

TEST REPORT

Report Number: 102248754MPK-011

Project Number: G102248754

October 22, 2015

**Testing performed on
Emberlight Smart Light Socket
Model: SE26W001**

**Manufacturer Declared Equivalent Model (Not Tested):
SE26G001**

**FCC ID: 2AF5C-SE26
IC: 20702- SE26**

to

**FCC Part 15 Subpart C (15.247)
Industry Canada RSS-247, Issue 1**

For

Emberlight, Inc.

Test Performed by:
Intertek
1365 Adams Court
Menlo Park, CA 94025, USA

Test Authorized by:
Emberlight, Inc.
607 Market St. #200
San Francisco, CA 94105 , USA

Prepared by: _____

Minh Ly

Date: October 22, 2015

Reviewed by: _____

Krishna K Vemuri

Date: October 22, 2015

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Report No. 102248754MPK-011

Equipment Under Test:	Emberlight Smart Light Socket
Trade Name:	Emberlight
Model Tested:	SE26W001
Model Not Tested:	SE26G001
Serial Numbers:	040232321115 040232321122
Applicant:	Emberlight, Inc.
Contact:	Atif Noori
Address:	Emberlight, Inc. 607 Market St. #200 San Francisco, CA 94105
Country	USA
Tel. Number:	(310) 569-7669
Email:	Atif@emberlight.co
Applicable Regulation:	FCC Part 15 Subpart C (15.247) Industry Canada RSS-247, Issue 1
Date of Test:	September 14 to October 09, 2015

We attest to the accuracy of this report:



Minh Ly
Project Engineer



Krishna K Vemuri
EMC Senior Staff Engineer

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1.0 Summary of Tests

Test	Reference FCC	Reference Industry Canada	Result
RF Output Power	15.247(b)(3)	RSS-247, 5.4	Complies
6 dB Bandwidth	15.247(a)(2)	RSS-247, 5.2	Complies
Power Density	15.247(e)	RSS-247, 5.2	Complies
Out of Band Antenna Conducted Emission	15.247(d)	RSS-247, 5.5	Complies
Transmitter Radiated Emissions	15.247(d), 15.209, 15.205	RSS-247, 5.5	Complies
AC Line Conducted Emission	15.207	RSS-GEN	Complies
Antenna Requirement	15.203	RSS-GEN	Complies (Internal Antenna)
RF Exposure	15.247(i), 2.1093(d)	RSS-102	Complies

EUT receive date: September 14, 2015

EUT receive condition: The pre-production version of the EUT was received in good condition with no apparent damage. As declared by the Applicant, it is identical to the production units.

Test start date: September 14, 2015

Test completion date: October 09, 2015

The test results in this report pertain only to the item tested.

2.0 General Information

2.1 Product Description

The Equipment Under Test (EUT), model number SE26W001 and SE26G001, is a smart lamp holder with the Edison 26 bulb size.

This test report covers only the Bluetooth radio. A separate test report, report # 102248754MPK-010, covers the Wifi radio.

Information about the 2.4 GHz radio is presented below:

Applicant	Emberlight, Inc.
Model Numbers	SE26W001 and SE26G001
FCC Identifier	2AF5C-SE26
IC Identifier	20702- SE26
Type of transmission	Digital Transmission System (DTS)
Rated RF Output	1.6 dBm (1.445 mW)
Frequency Range	2402 – 2480 MHz
Type of modulation/data rate	GFSK 1Mb/s
Number of Channel(s)	40
Antenna(s) & Gain	Internal antenna:PCB antenna, -2dBi peak gain
Applicant & Address	Emberlight, Inc. 607 Market St. #200 San Francisco, CA 94105 , USA

2.2 Related Submittal(s) Grants

None.

2.3 Test Facility

The test site used to collect the radiated data is site 1 (10-m semi-anechoic chamber). This test facility and site measurement data have been fully placed on file with the FCC, IC and A2LA accredited.

2.4 Test Methodology

Antenna conducted measurements were performed according to the FCC documents “Guidance for Performing Compliance Measurement on Digital Transmission Systems (DTS) Operating under §15.247” (KDB 558074), and RSS-247, RSS-GEN, and

Radiated emissions and AC mains conducted emissions measurements were performed according to the procedures in ANSI C63.10. Radiated tests were performed at an antenna to EUT distance of 3 meters, unless stated otherwise in the "Data Sheet" of this report.

2.5 Measurement Uncertainty

Compliance with the limits was based on the results of the measurements and doesn't take into account the measurement uncertainty.

Estimated Measurement Uncertainty

Measurement	Expanded Uncertainty (k=2)		
	0.15 MHz – 1 GHz	1 GHz – 2.5 GHz	> 2.5 GHz
RF Power and Power Density – antenna conducted	-	0.7 dB	-
Unwanted emissions - antenna conducted	1.1 dB	1.3 dB	1.9 dB
Bandwidth – antenna conducted	-	30 Hz	-
Radiated emissions	4.2 dB	3.4 dB	4.4 dB
AC mains conducted emissions	2.4 dB	-	-

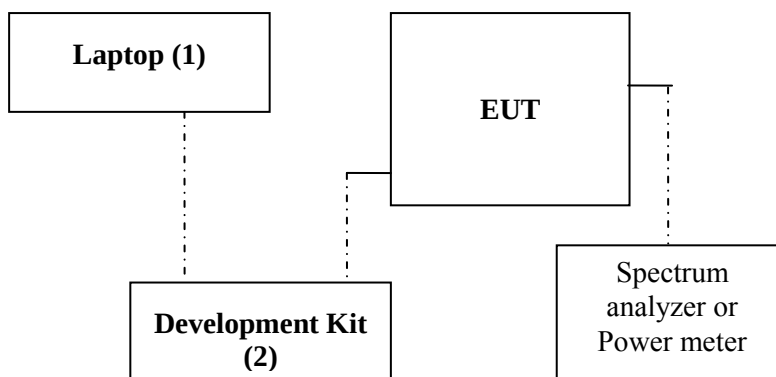
3.0 System Test Configuration

3.1 Support Equipment

Item #	Description	Model No./ Part No.	Serial No.
1	Samsung Laptop	NP900X3A	Not listed
2	Development Kit	Not Listed	Not Listed

3.2 Block Diagram of Test Setup

Antenna was removed and co-axial connector with a cable was installed for Conducted Measurements.
Internal antenna was used for Radiated Measurements.



Note: A 3.3VDC power supply was used to power the EUT during Conducted testing and 120VAC was used to power the EUT during Radiated testing.

S = Shielded	F = With Ferrite
U = Unshielded	m = Length in Meters

3.3 Justification

For radiated emission measurements the EUT is placed on a non-conductive table. The EUT is programmed to transmit full power.

As declared by the Applicant, the models SE26W001 and SE26G001 are identical except for their housing color . All tests were performed on SE26W001 only. The results in this report are valid for other model: SE26G001 as well.

3.4 Software Exercise Program

The EUT exercise program used during radiated and conducted testing was provided by Emberlight, Inc..

3.5 Mode of Operation during Test

During transmitter testing, the transmitter was setup to transmit at maximum RF power on low, middle and high frequencies/channels.

3.5 Modifications Required for Compliance

Intertek installed no modifications during compliance testing in order to bring the product into compliance.

3.6 Additions, Deviations and Exclusions from Standards

No additions, deviations or exclusions from the standard were made.

4.0 Measurement Results

4.1 6-dB Bandwidth and Occupied Bandwidth FCC Rule: 15.247(a)(2); RSS-247 5.2 and RSS-GEN;

4.1.1 Requirement

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

4.1.2 Procedure

The Procedure described in the FCC Publication 558074 was used.

The antenna port of the EUT was connected to the input of a spectrum analyzer (SA). For each RF output channel investigated, the spectrum analyzer center frequency was set to the channel carrier. A PEAK output reading was taken, a DISPLAY line was drawn 6 dB lower than PEAK level. The 6-dB bandwidth was determined from where the channel output spectrum intersected the display line.

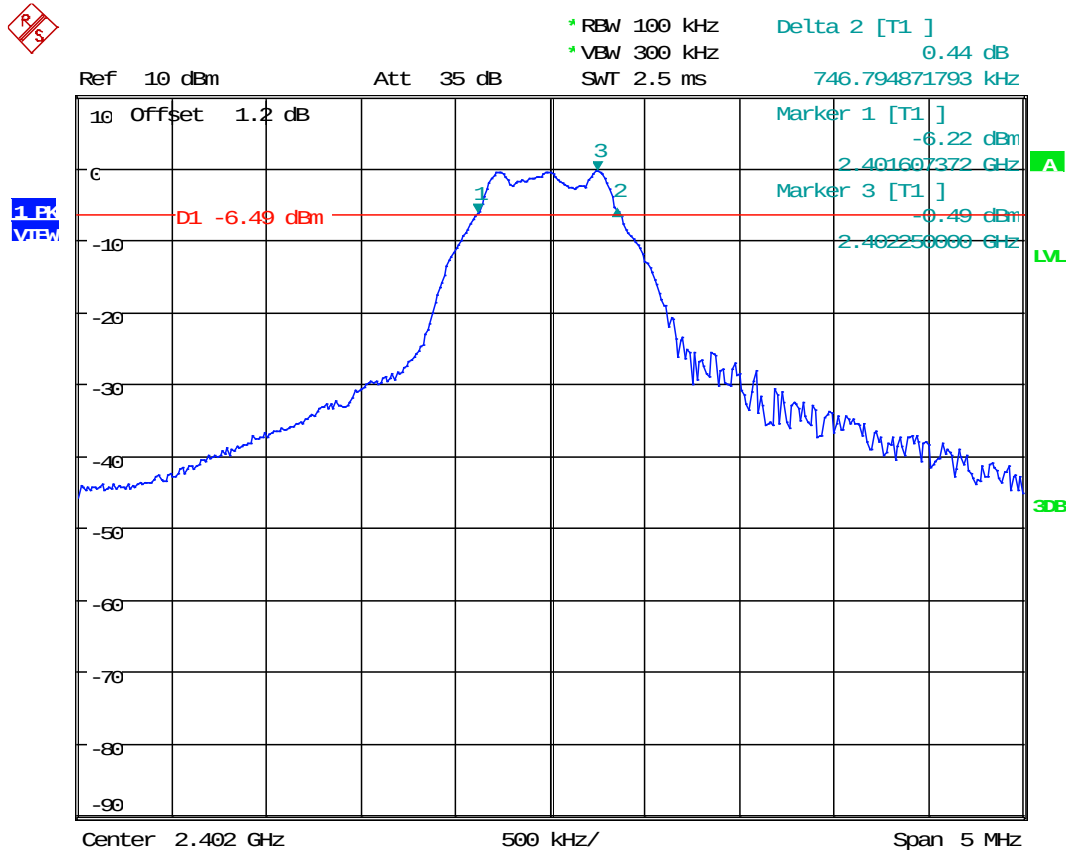
The occupied bandwidth was measured using the built-in spectrum analyzer function for 99% power bandwidth measurement.

4.1.3 Test Result

Frequency (MHz)	6-dB bandwidth FCC 15.247 MHz	Plot	6-dB bandwidth RSS-247 MHz	Plot	99% Bandwidth MHz	Plot
2402	0.746	1.1	0.722	1.4	1.050	1.4
2440	0.745	1.2	0.729	1.5	1.050	1.5
2480	0.769	1.3	0.729	1.6	1.037	1.6

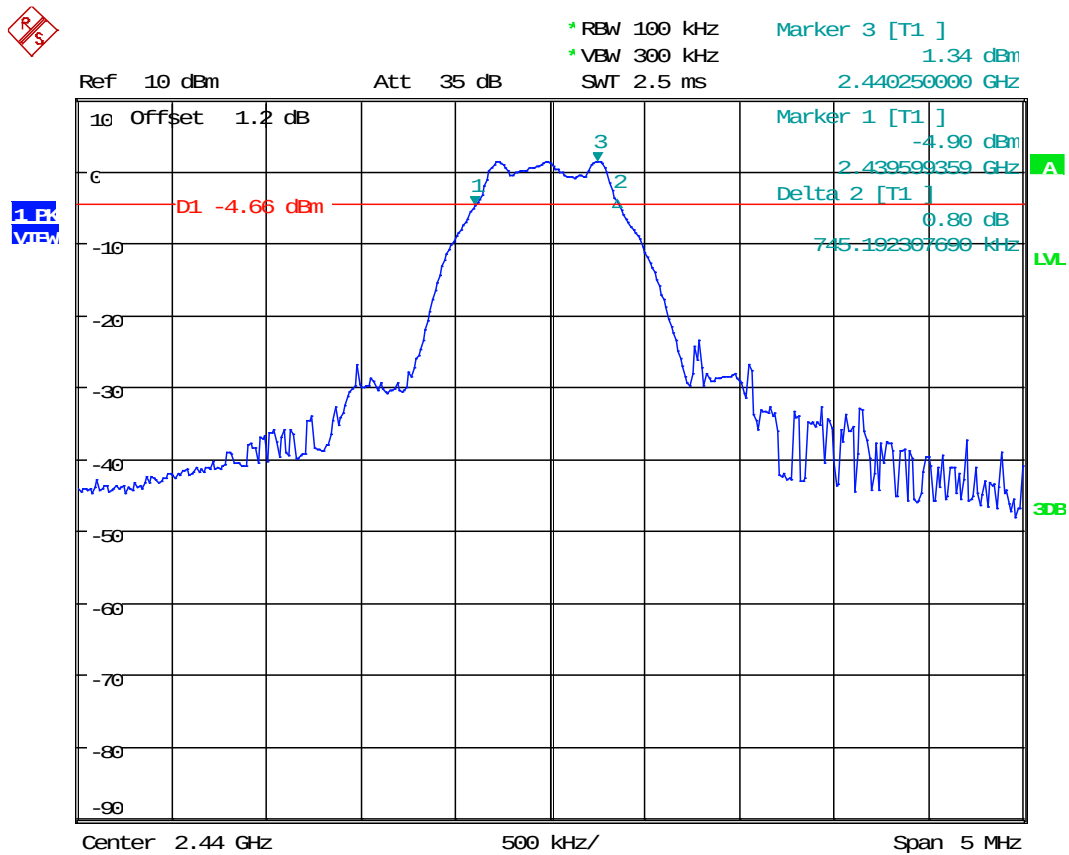
Results	Complies
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Plot 1. 1 - 6dB Bandwidth (FCC)



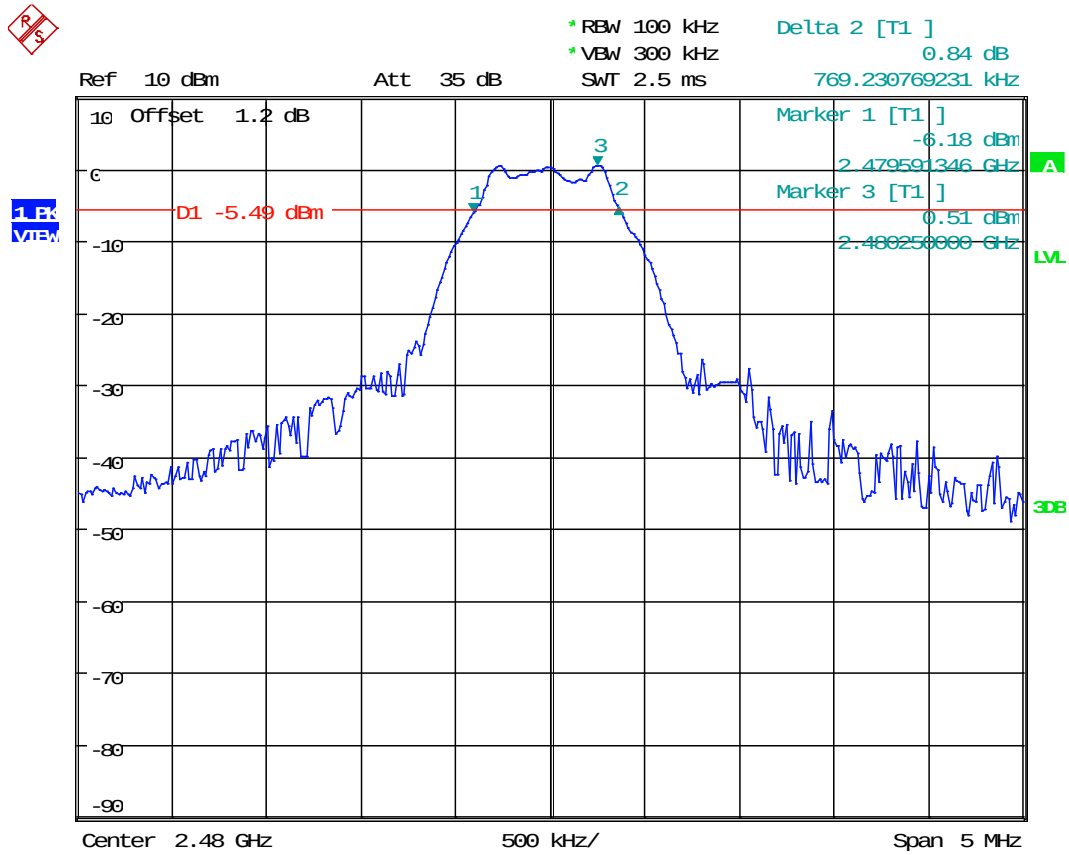
Date: 2.OCT.2015 11:17:05

Plot 1. 2 - 6dB Bandwidth (FCC)



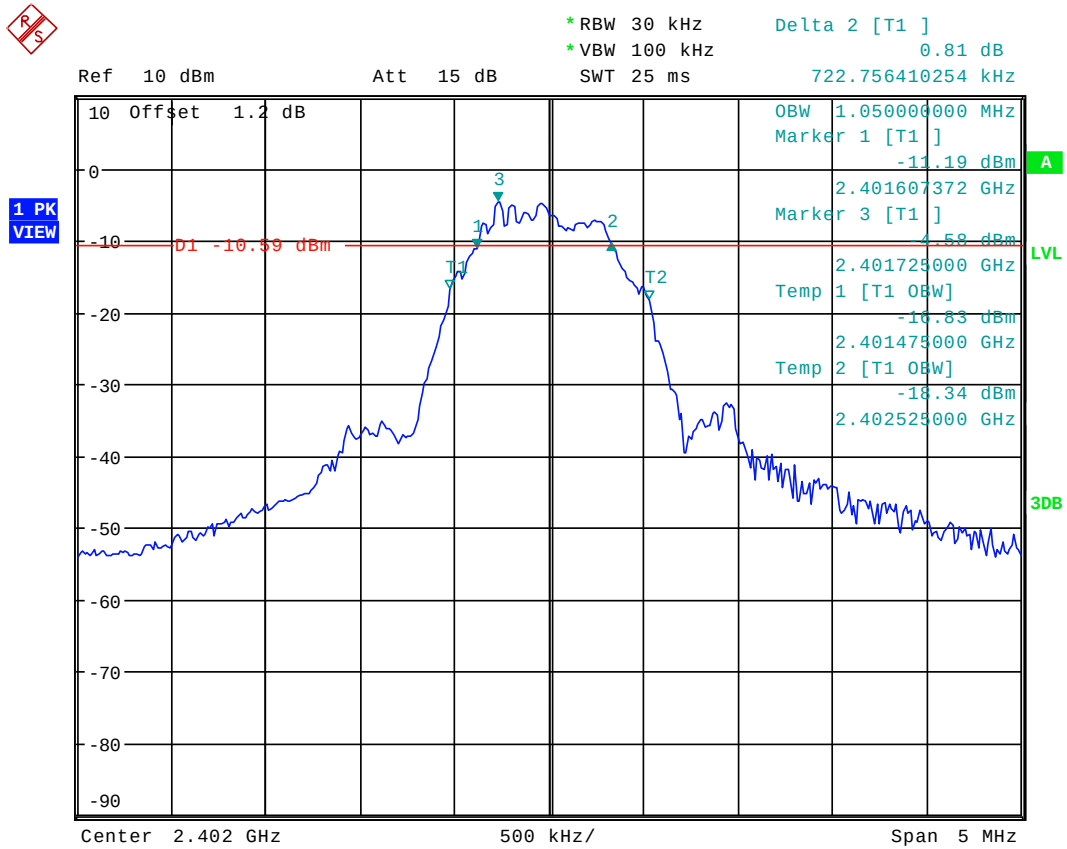
Date: 2.OCT.2015 11:35:17

Plot 1. 3 - 6dB Bandwidth (FCC)



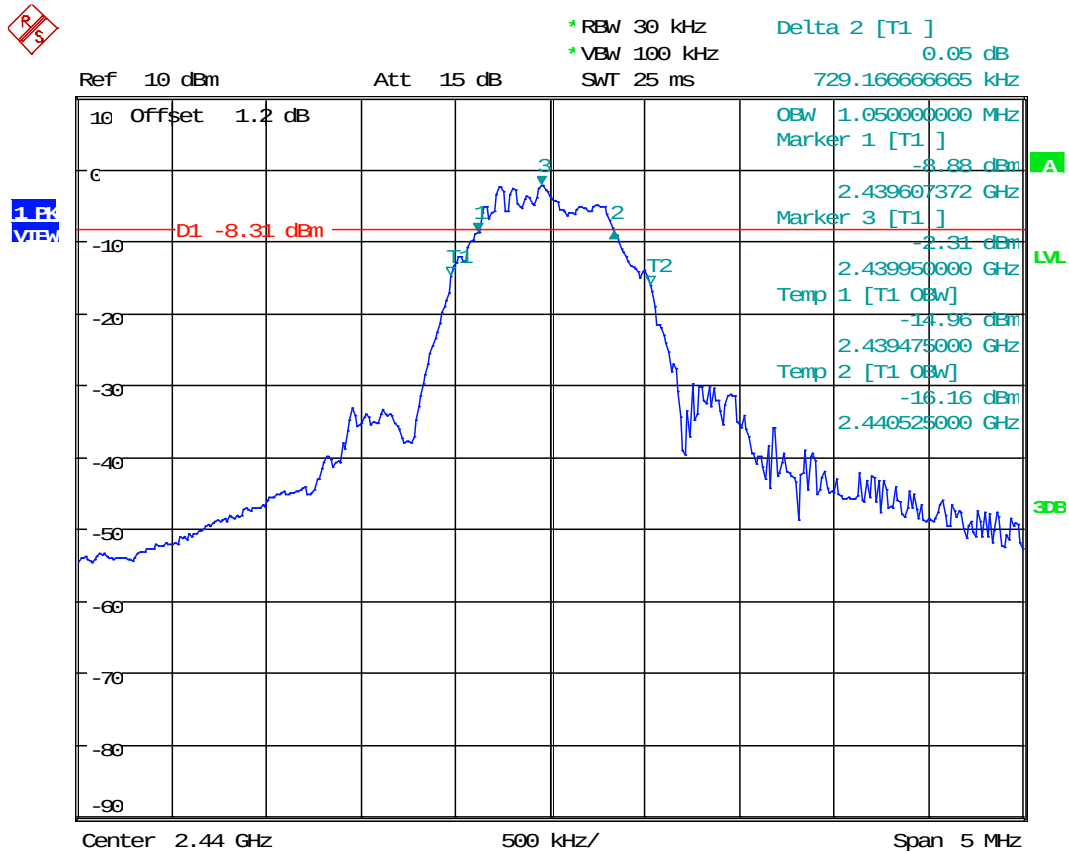
Date: 2.OCT.2015 11:36:49

Plot 1. 4 - 6dB Bandwidth & 99% Bandwidth (RSS)



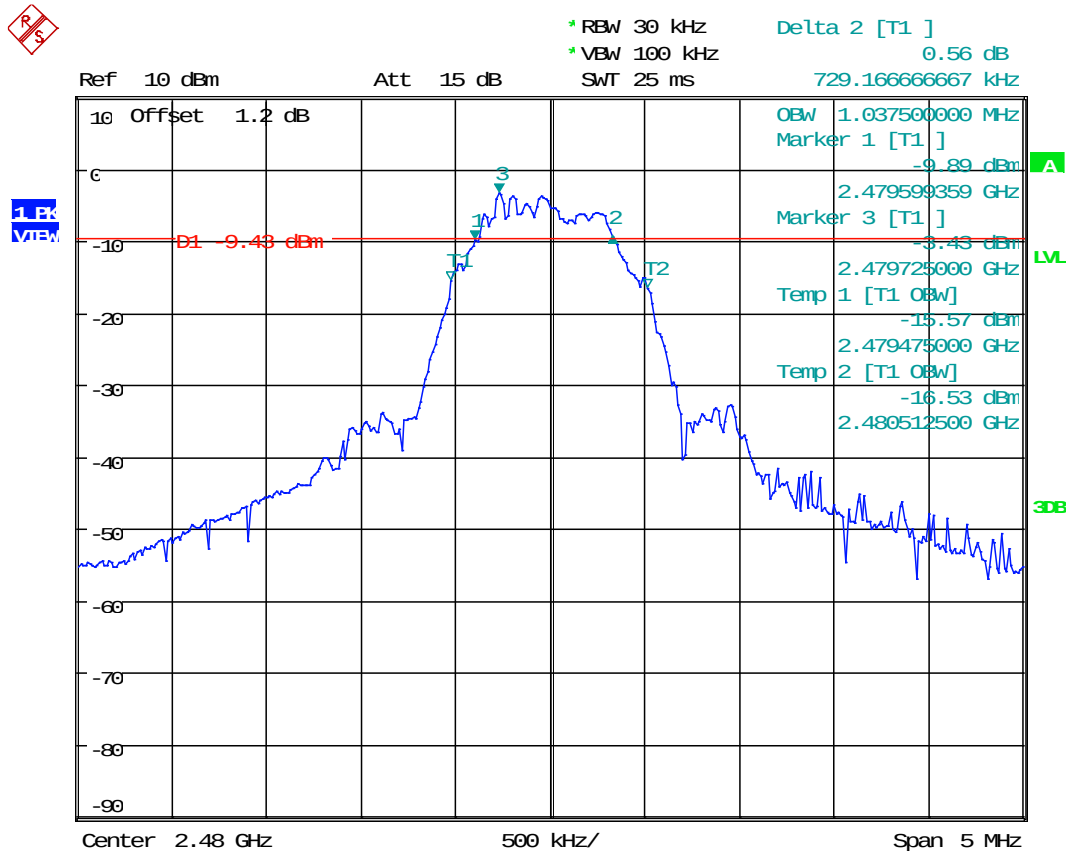
Date: 2.OCT.2015

Plot 1.5- 6dB Bandwidth & 99% Bandwidth (RSS)



Date: 2.OCT.2015 11:33:19

Plot 1.6- 6dB Bandwidth & 99% Bandwidth (RSS)



Date: 2.OCT.2015 11:38:09

4.2 Maximum Peak Conducted Output Power at Antenna Terminals

FCC Rule: 15.247(b)(3); RSS-247, 5.4

4.2.1 Requirement

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.

4.2.2 Procedure

The antenna port of the EUT was connected to the input of a spectrum analyzer/power meter to measure the Maximum Conducted Transmitter Output Power.

The procedure described in FCC Publication 558074, was used. Specifically, section 9.1.1 for Maximum Peak Conducted Output Power, with the spectrum analyzer's peak detector and Resolution Bandwidth $RBW > DTS \text{ Bandwidth}$.

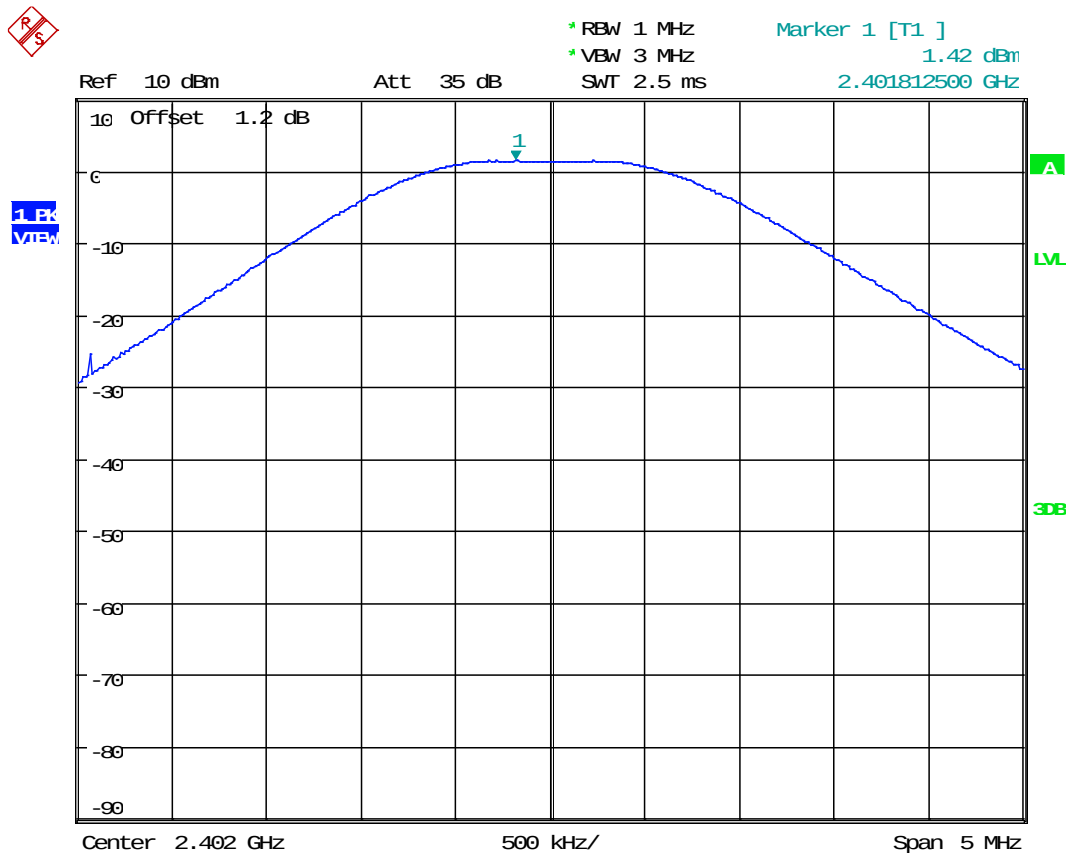
4.3.3 Test Result

Refer to the following plots 2.1 – 2.3 for the test details.

Frequency, MHz	Conducted Power (peak), dBm	Conducted Power (peak), mW	Plot
2402	1.42	1.390	2.1
2440	1.52	1.422	2.2
2480	1.60	1.445	2.3

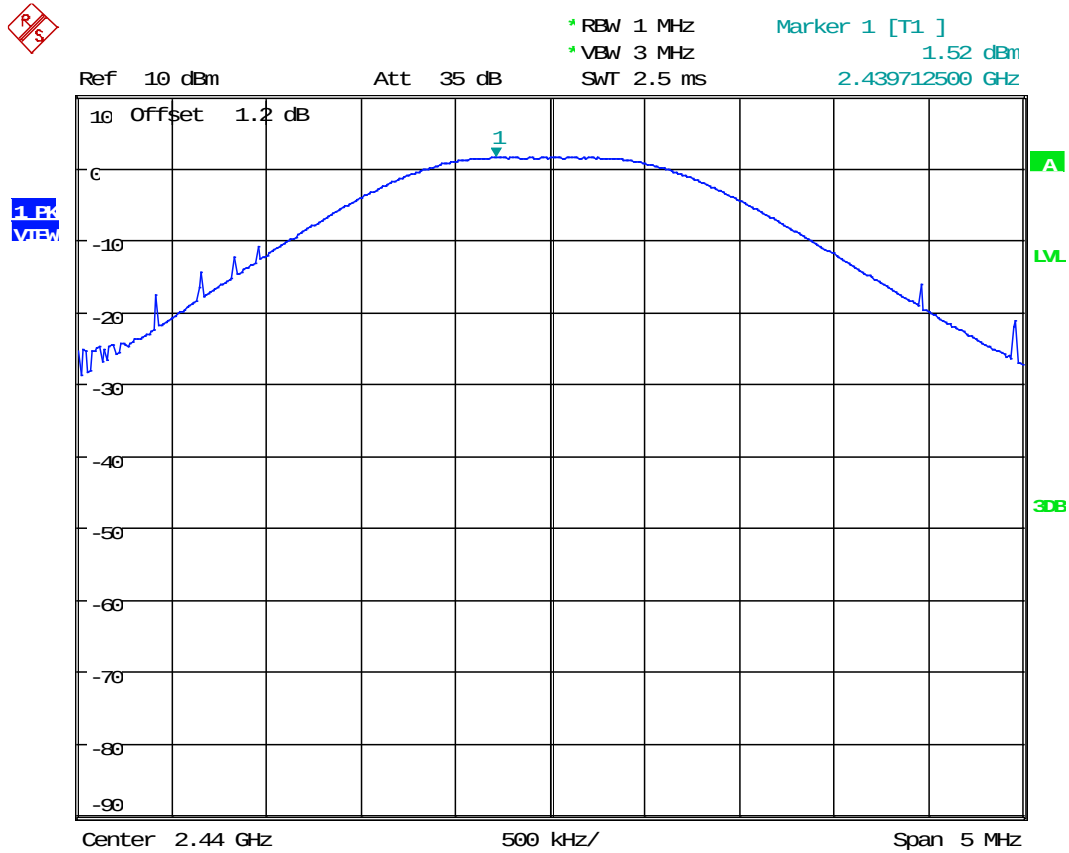
Results	Complies
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Plot 2. 1



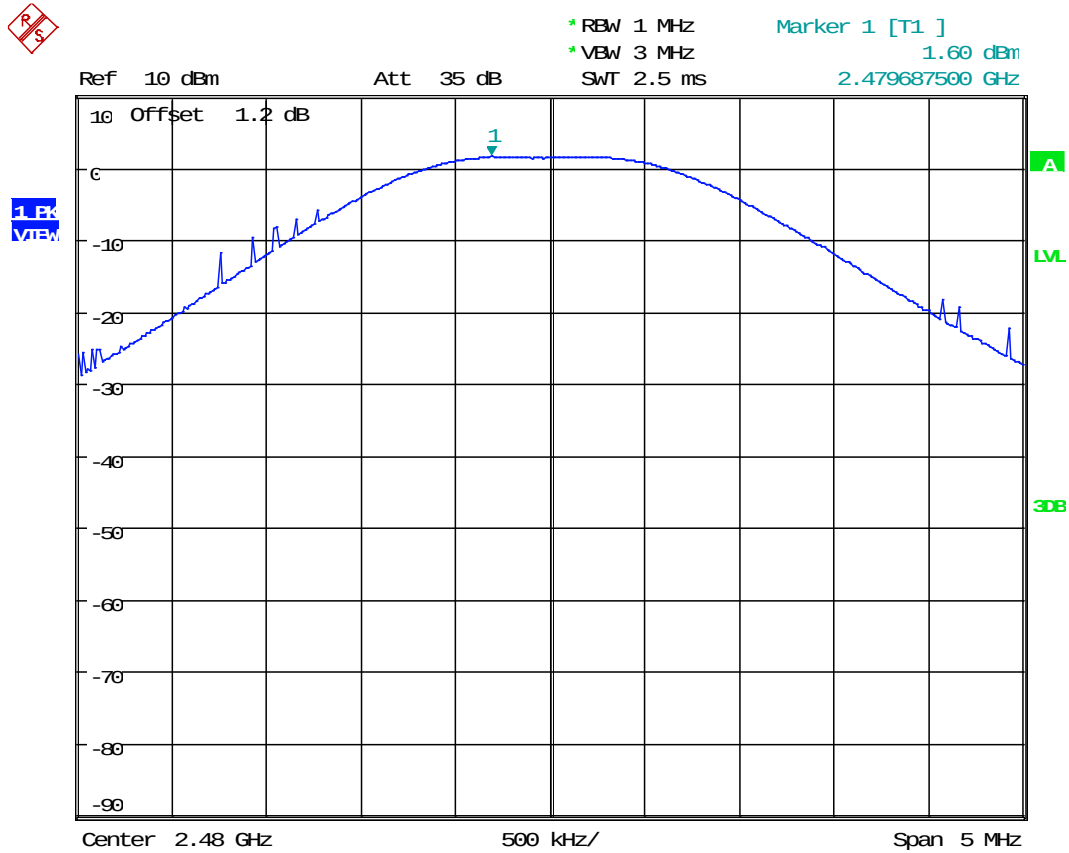
Date: 2.OCT.2015 11:42:41

Plot 2. 2



Date: 2.OCT.2015 11:41:53

Plot 2.3



Date: 2.OCT.2015 11:40:53

4.3 Maximum Power Spectral Density FCC: 15.247 (e); RSS-247, 5.2

4.3.1 Requirement

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.

4.3.2 Procedure

The antenna port of the EUT was connected to the input of a spectrum analyzer to measure the Transmitter Power Density (PSD).

The procedure described in FCC Publication 558074 was used. Specifically, section 10.2, Peak PSD, with peak detector and max hold trace mode. Spectrum analyzer resolution bandwidth was set to 3 kHz and span to at least 1.5 times the DTS (6 dB) channel bandwidth.

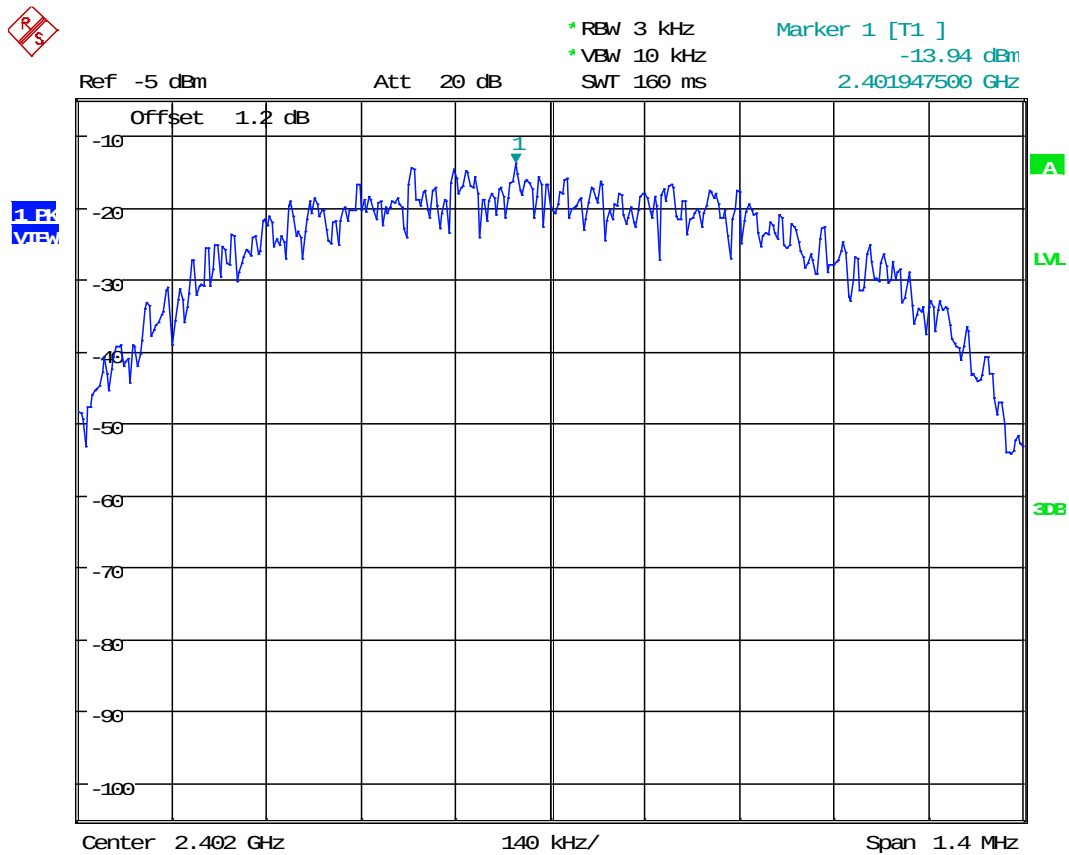
4.3.3 Test Result

Refer to the following plots for the test result

Frequency, MHz	Maximum Power Spectral Density, dBm	Maximum Power Spectral Density Limit, dBm	Margin, dB	Plot
2402	-13.94	8.0	-21.94	3.1
2440	-13.82	8.0	-21.82	3.2
2480	-14.79	8.0	-22.79	3.3

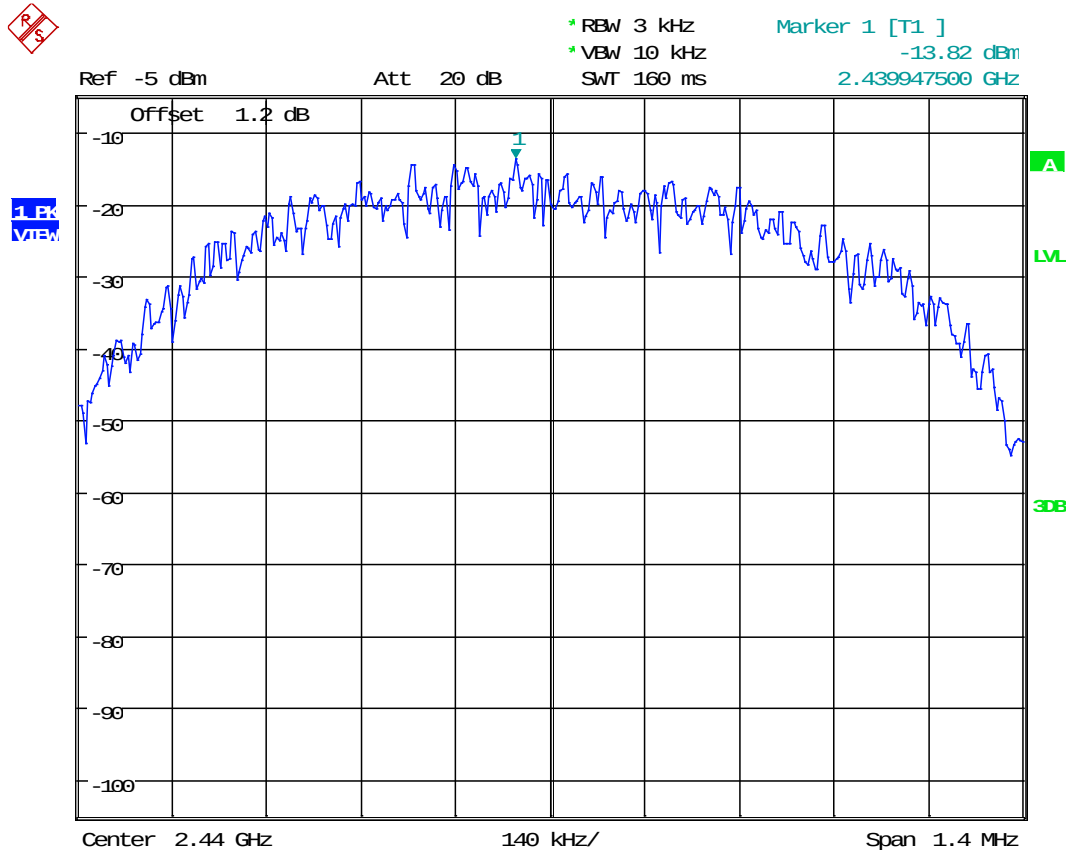
Results	Complies
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Plot 3. 1



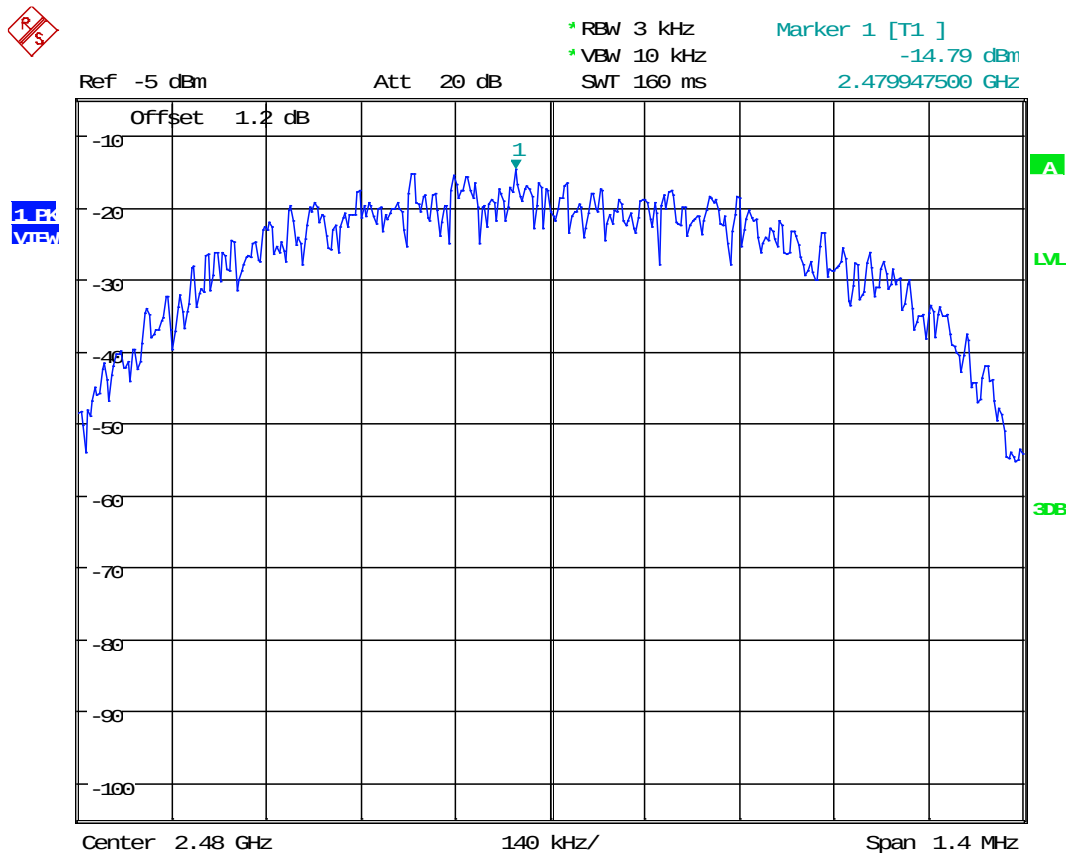
Date: 2.OCT.2015 11:44:47

Plot 3.2



Date: 2.OCT.2015 11:45:42

Plot 3.3



Date: 2.OCT.2015 11:46:23

4.4 Unwanted Conducted Emissions

FCC: 15.247(d); RSS-247, 5.5;

4.4.1 Requirement

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)

4.4.2 Procedure

A spectrum analyzer was connected to the antenna port of the transmitter. Analyzer Resolution Bandwidth was set to 100 kHz. For each channel investigated, the in-band and unwanted peak emission measurements (with max hold) were performed. For the wideband scan, Spectrum Analyzer setting of number of points 30000 was used.

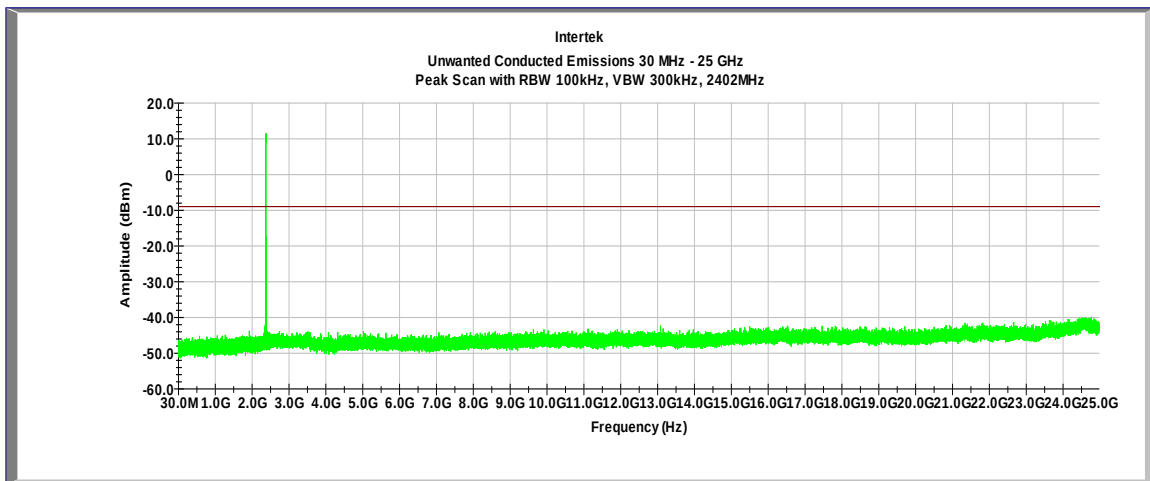
The unwanted emissions were measured from 30 MHz to 25 GHz.

4.4.3 Test Result

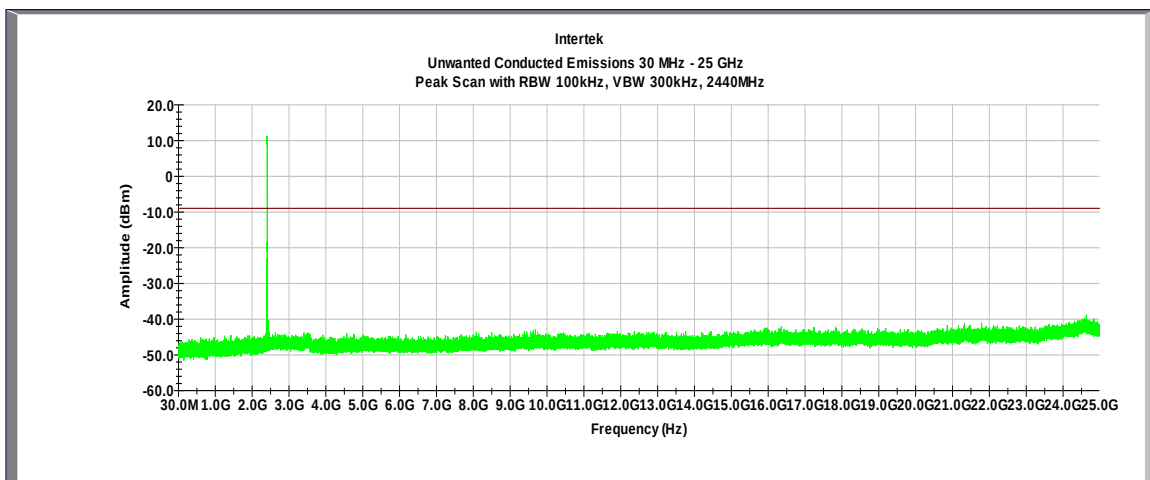
Refer to the following plots 4.1 – 4.3 for unwanted conducted emissions. The plot shows -20dB attenuation limit line.

Results	☒ Complies
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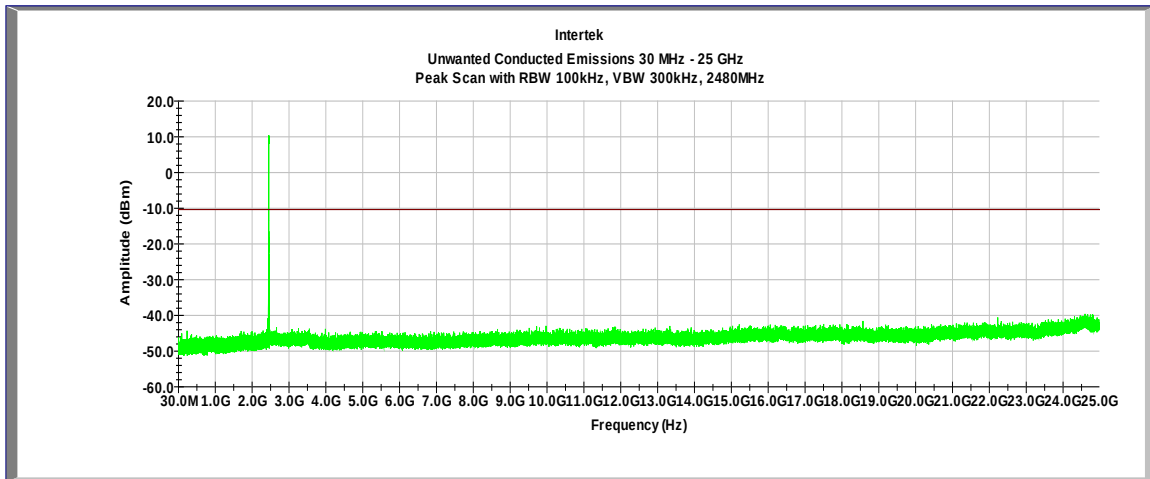
Plot 4.1 Tx @ Low Channel, 2402 MHz



Plot 4.2 Tx @ Mid Channel, 2440 MHz



Plot 4.3 Tx @ High Channel, 2480 MHz



4.5 Transmitter Radiated Emissions

FCC Rules: 15.247(d), 15.209, 15.205; RSS-247;

4.5.1 Requirement

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).

4.5.2 Procedure

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 100 kHz or greater for frequencies 30 MHz to 1000 MHz, 1 MHz for frequencies above 1000 MHz. Above 1000 MHz Peak and Average measurements were performed.

The EUT is placed on a plastic turntable that is 80 cm in height. 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 above 1 GHz and at 10 meters for frequencies below 1 GHz.

Measurements made from 1 GHz to 18GHz had a 2.4-2.5GHz notch filter in place. A preamp was used from 30MHz to 26GHz.

All measurements were made with a Peak Detector and compared to QP limits for 30MHz – 1GHz and Average limits for 1GHz – 26GHz.

Data is included of the worst-case configuration (the configuration which resulted in the highest emission levels).

4.5.3 Field Strength Calculation

Field Strength 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:

$FS = RA + AF + CF - AG$; if measurement is performed at a distance other than specified in the rule, a Distance Correction Factor (DCF) shall be added.

Where FS = Field Strength in dB(μ V/m)

RA = Receiver Amplitude (including preamplifier) in dB(μ V); AF = Antenna Factor in dB(1/m)

CF = Cable Attenuation Factor in dB; AG = Amplifier Gain in dB

Assume a receiver reading of 52.0 dB(μ V) is obtained. The antennas factor of 7.4 dB(1/m) and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving field strength of 32 dB(μ V/m). This value in dB(μ V/m) was converted to its corresponding level in μ V/m.

RA = 52.0 dB(μ V)

AF = 7.4 dB(1/m)

CF = 1.6 dB

AG = 29.0 dB

$FS = 52.0 + 7.4 + 1.6 - 29.0 = 32 \text{ dB}(\mu\text{V/m})$.

Level in μ V/m = Common Antilogarithm $[(32 \text{ dB}\mu\text{V/m})/20] = 39.8 \mu\text{V/m}$.

4.5.4 Test Results

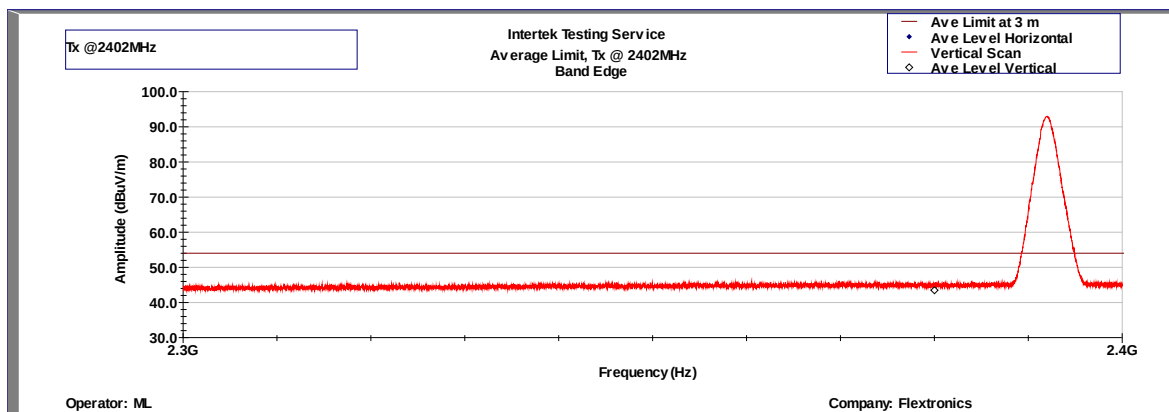
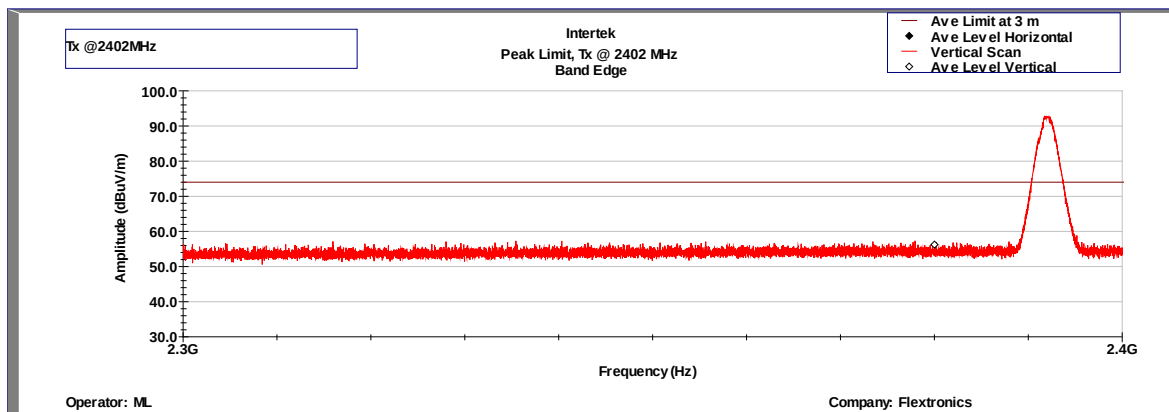
The data on the following pages list the significant emission frequencies, the limit and the margin of compliance.

Radiated emission measurements were performed up to 25GHz. No Emissions were identified when scanned from 18-25 GHz.

The EUT passed the test by 6.7dB

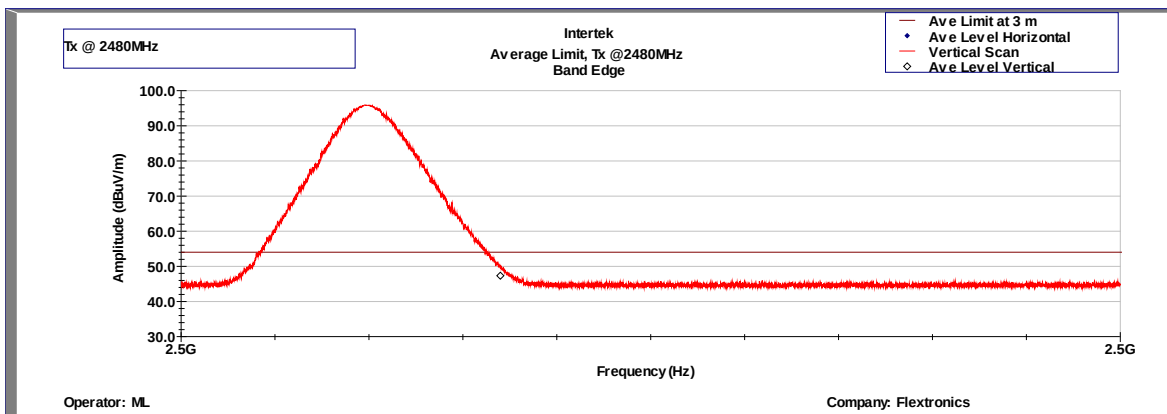
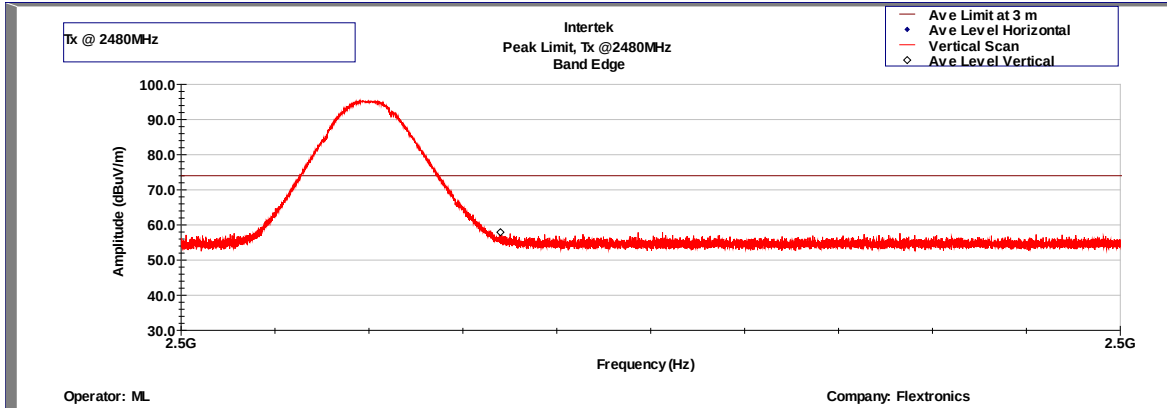
Test Results: 15.209/15.205 Restricted Band Emissions

Out-of-Band Radiated spurious emissions at the Band-edge @1m distance 2310–2390 MHz



Frequency	RA @ 3 m	AF	DCF	CF + Attenuator	FS @ 3m	Detector	Limit @ 3 m	Margin
(MHz)	(dBuV/m)	(dB/m)	(dB)	(dB)	(dBuV/m)	(Peak) / (Average)	(dBuV/m)	(dB)
2390.0	30.5	28.0	9.5	7.3	56.3	Peak	74.0	-17.7
	17.7	28.0	9.5	7.3	43.5	Average	54.0	-10.6

Out-of-Band Radiated spurious emissions at the Band-edge @1m distance 2483.5–2500 MHz



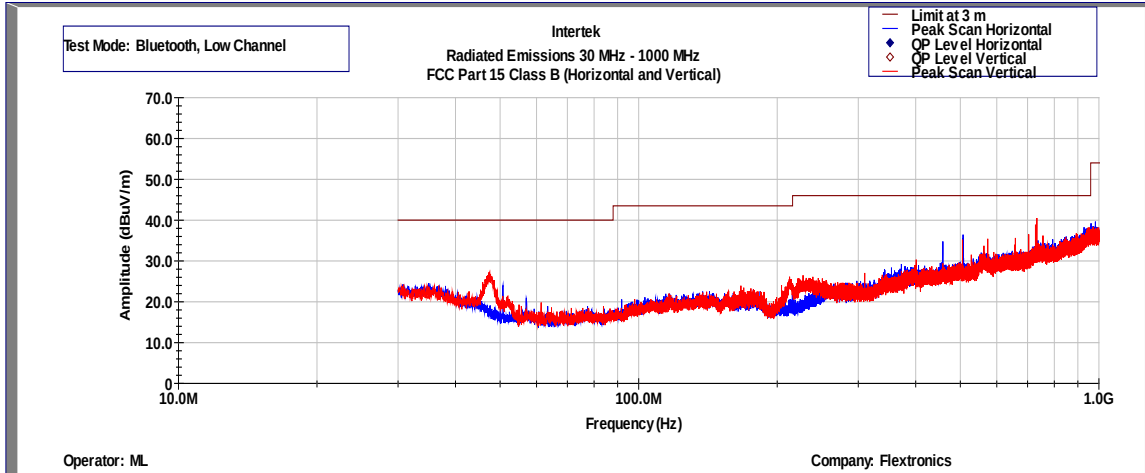
Frequency	RA @ 3 m	AF	DCF	CF + Attenuator	FS @ 3m	Detector	Limit @ 3 m	Margin
(MHz)	(dBuV/m)	(dB/m)	(dB)	(dB)	(dBuV/m)	(Peak) / (Average)	(dBuV/m)	(dB)
2483.5	31.9	28.1	9.5	7.42	57.9	Peak	74.0	-16.1
	21.3	28.1	9.5	7.42	47.3	Average	54.0	-6.7

Results

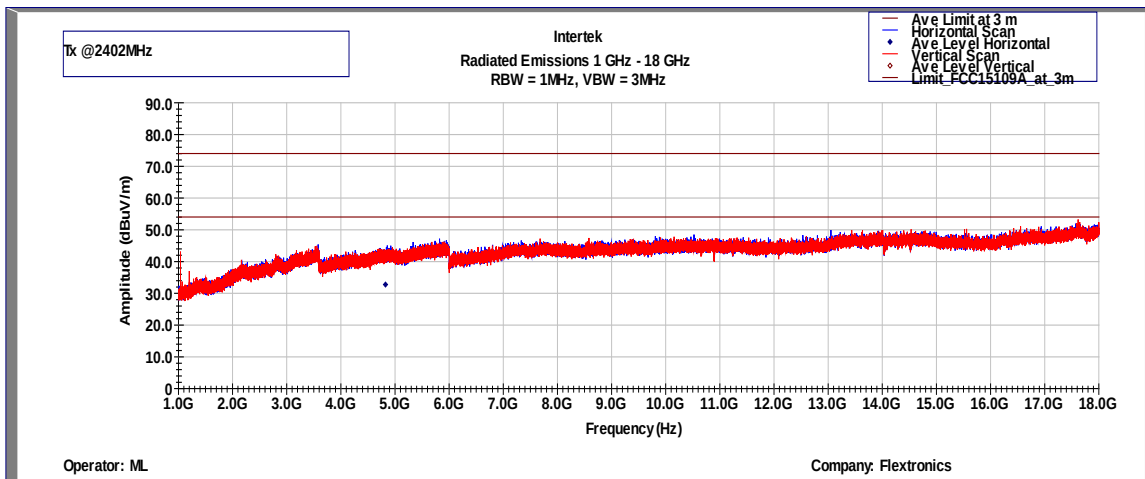
Complies

Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 2402MHz

Radiated Spurious Emissions 30 MHz - 1000 MHz



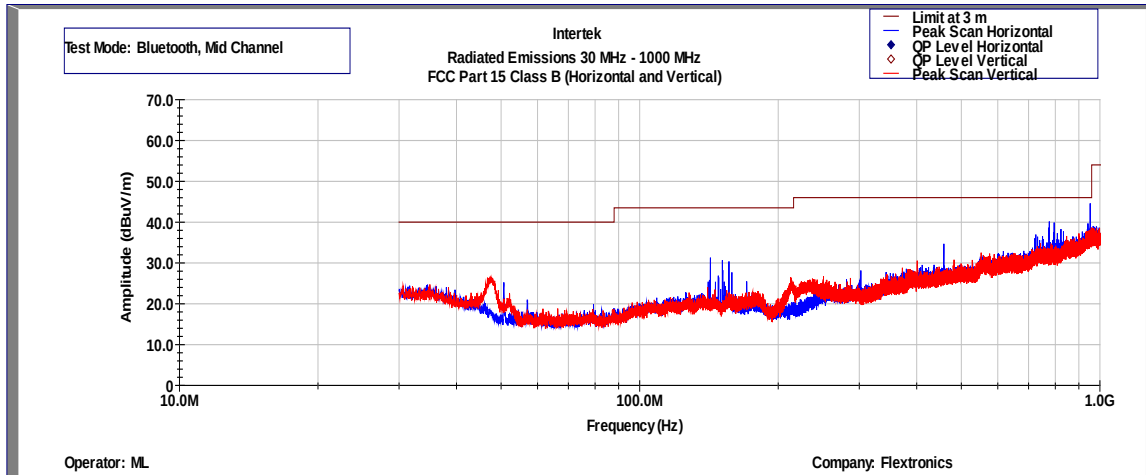
Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan



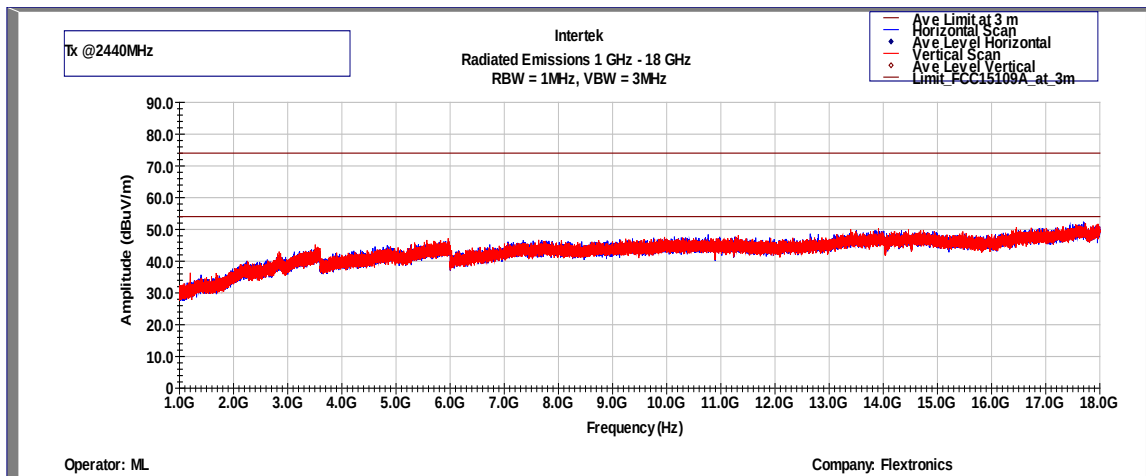
Note: Radiated emission measurements were performed up to 25GHz. No Emissions were identified when scanned from 18-25 GHz

Test Results: 15.209 Radiated Spurious Emissions Mid Channel, Tx at 2440MHz

Radiated Spurious Emissions 30 MHz - 1000 MHz



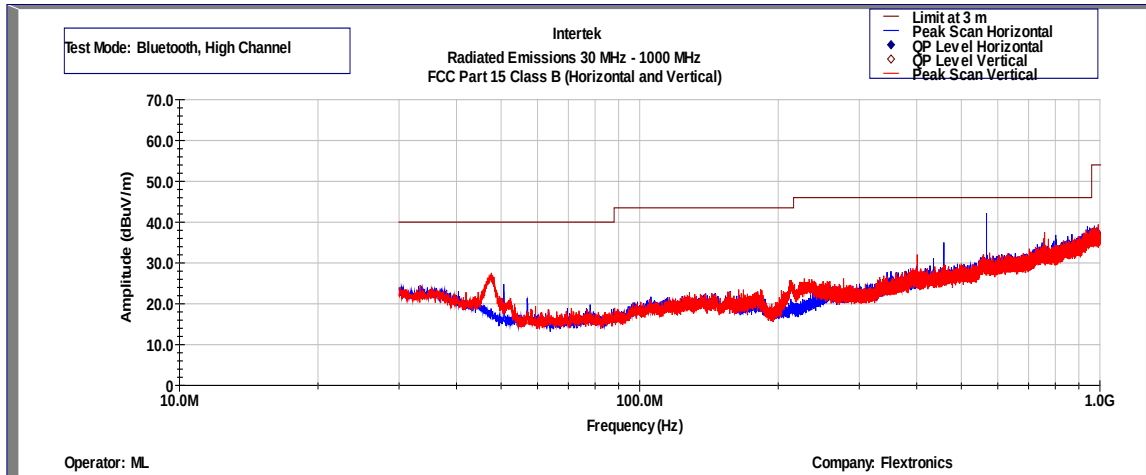
Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan



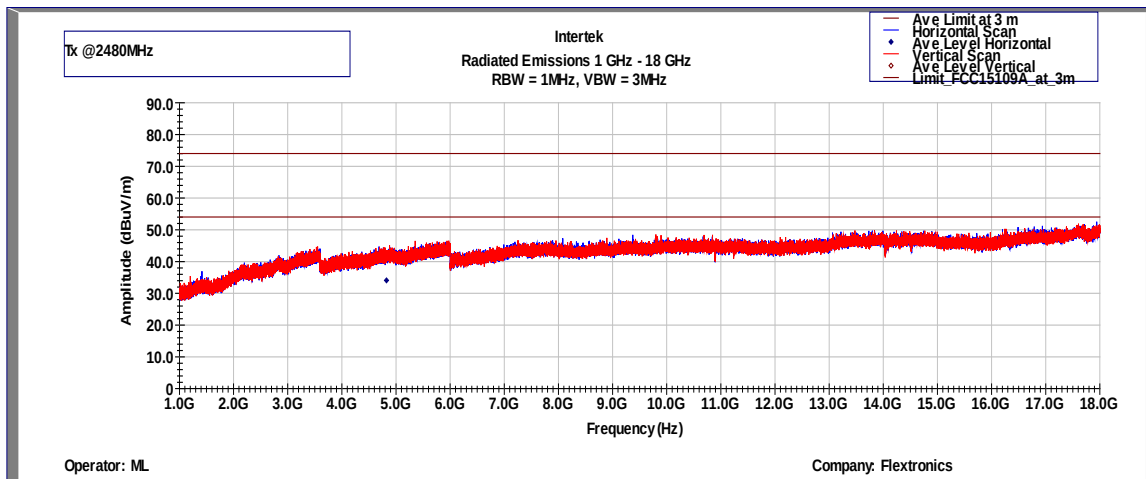
Note: Radiated emission measurements were performed up to 25GHz. No Emissions were identified when scanned from 18-25 GHz

Test Results: 15.209 Radiated Spurious Emissions High Channel, Tx at 2480MHz

Radiated Spurious Emissions 30 MHz - 1000 MHz



Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan

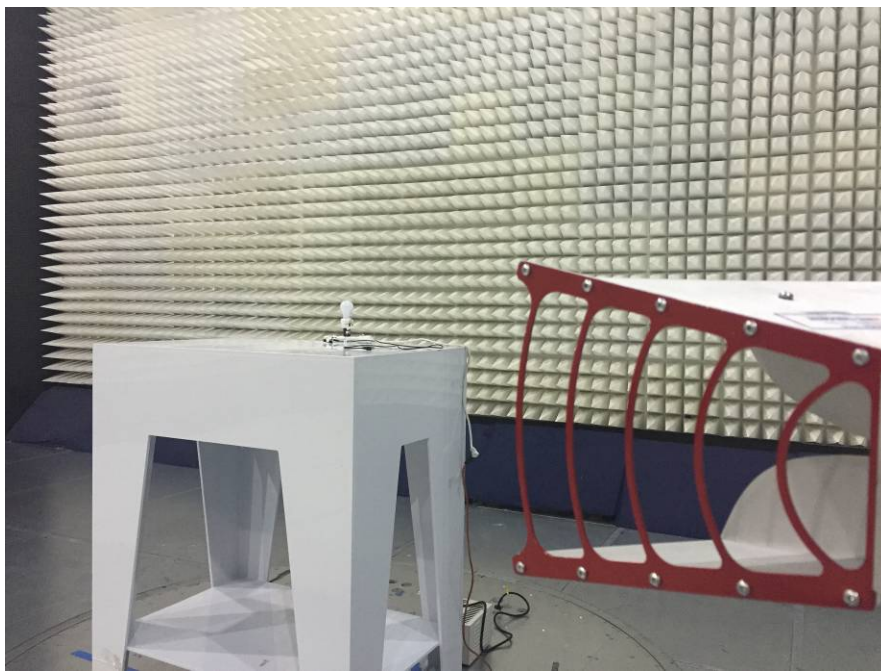
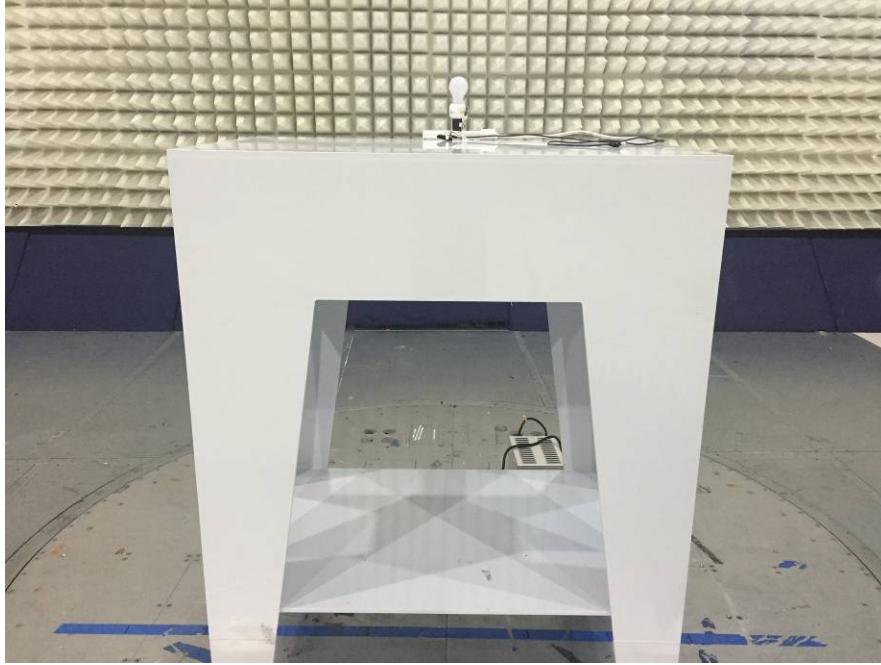


Note: Radiated emission measurements were performed up to 25GHz. No Emissions were identified when scanned from 18-25 GHz

Results	Complies
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4.5.4 Test setup photographs

The following photographs show the testing configurations used.



4.6 AC Line Conducted Emission FCC: 15.207; RSS-GEN

4.6.1 Requirement

Frequency Band MHz	Class B Limit dB(μ V)		Class A Limit dB(μ 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.*

4.6.2 Procedure

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.

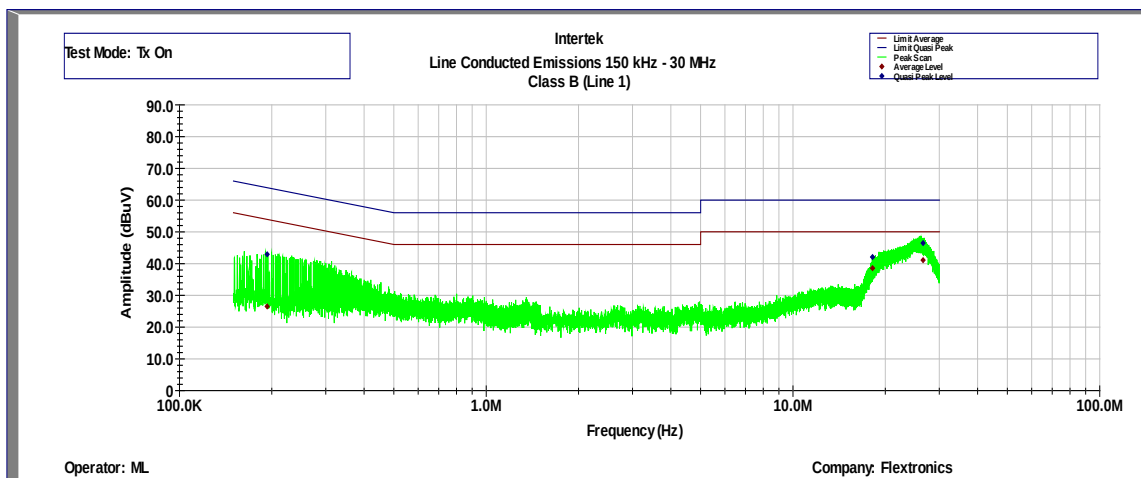
The EUT, where intended for tabletop use, is placed on a table whose top is 0.8m above the ground plane. A vertical, metal reference plane is placed 0.4m from the EUT. The vertical metal reference-plane is at least 2m by 2m. The EUT shall be kept at least 0.8m from any other metal surface or other ground 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.

4.6.3 Test Result

AC Line Conducted Emission Data, EUT in transmitting mode



Intertek Testing Services
Line Conducted Emissions 150 kHz - 30 MHz
FCC Class B (Line 1)

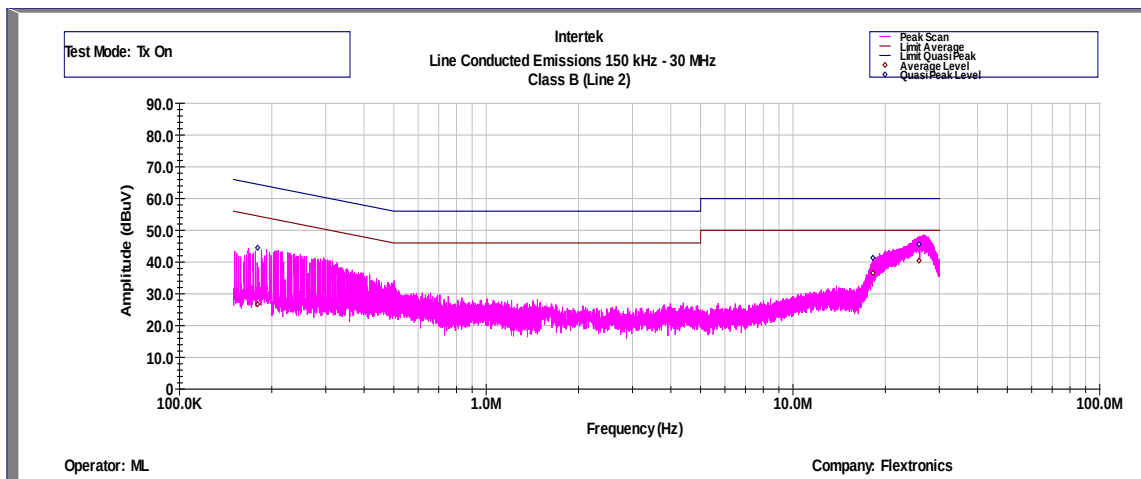
Operator: ML
July 24, 2014

Model Number: SE26W001
Company: Emberlight, Inc.

Frequency MHz	Av Level dBuV	QP Level dBuV	Av Limit dBuV	QP Limit dBuV	Av Margin dB	QP Margin dB
0.193	26.5	42.9	54.8	64.8	-28.3	-21.9
18.156	38.6	42.1	50.0	60.0	-11.4	-17.9
26.536	41.1	46.5	50.0	60.0	-8.9	-13.5

Test Mode: Transmitter On, 120V 60Hz
Temp.: 20.6C
Humidity: 49.9%

AC Line Conducted Emission Data, EUT in transmitting mode



Intertek Testing Services
Line Conducted Emissions 150 kHz - 30 MHz
FCC Class B (Line 2)

Operator: ML
July 24, 2014

Model Number: SE26W001
Company: Emberlight, Inc.

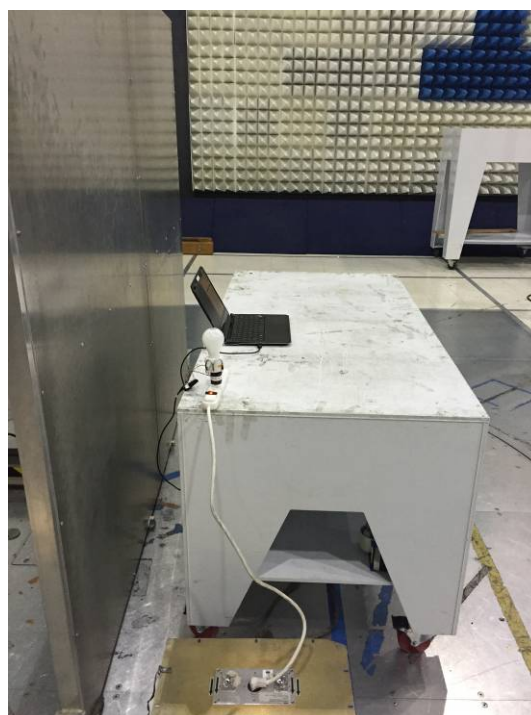
Frequency	Av Level	QP Level	Av Limit	QP Limit	Av Margin	QP Margin
MHz	dBuV	dBuV	dBuV	dBuV	dB	dB
0.180	26.7	44.5	55.1	65.1	-28.4	-20.7
18.209	36.6	41.4	50.0	60.0	-13.4	-18.6
25.736	40.4	45.6	50.0	60.0	-9.6	-14.4

Test Mode: Transmitter On, 120V 60Hz
Temp.: 20.6C
Humidity: 49.9%

Results **Complies** by 8.9 dB

4.6.4 Test Configuration Photographs

The following photographs show the testing configurations used.



5.0 RF Exposure Evaluation

MPE Evaluation (Bluetooth radio)

The EUT is a wireless device used in a mobile application, at least 20 cm from any body part of the user or nearby persons.

The maximum Peak EIRP calculated is +1.60 dBm or 1.445 mW; therefore, to comply with RF Exposure Requirement, the MPE is calculated.

The Power Density can be calculated using the formula

$$S = \text{EIRP} / 4\pi D^2$$

Where: S is Power Density in W/m^2

D is the distance from the antenna.

It is considered that 20 cm is the minimum distance that user can go closest to the EUT.

At 20 cm, $S = 0.00287 \text{ W}/\text{m}^2$, which is below the MPE Limit of $10 \text{ W}/\text{m}^2$

6.0 List of Test Equipment

Measurement equipment used for emission compliance testing utilized the equipment on the following list:

Equipment	Manufacturer	Model/Type	Asset #	Cal Int	Cal Due
Spectrum Analyzer	Rohde and Schwarz	FSU	ITS00913	12	12/16/15
EMI Receiver	Rohde and Schwarz	ESU	ITS 00961	12	06/02/16
BI-Log Antenna	Teseq	CBL 6111D	ITS 01058	12	11/21/15
Pyramidal Horn Antenna	EMCO	3160-09	ITS00571	#	#
Pre-Amplifier	Sonoma Instrument	310N	ITS 00942	12	11/26/15
Pre-Amplifier (1-18GHz)	Miteq	AMF-4D-001180-24-10P	ITS 00526	12	10/06/16
Pre-Amplifier (18-40GHz)	Miteq	JSD44-18004000-305P	ITS 00921	12	06/18/16
Horn Antenna	ETS Lindgren	3115	ITS 00982	12	11/21/15
LISN	FCC	FCC-LISN-50-50-M-H	ITS 00552	12	05/05/16

No Calibration required

7.0 Document History

Revision/ Job Number	Writer Initials	Reviewers Initials	Date	Change
1.0 / G102248754	ML	KV	October 22, 2015	Original document