NEMA

TS 2-2003

Click 656

As contracted by Wavetronix, Precision Test Solutions performed NEMA testing between October and December 2016. The following report documents the results of the test and is unedited by Wavetronix.

Tester contact information:

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PRECISION
TEST SOLUTIONS
Testing is Knowing™

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Customer: **WAVETRONIX**

P. O. No.: **PO0027949** Job No.: **119049-000**

Order Quantity: **1** Mfg. P/N

Customer P/N: **Click 656**

Specification **Wavetronix Test Procedure (6/20/2016) & NEMA TS 2-2003**

Part Type: **Cabinet Interface Device (loop detector)**

Prepared By: **Eric Brentzel** Date Prepared: **10/26/2016**

Reviewed By: Eric B. Brentzel Date Reviewed: ***10/26/2016***

CERTIFICATE OF COMPLIANCE

This is to certify that the referenced item was subjected to a testing program in accordance with your Procurement Document, as defined in the attached test plan. This plan specifies the test sequence, outlines the test conditions and provides a summary for each test.

Precision Test Solutions does not infer or imply that the test methods utilized in the body of this report have been granted suitability by the Defense Supply Center Columbus, (DSCC). A current listing of approved suitability methods is available upon request.

Mfr.: ***Wavetronix*** Date Code: ***N/A*** Accept: ***1*** Reject: ***0***

SEE ATTACHED DOCUMENTATION

Approved By: Eric B. Brentzel Date Approved: ***12/21/2016***

INCOMING INSPECTION	<table><tr><th>Quantity</th><th>Model Number</th><th>Serial #</th><th>Device Type</th></tr><tr><td>1</td><td>Click 656</td><td>N/A</td><td>Cabinet Interface Device</td></tr><tr><td></td><td></td><td></td><td></td></tr></table>	*10/26/2016*	*E.B.*

TEST RESULTS SUMMARY	**Documentation:** Wavetronix Test Procedure (6/20/2016) & NEMA TS 2-2003 **Test Summary:** ***A WAVETRONIX Click 656 Cabinet Interface Device was submitted for evaluation to the NEMA TS-2 Environmental Test Requirement.*** ***Throughout the operational testing phases, the Click 656 was connected to a Wavetronix SmartSensor with proper operation of the Click 656 confirmed via a combination of equipment SDLC RX / TX LED status indicator lights and use of a third-party (Econolite ASC/2S-2100) Traffic Controller to monitor the detector channel state.*** ***Testing was performed in accordance with the NEMA TS2 2003 and "equipment-specific" instructions found within the Wavetronix (6/20/2016 revision) Testing Procedure.*** ***At initial setup and throughout testing, the WAVETRONIX Click 656 was found to operate properly following initialization. Proper operation of the Click 656 was confirmed across the specified range and combinations of AC Voltages, Temperatures and Electrical /Mechanical stresses to which the equipment was exposed.*** ***At the conclusion of testing, it was determined that the WAVETRONIX Click 656 Cabinet Interface Device system was compliant to the applicable NEMA TS-2 Testing Requirements, as performed and chronicled within each evaluation section of this document.***	*12/21/2016*	*E.B.*

TASK	CONDITIONS	Date Completed	Operator Stamp
OPERATIONAL VERIFICATION TEST	**Documentation:** Wavetronix Test Procedure (6/20/2016) & NEMA TS 2-2003, Paragraph 2.2.7.1 **Initial Setup and Verification:** Connect the test unit AC input to an AC Power Source, programmable for both voltage and frequency output. **Procedure:** 1. Apply 120V, 60Hz +- 3Hz AC power to the AC inputs of the unit and verify system operation. 2. Vary input voltage from 89V to 135V, 60Hz +- 3Hz AC power to the AC inputs of the unit and verify system operation. 3. Confirm proper operation of equipment by exercising operating and communication mode functions, as appropriate. **Test Observations and Summary:** ***Following initial setup the WAVETRONIX Click 656 was found to operate properly across the specified range of voltages and frequencies specified within this section. Proper operation of the Click 656 was confirmed across the specified range and combinations of AC Voltages and Frequencies.*** ***Communication with the equipment and functional testing was performed without issue in accordance with the associated Wavetronix testing procedure.*** ***The WAVETRONIX Click 656 Cabinet Interface Device system is determined to be compliant to applicable NEMA TS-2, Operational Verification requirements, as described in this section.***	*10/27/2016*	*E.B.*

TRANSIENT TEST – (DC INPUT)

Documentation:
Wavetronix Test Procedure (6/20/2016), Section 4.2.1 &
NEMA TS 2-2003, Paragraph 2.8.1.3 Steps 1- 3, (**Inputs as applicable**)

Conditions:

AC Input Voltage:	**120V, 60Hz +- 3Hz**
Input Voltage Range:	**N/A - Click 656 DC output terminals.**
Transient Amplitude:	**300 volts +- 5%**
Transient Polarity:	**Positive and Negative**
Pulse Width:	**10 µs**
Source Impedance:	**1,000 Ω**
Repetition:	**5 Pulses /Polarity – 1 per second**

Procedure:
1. Apply nominal input power and configure unit to cycle, as appropriate.
2. Superimpose high-repetition noise transients on the DC terminals of the unit under test ("5" pulses at rate of "1" per second / each polarity).
3. Confirm that test unit continues to operate without malfunction.

12/12/2016 *E.B.*

TRANSIENT TEST – (I/O TERMINALS)

Conditions:

AC Input Voltage:	**120V, 60Hz +- 3Hz**
DC Input Voltage Range:	**N/A - Click 656 provides DC output terminals tested as I/O.**
Transient Amplitude:	**300 volts +- 5%**
Transient Polarity:	**Positive and Negative**
Pulse Width:	**10 µs**
Source Impedance:	**1,000 Ω**
Repetition:	**5 Pulses /Polarity – 1 per second**

Procedure:
1. Apply nominal input power and configure unit to cycle, as appropriate.
2. With equipment configured per WAVETRONIX test procedure, apply transients to selected RS485 terminals of equipment under test, ("5" pulses at rate of "1" per second in each polarity).
3. Confirm that test unit continues to operate without malfunction.

Test Observations:

The WAVETRONIX Click 656 Cabinet Interface Device system powered normally following application of the High- Repetition /Low-Repetition Transient test conditions.

Communication with the equipment and functional testing, as defined in the Wavetronix procedure, was accomplished without issue.

The WAVETRONIX Click 656 Cabinet Interface Device system is determined to be compliant to applicable NEMA TS-2, Transient Testing requirements, as performed in this section.

12/12/2016 *E.B.*

TRANSIENT TEST – (HIGH REPETITION NOISE TRANSIENTS)

Documentation:
Wavetronix Test Procedure (6/20/2016), Section 4.2 &
NEMA TS 2-2003, Paragraph 2.1.6.1 and 2.1.6.2

Conditions:

Line Input Voltage:	**120V, 60Hz +- 3Hz to AC inputs**
Transient Amplitude:	**300 volts +- 5%**
Transient Polarity:	**Positive and Negative**
Pulse Width:	**10 µs**
Peak Power:	**2,500 watts**
Duration:	**5 Minutes min. (each polarity)**

Procedure:

1. Apply nominal input power and configure unit to cycle, as appropriate.
2. Superimpose high-repetition noise transients on the AC input of the unit under test (1 pulse every other cycle, moving uniformly over the full wave to sweep across 360 degrees of the line cycle once every 3 seconds.).
3. Confirm that test unit continues to operate without malfunction during the entire test.

12/12/2016 *E.B.*

TRANSIENT TEST – (LOW REPETITION HIGH-ENERGY TRANSIENTS)

Conditions:

Line Input Voltage:	**120V, 60Hz +- 3Hz to AC inputs**
Transient Amplitude:	**600 volts +- 5%**
Transient Polarity:	**Positive and Negative**
Repetitions:	**10 (each polarity)**
Energy Source:	**Capacitor, oil-filled (10 microfarads)**

Procedure:

1. Apply nominal input power and configure unit to cycle, as appropriate.
2. Charge capacitor to specified voltage and discharge into the AC input of the unit under test (1 discharge every 10 seconds for a total of 10 discharges per polarity.).
3. Confirm that test unit continues to operate without malfunction.

12/12/2016 *E.B.*

Test Observations:

The WAVETRONIX Click 656 Cabinet Interface Device system powered normally following application of the High- Repetition /Low-Repetition Transient test conditions.

Communication with the equipment and functional testing, as defined in the Wavetronix procedure, was accomplished without issue.

The WAVETRONIX Click 656 Cabinet Interface Device system is determined to be compliant to applicable NEMA TS-2, Transient Testing requirements, as performed in this section.

TRANSIENT TEST – (NON-DESTRUCT TRANSIENT IMMUNITY)

Documentation:
Wavetronix Test Procedure (6/20/2016), Section 4.2 &
NEMA TS 2-2003, Paragraph 2.1.8

Conditions:

Line Input Voltage:	**NO POWER APPLIED**
Transient Amplitude:	**1000 volts +- 5%**
Transient Polarity:	**Positive and Negative**
Repetitions:	**3 (each polarity)**
Energy Source:	**Capacitor, oil-filled (15 microfarads)**

Procedure:

1. Apply **NO POWER** to unit.
2. Charge capacitor to specified voltage and discharge into the AC input of the unit under test, (1 discharge every 2 seconds for a total of 3 discharges per polarity.).
3. Upon completion of transient test, apply nominal "nominal" input power to unit and verify that device powers up and cycles through all functions normally.

Test Observations:

The WAVETRONIX Click 656 Cabinet Interface Device system powered normally following application of the Non-Destruct Transient test conditions.

The equipment powered normally following exposure to the specified transient test conditions with communication and functional testing, as defined in the Wavetronix procedure, accomplished without issue.

The WAVETRONIX Click 656 Cabinet Interface Device is determined to be compliant to applicable NEMA TS-2, Transient Testing requirements, as performed in this section.

12/13/2016

E.B.

LOW-TEMPERATURE – LOW-VOLTAGE TEST

Documentation:
Wavetronix Test Procedure (6/20/2016), Section 4.3 &
NEMA TS 2-2003 2.2.7.3 - 2.2.7.4, Table 2-1 & Figure 2-1

Conditions:

Applied Input Voltage:	**89V 60Hz +- 3Hz to AC inputs**
Temperature:	**-34°C**
Humidity:	**Uncontrolled**
Unit Status:	**Powered & operating in chamber**

Procedure:

1. Beginning at ambient conditions, set input voltage to specified level and confirm correct operation.
2. With unit operating, ramp chamber temperature to -34°C at a rate not exceeding 17°C per hour.
3. Allow unit to operate for a minimum of 5 hours before exercising functions to determine that unit continues proper operation.
4. Remove power from unit for a minimum of 5 hours.
5. Restore power to unit and perform Functional /Operational tests as applicable.

11/2/2016 *E.B.*

LOW-TEMPERATURE – HIGH-VOLTAGE TEST

Conditions:

Applied Input Voltage:	**135V 60Hz +- 3Hz to AC inputs**
Temperature:	**-34°C**
Humidity:	**18% (not to exceed 95% as temperature "ramps" to +74°C)**
Unit Status:	**Powered & operating in chamber**

Procedure:

1. With unit stabilized at -34°C, set input voltage to specified level and confirm correct operation.
2. Allow unit to operate for a minimum of 1 hour then exercise functions to determine that unit continues proper operation.
3. Perform Functional /Operational tests as applicable.
4. Confirm that test unit functions normally in all modes.

11/2/2016 *E.B.*

Test Observations:

The WAVETRONIX Click 656 Cabinet Interface Device system performed properly while operating with the specified "static" low-temperature and low/high voltage conditions applied.

The WAVETRONIX Click 656 Cabinet Interface Device is determined to be compliant to applicable NEMA TS-2, Low-Temperature testing requirements, as performed in this section.

HIGH-TEMPERATURE – HIGH-VOLTAGE TEST

Documentation:
Wavetronix Test Procedure (6/20/2016), Section 4.3 &
NEMA TS 2-2003 2.2.7.5 – 2.2.7.6, Table 2-1 & Figure 2-1

Conditions:

Applied Input Voltage:	**135V 60Hz +- 3Hz to AC inputs**
Temperature:	**+74°C**
Humidity:	**18%**
Unit Status:	**Powered & operating in chamber**

11/3/2016 *E.B.*

Procedure:

1. With unit operating, ramp chamber temperature to +74°C at a rate not exceeding 17°C per hour with humidity at 18%.
2. Maintain temperature and humidity conditions and allow unit to operate for a minimum of 15 hours before exercising functions to determine that unit continues proper operation.
3. Confirm that test unit functions normally in all modes.

HIGH-TEMPERATURE – LOW-VOLTAGE TEST

Conditions:

Applied Input Voltage:	**89V 60Hz +- 3Hz to AC inputs**
Temperature:	**+74°C**
Humidity:	**18%**
Unit Status:	**Powered & operating in chamber**

11/3/2016 *E.B.*

Procedure:

1. With unit stabilized at +74°C, set input voltage to specified level and confirm correct operation.
2. Perform Functional /Operational tests as applicable to confirm proper operation.
3. Ramp chamber temperature to room ambient at a rate not exceeding 17°C per hour.
4. Allow unit to stabilize at ambient condition for one hour prior to removal from chamber.
5. Confirm that test unit functions normally in all modes during the evaluation.

Test Observations:

The WAVETRONIX Click 656 Cabinet Interface Device system performed properly while operating with the specified "static" high-temperature and high/low voltage conditions applied.

The WAVETRONIX Click 656 Cabinet Interface Device is determined to be compliant to applicable NEMA TS-2, High-Temperature testing requirements, as performed in this section.

VIBRATION – (RESONANT SEARCH)

Documentation:
Wavetronix Test Procedure (6/20/2016), Section 4.1 &
NEMA TS 2-2003 2.2.8.1 – 2.2.8.5

Conditions:

Frequency Range:	**5 - 30Hz**
Displacement Level:	**0.015 inch DA**
Number of Sweeps:	**1**
Sweep Duration:	**12.5 minutes**
Number of axis:	**3 (X, Y & Z)**

Procedure:

1. Verify accelerometer operation
2. Attach unit to the vibration table.
3. Note resonant frequencies in a given plane and record the most severe
4. If resonances found are equally severe, record each frequency.
5. If no resonant frequency is found for a given plane, record 30Hz.

11/17/2016 *E.B.*

VIBRATION – (ENDURANCE TEST)

Conditions:

Frequency Range:	**5 - 30Hz (Per results of Resonant Search)**
Acceleration Level:	**0.5g**
Dwell Duration:	**1 hour per each axis**
Number of axis:	**3 (X, Y & Z)**

Procedure:

1. Verify accelerometer operation
2. Attach unit to the vibration table.
3. Vibrate test unit in each plane for specified period of time.
4. If more than one resonant frequency was recorded, the test period shall be divided equally between resonant frequencies.
5. If no resonant frequencies were noted the test shall be performed at 30Hz.

Details:

- Examine for physical damage attributable to vibration testing.
- Verify that the unit powers up and is able to function normally in all modes.

Test Observations:

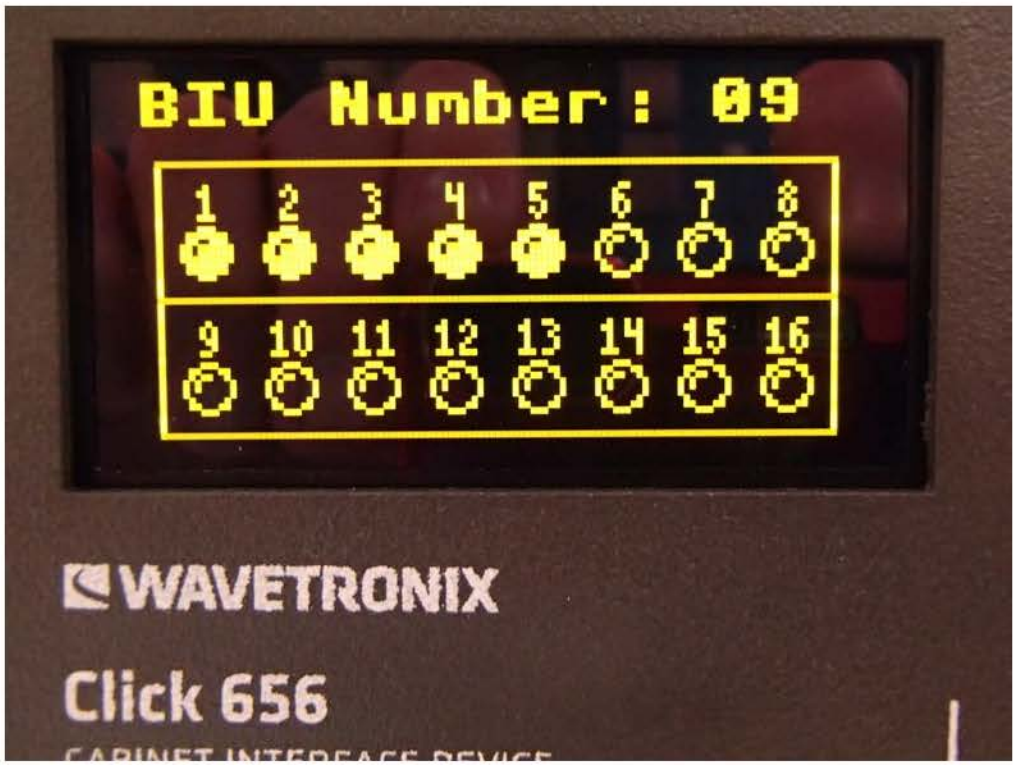
No Resonant Frequencies of the Wavetronix Click 656 Cabinet Interface Device were noted in the frequency range of applied vibration. The Endurance test was consequently performed at the single frequency of 30Hz. The test unit operated normally following exposure to the applied vibration test conditions.

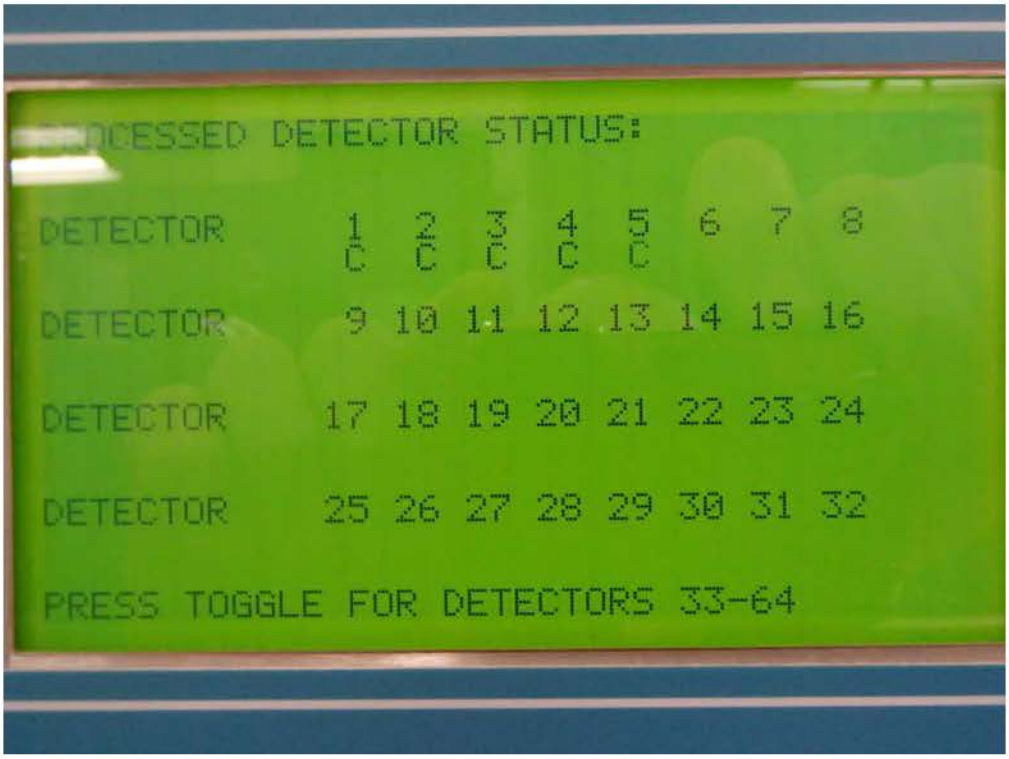
The WAVETRONIX Click 656 Cabinet Interface Device is determined to be compliant to applicable NEMA TS-2, Vibration testing requirements, as performed in this section.

11/17/2016 *E.B.*

TASK	CONDITIONS	Date Completed	Operator Stamp
SHOCK	**Documentation:** Wavetronix Test Procedure (6/20/2016), Section 4.4 & NEMA TS 2-2003 2.2.9.1 – 2.2.9.4 **Conditions:** Shock Amplitude: **10 g's** Shock Duration: **10 msec** Waveform: **Half-sine** Number of axis: **3 (X, Y & Z)** Number shocks per Orientation: **2 (one in each direction)** Total Shocks: **6** **Procedure:** 1. Verify accelerometer operation 2. Attach unit to the shock table. 3. Shock test unit in each plane in accordance with test requirement. **Details:** • Examine for physical damage attributable to shock testing. • Verify that the unit powers up and is able to function normally in all modes. **Test Observations:** ***Post-shock test evaluation revealed no physical or cosmetic damage to the test units. Subsequent electrical testing showed proper operation of the Wavetronix Click 656 Cabinet Interface Device.*** ***The Wavetronix Click 656 Cabinet Interface Device is determined to be compliant to applicable NEMA TS-2, Vibration and Shock testing requirements, as performed in this and the preceding section.***	*11/17/2016*	*E.B.*

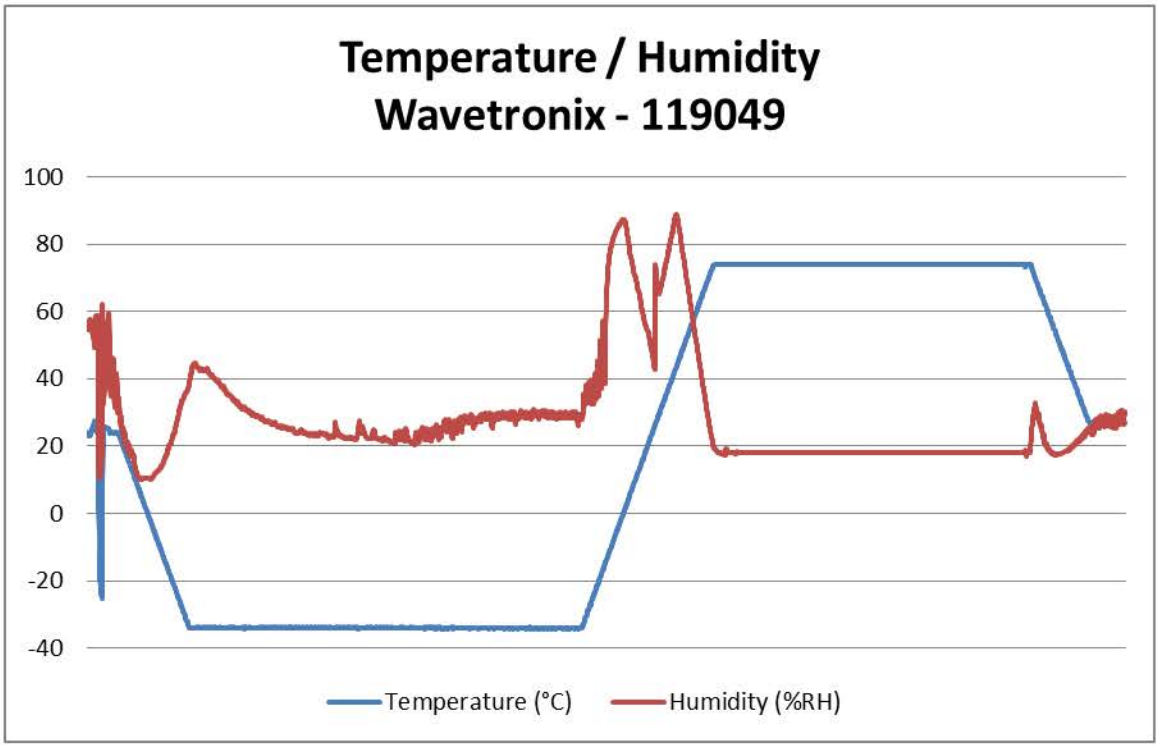
WAVETRONIX Click 656 Cabinet Interface Device





Note synchronization of channel #1 of Wavetronix Click 656 with Traffic Controller to confirm proper operation and continued communication.

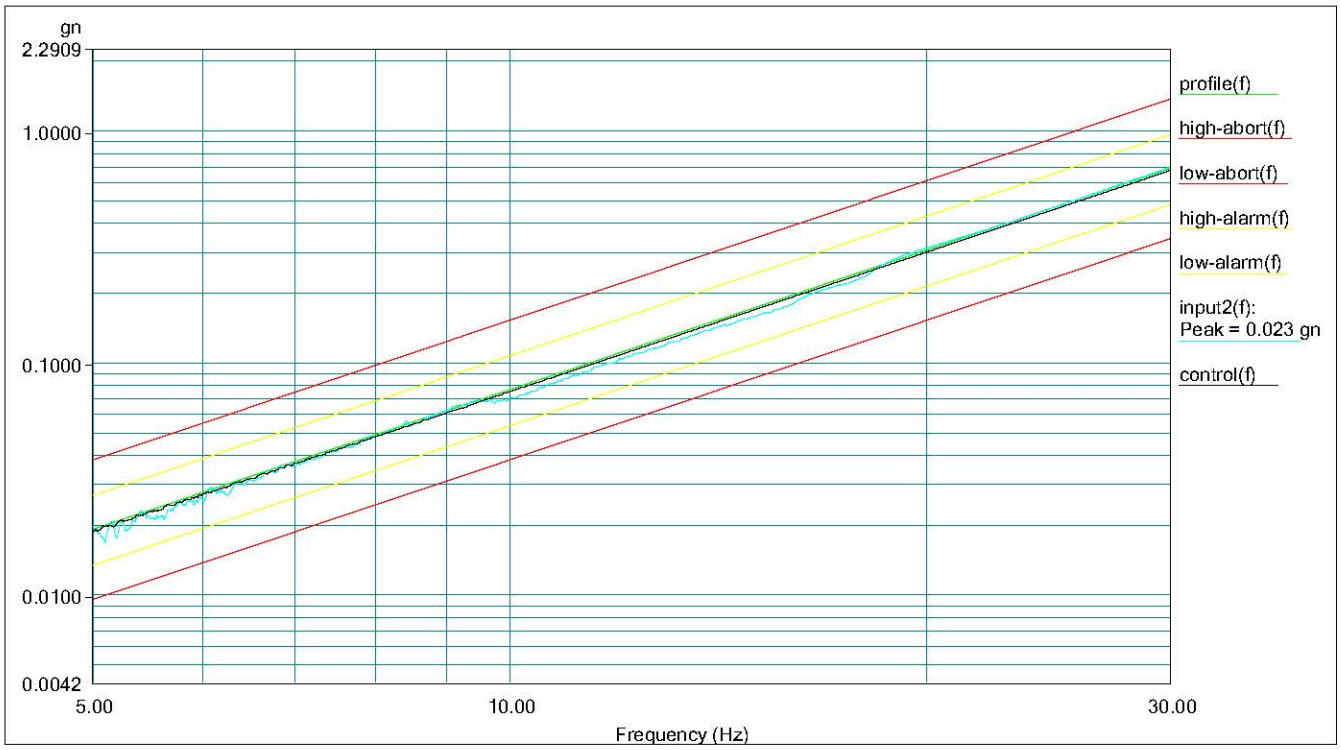
WAVETRONIX Click 656 - Configured for Temperature /Humidity Testing.
(NOTE: LCD Display remains legible operating at Cold or Hot extremes.)



NOTE: The data presented in this chart is representative of the actual conditions present during test however; you must refer to the applicable section of this report for the details pertaining to the applied conditions of Temperature, Humidity, and Test Duration.

WAVETRONIX Click 656 – Configured for Vibration and Shock Testing in X, Y & Z axis orientations.

DUT: **RESONANCE SEARCH - X-AXIS**
Serial Number:
Project File Name: NEMA RES SEARCH.prj
Profile Name: NEMA Resonant Search Test Type: Swept Sine Run Folder: .\RunDefault Nov 16, 2016 13-58-05



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Frequency:	5.001486 Hz	Time Remaining:	00:00:00	Sweep Rate:	0.414 Oct/Min

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DUT: **ENDURANCE DWELL - X-AXIS**
Serial Number:
Project File Name: NEMA ENDURANCE.prj
Profile Name: NEMA Resonant Search Test Type: Swept Sine Run Folder: .\RunDefault Nov 16, 2016 14-15-26

Level:	100 %	Full Level Time:	01:00:00	Sweep Type:	Logarithmic
Frequency:	30.000000 Hz	Time Remaining:	00:00:00	Sweep Rate:	1 Oct/Min

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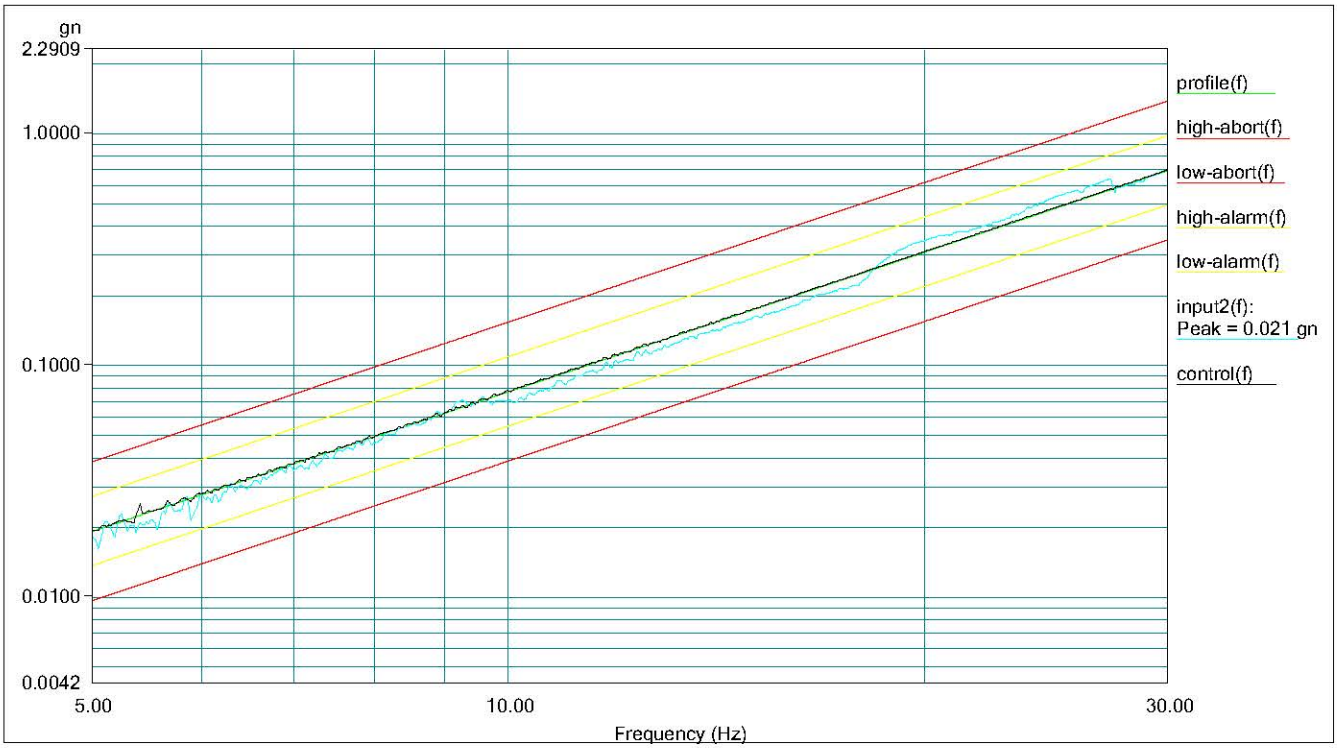
DUT: **RESONANCE SEARCH - Y-AXIS**
Serial Number:
Project File Name: NEMA RES SEARCH.prj
Profile Name: NEMA Resonant Search Test Type: Swept Sine Run Folder: .\RunDefault Nov 17, 2016 08-25-27



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Data saved at 08:38:33 AM, Thursday, November 17, 2016 Report created at 08:38:35 AM, Thursday, November 17, 2016

TASK	CONDITIONS	Date Completed	Operator Stamp

DUT: **ENDURANCE DWELL - Y-AXIS**
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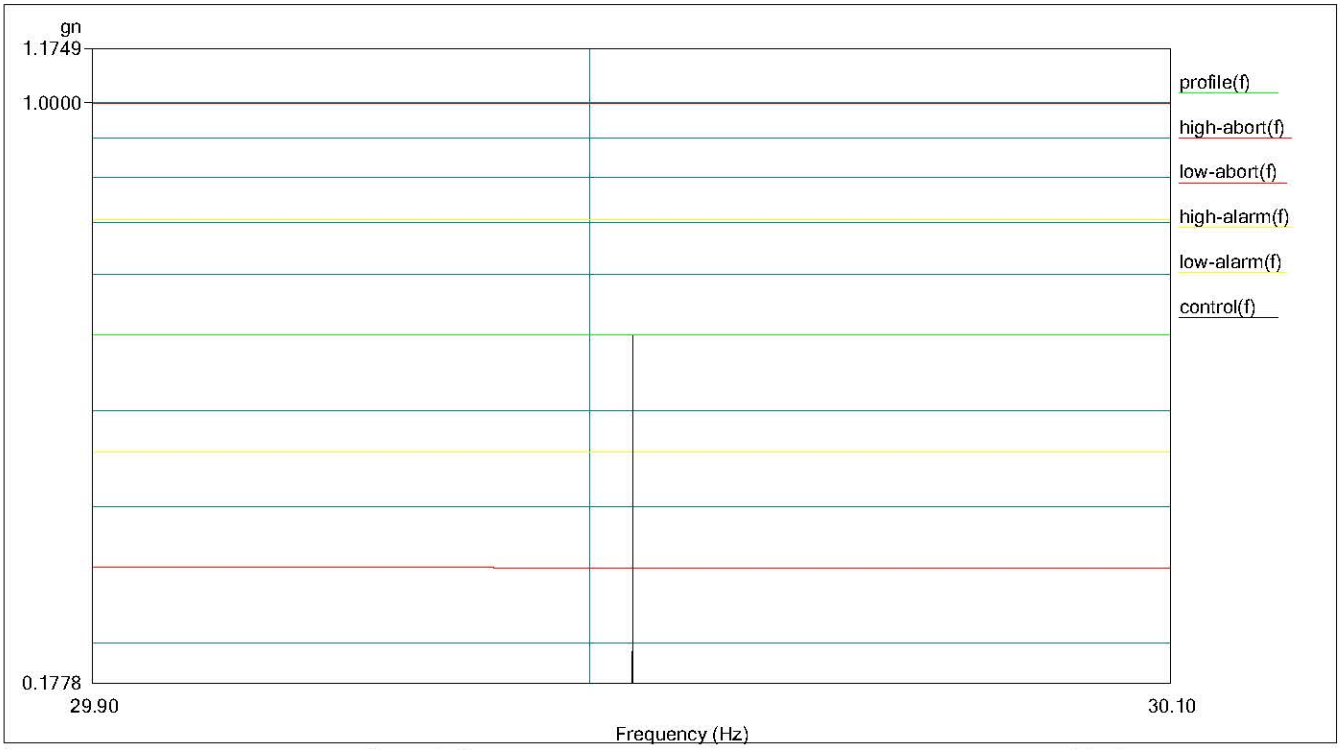

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Frequency:	30.000000 Hz	Time Remaining:	00:00:00	Sweep Rate:	1 Oct/Min

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TASK	CONDITIONS	Date Completed	Operator Stamp

DUT: **RESONANCE SEARCH - Z-AXIS**
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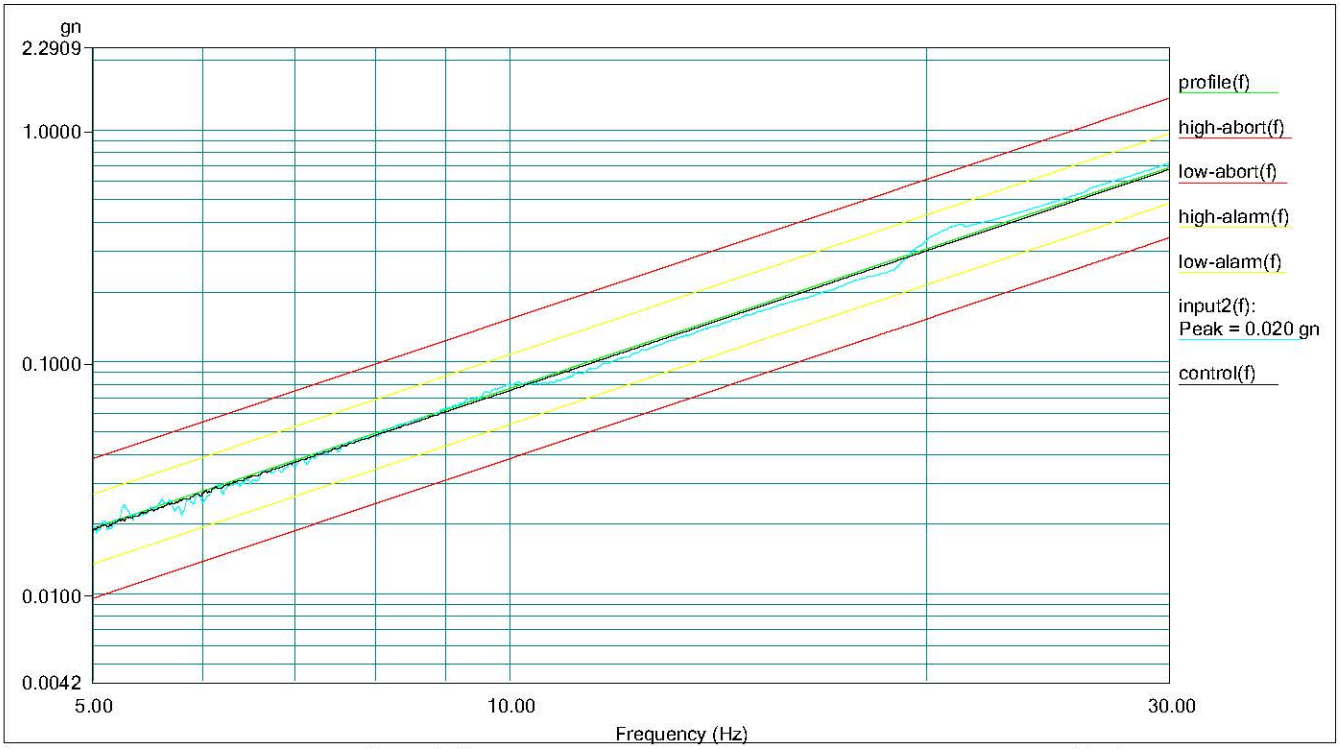
Profile Name: NEMA Resonant Search Test Type: Swept Sine Run Folder: .\RunDefault Nov 16, 2016 10-48-50



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Frequency:	5.000719 Hz	Time Remaining:	00:00:00	Sweep Rate:	0.414 Oct/Min

Data saved at 11:08:45 AM, Wednesday, November 16, 2016 Report created at 11:08:49 AM, Wednesday, November 16, 2016

DUT: **ENDURANCE DWELL - Z-AXIS**
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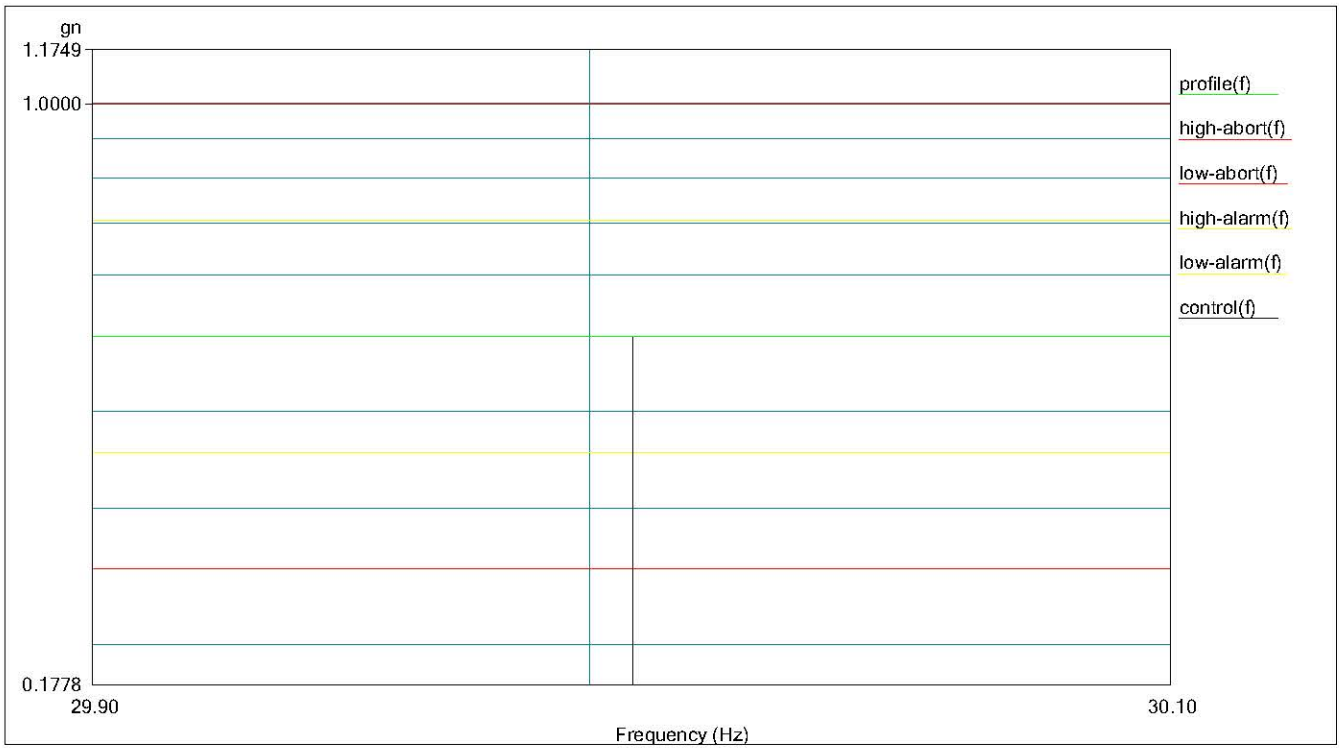

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TASK	CONDITIONS	Date Completed	Operator Stamp

DUT: **FORWARD SHOCK - X-AXIS**
Serial Number:
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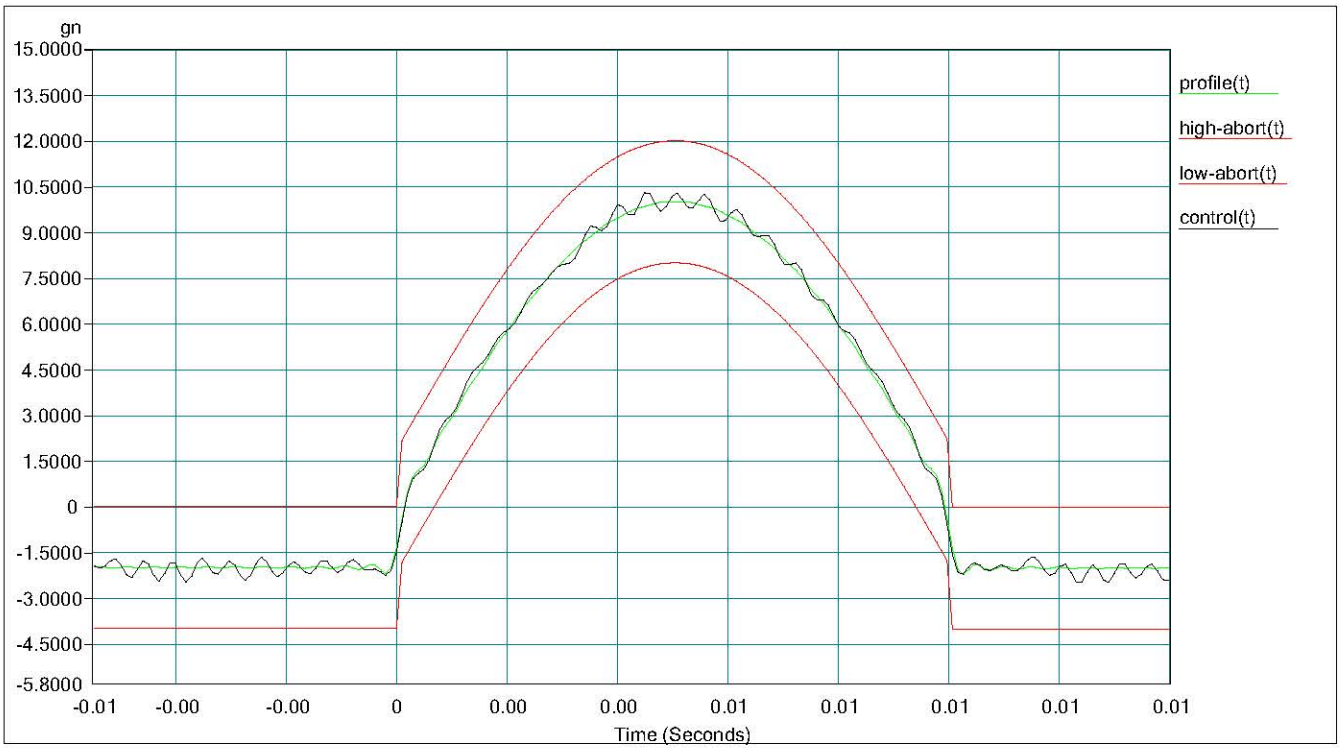
Profile Name: 10gn 10mSec Test Type: Classical Shock Run Folder: .\RunDefault Nov 17, 2016 10-19-15



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dT: 0.000098 Seconds Demand Peak: 9.999999 Demand RMS: 1.968296 Remaining Pulses: 0
Pulse Type: Half Sine Amplitude: 10.000000 Pulse Width: 10.000000 ms
Data saved at 10:20:12 AM, Thursday, November 17, 2016 Report created at 10:20:12 AM, Thursday, November 17, 2016

TASK	CONDITIONS	Date Completed	Operator Stamp

DUT: **REVERSE SHOCK - X-AXIS**
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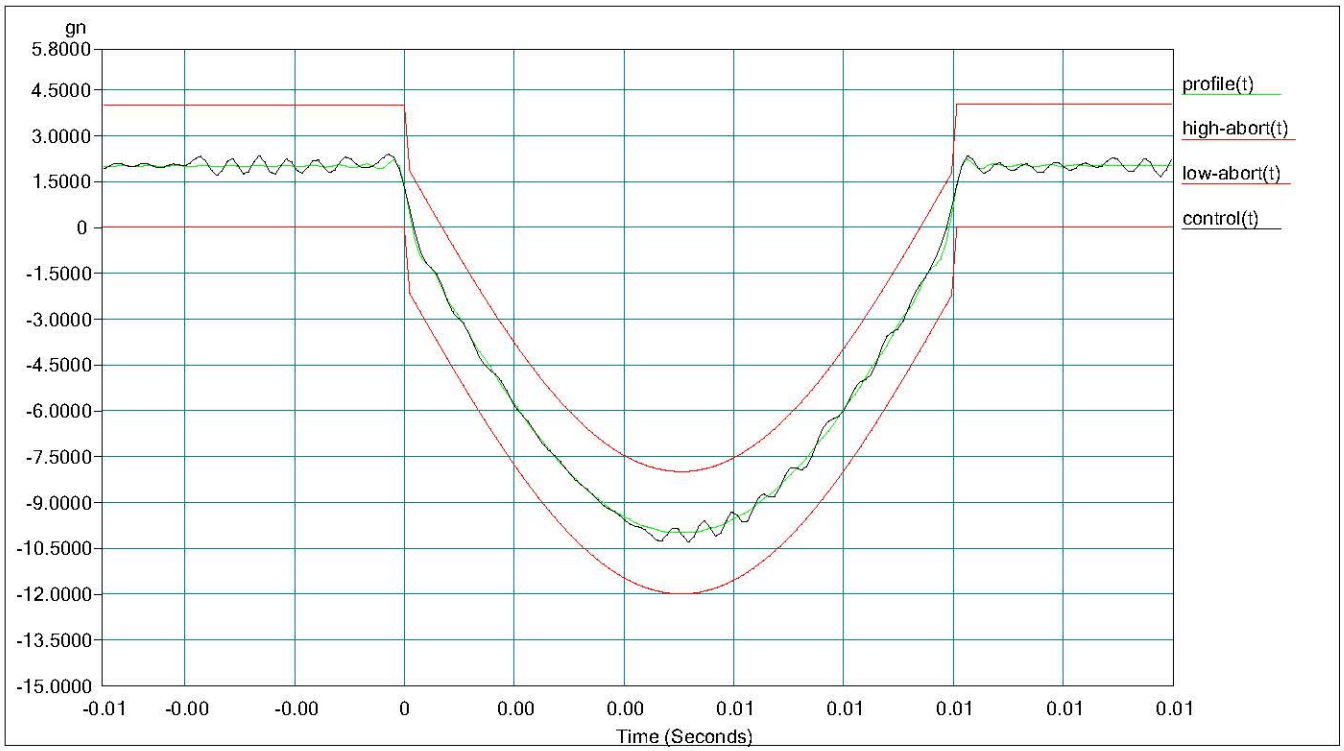

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dT: 0.000098 Seconds Demand Peak: 9.999999 Demand RMS: 1.968296 Remaining Pulses: 0
Pulse Type: Half Sine Amplitude: 10.000000 Pulse Width: 10.000000 ms
Data saved at 10:21:12 AM, Thursday, November 17, 2016 Report created at 10:21:13 AM, Thursday, November 17, 2016

DUT: **FORWARD SHOCK - Y-AXIS**
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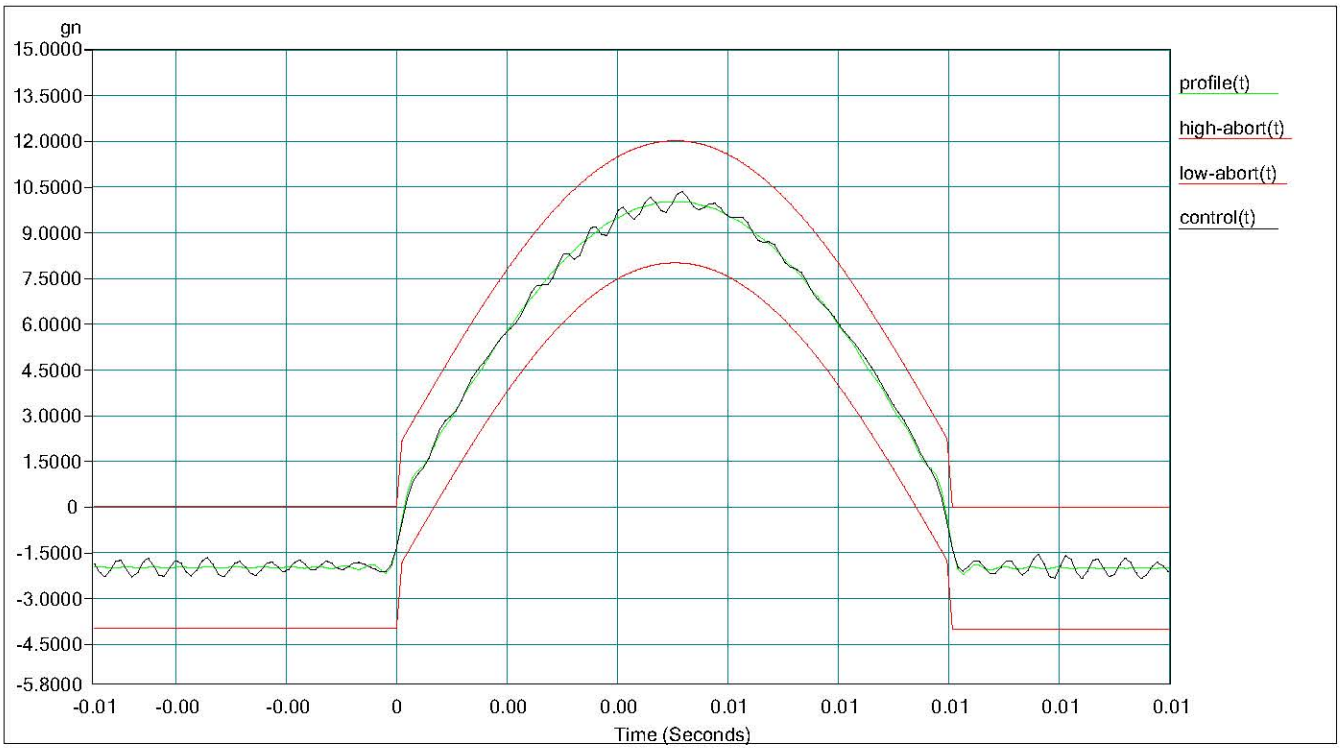
Profile Name: 10gn 10mSec Test Type: Classical Shock Run Folder: .\RunDefault Nov 17, 2016 09-44-17



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dT:	0.000098 Seconds	Demand Peak:	9.999999	Demand RMS:	1.968296	Remaining Pulses:	0
Pulse Type:	Half Sine	Amplitude:	10.000000	Pulse Width:	10.000000 ms		

Data saved at 09:44:37 AM, Thursday, November 17, 2016 Report created at 09:44:38 AM, Thursday, November 17, 2016

DUT: **REVERSE SHOCK - Y-AXIS**
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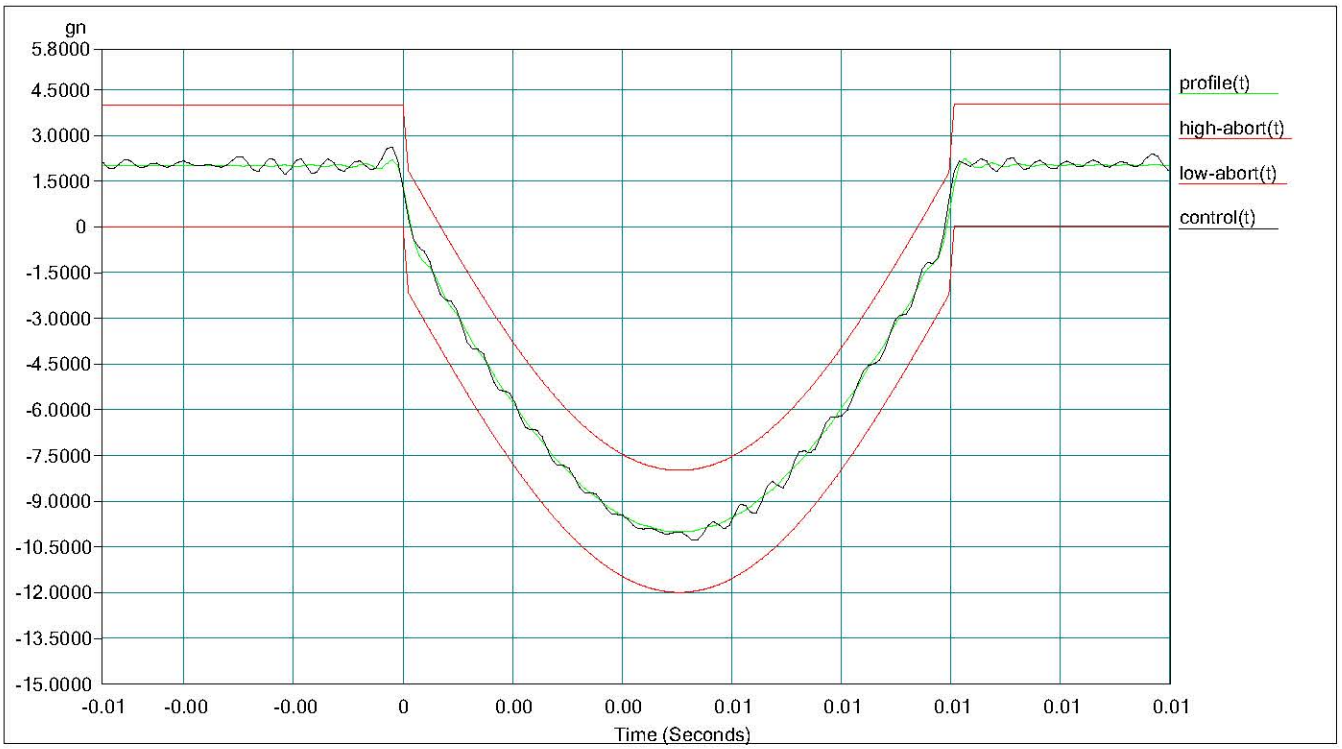
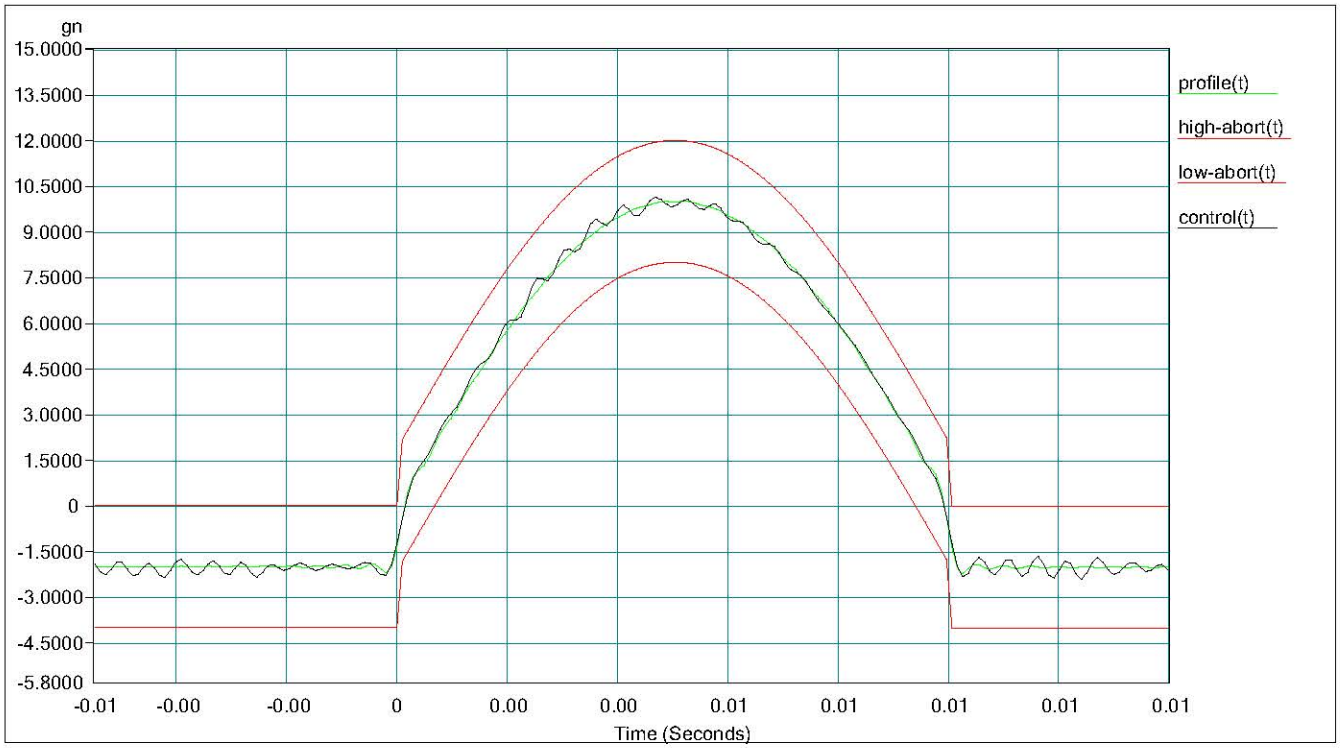


Level:	100 %	Block Size:	2048	Elapsed Pulses:	11		
Frame Time:	0.200000 Seconds	Control Peak:	10.287344	Control RMS:	1.983117	Full Level Elapsed Pulses:	1
dT:	0.000098 Seconds	Demand Peak:	9.999999	Demand RMS:	1.968296	Remaining Pulses:	0
Pulse Type:	Half Sine	Amplitude:	10.000000	Pulse Width:	10.000000 ms		

Data saved at 09:45:54 AM, Thursday, November 17, 2016 Report created at 09:45:55 AM, Thursday, November 17, 2016

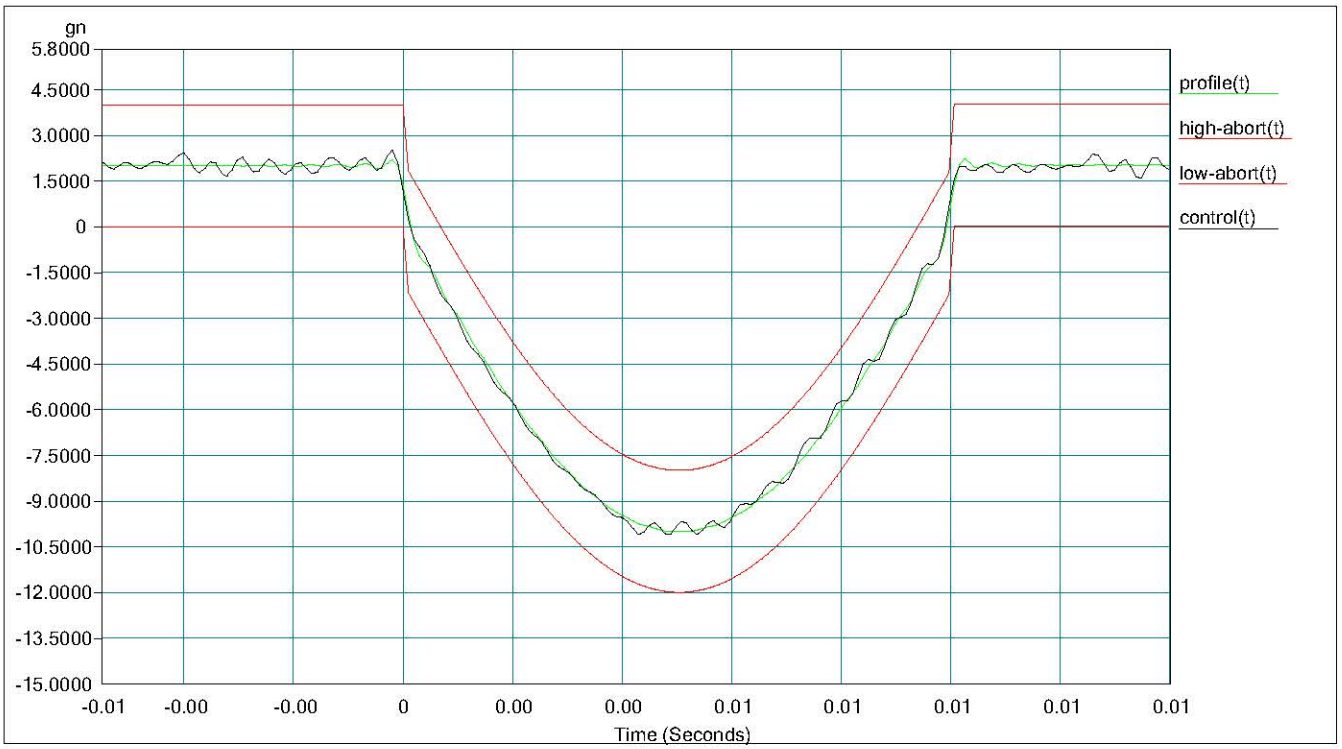
TASK	CONDITIONS	Date Completed	Operator Stamp

DUT: **FORWARD SHOCK - Z-AXIS**
Serial Number:
Project File Name: NEMA SHOCK 10G.prj
Profile Name: 10gn 10mSec Test Type: Classical Shock Run Folder: .\RunDefault Nov 17, 2016 11-45-14



Level: 100 % Block Size: 2048 Elapsed Pulses: 11
Frame Time: 0.200000 Seconds Control Peak: 10.128578 Control RMS: 1.981020 Full Level Elapsed Pulses: 1
dT: 0.000098 Seconds Demand Peak: 9.999999 Demand RMS: 1.968296 Remaining Pulses: 0
Pulse Type: Half Sine Amplitude: 10.000000 Pulse Width: 10.000000 ms
Data saved at 11:45:32 AM, Thursday, November 17, 2016 Report created at 11:45:35 AM, Thursday, November 17, 2016

DUT: **REVERSE SHOCK - Z-AXIS**
Serial Number:
Project File Name: NEMA SHOCK 10G.prj
Profile Name: 10gn 10mSec Test Type: Classical Shock Run Folder: .\RunDefault Nov 17, 2016 11-46-44



Level:	100 %	Block Size:	2048	Elapsed Pulses:	11		
Frame Time:	0.200000 Seconds	Control Peak:	10.097977	Control RMS:	1.970820	Full Level Elapsed Pulses:	1
dT:	0.000098 Seconds	Demand Peak:	9.999999	Demand RMS:	1.968296	Remaining Pulses:	0
Pulse Type:	Half Sine	Amplitude:	10.000000	Pulse Width:	10.000000 ms		

Data saved at 11:47:02 AM, Thursday, November 17, 2016 Report created at 11:47:03 AM, Thursday, November 17, 2016

TASK	CONDITIONS	Date Completed	Operator Stamp
USAGE LOG	All Equipment Station Logs Completed. **Manufacturer** / **Model # / Function** / **Asset #** / **Cal. Due** THERMOTRON #32 / Temp.-Humidity / Chamber / 0456 / 10/31/2017 LDS / DACTRON / Vibration System /Controller / 0334 / 9/30/2017 LDS / Shaker System / - / - KISTLER / Accelerometer / 0999 / 8/31/17 DYTRAN / Accelerometer / 0729 / 2/28/17 Pacific Power / 110-HE / AC Pwr. Sup. / 0332 / 10/31/17 Tektronix / TDS3052 /Oscope / 0735 / 4/30/17 Fluke / 87 Series III /DMM / 0720 / 4/30/17	*12/21/2016*	*E.B.*
PACK	Use original container or equivalent One copy of Test Report.		
SHIP TO:	WAVETRONIX, LLC 78 EAST 1700 SOUTH BUILDING B PROVO, UT 84606		
SHIP VIA:	FEDEX GROUND – Wavetronix Account # on file (235820625).		