TEST REPORT

Report Number: 102733709MPK-006
Project Number: G102733709
October 27, 2016

Testing performed on
CO Breath Sensor
Model: FP-20021
FCC ID: 2AJZM-FP20021
to

FCC Part 15 Subpart C (15.247)
Industry Canada RSS-247 Issue 1
FCC Part 15, Subpart B
Industry Canada ICES-003

For

Carrot Sense, Inc.

Test Performed by:	Test Authorized by:
Intertek	Carrot Sense, Inc.
1365 Adams Court	1600 Seaport Blvd, Suite 150
Menlo Park, CA 94025 USA	Redwood City, CA 94063 USA

Prepared by: _____ **Date:** October 27, 2016
Aaron Chang

Reviewed by: _____ **Date:** October 27, 2016
Krishna K Vemuri

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Report No. 102733709MPK-006

Equipment Under Test:	CO Breath Sensor
Trade Name:	CO Breath Sensor
Model Number:	FP-20021
Serial Number:	#19
Applicant:	Carrot Sense, Inc.
Contact:	Allen Jameson
Address:	Carrot Sense, Inc. 1600 Seaport Blvd, Suite 150 Redwood City, CA 94063
Country	USA
Telephone:	(650) 308-8735
Email:	allen@carrotsense.com
Applicable Regulation:	FCC Part 15 Subpart C (15.247) Industry Canada RSS-247 Issue 1 FCC Part 15, Subpart B Industry Canada ICES-003
Date of Test:	October 10 – October 25, 2016

We attest to the accuracy of this report:

Aaron Chang
Project Engineer

Krishna K Vemuri
Engineering Team Lead

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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-247, 5.4.4	Complies
6 dB Bandwidth	15.247(a)(2)	RSS-247, 5.2.1	Complies
Power Density	15.247(e)	RSS-247, 5.2.2	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 & Unique connector)
RF Exposure	15.247(i), 2.1093(d)	RSS-102	Complies

EUT receive date: October 10, 2016
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: October 10, 2016
Test completion date: October 25, 2016
The test results in this report pertain only to the item tested.

2.0 General Information

2.1 Product Description

Carrot Sense, Inc. supplied the following description of the EUT:

As described by the manufacturer, the CO Breath Sensor System is a hand-held carbon monoxide breath sensor.

This test report covers only the Bluetooth radio.

Information about the Bluetooth radio is presented below:

Applicant	Carrot Sense, Inc.
Model No.	FP-20021
FCC Identifier	2AJZM-FP20021
Type of transmission	Digital Transmission System (DTS)
Rated RF Output	-2.59 dBm (0.551 mW)
Antenna(s) & Gain	Internal Antenna, 1.7 dBi peak gain
EIRP	-2.59 dBm + 1.7 dBi = -0.89 dBm (0.815 mW)
Frequency Range	2402 – 2480 MHz
Type of modulation/data rate	GFSK / 1Mbps
Number of Channel(s)	40
Applicant Name & Address	Carrot Sense, Inc. 1600 Seaport Blvd, Suite 150 Redwood City, CA 94063 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 D01 DTS Meas Guidance v03r05 April 8, 2016), and RSS-247, RSS-GEN.

Radiated emissions and AC mains conducted emissions measurements were performed according to the procedures in ANSI C63.10-2013 & ANSI C63.4-2014. 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	-

Measurement	Expanded Uncertainty (k=2)		
	0.15 MHz – 30MHz	30 MHz – 1 GHz	1 GHz – 18 GHz
Radiated emissions	-	4.5	5.9 dB
AC mains conducted emissions	2.1 dB	-	-

3.0 System Test Configuration

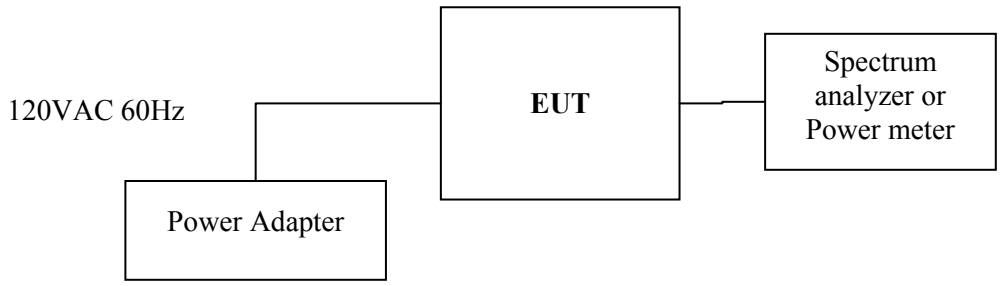
3.1 Support Equipment

No support equipment was used for testing.

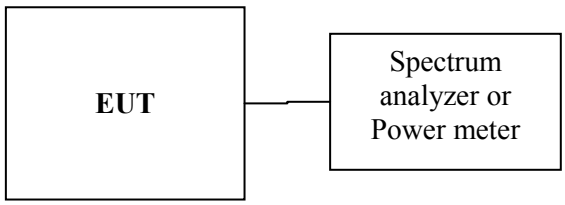
3.2 Block Diagram of Test Setup

AC Mode:

Antenna was removed and co-axial connector with a cable was installed for Conducted Measurements.
50Ohm load was used for Radiated Measurements.



Battery Mode:



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 Carrot Sense, 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 A8.2 and RSS-GEN;

4.1.1 Requirement

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

4.1.2 Procedure

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

For FCC 6dB Channel Bandwidth the Procedure described in the FCC Publication 558074 D01 DTS Meas Guidance v03r05 April 8, 2016 was used to determine the DTS occupied bandwidth. Section 8.1 Option 1 was used.

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

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

4.1.3 Test Result

AC Mode:

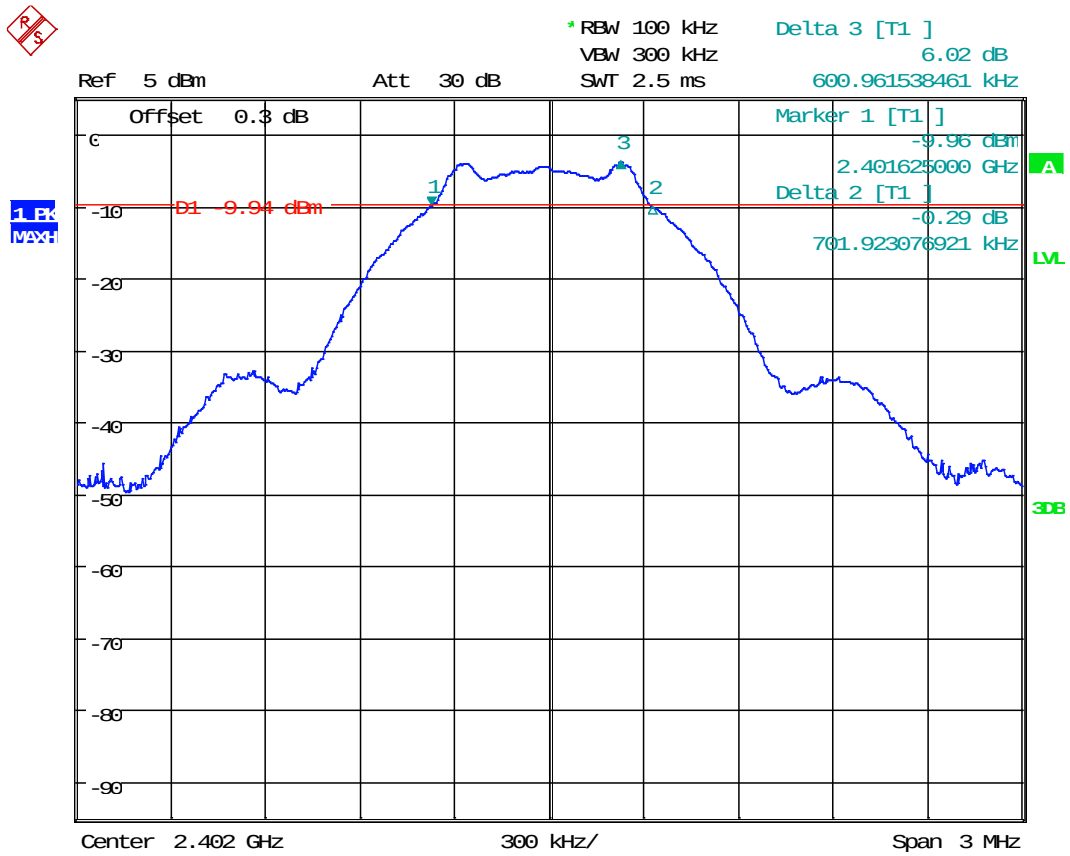
Frequency (MHz)	6-dB bandwidth FCC 15.247 & RSS-GEN, MHz	Occupied bandwidth, RSS-GEN, MHz	Plot
2402	0.701	--	1.1
	--	1.048	1.4
2440	0.711	--	1.2
	--	1.048	1.5
2480	0.721	--	1.3
	--	1.057	1.6

Battery Mode:

Frequency (MHz)	6-dB bandwidth FCC 15.247 & RSS-GEN, MHz	Occupied bandwidth, RSS-GEN, MHz	Plot
2402	0.711	--	1.7
	--	1.043	1.10
2440	0.721	--	1.8
	--	1.063	1.11
2480	0.730	--	1.9
	--	1.063	1.12

Date of Test:	October 11 - 12, 2016
Results	**Complies**

Plot 1. 1



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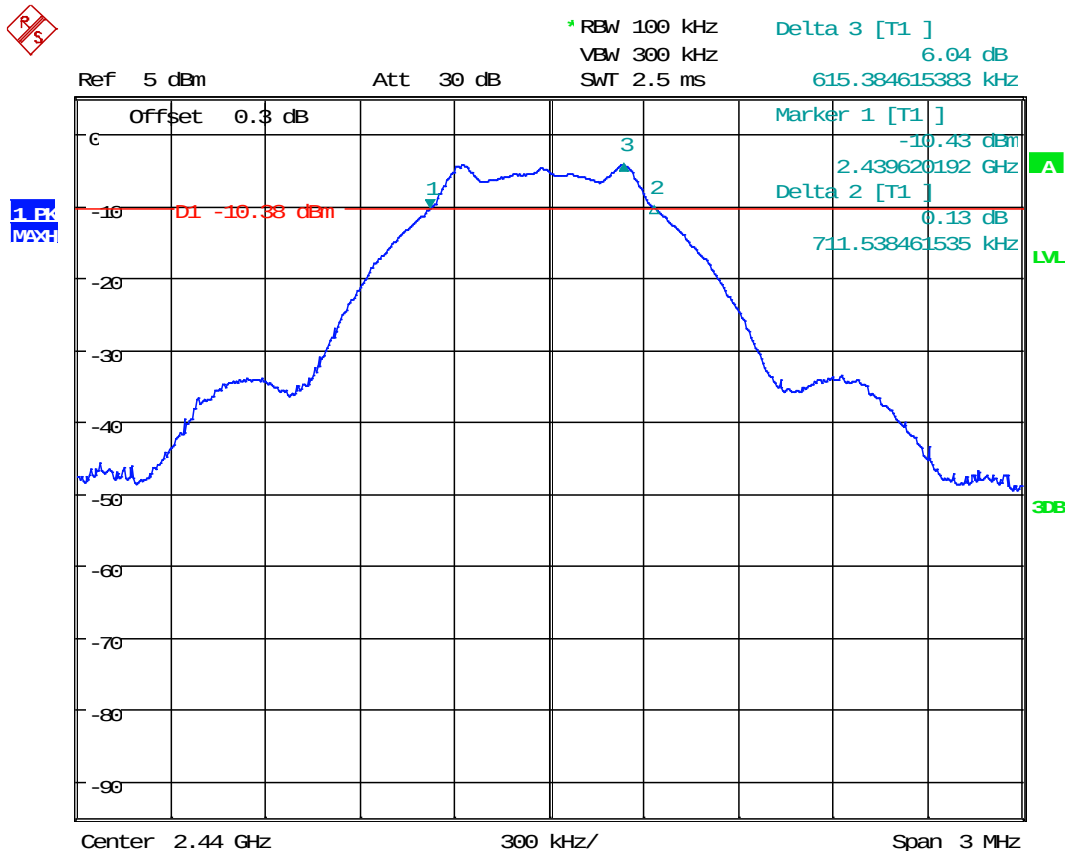
Plot 1. 2



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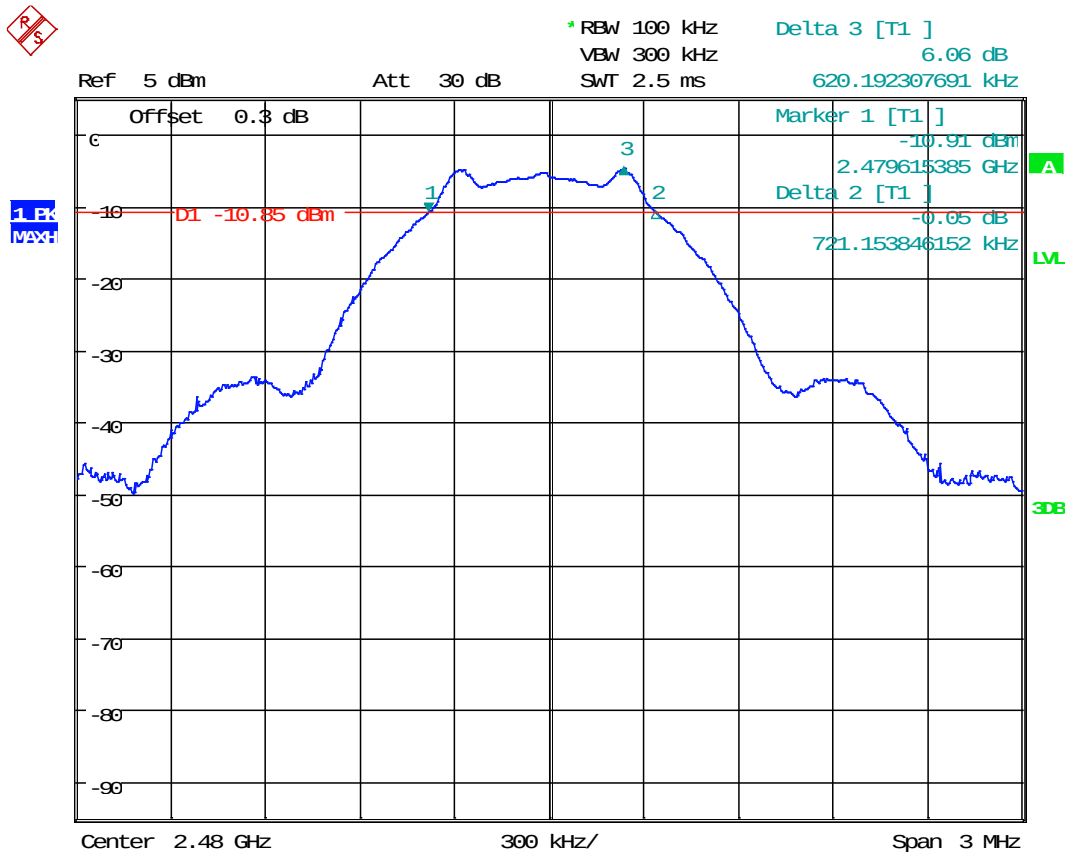

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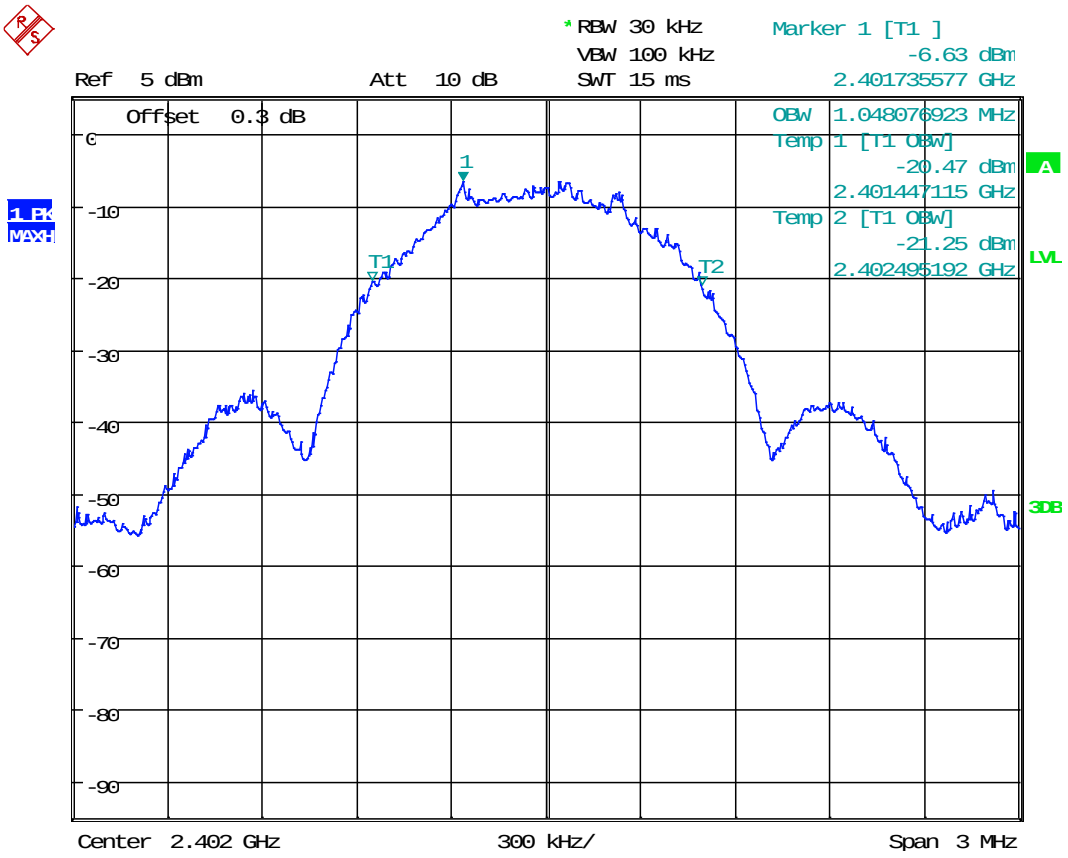

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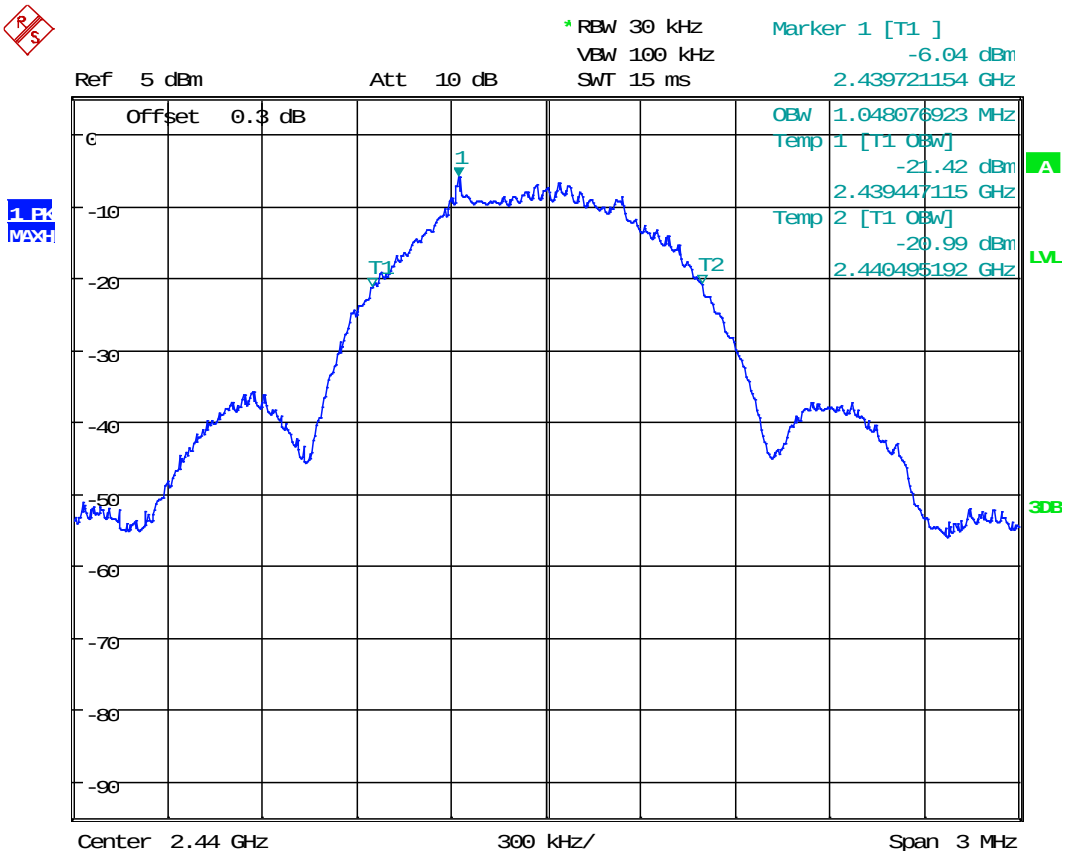

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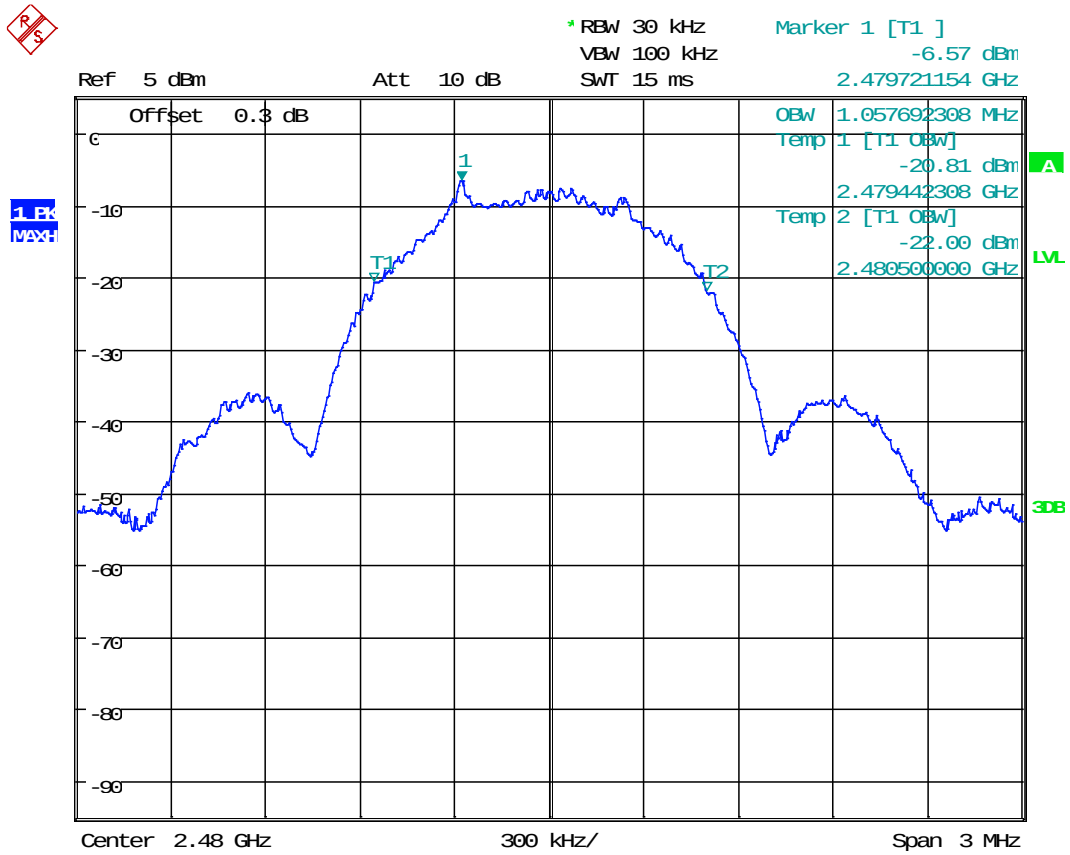
Plot 1.6



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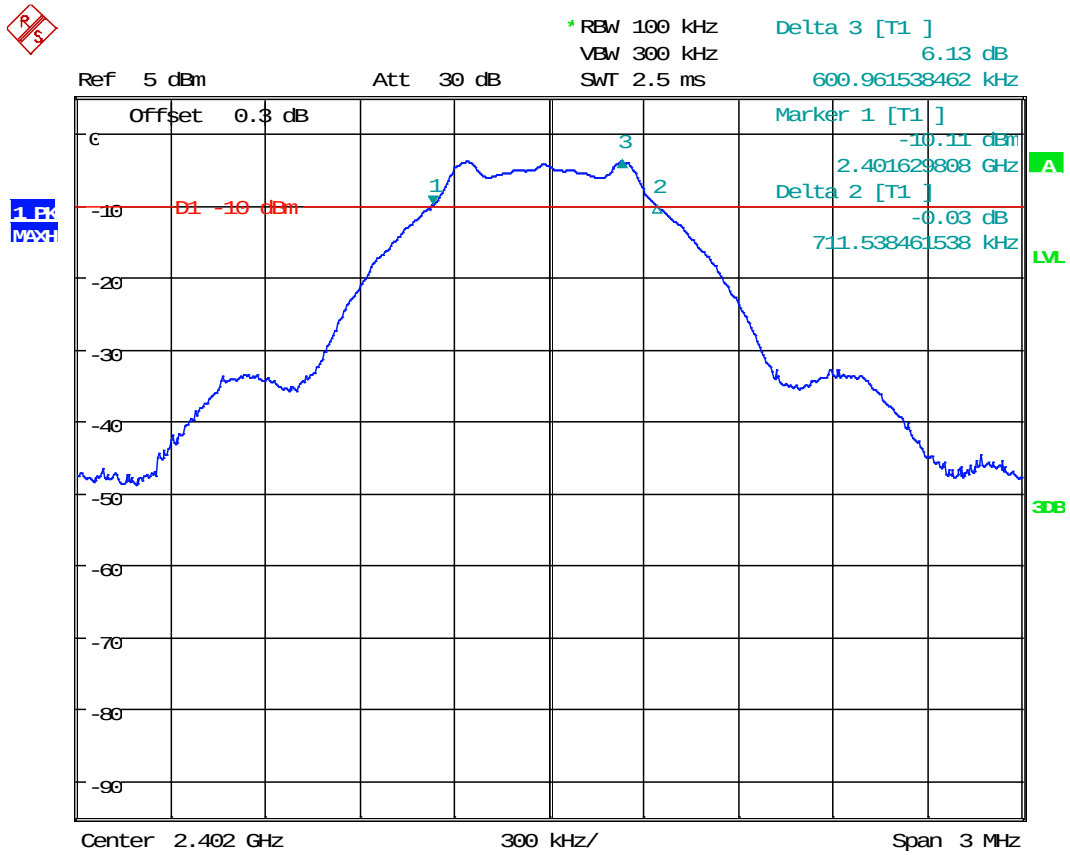
Plot 1. 7



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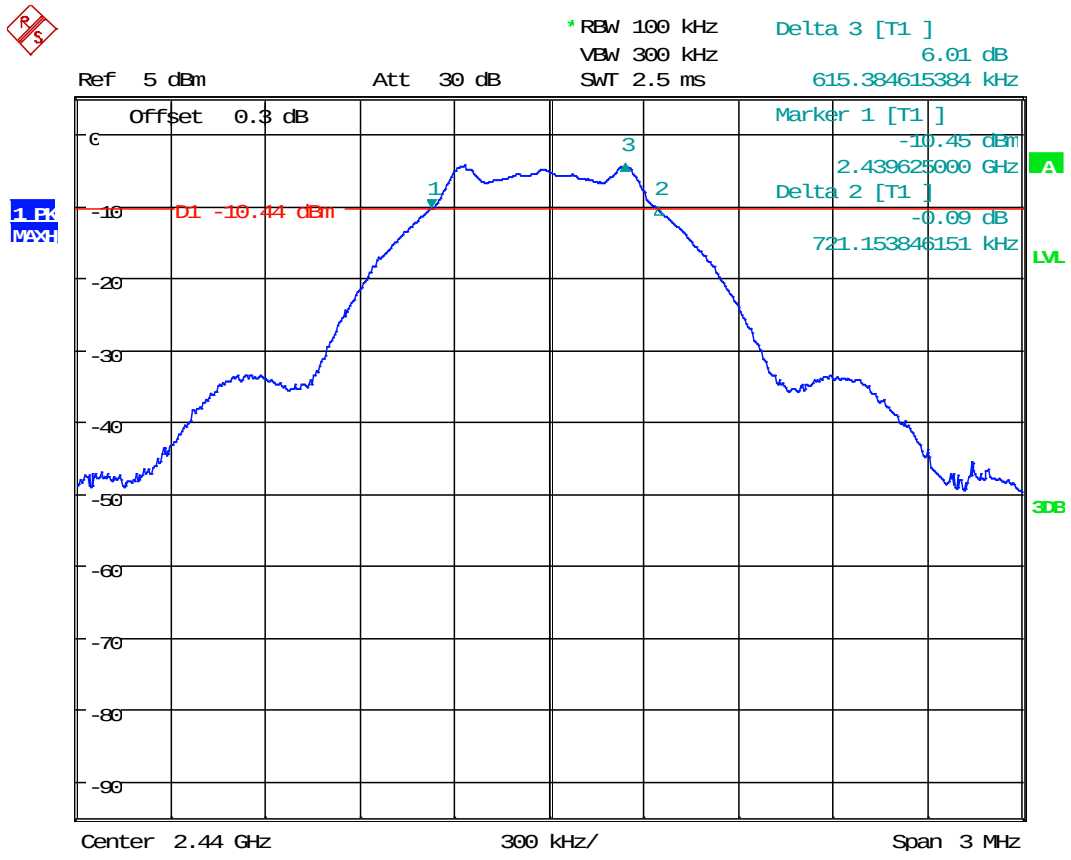
Plot 1. 8



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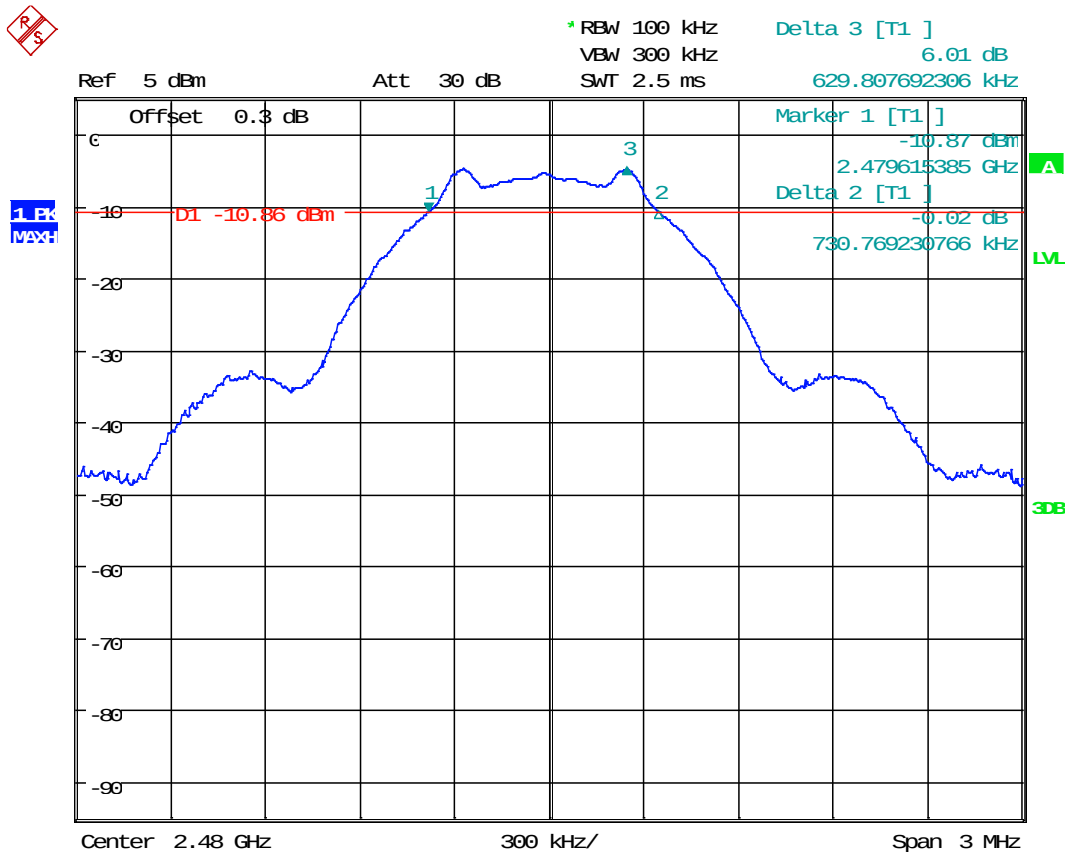
Plot 1. 9



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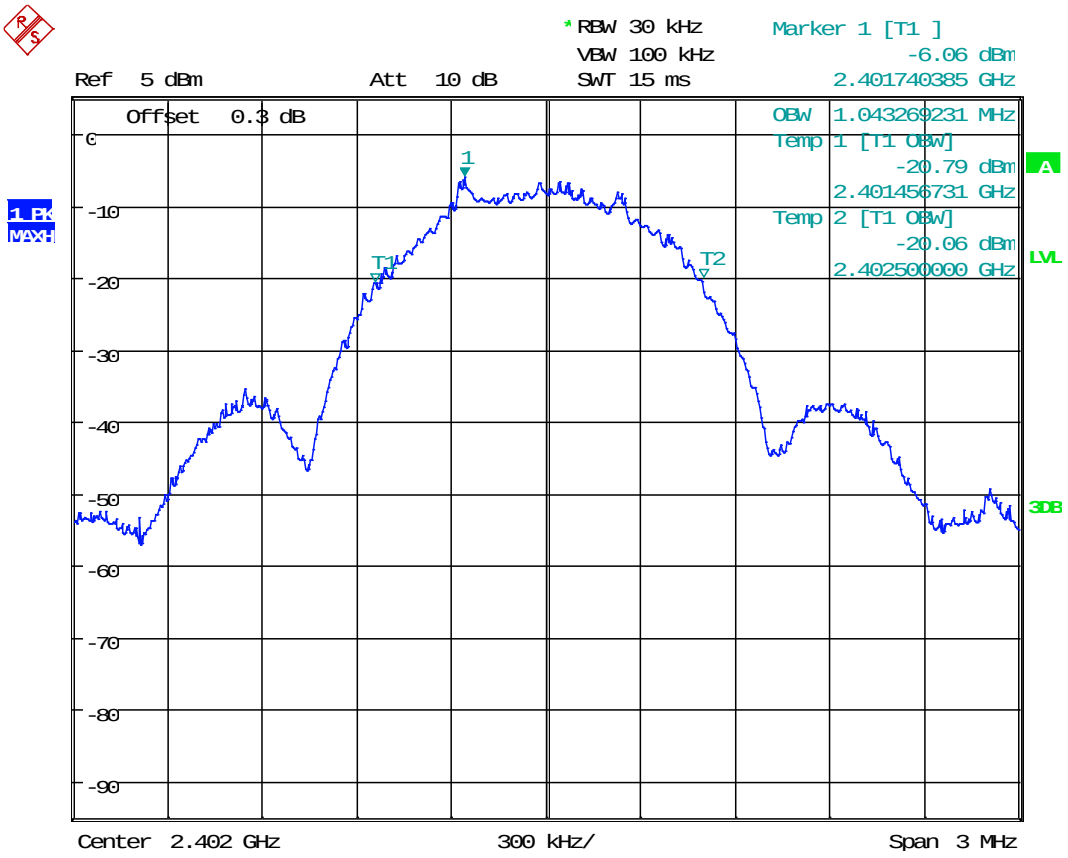
Plot 1. 10



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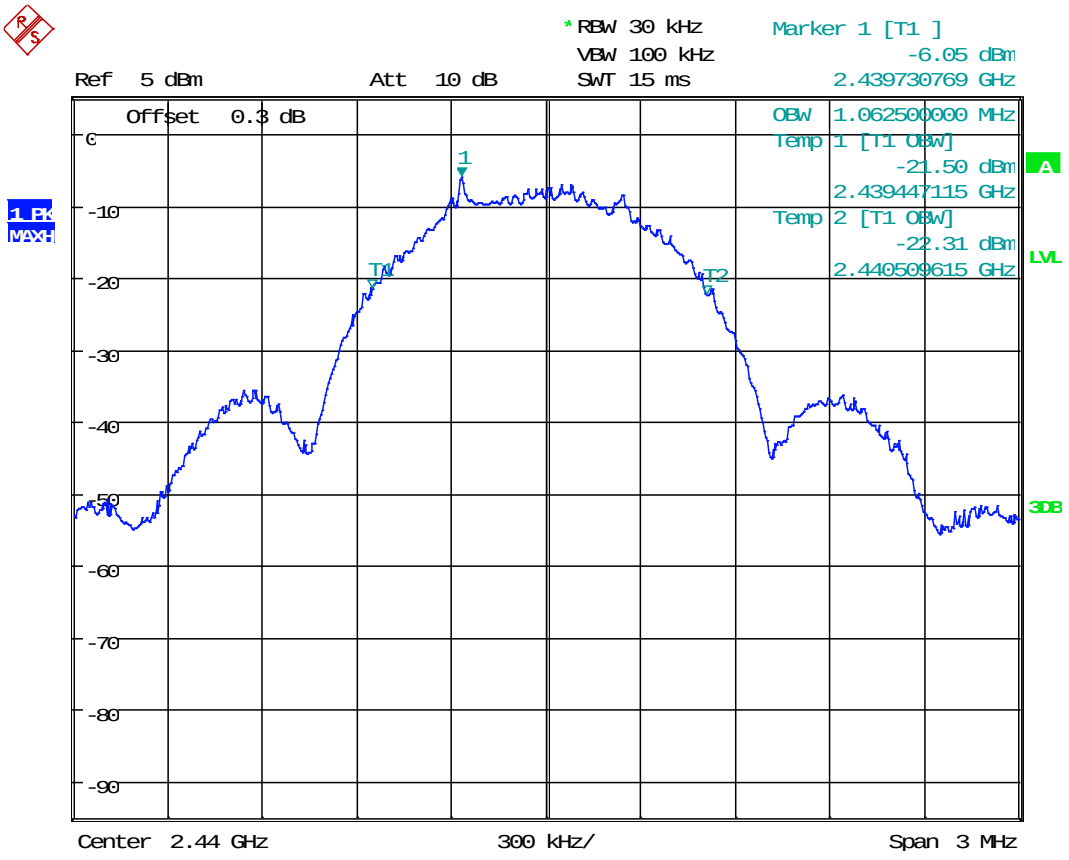
Plot 1.11



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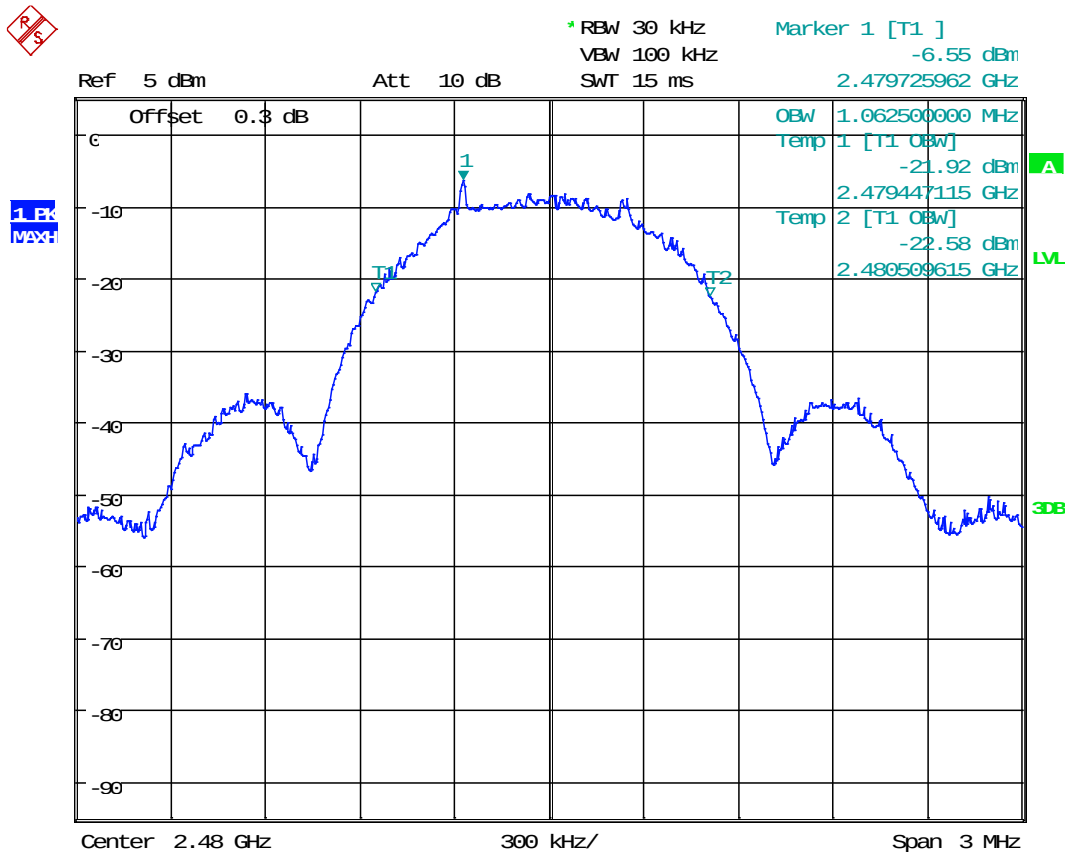
Plot 1.12



Date: 11.OCT.2016 14:03:12

4.2 Maximum Peak Conducted Output Power at Antenna Terminals
FCC Rule: 15.247(b)(3); RSS-247 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 procedure described in FCC Publication 558074 D01 DTS Meas Guidance v03r05 April 8, 2016 was used. Specifically, section 9.1.1 RBW ≥ DTS Bandwidth was utilized as the spectrum analyzer's resolution bandwidth was greater than the DTS bandwidth.

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

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

4.3.3 Test Result

Refer to the following plots 2.1 – 2.6 for the test details.

AC Power:

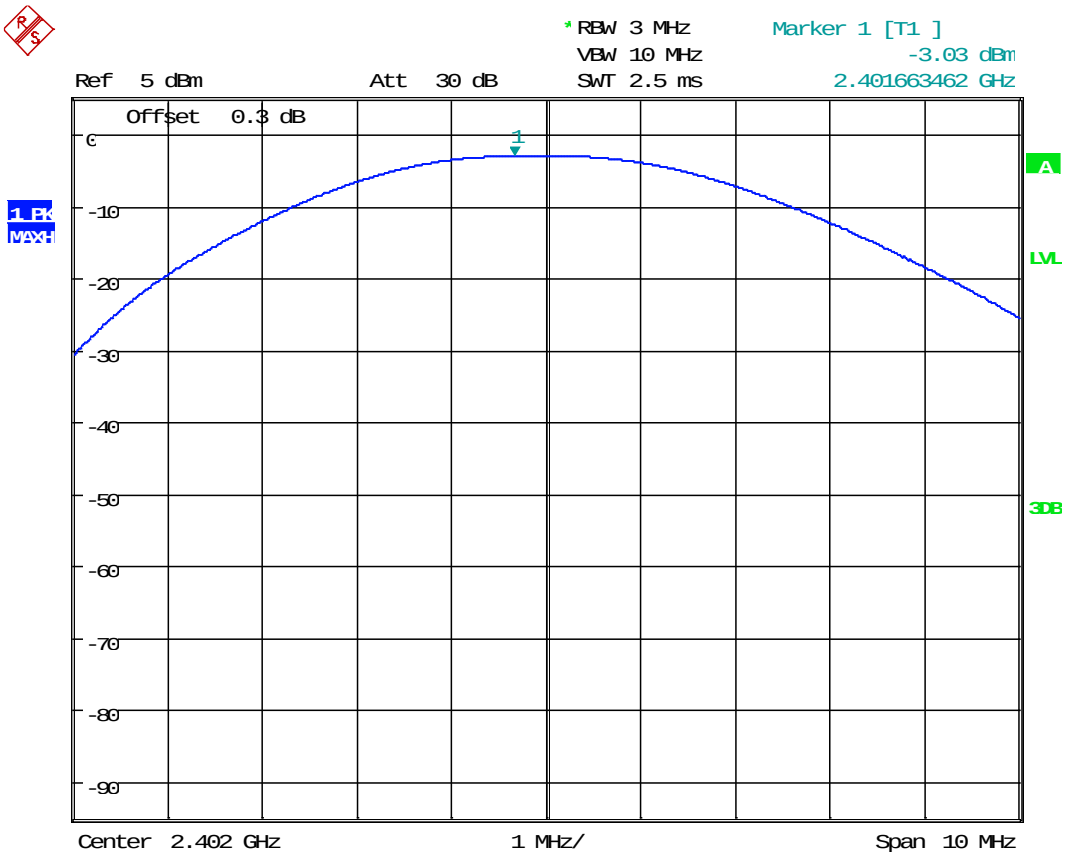
Frequency, MHz	Conducted Power (peak), dBm	Conducted Power (peak), mW	Plot
2402	-3.03	0.498	2.1
2440	-3.34	0.463	2.2
2480	-3.76	0.421	2.3

Battery Power:

Frequency, MHz	Conducted Power (peak), dBm	Conducted Power (peak), mW	Plot
2402	-2.59	0.551	2.4
2440	-3.24	0.474	2.5
2480	-3.69	0.428	2.6

Date of Test:	October 17, 2016
Results	**Complies**

Plot 2.1



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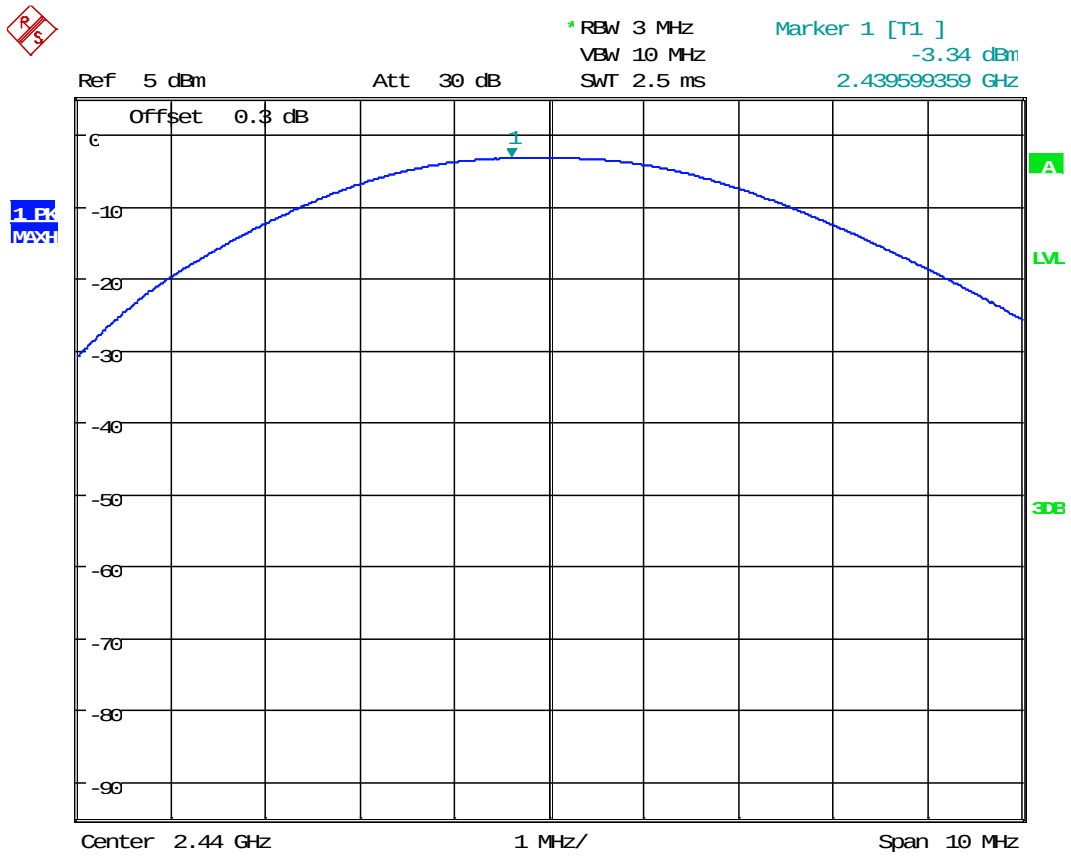
Plot 2.2



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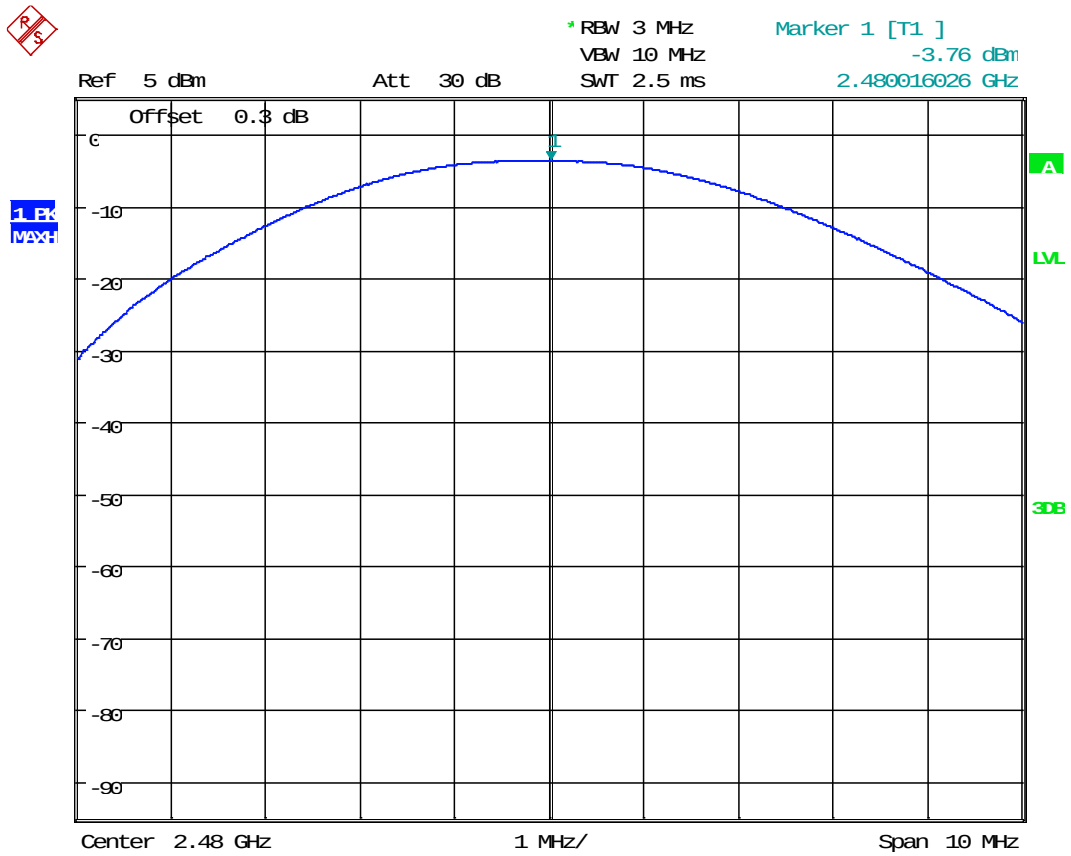
Plot 2.3



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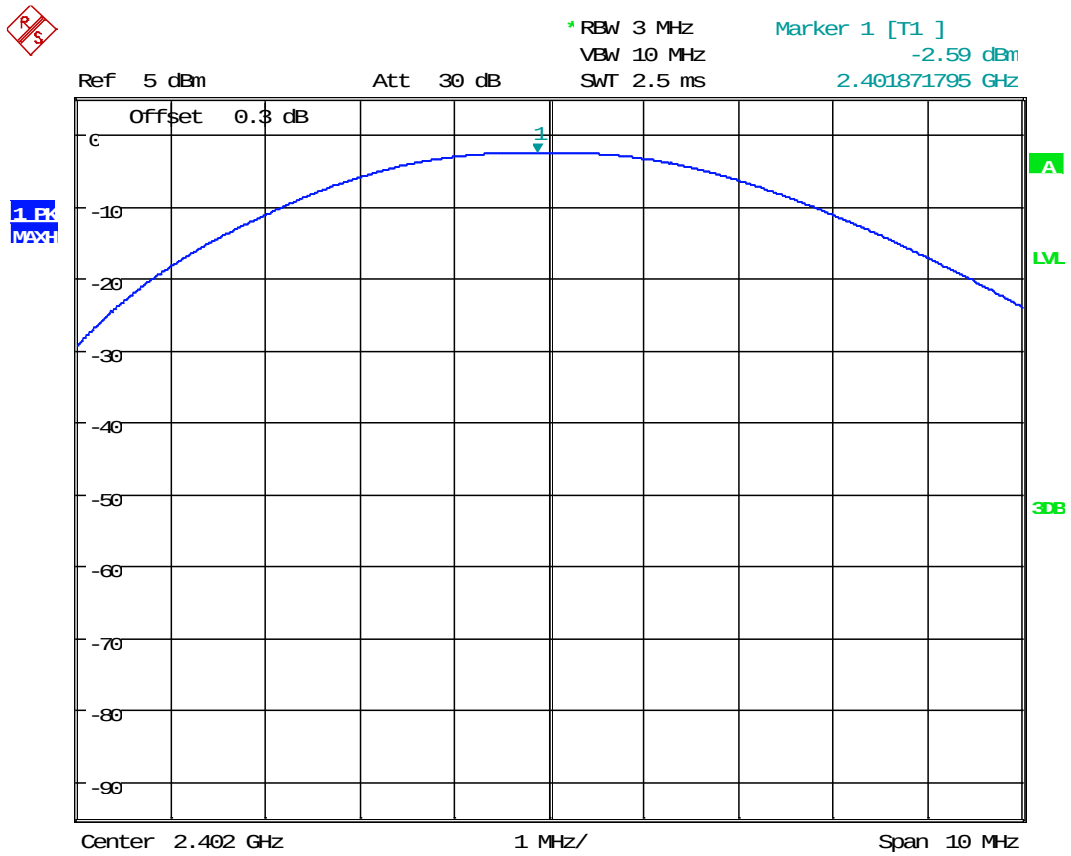
Plot 2.4



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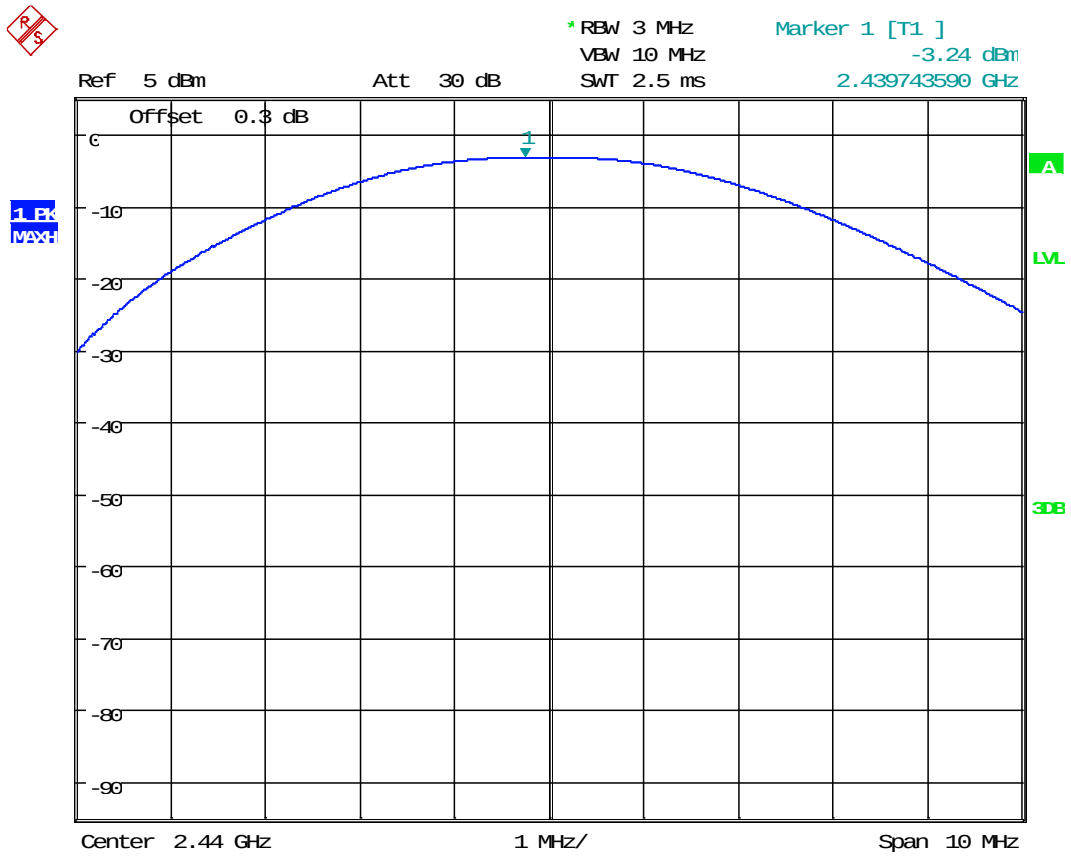
Plot 2.5



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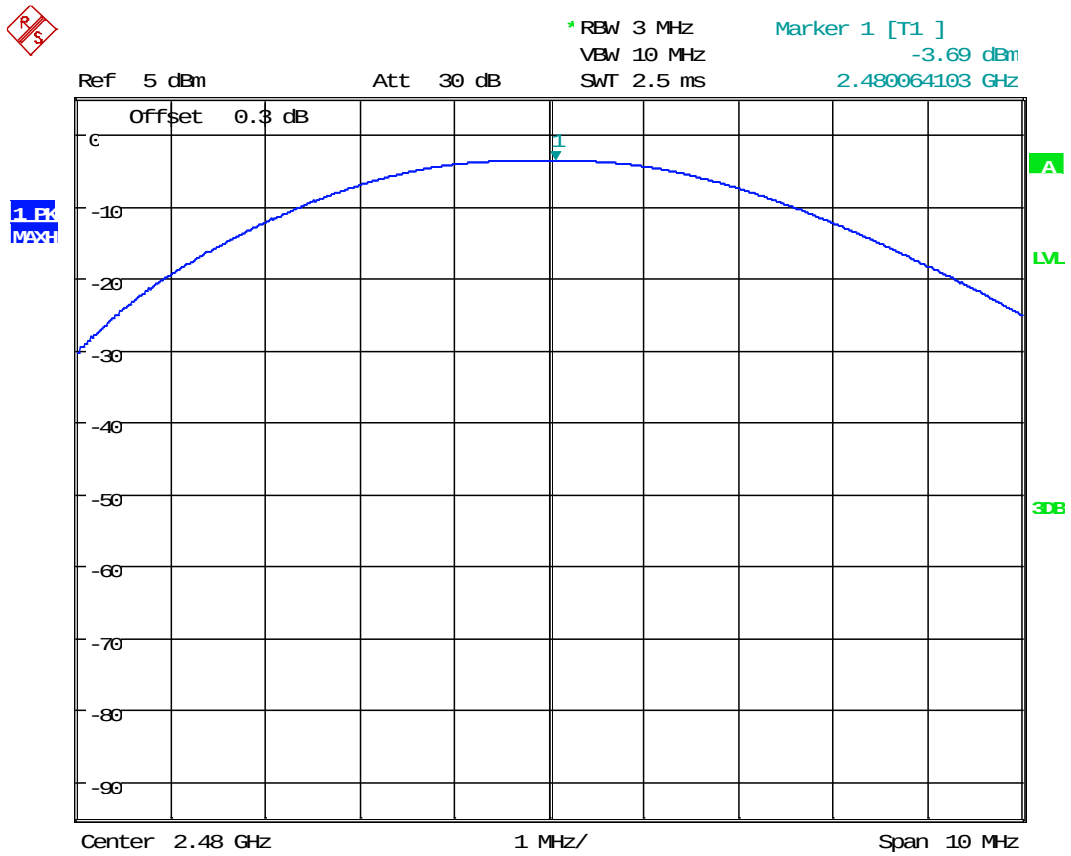
Plot 2.6



Date: 17.OCT.2016 15:46:23

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

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

The procedure described in FCC Publication 558074 D01 DTS Meas Guidance v03r05 April 8, 2016, specifically section 10.2 Method PKPSD (peak PSD).

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

4.3.3 Test Result

Refer to the following plots 3.1 – 3.6 for the test result

AC Power:

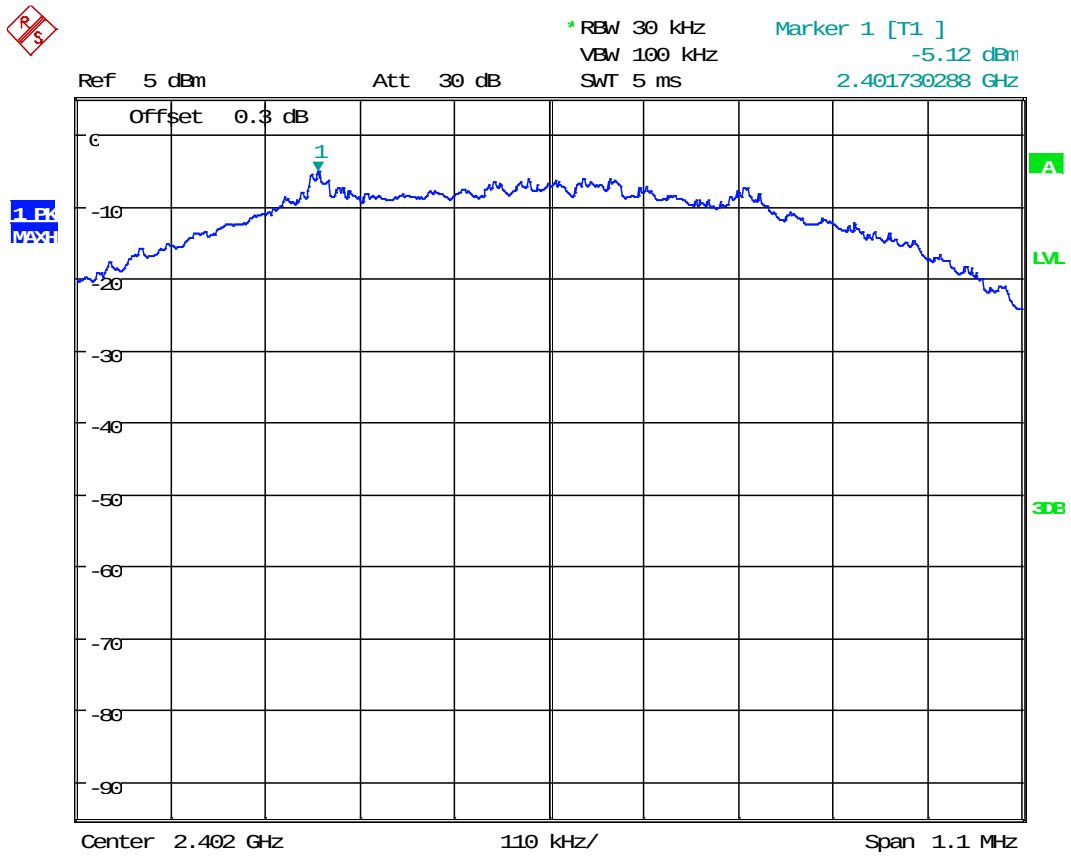
Frequency, MHz	Maximum Power Spectral Density, dBm	Maximum Power Spectral Density Limit, dBm	Margin, dB	Plot
2402	-5.12	8.0	-13.12	3.1
2440	-5.73	8.0	-13.73	3.2
2480	-6.02	8.0	-14.02	3.3

Battery Power:

Frequency, MHz	Maximum Power Spectral Density, dBm	Maximum Power Spectral Density Limit, dBm	Margin, dB	Plot
2402	-5.36	8.0	-13.36	3.4
2440	-5.59	8.0	-13.59	3.5
2480	-6.34	8.0	-14.34	3.6

Date of Test:	October 17, 2016
Results	**Complies**

Plot 3.1



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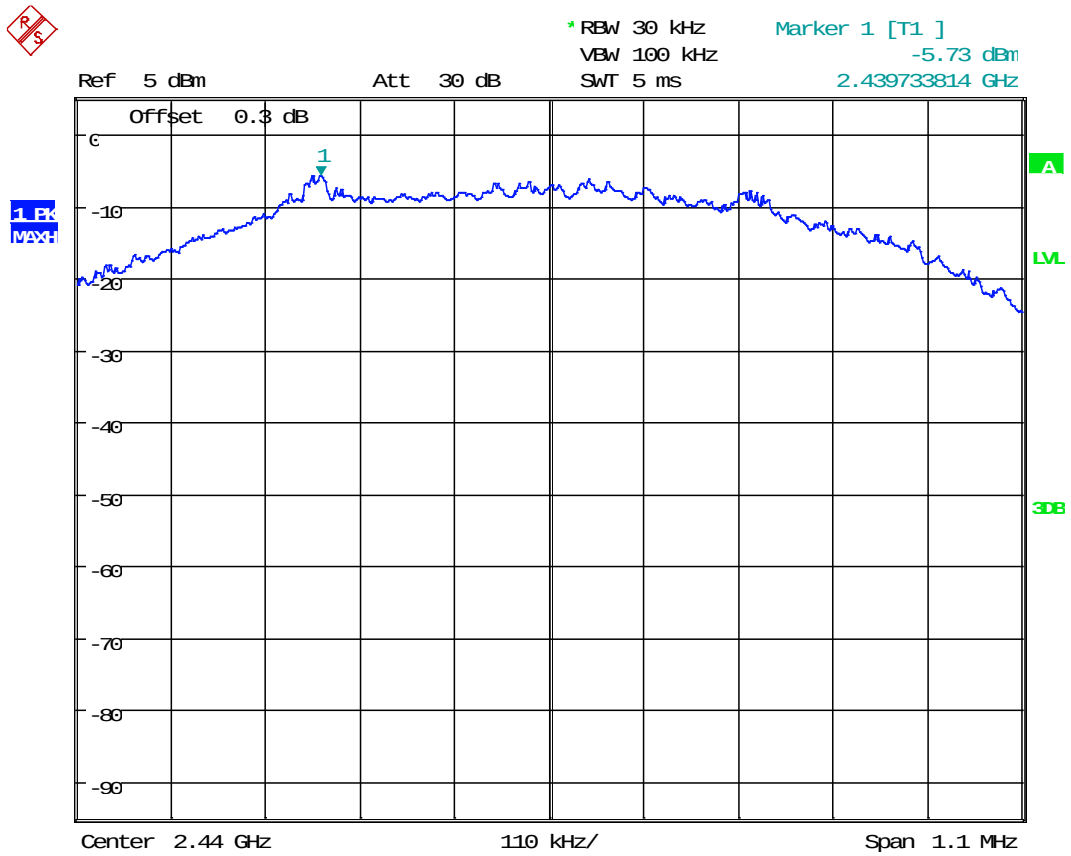
Plot 3.2



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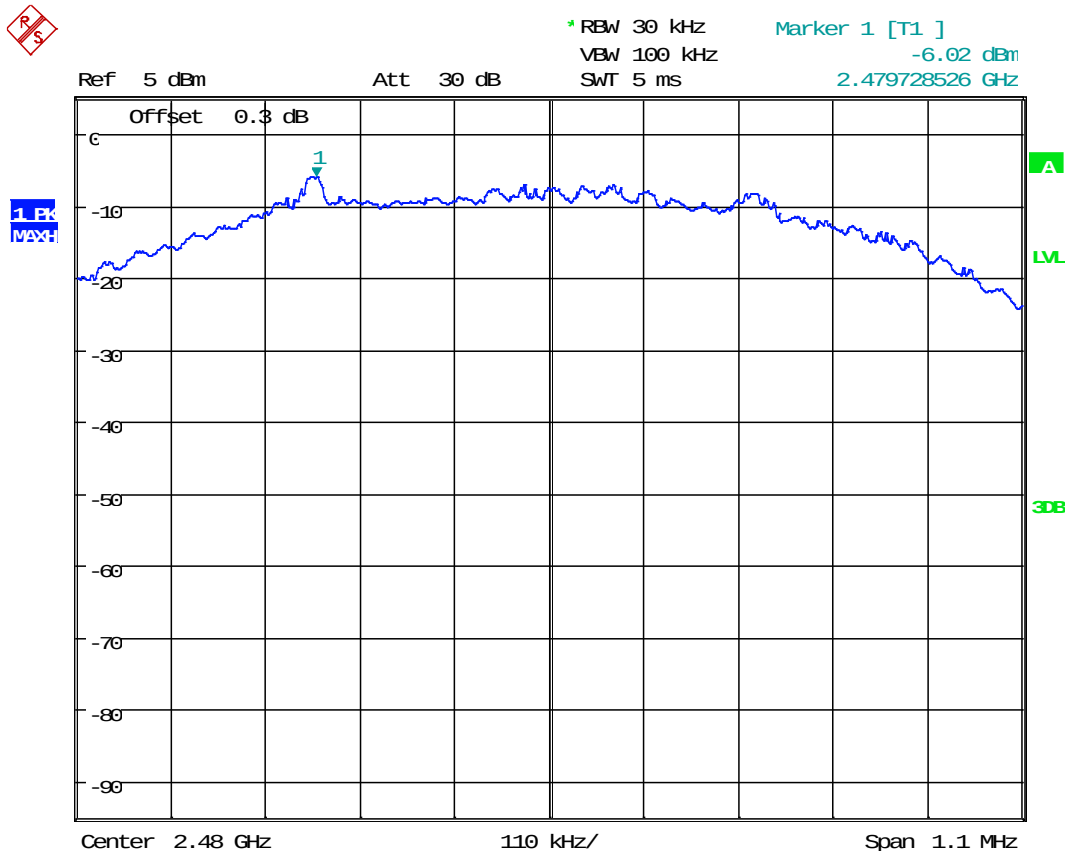
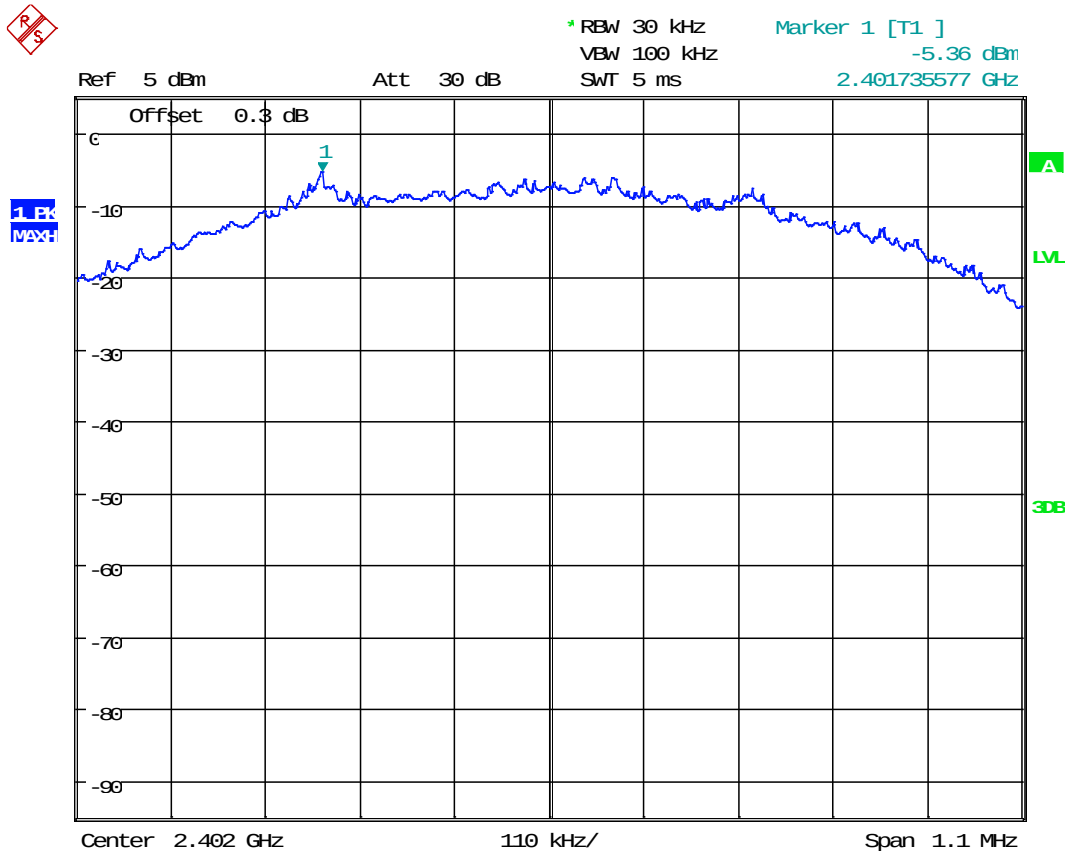
Plot 3.3



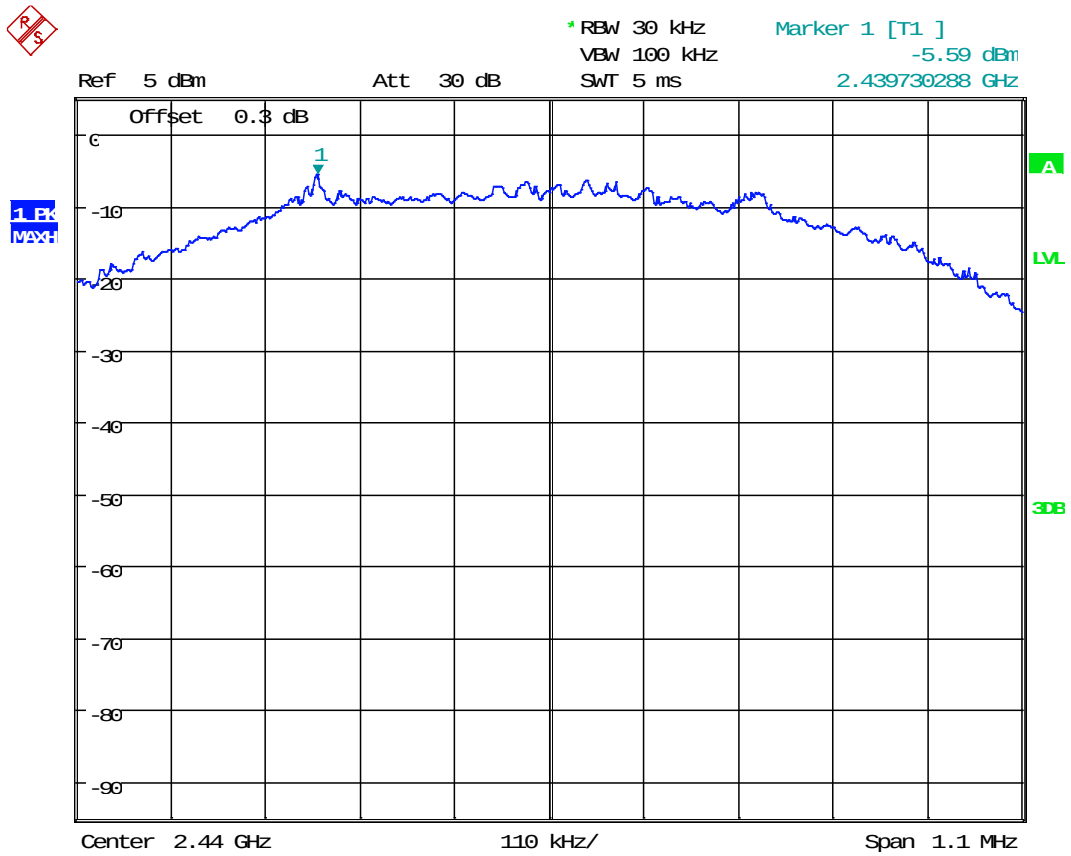
Date: 17.OCT.2016 17:24:06

Plot 3.4



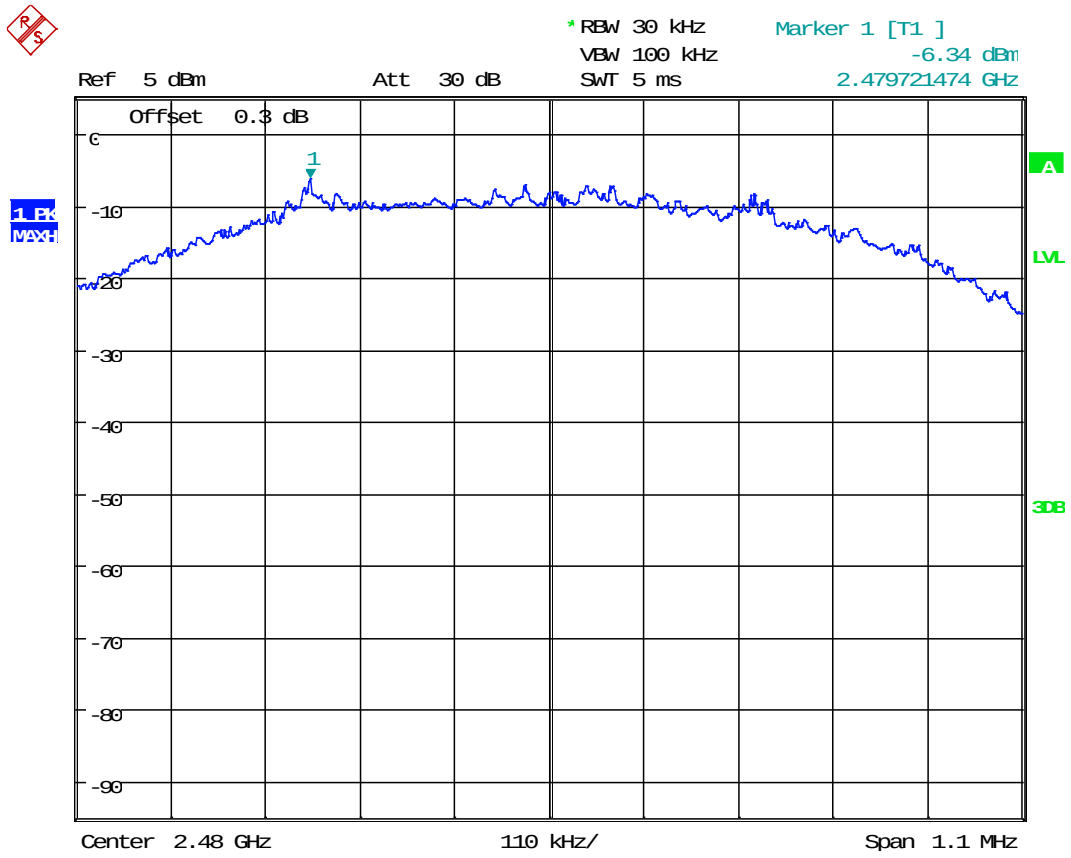
Date: 17.OCT.2016 15:49:45

Plot 3.5



Date: 17.OCT.2016 15:50:46

Plot 3.6



Date: 17.OCT.2016 15:48:59

4.4 Unwanted Conducted Emissions
FCC: 15.247(d); RSS-247 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

The procedure described in FCC Publication 558074 D01 DTS Meas Guidance v03r05 April 8, 2016, specifically section 11.0 Emissions in non-restricted frequency bands.

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

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

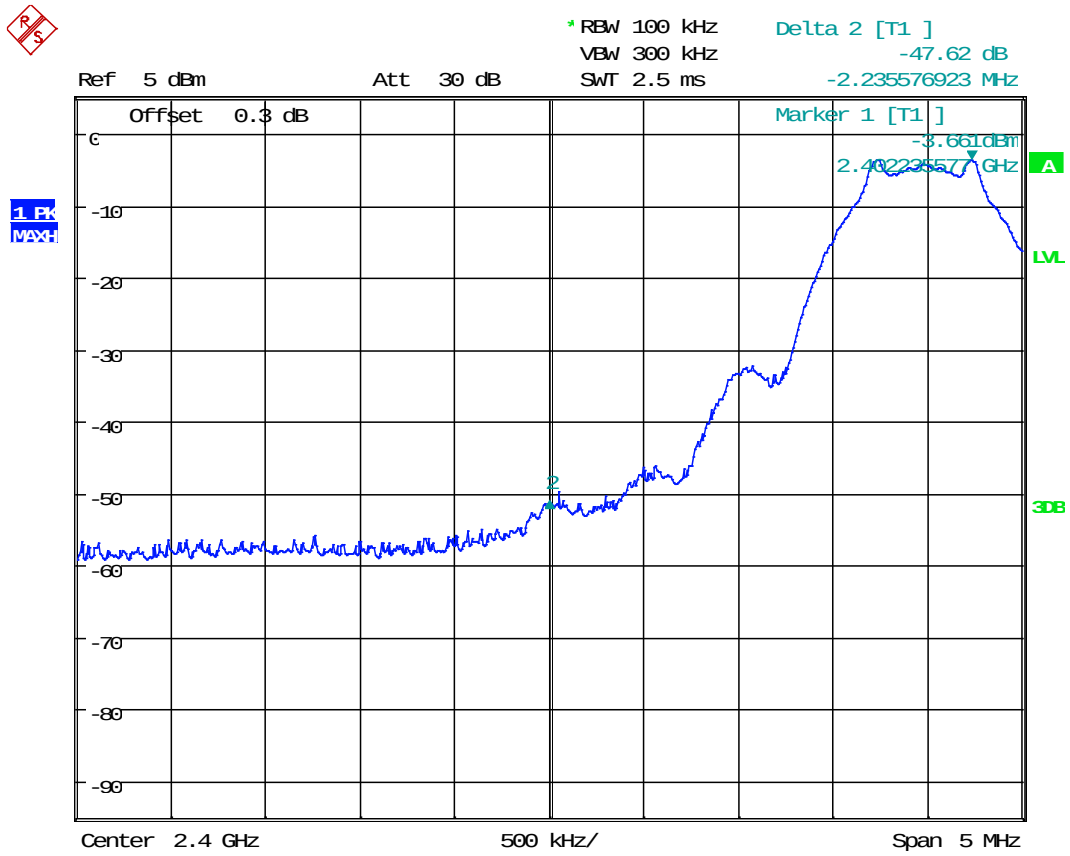
The unwanted emissions were measured from 30 MHz to 25 GHz. Plots below are corrected for cable loss and then compared to the limits.

4.4.3 Test Result

Refer to the following plots 4.1 – 4.10 for unwanted conducted emissions. The plot shows -20dB attenuation limit line.

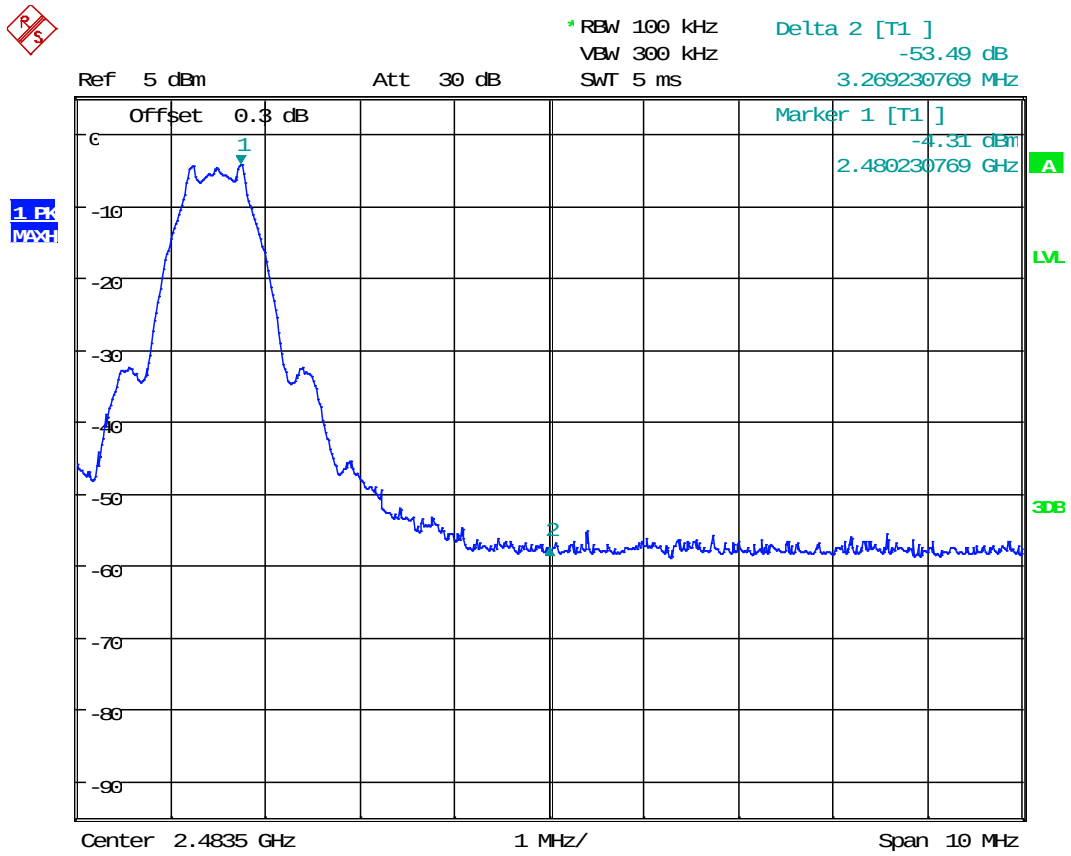
Date of Test:	October 17, 2016
Results	**Complies**

Tx @ Low Channel, 2400 MHz Band Edge, AC Power
Plot 4.1



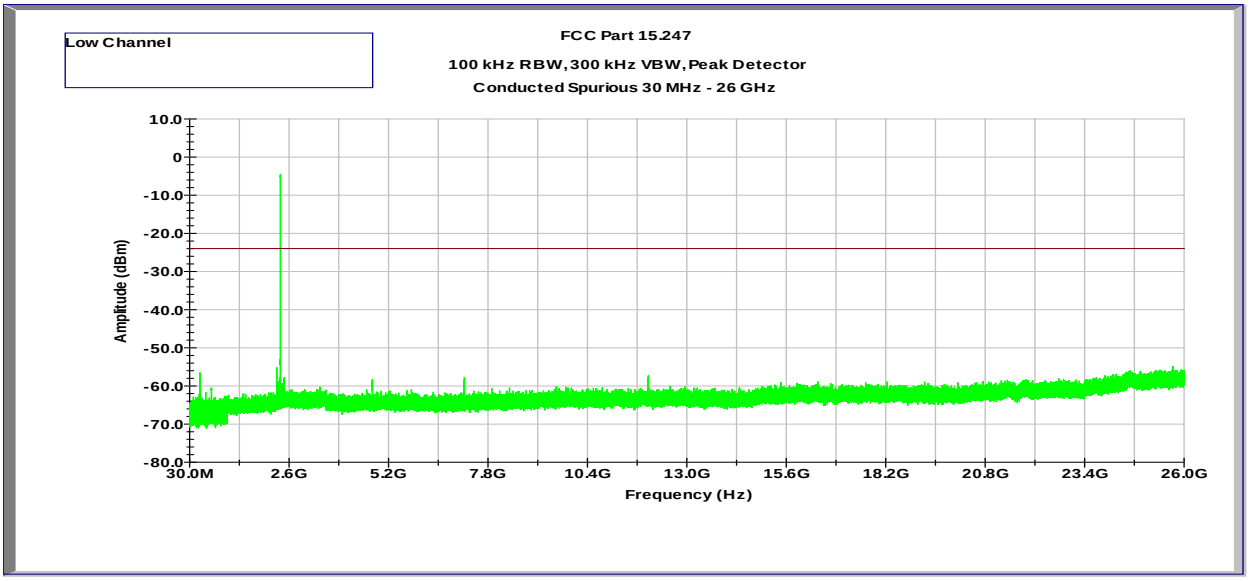
Date: 17.OCT.2016 17:48:06

Tx @ High Channel, 2483.5 MHz Band Edge, AC Power
Plot 4.2

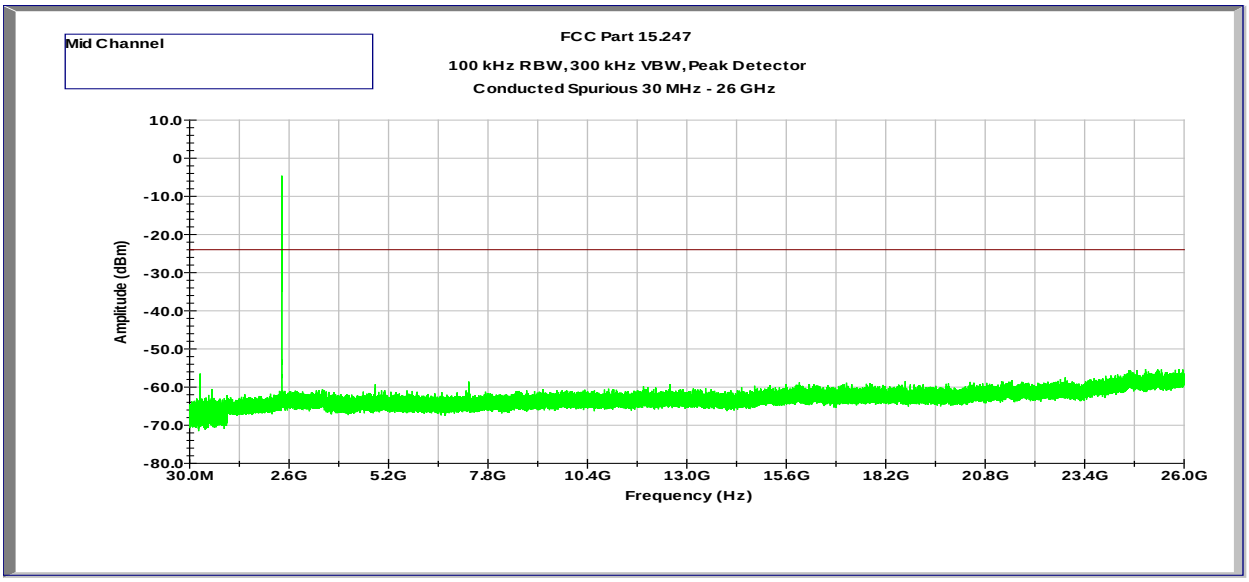


Date: 17.OCT.2016 17:50:04

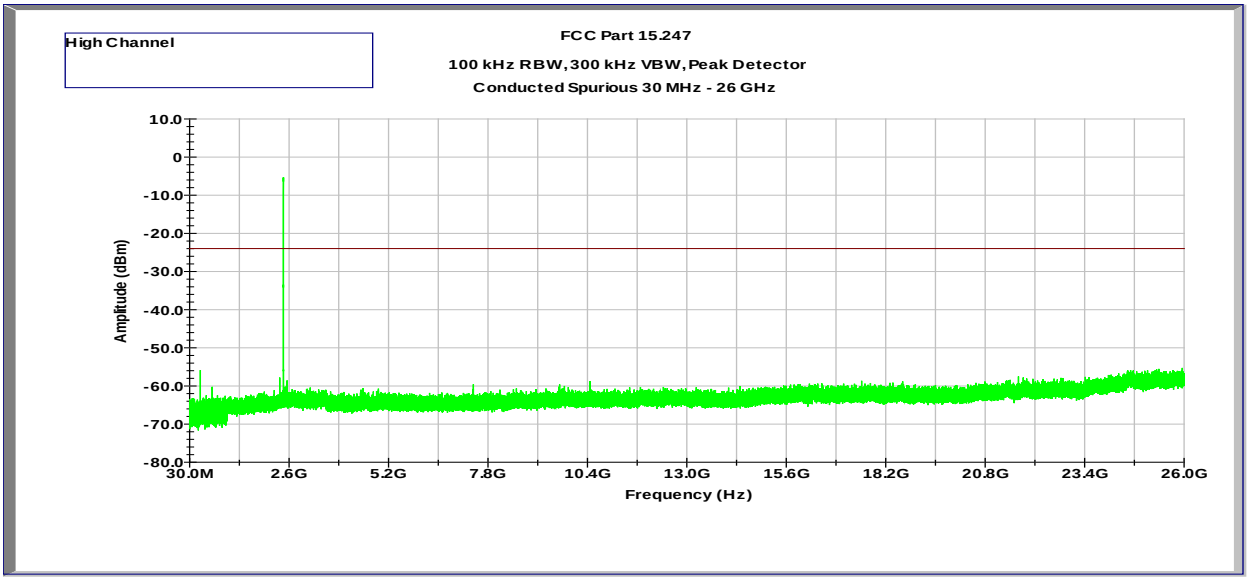
Tx @ Low Channel, 2402 MHz, AC Power
30MHz -26GHz Conducted Spurious
Plot 4.3



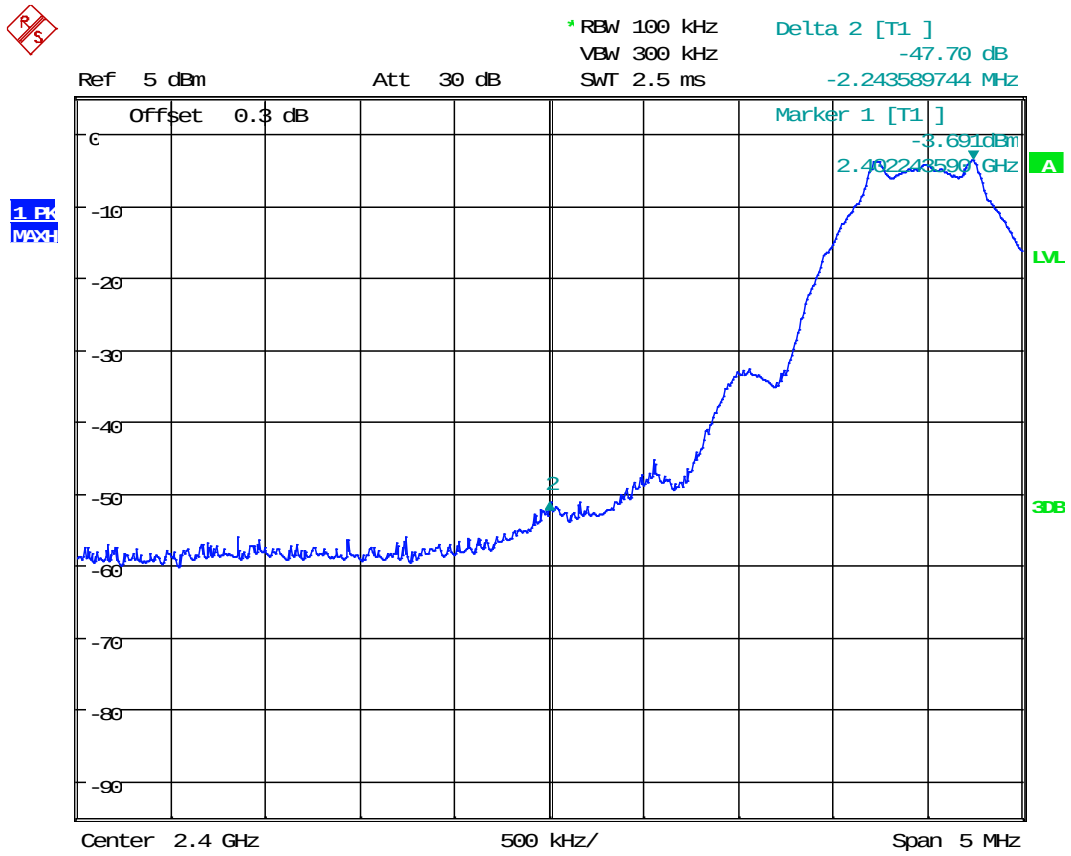
Tx @ Mid Channel, 2440 MHz, AC Power
30MHz -26GHz Conducted Spurious
Plot 4.4



Tx @ High Channel, 2480 MHz, AC Power
30MHz -26GHz Conducted Spurious
Plot 4.5

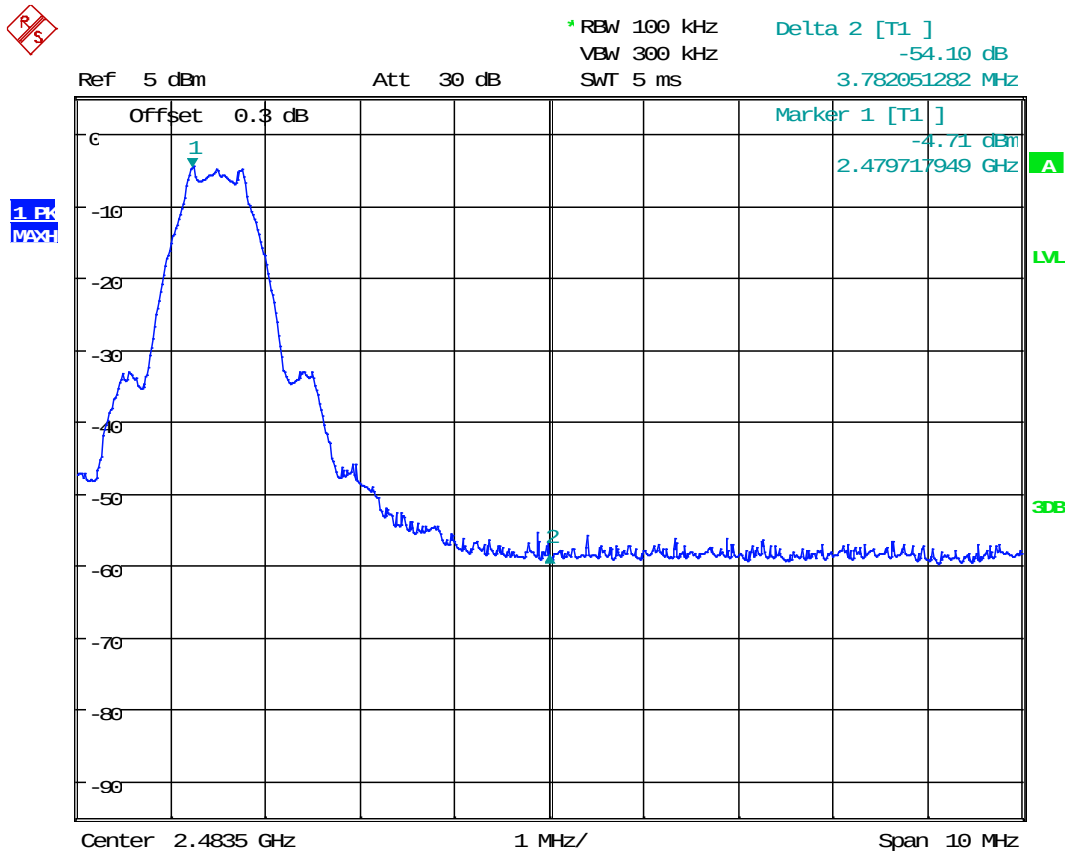


Tx @ Low Channel, 2400 MHz Band Edge, Battery Power
Plot 4.6



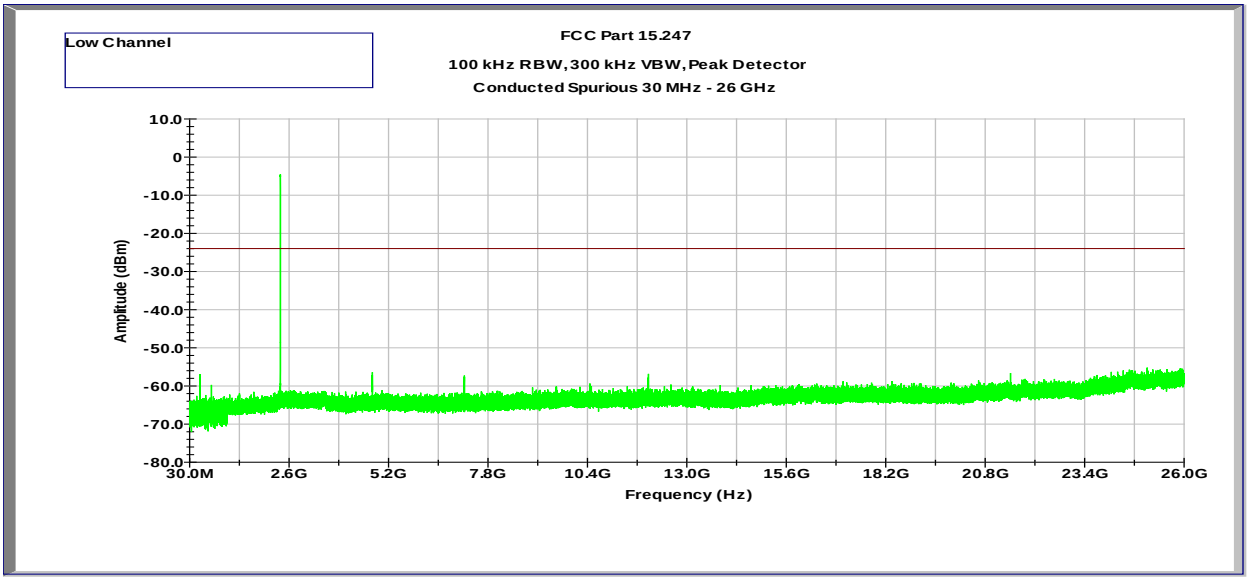
Date: 17.OCT.2016 15:54:03

Tx @ High Channel, 2483.5 MHz Band Edge, Battery Power
Plot 4.7

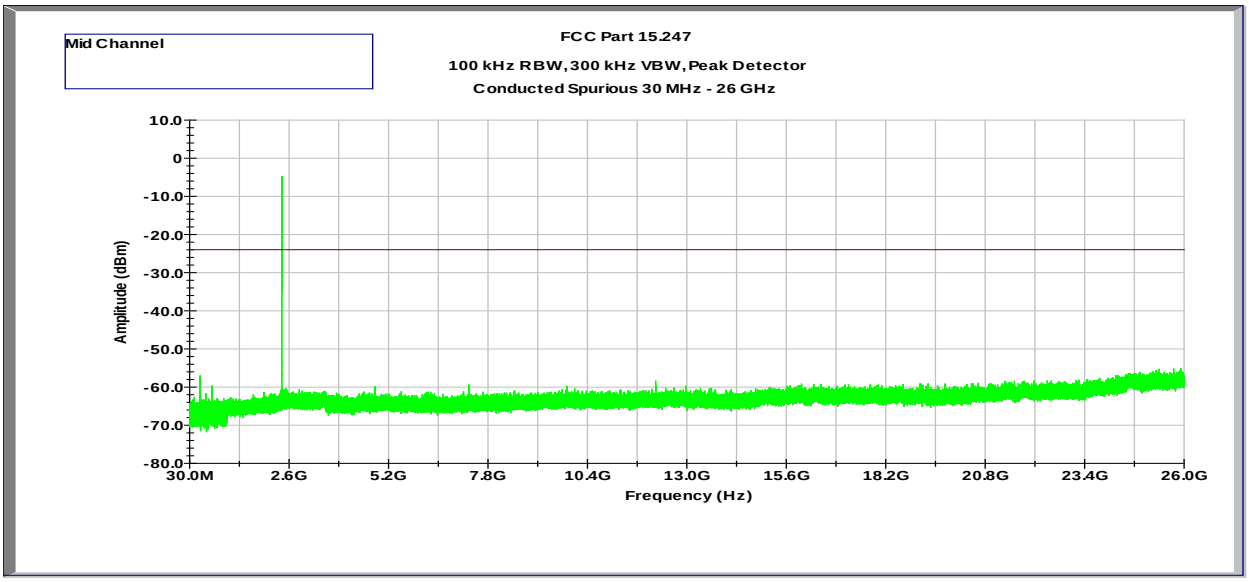


Date: 17.OCT.2016 15:52:31

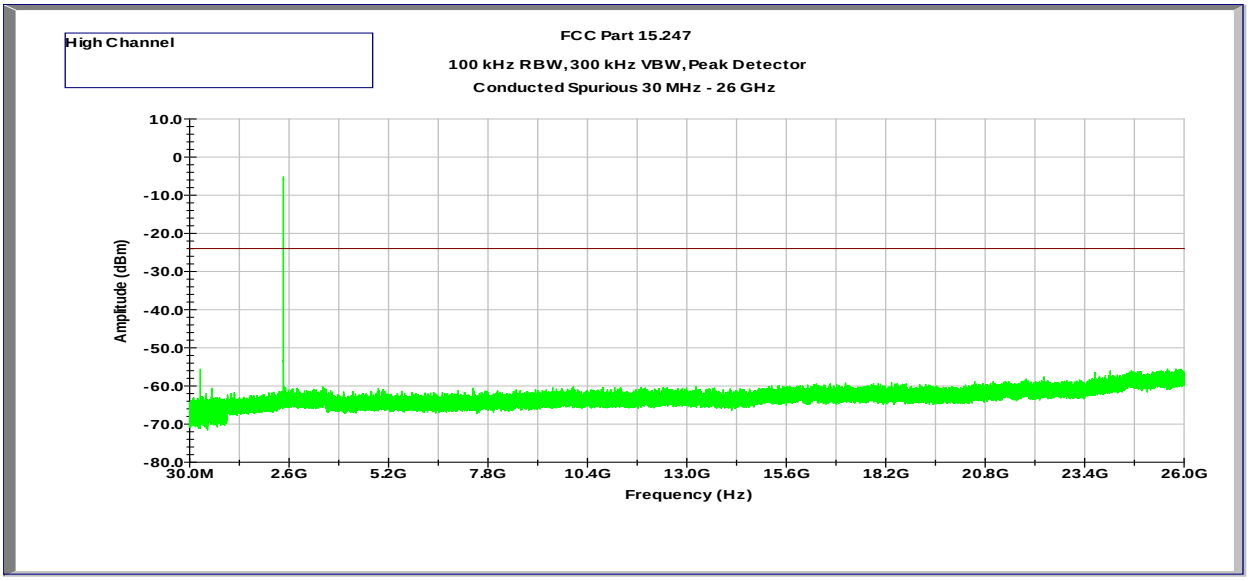
Tx @ Low Channel, 2402 MHz, Battery Power
30MHz -26GHz Conducted Spurious
Plot 4.8



Tx @ Mid Channel, 2440 MHz, Battery Power
30MHz -26GHz Conducted Spurious
Plot 4.9



Tx @ High Channel, 2480 MHz, Battery Power
30MHz -26GHz Conducted Spurious
Plot 4.10



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 also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

For out of band radiated emissions (except for frequencies in restricted bands), in any 100 k Hz bandwidths outside the EUT pass-band, the RF power shall be at least 20dB (peak) or 30 dB (average) below that of the maximum in-band 100 kHz emissions.

4.5.2 Procedure

Radiated emission measurements were performed from 30 MHz to 18 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 for below 1000MHz and 1.5m in height for above 1GHz. 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.

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(μV/m)
RA = Receiver Amplitude (including preamplifier) in dB(μV); 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(μV) 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(μV/m). This value in dB(μV/m) was converted to its corresponding level in μV/m.
RA = 52.0 dB(μV)
AF = 7.4 dB(1/m)
CF = 1.6 dB
AG = 29.0 dB
FS = 52.0+7.4+1.6-29.0 = 32 dB(μV/m).
Level in μV/m = Common Antilogarithm [(32 dBμV/m)/20] = 39.8 μV/m.

4.5.4 Antenna-port conducted measurements

Antenna-port conducted measurements may also be used as an alternative to radiated measurements for demonstrating compliance in the restricted frequency bands. If conducted measurements are performed, then proper impedance matching must be ensured and an additional radiated test for cabinet/case spurious emissions is required.

4.5.6 General Procedure for conducted measurements in restricted bands

a) Measure the conducted output power (in dBm) using the detector specified for determining quasi-peak, peak, and average conducted output power, respectively.

b) Add the maximum transmit antenna gain (in dBi) to the measured output power level to determine the EIRP level (see 12.2.5 for guidance on determining the applicable antenna gain)

c) Add the appropriate maximum ground reflection factor to the EIRP level (6 dB for frequencies ≤ 30 MHz, 4.7 dB for frequencies between 30 MHz and 1000 MHz, inclusive and 0 dB for frequencies > 1000 MHz).

d) For devices with multiple antenna-ports, measure the power of each individual chain and sum the EIRP of all chains in linear terms (*e.g.*, Watts, mW).

e) Convert the resultant EIRP level to an equivalent electric field strength using the following relationship:
$E = EIRP - 20\log D + 104.8$
where:
E = electric field strength in dBμV/m,
EIRP = equivalent isotropic radiated power in dBm
D = specified measurement distance in meters.
f) Compare the resultant electric field strength level to the applicable limit.
g) Perform radiated spurious emission test

4.5.7 Test Results

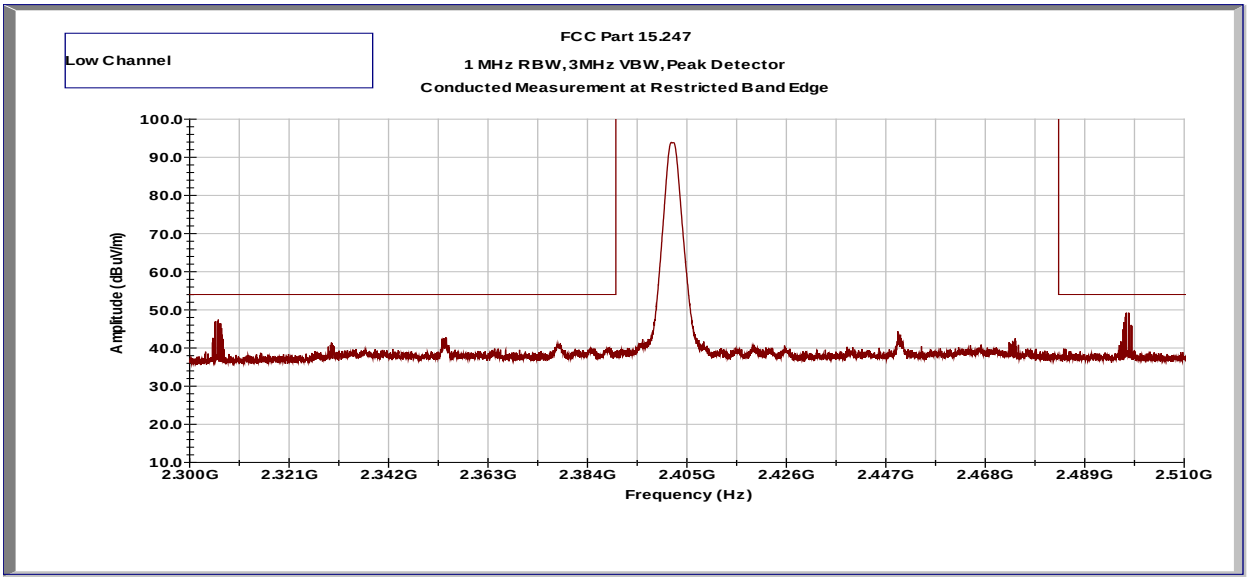
The data on the following pages list the significant emission frequencies, the limit and the margin of compliance where emissions are within 3dB of the limit.

All conducted antenna port plots are corrected with the consideration of a 2 dBi Antenna Gain.

Radiated emission measurements were performed up to 26GHz. No Emissions were identified when scanned from 18-25 GHz.

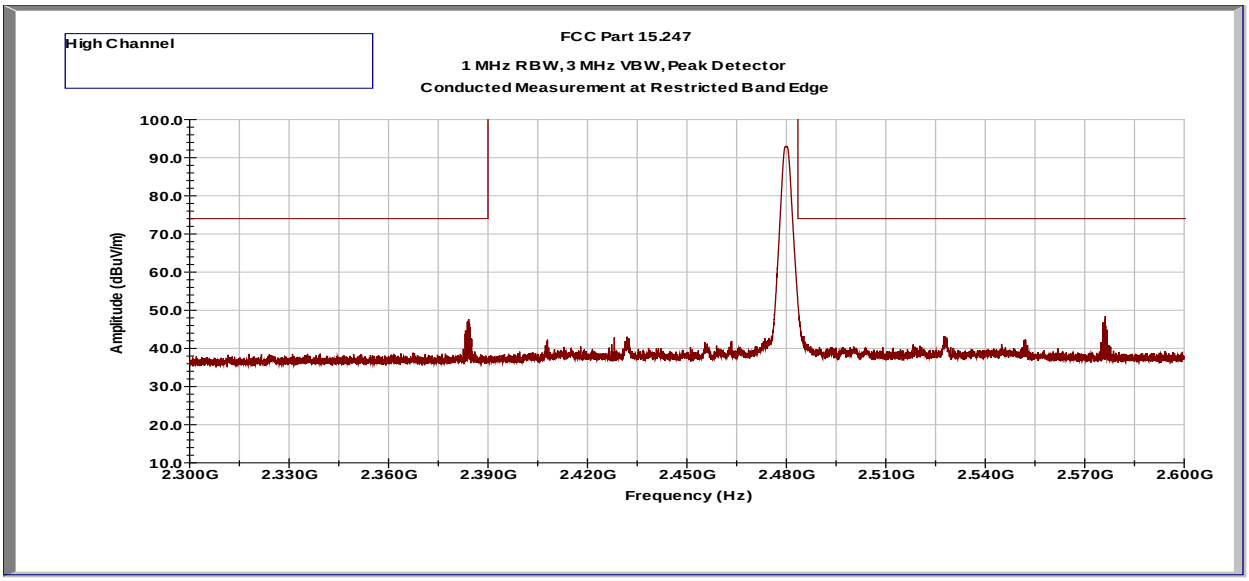
Test Results: 15.209/15.205 Restricted Band Emissions at Antenna Port

Out-of-Band Spurious Emissions at the Band Edge – Tx @ 2402 MHz, AC Power

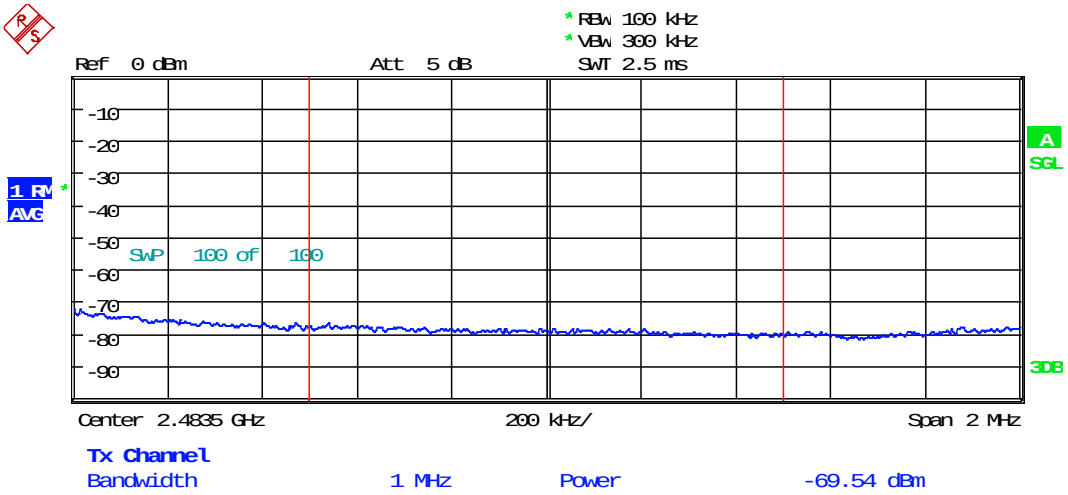


Frequency	Corrected Amplitude	Average Limit	Margin	Detector	Results
GHz	dBµV/m	dBµV/m	dB		
2.390	39.4	54	-14.6	Peak	Pass

Out-of-Band Spurious Emissions at the Band Edge – Tx @ 2480 MHz, AC Power



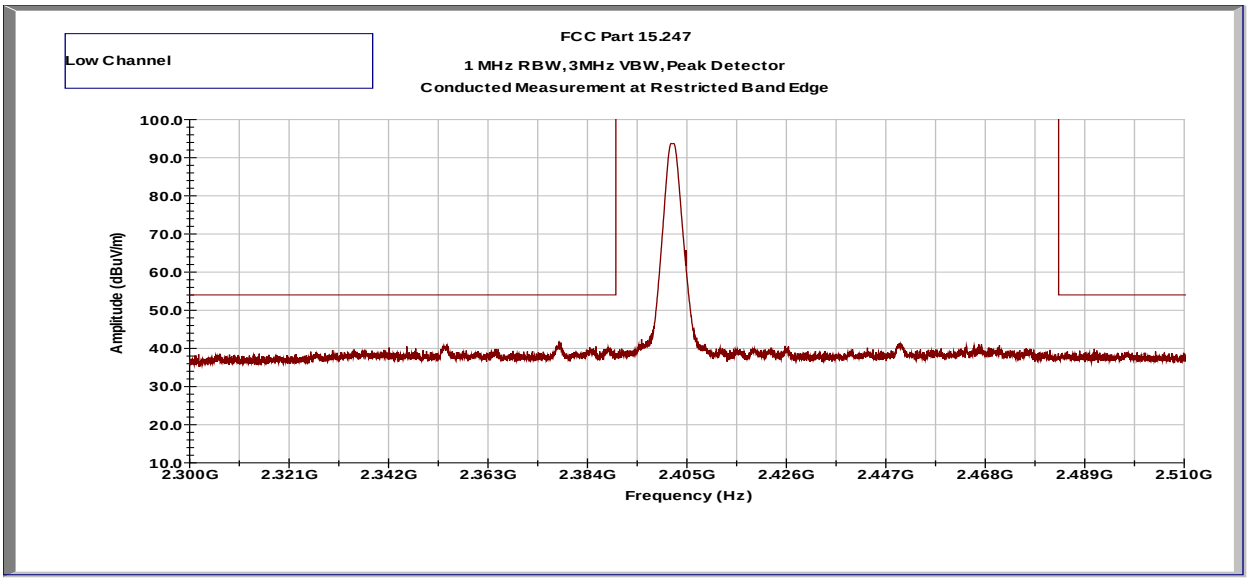
Frequency	Corrected Amplitude	Peak Limit	Margin	Detector	Results
GHz	dBµV/m	dBµV/m	dB		
2.4835	51.5	74.0	-22.5	Peak	Pass



Frequency	Detector	Corrected Amplitude	Raw Amplitude	Antenna Factor	Cable Loss	EIRP	Corr. Factor at 3 m	Average Limit	Margin
MHz	Peak / Avg	dB(uV/m)	dBm	dBi	dB	dBm	dB	dB(uV/m)	dB
2483.5	Avg	27.8	-69.54	1.7	0.3	-67.5	9.5	54	-26.2

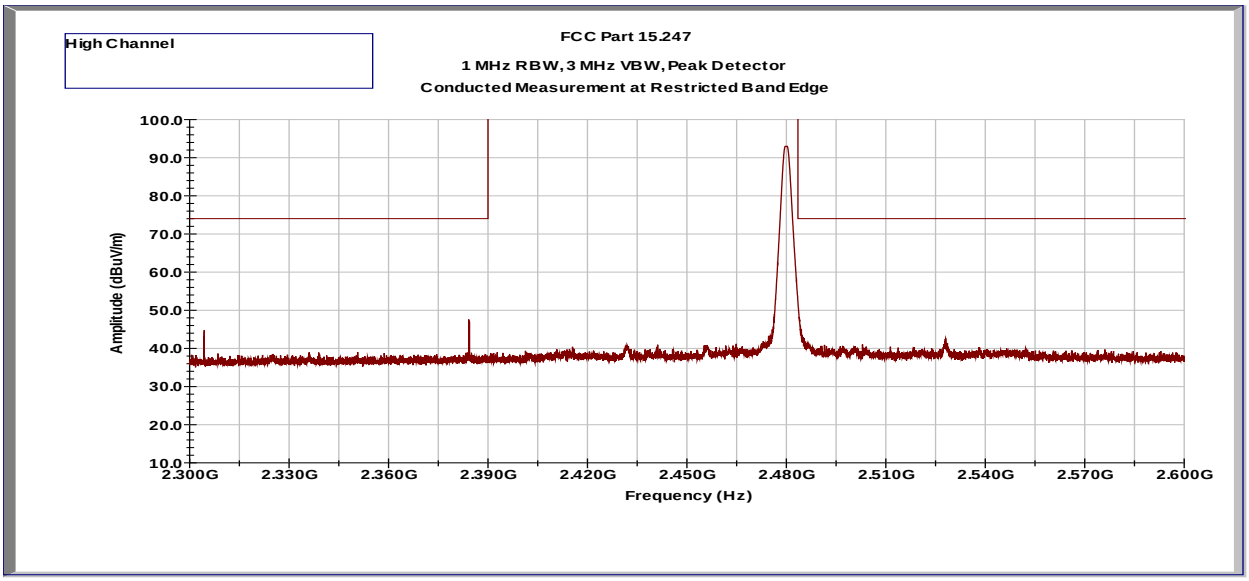
Convert the resultant EIRP level to an equivalent electric field strength using the following relationship:
E = EIRP + δ(dB) – 20log D + 104.8
where:
E = electric field strength in dBμV/m,
EIRP = equivalent isotropic radiated power in dBm
D = specified measurement distance in meters.

Out-of-Band Spurious Emissions at the Band Edge – Tx @ 2402 MHz, Battery Power

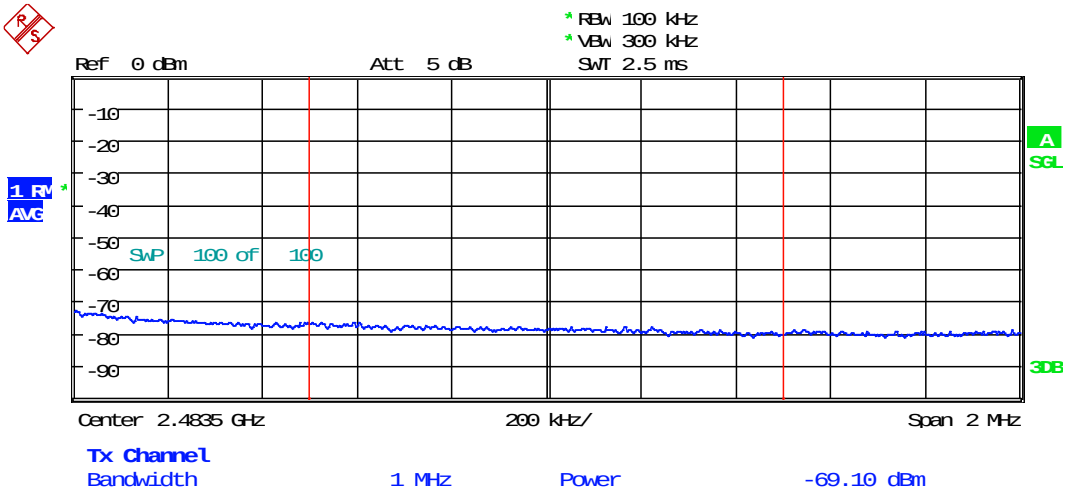


Frequency	Corrected Amplitude	Average Limit	Margin	Detector	Results
GHz	dBµV/m	dBµV/m	dB		
2.390	39.9	54	-14.1	Peak	Pass

Out-of-Band Spurious Emissions at the Band Edge – Tx @ 2480 MHz, Battery Power



Frequency	Corrected Amplitude	Peak Limit	Margin	Detector	Results
GHz	dBµV/m	dBµV/m	dB		
2.4835	51.3	74	-22.7	Peak	Pass



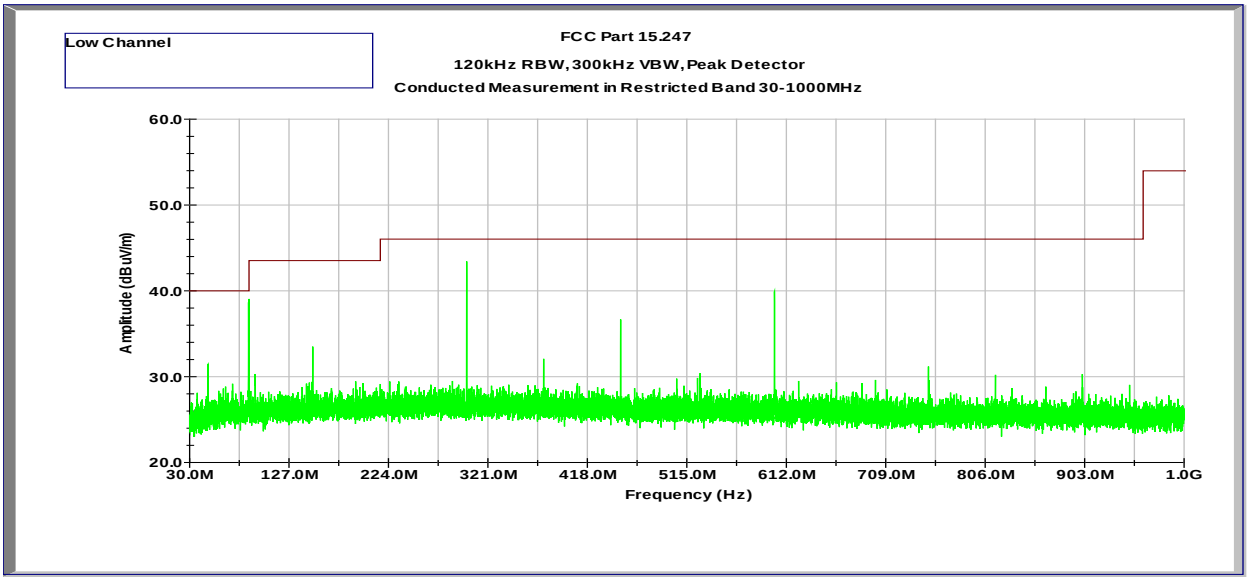
Frequency	Detector	Corrected Amplitude	Raw Amplitude	Antenna Factor	Cable Loss	EIRP	Corr. Factor at 3 m	Average Limit	Margin
MHz	Peak / Avg	dB(uV/m)	dBm	dBi	dB	dBm	dB	dB(uV/m)	dB
2483.5	Avg	28.2	-69.1	1.7	0.3	-67.1	9.5	54	-25.8

Convert the resultant EIRP level to an equivalent electric field strength using the following relationship:
$E = EIRP + \delta(dB) - 20\log D + 104.8$
where:
E = electric field strength in dBμV/m,
EIRP = equivalent isotropic radiated power in dBm
D = specified measurement distance in meters.

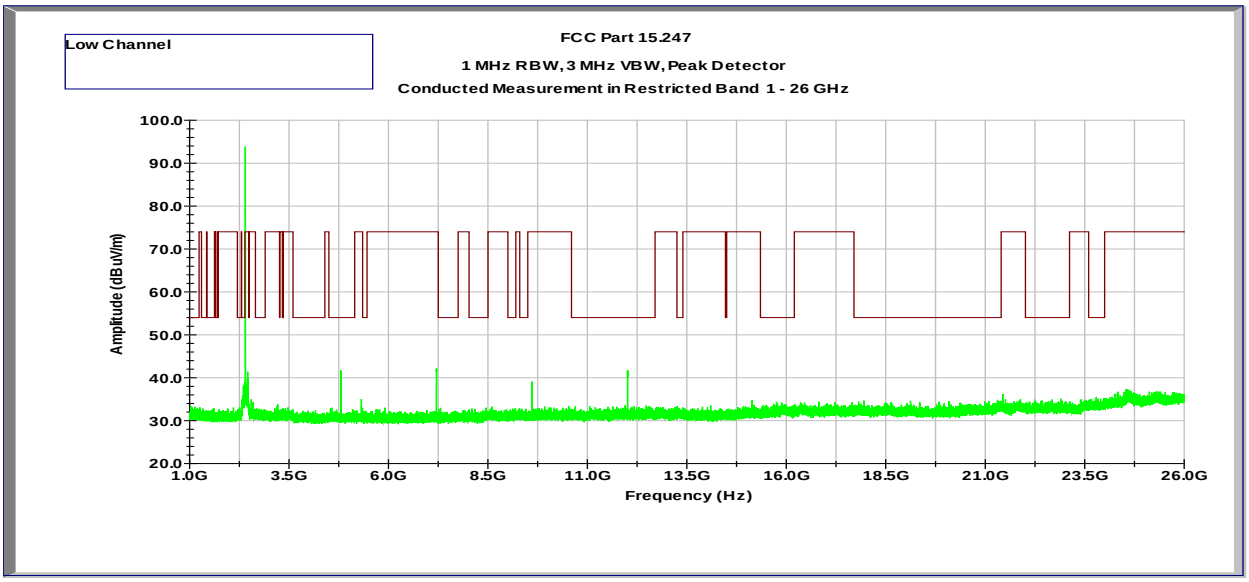
Out-of-Band Conducted Spurious Emissions (at Antenna Port)

Tx @ 2402 MHz, AC Power

Out-of-Band Spurious Emissions at Antenna Port - 30 MHz to 1 GHz

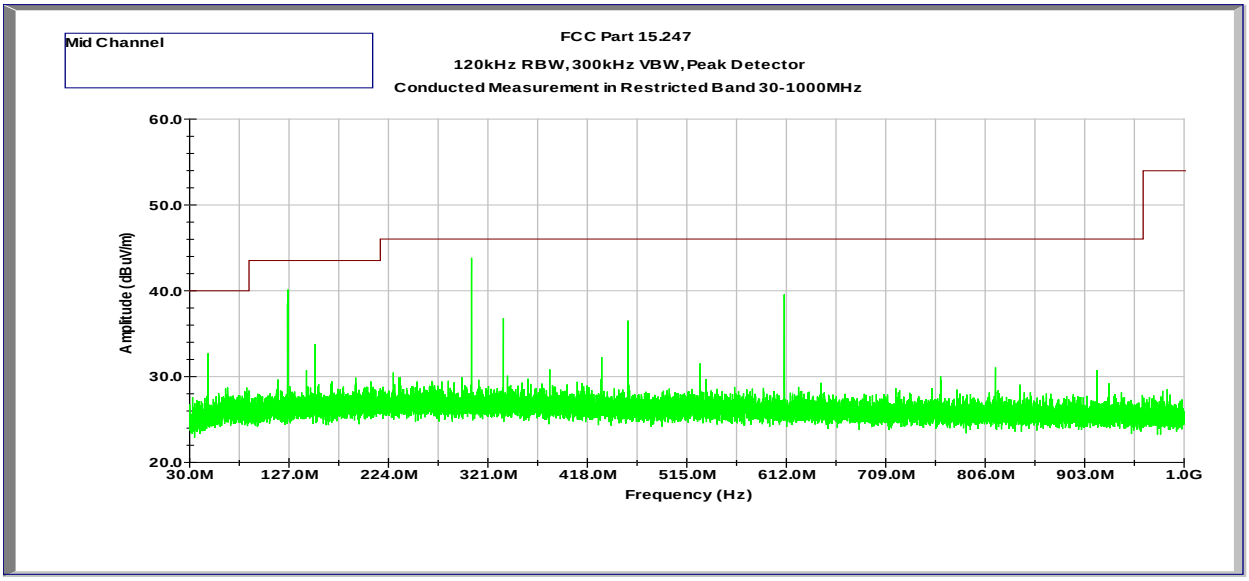


Out-of-Band Spurious Emissions at Antenna Port - 1 GHz to 26 GHz

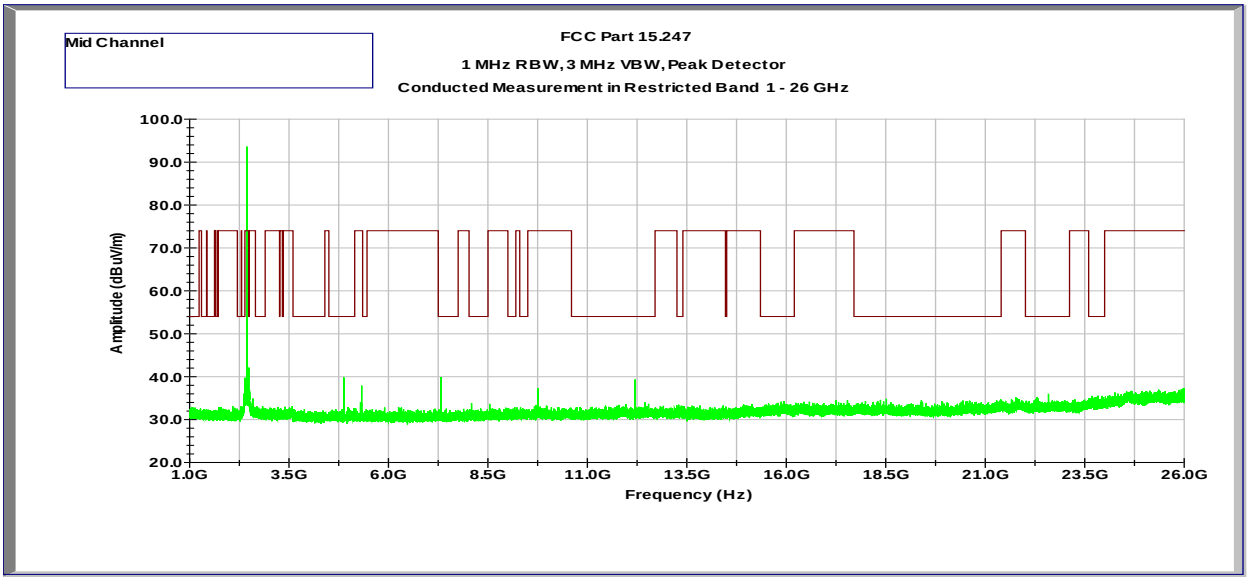


Tx @ 2440 MHz, AC Power

Out-of-Band Spurious Emissions at Antenna Port - 30 MHz to 1 GHz

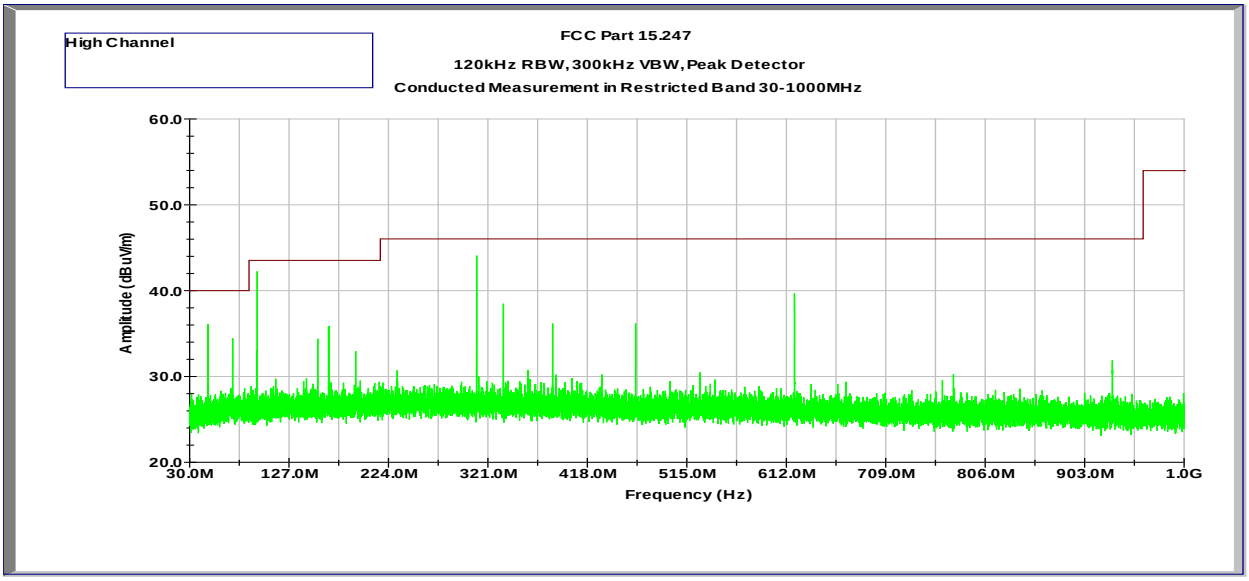


Out-of-Band Spurious Emissions at Antenna Port - 1 GHz to 26 GHz

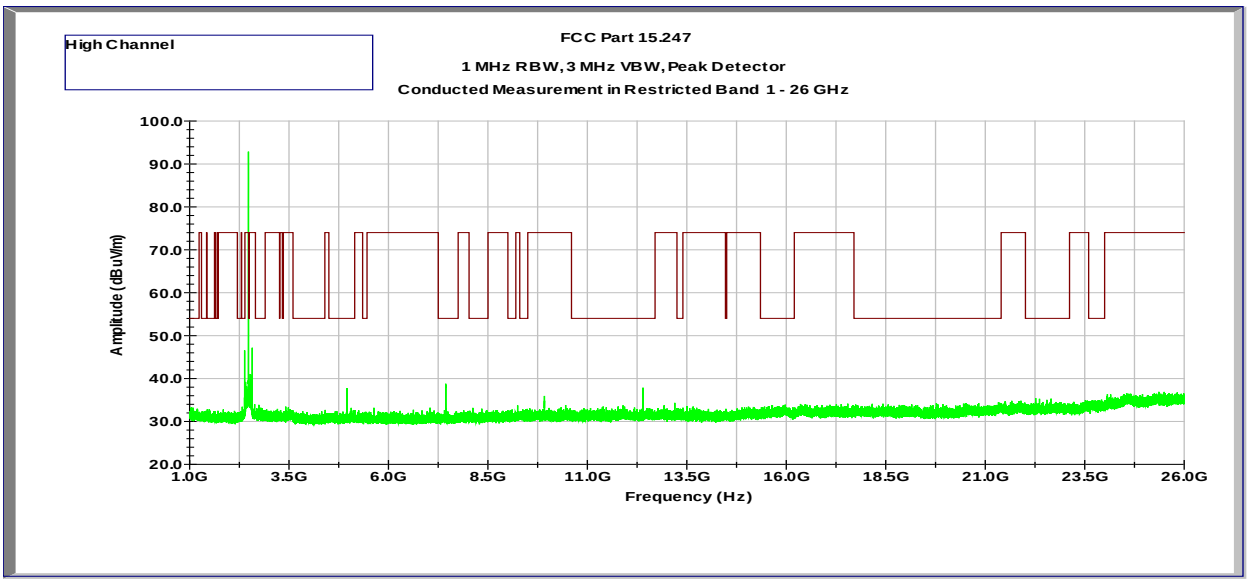


Tx @ 2480 MHz, AC Power

Out-of-Band Spurious Emissions at Antenna Port - 30 MHz to 1 GHz

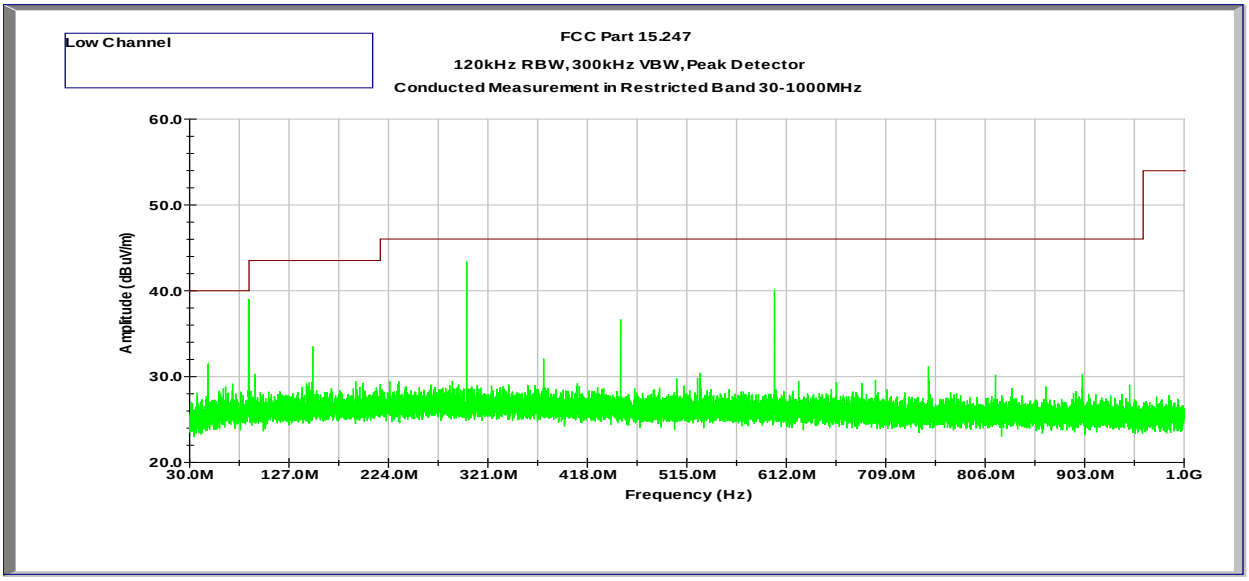


Out-of-Band Spurious Emissions at Antenna Port - 1 GHz to 26 GHz

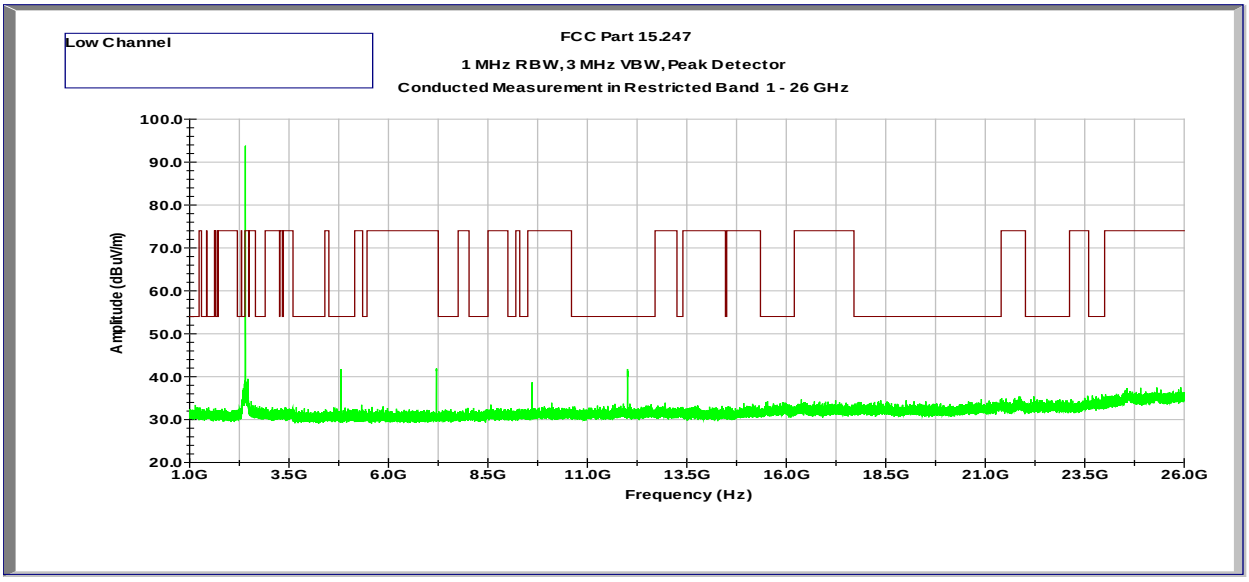


Tx @ 2402 MHz, Battery Power

Out-of-Band Spurious Emissions at Antenna Port - 30 MHz to 1 GHz

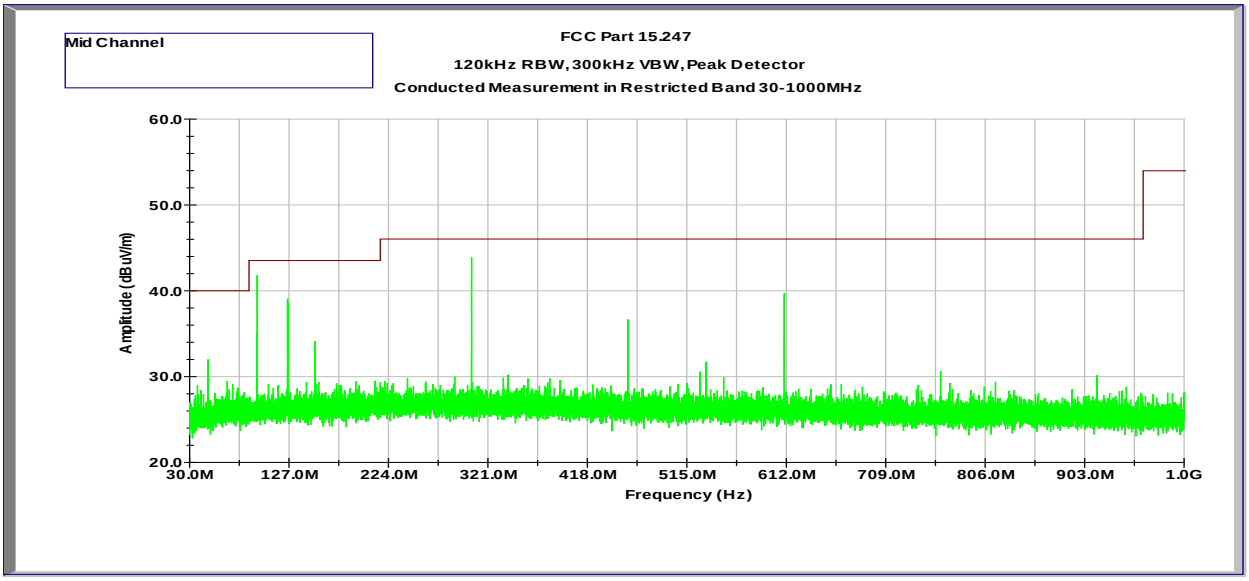


Out-of-Band Spurious Emissions at Antenna Port - 1 GHz to 26 GHz

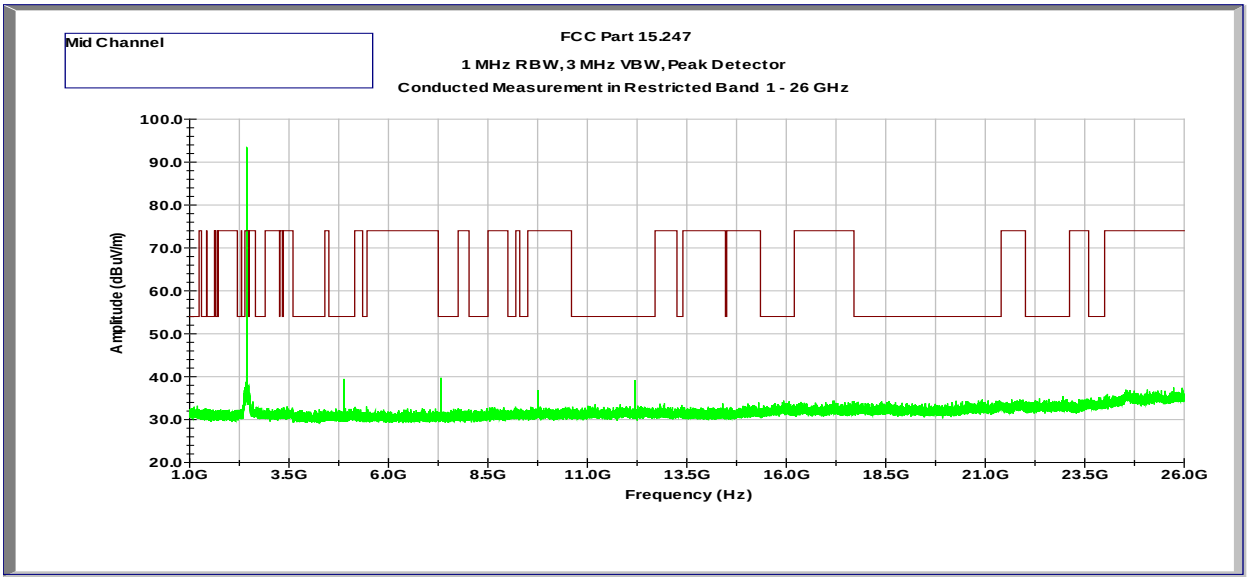


Tx @ 2440 MHz, Battery Power

Out-of-Band Spurious Emissions at Antenna Port - 30 MHz to 1 GHz

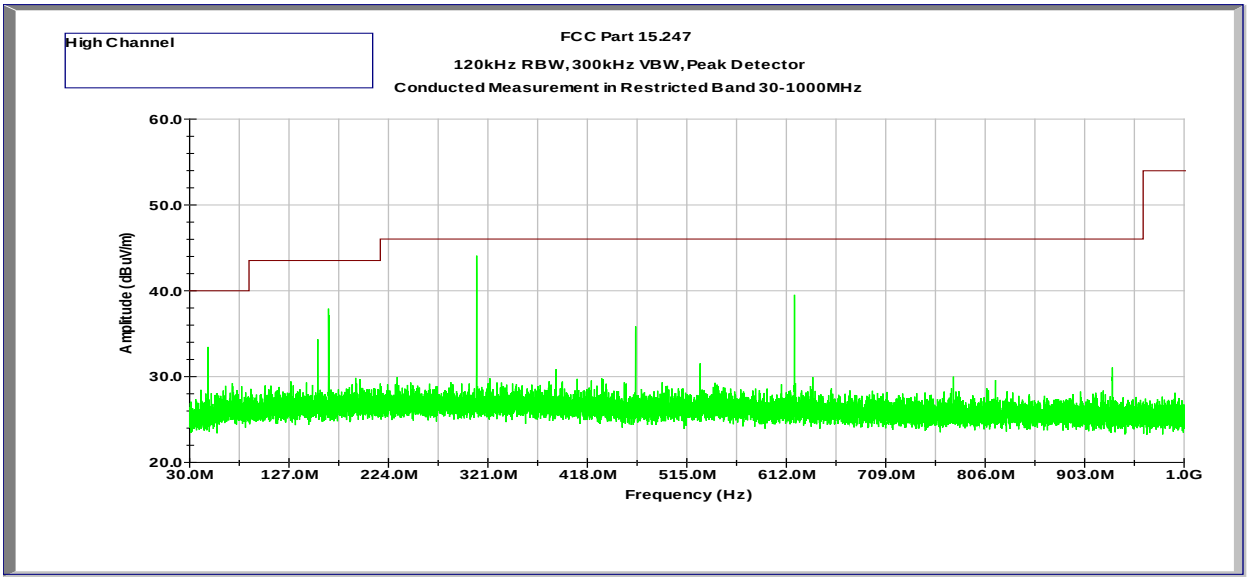


Out-of-Band Spurious Emissions at Antenna Port - 1 GHz to 26 GHz

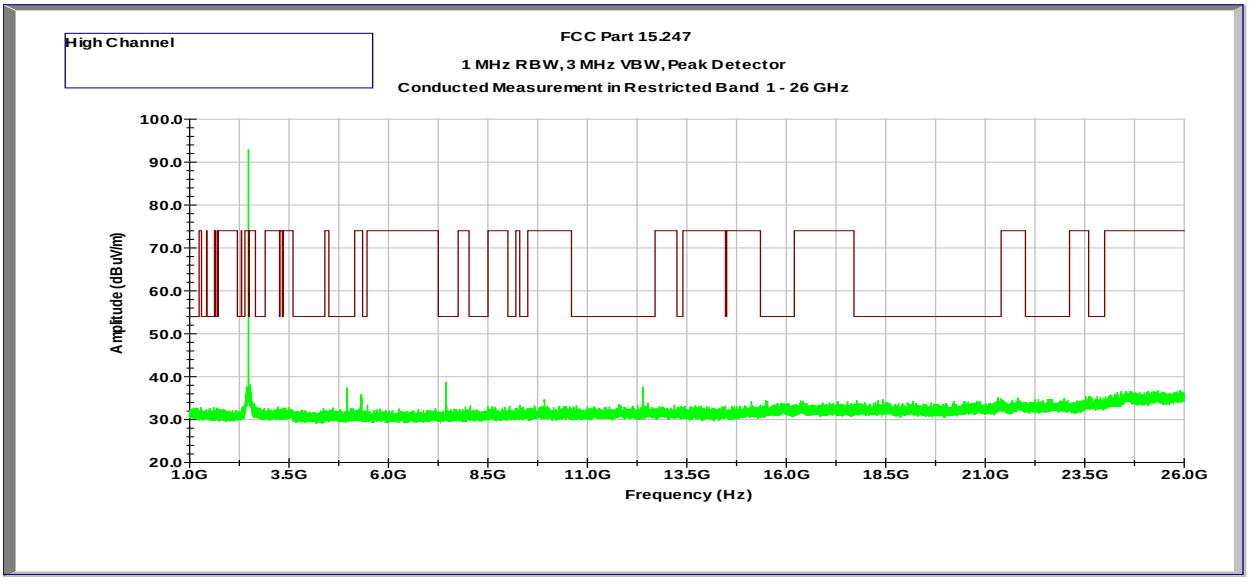


Tx @ 2480MHz, Battery Power

Out-of-Band Spurious Emissions at Antenna Port - 30 MHz to 1 GHz



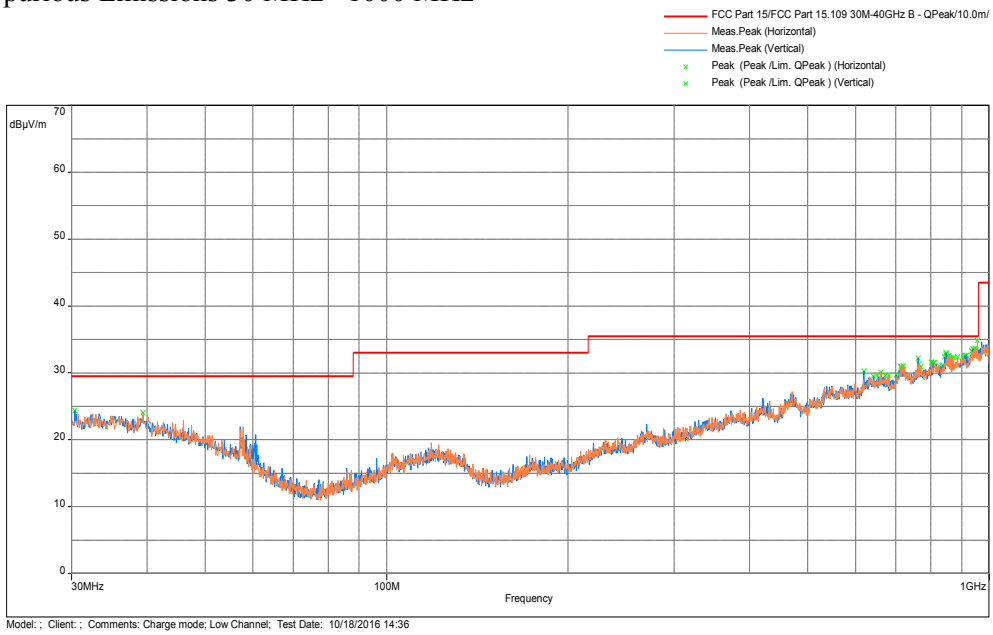
Out-of-Band Spurious Emissions at Antenna Port - 1 GHz to 26 GHz



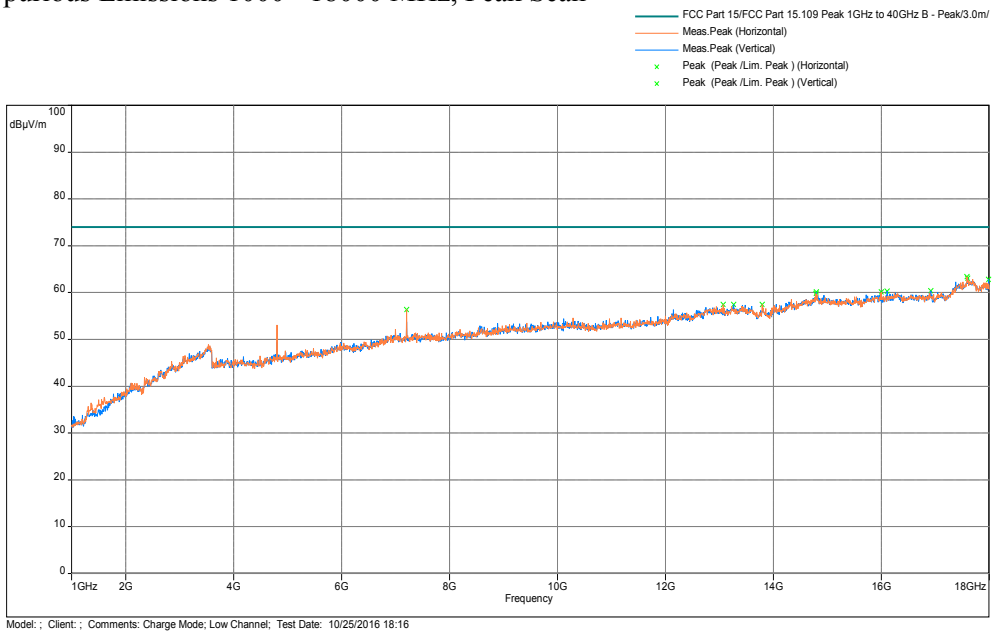
Out-of-Band Radiated Spurious Emissions (Cabinet Radiation)

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

Radiated Spurious Emissions 30 MHz - 1000 MHz

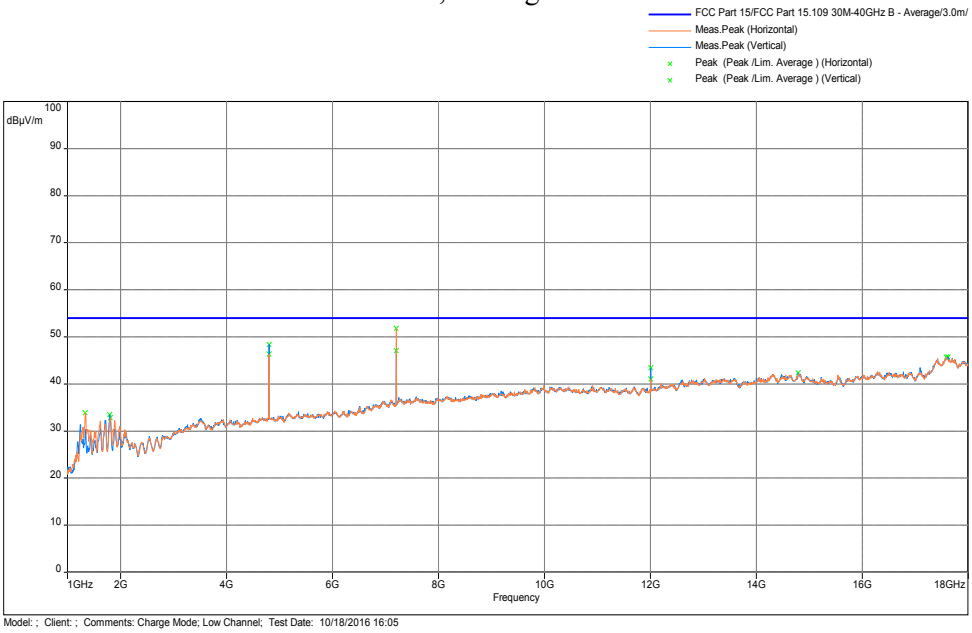


Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan



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

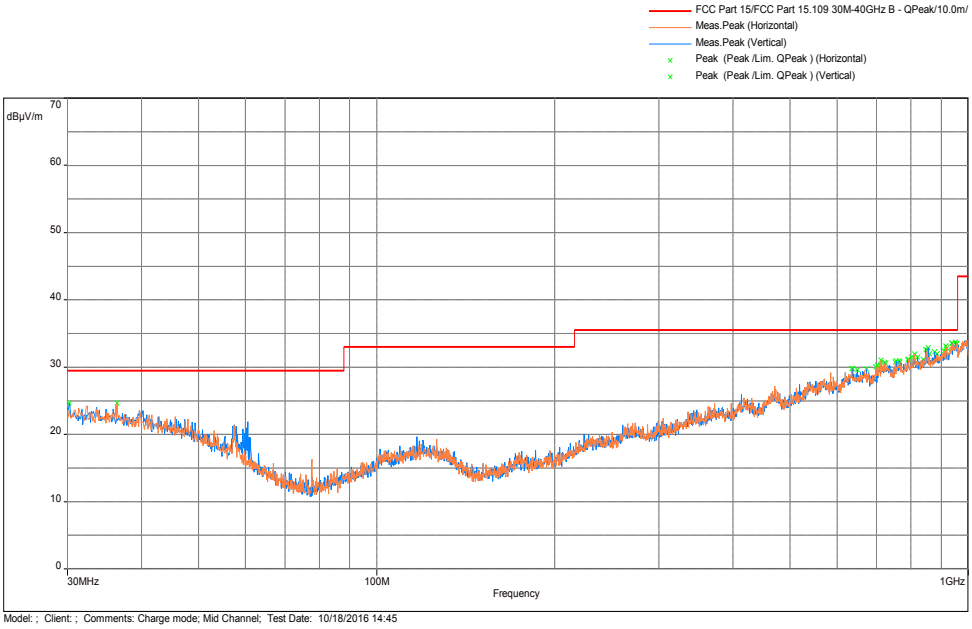
Radiated Spurious Emissions 1000 - 18000 MHz, Average Scan



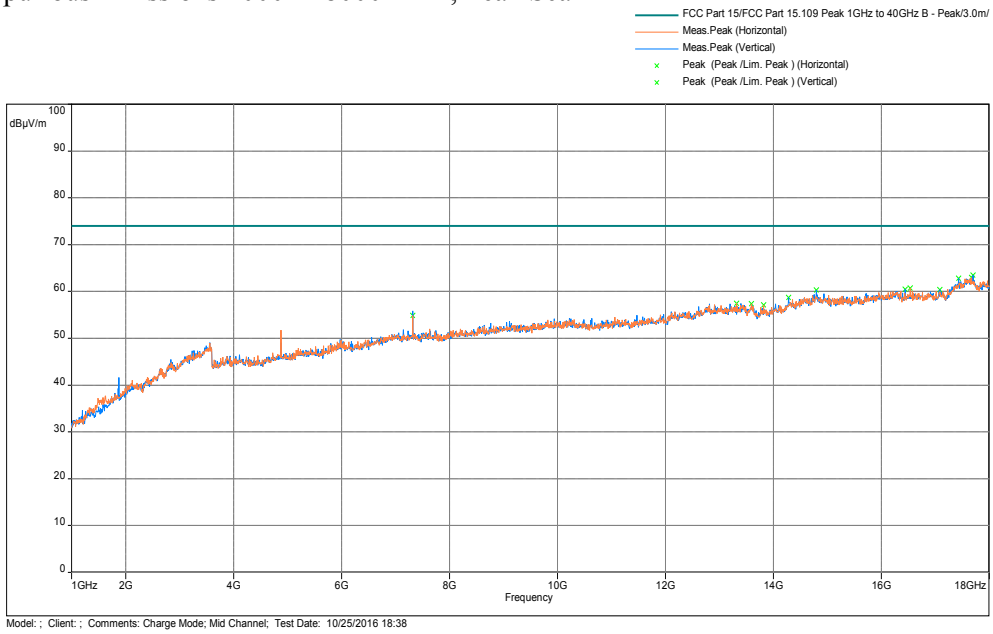
Note: FS@3m = RA + AF + CF - Preamp, (Average)

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

Radiated Spurious Emissions 30 MHz - 1000 MHz

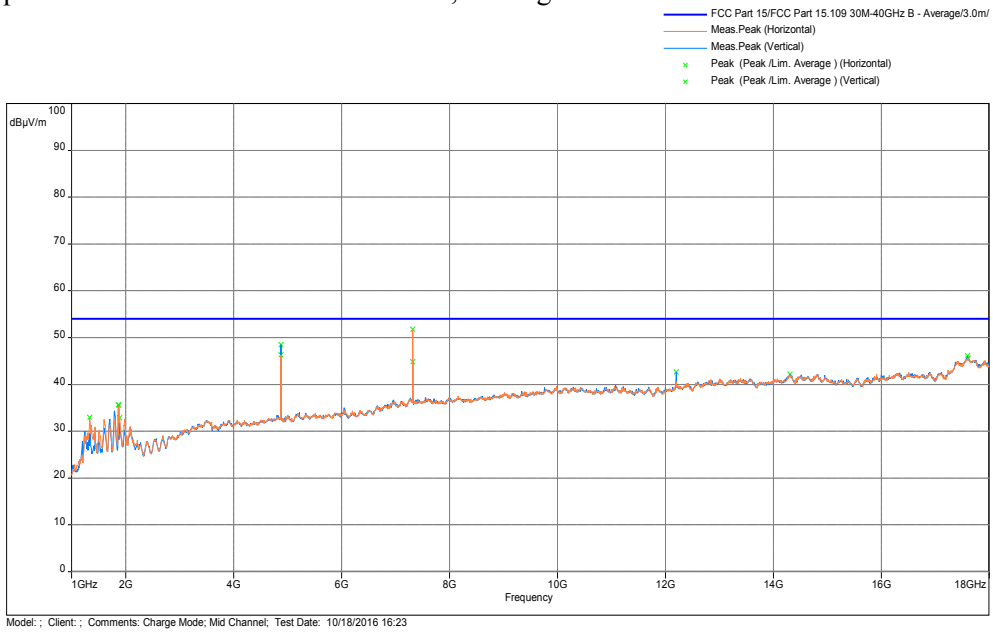


Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan



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

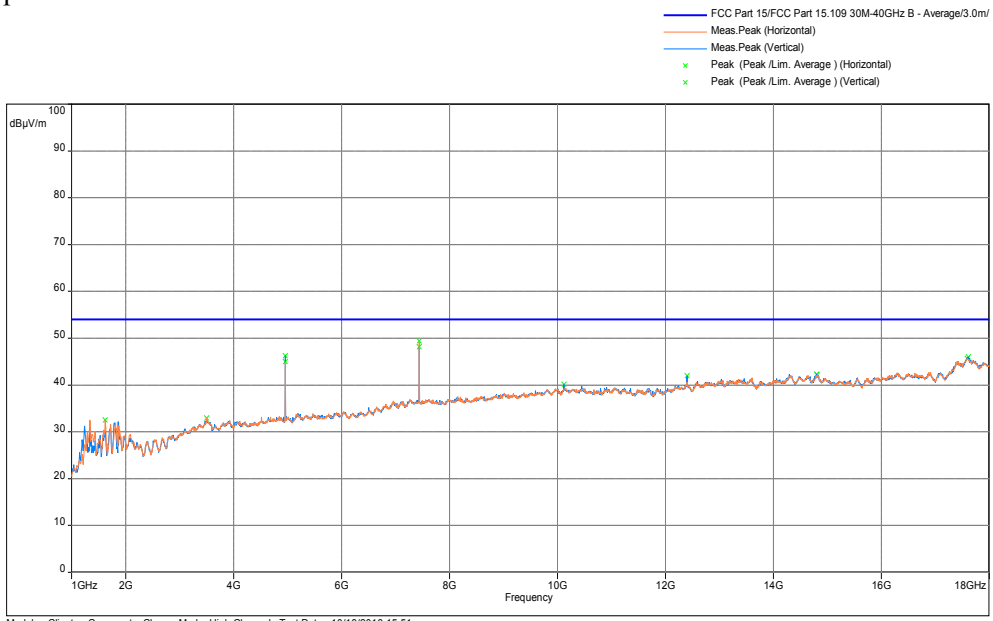
Radiated Spurious Emissions 1000 - 18000 MHz, Average Scan



Note: FS@3m = RA + AF + CF - Preamp, (Average)

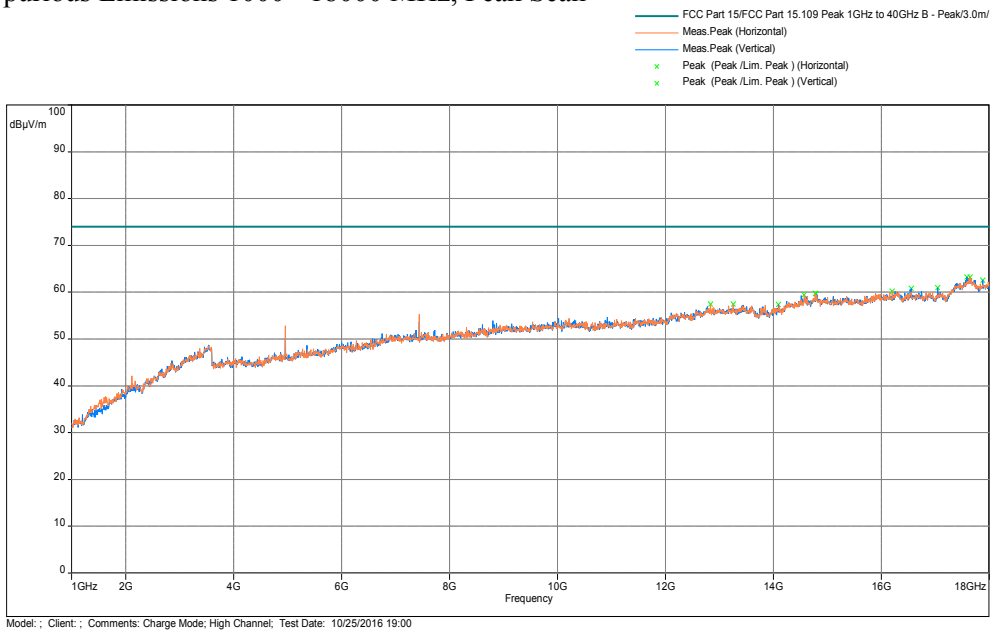
Test Results: 15.209 Radiated Spurious Emissions High Channel, Tx at 2480MHz, AC Power

Radiated Spurious Emissions 30 MHz - 1000 MHz



Model: ; Client: ; Comments: Charge Mode; High Channel; Test Date: 10/18/2016 15:51

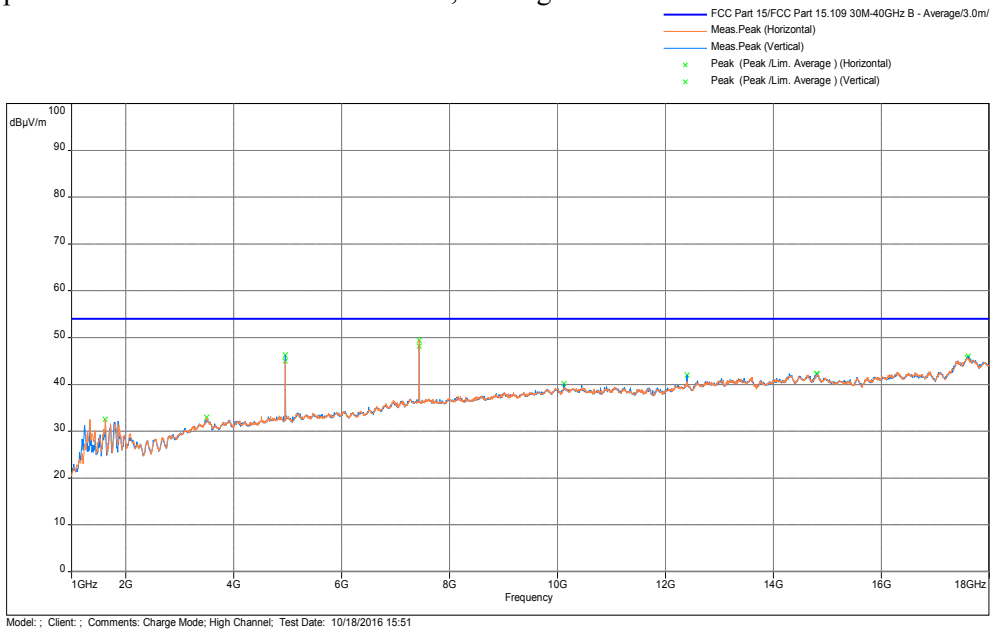
Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan



Model: ; Client: ; Comments: Charge Mode; High Channel; Test Date: 10/25/2016 19:00

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

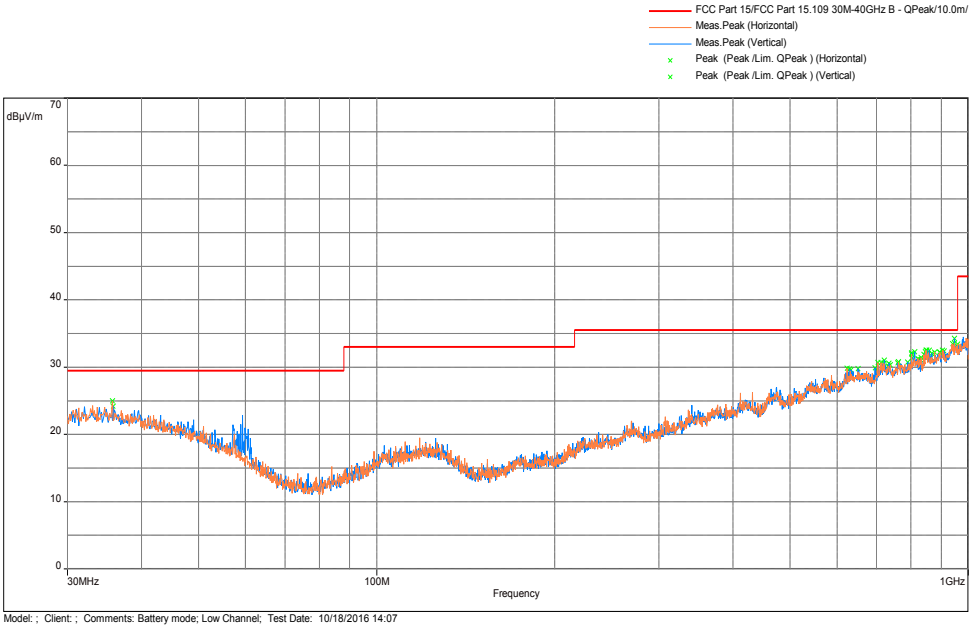
Radiated Spurious Emissions 1000 - 18000 MHz, Average Scan



Note: FS@3m = RA + AF + CF - Preamp, (Average)

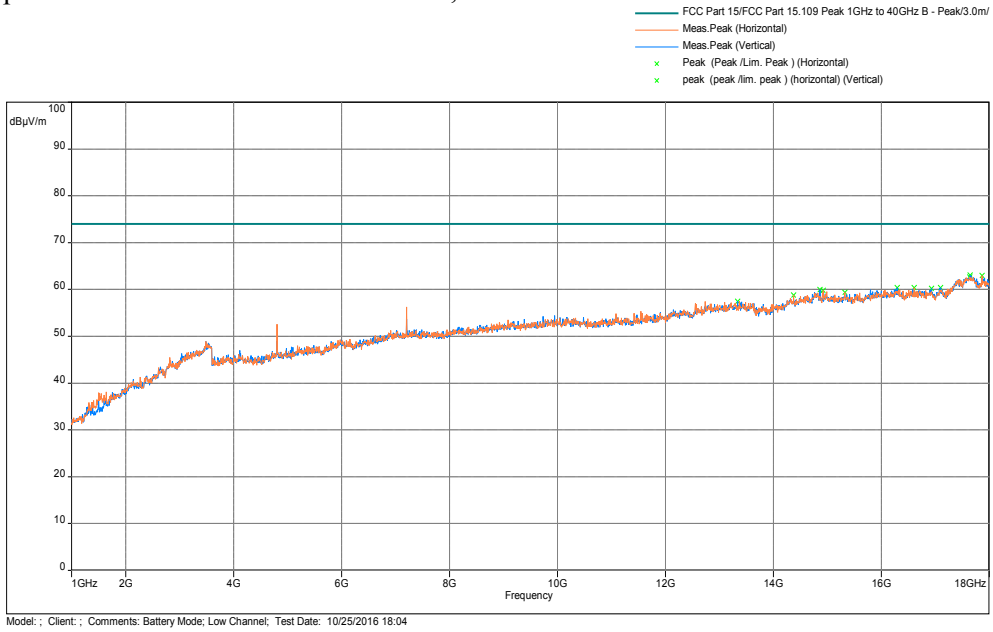
Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 2402MHz, Battery Power

Radiated Spurious Emissions 30 MHz - 1000 MHz



Model: ; Client: ; Comments: Battery mode; Low Channel; Test Date: 10/18/2016 14:07

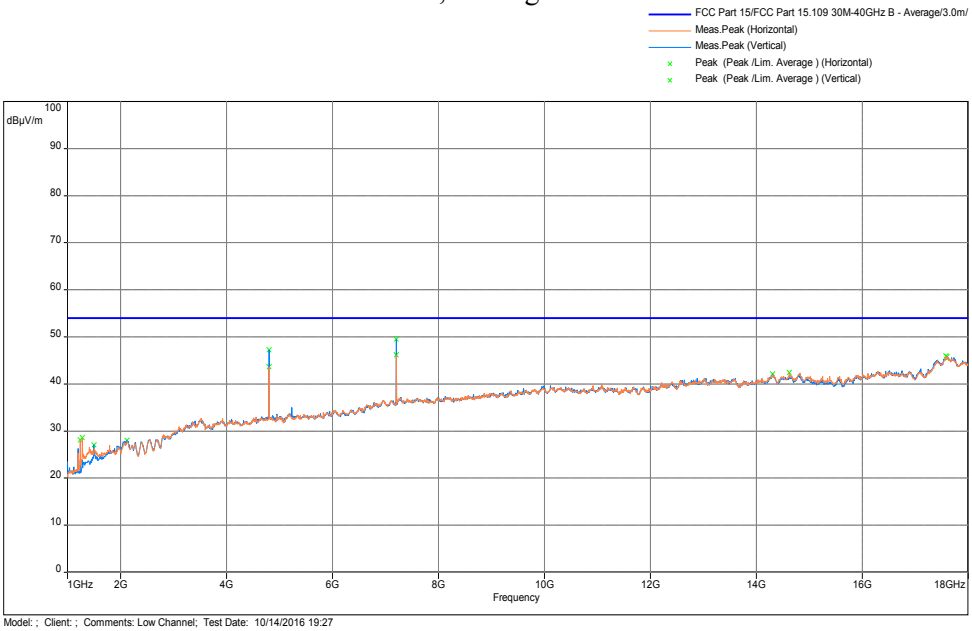
Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan



Model: ; Client: ; Comments: Battery Mode; Low Channel; Test Date: 10/25/2016 18:04

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

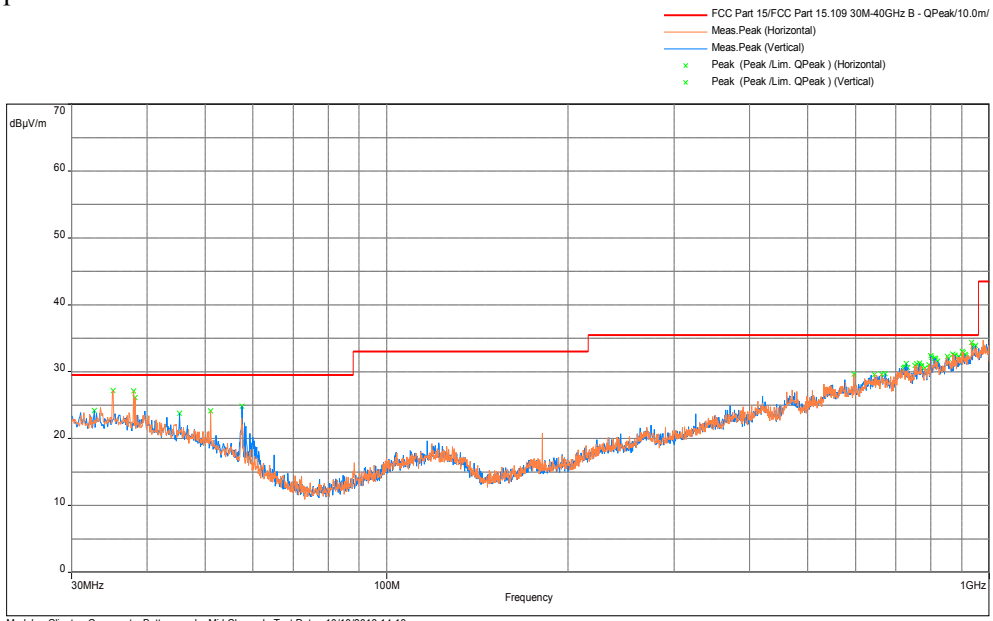
Radiated Spurious Emissions 1000 - 18000 MHz, Average Scan



Note: FS@3m = RA + AF + CF - Preamp, (Average)

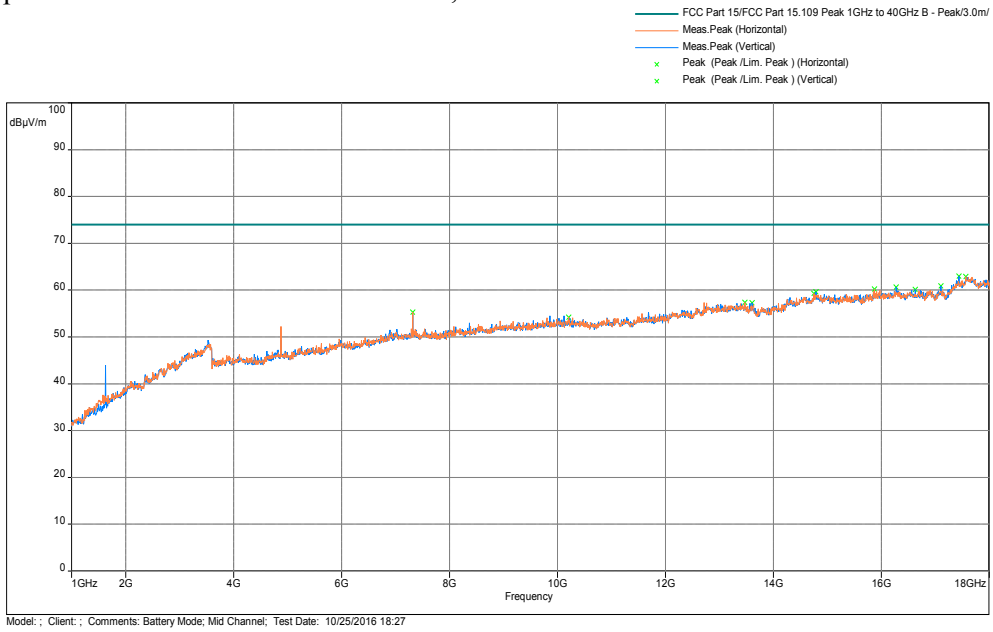
Test Results: 15.209 Radiated Spurious Emissions Mid Channel, Tx at 2440MHz, Battery Power

Radiated Spurious Emissions 30 MHz - 1000 MHz



Model: ; Client: ; Comments: Battery mode; Mid Channel; Test Date: 10/18/2016 14:16

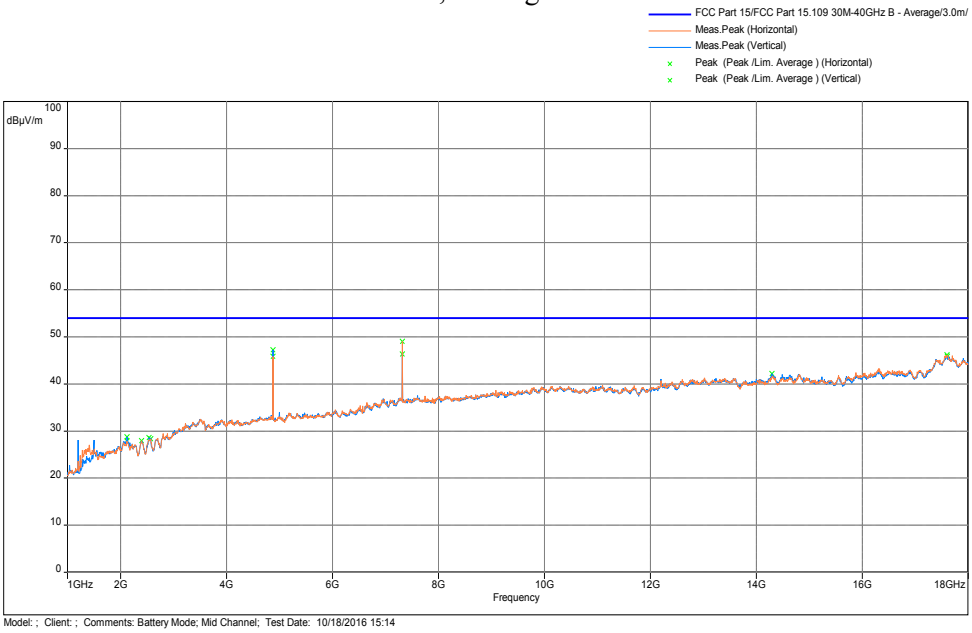
Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan



Model: ; Client: ; Comments: Battery Mode; Mid Channel; Test Date: 10/25/2016 18:27

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

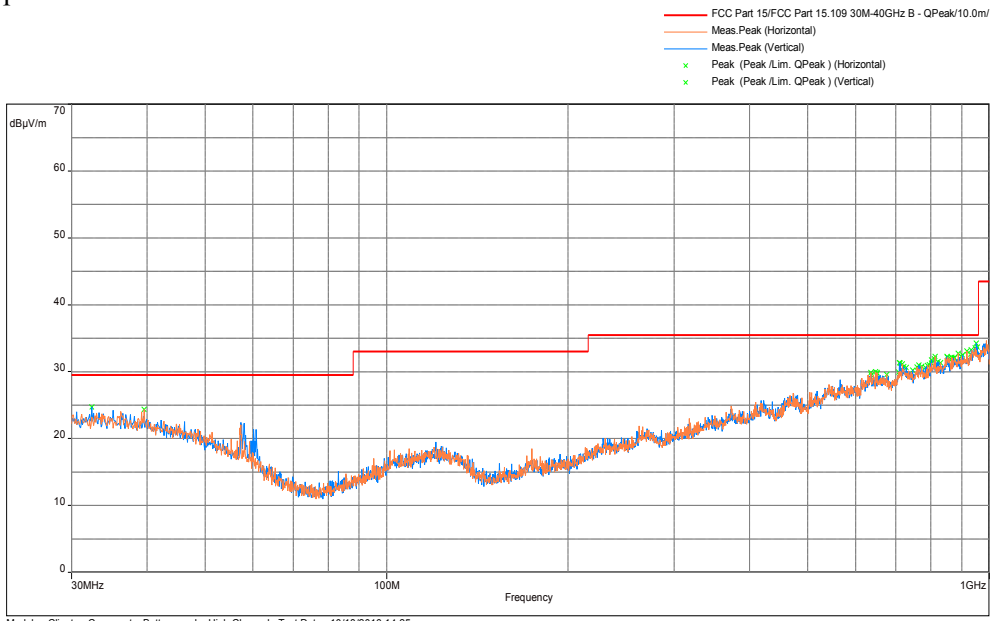
Radiated Spurious Emissions 1000 - 18000 MHz, Average Scan



Note: FS@3m = RA + AF + CF - Preamp, (Average)

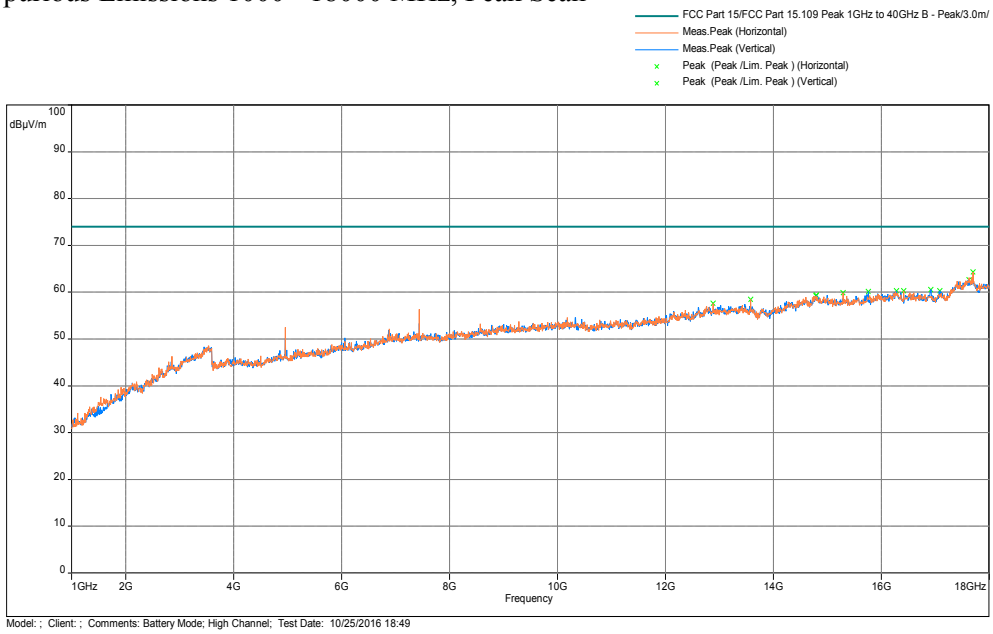
Test Results: 15.209 Radiated Spurious Emissions High Channel, Tx at 2480MHz, Battery Power

Radiated Spurious Emissions 30 MHz - 1000 MHz



Model: ; Client: ; Comments: Battery mode; High Channel; Test Date: 10/18/2016 14:25

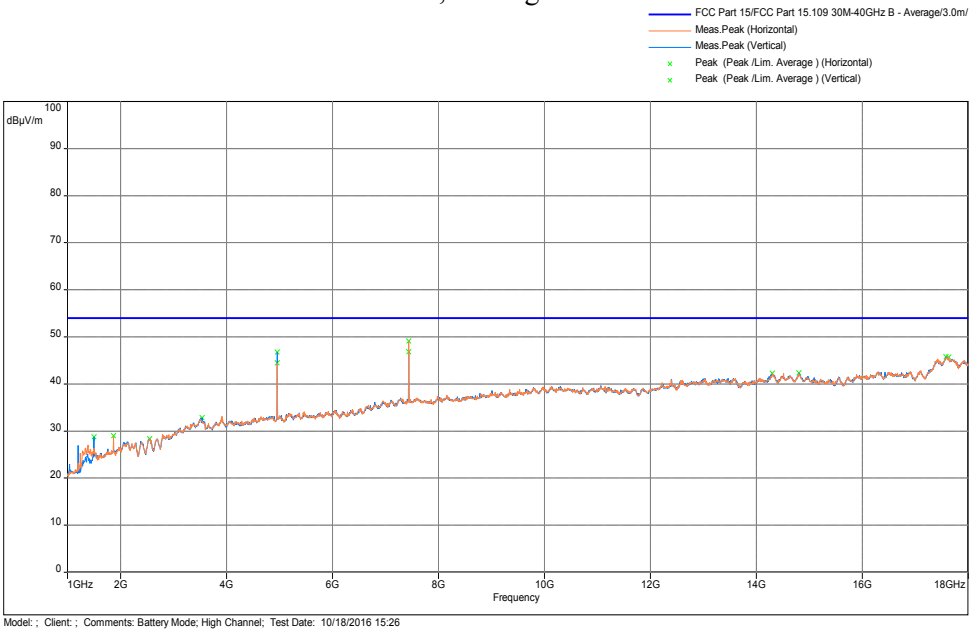
Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan



Model: ; Client: ; Comments: Battery Mode; High Channel; Test Date: 10/25/2016 18:49

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

Radiated Spurious Emissions 1000 - 18000 MHz, Average Scan

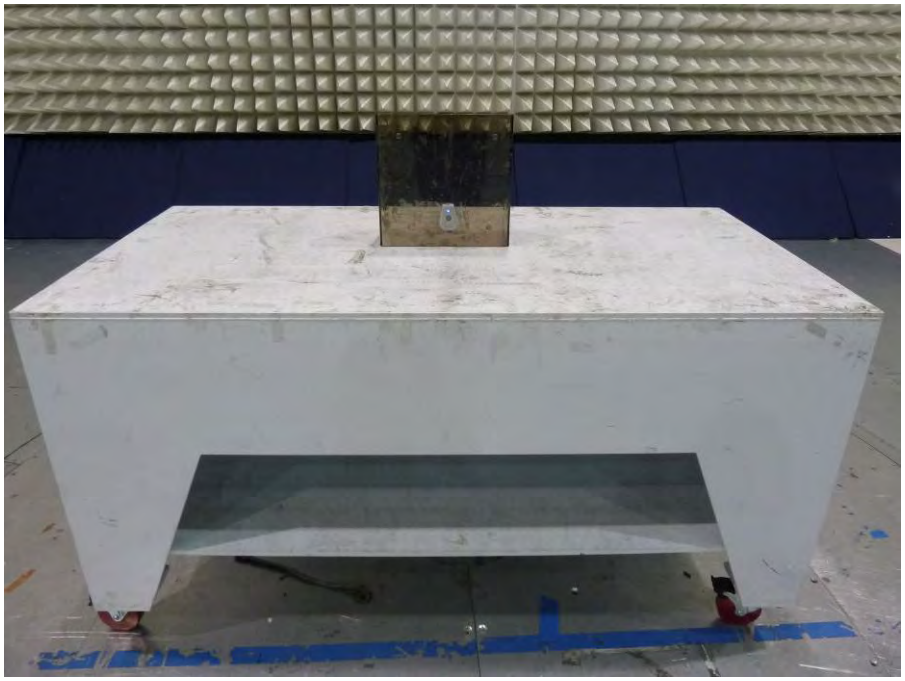


Note: FS@3m = RA + AF + CF - Preamp, (Average)

Results	**Complies**

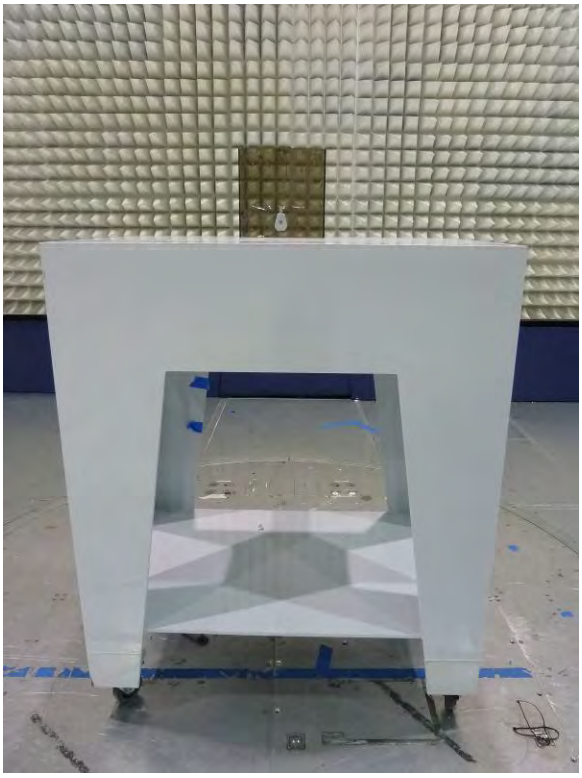
4.5.8 Test setup photographs

The following photographs show the testing configurations used.

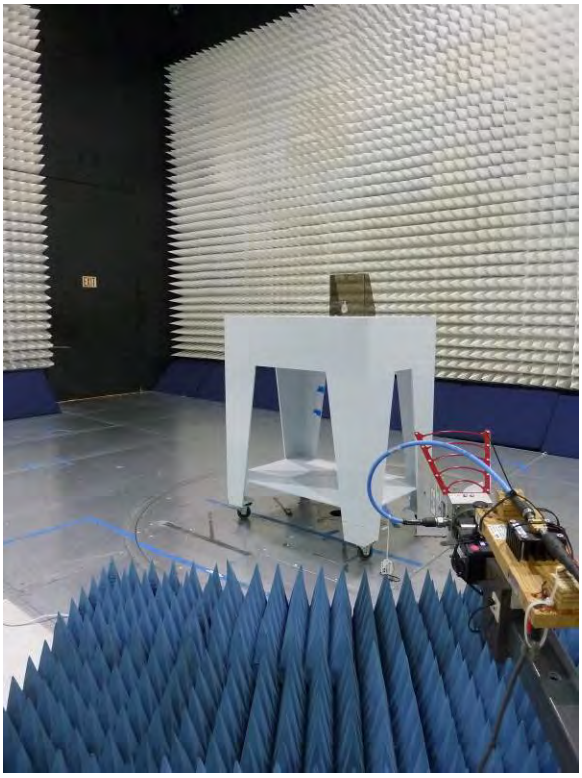


4.5.5 Test setup photographs (Continued)

4.5.5 Test setup photographs (Continued)



4.5.8 Test setup photographs (Continued)



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.

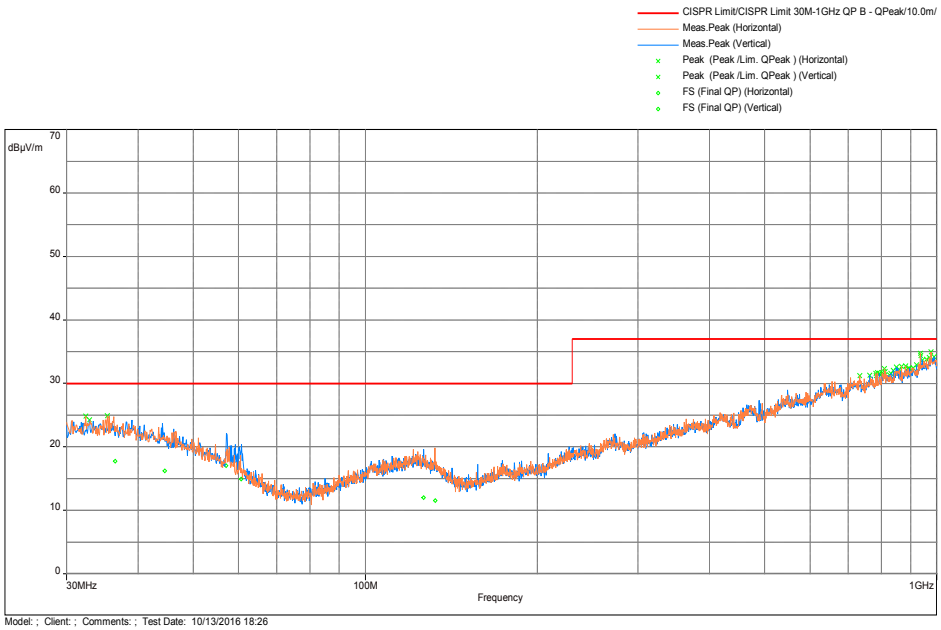
Equipment setup for radiated disturbance tests followed the guidelines of ANSI C63.4 and EN 55022.

4.6.3 Test Results

Radiated emission measurements were performed from 30 MHz to 18000 MHz. The data on the following pages list the significant emission frequencies, the limit and the margin of compliance.

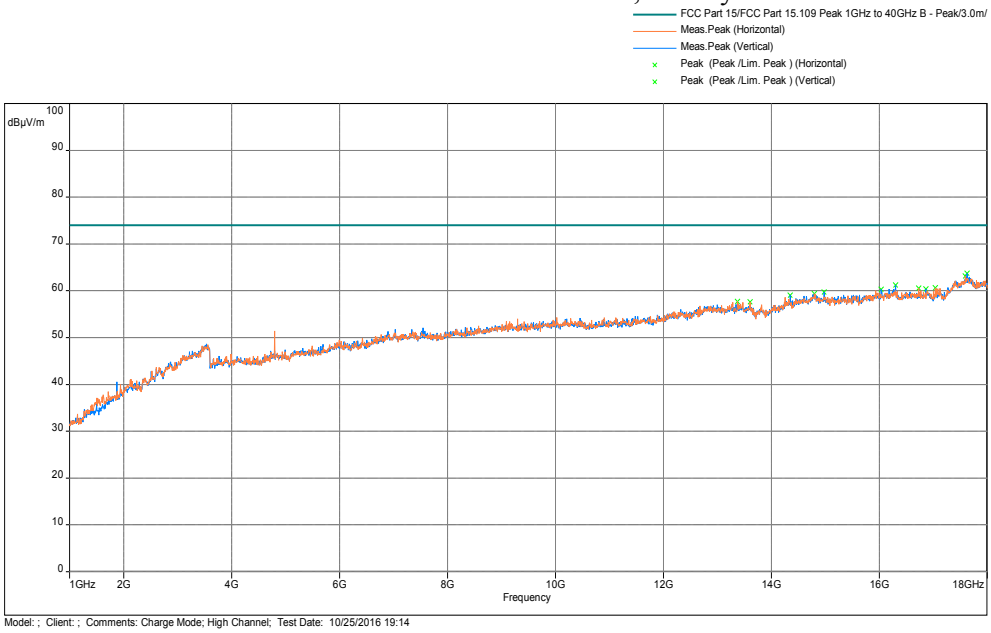
Date of Test:	October 13, 18 & 25, 2016
Results	**Complies**

Test Results: Radiated Emissions 30 MHz – 1000 MHz, Battery mode

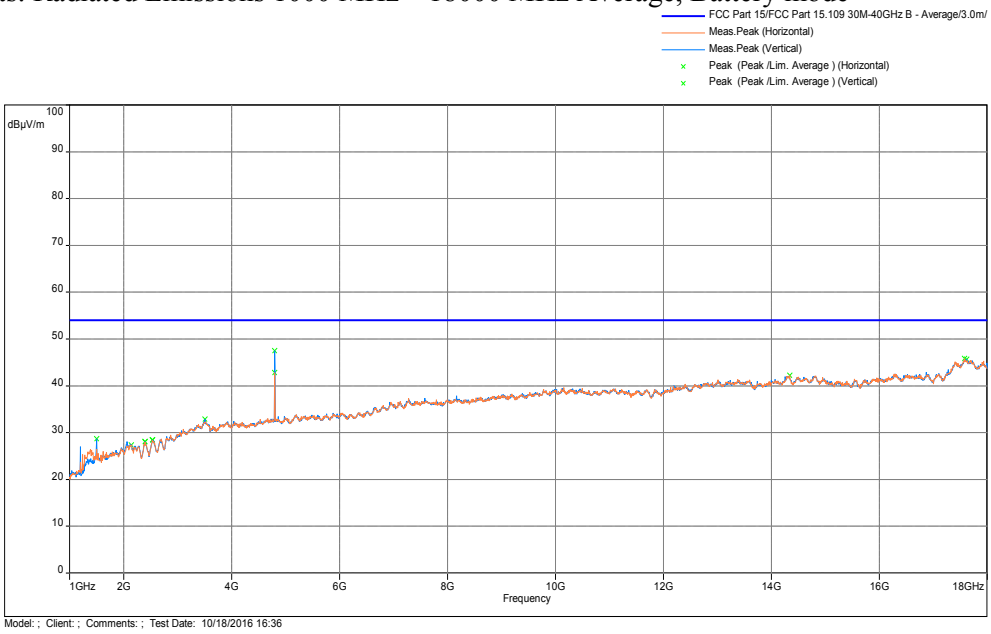


Frequency	Quasi Pk FS	Limit@3m	Margin	Azimuth	Height	Polarity	Raw	Correction
MHz	**dB(uV/m)**	**dB(uV/m)**	**dB**	**deg**	**cm**		**dB(uV/m)**	**dB**
36.544	17.76	30	-12.24	157	3.76	Horizontal	22.03	-4.34
132.652	11.52	30	-18.48	341	2.85	Horizontal	21.74	-10.26
44.518	16.22	30	-13.78	232.75	1.76	Vertical	22.05	-5.89
57.110	17.06	30	-12.94	264	2.24	Vertical	26.77	-9.7
60.696	14.94	30	-15.06	256.25	3.84	Vertical	25.96	-11
126.456	12	30	-18	253.5	4	Vertical	21.52	-9.51

Test Results: Radiated Emissions 1000 MHz – 18000 MHz Peak, Battery mode

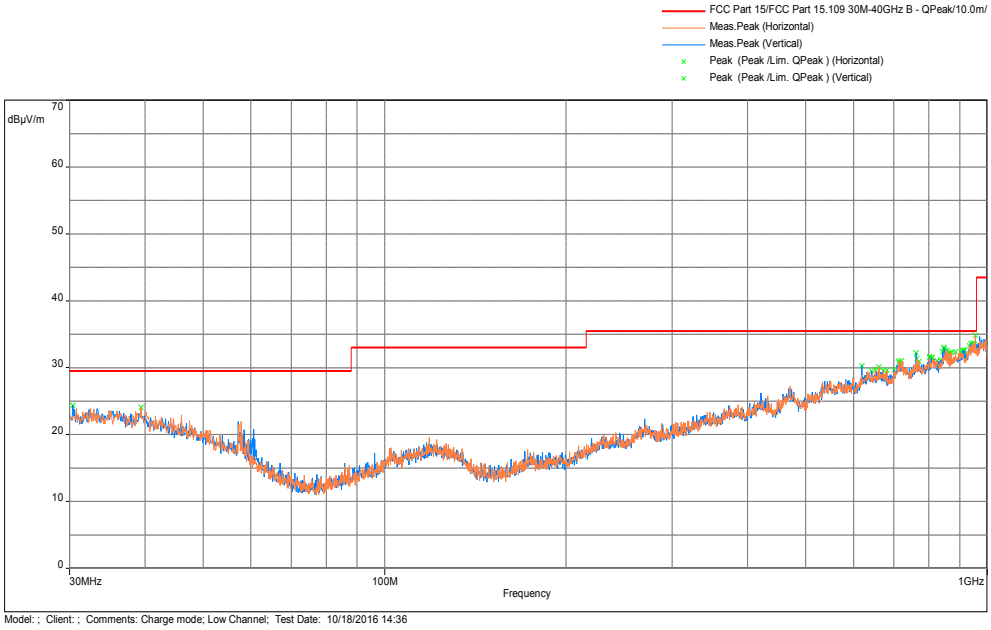


Test Results: Radiated Emissions 1000 MHz – 18000 MHz Average, Battery mode



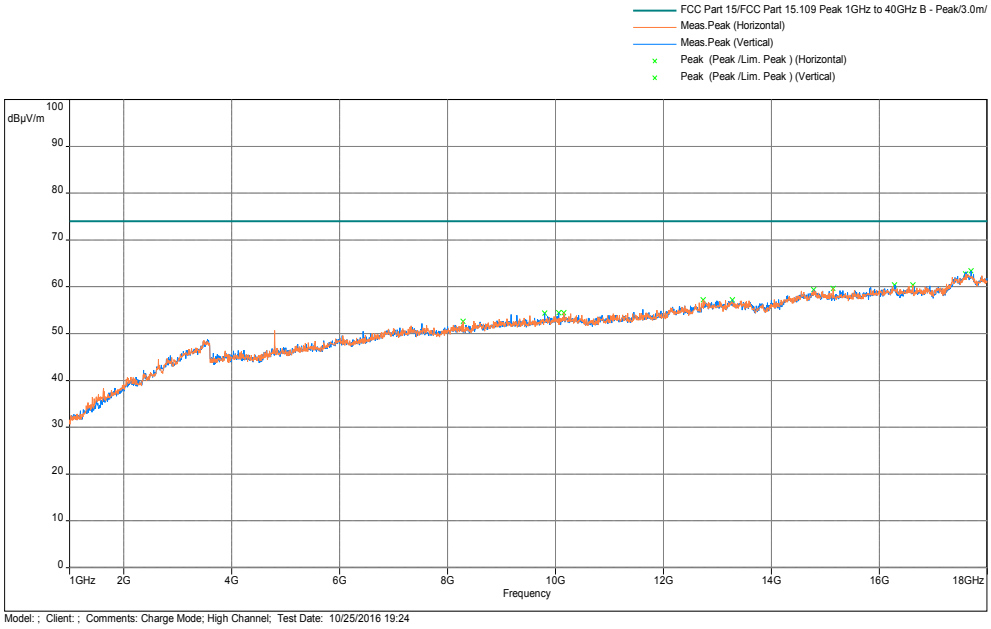
Note: Radiated emission measurements were performed up to 25GHz. No Emissions were identified when scanned from 18-25 GHz

Test Results: Radiated Emissions 30 MHz – 1000 MHz, AC mode

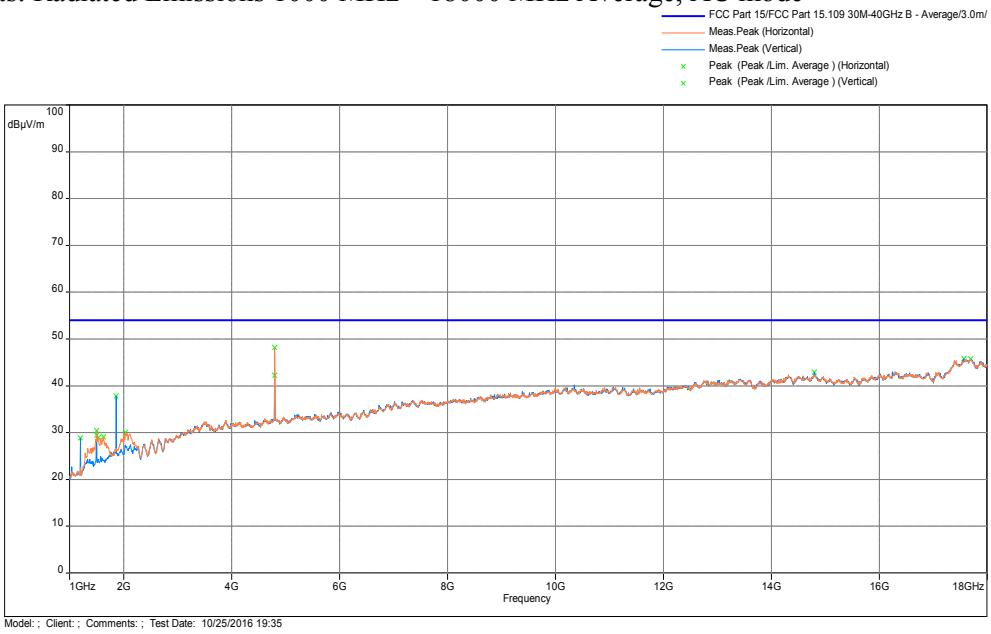


Frequency	Quasi Pk FS	Limit@3m	Margin	Height	Azimuth	Polarity	Raw	Correction
MHz	dB(uV/m)	dB(uV/m)	dB	cm	deg		dB(uV/m)	dB
35.82	24.18	29.5	-5.32	2.48	150.5	Vertical	28.35	-4.17
695.711	29.89	35.5	-5.61	1.02	348.75	Vertical	29.3	0.59
623.931	29.83	35.5	-5.67	2.48	0	Horizontal	29.48	0.35
651.188	29.74	35.5	-5.76	3.98	0	Vertical	28.92	0.82
630.236	29.68	35.5	-5.82	2.48	307.75	Vertical	28.81	0.87
633.34	29.61	35.5	-5.89	2.48	193.5	Vertical	28.6	1.01

Test Results: Radiated Emissions 1000 MHz – 18000 MHz Peak, AC mode



Test Results: Radiated Emissions 1000 MHz – 18000 MHz Average, AC mode

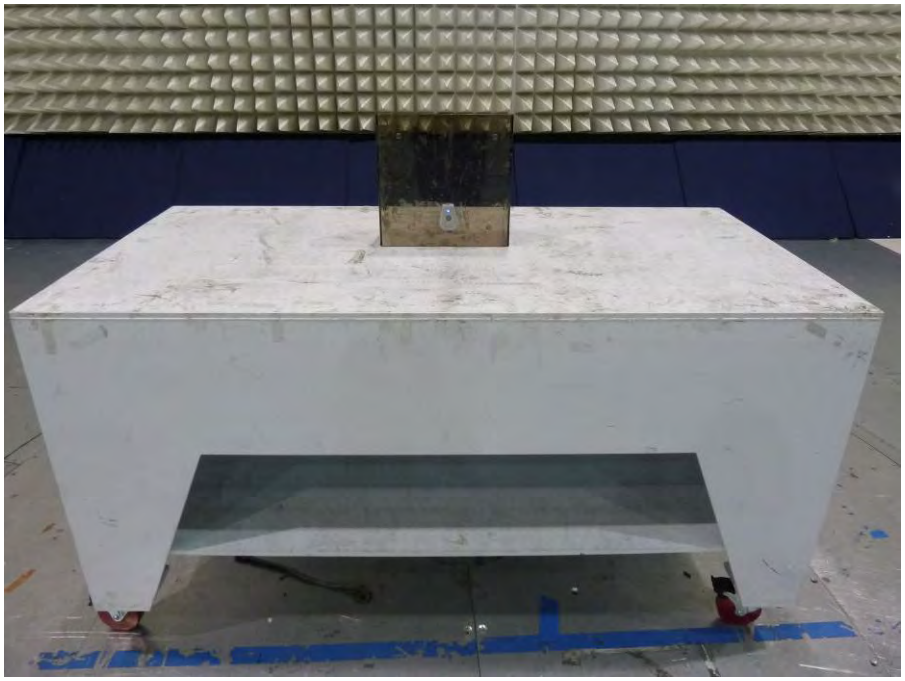


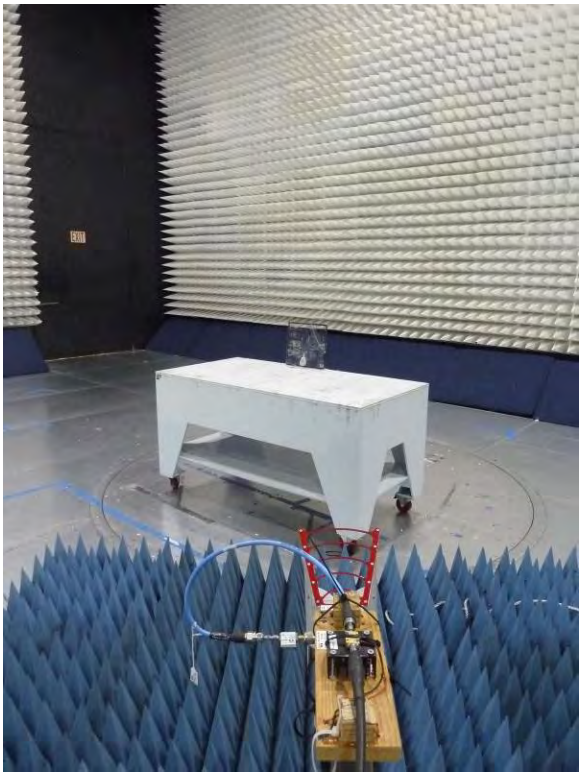
Note: Radiated emission measurements were performed up to 25GHz. No Emissions were identified when scanned from 18-25 GHz

Result:	**Complies** by 5.32 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(μV)		Class A Limit dB(μV)	
	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.

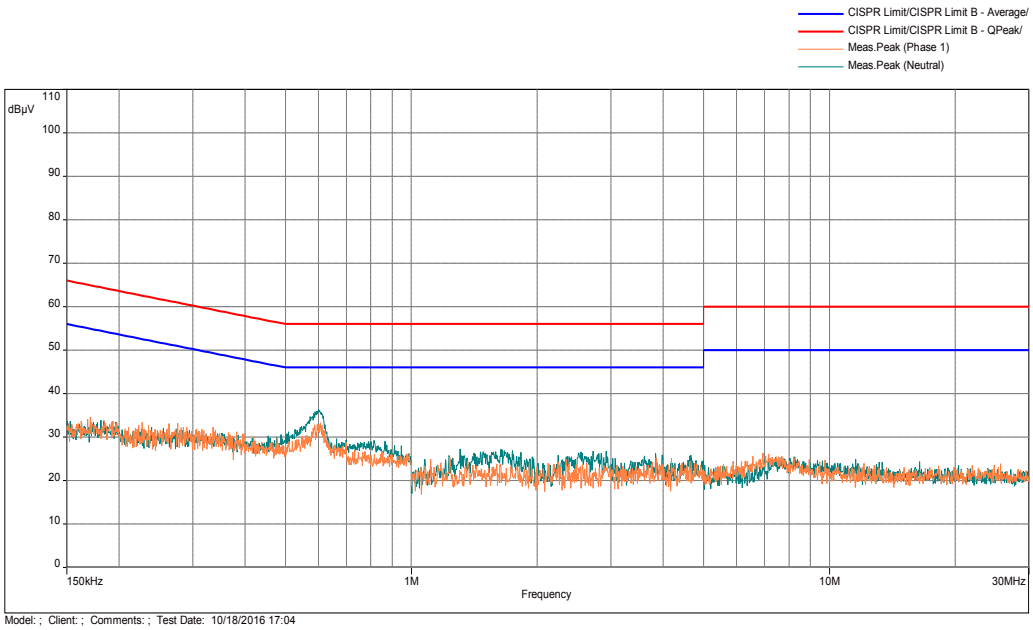
Floor standing EUT are placed on a horizontal metal ground plane and isolated from the ground plane by resting on an insulating material. The metal ground plane extends at least 0.5m beyond the boundaries of the EUT and has minimum dimensions of 2m by 2m.

Equipment setup for conducted disturbance tests followed the guidelines of ANSI C63.4: 2014.

4.7.3 Test Result

Date of Test:	October 18, 2016
Results	**Complies**

AC Line Conducted Emission Data



Intertek Testing Services
Line Conducted Emissions 150 kHz - 30 MHz
Operator: KR

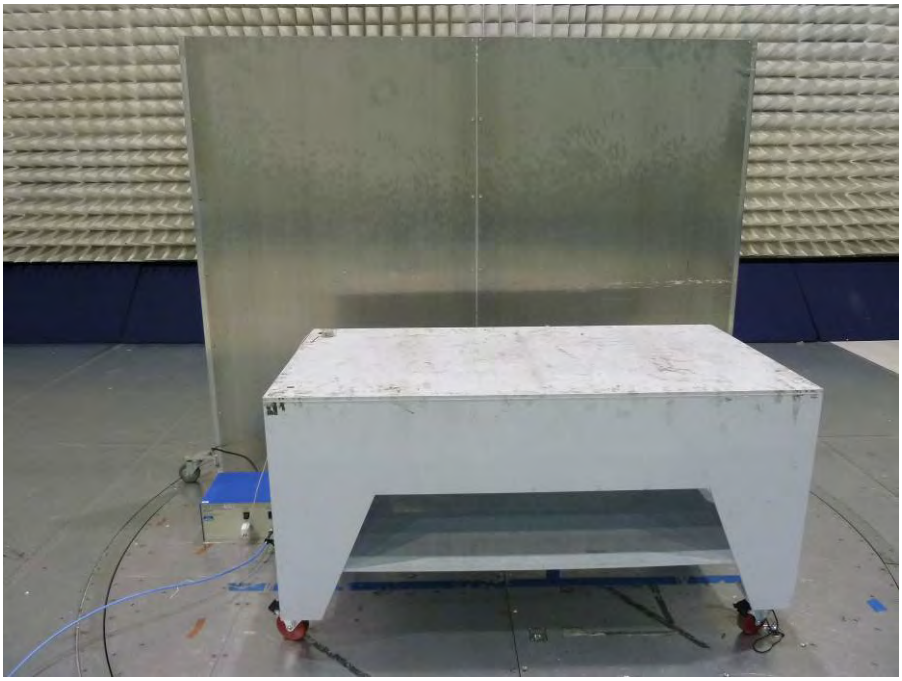
Model Number: Sevena
Company: Carrot Sense, Inc.

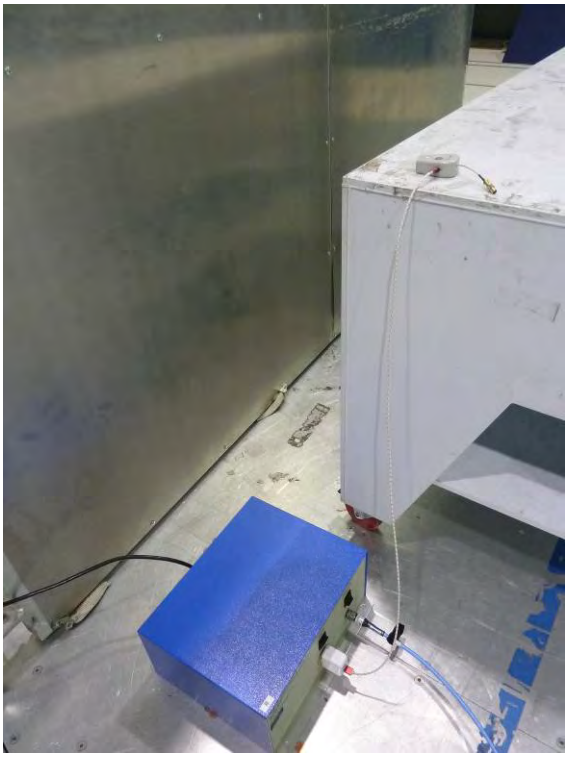
Frequency	Av Level	QP Level	Av Limit	QP Limit	Av Margin	QP Margin	Line
MHz	dBuV	dBuV	dBuV	dBuV	dB	dB	
1.236	25.36	25.36	46	56	-20.64	-30.64	Phase 1
2.350	24.85	24.85	46	56	-21.15	-31.15	Phase 1
3.776	24.29	24.29	46	56	-21.71	-31.71	Phase 1
3.854	25.17	25.17	46	56	-20.83	-30.83	Phase 1
4.187	25.18	25.18	46	56	-20.82	-30.82	Phase 1
4.636	24.45	24.45	46	56	-21.55	-31.55	Phase 1

Results	**Complies** by 20.64 dB

4.7.4 Test Configuration Photographs

The following photographs show the testing configurations used.





5.0 RF Exposure Evaluation

1. FCC KDB 447898 D01 v05r02.

SAR test exclusion threshold formula according to KDB 447898 D01 is:

$$\frac{EIRP\sqrt{f}}{d} < 3$$

Where:
EIRP is *max. average radiated power of a channel, including tune-up tolerance, mW*
f is operating frequency, GHz
d is *min. test separation distance, mm*

The maximum measured peak conducted output power is -2.59 dBm. The antenna gain, G is 1.7 dBi. Therefore, the maximum calculated average EIRP is -0.89 dBm or 0.815 mW.

At 5mm distance the condition for SAR exclusion threshold is:

$0.815 \times \sqrt{2.480} \div 5 = 0.257$ which is less than 3.

Therefore, SAR testing is not required as the SAR Test Exclusion Threshold condition is satisfied.

2. IC RSS-102 Issue 5.

SAR Exemption limit according to IC RSS-102 (sec. 2.5.1) is:

at frequency 2450 MHz and separation distance ≤ 5 mm SAR Exemption limit equals 4 mW.
SAR evaluation is not required since the higher of the maximum conducted or equivalent isotropically radiated power (EIRP) source-based, time averaged output power is below the exemption limit.

Date of Test:	October 25, 2016
Results	**Complies**

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
EMI Receiver	Rohde and Schwarz	ESU	ITS 00961	12	12/11/16
BI-Log Antenna	Antenna Research	LPB 2513	ITS 00355	12	09/09/17
Pre-Amplifier	Sonoma Instrument	310N	ITS 00942	12	01/07/17
Horn Antenna	ETS Lindgren	3117-PA	ITS 01365	12	08/09/17

No Calibration required

7.0 Document History

Revision/ Job Number	Writer Initials	Reviewers Initials	Date	Change
1.0 / G102733709	AC	KV	October 27, 2016	Original document