

TEST REPORT

Report Number: 101691132MPK-002

Project Number: G101691132

August 07, 2014

Testing performed on

Ollie

Model: 1B01

FCC ID: SXO-OLV1

IC: 10016A-OLV1

to

FCC Part 15 Subpart C (15.247)

Industry Canada RSS-210 Issue 8, Annex 8

FCC Part 15, Subpart B

Industry Canada ICES-003

For

Orbotix, Inc. dba Sphero

Test Performed by:

Intertek

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Test Authorized by:

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Prepared by:


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Date: August 07, 2014

Reviewed by:


Krishna K Vemuri

Date: August 07, 2014

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Report No. 101691132MPK-002

Equipment Under Test:	Ollie
Trade Name:	Ollie
Model Number:	1B01
Serial Numbers:	MPK14071809032-002 (Radiated Sample) MPK1407111108-002 (Conducted Sample)
Applicant:	Orbotix, Inc. dba Sphero
Contact:	Kate Chouinard
Address:	Orbotix, Inc. dba Sphero 4772 Walnut St., Suite 206 Boulder, CO 80301
Country	USA
Tel. Number:	(720) 295-7829
Email:	kate@orbotix.com
Applicable Regulation:	FCC Part 15 Subpart C (15.247) Industry Canada RSS-210 Issue 8, Annex 8 FCC Part 15, Subpart B Industry Canada ICES-003
Date of Test:	July 14 – July 25, 2014

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
Radiated Emissions	15.109	ICES-003	Complies
AC Line Conducted Emission	15.107	ICES-003	Complies
RF Output Power	15.247(b)(3)	RSS-210, A8.4	Complies
6 dB Bandwidth	15.247(a)(2)	RSS-210, A8.2	Complies
Power Density	15.247(e)	RSS-210, A8.2b	Complies
Out of Band Antenna Conducted Emission	15.247(d)	RSS-210, A8.5	Complies
Transmitter Radiated Emissions	15.247(d), 15.209, 15.205	RSS-210, A8.5	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 *

* Compliance with the SAR requirements is considered without testing because the RF power of channel is below SAR Test Exclusion Threshold. The SAR Test Exclusion Threshold (TET in mW) was calculated according to the KDB 447498, sec 4.3.1.1) using formula:

$$TET = 3 \times d / \sqrt{f_{(GHz)}}$$

where d = 5 mm – is the minimum test separation distance. At f = 2.45 GHz, TET = 9.6 mW (10 mW if rounded).

EUT receive date: July 14, 2014

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: July 14, 2014

Test completion date: July 25, 2014

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

2.0 General Information

2.1 Product Description

The Ollie is an app-controlled robot that works with iOS & Android devices. The unit is battery powered and it charged through USB port.

Information about the 2.4 GHz radio is presented below:

Applicant	Orbotix, Inc. dba Sphero
Model No.	1B01
FCC Identifier	SXO-OLV1
IC Identifier	10016A-OLV1
Type of transmission	Digital Transmission System (DTS)
Rated RF Output	8.70 dBm (7.430 mW)
Frequency Range	2402 – 2480 MHz
Type of modulation/data rate	GFSK 1Mb
Number of Channel(s)	40
Antenna(s) & Gain	PCB antenna, Gain: +2 dBi
Manufacturer Name & Address	Orbotix, Inc. dba Sphero 4772 Walnut St., Suite 206 Boulder, CO 80301 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-210, 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	-	-

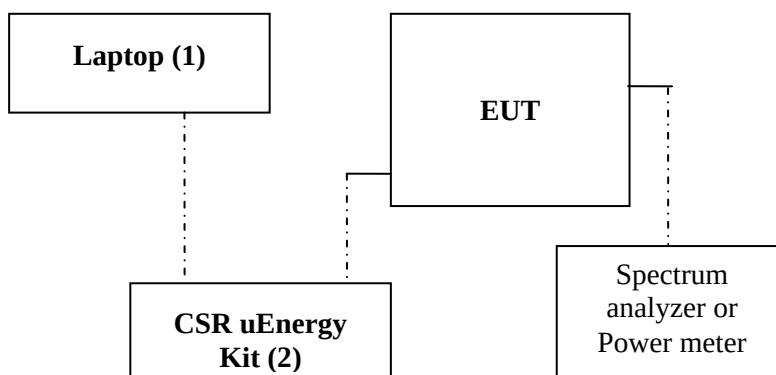
3.0 System Test Configuration

3.1 Support Equipment

Item #	Description	Model No./ Part No.	Serial No.
1	HP Laptop	EliteBook 2540P	CND11130WY
2	CSR uEnergy Development Kit	CSR1010	297518

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.



S = Shielded
U = Unshielded

F = With Ferrite
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.

3.4 Software Exercise Program

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

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-210 A8.2 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.

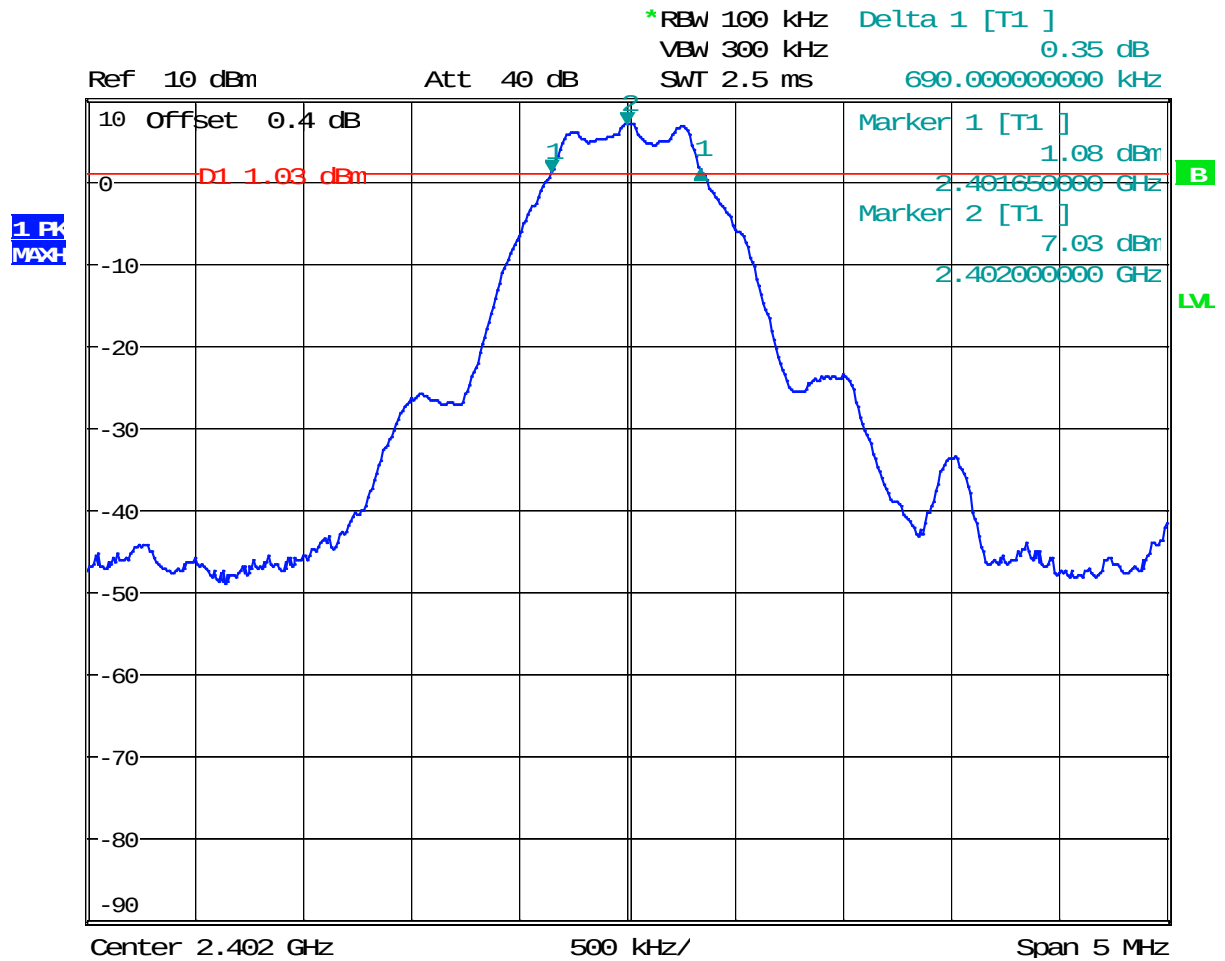
The occupied bandwidth was measured using the built-in spectrum analyzer function for 99% power bandwidth measurement.

4.1.3 Test Result

Frequency (MHz)	6-dB bandwidth FCC 15.247 & RSS-GEN, MHz	Occupied bandwidth, RSS-GEN, MHz	Plot
2402	0.690		1.1
		1.028	1.4
2440	0.710		1.2
		1.032	1.5
2480	0.700		1.3
		1.028	1.6

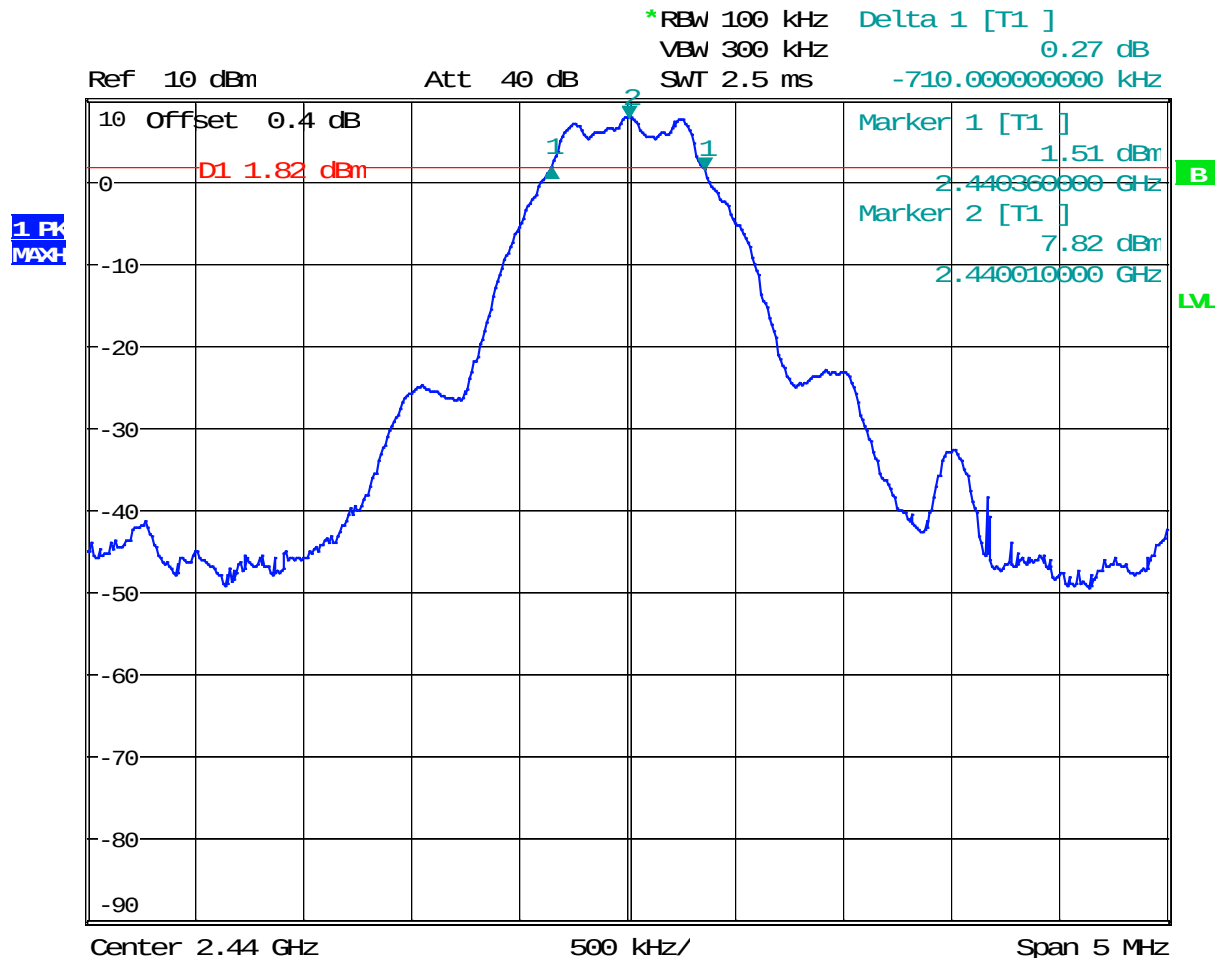
Results	Complies
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Plot 1. 1



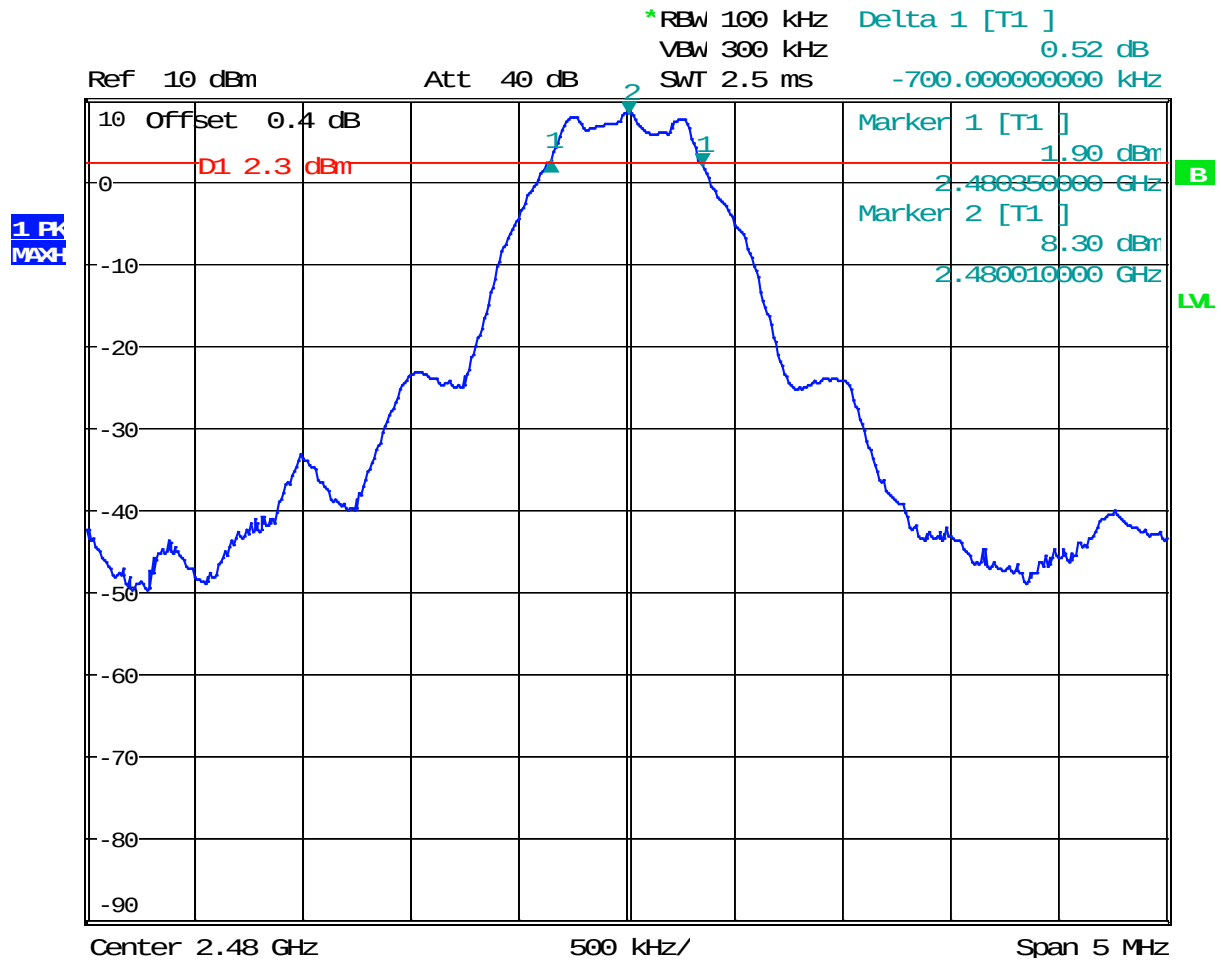
Date: 15.JUL.2014 08:52:06

Plot 1. 2



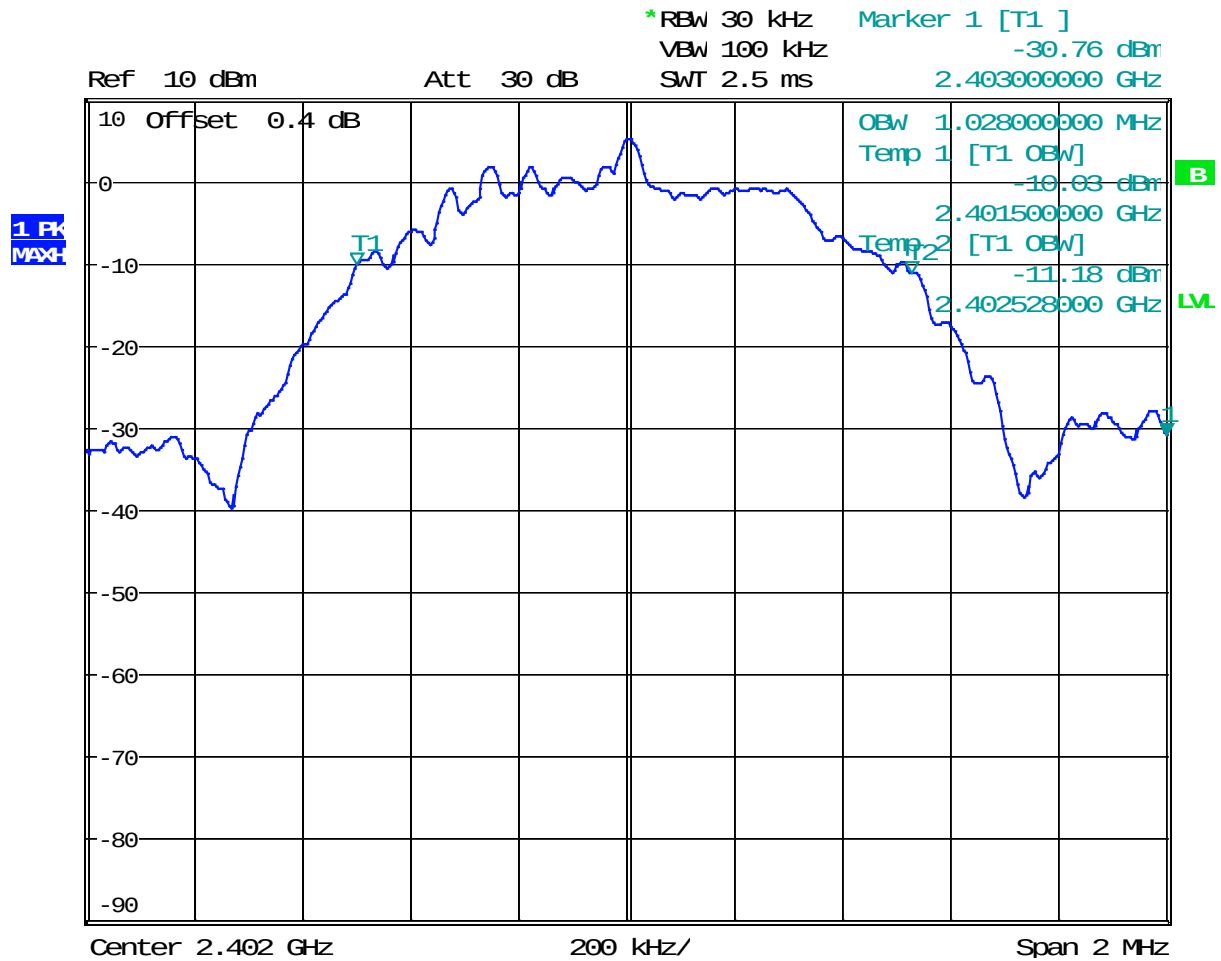
Date: 15.JUL.2014 08:53:54

Plot 1.3



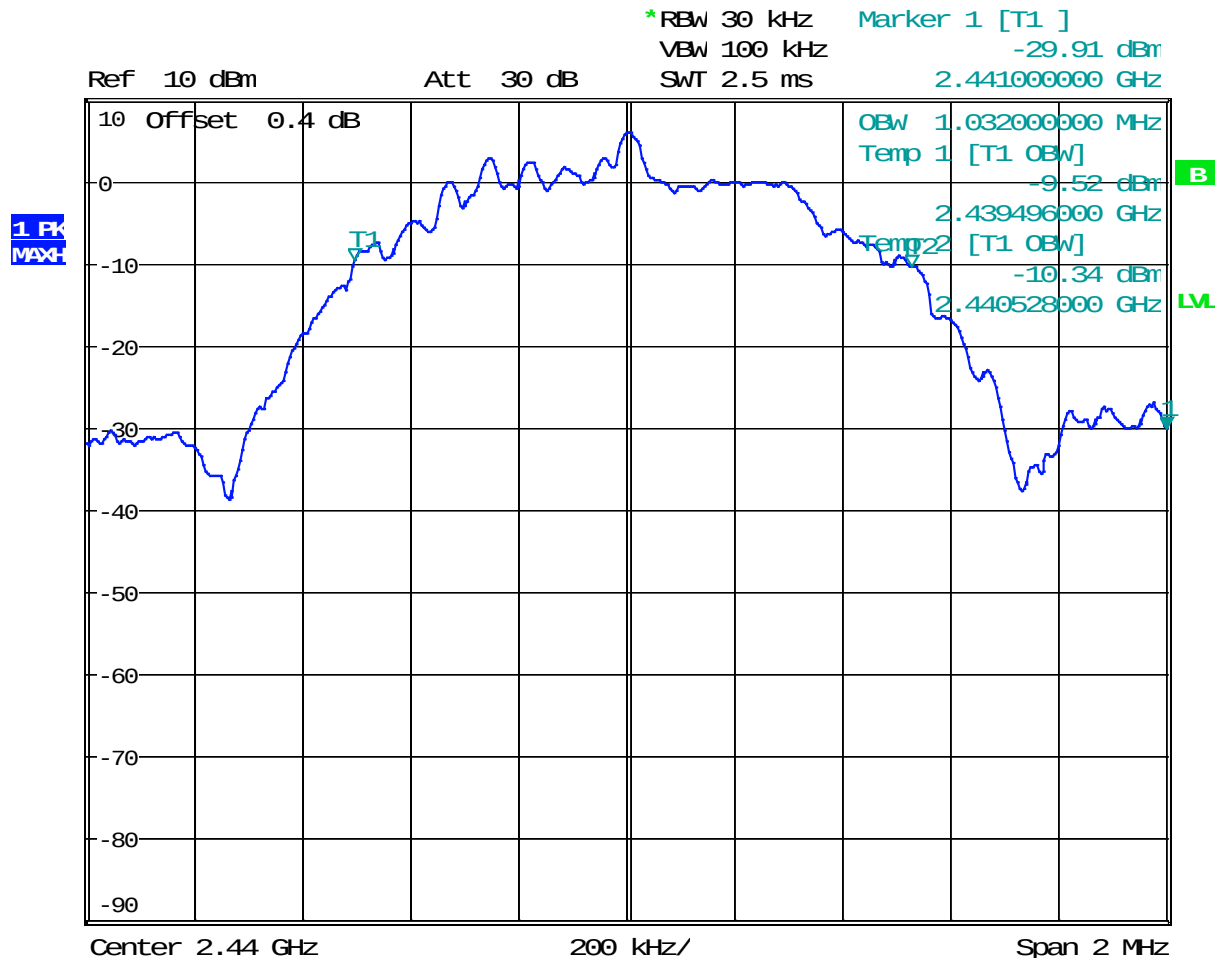
Date: 15.JUL.2014 08:55:28

Plot 1. 4



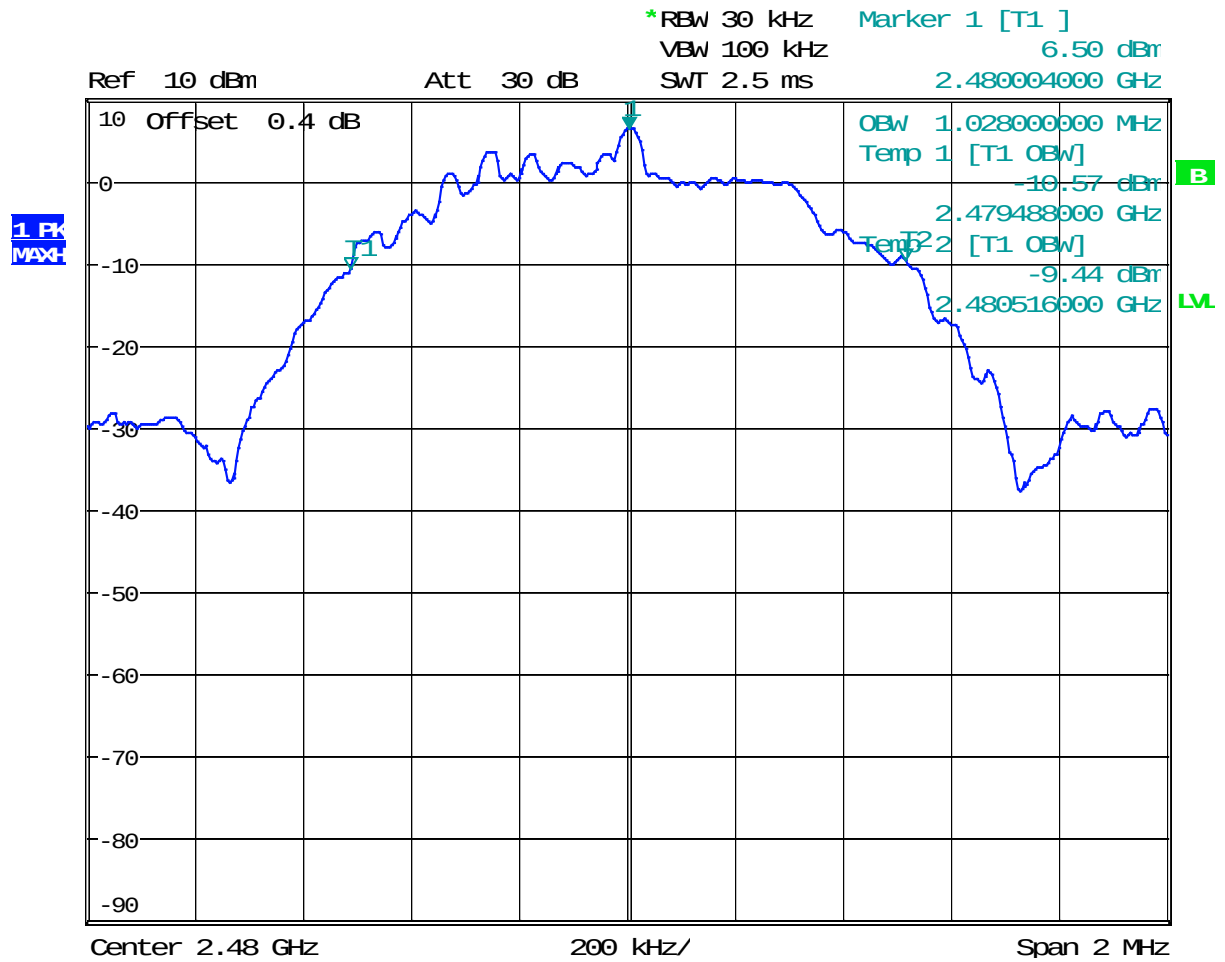
Date: 15.JUL.2014 09:02:29

Plot 1.5



Date: 15.JUL.2014 09:01:30

Plot 1.6



Date: 15.JUL.2014 09:00:39

4.2 Maximum Peak Conducted Output Power at Antenna Terminals

FCC Rule: 15.247(b)(3); RSS-210 A8.4;

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 $RBW > DTS \text{ Bandwidth}$.

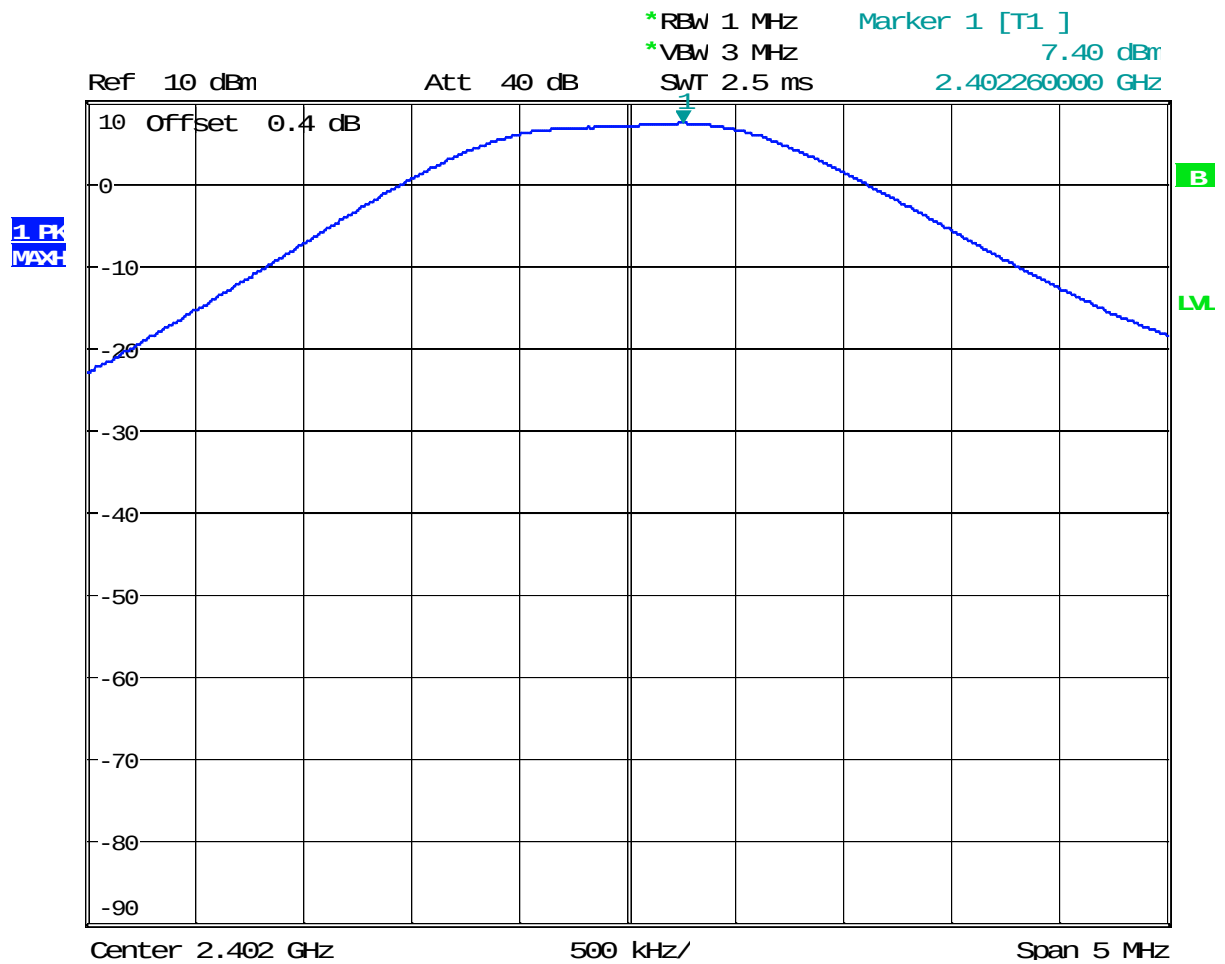
4.3.3 Test Result

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	7.40	5.508	2.1
2440	8.19	6.607	2.2
2480	8.70	7.430	2.3

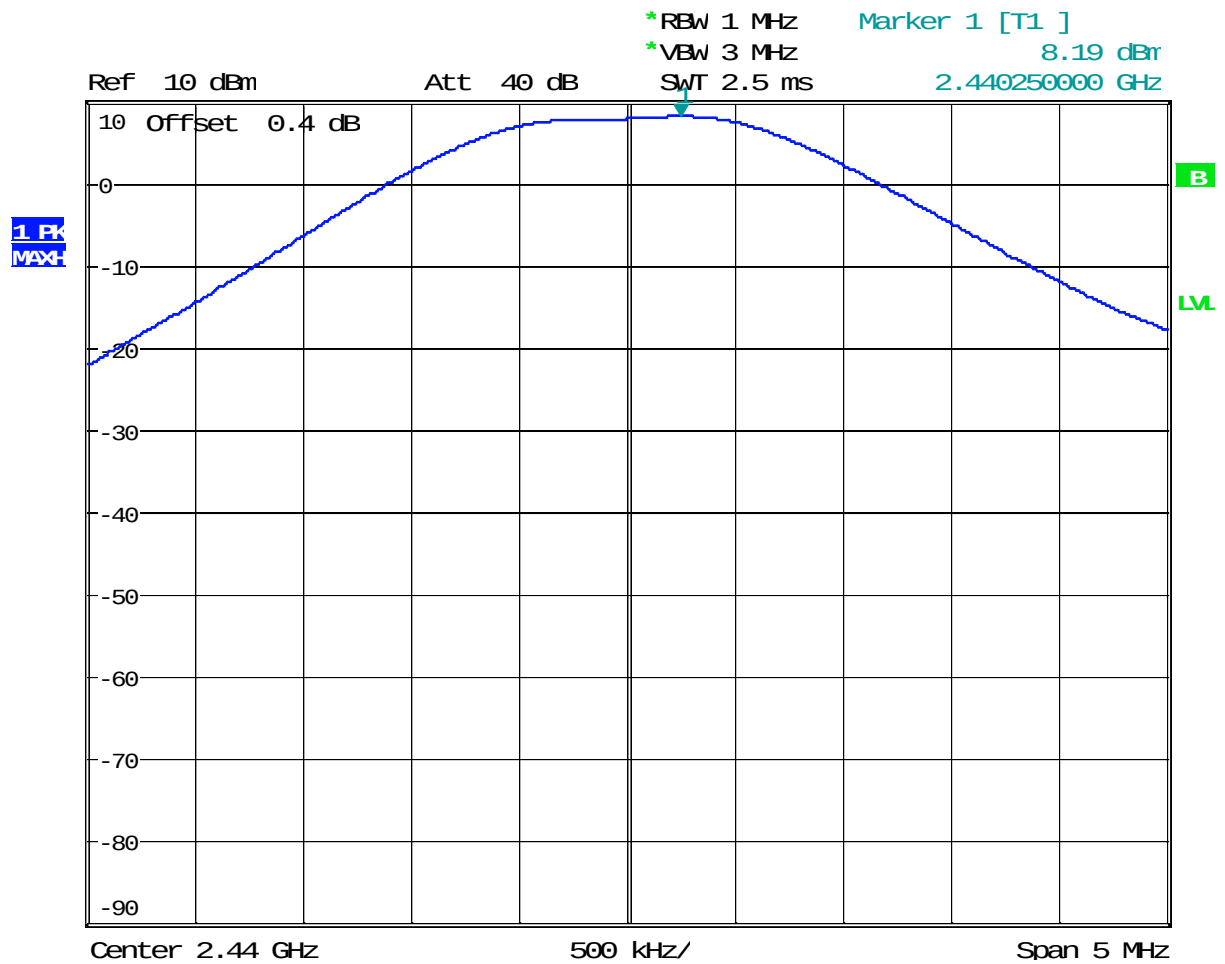
Results	Complies
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Plot 2. 1



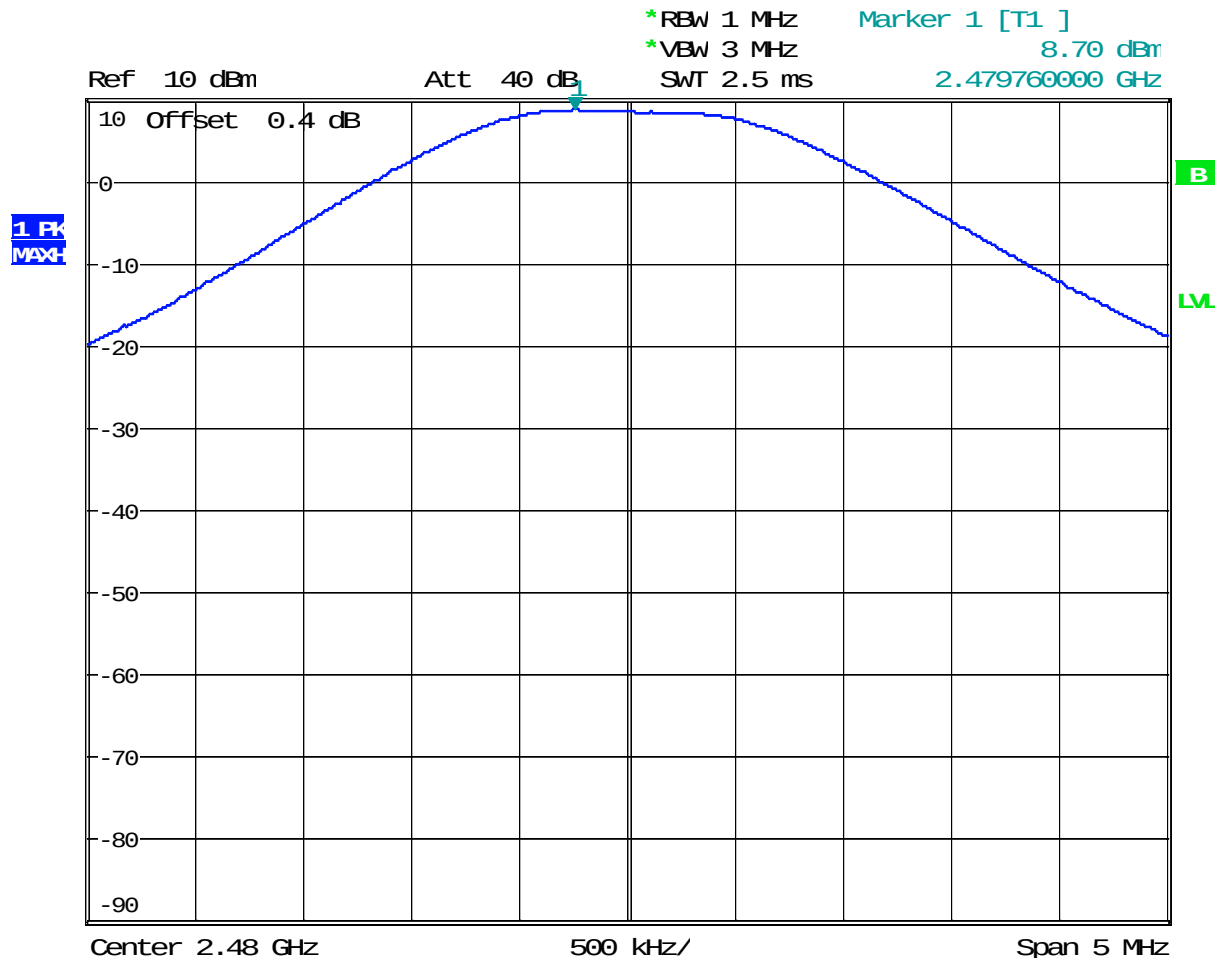
Date: 15.JUL.2014 09:04:55

Plot 2. 2



Date: 15.JUL.2014 09:05:51

Plot 2.3



Date: 15.JUL.2014 09:06:22

4.3 Maximum Power Spectral Density FCC: 15.247 (e); RSS-210 A8.2b;

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.

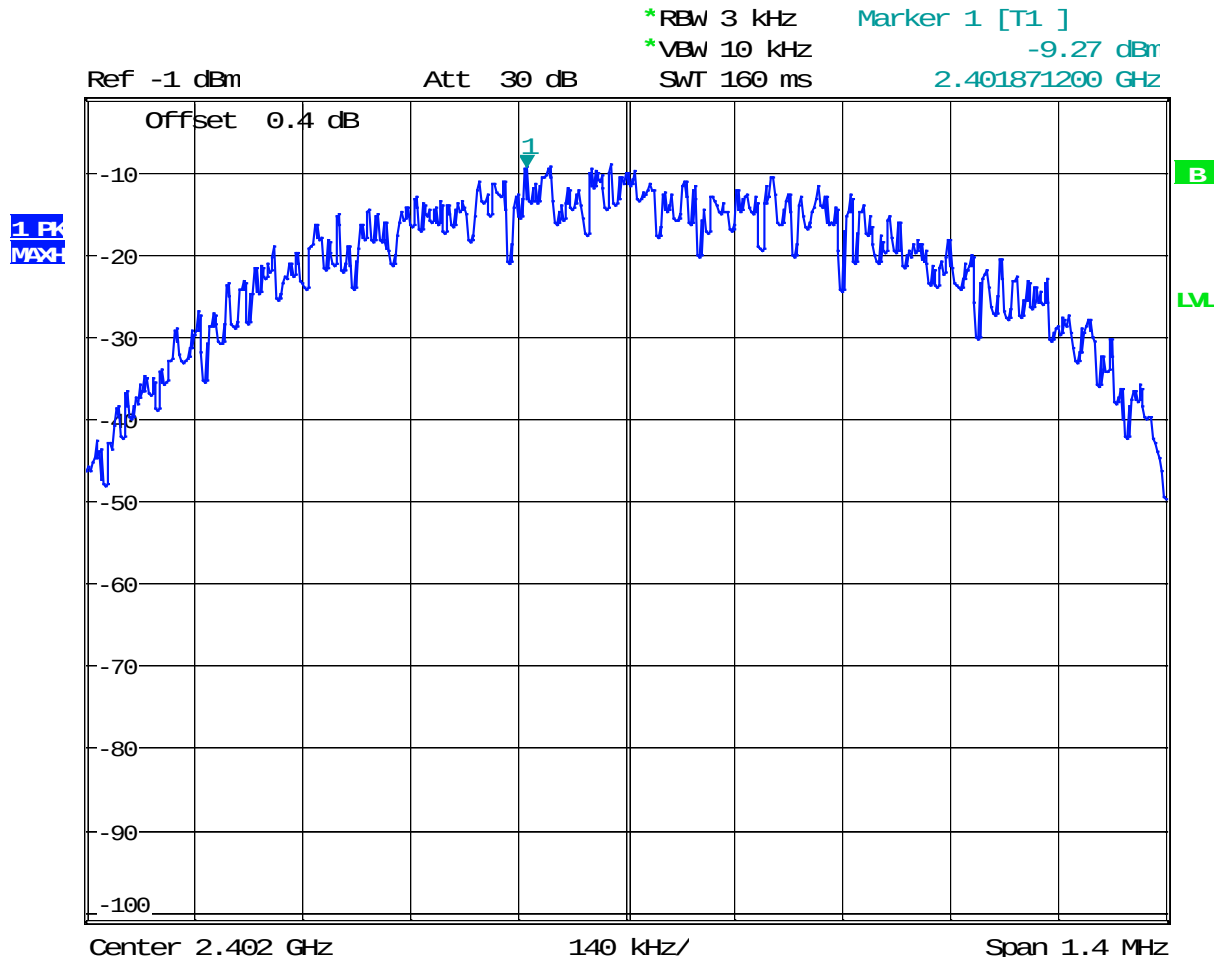
4.3.3 Test Result

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	-9.27	8.0	-17.27	3.1
2440	-8.21	8.0	-16.21	3.2
2480	-7.55	8.0	-15.55	3.3

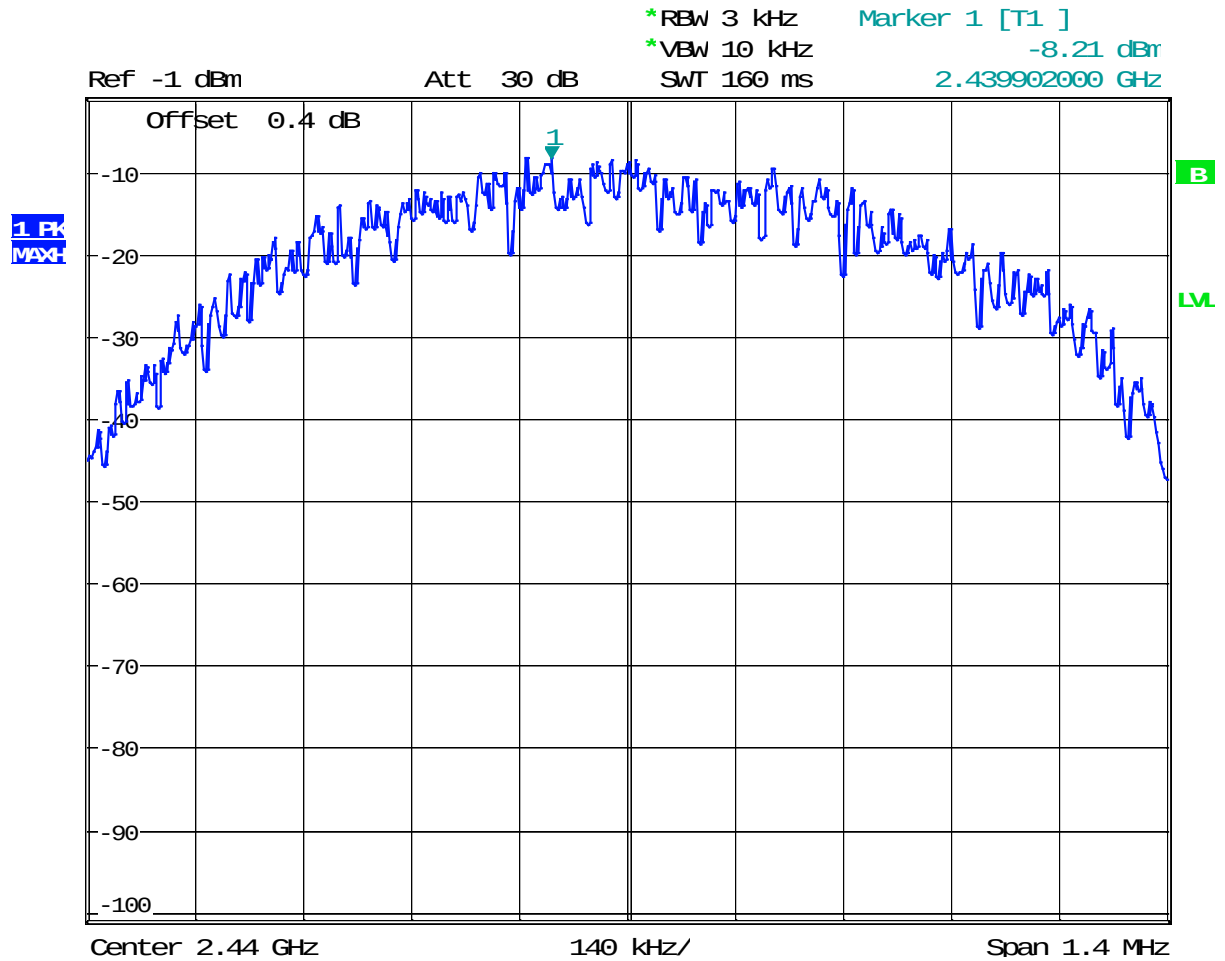
Results	Complies
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Plot 3. 1



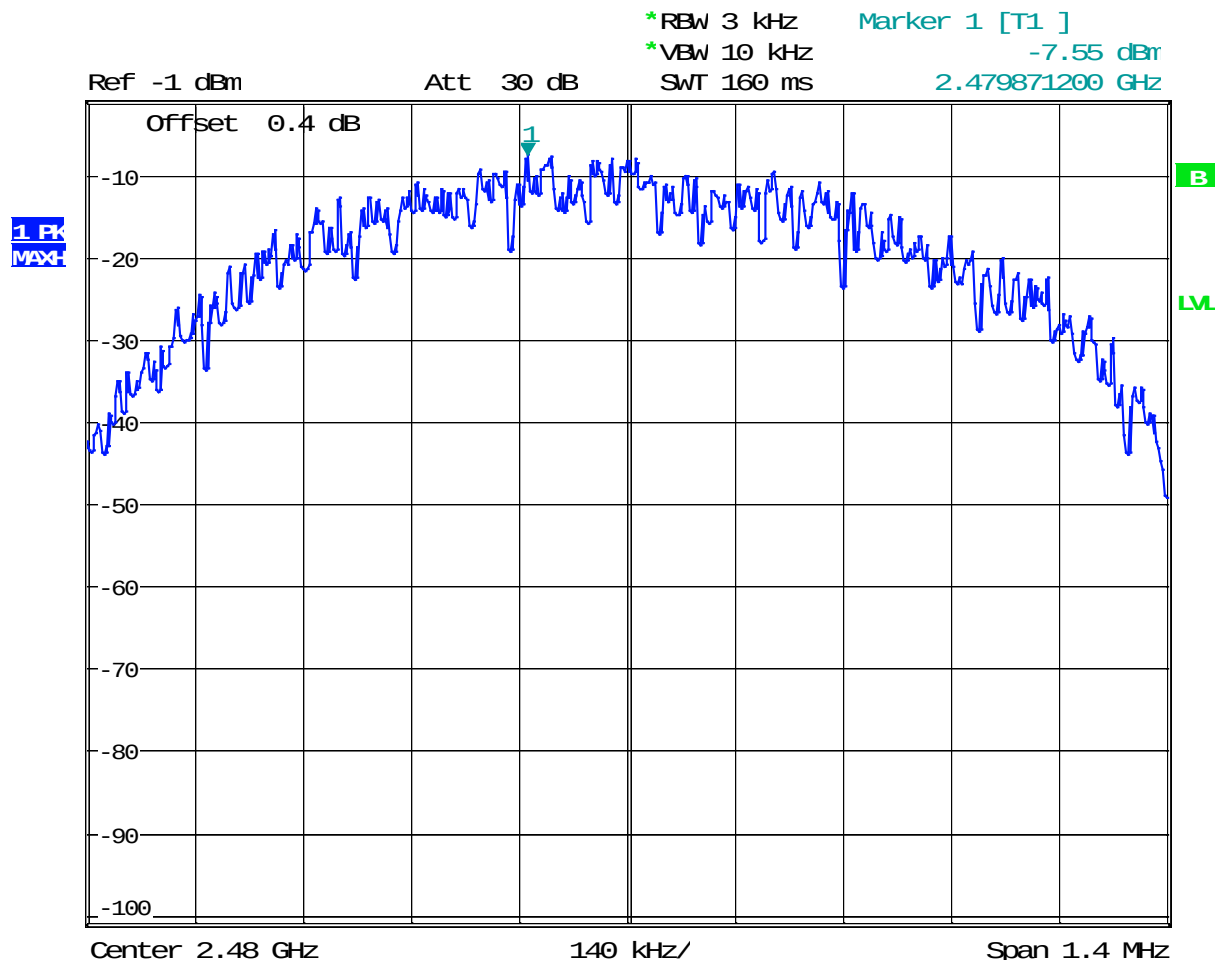
Date: 15.JUL.2014 14:32:04

Plot 3.2



Date: 15.JUL.2014 14:33:02

Plot 3.3



Date: 15.JUL.2014 14:33:36

4.4 Unwanted Conducted Emissions

FCC: 15.247(d); RSS-210 A8.5;

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.

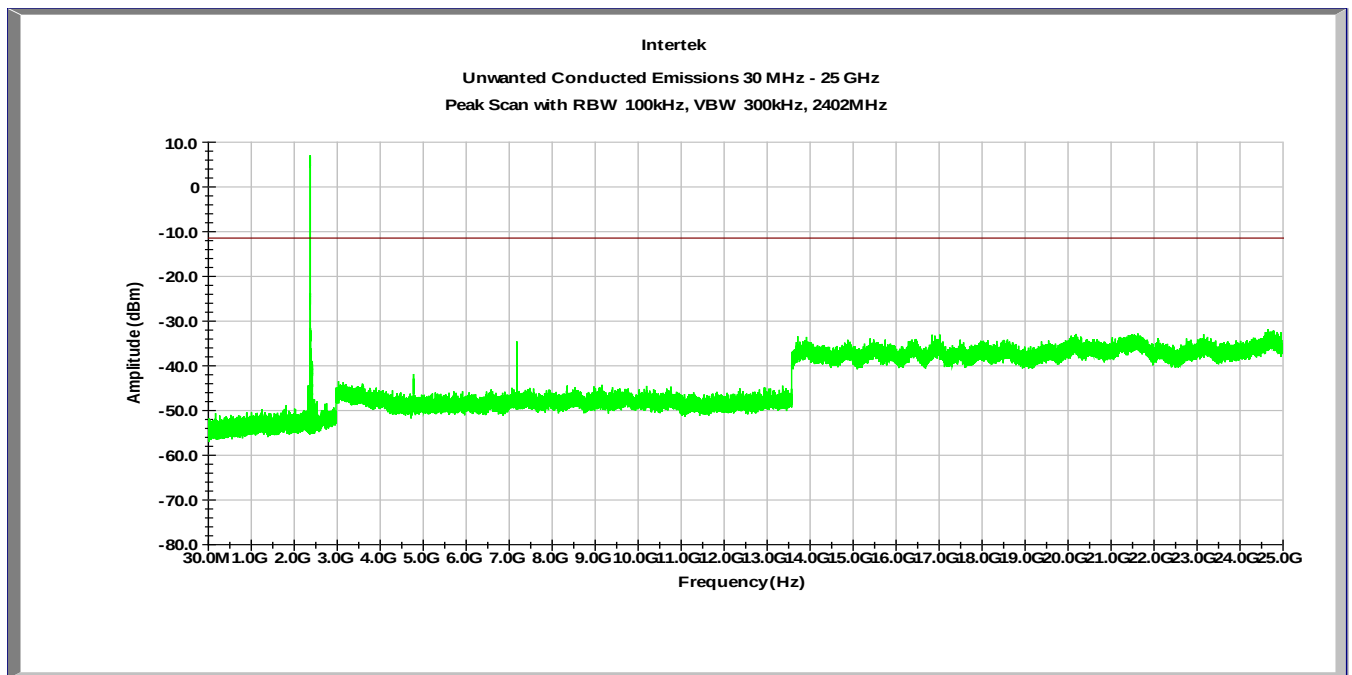
The unwanted emissions were measured from 30 MHz to 25 GHz.

4.4.3 Test Result

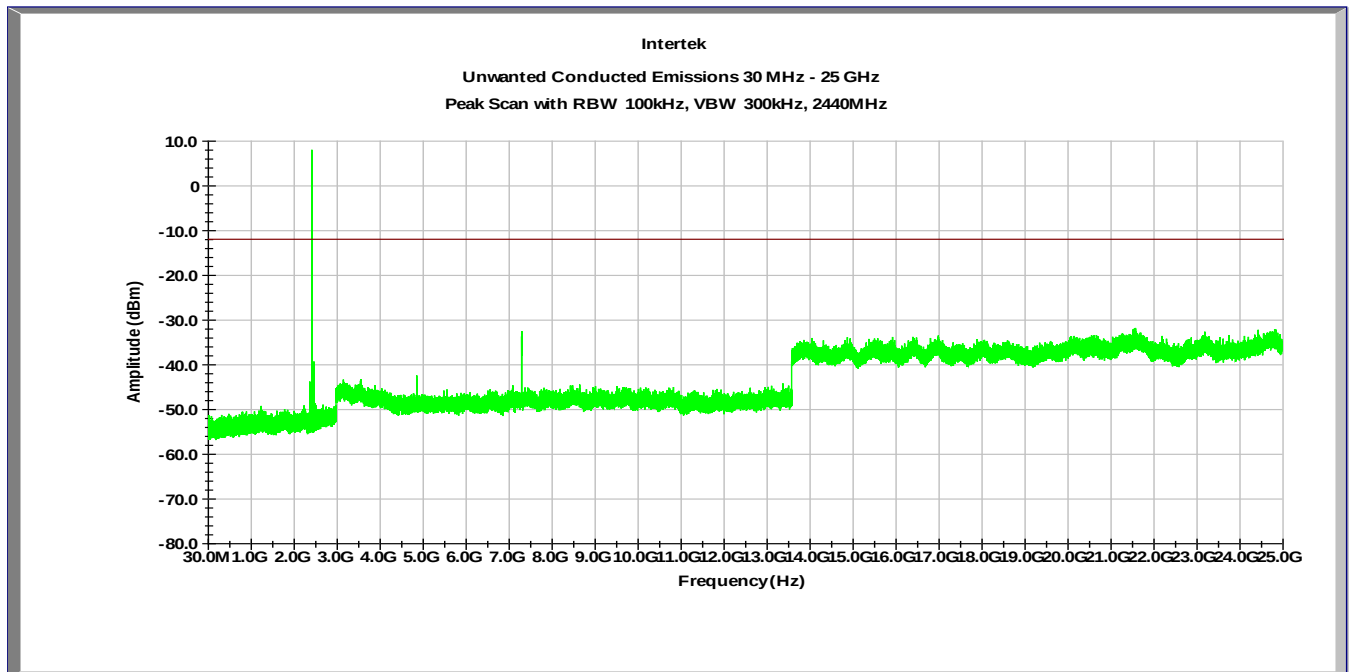
Refer to the following plots 4.1 – 4.3 for unwanted conducted emissions. The plot shows -20dB attenuation limit line.

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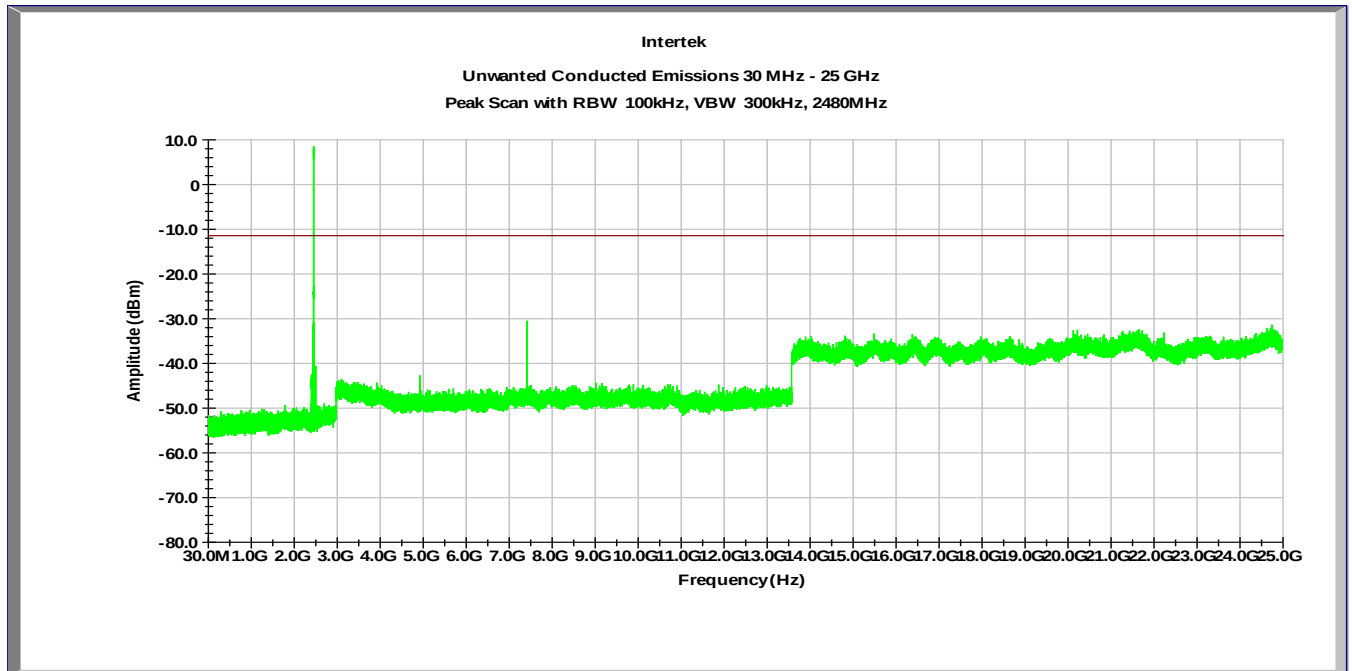
Plot 4.1 Tx @ Low Channel, 2402 MHz



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-210;

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.

Guidance for Performing Compliance Measurements on DTS Operating under §15.247 refers to ANSI C63.10. In sec. 7.5 of ANSI C63.10 the procedure for determining the average value of pulsed emissions is described.

Following this procedure, the Peak Field Strength (FS_{peak}) is measured and the Duty Cycle Correction Factor (δ) is applied. The Duty Cycle is defined as transmitter time-on (t) in T=100 ms interval.

$$\delta = t/T \text{ or in decibels } \delta(dB) = 20 \text{ Log } \delta$$
$$FS_{average} [\text{in dB}(\mu V/m)] = FS_{peak} [\text{in dB}(\mu V/m)] + \delta(dB)$$

Radiated emissions are taken at 10 meters for frequencies below 1 GHz and at 3 meters for frequencies above 1 GHz, except measurement at 1 meter for all band edge measurement.

Data included is representative 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

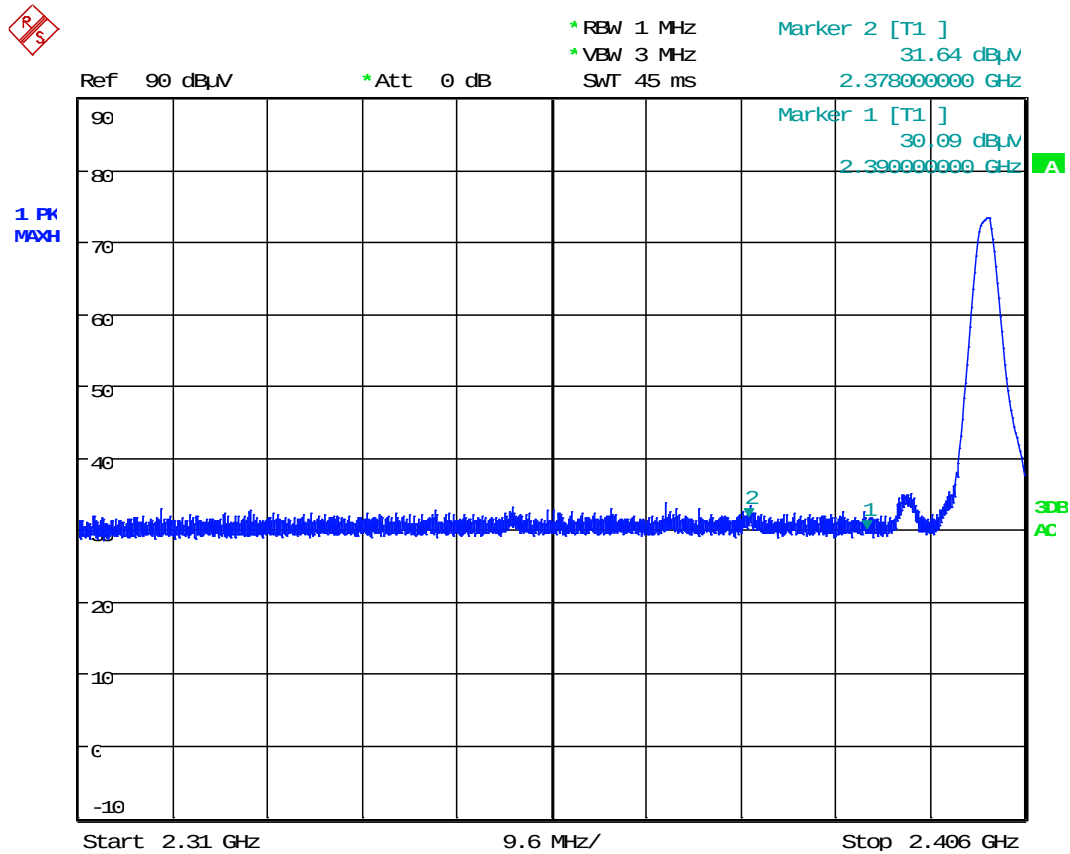
The data on the following pages list the significant emission frequencies, the limit and the margin of compliance.

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

The EUT passed the test by 3.98dB

Test Results: 15.209/15.205 Restricted Band Emissions

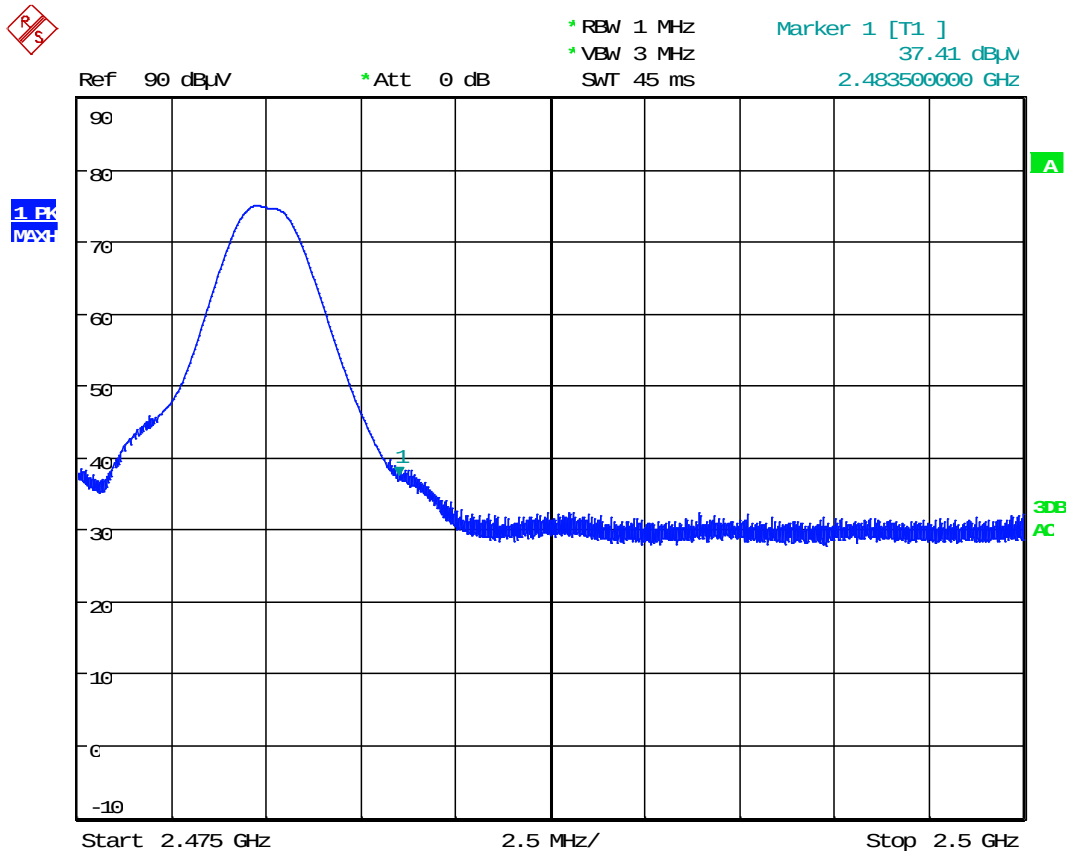
**Out-of-Band Radiated spurious emissions at the Band-edge @1m distance
2310–2390 MHz**



Radiated Band Edge

Date: 22.JUL.2014 16:19:27

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



Radiated Band Edge

Date: 22.JUL.2014 16:08:58

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

Frequency	RA @ 1 m	AF	DCF	δ (dB)*	CF + Attenuator	FS @ 3m	Detector	Limit @ 3 m	Margin
(MHz)	(dBuV/m)	(dB/m)	(dB)	(dB)	(dB)	(dBuV/m)	(Peak) / (Average)	(dBuV/m)	(dB)
Tx @ 2402MHz									
2378.00	31.64	27.5	9.54	--	7.1	56.7	Peak	74.0	-17.3
	31.64	27.5	9.54	-12.75	7.1	43.95	Average	54.0	-10.0

* δ (dB) - Duty Cycle Correction Factor. See Appendix A for Duty Cycle measurement and calculation. Duty cycle Correction Factor was applied for Average Field Strength (FS).

Note: $FS@3m = RA + AF - DCF + (CF + \text{Attenuator}), (\text{Peak})$

$FS@3m = RA + AF + \delta - DCF + (CF + \text{Attenuator}), (\text{Average})$

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

Frequency	RA @ 1 m	AF	DCF	δ (dB)*	CF + Attenuator	FS @ 3m	Detector	Limit @ 3 m	Margin
(MHz)	(dBuV/m)	(dB/m)	(dB)	(dB)	(dB)	(dBuV/m)	(Peak) / (Average)	(dBuV/m)	(dB)
Tx @ 2480MHz									
2483.50	37.41	27.8	9.54	--	7.1	62.77	Peak	74.0	-11.23
	37.41	27.8	9.54	-12.75	7.1	50.02	Average	54.0	-3.98

* δ (dB) - Duty Cycle Correction Factor. See Appendix A for Duty Cycle measurement and calculation. Duty cycle Correction Factor was applied for Average Field Strength (FS).

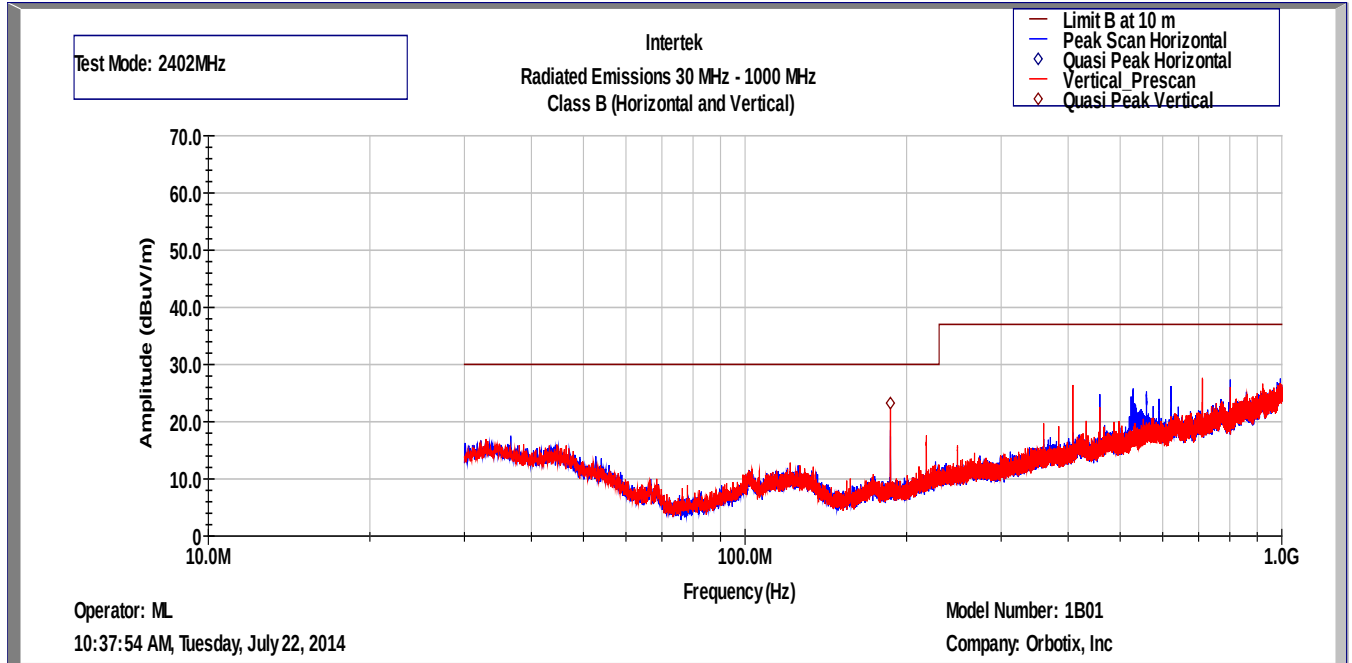
Note: $FS@3m = RA + AF - DCF + (CF + \text{Attenuator}), (\text{Peak})$

$FS@3m = RA + AF + \delta - DCF + (CF + \text{Attenuator}), (\text{Average})$

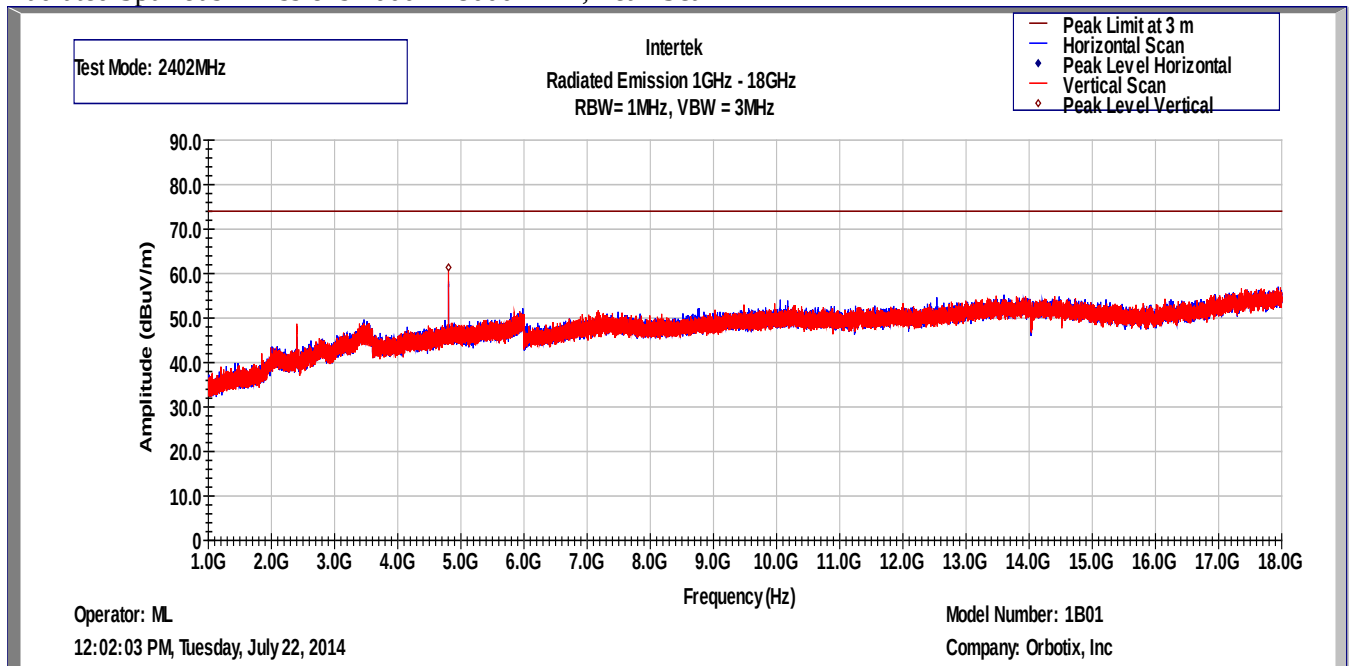
Results	Complies
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Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 2402MHz

Radiated Spurious Emissions 30 MHz - 1000 MHz



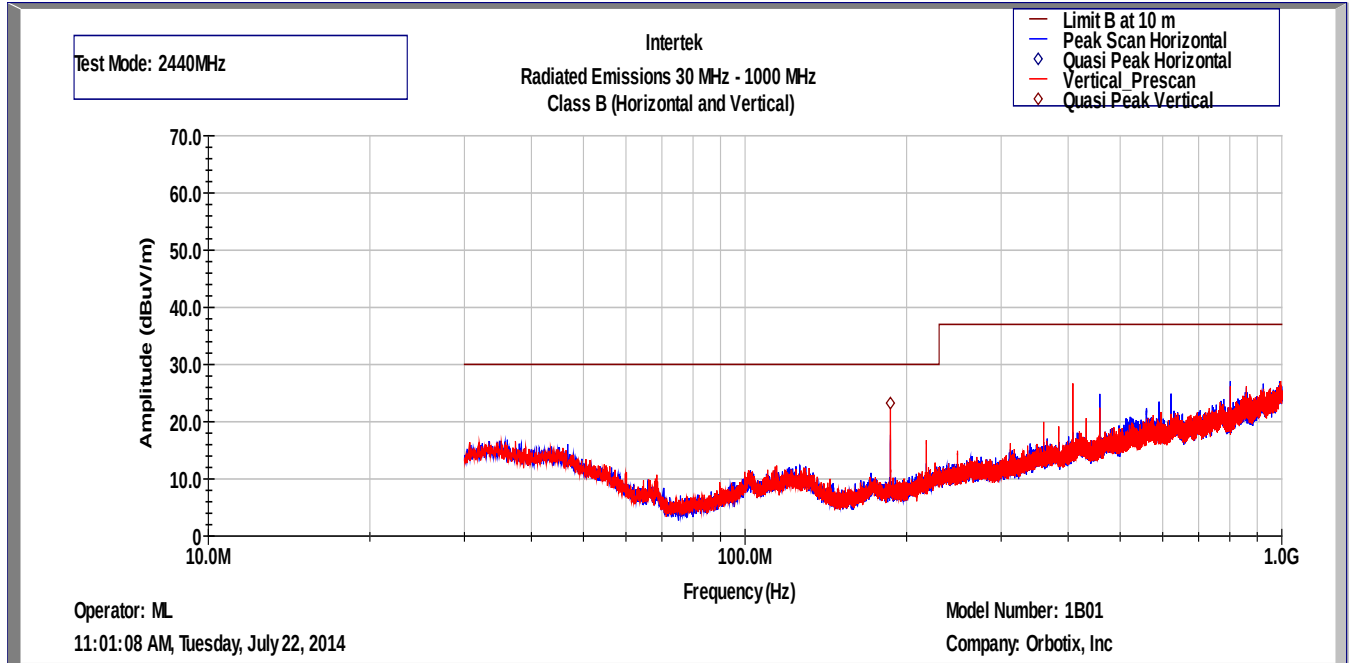
Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan



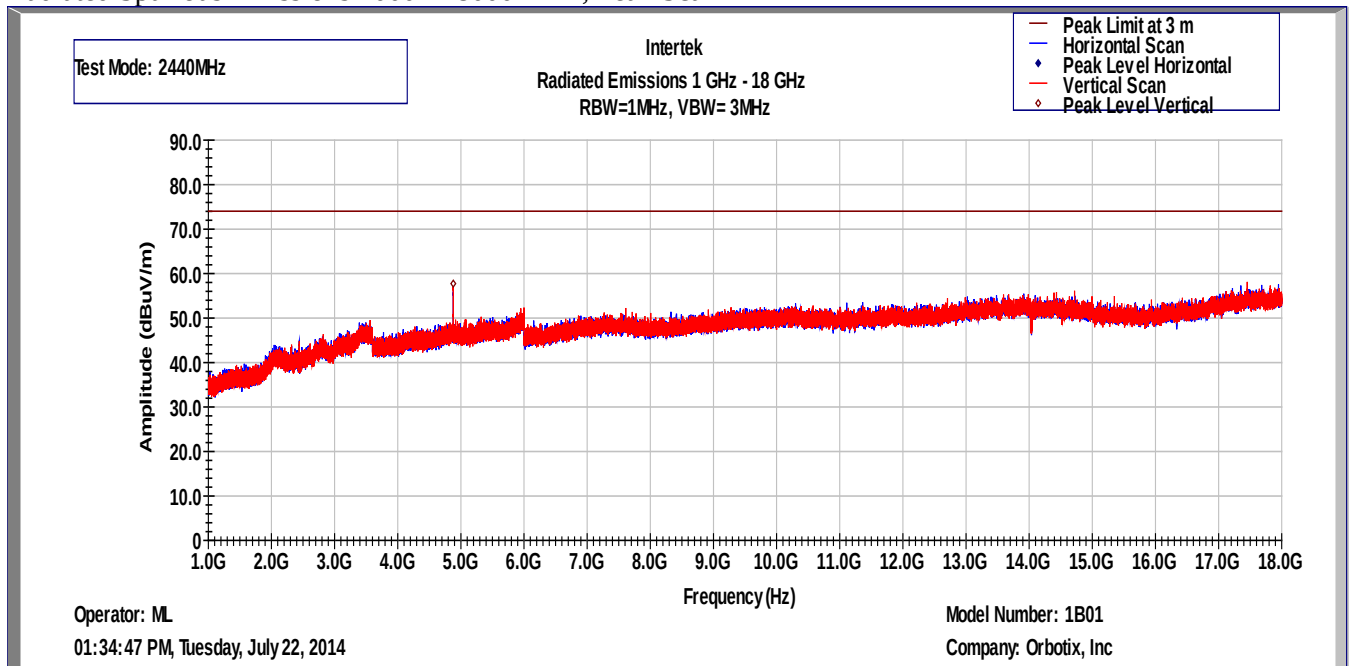
Note: Radiated emission measurements were performed up to 25GHz. No Emissions were identified when scanned from 18-25 GHz

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

Radiated Spurious Emissions 30 MHz - 1000 MHz



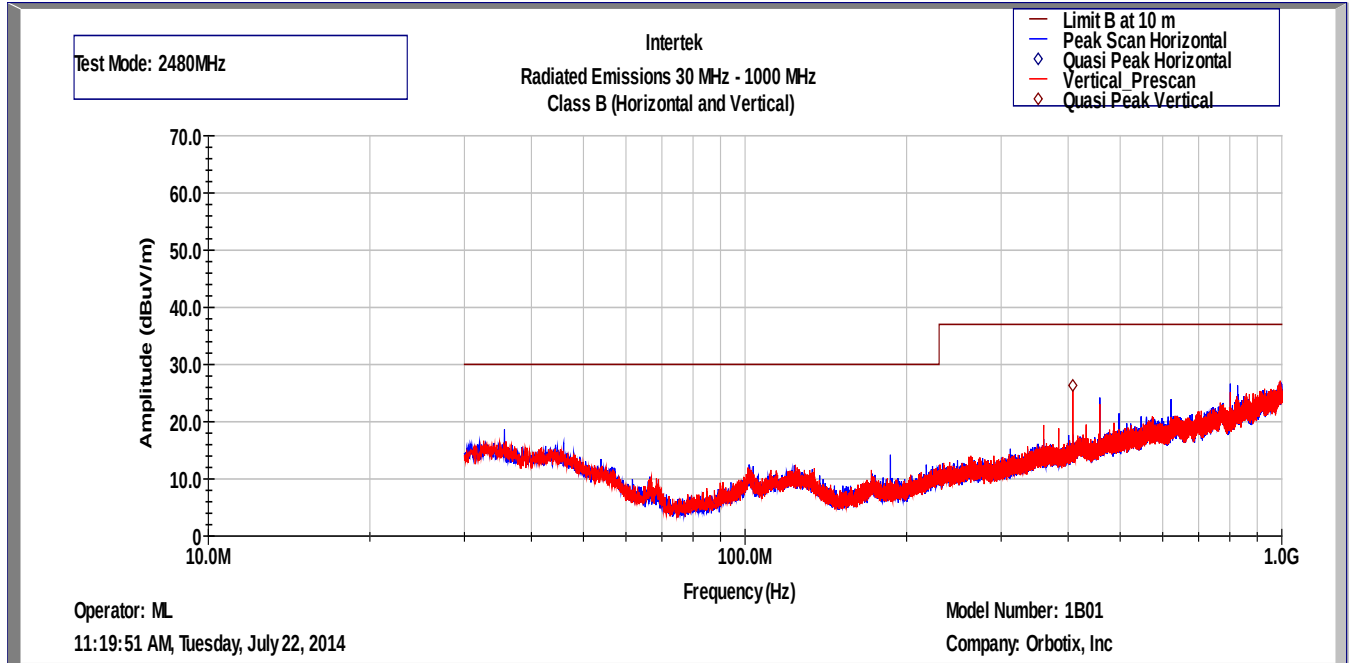
Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan



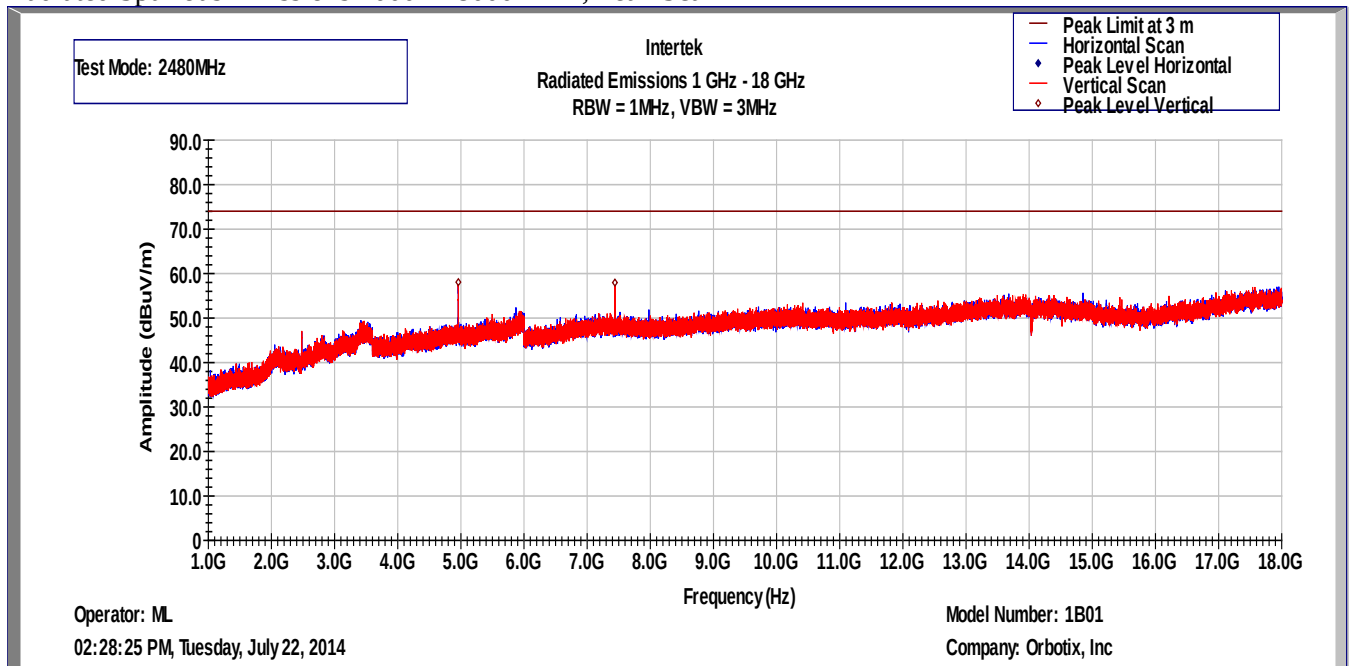
Note: Radiated emission measurements were performed up to 25GHz. No Emissions were identified when scanned from 18-25 GHz

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

Transmitter Radiated Emissions

Frequency	Antenna Polarity	Detector	Raw Amplitude @ 3 m	Preamp	Antenna Factor	CF + Attenuator	δ (dB)*	FS @ 3 m	FS Limit @ 3 m	Margin
GHz	H/V	Peak / Avg	dB(uV)	dB	dB(1/m)	dB	dB	dB(uV/m)	dB(uV/m)	dB
Tx @ 2402 MHz										
4804	V	Peak	54.2	34.5	32.6	9.032	--	61.3	74.0	-12.6
4804	V	Avg	54.2	34.5	32.6	9.032	-12.75	48.55	54.0	-5.45
Tx @ 2442 MHz										
4880	V	Peak	50.3	34.4	32.7	9.139	--	57.8	74.0	-16.2
4880	V	Avg	50.3	34.4	32.7	9.139	-12.75	45.05	54.0	-8.95
Tx @ 2480 MHz										
4.960	V	Peak	50.4	34.4	32.9	9.145	--	58	74.0	-16.0
7.440	V	Peak	43.2	33.5	37.4	10.83	--	57.9	74.0	-16.1
4.960	V	Avg	50.4	34.4	32.9	9.145	-12.75	45.15	54.0	-8.85
7.440	V	Avg	43.2	33.5	37.4	10.83	-12.75	45.15	54.0	-8.85

* δ (dB) - Duty Cycle Correction Factor. See Appendix A for Duty Cycle measurement and calculation. Duty cycle Correction Factor was applied for Average Field Strength (FS).

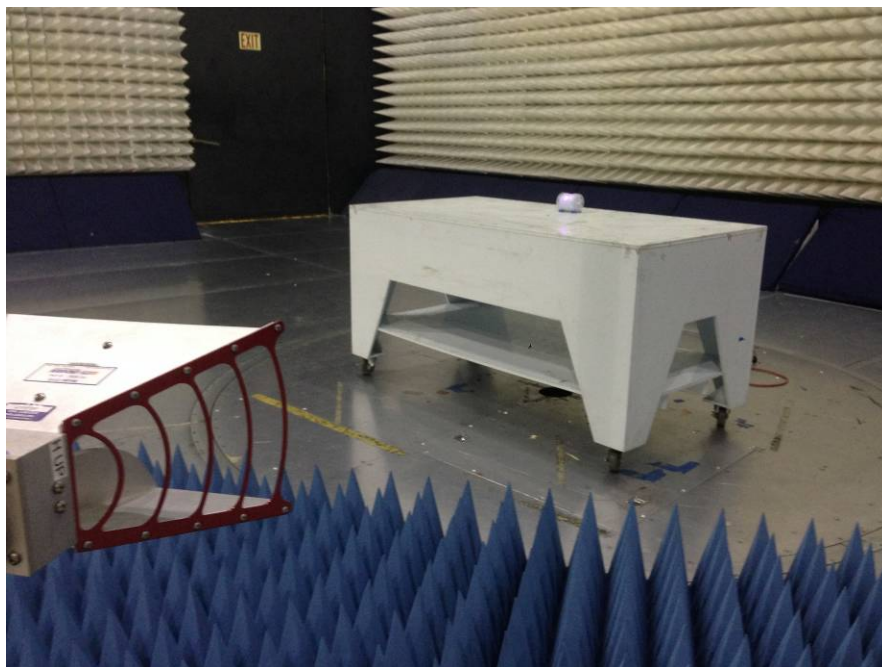
Note: $FS@3m = RA + AF - DCF + (CF + Attenuator)$, (Peak)

$FS@3m = RA + AF + \delta - DCF + (CF + Attenuator)$, (Average)

Results	Complies
---------	----------

4.5.4 Test setup photographs

The following photographs show the testing configurations used.



4.6 Radiated Emissions

FCC Ref: 15.109, ICES 003

4.6.1 Requirement

Limits for Electromagnetic Radiated Emissions FCC Section 15.109(b), ICES 003*, RSS GEN

Frequency (MHz)	Class A at 10m dB(μV/m)	Class B at 3m dB(μV/m)
30-88	39	40.0
88-216	43.5	43.5
216-960	46.4	46.0
Above 960	49.5	54.0

* According to FCC Part 15.109(g) an alternative to the radiated emission limits shown above, digital devices may be shown to comply with the limit of CISPR Pub. 22

4.6.2 Procedures

Measurements are conducted with a quasi-peak detector instrument in the frequency range of 30 MHz to 1000 MHz and with the average detector instrument in the frequency range above 1000 MHz. The measuring receiver meets the requirements of Section One of CISPR 16 and the measuring antenna correlates to a balanced dipole.

Measurements of the radiated field are made with the antenna located at a distance of 10 meters from the EUT. If the field-strength measurements at 10m cannot be made because of high ambient noise level or for other reasons, measurements of Class B equipment may be made at a closer distance, for example 3m. An inverse proportionality factor of 20 dB per decade should be used to normalize the measured data to the specified distance for determining compliance.

The antenna is adjusted between 1m and 4m in height above the ground plane for maximum meter reading at each test frequency.

The antenna-to-EUT azimuth is varied during the measurement to find the maximum field-strength readings.

The antenna-to-EUT polarization (horizontal and vertical) is varied during the measurements to find the maximum field-strength readings.

The EUT, where intended for tabletop use, is placed on a table whose top is 0.8m above the ground plane. The table is constructed of non-conductive materials. Its dimensions are 1m by 1.5m, but may be extended for a larger EUT.

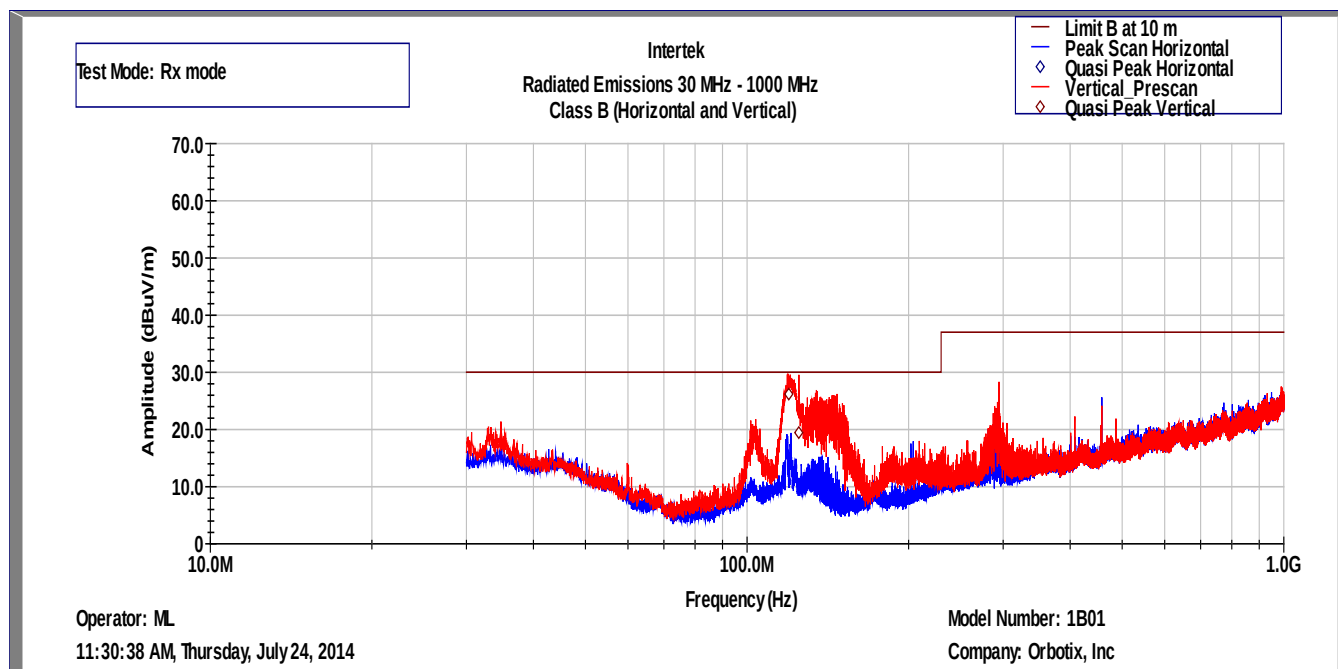
Floor standing EUT are placed on a horizontal metal ground plane and isolated from the ground plane by resting on an insulating material.

Equipment setup for radiated disturbance tests followed the guidelines of ANSI C63.4 and EN 55022.

4.6.3 Test Results

The highest clock frequency used in the EUT is 72 MHz; therefore testing for Radiated Emissions need be tested up to 1 GHz for FCC 15B. Radiated emission measurements were performed from 30 MHz to 1000 MHz. The data on the following pages list the significant emission frequencies, the limit and the margin of compliance.

Test Results: Radiated Emissions 30 MHz - 1000



Intertek Testing Services
Radiated Emissions 30 MHz - 1000 MHz
FCC Part 15 Class B (QP-Vertical)

Operator: ML

Model Number: TSII-CONTRL
Company: S&C Electric Company

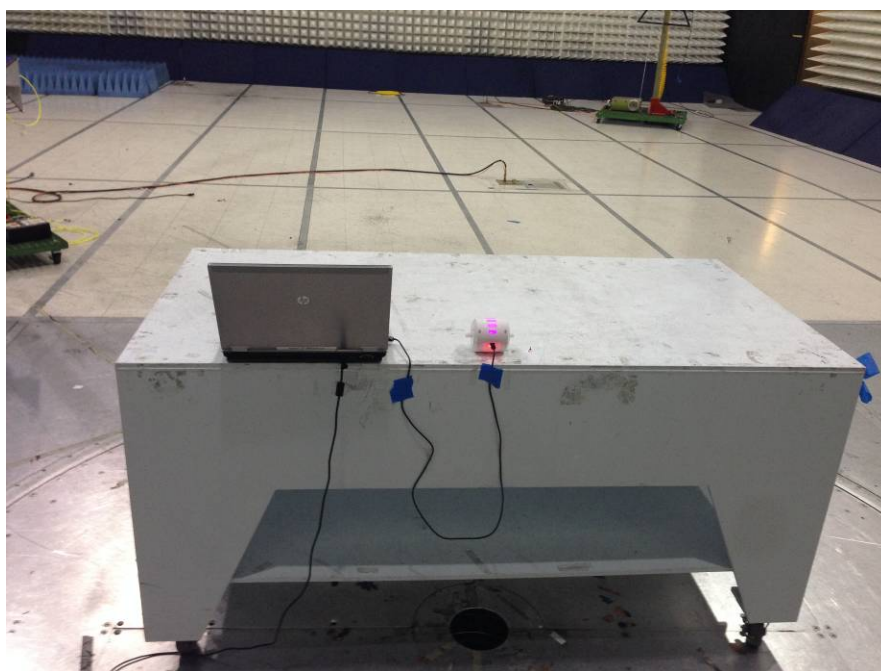
FCC Part 15 Class A (QP-Vertical)										
Frequency	Quasi Pk FS	Limit@3m	Margin	RA	Cable	AG	DCF	AF	Azimuth	Height
MHz	dB(uV/m)	dB(uV/m)	dB	dB(uV)	dB	dB	dB	dB(1/m)	deg	cm
119.63	36.7	43.5	-6.8	45.4	1.2	32.0	10.5	11.6	41.0	129.0
124.89	29.9	43.5	-13.6	38.5	1.2	32.0	10.5	11.8	360.0	100.0

Test Mode: Rx mode

Result: **Complies by 6.8 dB**

4.6.4 Test Configuration Photographs

The following photographs show the testing configurations used.



4.7 AC Line Conducted Emission FCC: 15.207, 15.107; RSS-GEN;

4.7.1 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.*

4.7.2 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.

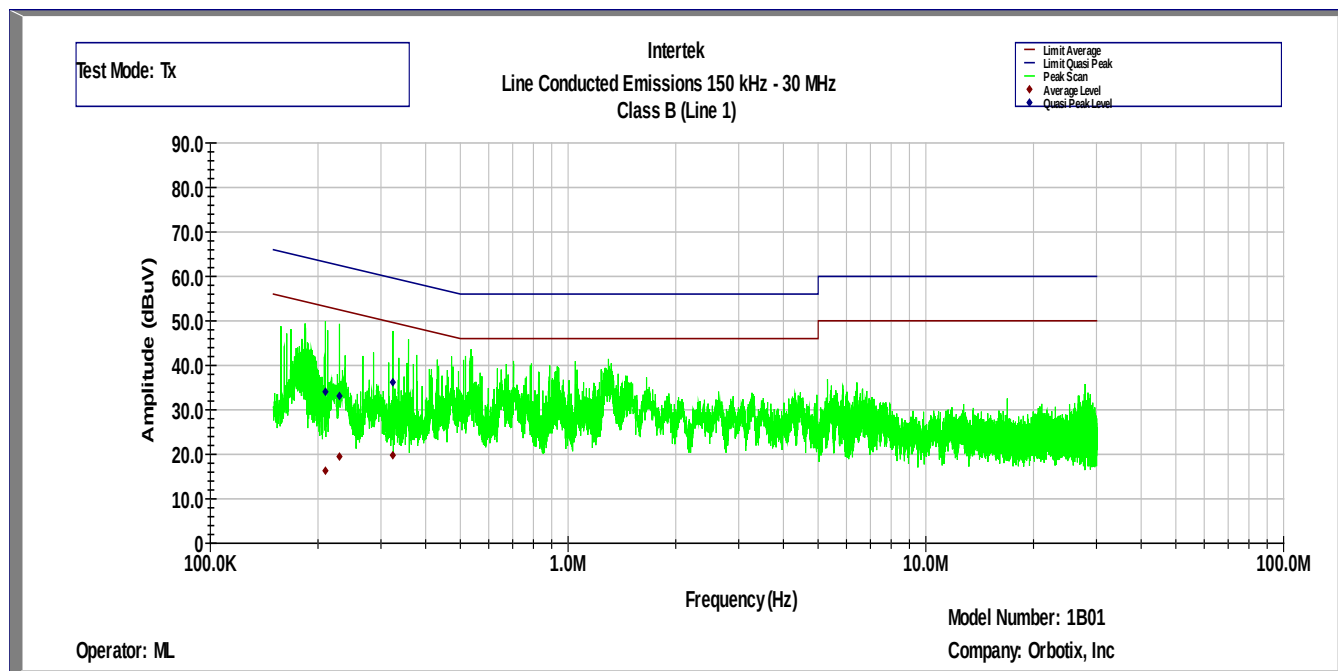
The EUT, where intended for tabletop use, is placed on a table whose top is 0.8m above the ground plane. A vertical, metal reference plane is placed 0.4m from the EUT. The vertical metal reference-plane is at least 2m by 2m. The EUT shall be kept at least 0.8m from any other metal surface or other ground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

4.7.3 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)

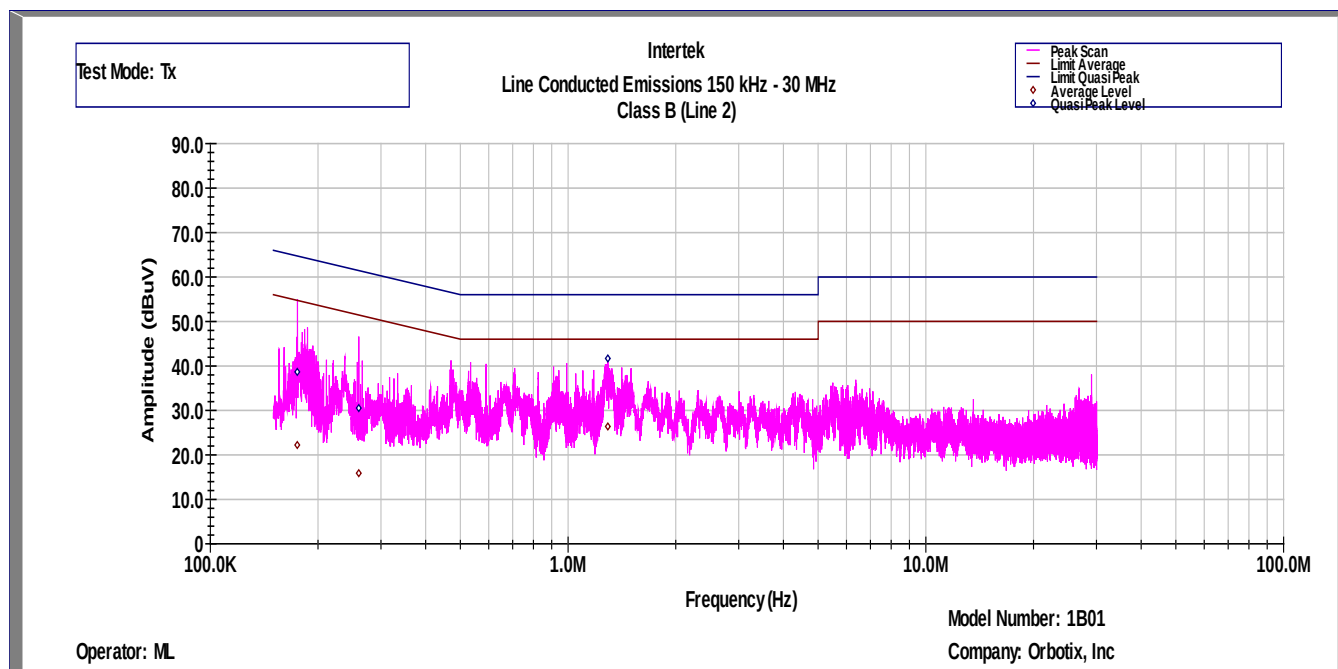
Operator: ML
July 24, 2014

Model Number: 1B01
Company: Orbotix, Inc. dba Sphero

Frequency	Av Level	QP Level	Av Limit	QP Limit	Av Margin	QP Margin
Hz	dBuV	dBuV	dBuV	dBuV	dB	dB
209800	16.3	34.0	54.3	64.3	-38.0	-30.2
229650	19.5	33.1	53.7	63.7	-34.2	-30.6
323800	19.8	36.2	51.0	61.0	-31.3	-24.9

Test Mode: Transmitter On, 120V 60Hz
Temp.: 21C
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: 1B01
Company: Orbotix, Inc. dba Sphero

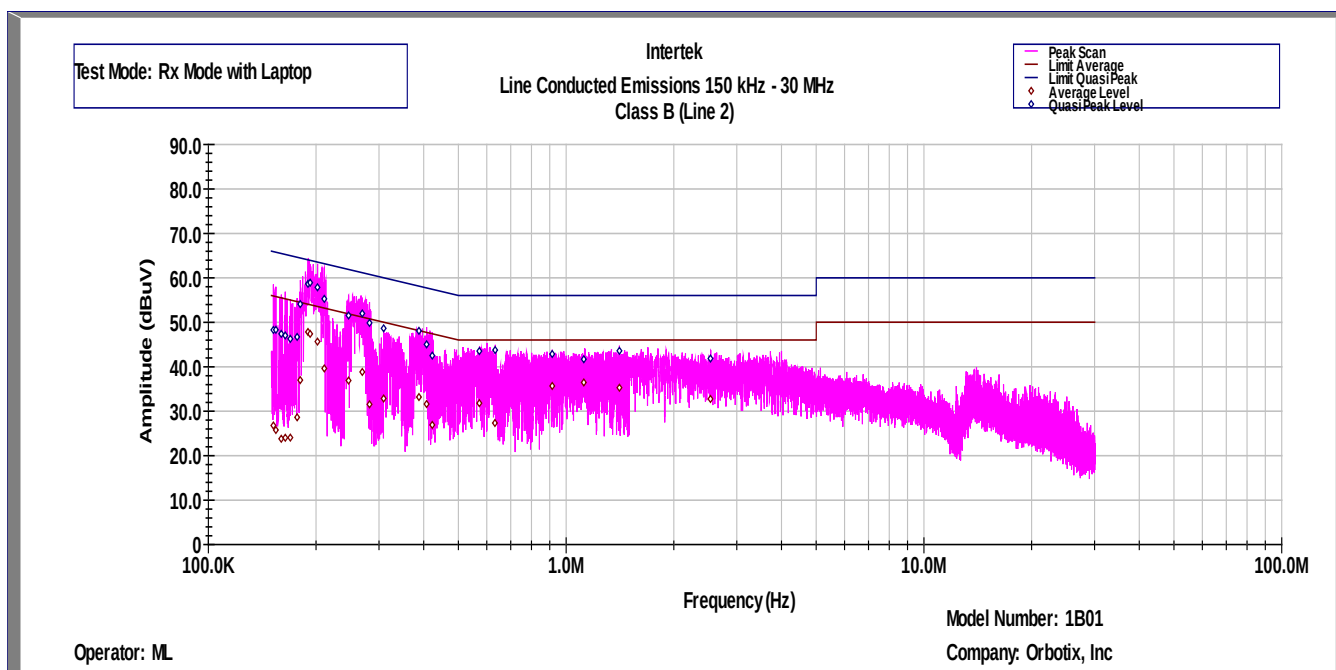
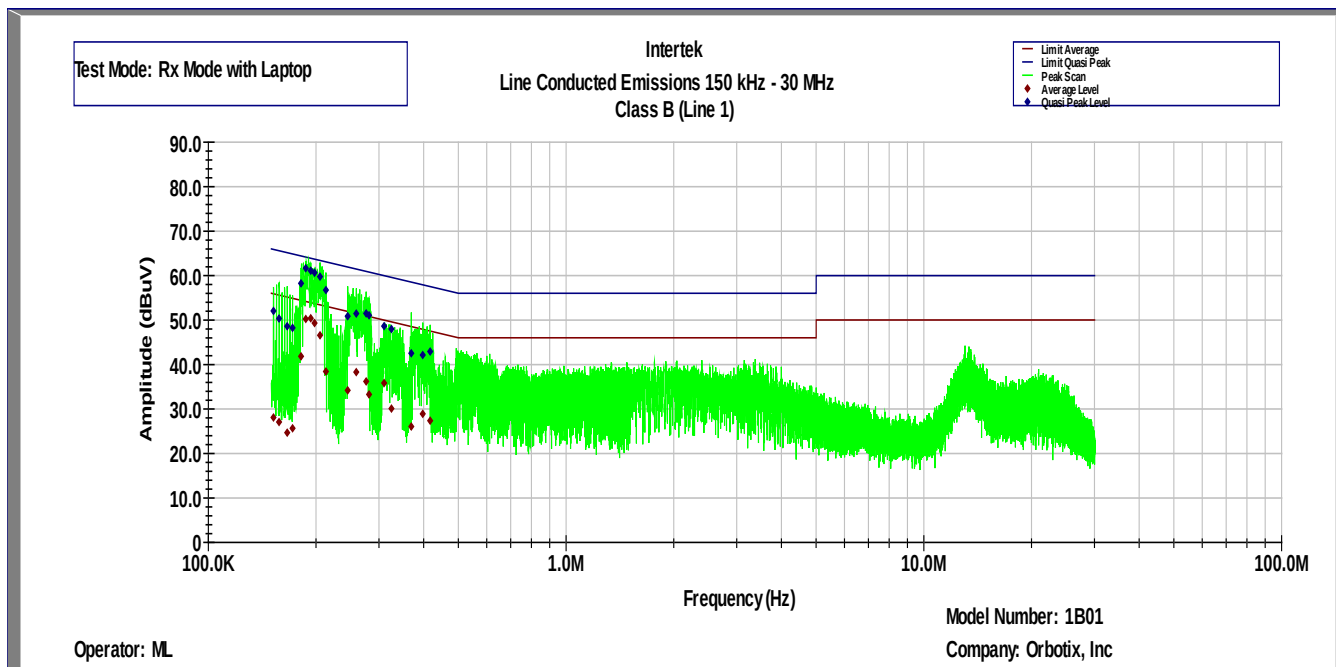
Frequency Hz	Av Level dBuV	QP Level dBuV	Av Limit dBuV	QP Limit dBuV	Av Margin dB	QP Margin dB
175000	22.2	38.7	55.3	65.3	-33.1	-26.6
260000	15.9	30.5	52.9	62.9	-37.0	-32.3
1.29E+06	26.4	41.7	46.0	56.0	-19.6	-14.3

Test Mode: Transmitter On, 120V 60Hz
Temp.: 21C
Humidity: 49.9%

Results **Complies by 3.7 dB**

AC Line Conducted Emission Data, Digital Parts Emissions

Test Mode: Charging with Laptop via USB Cable



AC Line Conducted Emission Data, Digital Parts Emissions
Test Mode: Charging with Laptop via USB Cable

Line Conducted Emissions 150 kHz - 30 MHz

FCC Class B (Line 1)

Operator: ML

July 24, 2014

Model Number: 1B01

Company: Orbotix, Inc. dba Sphero

Frequency	Av Level	QP Level	Av Limit	QP Limit	Av Margin	QP Margin
Hz	dBuV	dBuV	dBuV	dBuV	dB	dB
152160	28.1	52.0	55.9	65.9	-27.9	-13.9
157690	27.1	50.3	55.8	65.8	-28.7	-15.4
166200	24.7	48.6	55.5	65.5	-30.9	-17.0
172000	25.7	48.2	55.4	65.4	-29.7	-17.1
181600	41.8	58.2	55.1	65.1	-13.3	-6.9
187300	50.2	61.7	54.9	64.9	-4.7	-3.3
193300	50.4	61.1	54.8	64.8	-4.4	-3.7
198100	49.3	60.6	54.6	64.6	-5.3	-4.0
205200	46.6	59.7	54.4	64.4	-7.9	-4.7
213180	38.4	56.7	54.2	64.2	-15.8	-7.4
245170	34.2	50.9	53.3	63.3	-19.1	-12.4
259200	38.3	51.5	52.9	62.9	-14.6	-11.4
276220	36.2	51.5	52.4	62.4	-16.2	-10.9
281300	33.3	51.1	52.2	62.2	-19.0	-11.2
310000	35.8	48.6	51.4	61.4	-15.6	-12.8
325000	30.1	48	51	61	-20.9	-13
369240	26.1	42.5	49.7	59.7	-23.7	-17.2
397500	28.9	42.1	48.9	58.9	-20	-16.8
417030	27.3	42.9	48.4	58.4	-21	-15.4

Test Mode: Rx, 120V 60Hz

AC Line Conducted Emission Data, Digital Parts Emissions
Test Mode: Charging with Laptop via USB Cable

Line Conducted Emissions 150 kHz - 30 MHz

FCC Class B (Line 2)

Operator: ML

July 24, 2014

Model Number: 1B01

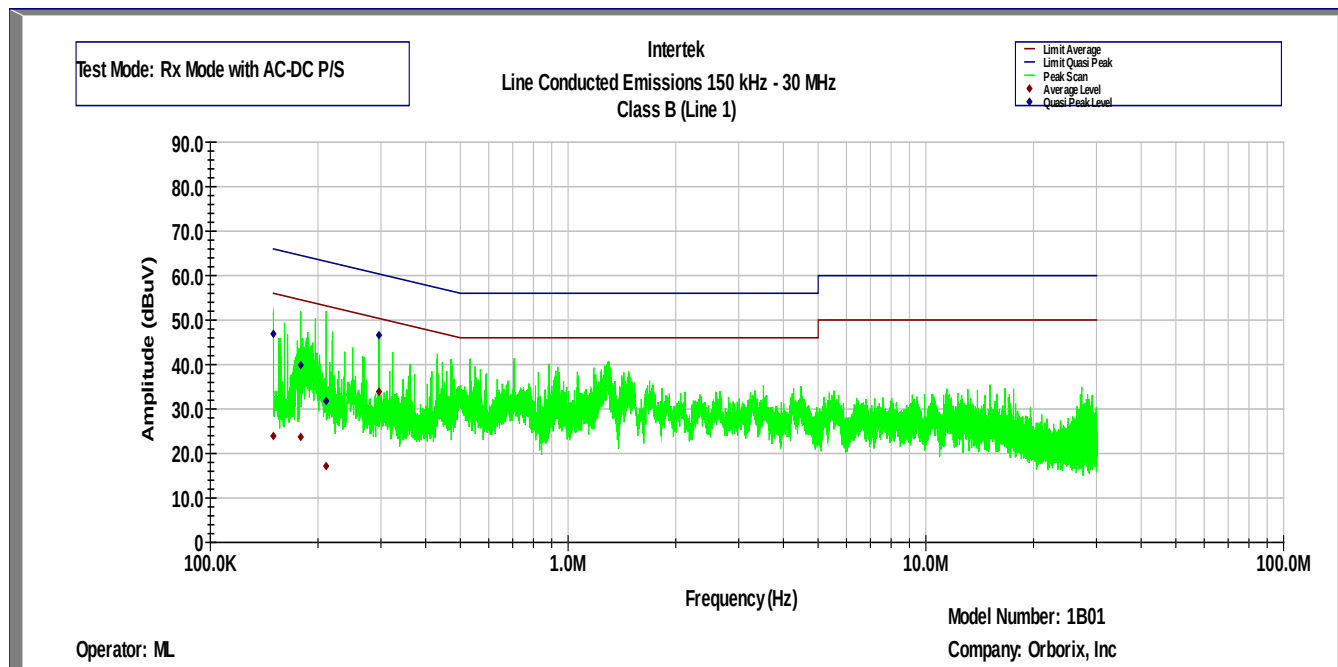
Company: Orbotix, Inc. dba
Sphero

Frequency	Av Level	QP Level	Av Limit	QP Limit	Av Margin	QP Margin
Hz	dBuV	dBuV	dBuV	dBuV	dB	dB
152000	26.8	48.3	55.9	65.9	-29.2	-17.7
154450	25.7	48.3	55.9	65.9	-30.1	-17.6
159900	23.8	47.4	55.7	65.7	-31.9	-18.3
164040	24.0	47.0	55.6	65.6	-31.6	-18.6
169500	24.0	46.3	55.4	65.4	-31.4	-19.2
177100	28.6	46.7	55.2	65.2	-26.6	-18.5
180700	37.0	54.1	55.1	65.1	-18.1	-11.0
189900	47.8	58.6	54.9	64.9	-7.1	-6.2
192600	47.4	58.9	54.8	64.8	-7.4	-5.9
201900	45.7	57.9	54.5	64.5	-8.9	-6.7
210880	39.6	55.3	54.3	64.3	-14.6	-9.0
246520	36.9	51.5	53.2	63.2	-16.4	-11.7
269340	38.8	52.0	52.6	62.6	-13.8	-10.6
282160	31.5	49.9	52.2	62.2	-20.7	-12.4
309000	32.8	48.6	51.5	61.5	-18.6	-12.8
387700	33.2	48.1	49.2	59.2	-16.0	-11.1
407440	31.6	45.0	48.6	58.6	-17.0	-13.6
422430	26.9	42.5	48.2	58.2	-21.3	-15.7
572000	31.8	43.5	46.0	56.0	-14.2	-12.5
632100	27.3	43.7	46.0	56.0	-18.7	-12.3
914000	35.7	42.9	46.0	56.0	-10.3	-13.1
1.12E+06	36.5	41.7	46.0	56.0	-9.5	-14.3
1.41E+06	35.3	43.6	46.0	56.0	-10.7	-12.4
2.53E+06	32.7	41.8	46.0	56.0	-13.3	-14.2

Test Mode: Rx, 120V 60Hz

Results	Complies by 3.3 dB
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AC Line Conducted Emission Data, Digital Parts Emissions
Test Mode: Charging with AC-DC Power Supply via USB Cable



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

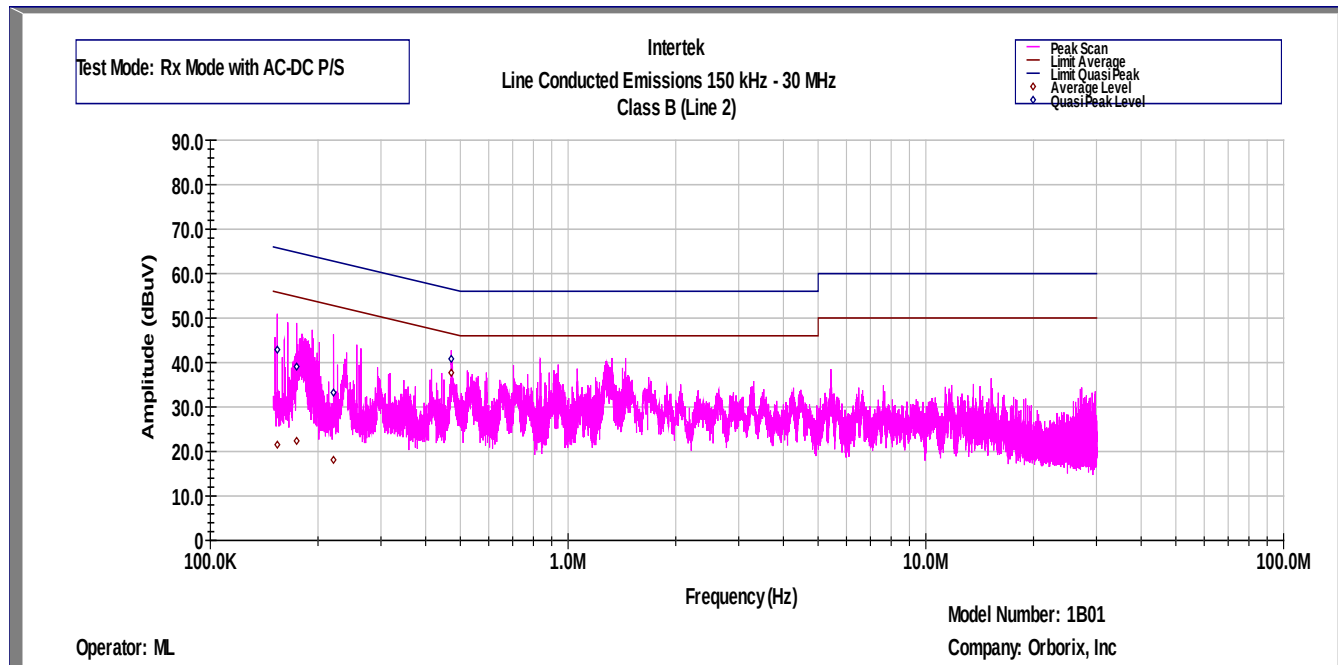
Operator: ML
July 24, 2014

Model Number: 1B01
Company: Orbotix, Inc. dba Sphero

Frequency	Av Level	QP Level	Av Limit	QP Limit	Av Margin	QP Margin
Hz	dBuV	dBuV	dBuV	dBuV	dB	dB
150130	23.9	46.9	56.0	66.0	-32.1	-19.1
179000	23.7	39.9	55.2	65.2	-31.5	-25.3
210750	17.1	31.8	54.3	64.3	-37.1	-32.5
296200	33.9	46.6	51.8	61.8	-17.9	-15.2

Test Mode: Rx, 120V 60Hz

AC Line Conducted Emission Data, Digital Parts Emissions
Test Mode: Charging with AC-DC Power Supply via USB Cable



Intertek Testing Services
Line Conducted Emissions 150 kHz - 30 MHz
FCC Class B (Line 2)
Operator: ML
July 24, 2014

Model Number: 1B01
Company: Orbotix, Inc. dba Sphero

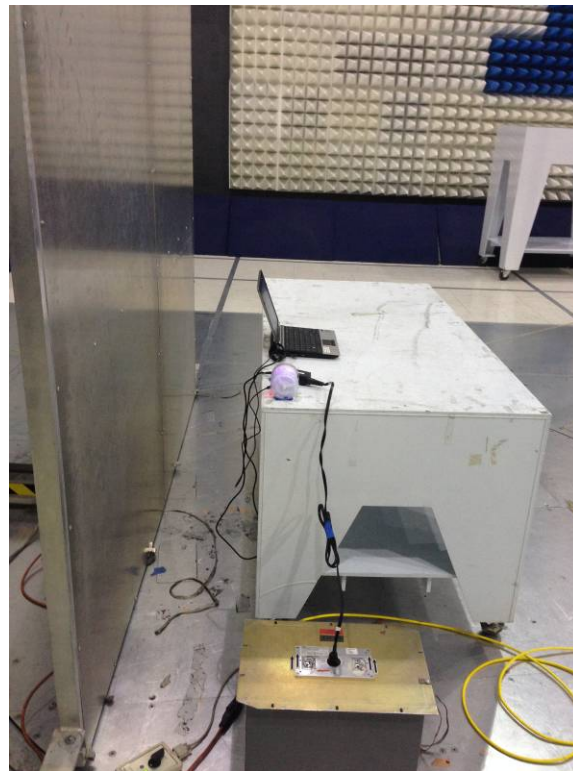
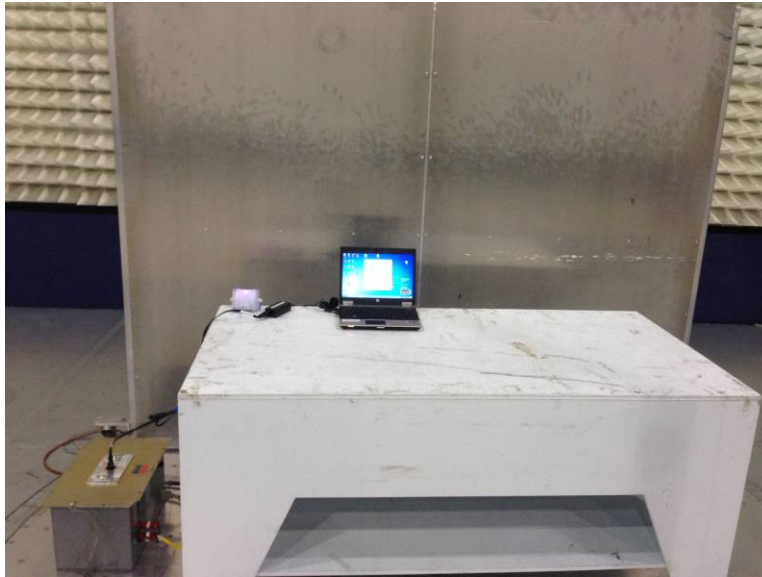
Frequency Hz	Av Level dBuV	QP Level dBuV	Av Limit dBuV	QP Limit dBuV	Av Margin dB	QP Margin dB
153900	21.5	42.9	55.9	65.9	-34.4	-23.0
174300	22.4	39.1	55.3	65.3	-32.9	-26.2
221000	18.1	33.2	54.0	64.0	-35.9	-30.7
471500	37.7	40.8	46.8	56.8	-9.10	-16.0

Test Mode: Rx, 120V 60Hz

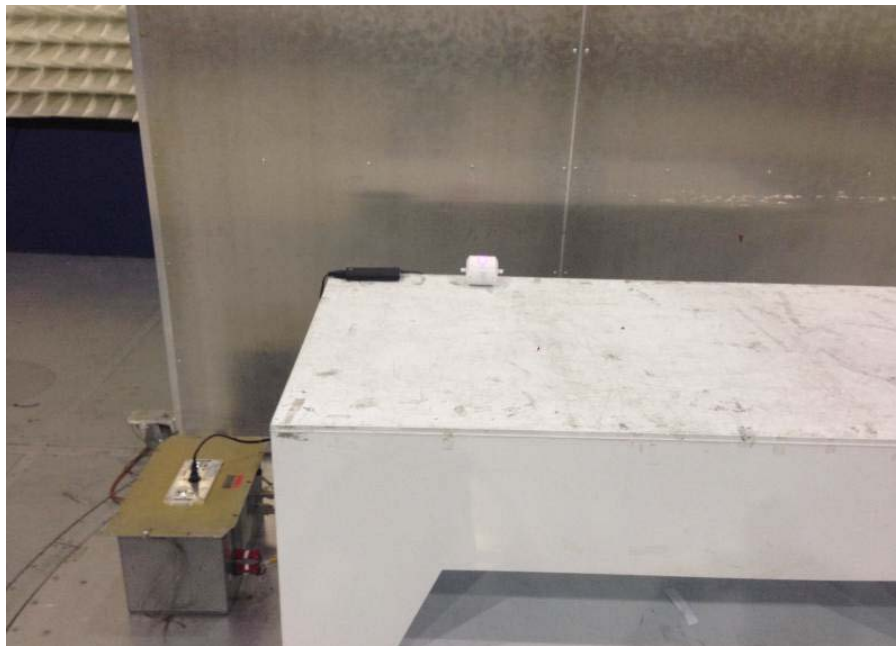
Results ☒ **Complies** by 5.1 dB

4.7.4 Test Configuration Photographs

The following photographs show the testing configurations used.



4.7.4 Test Configuration Photographs (Continued)



5.0 RF Exposure Evaluation

MPE Evaluation

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 +10.70 dBm or 11.75 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, $S = 0.0234 \text{ W/m}^2$, which is below the MPE Limit of 10 W/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	12/11/14
Spectrum Analyzer	Rohde and Schwarz	ESU	ITS 00961	12	11/04/14
BI-Log Antenna	ARA	LPB-2513/A	ITS00355	12	08/01/14
Pyramidal Horn Antenna	EMCO	3160-09	ITS00571	#	#
Pre-Amplifier	Sonoma Instrument	310N	ITS 00415	12	12/20/14
Pre-Amplifier (1-18GHz)	Miteq	AMF-4D-001180-24-10P	ITS 00526	12	09/27/14
Pre-Amplifier (18-40GHz)	Miteq	JSD44-18004000-305P	ITS 00921	12	05/13/15
Horn Antenna	ETS Lindgren	3115	ITS 00982	12	11/14/14
LISN	FCC	FCC-LISN-50-50-M-H	00551	12	05/05/15

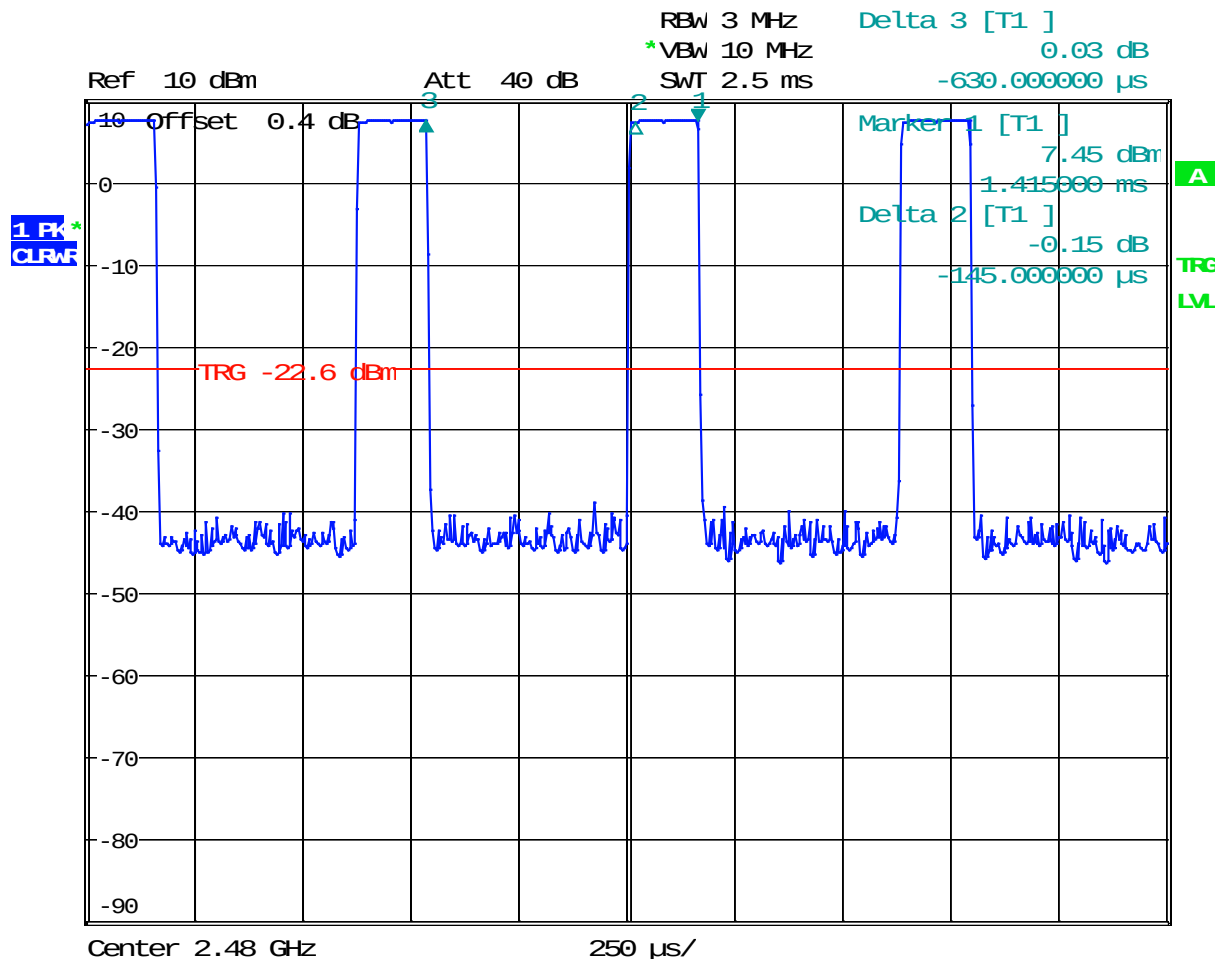
No Calibration required



7.0 Document History

Revision/ Job Number	Writer Initials	Reviewers Initials	Date	Change
1.0 / G101691132	ML	KK	August 07, 2014	Original document

Annex A - Duty Cycle Measurement



Date: 18.JUL.2014 18:08:33

Duty Cycle: DC = 145.0 / 630.0 = 0.23 or 23.0%

Duty Cycle Correction Factor $\delta(\text{dB}) = 20 \log (145.0 / 630.0) = -12.75\text{dB}$