EMISSIONS TEST REPORT

(FULL COMPLIANT)

Report Number: 102966681ATL-005
Project Number: G102966681

Report Issue Date: 06/15/2017

Model(s) Tested: MTW100 (BLE)
Model(s) Partially Tested: None
Model(s) Not Tested but declared equivalent by the client: None

Standards: FCC Part 15 Subpart C: 2017
FCC Part 15 Subpart B: 2017
RSS 247 Issue 2: 02/2017
RSS 102 Issue 5: 03/2015
ICES 003 Issue 6: 01/2016

Tested by:
Intertek Testing Services NA, Inc.
1950 Evergreen Blvd, Suite 100
Duluth, GA 30096
USA

Intertek Testing Services NA, Inc.
70 Codman Hill Road
Boxborough, MA 01719
USA

Client:
Owl Labs, Inc.
33 1/2 Union Sq
Somerville, MA 02143
USA

Report prepared by Naga Suryadevara

Naga Suryadevara/EMC Engineer

Report reviewed by Kouma Sinn

Kouma Sinn/EMC Staff Engineer

Table of Contents

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 **complies** 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
3	Client Information	--
4	Description of Equipment Under Test and Variant Models	--
5	System Setup and Method	--
6	Transmitter Conducted Output Power and Human RF Exposure (CFR47 FCC Part 15 Subpart C (15.247): 2017 RSS 247: 02/2017 RSS 102: 03/2015)	Compliant
7	Power Spectral Density (CFR47 FCC Part 15 Subpart C (15.247): 2017 RSS 247: 02/2017)	Compliant
8	Conducted 6dB Bandwidth (CFR47 FCC Part 15 Subpart C (15.247): 2017 RSS 247: 02/2017)	Compliant
9	Transmitter Conducted Spurious Emissions (CFR47 FCC Part 15 Subpart C (15.247): 2017 RSS 247: 02/2017)	Compliant
10	Conducted Band-Edge (CFR47 FCC Part 15 Subpart C (15.247): 2017 RSS 247: 02/2017)	Compliant
11	Radiated Emissions (Transmitter Spurious, Band edge, Digital devices and Receiver) (CFR47 FCC Part 15 Subpart C (15.247): 2017 RSS 247: 02/2017 FCC Part 15 Subpart B: 2017 ICES 003: 01/2016)	Compliant
12	Conducted Emissions (CFR47 FCC Part 15 Subpart C (15.247): 2017 RSS 247: 02/2017 FCC Part 15 Subpart B: 2017 ICES 003: 01/2016)	Compliant
13	Revision History	--

3 Client Information

This EUT was tested at the request of:

Client: Owl Labs, Inc.
33 1/2 Union Sq
Somerville, MA 02143
USA

Contact: Amy DeDeo
Telephone: 508-454-1900
Fax: 508-454-1900
Email: amy@owllabs.com

4 Description of Equipment Under Test and Variant Models

Manufacturer: Nanning Fugui Precision Industrial Co., Ltd.
B Factories Area, Foxconn Nanning Sci-Tech Park, No.51, Tongle Avenue
Nanning, Guangxi 530000
China

Equipment Under Test			
Description	Manufacturer	Model Number	Serial Number
Video Conferencing Device	Foxconn	MTW100	ATL1704121031-001 Option A – Conducted Sample
Video Conferencing Device	Foxconn	MTW100	ATL1704121031-002 Option A – Radiated Sample

Receive Date:	04/06/2017
Received Condition:	Good
Type:	Production

Description of Equipment Under Test (provided by client)
Video Conferencing device

Equipment Under Test Power Configuration			
Rated Voltage	Rated Current	Rated Frequency	Number of Phases
100 – 240 VAC	1.7 A	50/60 Hz	1

Operating modes of the EUT:

No.	Descriptions of EUT Exercising
1	Transmit low, mid, and high channels
2	Receive mode

Software used by the EUT:

No.	Descriptions of EUT Exercising
1	Qualcomm Radio Tool Kit QRTC3

Radio/Receiver Characteristics	
Frequency Band(s)	2402 - 2480 MHz
Modulation Type(s)	GFSK
Maximum Output Power	2.461 dBm = 0.0017623818031 W
Test Channels	Low Channel 2402 MHz Mid Channel 2442 MHz High Channel 2480 MHz
Occupied Bandwidth	735 kHz
Data Rate (Mbps)	N/A
Frequency Hopper: Number of Hopping Channels	N/A
Frequency Hopper: Channel Dwell Time	N/A
Frequency Hopper: Max interval between two instances of use of the same channel	N/A
MIMO Information (# of Transmit and Receive antenna ports)	One each
Equipment Type	Standalone
ETSI LBT/Adaptivity	N/A
ETSI Adaptivity Type	N/A
ETSI Temperature Category (I, II, III)	N/A
ETSI Receiver Category (1, 2, 3)	N/A
Antenna Type and Gain	2400-2500 MHz; Dipole, i-pex (MHF) connector, Gain = 2.6 dBi

Variant Models:

The following variant models were not tested as part of this evaluation, but have been identified by the manufacturer as being electrically identical models, depopulated models, or with reasonable similarity to the model(s) tested. Intertek does not make any claims of compliance for samples or variants which were not tested.

None

5 System Setup and Method

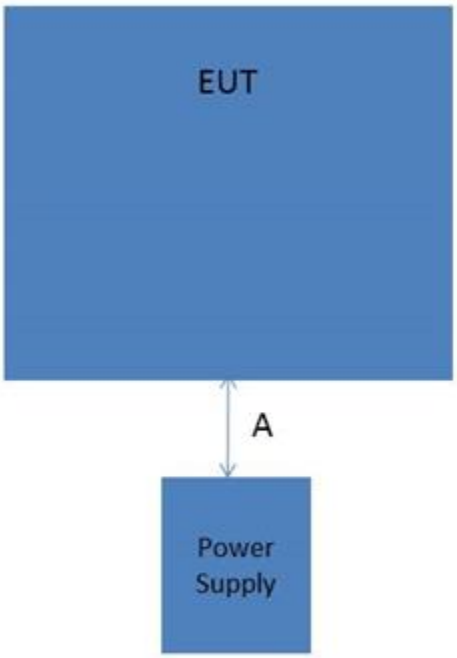
Cables					
ID	Description	Length (m)	Shielding	Ferrites	Termination
--	AC Adapter	2.5	No	No	AC Mains
--	USB Cable	2	Yes	No	Unterminated

Support Equipment			
Description	Manufacturer	Model Number	Serial Number
None			

5.1 Method:

Configuration as required by FCC Part 15 Subpart C: 2017, FCC Part 15 Subpart B: 2017, RSS 247 Issue 2: 02/2017, RSS 102 Issue 5: 03/2015, ICES 003 Issue 6: 01/2016, FCC KDB 558074 D01 DTS Measurement Guidance v03r02, ANSI C63.10: 2013, and ANSI C 63.4: 2014.

5.2 EUT Block Diagram:



6 Transmitter Conducted Output Power and Human RF Exposure

6.1 Method

Tests are performed in accordance with FCC Part 15 Subpart C (15.247), RSS 247, and RSS 102.

TEST SITE: EMC Lab (Duluth, GA)

The EMC Lab has one Semi-anechoic Chamber and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 400, and 480 3-Phase. Large reference ground-planes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

6.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
212104'	Barometric Pressure/Humidity/Temperature Datalogger	Extech	SD700	A.074980	10/21/2016	10/21/2017
031690'	EMC Analyzer	Agilent	E7405A	US40240205	09/21/2016	09/21/2017
MC1'	RF Coax Cable 10KHz-26.5GHz	MINI CIRCUITS	CBL10SMQ-SM+	131208	06/13/2016	06/13/2017

Software Utilized:

Name	Manufacturer	Version
None (Receiver Firmware)		

6.3 Results:

The sample tested was found to Comply.

FCC 15.247(b)(3)

b) The maximum peak conducted output power of the intentional radiator shall not exceed the following:

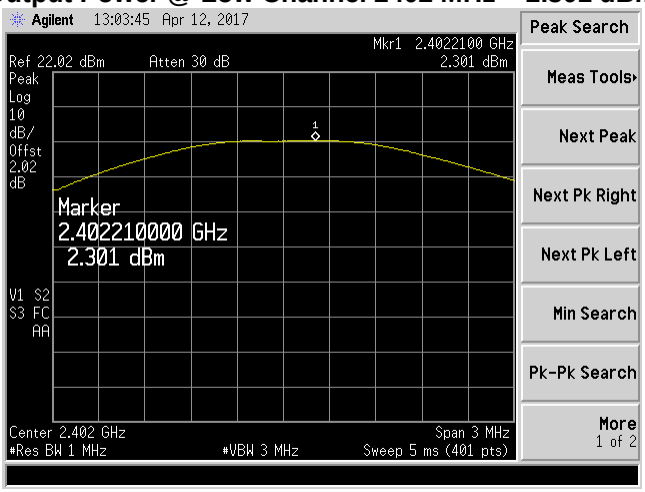
(3) For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt.

RSS-247 (d)

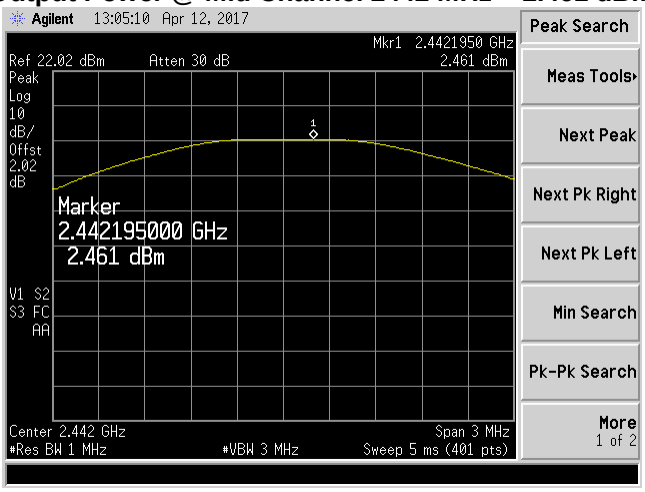
For DTSs employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e).

6.4 Plots/Data:

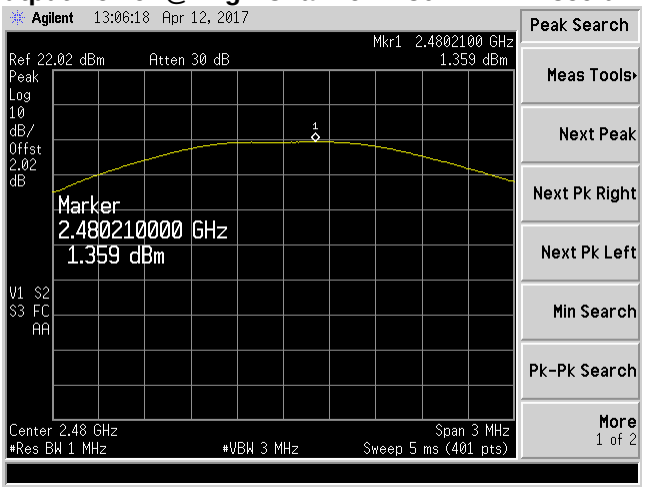
Output Power @ Low Channel 2402 MHz = 2.301 dBm



Output Power @ Mid Channel 2442 MHz = 2.461 dBm



Output Power @ High Channel 2480 MHz = 1.359 dBm



6.5 Human RF Exposure:

The maximum measured conducted power, P is 2.461 dBm.
The antenna gain, G is 2.6 dBi.
The maximum EIRP power = P+G
EIRP = 2.461 + 2.6 = 5.061 dBm or 0.0032070076803 W
The limits for Maximum Permissible Exposure (MPE) for transmitter operating at 2.4 GHz,
MPE is 1.0W/m^2.
RSS-102 Issue 5 Exposure Limit at 2.4 GHz = 5.35 W/m^2
The Power Density, S is related to EIRP with the equation:
$S = EIRP / 4\pi D^2$, where D is the safe separation distance and = 0.2m, or 20cm
$S = 0.0032070076803 W / 4\pi 0.2^2$,
S = 0.0063 W/m^2,
which is below the Maximum Permissible Exposure (MPE) of 10W/m^2 and RSS 102 Issue 5 RF Exposure limit 5.35 W/ m^2

Test Personnel:	Mary T Sampson MTS	Test Date:	04/12/2017
Supervising/Reviewing Engineer: (Where Applicable)	N/A		
Product Standard:	FCC 15.247 RSS 247	Limit Applied:	See Section 6.3
Input Voltage:	120VAC 60Hz		
		Ambient Temperature:	22.8 ºC
Pretest Verification:	N/A	Relative Humidity:	43.8 %
		Atmospheric Pressure:	990.6 mbars

Deviations, Additions, or Exclusions: None

7 Power Spectral Density

7.1 Method

Tests are performed in accordance with FCC Part 15 Subpart C (15.247) and RSS 247.

TEST SITE: EMC Lab (Duluth, GA)

The EMC Lab has one Semi-anechoic Chamber and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 400, and 480 3-Phase. Large reference ground-planes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

7.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
212104'	Barometric Pressure/Humidity/Temperature Datalogger	Extech	SD700	A.074980	10/21/2016	10/21/2017
031690'	EMC Analyzer	Agilent	E7405A	US40240205	09/21/2016	09/21/2017
MC1'	RF Coax Cable 10KHz-26.5GHz	MINI CIRCUITS	CBL10SMQ-SM+	131208	06/13/2016	06/13/2017

Software Utilized:

Name	Manufacturer	Version
None (Receiver Firmware)		

7.3 Results:

The sample tested was found to Comply.

FCC 15.247(e)

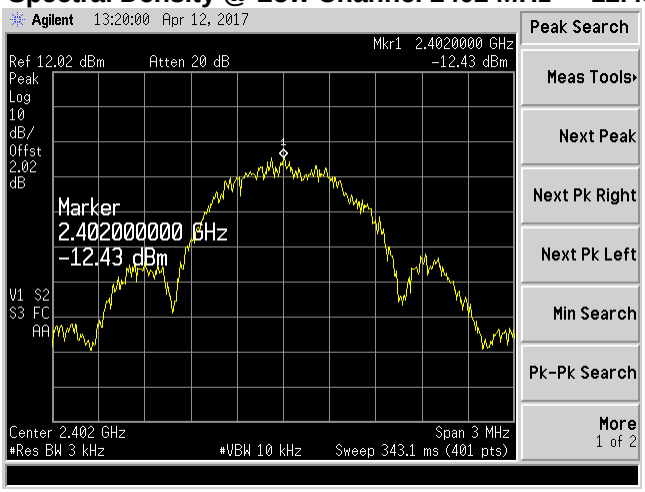
For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

RSS-247 Section 5.2(b)
DTSs include systems that employ digital modulation techniques resulting in spectral characteristics similar to direct sequence systems. The following applies to the bands 902-928 MHz and 2400-2483.5 MHz:

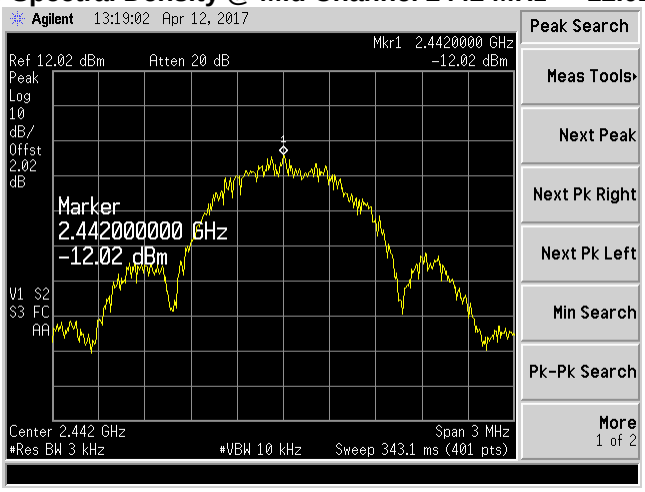
The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of section 5.4(d), (i.e. the power spectral density shall be determined using the same method as is used to determine the conducted output power).

7.4 Plots/Data:

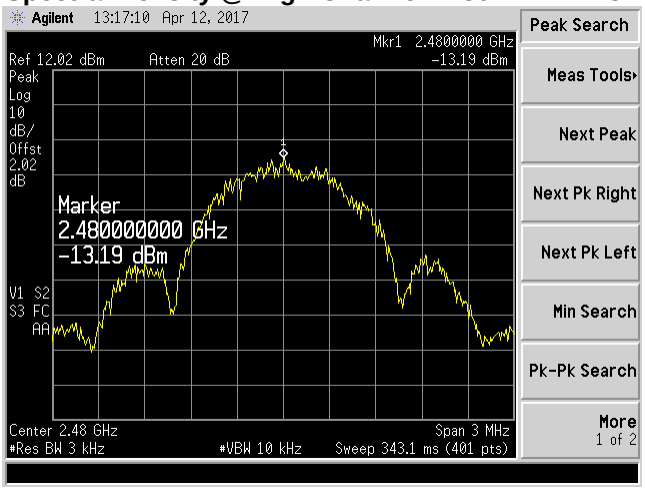
Power Spectral Density @ Low Channel 2402 MHz = -12.43 dBm



Power Spectral Density @ Mid Channel 2442 MHz = -12.02 dBm



Power Spectral Density @ High Channel 2480 MHz = -13.19 dBm



Test Personnel:	Mary T Sampson MTS	Test Date:	04/12/2017
Supervising/Reviewing Engineer: (Where Applicable)	N/A		
Product Standard:	FCC 15.247 RSS 247	Limit Applied:	See Section 7.3
Input Voltage:	120VAC 60Hz		
		Ambient Temperature:	22.8 ºC
Pretest Verification:	N/A	Relative Humidity:	43.8 %
		Atmospheric Pressure:	990.6 mbars

Deviations, Additions, or Exclusions: None

8 Conducted 6 dB Bandwidth

8.1 Method

Tests are performed in accordance with FCC Part 15 Subpart C (15.247) and RSS 247.

TEST SITE: EMC Lab (Duluth, GA)

The EMC Lab has one Semi-anechoic Chamber and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 400, and 480 3-Phase. Large reference ground-planes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

8.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
212104'	Barometric Pressure/Humidity/Temperature Datalogger	Extech	SD700	A.074980	10/21/2016	10/21/2017
031690'	EMC Analyzer	Agilent	E7405A	US40240205	09/21/2016	09/21/2017
MC1'	RF Coax Cable 10KHz-26.5GHz	MINI CIRCUITS	CBL10SMQ-SM+	131208	06/13/2016	06/13/2017

Software Utilized:

Name	Manufacturer	Version
None (Receiver Firmware)		

8.3 Results:

The sample tested was found to Comply.

FCC 15.247(a)(2)

(a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:

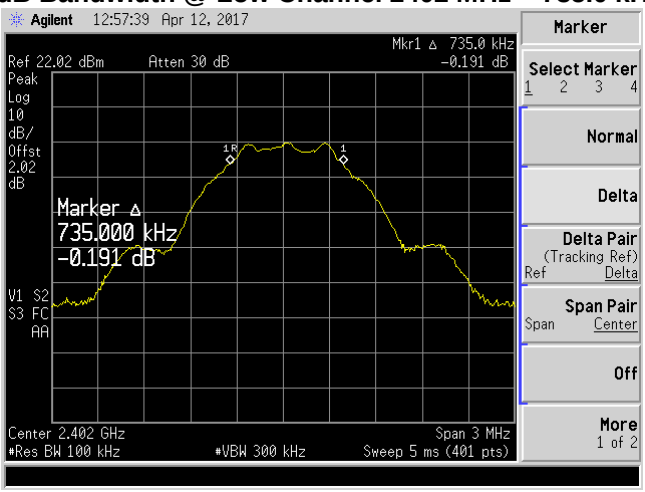
(2) Systems using digital modulation techniques may operate in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

RSS-247 5.2(a)
DTSs include systems that employ digital modulation techniques resulting in spectral characteristics similar to direct sequence systems. The following applies to the bands 902-928 MHz and 2400-2483.5 MHz:

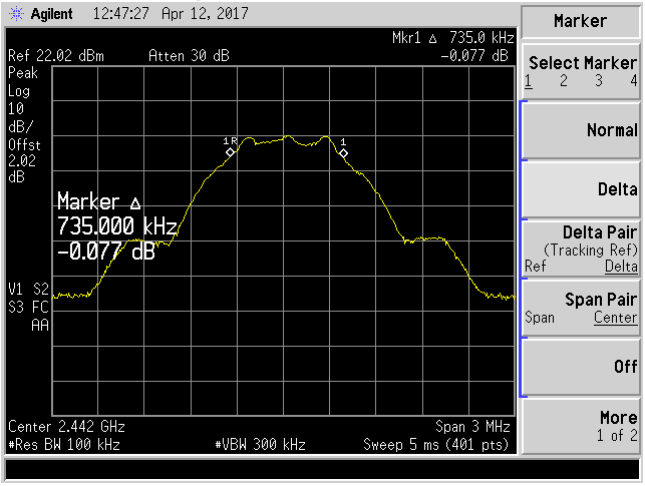
a) The minimum 6 dB bandwidth shall be 500 kHz.

8.4 Plots/Data:

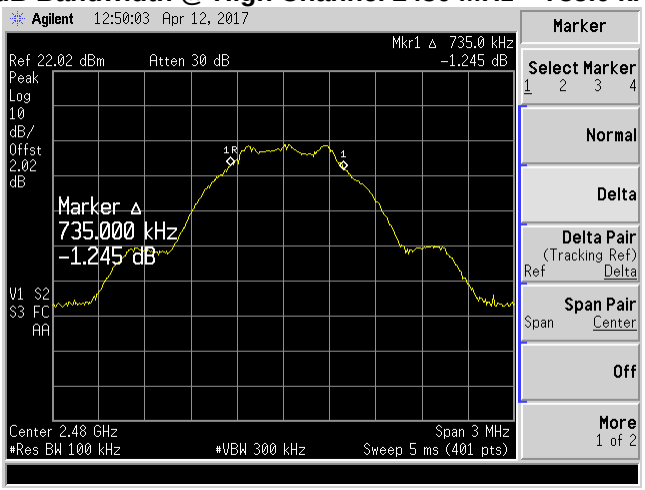
6dB Bandwidth @ Low Channel 2402 MHz = 735.0 kHz



6dB Bandwidth @ Mid Channel 2442 MHz = 735.0 kHz



6dB Bandwidth @ High Channel 2480 MHz = 735.0 kHz



Test Personnel:	Mary T Sampson MTS	Test Date:	04/12/2017
Supervising/Reviewing Engineer: (Where Applicable)	N/A		
Product Standard:	FCC 15.247 RSS 247	Limit Applied:	See Section 8.3
Input Voltage:	120VAC 60Hz		
		Ambient Temperature:	22.8 ºC
Pretest Verification:	N/A	Relative Humidity:	43.8 %
		Atmospheric Pressure:	990.6 mbars

Deviations, Additions, or Exclusions: None

9 Transmitter Conducted Spurious Emissions

9.1 Method

Tests are performed in accordance with FCC Part 15 Subpart C (15.247) and RSS 247.

TEST SITE: EMC Lab (Duluth, GA)

The EMC Lab has one Semi-anechoic Chamber and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 400, and 480 3-Phase. Large reference ground-planes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

9.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
212104'	Barometric Pressure/Humidity/Temperature Datalogger	Extech	SD700	A.074980	10/21/2016	10/21/2017
031690'	EMC Analyzer	Agilent	E7405A	US40240205	09/21/2016	09/21/2017
MC1'	RF Coax Cable 10KHz-26.5GHz	MINI CIRCUITS	CBL10SMQ-SM+	131208	06/13/2016	06/13/2017

Software Utilized:

Name	Manufacturer	Version
None (Receiver Firmware)		

9.3 Results:

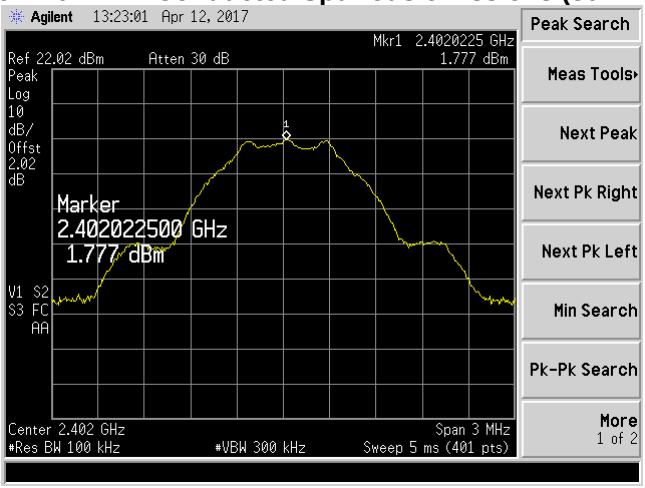
The sample tested was found to Comply.

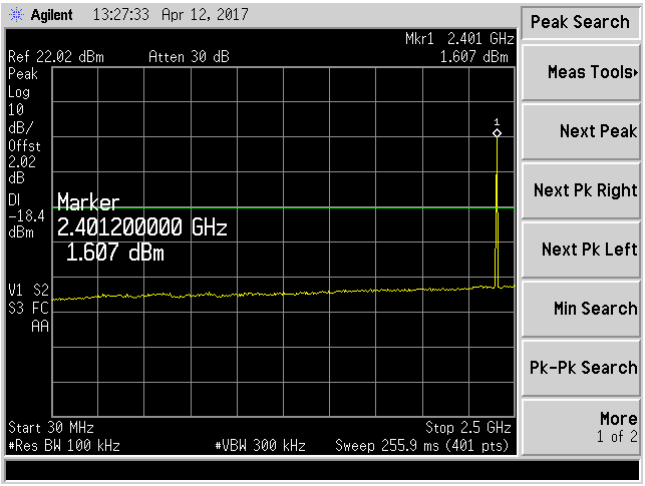
FCC Part 15.247(d)
In any 100 kHz bandwidth outside the frequency band , the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in §15.209(a) is not required. 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) (see 15.205(c)).

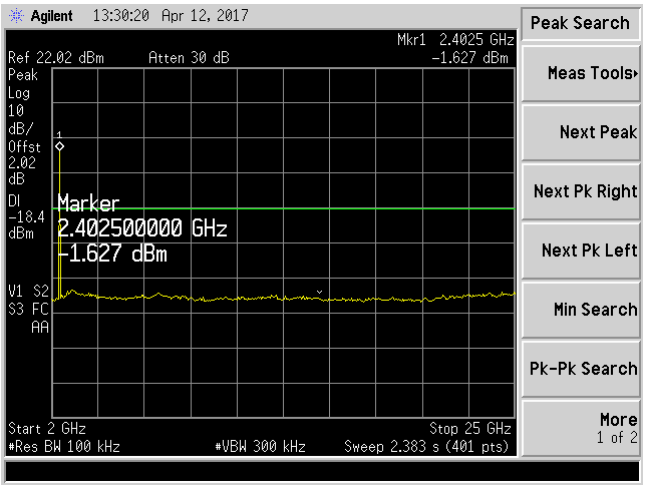
RSS-247 Section 5.5
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

9.4 Plots/Data:

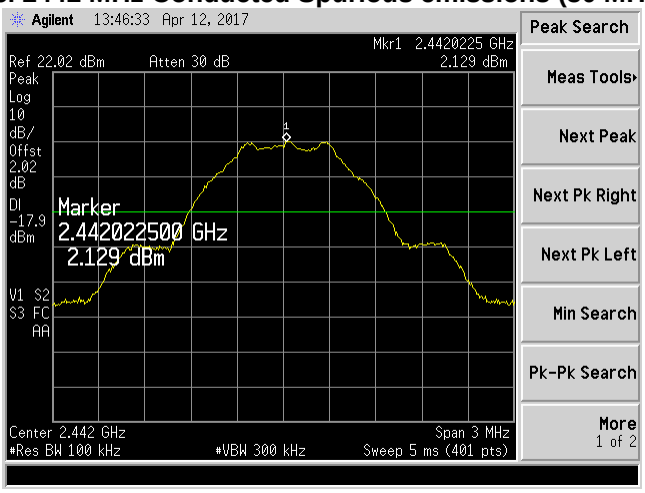
Low Channel 2402 MHz Conducted Spurious emissions (30 MHz – 25 GHz)

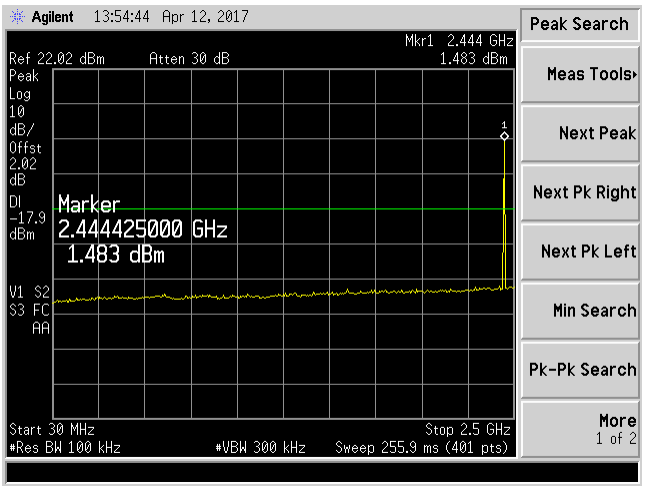


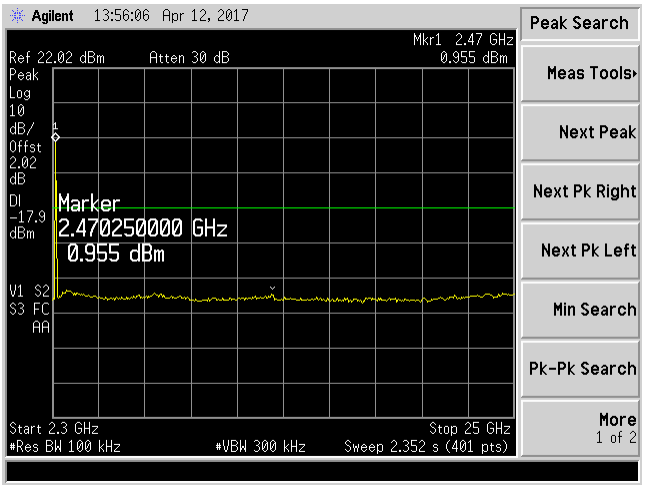




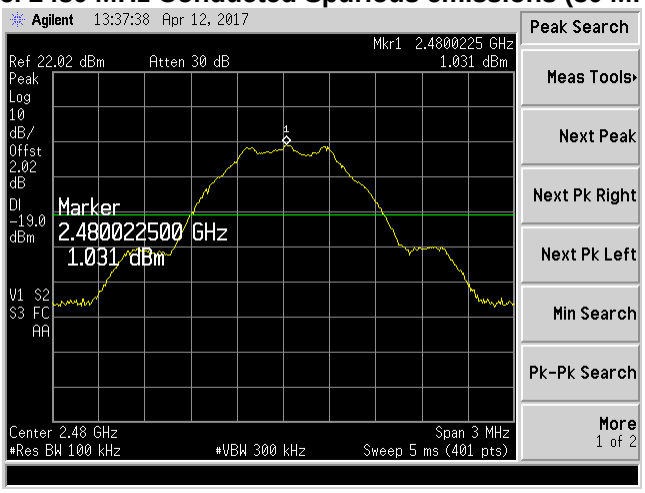
Mid Channel 2442 MHz Conducted Spurious emissions (30 MHz – 25 GHz)

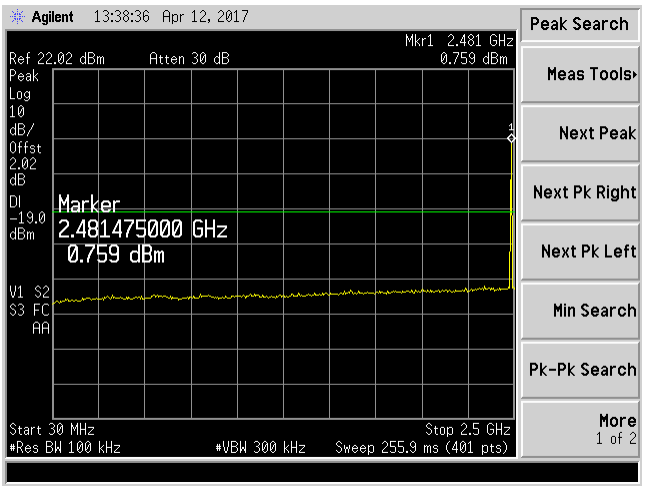


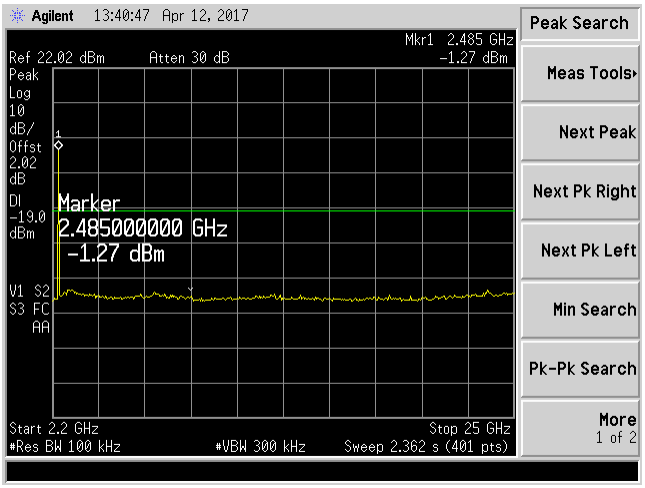




High Channel 2480 MHz Conducted Spurious emissions (30 MHz – 25 GHz)







Test Personnel:	Mary T Sampson MTS	Test Date:	04/12/2017
Supervising/Reviewing Engineer: (Where Applicable)	N.A		
Product Standard:	FCC 15.247 RSS 247	Limit Applied:	See Section 9.3
Input Voltage:	120VAC 60Hz		
Pretest Verification w/ Ambient Signals or BB Source:	N/A	Ambient Temperature:	22.8 ºC
		Relative Humidity:	43.8 %
		Atmospheric Pressure:	990.6 mbars

Deviations, Additions, or Exclusions: None

10 Conducted Band-Edge

10.1 Method

Tests are performed in accordance with FCC Part 15 Subpart C (15.247) and RSS 247.

TEST SITE: EMC Lab (Duluth, GA)

The EMC Lab has one Semi-anechoic Chamber and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 400, and 480 3-Phase. Large reference ground-planes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

10.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
212104'	Barometric Pressure/Humidity/Temperature Datalogger	Extech	SD700	A.074980	10/21/2016	10/21/2017
031690'	EMC Analyzer	Agilent	E7405A	US40240205	09/21/2016	09/21/2017
MC1'	RF Coax Cable 10KHz-26.5GHz	MINI CIRCUITS	CBL10SMQ-SM+	131208	06/13/2016	06/13/2017

Software Utilized:

Name	Manufacturer	Version
None (Receiver Firmware)		

10.3 Results:

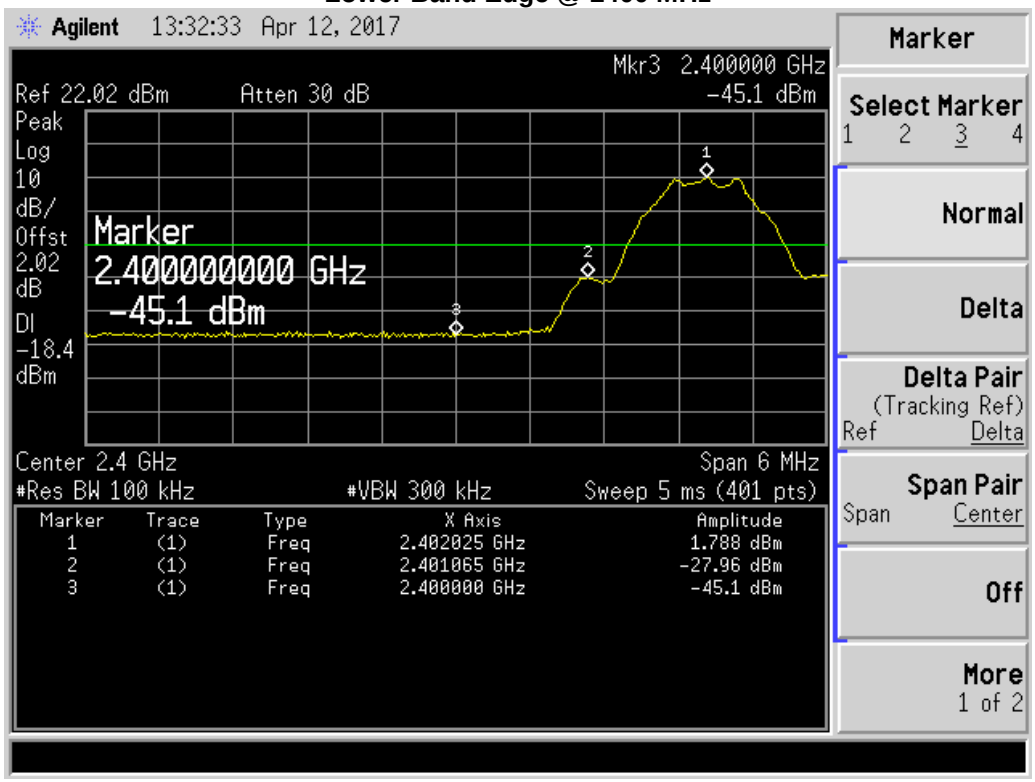
The sample tested was found to Comply.

FCC Part 15.247(d)
In any 100 kHz bandwidth outside the frequency band , the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in §15.209(a) is not required. 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) (see 15.205(c)).

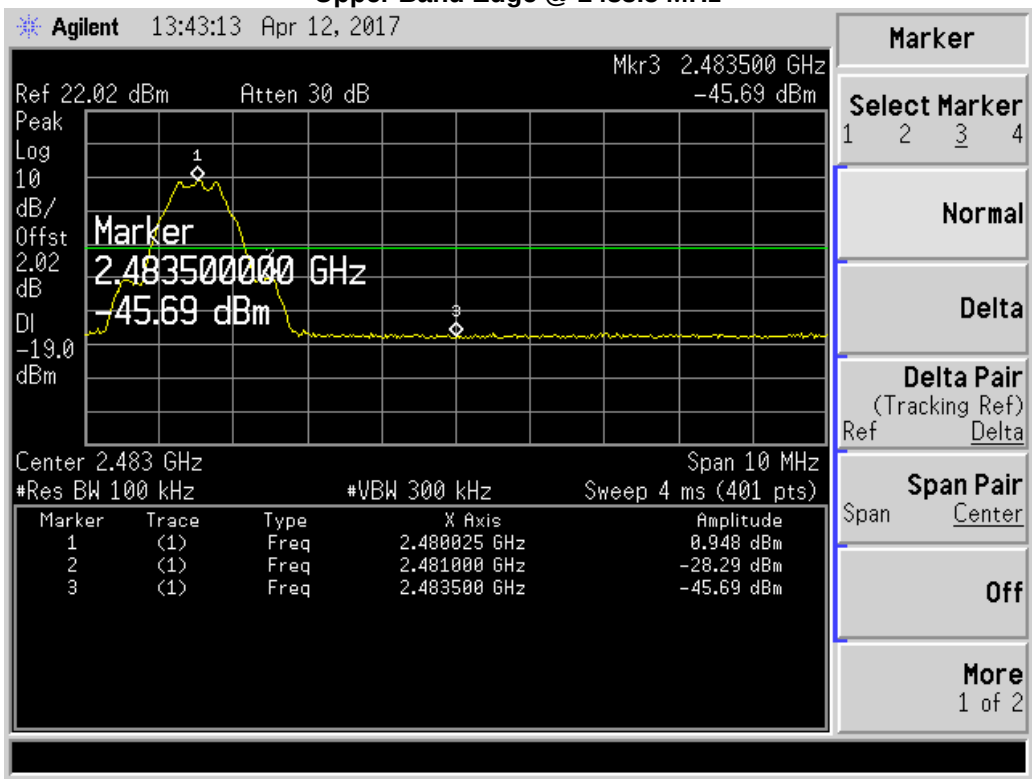
RSS-247 Section 5.5
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

10.4 Plots/Data:

Lower Band Edge @ 2400 MHz



Upper Band Edge @ 2483.5 MHz



Test Personnel:	Mary T Sampson MTS	Test Date:	04/12/2017
Supervising/Reviewing Engineer: (Where Applicable)	N/A		
Product Standard:	FCC 15.247 RSS 247	Limit Applied:	See Section 10.3
Input Voltage:	120VAC 60Hz		
		Ambient Temperature:	22.8 ºC
Pretest Verification:	N/A	Relative Humidity:	43.8 %
		Atmospheric Pressure:	990.6 mbars

11 Radiated Emissions (Transmitter Spurious, Digital Device and Receiver)

11.1 Method

Tests are performed in accordance with FCC Part 15 Subpart C (15.247), RSS 247, FCC Part 15 Subpart B and ICES 003.

TEST SITE: 10M ALSE Duluth, GA and 10M ALSE Boxborough, MA

10 Meter Semi-Anechoic Chamber The test site for radiated emissions is located at 1950 Evergreen Blvd, Suite 100, Duluth, Georgia 30096. It is a 10 meter semi-anechoic chamber manufactured by Panashield. Embedded in the floor is a 3 meter diameter turntable.

Measurement Uncertainty Duluth, Georgia

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucispr
Radiated Emissions, 10m	30-1000 MHz	3.6 dB	6.3 dB
Radiated Emissions, 3m	30-1000 MHz	3.9 dB	6.3 dB
Radiated Emissions, 3m	1-6 GHz	4.2 dB	5.2 dB
Radiated Emissions, 3m	6-15 GHz	4.2 dB	5.5 dB
Radiated Emissions, 3m	15-18 GHz	4.2 dB	5.5 dB
Radiated Emissions, 3m	18-40 GHz	4.2 dB	5.5 dB

Measurement Uncertainty Boxborough, Massachusetts

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucispr
Radiated Emissions, 10m	30-1000 MHz	4.6 dB	6.3 dB
Radiated Emissions, 3m	30-1000 MHz	5.3 dB	6.3 dB
Radiated Emissions, 3m	1-6 GHz	4.5 dB	5.2 dB
Radiated Emissions, 3m	6-15 GHz	5.2 dB	5.5 dB
Radiated Emissions, 3m	15-18 GHz	5.0 dB	5.5 dB
Radiated Emissions, 3m	18-40 GHz	5.0 dB	5.5 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, based on CISPR 22 and CISPR 11 (for 2006 and later revisions) Clause 11.

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 dBμV/m
RA = Receiver Amplitude (including preamplifier) in dBμV
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 dBμV 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 dBμV/m. This value in dBμV/m was converted to its corresponding level in μV/m.

RA = 52.0 dBμV
AF = 7.4 dB/m
CF = 1.6 dB
AG = 29.0 dB
FS = 32 dBμV/m

To convert from dBμV to μV or mV the following was used:

$UF = 10^{(NF / 20)}$ where UF = Net Reading in μV
NF = Net Reading in dBμV

Example:

FS = RA + AF + CF – AG = 52.0 + 7.4 + 1.6 – 29.0 = 32.0
$UF = 10^{(32\ dB\mu V / 20)}$ = 39.8 μV/m

11.2 Test Equipment Used:

Test equipment used on 04/11/2017 and 04/13/2017

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
213187;	Pocket weatherman - Rated 300 to 1099 mbar, 0 to 50°C, 0 to 100% RH.	Mannix	SAM700BAR	10030208	02/27/2017	02/27/2018
013662;	Multimeter	Fluke	77 II	61170590	12/13/2016	12/13/2017
232944;	EMI Receiver 10Hz-26.5GHz	Agilent	MXE-9038A	MY51210135	07/28/2016	07/28/2017
200069;	Preamplifier, 10 MHz to 2000 MHz, 40 dB gain	Mini-Circuits	ZKL-2	D011105	04/13/2016	04/13/2017
200074;	Preamplifier, 10 MHz to 2000 MHz, 37 dB gain	Mini-Circuits	ZKL-2	D052005	11/16/2016	11/16/2017
ST-6;	RF Coax Cable - Rated 9 kHz to 18 GHz.	Megaphase	A81-0303-275	16-01-801	02/07/2017	02/07/2018
TW2 211411;	Cable TW2	Andrews	Cable TW2	TW2	05/03/2016	05/03/2017
MM1;	RF Coax Cable 10KHz-18GHz	Maury Microwave	UC-N-MM36	161471	05/11/2016	05/11/2017
MM2;	RF Coax Cable 10KHz-18GHz	Maury Microwave	UC-N-MM78	1514381	05/11/2016	05/11/2017
213312;	Bilog antenna	Teseq	CBL 6112D	40527	05/18/2016	05/18/2017
213061;	Antenna, Horn, <18 GHz	EMCO	3115	9208-3919	09/16/2016	09/16/2017
200108;	Preamplifier, 20 MHz to 18 GHz, 40 dB	A.H. Systems	PAM-0118	199	06/14/2016	06/14/2017
MM9;	RF Coax Cable 9KHz-18GHz	Maury Microwave	UC-N-MM267	1635290	10/07/2016	10/07/2017
213153A;	Filter, 4 GHz High Pass	Reactel, Inc.	7HS-4G/18G-S11	01-7	08/16/2016	08/16/2017

Software Utilized:

Name	Manufacturer	Version
Tile – Emissions for MXE	Quantum Change	3.4.K.22
EMI Boxborough.xlsx	Intertek Boxborough	08/27/2010

Test equipment used on 05/06/2017

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
145145'	Broadband Hybrid Antenna 30 MHz - 3 GHz	Sunol Sciences Corp.	JB3	A122313	05/02/2017	05/02/2018
145-410'	Cables 145-420 145-421 145-422 145-406	Huber + Suhner	10m Track A Cables	multiple	07/30/2016	07/30/2017
PRE10'	30-1000MHz pre-amp	ITS	PRE10	PRE10	12/16/2016	12/16/2017
145128'	EMI Receiver (20 Hz - 40 Ghz)	Rohde & Schwarz	ESIB 40	839283/001	03/15/2017	03/15/2018
ETS002'	1-18GHz DRG Horn Antenna	ETS Lindgren	3117	00143260	05/13/2016	05/13/2017
145014'	Preamplifier (1 GHz to 26.5 GHz)	Hewlett Packard	8449B	3008A00232	05/27/2016	05/27/2017
EMC04'	ANTENNA, RIDGED GUIDE, 18-40 GHZ	EMCO	3116	2090	09/14/2016	09/14/2017
REA004'	3GHz High Pass Filter	Reactel, Inc	7HSX-3G/18G-S11	06-1	02/17/2017	02/17/2018
PRE9'	100MHz-40GHz Preamp	MITEQ	NSP4000-NFG	1260417	08/23/2016	08/23/2017
CBLHF2012-2M-1'	2m 9kHz-40GHz Coaxial Cable - SET1	Huber & Suhner	SF102	252675001	02/08/2017	02/08/2018
CBLHF2012-5M-1'	5m 9kHz-40GHz Coaxial Cable - SET 1	Huber & Suhner	SF102	252676001	02/08/2017	02/08/2018
145-416'	Cables 145-420 145-423 145-424 145-408	Huber + Suhner	3m Track B cables	multiple	07/30/2016	07/30/2017

Software Utilized:

Name	Manufacturer	Version
Tile – Emissions for MXE	Quantum Change	3.4.K.22
EMI Boxborough.xlsx	Intertek Boxborough	08/27/2010

11.3 Results:

The sample tested was found to Comply.

FCC Part 15.247(d)
In any 100 kHz bandwidth outside the frequency band , the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in §15.209(a) is not required. 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) (see 15.205(c)).

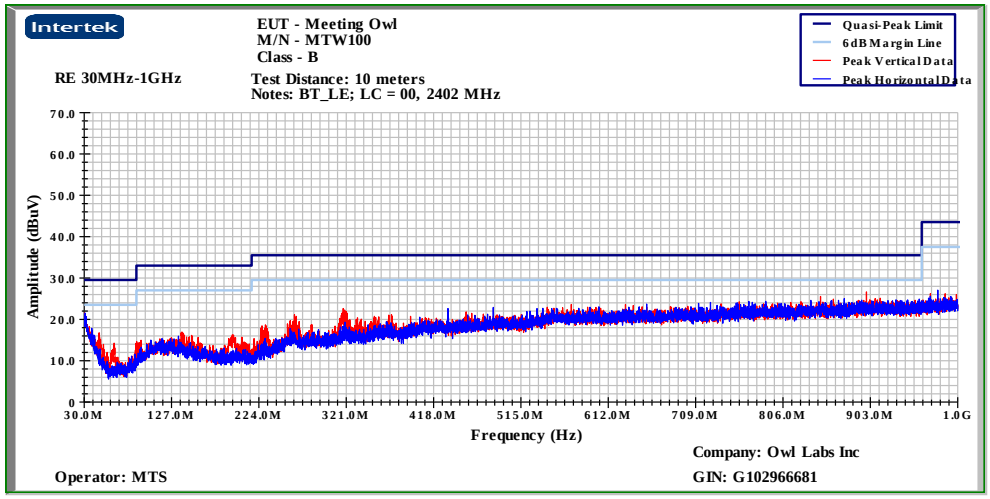
RSS-247 Section 5.5
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

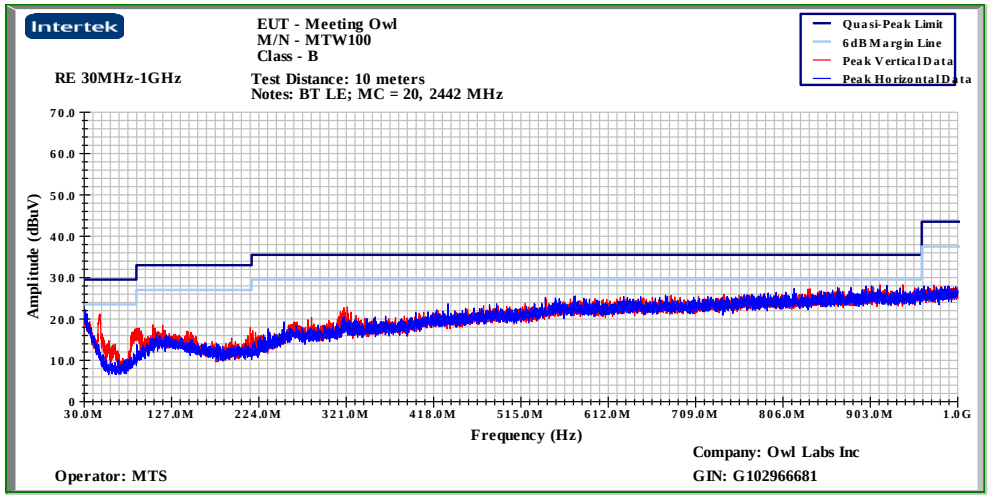
FCC Part 15.209(a) & RSS-210 A8.5 – Restricted Band Radiated Spurious/Harmonics Limits

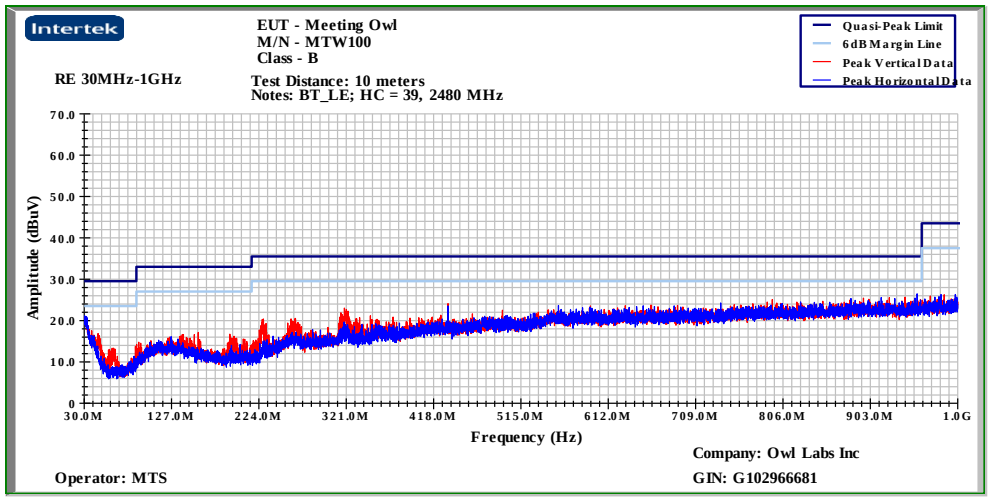
Frequency	**Field Strength**		**Test Distance**
(MHz)	µV/m	dBµV/m	(meters)
30–88	100	40.00	3
88–216	150	43.52	3
216–960	200	46.02	3
Above 960	500	53.98	3

11.4 Plots/Data:

30-1000 MHz Transmitter Spurious Emissions
Transmit on Low: 2402 MHz, Mid: 2442 MHz, and High: 2480 MHz – Pre-scan Plots







30-1000 MHz Transmitter Spurious Emissions (Worst Case data – Mid Channel: 2442 MHz)

Client: Owl Labs , Inc.
Model Number: MTW100
Project Number: G102966681
Tested By: MTS
Date: 04/13/2017
Frequency Range (MHz): 30 to 1000
Input power: 120Vac/60Hz
Receiver: Agilent MXE
Antenna: Teseq 40527
Cables: ST-6+TW2+MM1 +MM2
Preamp: ZKL-2 200074
Test Distance (m): 10
Limit: FCC15 Class B-10m
NOTE: BT_LE; MC = 20, 2442 MHz
Modifications for compliance (y/n): n

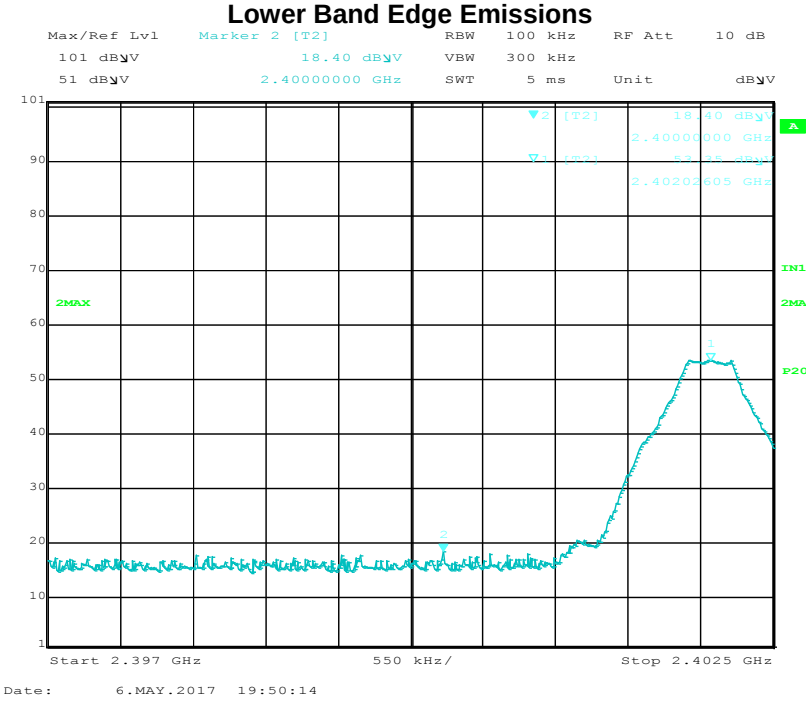
A	B	C	D	E	F	G	H	I	J
Ant. Pol. (V/H)	**Frequency MHz**	**Reading dB(uV)**	**Antenna Factor dB(1/m)**	**Cable Loss dB**	**Pre-amp Factor dB**	**Net dB(uV/m)**	**10m Limit dB(uV/m)**	**Margin dB**	**Detectors / Bandwidths Det/RBW**
H	31.213	32.6	23.3	0.6	40.3	16.2	29.5	-13.3	QP/120kHz
H	898.393	32.6	26.6	3.9	40.6	22.4	35.5	-13.1	QP/120kHz
H	904.576	32.7	26.6	3.9	40.6	22.5	35.5	-13.0	QP/120kHz
H	913.791	32.6	26.6	3.9	40.7	22.4	35.5	-13.1	QP/120kHz
H	921.430	32.6	26.6	3.9	40.7	22.5	35.5	-13.0	QP/120kHz
V	939.133	32.5	26.3	4.0	40.7	22.1	35.5	-13.4	QP/120kHz
Calculations		G=C+D+E-F		I=G-H					

1-25 GHz Transmitter Spurious Emissions
Transmit on Low: 2402 MHz, Mid: 2442 MHz, and High: 2480 MHz

Detector Type	Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB	Bandwidth
				BLE Low Channel @ 2402 MHz							
PK	V	4804.000	43.19	33.98	8.25	33.88	0.00	51.54	74.00	-22.46	1/3 MHz
AVG	V	4804.000	30.09	33.98	8.25	33.88	0.00	38.44	54.00	-15.56	1/3 MHz
PK	V	7206.000	40.12	35.71	10.75	34.63	0.00	51.95	74.00	-22.05	1/3 MHz
AVG	V	7206.000	28.09	35.71	10.75	34.63	0.00	39.92	54.00	-14.08	1/3 MHz
PK	V	9608.000	40.06	36.66	12.99	35.06	0.00	54.65	74.00	-19.35	1/3 MHz
AVG	V	9608.000	27.02	36.66	12.99	35.06	0.00	41.61	54.00	-12.39	1/3 MHz
				BLE Mid Channel @ 2442 MHz							
PK	V	4884.000	43.08	34.01	8.41	33.89	0.00	51.61	74.00	-22.39	1/3 MHz
AVG	V	4884.000	29.98	34.01	8.41	33.89	0.00	38.51	54.00	-15.49	1/3 MHz
PK	V	7326.000	39.89	35.74	11.07	34.73	0.00	51.97	74.00	-22.03	1/3 MHz
AVG	V	7326.000	27.12	35.74	11.07	34.73	0.00	39.20	54.00	-14.80	1/3 MHz
PK	V	9768.000	39.76	36.88	13.20	35.04	0.00	54.80	74.00	-19.20	1/3 MHz
AVG	V	9768.000	26.76	36.88	13.20	35.04	0.00	41.80	54.00	-12.20	1/3 MHz
				BLE High Channel @ 2480 MHz							
PK	V	4960.000	43.22	34.11	8.57	33.90	0.00	51.99	74.00	-22.01	1/3 MHz
AVG	V	4960.000	30.23	34.11	8.57	33.90	0.00	39.00	54.00	-15.00	1/3 MHz
PK	V	7440.000	40.24	35.71	11.23	34.82	0.00	52.36	74.00	-21.64	1/3 MHz
AVG	V	7440.000	29.12	35.71	11.23	34.82	0.00	41.24	54.00	-12.76	1/3 MHz
PK	V	9920.000	40.21	37.05	13.27	35.02	0.00	55.51	74.00	-18.49	1/3 MHz
AVG	V	9920.000	30.09	37.05	13.27	35.02	0.00	45.39	54.00	-8.61	1/3 MHz

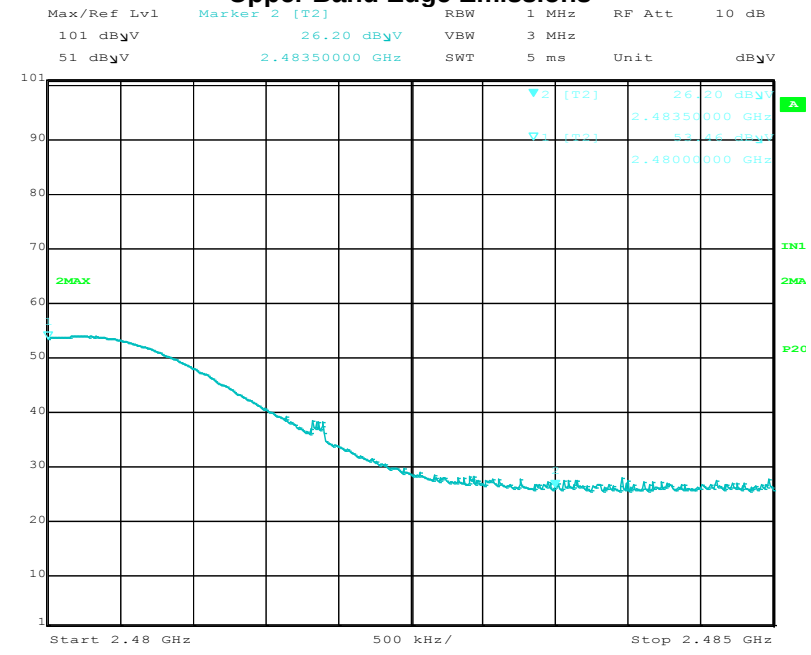
Note: No emissions other than at the frequencies indicated in the above table were detected above noise floor. Data from worst case antenna polarization is indicated in the above table.

Lower Band Edge Emissions



Emissions at lower band edge are 20 dB lower than the fundamental.

Upper Band Edge Emissions



Detector Type	Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB	Bandwidth
				BLE High Channel @ 2480 MHz							
PK	V	2483.500	26.20	32.30	5.18	0.00	0.00	63.68	74.00	-10.32	1/3 MHz
AVG	V	2483.500	12.98	32.30	5.18	0.00	0.00	50.46	54.00	-3.54	1/3 MHz

30-1000 MHz, Receive Mode

Detector Type	Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB	Bandwidth
QP	V	31.229	36.19	19.94	1.29	40.74	0.00	16.68	30.00	-13.32	120/300 kHz
QP	V	39.262	35.12	14.49	1.29	40.72	0.00	10.18	30.00	-19.82	120/300 kHz
QP	V	287.190	37.17	13.44	3.08	40.68	0.00	13.01	36.00	-22.99	120/300 kHz
QP	H	298.760	30.19	13.50	3.13	40.69	0.00	6.14	36.00	-29.86	120/300 kHz
QP	H	420.120	32.12	16.30	3.67	40.76	0.00	11.33	36.00	-24.67	120/300 kHz
QP	V	432.130	33.19	16.74	3.72	40.75	0.00	12.90	36.00	-23.10	120/300 kHz

Note: No emissions than at the frequencies indicated in the above table were detected above noise floor. Data from worst case polarization of the antenna is indicated in the above table.

1-25 GHz, Receive Mode

Detector Type	Ant. Pol. (V/H)	Frequency MHz	Reading dB(uV)	Antenna Factor dB(1/m)	Cable Loss dB	Pre-amp Factor dB	Distance Factor dB	Net dB(uV/m)	Limit dB(uV/m)	Margin dB	Bandwidth
				BLE Rx mode							
PK	V	1287.760	39.29	28.76	3.65	33.38	0.00	38.32	74.00	-35.68	1/3 MHz
AVG	V	1287.760	29.18	28.76	3.65	33.38	0.00	28.21	54.00	-25.79	1/3 MHz
PK	V	3129.240	37.26	33.05	6.02	33.72	0.00	42.60	74.00	-31.40	1/3 MHz
AVG	V	3129.240	28.47	33.05	6.02	33.72	0.00	33.81	54.00	-20.19	1/3 MHz
PK	V	9980.120	37.12	37.15	13.30	35.01	0.00	52.56	74.00	-21.44	1/3 MHz
AVG	V	9980.120	26.12	37.15	13.30	35.01	0.00	41.56	54.00	-12.44	1/3 MHz

Note: No emissions than at the frequencies indicated in the above table were detected above noise floor. Data from worst case polarization of the antenna is indicated in the above table.

Test Personnel:	Mary T Sampson MTS Naga Suryadevara N.S	Test Date:	04/11/2017 04/13/2017 05/06/2017
Supervising/Reviewing Engineer: (Where Applicable)	N/A		
Product Standard:	FCC 15.247 RSS 247	Limit Applied:	See Section 11.3
Input Voltage:	120VAC 60Hz		
Pretest Verification w/ Ambient Signals or BB Source:	BB source	Ambient Temperature:	24.5, 21.8, 24.0 ºC
		Relative Humidity:	31.3, 44.0, 37 %
		Atmospheric Pressure:	988.9, 991.5, 997 mbars

Deviations, Additions, or Exclusions: None

12 AC Mains Conducted Emissions

12.1 Method

Tests are performed in accordance with FCC Part 15 Subpart C, FCC Part 15 Subpart B, RSS 247 and ICES 003.

TEST SITE: EMC Lab (Boxborough, MA)

The EMC Lab has one Semi-anechoic Chamber and one Shielded Chamber. AC Mains Power is available at 120, 230, and 277 Single Phase; 208, 400, and 480 3-Phase. Large reference ground-planes are installed in the general lab area to facilitate EMC work not requiring a shielded environment.

Measurement Uncertainty

Measurement	Frequency Range	Expanded Uncertainty (k=2)	Ucispr
AC Line Conducted Emissions	150 kHz - 30 MHz	2.8dB	3.4dB
Telco Port Emissions	150 kHz - 30 MHz	3.2dB	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, based on CISPR 22 and CISPR 11 (for 2006 and later revisions) Clause 11.

Sample Calculations

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

NF = RF + LF + CF + AF
Where NF = Net Reading in dBμV
RF = Reading from receiver in dBμV
LF = LISN or ISN Correction Factor in dB
CF = Cable Correction Factor in dB
AF = Attenuator Loss Factor in dB

To convert from dBμV to μV or mV the following was used:

$UF = 10^{(NF / 20)}$ where UF = Net Reading in μV
NF = Net Reading in dBμV

Example:

NF = RF + LF + CF + AF = 28.5 + 0.2 + 0.4 + 20.0 = 49.1 dBμV
$UF = 10^{(49.1\ dB\mu V / 20)}$ = 285.1 μV/m

Alternately, when C5 Software is used, the “Level” includes all losses and gains and is compared directly in the “Margin” column to the “Limit”. “TF” is the Transducer Factor; in this case LISN or ISN loss.

12.2 Test Equipment Used:

Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due
DAV002'	Weather Station	Davis Instruments	7400	PE80519A93	06/01/2016	06/01/2017
ROS002'	9kHz to 3GHz EMI Test Receiver	Rohde & Schwartz	ESCI 1166.5950K03	100067	07/29/2016	07/29/2017
DS22'	Attenuator, 20dB	Mini Circuits	20dB, 50 ohm	DS22	09/08/2016	09/08/2017
CBLBNC7'	30 ft 50 ohm coax, BNC - BNC	ITT Pomona	RG 58 C/U	CBLBNC7	01/10/2017	01/10/2018
LISN34'	LISN - CISPR16 Compliant 9kHz-30MHz	Com-Power	LI-215A	191956	06/27/2016	06/27/2017

Software Utilized:

Name	Manufacturer	Version
Compliance 5	Teseq	5.26.46.46

12.3 Results:

The sample tested was found to Comply.

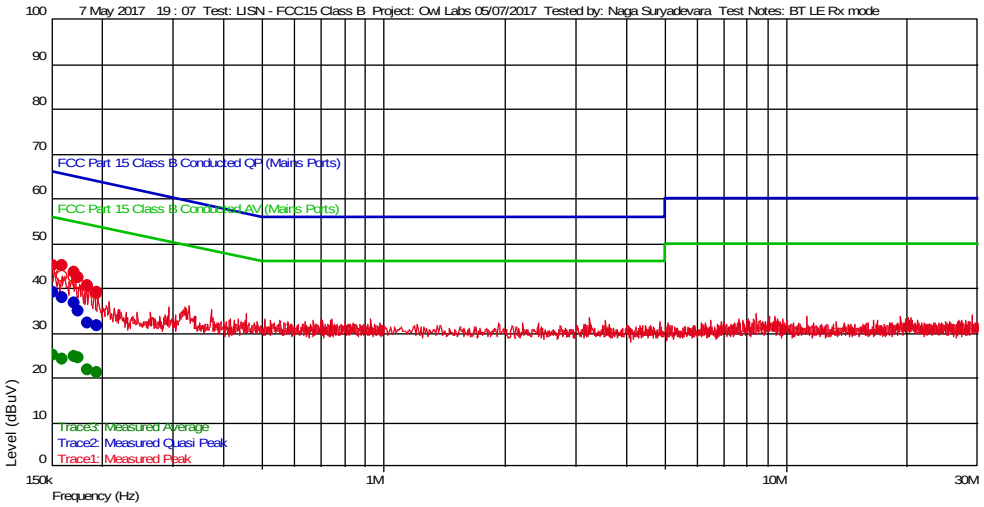
12.4 Plots/Data:

Recieve Mode

Test Information

Test Details	User Entry	Additional Information
Test:	LISN - FCC15 Class B	
Project:	Owl Labs 05/07/2017	
Test Notes:	BT LE Rx mode	
Temperature:	22 C	
Humidity:	29% 992 mbars	
Tested by:	Naga Suryadevara	
Test Started:	7 May 2017 19 : 07	

Prescan Emission Graph



- Measured Peak Value
- Measured Quasi Peak Value
- Measured Average Value
- Maximum Value of Mast and Turntable
- Swept Peak Data
- Swept Quasi Peak Data
- Swept Average Data

Emissions Test Data

Trace2: Measured Quasi Peak

Frequency(Hz)	Level(dBuV)	TF	PA+CL	Limit(dBuV)	Margin(dBuV)	RBW(Hz)	Comment	LINE
195.05 k	31.38	1.463	20.040	63.819	-32.44	9 k		L1
185.7 k	32.22	1.732	20.039	64.227	-32.00	9 k		L1
175.5 k	34.83	2.026	20.038	64.696	-29.86	9 k		N
171.25 k	36.42	2.148	20.037	64.900	-28.48	9 k		L1
160.2 k	37.79	2.466	20.036	65.454	-27.66	9 k		N
151.7 k	38.95	2.711	20.035	65.906	-26.96	9 k		N

Trace3: Measured Average

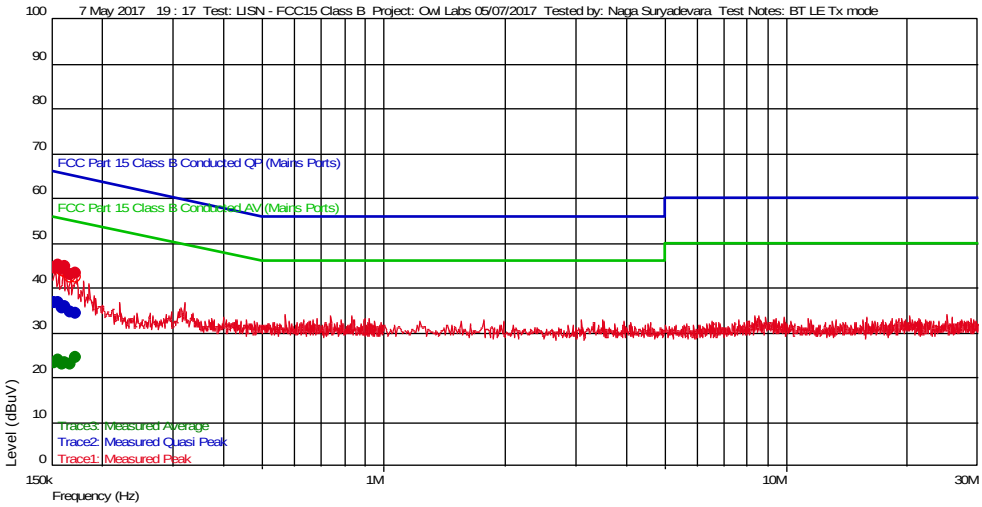
Frequency(Hz)	Level(dBuV)	TF	PA+CL	Limit(dBuV)	Margin(dBuV)	RBW(Hz)	Comment	LINE
195.05 k	21.06	1.463	20.040	53.819	-32.76	9 k		L1
185.7 k	21.56	1.732	20.039	54.227	-32.67	9 k		L1
160.2 k	24.10	2.466	20.036	55.454	-31.36	9 k		N
151.7 k	25.01	2.711	20.035	55.906	-30.90	9 k		N
175.5 k	24.36	2.026	20.038	54.696	-30.33	9 k		N
171.25 k	24.69	2.148	20.037	54.900	-30.21	9 k		L1

Transmit Mode

Test Information

Test Details	User Entry	Additional Information
Test:	LISN - FCC15 Class B	
Project:	Owl Labs 05/07/2017	
Test Notes:	BT LE Tx mode	
Temperature:	22 C	
Humidity:	29% 992 mbars	
Tested by:	Naga Suryadevara	
Test Started:	7 May 2017 19 : 17	

Prescan Emission Graph



- Measured Peak Value
- Measured Quasi Peak Value
- Measured Average Value
- Maximum Value of Mast and Turntable
- Swept Peak Data
- Swept Quasi Peak Data
- Swept Average Data

Emissions Test Data

Trace2: Measured Quasi Peak

Frequency(Hz)	Level(dBuV)	TF	PA+CL	Limit(dBuV)	Margin(dBuV)	RBW(Hz)	Comment	LINE
167.0 k	34.39	2.270	20.037	65.108	-30.72	9 k		N
172.95 k	34.15	2.099	20.037	64.818	-30.67	9 k		N
160.2 k	35.38	2.466	20.036	65.454	-30.08	9 k		N
162.75 k	35.63	2.393	20.036	65.322	-29.69	9 k		N
153.4 k	36.46	2.662	20.035	65.814	-29.35	9 k		L1
155.95 k	36.63	2.589	20.036	65.677	-29.05	9 k		N

Trace3: Measured Average

Frequency(Hz)	Level(dBuV)	TF	PA+CL	Limit(dBuV)	Margin(dBuV)	RBW(Hz)	Comment	LINE
153.4 k	23.01	2.662	20.035	55.814	-32.81	9 k		L1
160.2 k	22.86	2.466	20.036	55.454	-32.59	9 k		N
167.0 k	22.84	2.270	20.037	55.108	-32.26	9 k		N
162.75 k	23.15	2.393	20.036	55.322	-32.17	9 k		N
155.95 k	23.59	2.589	20.036	55.677	-32.09	9 k		N
172.95 k	24.26	2.099	20.037	54.818	-30.56	9 k		N

Test Personnel:	Naga Suryadevara N.S	Test Date:	05/07/2017
Supervising/Reviewing Engineer: (Where Applicable)	N/A		
Product Standard:	FCC Part 15 Subpart B ICES 003	Limit Applied:	All Class B
Input Voltage:	120VAC 60Hz		
Pretest Verification w/ Ambient Signals or BB Source:	Yes	Ambient Temperature:	22 ºC
		Relative Humidity:	29 %
		Atmospheric Pressure:	992 mbars

Deviations, Additions, or Exclusions: None

13 Revision History

Revision Level	Date	Report Number	Prepared By	Reviewed By	Notes
0	06/15/2017	102966681ATL-005	N.S	KPS KPS	Original Issue