TEST REPORT

Report Number: 103398220MPK-001
Project Number: G103398220
March 14, 2018

Testing performed on
NEXKEY CORE
Model: COR01
FCC ID: 2AO3ACOR01
to

FCC Part 15 Subpart C (15.247)
Industry Canada RSS-247 Issue 2
FCC Part 15, Subpart B
Industry Canada ICES-003

For

Nexkey, Inc.

Test Performed by:	Test Authorized by:
Intertek	Nexkey, Inc.
1365 Adams Court	1501 Powell Street Suite B
Menlo Park, CA 94025 USA	Emeryville, CA 94608 USA

Prepared by: _____ **Date:** March 14, 2018
Anderson Soungpanya

Reviewed by: _____ **Date:** March 14, 2018
Krishna K Vemuri

Report No. 103398220MPK-001

Equipment Under Test:	Nexkey Core
Trade Name:	Nexkey, Inc.
Model Number:	COR01
Applicant:	Nexkey, Inc.
Contact:	Will Rehlich
Address:	Nexkey, Inc. 1501 Powell Street Suite B Emeryville, CA 94608
Country	USA
Tel. Number:	(650) 400-3709
Email:	will.rehlich@nexkey.com
Applicable Regulation:	FCC Part 15 Subpart C (15.247) Industry Canada RSS-247 Issue 2 FCC Part 15, Subpart B Industry Canada ICES-003 Issue 6
Date of Test:	February 6 to March 9, 2018

We attest to the accuracy of this report:

Anderson Soungpanya
Project Engineer

Krishna K Vemuri
Engineering Team Lead

TABLE OF CONTENTS

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	Not Applicable – EUT is battery operated and non-rechargeable
Antenna Requirement	15.203	RSS-GEN	Complies (Internal Antenna)
Radiated Emission	15.109	RSS-GEN	Complies
AC Line Conducted Emission	15.107	RSS-GEN	Not Applicable – EUT is battery operated and non-rechargeable

EUT receive date: February 05, 2018

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: February 06, 2018

Test completion date: March 09, 2018

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

2.0 General Information

2.1 Product Description

Nexkey, Inc. supplied the following description of the EUT:

The Nexkey core is an electromechanical replacement for mechanical locks. The Nexkey core connects to smartphones and other host devices via Bluetooth and provides physical access control.

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

Information about the 2.4 GHz radio is presented below:

Applicant	Nexkey, Inc.
Model No.	COR01
FCC Identifier	2AO3ACOR01
Type of transmission	Digital Transmission System (DTS)
Rated RF Output	1.06 dBm
Antenna(s) & Gain	Internal Antenna, Gain: 0.9 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	Nexkey, Inc. 1501 Powell Street Suite B Emeryville, CA 94608 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 v04), 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

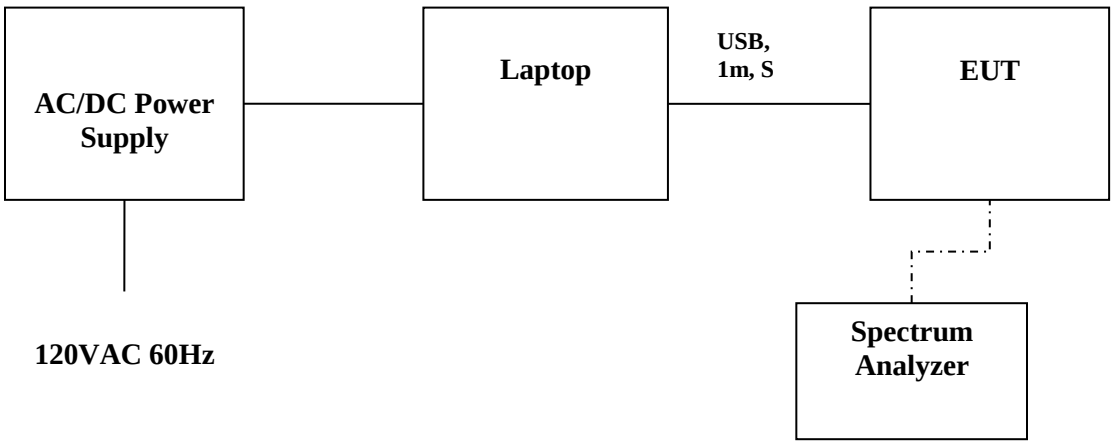
3.1 Support Equipment

Description	Manufacturer	Model Number
Laptop	Lenovo	Thinkpad W550s

3.2 Block Diagram of Test Setup

Equipment Under Test			
Description	**Manufacturer**	**Model Number**	**Serial Number**
Square with Button	Nexkey, Inc.	COR01	4178
Square with Capacitive Touch	Nexkey, Inc.	COR01	4136
Pill with Button	Nexkey, Inc.	COR01	4130
Pill with Capacitive Touch	Nexkey, Inc.	COR01	4131

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



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

3.3 Justification

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

According to the manufacturer, there are two different shapes of the aluminum handle (Square with rounded edges and a pill shape). The pill shape is larger. There are also two versions of wake mechanism (one uses capacitive touch and the other uses a mechanical button). In total there are 4 variations, listed below.

1. Square with Capacitive Touch
2. Square with Button
3. Pill with Capacitive Touch
4. Pill with Button

Besides the handle, the EUT's RF and electrical circuit for the 4 variations are identical. Therefore, antenna port measurements were performed once. Transmitter Radiated Spurious and Digital Part Radiated Emissions measurements were performed for all 4 variations listed above with the antenna in place.

3.4 Software Exercise Program

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

No modifications were made by the manufacturer or Intertek to the EUT in order to bring the EUT 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 99% Occupied Bandwidth
FCC Rule: 15.247(a)(2); RSS-247, 5.2.1 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 v04 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.

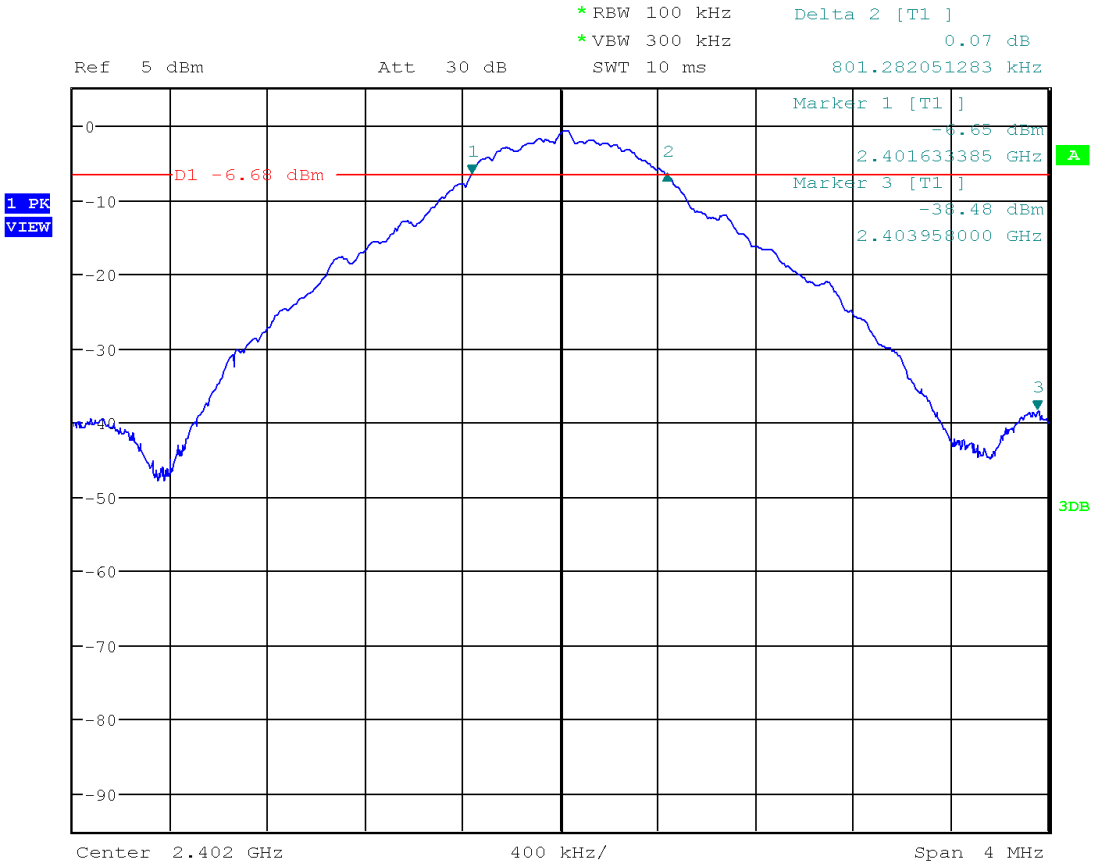
For 99% power bandwidth measurement, the bandwidth was determined by using the built-in 99% occupied bandwidth function of the spectrum analyzer. The resolution bandwidth is set to 1% of the selected span as is without being below 1%. The video bandwidth shall be set to 3 times the resolution bandwidth.

4.1.3 Test Result

Frequency (MHz)	6-dB bandwidth FCC 15.247 & RSS-GEN, kHz	Occupied bandwidth, RSS-GEN, MHz	Plot
2402	801.282	--	1.1
	--	1.794	1.4
2440	807.692	--	1.2
	--	1.790	1.5
2480	855.333	--	1.3
	--	1.784	1.6

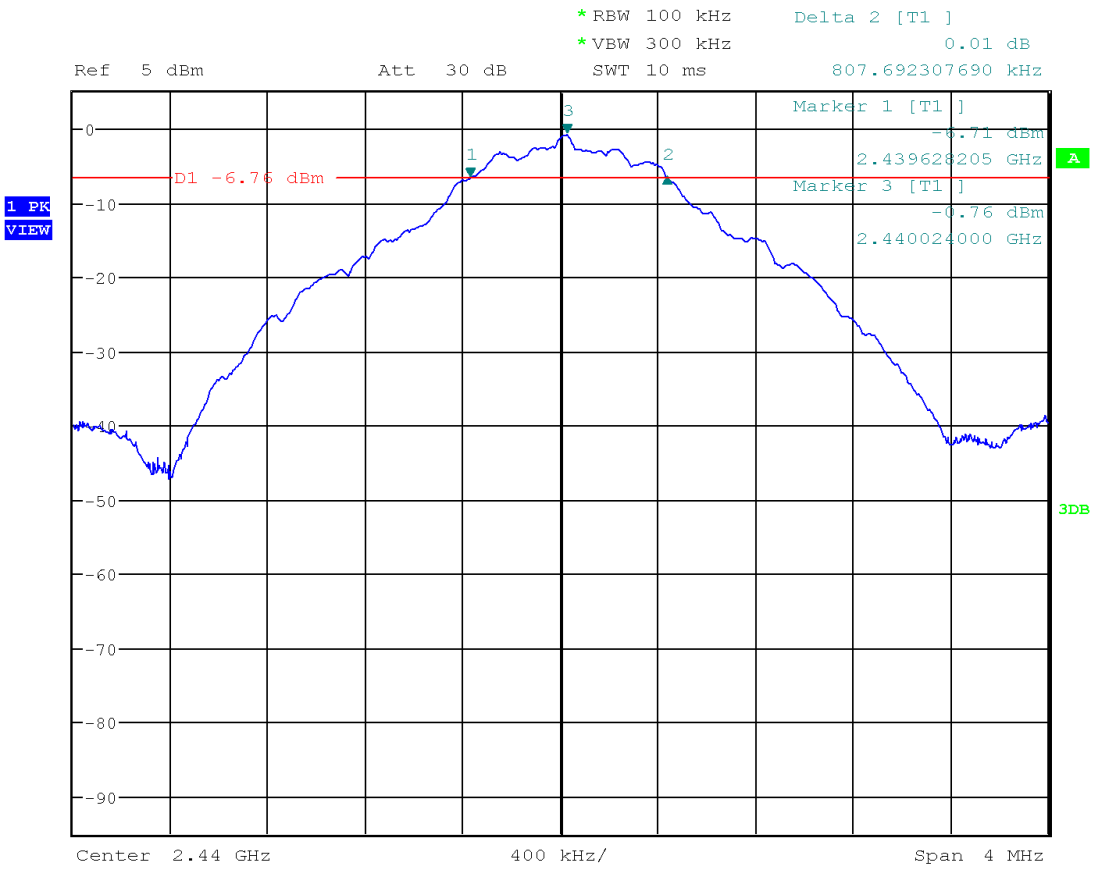
Date of Test:	February 9, 2018
Results	**Complies**

Plot 1. 1



Date: 9.FEB.2018 09:37:38

Plot 1. 2



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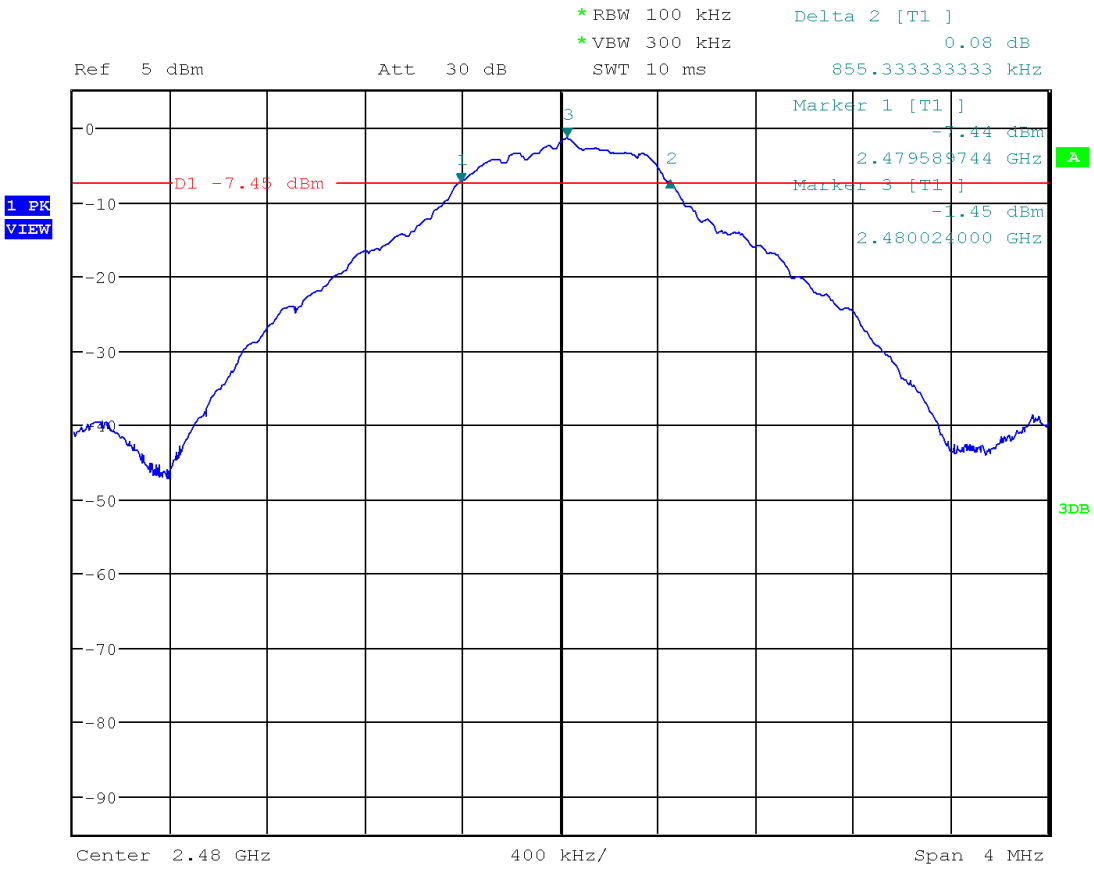
Plot 1. 3



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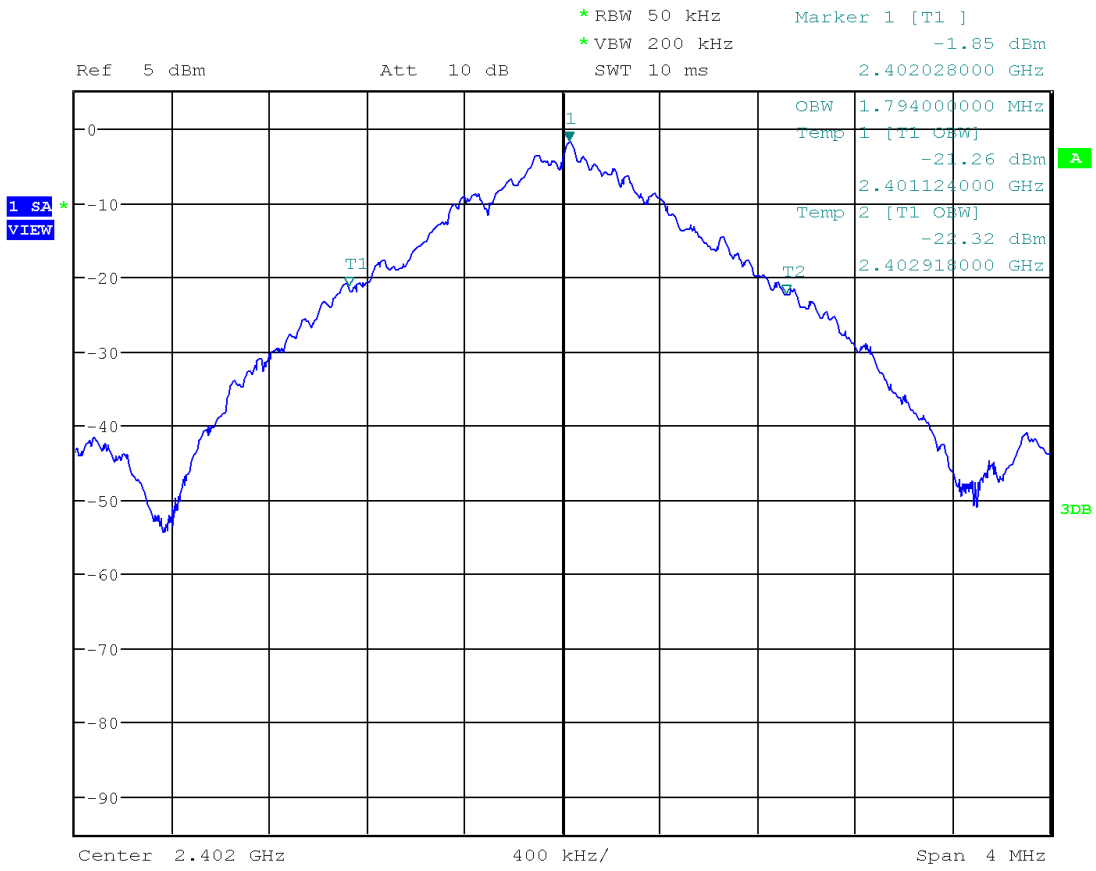
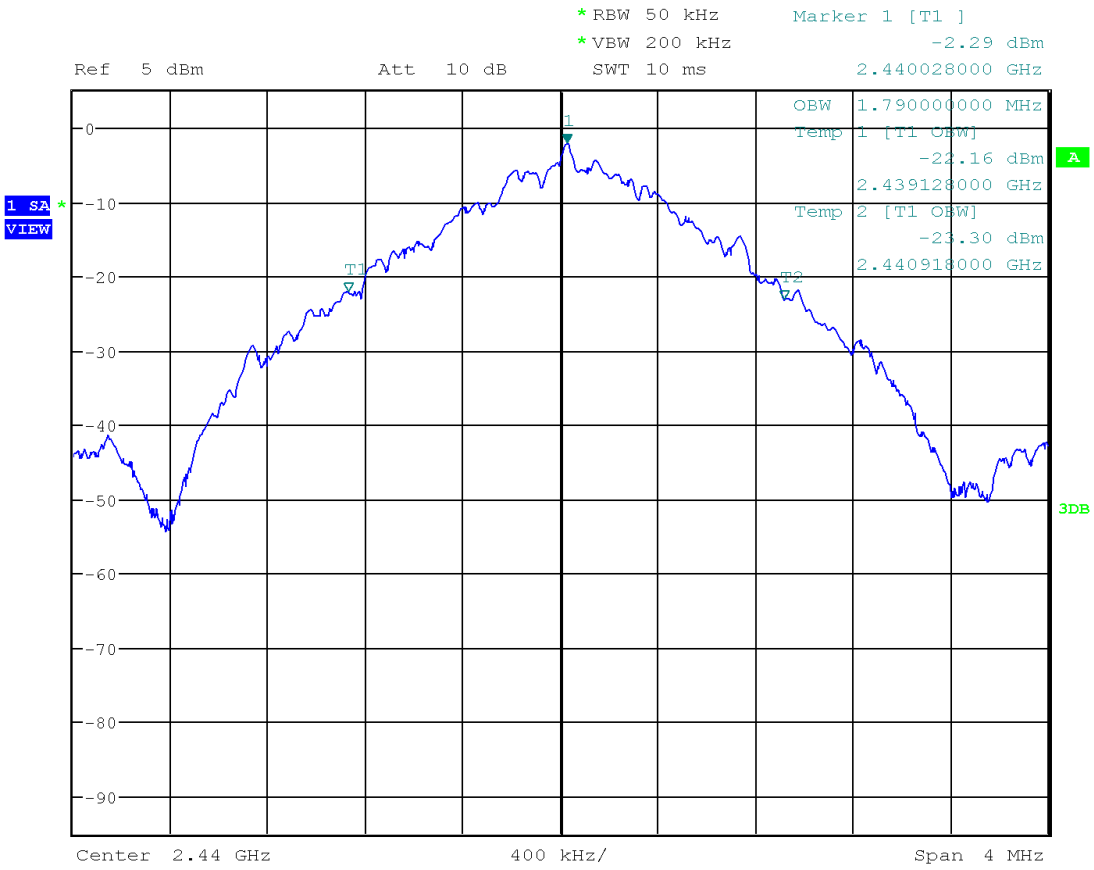
Plot 1. 4



Date: 9.FEB.2018 09:53:37

Plot 1.5



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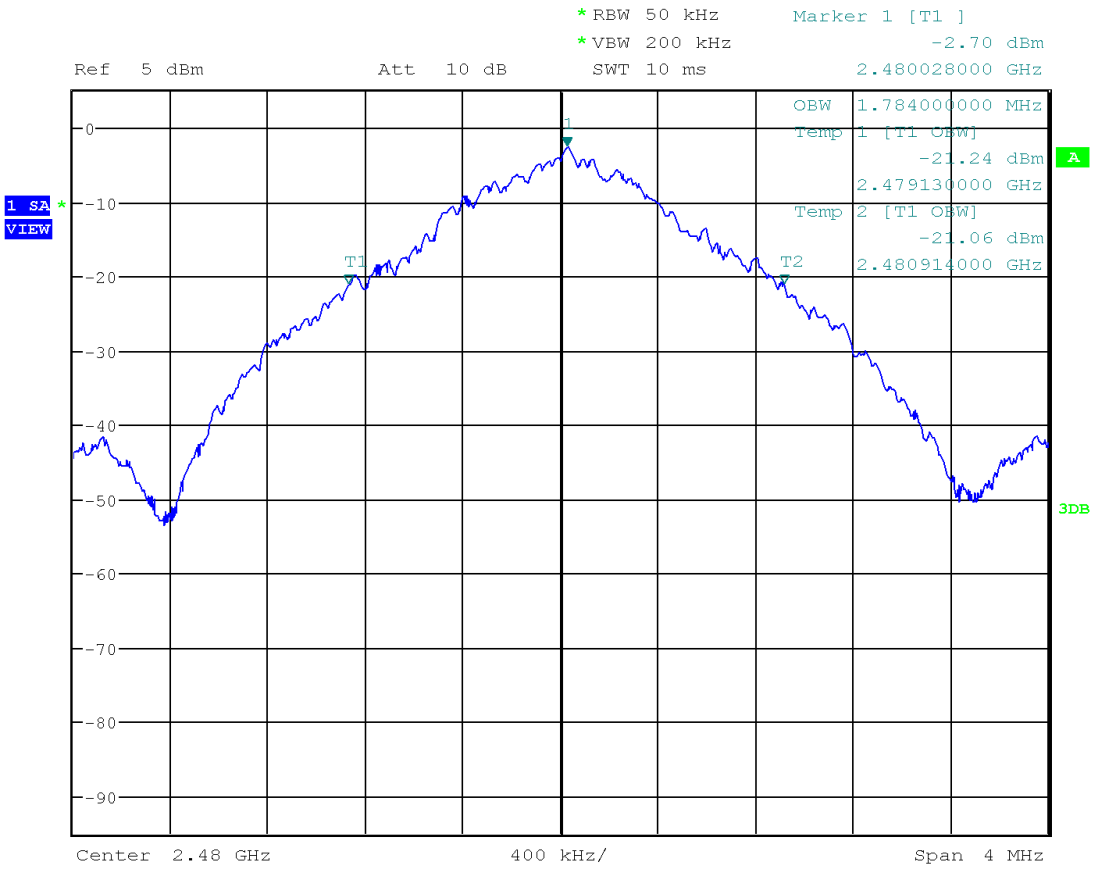
Plot 1.6



Date: 9.FEB.2018 09:50:45

4.2 Maximum Peak Conducted Output Power at Antenna Terminals
FCC Rule: 15.247(b)(3); RSS-247, 5.4.4;

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 v04 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.

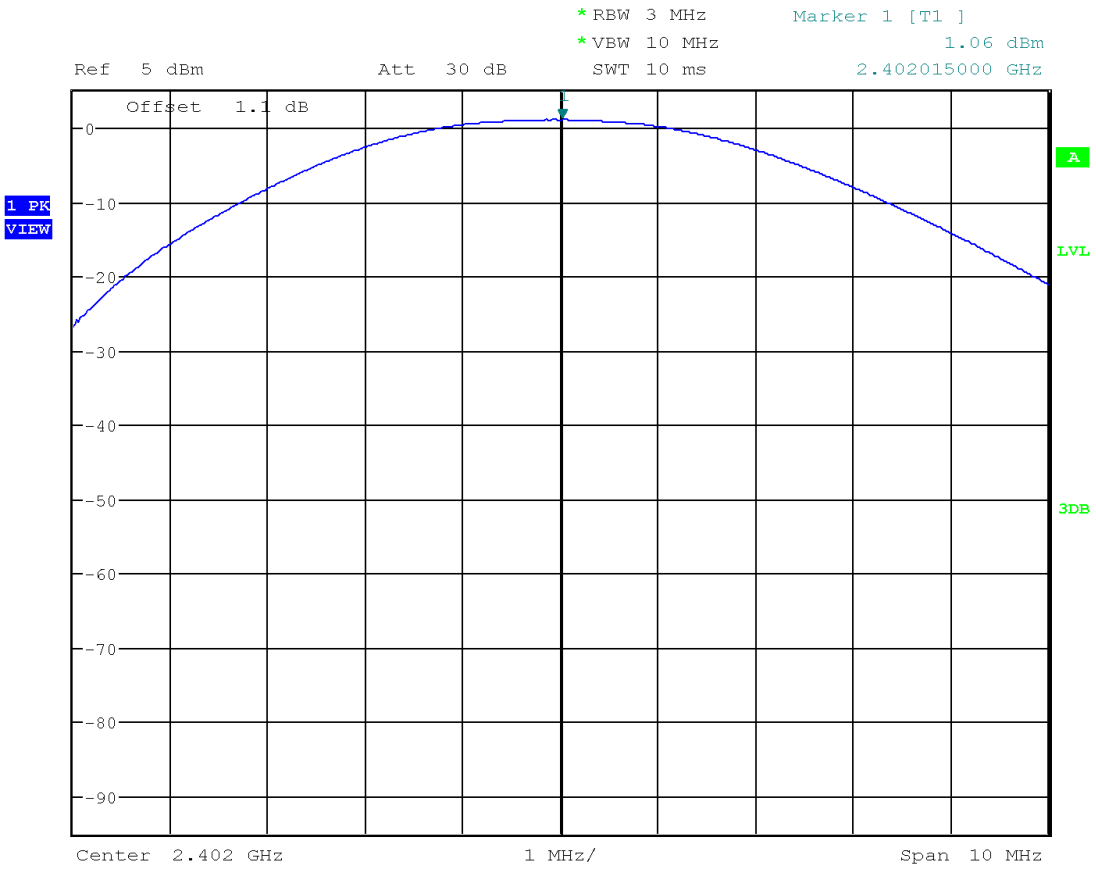
4.3.3 Test Result

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

Frequency, MHz	Conducted Power (peak), dBm	Conducted Power (peak), mW	Plot
2402	1.06	1.276	2.1
2440	0.38	1.091	2.2
2480	0.64	1.159	2.3

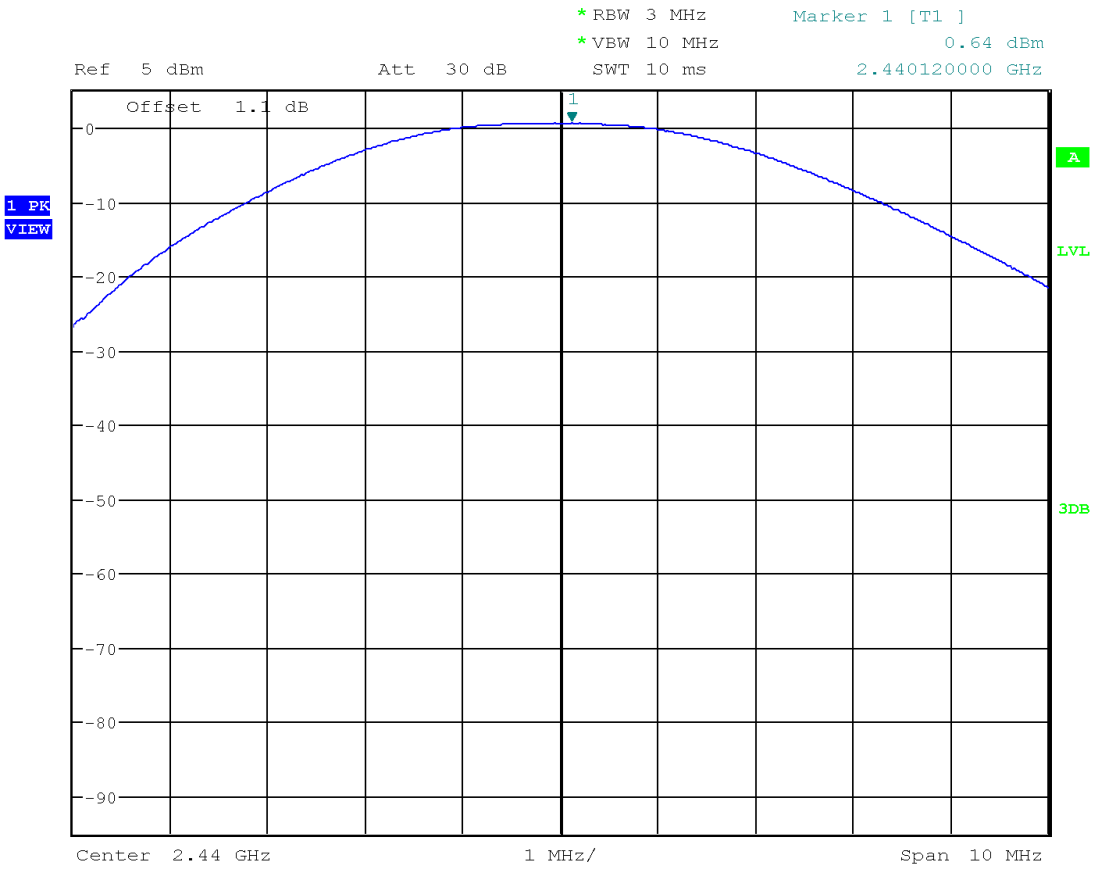
Date of Test:	February 9, 2018
Results	**Complies**

Plot 2. 1



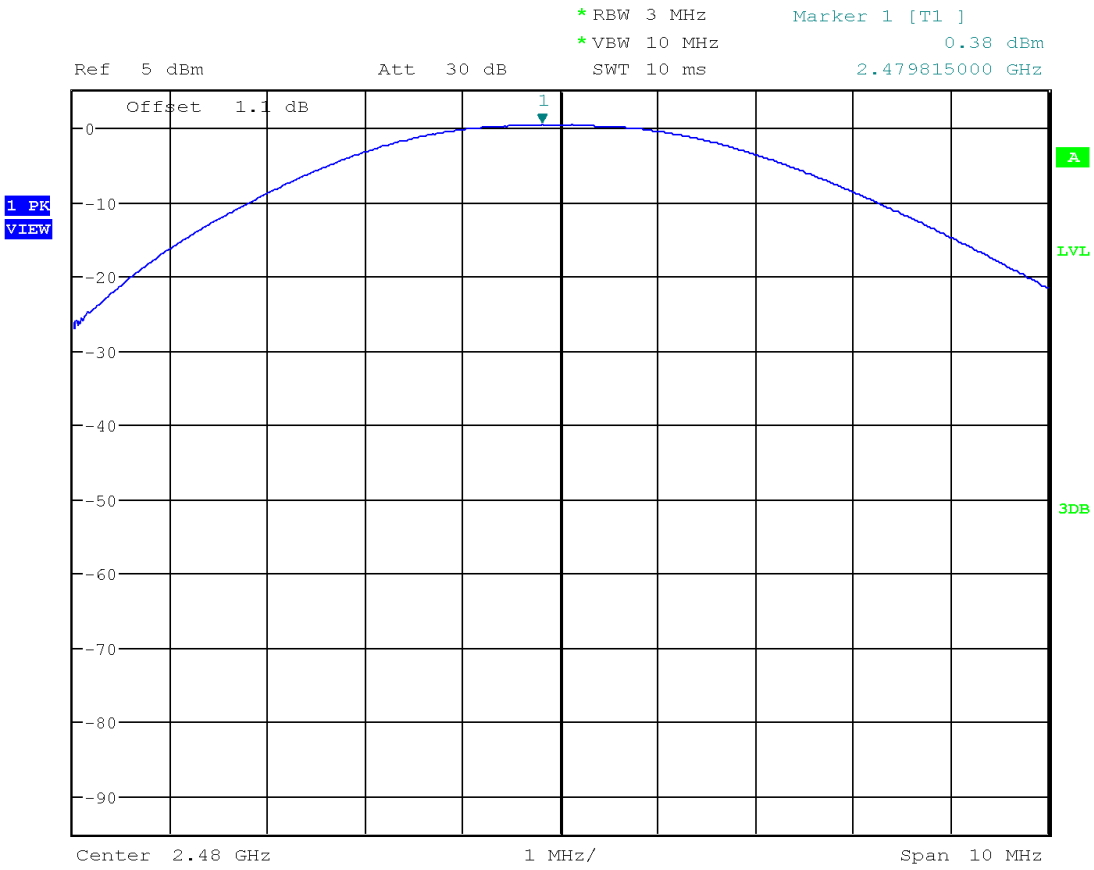
Date: 9.FEB.2018 10:36:18

Plot 2. 2



Date: 9.FEB.2018 10:35:32

Plot 2. 3



Date: 9.FEB.2018 10:34:36

4.3 Maximum Power Spectral Density
FCC: 15.247 (e); RSS-247, 5.2.2;

4.3.1 Requirement

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna should not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

4.3.2 Procedure

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

The procedure described in FCC Publication 558074 D01 DTS Meas Guidance v04, 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.

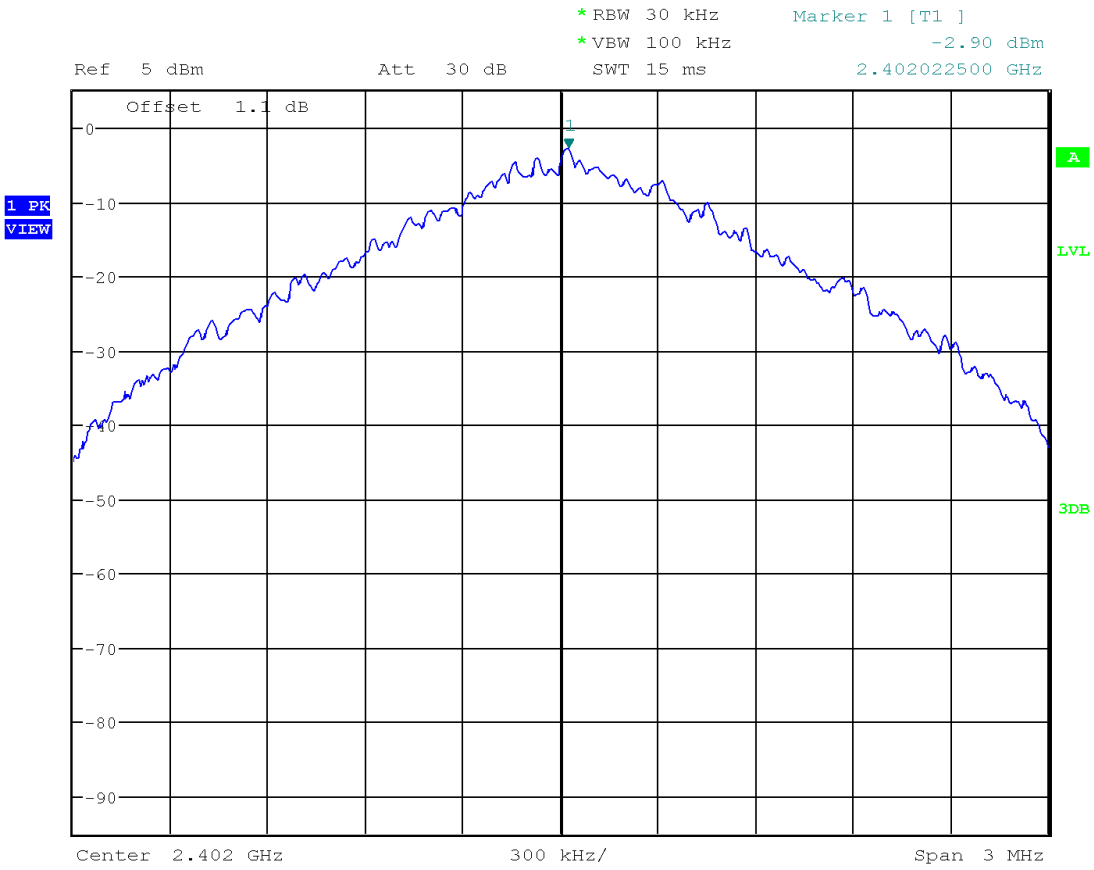
4.3.3 Test Result

Refer to the following plots for the test result

Frequency, MHz	Maximum Power Spectral Density, dBm	Maximum Power Spectral Density Limit, dBm	Margin, dB	Plot
2402	-2.90	8.0	-10.90	3.1
2440	-3.27	8.0	-11.27	3.2
2480	-3.19	8.0	-11.19	3.3

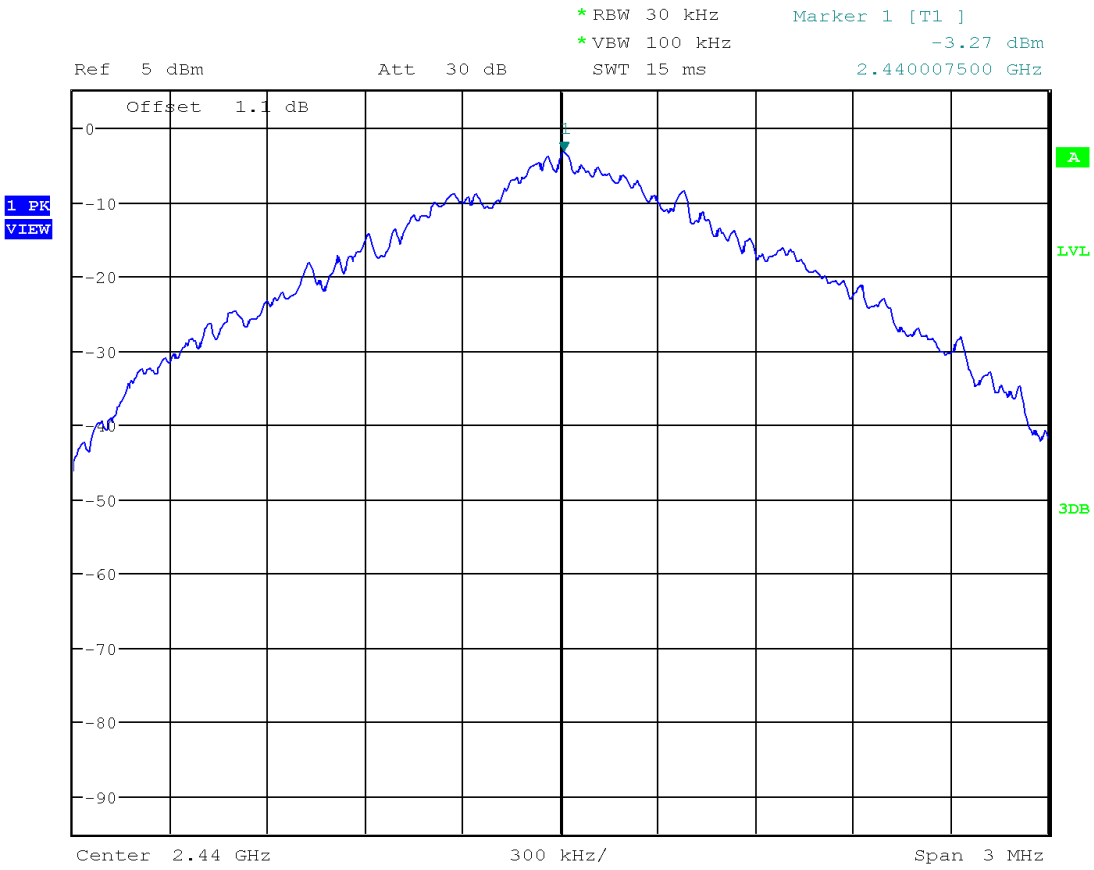
Date of Test:	February 9, 2018
Results	**Complies**

Plot 3. 1



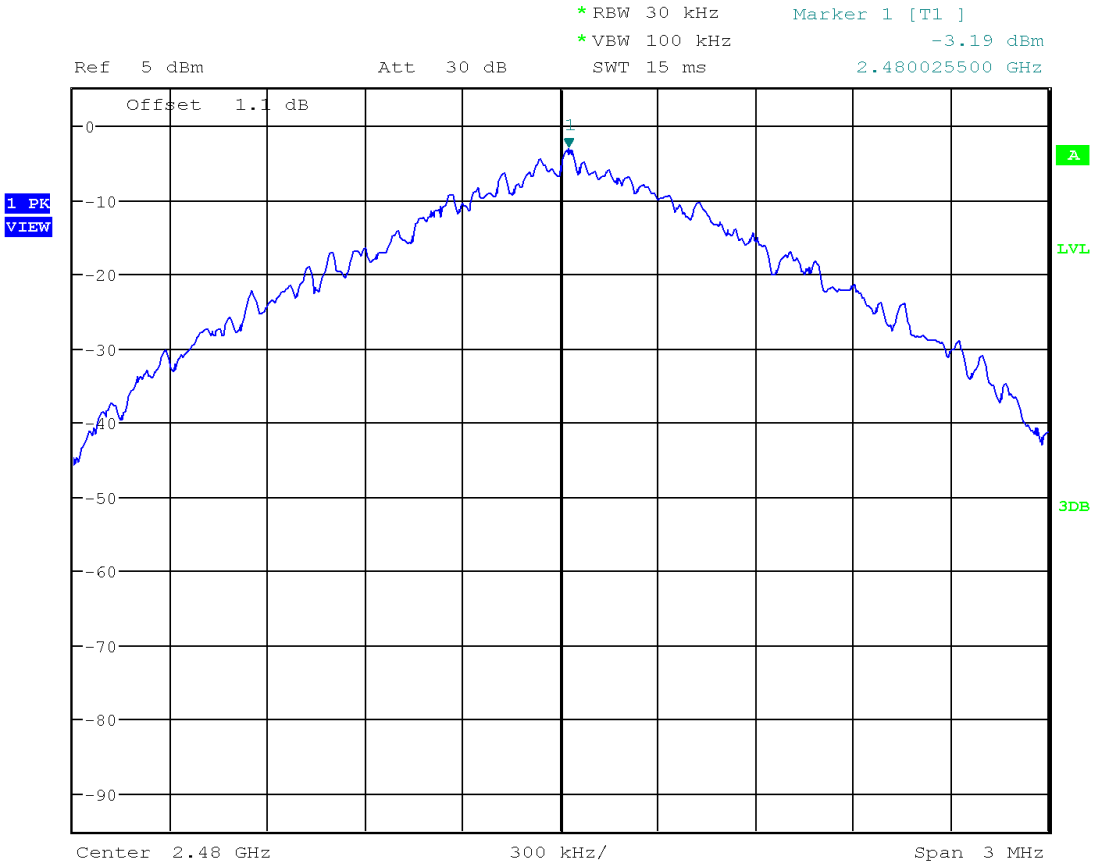
Date: 9.FEB.2018 10:37:32

Plot 3. 2



Date: 9.FEB.2018 10:38:23

Plot 3. 3



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4.4 Out of Band Antenna Conducted Emission
FCC: 15.247(d); RSS-247, 5.5;

4.4.1 Requirement

In any 100 kHz bandwidth outside the EUT pass-band, the RF power shall be below the maximum in-band 100 kHz emissions by at least 20 dB (if peak power of in-band emission is measured) or 30 dB (if average power of in-band emission is measured).

In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a)

4.4.2 Procedure

The procedure described in FCC Publication 558074 D01 DTS Meas Guidance v04, 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.

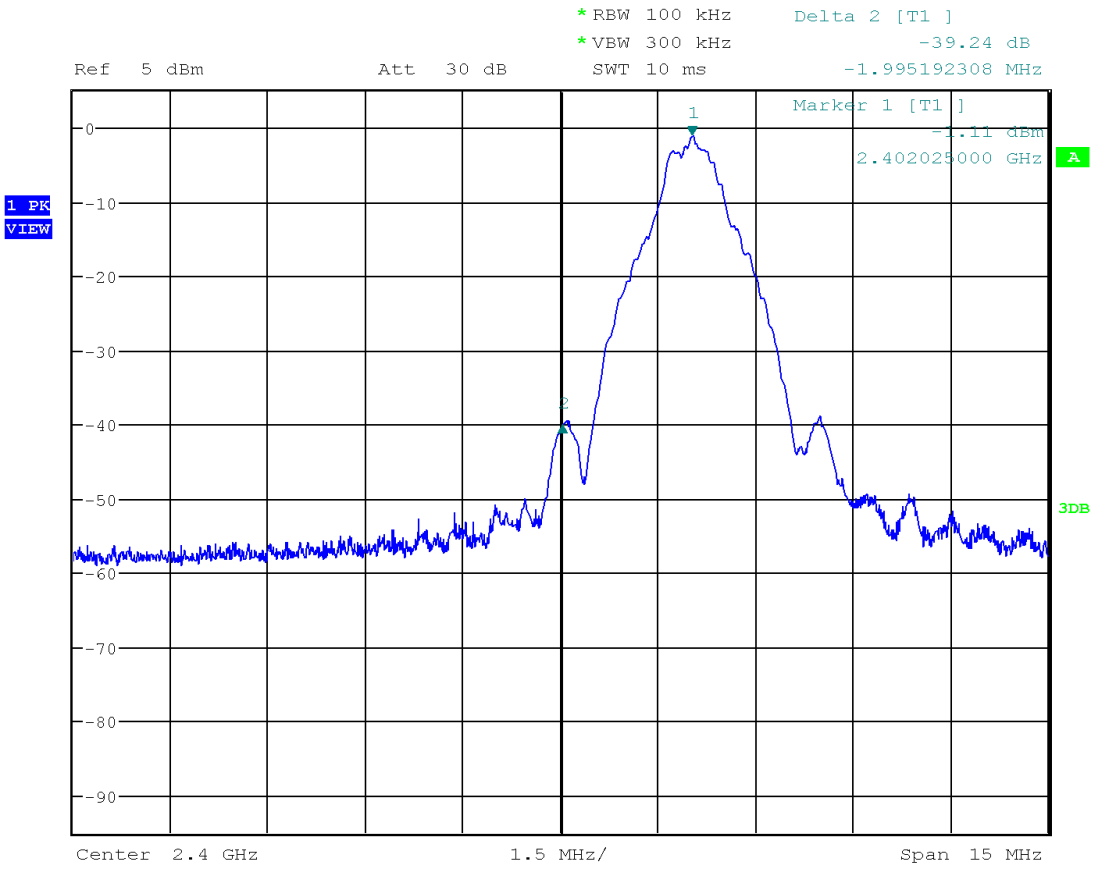
The unwanted emissions were measured from 30 MHz to 25 GHz. Plots below are corrected for cable loss and then compared to the limits.

4.4.3 Test Result

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

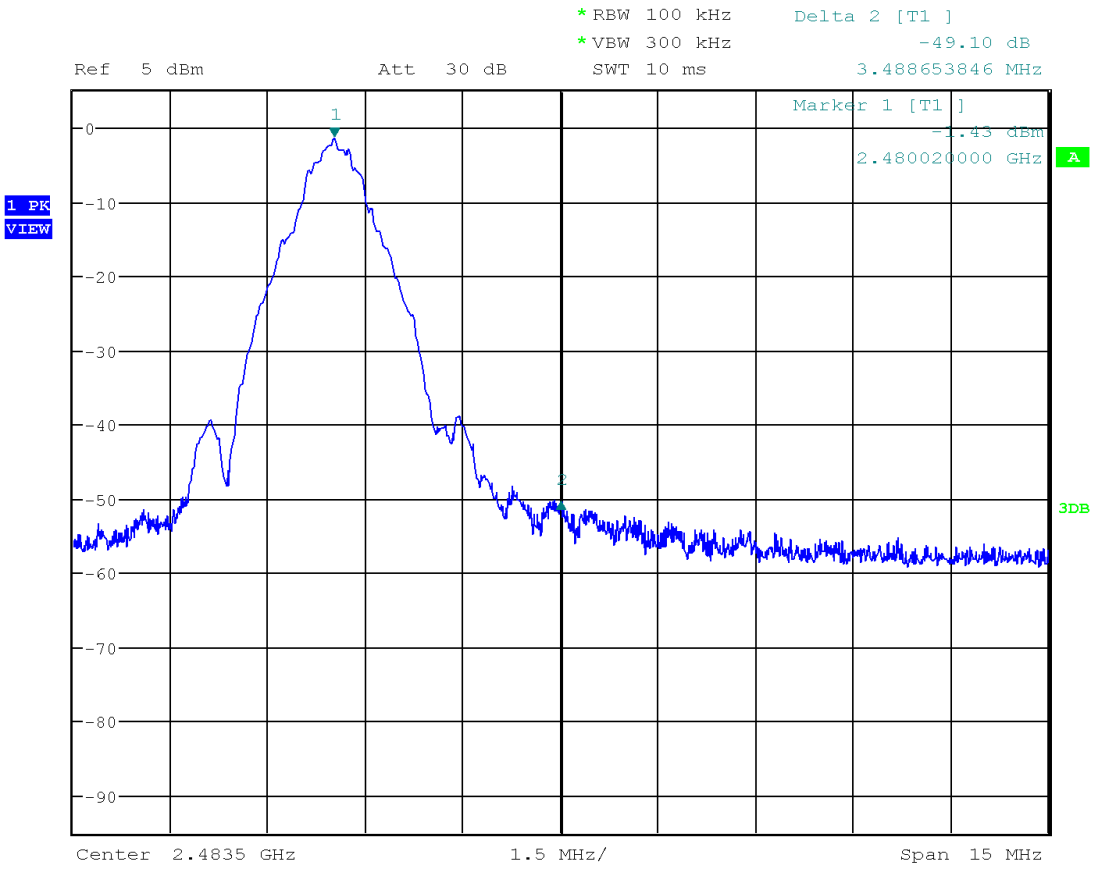
Date of Test:	February 9, 2018
Results	**Complies**

Tx @ Low Channel, 2400 MHz Band Edge
Plot 4.1



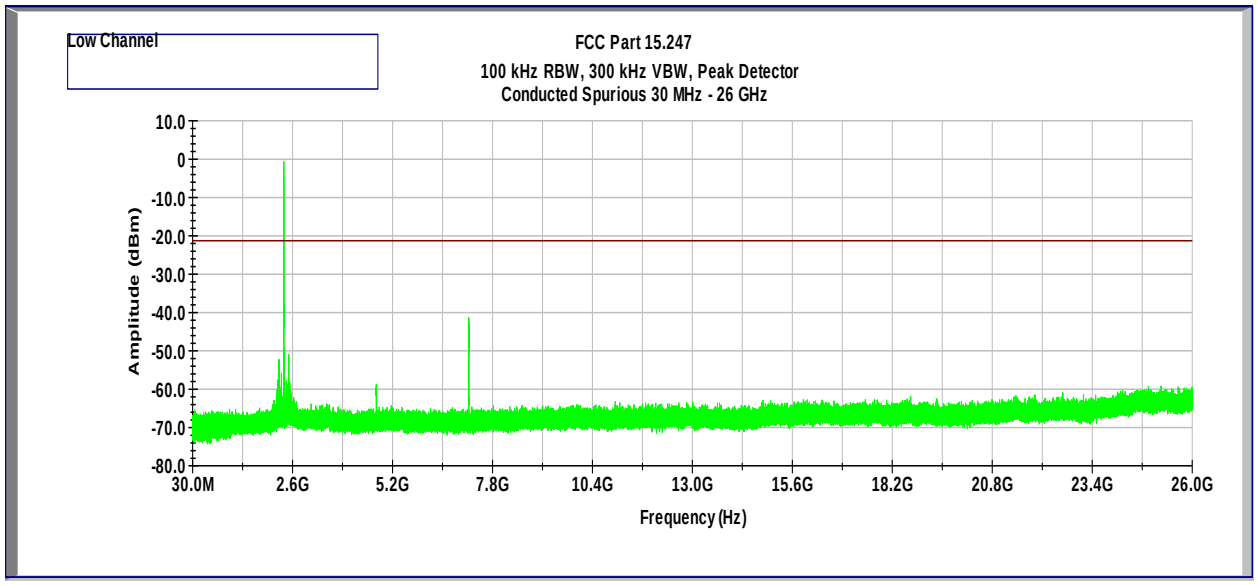
Date: 9.FEB.2018 10:47:32

Tx @ Low Channel, 2483.5 MHz Band Edge
Plot 4.2

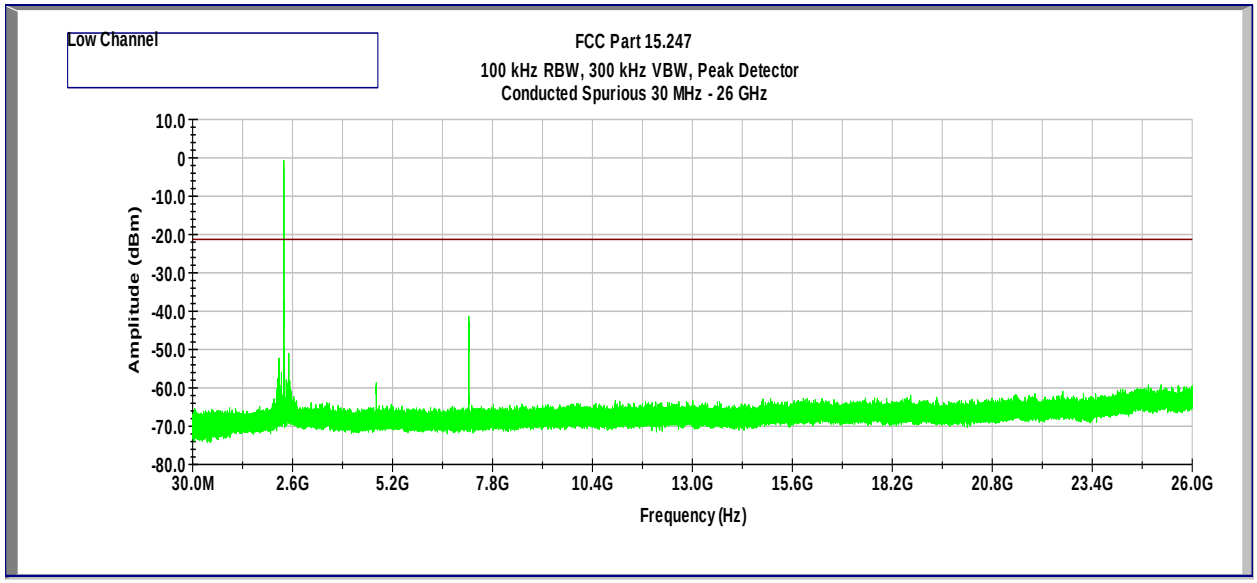


Date: 9.FEB.2018 10:44:07

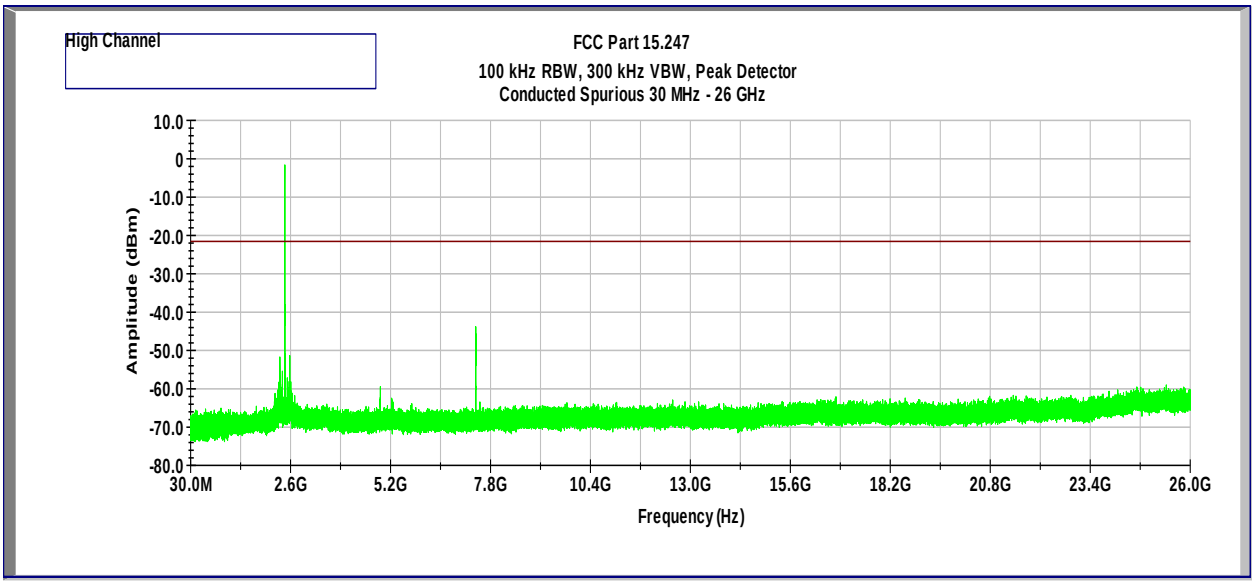
Tx @ Low Channel, 2402 MHz
30MHz -26GHz Conducted Spurious
Plot 4.3



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, 5.5;

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(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 – 20log D + 104.8+DCF (DCF for Average measurements)
where:
E = electric field strength in dBμV/m,
EIRP = equivalent isotropic radiated power in dBm
D = specified measurement distance in meters.
DCF = Duty Cycle Correction Factor
f) Compare the resultant electric field strength level to the applicable limit.
g) Perform radiated spurious emission test

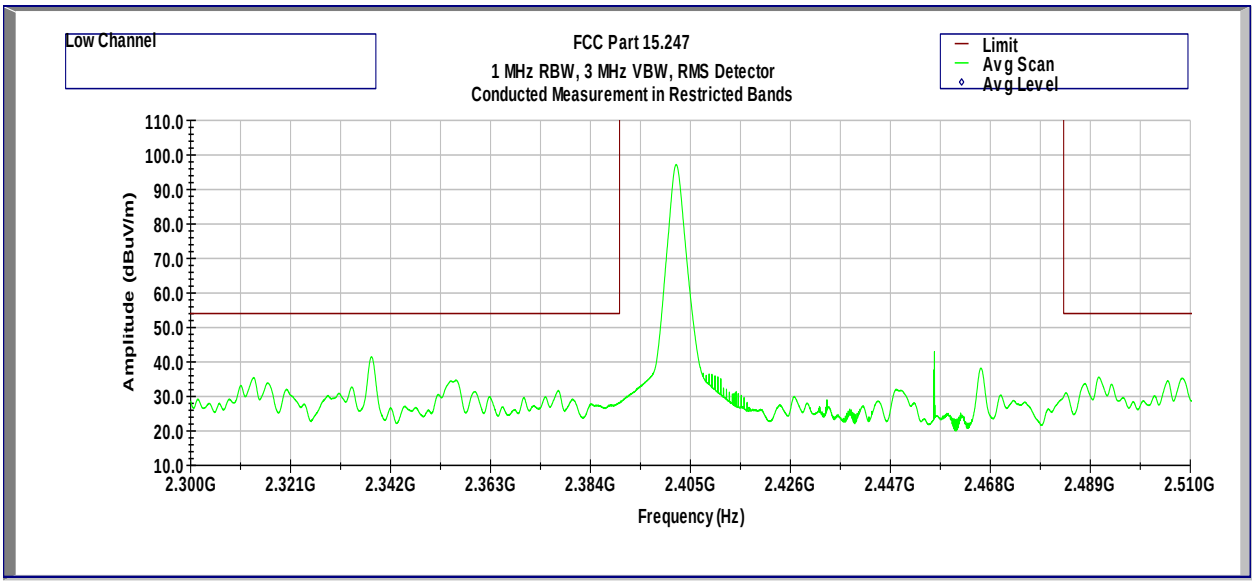
4.5.7 Test Results

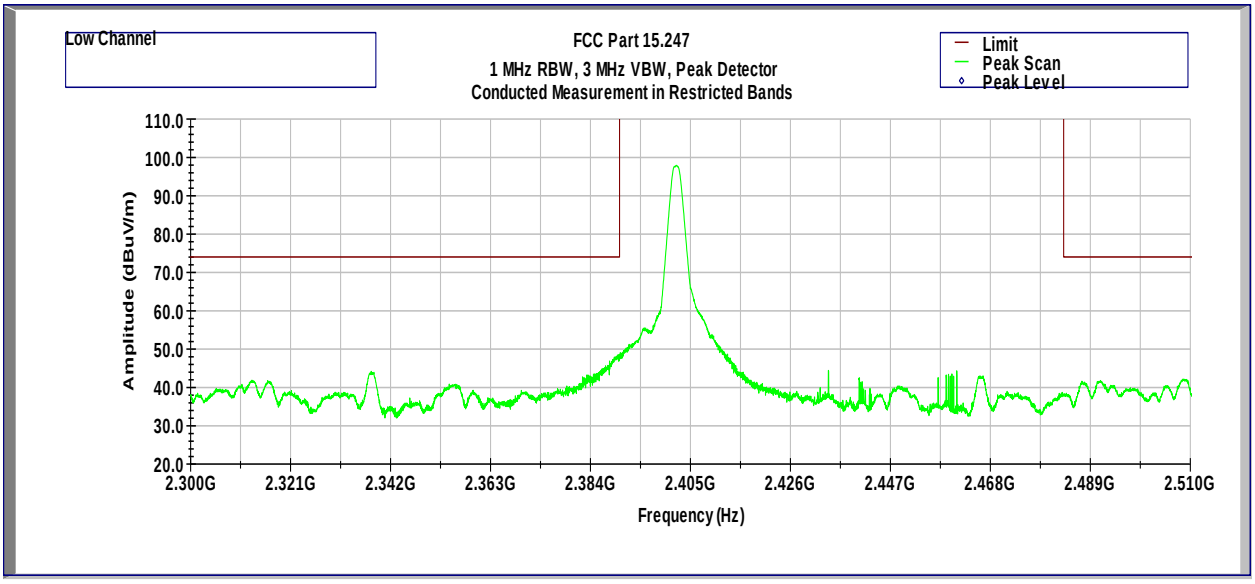
All conducted antenna port plots are corrected with the consideration of a 2 dBi Antenna Gain.

Date of Test:	February 9 – March 9, 2018
Results	**Complies**

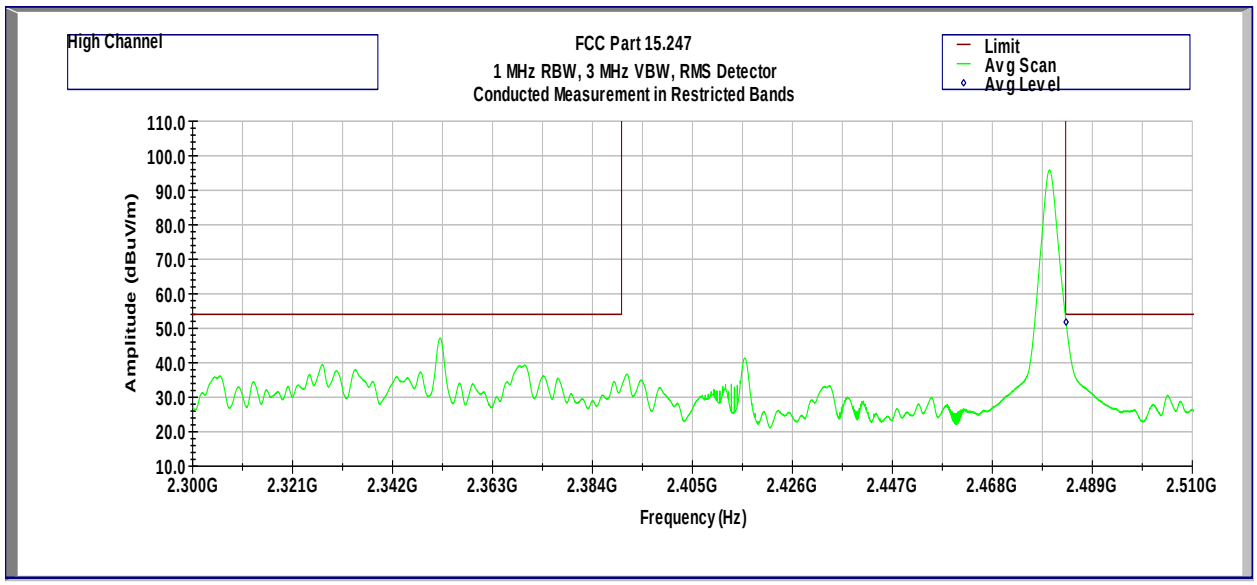
Test Results: 15.209/15.205 Restricted Band Emissions at Antenna Port

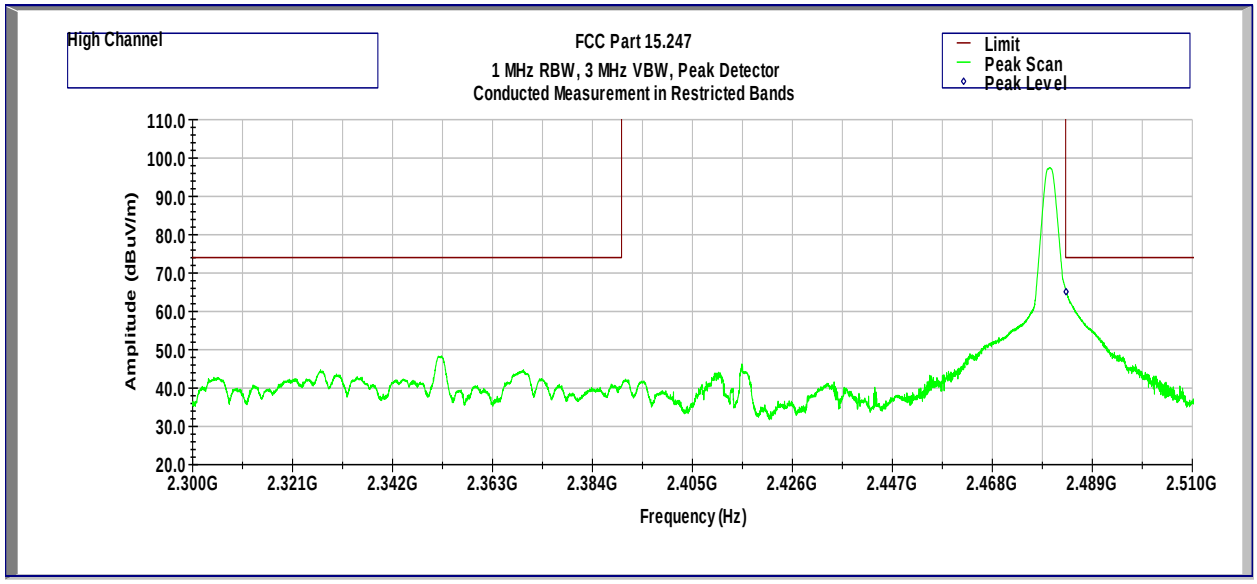
Out-of-Band Spurious Emissions at the Band Edge – Tx @ 2402 MHz





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



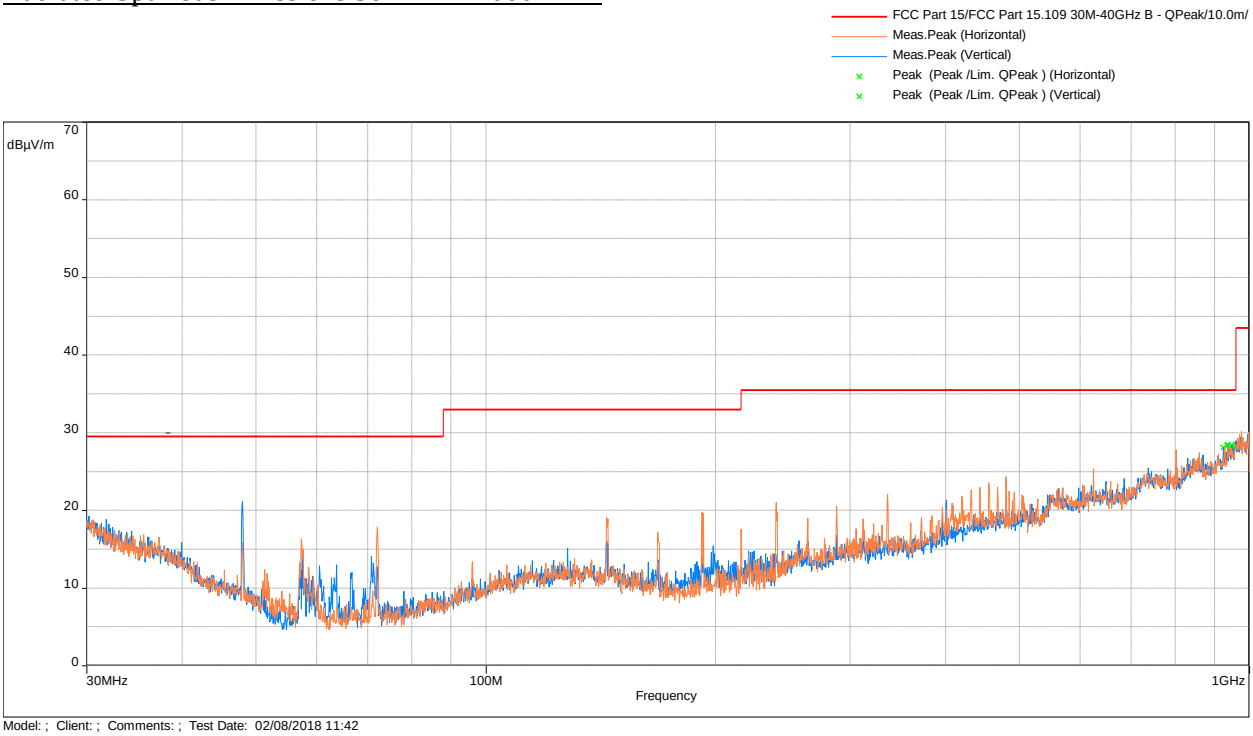


Frequency	Corrected Amplitude	Limit	Margin	Detector	Results
GHz	dBµV/m	dBµV/m	dB		
2.4835	51.8	54	-2.2	RMS	Pass
2.4835	65.1	74	-8.9	Peak	Pass

Out-of-Band Radiated Spurious Emissions – Square with Button

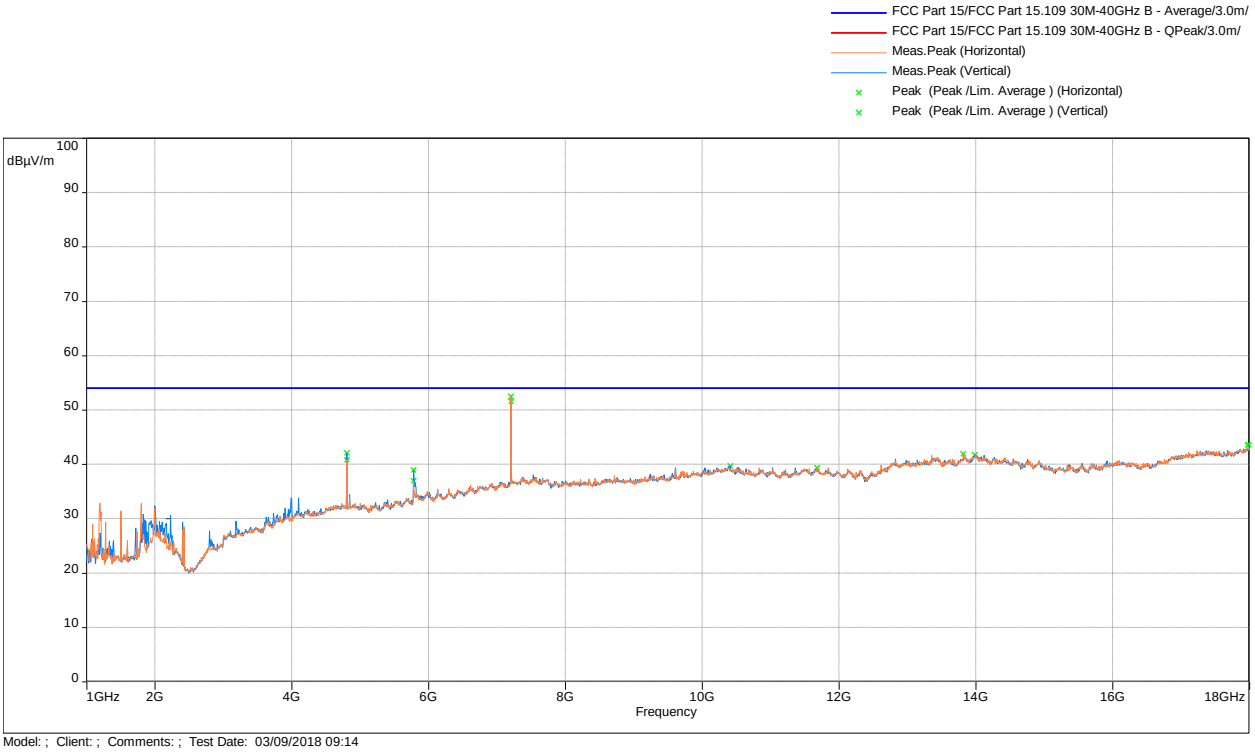
Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 2402MHz

Radiated Spurious Emissions 30 MHz - 1000 MHz



Model: ; Client: ; Comments: ; Test Date: 02/08/2018 11:42

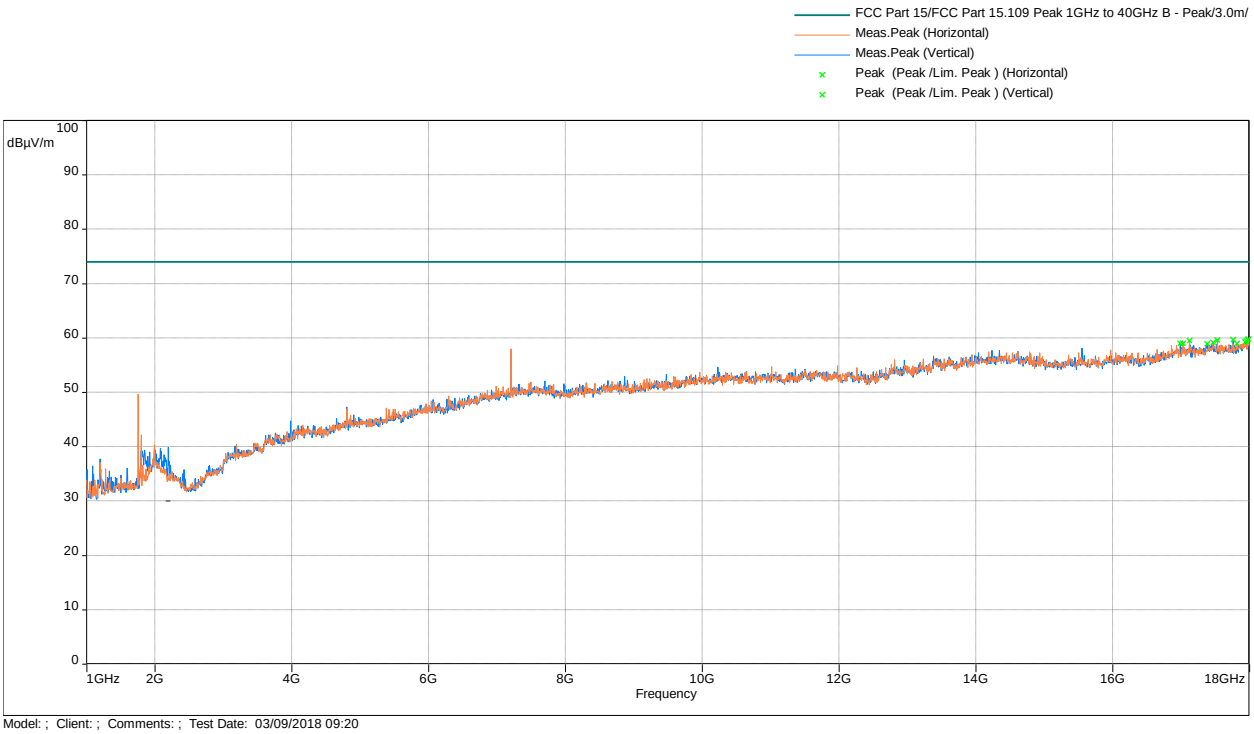
Radiated Spurious Emissions 1000 - 18000 MHz, Avg Scan vs Avg Limit



Model: ; Client: ; Comments: ; Test Date: 03/09/2018 09:14

Frequency	Average	Limit	Margin	Height	Angle	Polarization	Correction
MHz	dBµV/m	(dBµV/m)	(dB)	(m)	(°)		(dB)
4803.467	40.78	54	-13.22	1.30	228	Horizontal	4.92
7205.000	52.52	54	-1.48	1.35	298	Horizontal	11.94
4803.467	42.09	54	-11.91	1.44	85	Vertical	4.92
7205.000	51.52	54	-2.48	1.53	108	Vertical	11.94

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



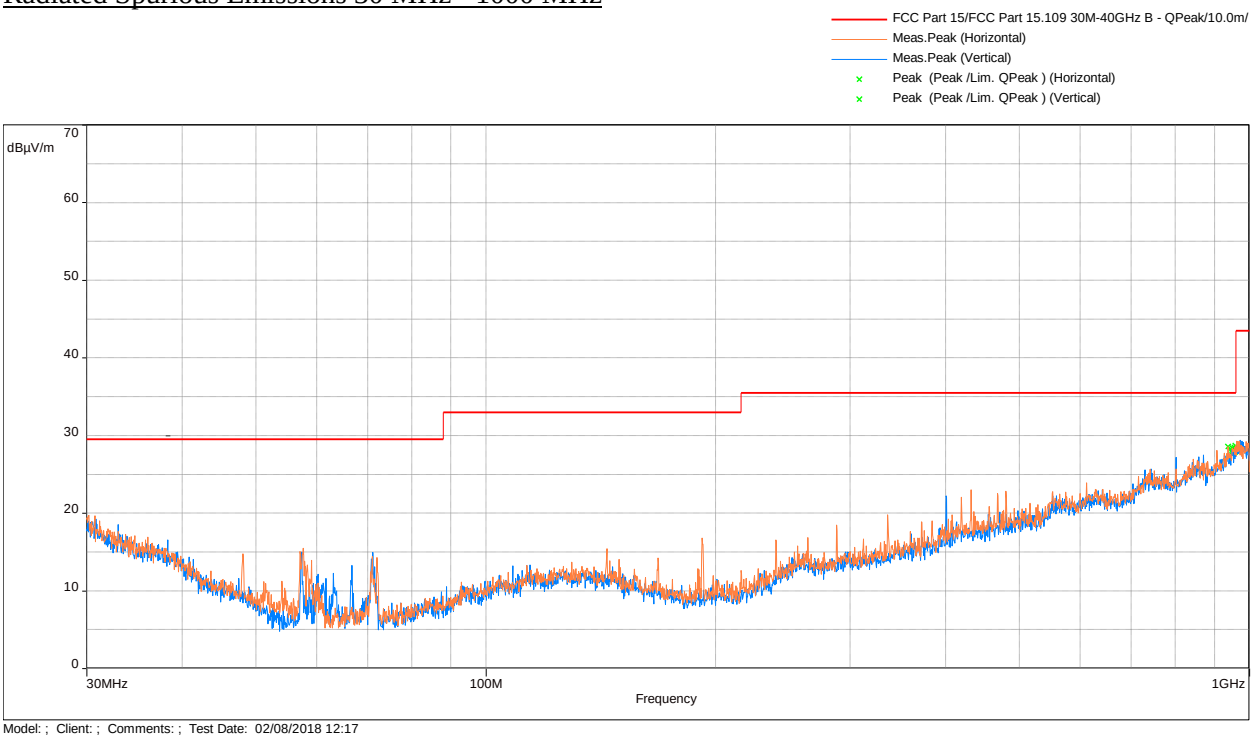
Note: Radiated emission measurements were performed up to 25GHz. No Emissions were identified when scanned from 18-25 GHz

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

Results	**Complies**

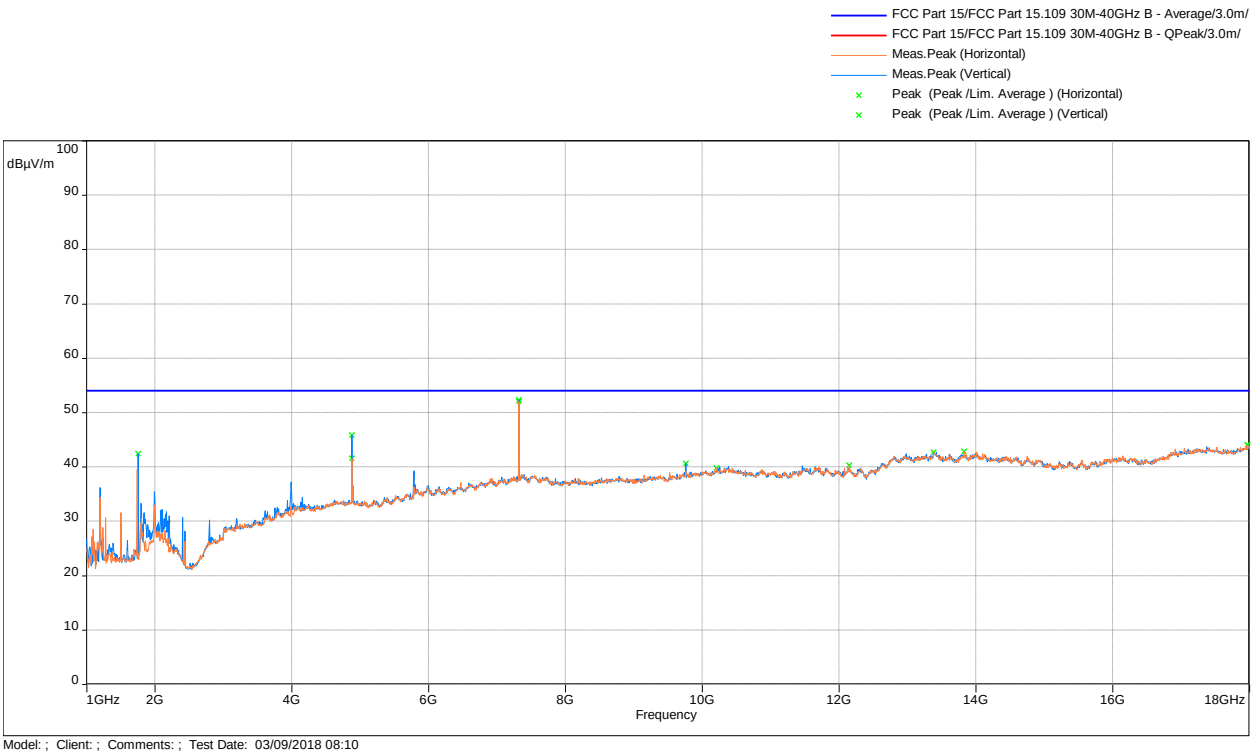
Test Results: 15.209 Radiated Spurious Emissions Mid Channel, Tx at 2440MHz

Radiated Spurious Emissions 30 MHz - 1000 MHz



Model: ; Client: ; Comments: ; Test Date: 02/08/2018 12:17

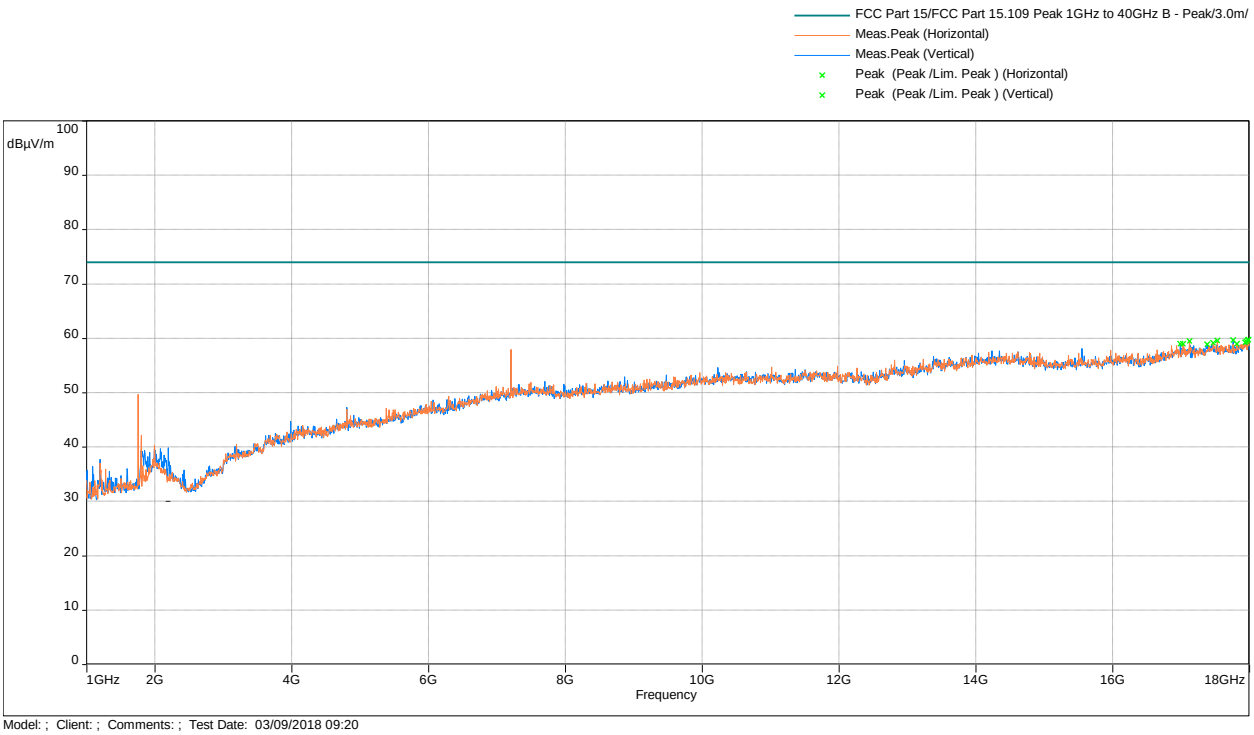
Radiated Spurious Emissions 1000 - 18000 MHz, Avg Scan vs Avg Limit



Model: ; Client: ; Comments: ; Test Date: 03/09/2018 08:10

Frequency	Average	Limit	Margin	Height	Angle	Polarization	Correction
MHz	dBµV/m	(dBµV/m)	(dB)	(m)	(°)		(dB)
4879.967	41.55	54	-12.45	1.38	318	Horizontal	6.44
7321.167	52.08	54	-1.92	1.31	320	Horizontal	13.35
4879.967	45.81	54	-8.19	1.45	181	Vertical	6.44
7321.167	52.35	54	-1.65	1.55	298	Vertical	13.35

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

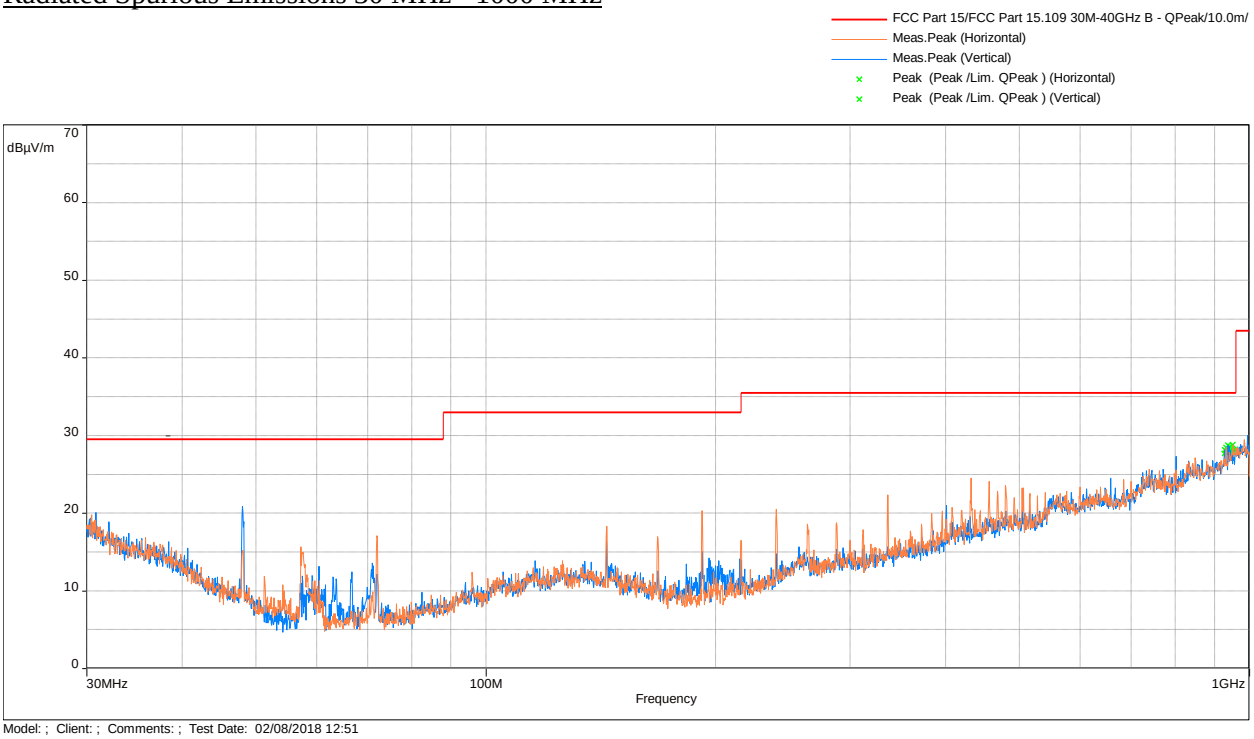


Note: Radiated emission measurements were performed up to 25GHz. No Emissions were identified when scanned from 18-25 GHz

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

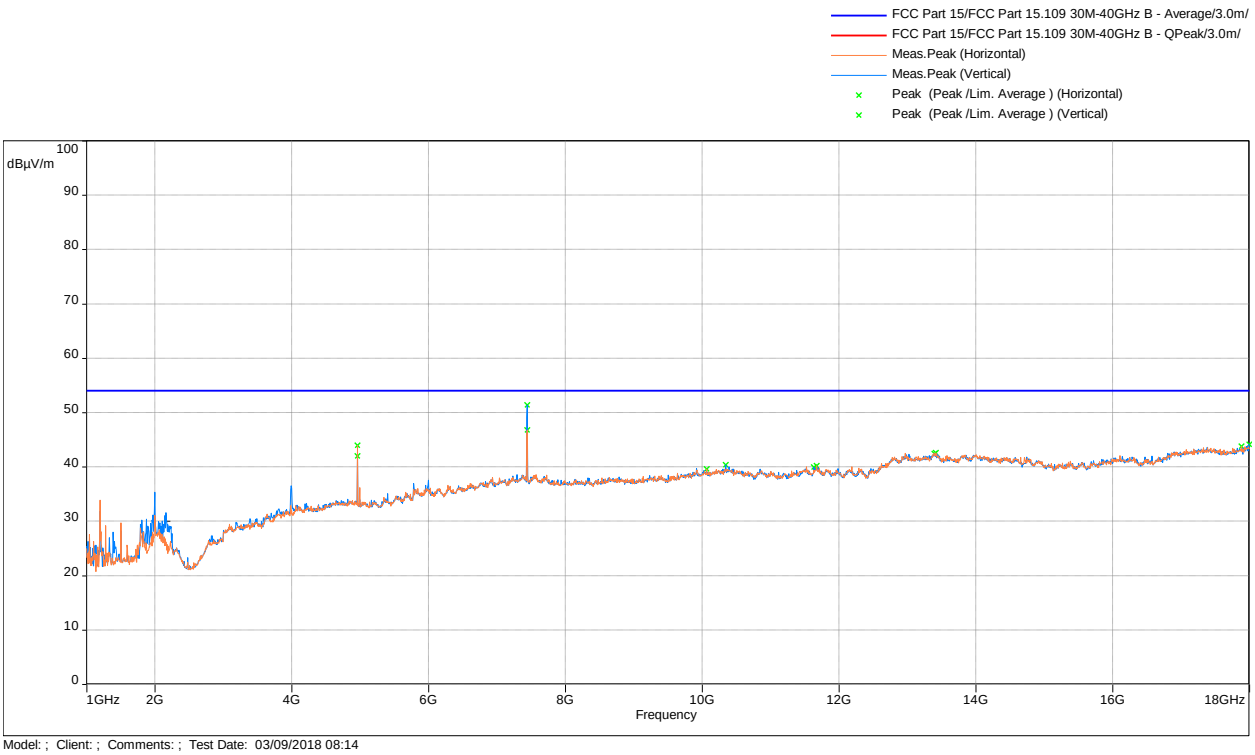
Results	**Complies**

Radiated Spurious Emissions 30 MHz - 1000 MHz



Model: ; Client: ; Comments: ; Test Date: 02/08/2018 12:51

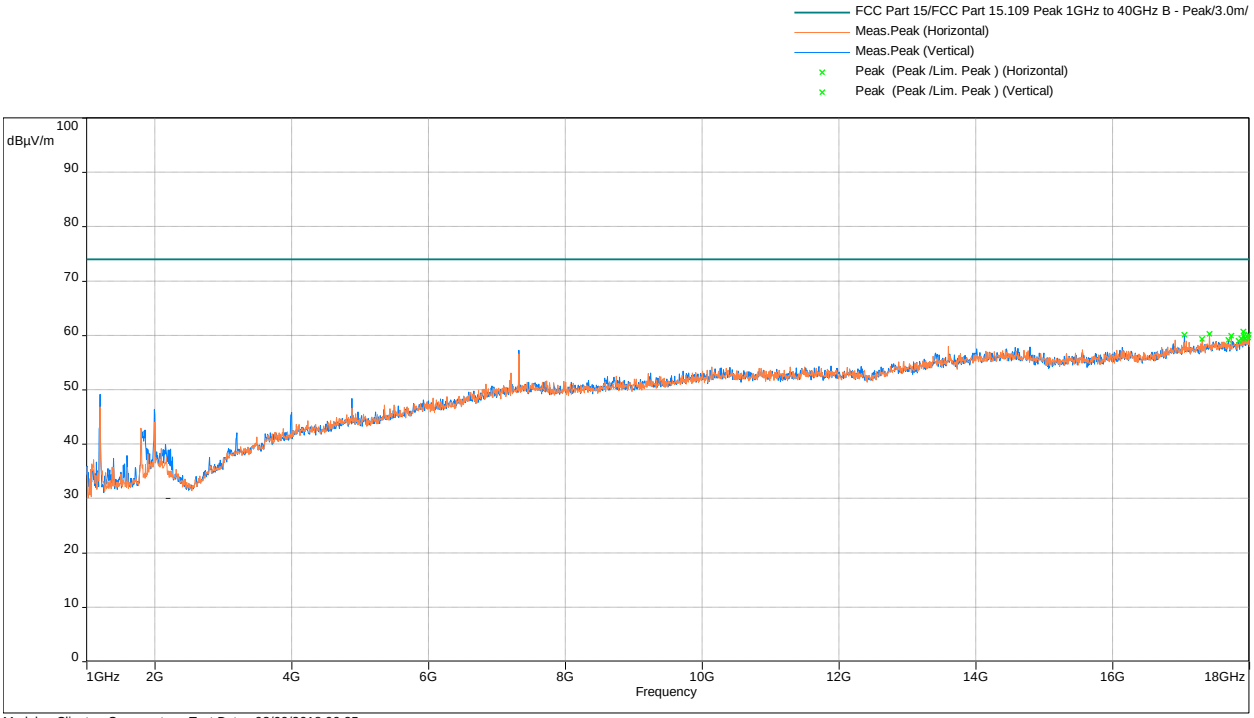
Radiated Spurious Emissions 1000 - 18000 MHz, Avg Scan vs Avg Limit



Model: ; Client: ; Comments: ; Test Date: 03/09/2018 08:14

Frequency	Average	Limit	Margin	Height	Angle	Polarization	Correction
MHz	dBµV/m	(dBµV/m)	(dB)	(m)	(°)		(dB)
4959.867	43.94	54	-10.06	1.45	318	Horizontal	6.62
7439.033	46.78	54	-7.22	1.39	329	Horizontal	13.35
4959.300	41.95	54	-12.05	1.44	263	Vertical	6.62
7439.033	51.33	54	-2.67	1.50	255	Vertical	13.35

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



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

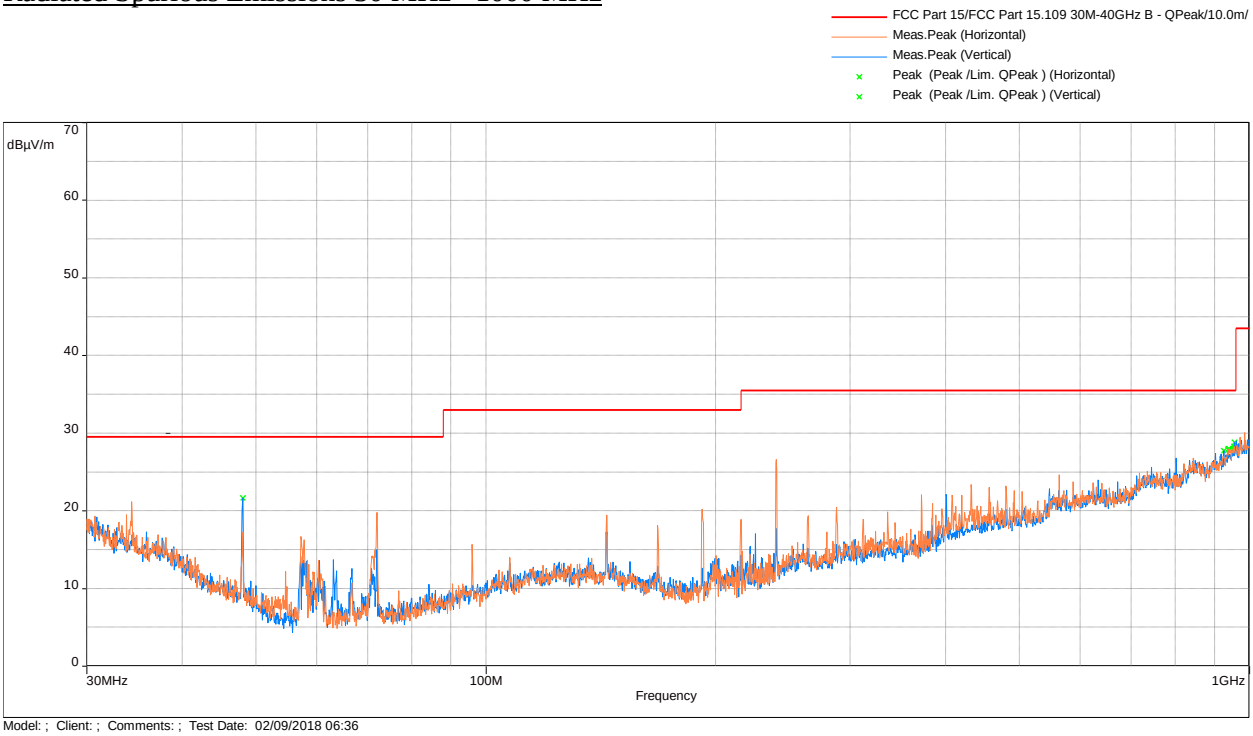
Note: FS@3m = RA + AF + CF - Preamp

Results	**Complies**

Out-of-Band Radiated Spurious Emissions – Square with Capacitive Touch

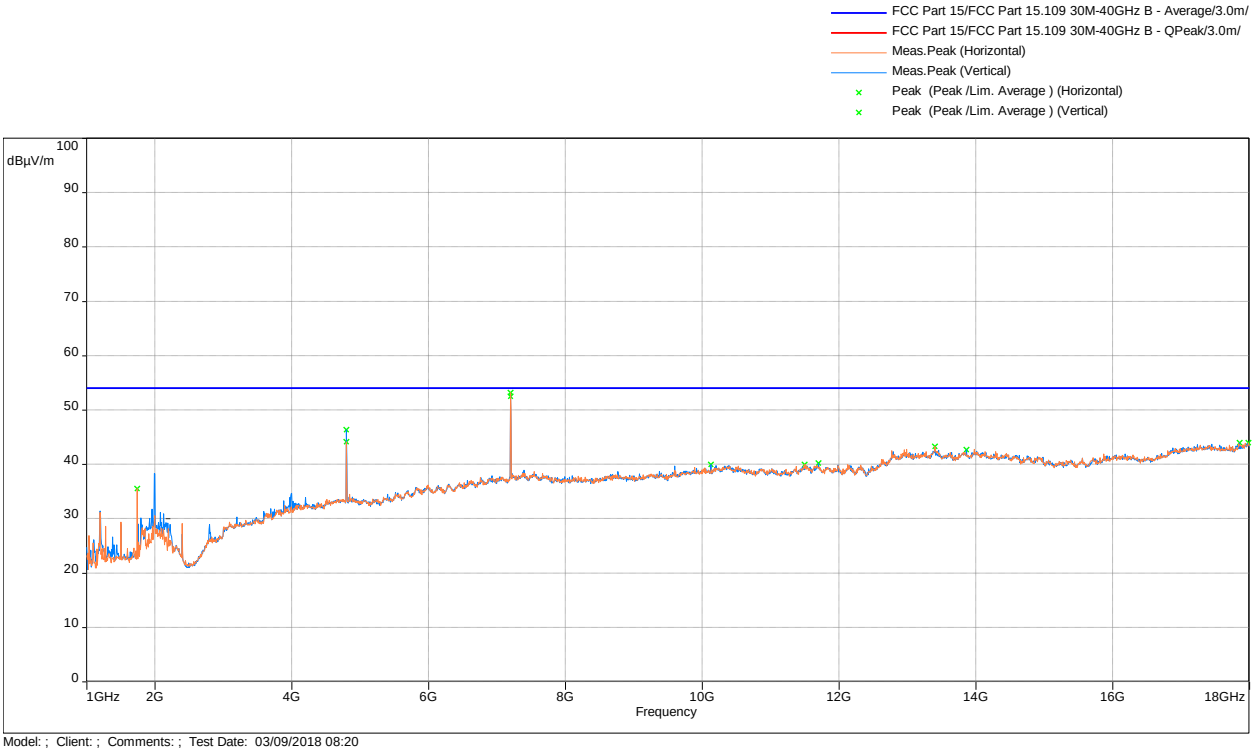
Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 2402MHz

Radiated Spurious Emissions 30 MHz - 1000 MHz



Model: ; Client: ; Comments: ; Test Date: 02/09/2018 06:36

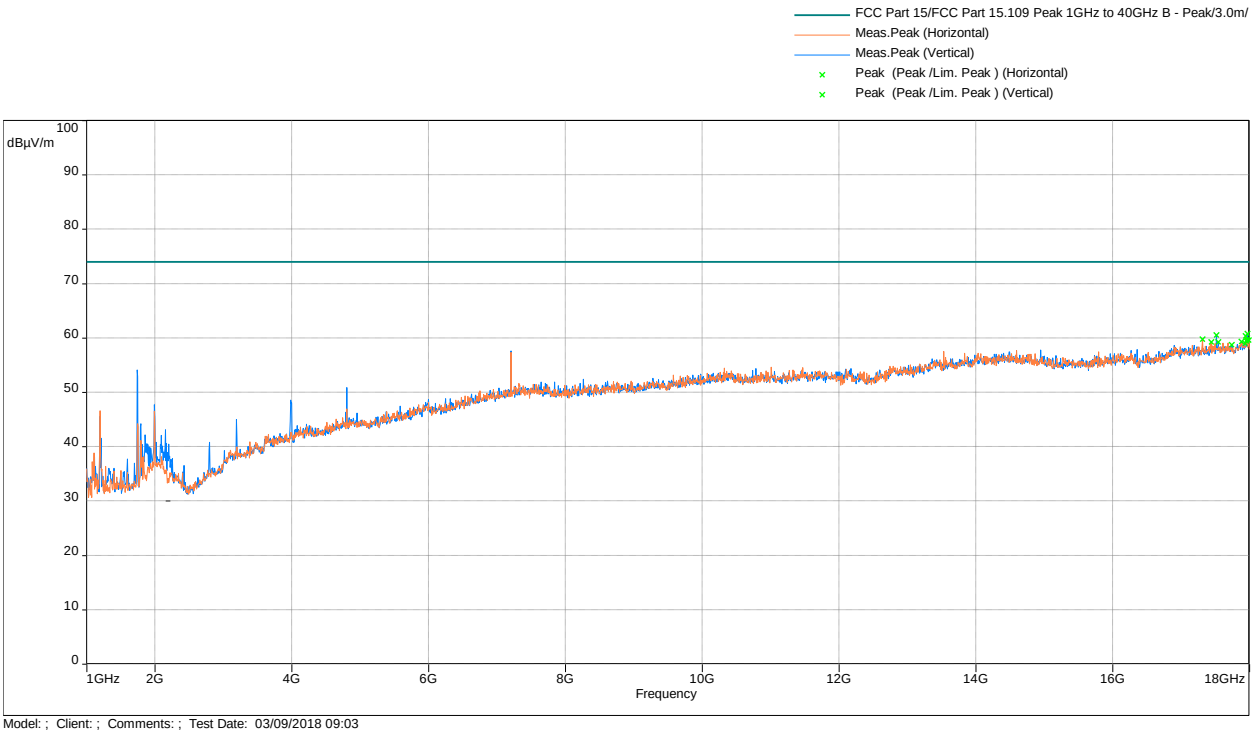
Radiated Spurious Emissions 1000 - 18000 MHz, Avg Scan vs Avg Limit



Model: ; Client: ; Comments: ; Test Date: 03/09/2018 08:20

Frequency	Average	Limit	Margin	Height	Angle	Polarization	Correction
MHz	dBµV/m	(dBµV/m)	(dB)	(m)	(°)		(dB)
4804.033	44.10	54	-9.90	1.34	0	Horizontal	4.92
7206.133	53.15	54	-0.85	1.44	327	Horizontal	11.94
4804.033	46.35	54	-7.65	1.53	173	Vertical	4.92
7205.000	52.50	54	-1.50	1.56	219	Vertical	11.94

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

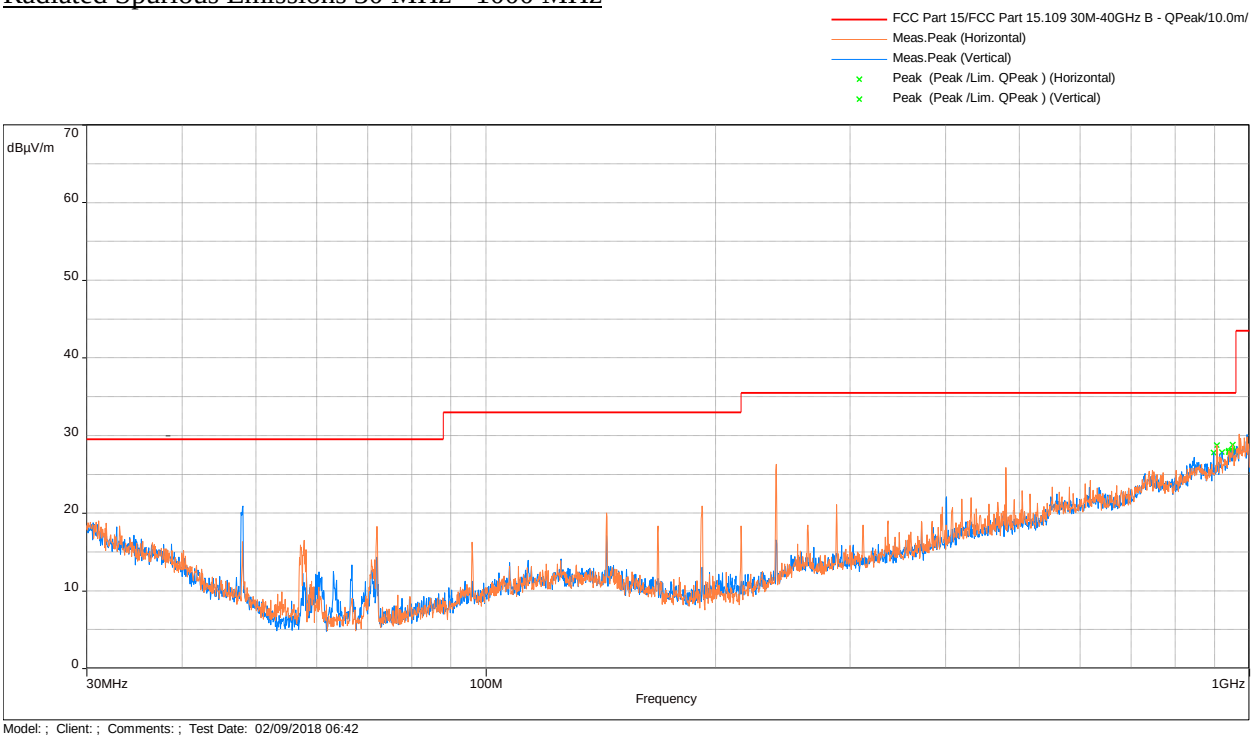


Note: Radiated emission measurements were performed up to 25GHz. No Emissions were identified when scanned from 18-25 GHz

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

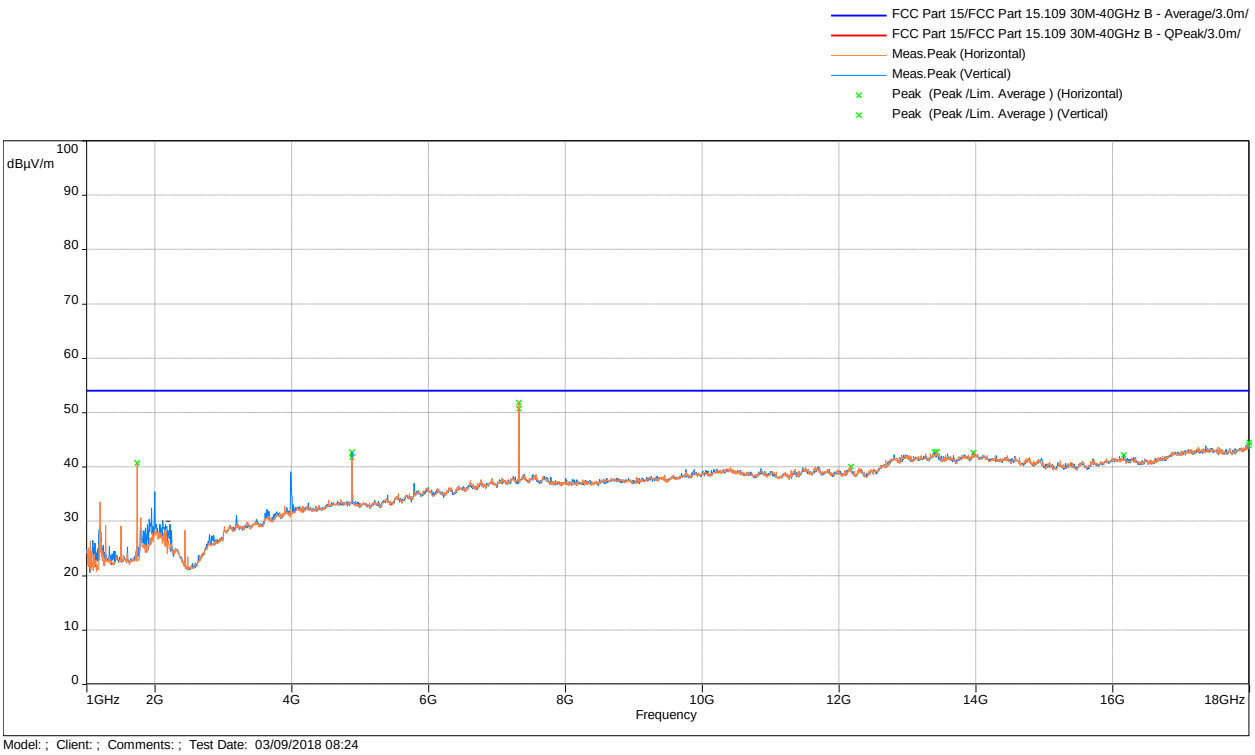
Results	**Complies**

Radiated Spurious Emissions 30 MHz - 1000 MHz



Model: ; Client: ; Comments: ; Test Date: 02/09/2018 06:42

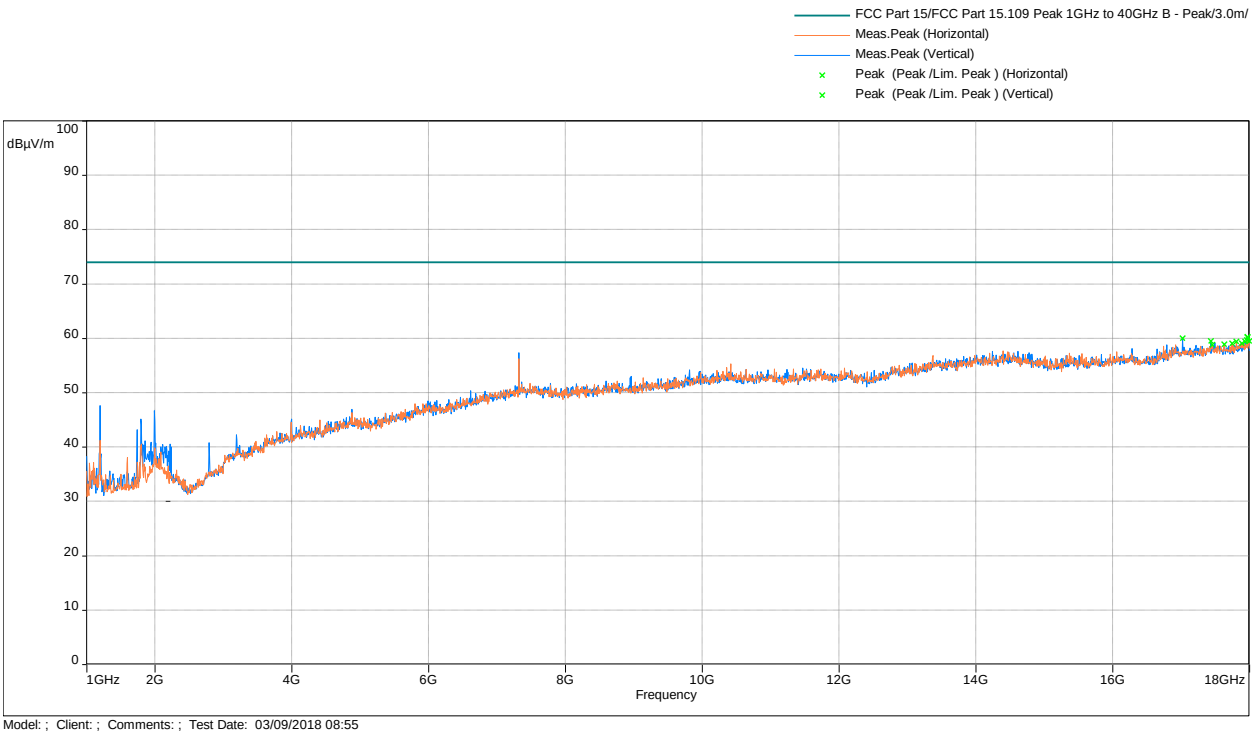
Radiated Spurious Emissions 1000 - 18000 MHz, Avg Scan vs Avg Limit



Model: ; Client: ; Comments: ; Test Date: 03/09/2018 08:24

Frequency	Average	Limit	Margin	Height	Angle	Polarization	Correction
MHz	dBµV/m	(dBµV/m)	(dB)	(m)	(°)		(dB)
4879.967	41.77	54	-12.23	1.33	139	Horizontal	6.44
7318.900	51.81	54	-2.19	1.49	4	Horizontal	13.34
4879.967	42.65	54	-11.35	1.52	172	Vertical	6.44
7321.167	50.71	54	-3.29	1.56	218	Vertical	13.35

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

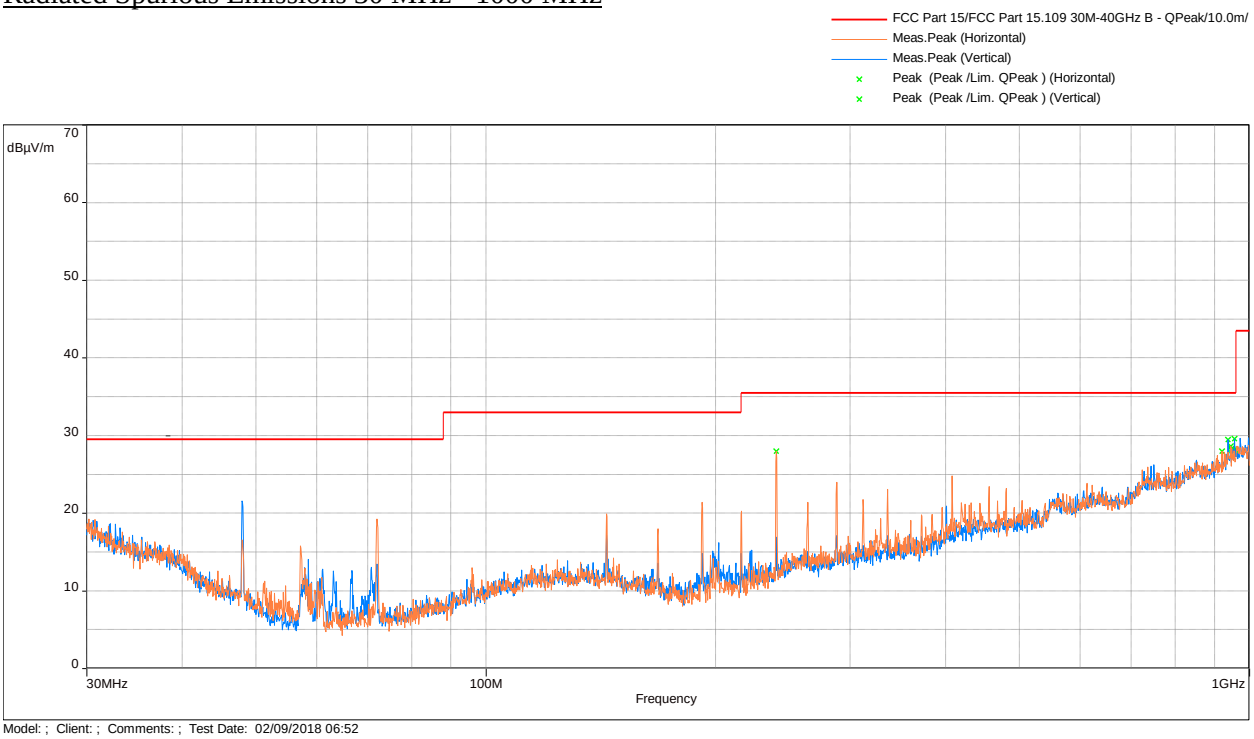


Note: Radiated emission measurements were performed up to 25GHz. No Emissions were identified when scanned from 18-25 GHz

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

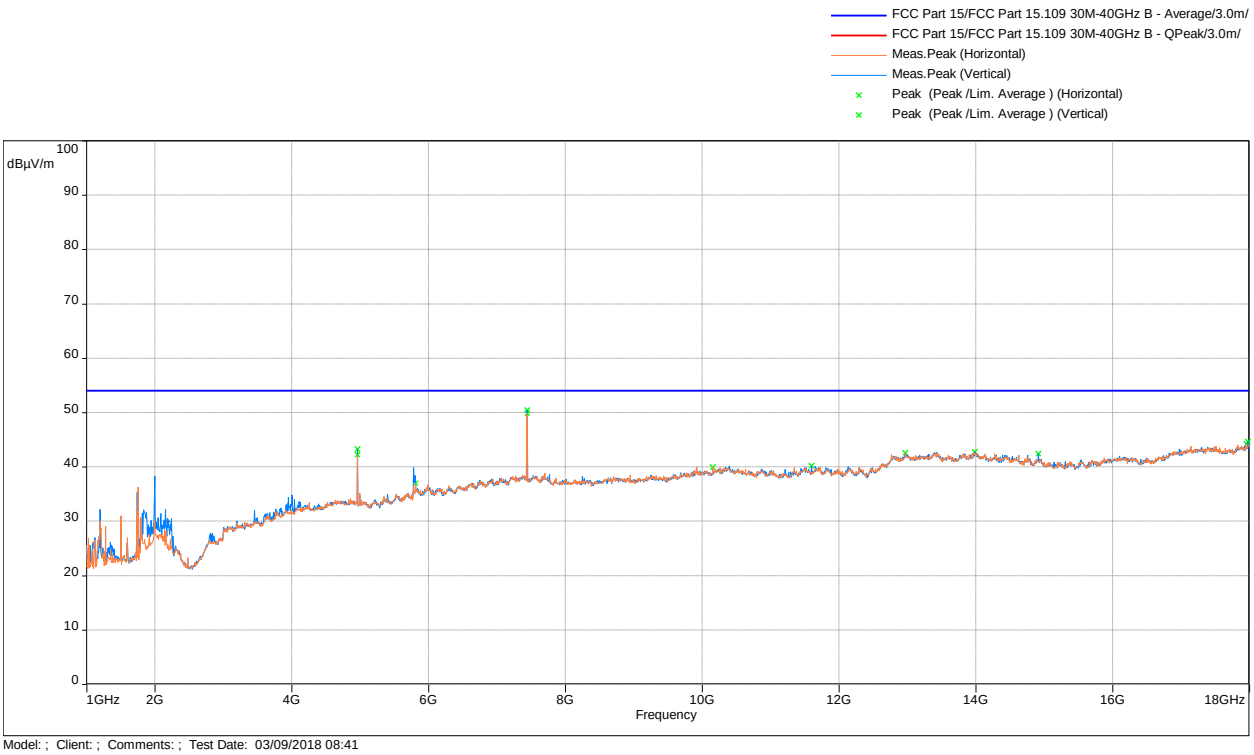
Results	**Complies**

Radiated Spurious Emissions 30 MHz - 1000 MHz



Model: ; Client: ; Comments: ; Test Date: 02/09/2018 06:52

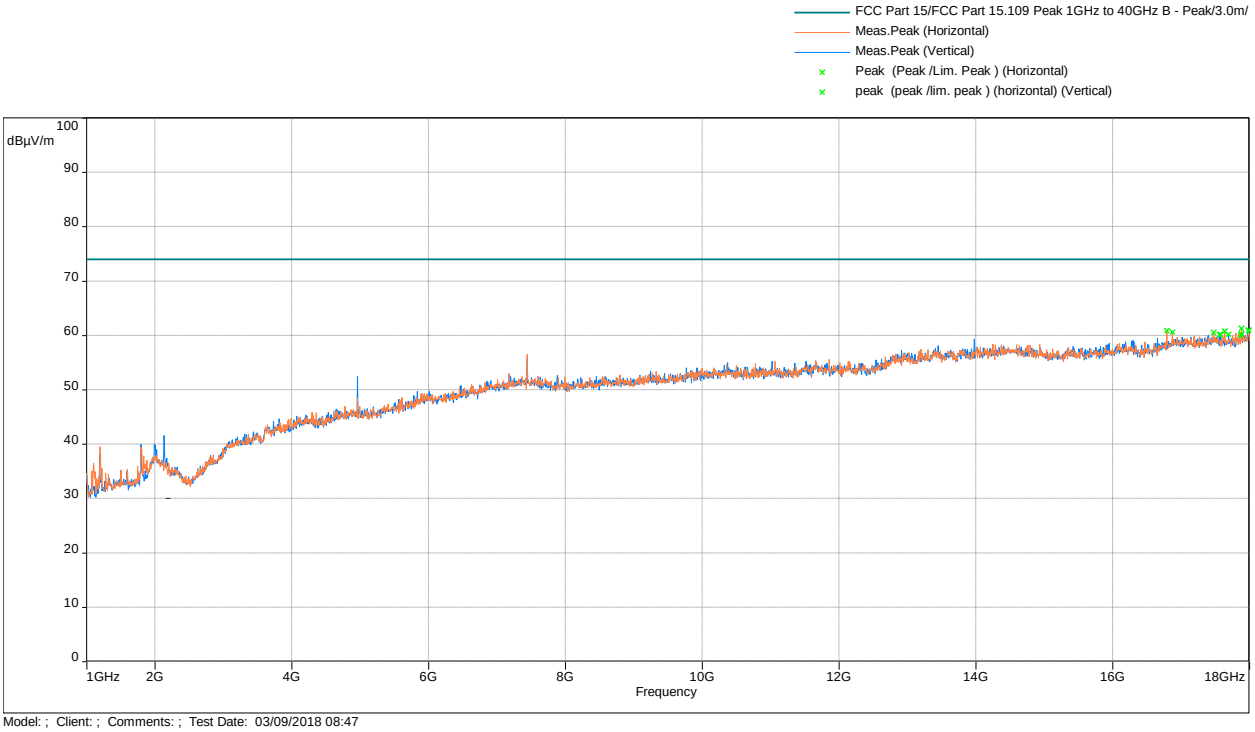
Radiated Spurious Emissions 1000 - 18000 MHz, Avg Scan vs Avg Limit



Model: ; Client: ; Comments: ; Test Date: 03/09/2018 08:41

Frequency	Average	Limit	Margin	Height	Angle	Polarization	Correction
MHz	dBµV/m	(dBµV/m)	(dB)	(m)	(°)		(dB)
4959.300	42.23	54	-11.77	1.52	318	Horizontal	6.62
7439.033	49.86	54	-4.14	1.43	14	Horizontal	13.35
4959.867	43.26	54	-10.74	1.44	204	Vertical	6.62
7439.033	50.41	54	-3.59	1.55	274	Vertical	13.35

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



Model: ; Client: ; Comments: ; Test Date: 03/09/2018 08:47

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

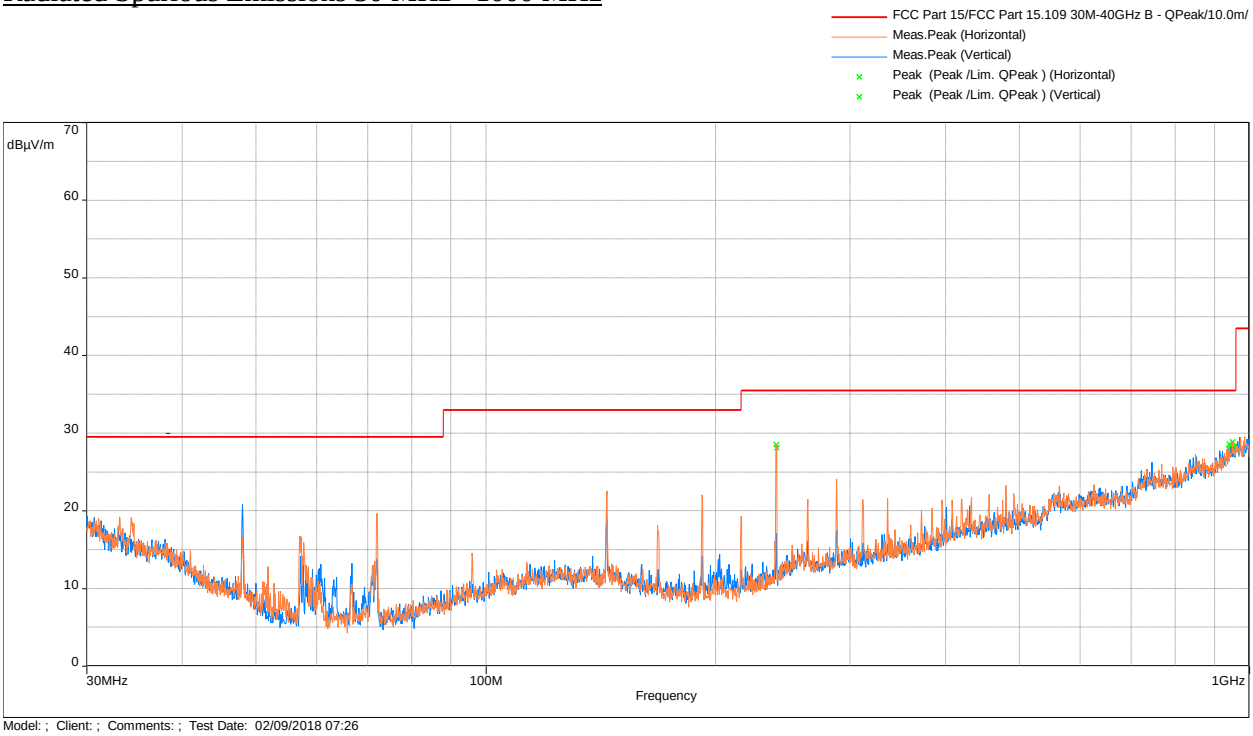
Note: FS@3m = RA + AF + CF - Preamp

Results	**Complies**

Out-of-Band Radiated Spurious Emissions – Pill with Button

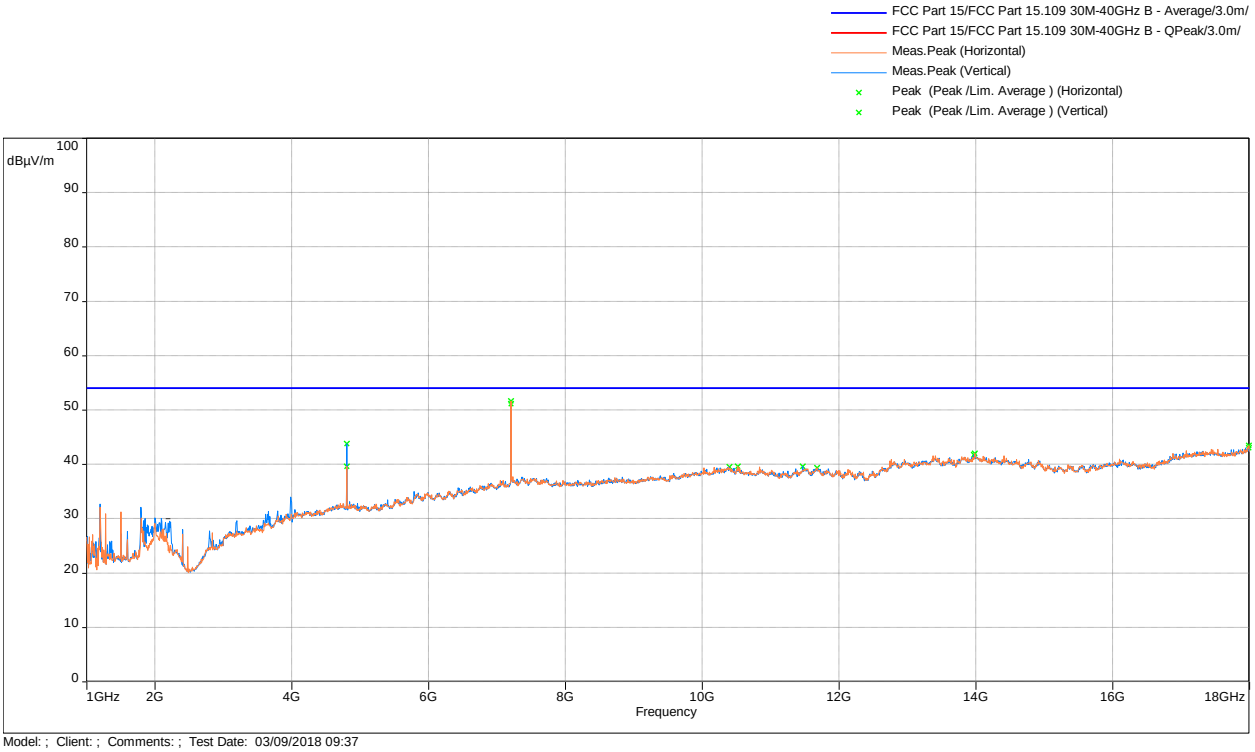
Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 2402MHz

Radiated Spurious Emissions 30 MHz - 1000 MHz



Model: ; Client: ; Comments: ; Test Date: 02/09/2018 07:26

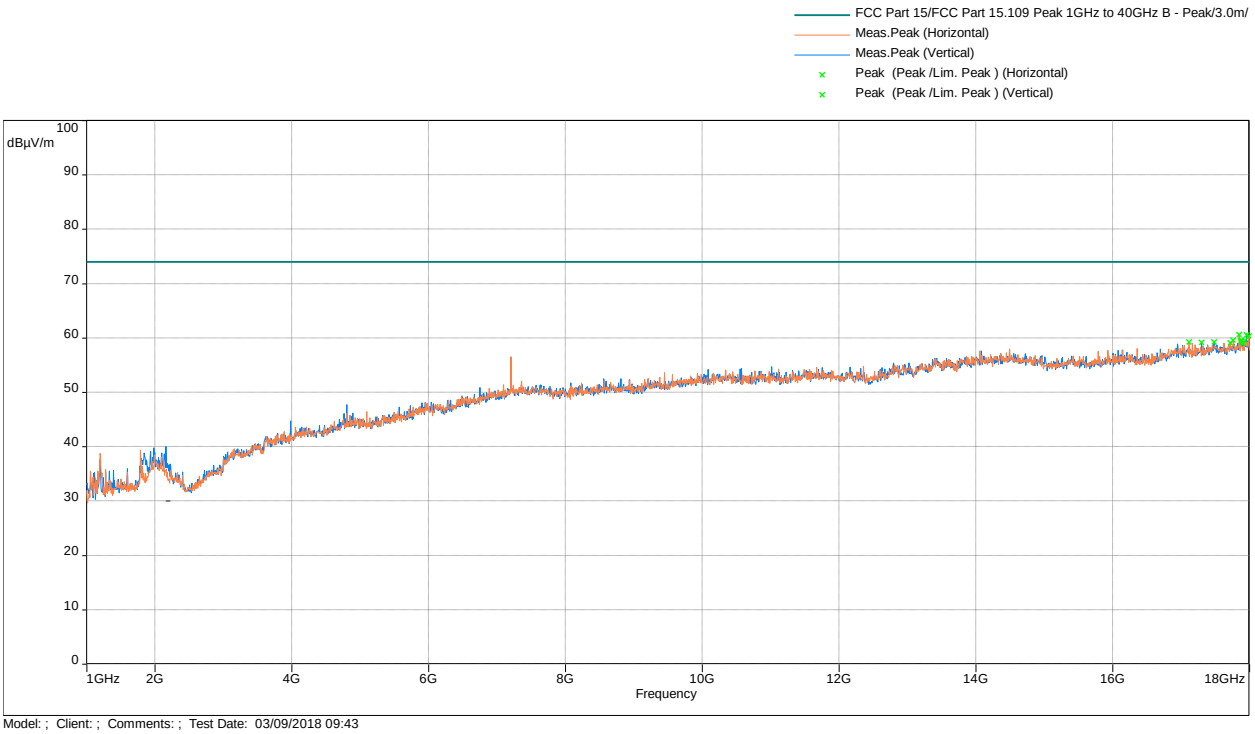
Radiated Spurious Emissions 1000 - 18000 MHz, Avg Scan vs Avg Limit



Model: ; Client: ; Comments: ; Test Date: 03/09/2018 09:37

Frequency	Average	Limit	Margin	Height	Angle	Polarization	Correction
MHz	dBµV/m	(dBµV/m)	(dB)	(m)	(°)		(dB)
4804.033	39.59	54	-14.41	1.39	228	Horizontal	4.92
7205.000	51.65	54	-2.35	1.33	322	Horizontal	11.94
4804.033	43.81	54	-10.19	1.44	201	Vertical	4.92
7206.133	51.12	54	-2.88	1.52	225	Vertical	11.94

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

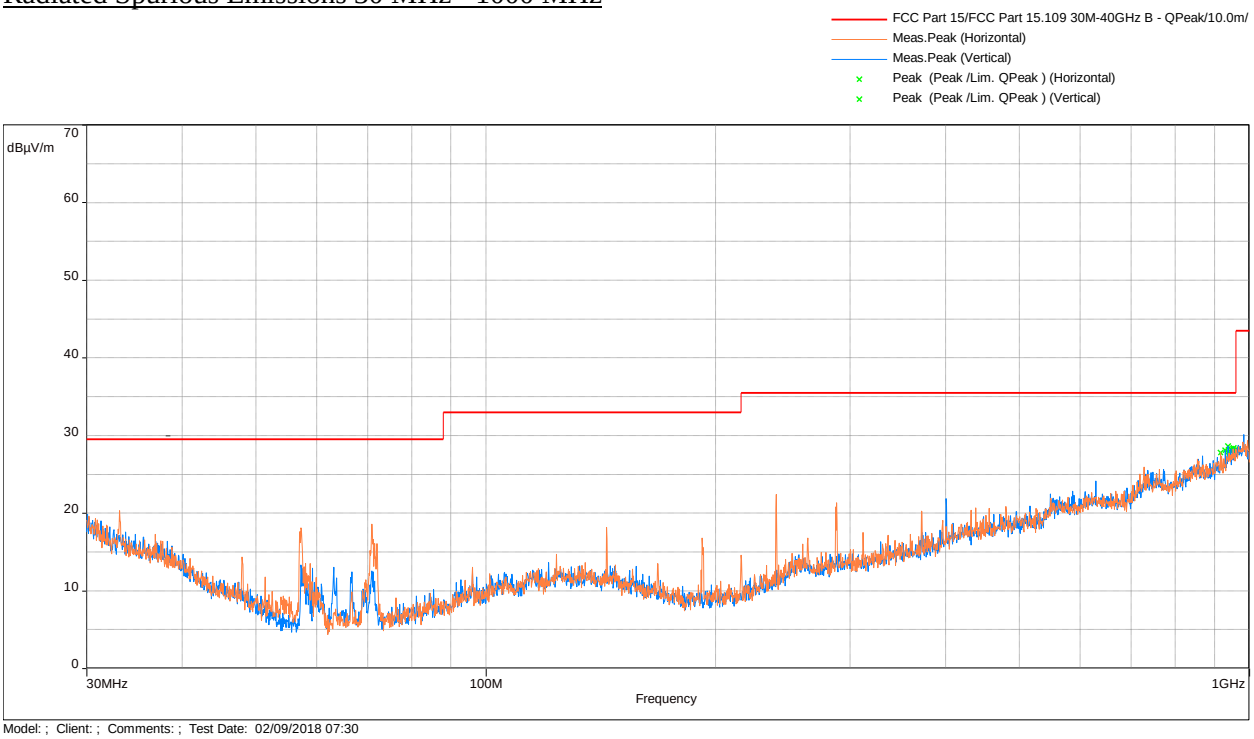


Note: Radiated emission measurements were performed up to 25GHz. No Emissions were identified when scanned from 18-25 GHz

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

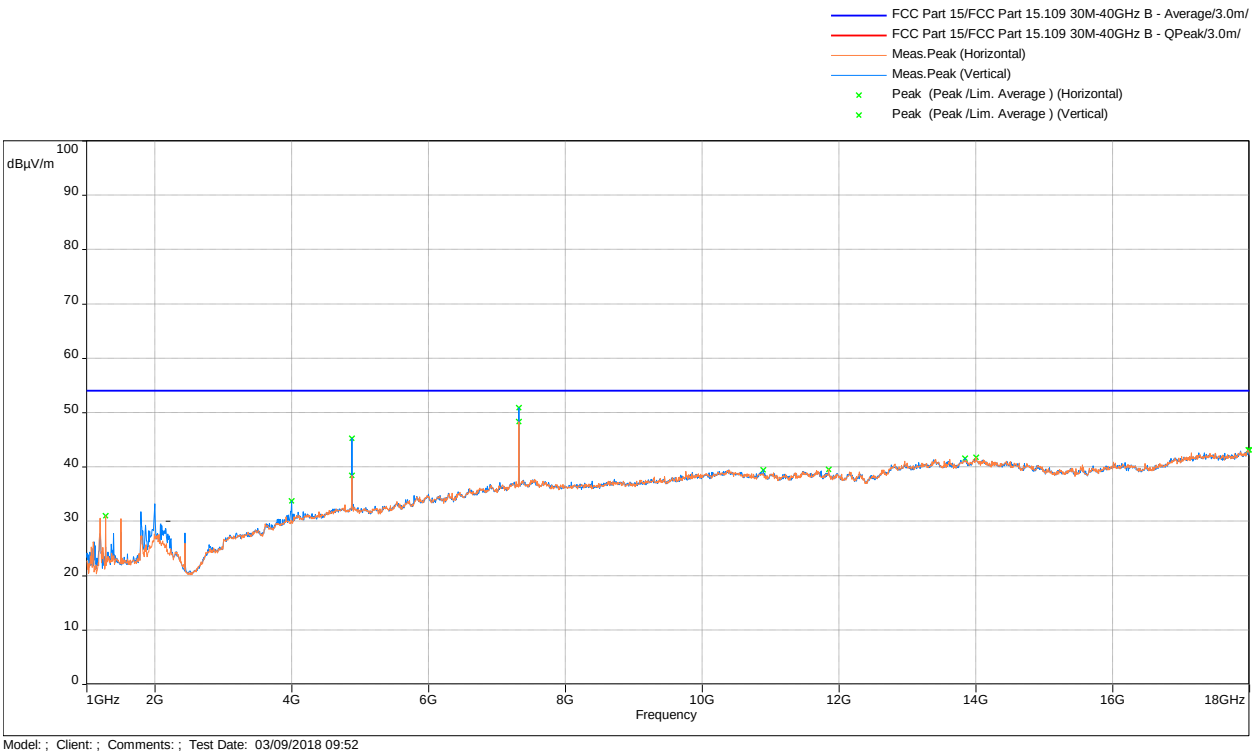
Results	**Complies**

Radiated Spurious Emissions 30 MHz - 1000 MHz



Model: ; Client: ; Comments: ; Test Date: 02/09/2018 07:30

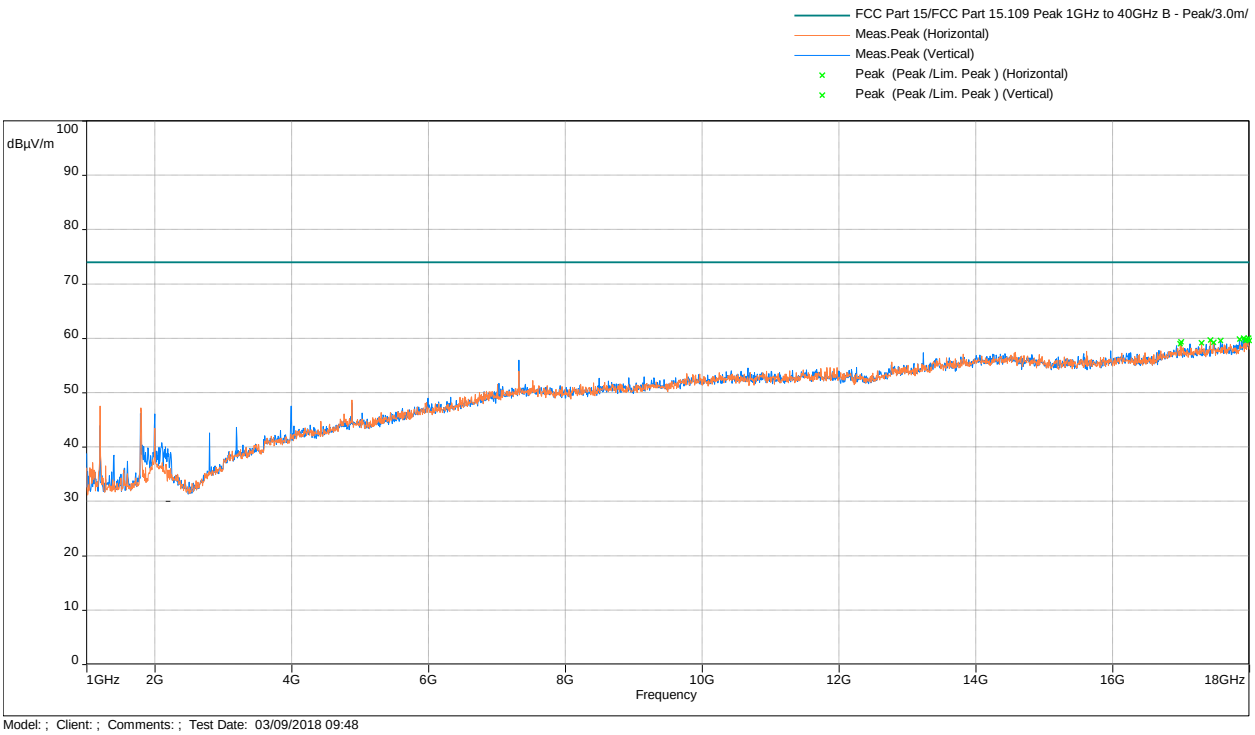
Radiated Spurious Emissions 1000 - 18000 MHz, Avg Scan vs Avg Limit



Model: ; Client: ; Comments: ; Test Date: 03/09/2018 09:52

Frequency	Average	Limit	Margin	Height	Angle	Polarization	Correction
MHz	dBµV/m	(dBµV/m)	(dB)	(m)	(°)		(dB)
4879.400	38.37	54	-15.63	1.43	182	38.37	5.18
7318.900	48.34	54	-5.66	1.46	323	48.34	12.31
4879.967	45.19	54	-8.81	1.29	201	45.19	5.19
7318.900	50.85	54	-3.15	1.53	201	50.85	12.31

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

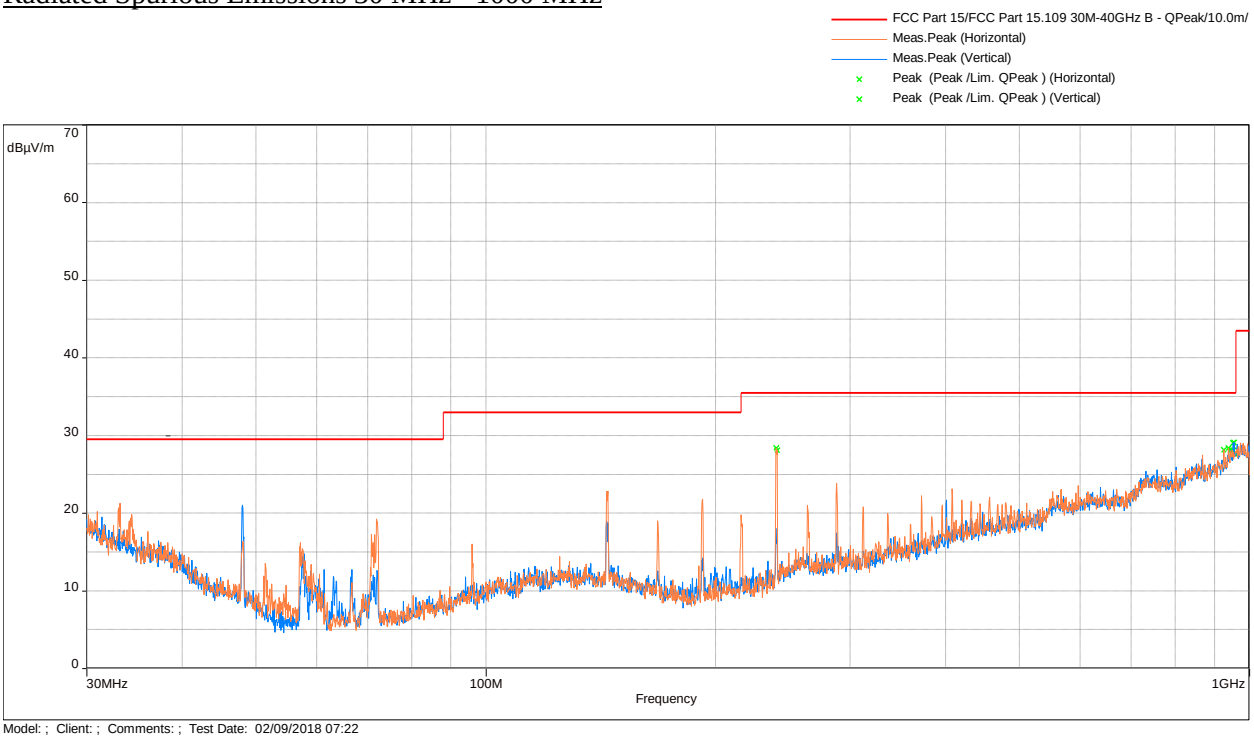


Note: Radiated emission measurements were performed up to 25GHz. No Emissions were identified when scanned from 18-25 GHz

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

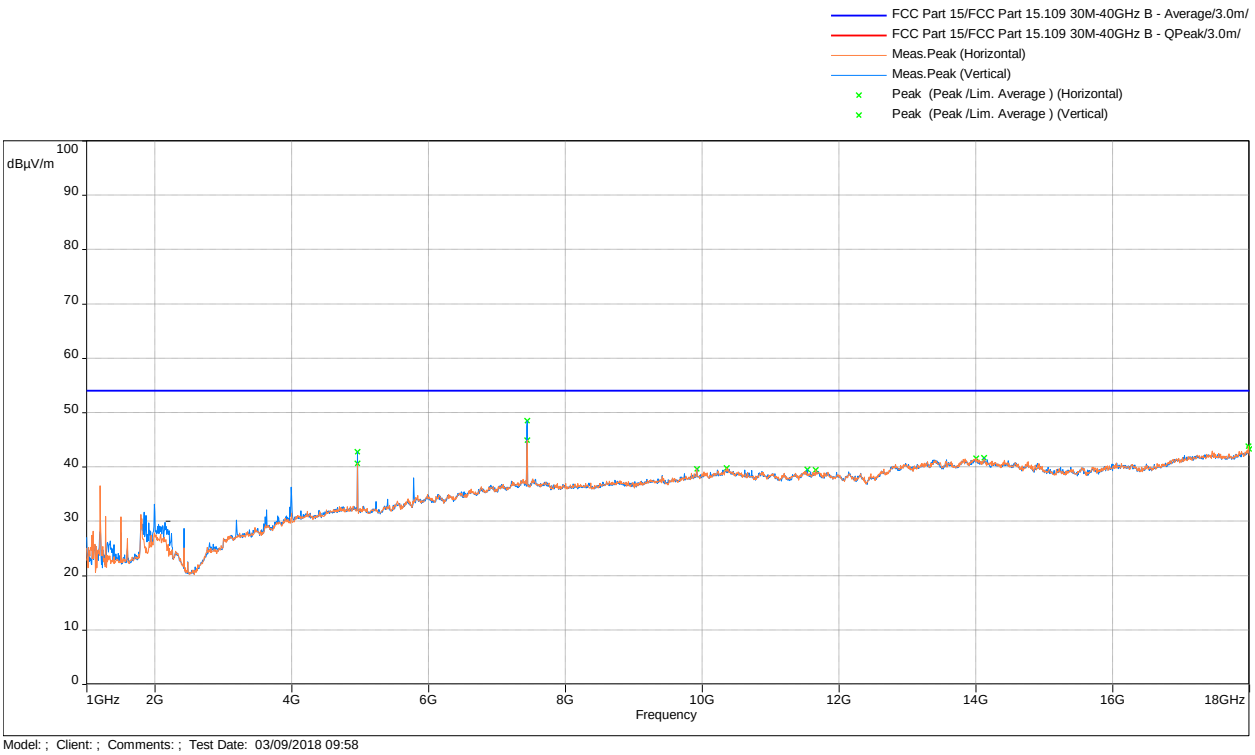
Results	**Complies**

Radiated Spurious Emissions 30 MHz - 1000 MHz



Model: ; Client: ; Comments: ; Test Date: 02/09/2018 07:22

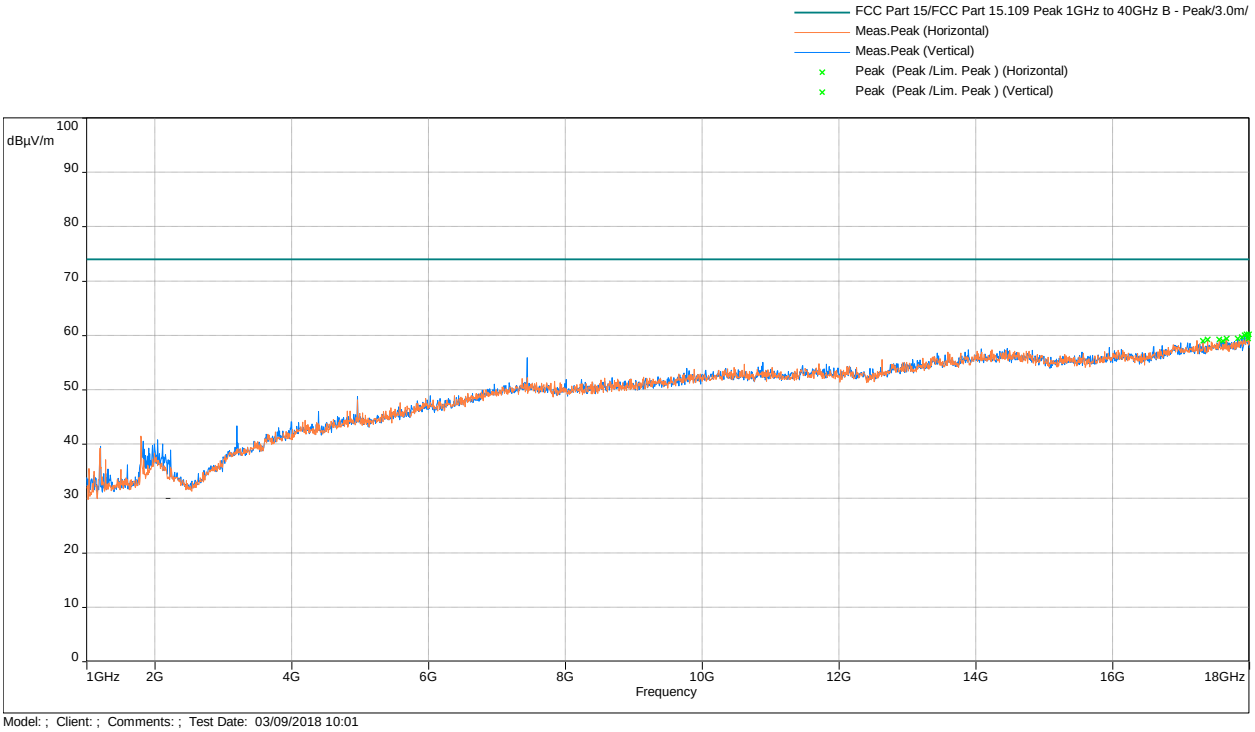
Radiated Spurious Emissions 1000 - 18000 MHz, Avg Scan vs Avg Limit



Model: ; Client: ; Comments: ; Test Date: 03/09/2018 09:58

Frequency	Average	Limit	Margin	Height	Angle	Polarization	Correction
MHz	dBµV/m	(dBµV/m)	(dB)	(m)	(°)		(dB)
4959.867	40.62	54	-13.38	1.32	135	Horizontal	5.38
7440.733	44.85	54	-9.15	1.34	0	Horizontal	12.36
4959.867	42.78	54	-11.22	1.53	248	Vertical	5.38
7440.733	48.46	54	-5.54	1.60	84	Vertical	12.36

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



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

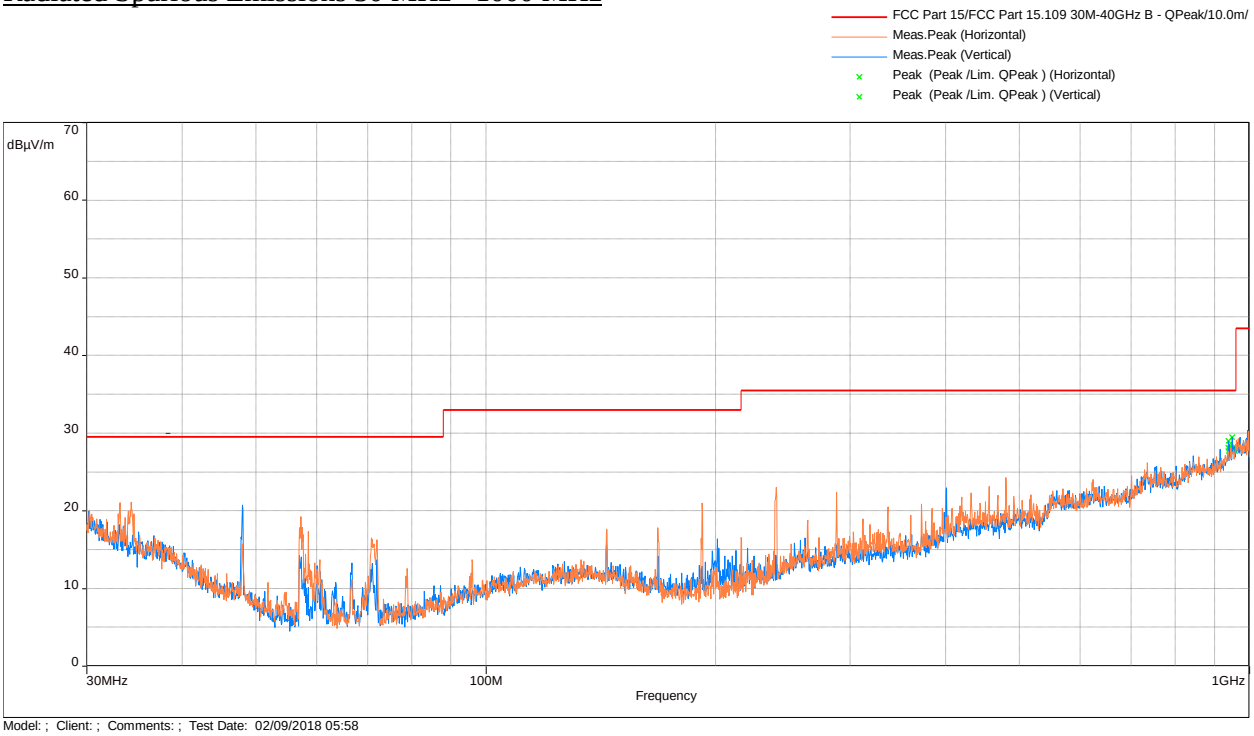
Note: FS@3m = RA + AF + CF - Preamp

Results	**Complies**

Out-of-Band Radiated Spurious Emissions – Pill with Capacitive Touch

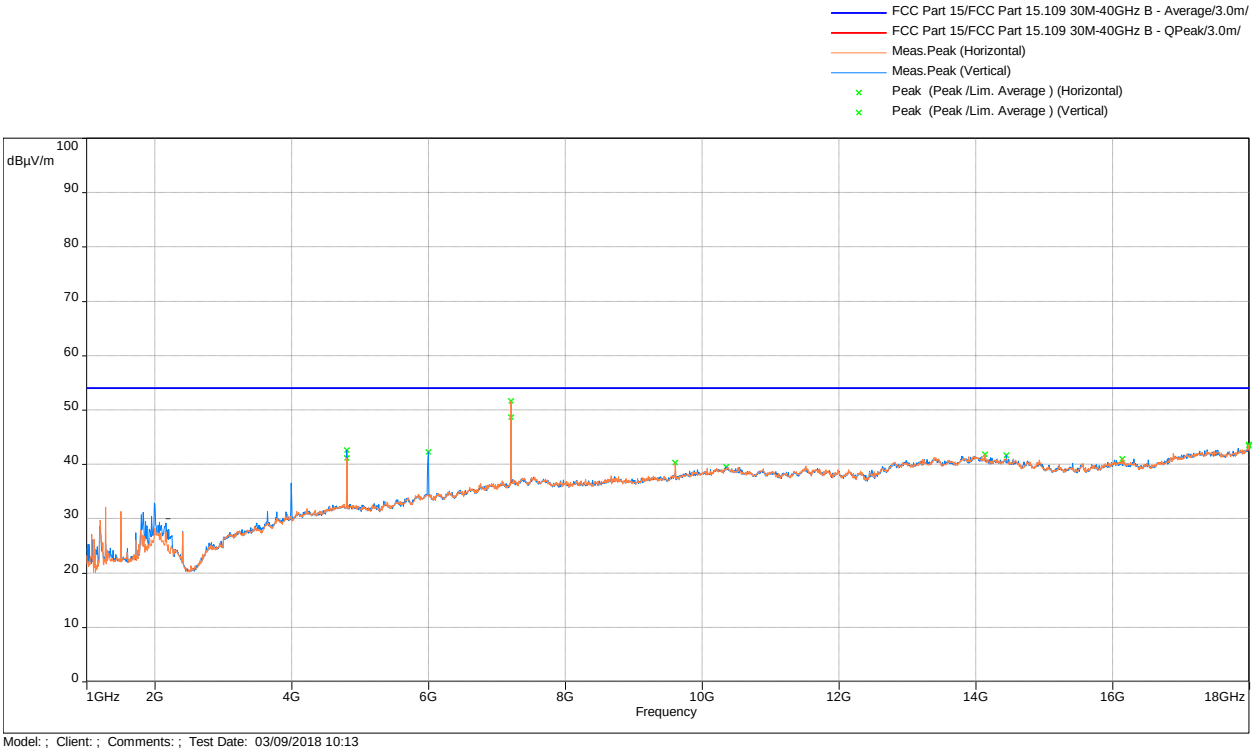
Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 2402MHz

Radiated Spurious Emissions 30 MHz - 1000 MHz



Model: ; Client: ; Comments: ; Test Date: 02/09/2018 05:58

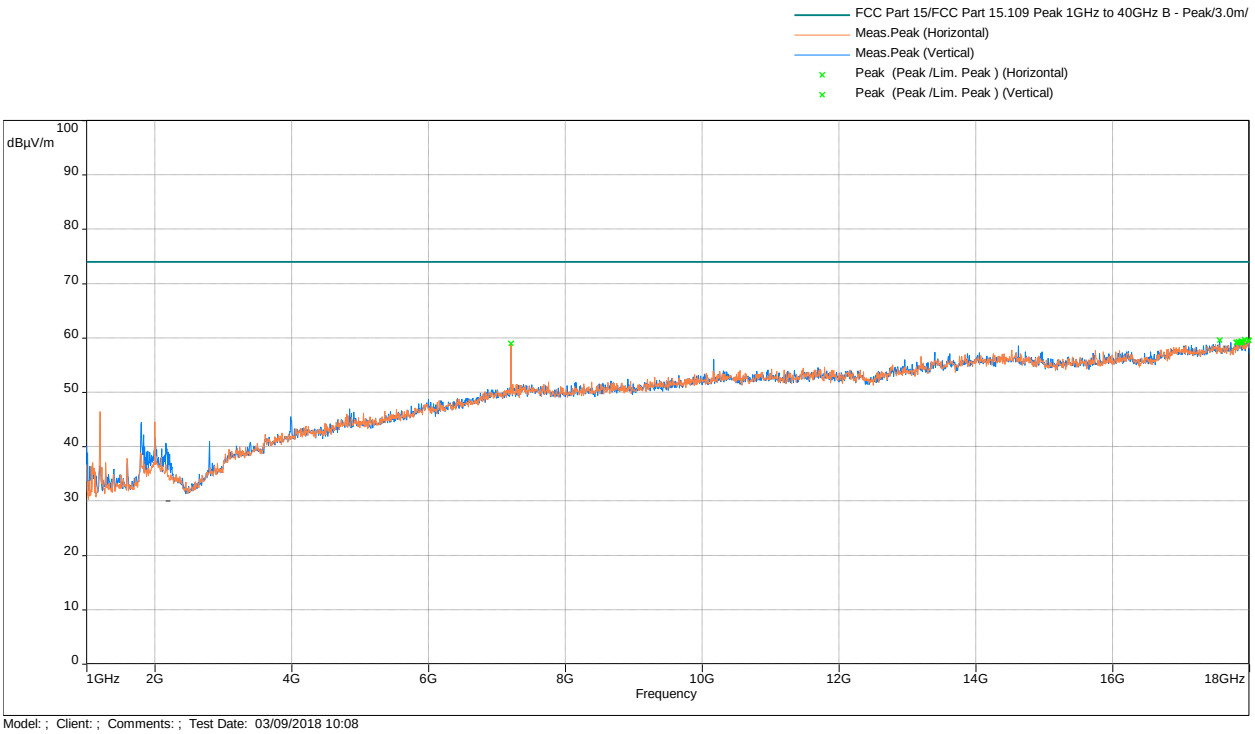
Radiated Spurious Emissions 1000 - 18000 MHz, Avg Scan vs Avg Limit



Model: ; Client: ; Comments: ; Test Date: 03/09/2018 10:13

Frequency	Average	Limit	Margin	Height	Angle	Polarization	Correction
MHz	dBµV/m	(dBµV/m)	(dB)	(m)	(°)		(dB)
4804.033	39.59	54	-14.41	1.32	228	Horizontal	4.92
7205.000	51.65	54	-2.35	1.45	322	Horizontal	11.94
4804.033	43.81	54	-10.19	1.24	201	Vertical	4.92
7206.133	51.12	54	-2.88	1.64	225	Vertical	11.94

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

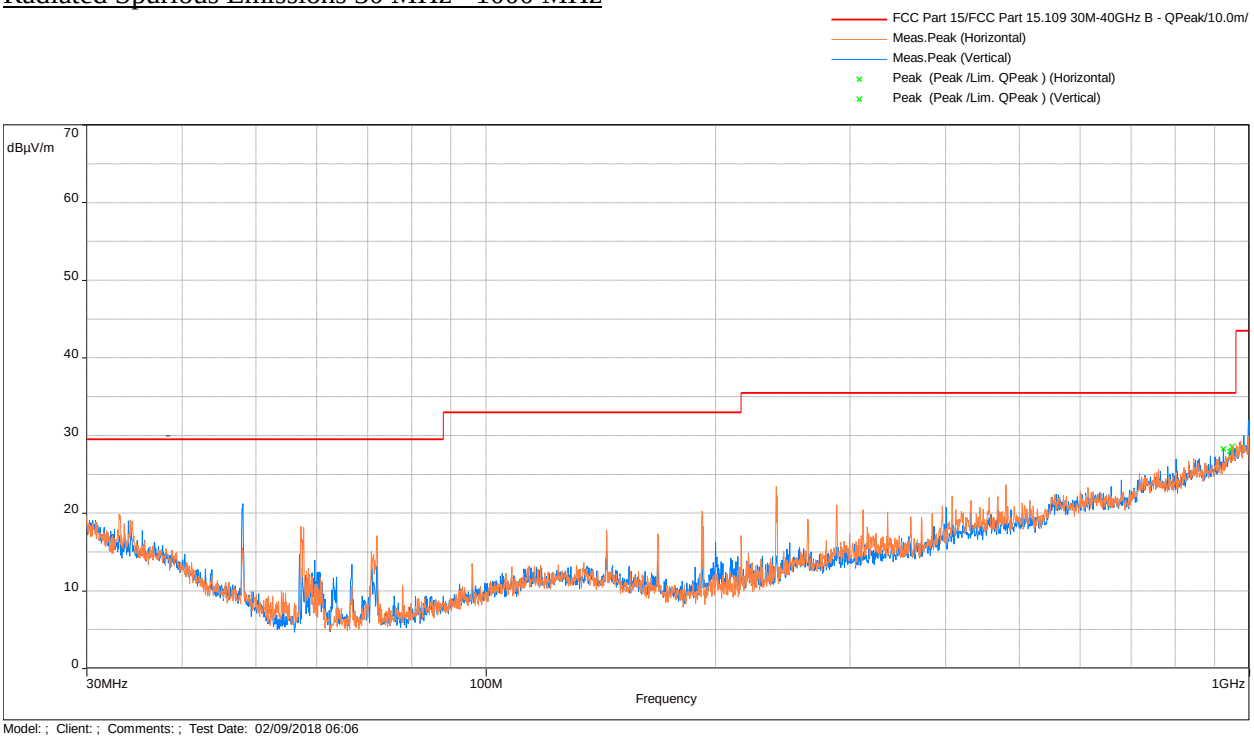


Note: Radiated emission measurements were performed up to 25GHz. No Emissions were identified when scanned from 18-25 GHz

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

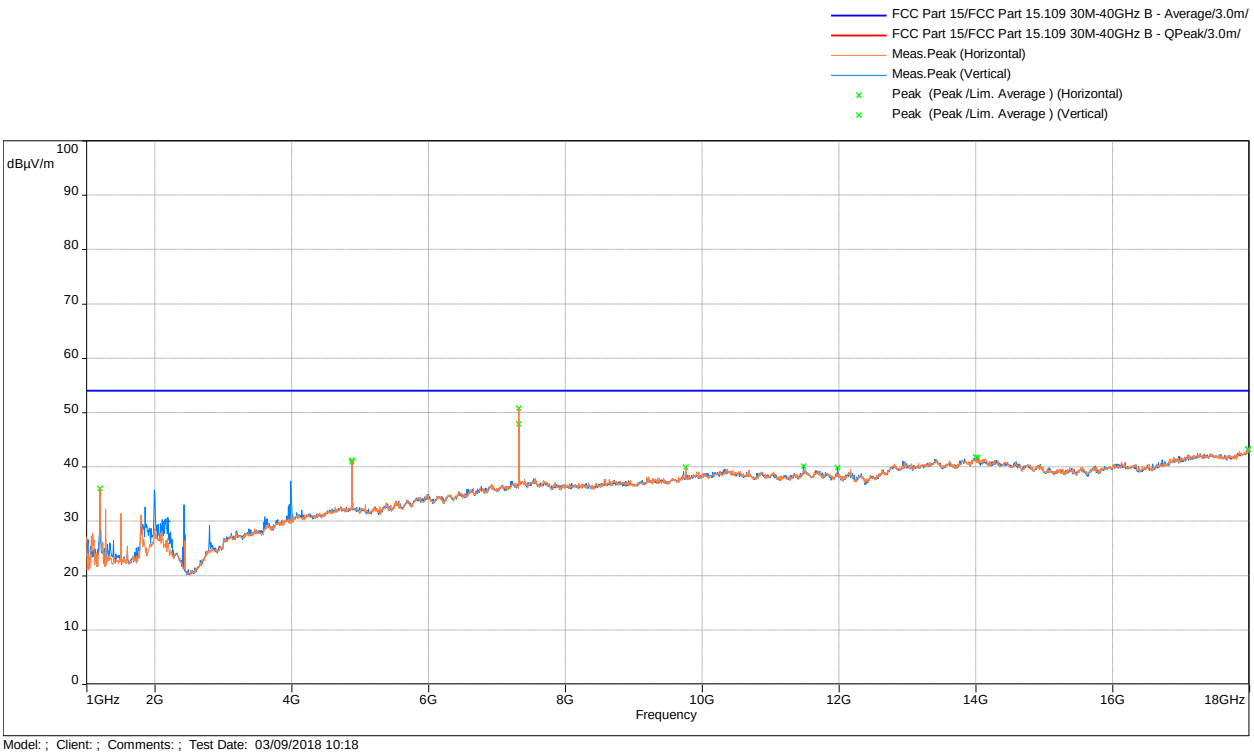
Results	**Complies**

Radiated Spurious Emissions 30 MHz - 1000 MHz



Model: ; Client: ; Comments: ; Test Date: 02/09/2018 06:06

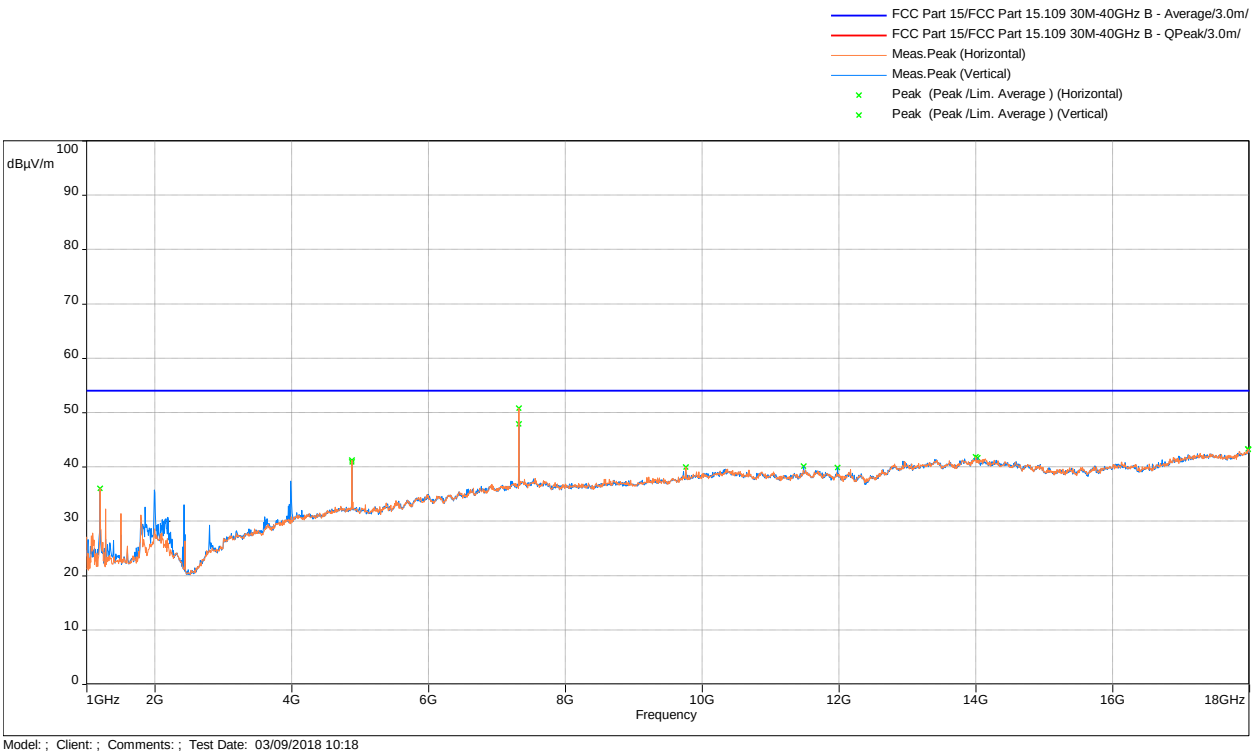
Radiated Spurious Emissions 1000 - 18000 MHz, Avg Scan vs Avg Limit



Model: ; Client: ; Comments: ; Test Date: 03/09/2018 10:18

Frequency	Average	Limit	Margin	Height	Angle	Polarization	Correction
MHz	dBµV/m	(dBµV/m)	(dB)	(m)	(°)		(dB)
4879.400	38.37	54	-15.63	1.49	182	38.37	5.18
7318.900	48.34	54	-5.66	1.53	323	48.34	12.31
4879.967	45.19	54	-8.81	1.47	206	45.19	5.19
7318.900	50.85	54	-3.15	1.62	201	50.85	12.31

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



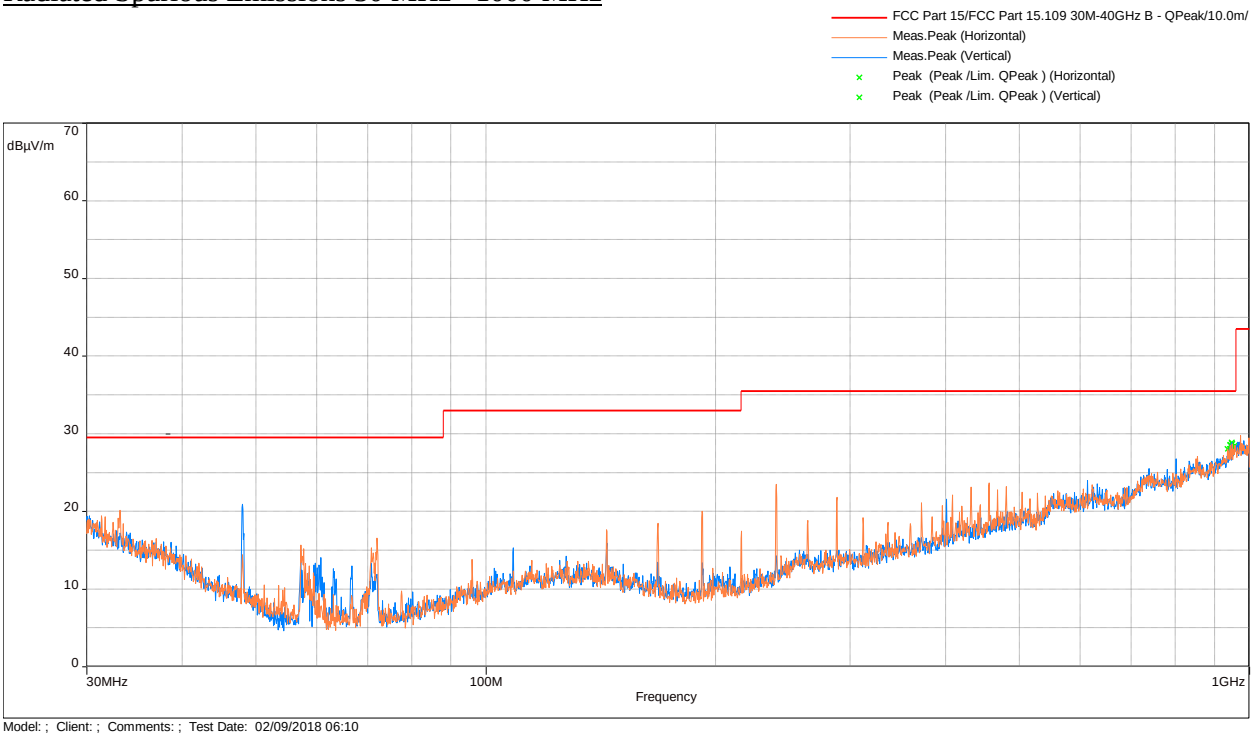
Note: Radiated emission measurements were performed up to 25GHz. No Emissions were identified when scanned from 18-25 GHz

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

Results	**Complies**

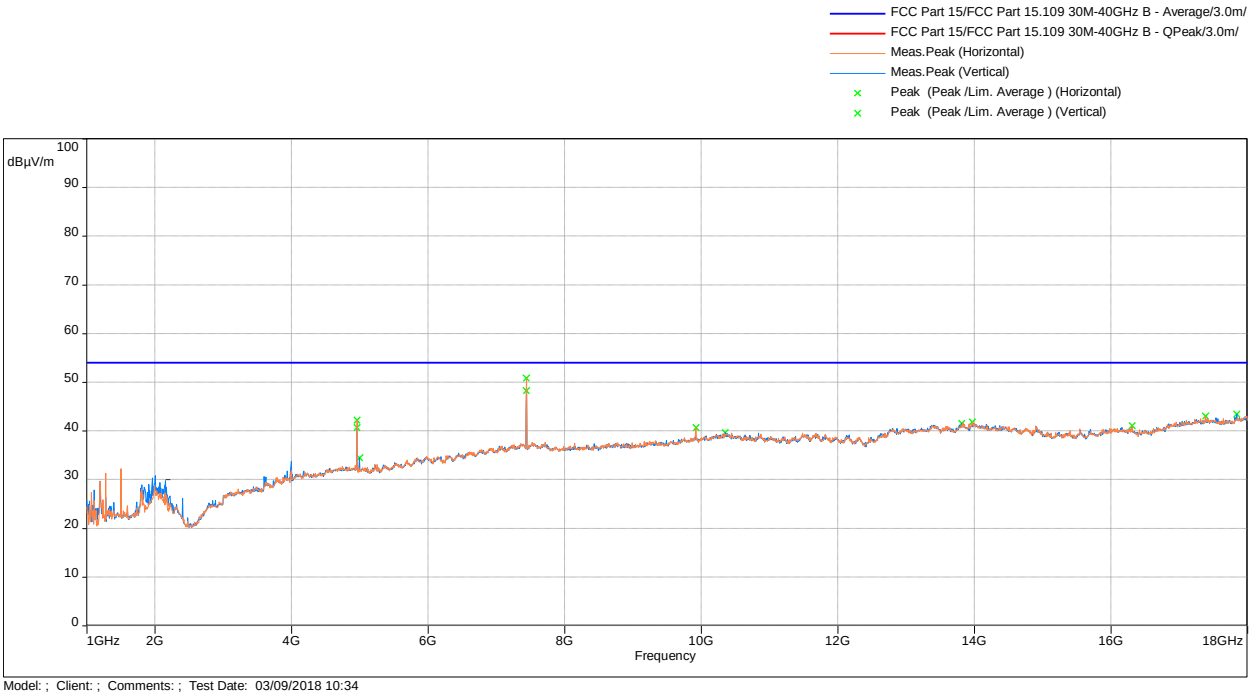
Test Results: 15.209 Radiated Spurious Emissions High Channel, Tx at 2480MHz

Radiated Spurious Emissions 30 MHz - 1000 MHz



Model: ; Client: ; Comments: ; Test Date: 02/09/2018 06:10

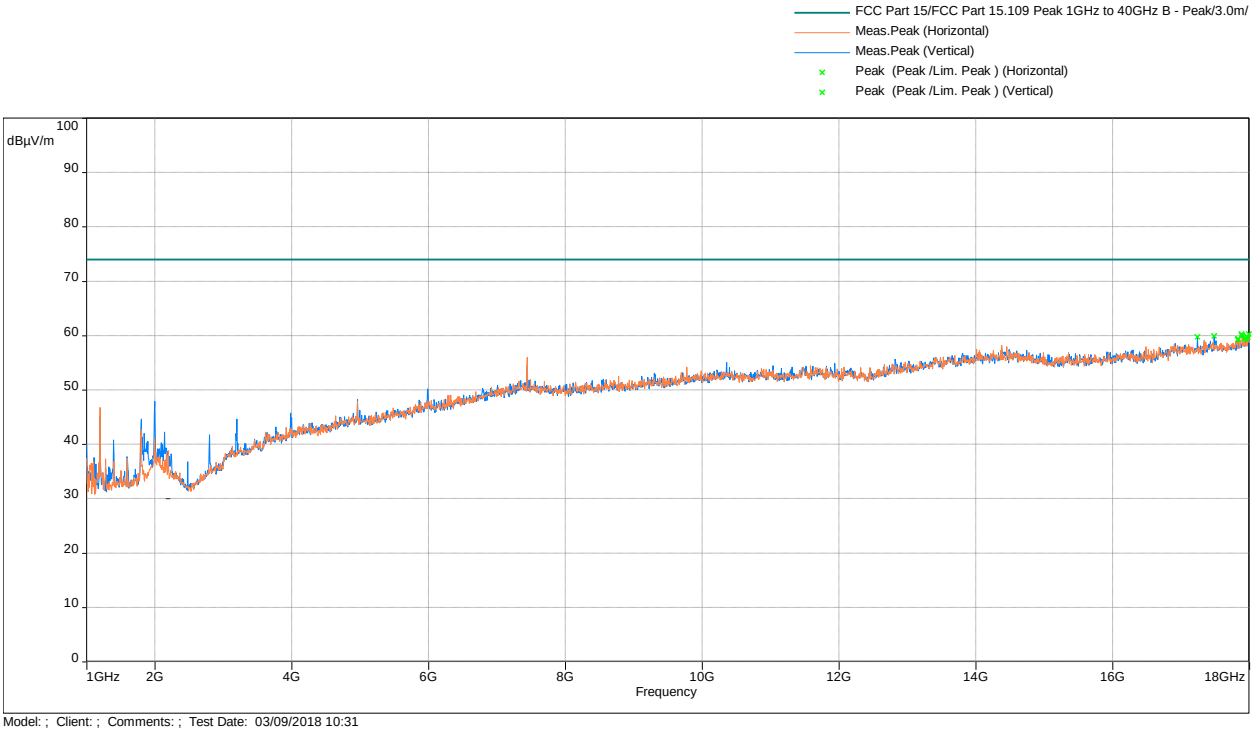
Radiated Spurious Emissions 1000 - 18000 MHz, Avg Scan vs Avg Limit



Model: ; Client: ; Comments: ; Test Date: 03/09/2018 10:34

Frequency	Average	Limit	Margin	Height	Angle	Polarization	Correction
MHz	dBµV/m	(dBµV/m)	(dB)	(m)	(°)		(dB)
4959.867	40.62	54	-13.38	1.23	135	Horizontal	5.38
7440.733	44.85	54	-9.15	1.34	0	Horizontal	12.36
4959.867	42.78	54	-11.22	1.44	248	Vertical	5.38
7440.733	48.46	54	-5.54	1.42	84	Vertical	12.36

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



Model: ; Client: ; Comments: ; Test Date: 03/09/2018 10:31

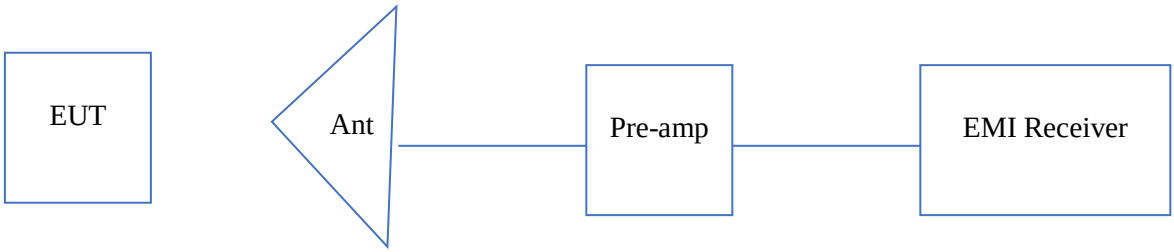
Note: Radiated emission measurements were performed up to 25GHz. No Emissions were identified when scanned from 18-25 GHz

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

Results	**Complies**

4.5.8 Test Setup Configuration

The following photographs show the testing configurations used.



4.6 Radiated Emissions from Digital Parts

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.

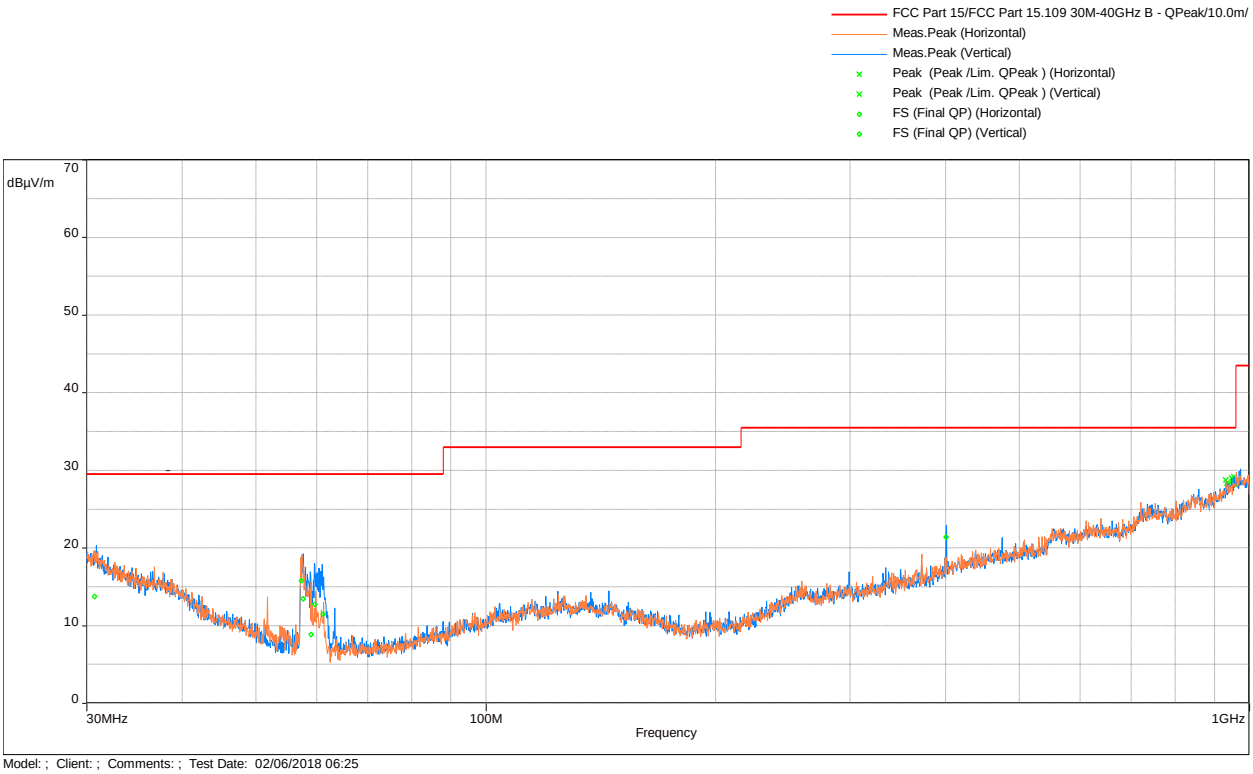
An inverse proportionality factor of 20 dB per decade was used to normalize the limit line of 30MHz to 1000MHz to the specified distance for determining compliance

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:	February 6 – 12, 2018

Square with Button

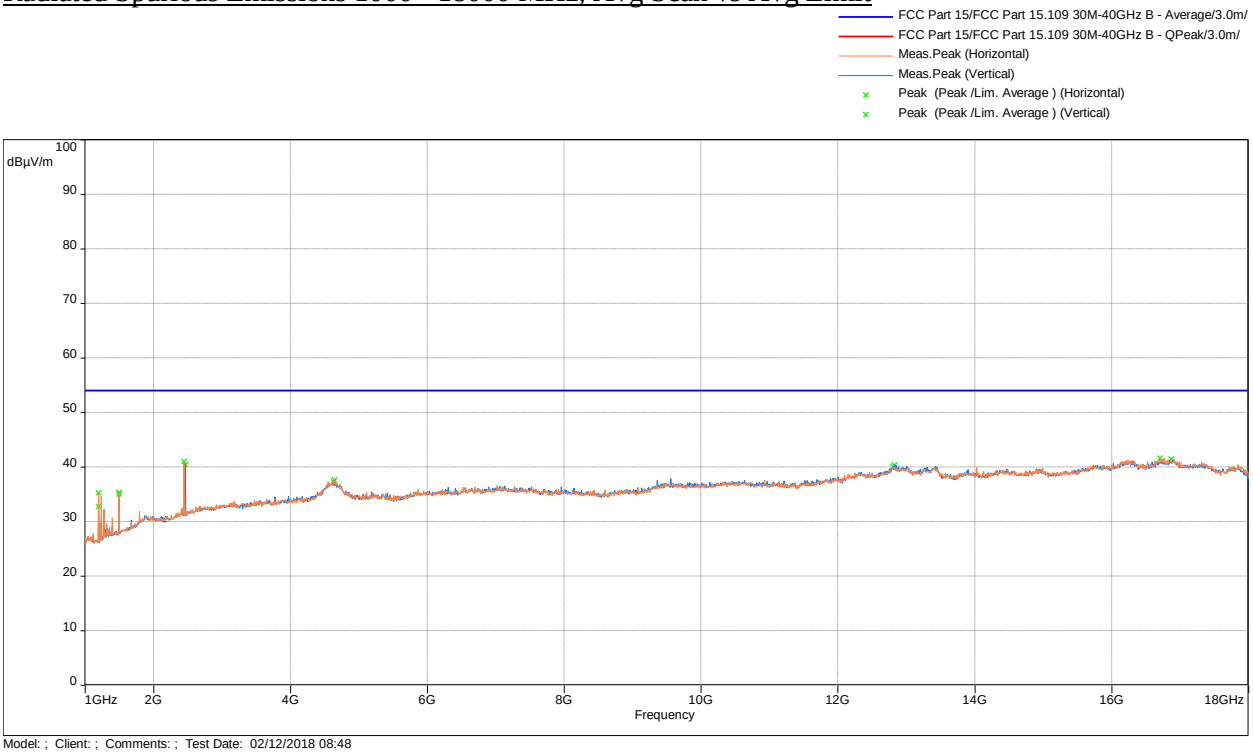
Test Results: Radiated Emissions 30 MHz - 1000



Model: ; Client: ; Comments: ; Test Date: 02/06/2018 06:25

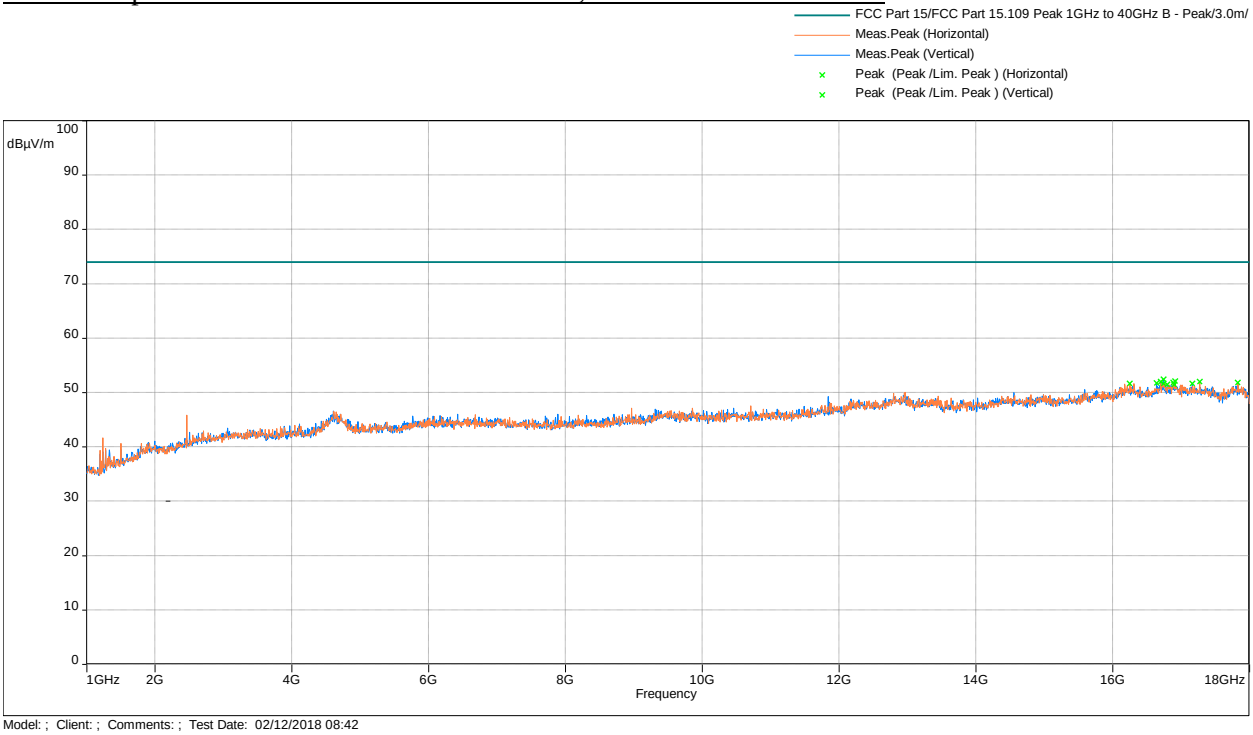
Frequency MHz	FS dBµV/m	Limit dBuV/m	Margin (dB)	Azimuth (deg)	Height (m)	Polarity	RA (dBuV)	Correction (dB)
30.733	13.73	29.50	-15.77	30	3.32	Horizontal	22.25	-8.51
57.646	13.42	29.50	-16.08	15	1.67	Horizontal	34.71	-21.31
58.987	8.86	29.50	-20.64	170	1.84	Horizontal	30.30	-21.44
57.331	15.79	29.50	-13.71	287	3.84	Vertical	37.11	-21.28
59.716	12.72	29.50	-16.78	93	3.80	Vertical	34.16	-21.43
61.277	11.49	29.50	-18.01	325	3.02	Vertical	32.89	-21.39
400.909	21.40	35.50	-14.10	248	3.23	Vertical	30.72	-9.31
Result:	**Complies** by 13.71 dB							

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



Model: ; Client: ; Comments: ; Test Date: 02/12/2018 08:48

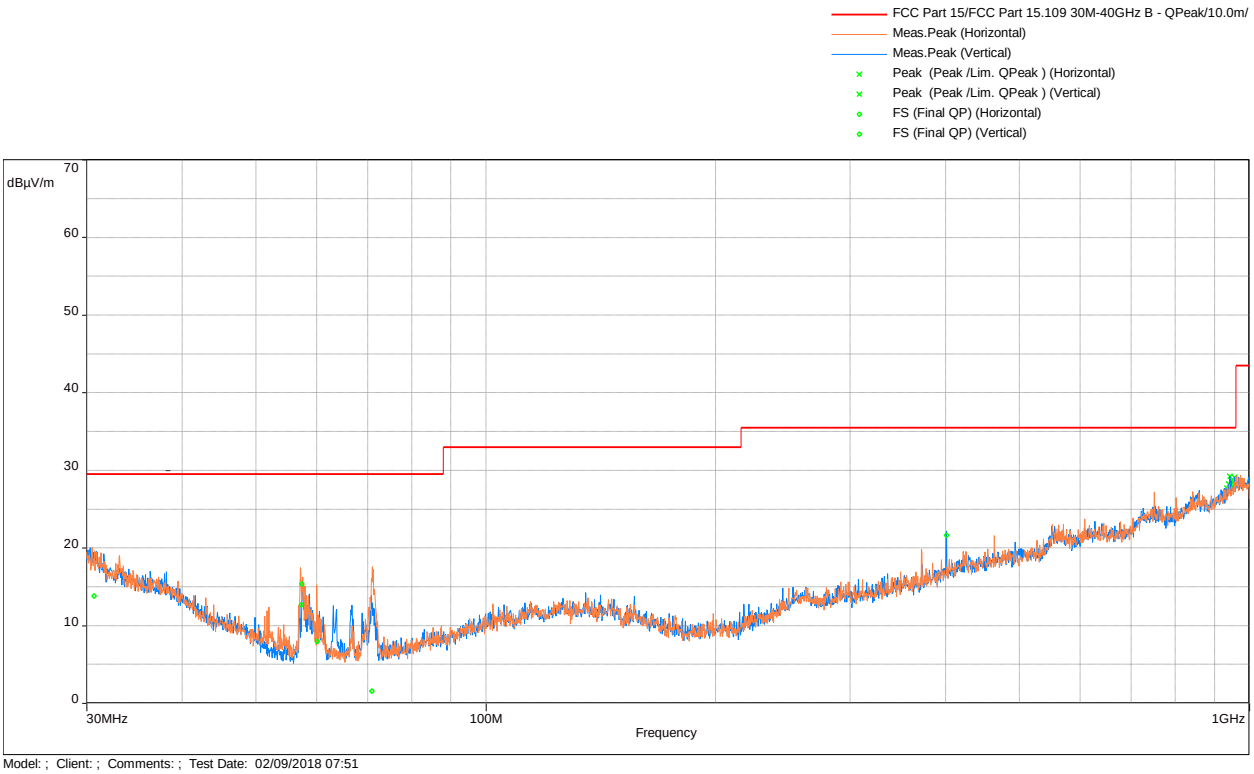
Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak Limit



Model: ; Client: ; Comments: ; Test Date: 02/12/2018 08:42

Square with Capacitive Touch

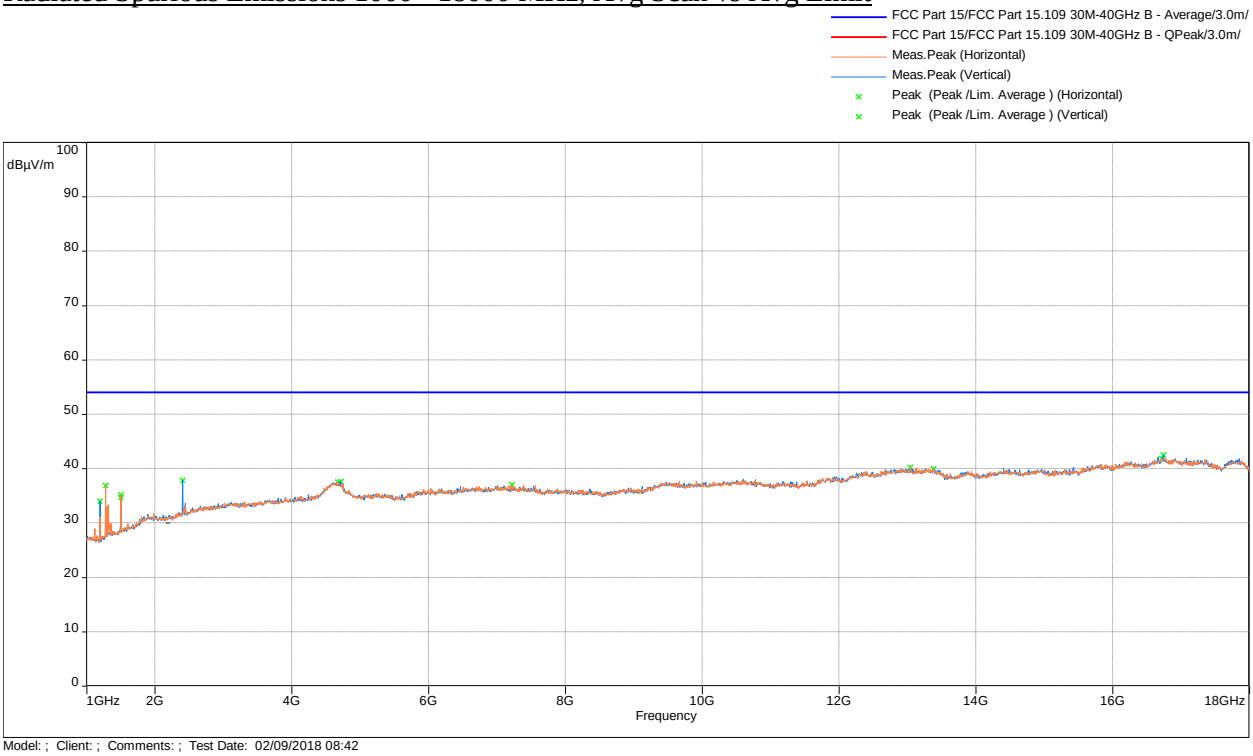
Test Results: Radiated Emissions 30 MHz - 1000



Model: ; Client: ; Comments: ; Test Date: 02/09/2018 07:51

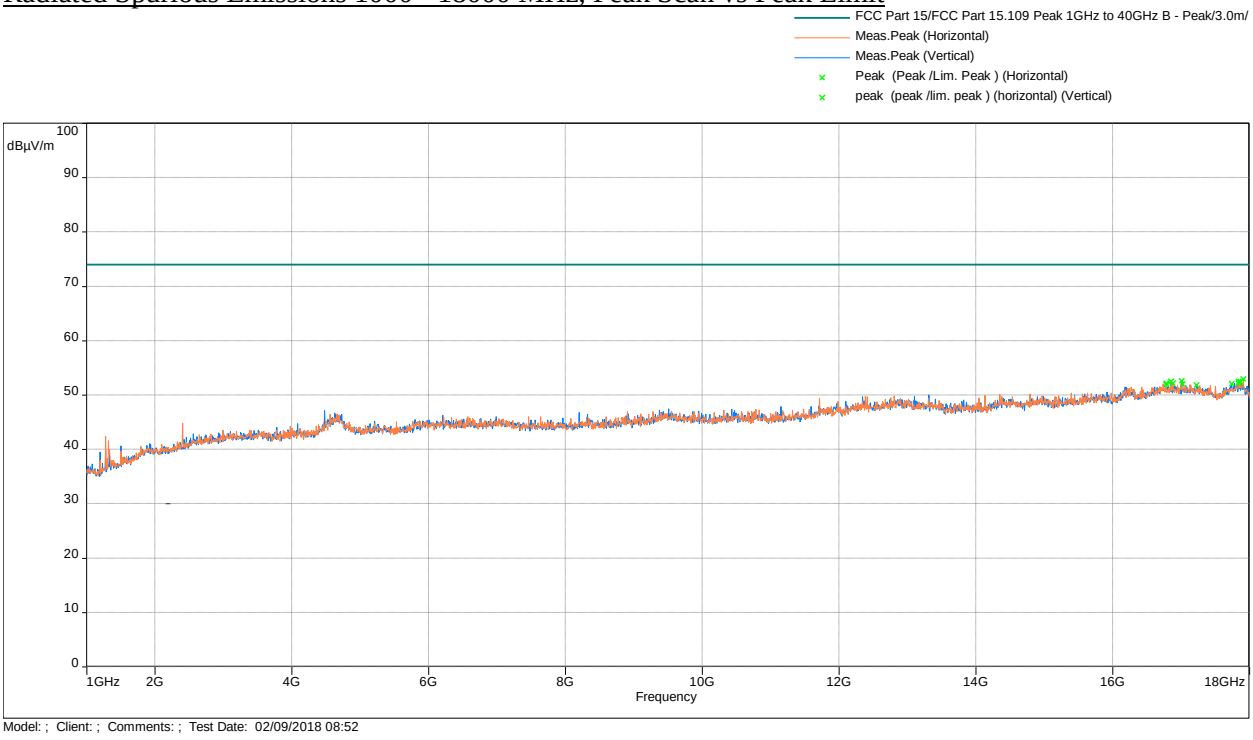
Frequency MHz	FS dBµV/m	Limit dBuV/m	Margin (dB)	Azimuth (deg)	Height (m)	Polarity	RA (dBuV)	Correction (dB)
57.349	12.69	29.50	-16.81	82	3.64	Horizontal	33.96	-21.29
60.136	7.96	29.50	-21.54	262	1.49	Horizontal	29.39	-21.43
70.895	1.55	29.50	-27.95	163	1.69	Horizontal	21.99	-20.44
30.692	13.80	29.50	-15.70	346	3.68	Vertical	22.15	-8.49
57.395	15.34	29.50	-14.16	155	3.88	Vertical	36.65	-21.29
400.912	21.62	35.50	-13.88	95	2.89	Vertical	30.94	-9.31
Result:	**Complies** by 13.88 dB							

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



Model: ; Client: ; Comments: ; Test Date: 02/09/2018 08:42

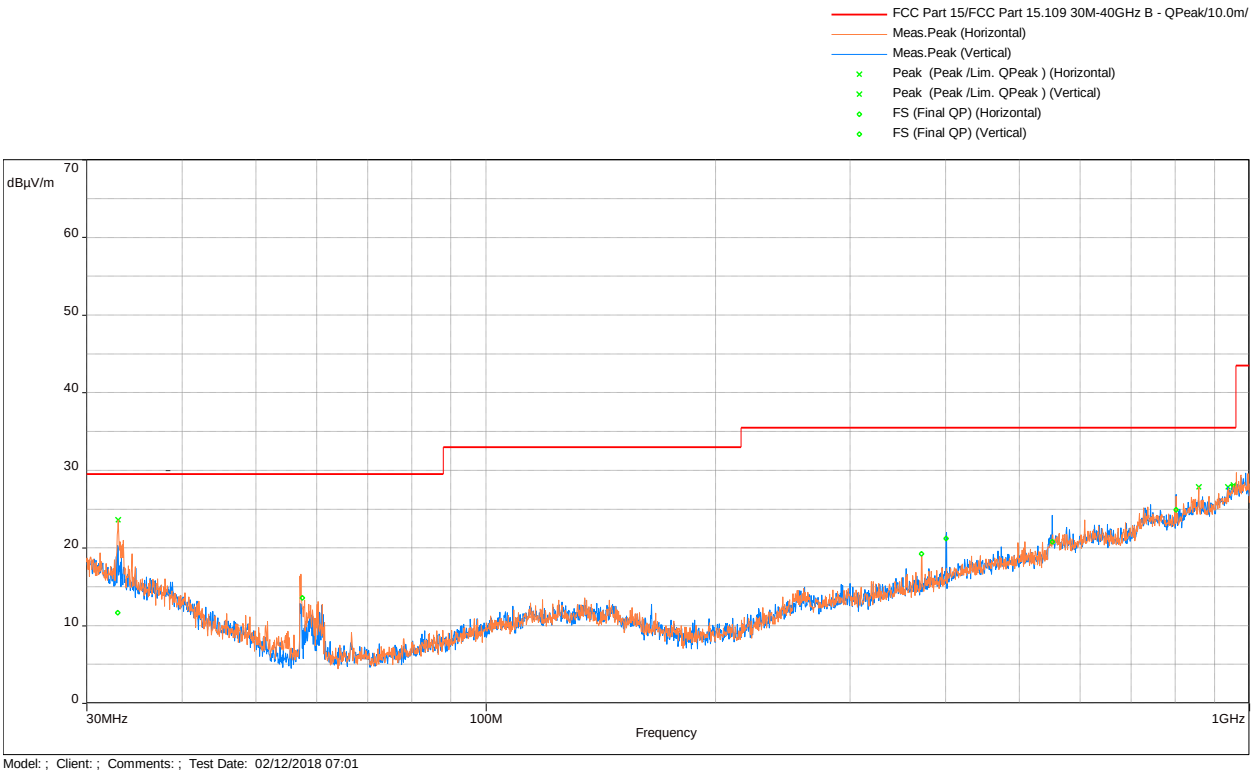
Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak Limit



Model: ; Client: ; Comments: ; Test Date: 02/09/2018 08:52

Pill with Button

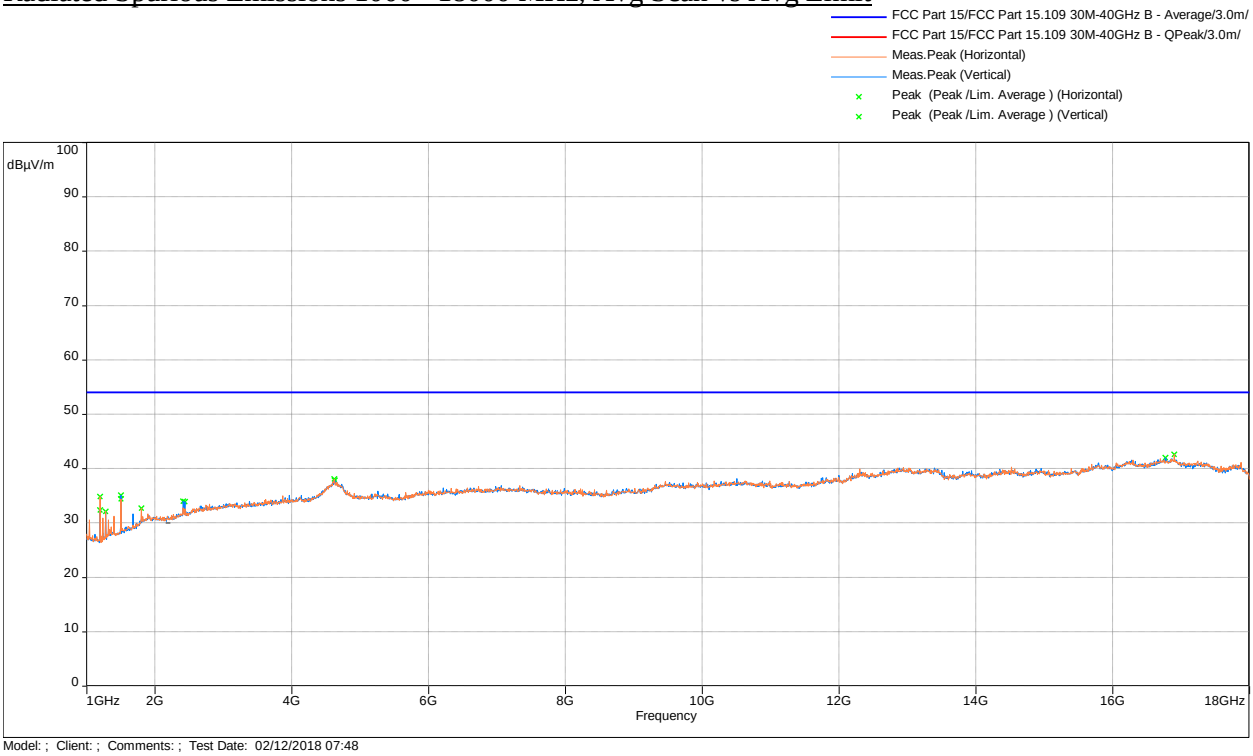
Test Results: Radiated Emissions 30 MHz - 1000



Model: ; Client: ; Comments: ; Test Date: 02/12/2018 07:01

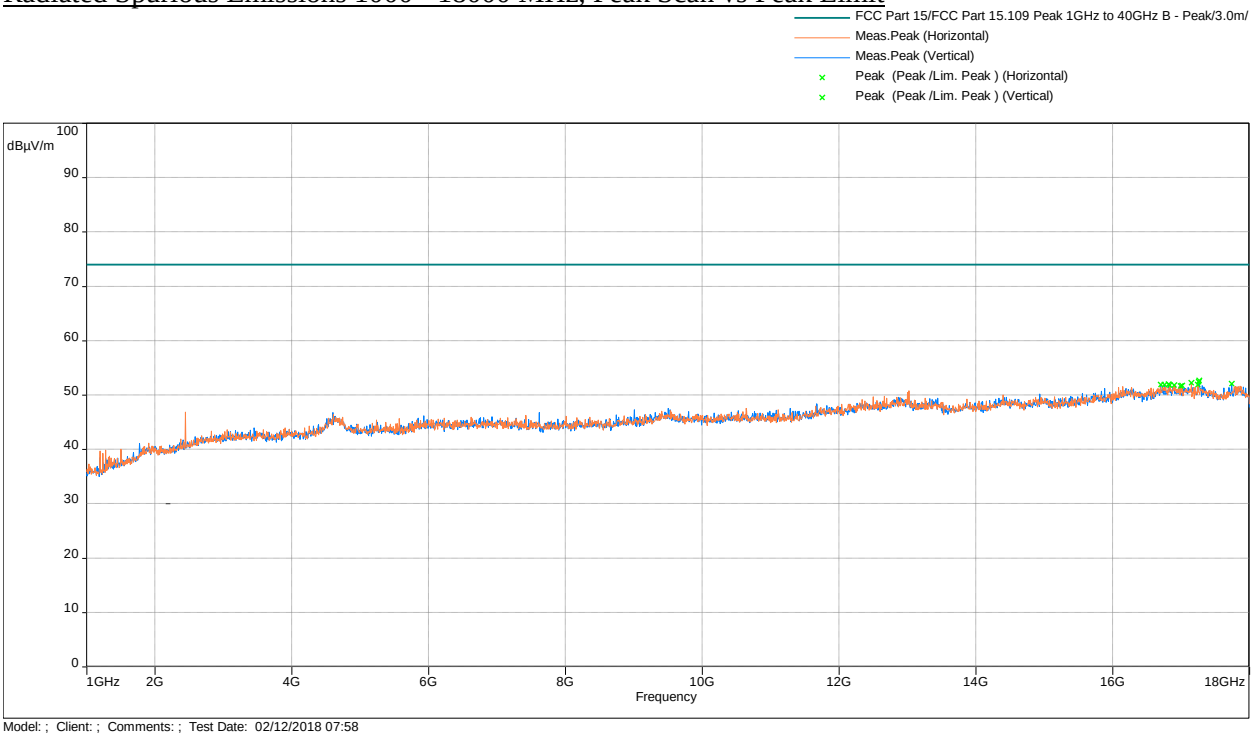
Frequency MHz	FS dBµV/m	Limit dBuV/m	Margin (dB)	Azimuth (deg)	Height (m)	Polarity	RA (dBuV)	Correction (dB)
32.930	11.62	29.50	-17.88	278	1.00	Horizontal	21.30	-9.66
57.496	13.55	29.50	-15.95	205	3.68	Horizontal	34.83	-21.30
372.276	19.25	35.50	-16.25	211	1.46	Horizontal	29.72	-10.47
400.910	21.22	35.50	-14.28	218	3.16	Vertical	30.53	-9.31
552.151	20.80	35.50	-14.70	223	1.67	Vertical	25.65	-4.86
801.823	24.92	35.50	-10.58	58	1.78	Vertical	27.21	-2.29
Result:	**Complies** by 10.58 dB							

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



Model: ; Client: ; Comments: ; Test Date: 02/12/2018 07:48

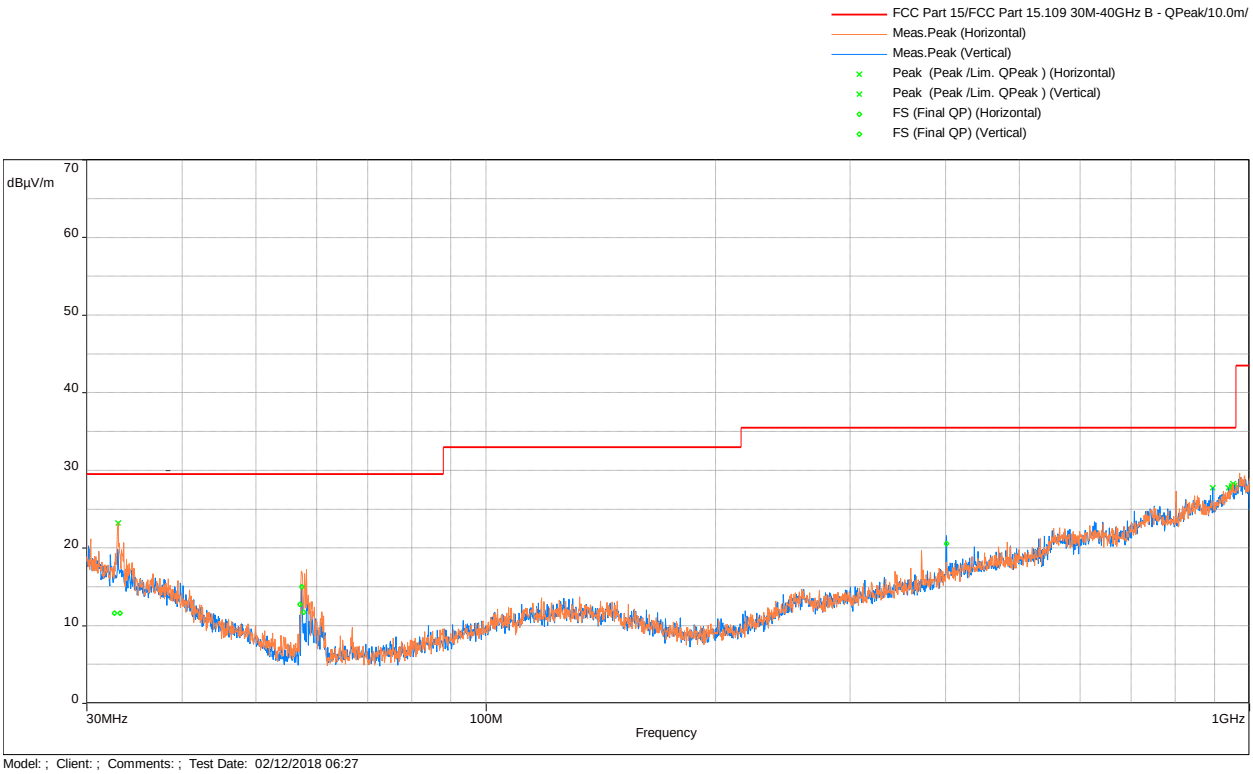
Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak Limit



Model: ; Client: ; Comments: ; Test Date: 02/12/2018 07:58

Pill with Capacitive Touch

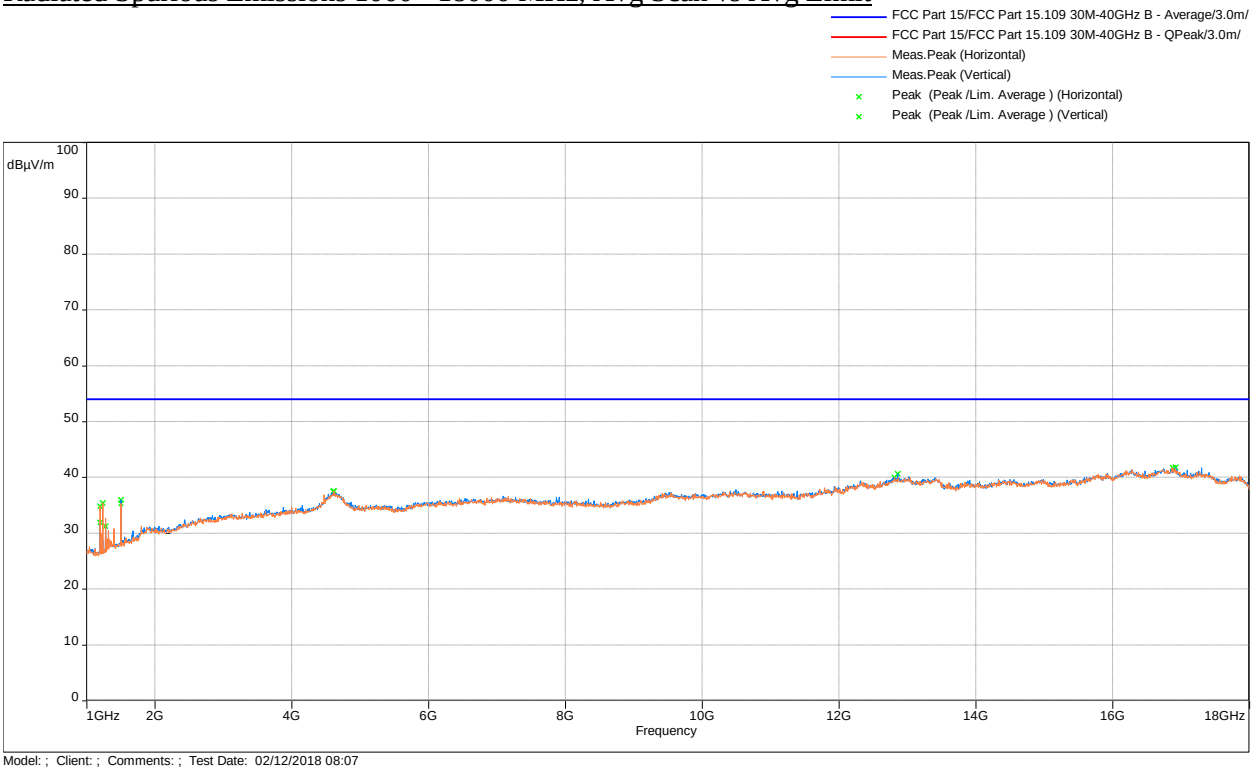
Test Results: Radiated Emissions 30 MHz - 1000



Model: ; Client: ; Comments: ; Test Date: 02/12/2018 06:27

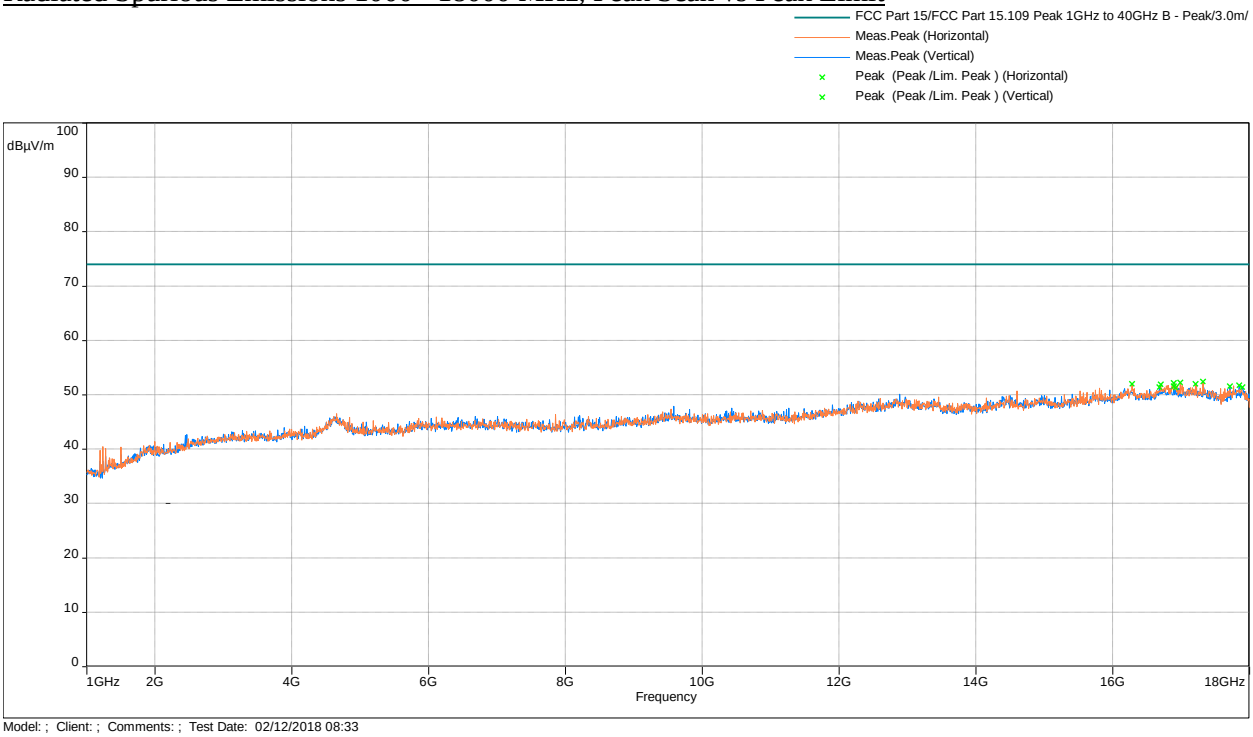
Frequency MHz	FS dBµV/m	Limit dBuV/m	Margin (dB)	Azimuth (deg)	Height (m)	Polarity	RA (dBuV)	Correction (dB)
33.156	11.59	29.50	-17.91	337	3.64	Horizontal	21.27	-9.78
57.125	12.71	29.50	-16.79	108	1.16	Horizontal	34.00	-21.26
57.735	11.70	29.50	-17.80	34	2.16	Horizontal	33.07	-21.32
32.635	11.61	29.50	-17.89	315	3.80	Vertical	21.27	-9.54
57.398	14.99	29.50	-14.51	254	3.03	Vertical	36.28	-21.29
400.912	20.54	35.50	-14.96	11	3.38	Vertical	29.85	-9.31
Result:	**Complies** by 14.51 dB							

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



Model: ; Client: ; Comments: ; Test Date: 02/12/2018 08:07

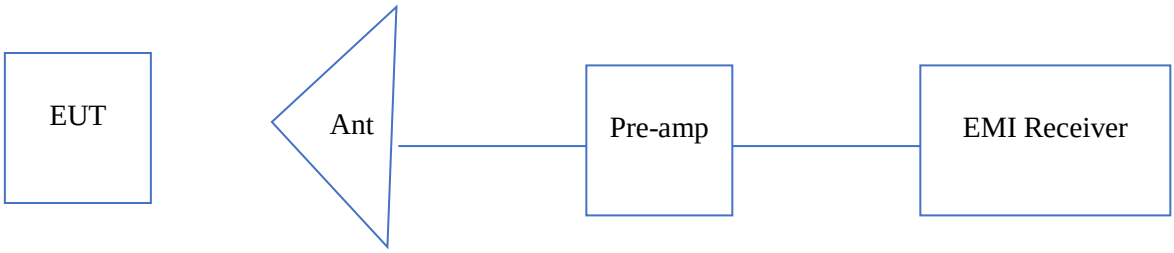
Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak Limit



Model: ; Client: ; Comments: ; Test Date: 02/12/2018 08:33

4.6.4 Test Setup Configuration

The following photographs show the testing configurations used.



5.0 List of Test Equipment

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

Equipment	Manufacturer	Model/Type	Asset #	Cal Int	Cal Due
Spectrum Analyzer	Rohde and Schwarz	FSU	ITS 00913	12	01/24/19
Pyramidal Horn Antenna	EMCO	3160-09	ITS 00571	#	#
Pre-Amplifier (18-40GHz)	Miteq	TTA1840-35-S-M	ITS 01393	12	04/18/18
Pre-Amplifier (1-18GHz)	Miteq	AMF-4D-001180-24-10P	ITS 00526	12	01/19/19
Active Horn Antenna	ETS-Lindgren	3117-PA	ITS 01325	12	01/25/19
EMI Receiver	Rohde and Schwarz	ESU	ITS 00961	12	07/10/18
Horn Antenna	ETS-Lindgren	3115	ITS 00982	12	02/08/19
BI-Log Antenna	Schaffner	CBL 6112D	ITS 01058	12	08/11/18
Pre-Amplifier	Sonoma Instrument	310N	ITS 01493	12	10/20/18
RF Cable	TRU Corporation	TRU CORE 300	ITS 01462	12	08/19/18
RF Cable	TRU Corporation	TRU CORE 300	ITS 01465	12	08/19/18
RF Cable	TRU Corporation	TRU CORE 300	ITS 01470	12	08/19/18
Notch Filter	MICRO-TRONICS	BRM50702	ITS 01166	12	12/08/18
RF Cable	Mega Phase	EMC1-K1K1-236	ITS 01538	12	06/13/18
RF Cable	TRU Corporation	TRU CORE 300	ITS 01330	12	11/29/18

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	103398220_Nexkey.bpp
RS Commander	Rohde Schwarz	1.6.4	Not Applicable (Screen grabber)

6.0 Document History

Revision/ Job Number	Writer Initials	Reviewers Initials	Date	Change
1.0 / G103398220	AS	KV	March 14, 2018	Original document