
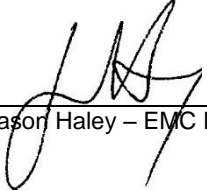




Test Report

BUREAU VERITAS Bureau Veritas Consumer Products Services Inc.

Report No	ES2174-2
Client	Powercast Corporation John Macho
Address	620 Alpha Dr. Pittsburgh, PA 15238
Phone	412-436-4077
Items tested	TX91511B
Standards	CFR 47 FCC Part 18
Test Dates	November 6 - 8, 2018
Results	As detailed within this report
Prepared by	 Kathlene McQuaid – Coordinator IV
Authorized by	 Jason Haley – EMC Manager
Issue Date	<u>5/24/2019</u>
Conditions of Issue	This Test Report is issued subject to the conditions stated in the 'Conditions of Testing' section on page 34 of this report.

Bureau Veritas Consumer Products Services Inc. is accredited by the American Association for Laboratory Accreditation for the specific scope of accreditation under Certificate Number 1627-01. This report may contain data which is not covered by the A2LA accreditation.



Bureau Veritas Consumer Products Services Inc.
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Contents

Contents.....2

Summary.....3

Product Tested.....4

 Configuration Documentation.....4

 Clock Frequencies.....4

Compliance Statement.....5

Modifications Required for Compliance.....5

RADIATED EMISSIONS.....6

CONDUCTED EMISSIONS.....22

RF Exposure Information.....30

Measurement Uncertainty.....31

Jurisdictional Labeling and Required Instruction Manual Inserts.....32

 FCC Part 18 Required Labeling for Industrial, Scientific and Medical Equipment.....32

Conditions Of Testing.....34

REV 20-APR-18
KMc



Summary

On November 6 - 8, 2018 we tested the TX91511B for compliance with the following requirements:

EMC Emissions:

- CFR 47 FCC Part 18 emissions requirements (USA)

This product operates on the 915MHz ISM band.

We found that the product met the above requirements without modification. The test sample was received in good condition. The sample was received on November 6, 2018.

Issue No.	Reason for change	Date Issued
1	Original Release	May 24, 2019



Product Tested

Configuration Documentation

EUT Configuration											
Work Order:	S2174										
Company:	Powercast Corporation										
Company Address:	620 Alpha Dr Pittsburgh, PA, 15238										
Contact:	Dan Harrist										
EUT:	MN						PN				SN
		TX91511B					--				Sample 1
EUT Description:	915MHz Transmitter										
EUT Max Frequency:	915 MHz										
EUT Min Frequency:	915 MHz										
EUT Components	MN					SN					
Radiated Unit	TX91511B					Sample 1					
Phihong AC/DC Supply	PSAC05R-050L6					Sample 1					
Port Label	Port Type	# ports	# populated	cable type	shielded	ferrites	length (m)	in/out	under test	comment	
DC power	Power DC	1	1	Power DC	No	No	1.47	in	yes		
Software Operating Mode Description:											
Transmitting at 915MHz in No Data mode (a.k.a. CW mode)											

Clock Frequencies

Clock Frequencies	
frequencies (MHz)	915



Compliance Statement

TEST	RESULT	STANDARD	TEST LEVEL	MARGIN	COMMENTS
Radiated Emissions	Pass	CFR 47 Part 18	N/A	-18.1dB @ 3661.38MHz	
Conducted Emissions	Pass	CFR 47 Part 18	N/A	-3.4 dB @ 0.436 MHz	FCC 18.307(b) limits

Modifications Required for Compliance

None



RADIATED EMISSIONS

Radiated Emissions Data Table(s):

Radiated Emissions Table												
Date: 06-Nov-18			Company: Powercast				Work Order: S2174					
Engineer: AKZ			EUT Operating Voltage/Frequency: 120Vac/60Hz									
Temp: 23°C			Humidity: 29%		Pressure: 1006mbar							
Frequency Range: 9kHz-1MHz						Measurement Distance: 3 m						
Notes: Filter asset 2130												
Antenna Polarization (0° - 90°)	Frequency (MHz)	Reading (dBµV)	Preamp Factor (dB)	Antenna Factor (dB/m)	Cable Factor (dB)	Adjusted Reading (dBµV/m)	---			FCC Part 18		
							Limit (dBµV/m)	Margin (dB)	Result (Pass/Fail)	Limit (dBµV/m)	Margin (dB)	Result (Pass/Fail)
No emissions found in this range.												
Test Site: EMI Chamber 2			Cable 1: Asset #2480				Cable 2: Asset #2459			Cable 3: ---		
Analyzer: ---			Preamp: Asset #2444				Antenna: Lg Loop			Preselector: ---		
CSsoft Radiated Emissions Calculator v 1.017.210 Adjusted Reading = Reading - Preamp Factor + Antenna Factor + Cable Factor Copyright Curtis-Straus LLC 2000												

Radiated Emissions Table												
Date: 06-Nov-18			Company: Powercast				Work Order: S2174					
Engineer: AKZ			EUT Operating Voltage/Frequency: 120Vac/60Hz									
Temp: 23°C			Humidity: 29%		Pressure: 1006mbar							
Frequency Range: 1-30MHz						Measurement Distance: 3 m						
Notes: Filter asset 2130												
Antenna Polarization (0° - 90°)	Frequency (MHz)	Reading (dBµV)	Preamp Factor (dB)	Antenna Factor (dB/m)	Cable Factor (dB)	Adjusted Reading (dBµV/m)	---			FCC Part 18		
							Limit (dBµV/m)	Margin (dB)	Result (Pass/Fail)	Limit (dBµV/m)	Margin (dB)	Result (Pass/Fail)
No emissions found in this range.												
Test Site: EMI Chamber 2			Cable 1: Asset #2480				Cable 2: Asset #2459			Cable 3: ---		
Analyzer: ---			Preamp: Asset #2444				Antenna: 5m Loop (high)			Preselector: ---		
CSsoft Radiated Emissions Calculator v 1.017.210 Adjusted Reading = Reading - Preamp Factor + Antenna Factor + Cable Factor Copyright Curtis-Straus LLC 2000												



Curtis Straus - a Bureau Veritas Company Radiated Emissions Electric Field 3m Distance Top Peaks Horizontal 30-1000MHz Operator: AKZ Notes:	Work Order - S2174 EUT Power Input - 120Vac/60Hz Test Site - CH-2 Conditions - 23°C; 29%RH; 1006mBar EUT Maximum Frequency - 915MHz
---	---

Data Taken at 10:30:26 AM, Tuesday, November 06, 2018

Frequency (MHz)	Peak Reading (dBµV)	Correction Factor (dB/m)	Adjusted Peak Amplitude (dBµV/m)	Lim1: FCC_pt18_3 05b_1 (dBµV/m)	Lim1 Margin (dB)	Lim1 Test Results (Pass/Fail)	Worst Margin Lim1 (dB)	Antenna Height (cm)	EUT Azimuth (degrees)
30.315	40.8	-1.5	39.3	68	-28.7	PASS	-28.7	200	135
132.602	35.6	-8.5	27.1	68	-40.9	PASS		150	315
700.44	37.8	-0.1	37.7	68	-30.3	PASS		150	135
814.706	32.1	2.2	34.3	68	-33.7	PASS		150	225
914.737	40.7	-97.3	-56.6	68	-124.6	PASS		150	45
999.976	29	-85.4	-56.4	68	-124.4	PASS		150	90

Curtis Straus - a Bureau Veritas Company Radiated Emissions Electric Field 3m Distance Top Peaks Vertical 30-1000MHz Operator: AKZ Notes:	Work Order - S2174 EUT Power Input - 120Vac/60Hz Test Site - CH-2 Conditions - 23°C; 29%RH; 1006mBar EUT Maximum Frequency - 915MHz
---	---

Data Taken at 10:30:26 AM, Tuesday, November 06, 2018

Frequency (MHz)	Peak Reading (dBµV)	Correction Factor (dB/m)	Adjusted Peak Amplitude (dBµV/m)	Lim1: FCC_pt18_3 05b_1 (dBµV/m)	Lim1 Margin (dB)	Lim1 Test Results (Pass/Fail)	Worst Margin Lim1 (dB)	Antenna Height (cm)	Turntable Azimuth (degrees)
30.097	41.2	-1.3	39.9	68	-28.1	PASS	-28.1	200	225
124.284	36.8	-8.4	28.5	68	-39.5	PASS		200	225
266.05	30.5	-8.9	21.6	68	-46.4	PASS		100	180
713.317	35.6	0.1	35.8	68	-32.2	PASS		200	225
814.536	31.6	2.2	33.8	68	-34.2	PASS		200	0
819.192	34.7	-4.9	29.8	68	-38.2	PASS		200	315



Curtis Straus - a Bureau Veritas Company Radiated Emissions Electric Field 3m Distance Top Peaks Horizontal 1-6GHz Operator: AKZ Notes:	Work Order - S2174 EUT Power Input - 120Vac/60Hz Test Site - CH-2 Conditions - 23°C; 29%RH; 1006mBar EUT Maximum Frequency - 915MHz
---	---

Data Taken at 11:48:42 AM, Tuesday, November 06, 2018

Frequency (MHz)	Raw Peak Reading (dBµV)	Correction Factor (dB/m)	Adjusted Peak Amplitude (dBµV/m)	Pk Lim: FCC_pt18_3 05b_1 (dBµV/m)	Margin to Peak Limit (dB)	Peak Limit Results (Pass/Fail)	Peak Limit Worst Margin (dB)	Antenna Height (cm)	EUT Azimuth (degrees)
3661.38	47.4	2.6	49.9	68	-18.1	PASS	-18.1	200	229
4576.13	45.9	3.9	49.8	68	-18.2	PASS		200	218

Curtis Straus - a Bureau Veritas Company Radiated Emissions Electric Field 3m Distance Top Peaks Vertical 1-6GHz Operator: AKZ Notes:	Work Order - S2174 EUT Power Input - 120Vac/60Hz Test Site - CH-2 Conditions - 23°C; 29%RH; 1006mBar EUT Maximum Frequency - 915MHz
---	---

Data Taken at 11:48:42 AM, Tuesday, November 06, 2018

Frequency (MHz)	Raw Peak Reading (dBµV)	Correction Factor (dB/m)	Adjusted Peak Amplitude (dBµV/m)	Pk Lim: FCC_pt18_3 05b_1 (dBµV/m)	Margin to Peak Limit (dB)	Peak Limit Test Results (Pass/Fail)	Peak Limit Worst Margin (dB)	Antenna Height (cm)	EUT Azimuth (degrees)
2743.88	49.4	-0.1	49.3	68	-18.7	PASS		100	0
3660.75	45.1	2.6	47.7	68	-20.3	PASS		300	159
5421.88	43.6	5.7	49.4	68	-18.6	PASS	-18.6	300	171



Curtis Straus - a Bureau Veritas Company Radiated Emissions Electric Field 1m Distance Top Peaks Horizontal 6-18GHz Operator: AKZ Notes:	Work Order - S2174 EUT Power Input - 12 Test Site - CH-2 Conditions - 23°C; 29' EUT Maximum Frequ
--	---

Data Taken at 02:56:14 PM, Tuesday, November 06, 2018

Frequency (MHz)	Raw Peak Reading (dBµV)	Correction Factor (dB/m)	Adjusted Peak Amplitude (dBµV/m)	Pk Lim: FCC_pt18_3 05b_1 (dBµV/m)	Margin to Peak Limit (dB)	Peak Limit Test Results (Pass/Fail)	Peak Limit Worst Margin (dB)	Antenna Height (cm)	EUT Azimuth (degrees)
6407.3	50.7	7.1	57.7	77.5	-19.8	PASS	-19.8	100	160
9985.9	43.6	10.5	54.1	77.5	-23.4	PASS		100	148

Curtis Straus - a Bureau Veritas Company Radiated Emissions Electric Field 1m Distance Top Peaks Vertical 6-18GHz Operator: AKZ Notes:	Work Order - S2174 EUT Power Input - 12 Test Site - CH-2 Conditions - 23°C; 29' EUT Maximum Frequ
--	---

Data Taken at 02:56:14 PM, Tuesday, November 06, 2018

Frequency (MHz)	Raw Peak Reading (dBµV)	Correction Factor (dB/m)	Adjusted Peak Amplitude (dBµV/m)	Pk Lim: FCC_pt18_3 05b_1 (dBµV/m)	Margin to Peak Limit (dB)	Peak Limit Test Results (Pass/Fail)	Peak Limit Worst Margin (dB)	Antenna Height (cm)	EUT Azimuth (degrees)
6407.4	48.1	7.1	55.1	77.5	-22.4	PASS	-22.4	150	6
9961.7	43.9	10.4	54.3	77.5	-23.2	PASS		175	91



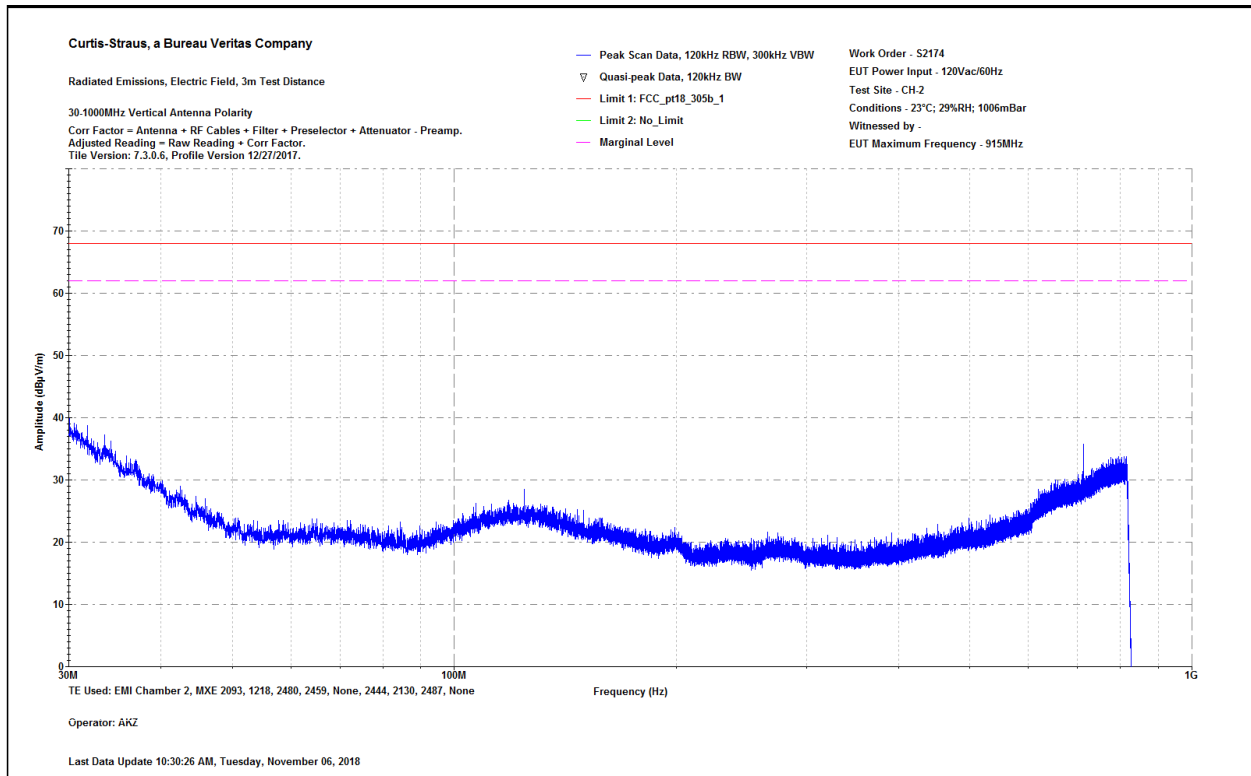
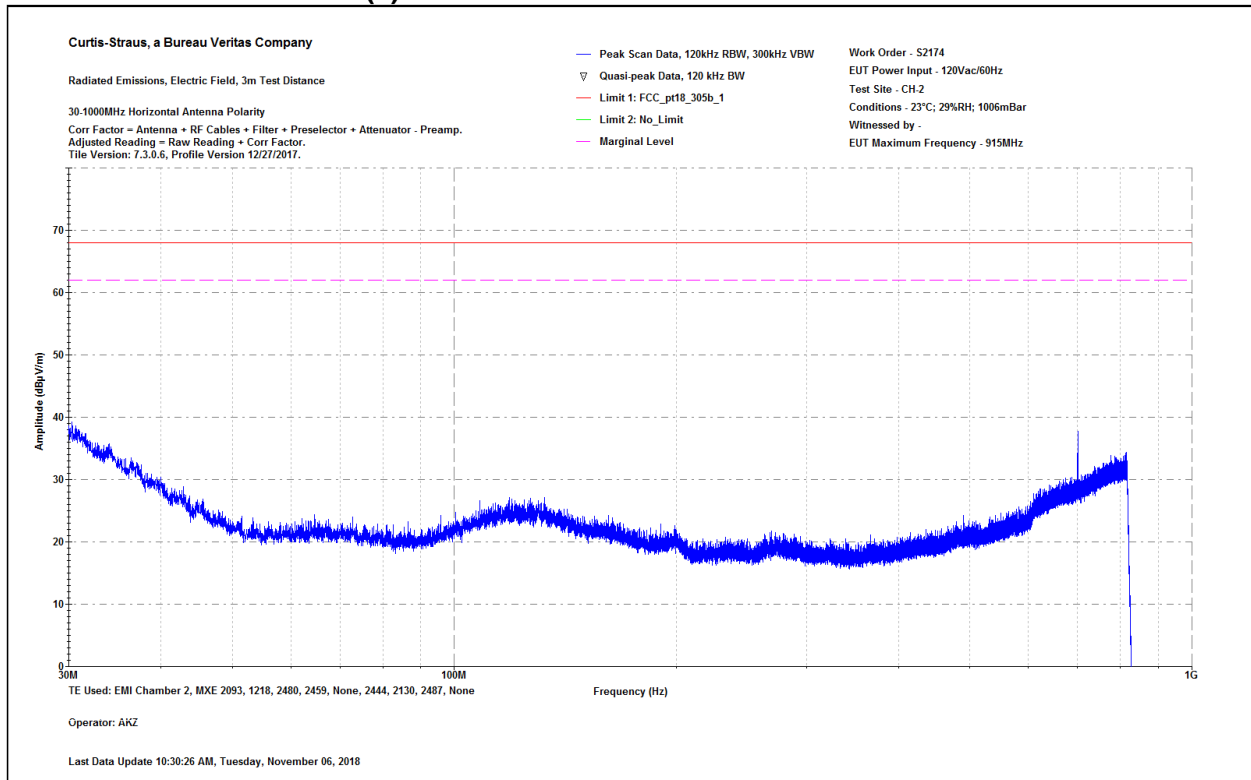
Rev. 10/31/2018

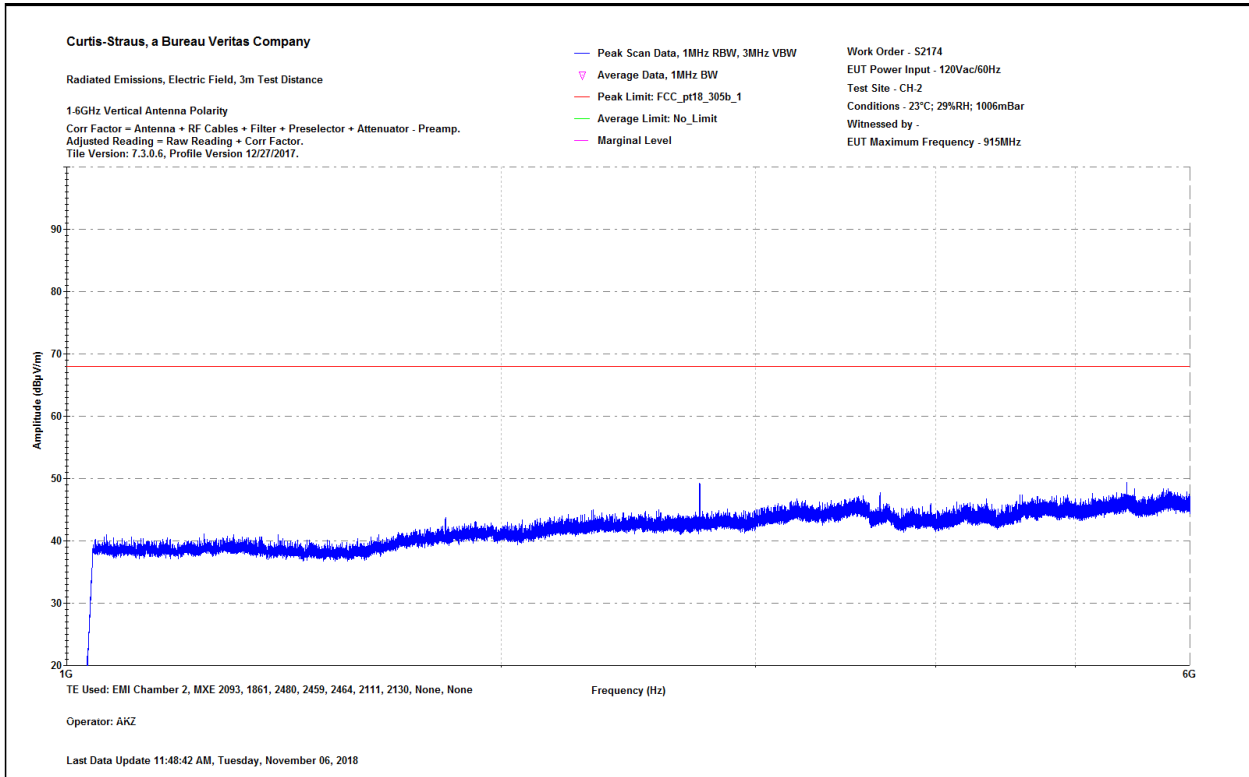
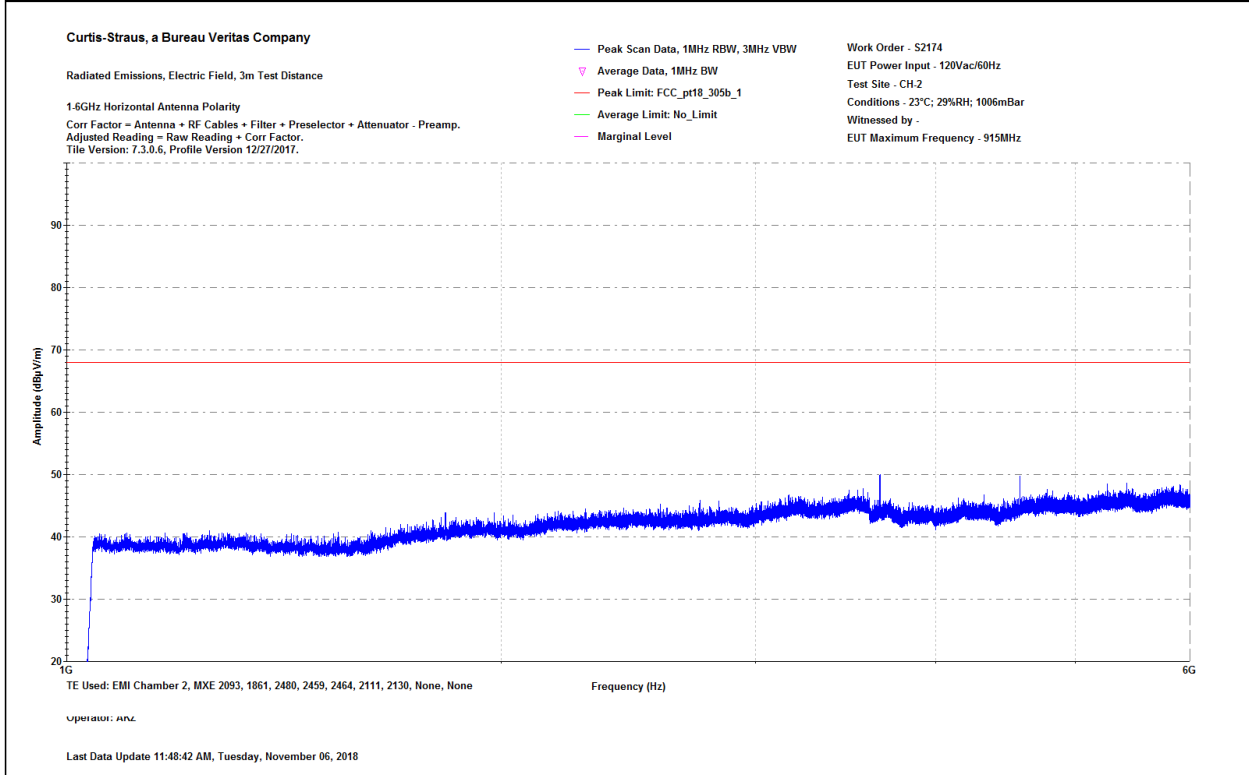
Spectrum Analyzers / Receivers / Preselectors									
	Range	MN	Mfr	SN	Asset	Cat	Calibration Due	Calibrated on	
2093 MXE EMI Receiver	20Hz-26.5GHz	N9038A	Agilent	MY51210181	2093	I	11/16/2018	11/16/2017	
Radiated Emissions Sites									
	FCC Code	IC Code	VCCI Code	Range	Asset	Cat	Calibration Due	Calibrated on	
EMI Chamber 2	719150	2762A-7	A-0015	30-1000MHz	1686	I	12/21/2018	12/21/2016	
EMI Chamber 2	719150	2762A-7	A-0015	1-18GHz	1686	I	12/21/2018	12/21/2016	
Preamps / Couplers Attenuators / Filters									
	Range	MN	Mfr	SN	Asset	Cat	Calibration Due	Calibrated on	
2310 PA	1-1000MHz	PAM-103	COM-POWER	441175	2310	II	10/29/2019	10/29/2018	
2444 PA	9KHz-6GHz	BBV9744	SCWARZBECK	67	2444	I	2/5/2019	2/5/2018	
2111 HF Preamp	0.5-18GHz	PAM-118A	COM-POWER	551063	2111	II	11/19/2018	11/19/2017	
Antennas									
	Range	MN	Mfr	SN	Asset	Cat	Calibration Due	Calibrated on	
Red-Brown Bilog	30-2000MHz	JB1	Sunol	A0032406	1218	I	1/13/2019	1/13/2017	
Meteorological Meters/Chambers									
		MN	Mfr	SN	Asset	Cat	Calibration Due	Calibrated on	
Weather Clock (Pressure Only)		BA928	Oregon Scientific	C3166-1	831	I	5/15/2020	5/15/2018	
TH A#2082		HTC-1	HDE		2082	II	3/22/2019	3/22/2018	
Cables									
	Range		Mfr			Cat	Calibration Due	Calibrated on	
Asset #2459	9KHz-18GHz		MegaPhase			II	10/31/2019	10/31/2018	
Asset #2464	9KHz-18GHz		MegaPhase			II	10/31/2019	10/31/2018	
Asset #2480	9KHz-18GHz		MegaPhase			II	10/29/2019	10/29/2018	
2487(6dB)	9KHz-18GHz					II	11/27/2018	11/27/2017	

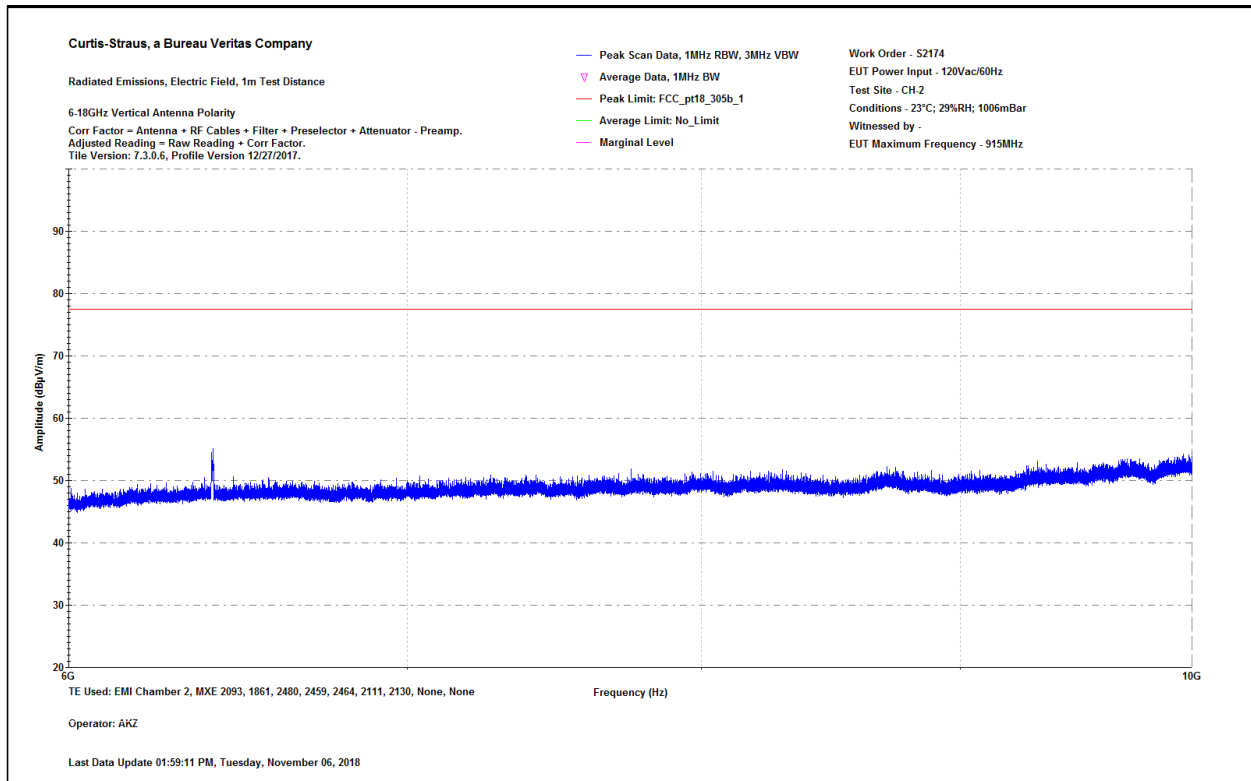
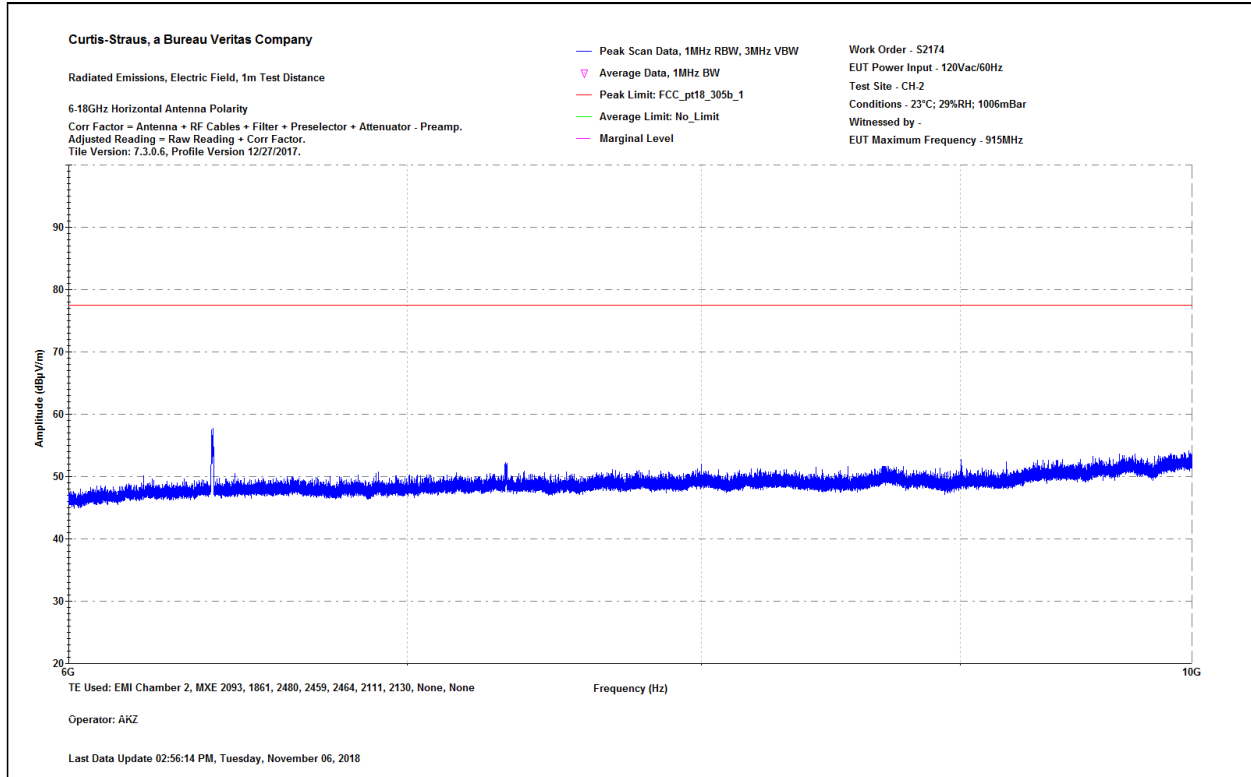
All equipment is calibrated using standards traceable to NIST or other nationally recognized calibration standard.



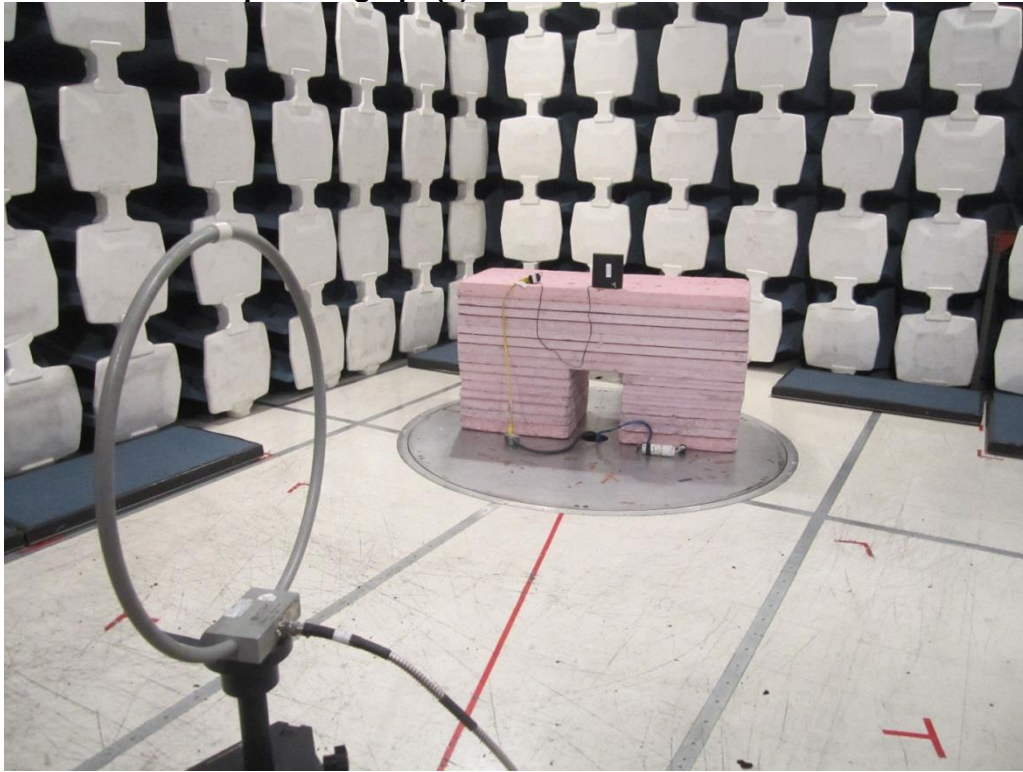
Radiated Emissions Plots(s):



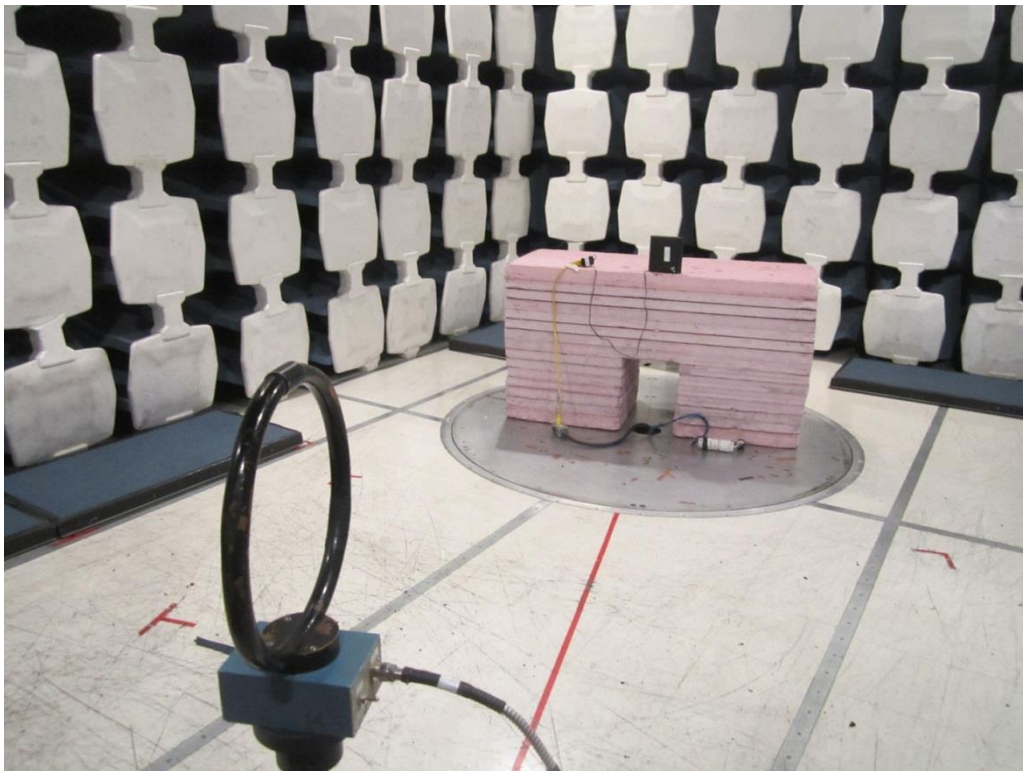




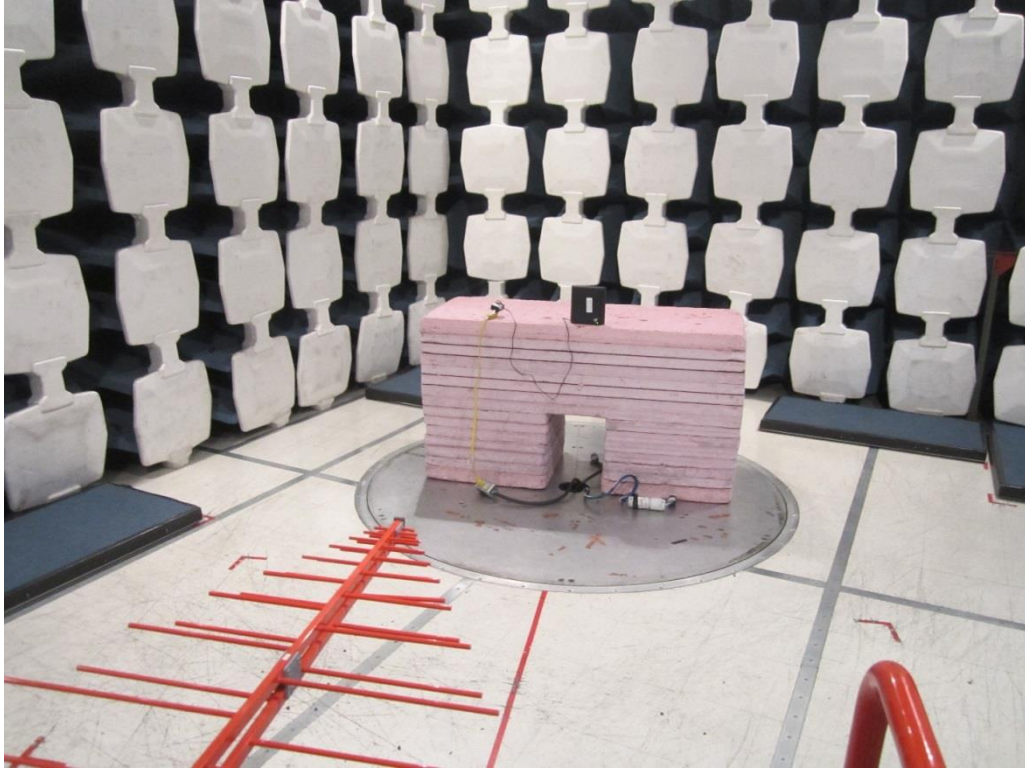
Radiated Emissions Setup Photograph(s):



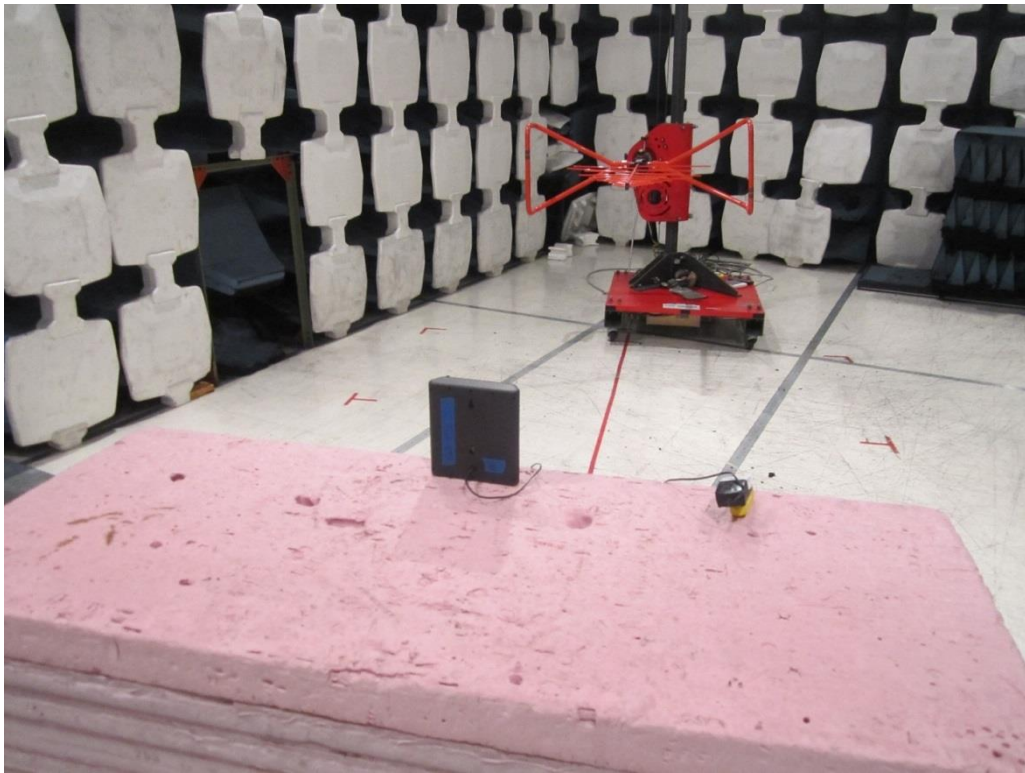
9kHz-1MHz



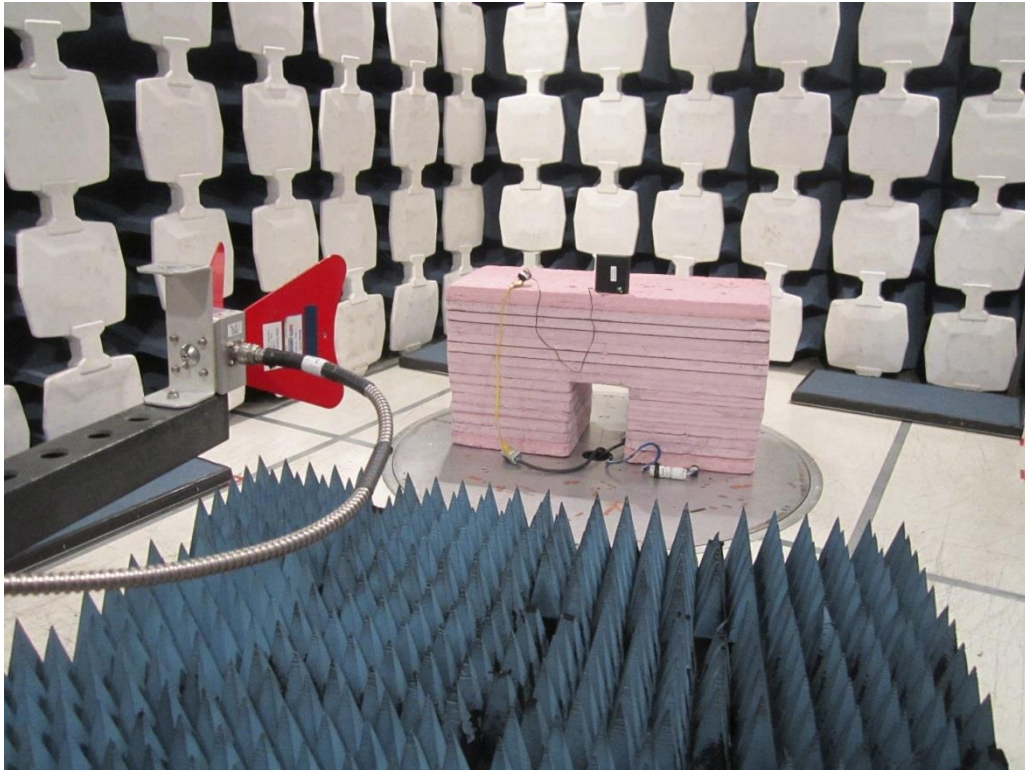
1-30MHz



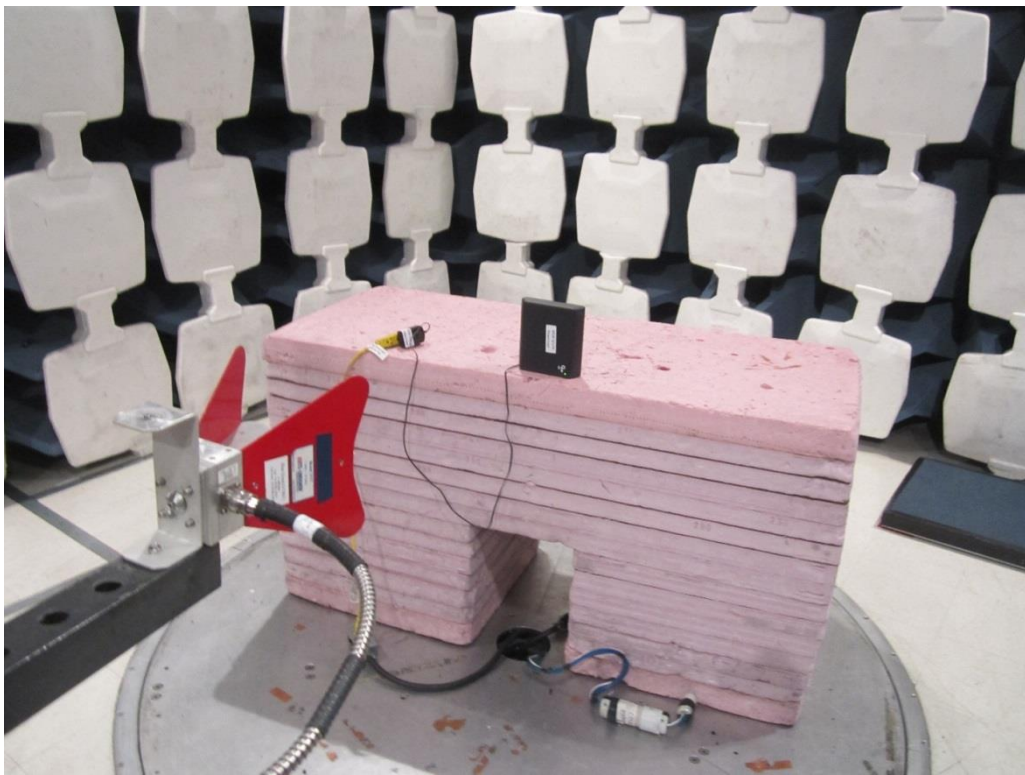
30-1000MHz - Front



30-1000MHz - Rear



1-6GHz



6-10GHz

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 C63.4:2014 and CISPR 22 and CISPR 32.

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 C63.4:2014. 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 Peak: 80	Avg: 54 Peak: 74	Avg: 56 Peak: 76	Avg: 50 Peak: 70	1000-3000
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.

Frequency Range	Appropriate Reslolution Bandwidth
60 Hz to 1 kHz	10 Hz
1kHz to 10 kHz	100 Hz
10kHz to 0.15 MHz	200 Hz
0.15 to 30 MHz	9 kHz
30 MHz to 1 GHz	120 kHz
1 GHz to 10 GHz	1 MHz

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:

$$\text{Field Strength (dBuV/m)} = \text{Voltage Reading (dBuV)} - \text{Preamp Gain (dB)} + \text{Cable Loss (dB)} + \text{Antenna Factor (dB/m)}$$

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

Conducted Emissions Data Table(s):

Curtis Straus - a Bureau Veritas Company Conducted Emissions per CISPR 16-2-1 Peak Detector Data Notes: EUT Line tested: 120VAC/60Hz; Neutral EUT Mode of Operation: CW Mode	Work Order # - S2174 EUT Power Input - 120VAC/ 60Hz Test Site - CEMI-3 Conditions: - 23.3°C; 47%RH; 1010mBar Test Engineer - Chris Bramley Witnessed by - N/A
Data Taken at 06:02:38 PM, Friday, September 21, 2018	

Frequency (MHz)	Raw Pk Reading (dBµV)	Correction Factor (dB)	Adjusted Pk Amplitude (dBµV)	QP Lim: Mains_FCC&CISPR_QP_Class_B (dBµV)	Margin to the QP Limit (dB)	Pk to QP Limit Results (Pass/Fail)	Worst Margin (QP Limit) (dB)
0.435	26.9	19.8	46.6	57.2	-10.5	PASS	-10.5
17.279	27.2	20.1	47.3	60	-12.7	PASS	
17.754	26.9	20.1	47	60	-13	PASS	
17.867	28.1	20.1	48.3	60	-11.7	PASS	
17.996	27.8	20.1	48	60	-12	PASS	
18.494	27.2	20.2	47.4	60	-12.6	PASS	

Curtis Straus - a Bureau Veritas Company Conducted Emissions per CISPR 16-2-1, CISPR Average Detector Final Average Detector Data Notes: EUT Line tested: 120VAC/60Hz; Neutral EUT Mode of Operation: CW Mode	Work Order # - S2174 EUT Power Input - 120VAC/ 60Hz Test Site - CEMI-3 Conditions: - 23.3°C; 47%RH; 1010mBar Test Engineer - Chris Bramley Witnessed by - N/A
Data Taken at 06:11:27 PM, Friday, September 21, 2018	

Frequency (MHz)	Raw Avg Reading (dBµV)	Correction Factor (dB)	Adjusted Avg Amplitude (dBµV)	Av Lim: Mains_FCC&CISPR_Avg_Class_B (dBµV)	Avg Margin (dB)	Avg Results (Pass/Fail)	Worst Avg Margin (dB)
0.436	23.4	19.8	43.1	47.1	-4	PASS	
0.436	24	19.8	43.8	47.1	-3.4	PASS	-3.4
0.436	23.8	19.8	43.6	47.1	-3.6	PASS	
17.856	15.3	20.1	35.5	50	-14.5	PASS	
17.857	16.4	20.1	36.5	50	-13.5	PASS	
18.207	15.9	20.2	36.1	50	-13.9	PASS	



Curtis Straus - a Bureau Veritas Company Conducted Emissions per CISPR 16-2-1 Peak Detector Data Notes: EUT Line tested: 120VAC/60Hz; Phase EUT Mode of Operation: CW Mode	Work Order # - S2174 EUT Power Input - 120VAC/ 60Hz Test Site - CEMI-3 Conditions: - 23.3°C; 47%RH; 1010mBar Test Engineer - Chris Bramley Witnessed by - N/A
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Data Taken at 06:17:12 PM, Friday, September 21, 2018

Frequency (MHz)	Raw Pk Reading (dBµV)	Correction Factor (dB)	Adjusted Pk Amplitude (dBµV)	QP Lim: Mains_FCC&CISPR_QP_Class_B (dBµV)	Margin to the QP Limit (dB)	Pk to QP Limit Results (Pass/Fail)	Worst Margin (QP Limit) (dB)
17.2	26.3	20.1	46.4	60	-13.6	PASS	
17.874	26.2	20.2	46.3	60	-13.7	PASS	
17.959	26.2	20.2	46.3	60	-13.7	PASS	
18.002	26.5	20.2	46.6	60	-13.4	PASS	
18.069	26.6	20.2	46.7	60	-13.3	PASS	-13.3
18.298	26.3	20.2	46.5	60	-13.5	PASS	

Curtis Straus - a Bureau Veritas Company Conducted Emissions per CISPR 16-2-1, CISPR Average Detector Quick Average Detector Data Notes: EUT Line tested: 120VAC/60Hz; Phase EUT Mode of Operation: CW Mode	Work Order # - S2174 EUT Power Input - 120VAC/ 60Hz Test Site - CEMI-3 Conditions: - 23.3°C; 47%RH; 1010mBar Test Engineer - Chris Bramley Witnessed by - N/A
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Data Taken at 06:17:12 PM, Friday, September 21, 2018

Frequency (MHz)	Raw Avg Reading (dBµV)	Correction Factor (dB)	Adjusted Avg Amplitude (dBµV)	Av Lim: Mains_FCC&CISPR_Avg_Class_B (dBµV)	Avg Margin (dB)	Avg Results (Pass/Fail)	Worst Avg Margin (dB)
0.438	19	19.8	38.8	47.1	-8.3	PASS	-8.3
17.775	19.8	20.2	40	50	-10	PASS	
17.826	20.3	20.2	40.5	50	-9.5	PASS	
17.87	20.6	20.2	40.8	50	-9.2	PASS	
17.921	20.1	20.2	40.3	50	-9.7	PASS	
18.17	20.1	20.2	40.2	50	-9.8	PASS	



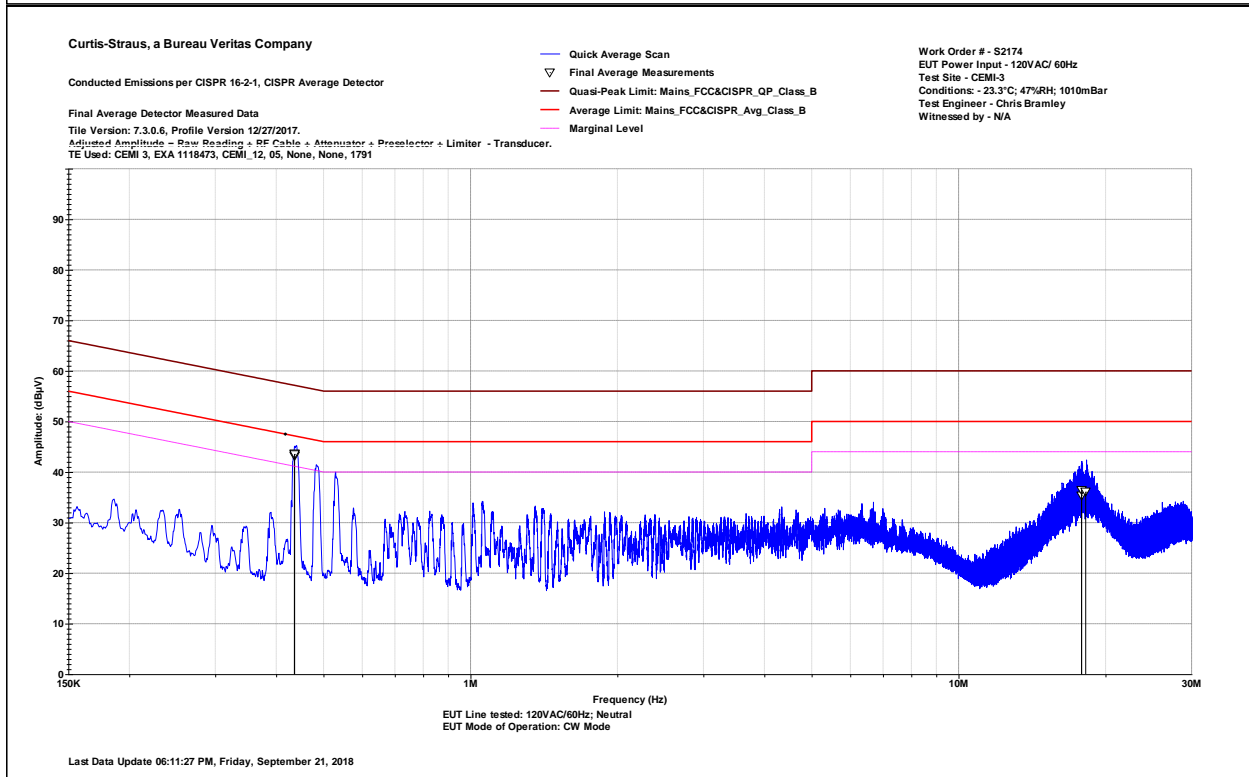
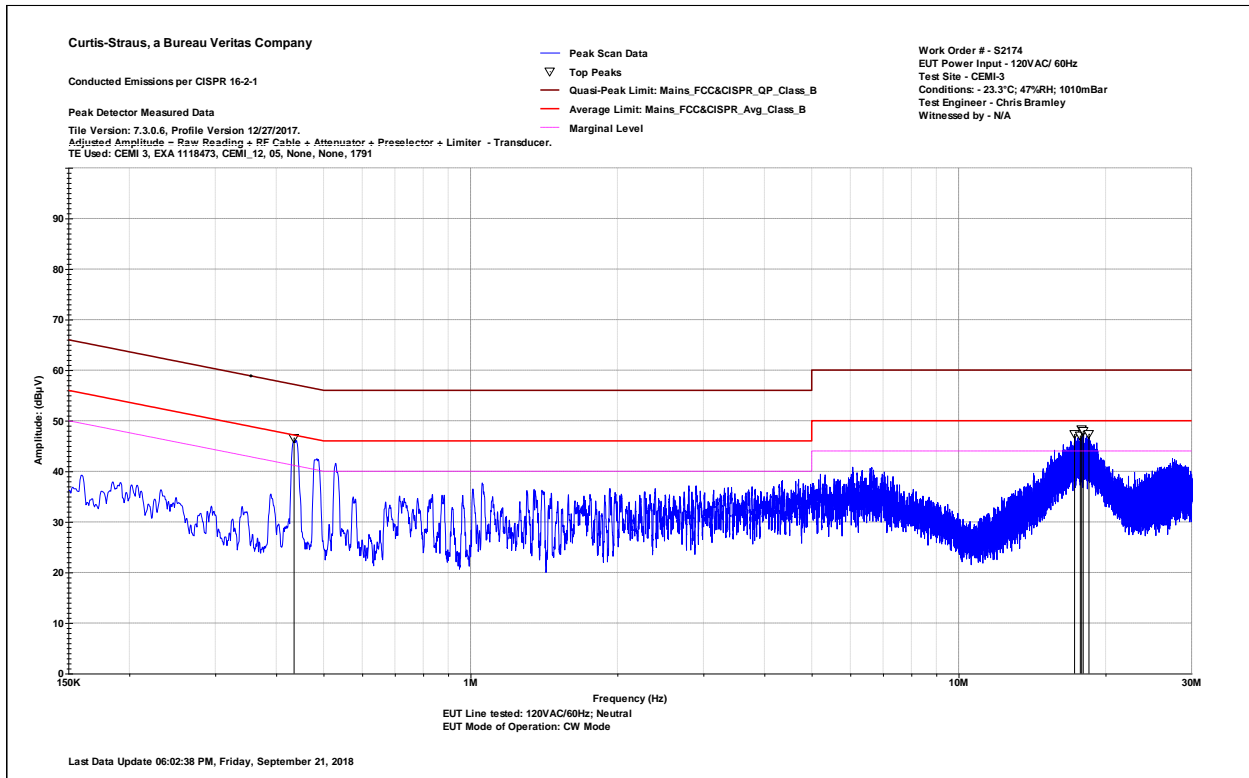
Rev. 9/19/2018

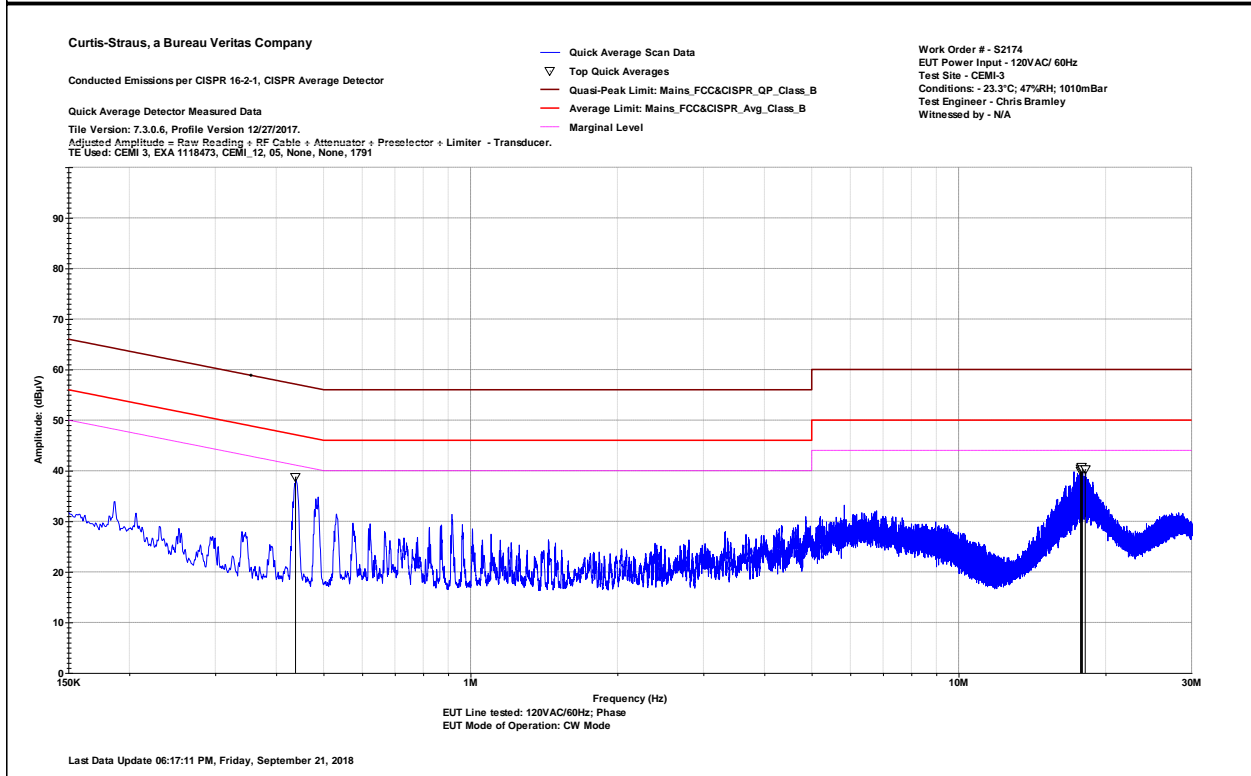
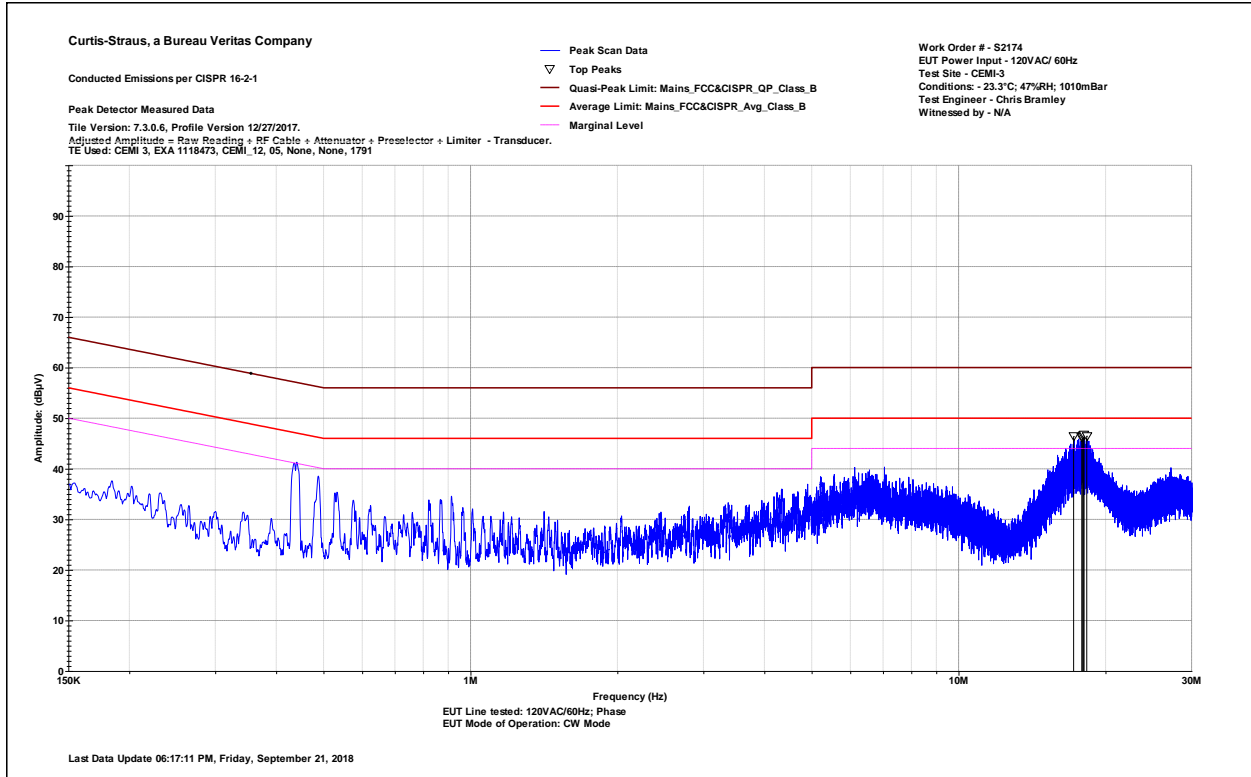
Spectrum Analyzers / Receivers /Preselectors	Range	MN	Mfr	SN	Asset	Cat	Calibration Due	Calibrated on
Rental EXA Signal Analyzer(1118473)	9KHz-26.5GHz	N9010A-526;N	AT	MY51170076	1118473	I	6/19/2019	6/19/2018
LISNs/Measurement Probes	Range	MN	Mfr	SN	Asset	Cat	Calibration Due	Calibrated on
LISN Asset 1791	9KHz-30MHz	NNLK 8121	Schwarzbeck	NNLK 8121-603	1791	I	6/20/2019	6/20/2018
Conducted Test Sites (Mains / Telco)	FCC Code		VCCI Code			Cat	Calibration Due	Calibrated on
CEMI 3	719150		A-0015			III	NA	N/A
Meteorological Meters/Chambers		MN	Mfr	SN	Asset	Cat	Calibration Due	Calibrated on
Weather Clock (Pressure Only)		BA928	Oregon Scientific	C3166-1	831	I	5/15/2020	5/15/2018
TH A#2078		HTC-1	HDE		2078	II	3/22/2019	3/22/2018
Cables	Range		Mfr			Cat	Calibration Due	Calibrated on
CEMI-12	9kHz - 2GHz		C-S			II	11/4/2018	11/4/2017
Attenuators	Range	MN	Mfr	SN	Asset	Cat	Calibration Due	Calibrated on
20dB Attenuator-05	9kHz-2GHz	2	Aeroflex/Weinschel	BS9092		II	8/4/2019	8/4/2018

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



Conducted Emissions Plots(s):





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.

RF Exposure Information

FCC ID: YESTX91501B	
<u>Prediction of MPE limit at a given distance</u>	
Equation from page 18 of OET Bulletin 65, Edition 97-01	
$S = \frac{PG}{4\pi R^2}$	
where:	S = power density
	P = power input to the antenna
	G = power gain of the antenna in the direction of interest relative to an isotropic radiator
	R = distance to the center of radiation of the antenna
Maximum peak output power at the antenna terminal:	26.50 (dBm)
Maximum peak output power at the antenna terminal:	446.6835922 (mW)
Antenna gain(typical):	8.343 (dBi)
Maximum antenna gain:	6.828101998 (numeric)
Prediction distance:	20 (cm)
Prediction frequency:	915 (MHz)
MPE limit for uncontrolled exposure at prediction frequency:	0.61 (mW/cm ²)
Power density at prediction frequency:	0.606778 (mW/cm²)
Therefore device complies with FCC RF radiation exposure limits for general population in mobile exposure category (distance > 20cm)	

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	5.6dB	N/A
CISPR	4.6dB	5.2dB (Ucisprr)
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	3.9dB	N/A
CISPR	3.6dB	3.6dB (Ucisprr)
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

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](http://www.fcc.gov/labhelp) 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.



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 where 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. Rev.160009121(2)_#684340 v14CS

