

TEST REPORT

Report Number: 103541366MPK-007

Project Number: G103541366

August 08, 2018

**Testing performed on
Real Immersive System**

Model: Model 0

Part Number: 13565 (WSM, Wireless Sensor Module)

FCC ID: 2AQU7-REAL00S

IC: 24199-REAL00S

to

FCC Part 15 Subpart C (15.247)

Industry Canada RSS-247 Issue 2

For

Penumbra, Inc.

Test Performed by:

Intertek

1365 Adams Court

Menlo Park, CA 94025 USA


Test Authorized by:

Penumbra, Inc.

One Penumbra Place

Alameda, CA 94502 USA

Prepared by: _____


Anderson Soungpanya

Date: August 08, 2018

Reviewed by: _____


Krishna K Vemuri

Date: August 08, 2018

This report is for the exclusive use of Intertek's Client and is provided pursuant to the agreement between Intertek and its Client. Intertek's responsibility and liability are limited to the terms and conditions of the agreement. Intertek assumes no liability to any party, other than to the Client in accordance with the agreement, for any loss, expense or damage occasioned by the use of this report. Only the Client is authorized to copy or distribute this report and then only in its entirety. Any use of the Intertek name or one of its marks for the sale or advertisement of the tested material, product or service must first be approved in writing by Intertek. The observations and test results in this report are relevant only to the sample tested. This report by itself does not imply that the material, product, or service is or has ever been under an Intertek certification program. This report must not be used to claim product endorsement by A2LA, NIST nor any other agency of the U.S. Government.

Report No. 103541366MPK-007	
Equipment Under Test:	Real Immersive System - Wireless Sensor Module
Trade Name:	Penumbra, Inc.
Model Number:	Model 0
Part Number:	13565
Applicant:	Penumbra, Inc.
Contact:	Royal Wang
Address:	Penumbra, Inc. One Penumbra Place Alameda, CA 94502
Country:	USA
Tel. Number:	(209) 640-9328
Email:	rwang@penunbrainc.com
Applicable Regulation:	FCC Part 15 Subpart C (15.247) Industry Canada RSS-247 Issue 2
Date of Test:	July 11-17, 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 4

2.0 General Information 5

2.1 Product Description 5

2.2 Related Submittal(s) Grants 6

2.3 Test Facility 6

2.4 Test Methodology 6

2.5 Measurement Uncertainty 6

3.0 System Test Configuration..... 7

3.1 Support Equipment 7

3.2 Block Diagram of Test Setup..... 7

3.3 Justification 8

3.4 Software Exercise Program..... 8

3.5 Mode of Operation during Test..... 8

3.6 Modifications Required for Compliance 8

3.7 Additions, Deviations and Exclusions from Standards..... 8

4.0 Measurement Results..... 9

4.1 6-dB Bandwidth and 99% Occupied Bandwidth 9

4.2 Maximum Peak Conducted Output Power at Antenna Terminals 16

4.3 Maximum Power Spectral Density 20

4.4 Out of Band Antenna Conducted Emission 24

4.5 Transmitter Radiated Emissions 29

5.0 List of Test Equipment 48

6.0 Document History 49

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)

EUT receive date: July 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: July 11, 2018

Test completion date: July 17, 2018

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

2.0 General Information

2.1 Product Description

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

Real Immersive System is a digital hardware and software medical device platform utilizing virtual reality technology designed for use in healthcare and focusing on physical and neuro rehabilitation. The use of the device is intended to be in a clinical environment supervised by a medical professional trained in rehabilitation therapy. The mode to test is in functional mode when the device is completely removed from the charging station and strapped to a patient.

The Real Immersive System is composed of:

- All-In-One Head Mounted Display (HMD)
- Wireless Sensor Modules (WSM)
- Wireless Transmitter Module (WTM)
- Dongles-Hub Module
- HMD Sensor Module
- Charger
- WiFi Router (tp-link TL-WR802N)
- Samsung Galaxy Tab S3

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

Information about the 2.4 GHz radio is presented below:

Applicant	Penumbra, Inc.
Model No.	Model 0
FCC Identifier	2AQU7-REAL00S
IC Identifier	24199-REAL00S
Type of transmission	Digital Transmission System (DTS)
Rated RF Output	1.06 dBm
Antenna(s) & Gain	Internal Antenna, Peak Gain: 1.3 dBi
Frequency Range	2402 – 2479 MHz
Type of modulation/data rate	Frequency-shift Keying (FSK) / 2Mbit/s
Number of Channel(s)	18
Applicant Name & Address	Penumbra, Inc. One Penumbra Place Alameda, CA 94502 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 Issue 5.

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

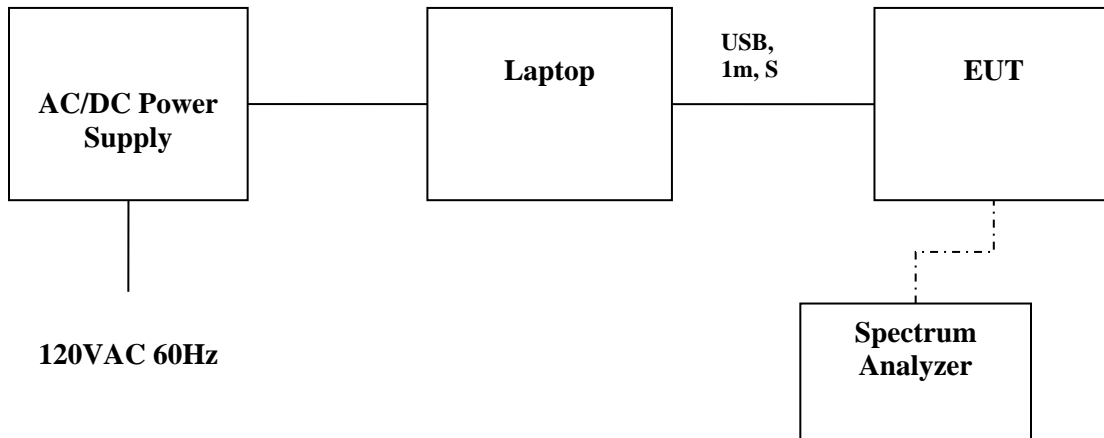
3.1 Support Equipment

Support Equipment		
Description	Manufacturer	Model Number
Laptop	Dell	Latitude 5480

3.2 Block Diagram of Test Setup

Equipment Under Test			
Description	Manufacturer	Part Number	Serial Number (LOT Number)
Radiated Sample of WSM, Wireless Sensor Module	Penumbra, Inc.	13565	E08763
Conducted Sample of WSM, Wireless Sensor Module	Penumbra, Inc.	13565	E08769

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



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.

According to the manufacturer, the WSM and WTM will be configured with one of the following channel configurations (20 – 25). Each Channel configuration will consist of 3 available frequencies. Each Real Immersive System will consist of 5 WSM and 1 WTM. The channels programmed into the system will not overlap. The 5 WSM and 1 WTM will be paired with 6 USB dongles inside the HMD.

Channel	F1	F2	F3
20	2402 MHz	2439 MHz	2469 MHz
21	2405 MHz	2444 MHz	2474 MHz
22	2410 MHz	2449 MHz	2479 MHz
23	2415 MHz	2454 MHz	2428 MHz
24	2420 MHz	2459 MHz	2431 MHz
25	2425 MHz	2464 MHz	2436 MHz

3.4 Software Exercise Program

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

3.5 Mode of Operation during Test

As instructed by the manufacturer, the EUT’s power setting was set to 0 dBm on the low, middle and high frequencies/channels.

3.6 Modifications Required for Compliance

No modifications were made by the manufacturer or Intertek to the EUT in order to bring the EUT into compliance.

3.7 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) $\geq 3 \times$ 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.

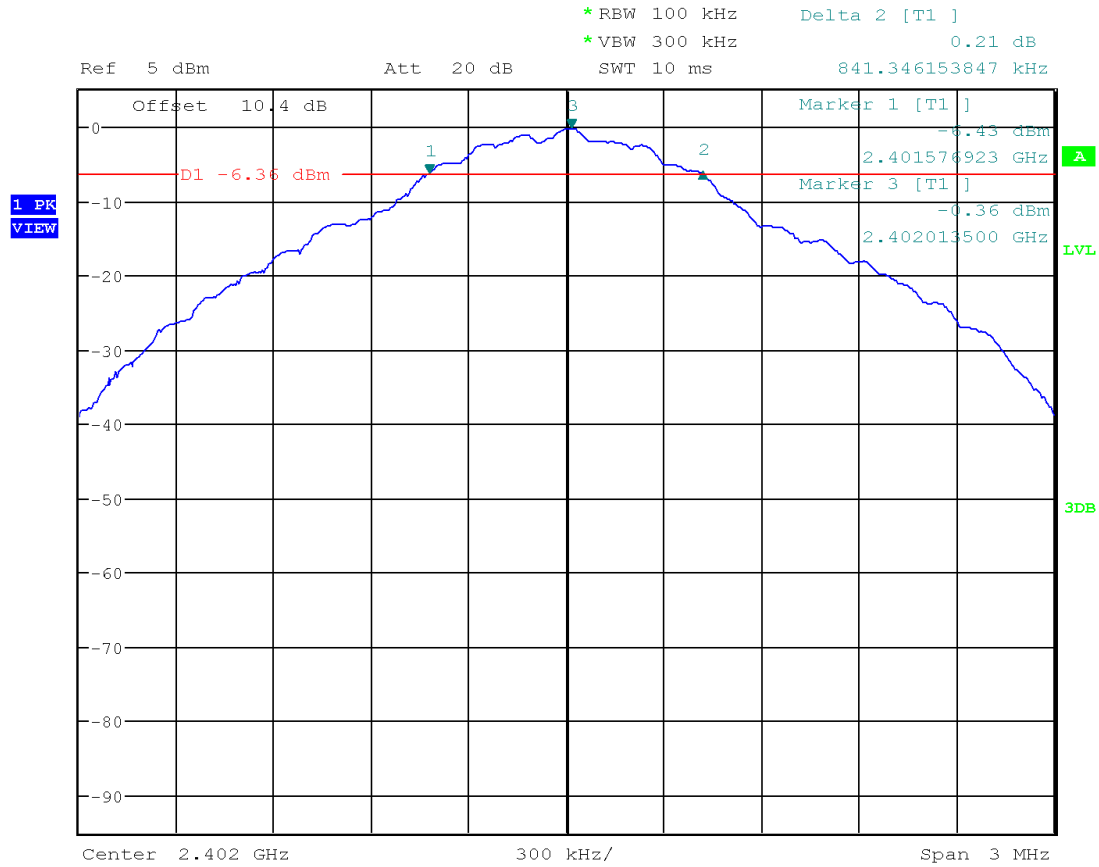
For 99% power bandwidth measurement, the bandwidth was determined by using the built-in 99% occupied bandwidth function of the spectrum analyzer. The resolution bandwidth is set to 1% of the selected span as is without being below 1%. The video bandwidth shall be set to 3 times the resolution bandwidth.

4.1.3 Test Result

Frequency (MHz)	6-dB bandwidth FCC 15.247 & RSS-GEN	Occupied bandwidth, RSS-GEN	Plot
MHz	kHz	MHz	
2402	801.282	--	1.1
	--	1.794	1.4
2439	807.692	--	1.2
	--	1.790	1.5
2479	855.333	--	1.3
	--	1.784	1.6

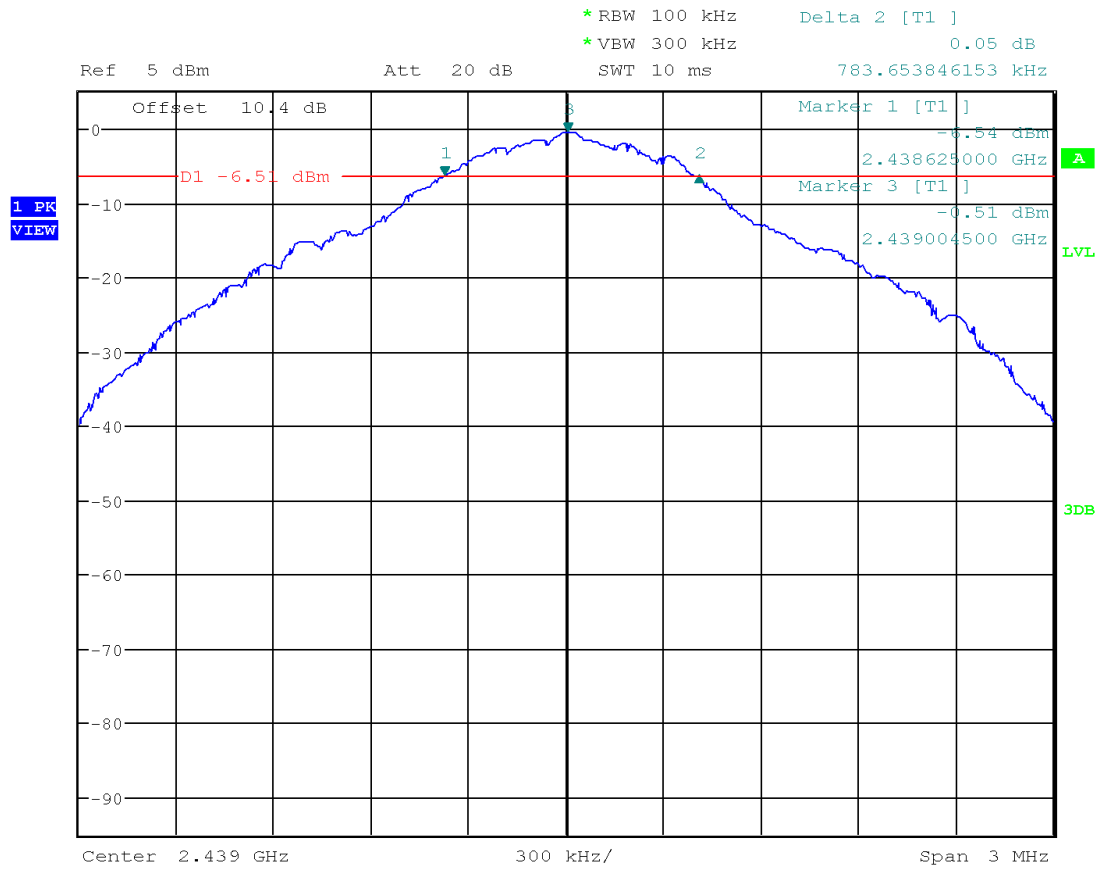
Tested By	Test Date
Anderson Soungpanya	July 17, 2018

Plot 1. 1



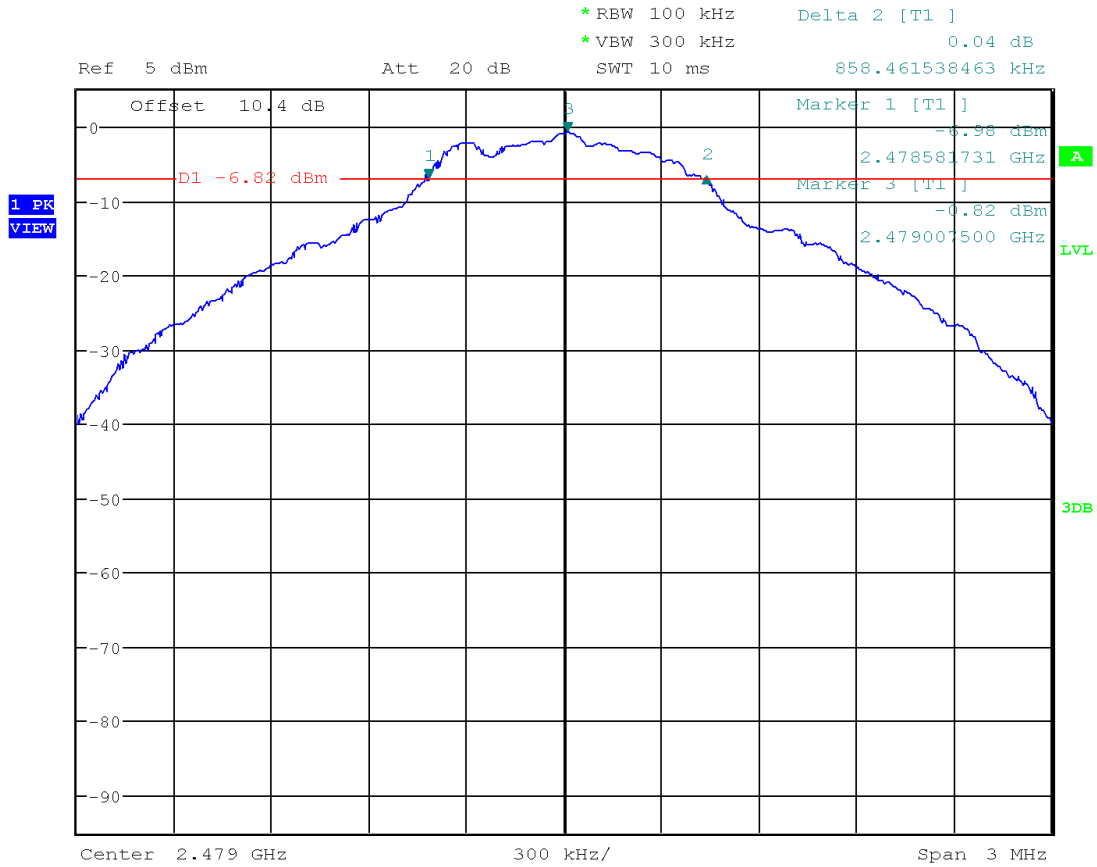
Date: 17.JUL.2018 07:50:02

Plot 1.2



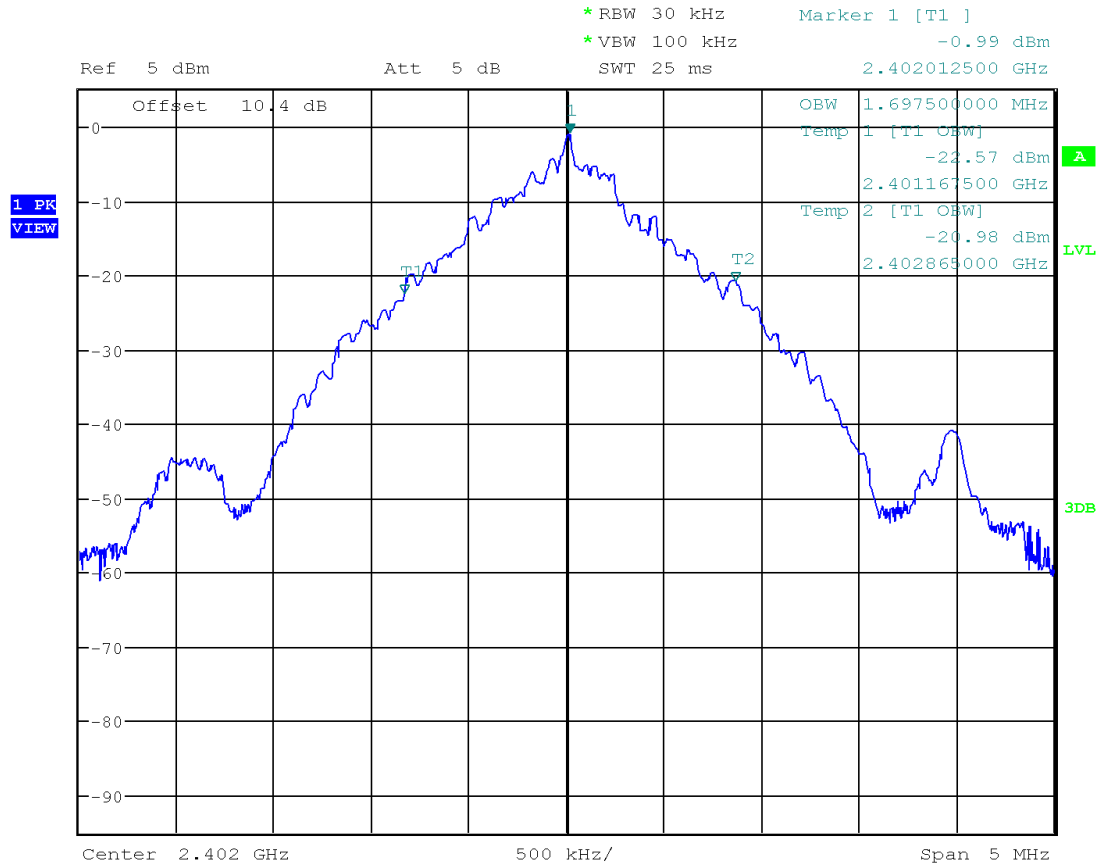
Date: 17.JUL.2018 07:46:49

Plot 1.3



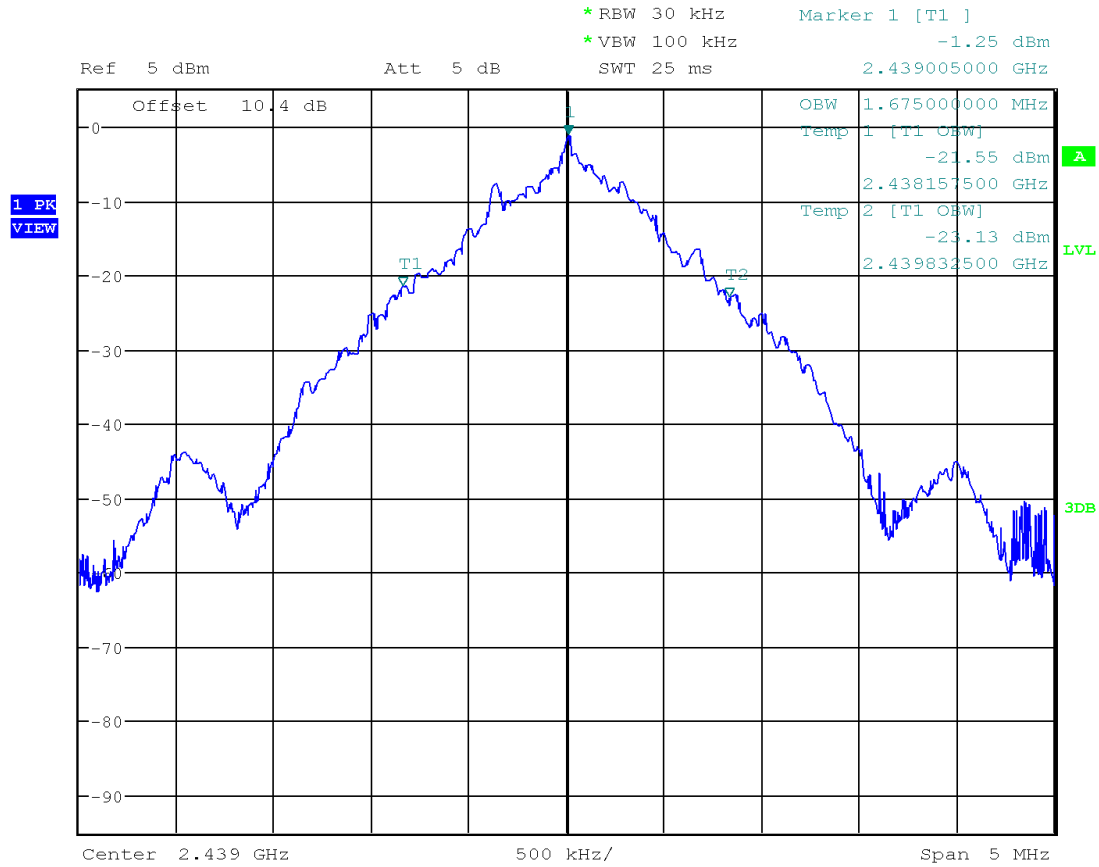
Date: 17.JUL.2018 07:54:16

Plot 1.4



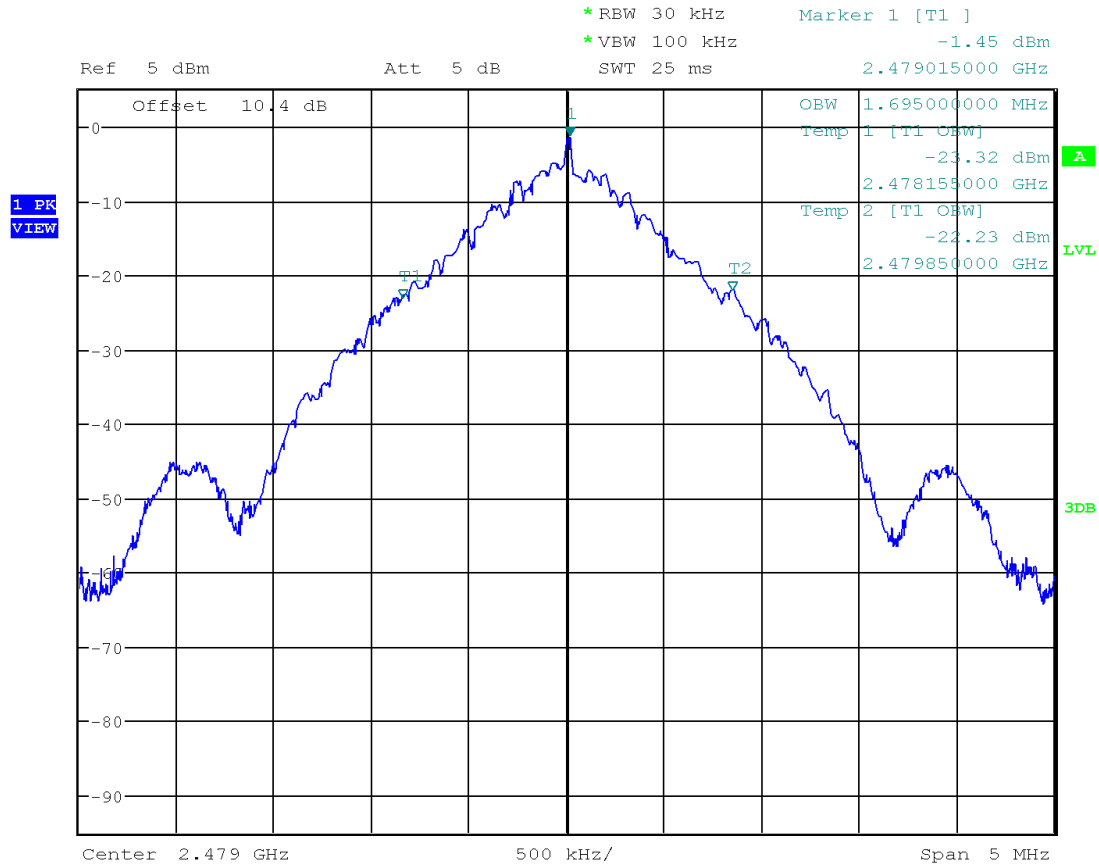
Date: 17.JUL.2018 07:58:20

Plot 1.5



Date: 17.JUL.2018 07:56:40

Plot 1.6



Date: 17.JUL.2018 07:55:27

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.

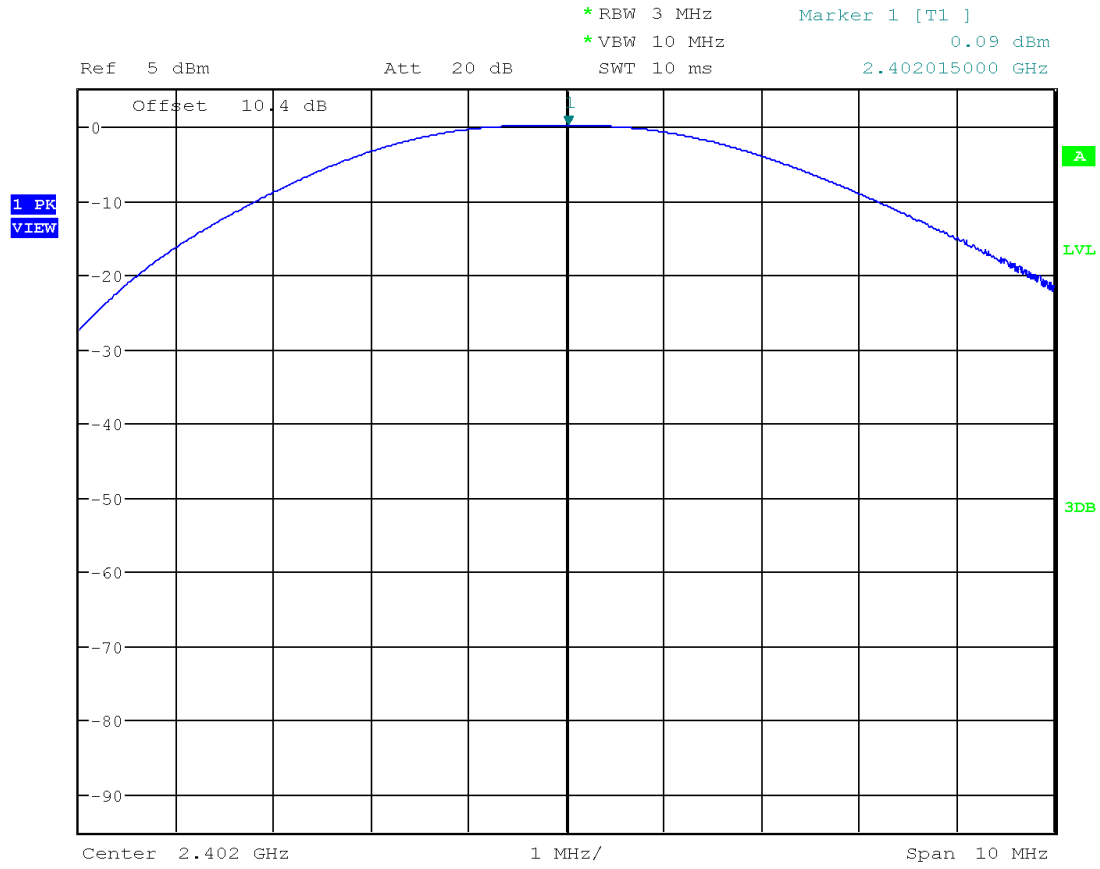
4.2.3 Test Result

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
2439	0.38	1.091	2.2
2479	0.64	1.159	2.3

Tested By	Test Date
Anderson Soungpanya	July 17, 2018

Plot 2. 1



Date: 17.JUL.2018 07:36:56

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: $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$.
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.

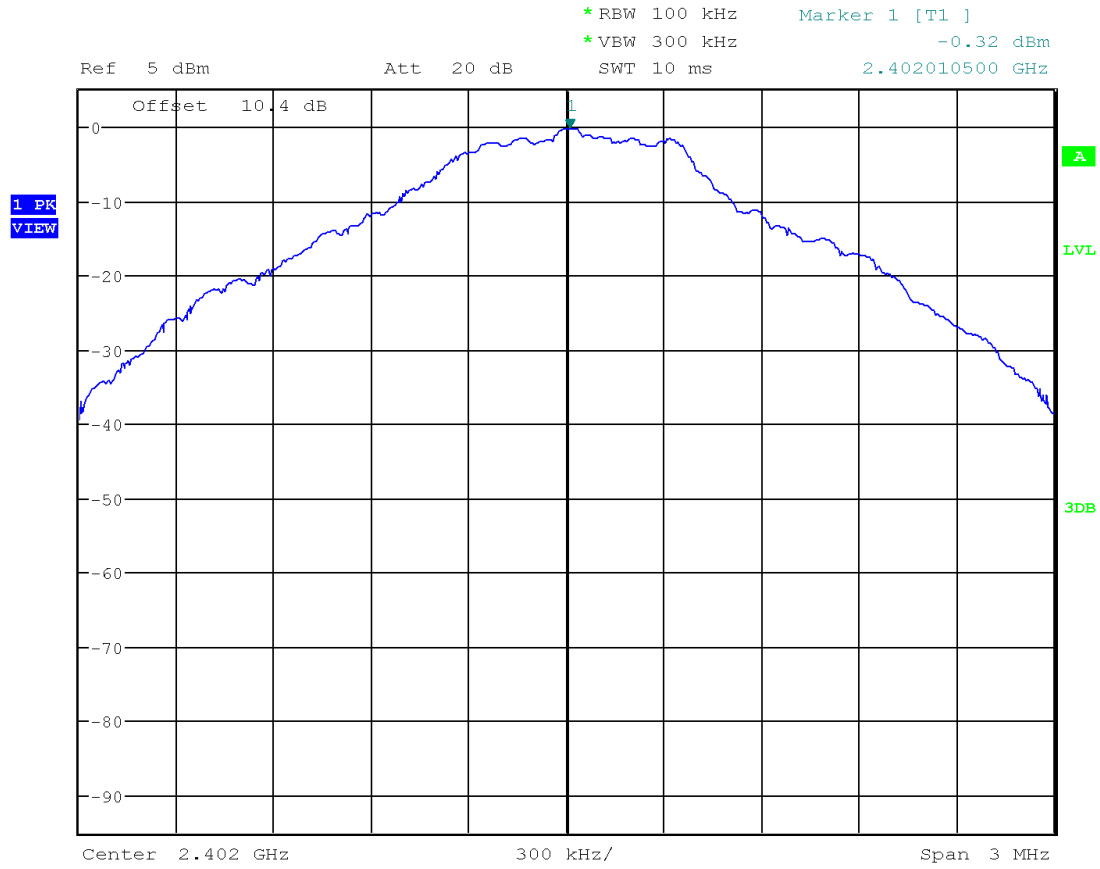
4.3.3 Test Result

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	-2.90	8.0	-10.90	3.1
2439	-3.27	8.0	-11.27	3.2
2479	-3.19	8.0	-11.19	3.3

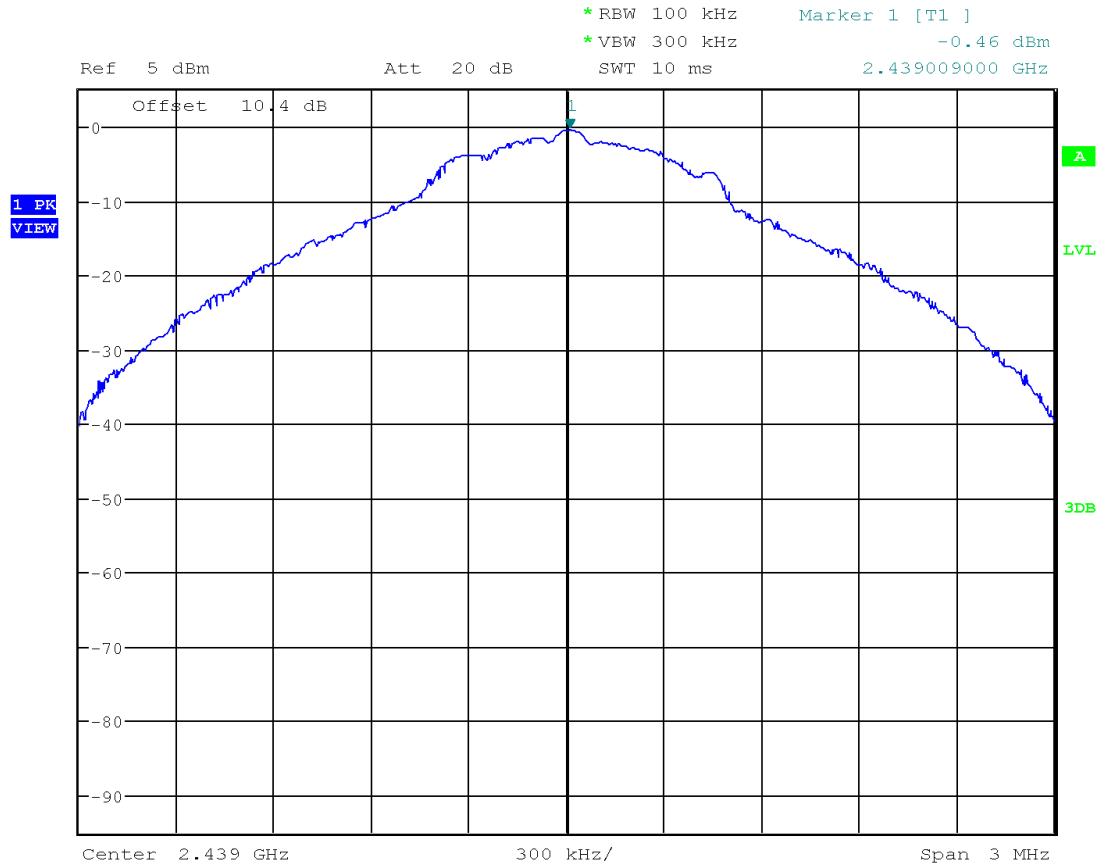
Tested By	Test Date
Anderson Soungpanya	July 17, 2018

Plot 3. 1



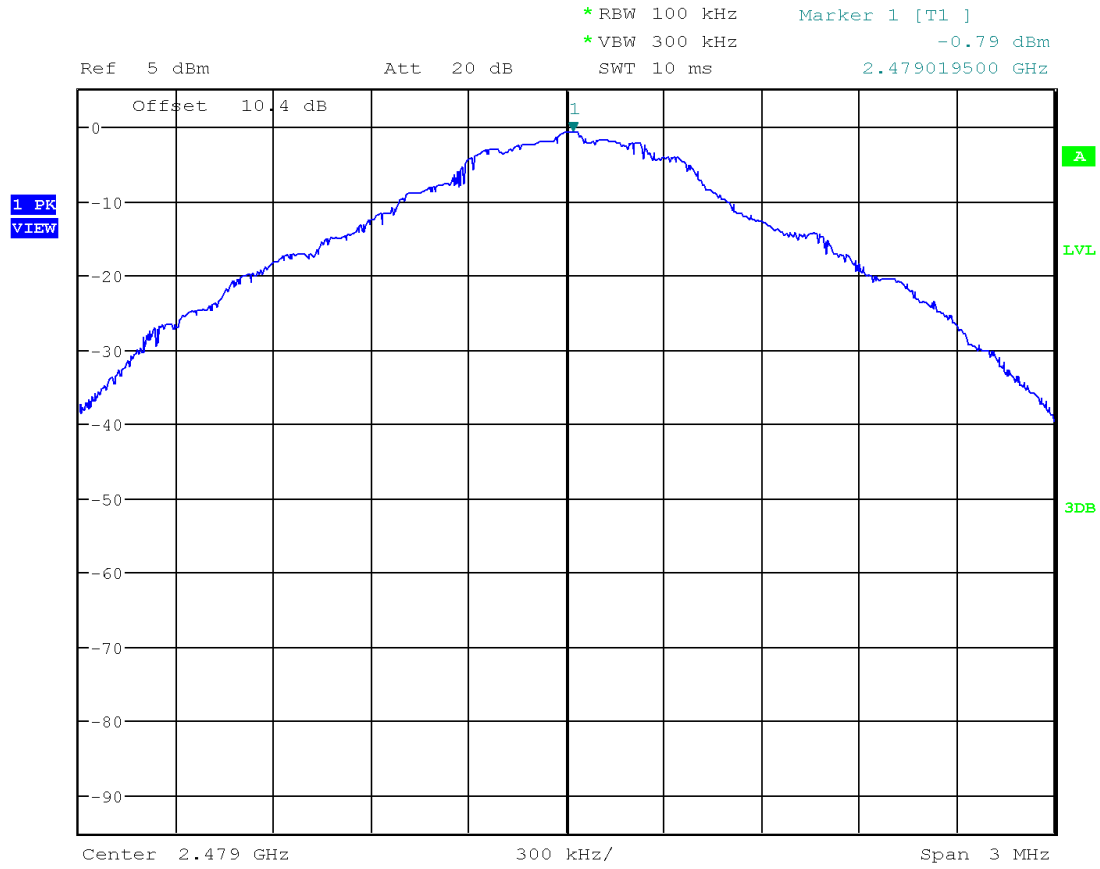
Date: 17.JUL.2018 07:42:37

Plot 3.2



Date: 17.JUL.2018 07:41:32

Plot 3.3



Date: 17.JUL.2018 07:40:39

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 $\geq 3 \times$ 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.

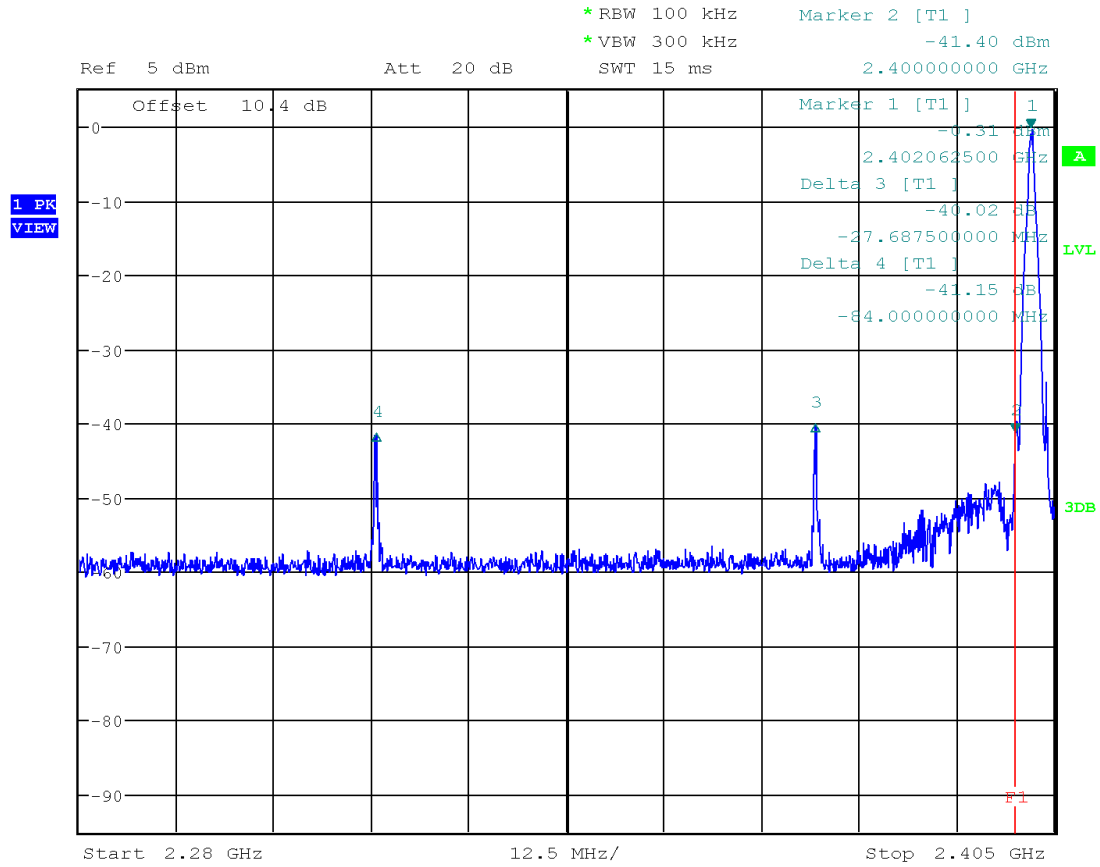
The unwanted emissions were measured from 30 MHz to 25 GHz. Plots below are corrected for cable loss and then compared to the limits.

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.

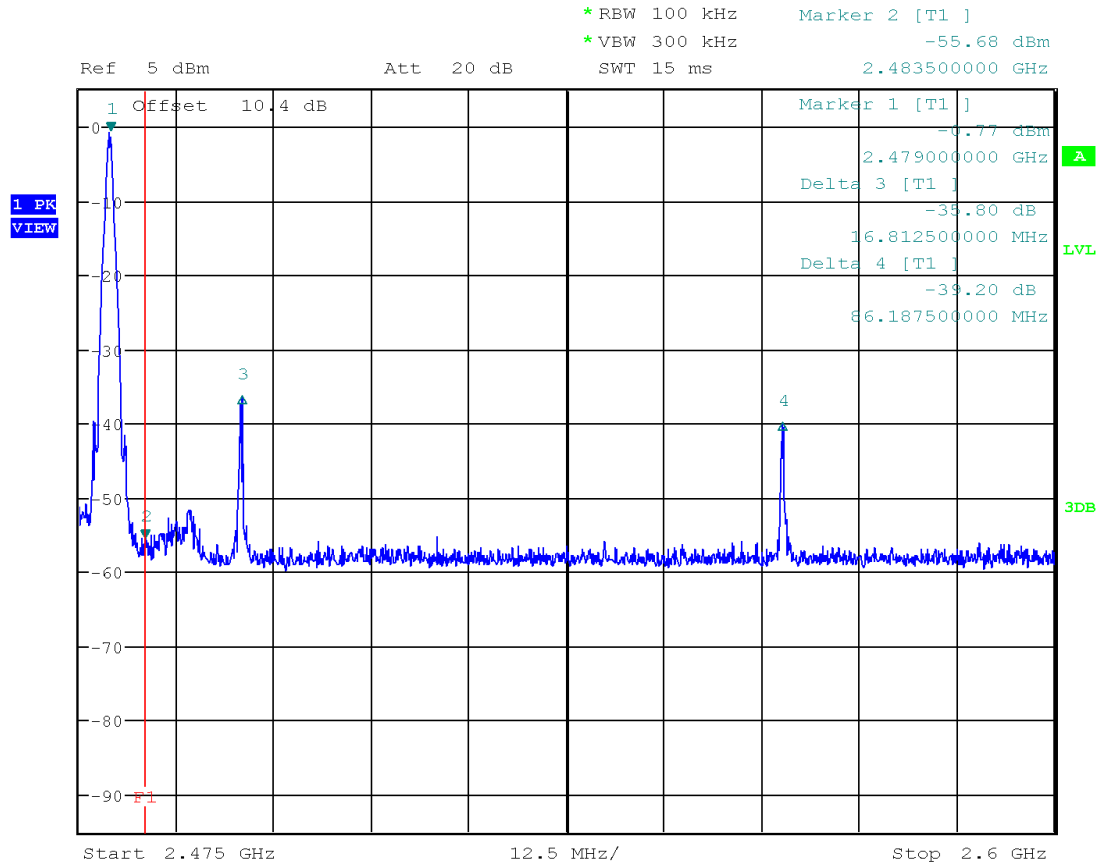
Tested By	Test Date
Anderson Soungpanya	July 17, 2018

Tx @ Low Channel, 2400 MHz Band Edge
Plot 4.1



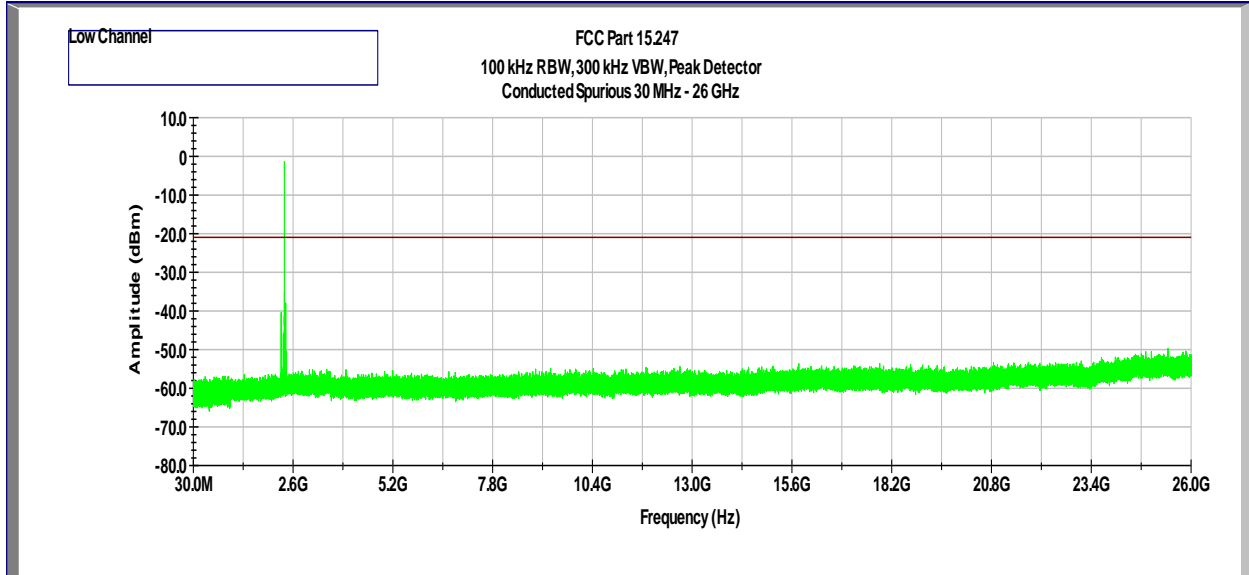
Date: 17.JUL.2018 08:07:58

Tx @ Low Channel, 2483.5 MHz Band Edge
Plot 4.2

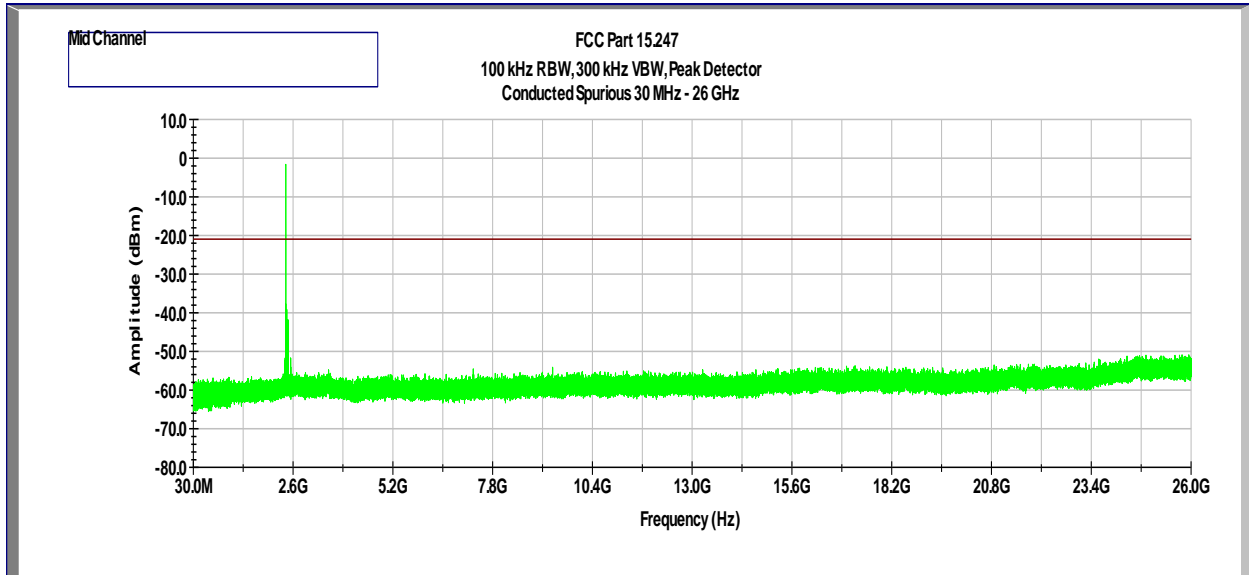


Date: 17.JUL.2018 08:04:57

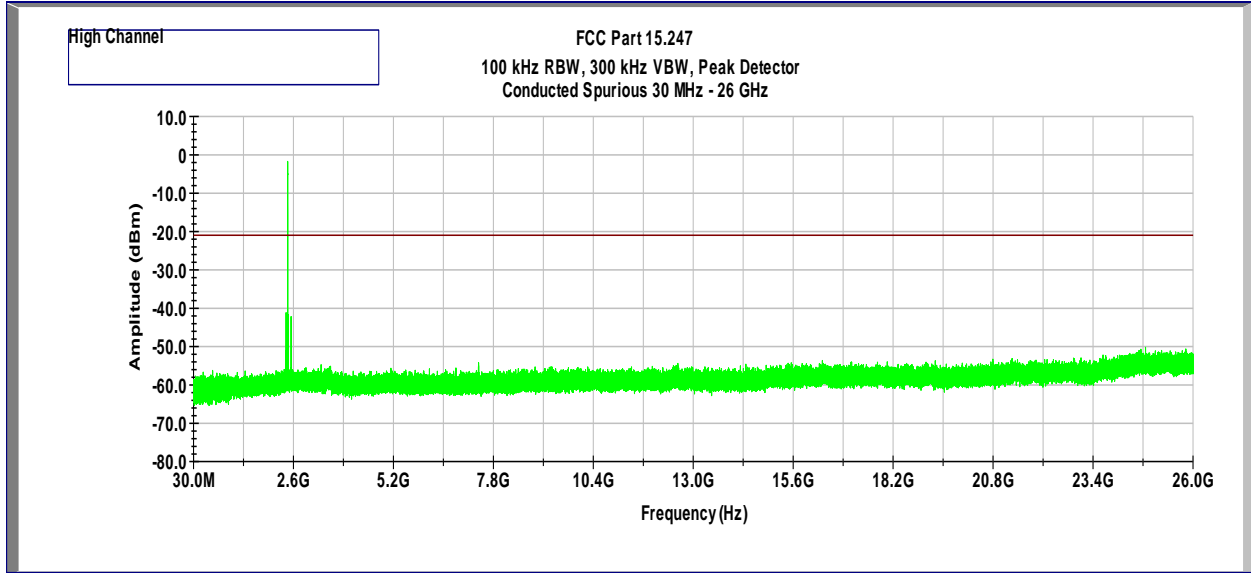
Tx @ Low Channel, 2402 MHz
30MHz -26GHz Conducted Spurious
Plot 4.3



Tx @ Mid Channel, 2439 MHz
30MHz -26GHz Conducted Spurious
Plot 4.4



Tx @ High Channel, 2479 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.

Radiated measurements were performed on the X, Y and Z orientation of the EUT. Data is presented with 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 = $52.0 + 7.4 + 1.6 - 29.0 = 32$ dB(μ V/m).

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

4.5.5 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 \leq 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:
 $E = \text{EIRP} - 20\log D + 104.8 + \text{DCF}$ (DCF for Average measurements)
 where:
 E = electric field strength in dB μ V/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

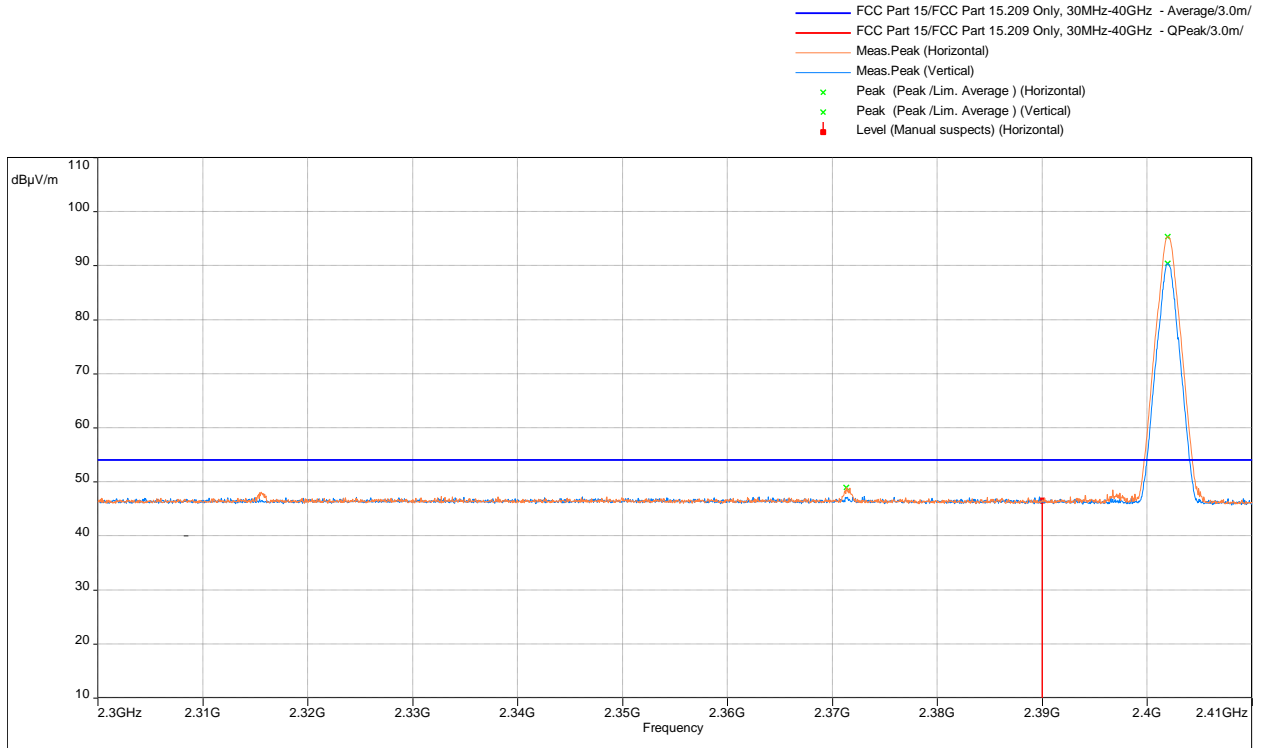
4.5.6 Test Results

All testing in this section were performed by radiated measurements.

Tested By	Test Date
Anderson Soungpanya	July 11- 17, 2018

Test Results: 15.209/15.205 Radiated Restricted Band Emissions

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



Frequency	Corrected Amplitude	Limit	Margin	Detector	Results
GHz	dBµV/m	dBµV/m	dB		
2.371	48.94	54	-5.06	RMS	Pass
2.390	46.54	54	-7.46	RMS	Pass

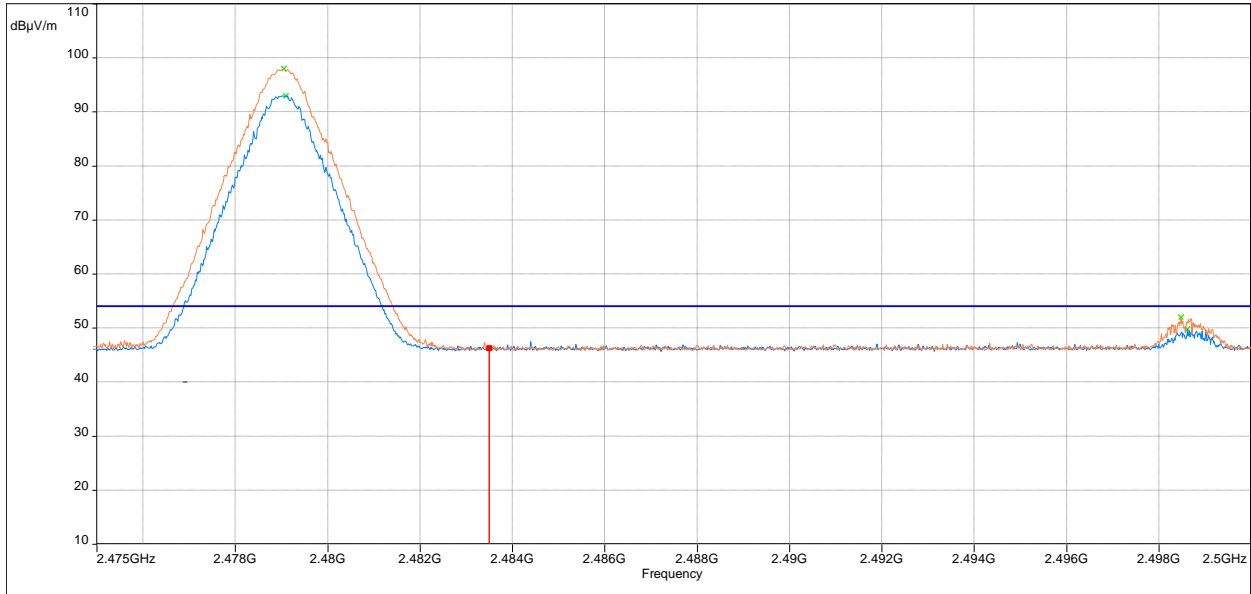
Out-of-Band Spurious Emissions at the Band Edge – Tx @ 2402 MHz, Peak



Frequency	Corrected Amplitude	Limit	Margin	Detector	Results
GHz	dBµV/m	dBµV/m	dB		
2.390	65.21	74	-8.79	Peak	Pass

Out-of-Band Spurious Emissions at the Band Edge – Tx @ 2479 MHz, Average

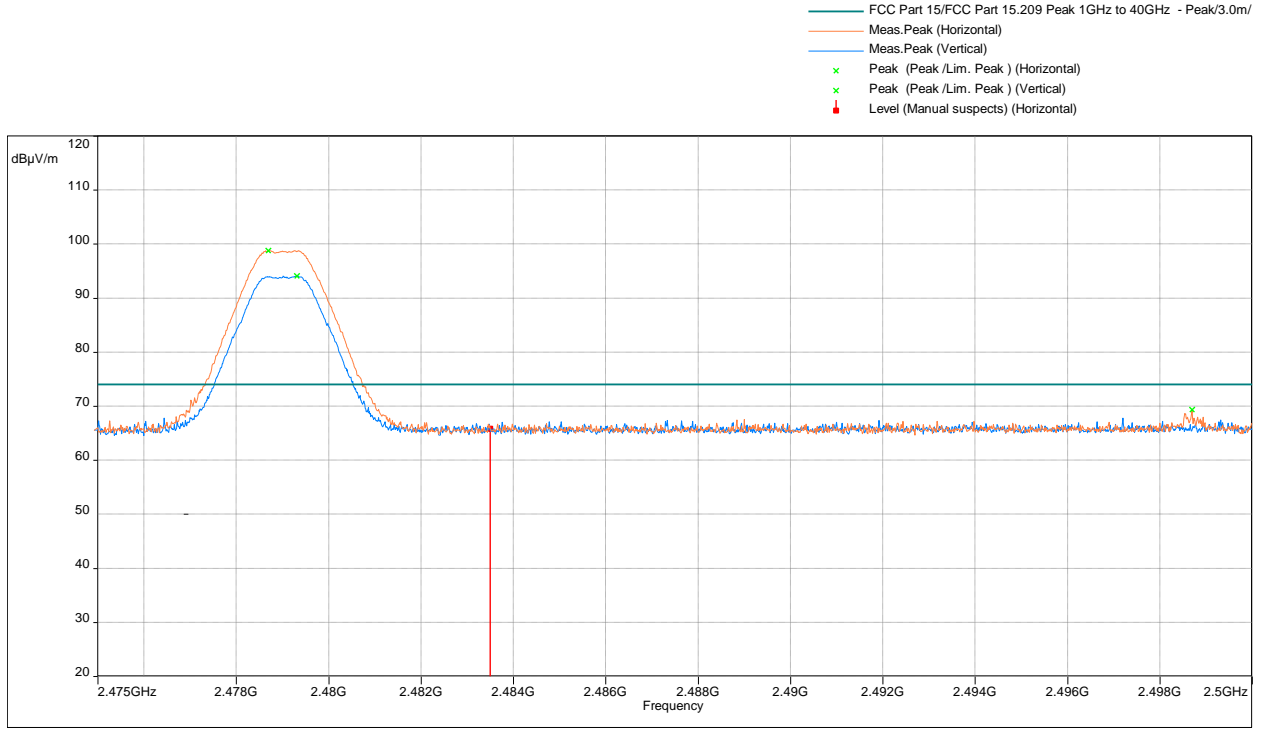
- FCC Part 15/FCC Part 15.209 Only, 30MHz-40GHz - Average/3.0m/
- FCC Part 15/FCC Part 15.209 Only, 30MHz-40GHz - QPeak/3.0m/
- ↓ Level (Manual suspects) (Horizontal)
- Meas.Peak (Horizontal)
- Meas.Peak (Vertical)
- x Peak (Peak /Lim. Average) (Horizontal)
- x Peak (Peak /Lim. Average) (Vertical)



Model: ; Client: ; Comments: ; Test Date: 07/17/2018 09:25

Frequency	Corrected Amplitude	Limit	Margin	Detector	Results
GHz	dBµV/m	dBµV/m	dB		
2.4835	46.28	54	-7.72	RMS	Pass
2.4985	51.99	54	-2.01	RMS	Pass

Out-of-Band Spurious Emissions at the Band Edge – Tx @ 2479 MHz, Peak

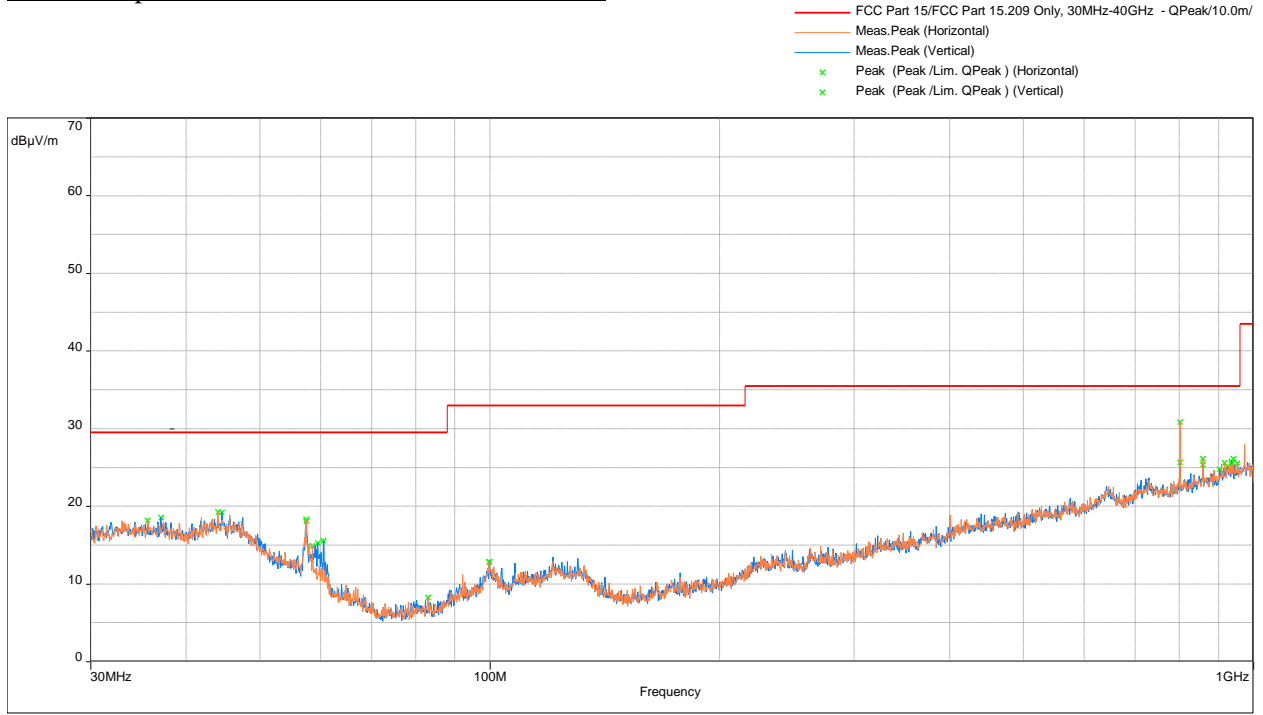


Frequency	Corrected Amplitude	Limit	Margin	Detector	Results
GHz	dBµV/m	dBµV/m	dB		
2.4835	65.80	74	-8.20	Peak	Pass
2.4987	69.34	74	-4.64	Peak	Pass

Out-of-Band Radiated Spurious Emissions

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

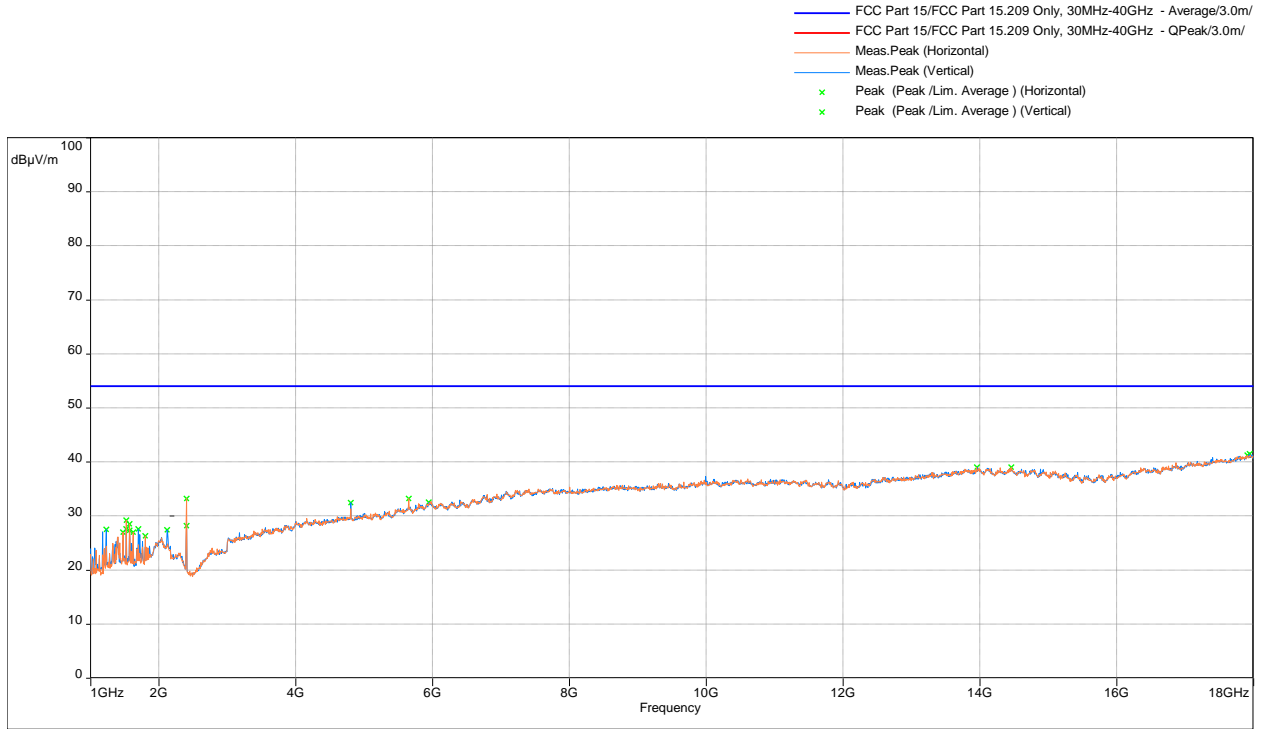
Radiated Spurious Emissions 30 MHz - 1000 MHz



Model: ; Client: ; Comments: ; Test Date: 07/11/2018 12:11

Frequency	QP	Limit	Margin	Height	Angle	Polarization	Correction
MHz	dBµV/m	(dBµV/m)	(dB)	(m)	(°)		(dB)
801.829	30.84	35.5	-4.66	1.1	75	Horizontal	-3.49

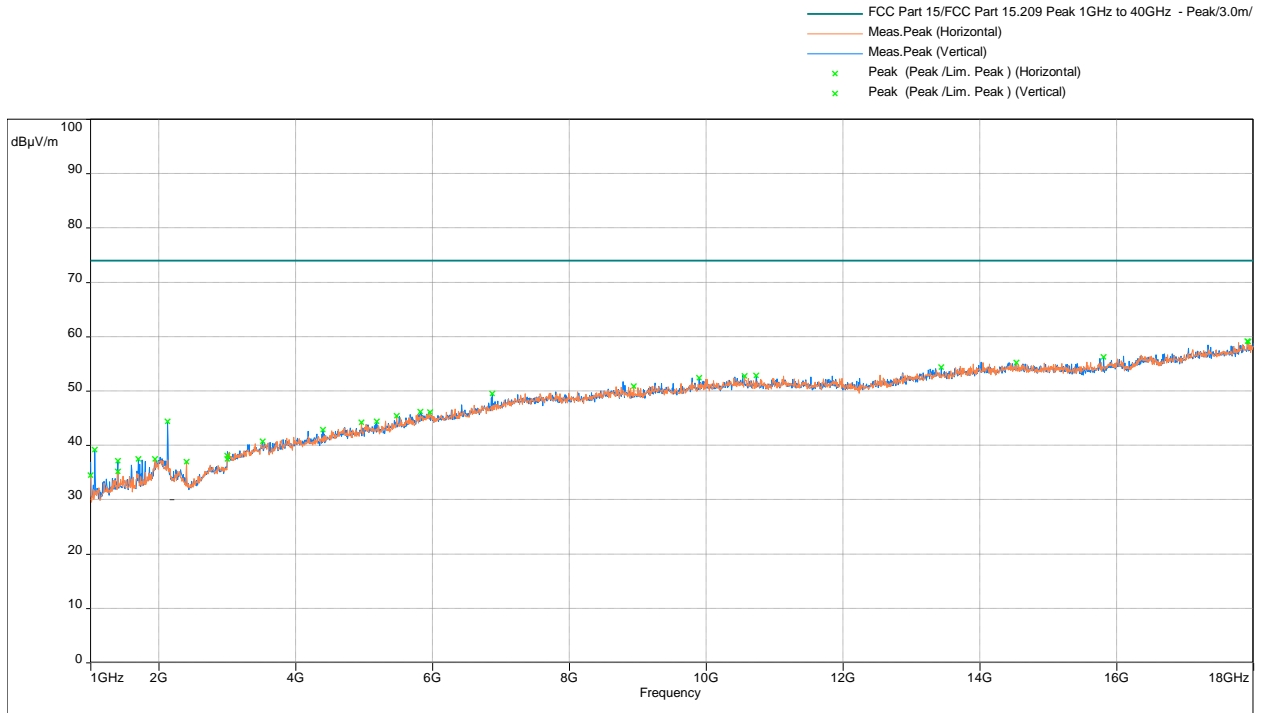
Radiated Spurious Emissions 1000 - 18000 MHz, Avg Scan vs Avg Limit



Model: ; Client: ; Comments: ; Test Date: 07/11/2018 09:22

Frequency	Average	Limit	Margin	Height	Angle	Polarization	Correction
MHz	dBµV/m	(dBµV/m)	(dB)	(m)	(°)		(dB)
4804	32.45	54	-21.55	1.51	204	Horizontal	4.92

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



Model: ; Client: ; Comments: ; Test Date: 07/11/2018 09:29

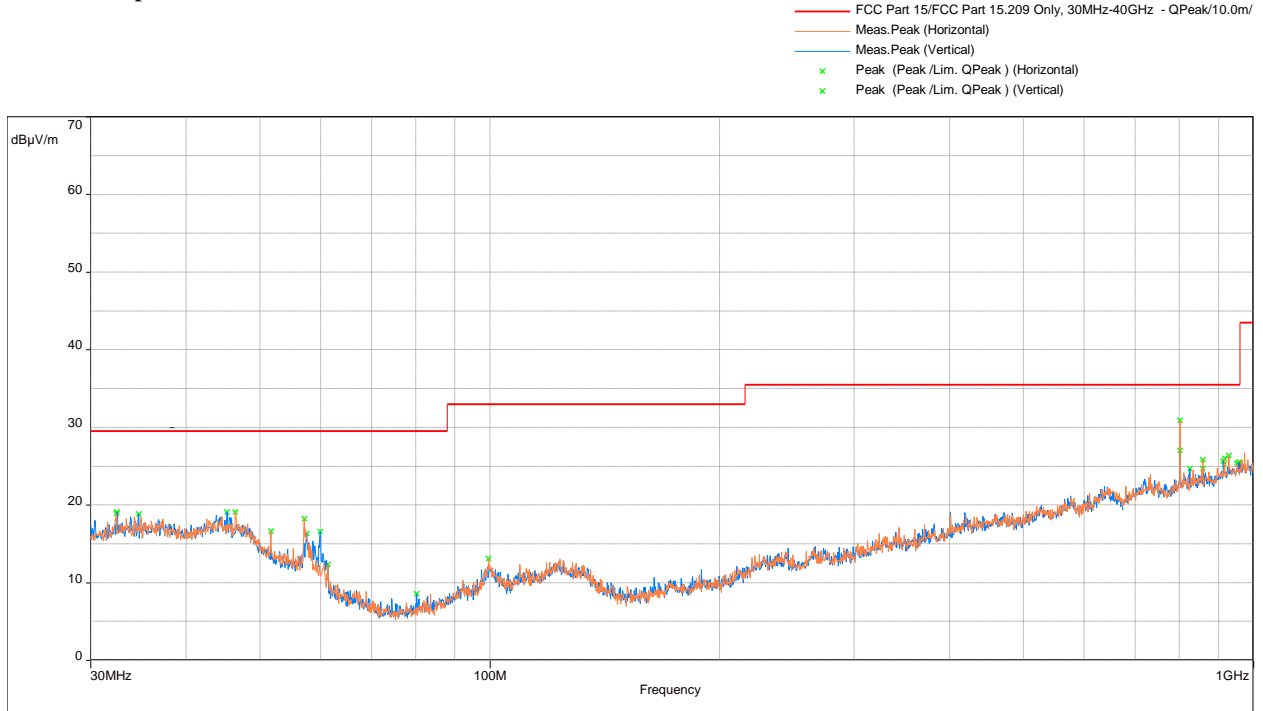
Note: Radiated emission measurements were performed up to 25GHz. No Emissions were identified when scanned from 18-25 GHz

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

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

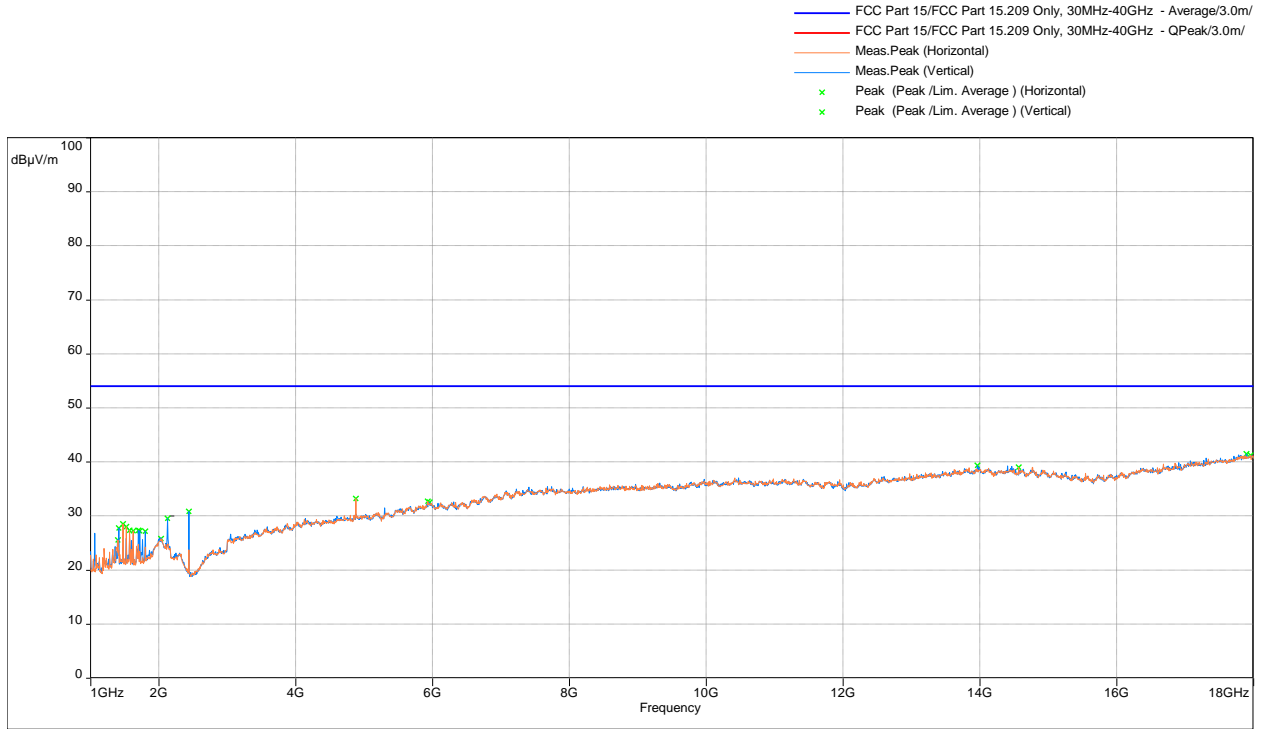
Test Results: 15.209 Radiated Spurious Emissions Mid Channel, Tx at 2439MHz

Radiated Spurious Emissions 30 MHz - 1000 MHz



Frequency	QP	Limit	Margin	Height	Angle	Polarization	Correction
MHz	dBµV/m	(dBµV/m)	(dB)	(m)	(°)		(dB)
801.829	30.88	35.5	-4.62	1.12	15	Horizontal	-3.49

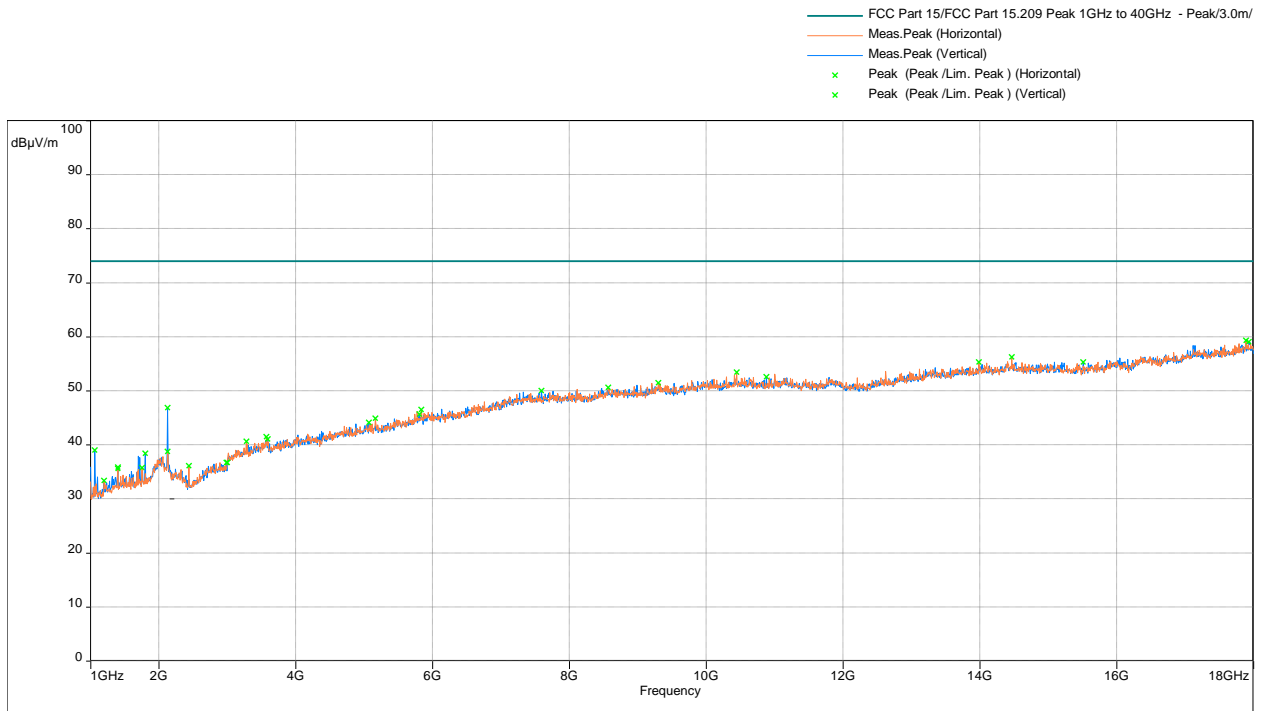
Radiated Spurious Emissions 1000 - 18000 MHz, Avg Scan vs Avg Limit



Model: ; Client: ; Comments: ; Test Date: 07/11/2018 08:50

Frequency	Average	Limit	Margin	Height	Angle	Polarization	Correction
MHz	dBµV/m	(dBµV/m)	(dB)	(m)	(°)		(dB)
4878.0	33.19	54	-20.81	1.80	314	Horizontal	5.19

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



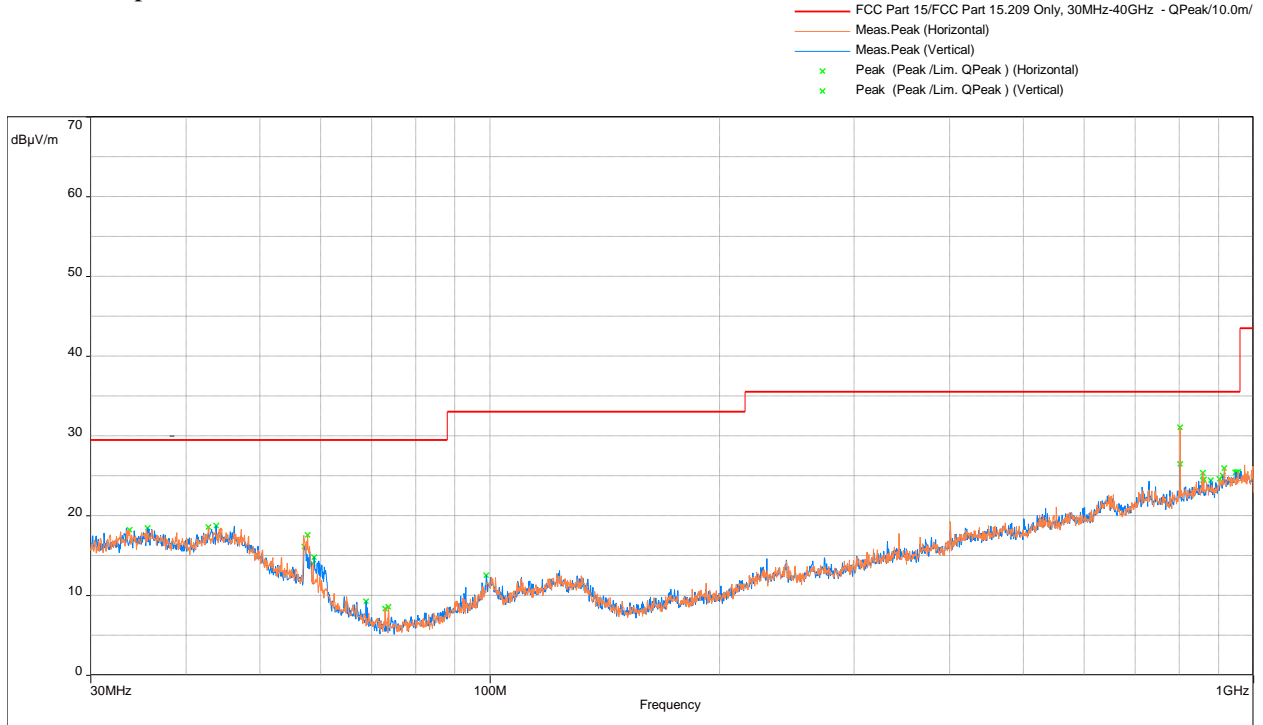
Note: Radiated emission measurements were performed up to 25GHz. No Emissions were identified when scanned from 18-25 GHz

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

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

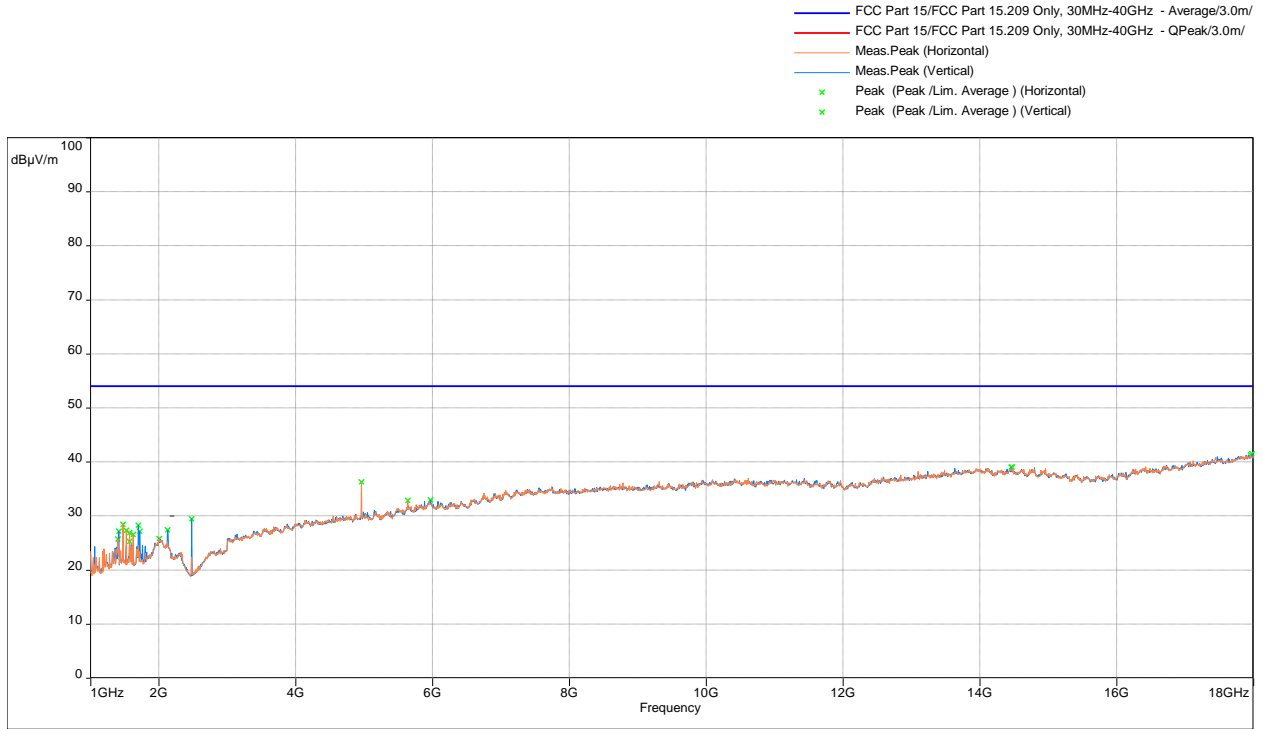
Test Results: 15.209 Radiated Spurious Emissions High Channel, Tx at 2479MHz

Radiated Spurious Emissions 30 MHz - 1000 MHz



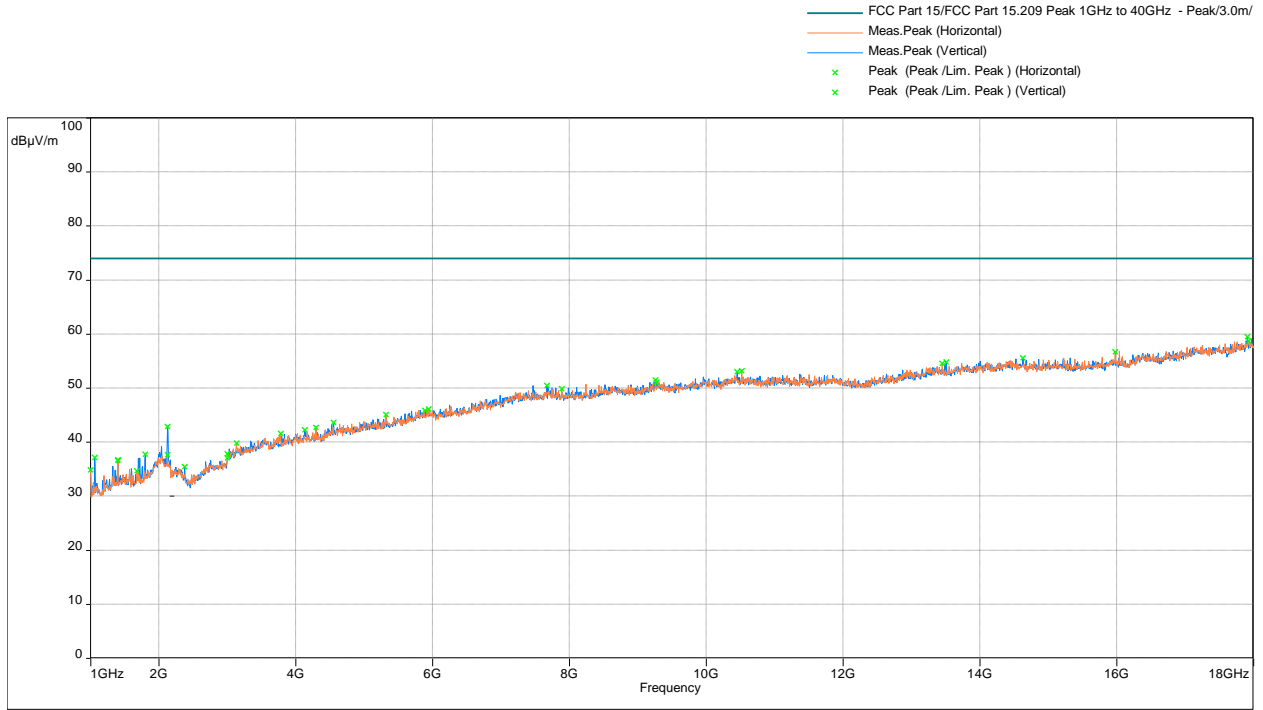
Frequency	QP	Limit	Margin	Height	Angle	Polarization	Correction
MHz	dBµV/m	(dBµV/m)	(dB)	(m)	(°)		(dB)
801.829	31.07	35.5	-4.43	1.15	349	Horizontal	-3.49

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



Frequency	Average	Limit	Margin	Height	Angle	Polarization	Correction
MHz	dBµV/m	(dBµV/m)	(dB)	(m)	(°)		(dB)
4958.0	36.27	54	-17.73	1.89	314	Vertical	5.38

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



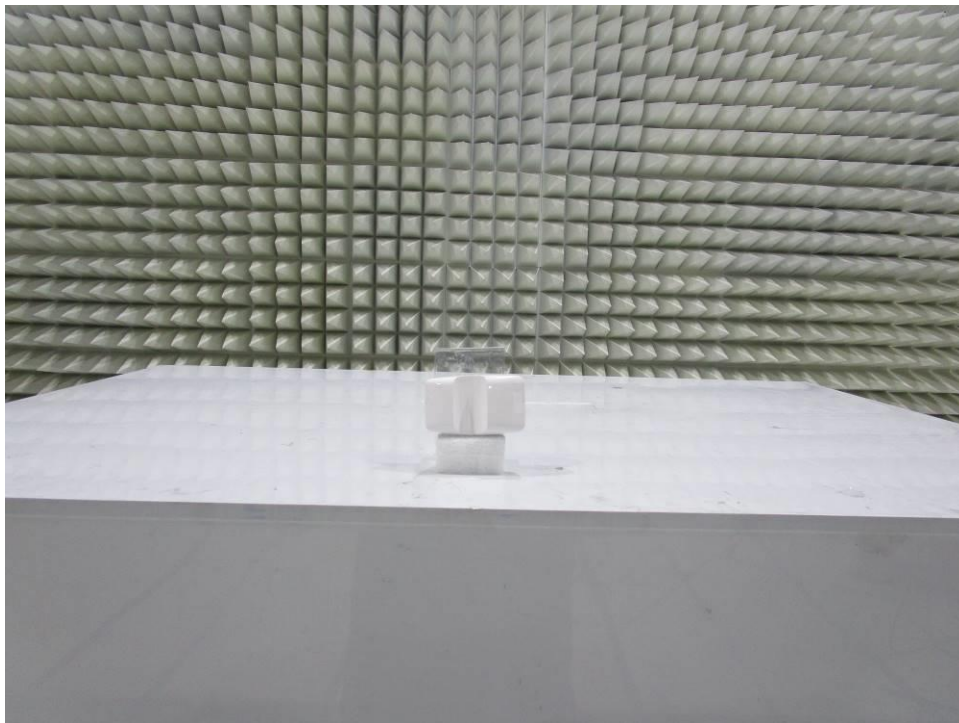
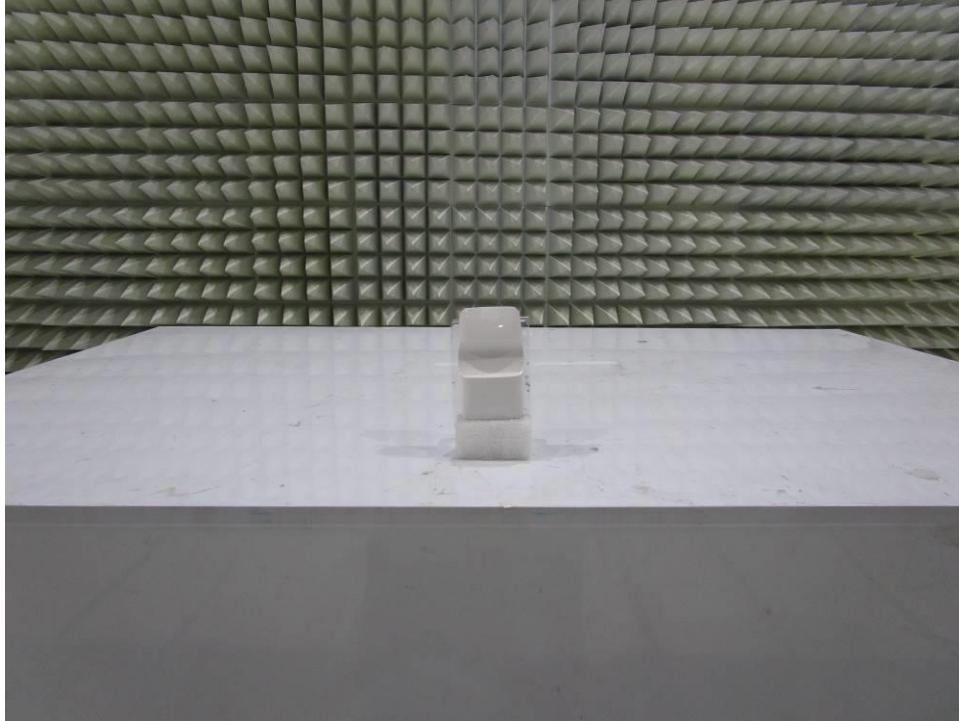
Note: Radiated emission measurements were performed up to 25GHz. No Emissions were identified when scanned from 18-25 GHz

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

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

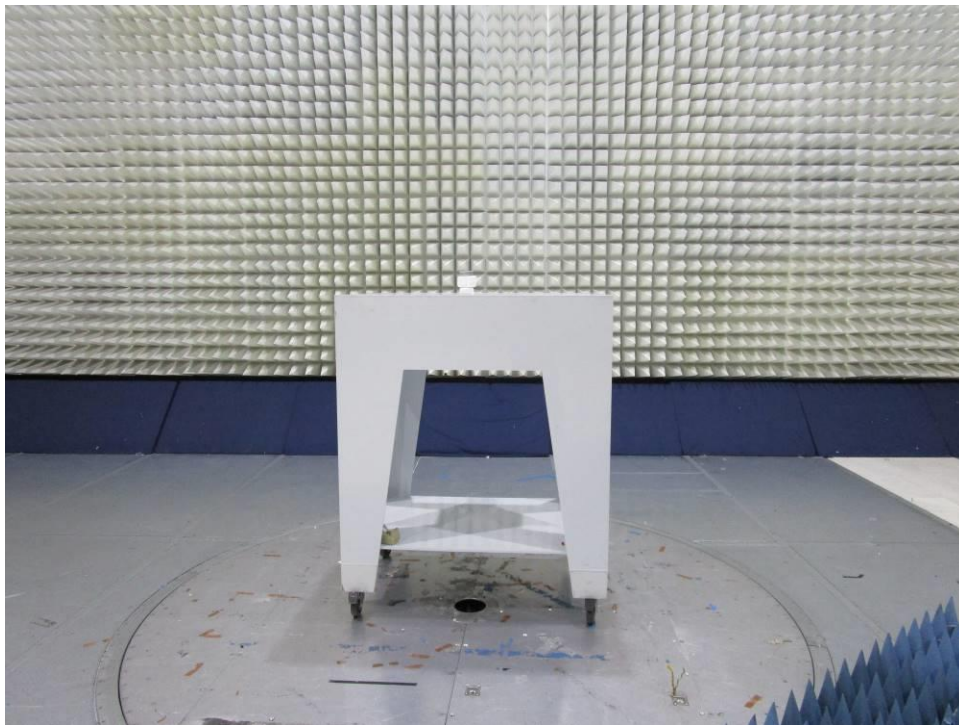
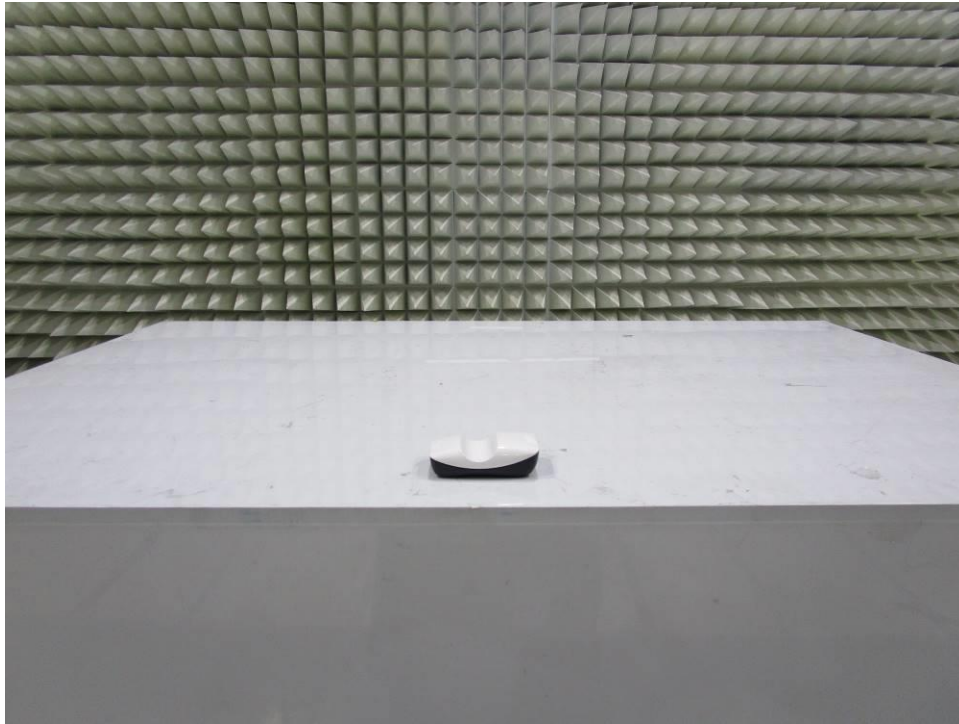
4.5.7 Test Setup Configuration

The following photographs show the testing configurations used.



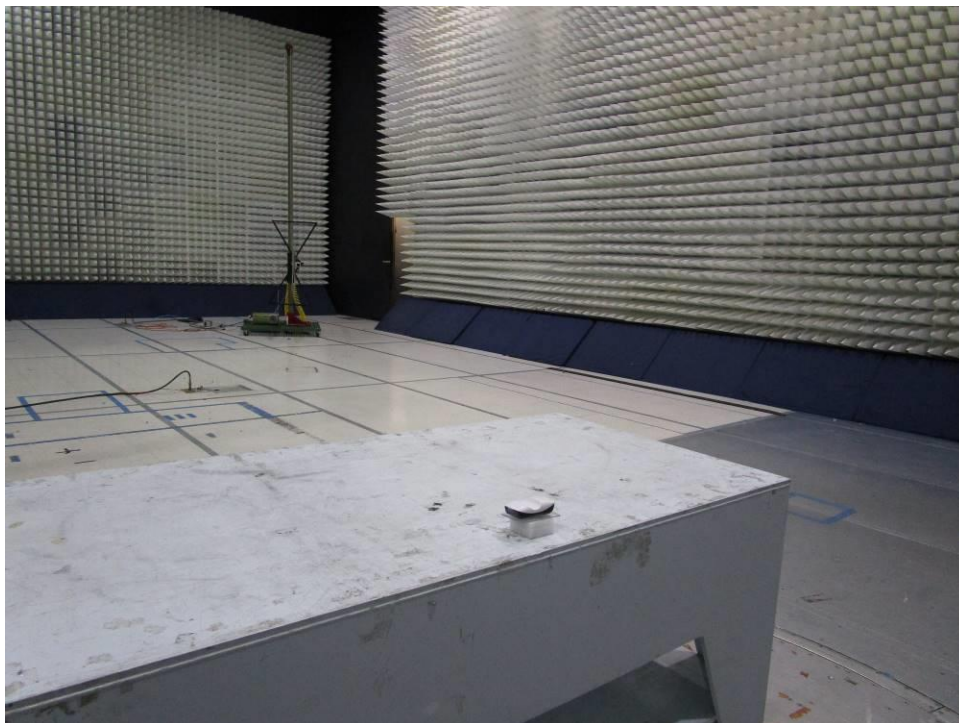
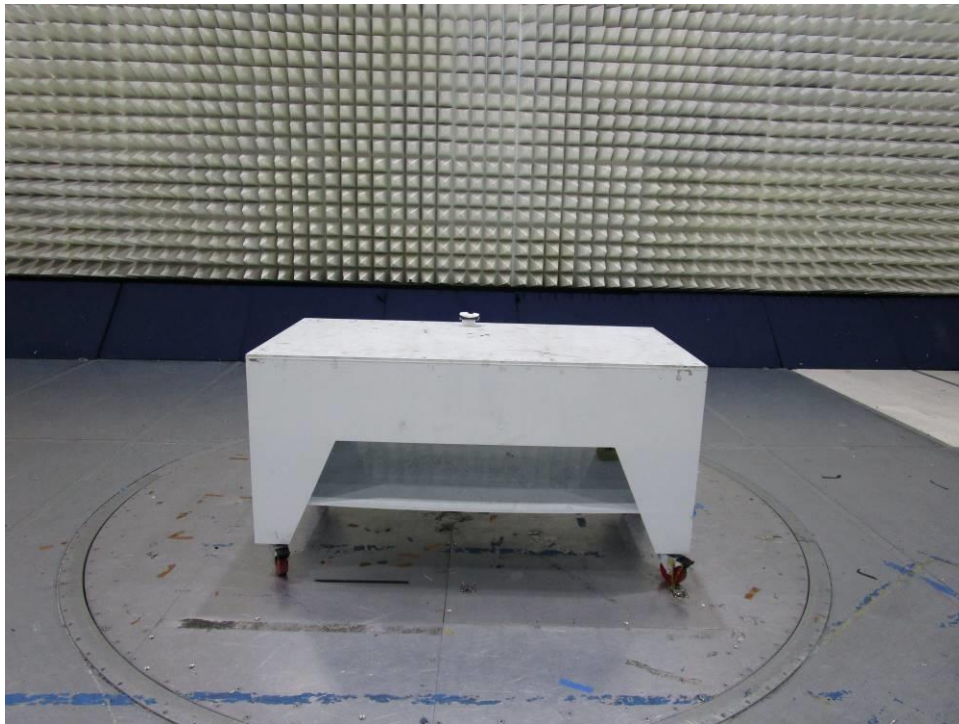
4.5.8 Test Setup Configuration (Continued)

The following photographs show the testing configurations used.



4.5.8 Test Setup Configuration (Continued)

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	01/19/19
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	ESR7	ITS 01607	12	10/09/18
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
10 dB Attenuator	Mini Circuits	BW-S10W5+	ITS 01582	12	08/31/18
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 Spurious_30M-26GHz
BAT-EMC	Nexio	3.16.0.64	103541366_Penumbra.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 / G103541366	AS	KV	August 08, 2018	Original document