ROBOTEQ, INC.

PRODUCT VIBRATION AND SHOCK TESTING

of the Controllers

Report No. 228-15-1049A R1

Proposal No. 38527, Rev. D

Customer Information

Roboteq, Inc.
Griffin Baker
7898 E. Acoma Drive, Suite 103
Scottsdale, AZ 85260

Laboratory Information

Test engineer:	Jeffrey Reid; *Westpak*™
Test dates:	05/14/2015 – 05/18/2015
Westpak™ laboratory:	San Diego, California

WESTPAK, Inc. is accredited to ISO 17025 *General Competence for Testing and Calibration Laboratories*. WESTPAK, Inc. is also registered to ISO 9001 *Quality Management* and ISO 14001 *Environmental Management Systems* (#10001175 and #10004260). For accredited test methodologies, please visit www.westpak.com for the Scope of Accreditation of Westpak, Inc.

WESTPAK, INC.
ISO 9001:2008
ISO 14001:2004
10001175 & 10004260

ISO 17025 ACCREDITED LABORATORY

ista CERTIFIED LABORATORY

Purpose of Testing

The purpose of this test was to determine what effect vibration and shock testing would have on the operational and mechanical performance of the Equipment Under Test (EUT): Controllers. Four (4) units were subjected to the following test inputs:

Test Input	Standard Referenced	Inspections
Product Vibration	EN 61800-5-1 and IEC 60068-2-6	External Only
Product Shock	IEC 61131-2 and IEC 60068-2-27	External Only

Acceptance criteria for the EUT are determined by **Roboteq, Inc.**

Product Information

Product: Controllers
Quantity: 4

Unit Number	Unit Description	Serial Number	External Dimensions										Weight	
			in (l x w x h)					cm (l x w x h)					lb	kg
1	HDC2450	I-2054	5.5	x	9.3	x	1.5	14	x	24	x	4	3.2	1.5
2	LDC1430	F00160	5.5	x	5.0	x	1.3	14	x	13	x	3	0.8	0.4
3	SDC2160	F-0001	2.9	x	2.9	x	1.1	7	x	7	x	3	0.2	0.1
4	MDC2460	R00342	5.5	x	6.0	x	1.2	14	x	15	x	3	1.0	0.5


HDC2450


LDC1430

SDC2160


MDC2460

Test Equipment and Instrumentation

Testing performed in the laboratory was conducted at ambient conditions.

Please refer to Appendix I for equipment and instrumentation information and calibration dates.

Product Orientation Identification

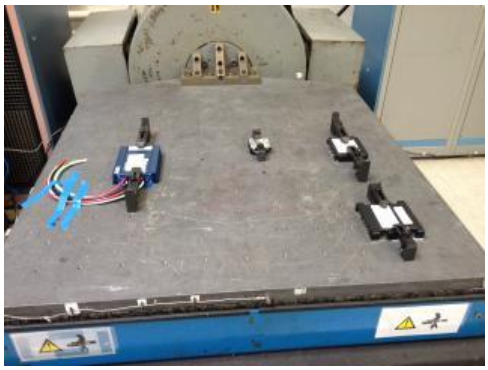
Test Descriptions

Product Vibration

Number of samples: 4
EUT status: Non-Operational
Frequency range: 10-150-10 Hz
Vibration intensity: 1.0 G (peak to peak) (10 m/s^2)
Sweep rate: 1 octave per minute

Vibration Spectrum Profile Break Points		
Frequency (Hz)	**Amplitude (mm)**	
10	0.075 (0.15 peak to peak)	
57.6		
Frequency (Hz)	**G**	**(m/s^2)**
57.6	1.0	10
150		

Orientation	Cycles
X-axis	10
Y-axis	10
Z-axis	10
Notes: Each cycle consists of a sweep from low to high frequency and back to low.	



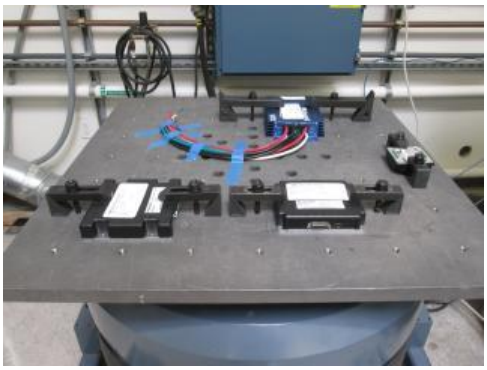
X-Axis

Y-Axis

Test Descriptions *(continued)*

Product Shock

Number of samples: 4
EUT status: Non-Operational
Pulse shape: Half-sine
Test levels: 15 G (147 m/s^2)
Pulse duration: 11 msec
Inputs per orientation: 3 (18 total)
Orientations: ±x, ±y and ±z axes



Z-Axis

Results and Observations

Test Input	Observations	Appendix
Product Vibration	Nothing unusual was observed to the exterior of the units following this test input.	II
Product Shock	Nothing unusual was observed to the exterior of the units following this test input.	III

Conclusions

Four (4) Controllers were subjected to vibration and shock testing as specified by **Roboteq, Inc.**

No unusual external physical damage was observed to the units throughout the test inputs.

Upon test completion, the units were returned to **Roboteq, Inc.** for further evaluation. **Roboteq, Inc.** reported that all units passed functional testing.

There were no anomalies throughout the conduct of this test that would detract from the ability of **Roboteq, Inc.** from making reasonable judgments concerning the testing as described herein.

WESTPAK™ is pleased to present this report to **Roboteq, Inc.** covering the product vibration and shock testing of the Controllers. The equipment used to conduct this testing has been recently calibrated and is known to be in good operating condition. In addition the test operator uses good laboratory practice at all times. Therefore, the data is considered accurate and reliable. However, there is no warranty expressed or implied with the submission of this report, and **Roboteq, Inc.** assumes all liability for use of the data contained herein.

Respectfully submitted,
WESTPAK, INCORPORATED

Jeffrey Reid
Mechanical Engineer
May 26, 2015
May 27, 2015 (Rev 1)

Reviewed By

Aaron Suarez
Director of Engineering
May 26, 2015

Revision History:
Rev 1 (May 27, 2015):

- Included client's posttest functional results in conclusions section on page 7 of report.

APPENDIX I

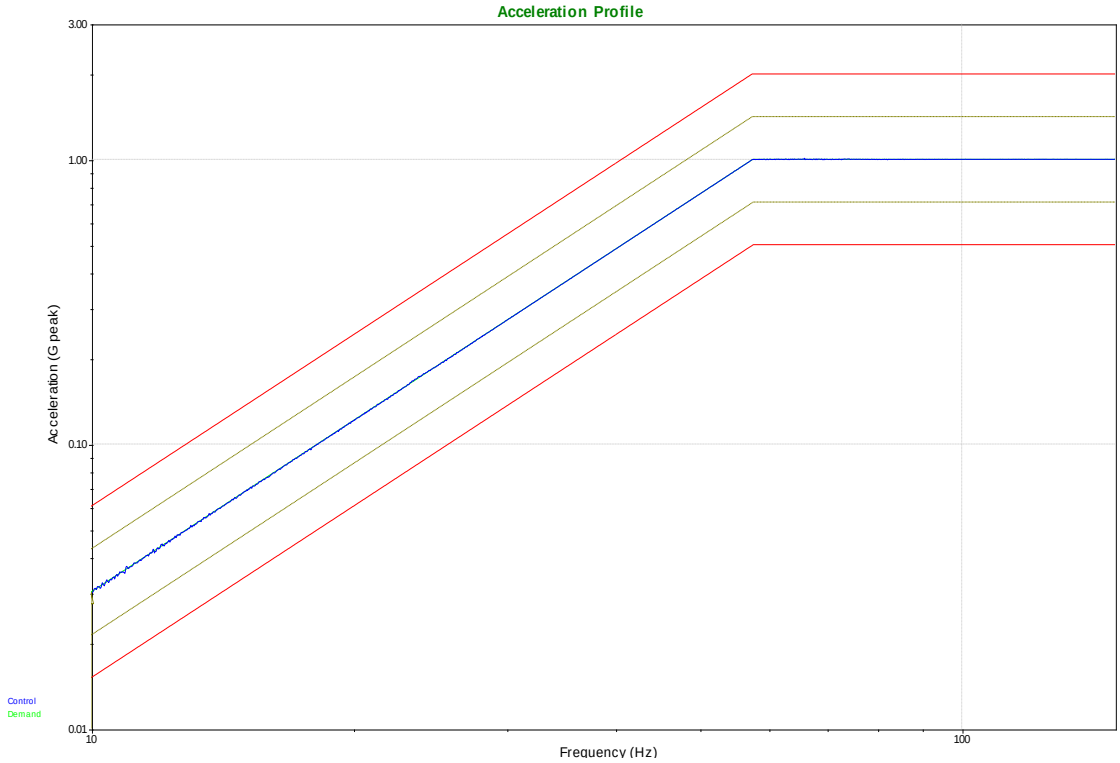
EQUIPMENT AND INSTRUMENTATION

Instrumentation & Equipment	Westpak™ No.	Model No.	Last Calibration Date
Stanley 16' Tape Measurer	1813	33-885	3/16/2015
Mettler Toledo Analog Bench Scale 300# capacity	1654	BBA221-B150	8/18/2014
Unholtz Dickie 2" E.D. Shaker	687	SA15-SA52	Not Required
PCB Accelerometer	1687	J352C33	12/16/2014
Vibration Research Controller	1682	VR9500	9/30/2014
UD Horizontal Shaker System	1704	T509	Not Required
PCB Single Axis Accelerometer	1877	J352C33	7/31/2014
Notes: All calibration conducted annually on instrumentation only.			

APPENDIX II

PRODUCT VIBRATION CONTROL DATA

Roboteq; Controllers; 228-15-1049A, Engineer: J. Reid
Sine Vibration, 10-150 Hz; 1 oct/min, Z-axis, 10 sweeps
End of Sweep Test



Breakpoint table

Start Freq.	Amplitude	End Freq.	Amplitude
10 Hz	0.15 mm	57.5506 Hz	0.15 mm
57.5506 Hz	1 G	150 Hz	1 G

Test level schedule:

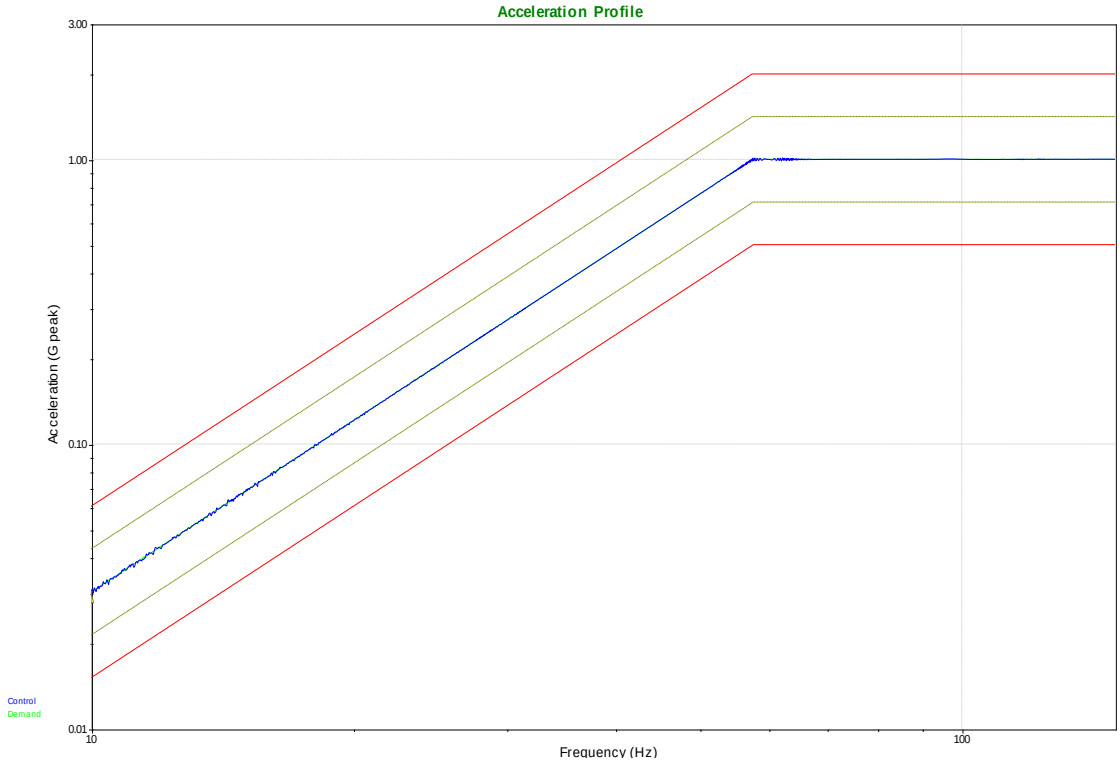
	Duration	Level
1)	20 sweeps	100 %

** Test started May 14, 2015 13:49:52, running for 1:18:21
** Current level: 1, running at 100 %, 20 of 20 sweeps complete

Current Measurements:

Demand: 0.15 mm at 10 Hz
Control: 0.0301 G
Ch1: 0.0301 G
Ch2: 0.001632 G

Roboteq; Controllers; 228-15-1049A, Engineer: J. Reid
Sine Vibration, 10-150 Hz; 1 oct/min, Y-axis, 10 sweeps
End of Sweep Test



Breakpoint table

Start Freq.	Amplitude	End Freq.	Amplitude
10 Hz	0.15 mm	57.5506 Hz	0.15 mm
57.5506 Hz	1 G	150 Hz	1 G

Test level schedule:

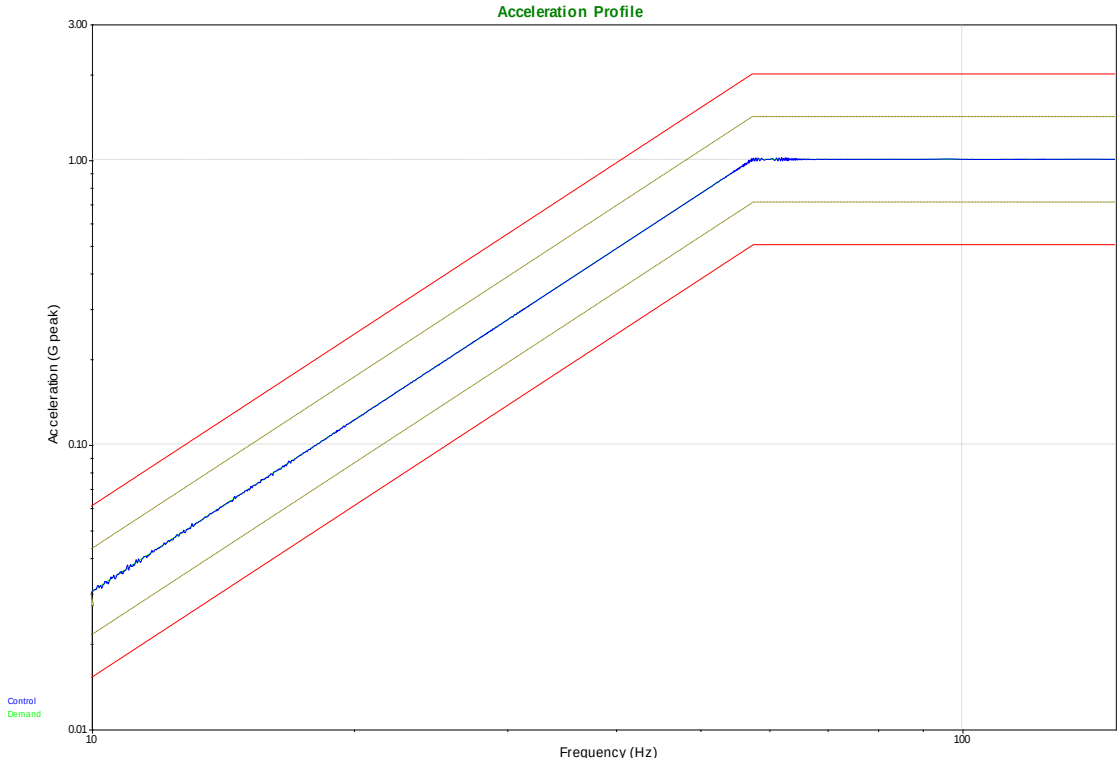
	Duration	Level
1)	20 sweeps	100 %

** Test started May 18, 2015 09:09:23, running for 1:18:20
** Current level: 1, running at 100 %, 20 of 20 sweeps complete

Current Measurements:

Demand: 0.15 mm at 10 Hz
Control: 0.0303 G
Ch1: 0.0004012 G
Ch2: 0.0303 G

Roboteq; Controllers; 228-15-1049A, Engineer: J. Reid
Sine Vibration, 10-150 Hz; 1 oct/min, X-axis, 10 sweeps
End of Sweep Test



Breakpoint table

Start Freq.	Amplitude	End Freq.	Amplitude
10 Hz	0.15 mm	57.5506 Hz	0.15 mm
57.5506 Hz	1 G	150 Hz	1 G

Test level schedule:

	Duration	Level
1)	20 sweeps	100 %

** Test started May 18, 2015 10:36:45, running for 1:18:42
** Current level: 1, running at 100 %, 20 of 20 sweeps complete

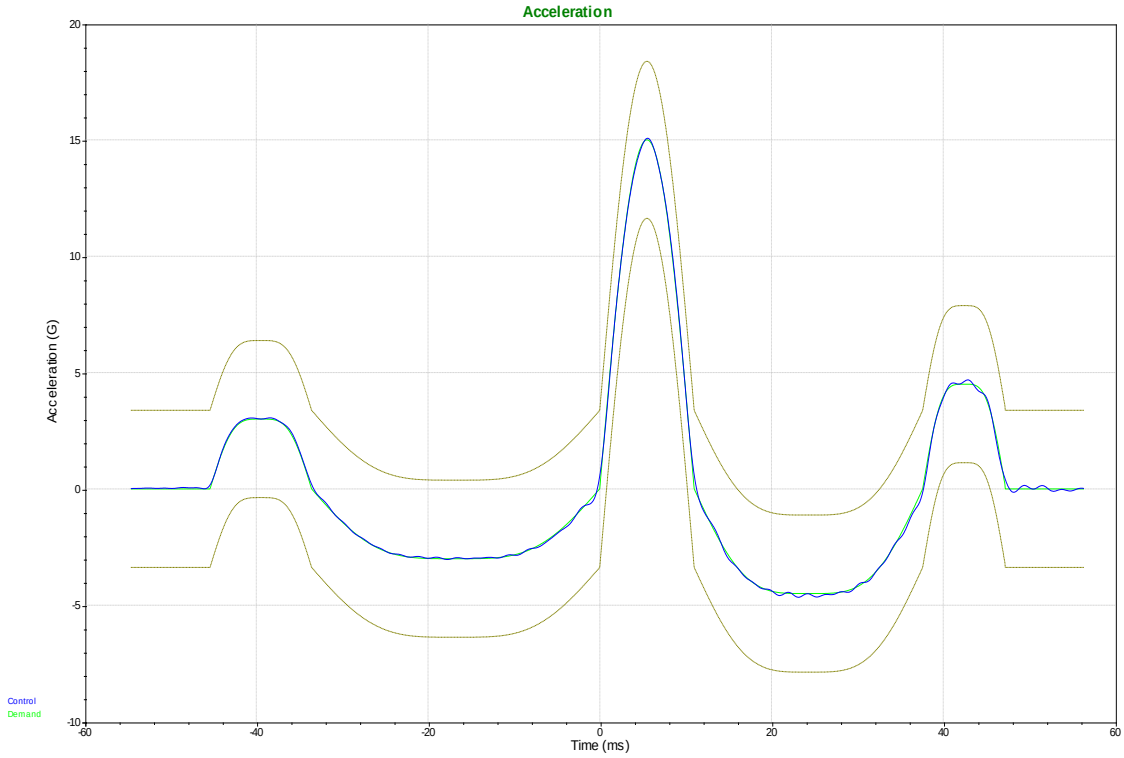
Current Measurements:

Demand: 0.15 mm at 10 Hz
Control: 0.02967 G
Ch1: 0.0003155 G
Ch2: 0.02967 G

APPENDIX III

PRODUCT SHOCK TEST DATA

Roboteq; Controllers; 228-15-1049A, Engineer: J. Reid
Half Sine Shock; 15g, 11 msec, 3 pulses, +Z-axis
End of Test



Test level schedule:

	Pulses	**Level**
1)	3	100 %

** Test started May 14, 2015 15:17:27
** Current level: 1, running at 100 % for 3 of 3 pulses

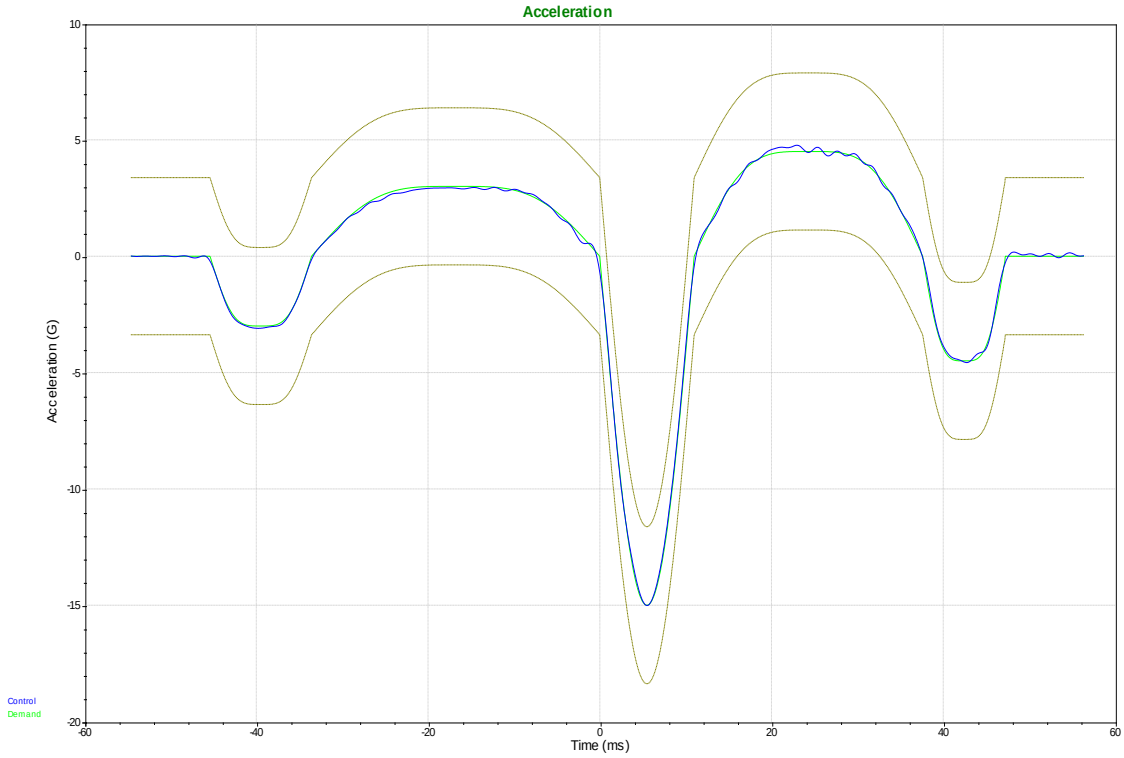
Current Measurements:

Control amplitude: 15.07 G
Output voltage: 3.581 Volts peak

Channel Measurements:

Ch1 15.07 G

Roboteq; Controllers; 228-15-1049A, Engineer: J. Reid
Half Sine Shock; 15g, 11 msec, 3 pulses, -Z-axis
End of Test



Test level schedule:

	Pulses	**Level**
1)	3	* 100 %

** Test started May 14, 2015 15:17:58
** Current level: 1, running at 100 % for 3 of 3 pulses

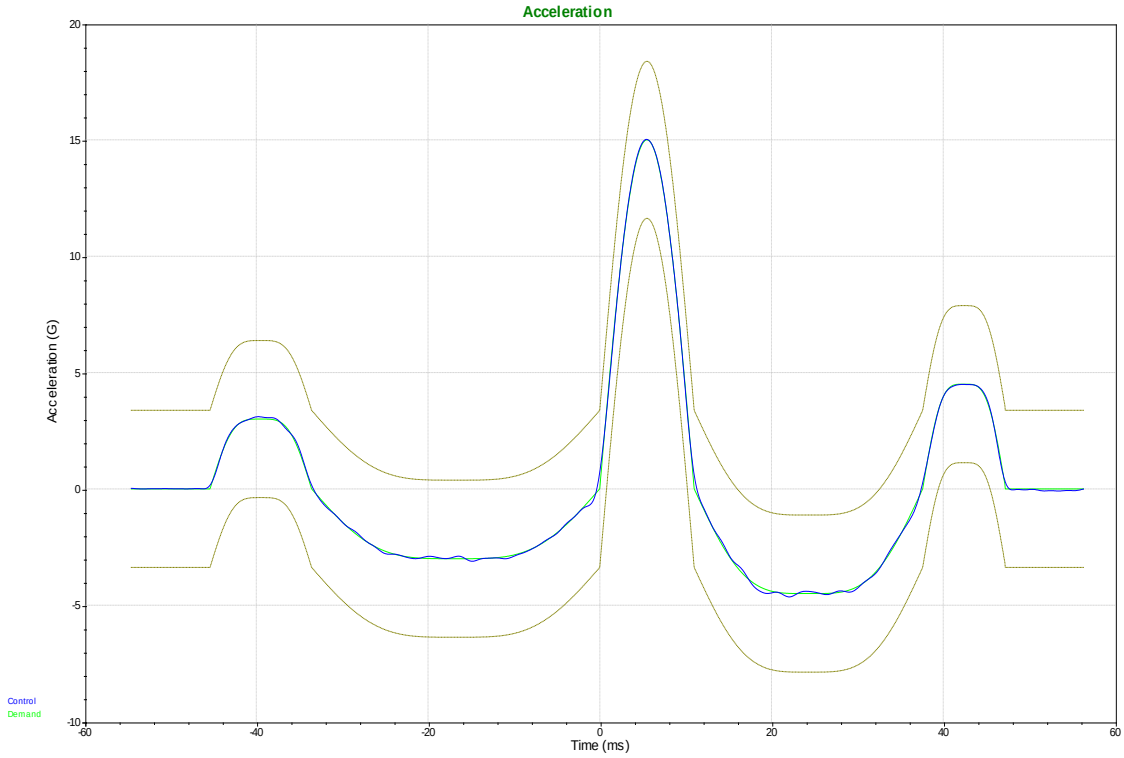
Current Measurements:

Control amplitude: 15.01 G
Output voltage: 3.569 Volts peak

Channel Measurements:

Ch1 -15.04 G

Roboteq; Controllers; 228-15-1049A, Engineer: J. Reid
Half Sine Shock; 15g, 11 msec, 3 pulses, +Y-axis
End of Test



Test level schedule:

	Pulses	**Level**
1)	3	100 %

** Test started May 18, 2015 10:28:22
** Current level: 1, running at 100 % for 3 of 3 pulses

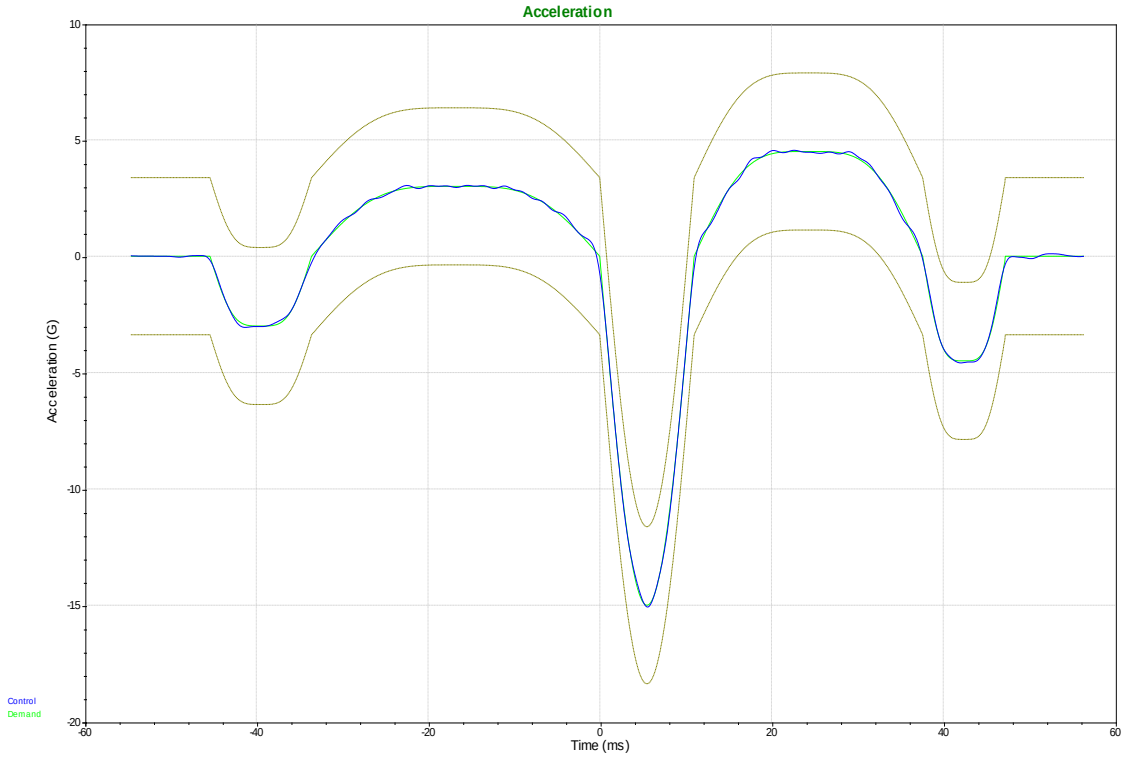
Current Measurements:

Control amplitude: 15.02 G
Output voltage: 2.952 Volts peak

Channel Measurements:

Ch2 14.99 G

Roboteq; Controllers; 228-15-1049A, Engineer: J. Reid
Half Sine Shock; 15g, 11 msec, 3 pulses, -Y-axis
End of Test



Test level schedule:

	Pulses	**Level**
1)	3	* 100 %

** Test started May 18, 2015 10:28:50
** Current level: 1, running at 100 % for 3 of 3 pulses

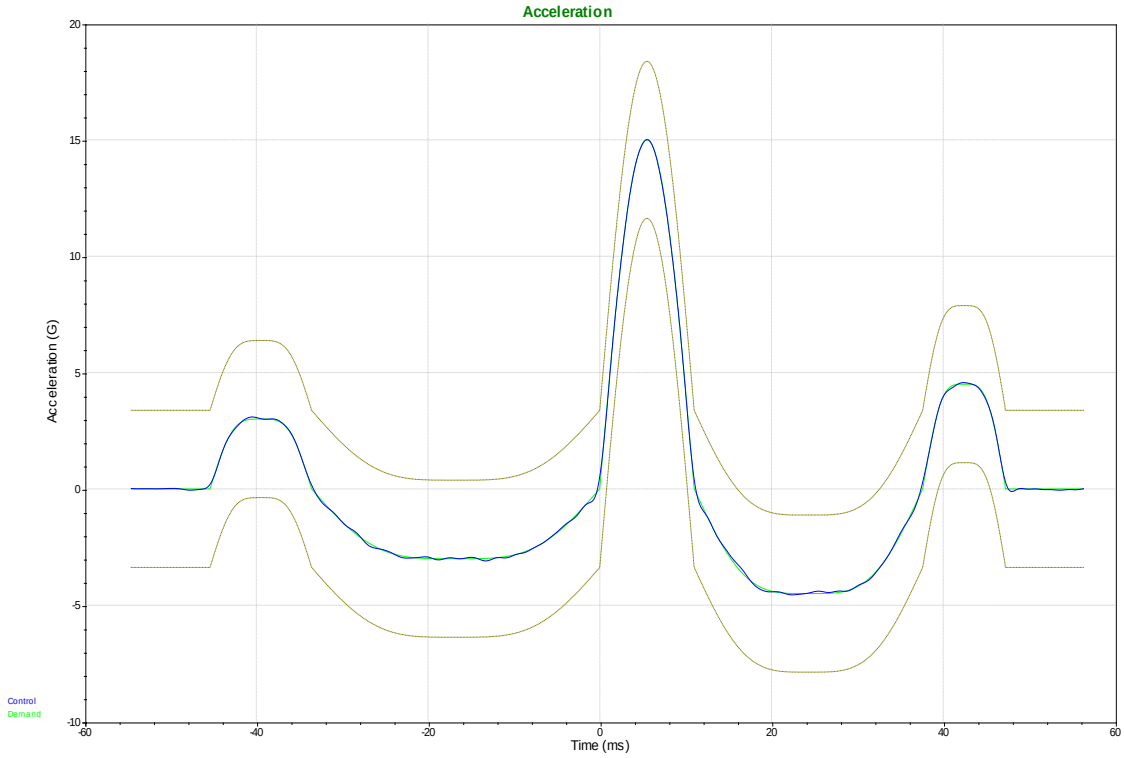
Current Measurements:

Control amplitude: 15.08 G
Output voltage: 2.945 Volts peak

Channel Measurements:

Ch2 -15.1 G

Roboteq; Controllers; 228-15-1049A, Engineer: J. Reid
Half Sine Shock; 15g, 11 msec, 3 pulses, +X-axis
End of Test



Test level schedule:

	Pulses	Level
1)	3	100 %

** Test started May 18, 2015 13:22:01
** Current level: 1, running at 100 % for 3 of 3 pulses

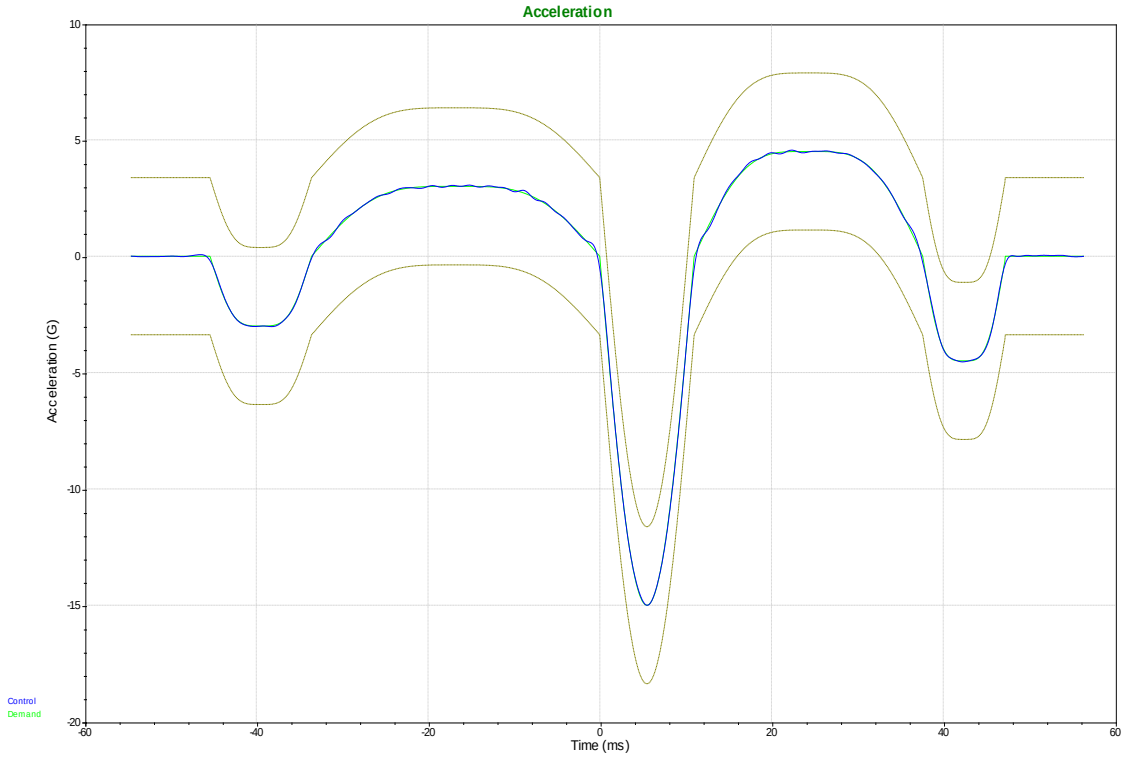
Current Measurements:

Control amplitude: 15.01 G
Output voltage: 4.753 Volts peak

Channel Measurements:

Ch2 14.98 G

Roboteq; Controllers; 228-15-1049A, Engineer: J. Reid
Half Sine Shock; 15g, 11 msec, 3 pulses, -X-axis
End of Test



Test level schedule:

	Pulses	**Level**
1)	3	* 100 %

** Test started May 18, 2015 13:22:30
** Current level: 1, running at 100 % for 3 of 3 pulses

Current Measurements:

Control amplitude: 15 G
Output voltage: 4.756 Volts peak

Channel Measurements:

Ch2 -15.01 G