





FCC PART 15, SUBPART C
IC RSS-210, ISSUE 8, DECEMBER 2010
TEST AND MEASUREMENT REPORT

For

Westhold Corporation

742 Charcot Avenue,
San Jose, CA 95131, USA

FCC ID: NKBTXLI-03
IC: 6677A-TXLI03

Report Type: Original Report	Product Type: RMS TXLI03 Transmitter
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Report Number: R1604051-15C	
Report Date: 2016-05-04	
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* This report may contain data that are not covered by the A2LA accreditation and are marked with an asterisk "*" Rev-10

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DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	R1604051-15C	Original Report	2016-05-04

1 General Description

1.1 Product Description for Equipment Under Test (EUT)

This test and measurement report has been compiled on behalf of *Westhold Corporation*, and their product, *FCC ID: NKBTXLI-03, IC: 6677A-TXLI03*, model number: *WH-RMS-2187-006*, which henceforth is referred to as the EUT (Equipment Under Test.) The EUT is a RMS TXLI03 Transmitter for use in motorsports race timing.

1.2 Mechanical Description of EUT

The EUT measures approximately 7 cm (L) x 5.2 cm (W) x 2 cm (H) and weighs approximately 0.06 kg.

The data gathered are from a typical production sample provided by the manufacturer with serial number: R1604051-01, assigned by BACL.

1.3 Objective

This report is prepared on behalf of *Westhold Corporation*., in accordance with Part 2, Subpart J, and Part 15, Subparts B and C of the Federal Communication Commission's rules and IC RSS-210 Issue 8, December 2010.

The objective is to determine compliance with FCC Part 15.205, 15.209 rules and with IC RSS-210 rules for Radiated Spurious Emissions.

1.4 Related Submittal(s)/Grant(s)

N/A

1.5 Test Methodology

All measurements contained in this report were conducted in accordance with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

1.6 Measurement Uncertainty

All measurements involve certain levels of uncertainties, especially in the field of EMC. The factors contributing to uncertainties are spectrum analyzer, cable loss, antenna factor calibration, antenna directivity, antenna factor variation with height, antenna phase center variation, antenna factor frequency interpolation, measurement distance variation, site imperfections, mismatch (average), and system repeatability.

Based on CISPR16-4-2:2011, The Treatment of Uncertainty in EMC Measurements, the values ranging from ± 2.0 dB for Conducted Emissions tests and ± 4.0 dB for Radiated Emissions tests are the most accurate estimates pertaining to uncertainty of EMC measurements at BACL Corp.

1.7 Test Facility

Bay area compliance Laboratories Corp. (BACL) is:

1- An independent Commercial Test Laboratory accredited to **ISO 17025: 2005** by **A2LA**, in the fields of: Electromagnetic Compatibility & Telecommunications covering Emissions, Immunity, Radio, RF Exposure, Safety and Telecom. This includes NEBS (Network Equipment Building System), Wireless RF, Telecommunications Terminal Equipment (TTE); Network Equipment; Information Technology Equipment (ITE); Medical Electrical Equipment; Industrial, Commercial, and Medical Test Equipment; Professional Audio and Video Equipment; Electronic (Digital) Products; Industrial and Scientific Instruments; Cabled Distribution Systems and Energy Efficiency Lighting.

2- An ENERGY STAR Recognized Laboratory, for the LM80 Testing, a wide variety of Luminaires and Computers.

3- A NIST Designated Phase-I and Phase-II CAB including: ACMA (Australian Communication and Media Authority), BSMI (Bureau of Standards, Metrology and Inspection of Taiwan), IDA (Infocomm Development Authority of Singapore), IC(Industry Canada), Korea (Ministry of Communications Radio Research Laboratory), NCC (Formerly DGT; Directorate General of Telecommunication of Chinese Taipei) OFTA (Office of the Telecommunications Authority of Hong Kong), Vietnam, VCCI - Voluntary Control Council for Interference of Japan and a designated EU CAB (Conformity Assessment Body) (Notified Body) for the EMC and R&TTE Directives.

4- A Product Certification Body accredited to **ISO Guide 65: 1996** by **A2LA** to certify:

2. Radio Standards Specifications (RSS) in the Category I Equipment Standards List and All Broadcasting Technical Standards (BETS) in Category I Equipment Standards List for Industry Canada.

3. Radio Communication Equipment for Singapore.

4. Radio Equipment Specifications, GMDSS Marine Radio Equipment Specifications, and Fixed Network Equipment Specifications for Hong Kong.

5. Japan MIC Telecommunication Business Law (A1, A2) and Radio Law (B1, B2 and B3).

6. Audio/Video, Battery Charging Systems, Computers, Displays, Enterprise Servers, Imaging Equipment, Set-Top Boxes, Telephony, Televisions, Ceiling Fans, CFLs (Including GU24s), Decorative Light Strings, Integral LED Lamps, Luminaires, Residential Ventilating Fans.

The test site used by BACL Corp. to collect radiated and conducted emissions measurement data is located at its facility in Sunnyvale, California, USA.

The test site at BACL Corp. has been fully described in reports submitted to the Federal Communication Commission (FCC) and Voluntary Control Council for Interference (VCCI). The details of these reports have been found to be in compliance with the requirements of Section 2.948 of the FCC Rules on February 11 and December 10, 1997, and Article 8 of the VCCI regulations on December 25, 1997. The test site also complies with the test methods and procedures set forth in CISPR 22:2008 §10.4 for measurements below 1 GHz and §10.6 for measurements above 1 GHz as well as ANSI C63.10-2013, ANSI C63.4-2014, TIA/EIA-603 & CISPR 24:2010.

The Federal Communications Commission and Voluntary Control Council for Interference have the reports on file and they are listed under FCC registration number: 90464 and VCCI Registration No.: A-0027. The test site has been approved by the FCC and VCCI for public use and is listed in the FCC Public Access Link (PAL) database.

Additionally, BACL Corp. is an American Association for Laboratory Accreditation (A2LA) accredited laboratory (Lab Code 3297-02). The current scope of accreditations can be found at

<http://www.a2la.org/scopepdf/3297-02.pdf?CFID=1132286&CFTOKEN=e42a3240dac3f6ba-6DE17DCB-1851-9E57-477422F667031258&jsessionid=8430d44f1f47cf2996124343c704b367816b>

2 System Test Configuration

2.1 Justification

The EUT was configured in accordance to ANSI C63.10-2013 Standards.

2.2 EUT Exercise Software

N/A

2.3 BACL EMI Measurement Software

The software used was EMISoft-Vasona 6.0023 for EMI testing.

2.4 Equipment Modifications

No modifications were made to the EUT.

2.5 Special Equipment

There were no special accessories required, included, or intended for use with EUT during these tests.

2.6 Local Support Equipment

N/A

2.7 EUT Internal Configuration Details

Manufacturer	Description	Model	Serial Number
Atmel	Microcontroller	ATTINY24-20SSU	-
Texas Instruments	Li-Ion Charger	LM3658SD	-
Texas Instruments	Charge Pump	LM2665M6	-

3 Summary of Test Results

Results reported relate only to the product tested.

FCC & IC Rules	Description of Test	Results
FCC §15.205, §15.209 IC RSS-Gen §8.9, §8.10, RSS-210 §2.5	Radiated Emissions	Compliant
FCC §15.215 IC RSS-Gen §6.6	Occupied Bandwidth	Compliant

4 FCC §15.205, §15.209 & IC RSS-Gen §8.9, §8.10, RSS-210 §2.5 - Radiated Emissions

4.1 Applicable Standards

As Per FCC §15.205(a) except as show in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090 – 0.110	16.42 – 16.423	960 – 1240	4.5 – 5.15
0.495 – 0.505	16.69475 – 16.69525	1300 – 1427	5.35 – 5.46
2.1735 – 2.1905	25.5 – 25.67	1435 – 1626.5	7.25 – 7.75
4.125 – 4.128	37.5 – 38.25	1645.5 – 1646.5	8.025 – 8.5
4.17725 – 4.17775	73 – 74.6	1660 – 1710	9.0 – 9.2
4.20725 – 4.20775	74.8 – 75.2	1718.8 – 1722.2	9.3 – 9.5
6.215 – 6.218	108 – 121.94	2200 – 2300	10.6 – 12.7
6.26775 – 6.26825	123 – 138	2310 – 2390	13.25 – 13.4
6.31175 – 6.31225	149.9 – 150.05	2483.5 – 2500	14.47 – 14.5
8.291 – 8.294	156.52475 – 156.52525	2690 – 2900	15.35 – 16.2
8.362 – 8.366	156.7 – 156.9	3260 – 3267	17.7 – 21.4
8.37625 – 8.38675	162.0125 – 167.17	3.332 – 3.339	22.01 – 23.12
8.41425 – 8.41475	167.72 – 173.2	3.3458 – 3.358	23.6 – 24.0
12.29 – 12.293	240 – 285	3.600 – 4.400	31.2 – 31.8
12.51975 – 12.52025	322 – 335.4		36.43 – 36.5
12.57675 – 12.57725	399.9 – 410		Above 38.6
13.36 – 13.41	608 – 614		

As per FCC §15.209(a): Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table

Frequency (MHz)	Field Strength (micro volts/meter)	Measurement Distance (meters)
0.009 - 0.490	2400/F(kHz)	300
0.490 - 1.705	24000/F(kHz)	30
1.705 - 30.0	30	30
30 - 88	100**	3
88 - 216	150**	3
216 - 960	200**	3
Above 960	500	3

** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.

As per IC RSS-210 2.5, General Field Strength Limits, RSS-Gen includes the general field strength limits of unwanted emissions, where applicable, for transmitters and receivers operating in accordance with the provisions specified in this standard.

Unwanted emissions of transmitters and receivers are permitted to fall within the restricted bands listed in RSS-Gen, and including the TV bands, but fundamental emissions are prohibited in the restricted bands.

As per IC RSS-210 2.5.1, Transmitters with Wanted Emissions that are Within the General Field Strength Limits, Whether or not their operation is addressed by published RSS standards, transmitters whose wanted and unwanted emissions are within the general field strength limits shown in RSS-Gen, they may operate in any of the frequency bands, other than the restricted bands listed in RSS-Gen and including the TV bands, and shall be certified under RSS-210. Under no conditions may the level of any unwanted emissions exceed the level of the fundamental emission.

Note: Devices operating below 490 kHz in which all emissions are at least 40 dB below the limit listed in RSS-Gen (General Field Strength Limits for Transmitters at Frequencies below 30 MHz) are Category II devices and are subject to RSS-310.

As per IC RSS-Gen 8.9,

Except when the requirements applicable to a given device state otherwise, emissions from licence-exempt transmitters shall comply with the field strength limits shown in Table 4 and Table 5 below. Additionally, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission.

Table 4 – General Field Strength Limits for Licence-Exempt Transmitters at Frequencies Above 30 MHz

Frequency (MHz)	Field Strength (micro volts/meter at 3 metres)
30 - 88	100
88 - 216	150
216 - 960	200
Above 960	500

* Unless otherwise specified, for all frequencies greater than 1 GHz, the radiated emission limits for licence-exempt radio apparatus stated in applicable RSSs (including RSS-Gen) are based on measurements using a linear average detector function having a minimum resolution bandwidth of 1 MHz. If an average limit is specified for the EUT, then the peak emission shall also be measured with instrumentation properly adjusted for such factors as pulse desensitization to ensure the peak emission is less than 20 dB above the average limit. Note: Transmitting devices are not permitted in restricted frequency bands unless stated otherwise in the specific RSS.

Table 5 – General Field Strength Limits for Licence-Exempt Transmitters at Frequencies below 30 MHz

Frequency (MHz)	Field Strength (micro volts/meter)	Magnetic Field Strength (H-Field) (micro A/m)	Measurement Distance (meters)
0.009 - 0.490	2400/F(kHz)	2400/377F(kHz)	300
0.490 - 1.705	24000/F(kHz)	24000/377F(kHz)	30
1.705 - 30.0	30	N/A	30

Note: The emission limits for the bands 9-90 kHz and 110-490 kHz are based on measurements employing a linear average detector. Transmitting devices are not permitted in restricted frequency bands unless stated otherwise in the relevant RSS.

As per IC RSS-Gen 8.10, Restricted bands, identified in Table 6, are designated primarily for safety-of-life services (distress calling and certain aeronautical bands), certain satellite downlinks, radio astronomy and some government uses. Except where otherwise indicated, the following restrictions apply:

- a) Fundamental components of modulation of licence-exempt radio apparatus shall not fall within the restricted bands of Table 6 except for apparatus complying under RSS-287;
- (b) Unwanted emissions that fall into restricted bands of Table 6 shall comply with the limits specified in RSS-Gen; and
- (c) Unwanted emissions that do not fall within the restricted frequency bands of Table 6 shall comply either with the limits specified in the applicable RSS or with those specified in this RSS-Gen.

Table 6 – Restricted Frequency Bands*

MHz	MHz	GHz
0.090-0.110	240-285	9.0-9.2
2.1735-2.1905	322-335.4	9.3-9.5
3.020-3.026	399.9-410	10.6-12.7
4.125-4.128	608-614	13.25-13.4
4.17725-4.17775	960-1427	14.47-14.5
4.20725-4.20775	1435-1626.5	15.35-16.2
5.677-5.683	1645.5-1646.5	17.7-21.4
6.215-6.218	1660-1710	22.01-23.12
6.26775-6.26825	1718.8-1722.2	23.6-24.0
6.31175-6.31225	2200-2300	31.2-31.8
8.291-8.294	2310-2390	36.43-36.5
8.362-8.366	2655-2900	Above 38.6
8.37625-8.38675	3260-3267	
8.41425-8.41475	3332-3339	
12.29-12.293	3345.8-3358	
12.51975-12.52025	3500-4400	
12.57675-12.57725	4500-5150	
13.36-13.41	5350-5460	
16.42-16.423	7250-7750	
16.69475-16.69525	8025-8500	
16.80425-16.80475		
25.5-25.67		
37.5-38.25		
73-74.6		
74.8-75.2		
108-138		
156.52475-156.52525		
156.7-156.9		

* Certain frequency bands listed in Table 6 and in bands above 38.6 GHz are designated for licence-exempt applications. These frequency bands and the requirements that apply to the devices are set out in the 200- and 300-series of RSSs, such as RSS-210 and RSS-310, which contain the requirements that apply to licence-exempt radio apparatus.

4.2 Test Setup

The radiated emissions tests were performed in the 5-meter Chamber, using the setup in accordance with ANSI C63.10-2013. The specification used was the FCC 15 Subpart C/IC RSS-210 limits.

The spacing between the peripherals was 10 centimeters.

External I/O cables were draped along the edge of the test table and bundle when necessary.

4.3 Test Procedure

For the radiated emissions test, the EUT host, and all support equipment power cords was connected to the AC floor outlet.

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

The EUT is set 3 meter away from the testing antenna, which is varied from 1-4 meter, and the EUT is placed on a turntable, which is 0.8 meter above ground plane, the table shall be rotated for 360 degrees to find out the highest emission. The receiving antenna should be changed the polarization both of horizontal/vertical and parallel/perpendicular.

4.4 Corrected Amplitude & Margin Calculation

The Corrected Amplitude (CA) is calculated by adding the Antenna Factor (AF), the Cable Loss (CL), the Attenuator Factor (Atten) and subtracting the Amplifier Gain (Ga) to indicated Amplitude (Ai) reading. The basic equation is as follows:

$$CA = Ai + AF + CL + Atten - Ga$$

For example, a corrected amplitude of 40.3 dBuV/m = Indicated Reading (32.5 dBuV) + Antenna Factor (+23.5dB) + Cable Loss (3.7 dB) + Attenuator (10 dB) - Amplifier Gain (29.4 dB)

The “**Margin**” column of the following data tables indicates the degree of compliance within the applicable limit. For example, a margin of -7 dB means the emission is 7 dB below the maximum limit. The equation for margin calculation is as follows:

$$\text{Margin} = \text{Corrected Amplitude} - \text{Limit}$$

4.5 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Last Cal	Cal Due
Sunol Sciences	Biconi-Log Antenna	JB3	A020106-2	2015-07-11	1 year
EMCO	Passive Loop Antenna	6512	34167	2014-04-30	2 year
Rohde & Schwarz	EMI Test Receiver	ESCI 1166.5950K03	100337	2015-06-18	1 year
HP	Pre-Amplifier	8447D	2944A06639	2015-06-08	1 year
Sonoma Instrument	Pre-Amplifier	315	303125	2015-07-23	1 year
Suirong	30 Ft Conducted Emission Cable	LMR 400	694	-	Cal. Not required

Statement of Traceability: BACL Corp. attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.

4.6 Test Environmental Conditions

Temperature:	20-25° C
Relative Humidity:	40-45 %
ATM Pressure:	101.2-103.5 kPa

The testing was performed by Leonard Gray on 2016-04-06 in 5m chamber3.

4.7 Summary of Test Results

According to the data hereinafter, the EUT complied with the FCC Title 47, Part 15C and IC RSS-210 standard's radiated emissions limits, and had the worst margin of:

Mode: Transmitting			
Margin (dB)	Frequency (MHz)	Polarization (Perpendicular/Parallel)	Range (MHz)
-27.767	5.82806	Parallel	0.009-30

Mode: Transmitting			
Margin (dB)	Frequency (MHz)	Polarization (Horizontal/Vertical)	Range (MHz)
-17.32	290.9178	Horizontal	30 to 1000

4.8 Radiated Emissions Test Data and Plots

1) 9 kHz - 30 MHz, measured at 3 meters distance

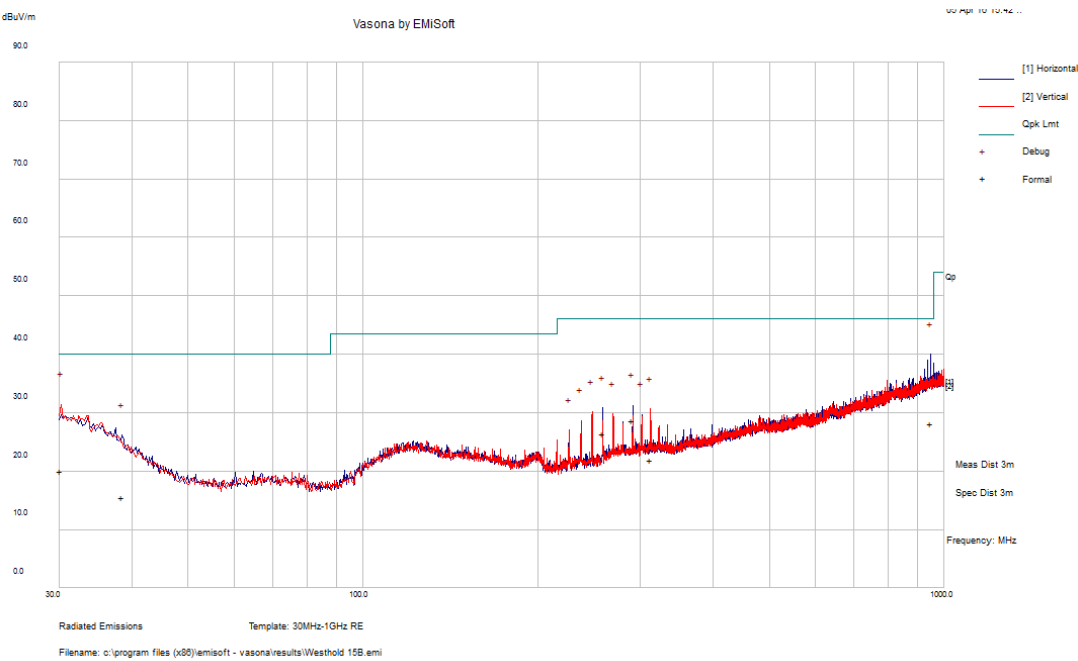
Frequency (MHz)	S.A. Reading (dBμV)	Turntable Azimuth (degrees)	Test Antenna			Cable Loss (dB)	Pre-Amp. (dB)	Cord. Reading (dBμV/m)	FCC/IC	
			Height (cm)	Polarity (Perp/Par)	Factor (dB/m)				Limit (dBμV/m)	Margin (dB)
5.82806	34.65	0	100	parallel	35.3	0.0	28.237	41.713	69.54	-27.827
5.82806	34.71	0	100	perpen.	35.3	0.0	28.237	41.773	69.54	-27.767
10.775	40.01	0	100	parallel	34.5	0.0	28.239	46.271	69.54	-23.269
10.7775	35.71	91	100	perpen.	34.5	0.0	28.239	41.971	69.54	-27.569
14.34522	32.88	0	100	parallel	34.5	0.0	28.225	39.155	69.54	-30.385
14.34522	32.96	0	100	perpen.	34.5	0.0	28.225	39.235	69.54	-30.305
24.78174	31.2	0	100	parallel	34.6	0.0	28.158	37.642	69.54	-31.898
24.78174	31.13	0	100	perpen.	34.6	0.0	28.158	37.572	69.54	-31.968
27.3009	30.85	0	100	parallel	34.6	0.0	28.141	37.309	69.54	-32.231
27.3009	30.85	0	100	perpen.	34.6	0.0	28.141	37.309	69.54	-32.231

Note: The final limit was determined by extrapolating the limit specified in FCC §15.209, frequency range 1.705-30 MHz, by 40 dB/decade. The EUT was tested at 3 meters.

$$\text{Limit in dB}\mu\text{V/m @ 3m} = \text{Limit in dB}\mu\text{V/m @ 30 meter} + 40 \cdot \log(30/3)$$

Note: Maximum Field Strength recorded had a value of 46.271dBμV/m which is within an acceptable range for RF Exposure exclusion. Therefore, RF Exposure need not be evaluated.

2) 30-1000 MHz, measured at 3 meters distance



Frequency (MHz)	Corrected Amplitude (dBμV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBμV/m)	Margin (dB)	Comments (PK/QP/Ave.)
948.2333	28.07	131	H	234	46	-17.93	QP
30.16375	19.96	248	V	186	40	-20.04	QP
38.499	15.47	125	H	250	40	-24.53	QP
290.9178	28.68	101	H	228	46	-17.32	QP
258.602	26.44	265	H	223	46	-19.56	QP
312.5233	21.99	253	V	96	46	-24.01	QP

5 FCC §15.215 & IC RSS-Gen §6.6 - Occupied Bandwidth

5.1 Applicable Standards

As per FCC §15.215(c), Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§15.217 through 15.257 and in subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated.

As per IC RSS-Gen §6.6, The emission bandwidth (x dB) is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated x dB below the maximum in-band spectral density of the modulated signal. Spectral density (power per unit bandwidth) is to be measured with a detector of resolution bandwidth in the range of 1% to 5% of the anticipated emission bandwidth, and a video bandwidth at least 3x the resolution bandwidth. When the occupied bandwidth limit is not stated in the applicable RSS or reference measurement method, the transmitted signal bandwidth shall be reported as the 99% emission bandwidth, as calculated or measured.

5.2 Test Setup

The radiated emissions tests were performed in the 5-meter Chamber, using the setup in accordance with ANSI C63.10-2013. The specification used was the FCC 15 Subpart C/IC RSS-210 limits.

The spacing between the peripherals was 10 centimeters.

External I/O cables were draped along the edge of the test table and bundle when necessary.

5.3 Test Procedure

For the radiated emissions test, the EUT host, and all support equipment power cords was connected to the AC floor outlet.

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

The EUT is set 3 meter away from the testing antenna, which is varied from 1-4 meter, and the EUT is placed on a turntable, which is 0.8 meter above ground plane, the table shall be rotated for 360 degrees to find out the highest emission. The receiving antenna should be changed the polarization both of horizontal/vertical and parallel/perpendicular.

5.4 Test Equipment List and Details

Manufacturer	Description	Model No.	Serial No.	Last Cal	Cal Due
Sunol Sciences	Biconi-Log Antenna	JB3	A020106-2	2015-07-11	1 year
EMCO	Passive Loop Antenna	6512	34167	2014-04-30	2 year
Rohde & Schwarz	EMI Test Receiver	ESCI 1166.5950K03	100337	2015-06-18	1 year
HP	Pre-Amplifier	8447D	2944A06639	2015-06-08	1 year
Sonoma Instrument	Pre-Amplifier	315	303125	2015-07-23	1 year
Suirong	30 Ft Conducted Emission Cable	LMR 400	694	-	Cal. Not required

Statement of Traceability: BACL Corp. attests that all calibrations have been performed per the A2LA requirements, traceable to the NIST.

5.5 Test Environmental Conditions

Temperature:	20-25° C
Relative Humidity:	40-45 %
ATM Pressure:	101.2-103.5 kPa

The testing was performed by Leonard Gray on 2016-04-06 in 5m chamber3.

5.6 Test Results

Frequency (MHz)	99% OBW (MHz)	20 dB OBW (MHz)	Result
10.77	1.6102	1.793	Compliant

Emission Bandwidth

