



# EMC TEST REPORT

**Report Number: 102302878LAX-003**

**Project Number: G102302878**

**Report Issue Date: November 30, 2015**

**Model(s) Tested: FFZB1-ECO**

**Standards: FCC CFR47 Part 15 Subpart C, 2015**

Intentional Radiator

§15.247, Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz

**FCC CFR47 Part 15 Subpart B, 2015**

Unintentional Radiator

**ISED RSS-Gen Issue 4, 2014**

**ISED RSS-247 Issue 1, May 2015**

Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHs) and Licence-Exempt Local Area Network (LE-LAN) Devices

**ISED ICES-003 Issue 5, Updated November 2014**

Information Technology Equipment (ITE) - Limits and methods of measurement

**Tested by:**

Intertek  
25791 Commercentre Drive  
Lake Forest, CA 92630  
USA

**Client:**

Ecolink Intelligent Technology  
2055 Corte Del Nogal  
Carlsbad, CA 92011  
USA

Report prepared by

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## 1 Introduction and Conclusion

The tests indicated in section 2.0 were performed on the product constructed as described in section 4.0. The remaining test sections are the verbatim text from the actual data sheets used during the investigation. These test sections include the test name, the specified test Method, a list of the actual Test Equipment Used, documentation Photos, Results and raw Data. No additions, deviations, or exclusions have been made from the standard(s) unless specifically noted.

Based on the results of our investigation, we have concluded the product tested comply with the requirements of the standard(s) indicated. The results obtained in this test report pertain only to the item(s) tested. Intertek does not make any claims of compliance for samples or variants which were not tested.

## 2 Test Summary

Section	Test full name	Result
6	6 dB Bandwidth (FCC §15.247(a)(2), IC RSS-247§5.2(1))	Compliant
7	Occupied Bandwidth (IC RSS-Gen Issue 4 §6.6)	Compliant
8	Maximum Peak Conducted Output Power at Antenna Terminals (FCC §15.247(b)(3), IC RSS-247§5.4(4))	Compliant
9	Maximum Power Spectral Density (FCC §15.247(e), IC RSS-247§5.2(2))	Compliant
10	Unwanted Conducted Emissions (FCC §15.247(d), IC RSS-247§5.5)	Compliant
11	Transmitter Radiated Spurious Emissions ((FCC §15.247(d), §15.209, §15.205; RSS-247§5.5)	Compliant
12	Receiver Radiated Spurious Emissions (FCC §15.109; IC ICES-003 Issue 5 §6.2)	Compliant
13	AC Mains Conducted Emissions (FCC §15.207; IC RSS-Gen Issue 4 §8.8) (FCC §15.107; IC ICES-003 Issue 5 §6.1)	N/A*

\*: EUT is battery powered

### 3 Client Information

This EUT was tested at the request of:

**Client:** Ecolink Intelligent Technology  
2055 Corte Del Nogal  
Carlsbad, CA 92011  
USA

**Contact:** Mike Archbold  
**Telephone:** (760) 431-8804  
**Fax:**  
**Email:** archbolm@discoverecolink.com

### 4 Description of Equipment Under Test and Variant Models

Equipment Under Test			
Description	Manufacturer	Model Number	Serial Number
Firefighter Wireless Audio Detector	Ecolink	FFZB1-ECO	NT-1
Firefighter Wireless Audio Detector	Ecolink	FFZB1-ECO	NT_2
Firefighter Wireless Audio Detector	Ecolink	FFZB1-ECO	Production Firmware

Receive Date:	10/21/2015
Received Condition:	Good
Type:	Production

Dates of Tests:	10/29/2015, 10/31/2015, 11/1/2015, 11/22/2015, 3/12/2016
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#### Description of Equipment Under Test

The equipment under test (EUT) is a Firefighter Wireless Audio Detector (a Zigbee device), operating within the band 2400-2483.5 MHz. The EUT is battery powered and uses an integral antenna with antenna gain of +3.3 dBi.

Equipment Under Test Power Configuration			
Rated Voltage	Rated Current	Rated Frequency	Number of Phases
3VDC	N/A	N/A	N/A

#### Operating modes of the EUT:

No.	Descriptions of EUT Exercising
1	Test Mode – Continuously Transmitting
2	Normal Operation

#### Software used by the EUT:

No.	Descriptions of EUT Exercising
1	Under test mode, the EUT was programmed to transmit continuously during testing.
2	Under normal operation, the EUT was programmed to operate as an end user would normally use.

<b>Radio/Receiver Characteristics</b>	
<b>Frequency Band(s)</b>	2400-2483.5 MHz
<b>Modulation Type(s)</b>	O-QPSK
<b>Maximum Output Power</b>	17.02 dBm (50.4 mW)
<b>Test Channels</b>	11 (2405 MHz), 18 (2440 MHz), 26 (2480 MHz)
<b>Occupied Bandwidth</b>	2.44 MHz
<b>Equipment Type</b>	Standalone
<b>Antenna Type and Gain</b>	Integral (PCB), +3.3 dBi

## 5 System Setup and Method

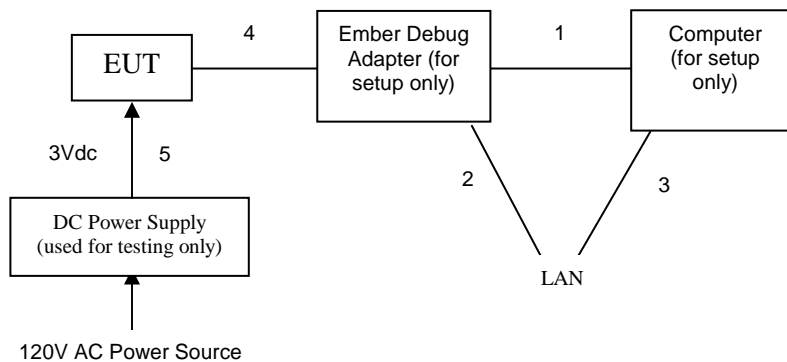
Cables					
ID	Description	Length (m)	Shielding	Ferrites	Termination
1	USB	1.8	N/A	N/A	N/A
2	Cat5e	6.0	N/A	N/A	N/A
3	Cat5e	12.0	N/A	N/A	N/A
4	10-conductor flat cable	0.2	N/A	N/A	N/A
5	AWG #18 Wires	1.6	N/A	N/A	N/A

Support Equipment			
Description	Manufacturer	Model Number	Serial Number
DC Power Supply	B&K Precision	1671A	249D15133
Ember Debug Adapter	Silicon Lab	ISA3	00:0D:6F:00:2B:C3
Computer	HP	Pavilion	Not Labeled

### 5.1 Method:

Configuration as required by ANSI C63.10-2013.

### 5.2 EUT Block Diagram:



## 6 6 dB Bandwidth

### 6.1 Requirement(s)

The minimum 6 dB bandwidth shall be at least 500 kHz.

### 6.2 Method

The procedure described in the FCC publication 558074 D01 DTS Meas Guidance v03r03 June 9, 2015 was used to determine the 6 dB bandwidth. Section 8.1 Option 1 was used.

1. Set RBW = 100 kHz.
2. Set the video bandwidth (VBW)  $\geq 3 \times$  RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Allow the trace to stabilize.
7. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

### TEST SITE:

The test is performed in the 3 meter semi-anechoic chamber located at 25791 Commercentre Drive, Lake Forest, California 92630 USA. This test facility meets the requirements of CISPR 16-1-4 and has been accredited by A2LA. IC test site registration number is 2042T.

### 6.3 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
637	3m Semi-anechoic Chamber	Panashield	3 meter	25 331-D-Z	August 2015	August 2018
1140	EMI Test Receiver	Rohde & Schwarz	ESC17	100825	02/04/2015	02/04/2016
1002	Lab Monitor	Omega	iBTHX-W	0440776	06/26/2015	06/26/2016

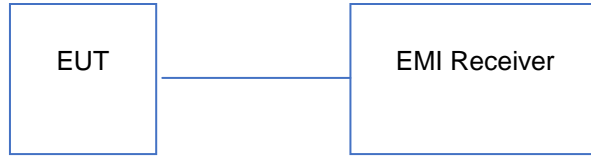
### Software Utilized:

Name	Manufacturer	Version	Profile
N/A	N/A	N/A	N/A

### 6.4 Results:

The sample tested was found to comply.

6.5 Setup Diagram:



6.6 Plots/Data:

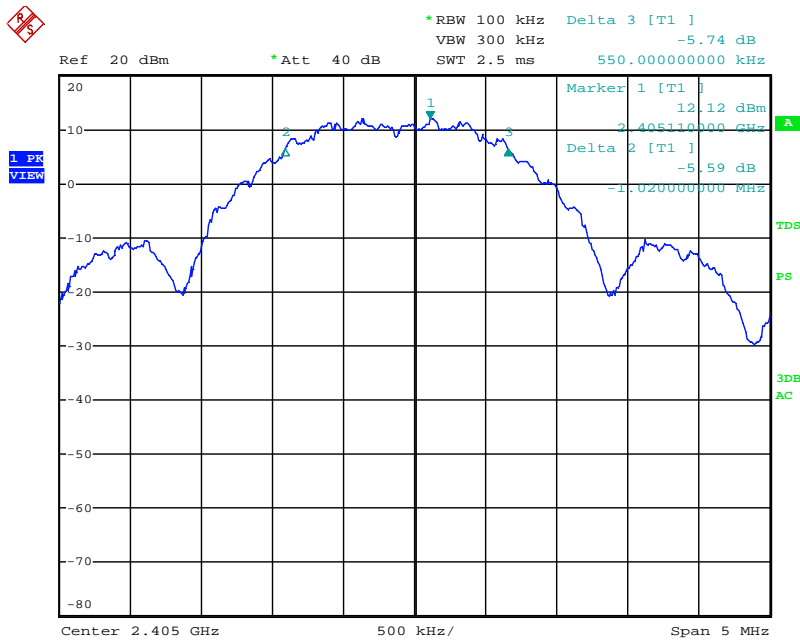
Test Personnel: Grace Lin  
 Product Standard: FCC 15.247, IC RSS-247  
 Input Voltage: 3Vdc Battery  
 Pretest Verification w/  
 Ambient Signals or  
 BB Source: N/A

Test Date: 10/29/2015  
 Limit Applied: FCC 15.247, IC RSS-247  
 Ambient Temperature: 22.4 °C  
 Relative Humidity: 55.9 %  
 Atmospheric Pressure: 987.4 mbars

Frequency (MHz)	Channel	6 dB Bandwidth (kHz)
2405	11	1570
2440	18	1600
2480	26	1590

Deviations, Additions, or Exclusions: None

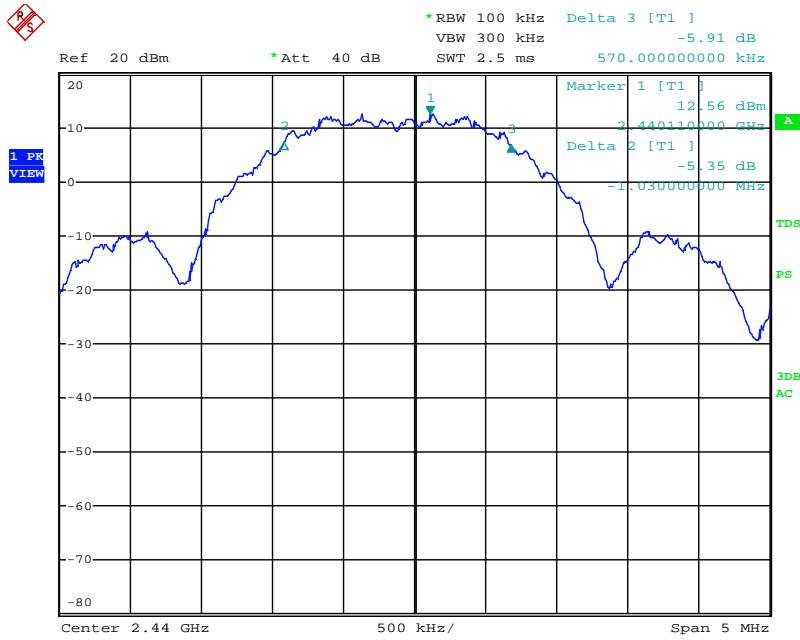
Channel 11:



Date: 28.OCT.2015 15:58:04

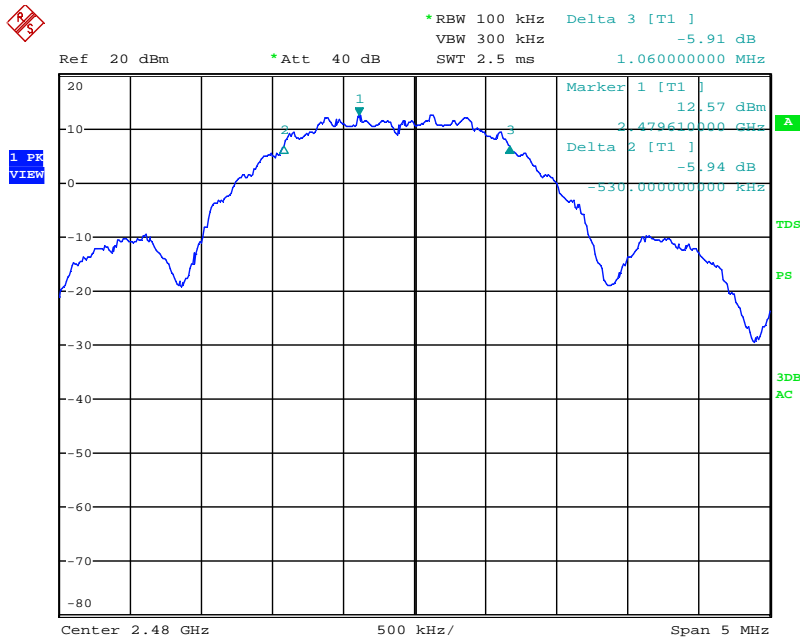


Channel 18:



Date: 28.OCT.2015 15:56:19

Channel 26:



Date: 28.OCT.2015 15:54:20

## 7 Occupied Bandwidth

### 7.1 Requirement(s)

The transmitted signal bandwidth shall be reported as the 99% emission bandwidth, as calculated or measured. (IC RSS-Gen Issue 4 §6.6)

### 7.2 Method

The bandwidth was determined by using the built-in 99% occupied bandwidth function of the spectrum analyzer. The resolution bandwidth is set to 1% of the selected span as is without being below 1%. The video bandwidth shall be set to 3 times the resolution bandwidth.

### TEST SITE:

The test is performed in the 3 meter semi-anechoic chamber located at 25791 Commercentre Drive, Lake Forest, California 92630 USA. This test facility meets the requirements of CISPR 16-1-4 and has been accredited by A2LA. IC test site registration number is 2042T.

### 7.3 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
637	3m Semi-anechoic Chamber	Panashield	3 meter	25 331-D-Z	August 2015	August 2018
1140	EMI Test Receiver	Rohde & Schwarz	ESC17	100825	02/04/2015	02/04/2016
1002	Lab Monitor	Omega	iBTHX-W	0440776	06/26/2015	06/26/2016

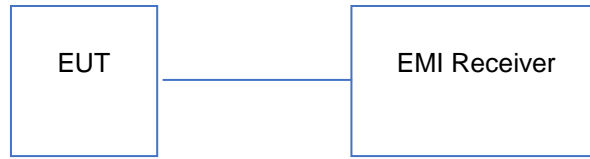
### Software Utilized:

Name	Manufacturer	Version	Profile
N/A	N/A	N/A	N/A

### 7.4 Results:

The sample tested was found to comply.

**7.5 Setup Diagram:**



**7.6 Plots/Data:**

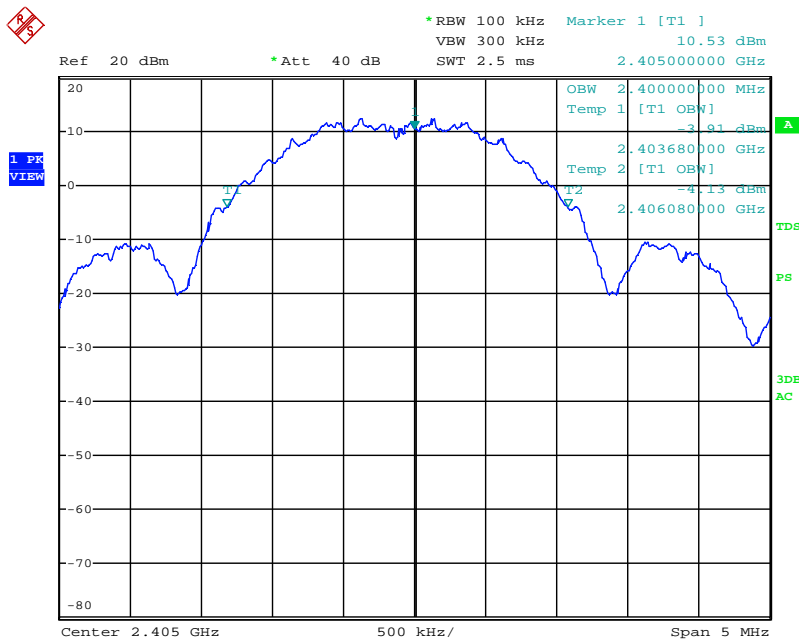
Test Personnel: Grace Lin  
 Product Standard: FCC 15.247, IC RSS-247  
 Input Voltage: 3 Vdc Battery  
 Pretest Verification w/  
 Ambient Signals or  
 BB Source: N/A

Test Date: 10/29/2015  
 Limit Applied: FCC 15.247, IC RSS-247  
 Ambient Temperature: 22.4 °C  
 Relative Humidity: 55.9 %  
 Atmospheric Pressure: 987.4 mbars

Frequency (MHz)	Channel	Occupied Bandwidth (MHz)
2405	11	2.40
2440	18	2.44
2480	26	2.44

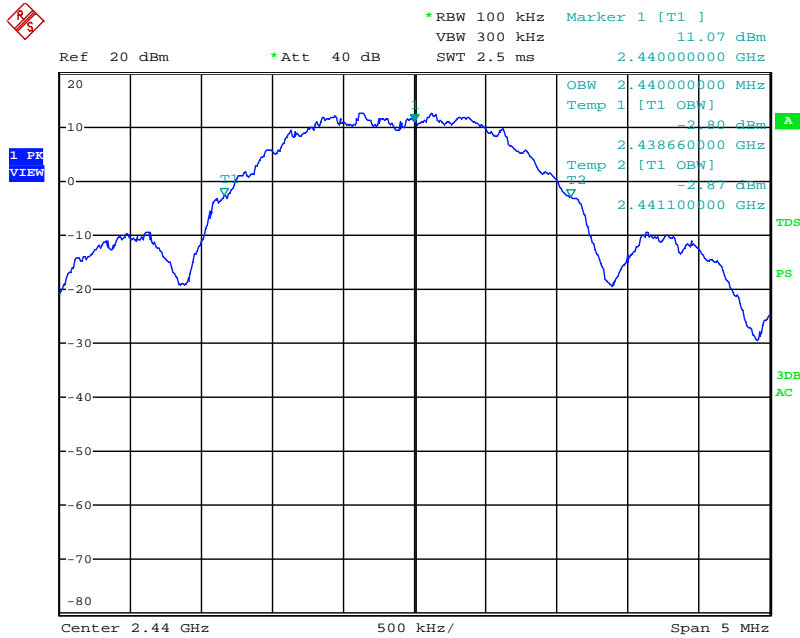
Deviations, Additions, or Exclusions: None

**Channel 11:**



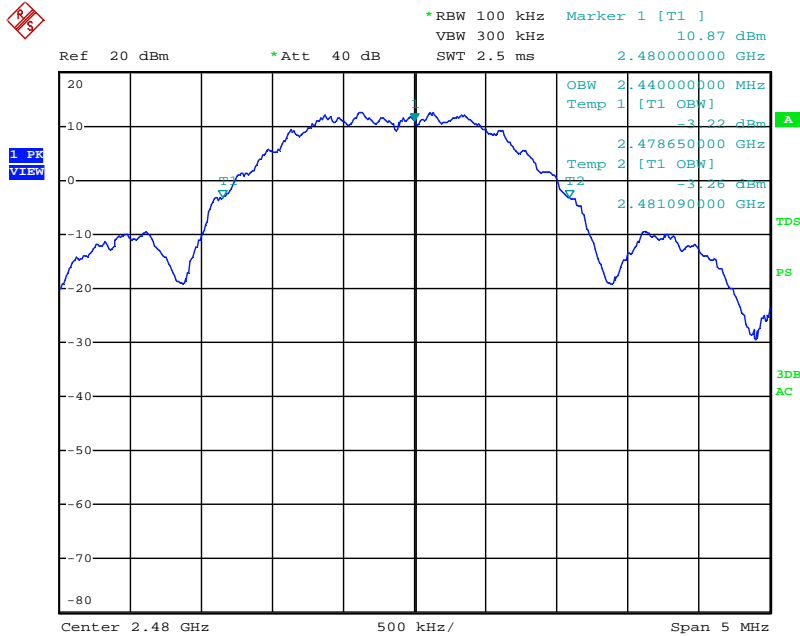
Date: 28.OCT.2015 16:11:30

Channel 18:



Date: 28.OCT.2015 16:13:02

Channel 26:



Date: 28.OCT.2015 16:14:22

## 8 Maximum Peak Conducted Output Power at Antenna Terminals

### 8.1 Requirement(s)

For antennas with gains of 6 dBi or less, maximum allowed transmitter output is 1 watt or 30 dBm. For antennas with gains greater than 6 dBi, transmitter output level must be decreased appropriately, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

### 8.2 Method

The procedure described in FCC Publication 558074 D01 DTS Meas Guidance v03r03 June 9, 2015 was used. Specifically, section 9.1.1 RBW  $\geq$  DTS bandwidth was utilized as the spectrum analyzer's resolution bandwidth was greater than the DTS bandwidth.

1. Set the RBW  $\geq$  DTS Bandwidth
2. Set the VBW  $\geq$  3 x RBW
3. Set the span  $\geq$  3 x RBW
4. Sweep time = Auto couple
5. Detector = Peak
6. Trace mode = Max Hold
7. Allow trace to fully stabilize
8. Use peak marker function to determine the peak amplitude level.

### TEST SITE:

The test is performed in the 3 meter semi-anechoic chamber located at 25791 Commercentre Drive, Lake Forest, California 92630 USA. This test facility meets the requirements of CISPR 16-1-4 and has been accredited by A2LA. IC test site registration number is 2042T.

### 8.3 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
637	3m Semi-anechoic Chamber	Panashield	3 meter	25 331-D-Z	August 2015	August 2018
1140	EMI Test Receiver	Rohde & Schwarz	ESC17	100825	02/04/2015	02/04/2016
1002	Lab Monitor	Omega	iBTHX-W	0440776	06/26/2015	06/26/2016

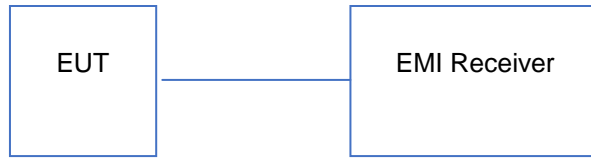
### Software Utilized:

Name	Manufacturer	Version	Profile
N/A	N/A	N/A	N/A

### 8.4 Results:

The sample tested was found to comply.

**8.5 Setup Diagram:**



**8.6 Plots/Data:**

Test Personnel: Grace Lin  
 Product Standard: FCC 15.247, IC RSS-247  
 Input Voltage: 3Vdc Battery  
 Pretest Verification w/  
 Ambient Signals or  
 BB Source: N/A

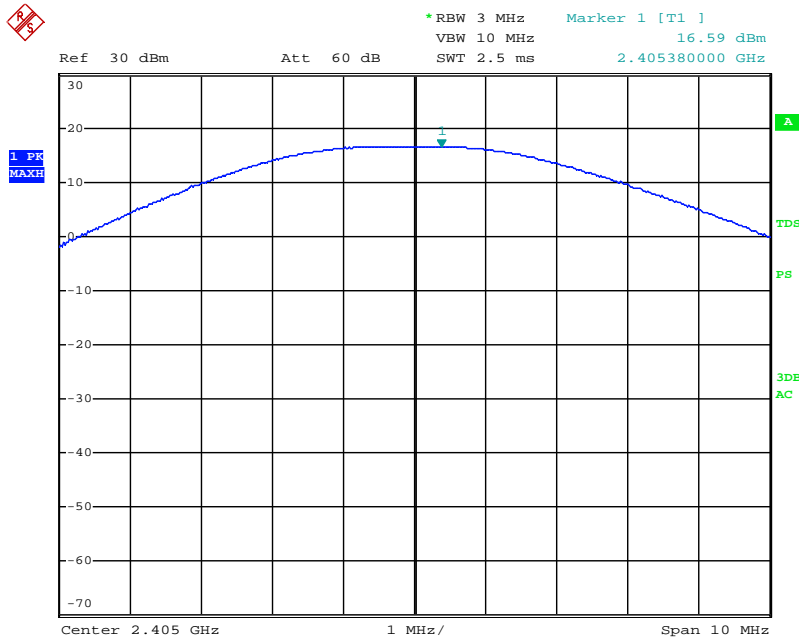
Test Date: 11/01/2015, 3/12/2016  
 Limit Applied: FCC 15.247, IC RSS-247  
 Ambient Temperature: 21.1 °C, 22.8 °C  
 Relative Humidity: 43.7 %, 40.4 %  
 Atmospheric Pressure: 992.2 mbars, 997.1 mbars

Frequency (MHz)	Channel	Peak Conducted Output Power	
		dBm	mW
2405	11	16.59	45.6
2440	18	17.02	50.4
2480	26	4.16	2.61

**Note:** The insertion loss was compensated for in the receiver.

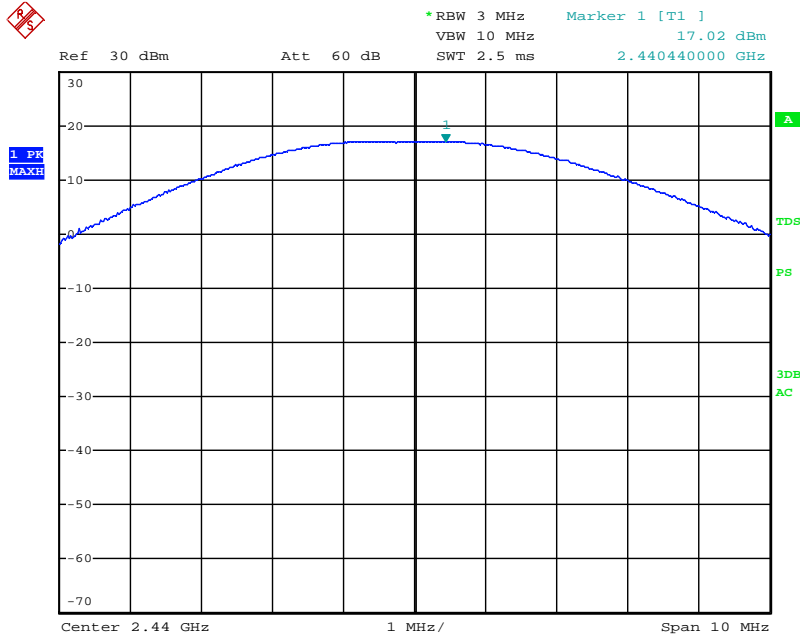
Deviations, Additions, or Exclusions: None

**Channel 11:**



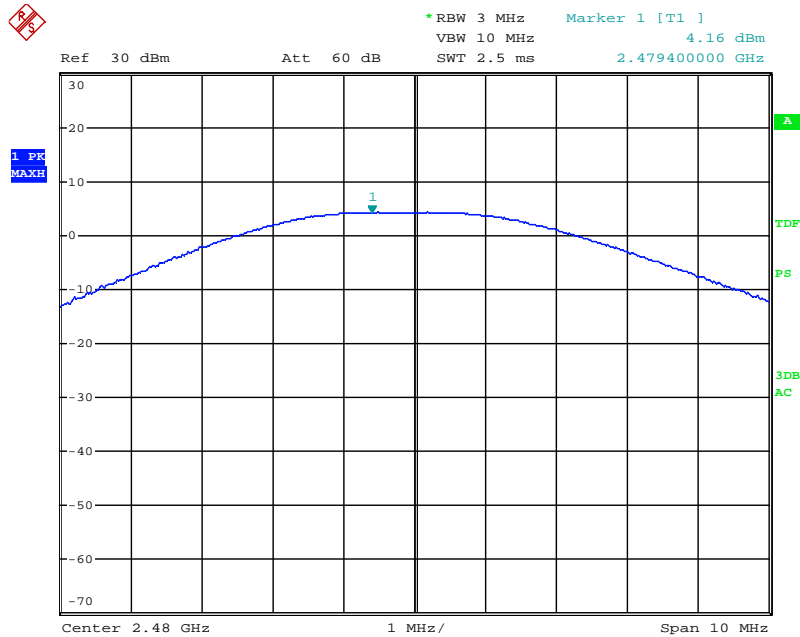
Date: 1.NOV.2015 14:35:45

Channel 18:



Date: 1.NOV.2015 14:36:55

Channel 26:



Date: 12.MAR.2016 19:49:54

## 9 Maximum Power Spectral Density

### 9.1 Requirement(s)

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna should not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

### 9.2 Method

The procedure described in FCC Publication 558074 D01 DTS Meas Guidance v03r03 June 9, 2015, specifically Section 10.2 Method PKPSD (peak PSD).

1. Set analyzer center frequency to DTS channel center frequency.
2. Set the span to 1.5 times the *DTS bandwidth*.
3. Set the RBW to:  $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$ .
4. Set the VBW  $\geq 3 \times \text{RBW}$ .
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level within the RBW.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

### TEST SITE:

The test is performed in the 3 meter semi-anechoic chamber located at 25791 Commercentre Drive, Lake Forest, California 92630 USA. This test facility meets the requirements of CISPR 16-1-4 and has been accredited by A2LA. IC test site registration number is 2042T.

### 9.3 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
637	3m Semi-anechoic Chamber	Panashield	3 meter	25 331-D-Z	August 2015	August 2018
1140	EMI Test Receiver	Rohde & Schwarz	ESC17	100825	02/04/2015	02/04/2016
1002	Lab Monitor	Omega	iBTHX-W	0440776	06/26/2015	06/26/2016

### Software Utilized:

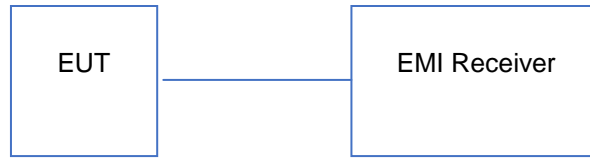
Name	Manufacturer	Version	Profile
N/A	N/A	N/A	N/A

### 9.4 Results:

The sample tested was found to comply.



**9.5 Setup Diagram:**



**9.6 Plots/Data:**

Test Personnel: Grace Lin  
 Product Standard: FCC 15.247, IC RSS-247  
 Input Voltage: 3Vdc Battery  
 Pretest Verification w/  
 Ambient Signals or  
 BB Source: N/A

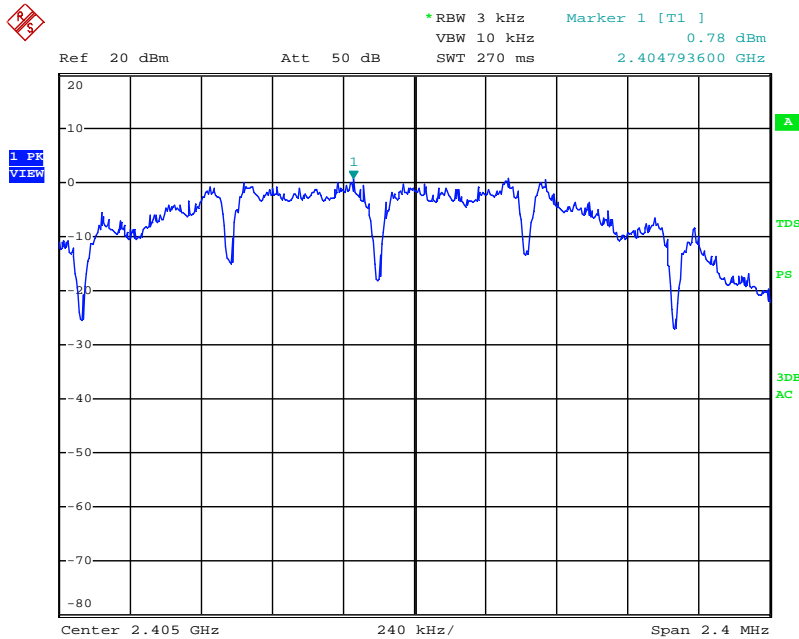
Test Date: 11/01/2015, 3/12/2016  
 Limit Applied: FCC 15.247, IC RSS-247  
 Ambient Temperature: 21.1 °C, 22.8 °C  
 Relative Humidity: 43.7 %, 40.4 %  
 Atmospheric Pressure: 992.2 mbars, 997.1 mbars

Frequency (MHz)	Channel	Maximum Power Spectral Density (dBm)
2405	11	0.78
2440	18	1.47
2480	26	-11.63

**Note:** The insertion loss was compensated for in the receiver.

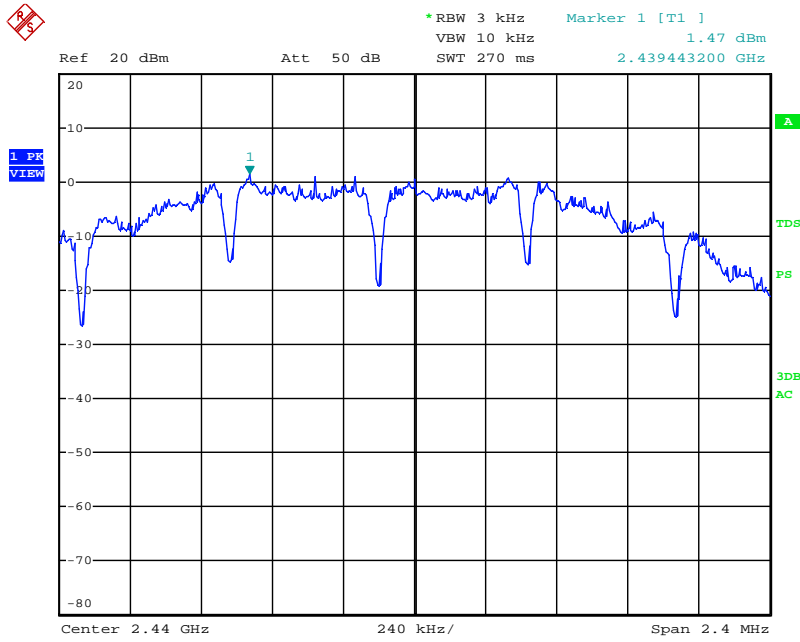
Deviations, Additions, or Exclusions: None

**Channel 11:**



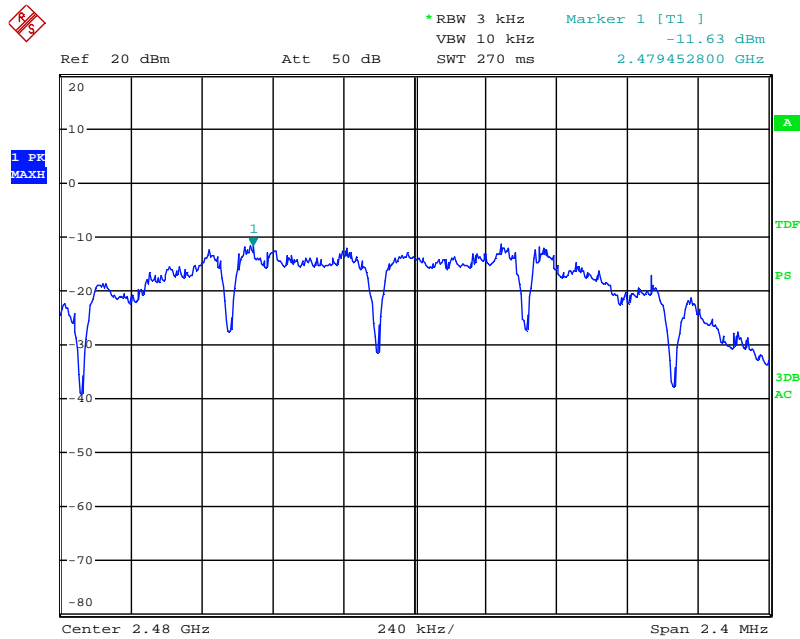
Date: 1.NOV.2015 14:53:00

Channel 18:



Date: 1.NOV.2015 14:51:22

Channel 26:



Date: 12.MAR.2016 20:09:59

## 10 Unwanted Conducted Emissions

### 10.1 Requirement(s)

In any 100 kHz bandwidth outside the EUT pass-band, the RF power shall be below the maximum in-band 100 kHz emissions by at least 20 dB (if peak power of in-band emission is measured) or 30 dB (if average power of in-band emission is measured).

In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a)

### 10.2 Method

The procedure described in FCC Publication 558074 D01 DTS Meas Guidance v03r03, June 9, 2015, specifically Section 11.0 Emissions in non-restricted frequency bands.

A spectrum analyzer was connected to the antenna port of the transmitter.

1. Set the RBW = 100 kHz.
2. Set the VBW  $\geq 3 \times$  RBW.
3. Detector = peak.
4. Sweep time = auto couple.
5. Trace mode = max hold.
6. Allow trace to fully stabilize.
7. Use the peak marker function to determine the maximum amplitude level.

The unwanted emissions were measured from 30 MHz to 25 GHz. Plots below are corrected for cable loss and then compared to the limits.

#### TEST SITE:

The test is performed in the 3 meter semi-anechoic chamber located at 25791 Commercentre Drive, Lake Forest, California 92630 USA. This test facility meets the requirements of CISPR 16-1-4 and has been accredited by A2LA. IC test site registration number is 2042T.

### 10.3 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
637	3m Semi-anechoic Chamber	Panashield	3 meter	25 331-D-Z	August 2015	August 2018
1140	EMI Test Receiver	Rohde & Schwarz	ESC17	100825	02/04/2015	02/04/2016
1002	Lab Monitor	Omega	iBTHX-W	0440776	06/26/2015	06/26/2016

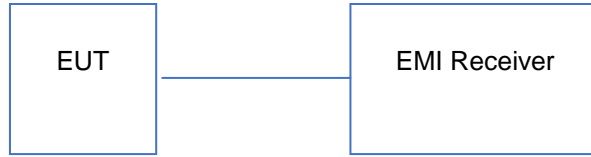
#### Software Utilized:

Name	Manufacturer	Version	Profile
N/A	N/A	N/A	N/A

### 10.4 Results:

The sample tested was found to comply.

10.5 Setup Diagram:

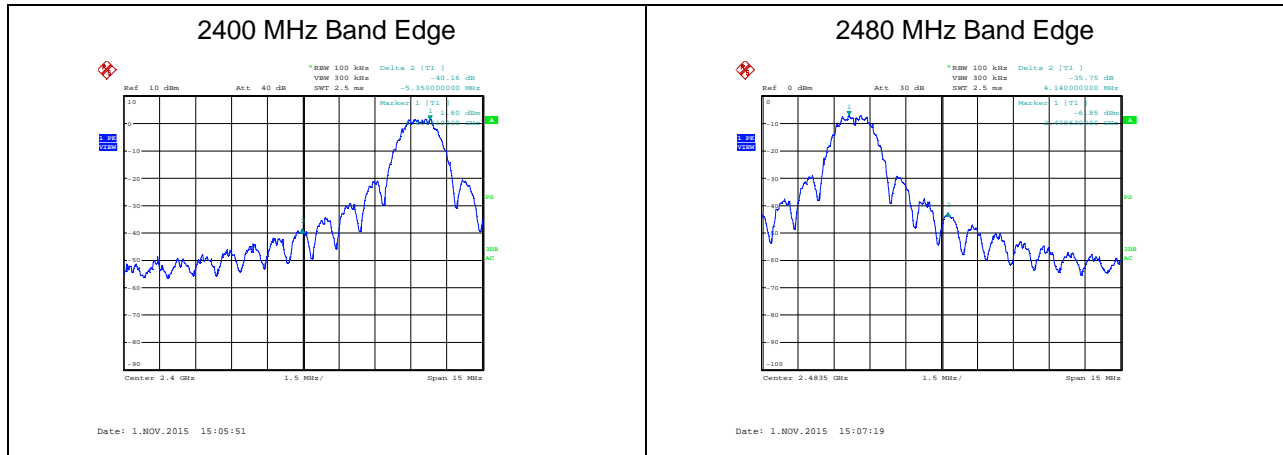


10.6 Plots/Data:

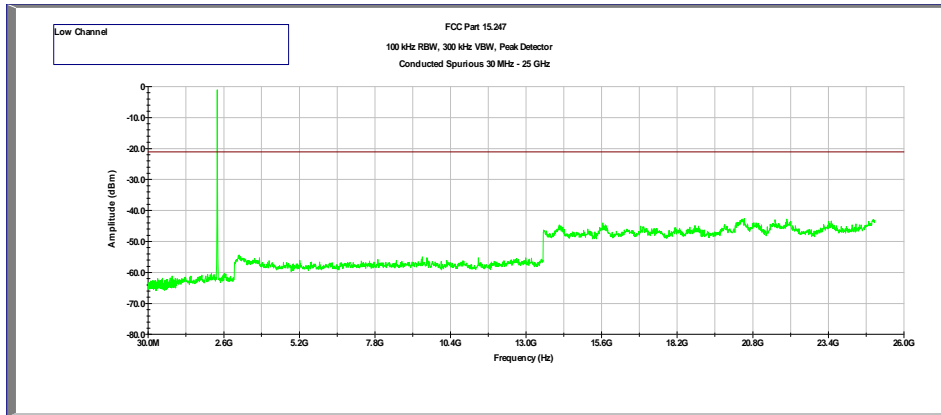
Test Personnel: Grace Lin  
 Product Standard: FCC 15.247, IC RSS-247  
 Input Voltage: 3Vdc Battery  
 Pretest Verification w/  
 Ambient Signals or  
 BB Source: N/A

Test Date: 11/01/2015  
 Limit Applied: FCC 15.247, IC RSS-247  
 Ambient Temperature: 21.1 °C  
 Relative Humidity: 43.7 %  
 Atmospheric Pressure: 992.2 mbars

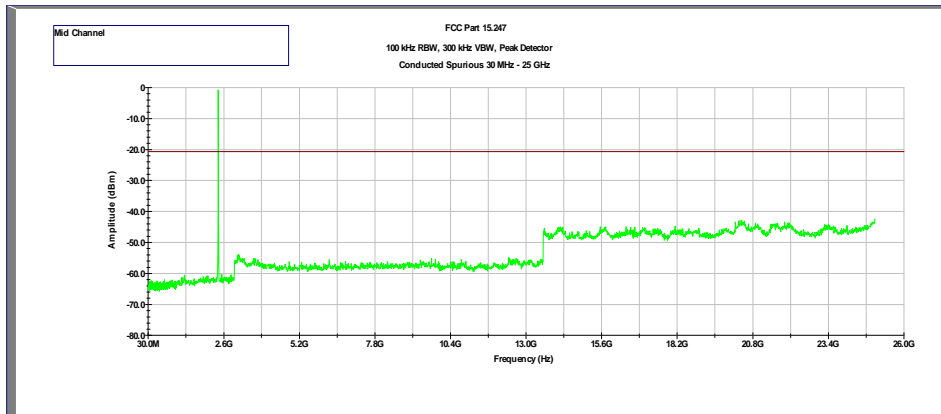
Band Edge



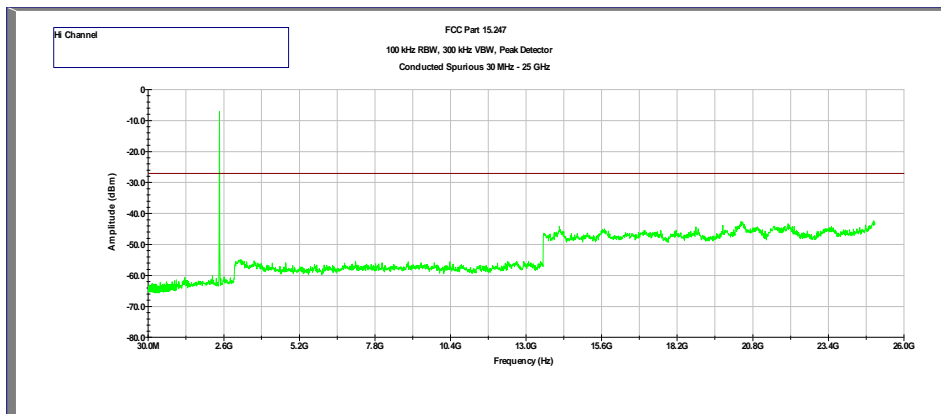
Channel 11:



Channel 18:



Channel 26:



Deviations, Additions, or Exclusions: None

## 11 Transmitter Radiated Spurious Emissions

### 11.1 Requirement(s)

Radiated emissions which fall in the restricted bands, as defined in §15.205(a), must comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

In any 100 kHz bandwidth outside the EUT pass-band, the RF power shall be below the maximum in-band 100 kHz emissions by at least 20 dB (if peak power of in-band emission is measured) or 30 dB (if average power of in-band emission is measured).

The field strength of emissions from intentional radiators operated within the frequency band shall comply with the following:

### 11.2 Method

EUT was configured to transmit continuously. Radiated emission measurements were performed from 30 MHz to 25 GHz according to the procedure described in ANSI C64.10. Spectrum analyzer resolution bandwidth is 120 kHz for frequencies 30 MHz to 1000 MHz. Above 1 GHz, both Peak and Average measurements were performed. The peak level of radiated emissions was measured with a resolution bandwidth (RBW) of 1 MHz and a video bandwidth (VBW) of 3 MHz. The average level of radiated emissions was measured with a resolution bandwidth (RBW) of 1 MHz and a video bandwidth (VBW) of 10 Hz.

The EUT is placed on a plastic turntable that is 80 cm in height for frequencies 30 MHz to 1000 MHz, 1.5 meters for frequency above 1000 MHz. If the EUT attaches to peripherals, they are connected and operational (as typical as possible). During testing, all cables were manipulated to produce worst-case emissions. The signal is maximized through rotation. The antenna height and polarization are varied during the search for maximum signal level. The antenna height is varied from 1 to 4 meters.

Radiated emissions are taken at 3 meters for frequencies below 18 and 1 meter for frequencies above 18 GHz.

Data included is representative of the worst-case configuration (the configuration which resulted in the highest emission levels). Plots below are corrected for distance, cables, preamp, filters and antenna factors then compared to the limits.

#### TEST SITE:

The test is performed in the 3 meter semi-anechoic chamber located at 25791 Commercentre Drive, Lake Forest, California 92630 USA. This test facility meets the requirements of CISPR 16-1-4 and has been accredited by A2LA. IC test site registration number is 2042T.

#### Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	U <sub>CISPR</sub>
Radiated Emissions, 3m	30-1000 MHz	4.3	6.3 dB
Radiated Emissions, 3m	1-18 GHz	5.5	5.2 dB

As shown in the table above our radiated emissions  $U_{lab}$  is less than the corresponding  $U_{CISPR}$  reference value in CISPR 16-4-2 Table 1, hence the compliance of the product is only based on the measured value, and no measurement uncertainty correction is required.

**Sample Calculation**

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CF - AG$$

Where

- FS = Field Strength in dB $\mu$ V/m
- RA = Receiver Amplitude (including preamplifier) in dB $\mu$ V
- CF = Cable Attenuation Factor in dB
- AF = Antenna Factor in dB
- AG = Amplifier Gain in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows.

Assume a receiver reading of 52.0 dB $\mu$ V is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 dB $\mu$ V/m. This value in dB $\mu$ V/m was converted to its corresponding level in  $\mu$ V/m.

RA = 52.0 dB $\mu$ V  
 AF = 7.4 dB/m  
 CF = 1.6 dB  
 AG = 29.0 dB  
 FS = 32 dB $\mu$ V/m

To convert from dB $\mu$ V to  $\mu$ V or mV the following was used:

$$UF = 10^{(NF / 20)} \text{ where } UF = \text{Net Reading in } \mu\text{V}$$

$$NF = \text{Net Reading in dB}\mu\text{V}$$

**Example:**

$$FS = RA + AF + CF - AG = 52.0 + 7.4 + 1.6 - 29.0 = 32.0$$

$$UF = 10^{(32 \text{ dB}\mu\text{V} / 20)} = 39.8 \mu\text{V/m}$$

**11.3 Test Equipment Used:**

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
637	3m Semi-anechoic Chamber	Panashield	3 meter	25 331-D-Z	August 2015	August 2018
1140	EMI Test Receiver	Rohde & Schwarz	ESCI7	100825	02/04/2015	02/04/2016
690	Spectrum Analyzer, 9 KHz - 40 GHz	Rohde & Schwarz	FSP40	100027	01/06/2015	01/06/2016
1147	Bilog Antenna	A.H. Systems, Inc.	SAS-521F-7	218	04/23/2015	04/23/2016
692	Horn Antenna	ETS-Lindgren	3115	00031626	05/06/2015	05/06/2016
880	Horn Antenna	ETS-Lindgren	3116C	00153521	11/25/2014	11/25/2015
1135	Preamplifier	Miteq	AMF-6D-00501800-24-10P	1685147	03/30/2015	03/30/2016
798	Cable	Insulated wire	Cable	00828	04/03/2015	04/02/2016
1517	Cable	Rohde & Schwarz	TSPR-B7	101528	06/23/2015	06/23/2016
1564	Cable	Rohde & Schwarz	TSPR-B8	101526	10/14/2015	10/14/2016
1002	Lab Monitor	Omega	iBTHX-W	0440776	06/26/2015	06/26/2016

**Software Utilized:**

Name	Manufacturer	Version	Profile
Tile	Quantum Change	3.4.K.29	<ul style="list-style-type: none"> <li>ESCI_FCC_CISPR-RE-30MHz-1GHz_Bilog</li> <li>FCC Part 15 FSP 1-18GHz</li> </ul>

**11.4 Results:**

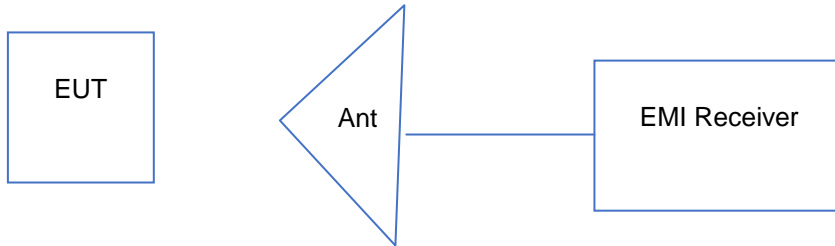
The data on the following pages list the significant emission frequencies, the limit and the margin of compliance.

Radiated emission measurements were performed up to 25GHz. Peak emissions that were identified were measured to be greater than 20dB below 74dB $\mu$ V peak limits. No Emissions were identified when scanned from 18-25 GHz.

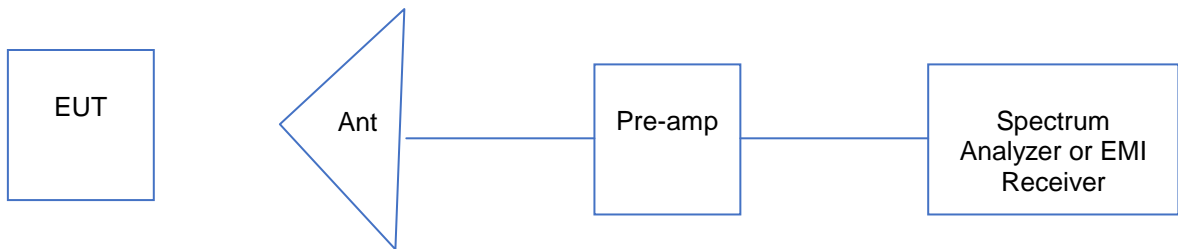


**11.5 Setup Diagram:**

Below 1 GHz:



Above 1 GHz:

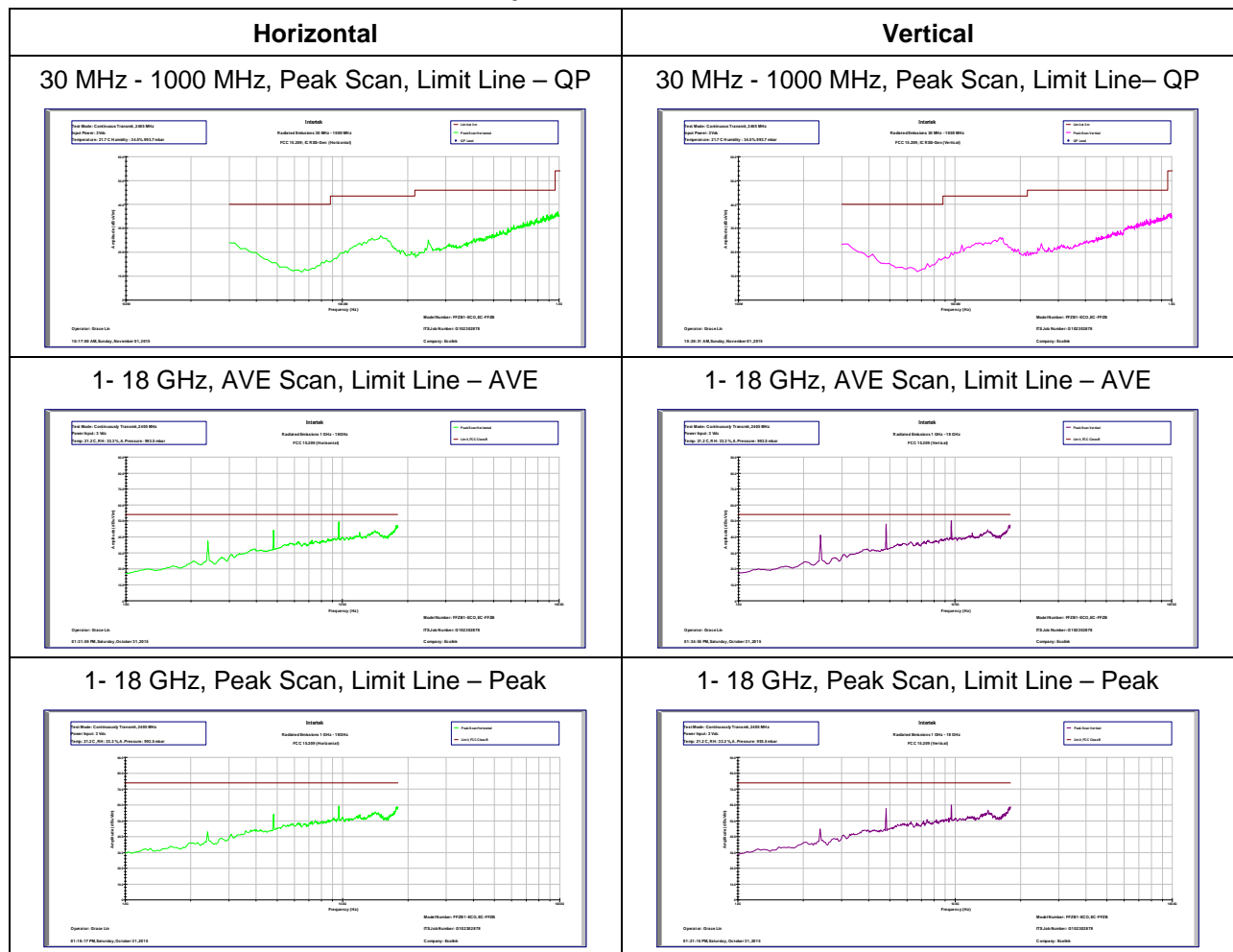


11.6 Plots/Data:

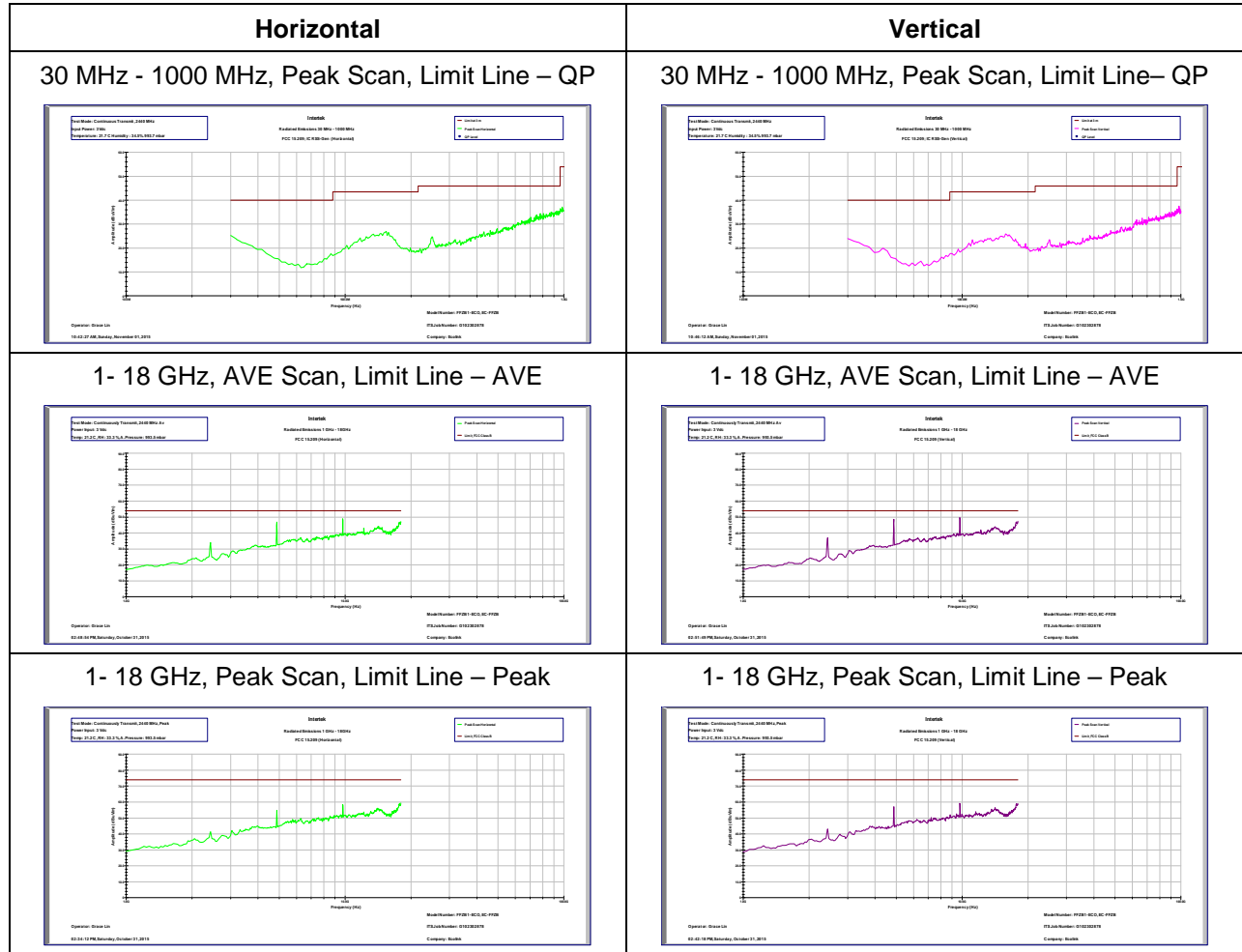
Test Personnel: Grace Lin  
 Product Standard: FCC 15.247, IC RSS-247  
 Input Voltage: 3Vdc  
 Pretest Verification w/  
 Ambient Signals or  
 BB Source: Yes

Test Date: 10/31/2015, 11/01/2015,  
 11/22/2015, 3/12/2016  
 Limit Applied: FCC 15.247, FCC 15.209, IC  
 RSS-247, IC RSS-Gen  
 Ambient Temperature: 21.2 °C, 21.7 °C, 21.7 °C, 22.8  
 °C  
 Relative Humidity: 33.3 %, 34.5%, 23.9%, 40.4%  
 Atmospheric Pressure: 993.5 mbars, 993.7 mbar, 991.6  
 mbar, 997.1 mbar

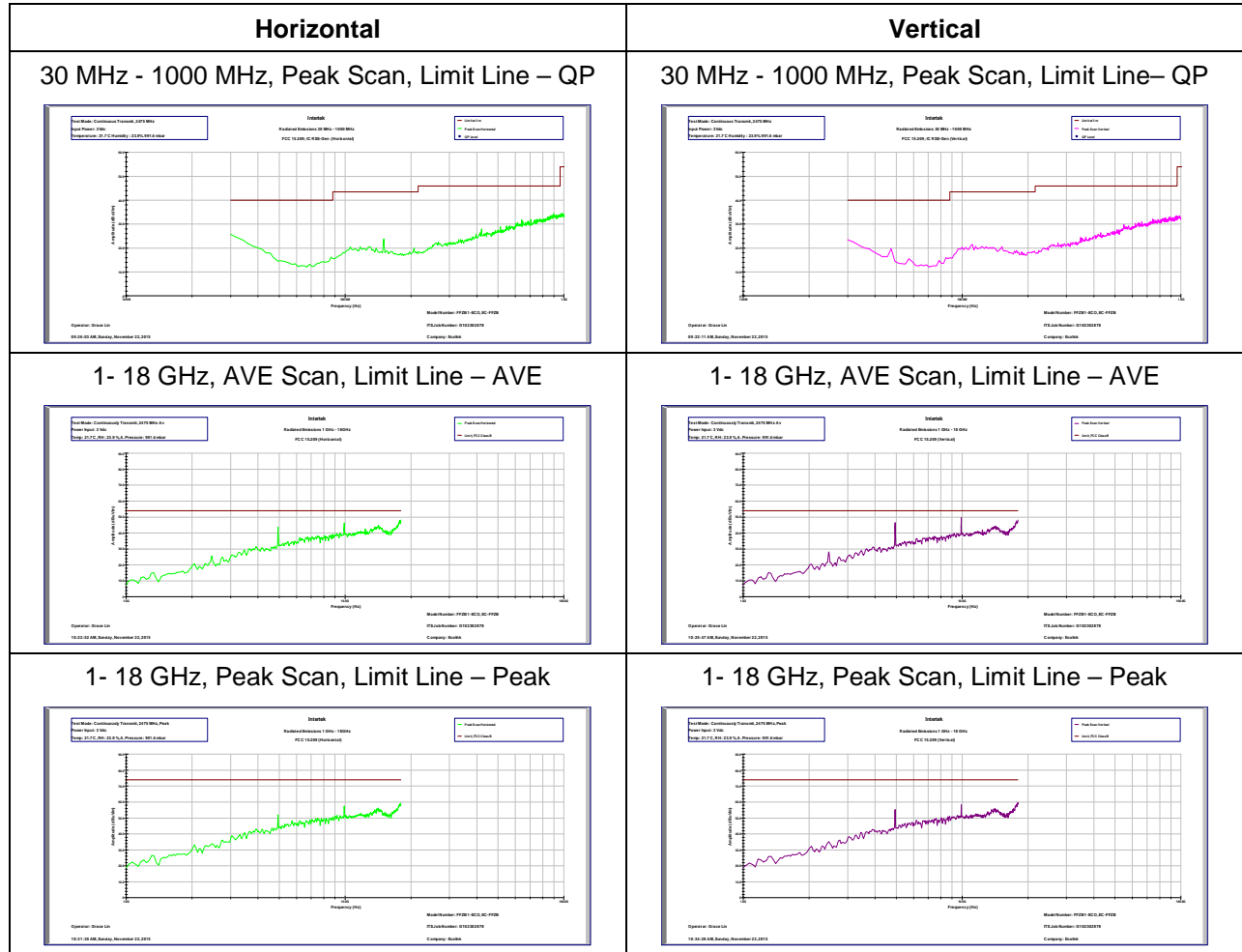
Radiated Spurious Emissions 2405 MHz



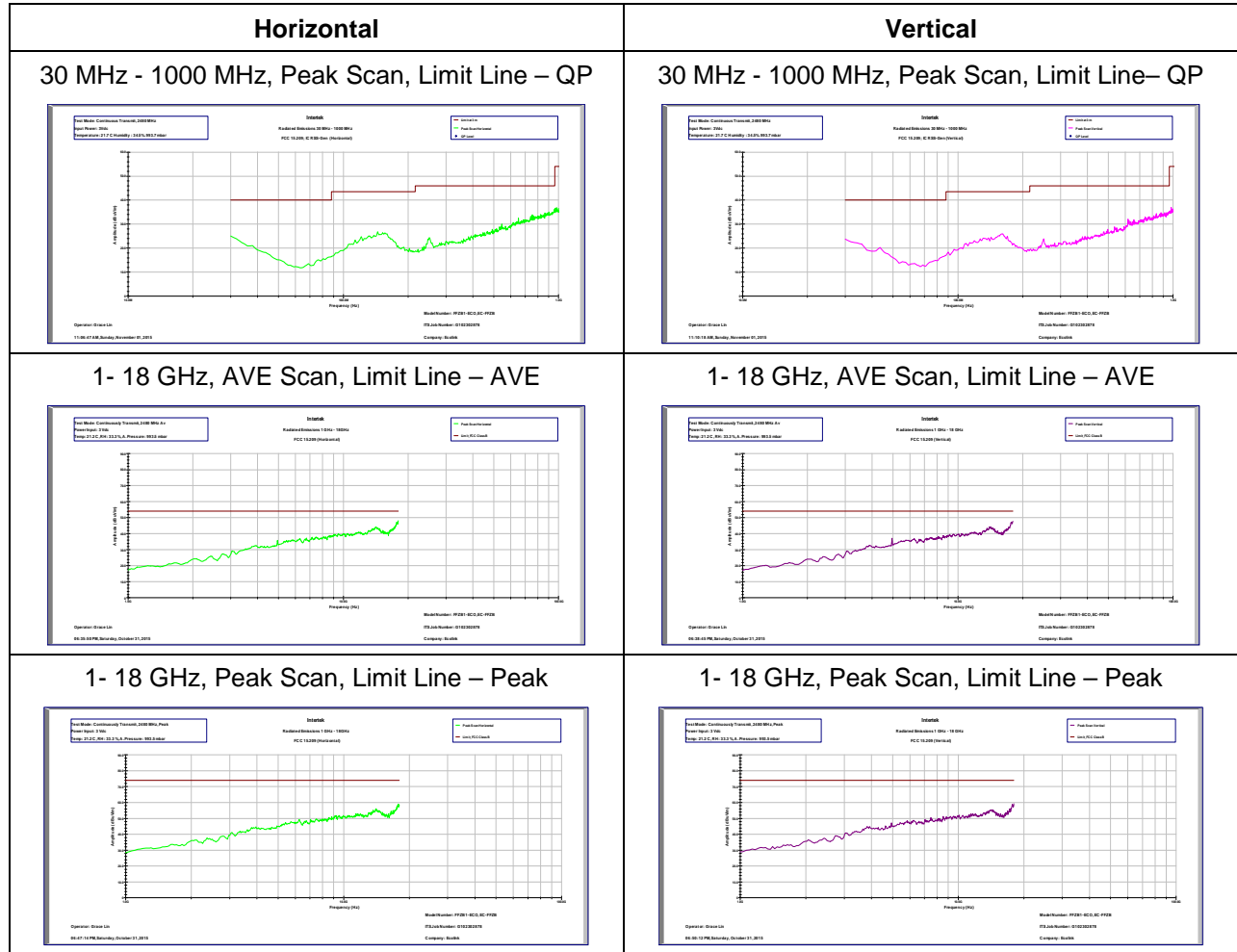
Radiated Spurious Emissions 2440 MHz



Radiated Spurious Emissions 2475 MHz



Radiated Spurious Emissions 2480 MHz



Antenna Polarization	Frequency (MHz)	Channel No.	Power Setting (Level)	EUT Orientation	Measured Data (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (cm)	Turntable Degree	Detector
V	2390	11	-7	ZX	50.67	54	-3.33	160.0	145.0	AVE
V	2390	11	-7	ZX	62.86	74	-11.14	160.0	145.0	PK
V	4810	11	-7	ZX	48.57	54	-5.43	256.0	178.0	AVE
V	4810	11	-7	ZX	57.76	74	-16.24	256.0	178.0	PK
V	9620	11	-7	ZX	49.52	54	-4.48	274.0	100.0	AVE
V	9620	11	-7	ZX	60.62	74	-13.38	274.0	100.0	PK
V	4950	18	-7	ZX	46.35	54	-7.65	165.0	264.0	AVE
V	4950	18	-7	ZX	56.03	74	-17.97	165.0	264.0	PK
V	9900	18	-7	ZX	46.61	54	-7.39	189.0	271.0	AVE
V	9900	18	-7	ZX	57.96	74	-16.04	189.0	271.0	PK
V	4880	18	-7	ZX	47.50	54	-6.50	270.0	174.0	AVE
V	4880	18	-7	ZX	57.16	74	-16.84	270.0	174.0	PK
V	9760	18	-7	ZX	48.25	54	-5.75	272.0	116.0	AVE
V	9760	18	-7	ZX	59.56	74	-14.44	272.0	116.0	PK
V	2483.5	26	-15	ZX	51.22	54	-2.78	178.0	100.0	AVE
V	2483.5	26	-15	ZX	60.14	74	-13.86	178.0	100.0	PK
V	2483.5	25	-7	ZX	47.34	54	-6.66	160.0	116.0	AVE
V	2483.5	25	-7	ZX	60.66	74	-13.34	160.0	116.0	PK
V	4960	26	-10	ZX	36.67	54	-17.33	258.0	133.0	AVE
V	4960	26	-10	ZX	48.86	74	-25.14	258.0	133.0	PK

Deviations, Additions, or Exclusions: None

## 12 Receiver Radiated Spurious Emissions

### 12.1 Method

Tests are performed in accordance with ANSI C63.4-2014.

The EUT was placed on a non-conducting table 80 cm above the ground plane (turntable). The antenna to EUT distance was 3 meters.

The spectrum from 30 MHz to the 5<sup>th</sup> harmonic was investigated with the EUT configured to normal operation. The turntable containing the EUT was rotated through 360 degrees and the receive antenna height was varied from 1 to 4 meters to locate the worst-case emissions levels. Measurements were made with the antenna in both the horizontal and vertical polarizations. EUT was tested at three orthogonal planes. The worst-case data is recorded in this report.

#### TEST SITE:

The test is performed in the 3 meter semi-anechoic chamber located at 25791 Commercentre Drive, Lake Forest, California 92630 USA. This test facility meets the requirements of CISPR 16-1-4 and has been accredited by A2LA. IC test site registration number is 2042T.

#### Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucisprr
Radiated Emissions, 3m	30-1000 MHz	4.3	6.3 dB
Radiated Emissions, 3m	1-18 GHz	5.5	5.2 dB

As shown in the table above our radiated emissions  $U_{lab}$  is less than the corresponding  $U_{CISPR}$  reference value in CISPR 16-4-2 Table 1, hence the compliance of the product is only based on the measured value, and no measurement uncertainty correction is required.

#### Sample Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CF - AG$$

Where

- FS = Field Strength in dB $\mu$ V/m
- RA = Receiver Amplitude (including preamplifier) in dB $\mu$ V
- CF = Cable Attenuation Factor in dB
- AF = Antenna Factor in dB
- AG = Amplifier Gain in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows.

Assume a receiver reading of 52.0 dB $\mu$ V is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving a field strength of 32 dB $\mu$ V/m. This value in dB $\mu$ V/m was converted to its corresponding level in  $\mu$ V/m.

$$RA = 52.0 \text{ dB}\mu\text{V}$$

AF = 7.4 dB/m  
 CF = 1.6 dB  
 AG = 29.0 dB  
 FS = 32 dB $\mu$ V/m

To convert from dB $\mu$ V to  $\mu$ V or mV the following was used:

$$UF = 10^{(NF / 20)} \text{ where } UF = \text{Net Reading in } \mu\text{V}$$

$$NF = \text{Net Reading in dB}\mu\text{V}$$

**Example:**

$$FS = RA + AF + CF - AG = 52.0 + 7.4 + 1.6 - 29.0 = 32.0$$

$$UF = 10^{(32 \text{ dB}\mu\text{V} / 20)} = 39.8 \mu\text{V/m}$$

**12.2 Test Equipment Used:**

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
637	3m Semi-anechoic Chamber	Panashield	3 meter	25 331-D-Z	August 2015	August 2018
1140	EMI Test Receiver	Rohde & Schwarz	ESCI7	100825	02/04/2015	02/04/2016
690	Spectrum Analyzer, 9 KHz - 40 GHz	Rohde & Schwarz	FSP40	100027	01/06/2015	01/06/2016
1147	Bilog Antenna	A.H. Systems, Inc.	SAS-521F-7	218	04/23/2015	04/23/2016
692	Horn Antenna	ETS-Lindgren	3115	00031626	05/06/2015	05/06/2016
1135	Preamplifier	Miteq	AMF-6D-00501800-24-10P	1685147	03/30/2015	03/30/2016
798	Cable	Insulated wire	Cable	00828	04/03/2015	04/02/2016
1517	Cable	Rohde & Schwarz	TSPR-B7	101528	06/23/2015	06/23/2016
1002	Lab Monitor	Omega	iBTHX-W	0440776	06/26/2015	06/26/2016

**Software Utilized:**

Name	Manufacturer	Version	Profile
Tile	Quantum Change	3.4.K.29	<ul style="list-style-type: none"> <li>• ESCI_FCC_CISPR-RE-30MHz-1GHz_Bilog</li> <li>• FCC Part 15 FSP 1-18GHz</li> </ul>

**12.3 Results:**

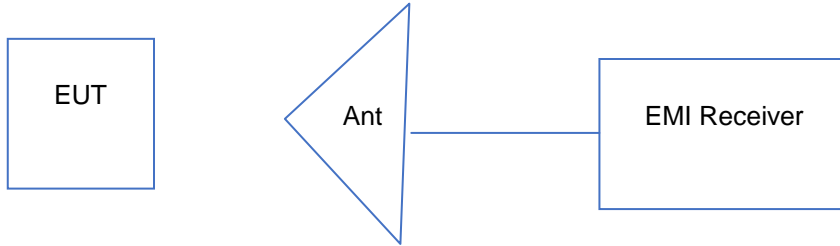
The sample tested was found to Comply.

During testing, the EUT was in receive mode in between transmit bursts. Therefore the results show compliance of the receive mode as well as the transmit mode.

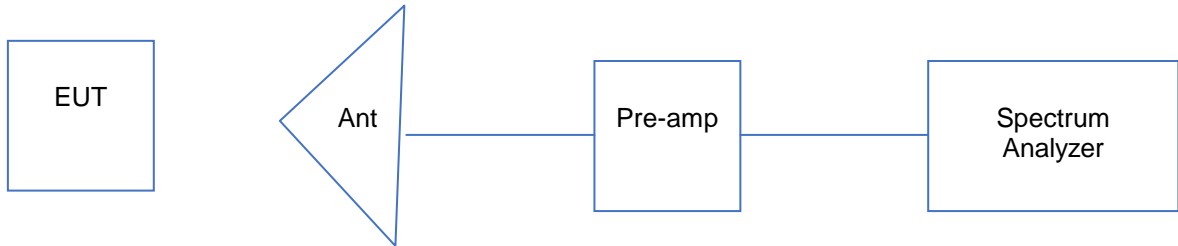


**12.4 Setup Diagram:**

Below 1 GHz:



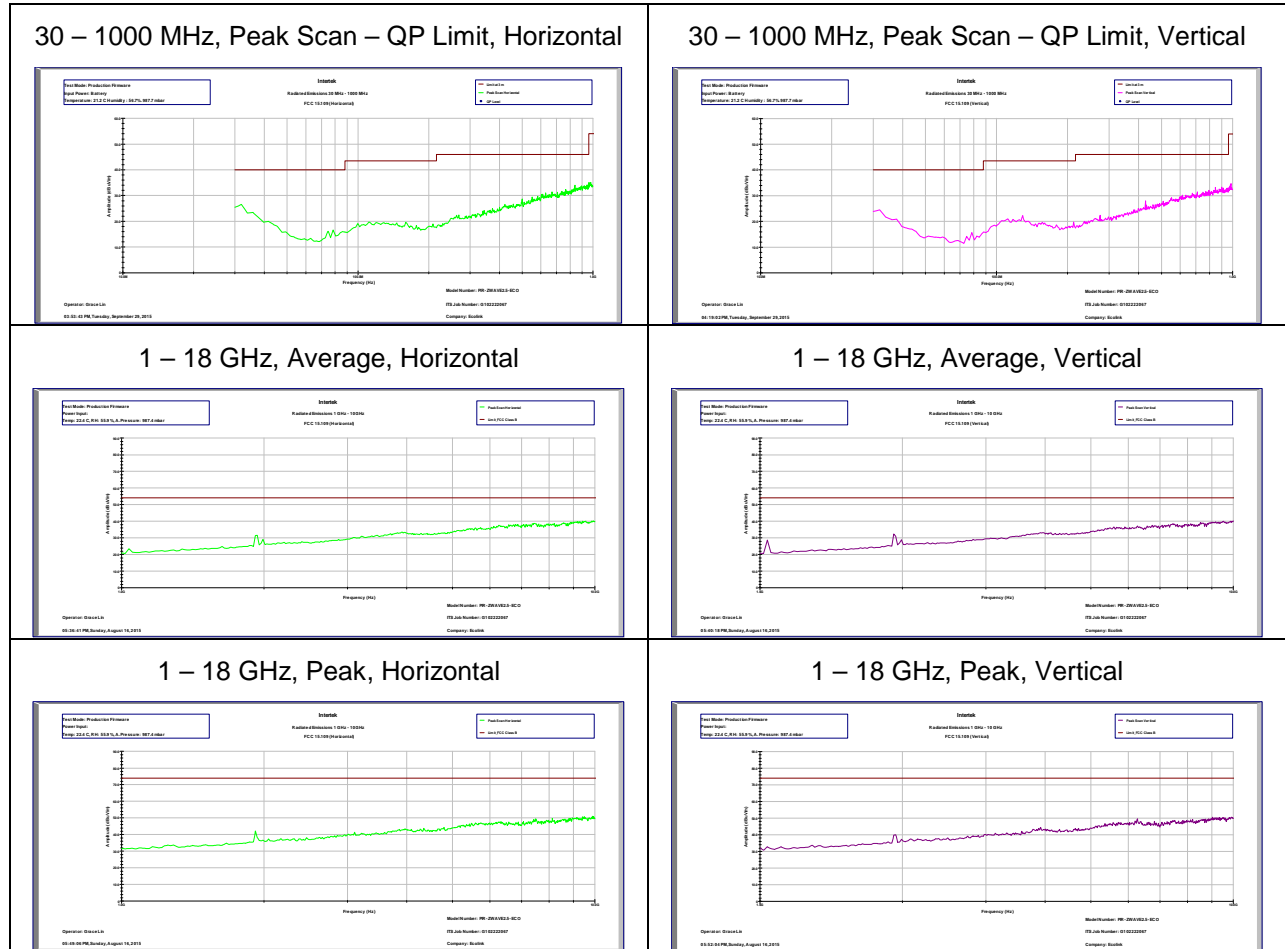
Above 1 GHz:



12.5 Plots/Data:

Test Personnel: Grace Lin  
 Product Standard: FCC 15B, IC ICES-003  
 Input Voltage: 3Vdc  
 Pretest Verification w/  
 Ambient Signals or  
 BB Source: Yes

Test Date: 10/31/2015, 11/01/2015  
 Limit Applied: FCC 15.109, IC ICES-003  
 Ambient Temperature: 21.2 °C, 21.7 °C  
 Relative Humidity: 33.3 %, 34.5%  
 Atmospheric Pressure: 993.5 mbars, 993.7 mbar



Deviations, Additions, or Exclusions: None

## 13 AC Mains Conducted Emissions

### 13.1 Performance Criterion

Frequency Band MHz	Class B Limit dB( $\mu$ V)		Class A Limit dB( $\mu$ V)	
	Quasi-Peak	Average	Quasi-Peak	Average
0.15-0.50	66 to 56 *	56 to 46 *	79	66
0.50-5.00	56	46	73	60
5.00-30.00	60	50	73	60

Note: \*Decreases linearly with the logarithm of the frequency  
At the transition frequency the lower limit applies.

### 13.2 Method

Measurements are carried out using quasi-peak and average detector receivers in accordance with CISPR 16. An AMN is required to provide a defined impedance at high frequencies across the power feed at the point of measurement of terminal voltage and also to provide isolation of the circuit under test from the ambient noise on the power lines. An AMN as defined in CISPR 16 shall be used.

The EUT is located so that the distance between the boundary of the EUT and the closest surface of the AMN is 0.8m.

Where a flexible mains cord is provided by the manufacturer, this shall be 1m long or if in excess of 1m, the excess cable is folded back and forth as far as possible so as to form a bundle not exceeding 0.4m in length.

The EUT is arranged and connected with cables terminated in accordance with the product specification.

Conducted disturbance is measured between the phase lead and the reference ground, and between the neutral lead and the reference ground. Both measured values are reported.

The EUT, where intended for tabletop use, is placed on a table whose top is 0.8m above the ground plane. A vertical, metal reference plane is placed 0.4m from the EUT. The vertical metal reference-plane is at least 2m by 2m. The EUT shall be kept at least 0.8m from any other metal surface or other ground plane not being part of the EUT. The table is constructed of non-conductive materials. Its dimensions are 1m by 1.5m, but may be extended for larger EUT.

Floor standing EUT are placed on a horizontal metal ground plane and isolated from the ground plane by resting on an insulating material. The metal ground plane extends at least 0.5m beyond the boundaries of the EUT and has minimum dimensions of 2m by 2m.

Equipment setup for conducted disturbance tests followed the guidelines of ANSI C63.4.

#### TEST SITE:

The test is performed in the 3 meter semi-anechoic chamber located at 25791 Commercentre Drive, Lake Forest, California 92630 USA. This test facility meets the requirements of CISPR 16-1-4 and has been accredited by A2LA. IC test site registration number is 2042T.

**Measurement Uncertainty**

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucispr
AC Line Conducted Emissions	150 kHz - 30 MHz	2.1 dB	3.4dB
Telco Port Emissions	150 kHz - 30 MHz	2.6 dB	5.0dB

As shown in the table above our conducted emissions  $U_{lab}$  is less than the corresponding  $U_{CISPR}$  reference value in CISPR 16-4-2 Table 1, hence the compliance of the product is only based on the measured value, and no measurement uncertainty correction is required.

**Sample Calculations**

The following is how net line-conducted readings were determined:

$$NF = RF + LF + CF + AF$$

Where NF = Net Reading in dB $\mu$ V

RF = Reading from receiver in dB $\mu$ V

LF = LISN or ISN Correction Factor in dB

CF = Cable Correction Factor in dB

AF = Attenuator Loss Factor in dB

To convert from dB $\mu$ V to  $\mu$ V or mV the following was used:

$$UF = 10^{(NF / 20)} \text{ where } UF = \text{Net Reading in } \mu\text{V}$$

$$NF = \text{Net Reading in dB}\mu\text{V}$$

**Example:**

$$NF = RF + LF + CF + AF = 28.5 + 0.2 + 0.4 + 20.0 = 49.1 \text{ dB}\mu\text{V}$$

$$UF = 10^{(49.1 \text{ dB}\mu\text{V} / 20)} = 285.1 \mu\text{V/m}$$

**13.3 Test Equipment Used:**

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
N/A	N/A	N/A	N/A	N/A	N/A	N/A

**Software Utilized:**

Name	Manufacturer	Version	Profile
N/A	N/A	N/A	N/A

**13.4 Results:**

This test is not applicable as the EUT is battery powered.

**14 Revision History**

Revision Level	Date	Report Number	Prepared By	Reviewed By	Notes
0	11/30/2015	102302878LAX-003	GL	KV	Initial Release
1	03/12/2016	102302878LAX-003	GL	KV	Corrected duty cycle correction factor (DCCF), radiated spurious emissions (RSE), output power (Ch 26), and PSD (Ch 26)
2	04/25/2016	102302878LAX-003	GL	KV	Removed DCCF from RSE data table and used VBW=10Hz average data, editorial corrections