TEST REPORT

Report Number: 104402894MPK-010
Project Number: G104402894
Issue Date: November 17, 2020

Testing performed on the
String Optimizer
Model: 31570023-00

FCC ID: X3R-TKKR
IC: 8399A-TKKR

To

FCC Part 15 Subpart C (15.247)
Industry Canada RSS-247 Issue 2

For

AMPT LLC

Test Performed by:	Test Authorized by:
Intertek	AMPT LLC
1365 Adams Court	4850 Innovation Dr
Menlo Park, CA 94025 USA	Fort Collins, CO 80525-5576 USA

Prepared by: _____ **Date:** November 17, 2020
Hung Huynh

Reviewed by: _____ **Date:** November 17, 2020
Krishna K Vemuri

Report No. 104402894MPK-010

Equipment Under Test:	String Optimizer ACP
Trade Name:	AMPT LLC
Model Number:	31570023-00
Applicant:	AMPT LLC
Contact:	Robin Richardson
Address:	4850 Innovation Dr Fort Collins, CO 80525-5576
Country	USA
Tel. Number:	970-372-6960
Email:	robin.richardson@ampt.com
Applicable Regulation:	FCC Part 15 Subpart C (15.247) Industry Canada RSS-247 Issue 2
Date of Test:	October 26 – November 13, 2020

We attest to the accuracy of this report:

Hung Huynh
Project Engineer

Krishna K Vemuri
EMC Manager

TABLE OF CONTENTS

1.0 Introduction

This report is designed to show compliance of the 2.4 GHz transceiver with the requirements of FCC Part 15 Subpart C (15.247) and RSS-247. This test report covers only the FHSS radio.

1.1 Summary of Tests

TEST	REFERENCE FCC Part 15 Subpart C (15.247)	REFERENCE Industry Canada	RESULTS
RF Output Power	15.247(b)	RSS-247, 5.4.2	Complies
20-dB Bandwidth	15.247(a)(1)	RSS-247, 5.1.1	Complies
Channel Separation	15.247(a)(1)	RSS-247, 5.1.2	Complies
Number of Hopping Channels	15.247(a)(1)	RSS-247, 5.14	Complies
Average Channel Occupancy Time	15.247(a)(1)	RSS-247, 5.14	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-GEN	Complies
AC Line Conducted Emission	15.207	RSS-GEN	Not Applicable[1]
Antenna Requirement	15.203	RSS-GEN	Complies (Internal Antenna)

[1] The equipment under test is DC powered. The EUT does not connect to the AC mains public network.

2.0 General Description

2.1 Product Description

AMPT LLC supplied the following description of the EUT:

The equipment under test is an Ampt String Optimizer, a DC/DC converter that is used to lower the cost and improve performance of new PV systems, upgrade existing systems to produce more energy, enable low-cost DC-coupled solar & storage systems, and provide string-level data for improved O&M.

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

Information about the Bluetooth FHSS 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	AMPT LLC
Model No.	31570023-00
FCC Identifier	X3R-TKKR
IC Identifier	8399A-TKKR
Type of Transmission	Frequency Hopping Spread Spectrum
Rated RF Output	-4.38dBm (0.36mW)
Antenna(s) & Gain	Internal Antenna, Gain: 4.0 dBi
Frequency Range	2410 MHz – 2474.5 MHz
Number of Channel(s)	FHSS: 255 (only 25 used at any given time)
Modulation Type	FSK (FHSS)
Data Rate	Up to 1Mbps
Applicant Name & Address	AMPT LLC 4850 Innovation Dr Fort Collins, CO 80525-5576 USA

EUT receive date: October 26, 2020

EUT receive condition: The pre-production version of the EUT was received in good condition with no apparent damage. As declared by the Applicant, it is identical to the production units.

Test start date: October 26, 2020

Test completion date: November 13, 2020

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

2.2 Related Submittal(s) Grants

None.

2.3 Test Methodology

Antenna conducted measurements were performed according to the FCC documents “Guidance for Performing Compliance Measurement on Digital Transmission Systems, Frequency Hopping Spread Spectrum System, and Hybrid System devices Operating under §15.247” (558074 D01 15.247 Meas Guidance v05r02), RSS-247 Issue 2, ANSI C63.10: 2013 and RSS-GEN Issue 5.

Radiated 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 Application.

All other measurements were made in accordance with the procedures in part 2 of CFR 47.

Following is the channel test plan:

Channels in 2.4 GHz band			
Test Channel		Frequency, MHz	Tested
Low	0	2410	√
Middle	127	2442	√
High	255	2474.5	√

2.4 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.

3.0 System Test Configuration

3.1 System Setup

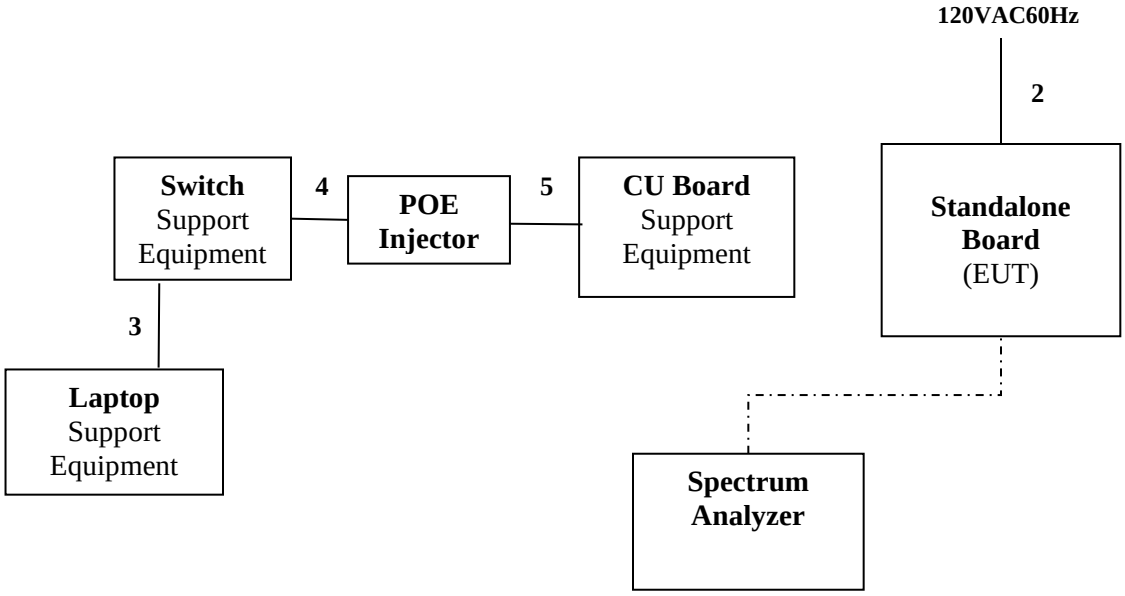
Equipment Under Test			
Description	Manufacturer	Model Number	Serial Number
Standalone String Optimizer	AMPT LLC	31570023-00	1720T000001
Encased String Optimizer	AMPT LLC	31570023-00	2120T0000034

Support Equipment			
Description	Manufacturer	Model Number	Serial Number
DC Power Supply	Meanwell	RS-25-48 (supplies 96 Vdc to EUT for testing)	EB38704297, EB38704299
Computer (initial setup)	DELL	P08S	Service Tag: FXJK5L1
AC/DC Adapter (for computer)	DELL	DA130PE1-00	CN-0JU012-48661-036-AW6T-A03
Switch	TP-Link	TL-SG105	218B759001502
POE Injector	EnGenius	EPE-5818af	126206394
CU Board	AMPT LLC	P33070020 Rev G	78450690001

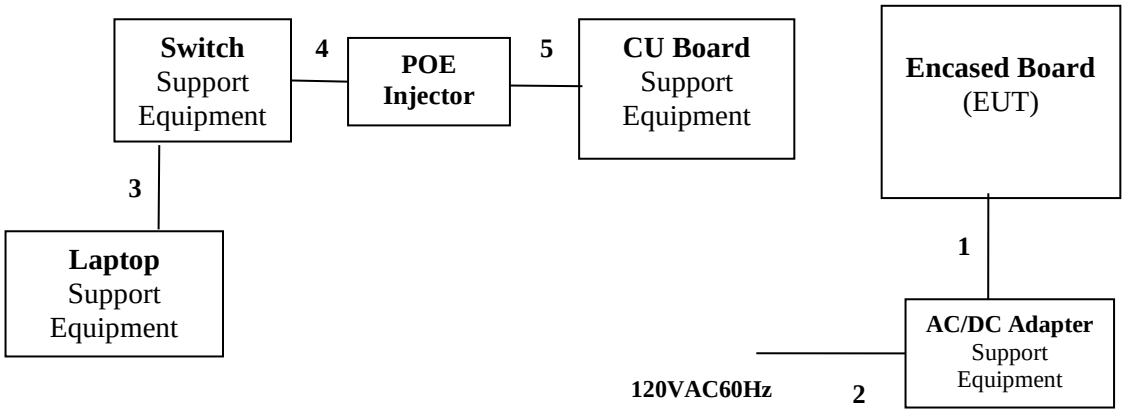
Cable					
ID	Description	Length (m)	Shielding	Ferrites	Termination
1	DC Power Wires (EUT-DC Power Supply)	2.2	No	No	Yes
2	Power Cord (DC Power Supply – Power Source)	1.5	No	No	Yes
3	Ethernet	1.0	No	No	Yes
4	Ethernet	1.0	No	No	Yes
5	Ethernet	1.0	No	No	Yes

3.2 Block Diagram of Test Setup

For Conducted Measurements.



For Radiated Measurements.



3.3 Justification

For radiated emission measurements the EUT is placed on a non-conductive table. The EUT is attached to peripherals and they are connected and operational (as typical as possible). The EUT is wired to transmit full power. During testing, all cables are manipulated to produce worst-case emissions. Different orientation of the EUT were tested and only the worse-case emissions were reported.

3.4 Software Exercise Program

The EUT exercise program used during radiated and conducted testing was provided by AMPT LLC.

3.5 Mode of Operation During Test

During transmitter testing, the transmitter was setup to transmit continuously at maximum RF power on the low channel, middle channel, high channel and with hopping channels enabled.

3.6 Modifications Required for Compliance

Intertek installed no modifications during compliance testing in order to bring the product into compliance.

3.7 Additions, Deviations and Exclusions from Standards

No additions, deviations or exclusions from the standard were made.

4.0 Transmitter Emissions Measurement Results

4.1 20dB Bandwidth, and 99% Occupied Bandwidth
FCC Rule 15.247(a)(1)

4.1.1 Procedure

For FCC 20dB Channel Bandwidth the Procedure described in the FCC Publication 558074 D01 Meas Guidance v05r02 & Section 7.8.7 of ANSI C63.10:2013 for Frequency Hopping Spread Spectrum Systems was used to determine the 20dB bandwidth.

- Span = Approximately 2 to 3 times the 20dB bandwidth, centered on a hopping channel
- RBW = 1% of the 20dB bandwidth
- VBW = 3 x RBW
- Sweep = Auto
- Detector function = Peak
- Trace = Max hold

The EUT should be transmitting at its maximum data rate. Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. Use the marker delta function to measure 20 dB down one side of the emission. Reset the marker-delta function, and move the marker to the other side of the emission, until it is (as close as possible to) even with the reference marker level. The marker-delta reading at this point is the 20dB bandwidth of the emission. If this value varies with different modes of operation (e.g., data rate, modulation format, etc.), repeat this test for each variation. The limit is specified in one of the subparagraphs of this Section. Submit this plot(s).

For 99% power bandwidth measurement, the bandwidth was determined by using the built-in 99% occupied bandwidth function of the spectrum analyzer.

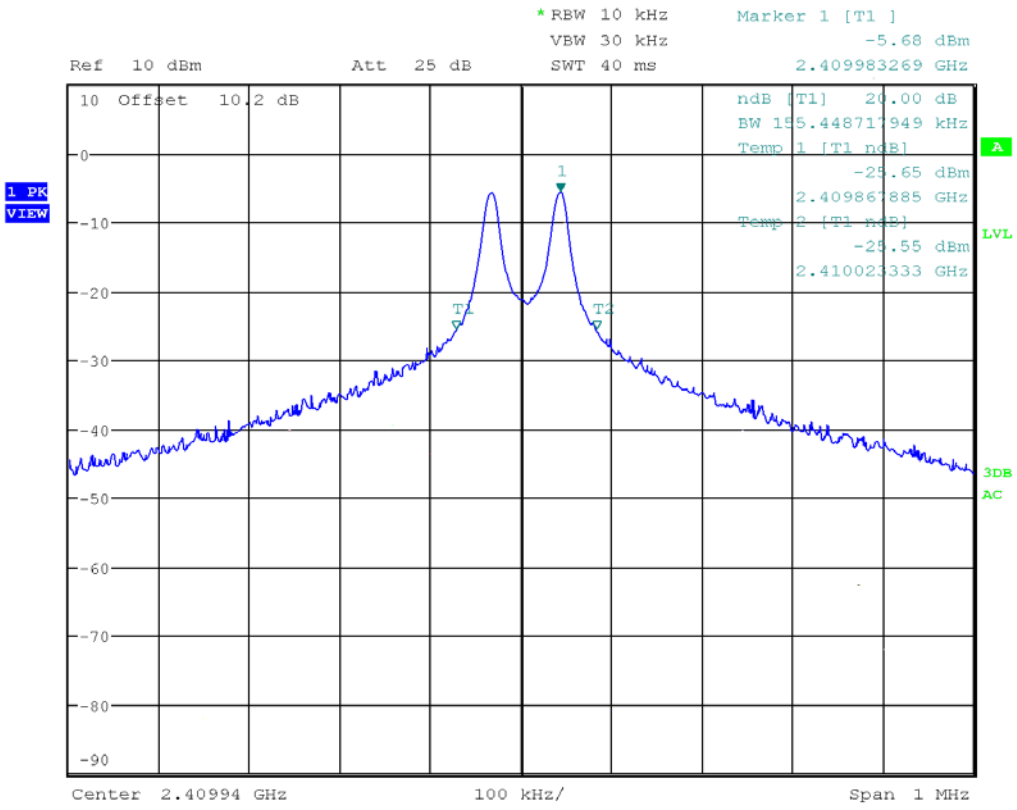
The antenna port of the EUT was connected to the input of a spectrum analyzer (SA). For each RF output channel investigated, the spectrum analyzer center frequency was set to the channel carrier. A Peak output reading was taken, a Display line was drawn for 20dB lower than Peak level. The 20dB bandwidth was determined from where the channel output spectrum intersected the display line.

Tested By:	Hung Huynh
Test Date:	October 26-29, 2020

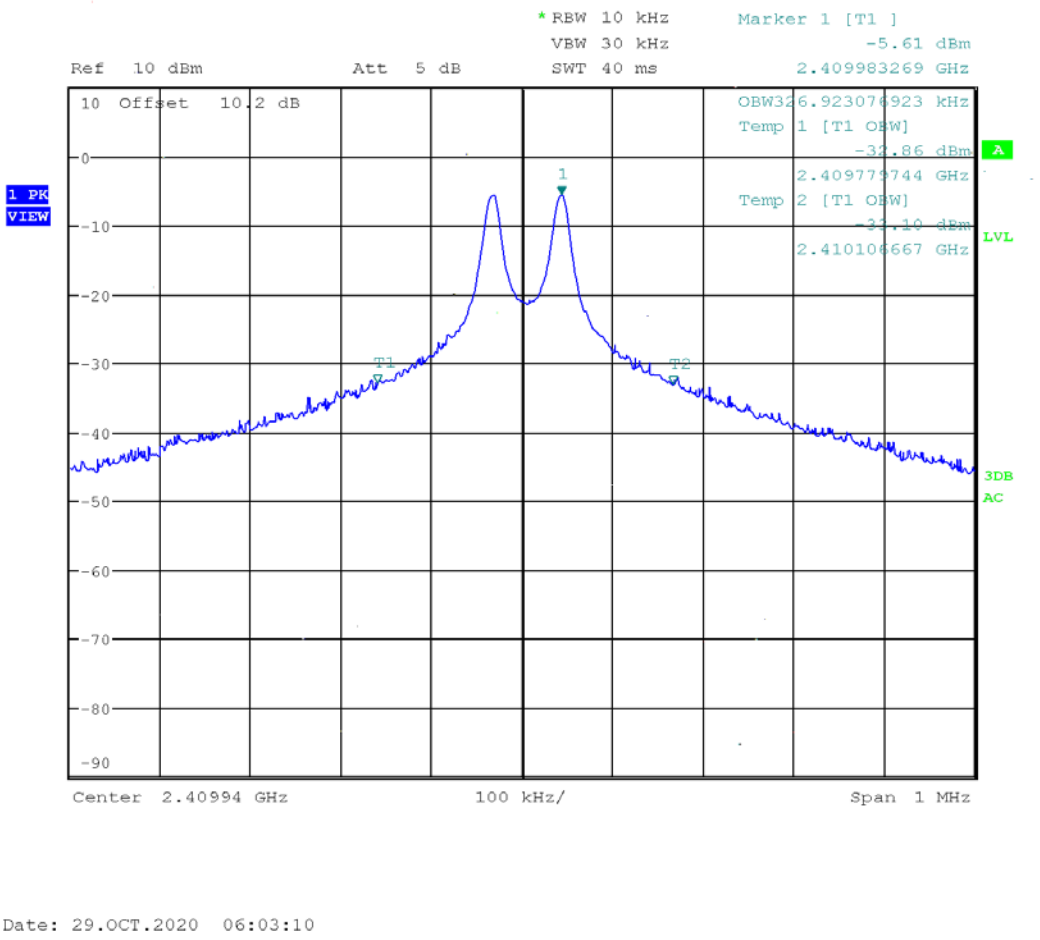
4.1.2 Test Result

Channel	Frequency MHz	20 dB FCC Bandwidth, kHz	99% Bandwidth, kHz	Plot #
0	2410	155.44	326.92	1.1, 1.2
127	2442	198.71	365.38	1.3, 1.4
255	2474.5	152.00	310.75	1.5, 1,6

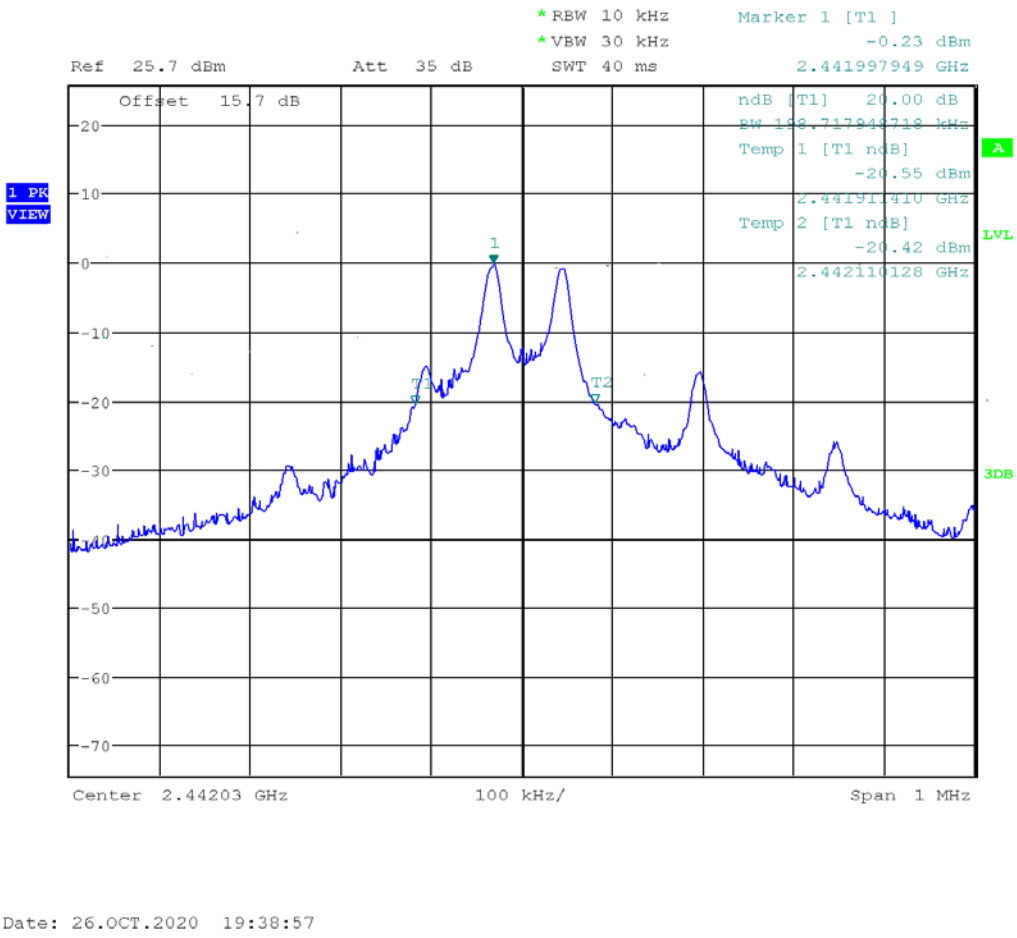
Plot 1. 1 – 20dB Bandwidth Low Channel



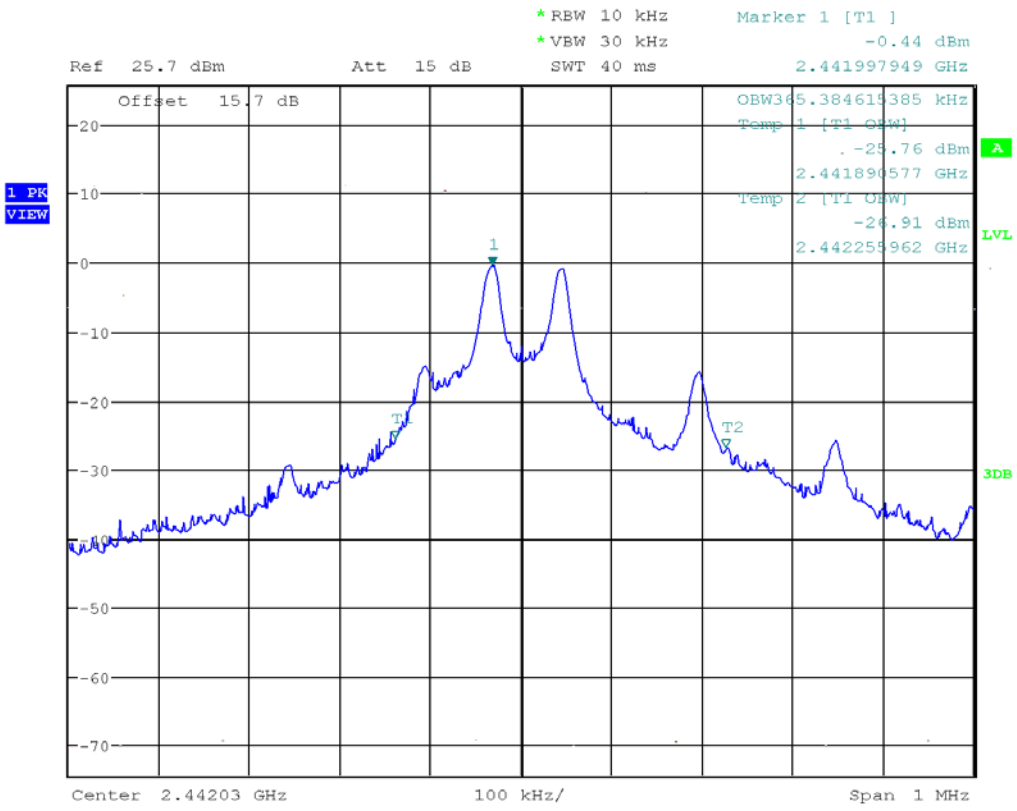
Plot 1.2 – 99% Bandwidth Low Channel



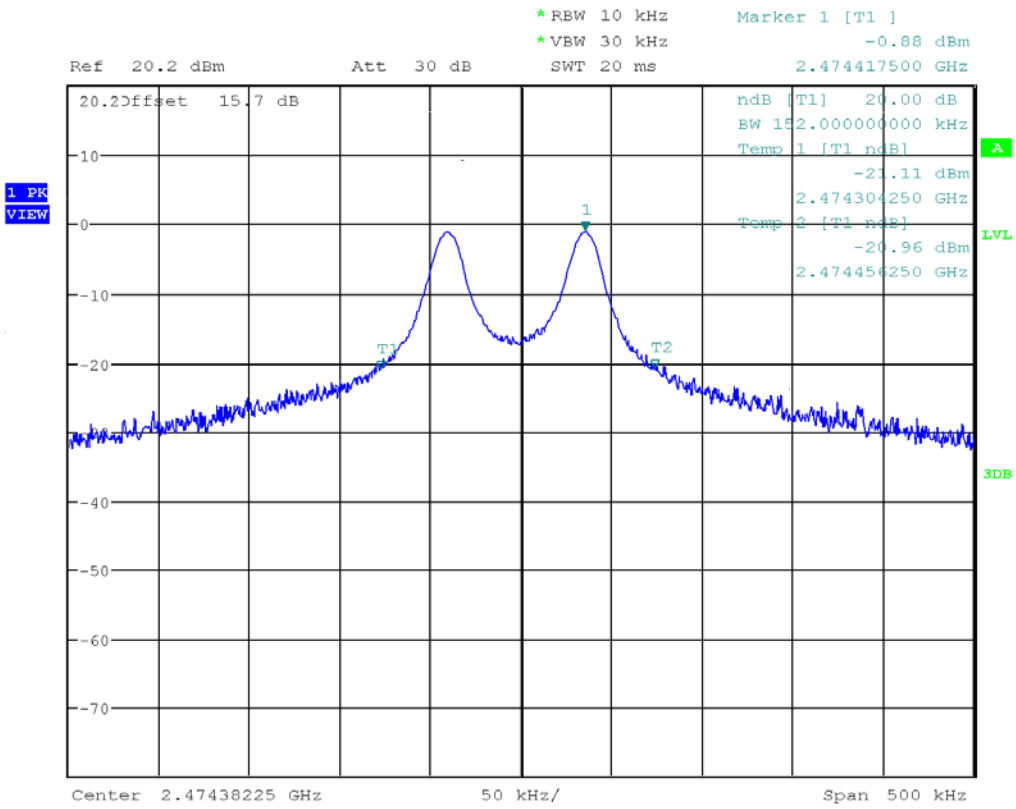
Plot 1. 3 – 20dB Bandwidth Middle Channel



Plot 1.4 – 99% Bandwidth Middle Channel



Plot 1.5 – 20dB Bandwidth High Channel



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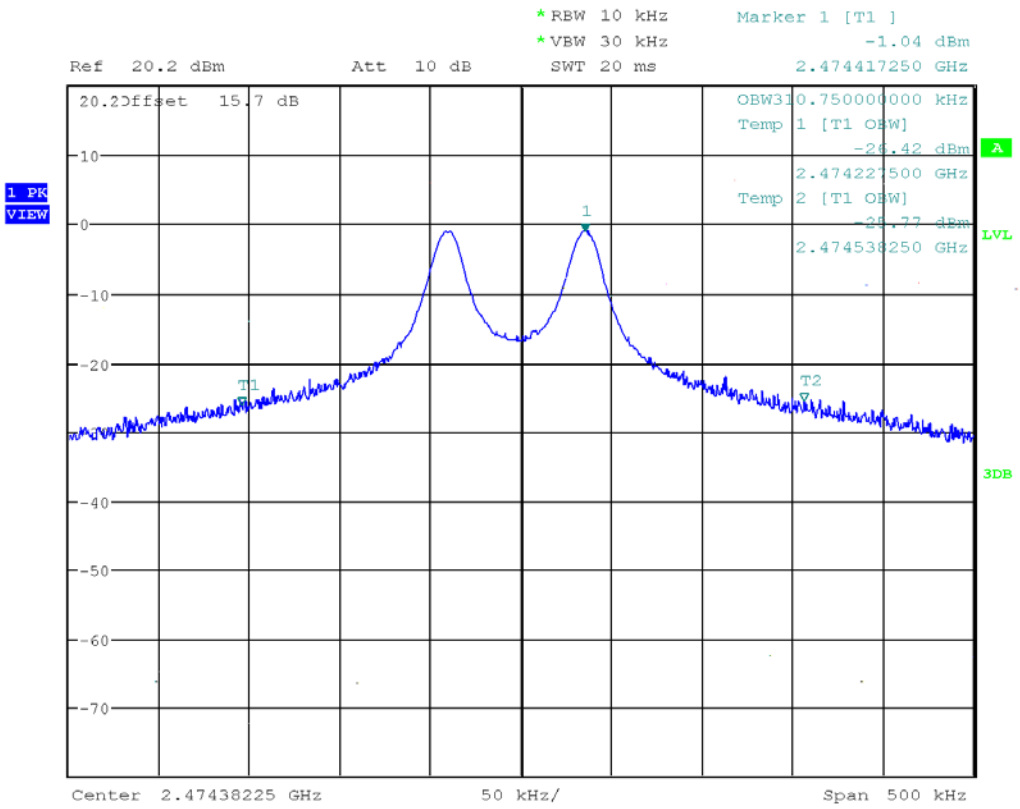
Plot 1.6 – 99% Bandwidth High Channel



4.2 Conducted Output Power at Antenna Terminals
FCC Rule 15.247(b)(1)

4.2.1 Requirement

For systems operating in the 2400-2483.5 MHz band employing at least 75 hopping channels, the maximum peak output power is 1 watt (30 dBm), for all other systems 0.125 W (21 dBm).

4.2.2 Procedure

The procedure described in FCC Publication 558074 D01 Meas Guidance v05r02 was used. Specifically, Section 7.8.5 of ANSI C63.10:2013 for Frequency Hopping Spread Spectrum Systems was used to determine the RF Output Power.

- Span = approximately 5 times the 20dB bandwidth, centered on a hopping channel
- RBW > the 20dB bandwidth of the emission being measured
- VBW = 3 x RBW
- Sweep = auto
- Detector function = peak
- Trace = max hold

Allow the trace to stabilize. Use the marker-to-peak function to set the marker to the peak of the emission. The indicated level is the peak output power (see the NOTE above regarding external attenuation and cable loss). The limit is specified in one of the subparagraphs of this Section. Submit this plot.

The antenna port of the EUT was connected to the input of a spectrum analyzer. Power was read directly from the spectrum analyzer and cable loss correction was added to the reading to obtain the power at the antenna terminals.

Tested By:	Hung Huynh
Test Date:	October 29, 2020

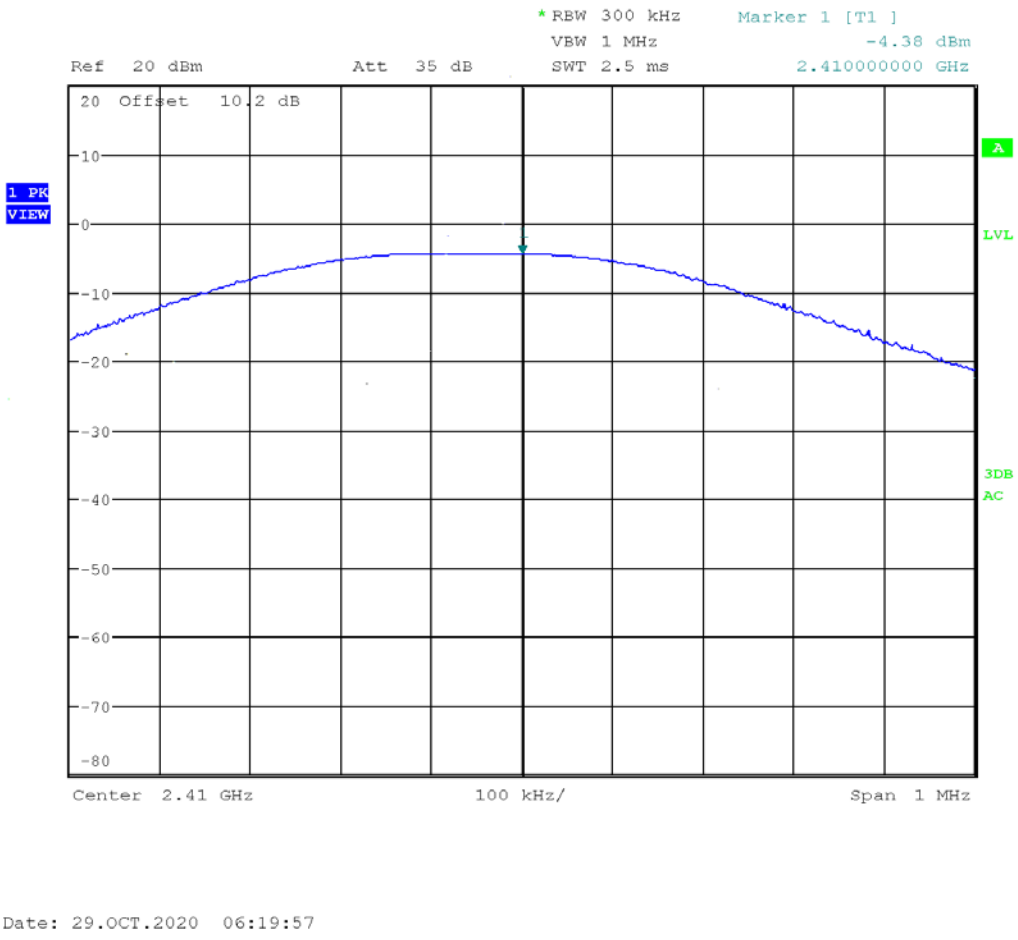
4.2.3 Test Result

Refer to the following plots for the test result:

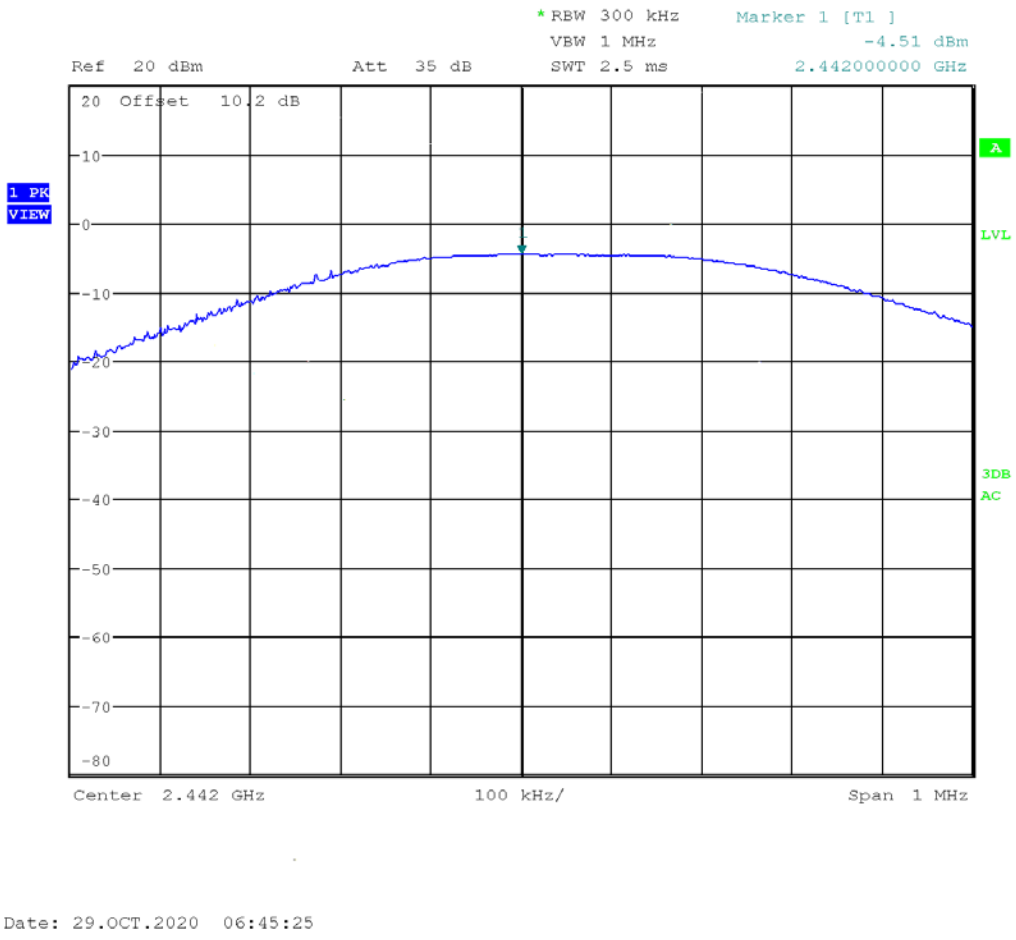
Channel	Frequency MHz	Conducted Peak Power dBm	Conducted Peak Power mW	Plot #
0	2410	-4.38	0.36	2.1
127	2442	-4.51	0.35	2.2
255	2474.5	-4.56	0.34	2.3

Results	Complies

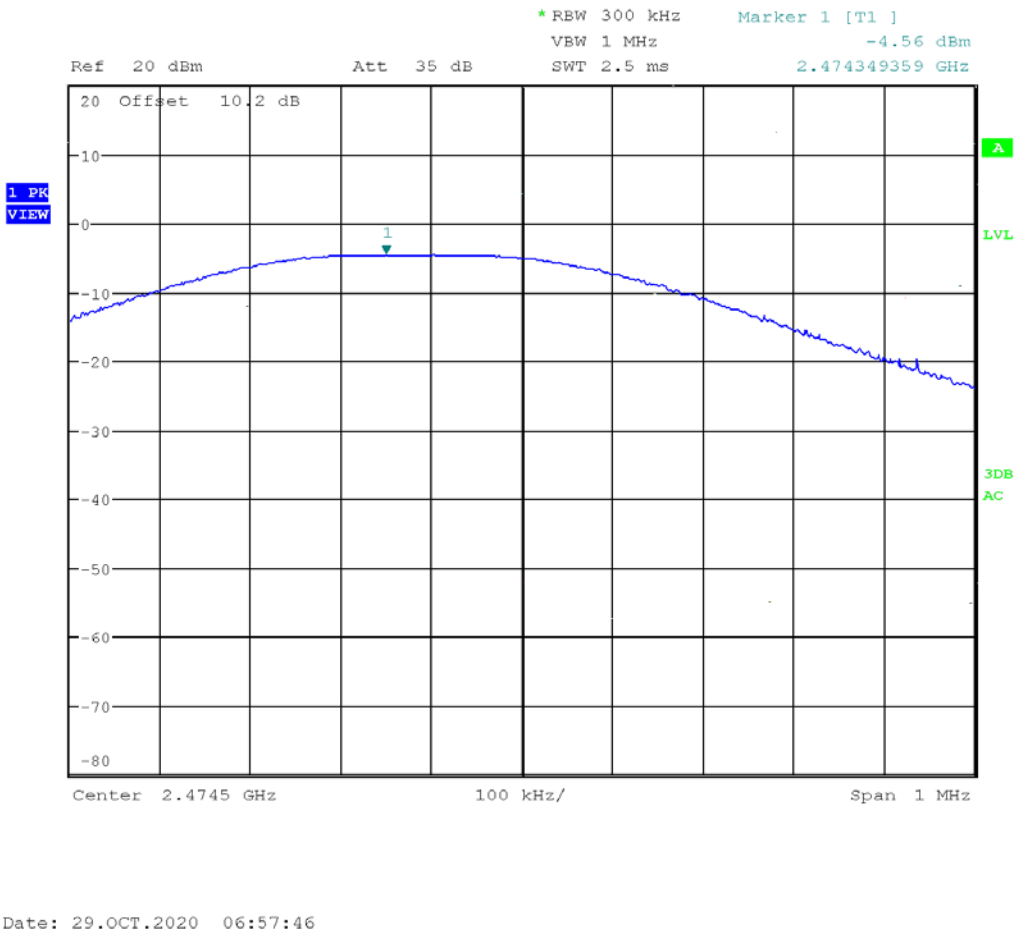
Plot 2.1– Output Power Low Channel



Plot 2.2 – Output Power Middle Channel



Plot 2.3 – Output Power High Channel



4.3 Carrier Frequency Separation
FCC 15.247 (a)(1)

4.3.1 Requirement

Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20dB bandwidth of the hopping channel, whichever is greater.

4.3.2 Procedure

The procedure described in FCC Publication 558074 D01 Meas Guidance v05r02 was used. Specifically, Section 7.8.2 of ANSI C63.10:2013 for Frequency Hopping Spread Spectrum Systems was used to determine the Carrier Frequency Separation.

- The EUT must have its hopping function enabled
- Span = wide enough to capture the peaks of two adjacent channels
- Resolution (or IF) Bandwidth (RBW) = Start with the RBW set to approximately 30% of the channel spacing; adjust as necessary to best identify the center of each individual channel.
- Video (or Average) Bandwidth (VBW) ≥ RBW
- Sweep = auto
- Detector function = peak
- Trace = max hold

Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels. The limit is specified in one of the subparagraphs of this Section. Submit this plot.

Tested By:	Hung Huynh
Test Date:	October 29, 2020

4.3.3 Test Result

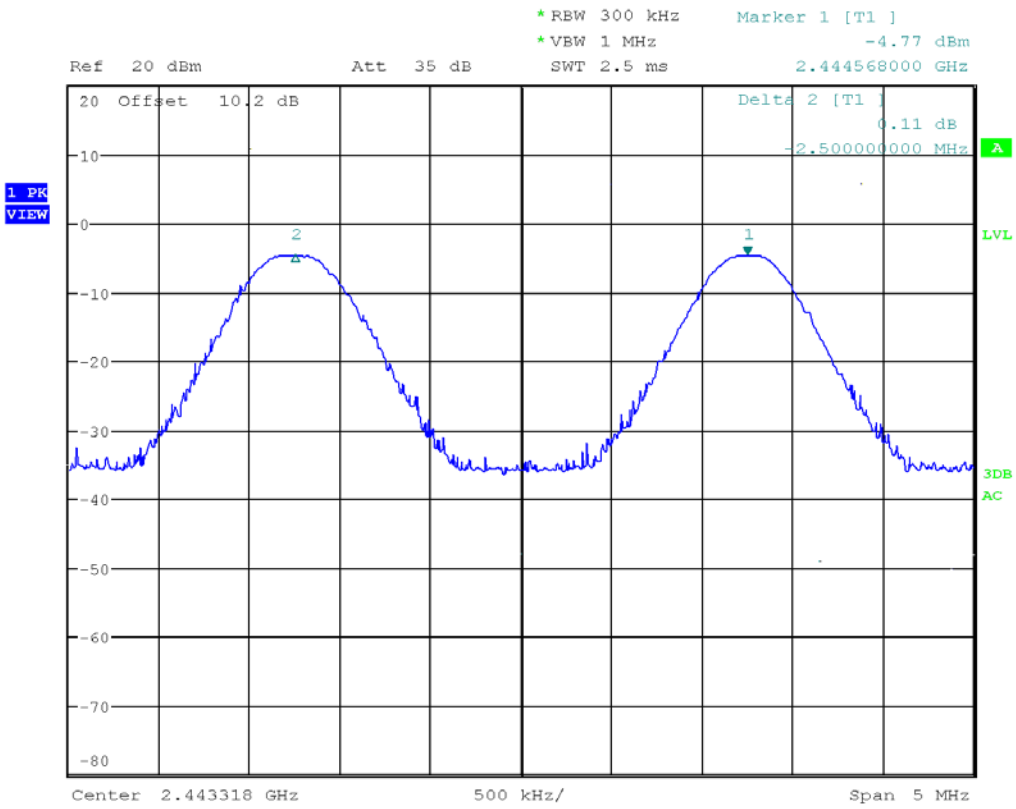
The worst case 20dB Bandwidth is 198 kHz, therefor this bandwidth was used to calculate the minimum limit for Carrier Frequency Separation below.

(2/3) * 198 kHz = 132 kHz (minimum requirement)

The Carrier Frequency Separation is **2.5 MHz**, therefore meets the minimum requirement. Please refer to spectrum analyzer plot 3.1 below for the test result.

Results	**Complies**

Plot 3.1– Channel Separation



4.4 Number of Channels
FCC 15.247 (a)(1)(iii)

4.4.1 Requirement

Systems operating in the 2400-2483.5 MHz band shall use at least 15 hopping channels.

4.4.2 Procedure

The procedure described in FCC Publication 558074 D01 Meas Guidance v05r02 was used. Specifically, Section 7.8.3 of ANSI C63.10:2013 for Frequency Hopping Spread Spectrum Systems was used to determine the Number of Channels.

- The EUT must have its hopping function enabled.
- Span = the frequency band of operation
- RBW = To identify clearly the individual channels, set the RBW to less than 30% of the channel spacing or the 20dB bandwidth, whichever is smaller
- VBW ≥ RBW
- Sweep = auto
- Detector function = peak
- Trace = max hold

Allow the trace to stabilize. It may prove necessary to break the span up to sections, in order to clearly show all of the hopping frequencies.

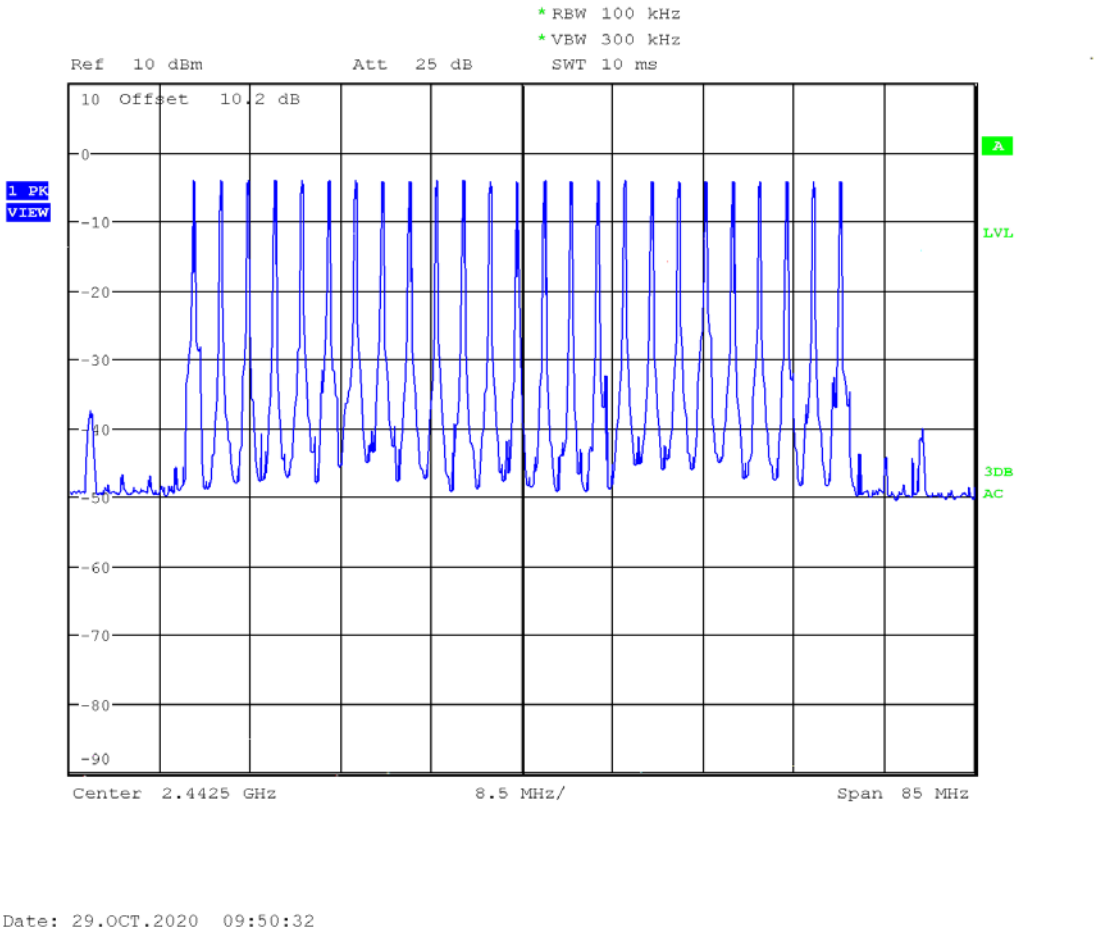
With the analyzer set to MAX HOLD, readings were taken once channels were filled in. The channel peaks were recorded and compared to the minimum number of channels required in the regulation.

Tested By:	Hung Huynh
Test Date:	October 29, 2020

4.4.3 Test Result

Results	25 Channels -Complies

Plot 4.1 - Number of hopping channels



4.5 Average Channel Occupancy Time
FCC 15.247(a)(1)

4.5.1 Requirement

For systems operating in the 2400-2483.5 MHz band, the average time of occupancy on any channel shall not be greater than 0.4 second within a period of 0.4 second multiplied by the number of hopping channels employed.

4.5.2 Procedure

The procedure described in FCC Publication 558074 D01 Meas Guidance v05r02 was used. Specifically, Section 7.8.4 of ANSI C63.10:2013 for Frequency Hopping Spread Spectrum Systems was used to determine the Average Channel Occupancy Time.

- The EUT must have its hopping function enabled.
- Span = zero span, centered on a hopping channel
- RBW shall be ≤ channel spacing and where possible RBW should be set >> 1 / T, where T is the expected dwell time per channel
- VBW = 3 x RBW
- Sweep = as necessary to capture the entire dwell time per hopping channel
- Detector function = peak
- Trace = max hold

If possible, use the marker-delta function to determine the dwell time. If this value varies with different modes of operation (e.g., data rate, modulation format, etc.), repeat this test for each variation. The limit is specified in one of the subparagraphs of this Section. An oscilloscope may be used instead of a spectrum analyzer.

The spectrum analyzer center frequency was set to one of the known hopping channels, the SPAN was set to ZERO SPANS, and the TRIGGER was set to VIDEO. The time duration of the transmission so captured was measured with the MARKER DELTA function.

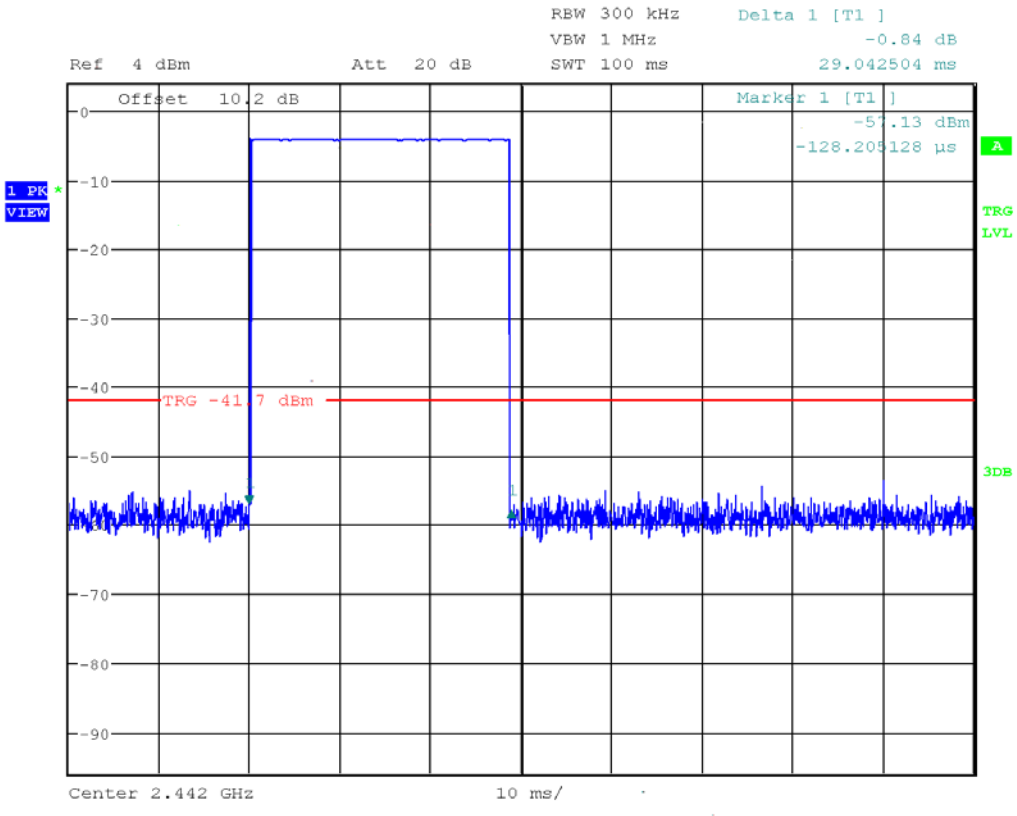
Since the radio is employed 25 hopping channels, the Occupancy Time was calculated for the period of 0.4 * 25 = 10 sec.

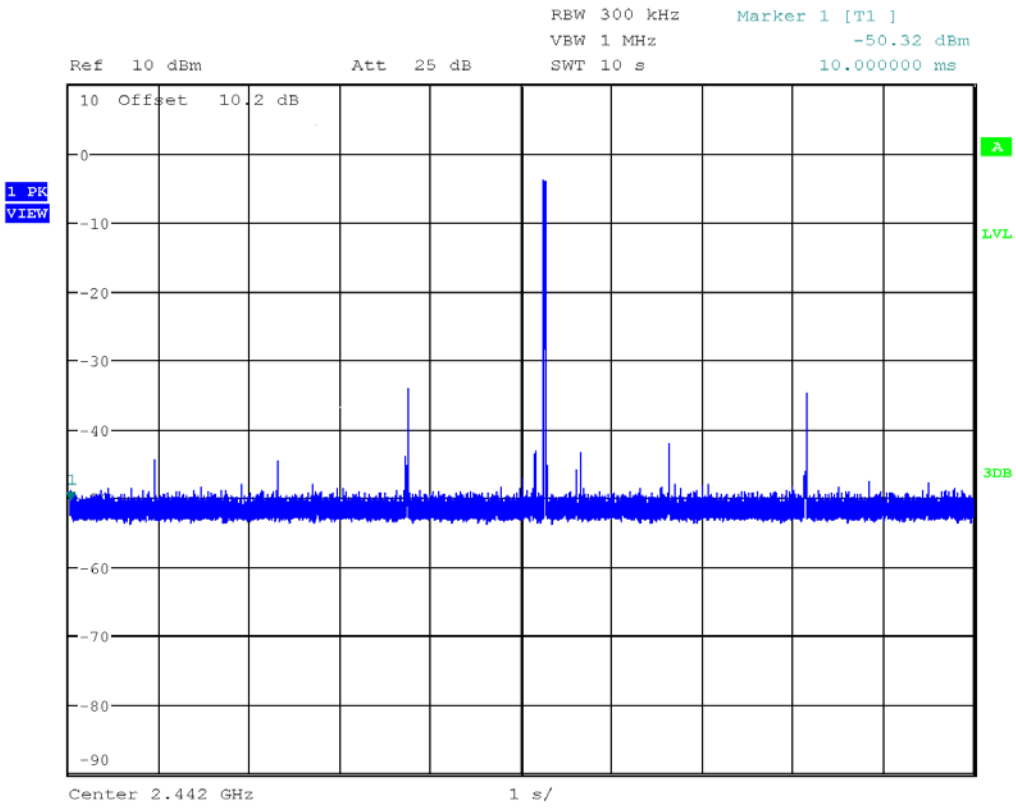
Tested By:	Hung Huynh
Test Date:	November 02, 2020

4.5.3 Test Results

Results	Complies

No. of Channels	Observation Period (s)	Burst On Time (ms) (Single)	No. of Burst	Dwell Time (ms)	Dwell Time limit (ms)
25	10	29	1	29	400





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4.6 Out-of-Band Conducted Emissions
FCC 15.247(d)

4.6.1 Requirement

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.

4.6.2 Procedure

The procedure described in FCC Publication 558074 D01 Meas Guidance v05r02 was used. Specifically, Section 7.8.8 of ANSI C63.10:2013 for Frequency Hopping Spread Spectrum Systems was used to determine the Out-of-Band Conducted Emissions.

- Span = wide enough to capture the peak level of the in-band emission and all spurious
- emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the
- 10th harmonic. Typically, several plots are required to cover this entire span.
- RBW = 100 kHz
- VBW = 3 x RBW
- Sweep = auto
- Detector function = peak
- Trace = max hold

Allow the trace to stabilize. Set the marker on the peak of any spurious emission recorded. The level displayed must comply with the limit specified in this Section.

A spectrum analyzer was connected to the antenna port of the transmitter. Analyzer Resolution Bandwidth was set to 100 kHz. For each channel investigated, the in-band and out-of-band emission measurements were performed. The out-of-band emissions were measured from 30 MHz to 26 GHz.

Tested By:	Hung Huynh
Test Date:	November 02, 2020

4.6.3 Test Result

Refer to the following plots and out-of-band conducted spurious emissions at the Band-Edge, Table 4.1 & 4.2 for the test results:

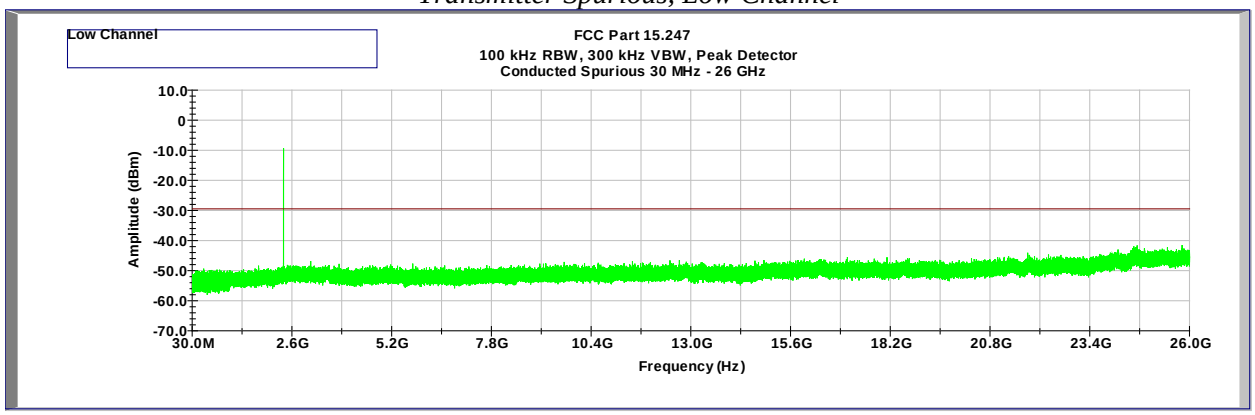
Table 4.1

Channel	Frequency MHz	Description	Plot #
0	2410	Scan 30 MHz – 26 GHz	6.1
127	2442	Scan 30 MHz – 26 GHz	6.2
255	2474.5	Scan 30 MHz – 26 GHz	6.3

Results	Complies

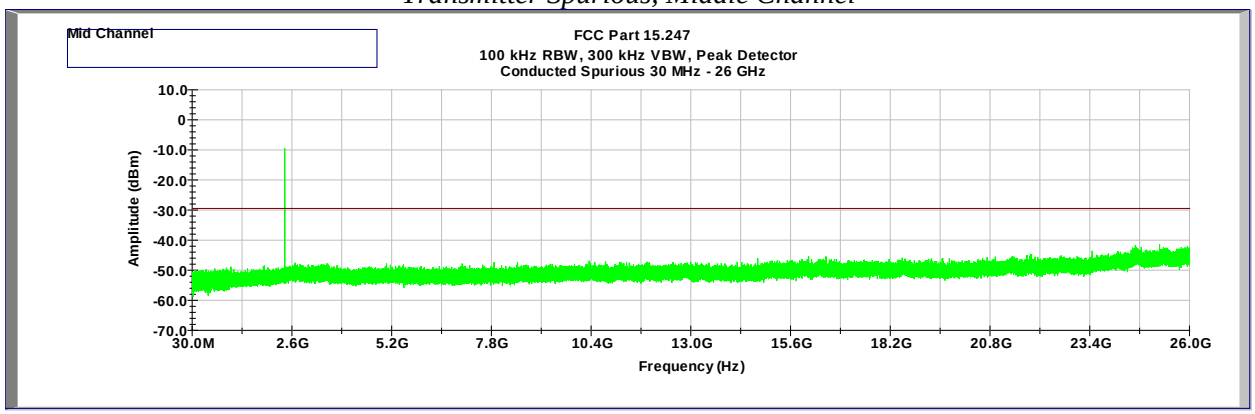
Plot 6.1

Transmitter Spurious, Low Channel



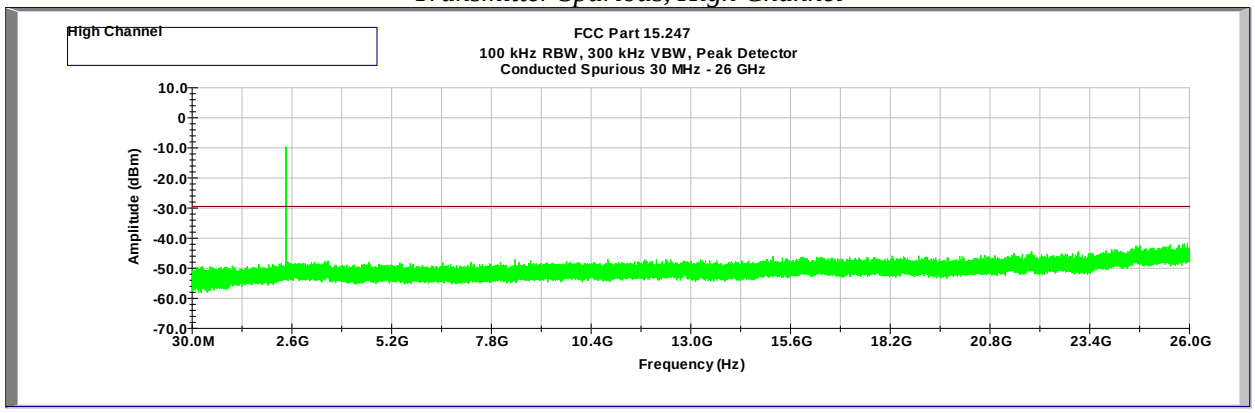
Plot 6.2

Transmitter Spurious, Middle Channel

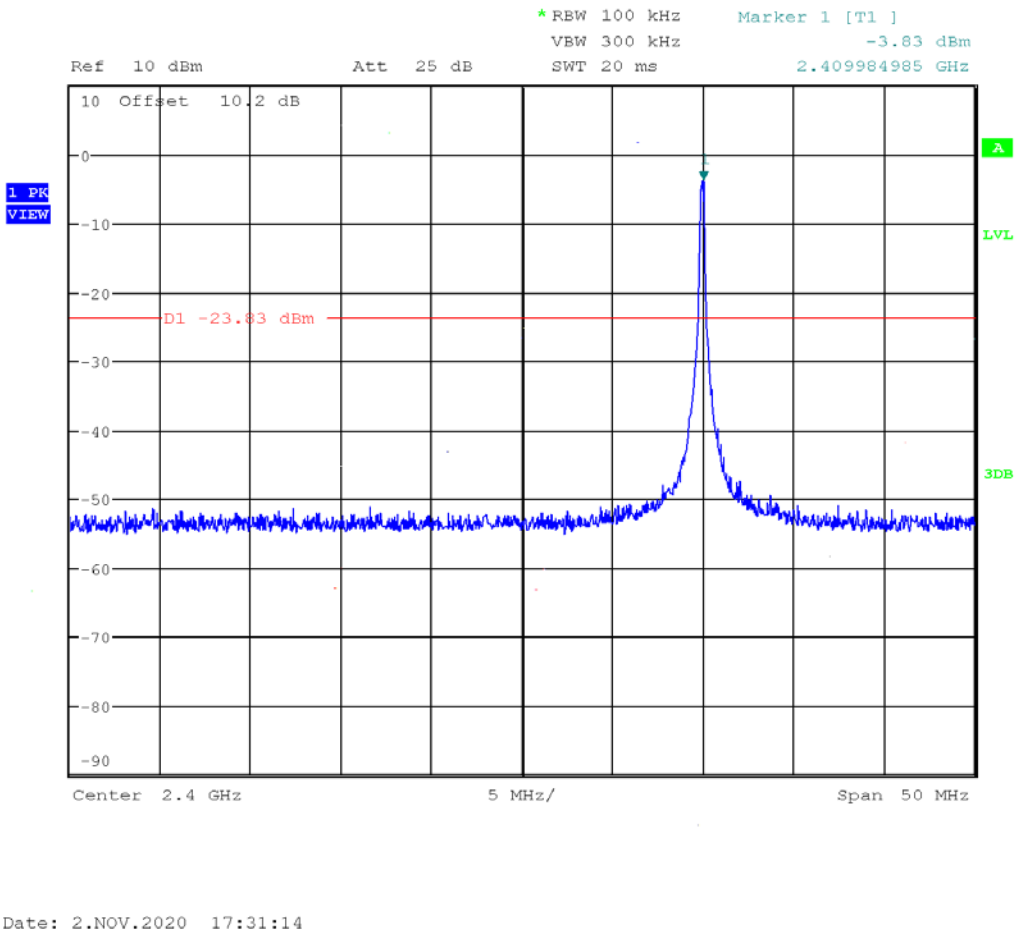


Plot 6.3

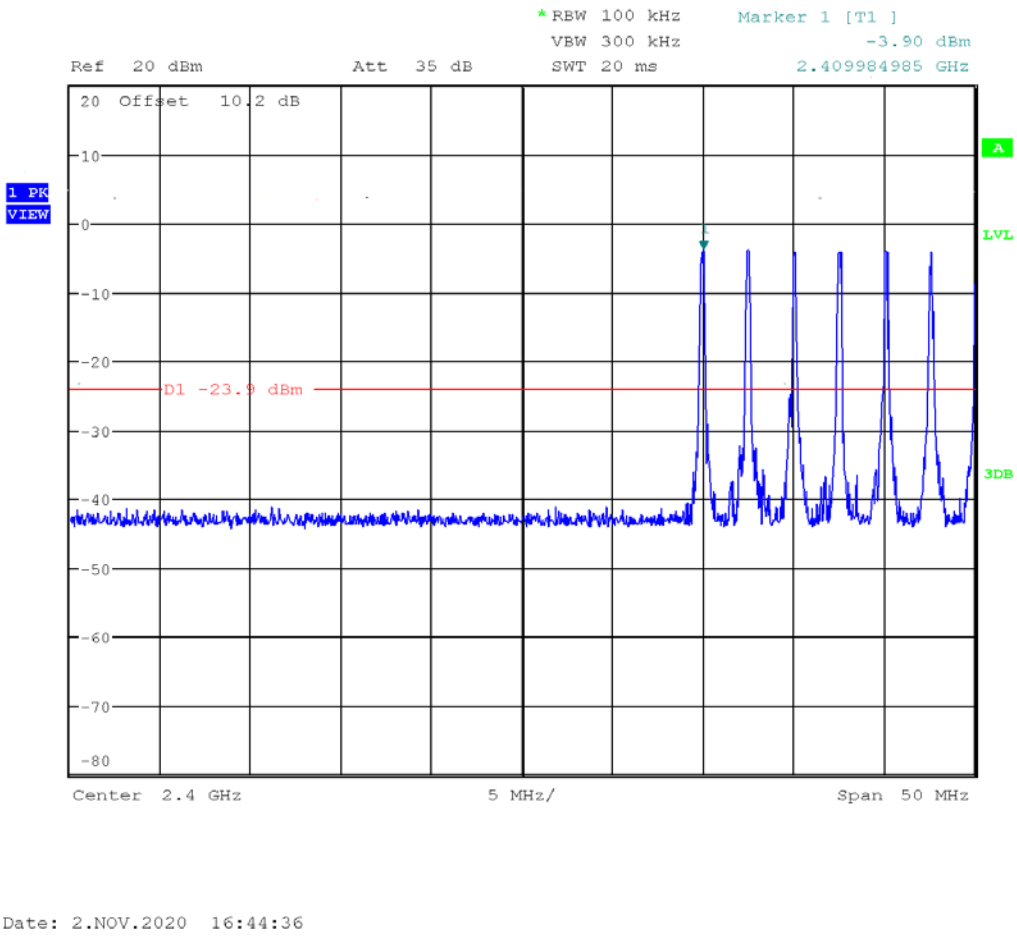
Transmitter Spurious, High Channel



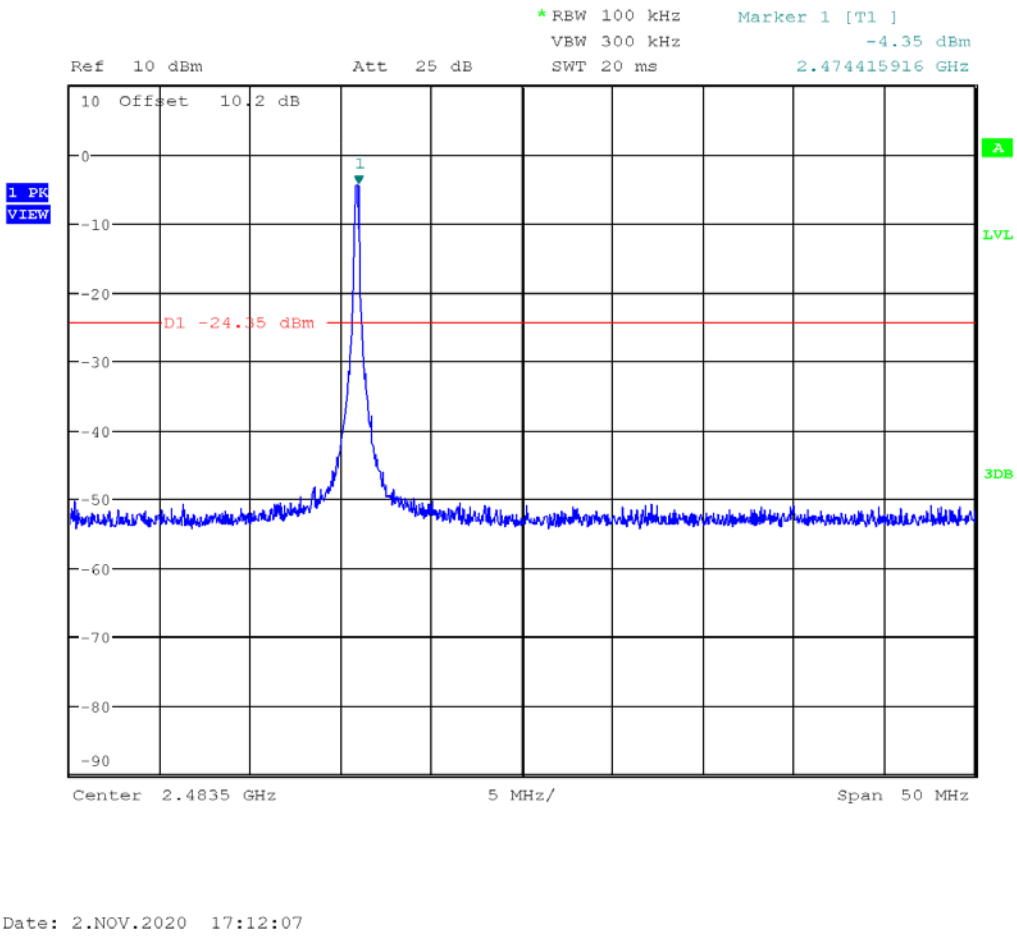
Plot 6.4
Conducted Band Edge, Low Channel



Plot 6.5
Conducted Band Edge, Low Channel (Hopping)

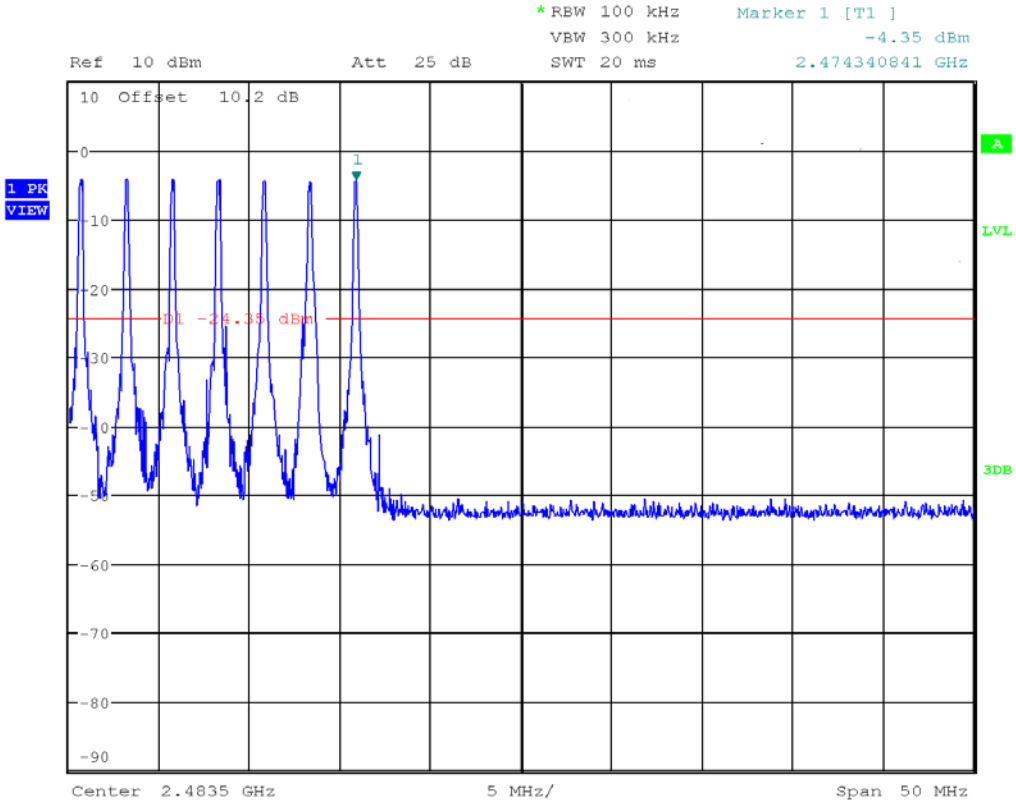


Plot 6.6
Conducted Band Edge, High Channel



Plot 6.7

Conducted Band Edge, High Channel (Hopping)



4.7 Transmitter Radiated Emissions
FCC Rule 15.247(d), 15.209, 15.205

4.7.1 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.

4.7.2 Procedure

Radiated emission measurements were performed from 9 kHz to 26 GHz according to the procedure described in ANSI C63.10: 2013. Spectrum Analyzer Resolution Bandwidth is 200Hz or greater for frequencies 9kHz to 30MHz, 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.

Radiated Band Edge measurements made were made from 2300- 2406 MHz for the low channel and 2470 – 2500 MHz for the high channel.

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 where applicable.

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

EUT was tested with Internal Antenna.

Correlation measurements were performed below 30MHz between 10m ALSE and Open Field site according to FCC KDB 414788 D01 Radiated Test Site v01r01 section 2. All readings were within the acceptable tolerance.

4.7.3 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); CF = Correction Factor in dB (CF = Antenna Factor in dB(1/m) (AF) + Cable Attenuation Factor in dB (CL) - Amplifier Gain in dB (AG)).

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)
CL = 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.

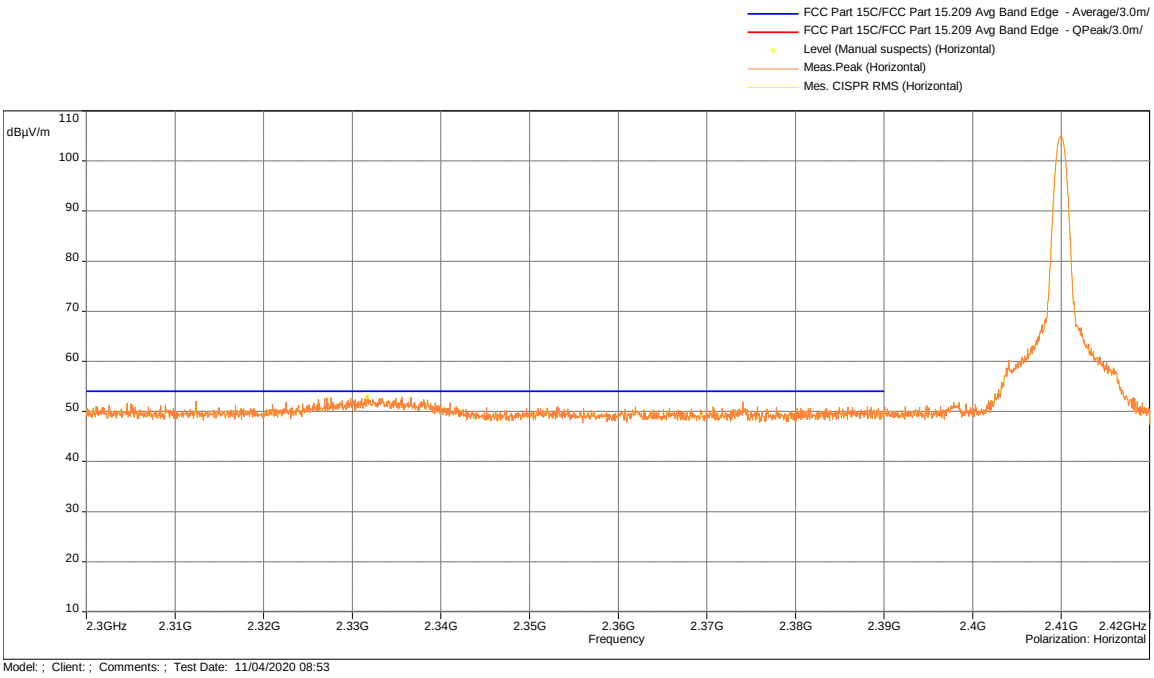
4.7.4 Test Results

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

Tested By:	Anderson Soungpanya
Test Date:	November 04 – 13, 2020

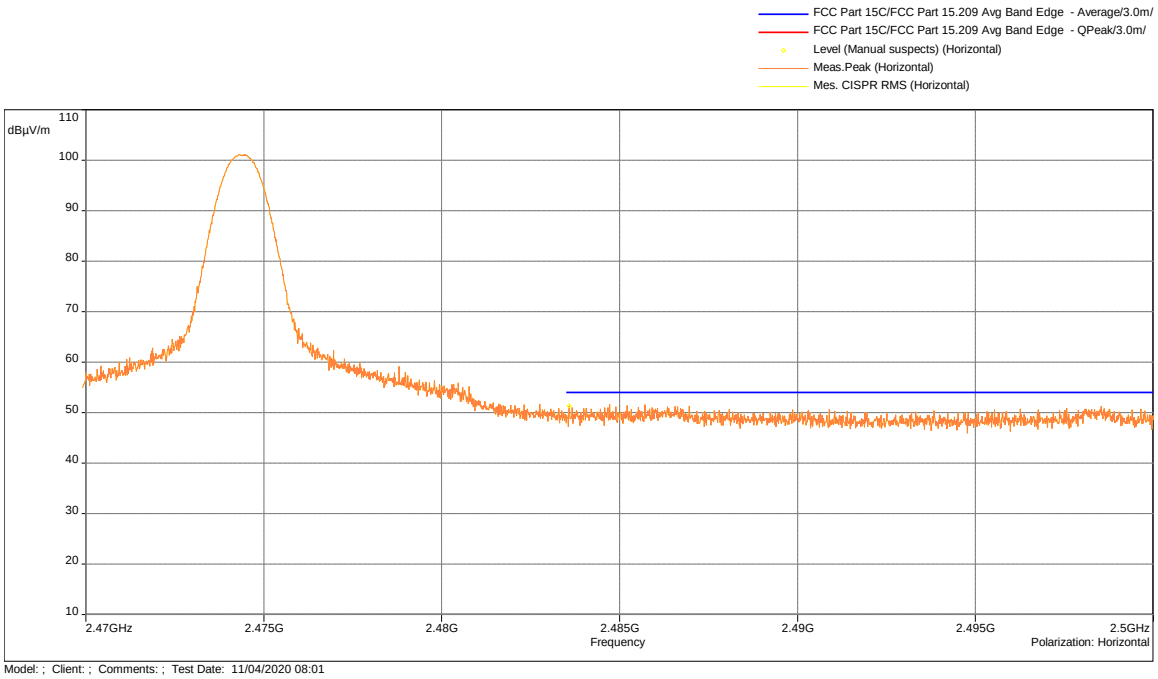
4.7.4 Test Results: 15.209/15.205 Restricted Band Emissions with Internal Antenna

Out-of-Band Radiated spurious emissions at the Band-edge @3m distance
2310–2390 MHz, Peak Scan with Average Limit



Frequency (MHz)	Peak Level (dBµV/m)	Av Limit (dBµV/m)	Margin (dB)	Angle (°)	Height (m)	Polarity	Raw (dBuV)	Correction (dB)
2331.68	52.99	54.0	-1.01	55.75	1.17	Horizontal	21.39	31.6

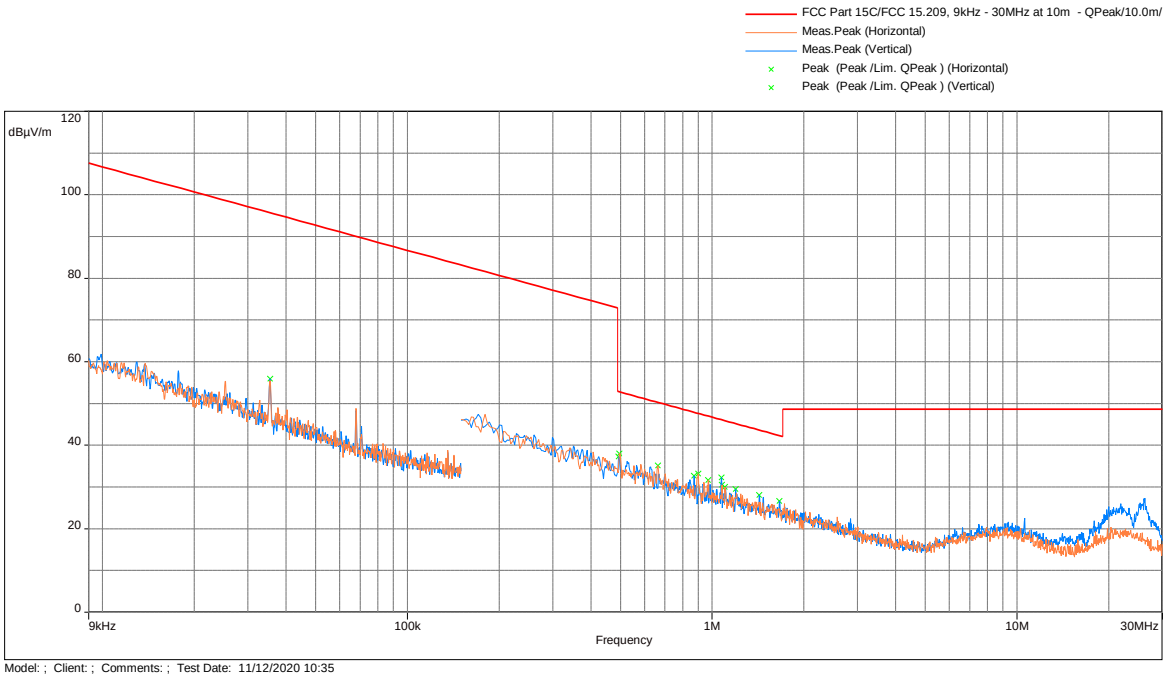
Out-of-Band Radiated spurious emissions at the Band-edge @3m distance
2483.5–2500 MHz, Peak Scan with Average Limit



Frequency (MHz)	Peak Level (dBµV/m)	Av Limit (dBµV/m)	Margin (dB)	Angle (°)	Height (m)	Polarity	Raw (dBuV)	Correction (dB)
2483.58	51.35	54.0	-2.65	47.75	1.3	Horizontal	20.1	31.25

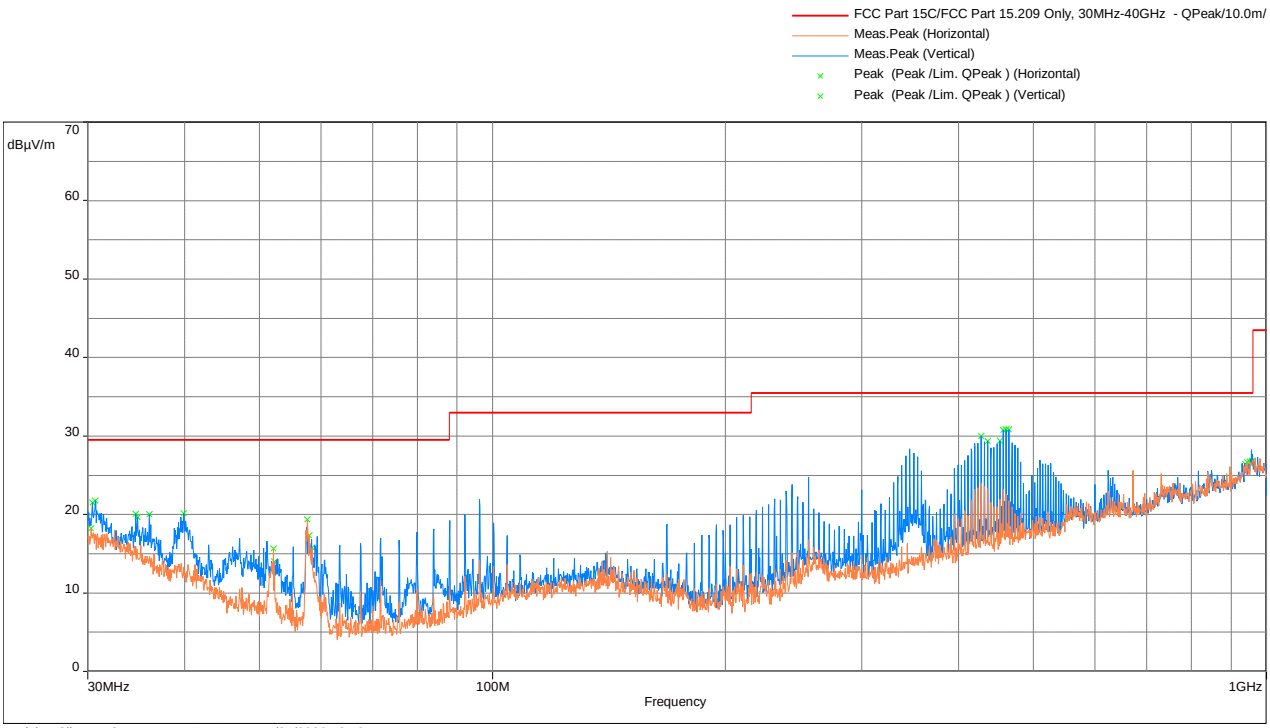
Test Results: 15.209 Out-of-Band Radiated Spurious Emissions, Low Channel

Radiated Spurious Emissions 9k – 30 MHz, Peak Scan, Low Channel



Model: ; Client: ; Comments: ; Test Date: 11/12/2020 10:35

Radiated Spurious Emissions 30 - 1000 MHz, Peak Scan, Low Channel

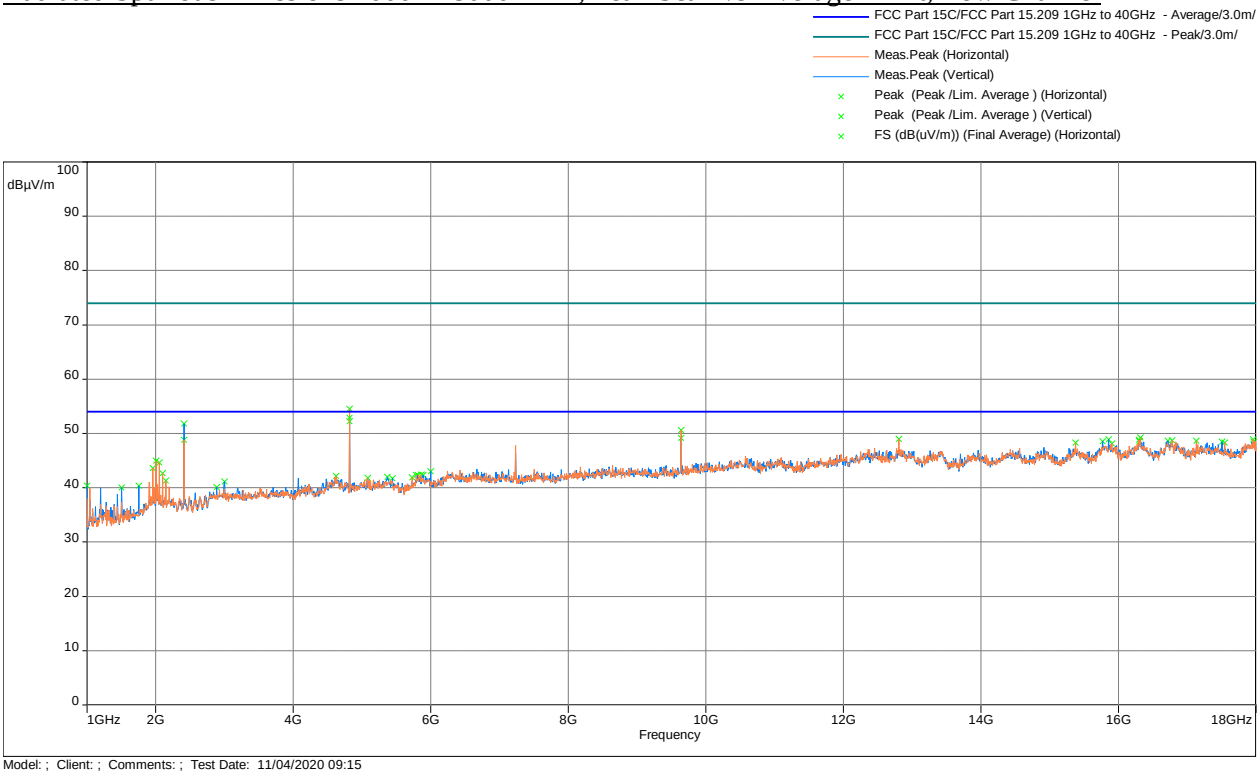


Model: ; Client: ; Comments: ; Test Date: 11/04/2020 13:40

Frequency (MHz)	FSQP@10m (dBµV/m)	Limit@10m (dBµV/m)	Margin (dB)	Angle (°)	Height (m)	Polarity	Raw (dBuV)	Correction (dB)
464.883	30.83	35.5	-4.67	114	0.99	Vertical	39.75	-8.92
428.0233	29.99	35.5	-5.51	179.75	0.99	Vertical	39.45	-9.46
436.236	29.34	35.5	-6.16	151	0.99	Vertical	38.88	-9.54
452.5967	29.37	35.5	-6.13	57	2.98	Vertical	38.61	-9.24
456.703	30.77	35.5	-4.73	186.5	0.99	Vertical	39.9	-9.13
460.777	30.82	35.5	-4.68	114	0.99	Vertical	39.84	-9.02

Note: FS@10m = RA + Correction
Correction = AF + CF – Preamp

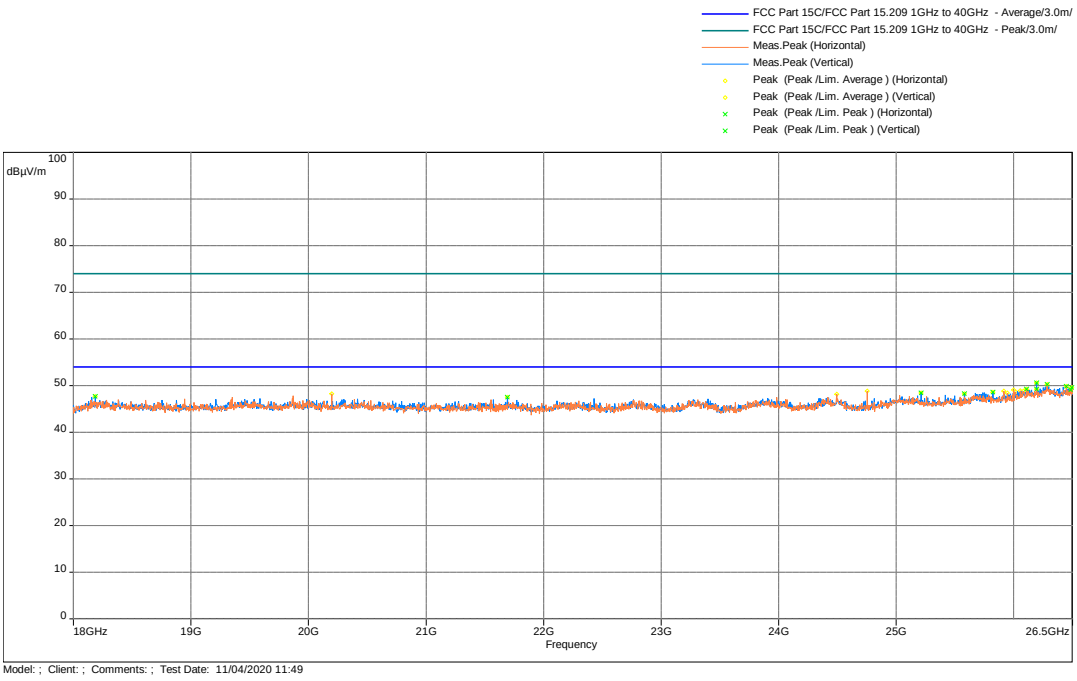
Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Average Limit, Low Channel



Frequency (MHz)	FSAv@3m (dBµV/m)	Av Limit@3m (dBµV/m)	Margin (dB)	Angle (°)	Height (m)	Polarity	Raw (dBuV)	Correction (dB)
4819.97	52.91	54	-1.09	96	2.74	Horizontal	61.32	-8.41

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

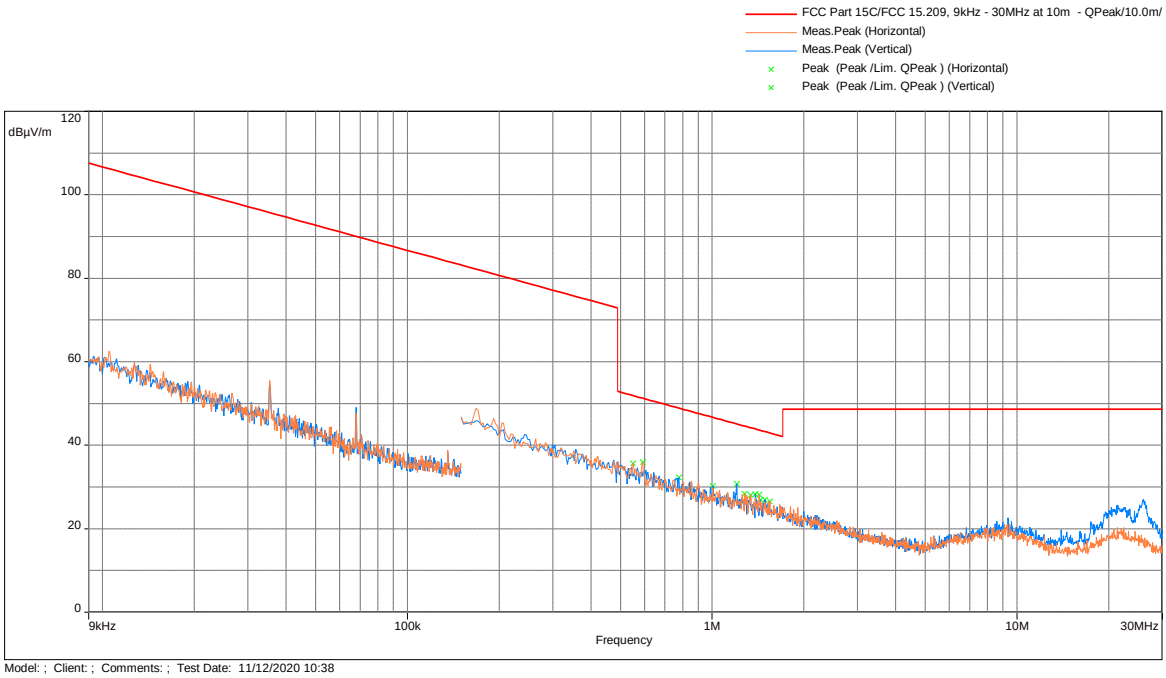
Radiated Spurious Emissions 18000 – 26500 MHz, Peak Scan vs Average Limit, Low Channel



Model: ; Client: ; Comments: ; Test Date: 11/04/2020 11:49

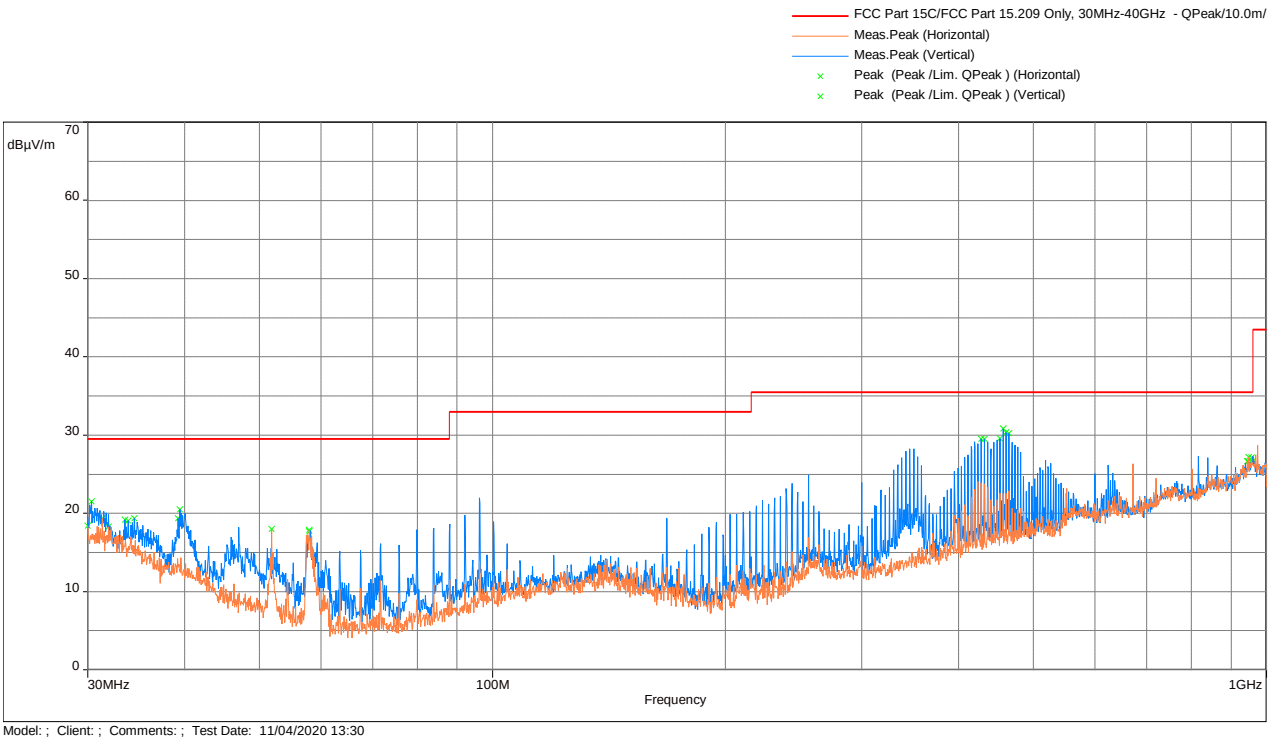
Test Results: 15.209 Out-of-Band Radiated Spurious Emissions, Middle Channel

Radiated Spurious Emissions 9k – 30 MHz, Peak Scan, Middle Channel



Model: ; Client: ; Comments: ; Test Date: 11/12/2020 10:38

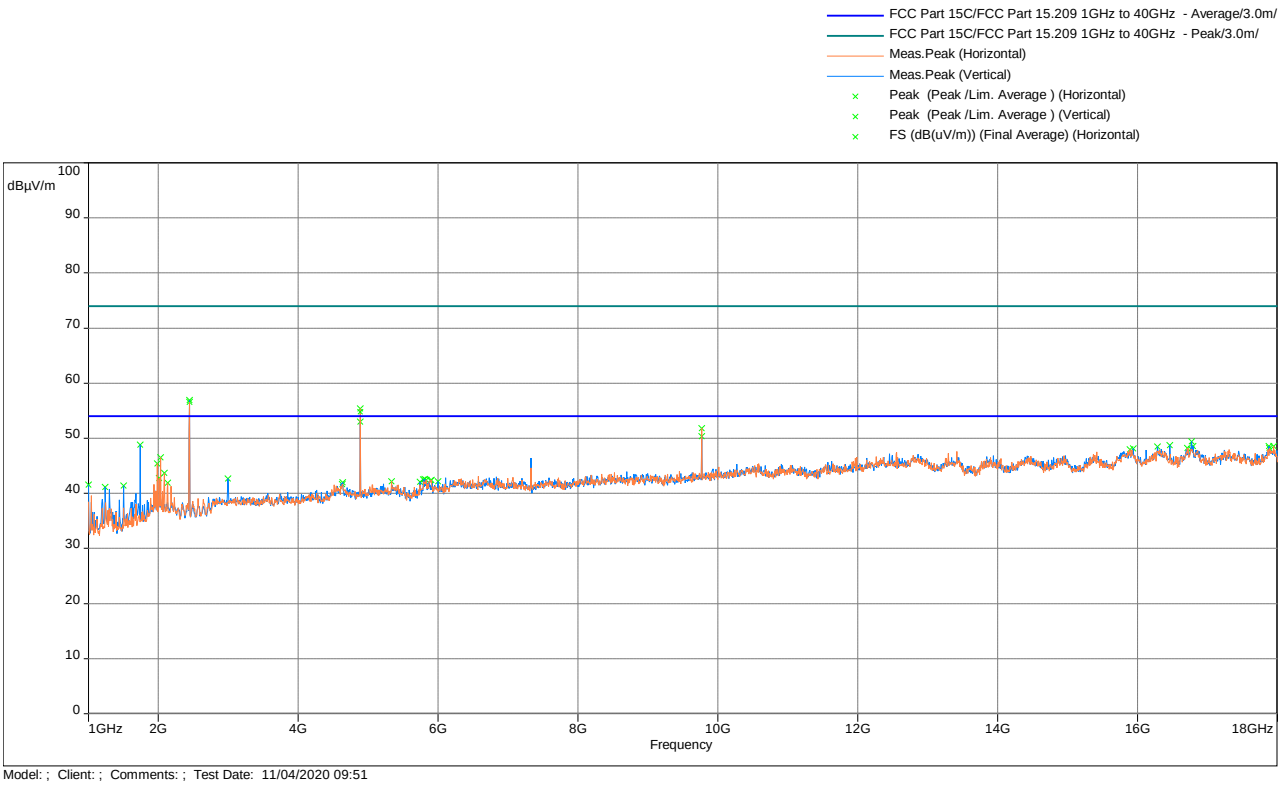
Radiated Spurious Emissions 30 - 1000 MHz, Peak Scan, Middle Channel



Frequency (MHz)	FSQP@10m (dBµV/m)	Limit@10m (dBµV/m)	Margin (dB)	Angle (°)	Height (m)	Polarity	Raw (dBuV)	Correction (dB)
428.0233	29.51	35.5	-5.99	0.75	0.98	Vertical	38.97	-9.46
432.1297	29.52	35.5	-5.98	357	0.98	Vertical	39.07	-9.55
452.5967	29.59	35.5	-5.91	264.5	0.98	Vertical	38.83	-9.24
456.703	30.82	35.5	-4.68	118.25	0.98	Vertical	39.95	-9.13
460.777	30.34	35.5	-5.16	64.25	0.98	Vertical	39.36	-9.02
464.8833	30.21	35.5	-5.29	118.25	0.98	Vertical	39.13	-8.92

Note: FS@10m = RA + Correction
Correction = AF + CF – Preamp

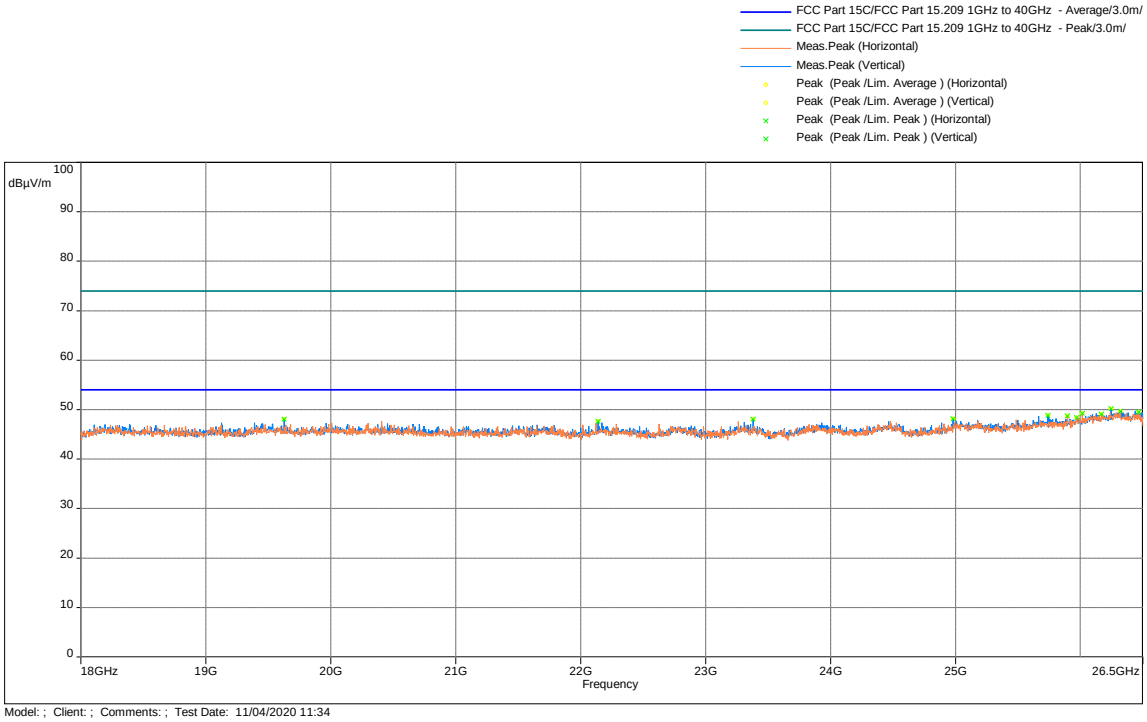
Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Average Limit, Middle Channel



Frequency (MHz)	FSAv@3m (dBµV/m)	Av Limit@3m (dBµV/m)	Margin (dB)	Angle (°)	Height (m)	Polarity	Raw (dBuV)	Correction (dB)
4884	53.78	54	-0.22	83.75	2.5	Horizontal	62.11	-8.33

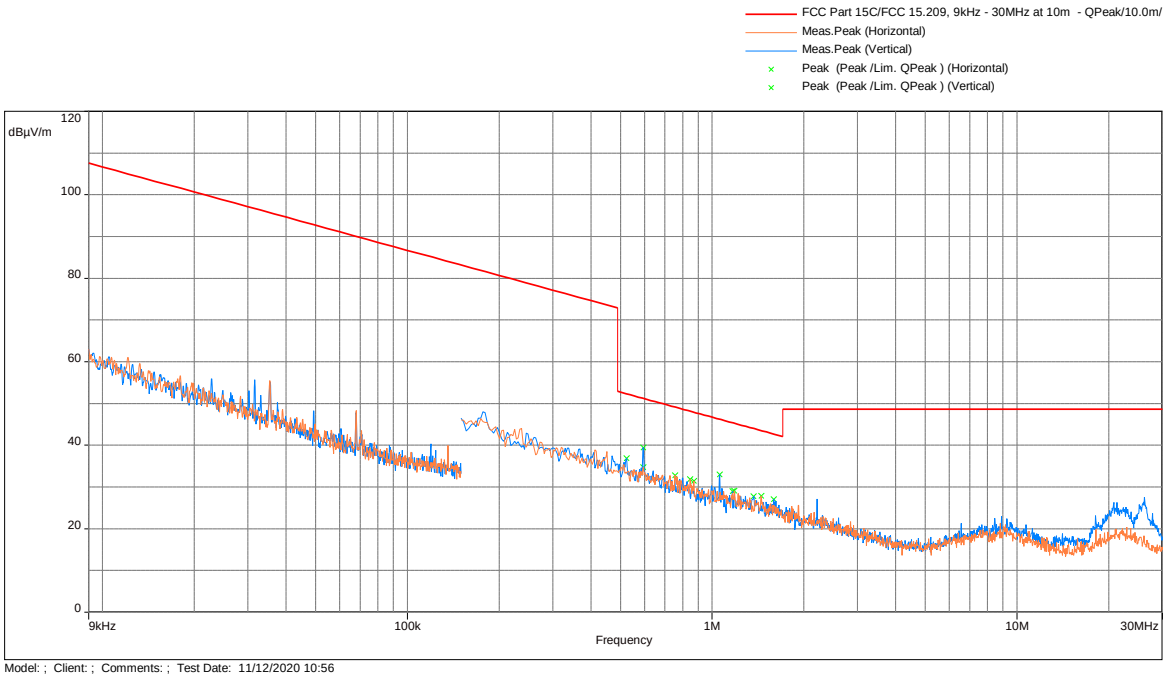
Note: FS@3m = RA + Correction
Correction = AF + CF – Preamp

Radiated Spurious Emissions 18000 – 26500 MHz, Peak Scan vs Average Limit, Middle Channel

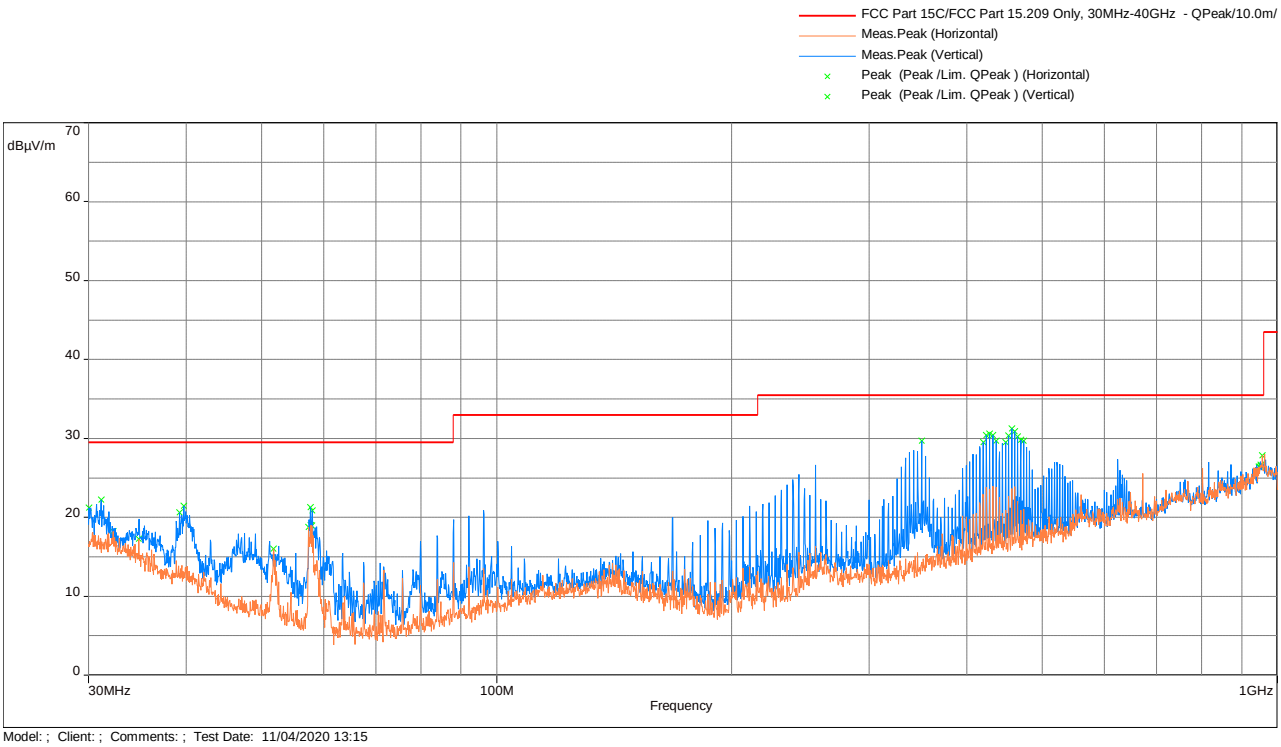


Test Results: 15.209 Out-of-Band Radiated Spurious Emissions, High Channel

Radiated Spurious Emissions 9k – 30 MHz, Peak Scan, High Channel



Radiated Spurious Emissions 30 - 1000 MHz, Peak Scan, High Channel

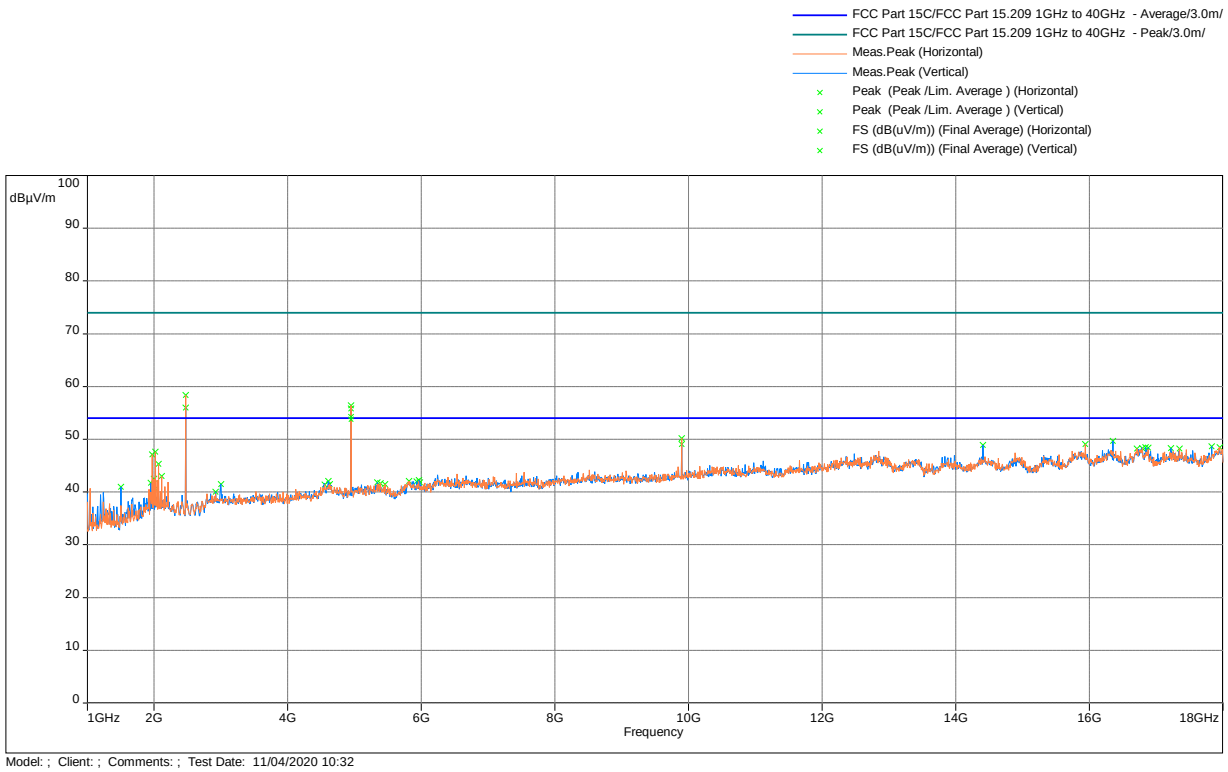


Model: ; Client: ; Comments: ; Test Date: 11/04/2020 13:15

Frequency (MHz)	FSQP@10m (dBµV/m)	Limit@10m (dBµV/m)	Margin (dB)	Angle (°)	Height (m)	Polarity	Raw (dBuV)	Correction (dB)
452.5967	30.32	35.5	-5.18	66.25	2.98	Vertical	39.56	-9.24
456.703	31.24	35.5	-4.26	105.25	2.98	Vertical	40.37	-9.13
460.8093	30.88	35.5	-4.62	56.75	2.98	Vertical	39.9	-9.02
464.8833	30.24	35.5	-5.26	20.75	1.98	Vertical	39.16	-8.92
468.9897	29.83	35.5	-5.67	331.5	1.98	Vertical	38.64	-8.81
473.096	29.71	35.5	-5.79	113.25	1.98	Vertical	38.42	-8.71

Note: FS@10m = RA + Correction
Correction = AF + CF – Preamp

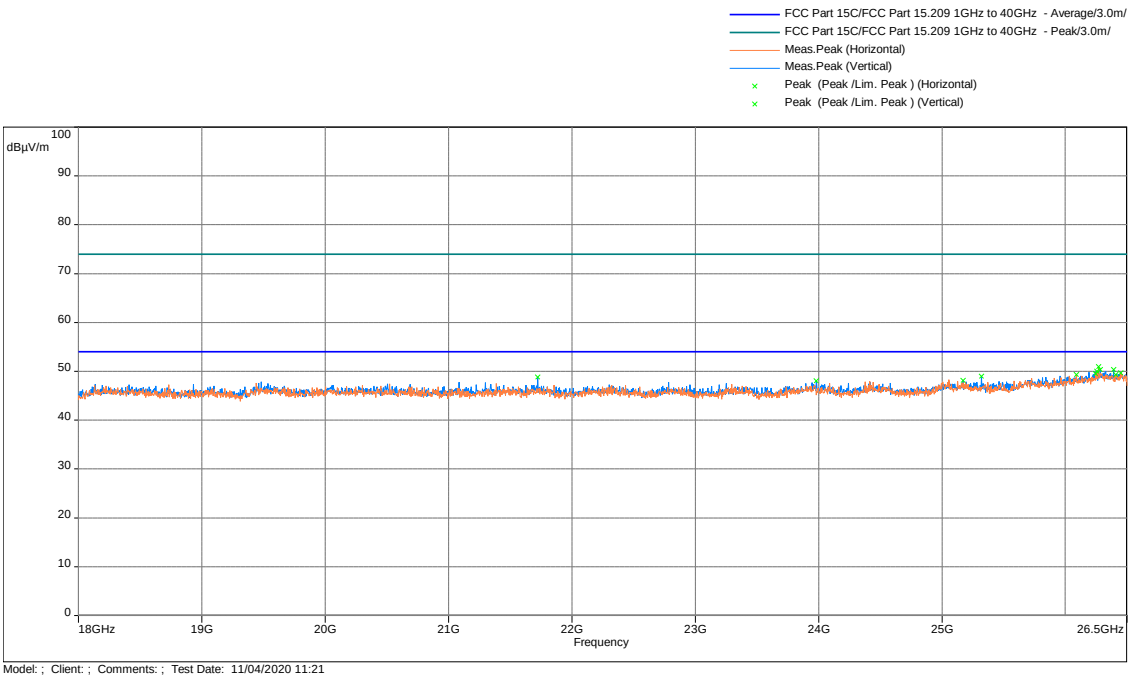
Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Average Limit, High Channel



Frequency (MHz)	FSAv@3m (dBµV/m)	Av Limit@3m (dBµV/m)	Margin (dB)	Angle (°)	Height (m)	Polarity	Raw (dBuV)	Correction (dB)
4948.838	53.27	54	-0.73	339.25	2.5	Horizontal	61.46	-8.19
4948.838	53.78	54	-0.22	28.75	1.27	Vertical	61.97	-8.19

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

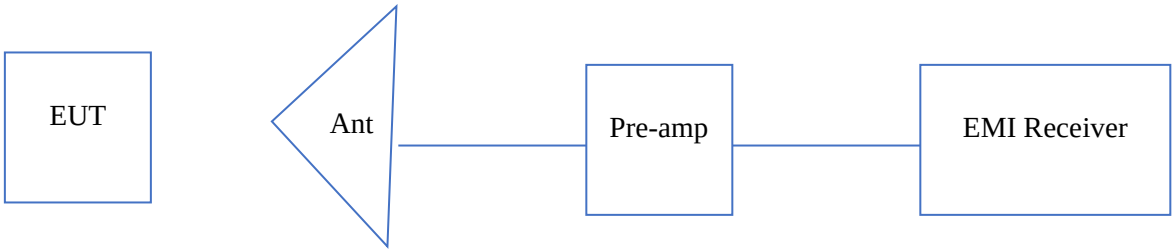
Radiated Spurious Emissions 18000 – 26500 MHz, Peak Scan vs Average Limit, High Channel



Results	**Complies**

4.7.5 Test Setup Photographs

The following photographs show the testing configurations used.



4.8 AC Line Conducted Emission
15.207

4.8.1 Requirement

Frequency Band MHz	Class B Limit dB(µV)		Class A Limit dB(µV)	
	Quasi-Peak	Average	Quasi-Peak	Average
0.15-0.50	66 to 56 *	56 to 46 *	79	66
0.50-5.00	56	46	73	60
5.00-30.00	60	50	73	60

*Note: *Decreases linearly with the logarithm of the frequency. At the transition frequency the lower limit applies.*

4.8.2 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 C63.10-2013

4.8.3 Test Results

Not Applicable. The equipment under test is DC powered. The EUT does not connect to the AC mains public network.

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	05/11/21
Pyramidal Horn Antenna	EMCO	3160-09	ITS 00571	#	#
Pre-Amplifier (18-40GHz)	Miteq	TTA1840-35-S-M	ITS 01393	12	03/02/21
Active Horn Antenna	ETS-Lindgren	3117-PA	ITS 01325	12	08/04/21
EMI Receiver	Rohde and Schwarz	ESU40	ITS 01375	12	06/16/21
BI-Log Antenna	Antenna Research	LPB-2513	ITS 00355	12	04/08/21
Pre-Amplifier	Sonoma Instrument	310N	ITS 01493	12	07/02/21
Notch Filter	Micro-Tronics	BRM50702	ITS 01166	12	06/11/21
RF Cable	Megaphase	EMC1-K1K1-236	ITS 01538	12	06/12/21
RF Cable	Megaphase	TM40-K1K1-59	ITS 01657	12	11/11/20
RF Cable	TRU Corporation	TRU CORE 300	ITS 01330	12	06/11/21
RF Cable	TRU Corporation	TRU CORE 300	ITS 01465	12	09/01/21
RF Cable	TRU Corporation	TRU CORE 300	ITS 01470	12	09/01/21
Loop Antenna	EMCO	6512	ITS 01598	12	11/03/21

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	3.19.1.19	AMPT FCC.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 / G104402894	HH	KV	November 17, 2020	Original document