Test Report

Curtis-Straus LLC, *a wholly owned subsidiary of BV CPS*

Report No	EO3841-2
Client	Danatronics Yogin Patel
Address	150A Andover Street, Suite 8C Danvers, MA 01923
Phone	978-777-0081
Items tested	ECHO
Standards	CFR 47 FCC Part 15 Subpart B, EN 55011:2009/A1:2010 Group 1, AS/NZS CISPR 11:2004, ICES-001 Issue 4, EN 61000-3-2:2006/A1:2009/A2:2009, EN 61000-3-3:2013, EN 61326-1:2013
Test Dates	February 13, March 3, 10, 12, 23, 31, April 2, May 12, 22, 23, and 30, 2015
Results	As detailed within this report
Prepared by	Ami Soni – Test Engineer
Authorized by	Stacey Costa – EMC Project Manager
Issue Date	9/15/2015
Conditions of Issue	This Test Report is issued subject to the conditions stated in the '*Conditions of Testing*' section on page 79 of this report.

Contents

REV 06-FEB-15 (SC)

Summary

On February 13, March 3, 10, 12, 23, 31, April 2, May 12, 22, 23, and 30, 2015 we tested the ECHO for compliance with the following requirements:

EMC Emissions:
- CFR 47 FCC Part 15 Subpart B Class A emissions requirements (USA)
- EN 55011:2009/A1:2010 Group 1 Class A ISM emissions requirements (EU)
- AS/NZS CISPR 11:2004 Class A ISM emissions requirements (Australia)
- ICES-001 Issue 4 ISM emissions requirements (Canada)
- EN 61000-3-2:2006/A1:2009/A2:2009 Limits for harmonic current emissions (equipment input current up to and including 16A per phase)
- EN 61000-3-3:2013 Limitation of voltage fluctuations and flicker in low-voltage supply systems for equipment with rated current up to and including 16 A

EMC Emissions and Immunity:
- EN 61326-1:2013 EMC requirements for Electrical equipment for measurement, control and laboratory use – General Use

We found that the product met the above requirements with modification (see *Modifications Required for Compliance* section on page 7). Yogin Patel from Danatronics was present during the testing. The test sample was received in good condition. The sample was received on February 13, 2015.

Please note that the EUT was tested in Battery and Charging modes.

Issue No.	Reason for change	Date Issued
1	Original Release	September 15, 2015

Product Tested

Configuration Documentation

EUT Configuration										
Work Order: O3841										
Company: Danatronics Corporation										
Company Address: 150A Andover Street, Suite 8C Danvers, MA 01923										
Contact: Yogin Patel										
Person Present: Yogin Patel										
		MN						**SN**		
EUT:		ECHO						05056941		
EUT Description: Ultrasonic Thickness Gage										
EUT Max Frequency: 100MHz										
EUT Min Frequency: 0.032768MHz										
Support Equipment:		**MN**						**SN**		
5 MHz Ultrasound transducer		DKS573						21951		
5 steps test block		5SB-09						--		
USB Charger		--						--		
EUT Ports:										
Port Label	**Port Type**	**No. of ports**	**No. Populated**	**Cable Type**	**Shielded**	**Ferrites**	**Length**	**Max Length**	**In/Out NEBS Type**	**Unpopulated Reason**
USB	USB	1	1	USB	Yes	No	<3m	N/A	In	
Coax	Coax	2	2	Coax	Yes	No	<3m	N/A	In	
Software / Operating Mode Description:										
The EUT measures thickness of the material nondestructively.										

Clock Frequencies

EUT Frequencies (MHz)
0.032768
0.6
1.2
1
2
6.75
12
54
80
96
100

Performance Criteria

Criterion A: The unit must operate as intended during the test. In particular, the thickness measurement shall be monitored. Acceptable measurement variance is +/-0.004.

Criterion B: The unit must operate as intended at the conclusion of the test with no loss of state or data.

Criterion C: Temporary loss of function is allowed, provided the function is self-recoverable or can be restored by the operation of the controls by the user in accordance with the manufacturer's instructions.

Compliance Statement

TEST	RESULT	STANDARD	TEST LEVEL	MARGIN	COMMENTS
Radiated Emissions	PASS	CFR 47 FCC Part 15 Subpart B EN55011:2009/A1:2010 AS/NZS CISPR11:2004 ICES-001 Issue 4	Class A	-2.5dB @ 400.0MHz	
AC Mains Conducted Emissions	PASS	CFR 47 FCC Part 15 Subpart B EN55011:2009/A1:2010 AS/NZS CISPR11:2004 ICES-001 Issue 4	Class A	-18.6dB @ 0.152MHz	
ESD	PASS	EN 61000-4-2	±4kV contact ±8kV air	N/A	Performance Criteria B
RFI - Amplitude Modulated	PASS	EN 61000-4-3	80-1000MHz @ 3V/m 1.4-2.0GHz @ 3V/m 2.0-2.7GHz @ 1V/m 1KHz 80% AM	N/A	Performance Criteria A
EFT	PASS	EN 61000-4-4	±1kV AC main	N/A	Performance Criteria B
AC Surge	PASS	EN 61000-4-5	±0.5kV L-L ±1kV L-PE	N/A	Performance Criteria B
DC Surge	N/A	EN 61000-4-5	N/A	N/A	EUT is AC powered
Signal/Telco Surge	N/A	EN 61000-4-5	N/A	N/A	No Telco ports

TEST	RESULT	STANDARD	TEST LEVEL	MARGIN	COMMENTS
CRFI	PASS	EN 61000-4-6	0.15-80MHz @ 3Vrms 1KHz 80% AM	N/A	Performance Criteria A
Power-Frequency Magnetic Field	PASS	EN 61000-4-8	3A/m	N/A	Performance Criteria A
Voltage Dips And Short Interruptions	PASS	EN 61000-4-11	0%V for 0.5 and 1 cycle (B) 70%V for 25/30 cycles (C) 0%V for 250/300 cycles (C)	N/A	
Harmonics	PASS	EN 61000-3-2	Class A	N/A	
Flicker	PASS	EN 61000-3-3	N/A	N/A	

Modifications Required for Compliance

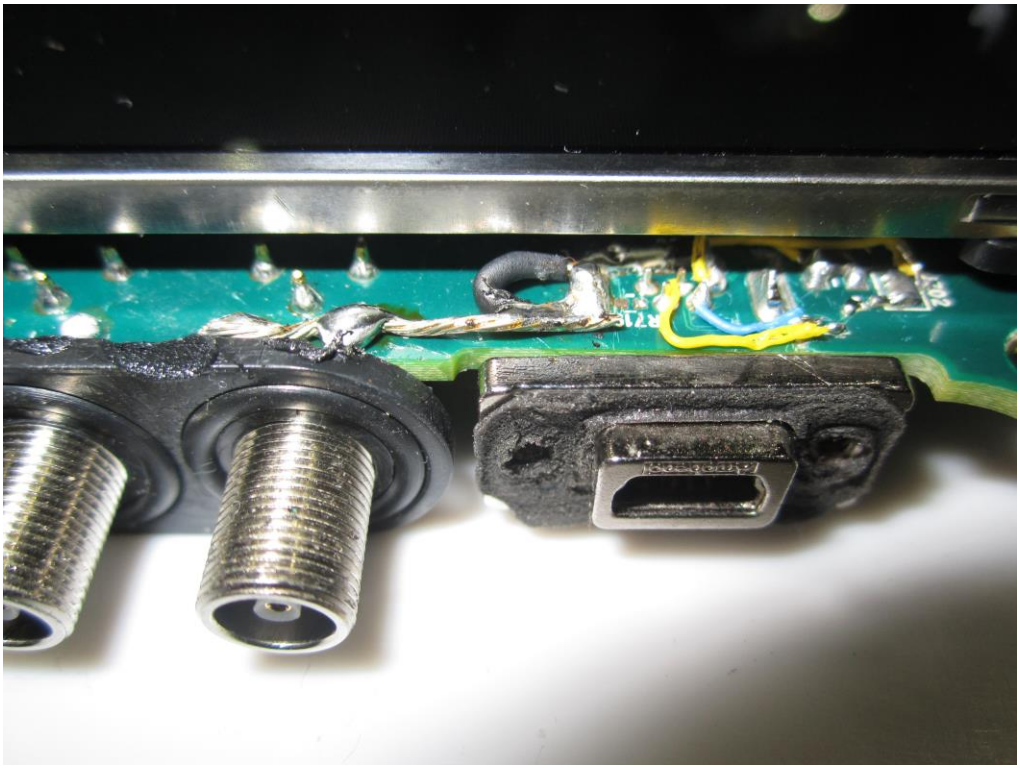
Modifications were required for the following tests:

- ESD
- RFI

In order to be compliant with ESD, a jumper wire was added to the USB cell. The jumper connected the USB cell to the digital ground and the analog ground. Prior to the modification, the EUT failed at ±4kV.

In order to be compliant with RFI in battery mode, a single loop fair-rite was added to the Transducer cable. Prior to the modification, the EUT failed from 82-84MHz for vertical antenna polarity.

Modification Photos:



ESD

RADIATED EMISSIONS

Test Method:

In accordance with the following:

- CFR 47 FCC Part 15 Subpart B
- EN55011:2009/A1:2010
- AS/NZS CISPR11:2004
- ICES-001 Issue 4

Results:

TEST	RESULT	TEST LEVEL	MARGIN	COMMENTS
Radiated Emissions	PASS	Class A	-2.5dB @ 400.0MHz	

Radiated Emissions Data Table(s):

Table 1

Radiated Emissions Table

Date: 23-May-15 **Company:** Danatronics **Work Order:** O3841
Engineer: Ahmed Ahmed **EUT Desc:** ECHO **EUT Operating Voltage/Frequency:** Battery powered
Temp: 23.6°C **Humidity:** 20% **Pressure:** 1012mBar
Frequency Range: 30-1000MHz **Measurement Distance:** 3 m
Notes: Battery Mode **EUT Max Freq:** 100MHz

Antenna Polarization (H / V)	Frequency (MHz)	Reading (dBµV)	Preamp Factor (dB)	Antenna Factor (dB/m)	Cable Factor (dB)	Adjusted Reading (dBµV/m)	CISPR Class A Limit (dBµV/m)	CISPR Class A Margin (dB)	CISPR Class A Result (Pass/Fail)	FCC Class A Limit (dBµV/m)	FCC Class A Margin (dB)	FCC Class A Result (Pass/Fail)
H	83.4	50.0	25.4	7.7	0.5	32.8	50.5	-17.7	Pass	49.5	-16.7	Pass
V	85.0	40.3	25.4	7.6	0.5	23.0	50.5	-27.5	Pass	49.5	-26.5	Pass
V	160.0	52.1	25.3	12.4	0.8	40.0	50.5	-10.5	Pass	54.0	-14.0	Pass
V	168.8	47.0	25.2	11.8	0.8	34.4	50.5	-16.1	Pass	54.0	-19.6	Pass
V	170.0	49.0	25.2	11.7	0.8	36.3	50.5	-14.2	Pass	54.0	-17.7	Pass
V	175.0	49.0	25.2	11.4	0.8	36.0	50.5	-14.5	Pass	54.0	-18.0	Pass
V	180.0	54.8	25.2	11.2	0.8	41.6	50.5	-8.9	Pass	54.0	-12.4	Pass
V	182.3	52.2	25.2	11.2	0.8	39.0	50.5	-11.5	Pass	54.0	-15.0	Pass
V	185.0	51.2	25.2	11.2	0.8	38.0	50.5	-12.5	Pass	54.0	-16.0	Pass
V	189.0	51.0	25.1	11.3	0.8	38.0	50.5	-12.5	Pass	54.0	-16.0	Pass
V	195.8	50.0	25.2	12.1	0.9	37.8	50.5	-12.7	Pass	54.0	-16.2	Pass
V	209.25	55.0	25.2	10.6	0.9	41.3	50.5	-9.2	Pass	54.0	-12.7	Pass
V	240.0	61.2	25.3	11.9	0.9	48.7	57.5	-8.8	Pass	56.9	-8.2	Pass
V	260.0	57.0	25.5	11.9	1.0	44.4	57.5	-13.1	Pass	56.9	-12.5	Pass
V	265.0	56.7	25.5	12.7	1.1	45.0	57.5	-12.5	Pass	56.9	-11.9	Pass
H	265.0	61.5	25.5	12.7	1.1	49.8	57.5	-7.7	Pass	56.9	-7.1	Pass
V	320.0	50.9	25.4	13.9	1.1	40.5	57.5	-17.0	Pass	56.9	-16.4	Pass
V	400.0	59.5	25.5	15.6	1.2	50.8	57.5	-6.7	Pass	56.9	-6.1	Pass
H	400.0	62.7	25.5	15.6	1.2	54.0	57.5	-3.5	Pass	56.9	-2.9	Pass
V	480.0	54.5	25.7	17.8	1.3	47.9	57.5	-9.6	Pass	56.9	-9.0	Pass
V	560.0	59.5	25.4	18.5	1.5	54.1	57.5	-3.4	Pass	56.9	-2.8	Pass
H	560.0	58.0	25.4	18.5	1.5	52.6	57.5	-4.9	Pass	56.9	-4.3	Pass
V	720.0	52.0	25.4	20.5	1.9	49.0	57.5	-8.5	Pass	56.9	-7.9	Pass
V	880.0	51.4	25.7	22.1	1.8	49.6	57.5	-7.9	Pass	56.9	-7.3	Pass
H	880.0	56.0	25.7	22.1	1.8	54.2	57.5	-3.3	Pass	56.9	-2.7	Pass

Table Result: Pass by -2.7 dB ***Worst Freq:*** 880.0 MHz

Test Site: EMI Chamber 2 **Cable 1:** Asset #2052 **Cable 2:** Asset #2054
Analyzer: Gold **Preamp:** Black **Antenna:** Red-Black

Table 2

Radiated Emissions Table

Date: 23-May-15 **Company:** Danatronics **Work Order:** O3841
Engineer: Ahmed Ahmed **EUT Desc:** ECHO **EUT Operating Voltage/Frequency:** 120V/60Hz
Temp: 23.6°C **Humidity:** 20% **Pressure:** 1012mBar
Frequency Range: 30-1000MHz **Measurement Distance:** 3 m
Notes: Charging Mode **EUT Max Freq:** 100MHz

Antenna Polarization (H / V)	Frequency (MHz)	Reading (dBµV)	Preamp Factor (dB)	Antenna Factor (dB/m)	Cable Factor (dB)	Adjusted Reading (dBµV/m)	CISPR Class A Limit (dBµV/m)	CISPR Class A Margin (dB)	CISPR Class A Result (Pass/Fail)	FCC Class A Limit (dBµV/m)	FCC Class A Margin (dB)	FCC Class A Result (Pass/Fail)
H	83.4	49.1	25.4	7.7	0.5	31.9	50.5	-18.6	Pass	49.5	-17.6	Pass
V	130.0	51.0	25.3	14.3	0.7	40.7	50.5	-9.8	Pass	54.0	-13.3	Pass
V	160.0	55.0	25.3	12.4	0.8	42.9	50.5	-7.6	Pass	54.6	-11.7	Pass
V	170.0	48.0	25.2	11.7	0.8	35.3	50.5	-15.2	Pass	54.6	-19.3	Pass
V	175.0	48.3	25.2	11.4	0.8	35.3	50.5	-15.2	Pass	54.6	-19.3	Pass
V	180.0	54.3	25.2	11.2	0.8	41.1	50.5	-9.4	Pass	54.6	-13.5	Pass
V	182.3	51.0	25.2	11.2	0.8	37.8	50.5	-12.7	Pass	54.6	-16.8	Pass
V	185.0	50.3	25.2	11.2	0.8	37.1	50.5	-13.4	Pass	54.6	-17.5	Pass
V	186.8	51.0	25.1	11.2	0.8	37.9	50.5	-12.6	Pass	54.6	-16.7	Pass
V	195.8	49.0	25.2	12.1	0.9	36.8	50.5	-13.7	Pass	54.6	-17.8	Pass
V	209.25	54.1	25.2	10.6	0.9	40.4	50.5	-10.1	Pass	54.6	-14.2	Pass
V	240.0	62.5	25.3	11.9	0.9	50.0	57.5	-7.5	Pass	56.9	-6.9	Pass
V	260.0	56.0	25.5	11.9	1.0	43.4	57.5	-14.1	Pass	56.9	-13.5	Pass
V	265.0	55.0	25.5	12.7	1.1	43.3	57.5	-14.2	Pass	56.9	-13.6	Pass
H	265.0	57.0	25.5	12.7	1.1	45.3	57.5	-12.2	Pass	56.9	-11.6	Pass
H	320.0	59.0	25.4	13.9	1.1	48.6	57.5	-8.9	Pass	56.9	-8.3	Pass
H	400.0	63.1	25.5	15.6	1.2	54.4	57.5	-3.1	Pass	56.9	-2.5	Pass
V	480.0	54.0	25.7	17.8	1.3	47.4	57.5	-10.1	Pass	56.9	-9.5	Pass
V	560.0	59.0	25.4	18.5	1.5	53.6	57.5	-3.9	Pass	56.9	-3.3	Pass
H	880.0	55.0	25.7	22.1	1.8	53.2	57.5	-4.3	Pass	56.9	-3.7	Pass

Table Result: Pass by -2.5 dB ***Worst Freq:*** 400.0 MHz

Test Site: EMI Chamber 2 **Cable 1:** Asset #2052 **Cable 2:** Asset #2054
Analyzer: Gold **Preamp:** Black **Antenna:** Red-Black

Rev. 5/18/2015

Spectrum Analyzers / Receivers /Preselectors	Range	MN	Mfr	SN	Asset	Cat	Calibration Due	Calibrated on
Gold	100Hz-26.5 GHz	E4407B	Agilent	MY45113816	1284	I	4/22/2016	4/22/2015
SA #2 (1860)	9kHz-26.5 GHz	E7405A	Agilent	MY45104916	1860	I	6/4/2015	6/4/2014

Radiated Emissions Sites	FCC Code	IC Code	VCCI Code	Range		Cat	Calibration Due	Calibrated on
EMI Chamber 2	719150	2762A-7	A-0015	30-1000MHz		II	3/22/2017	3/22/2015

Preamps /Couplers Attenuators / Filters	Range	MN	Mfr	SN	Asset	Cat	Calibration Due	Calibrated on
Black	0.009-2000MHz	ZFL-1000-LN	CS	N/A	799	II	4/11/2016	4/11/2015

Antennas	Range	MN	Mfr	SN	Asset	Cat	Calibration Due	Calibrated on
Red-Black Bilog	30-2000MHz	JB1	Sunol	A091604-2	1106	I	2/9/2017	2/9/2015

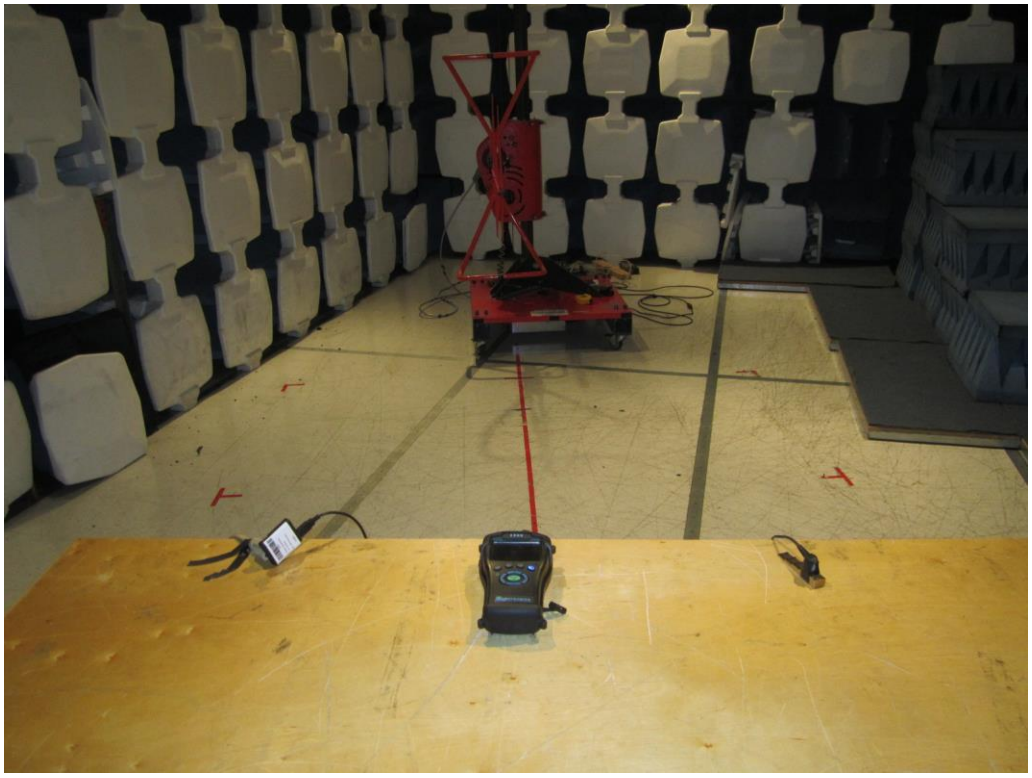
Meteorological Meters		MN	Mfr	SN	Asset	Cat	Calibration Due	Calibrated on
Weather Clock (Pressure Only)		BA928	Oregon Scientific	C3166-1	831	I	3/19/2016	3/19/2014
TH A#2081		HTC-1	HDE		2081	II	4/2/2016	4/2/2015
Asset #2052	9kHz - 18GHz		Florida RF			II	3/8/2016	3/8/2015

All equipment is calibrated using standards traceable to NIST or other nationally recognized calibration standard.

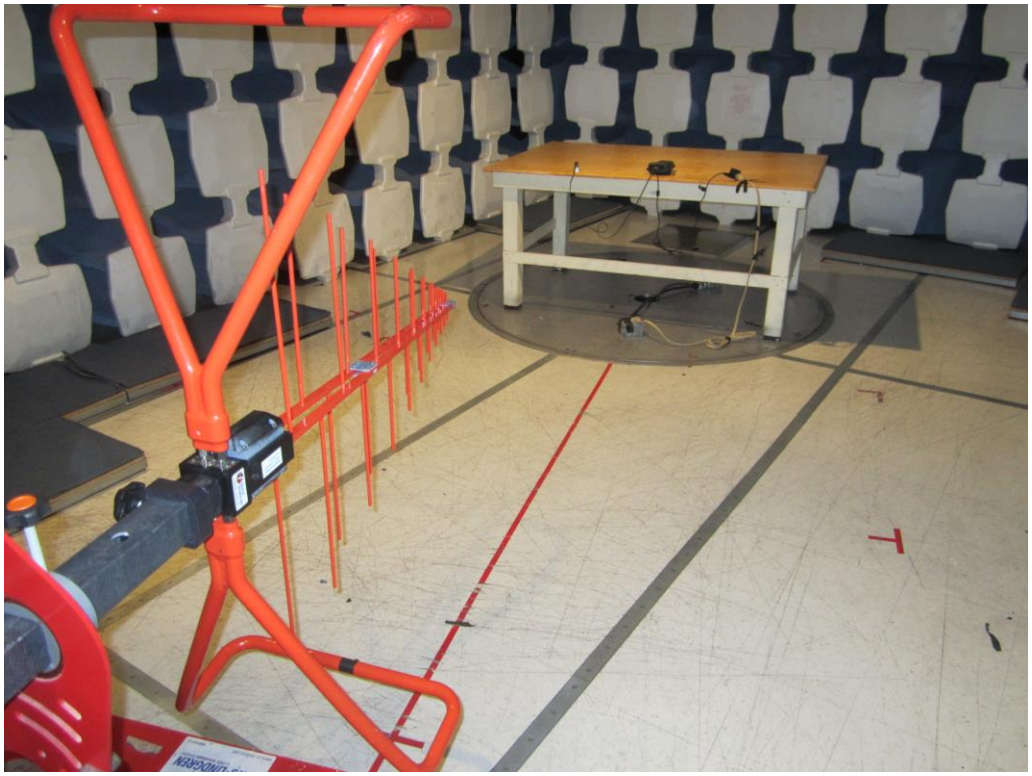
Radiated Emissions Modifications:

None

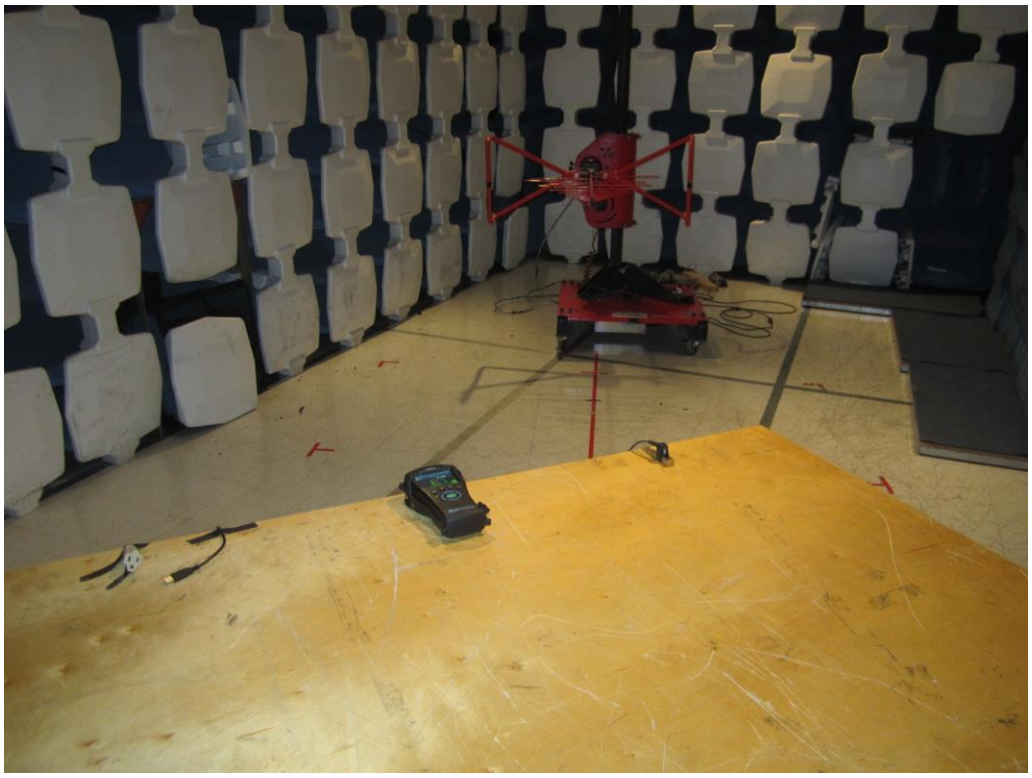
Radiated Emissions Setup Photograph(s):



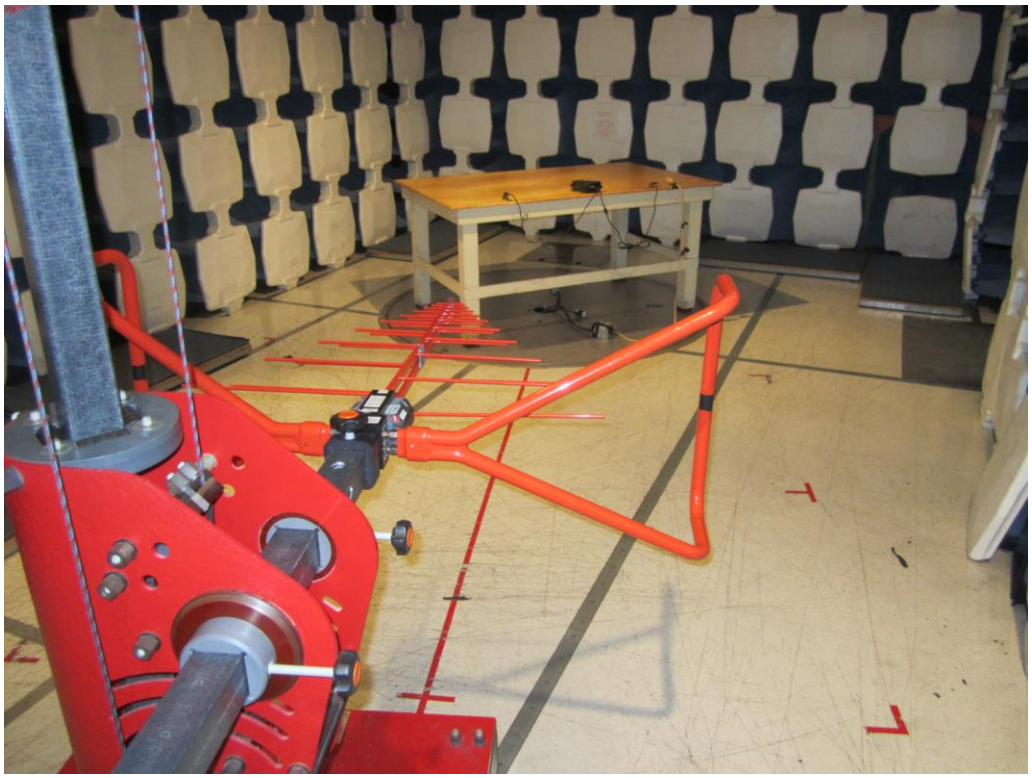
Charging mode (Front)



Charging mode (Rear)



Battery mode (Front)



Battery mode (Rear)

Radiated Emissions Testing Overview

REV 10-APR-09

Digital and microprocessor based devices use radio frequency (RF) digital signals for timing purposes. An unintentional consequence of this signal usage is that a certain amount of RF energy is radiated from the device into the local environment. This radiated RF energy has the potential to interfere with constructive uses of the RF spectrum such as television broadcasting, police and fire radio, and the like. In order to reduce the likelihood that a device will interfere with these services, it is required that the amplitudes of radiated RF signals from the device are kept below an allowable level.

These RF signals decrease in strength as the distance from the source increases. Thus if the potential victim of interference, e.g. a TV receiver, is far enough from the radiator, e.g. a computer, then no interference will occur. For certain environments it is appropriate to expect that potential interference victims will be located at least a minimum distance from the radiator. For the residential environment this distance is generally accepted to be 10 meters while in the commercial environment the accepted distance is 30 meters. The allowable emissions levels are therefore specified to protect equipment which is located further than that distance from the radiator. In general, radiation from the Equipment Under Test (EUT) is measured at 3 or 10 meters to insure that it is at or below allowable levels.

Measurements of the radiated energy are made by recording the field strength indicated by an antenna placed at a specific distance from the device. Most devices do not radiate the RF energy in a predictable manner. The emitted energy may vary with changes in operating mode, physical configuration, or orientation. During the measurement process these parameters are varied to confirm that the emissions will remain below the allowable levels in the range of typical installations.

The extent of annoyance experienced by a person who is being affected by interference is related to the persistence of the interfering signal. For example, a low level steady whine from a receiver is considered to be more annoying than brief, loud, intermittent pops or clicks. This “human factor” is accounted for by the use of a “quasi-peak” detector in the receiver or spectrum analyzer which measures the signal from the measurement antenna. The detector is a weighted averaging filter with a fast charge time and a slow discharge time. Thus steady continuous signals will charge the quasi-peak detector fully while intermittent signals (those with pulse repetition rates less than 1kHz) are reported at a level which can be significantly below their peak level. It should be noted that most RF signals produced by digital devices are continuous in nature and thus the quasi-peak reading will be identical to the peak signal reading. To reduce the test time, the peak emission level is recorded for continuous wave signals as it is the same as the quasi-peak signal level.

Testing is performed according to test methods from ANSI C63.4 and CISPR 22.

The test site used for measuring radiated emissions follows the format developed internationally for a weather protected Open Area Test Site (OATS). The test site used for measuring radiated emissions above 1GHz for CISPR limits is a Free Space Open Area Test Site (FSOATS). An antenna mast is installed at the specified distance from a rotating table and is used to raise and lower the measuring antenna. The reference site is clear of reflecting objects, such as metal fences and buildings for an ellipse of twice the measurement test

distance. Measuring equipment and personnel are present within the ellipse to facilitate cable manipulation, but measures are taken to minimize the effects. Often preliminary radiated emissions measurements are made at alternate test sites which do not meet the clear space reference criteria. The data collected at alternate test sites is not considered conclusive unless the alternate site also complies with a volumetric site attenuation survey performed over the area that the EUT occupies. The EUT and measuring antenna mark the two foci of the ellipse. The ground plane is made of a combination of galvanized steel sheets and tight wire mesh electrically connected along the seams. This metal ground plane extends 1 meter beyond the furthest extent of the EUT and the measuring antenna. It also covers the area between the EUT and the measuring antenna. The hardware cloth is connected to the utility ground or to stakes driven into the earth for safety. The site configuration for CISPR testing above 1GHz is a semi-anechoic chamber. The ground plane in the test volume is covered by an absorbing material between the antenna and the EUT. In the case of table top equipment, the absorbing material is also placed under the table. In the case of floor-standing equipment the absorbing material extends up from the ground plane 30cm into the test volume, and surrounds the EUT by at most 10cm from the footprint of the equipment.

In order for accurate emissions measurements to be made the test site must possess propagation characteristics which fall within accepted norms. The site has been checked for suitability using techniques specified in American National Standards Institute (ANSI) document C63.4. This document details a procedure which measures the attenuation of the site which is the chief indicator of site acceptability. The theory behind site attenuation is quite simple. A transmitting antenna is set up at a fixed location at one end of the site with a receiving antenna at the other end. If a signal of some arbitrary amplitude is fed into the transmitting antenna, a lesser amount of signal ought to be measured at the receiving antenna. This difference in signal amplitude is known as the site attenuation, which should follow a predicted curve. Data that does not correspond to the predicted site attenuation curve points to a problem with either the equipment being used or the physical characteristics of the site.

Actual emissions measurements are taken with broadband biconical-log-periodic hybrid antennas calibrated in accordance with the standard site method detailed in ANSI C63.5. Emissions are measured with the receiving antenna oriented in horizontal and vertical polarization with respect to the ground plane. If measurements are made at other than the limit distance, then the readings obtained are scaled to the limit distance using an inverse relationship. The actual test distance used is noted in the report.

The antenna mast is capable of a varying the antenna height between 1 and 4 meters above the ground plane. The receiving antenna is moved over this range at each emission frequency in order to record the maximum observed signal. The mast is non-conductive and remotely controllable. The test distance is measured from the antenna center (marked during calibration) and the periphery of the EUT.

The Equipment Under Test (EUT) is rotated in order to maximize emissions during the test. For equipment intended to operate on a tabletop or desk radiated tests are conducted on a 0.8 meter high, non-conductive platform. Larger floor standing equipment is tested on a floor mounted rotatable platform. In some cases, large equipment on its own casters may be tested without a platform.

Since radiated emissions are a function of cable placement, the cable placement is varied to encompass typical configurations that an end user might encounter to determine the configuration resulting in maximum emissions. At least one cable for each I/O port type is attached to the EUT. If peripherals or modules are available, at least one of each available type is installed and noted in the report. Excess cable length beyond one meter is bundled in the center into a 30 to 40 cm bundle. Cables requiring non-standard lead dress are recorded in the report.

Network connections are simulated if necessary. Any simulator used matches the expected real network connection in terms of both functionality and impedance. For distributed systems, the support equipment may be placed at such a distance that it does not influence the measured emissions. If this option is used, such placement is noted in the test report.

The possible operating modes of the EUT are explored to determine the configuration which maximizes emissions. Software is investigated as well as different methods of displaying data if available. Data is recorded in the worst case operating mode.

At least the six highest emissions with respect to the limit are recorded. If less than six emissions are visible above the noise floor of the instrumentation, then noise floor measurements at six representative frequencies are recorded. The test report will document if noise floor readings are reported.

FCC and European Norms Radiated Emissions Limits at 10 meters

Frequency (MHz)	FCC Class A	FCC Class B	CISPR Class A	CISPR Class B	Frequency (MHz)
30-88	39.1	29.5	40	30	30-88
88-216	43.5	33.1	40	30	88-216
216-230	46.4	35.6	40	30	216-230
230-960	46.4	35.6	47	37	230-960
960-1000	49.5	43.5	47	37	960-1000
1000-3000	Avg: 49.5 Peak: 69.5	Avg: 43.5 Peak: 63.5	Not defined	Not defined	1000-3000
3000+	Avg: 49.5 Peak: 69.5	Avg: 43.5 Peak: 63.5	Not defined	Not defined	3000+

At the transitions, the lower limit applies.
Simple inverse scaling utilized to convert limits where appropriate.

FCC and European Norms Radiated Emissions Limits at 3 meters

Frequency (MHz)	FCC Class A	FCC Class B	CISPR Class A	CISPR Class B	Frequency (MHz)
30-88	49.5	40	50.5	40.5	30-88
88-216	54	43.5	50.5	40.5	88-216
216-230	56.9	46	50.5	40.5	216-230
230-960	56.9	46	57.5	47.5	230-960
960-1000	60	54	57.5	47.5	960-1000
1000-3000	Avg: 60	Avg: 54	Avg: 56	Avg: 50	1000-3000

	Peak: 80	Peak: 74	Peak: 76	Peak: 70	
3000+	Avg: 60 Peak: 80	Avg: 54 Peak: 74	Avg: 60 Peak: 80	Avg: 54 Peak: 74	3000+
At the transitions, the lower limit applies. Simple inverse scaling utilized to convert limits where appropriate.					

The measurement range is based on the highest frequency signal present or used in the device. The following table details the frequency range of measurements performed.

Frequency range of radiated emissions measurements		
Highest frequency generated or used in the device or on which the device operates or tunes (MHz)	Upper frequency of measurement range (MHz)	
	FCC	EU/CISPR
Below 1.705	30 (No radiated measurements)	1000
1.705-108	1000	1000
108-500	2000	2000
500-1000	5000	5000
Above 1000	5^{th} harmonic of the highest frequency 40 GHz whichever is lower.	5^{th} harmonic of the highest frequency 6 GHz whichever is lower.

The test data is derived from the voltage on the spectrum analyzer. First the reading is corrected for gain factors associated with the use of preamps and loss in the cable. A factor in dB is subtracted from the reading to account for preamp gain, while a factor in dB is added to the signal to account for cable loss. A conversion is performed from the resulting voltage to field strength by multiplying the voltage by the antenna factor. Since antenna factor is expressed as a logarithm (dB/m), this operation takes the form of an addition (to multiply logarithmic numbers, you add them together). Thus:

Field Strength (dBuV/m) = Voltage Reading (dBuV) - Preamp Gain (dB) + Cable Loss (dB) + Antenna Factor (dB/m)

When the levels of ambient radio signals such as local television stations are within 6 dB of the appropriate limit, the following steps may be taken to assure compliance:

1. The measurement bandwidth may be reduced. A check is made to see that peak readings are not affected. The use of a narrower bandwidth allows examination of emissions close to local ambient signals.
2. The antenna may be brought closer to the EUT to increase signal-to-ambient signal strength.
3. For horizontally polarized signals the axis of the test site may be rotated to discriminate against local ambients.

CONDUCTED EMISSIONS

Test Method:

In accordance with the following:

- CFR 47 FCC Part 15 Subpart B
- EN55011: 2009/A1:2010
- ICES-001 Issue 4
- AS/NZS CISPR11:2004

Results:

TEST	RESULT	TEST LEVEL	MARGIN	COMMENTS
AC Mains Conducted Emissions	PASS	Class A	-18.6dB @ 0.152MHz	

Conducted Emissions Data Table(s):

Table 3

AC Conducted Emissions Data Table

Date: 22-May-15 **Company:** Danatronics **Work Order:** O3841
Engineer: William Conroy **EUT Desc:** ECHO
Temp: 21.5 ºC **Humidity:** 31% **Pressure:** 1001 mBar
Notes:
Frequency Range: .15-30MHz **EUT Input Voltage/Frequency:** 120V60Hz

Frequency	Quasi-Peak Readings		Average Readings		LISN Factors		Cable	ATTN	FCC/CISPR Class A			FCC/CISPR Class A		
	QP1	QP2	AVG1	AVG2	L1	L2	Factor	Factor	QP Limit	Margin	Result	AVG Limit	Margin	Result
(MHz)	(dBµV)	(dBµV)	(dBµV)	(dBµV)	(dB)	(dB)	(dB)	(dB)	(dBµV)	(dB)	(Pass/Fail)	(dBµV)	(dB)	(Pass/Fail)
0.15	28.4	30.0	16.9	18.6	-0.1	-0.1	-0.1	-20.4	79.0	-28.4	Pass	66.0	-26.9	Pass
0.20	24.0	25.5	15.2	16.0	-0.1	-0.1	-0.1	-20.4	79.0	-33.0	Pass	66.0	-29.5	Pass
3.71	14.2	13.3	9.4	7.5	0.0	-0.1	-0.1	-20.4	73.0	-38.3	Pass	60.0	-30.1	Pass
12.46	14.8	11.6	9.0	6.8	-0.1	-0.1	-0.2	-20.3	73.0	-37.6	Pass	60.0	-30.4	Pass
16.59	9.7	8.4	4.7	3.2	-0.1	-0.1	-0.3	-20.4	73.0	-42.5	Pass	60.0	-34.5	Pass
24.26	8.1	8.0	3.3	2.6	-0.1	-0.1	-0.3	-20.4	73.0	-44.1	Pass	60.0	-35.8	Pass

Result: Pass ***Worst Margin:*** -26.9 dB ***Frequency:*** 0.152 MHz

Measurement Device: LISN ASSET 1732(Line 1) LISN ASSET 1733(Line 2) **Cable:** CEMI-10 **Spectrum Analyzer:** Black
Attenuator: 20dB Atten-4 **Site:** CEMI 5

Table 4

AC Conducted Emissions Data Table

Date: 22-May-15 **Company:** Danatronics **Work Order:** O3841
Engineer: William Conroy **EUT Desc:** ECHO
Temp: 21.5 ºC **Humidity:** 31% **Pressure:** 1001 mBar
Notes:
Frequency Range: .15-30MHz **EUT Input Voltage/Frequency:** 230V50Hz

Frequency	Quasi-Peak Readings		Average Readings		LISN Factors		Cable	ATTN	FCC/CISPR Class A			FCC/CISPR Class A		
	QP1	QP2	AVG1	AVG2	L1	L2	Factor	Factor	QP Limit	Margin	Result	AVG Limit	Margin	Result
(MHz)	(dBµV)	(dBµV)	(dBµV)	(dBµV)	(dB)	(dB)	(dB)	(dB)	(dBµV)	(dB)	(Pass/Fail)	(dBµV)	(dB)	(Pass/Fail)
0.15	39.9	39.7	15.7	14.2	-0.1	-0.1	-0.1	-20.4	79.0	-18.6	Pass	66.0	-29.8	Pass
0.21	29.2	38.8	14.8	11.8	-0.1	-0.1	-0.1	-20.4	79.0	-19.7	Pass	66.0	-30.7	Pass
0.52	23.4	24.4	17.4	16.2	0.0	0.0	-0.1	-20.4	73.0	-28.2	Pass	60.0	-22.1	Pass
6.79	19.6	13.0	11.6	7.2	0.0	-0.1	-0.2	-20.4	73.0	-32.9	Pass	60.0	-27.8	Pass
10.37	18.0	11.4	10.2	4.7	-0.1	-0.1	-0.2	-20.3	73.0	-34.5	Pass	60.0	-29.3	Pass
23.01	8.2	8.1	3.4	2.7	-0.1	-0.1	-0.3	-20.4	73.0	-44.0	Pass	60.0	-35.8	Pass

Result: Pass ***Worst Margin:*** -18.6 dB ***Frequency:*** 0.152 MHz

Measurement Device: LISN ASSET 1732(Line 1) LISN ASSET 1733(Line 2) **Cable:** CEMI-10 **Spectrum Analyzer:** Black
Attenuator: 20dB Atten-4 **Site:** CEMI 5

Rev. 5/18/2015

Spectrum Analyzers / Receivers /Preselectors	Range	MN	Mfr	SN	Asset	Cat	Calibration Due	Calibrated on
Black	9kHz-12.8GHz	8596E	Agilent	3710A00944	337	I	2/12/2016	2/12/2015
LISNs/Measurement Probes	**Range**	**MN**	**Mfr**	**SN**	**Asset**	**Cat**	**Calibration Due**	**Calibrated on**
LISN Asset 1732	150kHz-30MHz	LI-150A	Com-Power	201094	1732	I	2/12/2016	2/12/2015
LISN Asset 1733	150kHz-30MHz	LI-150A	Com-Power	201095	1733	I	2/12/2016	2/12/2015
Conducted Test Sites (Mains / Telco)	**FCC Code**		**VCCI Code**			**Cat**	**Calibration Due**	**Calibrated on**
CEMI 5	719150		A-0015			III	NA	N/A
Meteorological Meters		**MN**	**Mfr**	**SN**	**Asset**	**Cat**	**Calibration Due**	**Calibrated on**
Weather Clock (Pressure Only)		BA928	Oregon Scientific	C3166-1	831	I	3/19/2016	3/19/2014
TH A#2077		HTC-1	HDE		2077	II	4/2/2016	4/2/2015
Cables	**Range**		**Mfr**			**Cat**	**Calibration Due**	**Calibrated on**
CEMI-10	9kHz - 2GHz		C-S			II	4/4/2016	4/4/2015
Attenuators	**Range**	**MN**	**Mfr**	**SN**	**Asset**	**Cat**	**Calibration Due**	**Calibrated on**
20dB Attenuator-04	9kHz-2GHz			N/A		II	6/30/2015	6/30/2014

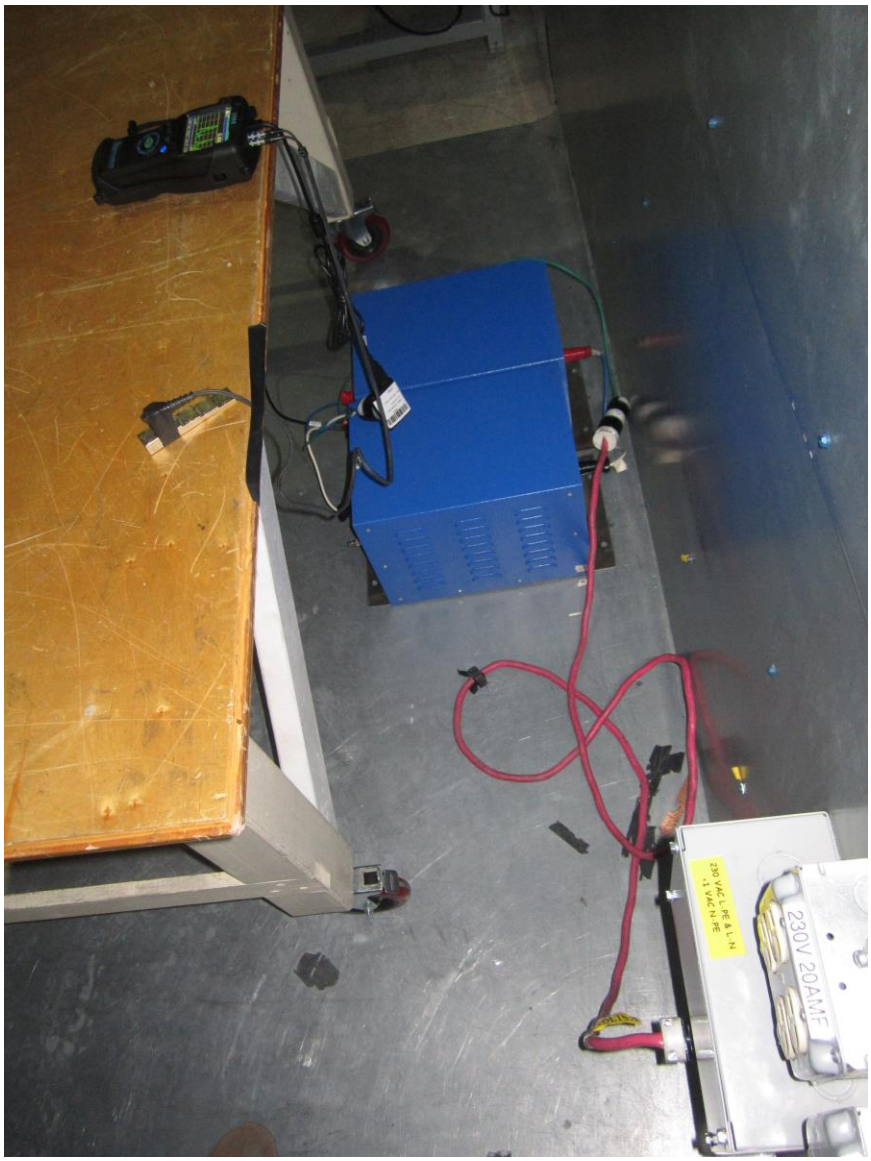
All equipment is calibrated using standards traceable to NIST or other nationally recognized calibration standard.

Conducted Emissions Modifications:

None

Conducted Emissions Setup Photograph(s):

Front



Rear

Line Conducted Emissions Overview:

REV 9-MAY-06

Digital and microprocessor based devices use radio frequency (RF) digital techniques for timing purposes and in applications such as switching power supplies. An unintentional consequence of this for AC powered devices is that a certain amount of the RF energy is impressed upon the AC power mains in the form of a conducted noise voltage. These conducted emissions have the potential to interfere with constructive uses of the RF spectrum such as AM radio and may also interfere with other devices attached to the same AC mains circuit. In order to reduce the likelihood that a device will interfere it is required that the conducted RF signals from the device are below an allowable level.

Testing is performed according to test methods from ANSI C63.4 and CISPR 22.

Line conducted emissions are measured from the device over the frequency range of 0.15 to 30 MHz. The EUT is powered from a Line Impedance Stabilization Network (LISN). The purpose of the LISN is to provide a calibrated impedance across which to measure the conducted emissions. The RF noise voltage produced by the EUT across the LISN is measured and compared to the limit. In order for the LISN to perform properly it is attached to a ground plane at least 2 meters by 2 meters in size. For tabletop equipment the measurement is performed with the equipment 40 cm from a vertical conducting surface bonded to a ground plane under the product. The ground plane extends 0.5 meters beyond the product and is 2.5mx3.7m in size. The vertical surface is 2.5mx2.5m.

As with radiated emissions, the “human factor” is accounted for by the use of a “quasi-peak” detector in the receiver or spectrum analyzer that measures the signal from the LISN. For certain tests (such as EN55022), both an average and a quasi-peak limit are specified. Emissions from a device must be below both limits when measured with the appropriate detector. If the emission level is below the average limit when measured with the quasi-peak detector, the EUT is presumed to pass both limits.

The possible operating modes of the EUT are explored to determine the configuration that maximizes emissions. Software is investigated as well as different methods of displaying data if available. Data is recorded in the worst case operating mode.

As of September 9, 2002, the FCC has harmonized it’s conducted emission limits with CISPR. The following table displays the limits applicable to both FCC and CISPR.

Line Conducted Emissions Limits: Class A (dBµV)		
Frequency (MHz)	Quasi-Peak	Average
0.15 - 0.5	79	66
0.5 - 30	73	60
Line Conducted Emissions Limits: Class B (dBµV)		
Frequency (MHz)	Quasi-Peak	Average
0.15 - 0.5	66 - 56*	56 - 46*
0.5 - 5	56	46
5 - 30	60	50
Note 1: The lower limit applies at the transition frequencies *Note 2: The limit decreases linearly with the logarithm of the frequency		

At least the six highest emissions with respect to the limit are recorded. If less than six emissions are visible above the noise floor of the instrumentation, then the noise floor at six representative frequencies is recorded. The test report will document if noise floor readings are reported.

All testing is performed within the framework of a laboratory quality system modeled on ISO/IEC 17025 *General requirements for the competence of calibration and testing laboratories* and is subject to our terms and conditions. This test method is covered by our A2LA accreditation.

ELECTROSTATIC DISCHARGE IMMUNITY

Test Method:

In accordance with EN 61000-4-2:2009.

Results:

TEST	RESULT	TEST METHOD	TEST LEVEL	COMMENTS
ESD	PASS	EN 61000-4-2	±4kV Contact ±8kV Air	Performance Criteria B

Electrostatic Discharge Immunity Data Table(s):

Table 5

ESD DATA SHEET

Work Order: O3841
Date(s): 13-Feb-15 6-Mar-15 10-Mar-15 12-Mar-15 23-Mar-15 31-Mar-15 2-Apr-15 12-May-15 22-May-15
Engineer(s): Ryan Brown, Patrick Crozier, Chris Bramley, Ahmed Ahmed, William Conroy
EUT: ECHO
Company: Danatronics **Client Present:** Yogin Patel

Testing Location: Littleton Distribution Center, One Distribution Center Circle, #1 Littleton, MA 01460

Performance Criteria: B
Maximum Test Parameters: ±4kV contact ±8kV air
EUT Operating Voltage/Frequency: 230Vac/50Hz and Battery powered

Test Equipment Used:

ESD Generators	MN	Mfr	SN	Asset	Cat	Calibration Due	Calibrated on
A#1841	NSG 438	TESEQ	1277	1841	I	12/13/2015	12/13/2014
Green	NSG435	Schaffner	839	763	I	8/15/2015	8/15/2014
Oscilloscopes and Probes	**MN**	**Mfr**	**SN**	**Asset**	**Cat**	**Calibration Due**	**Calibrated on**
ESD Reference 1GHz	TDS 684B	Tektronix	B011287	1819	I	5/31/2015	5/31/2014
Meteorological Meters	**MN**	**Mfr**	**SN**	**Asset**	**Cat**	**Calibration Due**	**Calibrated on**
Weather Clock (Pressure Only)	BA928	Oregon Scientific	C3166-1	831	I	3/19/2016	3/19/2014
TH A#1828	35519-044	Control Company	130318292	1828	II	6/13/2015	6/13/2013
TH A#1829	35519-044	Control Company	130320899	1829	II	6/13/2015	6/13/2013
TH A#2077	HTC-1	HDE		2077	II	4/2/2016	4/2/2015

Atmospheric Conditions:

13-Feb-2015 Temp: 23.8°C	**Humidity:** 2%	**Pressure:** 1006mbar
10-Mar-2015 Temp: 23.5°C	**Humidity:** 2%	**Pressure:** 1013mbar
12-Mar-2015 Temp: 22.1°C	**Humidity:** 36%	**Pressure:** 1021mbar
23-Mar-2015 Temp: 22.2°C	**Humidity:** 34%	**Pressure:** 1010mbar
31-Mar-2015 Temp: 24.0°C	**Humidity:** 22%	**Pressure:** 1010mbar
2-Apr-2015 Temp: 19.8°C	**Humidity:** 33%	**Pressure:** 1014mbar
12-May-2015 Temp: 25.3°C	**Humidity:** 42%	**Pressure:** 1009mbar
22-May-2015 Temp: 21.5°C	**Humidity:** 31%	**Pressure:** 1001mbar

Test Points:	Pass/Fail	Test Levels:	Comments:
Horizontal Coupling Plane	Pass	±2kV, ±4kV	
Vertical Coupling Plane	Pass	±2kV, ±4kV	
Contact Discharge Test Points	Pass	±2kV, ±4kV	

Photo Label
All contact discharge points are labeled with a **C** on the photos provided.

Air Discharge Test Points	Pass	±2kV, ±4kV, ±8kV

Photo Label
All air discharge points are labeled with an **A**. Points where a discharge occurred are listed below:

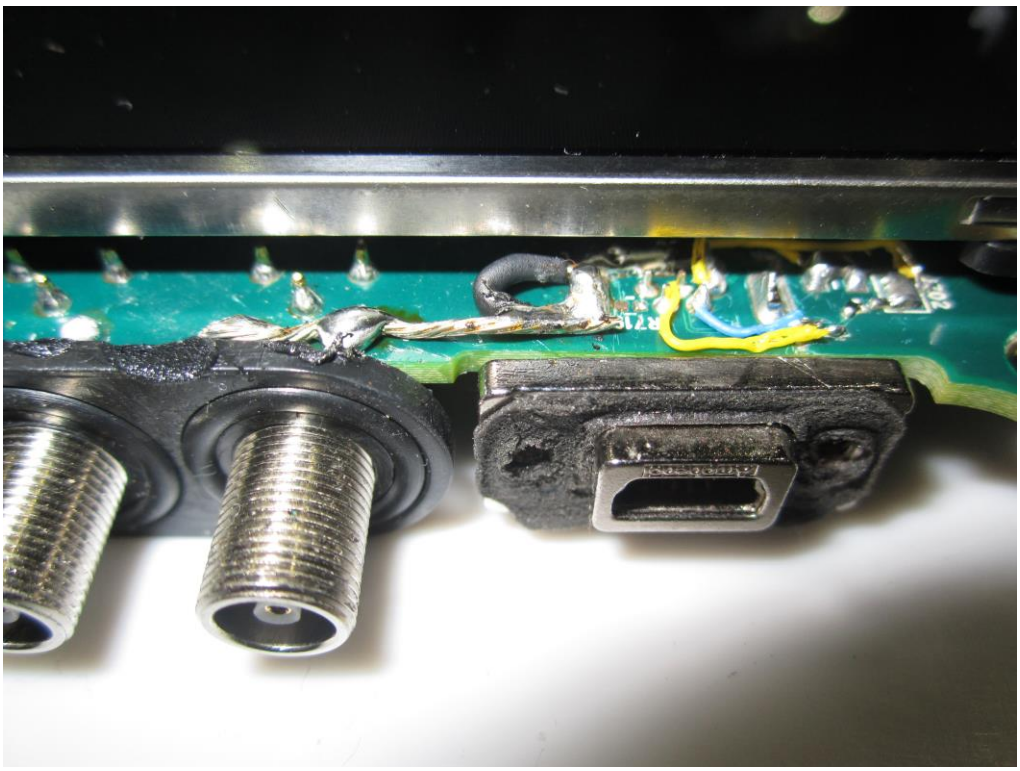
Discharge Point Description	Discharge Voltage
N/A	N/A

Please note that the EUT was tested in charging and battery modes.

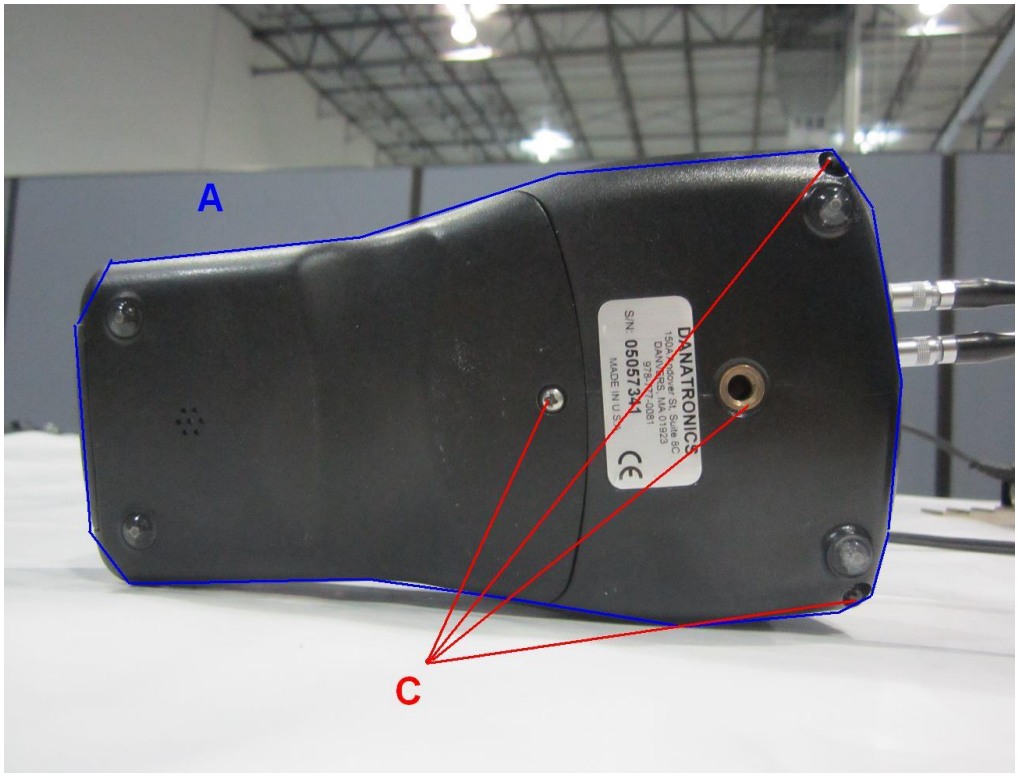
ESD Modifications:

In order to be compliant with ESD, a jumper wire was added to the USB cell. The jumper connected the USB cell to the digital ground and the analog ground. Prior to the modification, the EUT failed at ±4kV.

Modification Photos:



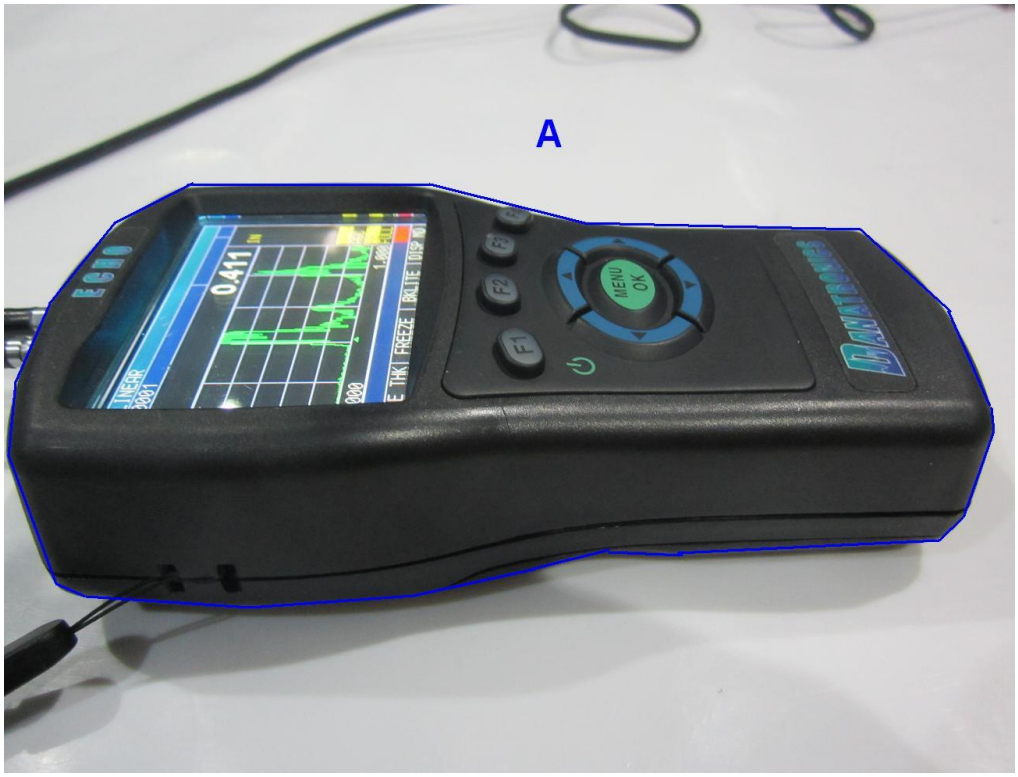
Electrostatic Discharge Test Points:



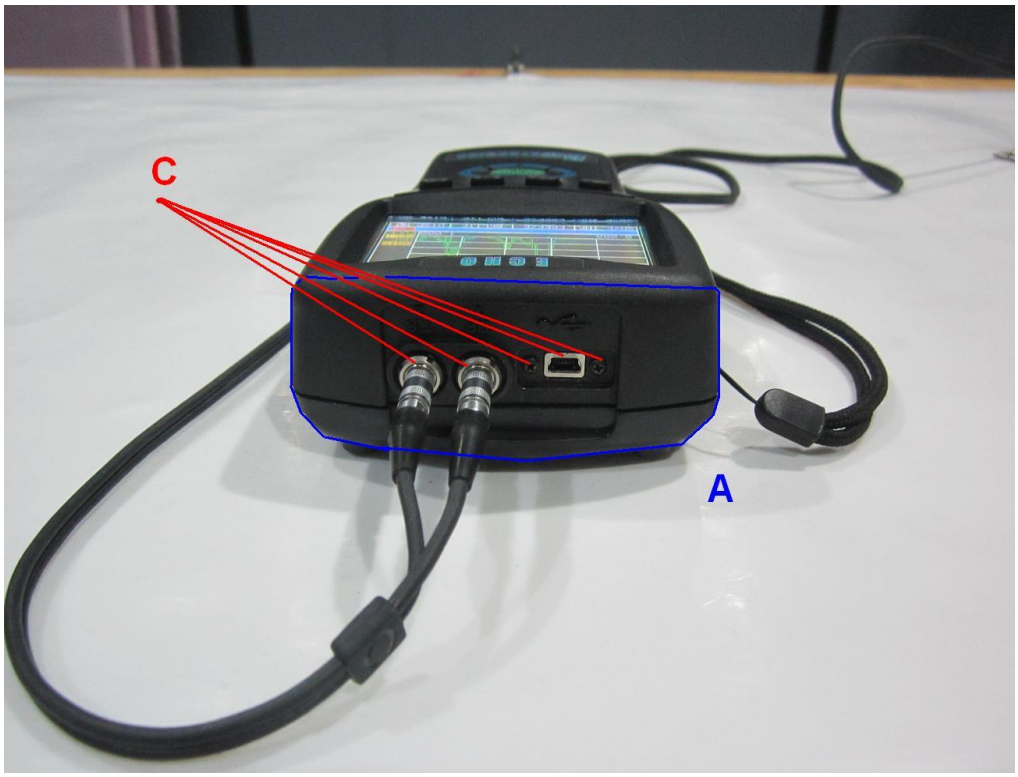
Bottom

Left

Back

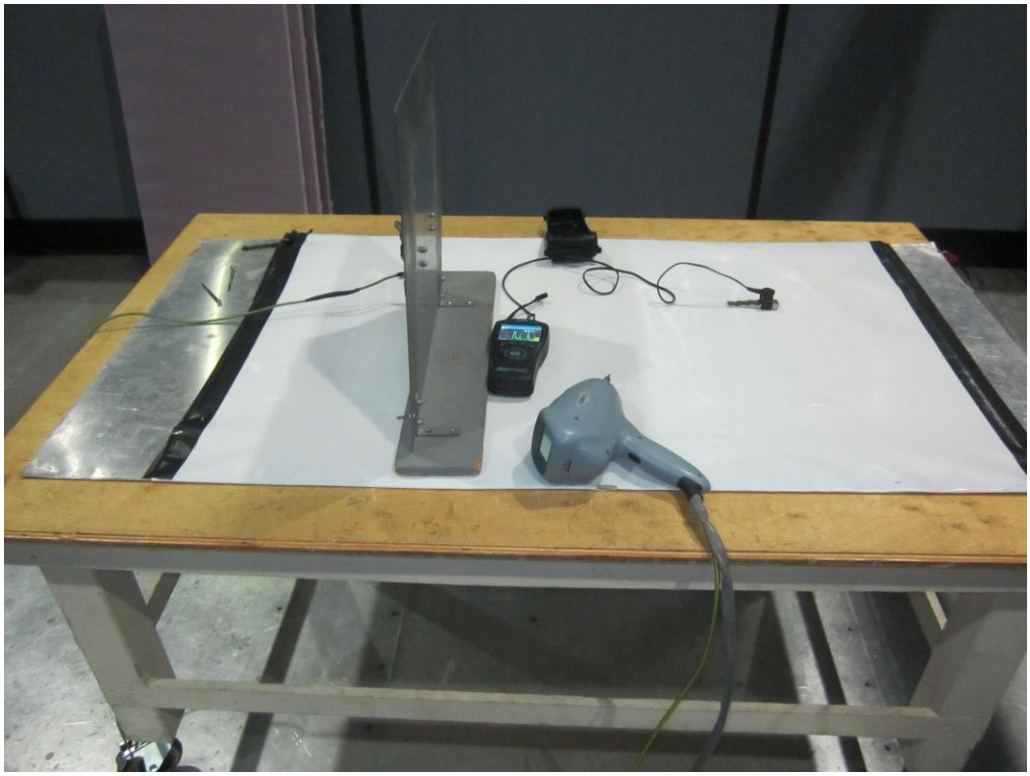


Right and Top



Front

Electrostatic Discharge Immunity Setup Photograph(s):



Electrostatic Discharge Testing Overview

REV 17-FEB-04

Electrostatic charges build up on isolated materials under various conditions. One such condition is the rubbing of two materials together. When this occurs, the materials develop opposing charges. If they are isolated, this charge does not dissipate and will continue to accumulate. At some high level of voltage, depending on the material types and spacing, the insulation will break down and the charge will rapidly migrate in an attempt to reach equilibrium. This is what is commonly referred to as "Electrostatic Discharge" (ESD).

One example of materials rubbing creating an electrostatic buildup through friction is that of shoes (rubber, plastic, leather, etc.) on carpet (nylon, etc.), as a result of walking. A human body exhibits a capacitance depending on several factors including physical size. This capacitance stores the charge created by walking or other motions which can cause charge storage. The level of the stored voltage is limited by the size of the capacitance (human body is typically 100-400 pF) and the effects of leakage and corona discharge. Once the body accumulates charge, contact with a neutral or oppositely charged item causes a rapid discharge. The shape of the discharge waveform, and the amplitude of the discharge current, depend in part on the distributed capacitance and series resistance of the human body. A lumped element model of these distributed elements is commonly referred to as a human body model. The values of the lumped elements of the human body model, as well as the maximum charge voltage, vary widely. The model currently selected for use in EN 61000-4-2 is 330 Ohm/150 pF, usually with a charge voltage of 4kV contact mode/ 8 kV air discharge mode.

EN 61000-4-2 is the basic procedure for ESD testing. The preferred discharge method specified in EN 61000-4-2 is referred to as "contact discharge". In this method, a charged internal 150pF capacitor is isolated from the probe tip by a mechanical relay (typically filled with sodium hexaflorine gas). The tip is applied to a nearby metal surface or metal points on the product that the user may touch. The relay is then closed and the arc occurs within the relay, transferring the charge on the cap down the tip. If the product has insulated surfaces, then the “air discharge” method is also employed. In this method the relay is closed while the tip is at a great distance from the product. The tip is then brought to the insulated parts of the product at high speed. If an arc over occurs (though the insulation or more typically through cracks or slots) then that area is subject to more ESD stimulation.

For air discharge the high approach speed is especially important. As the length of the ionized air gap changes, it is necessary to control this variable. Some control can be exerted by making the discharge electrode approach the device under test at high speed. This high approach speed makes test results more repeatable because it reduces the variability of the discharge impedance.

The test site is assembled on top of a ground plane made of overlapping galvanized steel sheets 2.5m x 3.5m. The ground plane is connected to safety earth. Table top equipment is tested on an .8mx1.6m non-conductive table placed on this ground plane. If the tabletop system is especially large a second, separate table is added to support the additional equipment. A sheet of galvanized steel is placed on the tabletop. This plate is connected to the lower ground plane by a wire with 470k Ohm resistors at each end. The plate is called the Horizontal Coupling Plane (HCP). An additional .5mx.5m galvanized steel plate is used as a

Vertical Coupling Plane (VCP). The VCP is also connected to the lower ground plane via a wire with 470k Ohm resistors at each end. Tabletop EUTs are isolated from the HCP by an insulator <.5mm thick. Typically a plastic sheet is employed. Floor standing equipment is tested on a 10cm insulator on top of the ground plane. For floor standing EUT configurations which do not have a tabletop component, an HCP is not part of the test setup as the ground plane is not an HCP. The EUT is grounded as normally installed.

The test begins with discharges to the HCP (if present) and VCP. All discharges are applied only in the contact discharge mode. 15 discharges are applied to the HCP 10cm from the EUT, at each of the four sides of the EUT at each voltage and polarity. Every voltage step of 2, 4, 6, 8kV is explored if below or equal to the maximum voltage to be applied. 15 discharges are also applied to the VCP held in four positions so that it illuminates in turn the four sides of the EUT. For large distributed floor standing systems, additional illumination points for the HCP and VCP are usually explored and will be noted in the test report. For EN55024, a minimum of four discharge points may be selected; this includes the coupling planes as well as the contact and air discharge points. The front center of the HCP must be one of the discharge points selected.

Once the indirect discharges to the coupling planes are done, testing moves on to direct discharges to the product itself. If the product is totally metal, only direct discharges are applied as that is the preferred mode. Air discharges are not performed to metal areas of the product. If the product has areas covered with an insulating material than those areas are subject to an air discharge test to see if an arc occurs. Contact discharges are not performed to insulated areas of the product. Some products are tested with only contact discharge (exclusively metal products) and some with only air discharge (insulated products such as those with plastic enclosures). Every voltage step in the standard is explored up to and including the maximum specified in the test. Thus 2 and 4 kV would be applied in a 4kV test. Each point subject to final ESD testing is noted in the test report.

While humidity is important in the charging of actual humans, it is much less important in the testing environment where a power supply within the ESD simulator controls very exactly the test voltage applied. For humans, the upper charging voltage achieved is limited by the bleed off of charge through the humidified atmosphere. EN 61000-4-2 requires air discharge testing to be performed with humidity in the range of 30% to 60%. Due to the lack of influence of humidity on ESD testing with ESD simulators operated with high approach speeds, we will occasionally perform testing outside of this range when atmospheric conditions warrant. Actual humidity conditions during the test are recorded on the test data sheet.

All testing is performed within the framework of a laboratory quality system modeled on ISO/IEC 17025 *General requirements for the competence of calibration and testing laboratories* and is subject to our terms and conditions. This test method is covered by our A2LA accreditation.

RADIATED RADIO-FREQUENCY IMMUNITY

Test Method:

In accordance with EN 61000-4-3:2010.

Results:

TEST	RESULT	TEST METHOD	TEST LEVEL	COMMENTS
RFI	PASS	EN 61000-4-3	80-1000MHz @ 3V/m 1.4-2.0GHz @ 3V/m 2.0-2.7GHz @ 1V/m 1KHz 80% AM	Performance Criteria A

Radiated RF Immunity Data Table(s):

Table 6

RFI DATA SHEET

Work Order: O3841
Date(s): 12-Feb-15 30-May-15
Engineer(s): Ryan Brown, Ahmed Ahmed, Evan Griffith
EUT: ECHO
Company: Danatronics **Client Present:** No

Testing Location: Littleton Distribution Center, One Distribution Center Circle, #1 - Littleton, MA 01460

Performance Criteria: A
Frequency Range: 80-1000MHz 1400-2000MHz 2000-2700MHz
Maximum Field Strength: 3V/m 3V/m 1V/m
Modulation: 1KHZ 80% AM
Dwell frequencies: none

EUT Operating Voltage/Frequency: 230Vac, 50Hz and Battery powered **EUT Cycle Time:** Continuous
Clock dwell frequencies include: 96,100, and 80MHz

Test Equipment Used:

RFI Systems	Range	Equipment Combo	Mfr	SN	Asset	Cat	Calibration Due	Calibrated on
EMI Chamber 2 - Green Amp - ETS 1503 Bilog	80 - 1000MHz	RFI Combo 9				II	7/12/2015	7/12/2014
EMI Chamber 2		DRS2014X8LH	ETS	J1173 - 0002B	1686	II		
Green Amp	0.5-1000MHz	10W1000B	AR	23423	123	II		
ETS 1503 Bilog	26MHz-6GHz	3142D	ETS	102060	1503	I		
EMI Chamber 2 - 1863 High Amp - Red Horn - EU	1 - 10GHz	RFI High Combo 27				II	2/25/2015	1/25/2014
EMI Chamber 2		DRS2014X8LH	ETS	J1173 - 0002B	1686	II		
1863 High Amp	1.0-4.2GHz	60S1G4	AR	390912	1863	II		
Red Horn	1-10GHz	3115	EMCO		1687	II		
RFI 1 - 1862 LB Amp - Red Horn - EU	1 - 4.2GHz	RFI High Combo 22A				II	3/29/2016	3/29/2015
RFI 1		3 Meter Compact	Panashield	N/A	797	II		
Red Horn	1-10GHz	3115	EMCO		1687	II		
RFI 1 -Rental Yellow Amp - Yellow-Black Bilog	80 - 1000MHz	RFI Combo 34				II	10/8/2015	10/8/2014
Yellow-Black Bilog	20-2000MHz	CBL6140A	Chase	1112	126	II		

Field Probes	Range	MN	Mfr	SN	Asset	Cat	Calibration Due	Calibrated on
Blue	0.01-1000MHz	HI-4422	Holaday	95696	1100	I	10/27/2015	10/27/2014

Signal Generators	Range	MN	Mfr	SN	Asset	Cat	Calibration Due	Calibrated on
Blue	0.1-1000MHz	HP8648A	Agilent	3426A00548	34	I	10/10/2015	10/10/2014
AFG3021B Function Generator	1µHz - 25MHz	AFG3021B	Tektronix	C034126	1331	I	4/8/2015	4/8/2014
RFI-High Sweeper 1	0.01-20.0GHz	HP83752A	Agilent	3610A01133	87	I	10/20/2015	10/20/2014
RFI-High Sweeper 2	0.01-20.0GHz	HP83752B	Agilent	3610A01297	1820	I	10/21/2015	10/21/2014

Meteorological Meters		MN	Mfr	SN	Asset	Cat	Calibration Due	Calibrated on
Weather Clock (Pressure Only)		BA928	Oregon Scientific	C3166-1	831	I	3/19/2016	3/19/2014
TH A#1833		35519-044	Control Company	130318278	1833	II	6/13/2015	6/13/2013
Weather Clock (Pressure Only)		BA928	Oregon Scientific	C3166-1	831	I	3/19/2016	3/19/2014
TH A#2079		HTC-1	HDE		2079	II	4/2/2016	4/2/2015

Cables	Range	Mfr	Cat	Calibration Due	Calibrated on
Asset #1506	9kHz - 18GHz	Florida RF	II	3/7/2015	3/7/2014
Asset #1507	9kHz - 18GHz	Florida RF	II	2/23/2015	2/23/2014
RFI-High-08	1GHz - 10GHz	C-S	II	5/23/2015	5/23/2014
Asset #1505	9kHz - 18GHz	Florida RF	II	3/8/2016	3/8/2015
Asset #1522	9kHz - 18GHz	Florida RF	II	2/15/2016	2/15/2015
CRFI-RFI-27	9kHz - 2GHz	C-S	II	9/12/2015	9/12/2014

Atmospheric Conditions:
12-Feb-2015 Temp: 22.5°C **Humidity:** 2% **Pressure:** 1001mbar
30-May-2015 Temp: 23.7°C **Humidity:** 51% **Pressure:** 1003mbar

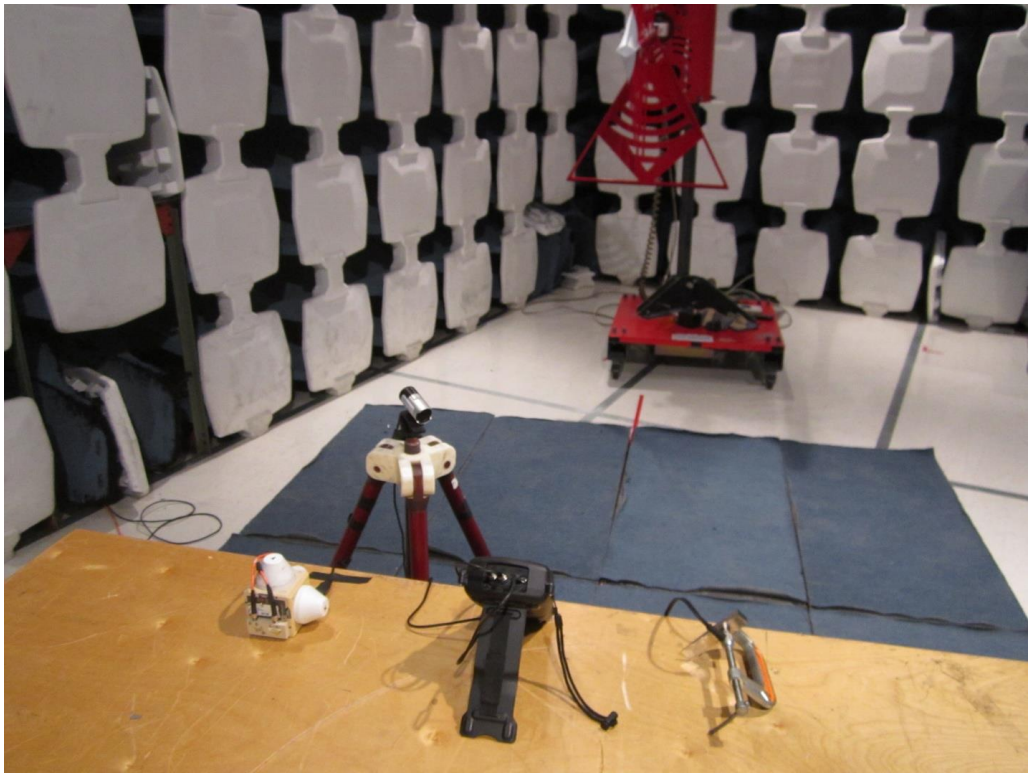
Results:

	Front	*Back*	*Left*	*Right*	*Comments*
Horizontal	Pass	Pass	Pass	Pass	EUT was tested in battery and charging modes.
Vertical	Pass	Pass	Pass	Pass	EUT was tested in battery and charging modes.

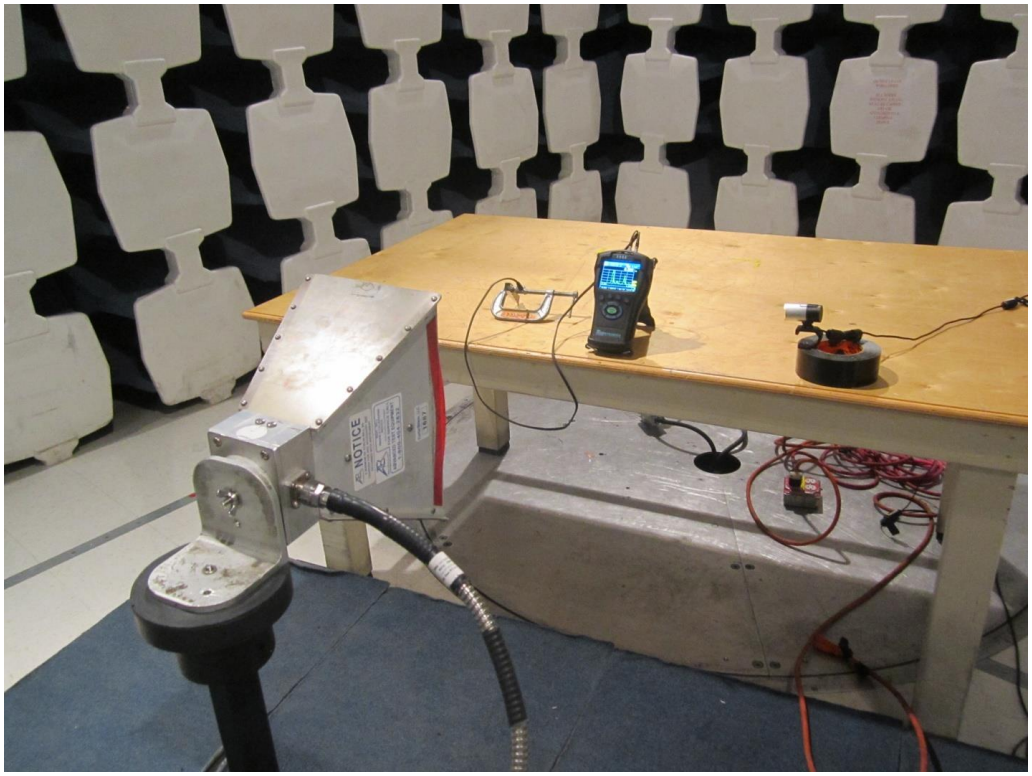
RFI Modifications:

In order to be compliant with RFI in battery mode, a single loop fair-rite was added to the Transducer cable. Prior to the modification, the EUT failed from 82-84MHz for vertical antenna polarity.

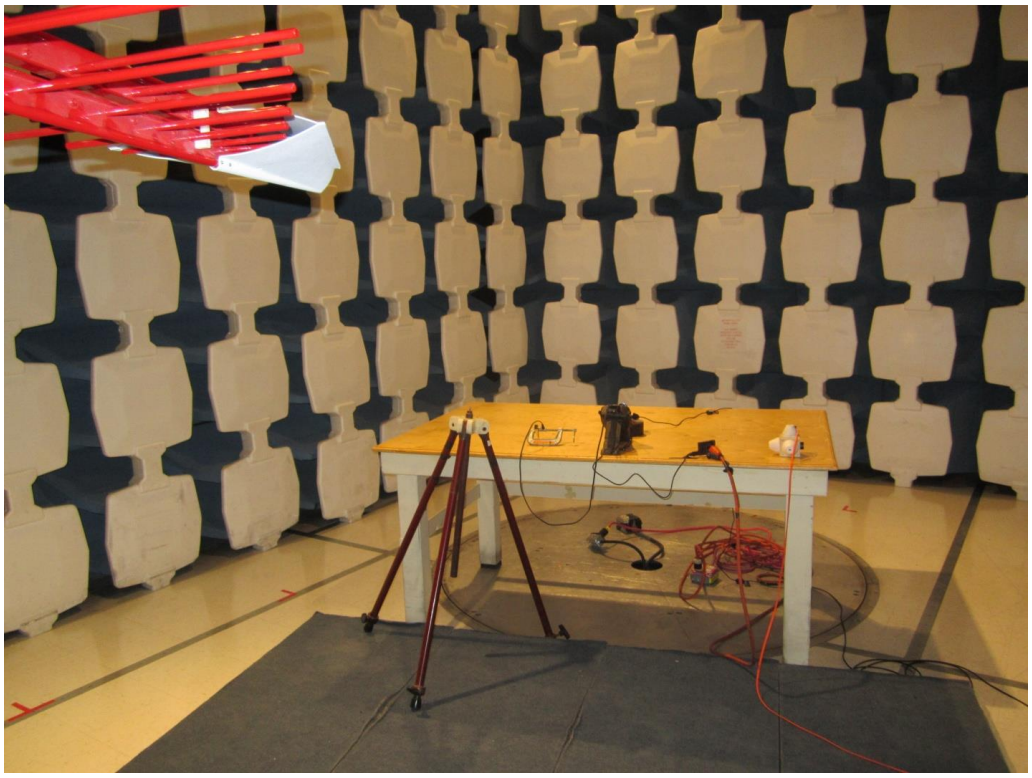
Radiated RF Immunity Setup Photograph(s):



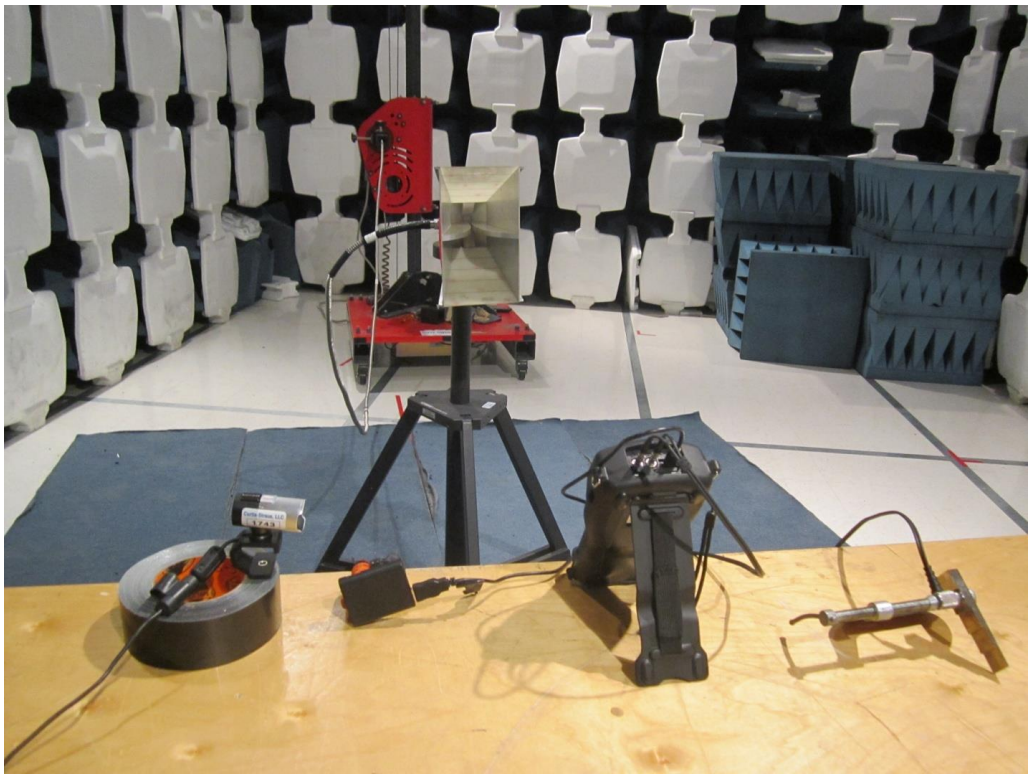
Battery Mode, 30-1000MHz



Battery mode, 1.4-2.7GHz



Charging mode, 30-1000MHz



Charging mode, 1.4-2.7GHz

Radiated RF Immunity Testing Overview

REV 13-SEP-07

Radiated fields result from many sources. In today's environment the RF spectrum is crowded by broadcast media (radio and TV), cellular phone systems, telemetry, amateur radio, radio navigation aids, industrial scientific, medical (ISM) devices, etc. All of which have the potential to disturb electronic products.

The development of test standards is based on statistical analysis of various RF sources within these allocations. In some rare cases, electrical field levels can reach hundreds of volts per meter (e.g. - an installation close to a high power broadcast transmitter). At other, remote locations, fields are usually less than 1 V/m. Modulation types and levels also vary from site to site.

The generic immunity standard for residential, commercial and light industrial environments EN 50082-1 and EN61000-6-1 specify the EN 61000-4-3 test methodology and applies a field intensity level of 3 V/m in the frequency range of 80 to 1000 MHz. The 3V/m field intensity, which corresponds to Severity Level 2 as specified in EN 61000-4-3, is generated with 1kHz, 80% depth amplitude modulation.

The generic heavy industrial immunity specification EN 61000-6-2 specifies the EN 61000-4-3 test methodologies. It applies a field intensity level of 10 V/m in the frequency range of 80 to 1000 MHz with reductions to 3 V/m in the European TV bands of 87-108 MHz, 174-230 MHz, and 470-790 MHz. The 3V/m field intensity, which corresponds to Severity Level 2 as specified in EN 61000-4-3, is generated with 1kHz, 80% depth amplitude modulation. Other test levels and frequency ranges may be explored depending on client request. Frequency ranges, field strength levels, and modulation schemes are recorded on the test data sheets.

The field levels specified in EN 61000-4-3, while generally lower than accepted safe human exposure levels, can cause harmful interference to communications and other electronics. For this reason, testing for radiated immunity must be conducted in a controlled area. This controlled area may be a RF shielded enclosure, a Transverse Electromagnetic (TEM) cell (also known as a Crawford cell) or an RF absorber lined shielded enclosure. Most testing is performed in a shielded enclosure.

Power is applied to the EUT in its normal operating condition either through an AC power cord, from an external power supply or battery. In the case of DC units, the power supply or battery is placed on the floor of the shielded enclosure.

Any Test Support Equipment (TSE) which is used to operate or monitor the performance of the EUT is placed either outside of the shielded enclosure or at such a distance that it is unaffected by the field. In cases where cable length prohibits placement of the TSE outside the enclosure, the TSE is placed on the enclosure floor or otherwise isolated from the radiated field. Unless specified by the manufacturer, all interface cabling used is twisted pair wire which is unshielded for at least 1m from the EUT. I/O cables are terminated in their normal resistance as specified by the manufacturer. All cables beyond 1m may be shielded to prevent additional coupling. All cables which exit the shielded enclosure are filtered or suppressed using ferrite beads to prevent affecting the TSE.

In cases where no TSE is used to monitor EUT performance, a closed circuit TV camera may be set up inside the shielded enclosure. The camera is used to monitor any performance

indications. The TV monitor can be located outside the enclosure and the EUT is observed for performance deviations during testing.

The RF field is generated by linearly polarized antennas such as bicon/log periodic hybrid antennas. The antenna is set up at a distance of 1m from the EUT. A signal generator is set up outside of the enclosure and connected by a coaxial cable to a 10 watt broadband amplifier. The output of the amplifier is connected via coaxial cable to the transmitting antenna. An isotropic field probe is placed near the EUT to monitor the field strength present at the EUT.

For EN 61000-4-3 and similar standards, the signal generator and amplifier are adjusted by a leveling computer to generate a constant field as the signal generator is tuned from 80 to 1000 MHz at a rate of approximately 10 minutes per decade (.0015 decades/second). Step size for the frequency tuning is 1%. As the frequency is tuned, the signal generator output amplitude is adjusted by the computer to maintain the required field strength. The amplitudes are then reproduced for the desired immunity disturbance level once the EUT is configured inside the enclosure. In each frequency band, the test is performed with the antenna in both horizontal and vertical polarization, for each of the 4 sides of the EUT.

For EN 61000-4-3, the enclosure is calibrated without the EUT present. The 1.5m x 1.5m field is uniform within 0 to +6dB of the calibration level. At the 40cm height, the field is uniform within -12 to +6dB of the calibration level. The distance between the UFA and the antenna is 3m.

In the event of an operating anomaly, the transmitting frequency and the nature of the anomaly is recorded. The field strength is reduced until the normal operation is restored. This field strength is recorded as the threshold of susceptibility. After the device is characterized in the required environment, modifications are made to the EUT to improve immunity as appropriate. In some cases, the EUT is extremely sensitive at several frequencies. In these instances, characterization testing may be terminated early to preclude damage.

All testing is performed within the framework of a laboratory quality system modeled on ISO/IEC 17025 *General requirements for the competence of calibration and testing laboratories* and is subject to our terms and conditions. This test method is covered by our A2LA accreditation.

ELECTRICAL FAST TRANSIENTS IMMUNITY

Test Method:

In accordance with EN 61000-4-4:2012.

Results:

TEST	RESULT	TEST METHOD	TEST LEVEL	COMMENTS
EFT	PASS	EN 61000-4-4	±1kV AC main	Performance Criteria B

Electrical Fast Transient Burst Immunity Data Table(s):

Table 7

EFT DATA SHEET

Work Order: O3841
Date(s): 31-Mar-15
Engineer(s): Ahmed Ahmed
EUT: ECHO
Company: Danatronics **Client Present:** No

Testing Location: Littleton Distribution Center, One Distribution Center Circle, #1 Littleton, MA 01460

Performance Criteria: B

Maximum Test Parameters: ±1kV AC

EUT Operating Voltage/Frequency: 230Vac, 50Hz

Test Equipment Used:

EFT	MN	Mfr	SN	ASSET	Cat	Calibration Due	Calibrated on
NSG 3040	NSG 3040	Teseq	2041	1842	II	5/12/2015	5/12/2014

Meteorological Meters	MN	Mfr	SN	Asset	Cat	Calibration Due	Calibrated on
Weather Clock (Pressure Only)	BA928	Oregon Scientific	C3166-1	831	I	3/19/2016	3/19/2014
TH A#1828	35519-044	Control Company	130318292	1828	II	6/13/2015	6/13/2013

Atmospheric Conditions:

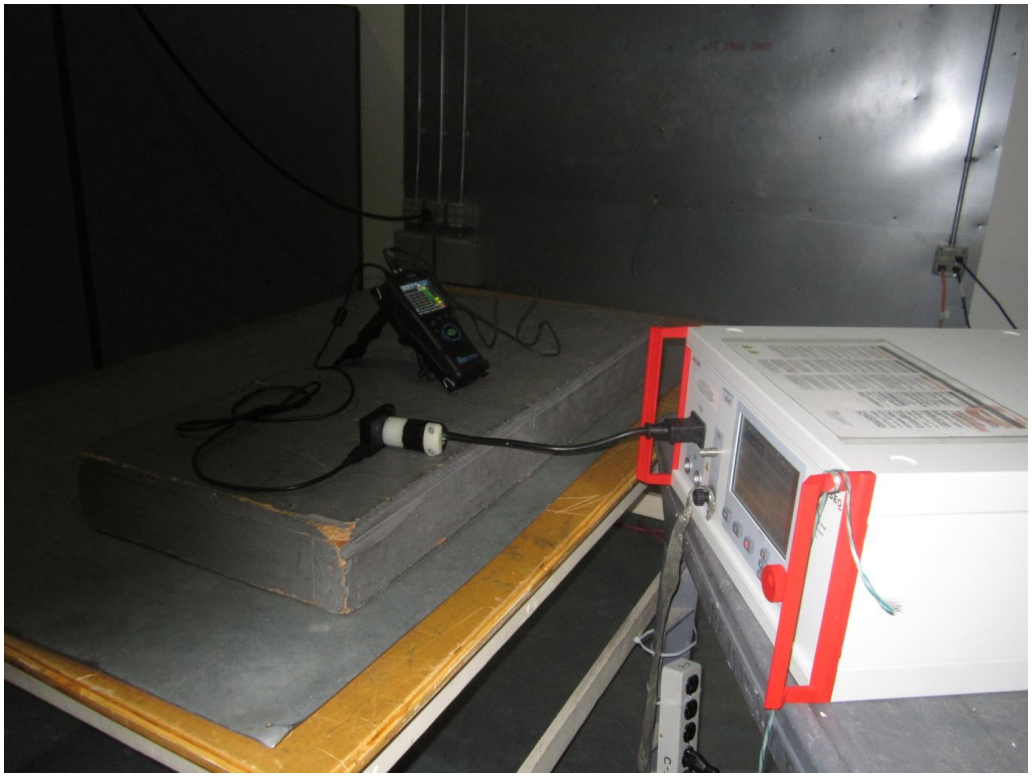
31-Mar-2015 Temp: 24.0°C **Humidity:** 22% **Pressure:** 1010mbar

Test Points:	Pass/Fail/NA	Comments:
Ac mains	Pass	

EFT Modifications:

None

Electrical Fast Transient Burst Immunity Setup Photograph(s):



Electrical Fast Transient Burst Testing Overview

REV 18-MAR-04

High-voltage transients are developed on the power mains as a result of numerous types of switching actions. The interruption of current to inductive loads, relay contact bounce, and other actions may cause transients of several thousands of volts. These transients are characterized by very fast rise times and short pulse widths. They typically occur in bursts, with repetition rates as high as 100 kHz.

With the fast rise time associated with the transient, the energy content of the waveform extends to several hundred megahertz. With this high frequency content, the generated noise exists not only on the power lines, but also as noise coupled to the control and signal lines.

The basic measurement standard for these Electrical Fast Transient Bursts (EFT) is EN 61000-4-4. This standard specifies transients with a double exponential waveshape. The rise time of the pulse is 5 nS, and the pulse width is 50 nS. The transients are injected in 15 mS bursts with a repetition rate between individual pulses of 5 kHz. The period between each burst is 300 mS.

The test equipment necessary to generate the required bursts usually uses an energy storage capacitor and high voltage source to charge the capacitor. The capacitor is charged to a specified high voltage and discharged into a discharge shaping resistor. The interaction of the storage capacitor and the discharge resistor determine the fall time of the pulse. The rise time of the waveform depends on the inductance in the discharge path, and the capacitance to ground. The standard (EN 61000-4-4) specifies that the transient generator should have a source impedance of 50 Ohms and that signal characteristics should be measured with the generator loaded with a matched 50 Ohm impedance.

EN 61000-4-4 offers a choice between two different test set-ups. The first is for a "field test" which is performed in actual installed conditions. In the case of a stationary, floor-mounted EUT, a 1m x 1m reference ground plane is placed near the EUT and grounded to the protective earth at the electrical mains outlet. The plane must be a metallic sheet of at least 0.25mm thick if made of copper or aluminum, or 0.65mm thick if made of other metal. The transient generator is located on the ground plane and grounded directly to the plane. The transient output of the generator is connected by an unshielded wire through a 33 nF capacitor to each of the power supply terminals and the protective earth terminal.

For field tests on non-stationary equipment, the EUT is in a normal configuration, and no artificial ground plane is used. The transient is injected between each power supply terminal and the protective earth terminal at the mains outlet to which the EUT is connected.

"Type tests", which are performed in a laboratory, use a somewhat different set-up. Our tests are type tests unless otherwise noted.

During laboratory tests, all equipment whether floor standing or tabletop must be mounted on a ground plane. The ground plane is 2.5m x 3.5m and is made of galvanized sheet steel. It is connected to the green wire of protective earth of the facility.

In the case of floor standing equipment, the EUT is placed on the groundplane and insulated from it by a 10 cm support. The EUT is configured and operated in accordance with its normal installation procedures. Any conductive structures located near the EUT must be a minimum of 50 cm from it. All connections to earth ground, whether the "green wire safety

ground" or cable shields, etc., are made in accordance with manufacturer's specifications. No additional connections of the chassis or ground system to the ground plane are permitted.

For tabletop equipment, the EUT is mounted approximately 0.8m above the reference ground plane. This is accomplished by placing the device on a wooden table. The requirements for ground plane size and connection to the ground plane by the EUT are the same as floor standing equipment.

The EFT test voltages are applied to the EUT in three basic configurations. First, the injection is performed on power supply inputs through a coupling network. This network consists of a capacitor to inject the signal onto the power line, and a decoupling network to prevent the injected signals from being impressed on the AC mains supply. They are built into the test equipment. The test voltage is applied between each power line individually with respect to earth ground. For higher current applications, the transient is injected using a discrete 33 nF capacitor into the power lines.

The second configuration involves injection of the EFT bursts onto I/O circuits and communication lines. This injection requires the use of a capacitive coupling clamp. The appropriate I/O cables are placed inside the coupling clamp and the specified peak voltage is injected between the coupling clamp and ground plane. The coupling clamp is placed at a distance of 1m or less from the EUT. In cases where the I/O cables exceeds 1m in length, the excess length is coiled, with a 0.4m diameter, and placed 10 cm above the ground plane. In the case of an uninterruptible power source tested to the requirements of EN50091-2, all cabling including AC input and output cabling and communication lines is conditioned using this injection method.

The third injection point is the earth connection of the EUT. In general, this earth connection is the "green wire ground" connected via the power cable. In some cases, additional grounding points may be installed. In these cases, the transient voltage is injected through the coupling network into these ground terminals as well. The EFT is injected via a coupling network similar to the power line injection method.

EN 61000-4-4 specifies that the bursts are injected for a period of 1 minute or more each configuration and polarity. Longer times are used for equipment with longer cycle times in order to apply the bursts during all EUT states. Injection is usually performed first at lower levels and then increased incrementally to the specification level. This incremental method again is performed in order to increase the probability of detecting anomalies before any potential damage is suffered at the higher voltage levels.

In the case of any anomalies, the peak level of the transient voltage is recorded, as well as the nature of the anomaly and the injection point.

All testing is performed within the framework of a *laboratory* quality system modeled on ISO/IEC 17025 *General requirements for the competence of calibration and testing laboratories* and is subject to our terms and conditions. This test method is covered by our A2LA accreditation.

SURGE IMMUNITY

Test Method:

In accordance with EN 61000-4-5:2006.

Results:

TEST	RESULT	TEST METHOD	TEST LEVEL	COMMENTS
AC Surge	PASS	EN 61000-4-5	±0.5kV L-L ±1kV L-PE	Performance Criteria B
DC Surge	N/A	EN 61000-4-5	N/A	EUT is AC powered
Signal/Telco Surge	N/A	EN 61000-4-5	N/A	No Telco ports

Surge Immunity Data Table(s):

Table 8

SURGE DATA SHEET

Work Order: O3841
Date(s): 31-Mar-15 2-Apr-15
Engineer(s): Ahmed Ahmed, Patrick Crozier
EUT: ECHO
Company: Danatronics **Client Present:** Yogin Patel

Testing Location: Littleton Distribution Center, One Distribution Center Circle, #1 Littleton, MA 01460

Performance Criteria: B

Maximum Test Parameters: *Input and Output AC Power Ports*

Open Circuit Waveshape (Tr/Th): 1.2/50µs **Repitition Rate:** 1 surge per minute

	Voltage	*Impedance / Current*	**Reps/Polarity/Phase Angle:** 5 (maximum test level)
Line-to-earth:	±1kV	12Ω	1 (lower test levels)
Line-to-line:	±0.5kV	2Ω	

EUT Operating Voltage/Frequency: 230Vac, 50Hz

Test Equipment Used:

LISNs/Measurement Probes	Range	MN	Mfr	SN	Asset	Cat	Calibration Due	Calibrated on
Surge Current Probe	NA	CM-1-L	Ion Physics	896730	1265	I	2/2/2016	2/2/2015
Surge Current Probe	NA	CM-1-L	Ion Physics	NA	1276	I	7/25/2015	7/25/2014
Oscilloscopes and Probes		**MN**	**Mfr**	**SN**	**Asset**	**Cat**	**Calibration Due**	**Calibrated on**
400MHz e*Scope		TDS 3044B	Tektronix	C010074	1275	I	5/31/2015	5/31/2014
Differential Probe		TT-SI9110	Testech	113013	1717	I	7/22/2015	7/22/2014
Surge Generators		**MN**	**Mfr**	**SN**	**Asset**	**Cat**	**Calibration Due**	**Calibrated on**
NSG 3040		NSG 3040	Teseq	2041	1842	I	5/9/2015	5/9/2014
Modula6150		Modula6150	Teseq	34525	1268	I	7/29/2015	7/29/2014
Meteorological Meters		**MN**	**Mfr**	**SN**	**Asset**	**Cat**	**Calibration Due**	**Calibrated on**
Weather Clock (Pressure Only)		BA928	Oregon Scientific	C3166-1	831	I	3/19/2016	3/19/2014
TH A#1828		35519-044	Control Company	130318292	1828	II	6/13/2015	6/13/2013
TH A#1831		35519-044	Control Company	130319991	1831	II	6/13/2015	6/13/2013

Atmospheric Conditions:

31-Mar-2015 Temp: 24.0°C **Humidity:** 22% **Pressure:** 1010mbar
2-Apr-2015 Temp: 19.8°C **Humidity:** 33% **Pressure:** 1014mbar

Test Points:

Ac mains	Test Level	Pass/Fail	Phase Angle	Comment
L-N	±0.5kV	Pass	0°, 90°, 180°, 270°	
L-PE	±0.5kV	Pass	0°, 90°, 180°, 270°	
L-PE	±1kV	Pass	0°, 90°, 180°, 270°	
N-PE	±0.5kV	Pass	0°, 90°, 180°, 270°	
N-PE	±1kV	Pass	0°, 90°, 180°, 270°	

Surge Modifications:

None

Surge Immunity Setup Photograph(s):

Power Line Lightning Transient Testing

REV 17-FEB-04

Power lines are subjected to surges which result primarily from lightning events. Typical lightning waveforms, are specified in EN 61000-4-5. The transients specified are double exponential waveforms with a rise time of 1.2 µS and a pulse width of 50 µS (open circuit). The short circuit waveform is an 8 x 20 µS double exponential. The usual level for longitudinal common mode injection AC power ports is 2 kV open circuit with a short circuit current of 1 kA. In the differential mode (between phase and neutral) the peak level is limited to 1 kV. The surges are injected in both positive and negative polarities into the AC line at phase angles between 0 and 360º. A CDI M5 Universal Surge Generator™ is used to generate the appropriate waveshapes and amplitudes.

For the EN 61000-4-5 test method, 5 repetitions are applied in each polarity and at the 0, 90, 180, and 270 points of the AC cycle. Surges are applied from each line to ground using a 12 Ohm source impedance and from each line to every other line combination (including neutral) using a 2 Ohm source impedance. DC power ports and some signal lines are also subjected to 1.2 x 50 µS lightning surges. In this case, however, the peak voltage is usually limited to 500 volts in both common and differential mode.

All testing is performed within the framework of a laboratory quality system modeled on ISO/IEC 17025 *General requirements for the competence of calibration and testing laboratories* and is subject to our terms and conditions. This test method is covered by our A2LA accreditation.

CONDUCTED RADIO FREQUENCY IMMUNITY

Test Method:

In accordance with EN 61000-4-6:2009.

Results:

TEST	RESULT	TEST METHOD	TEST LEVEL	COMMENTS
CRFI	PASS	EN 61000-4-6	0.15-80MHz @ 3Vrms 1KHz 80% AM	Performance Criteria A

Conducted RF Immunity Data Table(s):

Table 9

CRFI DATA SHEET

Work Order: O3841
Date(s): 2-Apr-15
Engineer(s): Patrick Crozier
EUT: ECHO
Company: Danatronics **Client Present:** Yogin Patel

Testing Location: Littleton Distribution Center, One Distribution Center Circle, #1 Littleton, MA 01460

Performance Criteria: A
Frequency Range: 0.15-80MHz
Signal Level: 3Vrms
Modulation: 1KHZ 80% AM
Dwell frequencies: none

EUT Operating Voltage/Frequency: 230Vac, 50Hz **EUT Cycle Time:** continuous
Clock Frequencies: 0.6, 1, 1.2, 2, 6.75, 12, 54, 80MHz

Test Equipment Used:

CRFI Systems	Range	Equipment Combo	Mfr	SN	Asset	Cat	Calibration Due	Calibrated on
Blue Amp - Asset 1653 M2	0.1-230MHz	CRFI Combo 29				II	9/22/2015	9/22/2014
Blue Amp	0.01-250MHz	75A250	AR	19165	39	II		
Asset 1653 M2	0.1-100MHz	CDN M2-25	COM-Power	511026	1653	I		
Signal Generators	**Range**	**MN**	**Mfr**	**SN**	**Asset**	**Cat**	**Calibration Due**	**Calibrated on**
Green	0.009-2000MHz	HP8648B	Agilent	3623A02072	125	I	3/11/2015	3/11/2014
Meteorological Meters		**MN**	**Mfr**	**SN**	**Asset**	**Cat**	**Calibration Due**	**Calibrated on**
Weather Clock (Pressure Only)		BA928	Oregon Scientific	C3166-1	831	I	3/19/2016	3/19/2014
THA#1831		35519-044	Control Company	130319991	1831	II	6/13/2015	6/13/2013
Cables	**Range**		**Mfr**			**Cat**	**Calibration Due**	**Calibrated on**
CRFI-RFI-11	9kHz - 2GHz		C-S			II	9/14/2015	9/14/2014
CRFI-RFI-27	9kHz - 2GHz		C-S			II	9/12/2015	9/12/2014

Atmospheric Conditions:
2-Apr-2015 Temp: 19.8°C **Humidity:** 33% **Pressure:** 1014mbar

Test Points:	Pass/Fail/NA	Comments:
AC mains	Pass	

CRFI Modifications:

None

Conducted RF Immunity Setup Photograph(s):

Conducted RF Immunity Testing Overview

REV 17-FEB-04

At lower frequencies it is difficult to design a radiating test source to simulate the coupling that occurs in the real world due to radiated fields. For all testing below 26MHz and occasionally for testing as high as 230MHz, Conducted RF (sometimes called “bulk current injection”) is utilized to simulate radiated field disturbances.

Radiated fields result from many sources. In today's environment the RF spectrum is crowded by broadcast media (radio and TV), cellular phone systems, telemetry, amateur radio, radio navigation aids, industrial scientific and medical (ISM) devices, and others, all of which have the potential to disturb electronic products.

Development of test standards is based on statistical analysis of various RF sources within these allocations. In some rare cases, electrical field levels can reach hundreds of volts per meter (e.g. - an installation close to a high power broadcast transmitter). At other, remote locations, fields are usually less than 1 V/m. Modulation types and levels also vary from site to site. For stimulation from a 150 Ohm RF source, EN 61000-4-6 has set a level of 1 V open circuit as equivalent to 1 V/m.

The EUT is configured on a 0.1 meter high non-conductive platform over a ground plane which extends at least 0.5 meters beyond the edge of the EUT. All vertical conducting surfaces are at a distance of at least 0.5 meters. Where possible, each cable leaving the EUT is terminated in an equivalent 150 Ohm common mode load. The purpose of the test is to have RF current flow through the EUT as if it was the center of a dipole made from it and its cables. Thus one cable is stimulated at a time with a 150 Ohm RF source and the current flows to the EUT and out to the cables which are passively terminated to the ground plane in 150 Ohm common mode loads. For shielded (screened) cables, the shield is the injection point. For unshielded cables either a decoupling network with a total parallel impedance of 150 Ohms or a bulk current injection clamp is utilized to inject the disturbance. For the AC mains, a decoupling network with 150 Ohm parallel RF impedance is used.

The signal generator and amplifier are adjusted by a computer using predetermined signal levels derived during a calibration routine. During calibration, a 150 Ohm load is driven by the signal generator and the coupling network or clamp being calibrated. Signal levels at specific frequencies required to produce the desired stimulation level are recorded. The stimulation level desired is one-half that the open circuit voltage as the 150 Ohm source is loaded with 150 Ohms. If a bulk current probe is used, a second measurement current probe is inserted over the cable and the signal level is reduced if the current exceeds that which would be injected into a 150 Ohm load.

For complex EUT’s, not all possible conduction paths are explored. In accordance with EN 61000-4-6, n paths are evaluated, where $2 \leq n \leq 5$. This is assumed to adequately stimulate the EUT and expose failures. The paths are picked based on an evaluation of the EUT architecture and are expected to be the most vulnerable to the conducted disturbances. The test report will detail the paths selected for stimulation.

In the event of an operating anomaly, the frequency and the nature of the anomaly is recorded. The signal strength is reduced until the normal operation is restored. The equivalent open circuit voltage is recorded as the threshold of susceptibility. After the device is characterized

in the required environment, modifications are made to the EUT to improve immunity as appropriate. In some cases, the EUT is extremely sensitive at several frequencies. In these instances, characterization testing may be terminated early to preclude damage.

All testing is performed within the framework of a laboratory quality system modeled on ISO/IEC 17025 *General requirements for the competence of calibration and testing laboratories* and is subject to our terms and conditions. This test method is covered by our A2LA accreditation.

MAGNETIC FIELD IMMUNITY

Test Method:

In accordance with EN 61000-4-8:2010.

Results:

TEST	RESULT	TEST METHOD	TEST LEVEL	COMMENTS
Power-Frequency Magnetic Field	PASS	EN 61000-4-8	3A/m	Performance Criteria A

Power Frequency Magnetic Field Immunity Data Table(s):

Table 10

Power-Frequency Magnetic Field

Work Order: O3841
Date(s): 13-Feb-15
Engineer(s): Ryan Brown
EUT: ECHO
Company: Danatronics **Client Present:** No

Testing Location: Littleton Distribution Center, One Distribution Center Circle, #1 Littleton, MA 01460

Performance Criteria: A
Maximum Test Parameters: 3A/m
Frequency: 50Hz

EUT Operating Voltage/Frequency: Battery

Test Equipment Used:

Amplifiers	Range	MN	Mfr	SN	Asset	Cat	Calibration Due	Calibrated on
Audio Amp	Audio Freq	MPA-200	Radio Shack	708545	862	III	N/A	N/A
Field Probes	**Range**	**MN**	**Mfr**	**SN**	**Asset**	**Cat**	**Calibration Due**	**Calibrated on**
Gaussmeter (ELF Meter)	25Hz–1kHz	4080	Sypris	114173	1305	I	7/23/2015	7/23/2014
Signal Generators	**Range**	**MN**	**Mfr**	**SN**	**Asset**	**Cat**	**Calibration Due**	**Calibrated on**
Brown-White	0.01Hz-15MHz	HP33120A	Agilent	SG40019842	1232	I	5/31/2015	5/31/2014
RMS Voltmeters/Current Clamp		**MN**	**Mnfr**	**SN**	**Asset**	**Cat**	**Calibration Due**	**Calibrated on**
D+I Verification DMM		115	Fluke	94470416	1294	I	5/31/2015	5/31/2014
Meteorological Meters		**MN**	**Mfr**	**SN**	**Asset**	**Cat**	**Calibration Due**	**Calibrated on**
Weather Clock (Pressure Only)		BA928	Oregon Scientific	C3166-1	831	I	3/19/2016	3/19/2014
THA#1828		35519-044	Control Company	130318292	1828	II	6/13/2015	6/13/2013

Atmospheric Conditions:
13-Feb-2015 Temp: 23.8°C **Humidity:** 2% **Pressure:** 1006mbar

Orthogonal Axes Tested:

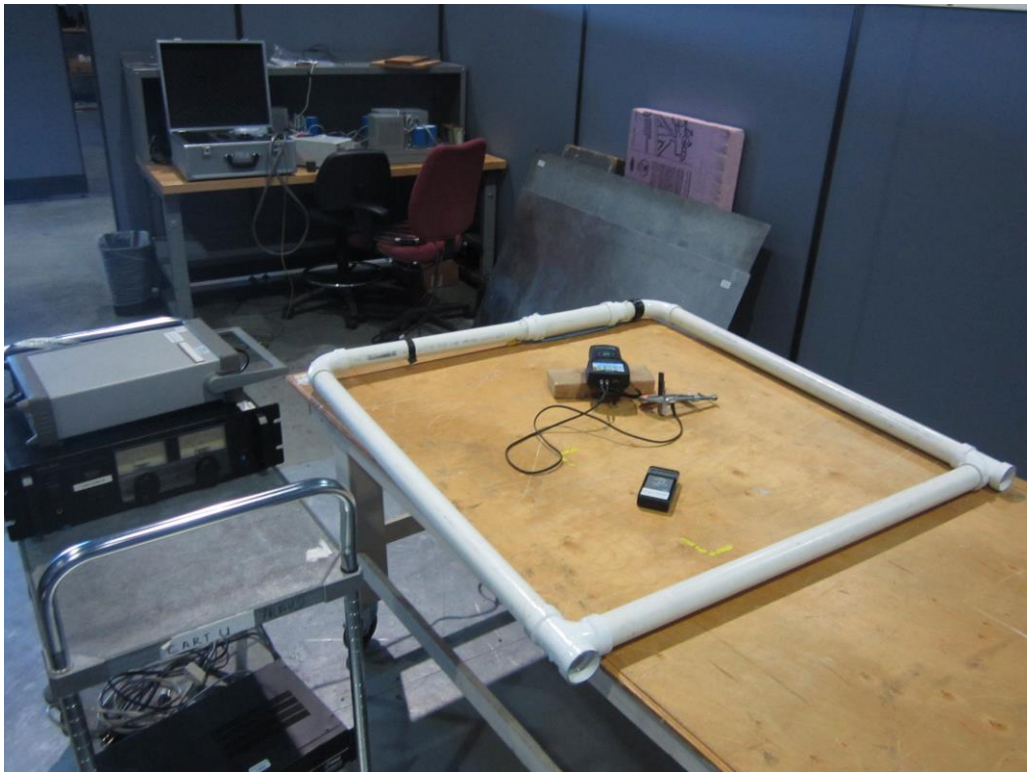
X	Y	Z	Pass/Fail
Pass	Pass	Pass	

Please note that the EUT was tested in battery mode only.

Magnetic Field Modifications:

None

Power Frequency Magnetic Field Immunity Setup Photograph(s):



Battery mode

Charging mode

Power Frequency Magnetic Field Immunity Testing Overview

REV 17-FEB-04

Magnetic Fields created by power distribution at 50 or 60 Hz can interfere with normal equipment operation. Particularly sensitive are devices which use electron beams, such as monitors. Typical manifestations of interference are the wavy images on a computer monitor screen. Only devices with known sensitivity to magnetic fields such as monitors and devices incorporating hall effect sensors are tested.

Usually, equipment is tested only for its immunity to continuous steady magnetic fields, although occasionally, test plans call for evaluation to brief peak levels such that might be observed in a substation during fault clearing.

Equipment is tested by placing it within the uniform area (to 3dB) of a magnetic loop and observing its behavior while a current known to produce a specific magnetic field level is run through the loop. The current is run at the nominal power frequency of 50Hz for equipment destined for Europe.

EN 61000-4-8 is the basic procedure for power frequency magnetic immunity testing. Typically one of two loops is used. For table top equipment less than 0.6 meters on a side (excluding cables), a 10-turn 1 meter square loop is used to produce the field. Current is supplied from an audio amplifier through a 5 Ohm resistor. The voltage is monitored across the resistor with an oscilloscope and the drive level is adjusted until the desired current through the resistor (and therefore the loop) is achieved. Calibration is performed using a Tibitts coil as the measuring pickup. For floor standing equipment, the equipment is placed within a floor-standing loop which measures 1.5x2 meters. Occasionally other loops may be used and these are noted in the test report.

Equipment is tested with stimulation in three orthogonal axes wherever possible. Deviations are noted in the test report.

All testing is performed within the framework of a laboratory quality system modeled on ISO/IEC 17025 *General requirements for the competence of calibration and testing laboratories* and is subject to our terms and conditions. This test method is covered by our A2LA accreditation.

VOLTAGE DIPS AND INTERRUPTS IMMUNITY

Test Method:

In accordance with EN 61000-4-11:2004.

Results:

TEST	RESULT	TEST METHOD	TEST LEVEL	COMMENTS
Voltage Dips and Short Interruptions	PASS	EN 61000-4-11	0%V for 0.5 and 1 cycle (B) 70%V for 25/30 cycles (C) 0%V for 250/300 cycles (C)	

Mains Supply Voltage Dips, Short Interrupts and Variations Data Table(s):

Table 11

VOLTAGE DIPS AND INTERRUPTS DATA SHEET

Work Order: O3841
Date(s): 2-Apr-15
Engineer(s): Patrick Crozier
EUT: ECHO
Company: Danatronics **Client Present:** Yogin Patel

Testing Location: Littleton Distribution Center, One Distribution Center Circle, #1 Littleton, MA 01460

Maximum Test Parameters: 100% Voltage Reduction 5.0 Seconds

Test Equipment Used:

Dips and Interrupts	MN	Mfr	SN	Asset	Cat	Calibration Due	Calibrated on
Modula6150	Modula6150	Teseq	34525	1268	I	5/3/2015	5/3/2014
RMS Voltmeters/Current Clamp	**MN**	**Mnfr**	**SN**	**Asset**	**Cat**	**Calibration Due**	**Calibrated on**
DMM	114	Fluke	25660082	1865	I	1/19/2016	1/19/2015
Meteorological Meters	**MN**	**Mfr**	**SN**	**Asset**	**Cat**	**Calibration Due**	**Calibrated on**
Weather Clock (Pressure Only)	BA928	Oregon Scientific	C3166-1	831	I	3/19/2016	3/19/2014
TH A#1831	35519-044	Control Company	130319991	1831	II	6/13/2015	6/13/2013

Atmospheric Conditions:
2-Apr-2015 Temp: 19.8°C **Humidity:** 33% **Pressure:** 1014mbar

EUT Low Voltage: 100Vac, 60Hz

%V	Duration	Criteria	Result	Comment
0%	0.5 cycle	B	Pass	90 and 270deg
0%	1 cycle	B	Pass	
70%	30 cycles	C	Pass	
0%	300 cycles	C	Pass	

EUT High Voltage: 240Vac, 50Hz

%V	Duration	Criteria	Result	Comment
0%	0.5 cycle	B	Pass	90 and 270deg
0%	1 cycle	B	Pass	
70%	25 cycles	C	Pass	
0%	250 cycles	C	Pass	

Dips and Interrupts Modifications:
None

Mains Supply Voltage Dips, Short Interrupts and Variations Setup Photograph(s):

Mains Supply Voltage Dips, Short Interrupts and Variations

REV 17-FEB-04

A device connected to an a.c. mains distribution network will often experience changes, abrupt or gradual, in the voltage level seen on the line due to activity on the network. This includes reductions, interruptions and variations in voltage associated with load switching and operation of protection devices.

A voltage dip is a sudden reduction of the supply voltage at a particular node in the distribution network which is followed by voltage recovery after a short period of time (0.5 cycles to a few seconds). A short interrupt is the disappearance of this supply voltage for a period of time (usually less than 1 minute); it is a voltage dip with 100% (>95%) amplitude. If the change to the supply voltage is gradual, it is considered a voltage variation. A voltage variation can be higher or lower than the rated voltage, and the duration of change can be short or long with regard to the period. These phenomena are often random and can be characterized in terms of duration and deviation from the rated voltage.

Rotating machines and protection elements connected to the mains network help dictate the behavior the network exhibits when large portions of the network are disconnected (local within a plant or wide area within a region). When the disconnection occurs, the slow reaction time of many rotating machines forces a gradual reduction in voltage; for a short period, these machines will actually operate as generators, sending power into the network.

Some equipment is more sensitive to gradual variations in voltage than to abrupt change. Most data processing equipment, for instance, have built in power fail detectors in order to protect and save the data properly; these detectors will often not react fast enough to a gradual decrease in mains voltage. The DC voltage to the integrated circuits may decrease to a level below the minimum operating voltage before the detector is activated and results in lost or distorted data, generally making necessary the re-programming of the data processing equipment.

We use the international standard EN 61000-4-11 which outlines the procedure and apparatus used to demonstrate the immunity of equipment to the reductions, interruptions and variations in voltage supplied by an a.c. mains distribution network. The test is performed with the EUT connected to the test generator as described in EN 61000-4-11. EN 61000-4-11 offers the preferred test levels and duration times of conditioning, although whenever possible a specific product standard should be consulted for these values. The EUT is tested for each selected combination of test level and duration with a sequence of 3 dips/interruptions with intervals of at least 10 seconds between each event. Each representative mode of operation is tested. The equipment is considered immune if, during and after the conditioning, it is able to fulfill the functional requirements established by the specific product standard.

For voltage variations we expose the equipment to each of the maximum (e.g. nominal supply voltage + 10%) and minimum (e.g. nominal supply voltage – 15%) power supply conditions for a sufficient time to obtain temperature stability. Where provision is made to adapt the equipment to suit a number of nominal supply voltages such as with a transformer tap change, the maximum and minimum values are tested for each value. For equipment which is claimed to be suitable for a range of nominal mains voltages (e.g. 120/240 V) without user intervention, the minimum condition is applied to the lower end of the range, while the maximum

condition is applied to the larger value in the range. The equipment is considered immune if, during the conditioning, it is able to fulfill the functional requirements established by the specific product standard.

All testing is performed within the framework of a laboratory quality system modeled on ISO/IEC 17025 *General requirements for the competence of calibration and testing laboratories* and is subject to our terms and conditions. This test method is covered by our A2LA accreditation.

HARMONIC EMISSIONS AND VOLTAGE FLUCTUATIONS/FLICKER

Test Method:

In accordance with EN 61000-3-2:2006/A1:2009/A2:2009 and EN 61000-3-3:2013.

Results:

TEST	RESULT	TEST METHOD	EQUIPMENT TYPE	COMMENTS
Harmonics	PASS	EN 61000-3-2	Class A	
Flicker	PASS	EN 61000-3-3	N/A	

Harmonic Emissions and Voltage Fluctuations/Flicker Data Table(s):

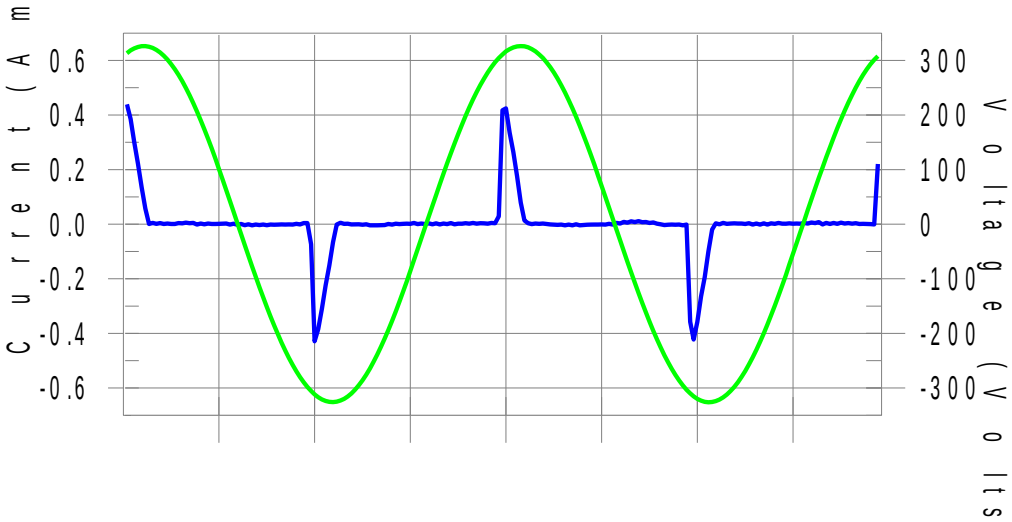
Table 12

Harmonics – Class-A per Ed. 3.2 (2009)(Run time)

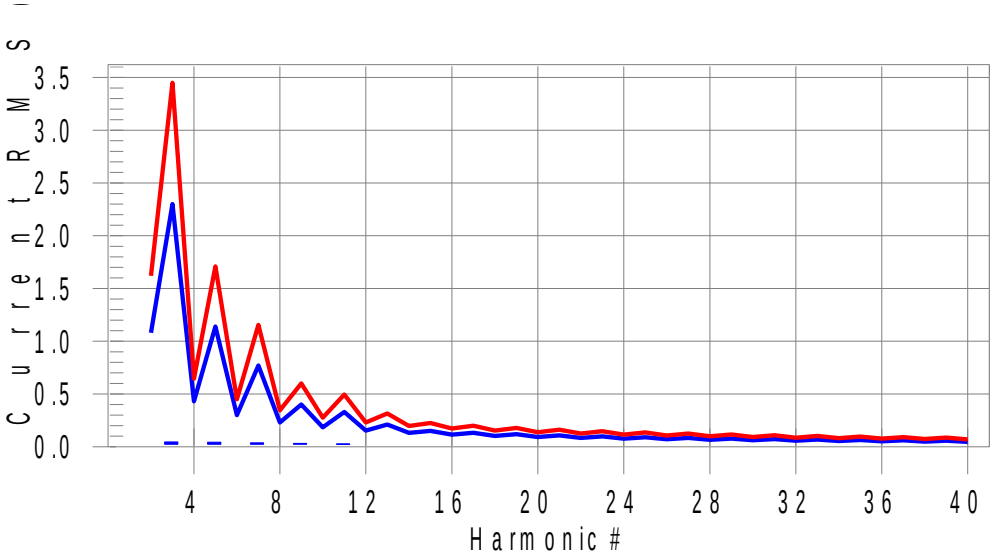
EUT: ECHO **Tested by: Patrick Crozier**
Test category: Class-A per Ed. 3.2 (2009) (European limits) **Test Margin: 100**
Test date: 4/2/2015 **Start time: 4:09:26 PM** **End time: 4:19:47 PM**
Test duration (min): 10 **Data file name: H-000516.cts_data**
Comment: 19.8°C; H: 33%; P:1014mBar; EMC3, Work Order: O3841
Customer: Danatronics

Test Result: Pass **Source qualification: Normal**

Current & voltage waveforms



Harmonics and Class A limit line **European Limits**



Test result: Pass Worst harmonic was #15 with 10.33% of the limit.

Current Test Result Summary (Run time)

EUT: ECHO **Tested by: Patrick Crozier**
Test category: Class-A per Ed. 3.2 (2009) (European limits) **Test Margin: 100**
Test date: 4/2/2015 **Start time: 4:09:26 PM** **End time: 4:19:47 PM**
Test duration (min): 10 **Data file name: H-000516.cts_data**
Comment: 19.8°C; H: 33%; P:1014mBar; EMC3, Work Order: O3841
Customer: Danatronics

Test Result: Pass **Source qualification: Normal**

THC(A): 0.09 **I-THD(%): 193.47** **POHC(A): 0.019** **POHC Limit(A): 0.251**

Highest parameter values during test:

V_RMS (Volts):	230.74	Frequency(Hz):	50.00
I_Peak (Amps):	0.460	I_RMS (Amps):	0.102
I_Fund (Amps):	0.047	Crest Factor:	4.564
Power (Watts):	10.7	Power Factor:	0.458

Harm#	Harms(avg)	100%Limit	%of Limit	Harms(max)	150%Limit	%of Limit	Status
2	0.000	1.080	0.0	0.000	1.620	0.01	Pass
3	0.044	2.300	1.9	0.045	3.450	1.31	Pass
4	0.000	0.430	0.0	0.000	0.645	0.03	Pass
5	0.041	1.140	3.6	0.042	1.710	2.44	Pass
6	0.000	0.300	0.1	0.000	0.450	0.11	Pass
7	0.037	0.770	4.8	0.037	1.155	3.21	Pass
8	0.000	0.230	0.1	0.000	0.345	0.06	Pass
9	0.032	0.400	7.9	0.032	0.600	5.27	Pass
10	0.000	0.184	0.1	0.000	0.276	0.07	Pass
11	0.026	0.330	7.8	0.026	0.495	5.28	Pass
12	0.000	0.153	0.2	0.000	0.230	0.18	Pass
13	0.020	0.210	9.7	0.021	0.315	6.57	Pass
14	0.000	0.131	0.1	0.000	0.197	0.09	Pass
15	0.015	0.150	10.3	0.016	0.225	7.04	Pass
16	0.000	0.115	0.1	0.000	0.173	0.11	Pass
17	0.012	0.132	8.9	0.012	0.199	6.06	Pass
18	0.000	0.102	0.2	0.000	0.153	0.20	Pass
19	0.009	0.118	8.0	0.010	0.178	5.45	Pass
20	0.000	0.092	0.2	0.000	0.138	0.18	Pass
21	0.009	0.107	7.9	0.009	0.161	5.39	Pass
22	0.000	0.084	0.2	0.000	0.125	0.22	Pass
23	0.008	0.098	8.4	0.008	0.147	5.72	Pass
24	0.000	0.077	0.2	0.000	0.115	0.27	Pass
25	0.008	0.090	8.9	0.008	0.135	6.05	Pass
26	0.000	0.071	0.3	0.000	0.106	0.25	Pass
27	0.007	0.083	9.0	0.008	0.125	6.14	Pass
28	0.000	0.066	0.3	0.000	0.099	0.26	Pass
29	0.007	0.078	8.6	0.007	0.116	5.93	Pass
30	0.000	0.061	0.3	0.000	0.092	0.30	Pass
31	0.006	0.073	7.8	0.006	0.109	5.45	Pass
32	0.000	0.058	0.3	0.000	0.086	0.31	Pass
33	0.005	0.068	7.0	0.005	0.102	4.95	Pass
34	0.000	0.054	0.3	0.000	0.081	0.35	Pass
35	0.004	0.064	6.5	0.004	0.096	4.58	Pass
36	0.000	0.051	0.4	0.000	0.077	0.45	Pass
37	0.004	0.061	6.4	0.004	0.091	4.43	Pass
38	0.000	0.048	0.4	0.000	0.073	0.51	Pass
39	0.004	0.058	6.5	0.004	0.087	4.42	Pass
40	0.000	0.046	0.5	0.000	0.069	0.56	Pass

Voltage Source Verification Data (Run time)

EUT: ECHO **Tested by: Patrick Crozier**
Test category: Class-A per Ed. 3.2 (2009) (European limits) **Test Margin: 100**
Test date: 4/2/2015 **Start time: 4:09:26 PM** **End time: 4:19:47 PM**
Test duration (min): 10 **Data file name: H-000516.cts_data**
Comment: 19.8°C; H: 33%; P:1014mBar; EMC3, Work Order: O3841
Customer: Danatronics

Test Result: Pass **Source qualification: Normal**

Highest parameter values during test:

Voltage (Vrms):	**230.74**	**Frequency(Hz):**	**50.00**
I_Peak (Amps):	**0.460**	**I_RMS (Amps):**	**0.102**
I_Fund (Amps):	**0.047**	**Crest Factor:**	**4.564**
Power (Watts):	**10.7**	**Power Factor:**	**0.458**

Harm#	Harmonics V-rms	Limit V-rms	% of Limit	Status
2	0.070	0.461	15.07	OK
3	0.379	2.076	18.27	OK
4	0.026	0.461	5.71	OK
5	0.013	0.923	1.35	OK
6	0.019	0.461	4.13	OK
7	0.046	0.692	6.70	OK
8	0.016	0.461	3.54	OK
9	0.026	0.461	5.74	OK
10	0.017	0.461	3.70	OK
11	0.023	0.231	10.12	OK
12	0.016	0.231	7.03	OK
13	0.009	0.231	3.87	OK
14	0.009	0.231	4.09	OK
15	0.015	0.231	6.63	OK
16	0.018	0.231	7.81	OK
17	0.015	0.231	6.51	OK
18	0.021	0.231	8.98	OK
19	0.005	0.231	2.12	OK
20	0.022	0.231	9.64	OK
21	0.014	0.231	5.93	OK
22	0.008	0.231	3.61	OK
23	0.010	0.231	4.34	OK
24	0.007	0.231	2.93	OK
25	0.010	0.231	4.39	OK
26	0.008	0.231	3.63	OK
27	0.013	0.231	5.69	OK
28	0.005	0.231	2.36	OK
29	0.003	0.231	1.50	OK
30	0.005	0.231	1.98	OK
31	0.012	0.231	4.99	OK
32	0.005	0.231	2.32	OK
33	0.008	0.231	3.44	OK
34	0.003	0.231	1.42	OK
35	0.006	0.231	2.57	OK
36	0.004	0.231	1.72	OK
37	0.009	0.231	3.71	OK
38	0.002	0.231	1.02	OK
39	0.005	0.231	2.17	OK
40	0.014	0.231	6.16	OK

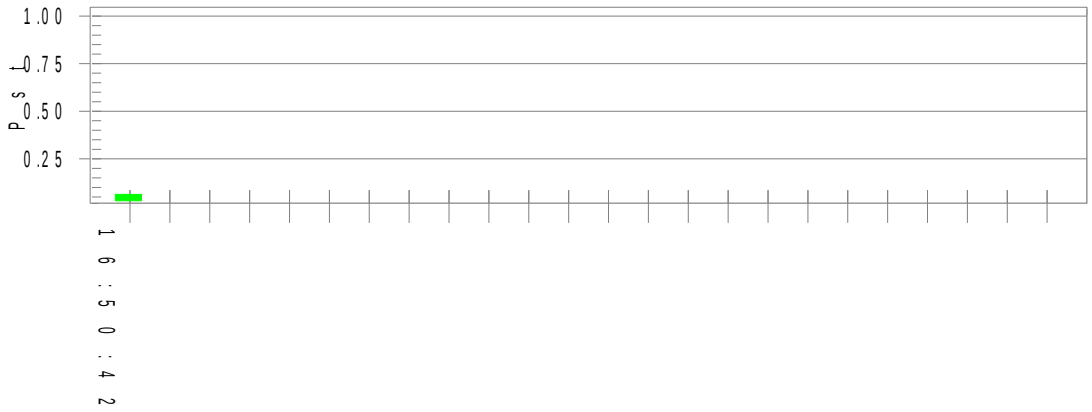
Table 13

Flicker Test Summary per EN/IEC61000-3-3 (Run time)

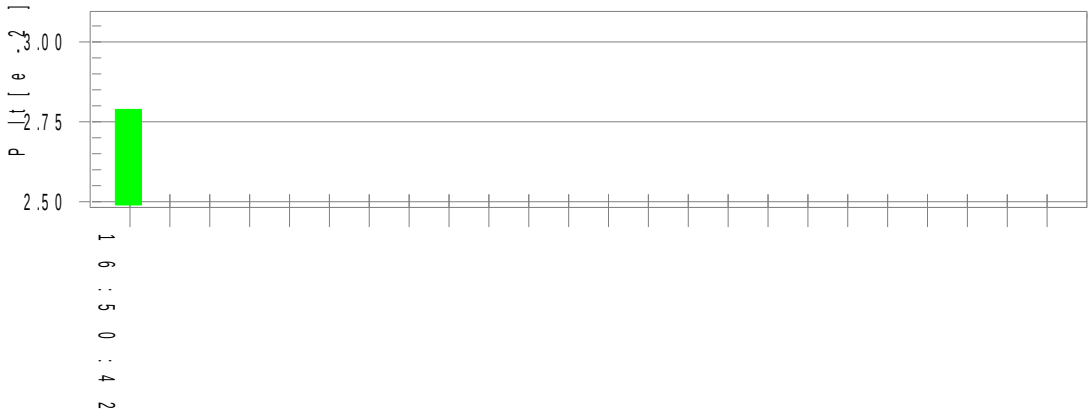
EUT: ECHO **Tested by: Patrick Crozier**
Test category: dt,dmax,dc and Pst (European limits) **Test Margin: 100**
Test date: 4/2/2015 **Start time: 4:40:22 PM** **End time: 4:50:43 PM**
Test duration (min): 10 **Data file name: F-000518.cts_data**
Comment: 19.8°C; H: 33%; P:1014mBar; EMC3, Work Order: O3841
Customer: Danatronics

Test Result: Pass **Status: Test Completed**

Pst_i and limit line **European Limits**



Plt and limit line



Parameter values recorded during the test:

Vrms at the end of test (Volt):	**230.69**			
Highest dt (%):	**0.00**	**Test limit (%):**	**3.30**	**Pass**
Time(mS) > dt:	**0.0**	**Test limit (mS):**	**500.0**	**Pass**
Highest dc (%):	**0.00**	**Test limit (%):**	**3.30**	**Pass**
Highest dmax (%):	**0.00**	**Test limit (%):**	**4.00**	**Pass**
Highest Pst (10 min. period):	**0.064**	**Test limit:**	**1.000**	**Pass**

Rev. 3/22/2015

Harmonic & Flicker and Power Analyzer	MN	Mfr	SN	Asset	Cat	Calibration Due	Calibrated on
5001IX AC POWER SYSTEM	5001IX	CI	HK53687	376	II	8/1/2015	8/1/2014
Meteorological Meters	**MN**	**Mfr**	**SN**	**Asset**	**Cat**	**Calibration Due**	**Calibrated on**
Weather Clock (Pressure Only)	BA928	Oregon Scientific	C3166-1	831	I	3/19/2016	3/19/2014

All equipment is calibrated using standards traceable to NIST or other nationally recognized calibration standard.

Harmonics and Flicker Modifications:

None

Harmonic Emissions and Voltage Fluctuations/Flicker Setup Photograph(s):

Meeting Harmonic Emissions Requirements:

REV 17-FEB-04

Power line harmonics are generated when a load draws a non-linear current from a sinusoidal voltage. Consider an ideal single phase line. If that line is a perfect sinusoidal voltage source, with zero source impedance, it would not matter how non-linear the attached equipment is. In the real world, however, wiring raises the power line impedance to a non-zero level. If a device demands an unusually high proportion of higher frequency harmonics, it will impose high frequency supply fluctuations on adjacent equipment. Some components, such as motor start/run capacitors, will dissipate excessive energy and be damaged. A second effect can be seen in three phase lines. Here, third harmonic energy winds up in phase, causing current to flow on the neutral lead. This situation has undesired safety consequences.

Switching power supplies are a common source of harmonics due to the discontinuous current drain which they present to the supply line. The increasing use of microprocessors and sensitive digital circuitry in many electronic products has given rise to increased concern over utility power quality. Low level digital circuitry is more sensitive to line variations than heavier industrial loads such as motors and standard lighting. Unfortunately, such devices also generally present non-linear loads to the power lines, which result in distortion on the supply in the form of harmonic generation and transients.

We measure the first 40 harmonic emissions of 50/60Hz in accordance with EN61000-3-2 using an HP test set.

All testing is performed within the framework of a laboratory quality system modeled on ISO/IEC 17025 *General requirements for the competence of calibration and testing laboratories* and is subject to our terms and conditions. This test is covered by our A2LA accreditation.

Meeting Voltage Fluctuation Requirements

REV 16-FEB-04

Household appliances and similar equipment, having electronic or electromechanical control devices, may produce voltage fluctuations in the supply systems they are attached to as the power demands of such equipment changes with time. In some installations the combination of these time varying current requirements and high supply system impedance can cause excessive changes in the power mains line voltage. If excessive voltage changes are repeated at short intervals of time, objectionable fluctuations of luminance (flicker) will be produced in lumination sources, e.g. an incandescent light bulb, connected to the same supply network.

EN 61000-3-3 specifies the measurements which must be made to ensure that these voltage fluctuations are kept to an acceptable level. The equipment under test is powered from a low impedance AC power main through a controlled impedance. Observations are made of the subjective flicker of a flicker meter to determine if the equipment is producing objectionable luminary flicker. The flicker meter implements a complex mathematical model of the human response to light flicker taking into account factors such as frequency, amplitude and duration of flicker events. All operating automatic modes of the equipment are evaluated. Changes caused by manual switching are not measured.

Examples of electrical equipment to which this requirement applies are appliances for cooking and heating, motor operated or magnetically driven appliances, and portable tools. Equipment which is connected to higher than 240 VAC single phase power mains or 415 VAC three phase power mains is excluded from testing as are devices which produce less than one voltage change per hour or more than 1800 per minute. Other types and applications of equipment are currently under consideration for inclusion in future drafts of the standard.

All testing is performed within the framework of a laboratory quality system modeled on ISO/IEC 17025 *General requirements for the competence of calibration and testing laboratories* and is subject to our terms and conditions. This test method is covered by our A2LA accreditation.

Measurement Uncertainty

The listed uncertainties are the worst case uncertainty for the entire range of measurement. Please note that the uncertainty values are provided for informational purposes only and are not used in determining the PASS/FAIL results.

Measurement	Expanded Uncertainty k=2	Maximum allowable uncertainty
Radiated Emissions (30-1000MHz) NIST CISPR	 5.6dB 4.6dB	 N/A 5.2dB (Ucispr)
Radiated Emissions (1-26.5GHz)	4.6dB	N/A
Radiated Emissions (above 26.5GHz)	4.9dB	N/A
Magnetic Radiated Emissions	5.6dB	N/A
Conducted Emissions NIST CISPR	 3.9dB 3.6dB	 N/A 3.6dB (Ucispr)
Telco Conducted Emissions (Current)	2.9dB	N/A
Telco Conducted Emissions (Voltage)	4.4dB	N/A
Electrostatic Discharge	11.5%	N/A
Radiated RF Immunity (Uniform Field)	1.6dB	N/A
Electrical Fast Transients	23.1%	N/A
Surge	23.1%	N/A
Conducted RF Immunity	3dB	N/A
Magnetic Immunity	12.8%	N/A
Dips and Interrupts	2.3V	N/A
Harmonics	3.5%	N/A
Flicker	3.5%	N/A
Radio frequency (@ 2.4GHz)	3.23×10^{-8}	1×10^{-7}
RF power, conducted	0.40dB	0.75dB
Maximum frequency deviation: • Within 300Hz and 6kHz of audio frequency / Within 6kHz and 25kHz of audio frequency	 3.4% 0.3dB	 5% 3dB
Adjacent channel power	1.9dB	3dB
Conducted spurious emission of transmitter, valid up to 12.75GHz	2.39dB	3dB
Conducted emission of receivers	1.3dB	3dB
Radiated emission of transmitter, valid up to 26.5GHz	3.9dB	6dB
Radiated emission of transmitter, valid up to 80GHz	3.3dB	6dB
Radiated emission of receiver, valid up to 26.5GHz	3.9dB	6dB
Radiated emission of receiver, valid up to 80GHz	3.3dB	6dB
Humidity	2.37%	5%
Temperature	0.7°C	1.0°C
Time	4.1%	10%
RF Power Density, Conducted	0.4dB	3dB
DC and low frequency voltages	1.3%	3%
Voltage (AC, <10kHz)	1.3%	2%
Voltage (DC)	0.62%	1%
The above reflects a 95% confidence level		

Jurisdictional Labeling and Required Instruction Manual Inserts

CE Marking - European Union (EU)

The CE mark is affixed by a manufacturer to its product in order to demonstrate to customs and other officials that the product marked is in conformity with all applicable European Union (EU) Directives. The CE mark must take the form shown below and must be affixed to the product unless the product is too small. If the product is too small, the CE mark may be affixed to the packaging, instructions for use or the guarantee certificate. The CE mark must be a minimum 5mm in height.

It is customary to include the written Declaration of Conformity with the shipment of the product as well in case of questions at the border. Supplying the Declaration of Conformity with the product is not required, it's just good preventative practice. It is required that the directive be held available to EU officials for a period of ten years following the placement of the product on the market.

The CE marking is available in bit-mapped form from the Curtis-Straus web site at http://www.curtis-straus.com or call us for a complementary disk.

Sample Declaration of Conformity

Declaration of conformity
Konformitätserklärung
Déclaration de conformité
Declaración de Confomidad
Verklaring de overeenstemming
Dichiarazione di conformità

We/Wir/ Nous/WIJ/Noi: ***COMPANY NAME***
ADDRESS
declare under our sole responsibility that the product,
erklären, in alleniniger Verantwortung,daß dieses Produkt,
déclarons sous notre seule responsabilité que le produit,
declaramos, bajo nuestra sola responsabilidad, que el producto,
verklaren onder onze verantwoordelijkheid, dat het product,
dichiariamo sotto nostra unica responsabilità, che il prodotto,
MODEL NUMBER
SERIAL NUMBER RANGE
to which this declaration relates is in conformity with the following standard(s) or other normative documents.
auf das sich diese Erklärung bezieht, mit der/den folgenden Norm(en) oder Richtlinie(n) übereinstimmt.
auquel se réfère cette déclaration est conforme à la (aux) norme(s) ou au(x) document(s) normatif(s).
al que se refiere esta declaración es conforme a la(s) norma(s) u otro(s) documento(s) normativo(s).
waarnaar deze verklaring verwijst, aan de volende norm(en) of richtlijn(en) beantwoordt.
a cui si riferisce questa dichiarazione è conforme alla/e seguente/i norma/o documento/i normativo/i.
LIST OF DIRECTIVES AND EN'S TO WHICH CONFORMANCE IS CLAIMED (Including Title and edition date).
SIGNATURE OF RESPONSIBLE PARTY, DATE, and PLACE OF ISSUE

EN 55022 Class A Warning Requirements

EN 55022 does not restrict the marketing of Class A information technology equipment, but does require it to include the following warning in the instructions for use.

Warning

This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

FCC Requirements

Required Equipment Authorization for Device Type

Type of Device	Equipment Authorization Required
TV broadcast receiver	Verification
FM broadcast receiver	Verification
CB receiver	Declaration of Conformity or Certification
Superregenerative receiver	Declaration of Conformity or Certification
Scanning receiver	Certification
Radar detector	Certification
All other receivers subject to part 15	Declaration of Conformity or Certification
TV interface device	Declaration of Conformity or Certification
Cable system terminal device	Declaration of Conformity
Stand-alone cable input selector switch	Verification
Class B personal computers and peripherals	Declaration of Conformity or Certification
CPU boards and internal power supplies used with Class B personal computers	Declaration of Conformity or Certification
Class B personal computers assembled using authorized CPU boards or power supplies	Declaration of Conformity
Class B external switching power supplies	Verification
Other Class B digital devices & peripherals	Verification
Class A digital devices, peripherals & external switching power supplies	Verification
Access Broadband over Power Line (Access BPL)	Certification
All other devices	Verification

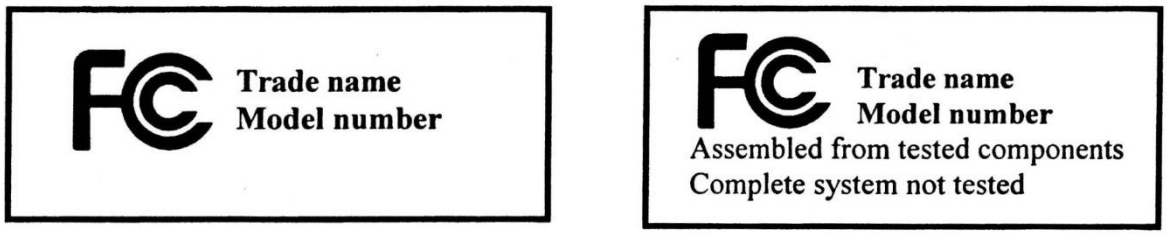
FCC Required labeling for Verified Devices 47 CFR Part 15.19

The specific labeling requirements for a device subject to the Verification or Certification procedure are contained in Section 15.19(a). These labelling requirements are:

- One of three compliance statements specified in Section 15.19(a);
- If the device is subject only to Verification include a label bearing a unique identifier - Section 2.954;
- If the device is subject to Certification (1) Section 2.925 contains information on identification of the equipment; (2) include a label bearing an FCC Identifier (FCC ID) - Section 2.926.

If the labeling area for the device is so small, and / or it is not practical to place the required statement on the device, then the statement can be placed in the user manual or product packaging - Section 15.19(a)(5). Generally, devices smaller than the palm of the hand are considered small. However, the device must still be labeled with the unique identifier (Verification) or the FCC ID (Certification).

Declaration of Conformity (DoC):
The labeling requirements for a device subject to the Declaration of Conformity (DoC) procedure are specified in Section 15.19(b). The label should include the FCC logo along with the Trade Name and Model Number, which satisfies the unique identifier requirement of Section 2.1074 if it represents the identical equipment tested for DoC compliance. For personal computers assembled from authorized components, the following additional text must also be included: "Assembled from tested components," "Complete system not tested." When the device is so small and / or when it is not practical to place the required additional text on the device, the text may be placed in the user manual or pamphlet supplied to the user. However, the FCC logo, Trade Name, and Model Number must still be displayed on the device - Section 15.19(b)(3).



Part 15 Declaration of Conformity (DoC) Label Examples

FCC Required Instruction Manual Inserts CFR 47 Part 15.21 and 15.105

Section 15.21 requires that in the user manual, the user shall be cautioned that changes / modifications not approved by the responsible party could void the user's authority to operate the equipment. The acceptable formats for user information dissemination are paper, computer disk or over the Internet. Where special accessories, such as shielded cables and/or special connectors, are required to comply with the emission limits, the instruction manual shall include appropriate instructions on the first page of the text describing the installation of the device (Section 15.27(a)).

For a Class A or Class B digital device (unintentional radiator), as well as any composite device that is both an intentional and unintentional radiator, the text specified in Section 15.105 must be placed in the user manual.

Devices authorized under the Declaration of Conformity (DoC) procedure must also include a compliance information statement (in the user manual or on a separate sheet) as required by Section 2.1077. The objective of this compliance statement is to allow the FCC to associate the equipment with the party responsible for compliance with the DoC requirements.

Devices certified as software defined radio that use an electronic labeling method to display the FCC ID must provide instructions in the user manual on how to access the electronic display (Section 2.925(e)).

Additional statements and information may be required for compliance to specific or general rule parts. The following is an example of some additional user information requirements. The party responsible for compliance must provide any additional statement(s) required.

- Kits - TV interface and Cable system terminal device marketed as Kits: Section 15.25 (d);
- TV interface devices, including cable system terminal devices: Section 15.115 (c) (5);
- Labeling of digital cable ready products: Section 15.123 - use of the term cable ready/compatible;
- External power amplifiers and antenna modifications: Section 15:204 (d) (2) – 1 notice of authorized amplifiers;
- Cordless telephones: Section 15.214 (c) & (d) (3) - privacy statement & security code statement;
- Cordless telephones: Section 15.233 (b) (2) (ii) - interference to TV;
- Cordless telephones: Section 15.233 (h) - cordless phones without digital security (Section 15.214);
- Professionally installed systems: Section 15.247 (c) (1) (iii);
- Operation within the Band 92-95 GHz: Section 15.257 (a) (4) - indoor use only;
- Unlicensed PCS: Section 15.311 - notification and coordination with UTAM, Inc.;
- RF exposure statements: Section 2.1091 (d) (3) - Mobile devices (a minimum separation distance may be required).

Our facility codes can be found in the test equipment lists in each emissions section of this report.

FCC Part 18 Required Labeling for Industrial, Scientific and Medical Equipment

Labeling Requirements for Part 18 Devices:
Equipment that intentionally generates radio frequency energy for non telecommunications functions for industrial, scientific, medical (ISM) or other purposes must be authorized and labeled according to the procedures outlined in Part 2, Subpart J, Sections 18.203 and 18.209.

Non-consumer ISM equipment is authorized under the Verification procedure. Consumer ISM equipment is authorized under either the Declaration of Conformity or Certification procedure, except that consumer ultrasonic equipment generating less than 500 watts and operating below 90 KHz is subject to the Verification procedure.

Labeling for Verification requires a unique identifier (Section 2.954) to facilitate positive identification of the Verified device. The identification should not be confused with the FCC ID used on devices subject to Certification Labels for Part 18 devices subject to Certification require an FCC Identifier as described in Section 2.926.

For Declaration of Conformity the device shall be permanently labelled with the Part 18 logo (Section 18.209) illustrated below, in addition to a unique identifier (Section 2.1074) to facilitate positive identification.

Part 18 Declaration of Conformity (DoC) Logo

All Artwork shown above for Declaration of Conformity labels is available at: http://www.fcc.gov/labhelp KDB Number 784748 (Select link on the left hand side "Detail Criteria Search" and in the Publication Number field enter 784748; then push the Submit Query button.)

User Manual and User Information for Part 18 Devices:
For all industrial, scientific, medical (ISM) devices, the instruction manual or, if no instruction manual is provided, the product packaging must provide information that addresses the following: (1) interference potential of the device, (2) maintenance of the system and (3) simple measures that can be taken to correct interference. RF lighting devices must add a statement similar to the following: "This product may cause interference to radio equipment and should not be installed near maritime safety communications equipment, ships at sea or other critical navigation or communications equipment operating between 0.45-30 MHz." (Section 18.213)

In addition, Part 18 devices that are authorized under the Declaration of Conformity procedure shall also include in the instruction manual, on a separate sheet, or on the packaging the following: identification of the product (e.g. name and model number), a statement similar to "This device complies with Part 18 of the FCC Rules" (Section 18.212), and the name and address of the responsible party (Section 2.909).

Multiple Authorization Procedures:
A device subject to multiple authorization procedures requires appropriate testing and labeling for each of the respective authorization procedures. As a general rule, the Declaration of Conformity (DoC) text statement is required over any Verification statement. For devices subject to DoC and Verification, or Certification and Verification, the labeling requirements for DoC or Certification need only apply. When a device is authorized under both DOC and Certification procedures, the DoC logo and FCC ID (or FCC IDs if applicable) are required.

This requirement does not negate the testing requirement for each individual device that is subject to both multiple authorization procedures, and / or multiple technical rules. For example, an 802.11 WIFI Router that is also a CLASS B personal computer peripheral digital device must be tested as a computer peripheral (Section 15.3) and as a Digital Transmitter (Section 15.247) and must be labeled with the DoC logo and an FCC ID.

When supplying information to users, all relevant instructions that pertain to all components of a composite device are required. For example, Class A or Class B statements in Section 15.105; all warning statements and special instructions as required by Sections 15.21 and 15.27; and all Part 18 applicable instructions must be clearly stated. Variations in editing to clarify the language and structure are permitted if all the relevant points applicable to all of the components are represented.

Australian Communications and Media Authority (ACMA)

Labeling
Before a product can be marketed it must be labeled. Labeling for EMC is intended to provide a traceable link between a device and the supplier responsible for placing it on the Australian market, that is, the Australian manufacturer, importer or agent for an overseas manufacturer.

Under the EMC framework, manufacturers and importers of a device must satisfy certain requirements before a label can be affixed to a device. In general these involve completing the supplier's Declaration of Conformity and establishing a Compliance Folder.

General Labeling Conditions
The label should meet the following specifications:

Location:	The label shall normally be placed on the external surface of the product as near as practical to the model identification. Where this is not practical, due to the size or nature of the product, the label may be placed on the labeling or packaging or warranty or instructions of this device. In addition the label may be placed on promotional material associated with the product.
Method of Marking:	The label shall be durably applied by any suitable means such as printing, painting, molding, etching and engraving. Reproduction shall be legible and conform the specifications for each mark.
Scale:	The label shall be legible with characters generally larger than 3mm.
Color:	The label may be reproduced in any color provided that visibility is assured through either contrast with the background color or marking in relief (molding, engraving etc.)
Identification of the supplier:	Devices bearing the compliance mark shall also be marked with some means of identifying the person responsible for placing the product on the Australian market: In the case of products manufactured in Australia this will be the manufacturer. For devices manufactured outside Australia this will be the importer or agent of an overseas manufacturer/supplier.

The label may be affixed to a product at any point prior to its being offered for sale on the Australian market. The ACMA recognizes that for many imported products it will be more cost effective to label the product at the time of manufacture rather than to apply the label at the time of marketing and distribution. A product may not be offered for sale unless it is properly labeled and the Compliance Folder is complete. Penalties apply to the misuse of the label.

C-Tick Mark
The C-Tick Mark is intended for use on all articles which conform with the EMC framework. The C-Tick Mark can also be used to show compliance with telecommunications and radiocommunications standards. For EMC compliance the C-Tick Mark must be accompanied by:

- The registered name and address of the place of business of the Australian supplier; or
- The Australian Company Number (ACN); or
- A supplier code issued by the ACMA; or
- Trademark/Name registered in Australia.

If the Trademark/Name option is to be used, registration details of the Trademark/Name should accompany the application. Suppliers may elect their preferred option for labeling using the C-Tick Mark. The components of the compliance label will be combined in such a manner that the C-Tick Mark and supplier identification information are contiguous.

Before a device is labeled with the C-Tick Mark the supplier must submit a written notice to the ACMA. A supplier is only required to submit one application to the ACMA advising of their intention to use the C-Tick Mark on all compliant products. The ACMA proposes that retailers and wholesalers satisfy themselves that a product is correctly labeled before offering it for sale.

Regulatory Compliance Mark
The Regulatory Compliance Mark (RCM) is described in joint Australian and New Zealand standard AS/NZS 4417. The mark is intended for use by a number of regulators and covers main-connected devices. Some devices may be ineligible to use the mark and should therefore apply the C-Tick Mark. All devices that acquire a Certificate of Suitability for electrical safety

compliance will be eligible to use the RCM to denote EMC compliance once compliance has been established.
When using the RCM, the means of identifying the person responsible for placing a device on the Australian market will be through:

- The registered name and address of the place of business of the Australian supplier; or
- The Australian Company Number (ACN); or
- A supplier code issued by the ACMA; or
- Trademark/Name registered in Australia

Where a supplier intends to use the RCM for EMC compliance they should complete the application form in AS/NZS 4417 part 3.

Further information can be found at the ACMA web site at http://www.acma.gov.au/acmainter .

Canadian Requirements

Digital products and ISM products must be labeled by a notice in French and English. The notice **must** take the form of a label on the product. As an alternative, where it is not feasible to label the product due to product size or other consideration, the notice must be reproduced in the manual. Note that considerations such as product appearance are not considered to meet the feasibility test. The notice must state that the product is in compliance with Canadian Interference-Causing Equipment regulations and may be in your own words. A suggested text is:

For ITE products:
This Class A or B digital apparatus complies with Canadian ICES-003.
Cet appareil numerique de la classe A or B est conforme a la norme NMB-003 du Canada.

For ISM products:
This ISM apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.
Ce generateur de frequence radio ISM respecte toutes les exigences du Reglement sur le materiel brouilleur du Canada.

Although the ITE limits are different from the FCC in some minor ways, equipment which complies with the FCC limits is considered by Industry Canada to be compliant with the Canadian rules. For ITE, equipment in compliance with either FCC Part 15 or CISPR 22 is considered to meet ICES-003. ISM equipment limits are the same as the EU EN55011 emission limits. Reports must be kept on file for review by the appropriate Canadian Minister for a period of five years.

Our facility codes can be found in the test equipment lists in each emissions section of this report.

VCCI Requirements

In order to comply with VCCI and appropriately label your product, you must be a member of the Voluntary Control Council for Interference (VCCI). Every company is eligible to join the VCCI. Membership dues are assessed based on company size and vary from 200,000 yen to 800,000 yen (about $2,000 to $8,000) per year. Since the VCCI fiscal year commences April 1, it may be prudent to wait for April if that month is near to avoid paying double dues.

This report contains the information you need to fill out the Conformity Verification Report. Once filled out, it must be sent to VCCI. You must also label your product with the appropriate class A or class B mark and supply the required user information in your manual. The Conformity Verification Report label marks and other VCCI forms, documents and instructions can be found at the VCCI member page http://www.vcci.jp/vcci_e/member/index.html.

Curtis-Straus, the measurement facility, is a VCCI supporting member Rank D, acceptance number 818. Our facility codes can be found in the test equipment lists in each emissions section of this report.

Conditions Of Testing

[Bureau Veritas Consumer Products Services, Inc., a Massachusetts corporation], and/or its affiliates (collectively, the "Company") will conduct, at the request of the Submitter ("Client"), the tests specified on the submitted Test Request Form or equivalent in accordance with, and subject to, the following terms and conditions (collectively, "Conditions"):

1. All orders for tests are subject to acceptance by the Company, and no order will constitute a binding commitment of the Company unless and until such order is accepted by it, as evidenced by the issuance of a written report ("Test Report") by the Company. The Test Report is issued solely by the Company, is intended for the exclusive use of Client and shall not be published, used for advertising purposes, copied or replicated for distribution to any other person or entity or otherwise publicly disclosed without the prior written consent of the Company. By submitting a request for services to the Company, Client consents to the disclosure to accreditation bodies of those records of Client relevant to the accreditation body's assessment of the Company's competence and compliance with relevant accreditation criteria. The Company shall not be liable for any loss or damage whatsoever resulting from the failure of the Company to provide its services within any time period for completion estimated by the Company. If Client anticipates using the Test Report in any legal proceeding, arbitration, dispute resolution forum or other proceeding, it shall so notify the Company prior to submitting the Test Report in such proceeding. The Company has no obligation to provide a fact or expert witness at such proceeding unless the Company agrees in advance to do so for a separate and additional fee.
2. The Test Report will set forth the findings of the Company solely with respect to the test samples identified therein. Unless specifically and expressly indicated in the Test Report, the results set forth in such Test Report are not intended to be indicative or representative of the quality or characteristics of the lot from which a test sample is taken, and Client shall not rely upon the Test Report as being so indicative or representative of the lot or of the tested product in general. The Test Report will reflect the findings of the Company at the time of testing only, and the Company shall have no obligation to update the Test Report after its issuance. The Test Report will set forth the results of the tests performed by the Company based upon the written information provided to the Company. The Test Report will be based solely on the samples and written information submitted to the Company by Client, and the Company shall not be obligated to conduct any independent investigation or inquiry with respect thereto.
3. The Company may, in its sole discretion, destroy samples which have been furnished to the Company for testing and which have not been destroyed in the course of testing. The Company may delegate the performance of all or a portion of the services contemplated hereunder to an affiliate, agent or subcontractor of the Company, and Client consents to such delegation.
4. These Conditions and the Test Report represent the entire understanding of the parties hereto with respect to the subject matter hereof and of the Test Report, and no modification, variance or extrapolation with respect thereto shall be permitted without the prior written consent of the Company.
5. The names, service marks, trademarks and copyrights of the Company and its affiliates, including the names "**BUREAU VERITAS," "BUREAU VERITAS CONSUMER PRODUCTS SERVICES," "BVCPS", "MTL", "ACTS", "MTL-ACTS" and CURTIS-STRAUS** (collectively, the "Marks") are and shall remain the sole property of the Company or its affiliates and shall not be used by Client except solely to the extent that Client obtains the prior written approval of the Company and then only in the manner prescribed by the Company. Client shall not contest the validity of the Marks or take any action that might impair the value or goodwill associated with the Marks or the image or reputation of the Company or its affiliates.
6. Payment in full shall be due 30 days after the date of invoice. Interest shall be due on overdue amounts from the due date until paid at an interest rate of 1.5% per month or, if less, the maximum rate permitted by law. The Company reserves the right, at any time and from time to time, to revoke any credit extended to Client. Client shall reimburse the Company for any costs it incurs in collecting past due amounts, including court costs and fees and expenses of attorneys and collection agencies. The Test Report may not be used or relied upon by Client if and for so long as Client fails to pay when due any invoice issued by the Company or any affiliate of it to Client or any affiliate or subsidiary of Client together with interest and penalties, if any, accrued thereon.
7. The Company disclaims any and all responsibility or liability arising out of or in connection with e-mail transmissions of such information.
8. Client understands and agrees that the Company is neither an insurer nor a guarantor, that the Company does not take the place of Client or any designer, manufacturer, agent, buyer, distributor or transportation or shipping company, and that the Company disclaims all liability in such capacities. Client further understands that if it seeks assurance against loss or damage, it should obtain appropriate insurance.
9. Client agrees that the Company, by providing the services, does not take the place of Client nor any third party, nor does the Company release them from any of their obligations, nor does the Company otherwise assume, abridge, abrogate or undertake to discharge any duty of any third party to Client or any duty of Client or any third party to any other third party, and Client will not release any third party from its obligations and duties with respect to the tested goods.
10. Client shall, on a timely basis, (a) provide adequate instructions to the Company in order to enable the Company to perform properly its services, (b) provide, or cause Client's suppliers and contractors to provide, the Company with all documents necessary to enable the Company to perform its services, (c) furnish the Company with all relevant information regarding Client's intended use and purposes of the tested goods, (d) advise the Company of essential dates and deadlines relevant to the tested goods and (e) fully exercise all rights and remedies available to Client against third parties in respect of the tested goods.
11. The Company shall undertake due care and ordinary skill in the performance of its services to Client, and the Company shall accept responsibility only were such skill has not been exercised and, even in such event, only to the extent of the limitation of liability set forth herein.
12. If Client desires to assert a claim arising from or relating to (i) the performance, purported performance or non-performance of any services by the Company or (ii) the sale, resale, manufacture, distribution or use of any tested goods, it must submit that claim to the Company in a writing that sets forth with particularity the basis for such claim within 60 days from discovery of the potential claim and not more than six months after the date of issuance of the Test Report to Client. Client waives any and all such claims including, without limitation, claims that the Test Report is inaccurate, incomplete or misleading or that additional or different testing is required, unless and then only to the extent that Client submits a written claim to the Company within both such time periods.
13. CLIENT SHALL, EXCEPT TO THE EXTENT OF COMPANY'S LIABILITY TO CLIENT HEREUNDER (WHICH IN NO EVENT SHALL EXCEED THE LIMITATION OF LIABILITY HEREIN), HOLD HARMLESS AND INDEMNIFY THE COMPANY, ITS AFFILIATES AND THEIR RESPECTIVE DIRECTORS, OFFICERS, EMPLOYEES, AGENTS AND SUBCONTRACTORS AGAINST ALL ACTUAL OR ALLEGED THIRD PARTY CLAIMS FOR LOSS, DAMAGE OR EXPENSE OF WHATSOEVER NATURE AND HOWSOEVER ARISING FROM OR RELATING TO (i) THE PERFORMANCE, PURPORTED PERFORMANCE OR NON-PERFORMANCE OF ANY SERVICES BY THE COMPANY OR (ii) THE SALE, RESALE, MANUFACTURE, DISTRIBUTION OR USE OF ANY TESTED GOODS.

14. EXCEPT AS MAY OTHERWISE BE EXPRESSLY AGREED TO IN WRITING BY THE COMPANY AND NOTWITHSTANDING ANY PROVISION TO THE CONTRARY CONTAINED HEREIN OR IN ANY TEST REPORT, NO WARRANTY OR GUARANTEE, EXPRESS OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR USE, IS MADE.
15. (A) IN NO EVENT WHATSOEVER SHALL THE COMPANY BE LIABLE FOR ANY CONSEQUENTIAL, SPECIAL, INCIDENTAL, EXEMPLARY OR PUNITIVE DAMAGES IN CONNECTION WITH, RELATING TO OR ARISING OUT OF THE TEST REPORT OR THE SERVICES PROVIDED BY THE COMPANY HEREUNDER, INCLUDING WITHOUT LIMITATION LOSS OF OR DAMAGE TO PROPERTY; LOSS OF INCOME, PROFIT OR USE; OR ANY CLAIMS OR DEMANDS MADE AGAINST CLIENT OR ANY OTHER PERSON BY ANY THIRD PARTY IN CONNECTION WITH, RELATING TO OR ARISING OUT OF THE SERVICES PROVIDED BY THE COMPANY HEREUNDER.

(B)NOTWITHSTANDING ANY PROVISION TO THE CONTRARY CONTAINED HEREIN, AND IN RECOGNITION OF THE RELATIVE RISKS AND BENEFITS TO CLIENT AND THE COMPANY ASSOCIATED WITH THE TESTING SERVICES CONTEMPLATED HEREBY, THE RISKS HAVE BEEN ALLOCATED SUCH THAT UNDER NO CIRCUMSTANCES WHATSOEVER SHALL THE LIABILITY OF THE COMPANY TO CLIENT OR ANY THIRD PARTY IN RESPECT OF ANY CLAIM FOR LOSS, DAMAGE OR EXPENSE, OF WHATSOEVER NATURE OR MAGNITUDE, AND HOWSOEVER ARISING, EXCEED AN AMOUNT EQUAL TO FIVE (5) TIMES THE AMOUNT OF THE FEES PAID TO THE COMPANY FOR THE SPECIFIC SERVICES WHICH GAVE RISE TO SUCH CLAIM OR U.S.$10,000, WHICHEVER IS THE LESSER AMOUNT.

16. The Company shall not be liable for any loss or damage resulting from any delay or failure in performance of its obligations hereunder resulting directly or indirectly from any event of force majeure or any event outside the control of the Company. If any such event occurs, the Company may immediately cancel or suspend its performance hereunder without incurring any liability whatsoever to Client.
17. Company's services, including these Conditions, shall be governed by, and construed in accordance with, the local laws of the country where the Company performs the tests or, in the case of tests performed in the United States of America, the laws of Massachusetts without regard to conflicts of laws principles. If any aspect(s) of these Conditions is found to be illegal or unenforceable, the validity, legality and enforceability of all remaining aspects of these Conditions shall not in any way be affected or impaired thereby. Any proceeding related to the subject matter hereof shall be brought, if at all, in the courts of the country where the Company performs the tests or, in the case of tests performed in the United States of America, in the courts of Massachusetts. Client waives the right to interpose any counterclaim or setoffs of any nature in any litigation arising hereunder.

The complete list of the Approved Subcontractors Curtis-Straus may use to delegate the performance of work can be provided upon request.
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