

TEST REPORT

Report Number: 102738196MPK-014

Project Number: G102738196

January 27, 2017

**Testing performed on
AcceleDent Optima Activator**

Model: 300-0027-001

FCC ID: 2AKKO-3

IC: 22276-3

to

FCC Part 15 Subpart C (15.247)

Industry Canada RSS-247 Issue 1

FCC Part 15, Subpart B

Industry Canada ICES-003

For

OrthoAccel Technologies, Inc.

Test Performed by:

Intertek

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Menlo Park, CA 94025 USA

Test Authorized by:

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Date: January 27, 2017

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Date: January 27, 2017

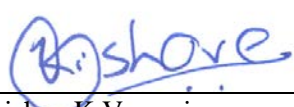
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Report No. 102738196MPK-014

Equipment Under Test:	AcceleDent Optima Activator
Trade Name:	OrthoAccel Technologies, Inc.
Model Number:	300-0027-001
Applicant:	OrthoAccel Technologies, Inc.
Contact:	Alex Bevly III
Address:	OrthoAccel Technologies, Inc. 6575 West Loop S Ste 200 Bellaire, TX 77401
Country	USA
Tel. Number:	(832) 260-0101
Email:	Abevly@orthoaccel.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:	January 5-20, 2017

We attest to the accuracy of this report:



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Project Engineer

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TABLE OF CONTENTS

1.0	Summary of Tests	5
2.0	General Information.....	6
2.1	Product Description	6
2.2	Related Submittal(s) Grants.....	7
2.3	Test Facility	7
2.4	Test Methodology.....	7
2.5	Measurement Uncertainty.....	7
3.0	System Test Configuration.....	8
3.1	Support Equipment	8
3.2	Block Diagram of Test Setup.....	8
3.3	Justification.....	10
3.4	Software Exercise Program.....	10
3.5	Mode of Operation during Test.....	10
3.5	Modifications Required for Compliance	11
3.6	Additions, Deviations and Exclusions from Standards.....	11
4.0	Measurement Results.....	12
4.1	6-dB Bandwidth and Occupied Bandwidth	12
4.1.1	Requirement.....	12
4.1.2	Procedure	12
4.1.3	Test Result	12
4.2	Maximum Peak Conducted Output Power at Antenna Terminals	19
4.2.1	Requirement.....	19
4.2.2	Procedure	19
4.3.3	Test Result	19
4.3	Maximum Power Spectral Density	23
4.3.1	Requirement.....	23
4.3.2	Procedure	23
4.3.3	Test Result	23
4.4	Unwanted Conducted Emissions	27
4.4.1	Requirement.....	27
4.4.2	Procedure	27
4.4.3	Test Result	27
4.5	Transmitter Radiated Emissions	32
4.5.1	Requirement.....	32
4.5.2	Procedure	32
4.5.3	Field Strength Calculation	33
4.5.4	Antenna-port conducted measurements	34
4.5.6	General Procedure for conducted measurements in restricted bands.....	34
4.5.7	Test Results.....	34
4.5.8	Test setup photographs	52
4.6	Radiated Emissions.....	56
4.6.1	Requirement.....	56
4.6.2	Procedures.....	57
4.6.3	Test Results.....	57

4.6.4	Test Configuration Photographs	62
4.7	AC Line Conducted Emission	64
4.7.1	Requirement.....	64
4.7.2	Procedure	64
4.7.3	Test Results.....	65
4.7.4	Test Configuration Photographs	66
5.0	RF Exposure Evaluation	67
6.0	List of Test Equipment	68
7.0	Document History	69
Annex A	- Duty Cycle Measurement.....	70

1.0 Summary of Tests

Test	Reference FCC	Reference Industry Canada	Result
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)
RF Exposure	15.247(i), 2.1093(d)	RSS-102	Complies

EUT receive date: December 14, 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: January 05, 2017

Test completion date: January 20, 2017

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

2.0 General Information

2.1 Product Description

OrthoAccel Technologies, Inc. supplied the following description of the EUT:

The AcceleDent is an orthodontic accessory for use during orthodontic treatment. It is used in conjunction with orthodontic appliances such as braces and aligners to help facilitate minor anterior tooth movement.

Charging Case that accepts USB DC power and converts to wireless inductive power to charge an Activator. When not powered the Charging Case only purpose is to store the Activator.

For more information, see user's manual provided by the manufacturer.

Information about the Bluetooth 4.0 (BLE) radio is presented below:

For more information, refer to the following product specification, declared by the manufacturer.

Information about the 2.4 GHz radio is presented below:

Applicant	OrthoAccel Technologies, Inc.
Model No.	300-0027-001
FCC Identifier	2AKKO-3
IC Identifier	22276-3
Type of transmission	Digital Transmission System (DTS)
Rated RF Output	-5.10 dBm
Antenna(s) & Gain	Internal Antenna, Gain: 0 dBi
Frequency Range	2402 – 2480 MHz
Type of modulation/data rate	GFSK / 1Mbit/s
Number of Channel(s)	40, Channel 0-39
Applicant Name & Address	OrthoAccel Technologies, Inc. 6575 West Loop S Ste 200 Bellaire, TX 77401 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), and RSS-247, RSS-GEN.

Radiated emissions and AC mains conducted emissions measurements were performed according to the procedures in ANSI C63.10: 2013. 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 – 200 MHz	200 MHz – 1 GHz	1 GHz – 18 GHz
Radiated emissions	-	4.7	4.6	5.1 dB
AC mains conducted emissions	2.1 dB	-	-	-

3.0 System Test Configuration

3.1 Support Equipment

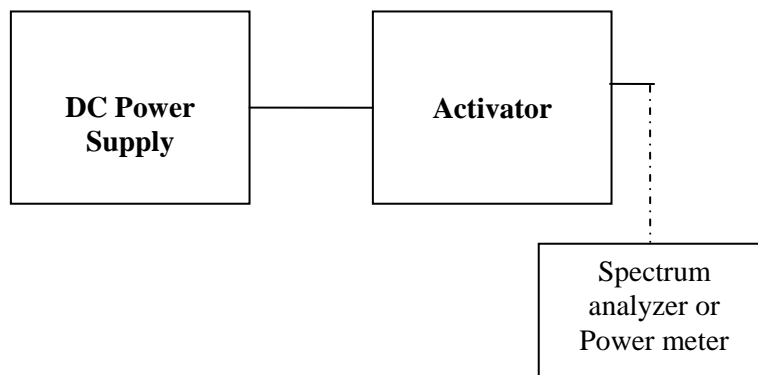
Description	Manufacturer	Model Number	Serial Number
DC Power Supply	Extech	EP-3003	D30030012

3.2 Block Diagram of Test Setup

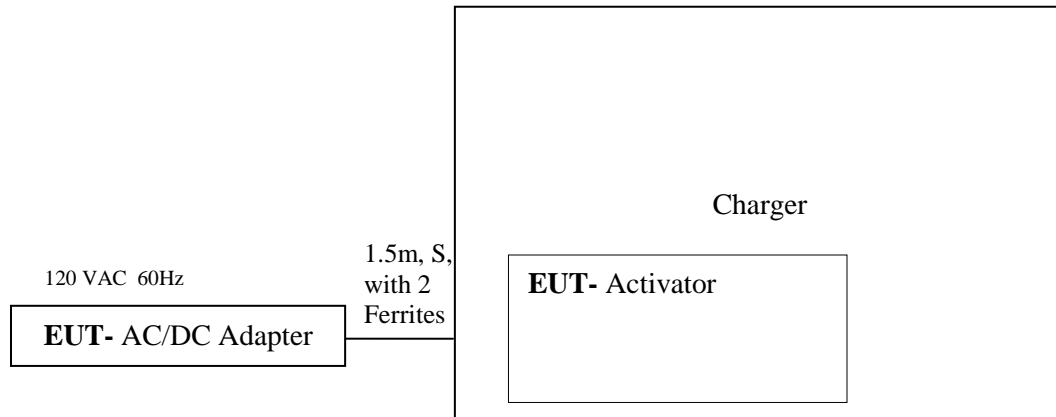
Equipment Under Test			
Type	Part #	Quantity	S/N or L/N
Activator	300-0027-001	1	3000080
Charging Case	300-0027-001	1	3000082
Mass Power AC Adapter	NB05B050100VUU	1	Not Marked
USB cable	NA	1	Not Marked

Battery mode

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



Charging mode



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

3.3 Justification

For radiated emission measurements the EUT is placed on a non-conductive table.

3.4 Software Exercise Program

The EUT exercise program used during radiated and conducted testing was provided by OrthoAccel Technologies, 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

Modifications were made by the manufacturer to the charging case and USB cable in order to bring the EUT into compliance for radiated emissions testing.

As provided by the manufacturer, the modifications made to the charging case are detailed below.

Ref Des	Original	Modifications
C13 C14	Samsung, CL31A226MOCLNNC, CAP CER 22UF 16V 20% X5R 1206	TDK, C3216X5R1A107M160AC, 100μF ±20% 10V Ceramic Capacitor X5R 1206 (3216 Metric)
C17 C18	Samsung, CL05C681JB5NNNC, CAP CER 680PF 50V NP0 0402	Samsung, CL05A106MP5NUNC, 10μF ±20% 10V Ceramic Capacitor X5R 0402 (1005 Metric)
C19	Samsung, CL05B472KB5NNNC, CAP CER 4700PF 50V 10% X7R 0402	Samsung, CL05A106MP5NUNC, 10μF ±20% 10V Ceramic Capacitor X5R 0402 (1005 Metric)
C20	Murata, GRM155R72A222KA01D, CAP CER 2200PF 100V 10% X7R 0402	Samsung, CL05A106MP5NUNC, 10μF ±20% 10V Ceramic Capacitor X5R 0402 (1005 Metric)
FB1	Taiyo Yuden, BKP1005EM331-T, FERRITE BEAD 330 OHM 0402	Samsung, CIM05J152NC, FERRITE BEAD 1.5 KOHM 0402 1LN
L4 -> FB2	Taiyo Yuden, BRC2012T2R2MD, FIXED IND 2.2UH 1A 143 MOHM SMD	Samsung Electro-Mechanics America, Inc., CIM21J252NE, FERRITE BEAD 2.5 KOHM 0805 1LN

The two ferrites added to the USB cable were clip-on off the shelf parts:

Laird-Signal Integrity Products 28A0392-0A0

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

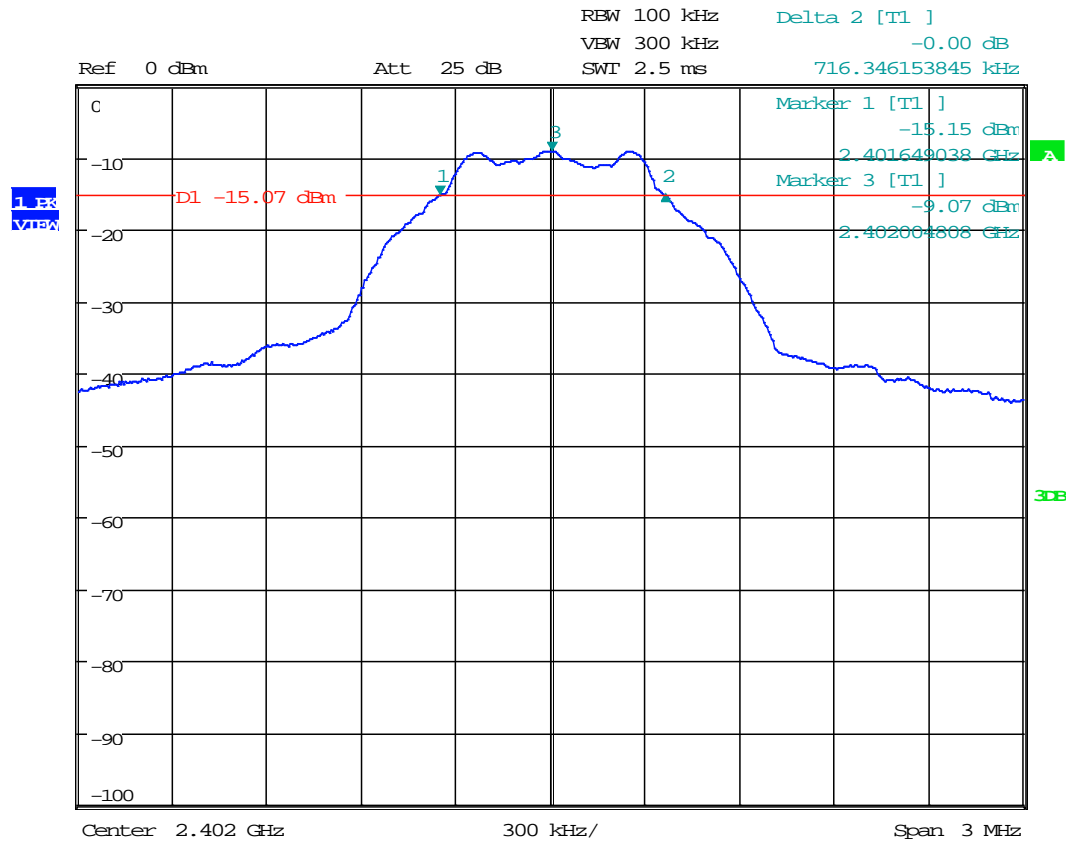
For 99% power bandwidth measurement, the bandwidth was determined by using the built-in 99% occupied bandwidth function of the spectrum analyzer. The resolution bandwidth is set to 1% of the selected span as is without being below 1%. The video bandwidth shall be set to 3 times the resolution bandwidth.

4.1.3 Test Result

Frequency (MHz)	6-dB bandwidth FCC 15.247 & RSS-GEN, kHz	Occupied bandwidth, RSS-GEN, MHz	Plot
2402	716.346	--	1.1
	--	1.053	1.4
2440	701.923	--	1.2
	--	1.058	1.5
2480	721.153	--	1.3
	--	1.058	1.6

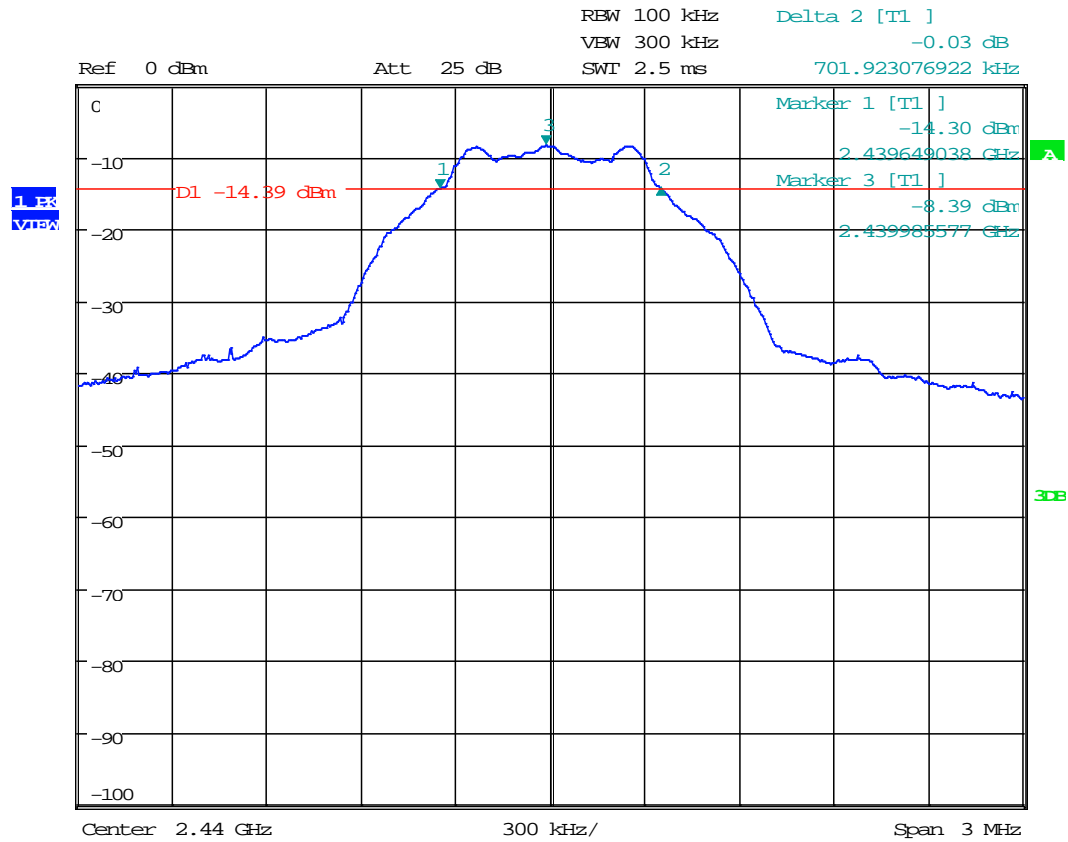
Date of Test:	January 6, 2017
Results	Complies

Plot 1. 1



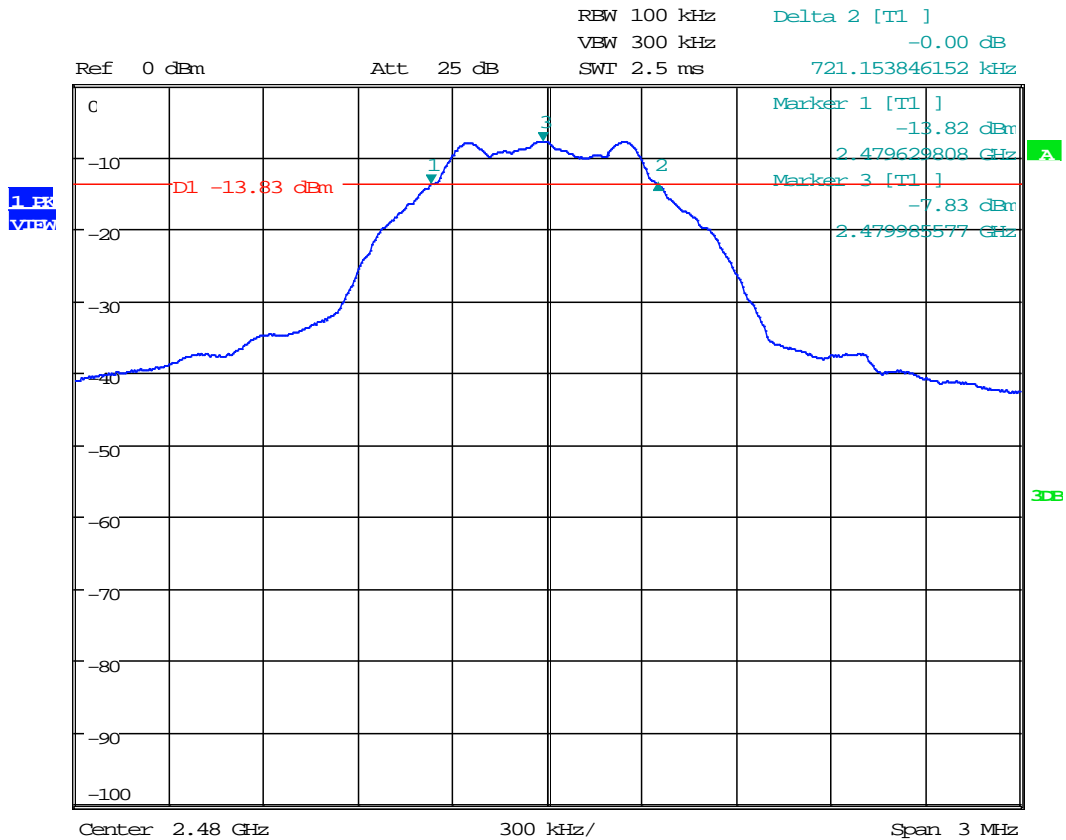
Date: 6.JAN.2017 08:26:45

Plot 1.2



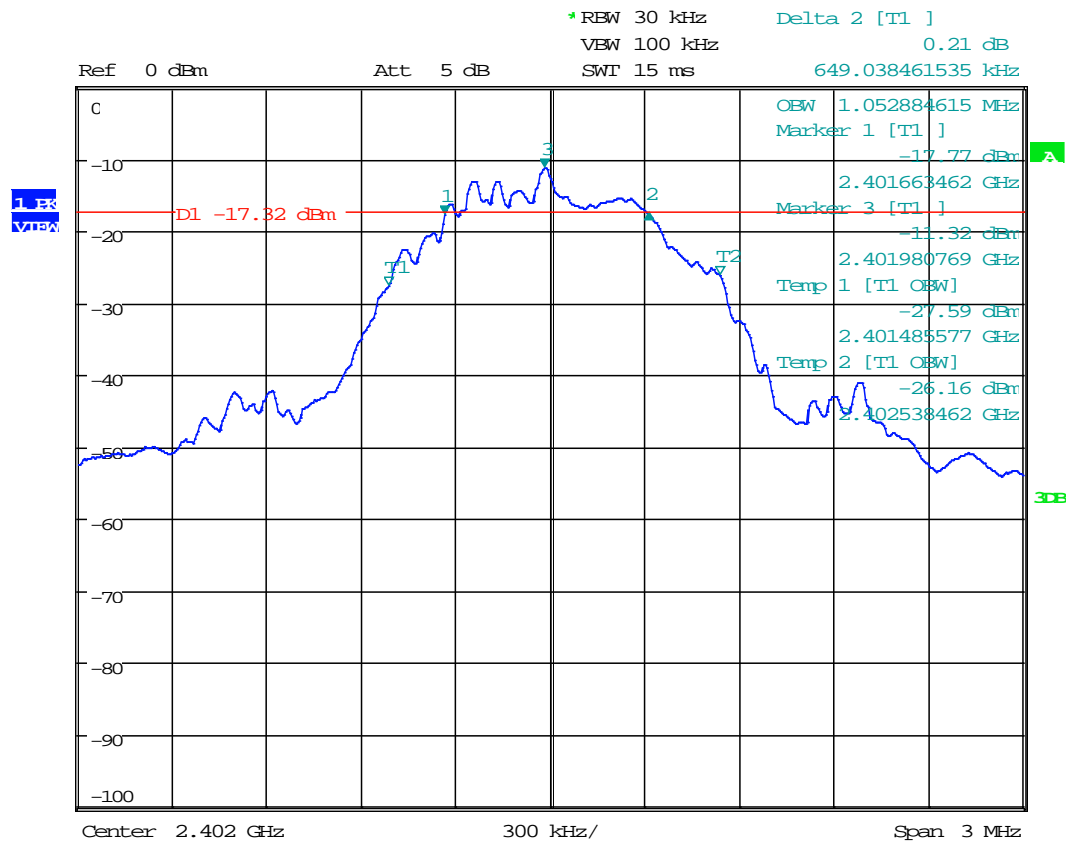
Date: 6.JAN.2017 08:29:27

Plot 1.3



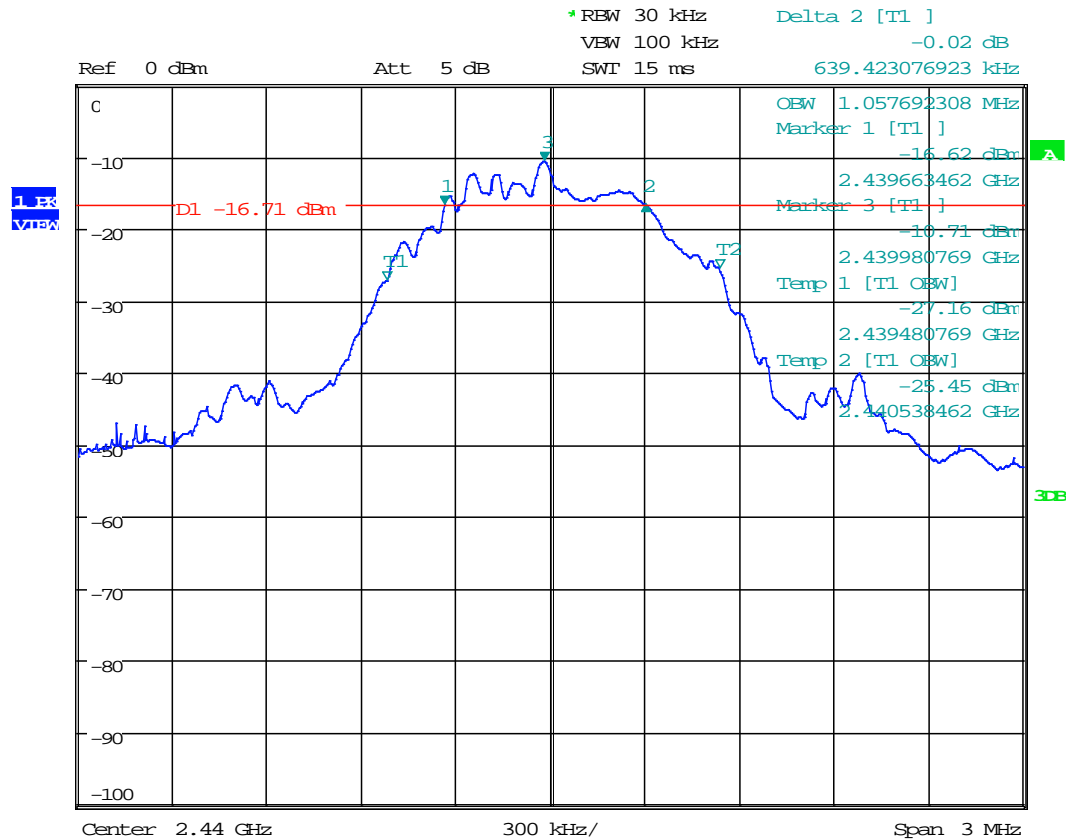
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Plot 1.4



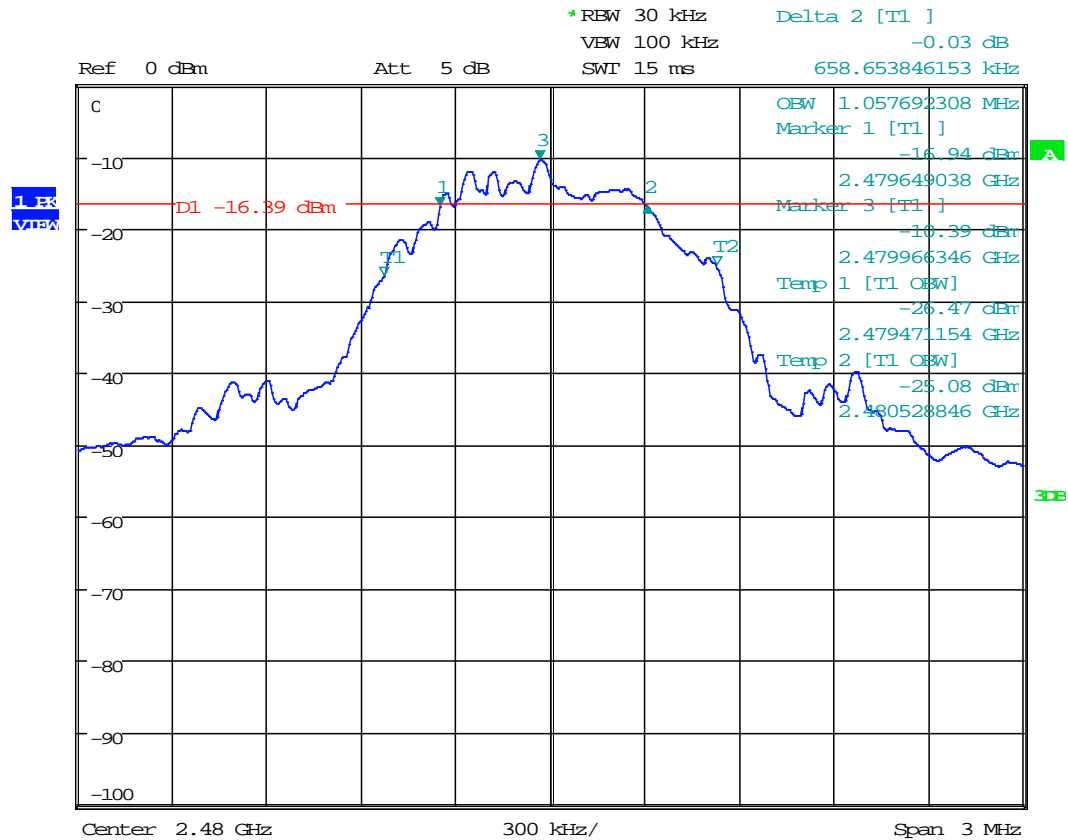
Date: 6.JAN.2017 08:34:19

Plot 1.5



Date: 6.JAN.2017 08:35:32

Plot 1.6



Date: 6.JAN.2017 08:32:21

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 was used. Specifically, section 9.1.1 RBW \geq DTS Bandwidth was utilized as the spectrum analyzer's resolution bandwidth was greater than the DTS bandwidth.

1. Set the RBW \geq DTS Bandwidth
2. Set the VBW $\geq 3 \times$ RBW
3. Set the span $\geq 3 \times$ 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.

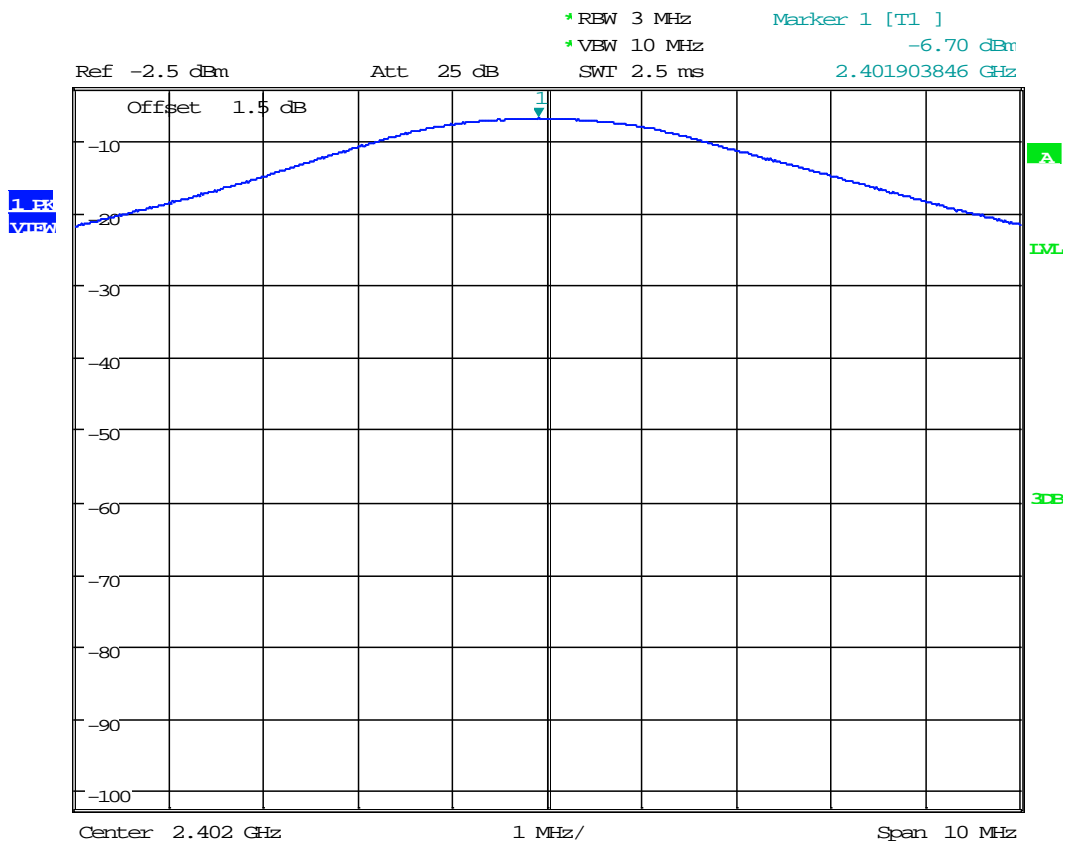
4.3.3 Test Result

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

Frequency, MHz	Conducted Power (peak), dBm	Conducted Power (peak), mW	Plot
2402	-6.70	0.214	2.1
2440	-5.71	0.269	2.2
2480	-5.10	0.309	2.3

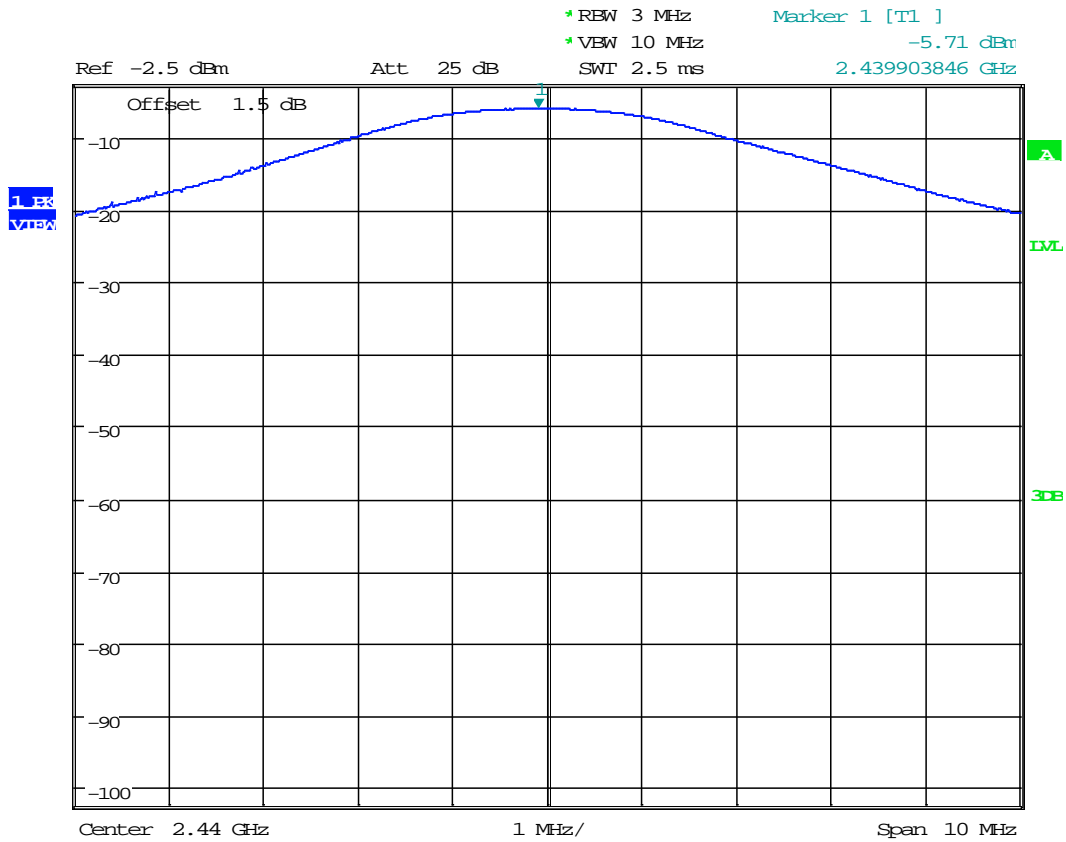
Date of Test:	January 5, 2017
Results	Complies

Plot 2. 1



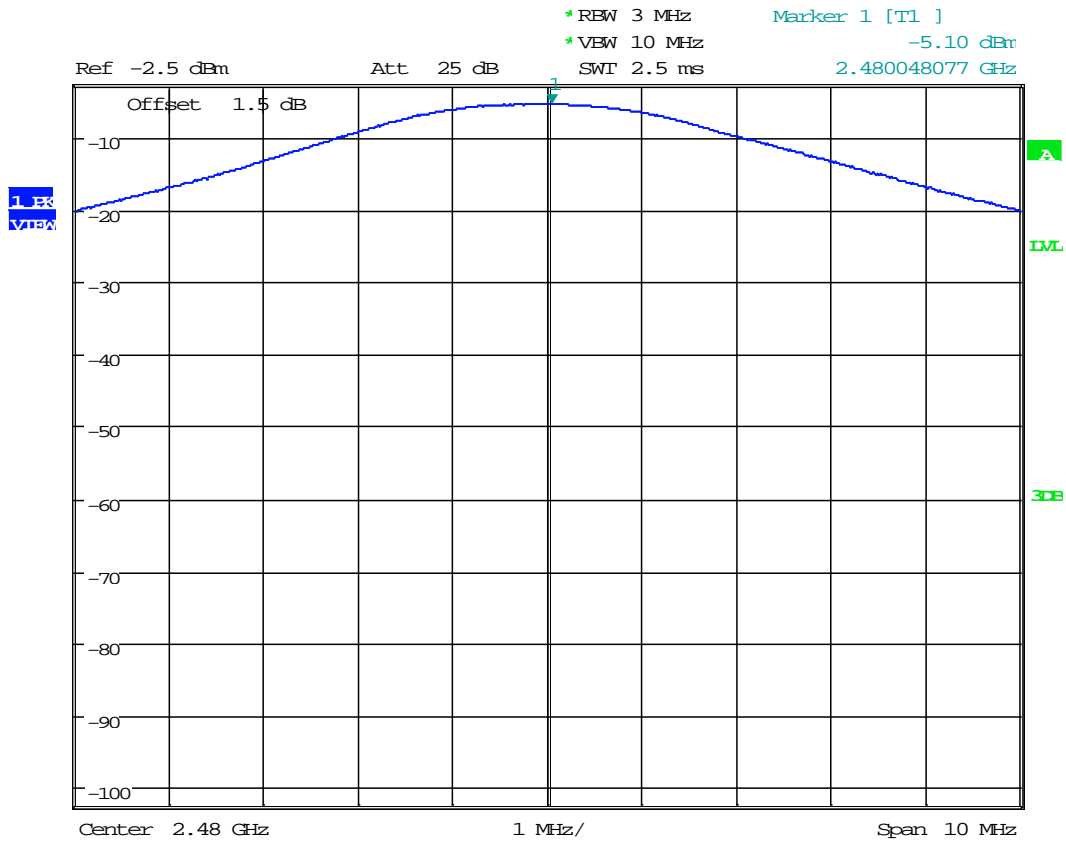
Date: 5.JAN.2017 09:55:06

Plot 2. 2



Date: 5.JAN.2017 09:57:58

Plot 2.3



Date: 5.JAN.2017 09:58:45

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, specifically section 10.2 Method PKPSD (peak PSD).

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

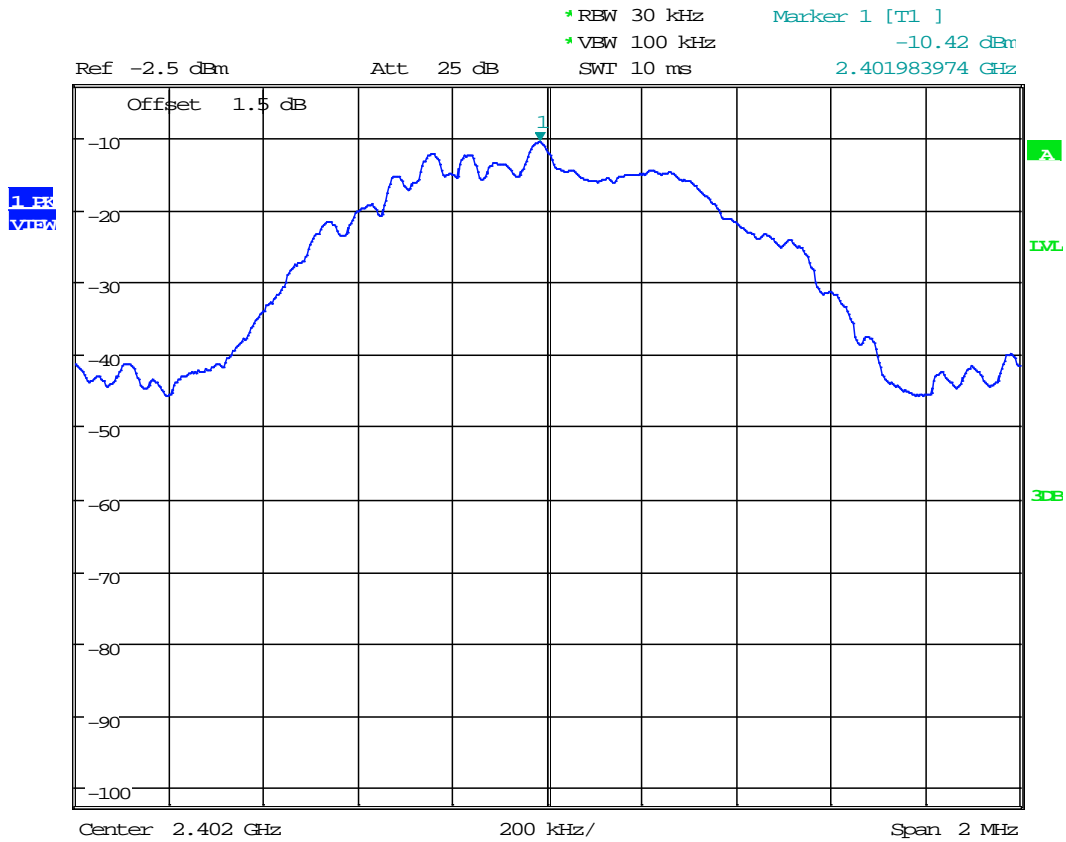
4.3.3 Test Result

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	-10.42	8.0	-18.42	3.1
2440	-9.41	8.0	-17.41	3.2
2480	-8.80	8.0	-16.80	3.3

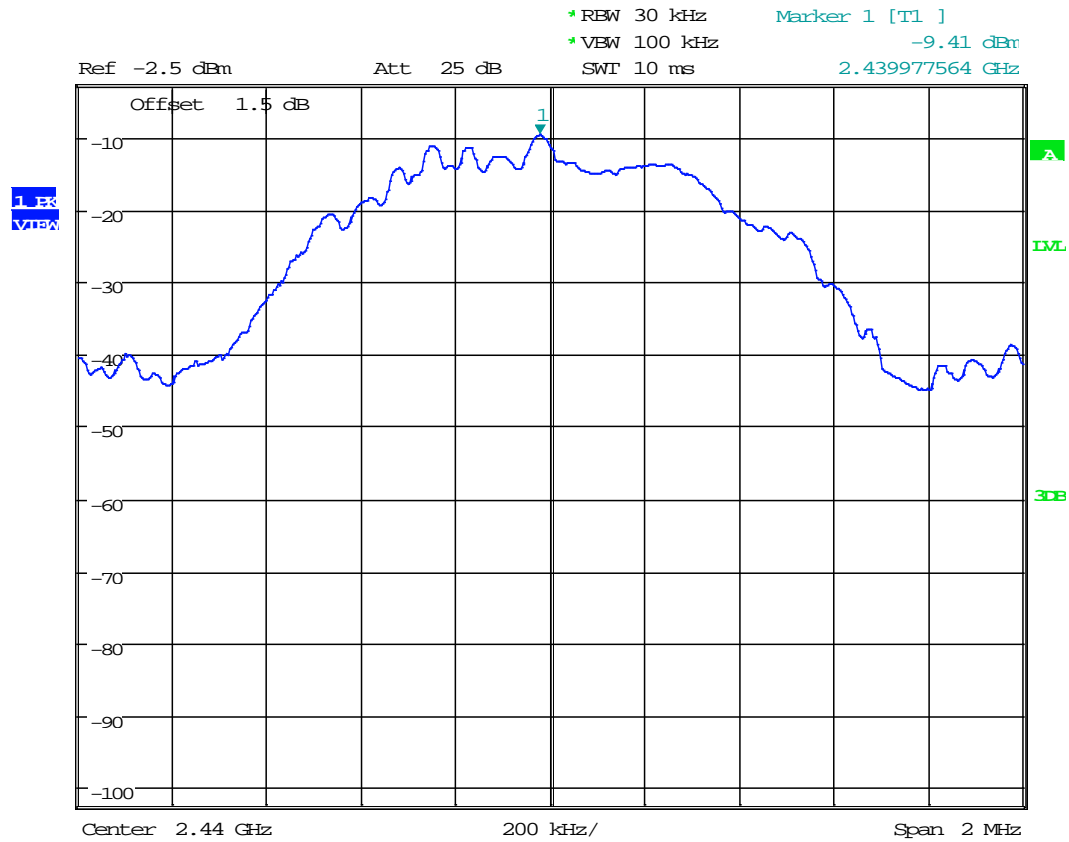
Date of Test:	January 5, 2017
Results	Complies

Plot 3. 1



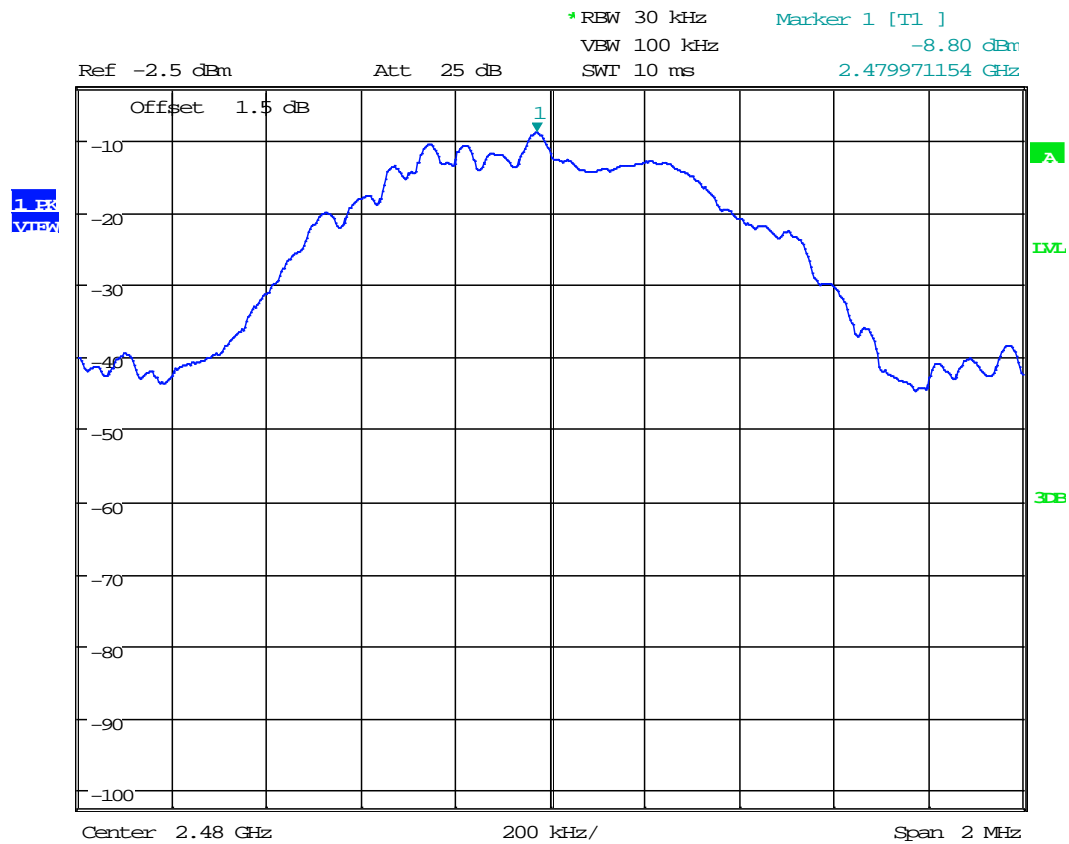
Date: 5.JAN.2017 09:56:10

Plot 3.2



Date: 5.JAN.2017 09:57:03

Plot 3.3



Date: 5.JAN.2017 09:59:42

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, specifically section 11.0 Emissions in non-restricted frequency bands.

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

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

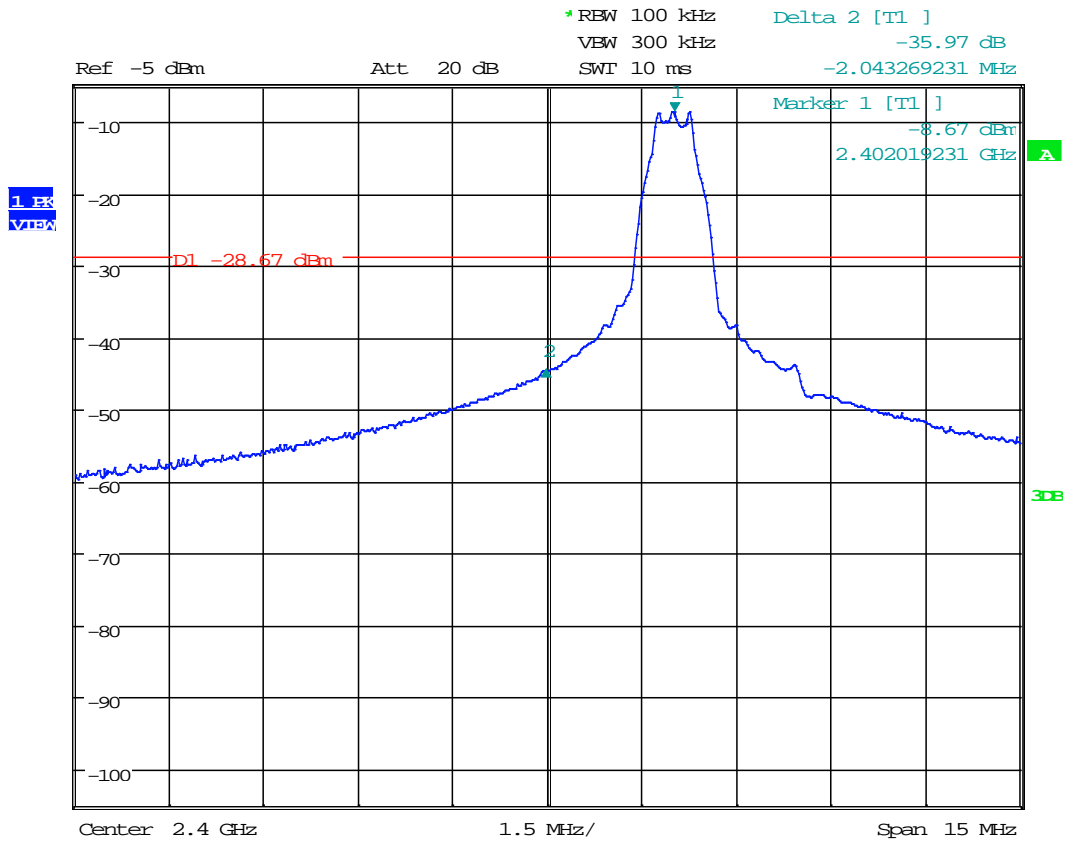
The unwanted emissions were measured from 30 MHz to 25 GHz. Plots below are corrected for cable loss and then compared to the limits.

4.4.3 Test Result

Refer to the following plots 4.1 – 4.5 for unwanted conducted emissions. The plot shows -20dB attenuation limit line.

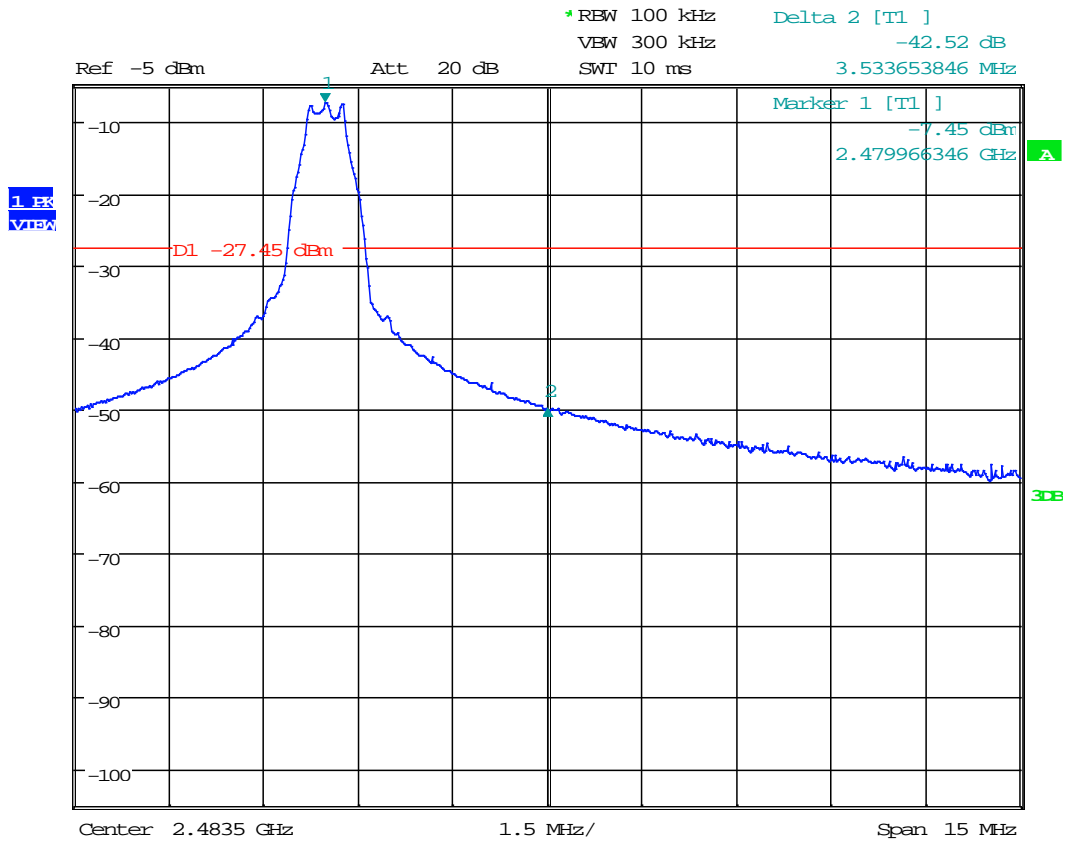
Date of Test:	January 06, 2017
Results	Complies

Tx @ Low Channel, 2400 MHz Band Edge
Plot 4.1



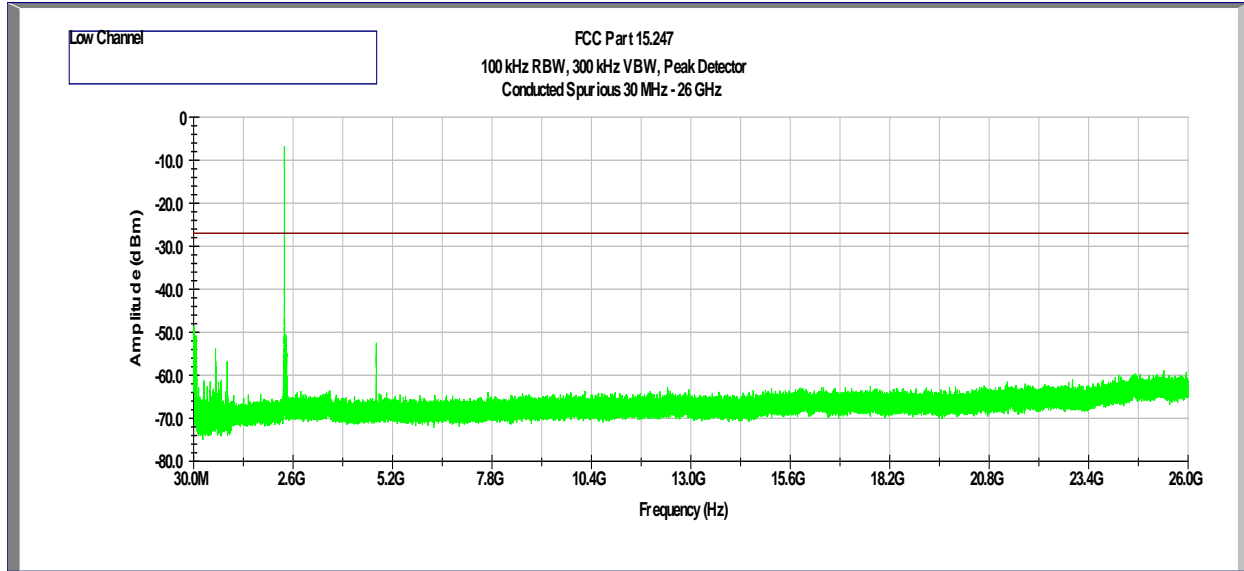
Date: 6.JAN.2017 08:54:41

Tx @ Low Channel, 2483.5 MHz Band Edge
Plot 4.2

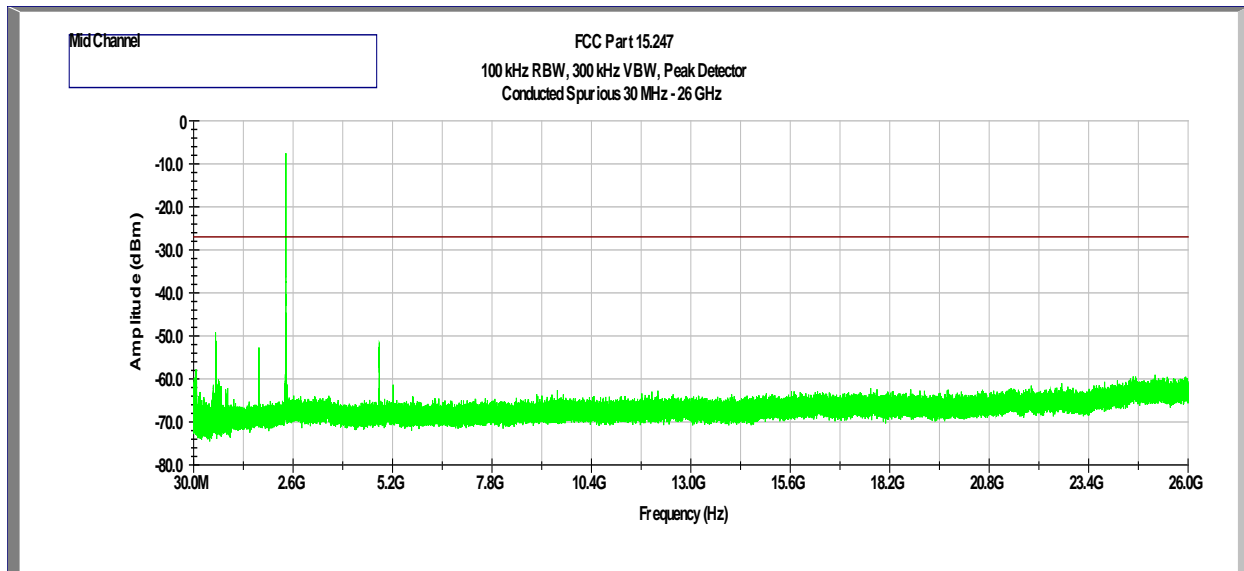


Date: 6.JAN.2017 08:52:32

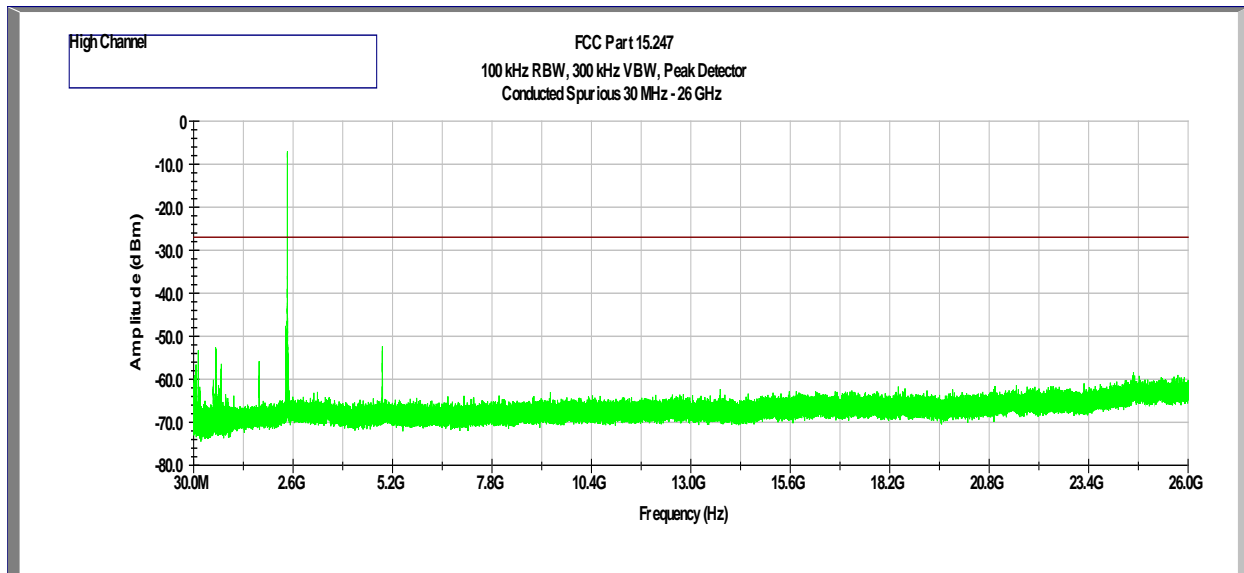
Tx @ Low Channel, 2402 MHz
30MHz -26GHz Conducted Spurious
Plot 4.3



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



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



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 kHz 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 25 GHz according to the procedure described in ANSI C63.10: 2013. 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.

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

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

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

4.5.3 Field Strength Calculation

Field Strength Calculation

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

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

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

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

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

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

RA = 52.0 dB(μ V)

AF = 7.4 dB(1/m)

CF = 1.6 dB

AG = 29.0 dB

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

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

4.5.4 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:
$$E = \text{EIRP} - 20\log D + 104.8$$
where:
E = electric field strength in dB μ V/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

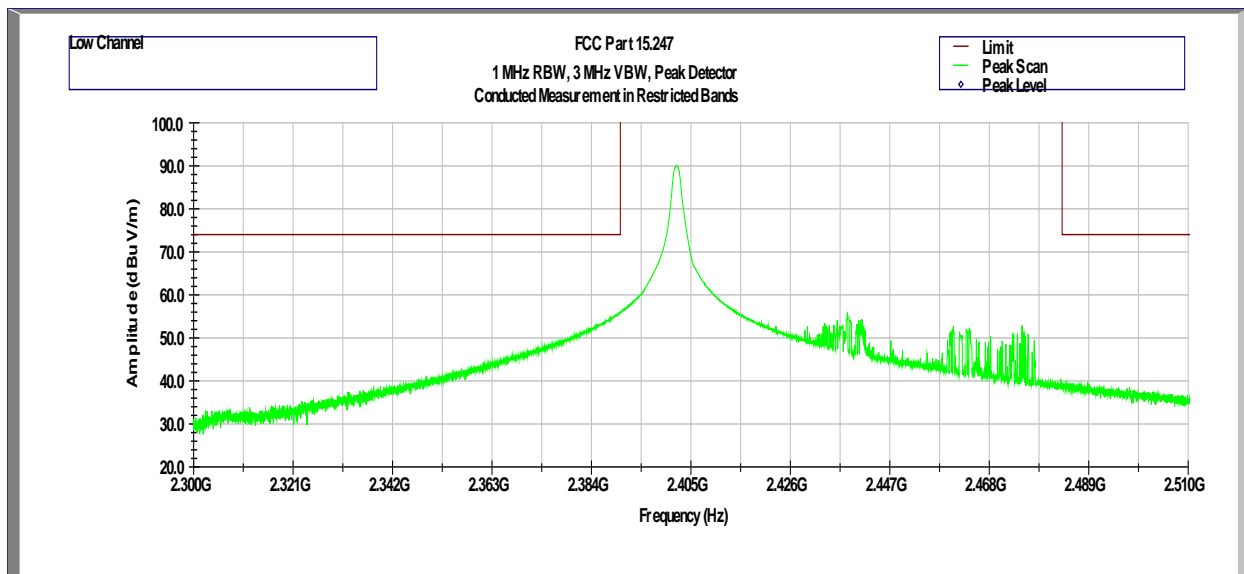
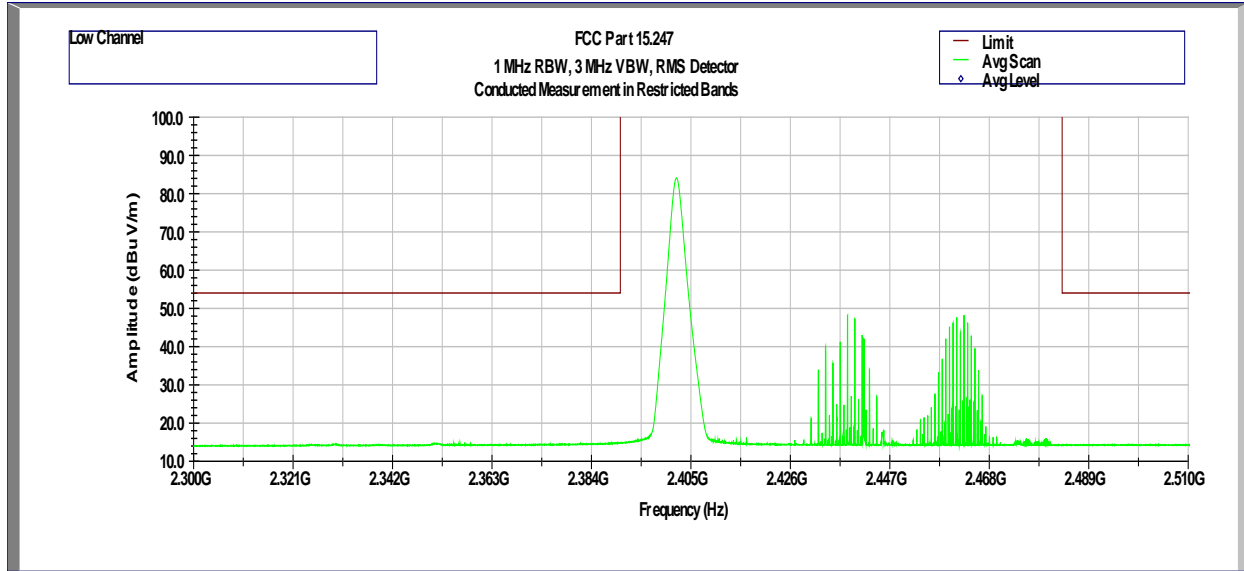
The data on the following pages list the significant emission frequencies, the limit and the margin of compliance where emissions are within 3dB of the limit.

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

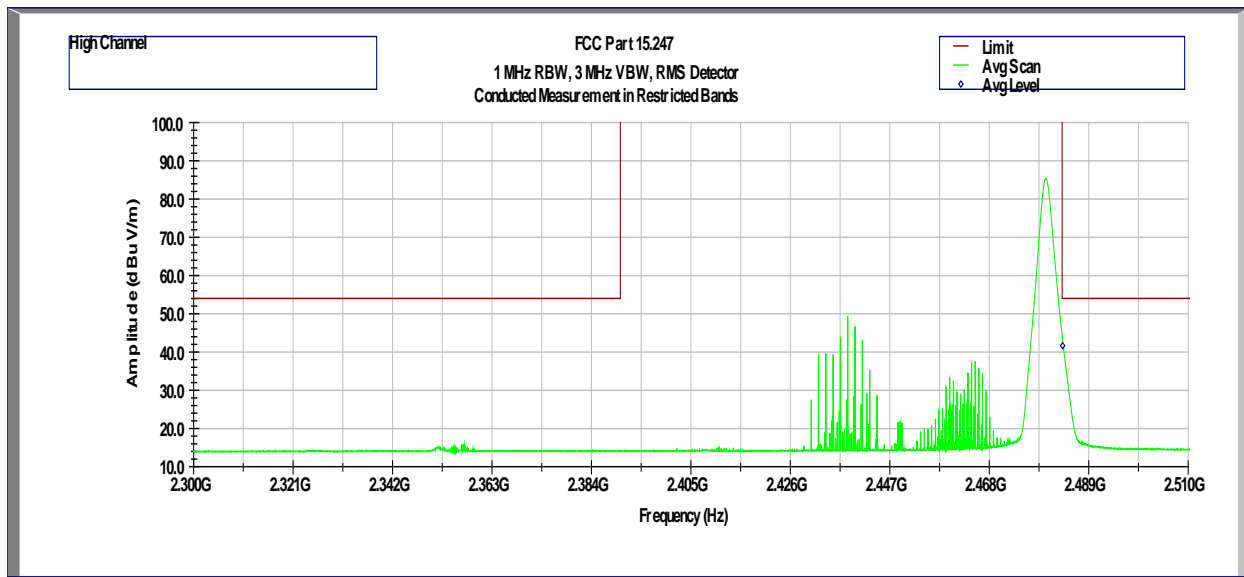
Date of Test:	January 6 - 18, 2017
Results	Complies

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

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

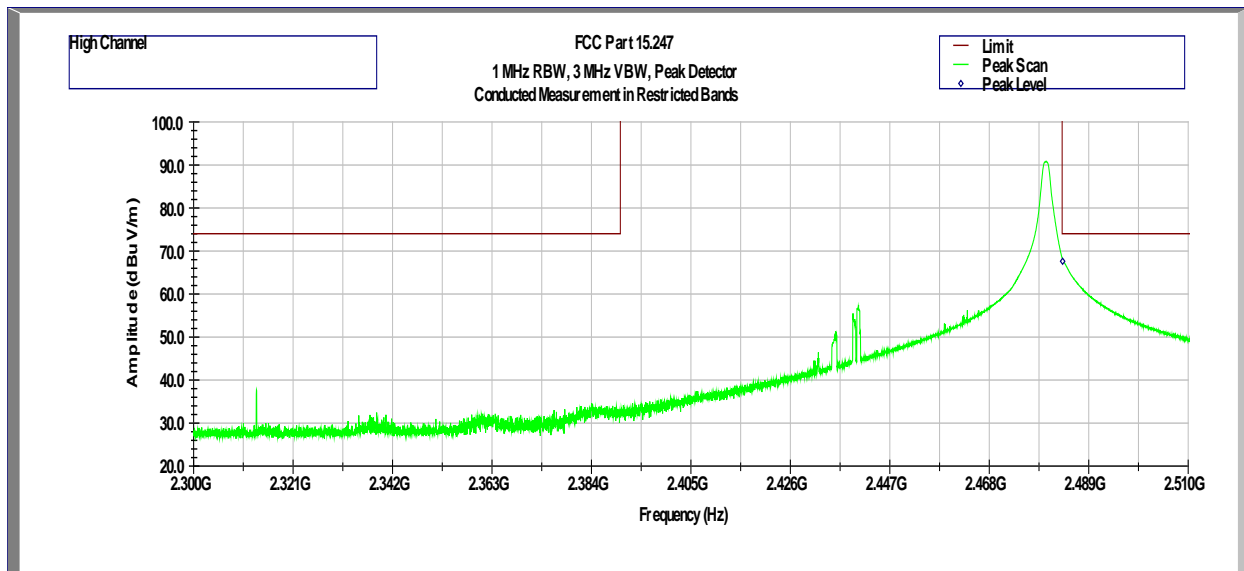


Out-of-Band Spurious Emissions at the Band Edge – Tx @ 2480 MHz



Frequency	Corrected Amplitude	Avg Limit	Duty cycle correction	Margin	Detector	Results
GHz	dBμV/m	dBμV/m	dB	dB		
2.4835	42.8	54	2.1	-11.2	RMS	Pass

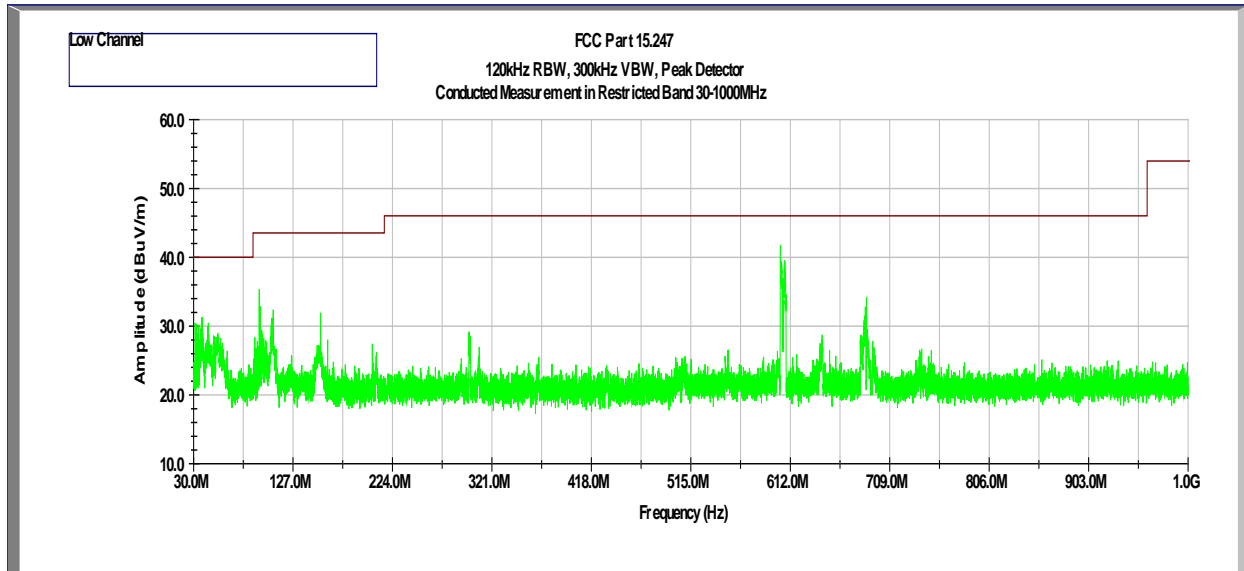
Trace averaging across on and off times of the EUT transmissions followed by duty cycle correction was utilized from section 13.3.2 in KDB 558074 D01 DTS Meas Guidance v03r05.



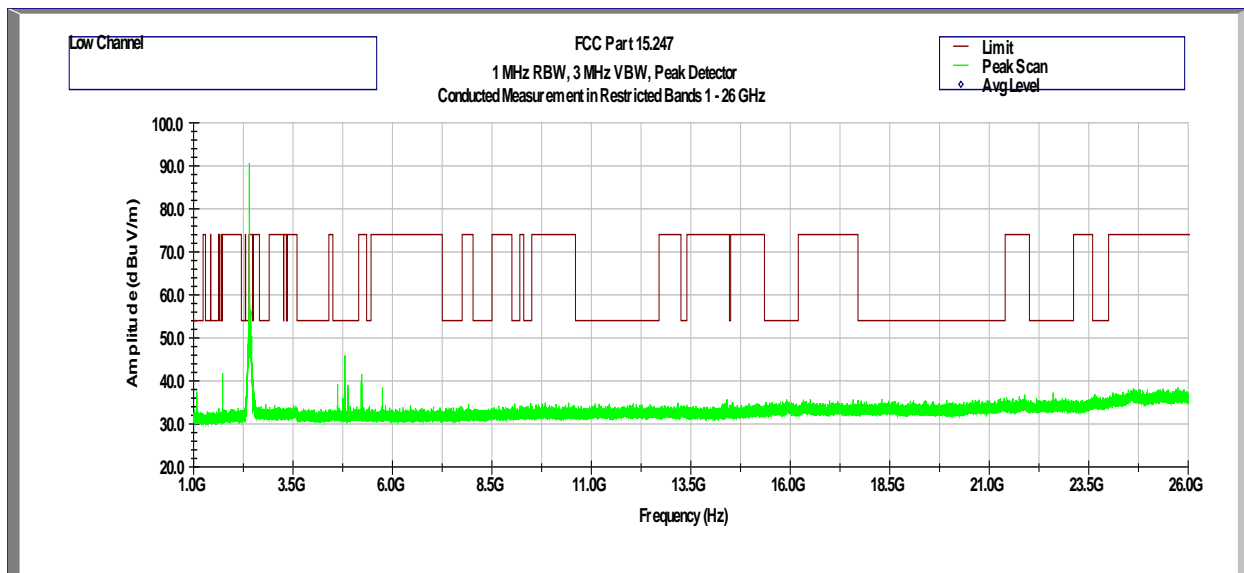
Out-of-Band Conducted Spurious Emissions (at Antenna Port)

Tx @ 2402MHz

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



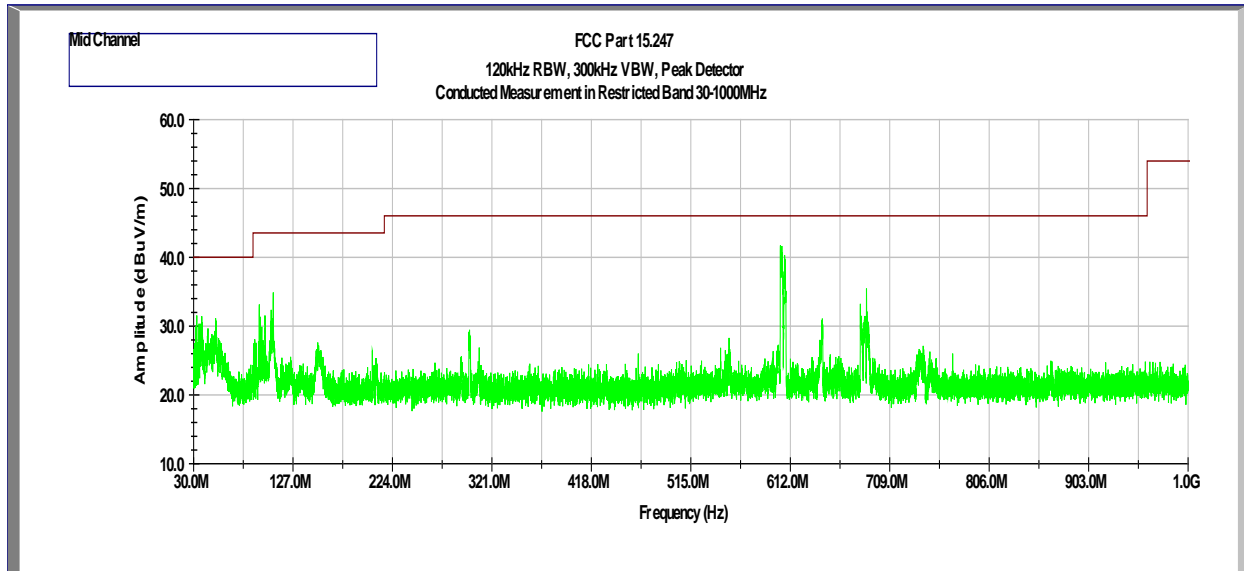
Out-of-Band Spurious Emissions at Antenna Port – 1 - 26 GHz Peak Detector vs Avg Limit



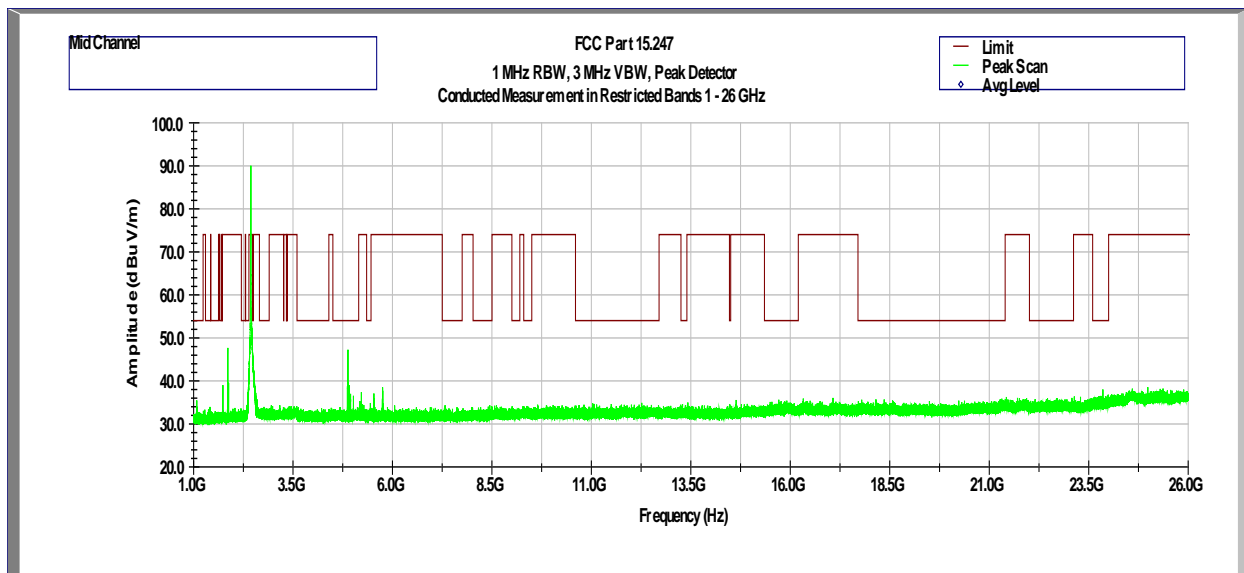
Out-of-Band Conducted Spurious Emissions (at Antenna Port)

Tx @ 2440MHz

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



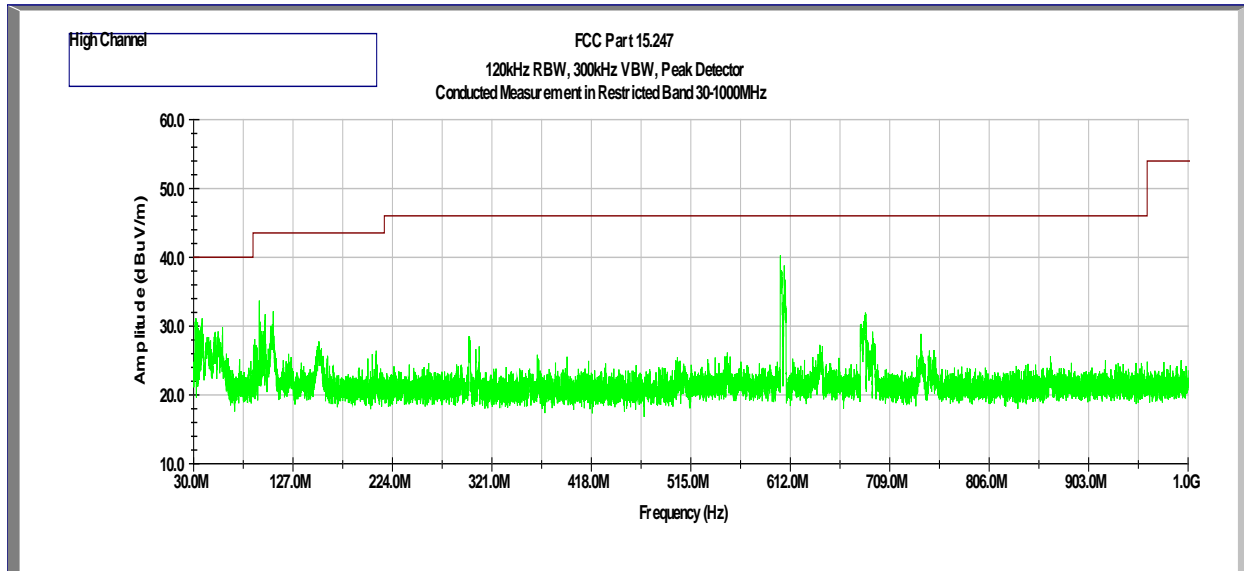
Out-of-Band Spurious Emissions at Antenna Port – 1 - 26 GHz Peak Detector vs Avg Limit



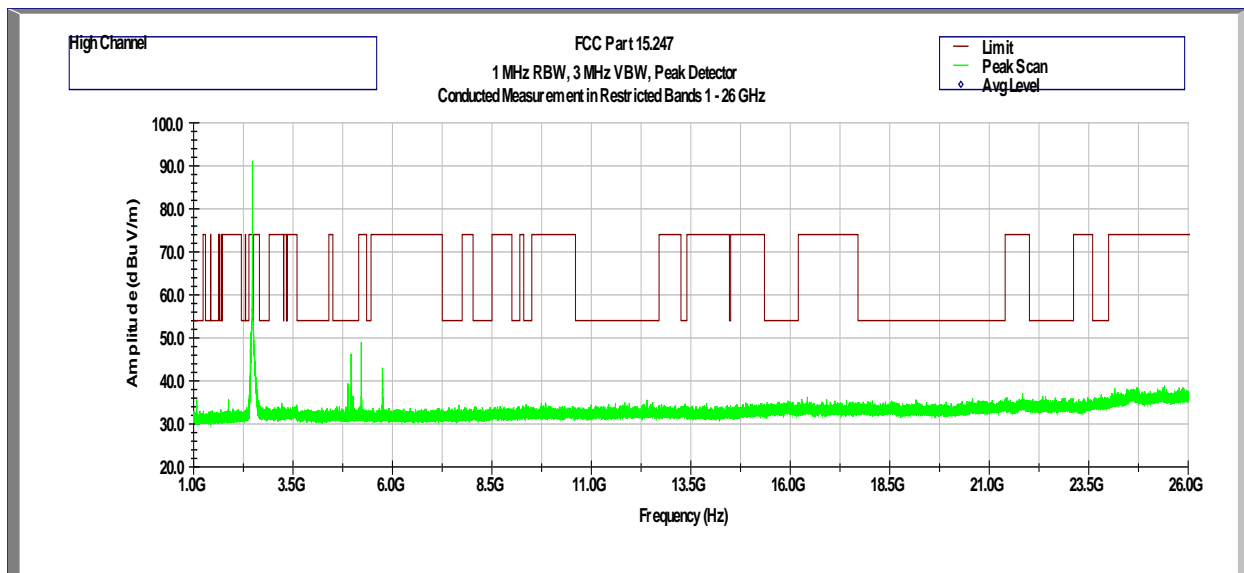
Out-of-Band Conducted Spurious Emissions (at Antenna Port)

Tx @ 2480MHz

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



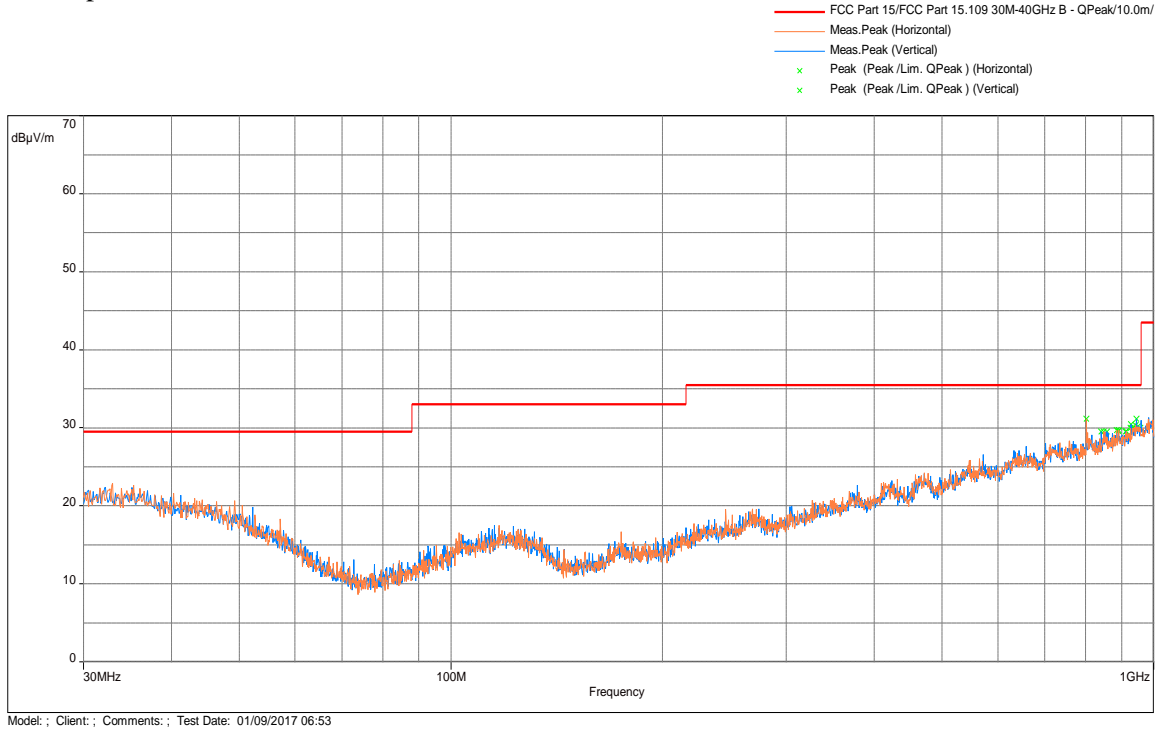
Out-of-Band Spurious Emissions at Antenna Port – 1 - 26 GHz Peak Detector vs Avg Limit



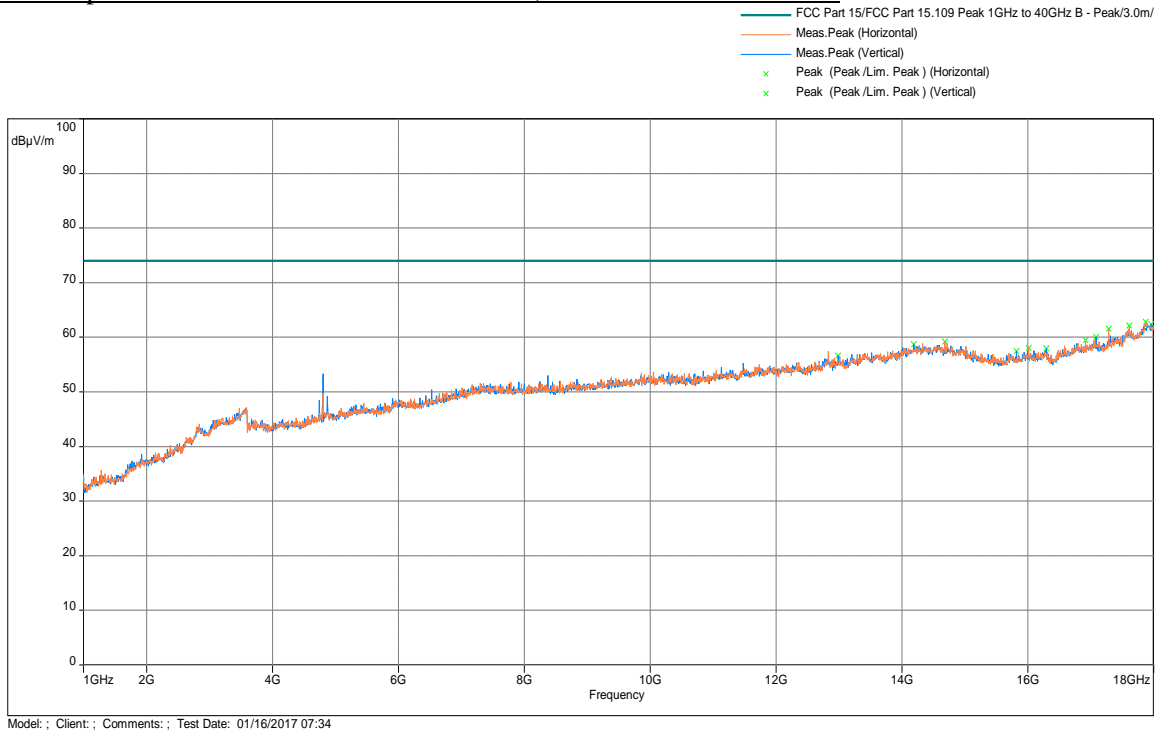
Out-of-Band Radiated Spurious Emissions (Cabinet Radiation, Battery mode)

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

Radiated Spurious Emissions 30 MHz - 1000 MHz

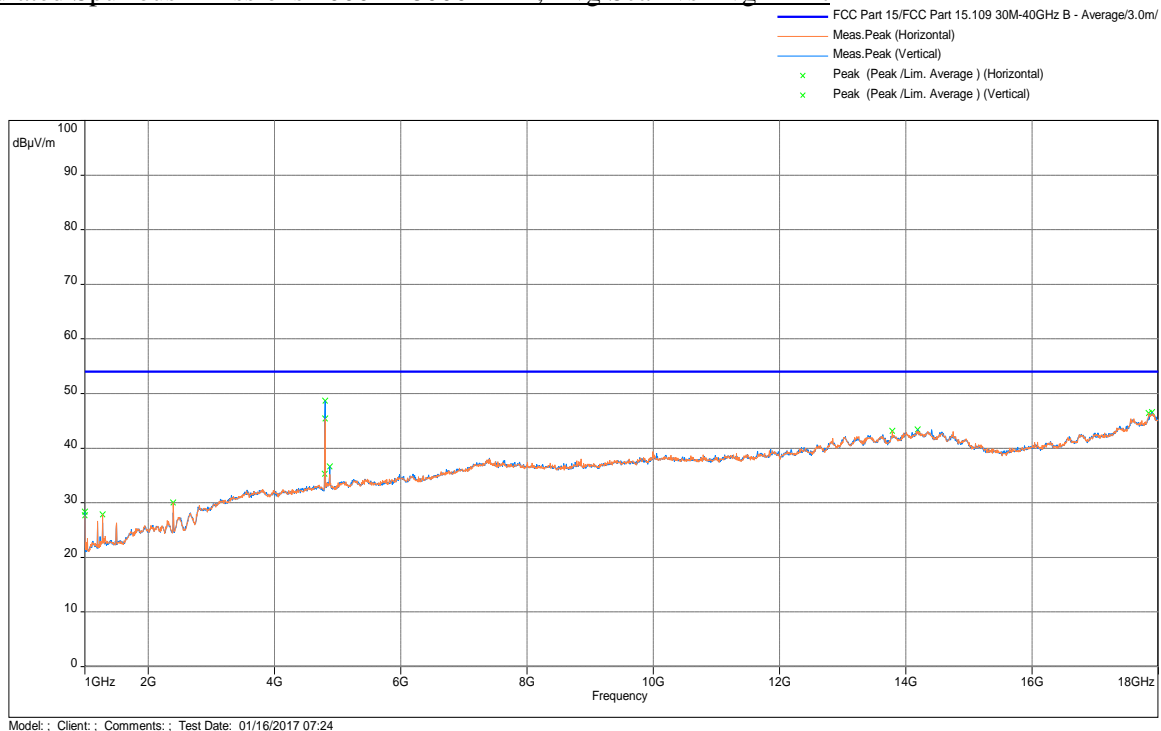


Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak Limit





Radiated Spurious Emissions 1000 - 18000 MHz, Avg Scan vs Avg Limit



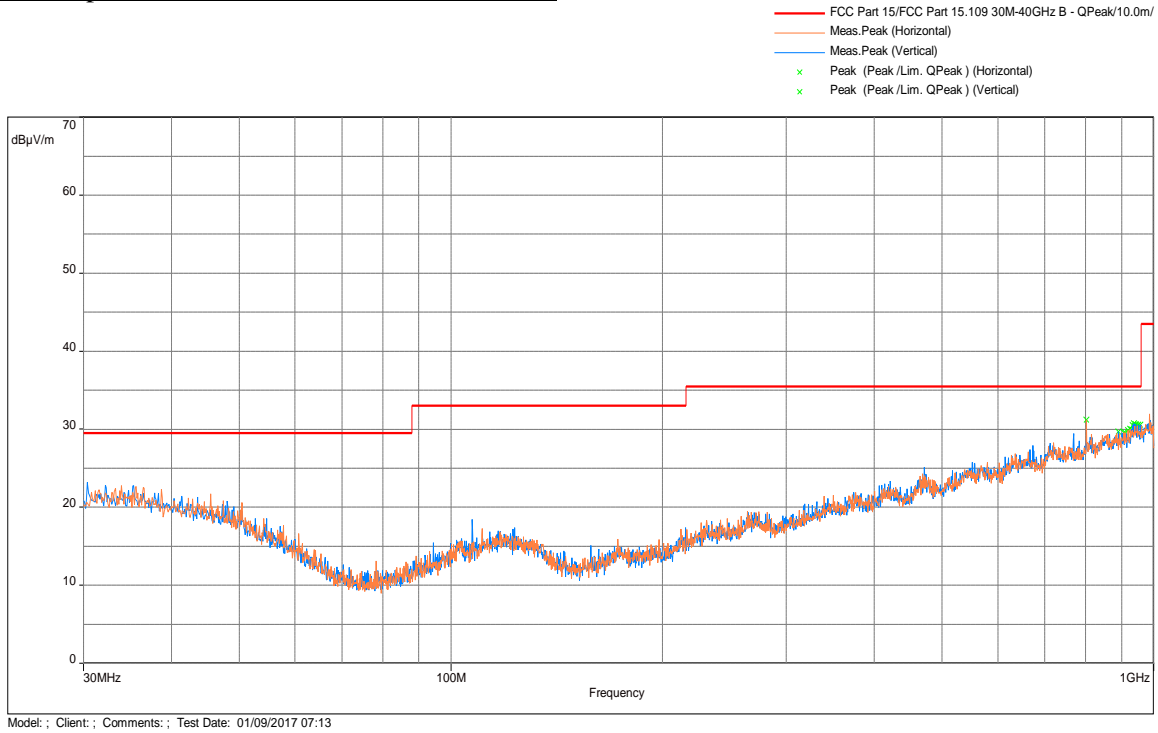
Note: Radiated emission measurements were performed up to 25GHz. No Emissions were identified when scanned from 18-25 GHz

Note: FS@3m = RA + AF + CF - Preamp

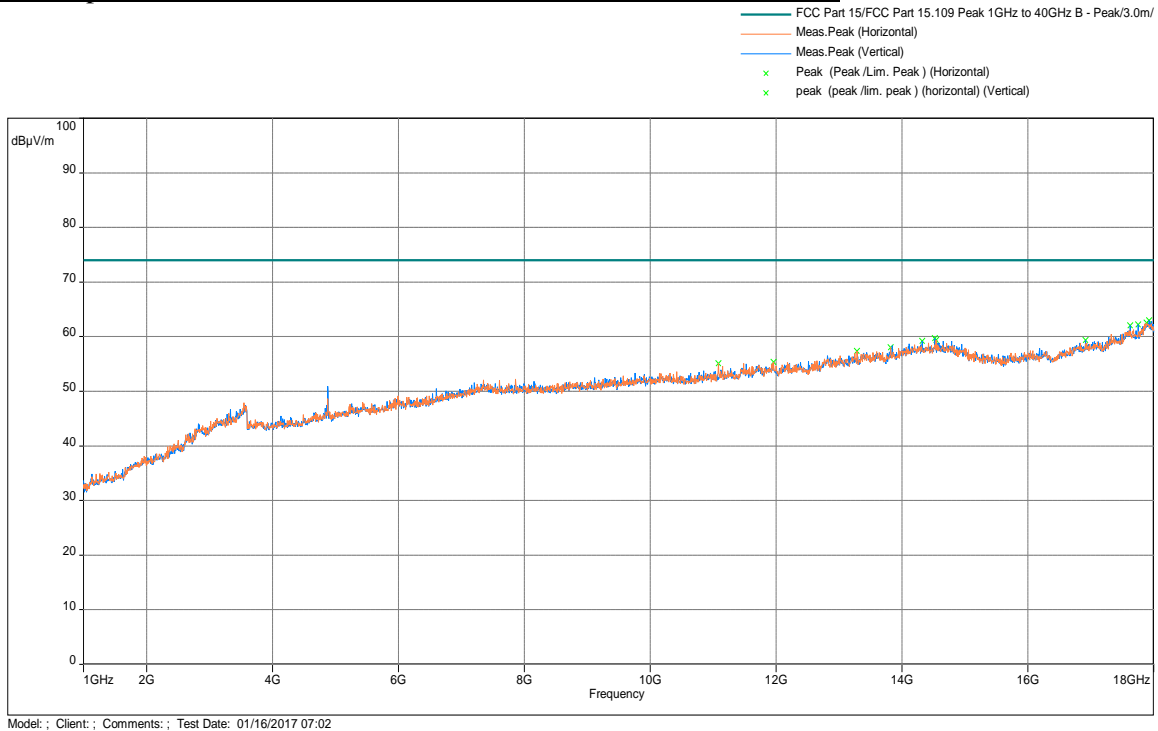
Results	Complies
---------	----------

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

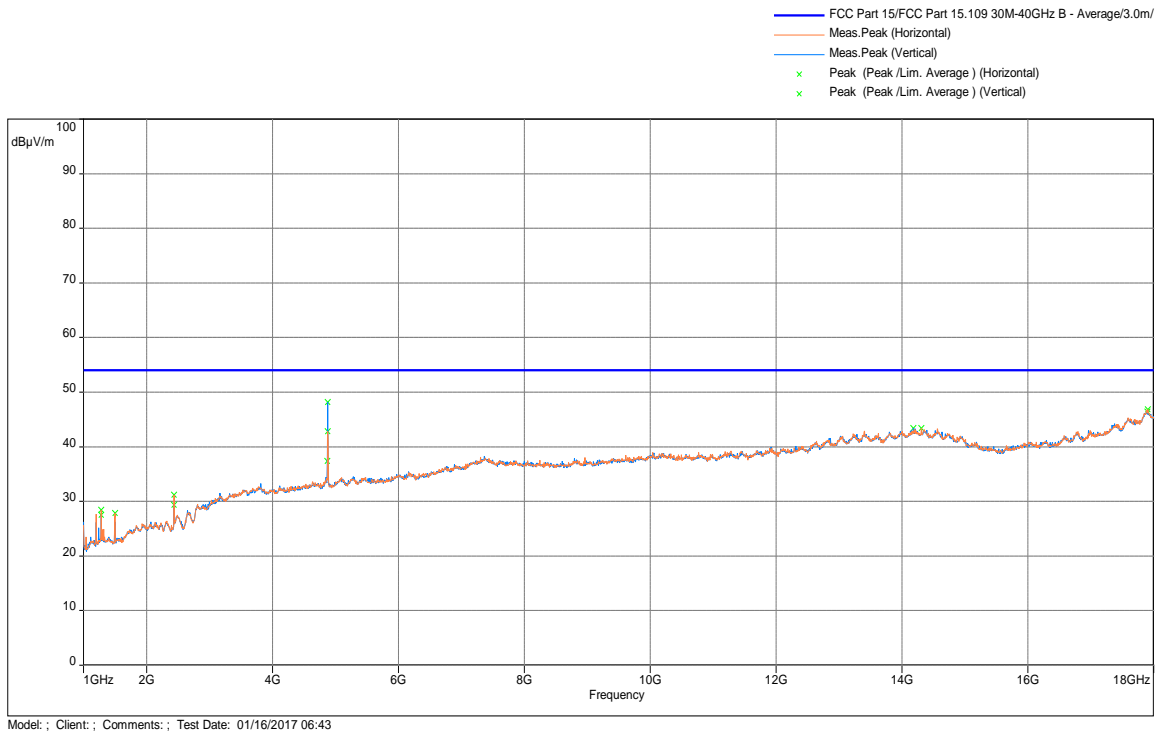
Radiated Spurious Emissions 30 MHz - 1000 MHz



Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak Limit



Radiated Spurious Emissions 1000 - 18000 MHz, Avg Scan vs Avg Limit



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

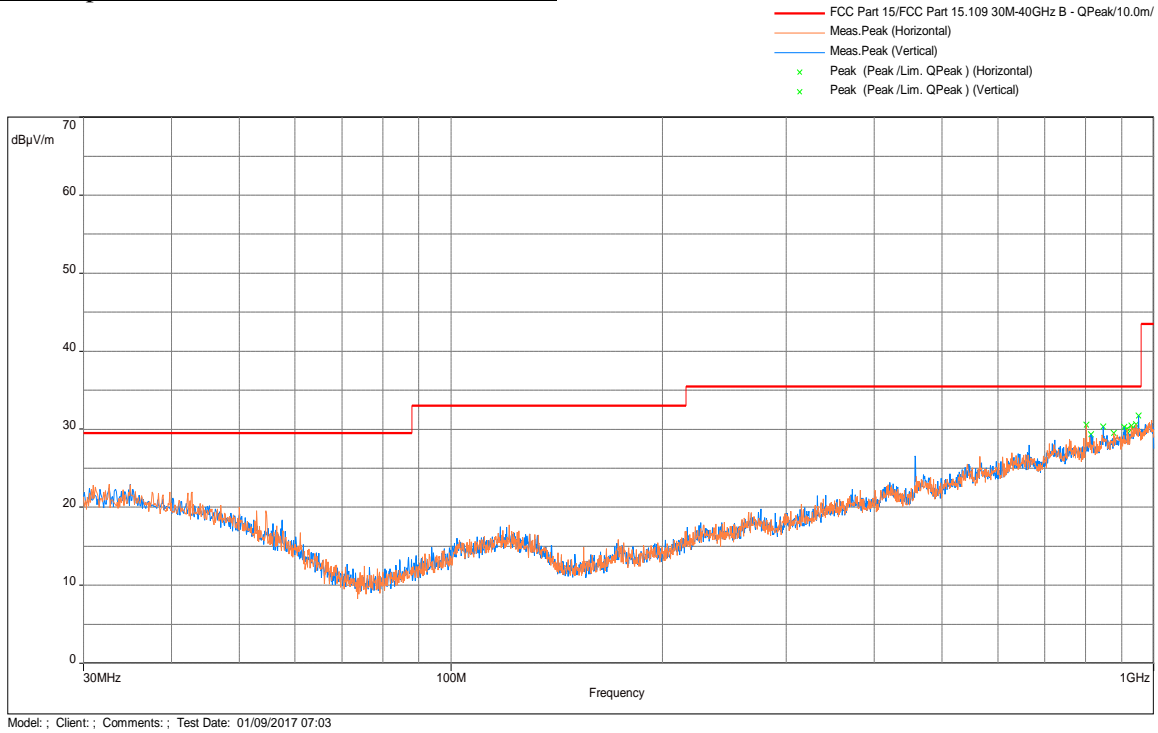
Note: FS@3m = RA + AF + CF - Preamp

Results

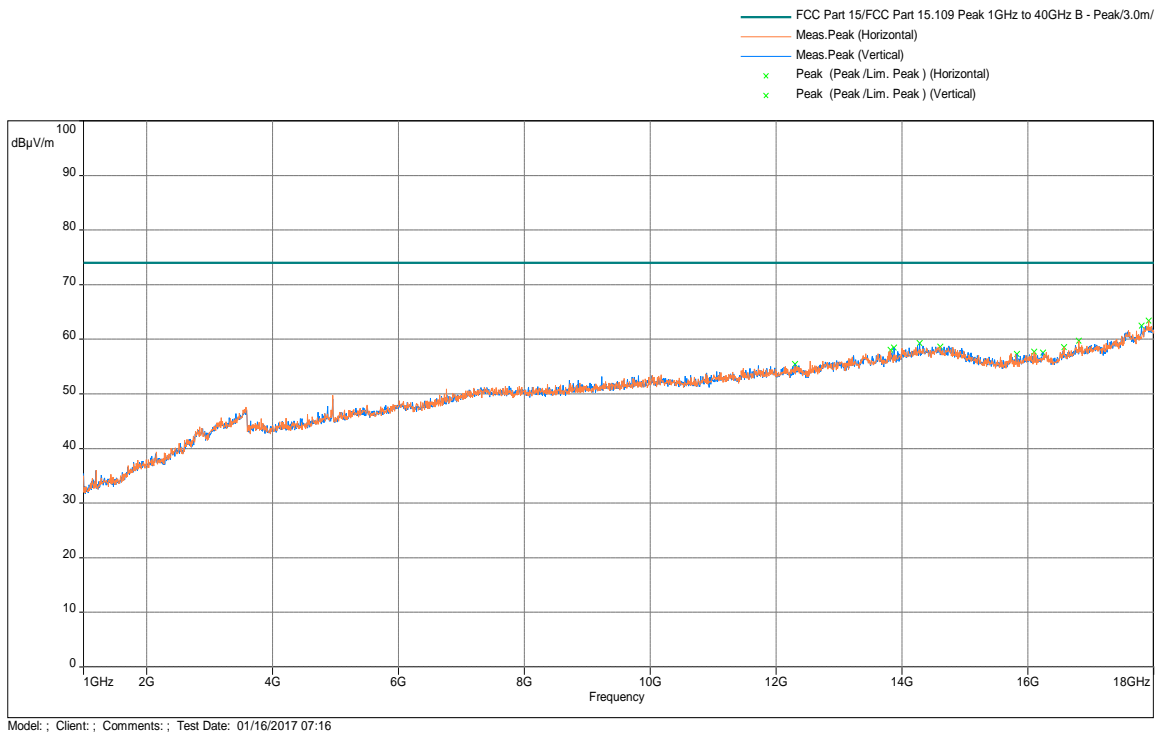
Complies

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

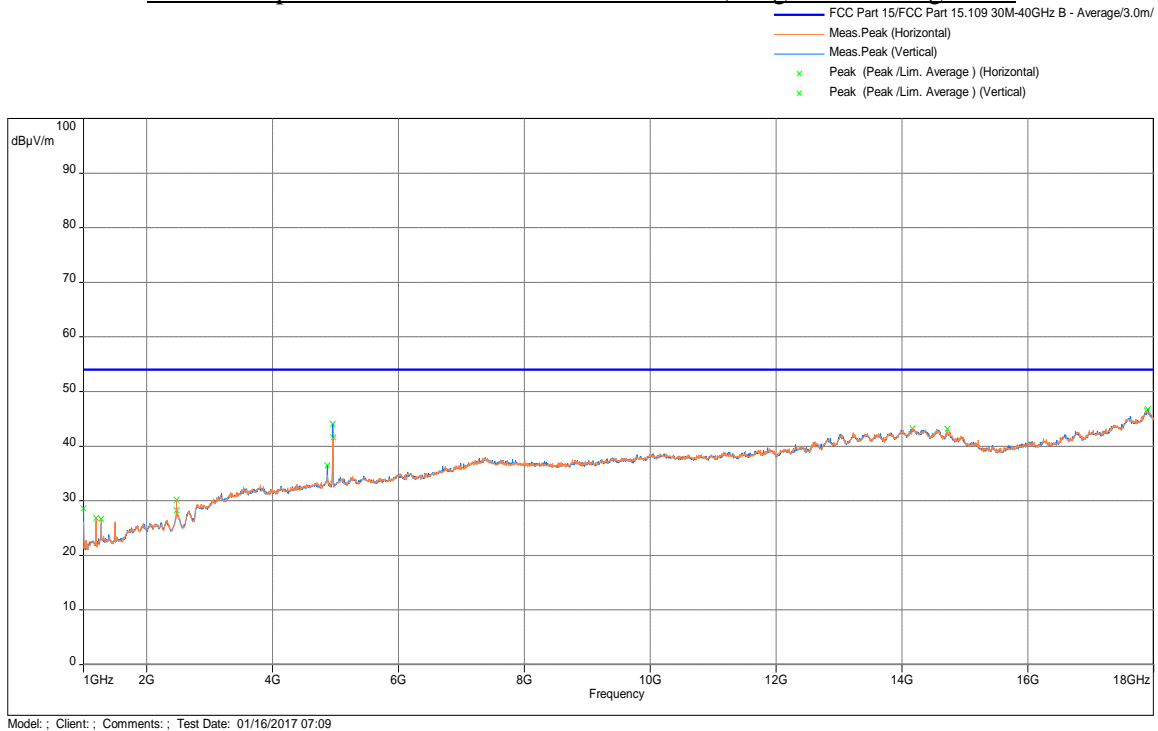
Radiated Spurious Emissions 30 MHz - 1000 MHz



Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak Limit



Radiated Spurious Emissions 1000 - 18000 MHz, Avg Scan vs Avg Limit



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

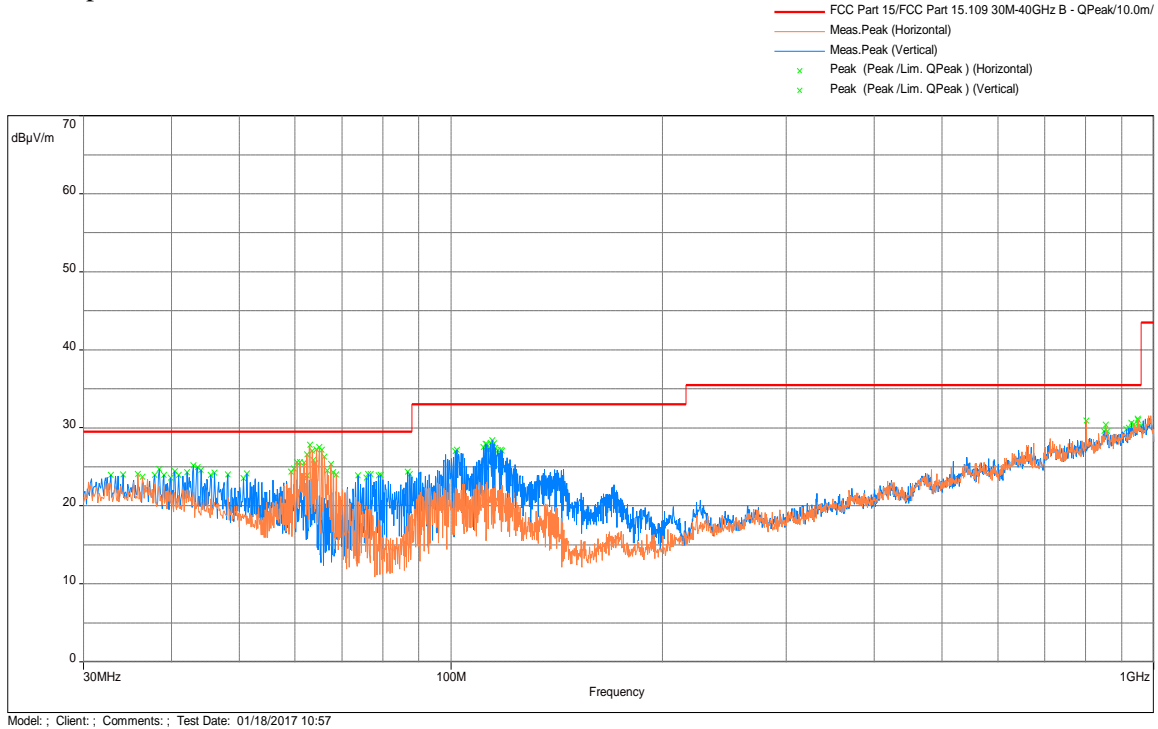
Note: FS@3m = RA + AF + CF - Preamp

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

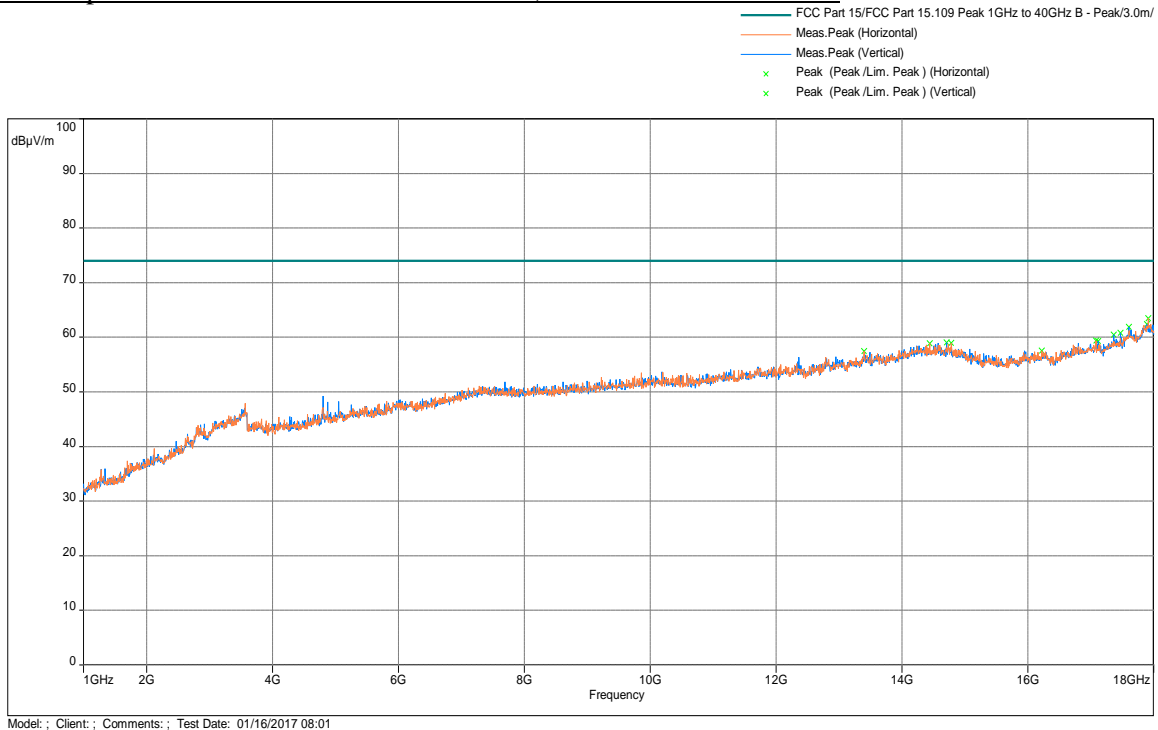
Out-of-Band Radiated Spurious Emissions (Cabinet Radiation, Charging mode)

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

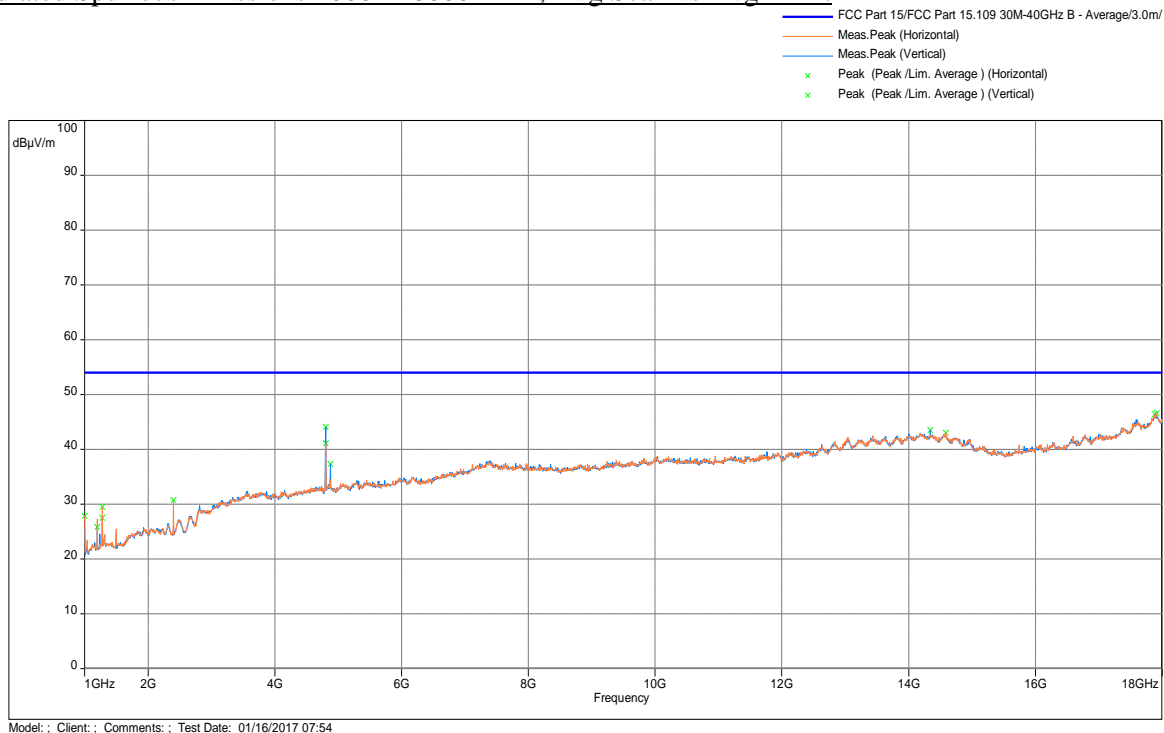
Radiated Spurious Emissions 30 MHz - 1000 MHz



Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak Limit



Radiated Spurious Emissions 1000 - 18000 MHz, Avg Scan vs Avg Limit



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

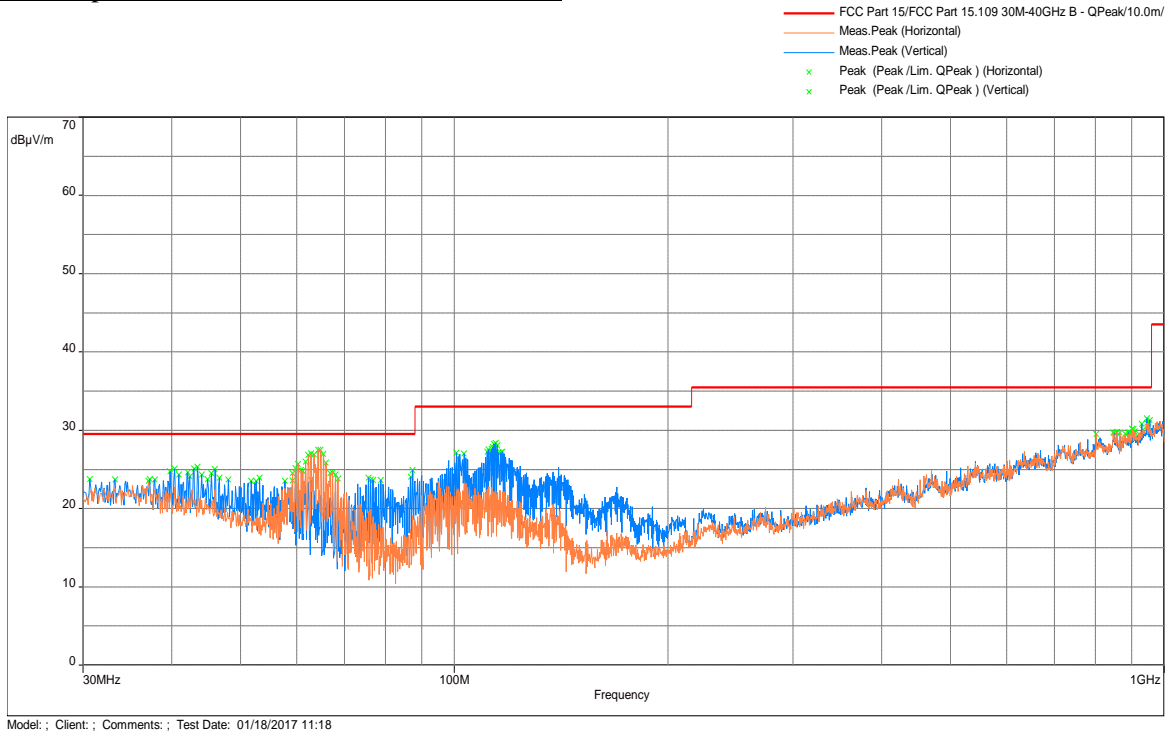
Note: FS@3m = RA + AF + CF - Preamp

Results

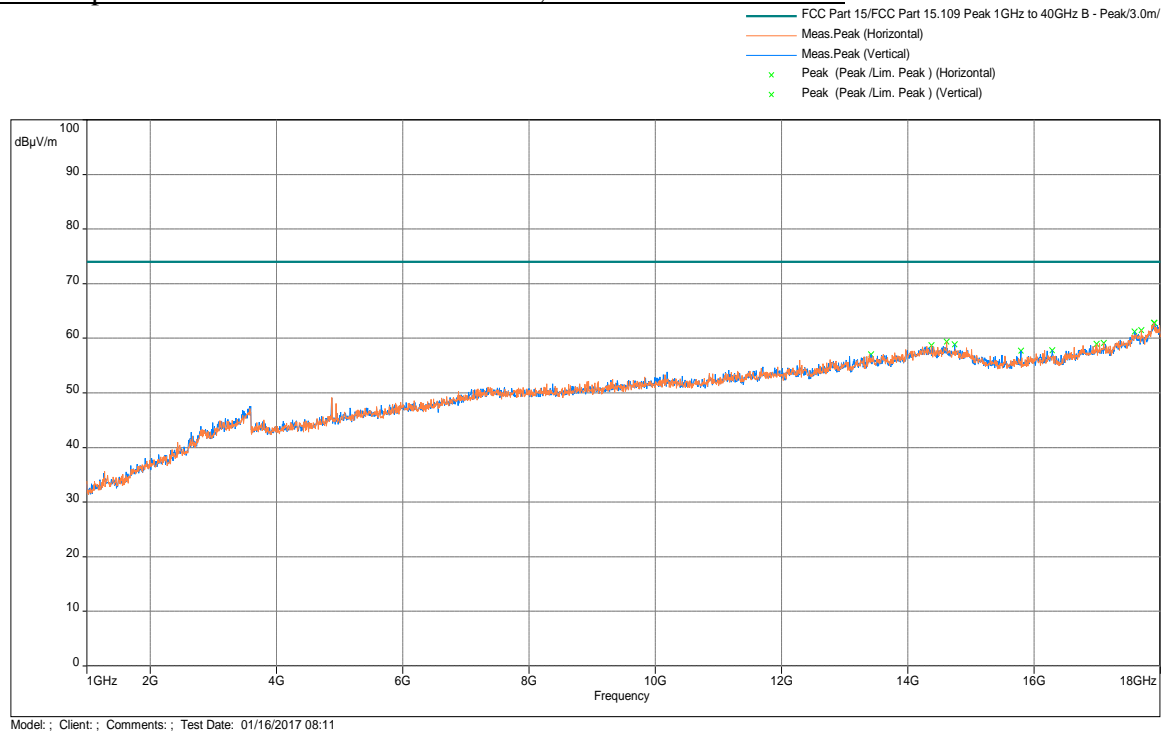
Complies

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

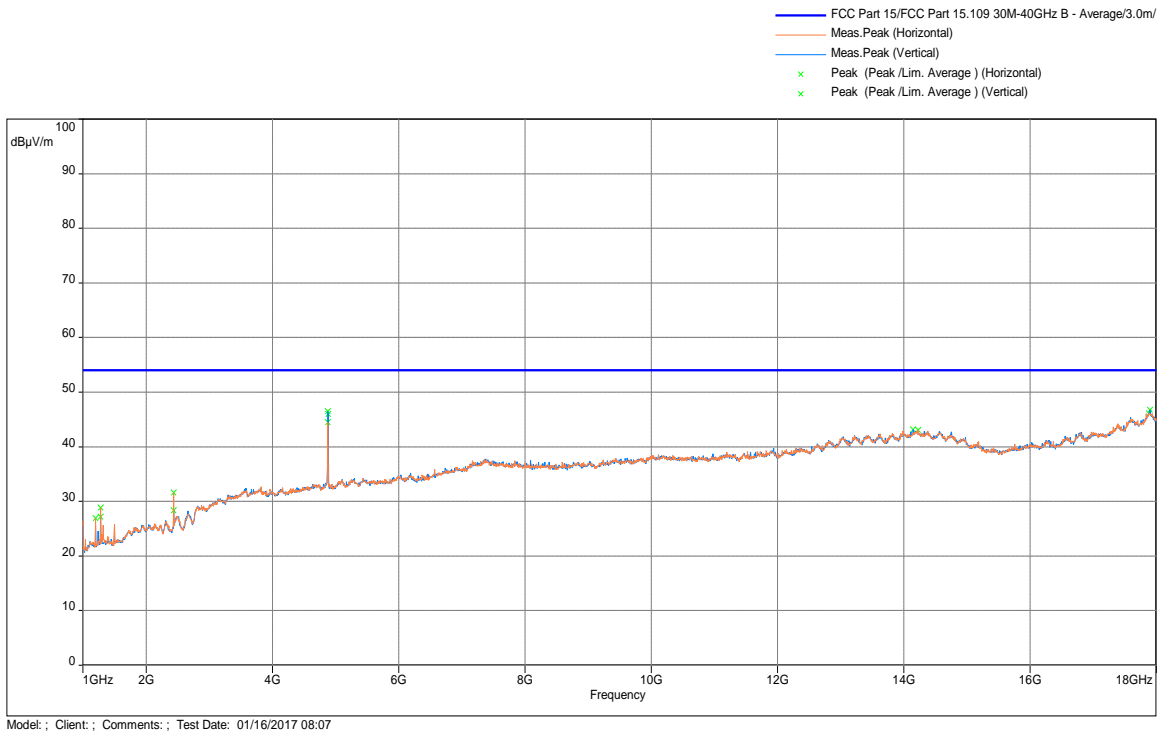
Radiated Spurious Emissions 30 MHz - 1000 MHz



Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak Limit



Radiated Spurious Emissions 1000 - 18000 MHz, Avg Scan vs Avg Limit



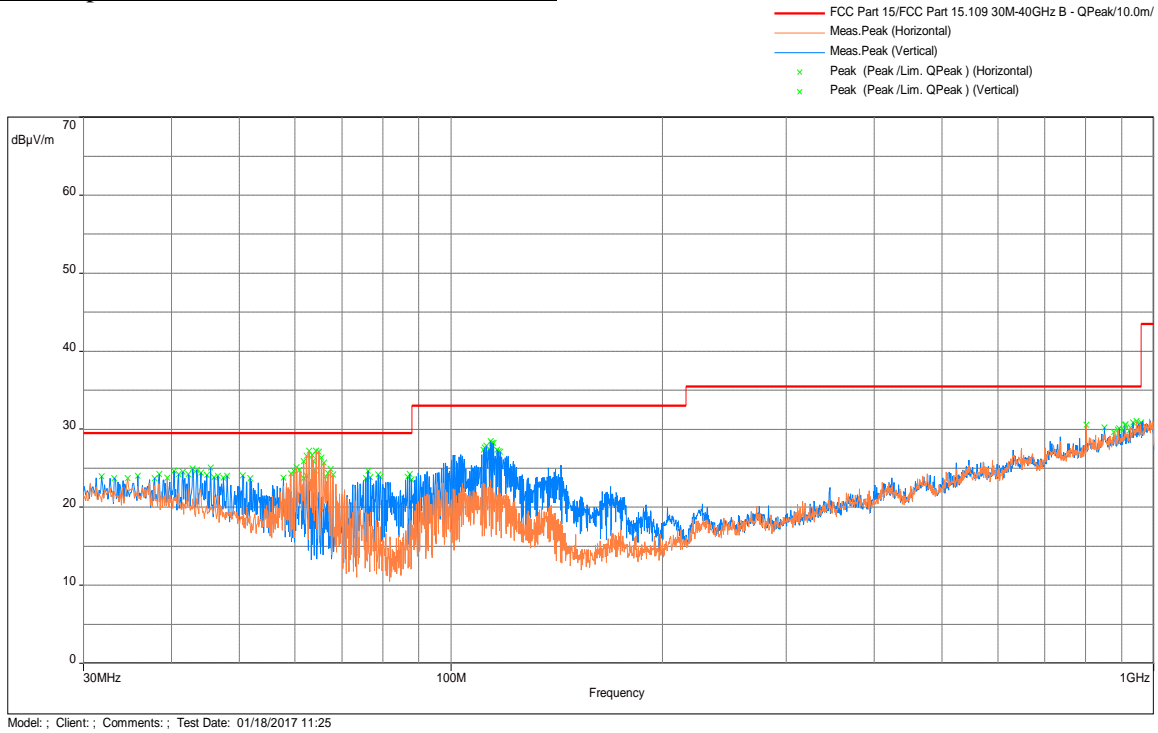
Note: Radiated emission measurements were performed up to 25GHz. No Emissions were identified when scanned from 18-25 GHz

Note: FS@3m = RA + AF + CF - Preamp

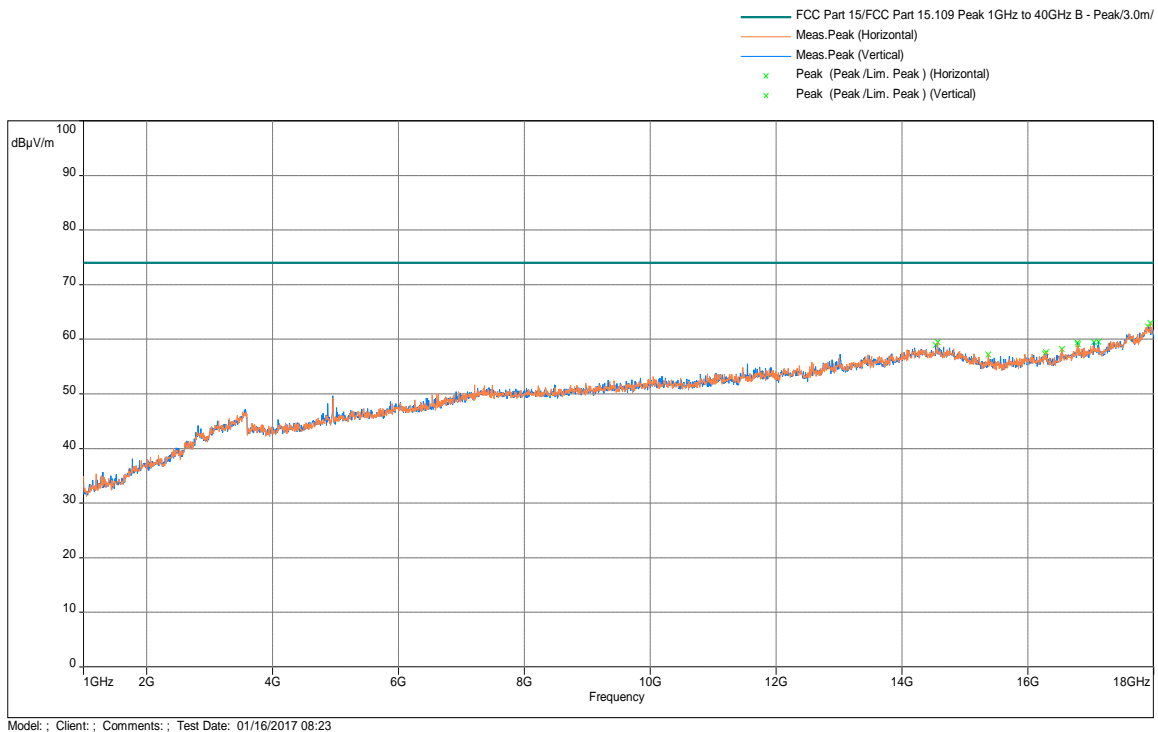
Results	Complies
---------	----------

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

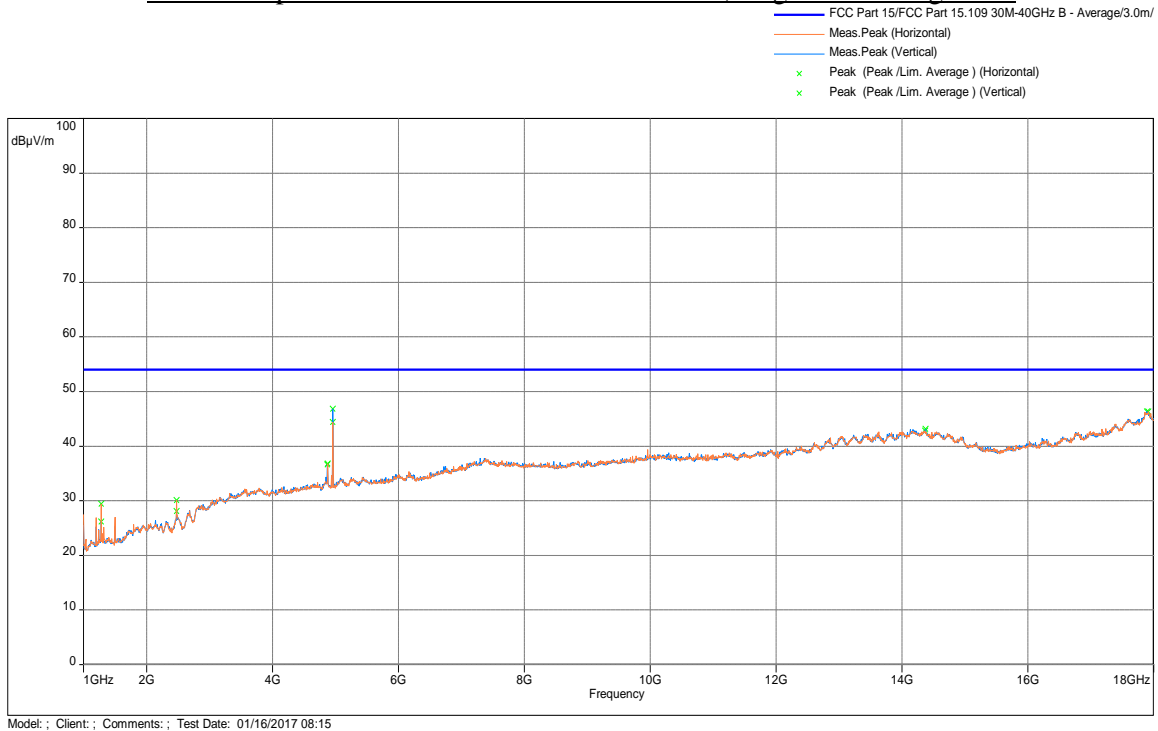
Radiated Spurious Emissions 30 MHz - 1000 MHz



Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak Limit



Radiated Spurious Emissions 1000 - 18000 MHz, Avg Scan vs Avg Limit



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

Note: FS@3m = RA + AF + CF - Preamp

Results

Complies



4.5.8 Test setup photographs

The following photographs show the testing configurations used.

Not included in the report. Refer to Test Setup photos exhibit



4.5.8 Test setup photographs (continued)

Not included in the report. Refer to Test Setup photos exhibit



4.5.8 Test setup photographs (continued)

Not included in the report. Refer to Test Setup photos exhibit



4.5.8 Test setup photographs (continued)

Not included in the report. Refer to Test Setup photos exhibit

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 or limit line 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: 2014

4.6.3 Test Results

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.

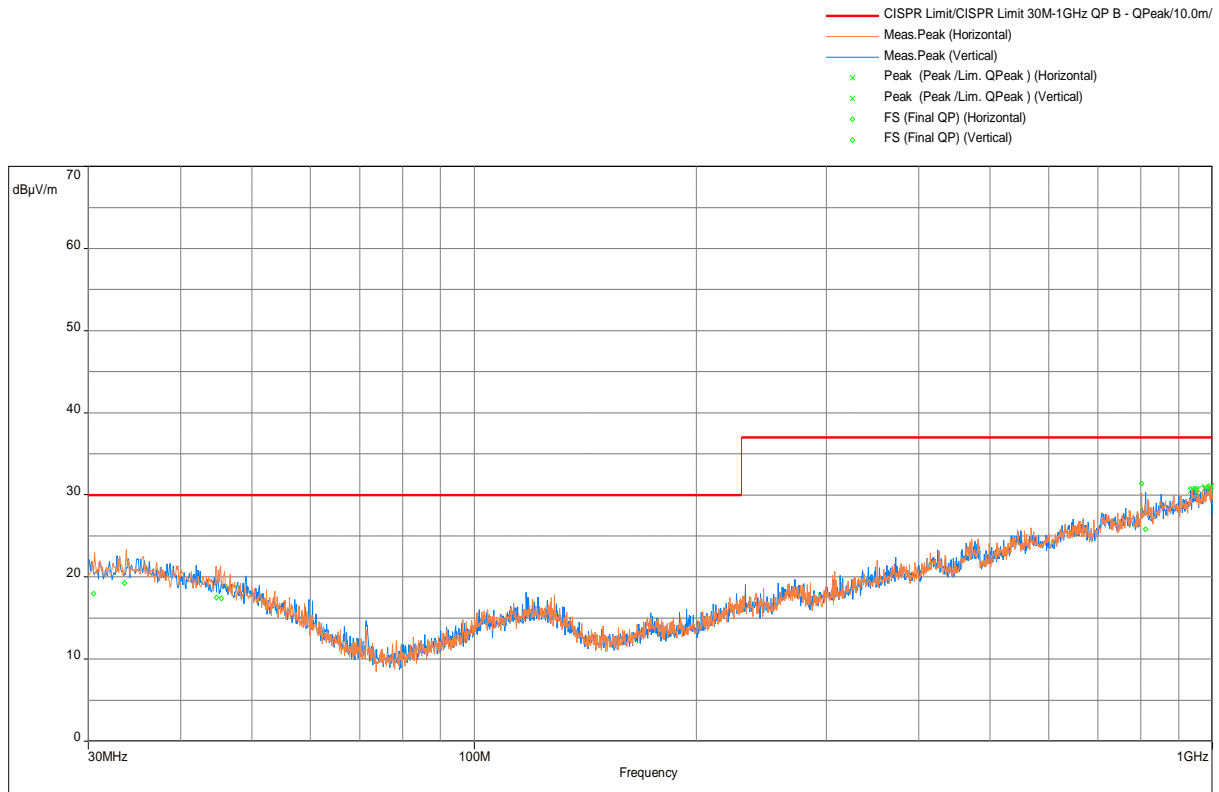
An inverse proportionality factor of 20 dB per decade was used to normalize the limit line of 30MHz to 1000MHz to the specified distance for determining compliance

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

Tested By:	Anderson Soungpanya
Test Date:	January 16-19, 2017

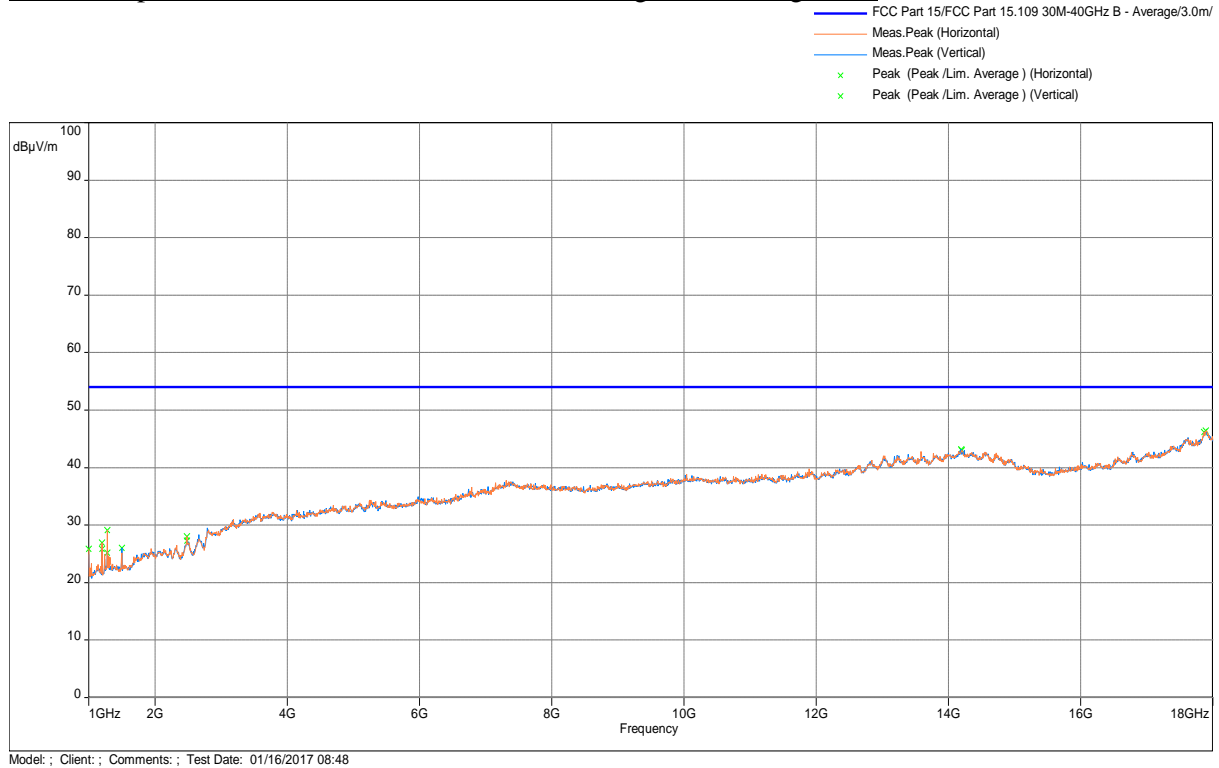
FCC Part 15B in normal operation

Test Results: Radiated Emissions 30 MHz - 1000

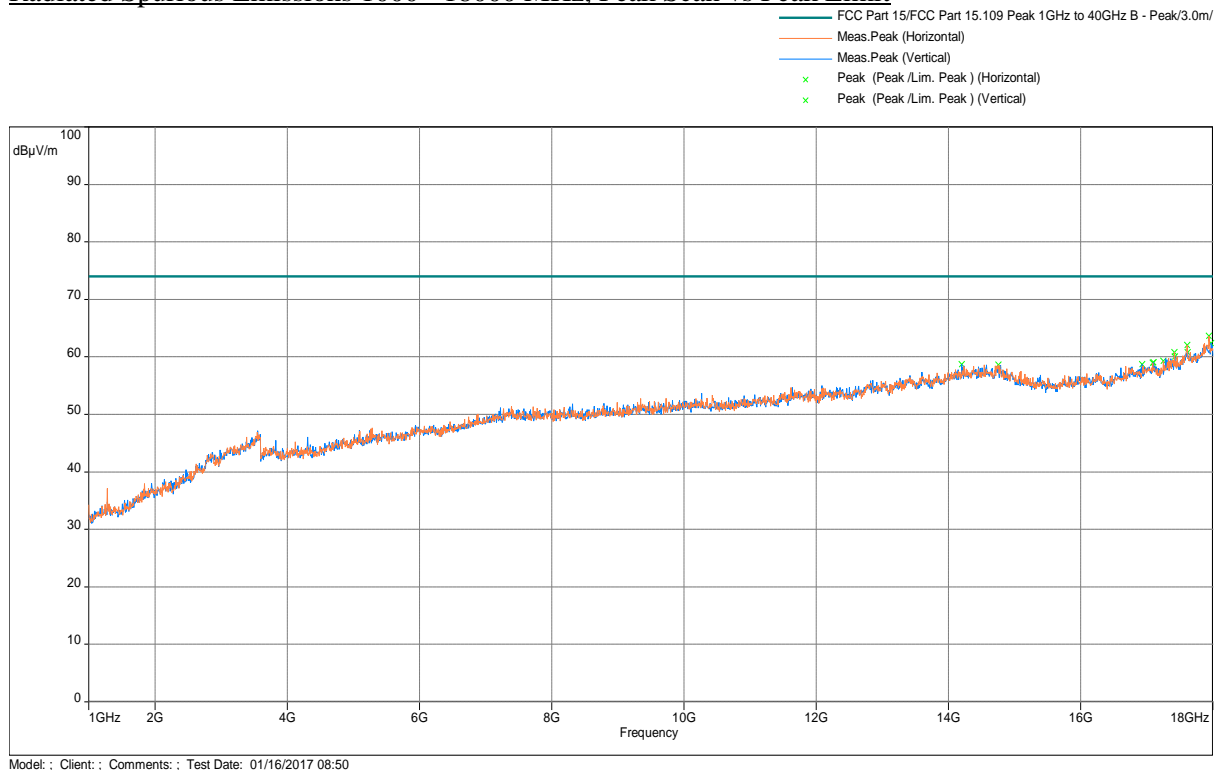


Frequency MHz	FS dBμV/m	Limit dBuV/m	Margin (dB)	Azimuth (deg)	Height (m)	Polarity	RA (dBuV)	Correction (dB)
30.489	18.00	30	-12.00	347	3.43	Horizontal	22.06	-4.08
33.613	19.26	30	-10.74	49	1.31	Horizontal	23.50	-4.17
44.774	17.49	30	-12.51	261	1.53	Horizontal	23.31	-5.83
45.409	17.39	30	-12.61	15	3.96	Horizontal	23.32	-5.95
801.817	31.38	37	-5.62	85	1.00	Horizontal	28.91	2.46
811.836	25.80	37	-11.20	251	3.14	Vertical	22.68	3.13
Result: Complies by 5.62 dB								

Radiated Spurious Emissions 1000 - 18000 MHz, Avg Scan vs Avg Limit

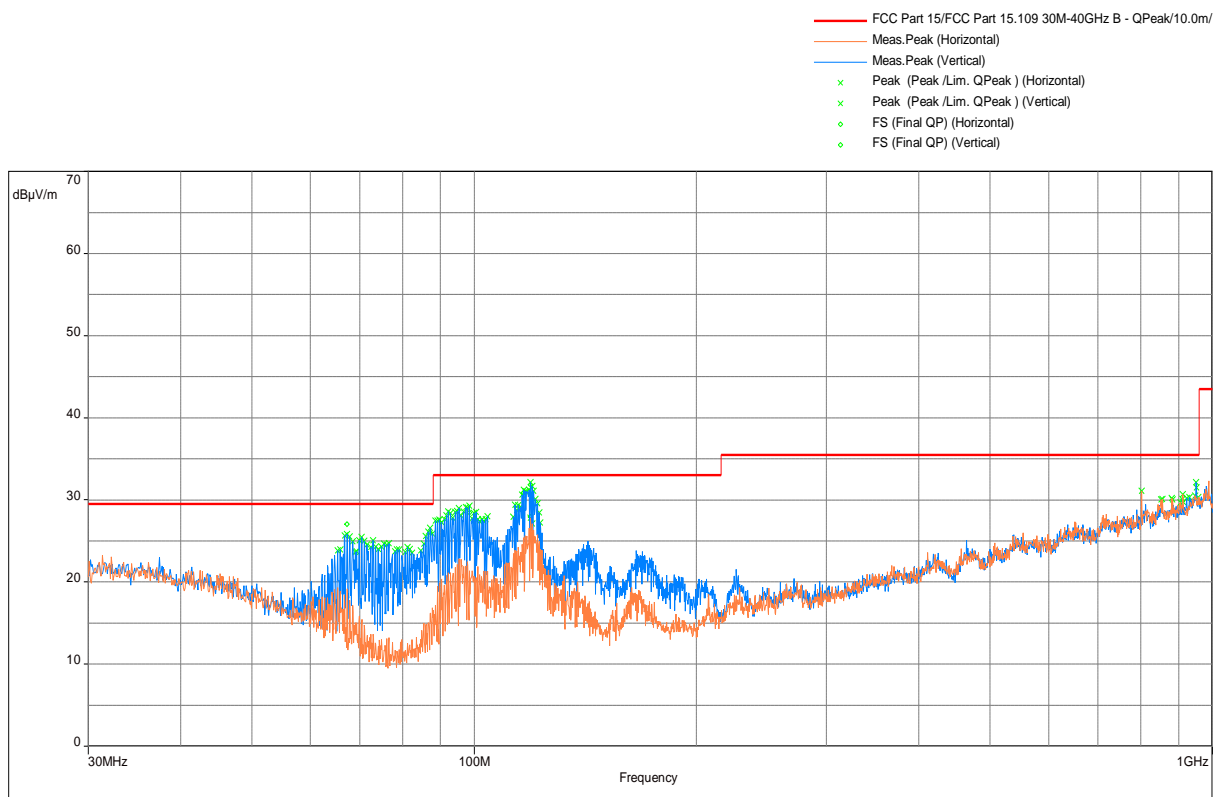


Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak Limit



FCC Part 15B in charging mode

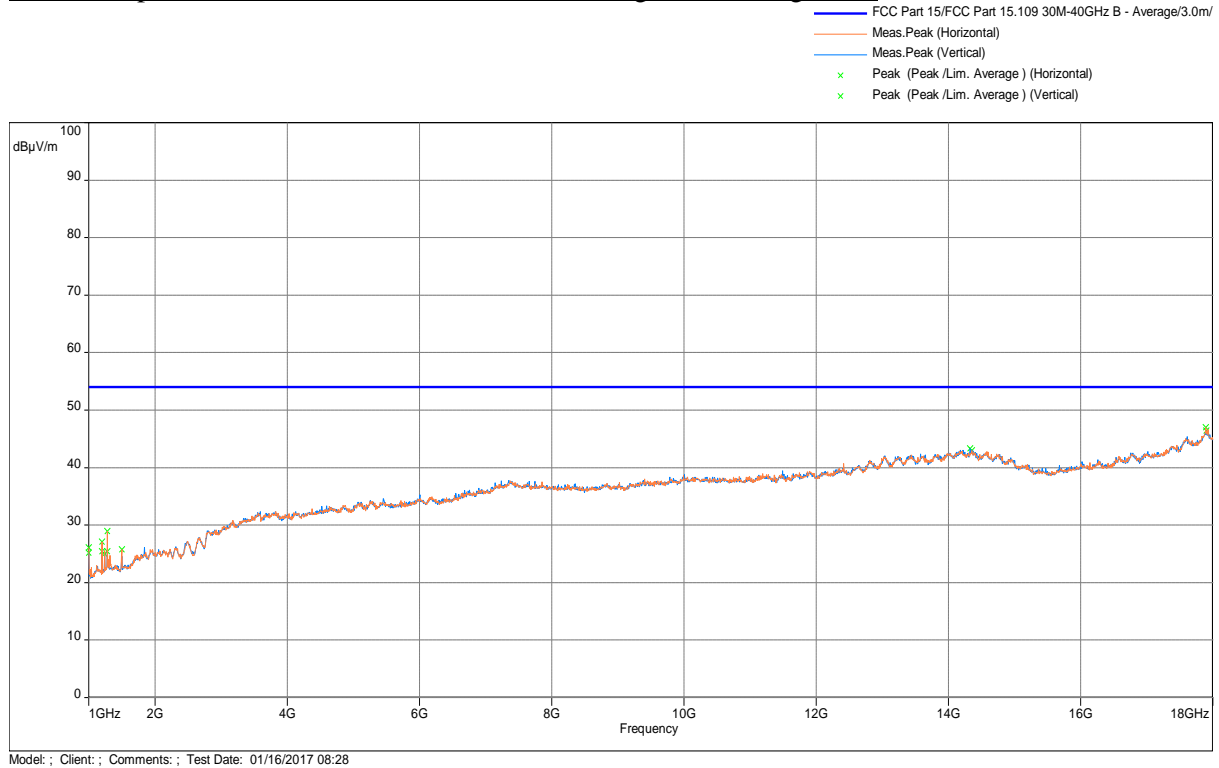
Test Results: Radiated Emissions 30 MHz - 1000



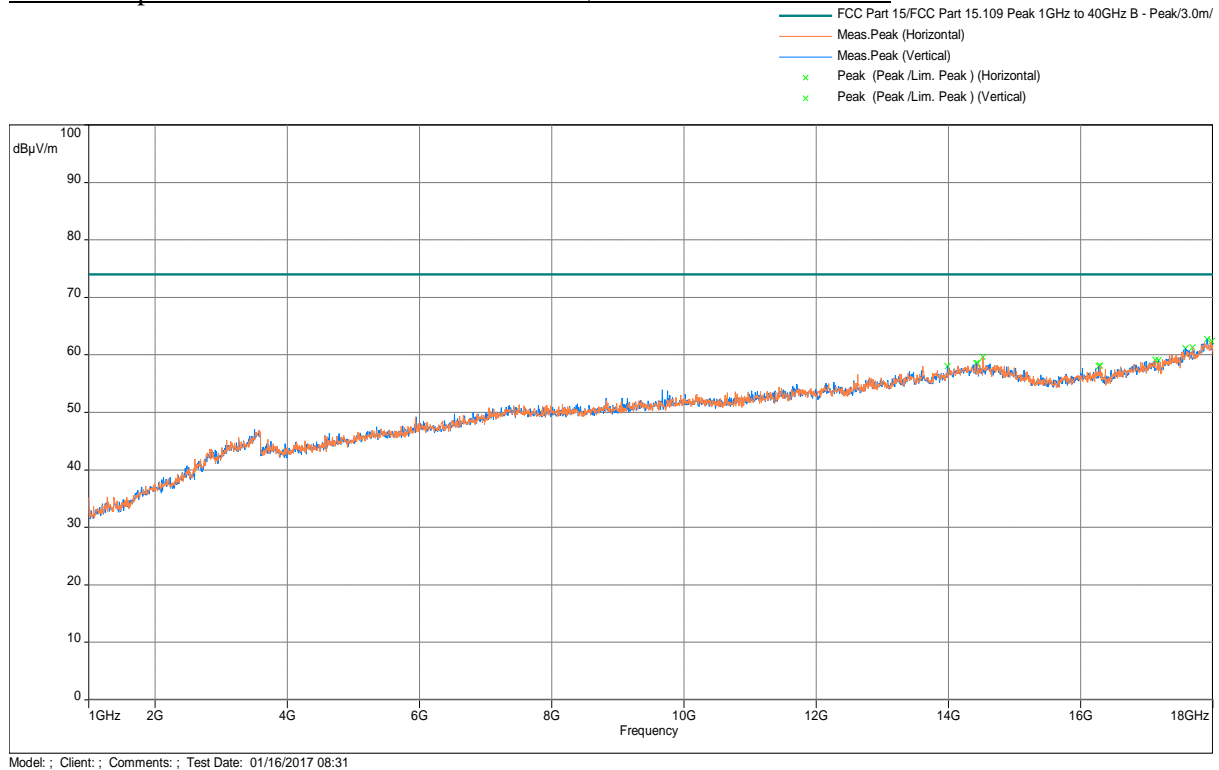
Model: ; Client: ; Comments: ; Test Date: 01/18/2017 09:35

Frequency MHz	FS dBμV/m	Limit dBμV/m	Margin (dB)	Azimuth (deg)	Height (m)	Polarity	RA (dBμV)	Correction (dB)
119.233	27.94	33.0	-5.06	1	2.61	Horizontal	37.08	-9.14
67.265	27.02	29.5	-2.48	63	2.23	Vertical	40.41	-13.39
87.131	26.06	29.5	-3.44	289	1.76	Vertical	39.37	-13.30
98.476	28.44	33.0	-4.56	233	1.19	Vertical	40.03	-11.61
116.633	29.84	33.0	-3.16	21	1.08	Vertical	40.13	-9.30
119.171	29.85	33.0	-3.15	21	1.0	Vertical	40.99	-9.14
Result: Complies by 2.48 dB								

Radiated Spurious Emissions 1000 - 18000 MHz, Avg Scan vs Avg Limit



Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak Limit





4.6.4 Test Configuration Photographs

The following photographs show the testing configurations used.

Not included in the report. Refer to Test Setup photos exhibit



4.6.4 Test Configuration Photographs (continued)

Not included in the report. Refer to Test Setup photos exhibit

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.

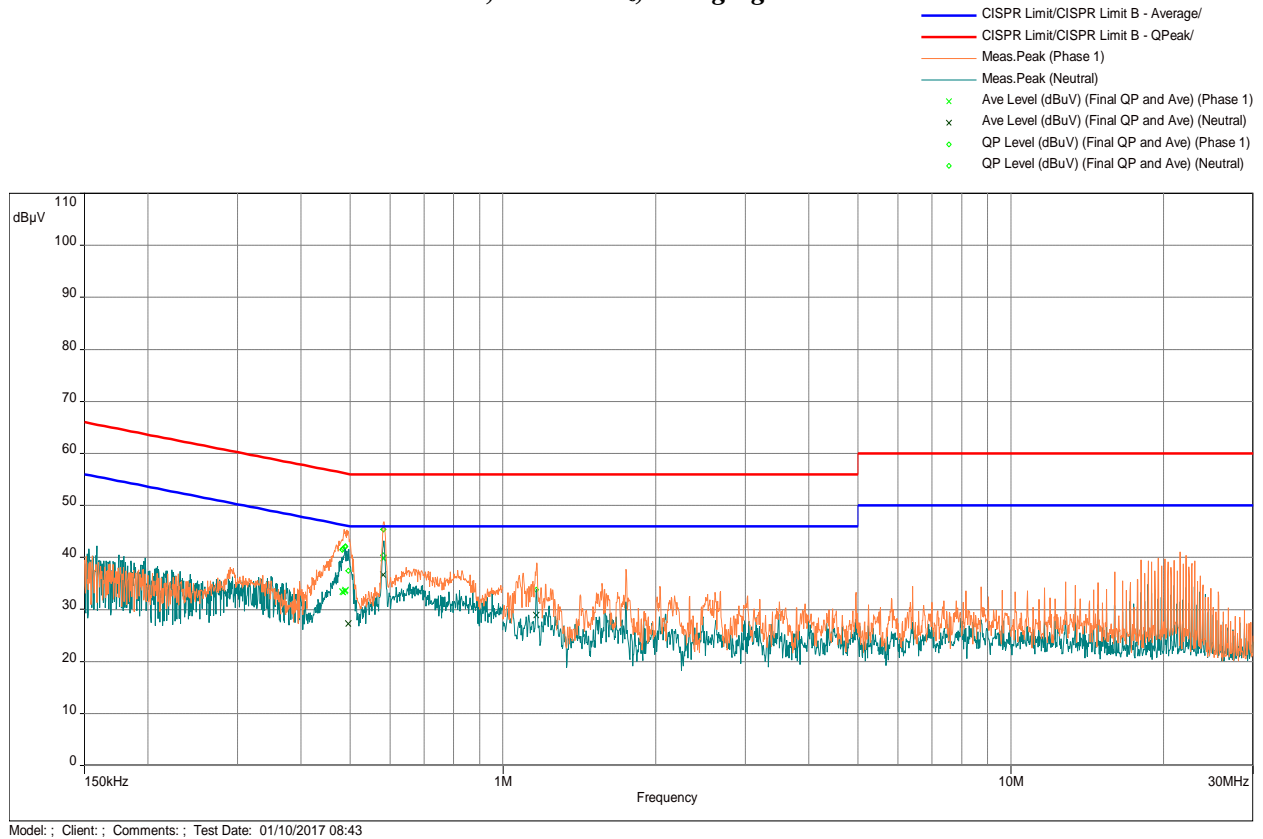
Equipment setup for conducted disturbance tests followed the guidelines of ANSI C63.4:2014.

Tested By:	Anderson Soungpanya
Test Date:	January 10, 2017

4.7.3 Test Results

The EUT met the conducted disturbance requirement of FCC Part 15B for a Class B device.

FCC Part 15B Conducted Disturbances, 120V 60Hz, Charging mode



Frequency (MHz)	Ave Level (dBuV)	QP Level (dBuV)	Ave Limit (dBuV)	QP Limit (dBuV)	Ave Margin (dB)	QP Margin (dB)	Line	Correction (dB)
0.489	33.54	42.05	46.18	56.18	-12.64	-14.13	Phase 1	11.10
0.490	33.68	42.15	46.16	56.16	-12.48	-14.02	Phase 1	11.10
0.582	39.86	45.39	46.00	56.00	-6.14	-10.61	Phase 1	11.10
0.496	27.26	37.39	46.07	56.07	-18.81	-18.68	Neutral	11.10
0.581	36.66	40.40	46.00	56.00	-9.34	-15.60	Neutral	11.10
1.163	28.92	33.82	46.00	56.00	-17.08	-22.18	Neutral	11.14

Results: Complies by 6.14 dB at 120V 60Hz



4.7.4 Test Configuration Photographs

The following photographs show the testing configurations used.

Not included in the report. Refer to Test Setup photos exhibit

AC Mains Line-Conducted Disturbance Setup Photograph

5.0 RF Exposure Evaluation

The device is used in a portable RF exposure configuration – at a distance less than 20 cm from human's body. For this configuration SAR evaluation is required.

The RF Power is low; therefore the SAR test exclusion threshold is calculated.

SAR test exclusion threshold formula according to FCC KDB 447898 D01 v05r02 is

$$P \cdot \sqrt{f/d} < 3$$

Where:

P is maximum RF conducted power of a channel or EIRP, including tune-up tolerance, mW;

f is operating frequency in GHz;

d is the minimum test separation distance, mm; the minimum distance is 5 mm.

The maximum Peak EIRP calculated is -5.10 dBm (RF Conducted Power) 0 dBi (Antenna Gain) = -5.10 dBm or 0.309 mW (P); therefore, to comply with RF Exposure Requirement, the MPE is calculated.

The **SAR test exclusion threshold** at 5mm distance is calculated as:

$$0.309 \times \sqrt{2.480 \div 5} = 0.1 < 3.$$

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

For IC: **SAR Exemption limit according to IC RSS-102 Issue 5, at 5 mm separation distance = 4 mW**

Routine evaluation is not required since the higher of the maximum conducted or equivalent isotropically radiated power (e.i.r.p.) source-based, time averaged output power is below the exemption limit.

Date of Test:	January 6, 2017
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
Spectrum Analyzer	Rohde and Schwarz	FSP	ITS 01475	12	10/10/17
Pyramidal Horn Antenna	EMCO	3160-09	ITS 00571	#	#
Pre-Amplifier (18-40GHz)	Miteq	TTA1840-35-S-M	ITS 01393	12	04/13/17
Active Horn Antenna	ETS-Lindgren	3117-PA	ITS 01365	12	08/09/17
EMI Receiver	Rohde and Schwarz	ESU	ITS 00961	12	07/07/17
BI-Log Antenna	Antenna Research	LPB-2513	ITS 00355	12	09/09/17
Pre-Amplifier	Sonoma Instrument	310	ITS 01493	12	09/28/17

No Calibration required

Software used for emission compliance testing utilized the following:

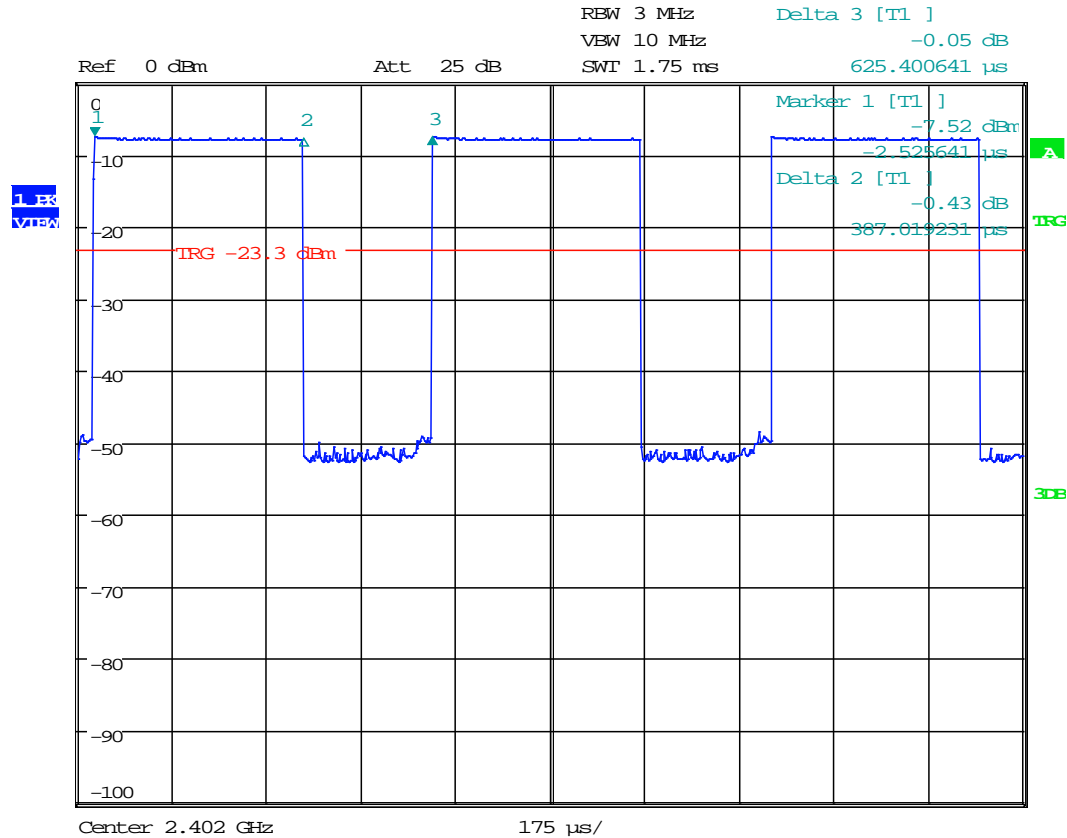
Name	Manufacturer	Version	Template/Profile
Tile	Quantum Change	3.4.K.22	Conducted Restricted Band Edge_Avg Conducted Restricted Band Edge_Peak Conducted Restricted Band_1-26GHz Conducted Restricted Band_30M-1GHz Conducted Spurious_30M-26GHz
BAT-EMC	Nexio	3.16.0.64	102738196_OrthoAccel.bpp
RS Commander	Rohde Schwarz	1.6.4	Not Applicable (Screen grabber)



7.0 Document History

Revision/ Job Number	Writer Initials	Reviewers Initials	Date	Change
1.0 / G102738196	AS	KV	January 27, 2017	Original document

Annex A - Duty Cycle Measurement



Date: 6.JAN.2017 08:56:53

Duty Cycle: $DC = 387.2 / 625.4 = 0.619$ or 61.9%

Duty Cycle Correction Factor δ (dB) = $10 \log (387.2 / 625.4) = 2.1\text{dB}$