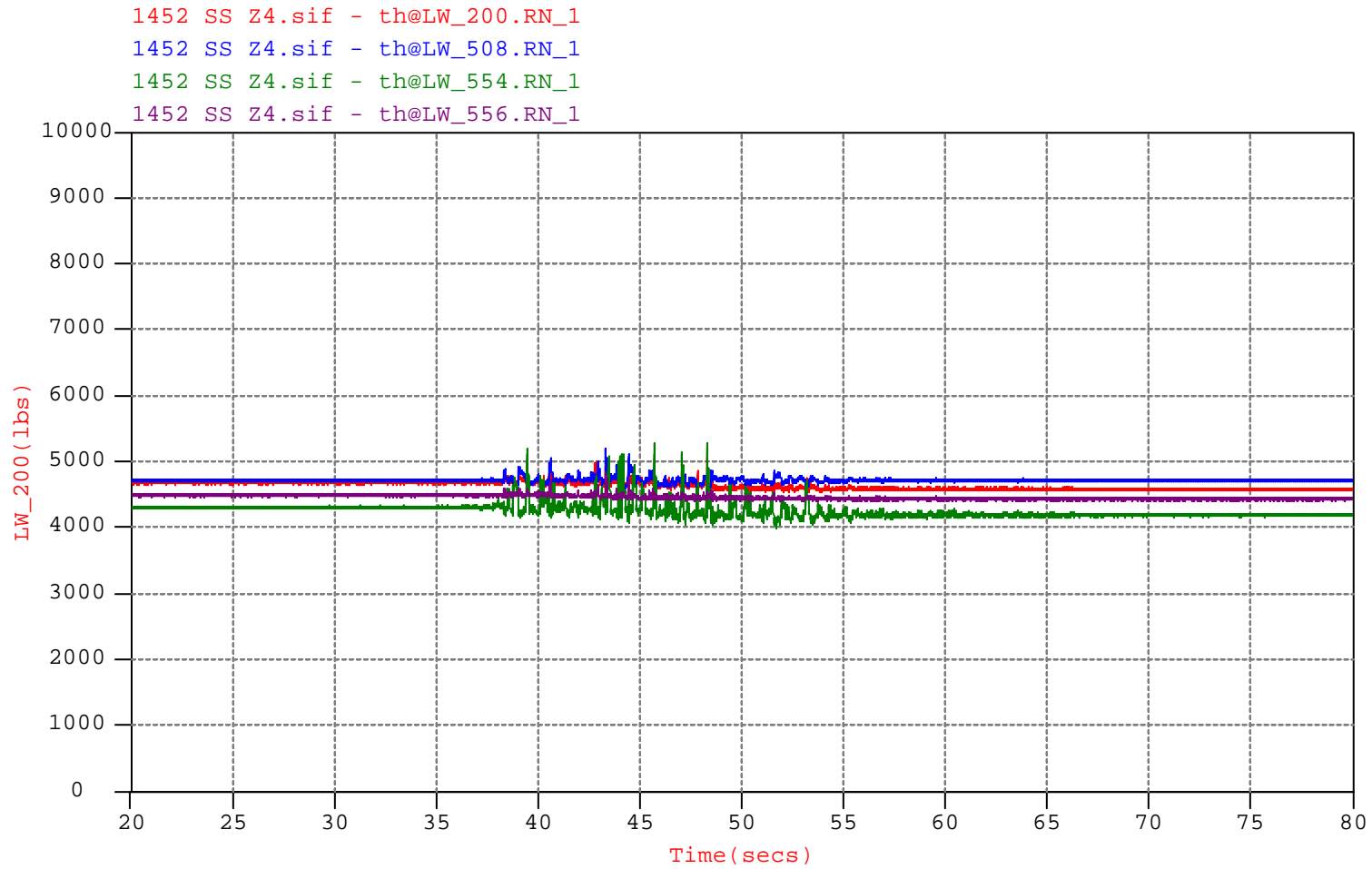
Project File Name: Horizontal Z4 Waveform.prj  
 Profile Name: Bel Test Type: Transient Time History Run Folder: .\RunDefault Oct 15, 2015 11-03-30



Level:	100 %	Block Size:	16384	Elapsed Pulses:	6	
Frame Time:	51.200000 Seconds	Control Peak:	1.994042	Control RMS:	0.314292	Full Level Elapsed Pulses: 2
dT:	0.003125 Seconds	Demand Peak:	1.646201	Demand RMS:	0.297686	Remaining Pulses: 8
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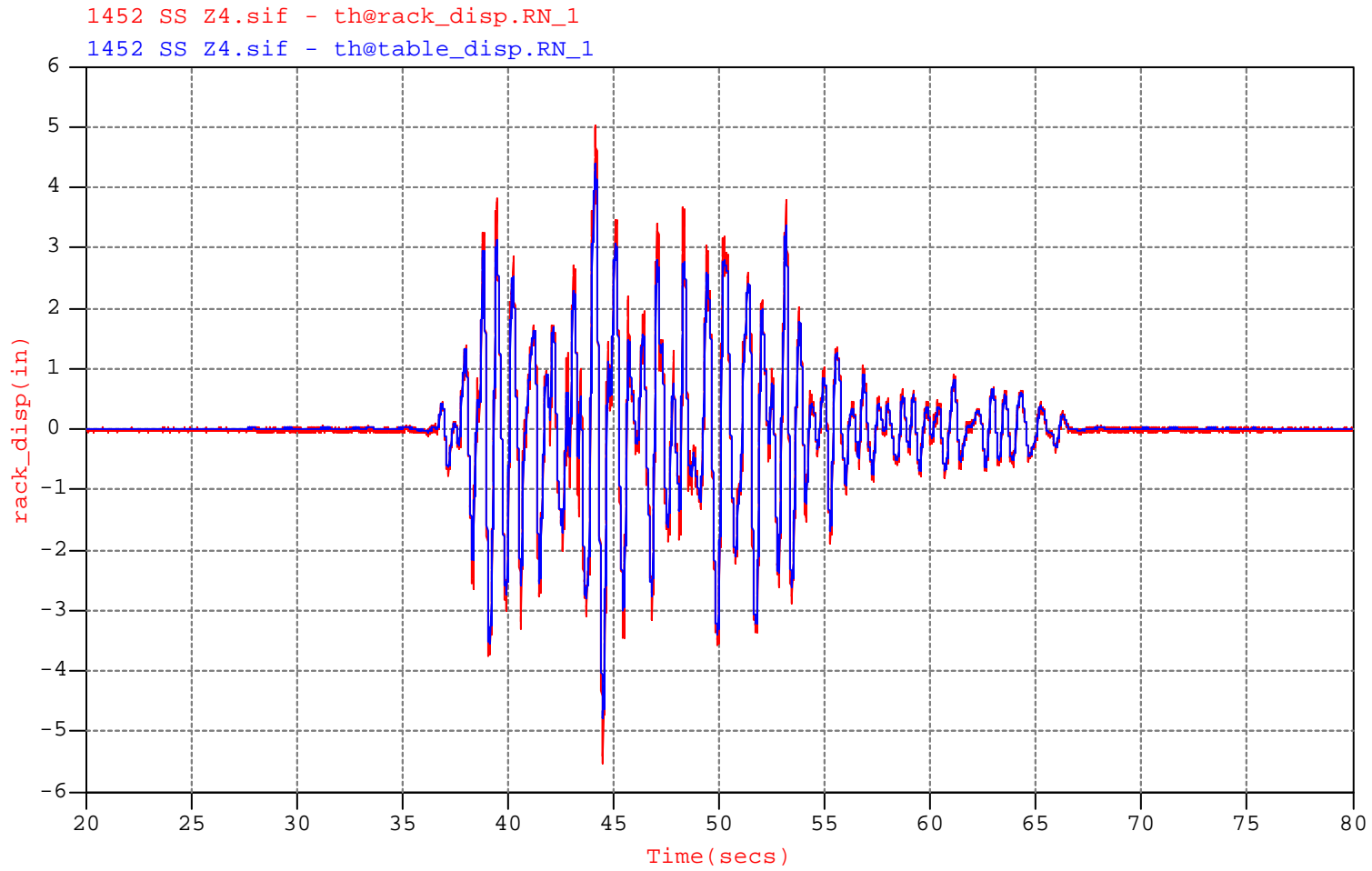


### Side / Side Axis Zone 4 Waveform Test, Load Washer Time History Plot

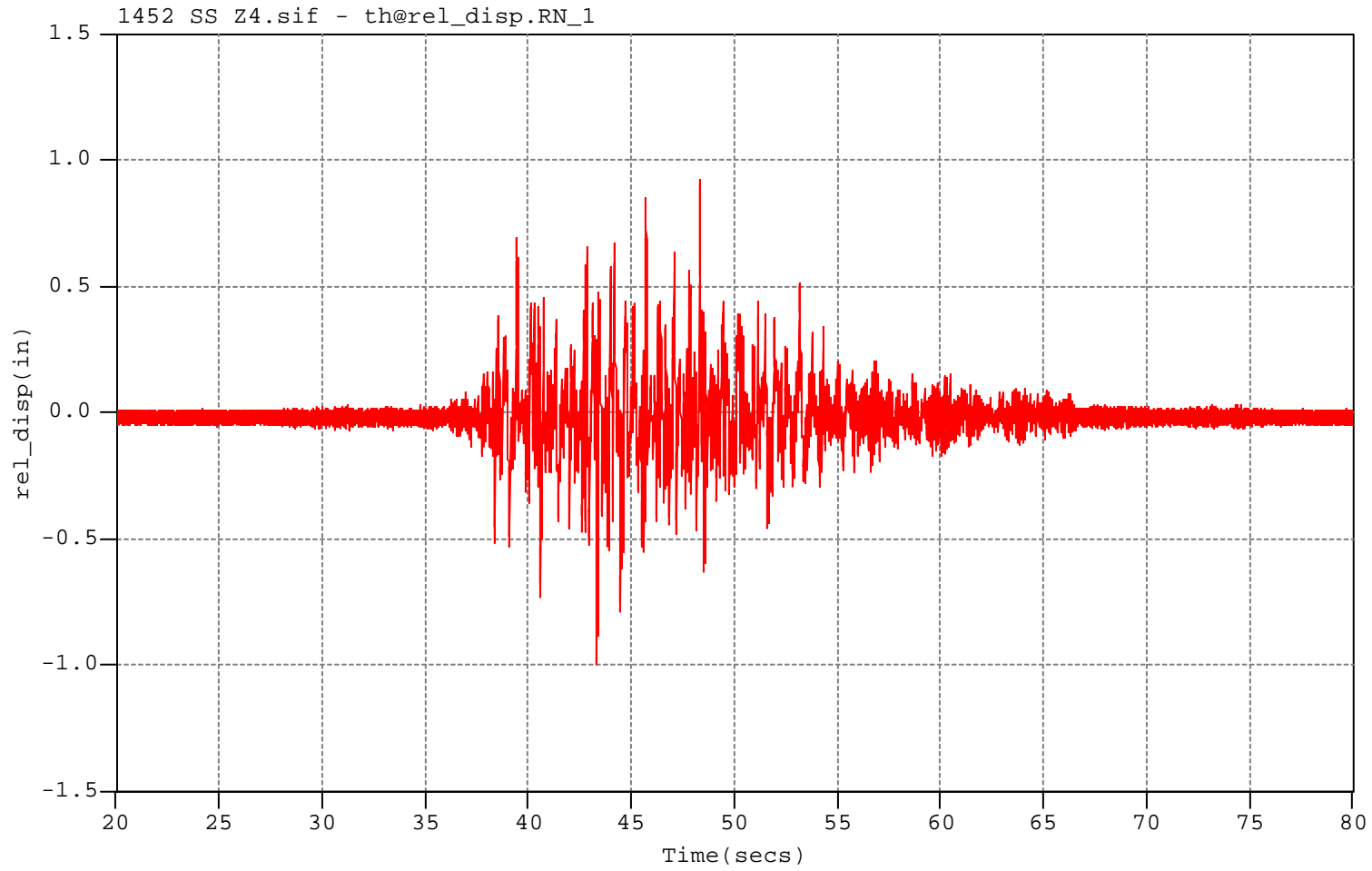




### Side / Side Axis Zone 4 Waveform Test, Top of Rack and Table Displacement Time History Plot

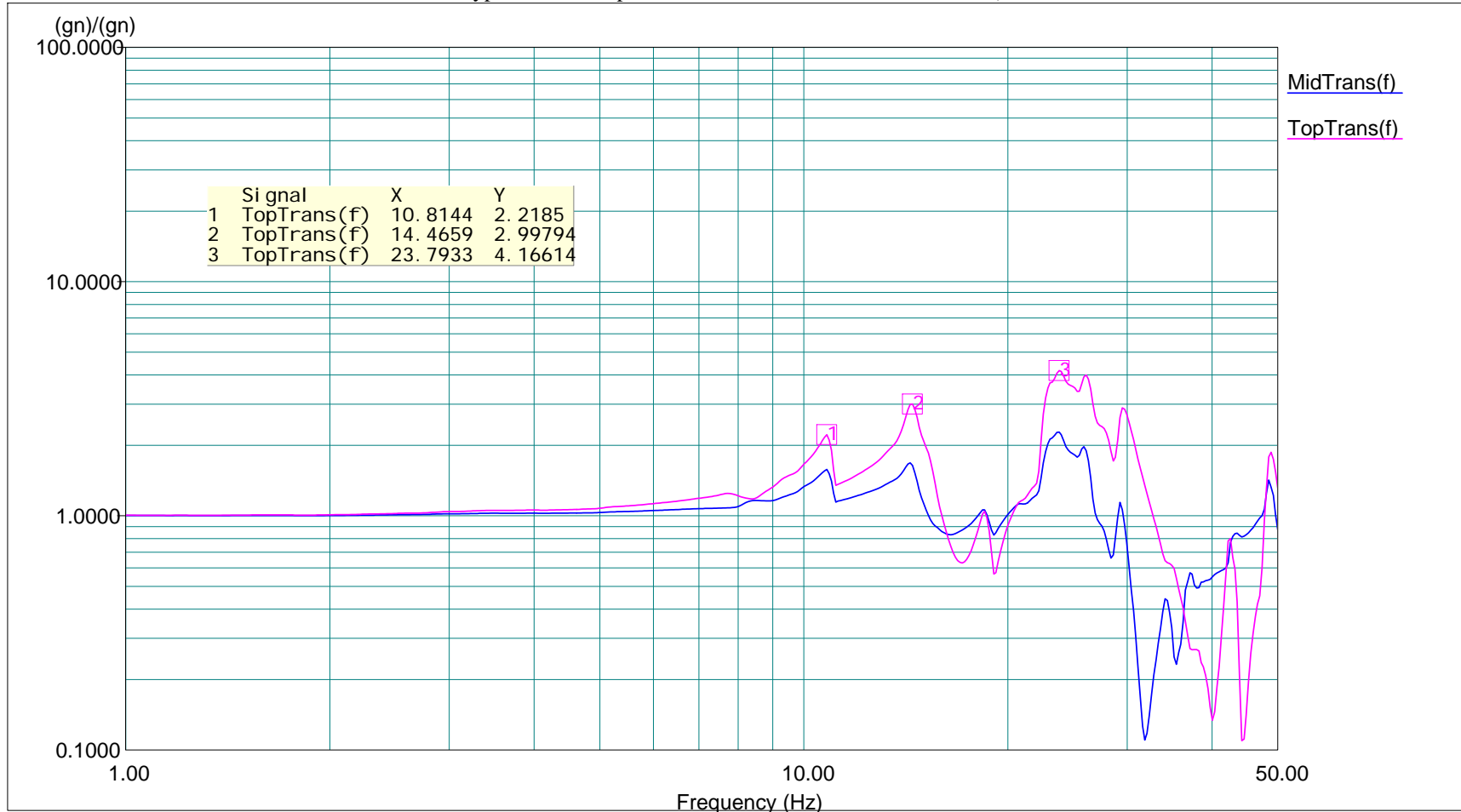


**Side / Side Axis Zone 4 Waveform Test, Relative Displacement Between Top of Rack and Table, Time History Plot**



### Front / Back Axis Sine Survey, Transmissibility Plot

Project File Name: Sine Survey.prj  
 Profile Name: Low Level Test Type: Swept Sine Run Folder: .\RunDefault Oct 15, 2015 12-02-31

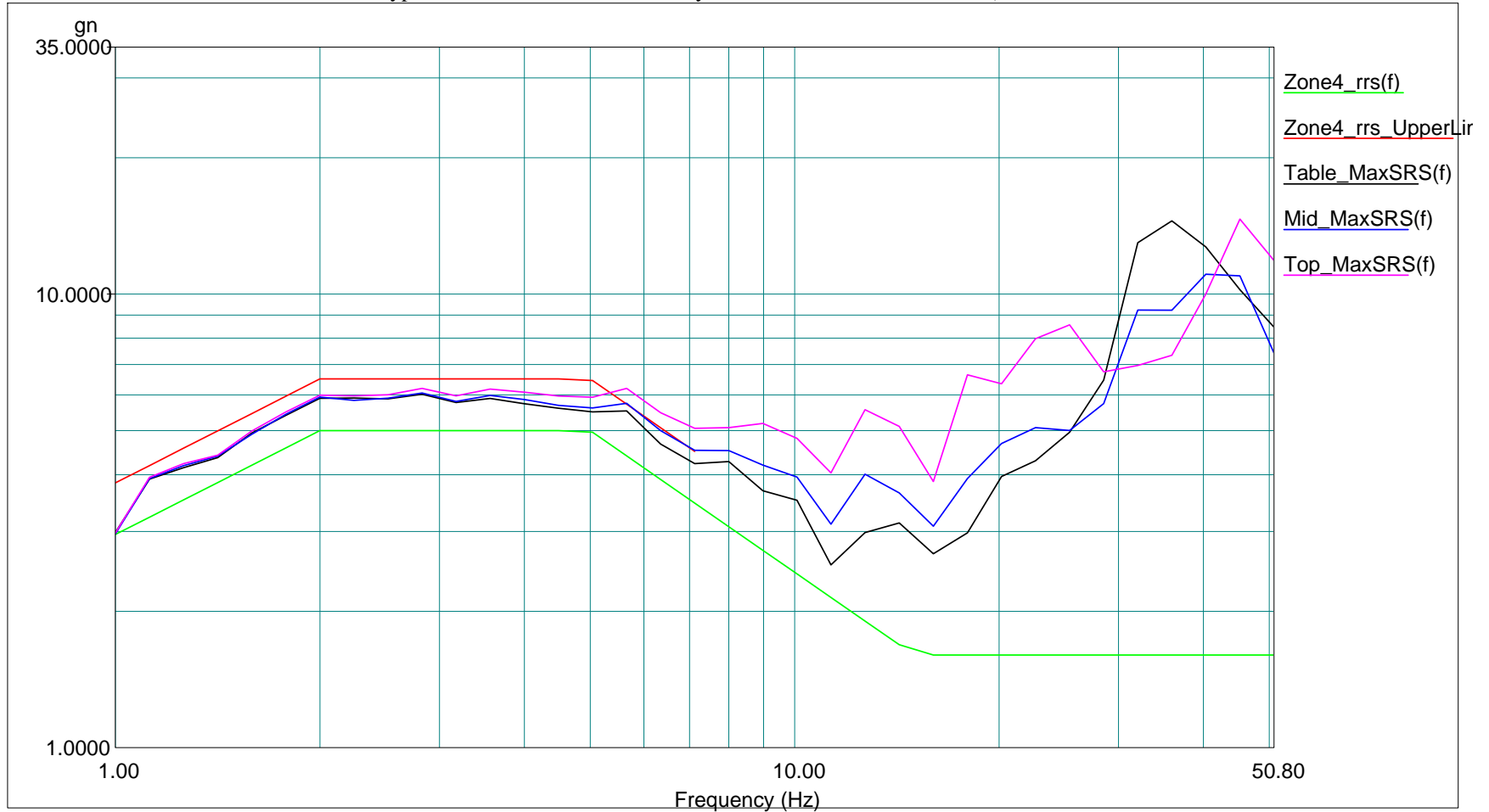


Level: 100 % Full Level Time: 00:05:39 Sweep Type: Logarithmic  
 Frequency: 49.992188 Hz Time Remaining: 00:00:00 Sweep Rate: 1 Oct/Min  
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### Front / Back Axis Zone 4 Waveform Test, Spectral Plot

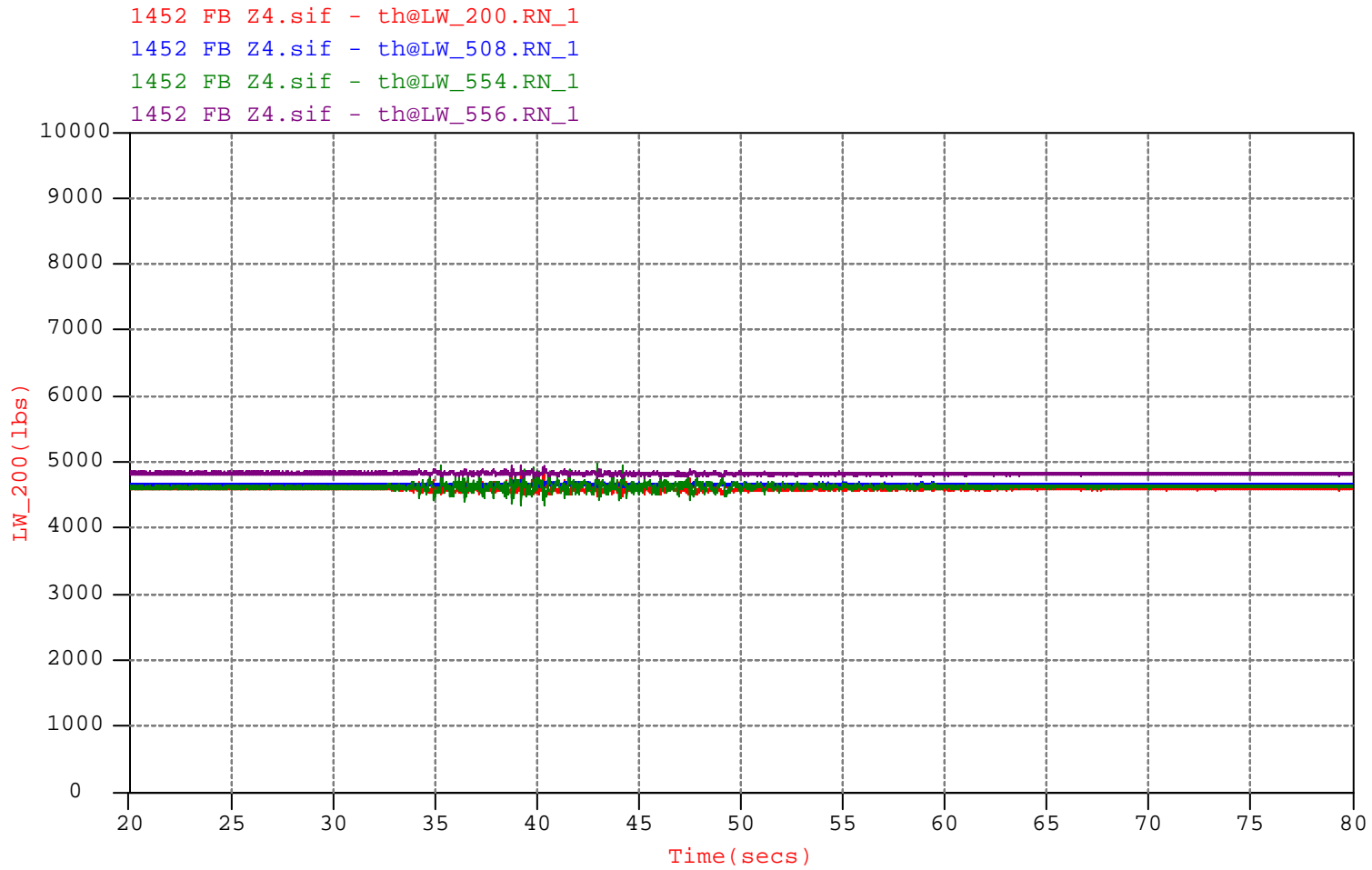
Project File Name: Horizontal Z4 Waveform.prj  
 Profile Name: Bel Test Type: Transient Time History Run Folder: .\RunDefault Oct 15, 2015 12-12-37



Level:	100 %	Block Size:	16384	Elapsed Pulses:	6	
Frame Time:	51.200000 Seconds	Control Peak:	3.454490	Control RMS:	0.349805	Full Level Elapsed Pulses: 2
dT:	0.003125 Seconds	Demand Peak:	1.646201	Demand RMS:	0.297686	Remaining Pulses: 8
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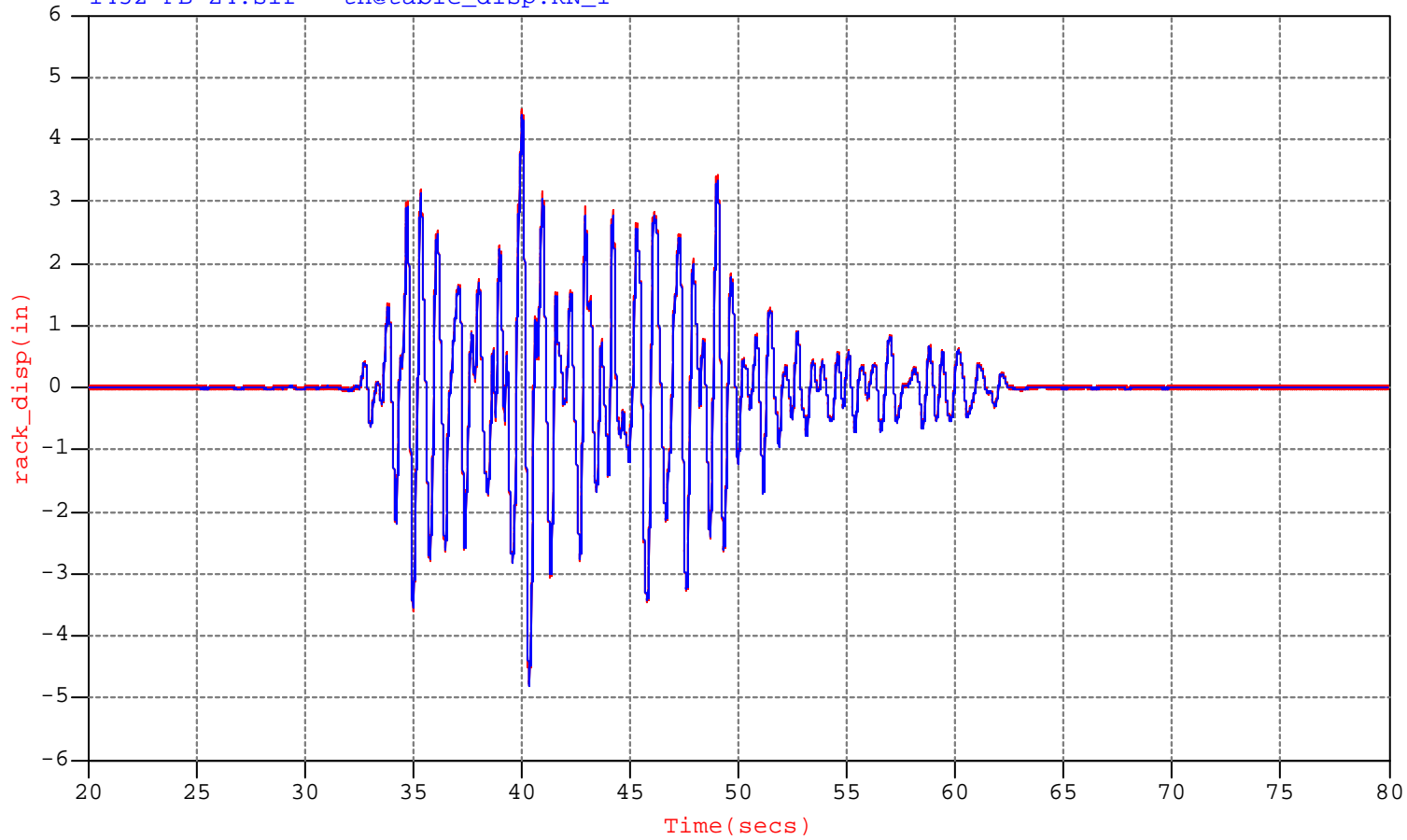
### Front / Back Axis Zone 4 Waveform Test, Load Washer Time History Plot



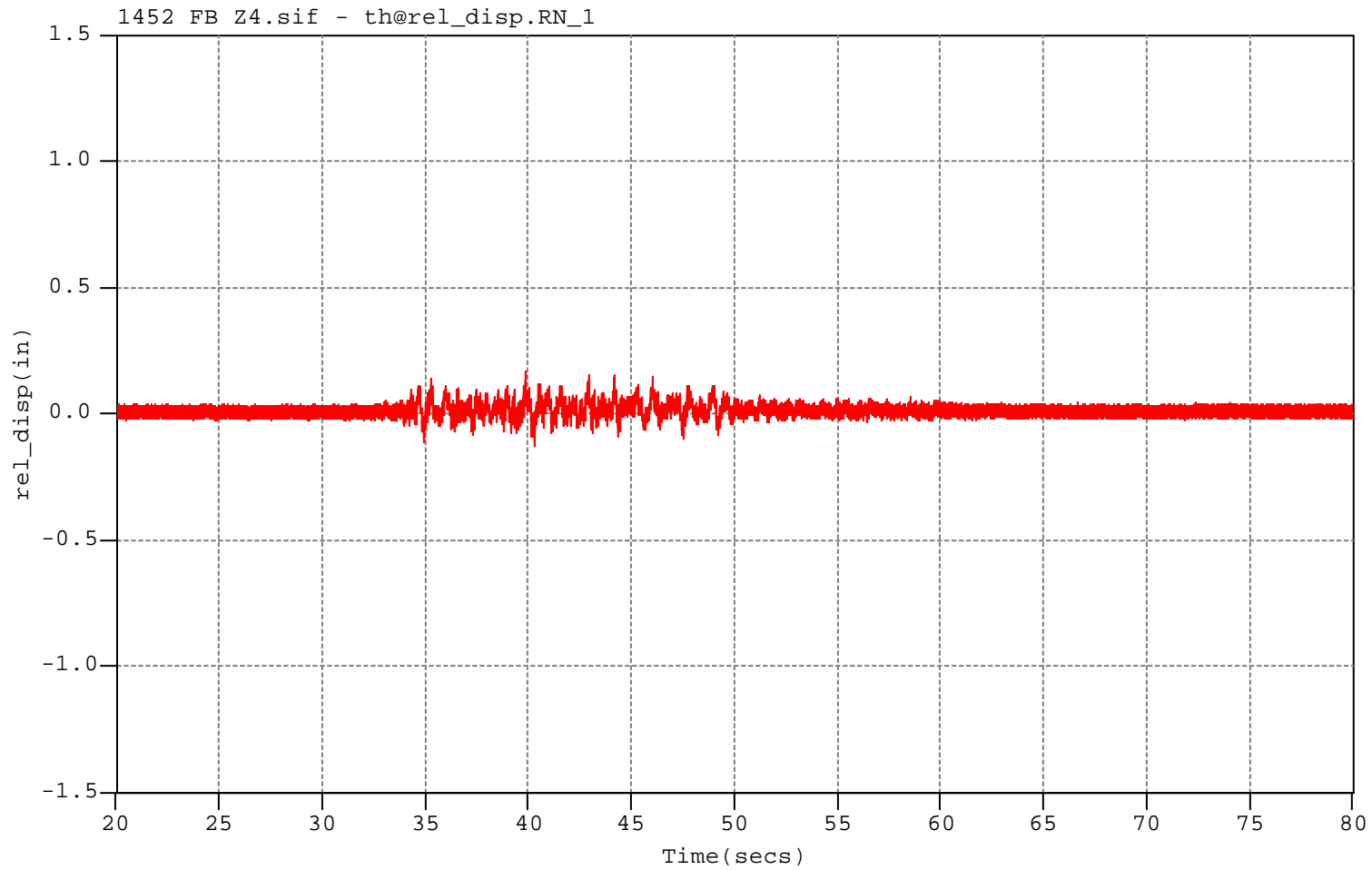
### Front / Back Axis Zone 4 Waveform Test, Top of Rack and Table Displacement Time History Plot

1452 FB Z4.sif - th@rack\_disp.RN\_1

1452 FB Z4.sif - th@table\_disp.RN\_1



**Front / Back Axis Zone 4 Waveform Test, Relative Displacement Between Top of Rack and Table, Time History Plot**



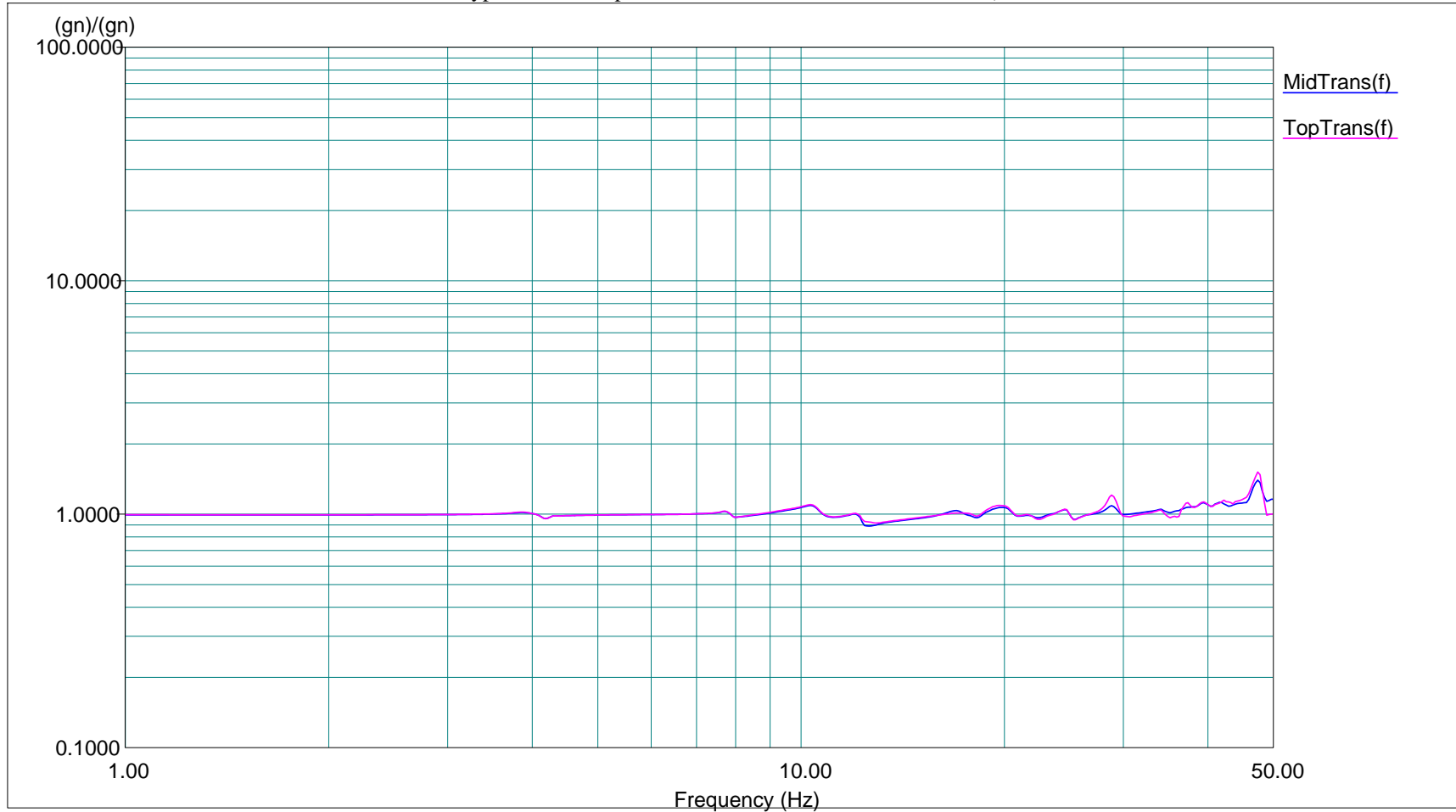
# Vertical Axis Sine Survey Transmissibility Plot

Project File Name: Sine Survey.prj

Profile Name: Low Level

Test Type: Swept Sine

Run Folder: .\RunDefault Oct 15, 2015 13-39-18



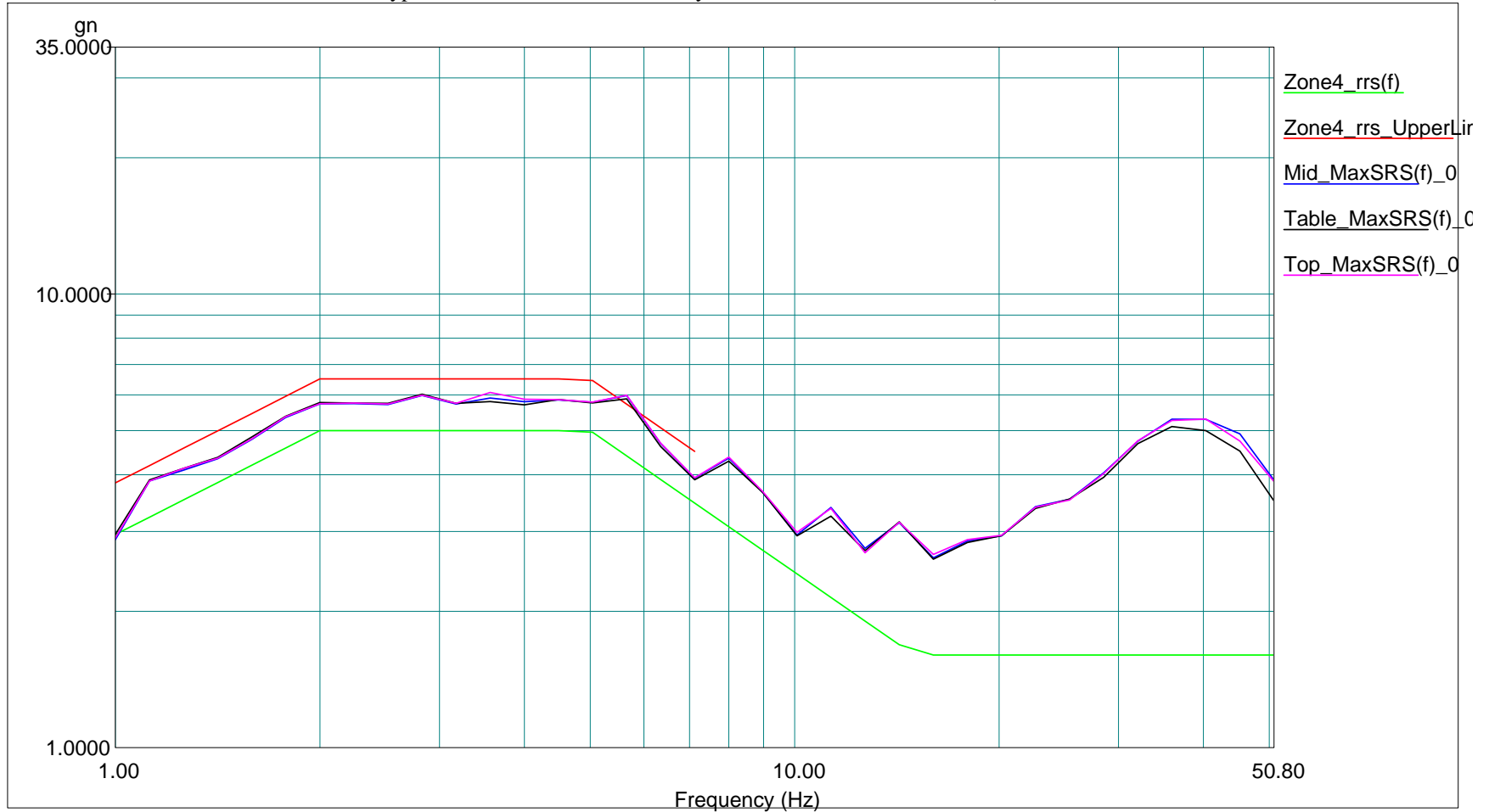
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Frequency: 49.992188 Hz Time Remaining: 00:00:00 Sweep Rate: 1 Oct/Min  
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### Vertical Axis Zone 4 Waveform Test, Spectral Plot

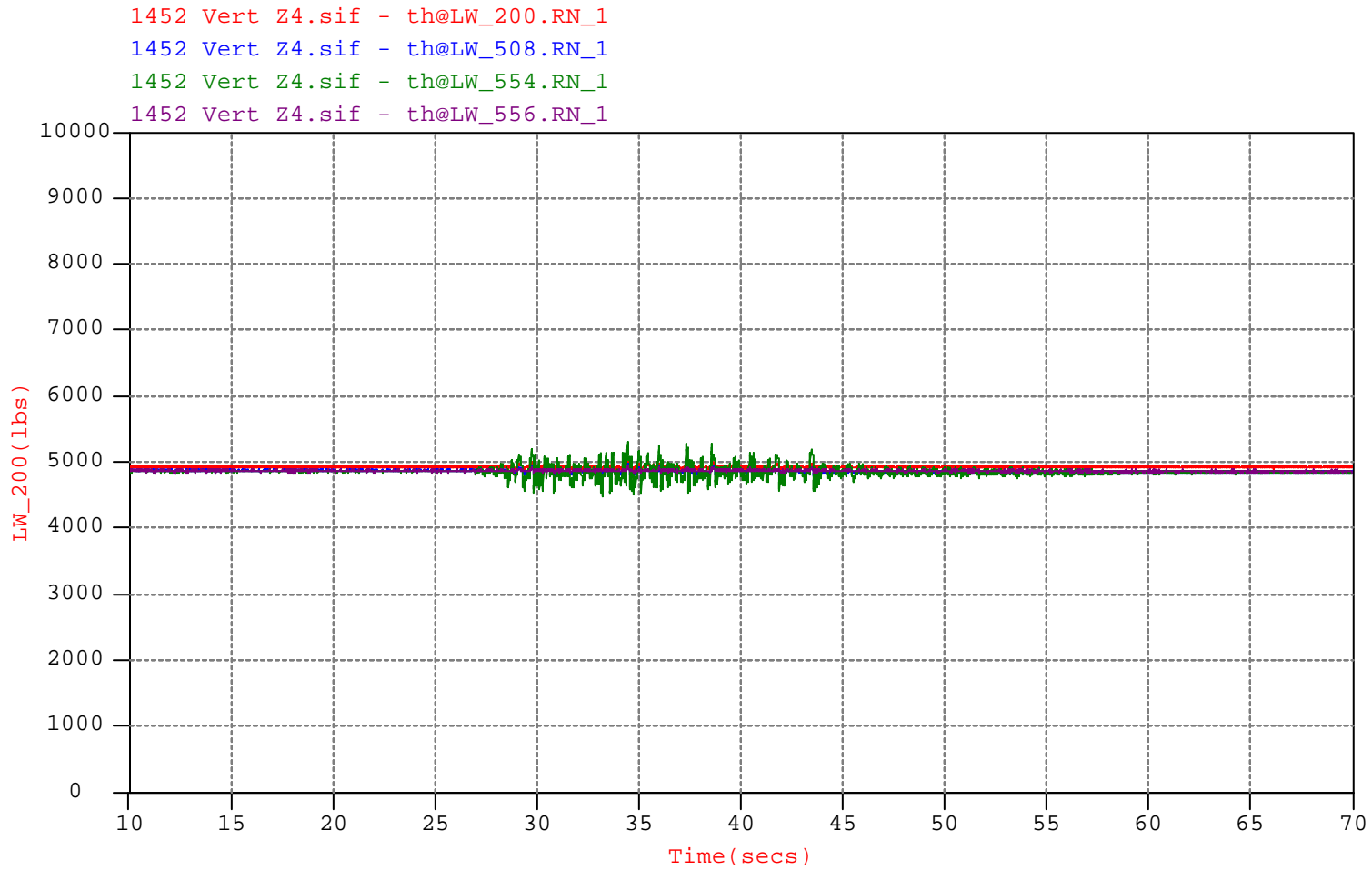
Project File Name: Horizontal Z4 Waveform.prj  
 Profile Name: Bel Test Type: Transient Time History Run Folder: .\RunDefault Oct 16, 2015 15-42-28



Level:	100 %	Block Size:	16384	Elapsed Pulses:	7		
Frame Time:	51.200000 Seconds	Control Peak:	2.750437	Control RMS:	0.332010	Full Level Elapsed Pulses:	3
dT:	0.003125 Seconds	Demand Peak:	1.646201	Demand RMS:	0.297686	Remaining Pulses:	7
Data saved at 04:25:28 PM, Friday, October 16, 2015				Report created at 04:25:28 PM, Friday, October 16, 2015			



### Vertical Axis Zone 4 Waveform Test, Load Washer Time History Plot



## Sine Survey Test Parameters

### Control Parameters

#### Test Parameters

Max. Test Frequency:	75.00 Hz
Sweep Type:	Logarithmic
Sweep Rate:	1.000000 Oct/Min
Measurement Strategy:	Single Channel
Filter Type:	Fixed
Band Width:	2.00 Hz
Drive Limit:	10.00 Volts
Abort Latency:	1.00 seconds
Compression Speed Type:	Fixed
Compression Speed:	1.50 dB/second

#### Initial Ramp-up Parameters

Initial Peak Drive:	0.100000 Volts
Ramp-Up Rate:	Slow
Maximum Drive during Ramp-up:	7.000000 Volts

### Profile Parameters

Profile Maximum Acceleration (Peak):	0.2000 gn
Profile Maximum Velocity (Peak):	12.2896 in/s
Profile Maximum Displacement (Peak-Peak):	3.9119 in

#### Profile Table:

Frequency	Acceleration	Velocity	Displacement	Segment Type	High Abort	High Alarm	Low Alarm	Low Abort
Hz	(gn) Peak	(in/s) Peak	(in) Peak-Peak		dB	dB	dB	dB
1.0	0.2	12.2896	3.9119	Slope log-log	6.00	3.00	-3.00	-6.00
50.0	0.2	0.245792	0.00156476		6.00	3.00	-3.00	-6.00

### Schedule Parameters

Fwd Swp From 1.00Hz Btwn 1.00Hz And 50.00Hz for 1.00Sweeps at 1.00 Oct/Min



## Zone 4 Waveform Test Parameters

### Control Parameters

#### Test Parameters

Block Size:	Auto
Averaging Number:	3
Drive Limit:	10.00 Volts
Pulse Interval:	3.000 seconds
Point Abort Ratio:	0.10
Low-Pass Filter Type:	Apply filter using user-defined cutoff frequency
Filter Cutoff Frequency:	55.000000Hz
Data Points/Frame:	16384
Frame Time:	51.200000 Seconds
Sampling Rate:	320 Hz
dT:	0.003125 Seconds
Maximum Analysis Frequency:	140.625 Hz
SRS Analysis:	Enable
SRS Analysis Low Frequency Bound:	1.000000Hz
SRS Analysis High Frequency Bound:	50.000000Hz
SRS Analysis Reference Frequency:	1.000000Hz
SRS Analysis Damping Ratio:	0.020000
SRS Analysis Fractional Octave Number:	1/6

#### Pre-test Parameters

Method of Acquiring the Loop Frequency Response Function:	Measure during close-loop pre-test
Initial Peak Drive:	0.300000 Volts
Ramp-Up Rate:	Fast
Response Level Goal:	67.00 %
Maximum Peak Drive:	6.700000 Volts



**Zone 4 Waveform Test Parameters, continued**

**Channel Parameters**

**Input Channel Parameters**

Input	Type	Max. Volts	mv/(EU)	Weighting	Coupling	Quantity	I.D.	Location
1	Control	10.0	964.9999mv/(g n)	1.0000	DC	Acce.	Table	23408
2	Response	10.0	986.0000mv/(g n)	1.0000	DC	Acce.	Mid	9652
3	Response	10.0	1002.0000mv/( gn)	1.0000	DC	Acce.	Top	9653

**Schedule Parameters**

10 Pulses at Level 100.00 %  
 Auto-Save Signals  
 Save All Panes



## 5.0 EQUIPMENT LIST



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### Test Equipment List

**Test Title:** GR63 Seismic      **Project Number:** I31-17065  
**Specimen:** Titan Z4 Rack      **Customer:** IMS Engineered Products  
**Sample Quantity:** 1      **Start / End Date:** 15-Oct-2015 | 15-Oct-2015

Equipment	Manufacturer	Model Number	Serial Number	Calibration	
				Last	Due
Seismic Actuator	MTS	5.5kip, 10in	HOR5.5-10	N/A	N/A
Servo Valve	Moog	G761-3264	8939	N/A	N/A
Hydraulic Controller	MTS	407	#2	N/A	N/A
Hydraulic Actuator	MTS	248.04	284	N/A	N/A
Servo Valve	Moog	G761-3264	9222	N/A	N/A
Servo Valve	Moog	G761-3264	9227	N/A	N/A
Hydraulic Controller	MTS	407	#1	N/A	N/A
Vibration Controller	Dactron #9	Laser USB DP 420	5083465	26-May-2015	26-May-2016
Signal Conditioner	PCB	482A17	432	26-Jan-2015	4-Mar-2017
Accelerometer	PCB	393A03	23408	11-Feb-2015	4-Mar-2016
Accelerometer	PCB	393A03	9652	15-Apr-2015	14-Oct-2016
Accelerometer	PCB	393A03	9653	10-Jul-2015	14-Oct-2016
Load Washer	Transducer Techniques, Inc.	LWO-20	177200	3-Aug-2015	14-Oct-2016
Load Washer	Transducer Techniques, Inc.	LWO-20	124508	13-Jul-2015	14-Oct-2016
Load Washer	Transducer Techniques, Inc.	LWO-20	221554	17-Jul-2015	14-Oct-2016
Load Washer	Transducer Techniques, Inc.	LWO-20	221556	13-Jul-2015	14-Oct-2016
String Pot	First Mark Controls	60-35-8421	033025	7-Jul-2015	14-Oct-2016
Data Acquisition	Somat	LoLev_1	MSLLB.03-2046	15-Jan-2014	28-Jul-2016
Data Acquisition	Somat	LoLev_1	MSLLB.03-2109	10-Oct-2013	23-Dec-2015
Dial indicator	Chicago Dial Indicator	26504CJ	093219559	2-Feb-2015	2-Mar-2016
Load Cell	Lebow	3143-2K	100956A	18-Aug-2014	20-Jan-2016
Measurement Instrument	Vishay	P-3500	83589	1-Apr-2014	8-Apr-2017
Decade Resistor	General Radio	1432-P	20915	8-Jan-2014	24-Jan-2016

Certificates and reports of all calibrations are retained in the DATASYST Engineering & Testing Services, Inc. files and are available for inspection upon request.



**6.0 PHOTOGRAPHS**



**Side / Side Axis Test Setup**



**Front / Back Axis Test Setup**







**Vertical Axis Test Setup**



**Middle and Top Response Accelerometers**







**Top Displacement Measurement**



**Load Washer at Anchor Point**

