

TEST REPORT

Report Number: 105214557MPK-013
Project Numbers: G105214557, G105245638
Report Issue Date: January 04, 2023
Revision Date: March 7, 2023

Testing performed on
Beats IP FCU Controller
Model Tested: UNI-RL1644ESB24NM
Model Not Tested: UNI-RL1644ESB24NM(C/D)
UN-RL1644ESB24NM
UN-RL1644ESB24NM(C/D)

to

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

For


Honeywell International, Inc.

Test Performed by:
Intertek
1365 Adams Court
Menlo Park, CA 94025 USA

Test Authorized by:
Honeywell International, Inc.
12 Clintonville Rd
Northford, CT 06472-1610

Prepared by: 
Erica Chan

Date: February 10, 2023

Reviewed by: 
Anderson Soungpanya

Date: February 10, 2023

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Report No. 105214557MPK-013	
Equipment Under Test:	Beats IP FCU Controller
Model Number:	UNI-RL1644ESB24NM
Applicant:	Honeywell International, Inc.
Contact:	Mafer Diaz Rodriguez
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Applicable Regulation:	FCC Part 15 Subpart C (15.247) ISED RSS-247 Issue 2
Date of Test:	November 29, 2022 to January 3, 2023

We attest to the accuracy of this report:



Erica Chan
Project Engineer



Anderson Soungpanya
EMC Team Leader

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1.0 Summary of Tests

Test	Reference FCC	Reference Industry Canada	Result
RF Output Power	15.247(b)(3)	RSS-247, 5.4.d)	Complies
6 dB Bandwidth	15.247(a)(2)	RSS-247, 5.2.a)	Complies
Power Density	15.247(e)	RSS-247, 5.2.b)	Complies
Out of Band Antenna Conducted Emission	15.247(d)	RSS-247, 5.5	Complies
Transmitter Radiated Emissions	15.247(d), 15.209, 15.205	RSS-247, 5.5	Complies
AC Line Conducted Emission	15.207	RSS-GEN	Complies.
Antenna Requirement	15.203	RSS-GEN	Complies (Internal Antenna)

EUT receive date: October 31, 2022

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: November 29, 2022

Test completion date: January 3, 2023

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

2.0 General Information

2.1 Product Description

Honeywell International, Inc. supplied the following description of the EUT:
HVAC Controller

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

Information about the 2.4 GHz radio is presented below:

Applicant	Honeywell International, Inc.
Model No.	UNI-RL1644ESB24NM
Type of transmission	Digital Transmission System (DTS)
Rated RF Output	7.12 dBm or 5.152 mW
Antenna(s) & Gain*	Internal Antenna, Gain: 3.72 dBi
Frequency Range	2402 – 2480 MHz
Type of modulation/data rate	GFSK / 1Mbit/s
Number of Channel(s)	40
Applicant Name & Address	Honeywell International, Inc. 12 Clintonville Rd Northford, CT 06472-1610

*As provided by the client. Intertek takes no responsibility for the accuracy of this information.

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 v05r02), and RSS-247 Issue 2, 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 does not 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

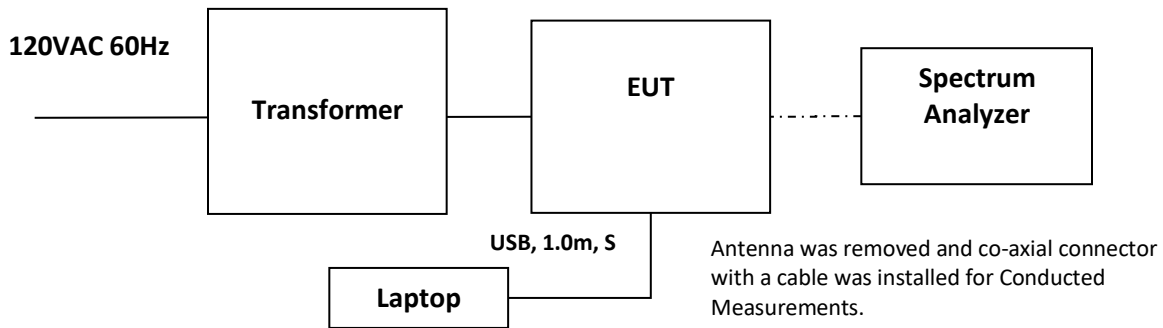
3.1 Support Equipment

Support Equipment		
Description	Manufacturer	Model
Transformer	Veris Industries	X040AAB
Laptop	Dell	Latitude 5400

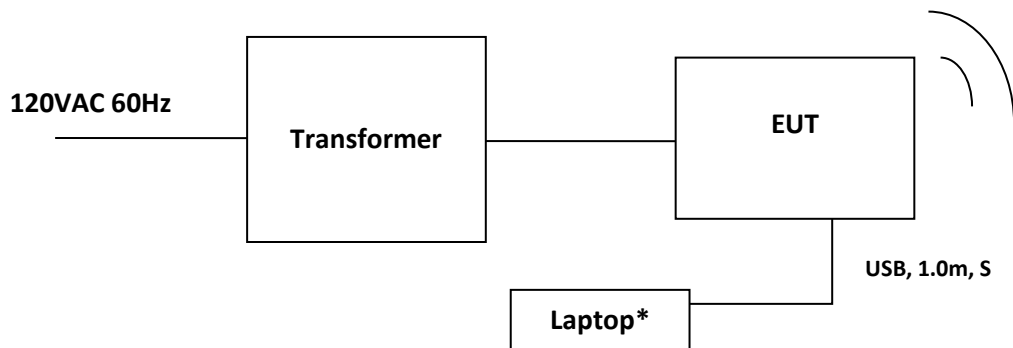
3.2 Block Diagram of Test Setup

Equipment Under Test			
Description	Manufacturer	Model	Serial Number
BEATS FCU – Radiated Sample	Honeywell International, Inc.	UNI-RL1644ESB24NM	P0002
Conducted Sample	Honeywell International, Inc.	UNI-RL1644ESB24NM	P0001

Conducted Measurements Setup



Radiated Measurements SETUP



*Note: Laptop and USB cable were removed during testing.

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

EUT Photo



3.3 Justification

For radiated emission measurements the EUT is placed on a non-conductive table. The EUT was configured to continuously transmit. The highest clock frequency used in the EUT is 2.48 GHz.

3.4 Software Exercise Program

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

3.5 Mode of Operation during Test

Mode of operation during the tests was setup using a laptop which allows controlling the radio by test software. During the transmitter tests, the transmitter was setup to transmit maximum communication and RF power levels.

EUT was placed into transmit mode at the lowest (2402MHz) middle (2440MHz), and highest (2480MHz) channels.

3.6 Variant Models

UNI-RL1644ESB24NM(C/D)
UN-RL1644ESB24NM
UN-RL1644ESB24NM(C/D)

Per Honeywell International Inc.:

- Model UN-RL1644ESB24NM is electrically and mechanically identical to the tested model UNI-RL1644ESB24NM. The model number was changed after production began as the factory system limits the number of characters for the model number.
- (C) or (D) modifiers – used to indicate channel of distribution for sales. May be added to customer orders or invoices when product is sold and does not appear on labels. No difference between models without the modifier.

3.7 Modifications Required for Compliance

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

3.8 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.a) 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 KDB 558074 D01 Meas Guidance v05r02 was used to determine the DTS occupied bandwidth. Section 11.8.1 Option 1 of ANSI 63.10 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.

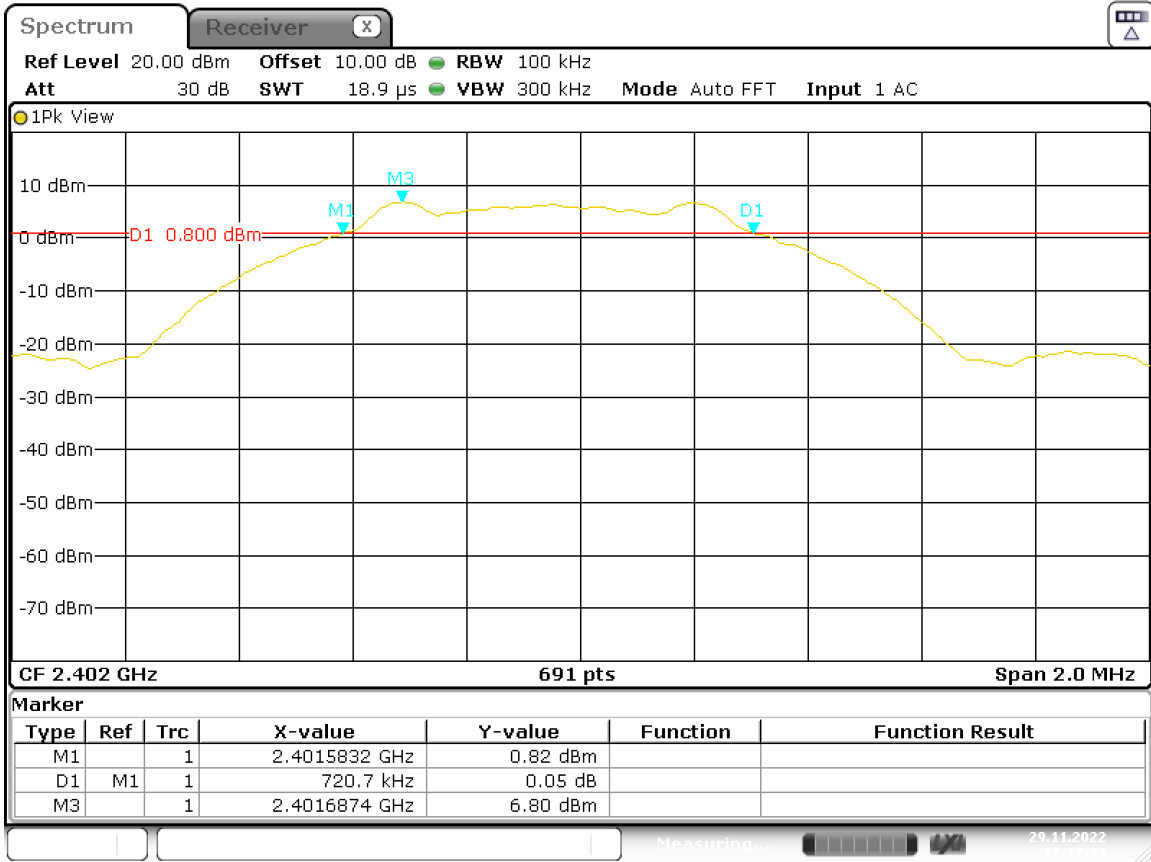
For 99% power bandwidth measurement, the bandwidth was determined by using the built-in 99% occupied bandwidth function of the spectrum analyzer. The resolution bandwidth is set to 1-5% occupied bandwidth. The video bandwidth shall be set to 3 times the resolution bandwidth.

4.1.3 Test Result

Frequency (MHz)	6-dB bandwidth FCC 15.247 & RSS-GEN, kHz	Occupied bandwidth, RSS-GEN, MHz	Plot
2402	720.7	--	1.1
	--	1.061	1.4
2440	726.5	--	1.2
	--	1.071	1.5
2480	714.9	--	1.3
	--	1.071	1.6

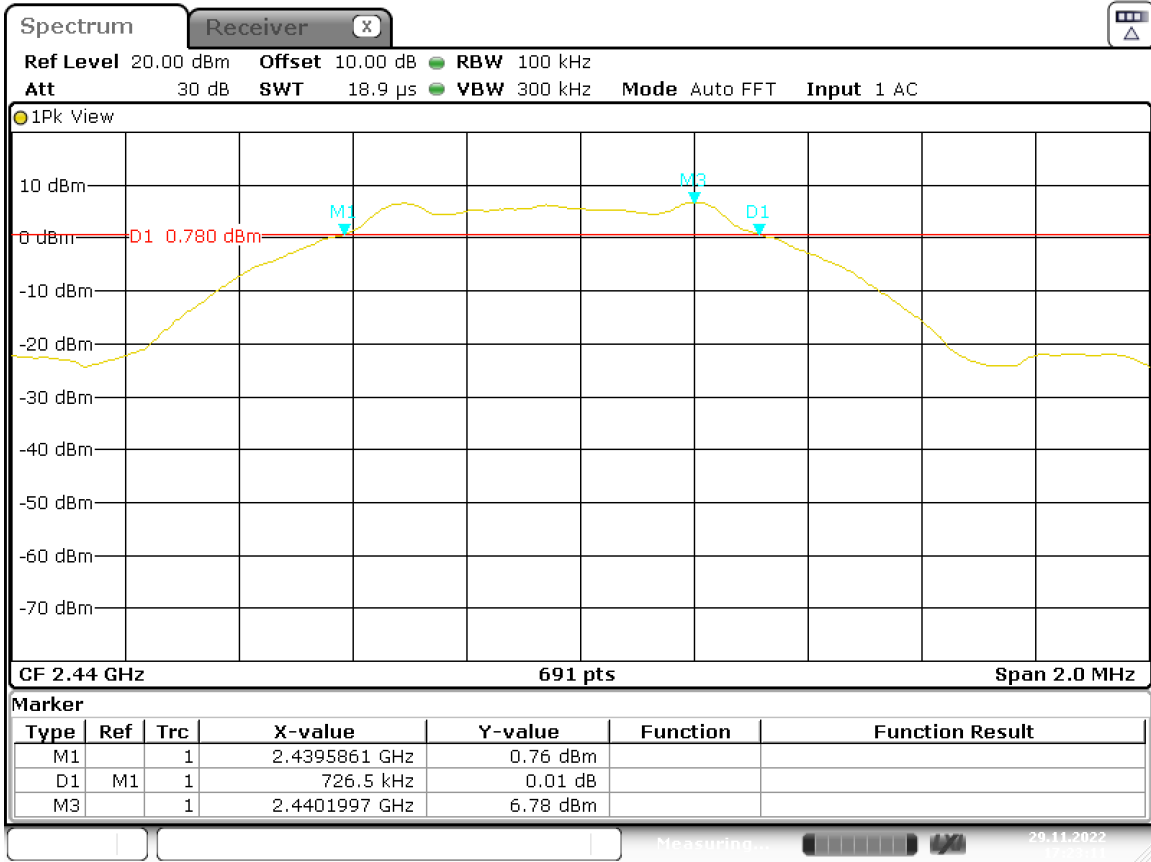
Tested By	Test Date	Results
Erica Chan	November 29, 2022 January 3, 2023	Complies

Plot 1. 1



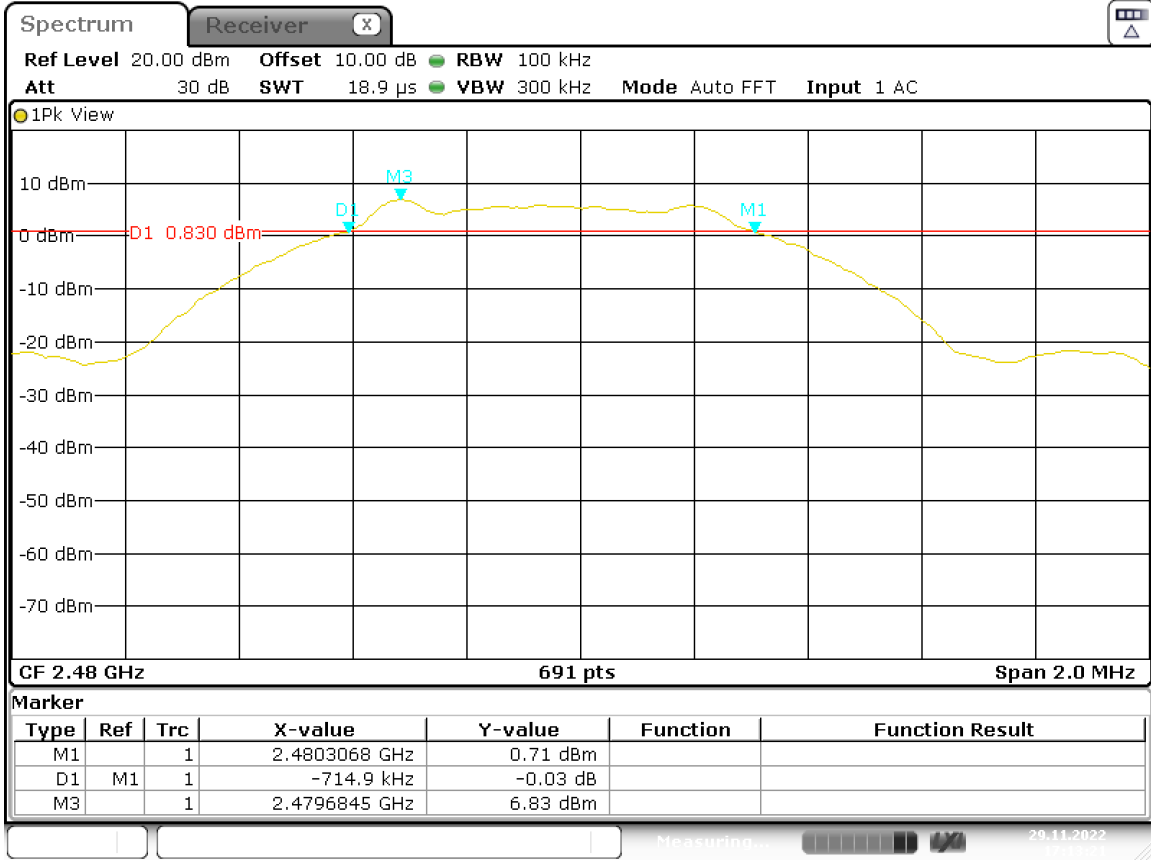
Date: 29.NOV.2022 17:17:03

Plot 1. 2



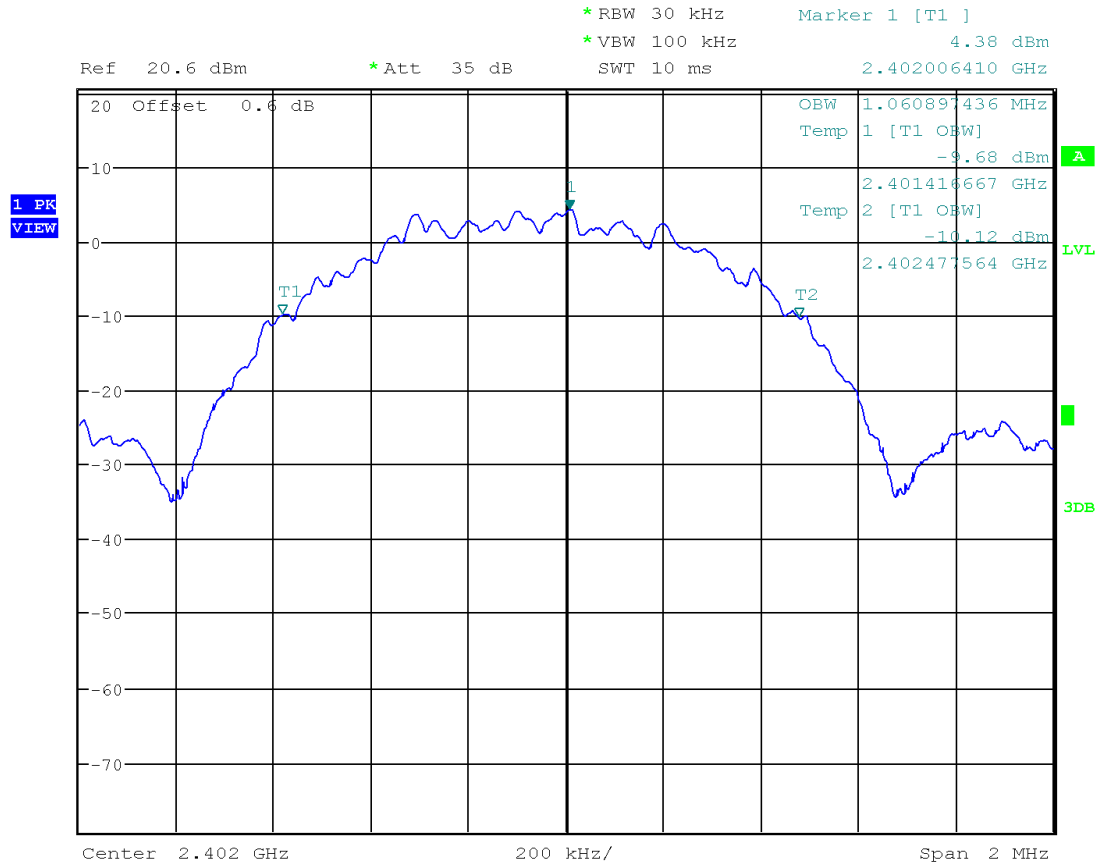
Date: 29.NOV.2022 17:23:12

Plot 1. 3



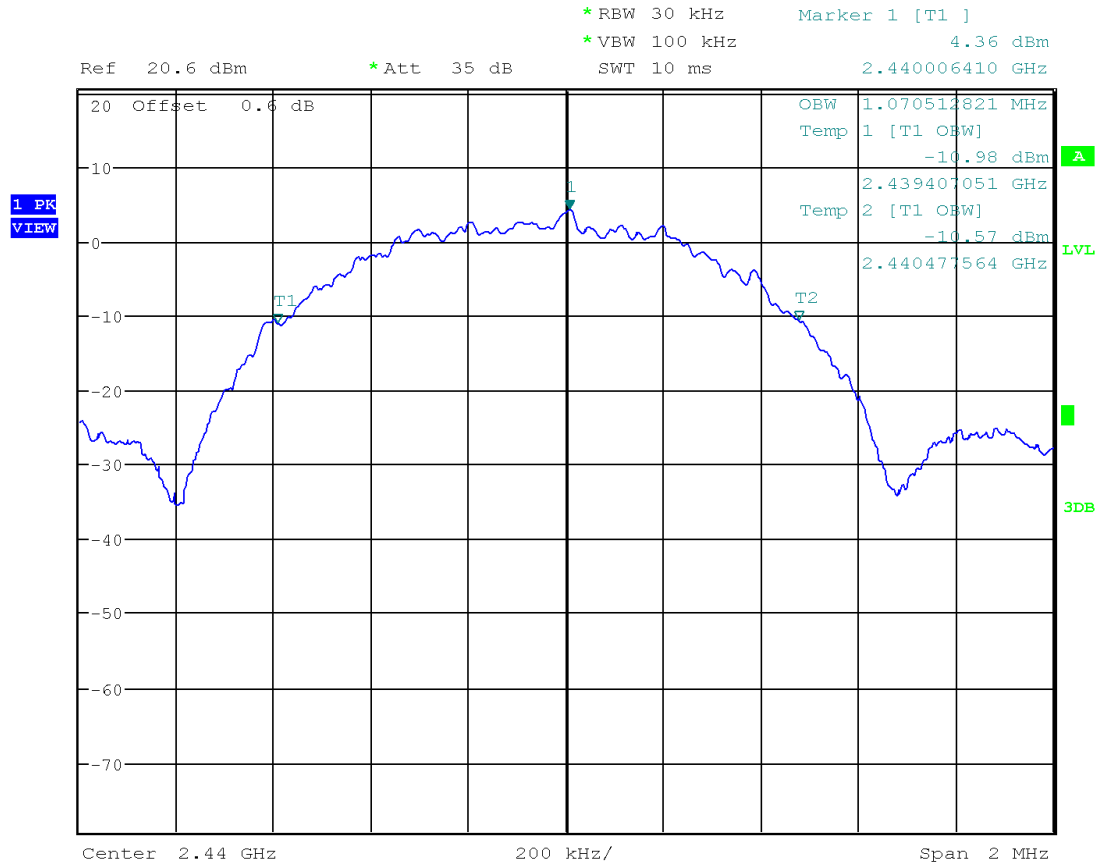
Date: 29.NOV.2022 17:13:22

Plot 1. 4



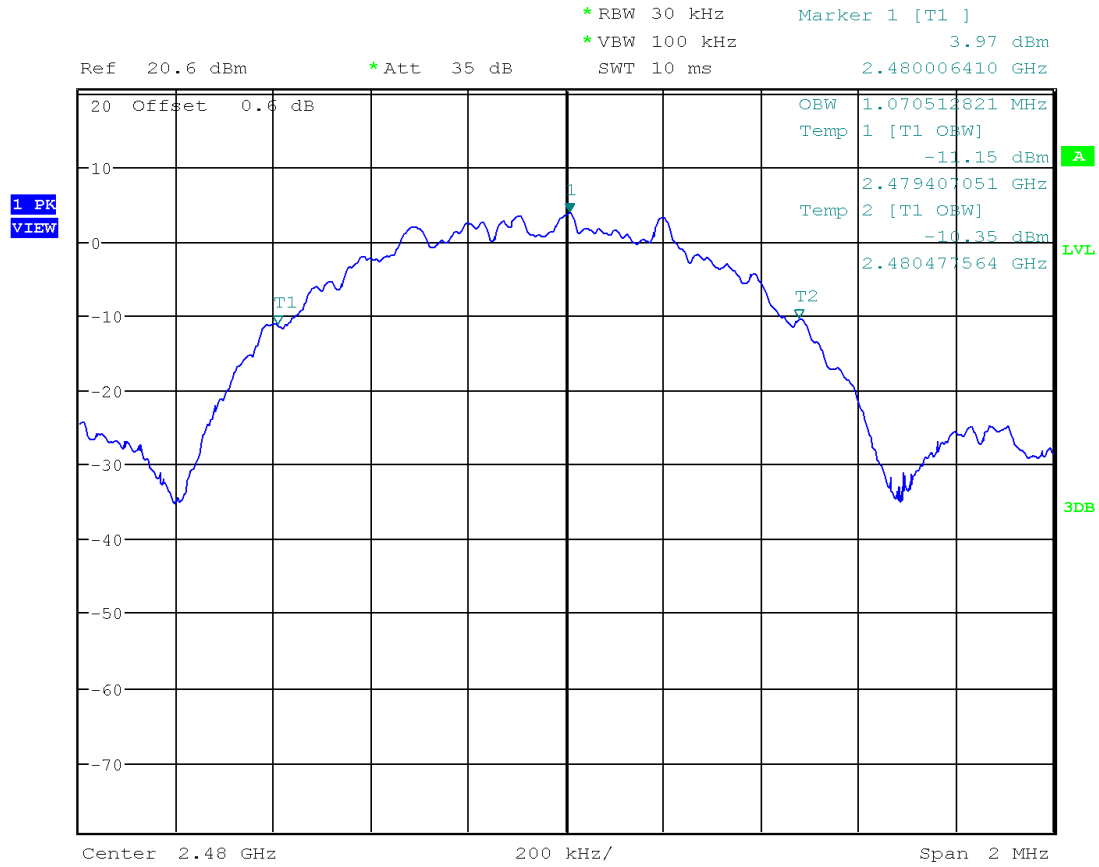
Date: 3.JAN.2023 14:28:58

Plot 1.5



Date: 3.JAN.2023 14:25:33

Plot 1.6



Date: 3.JAN.2023 14:16:31

Results	Complies
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4.2 Maximum Peak Conducted Output Power at Antenna Terminals

FCC Rule: 15.247(b)(3); RSS-247, 5.4.d);

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 KDB 558074 D01 Meas Guidance v05r02 was used. Specifically, section 11.9.1.1 $RBW \geq DTS$ bandwidth in ANSI 63.10.

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

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

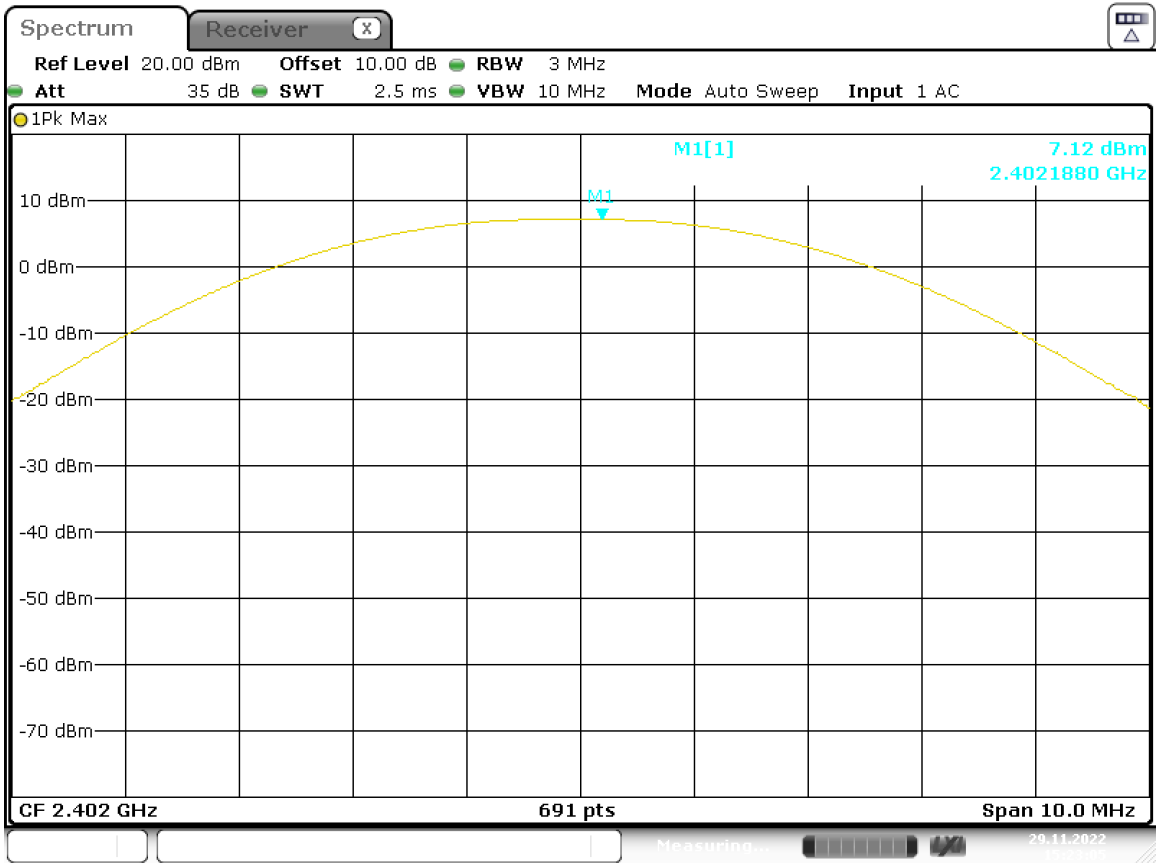
4.2.3 Test Result

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

Frequency	Conducted Power (peak)		Plot
	MHz	dBm	
2402	7.12	5.152	2.1
2442	7.02	5.035	2.2
2480	6.88	4.875	2.3

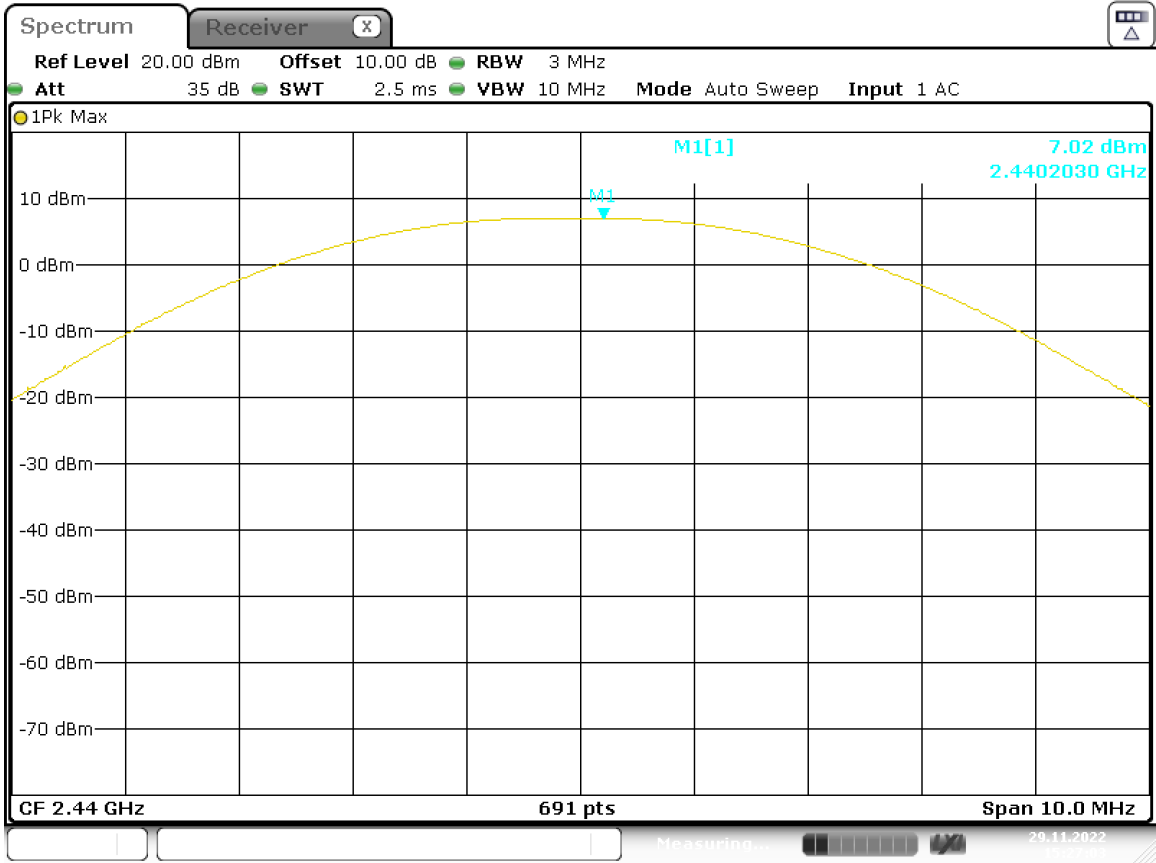
Tested By	Test Date	Results
Erica Chan	November 29, 2022	Complies

Plot 2. 1



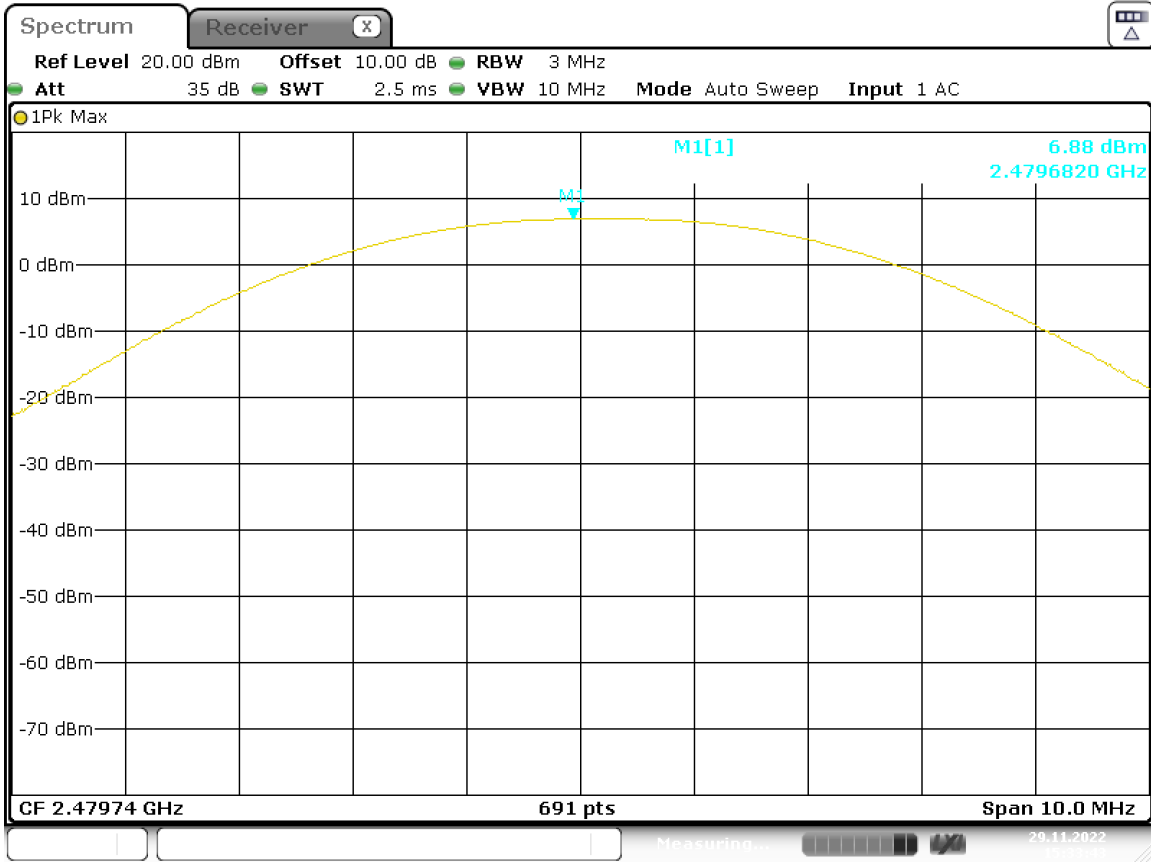
Date: 29.NOV.2022 15:23:06

Plot 2. 2



Date: 29.NOV.2022 15:27:04

Plot 2. 3



Date: 29.NOV.2022 15:33:44

Results **Complies**

4.3 Maximum Power Spectral Density

FCC: 15.247 (e); RSS-247, 5.2.b);

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 KDB 558074 D01 Meas Guidance v05r02, specifically section 11.10.2 Method PKPSD (peak PSD) of ANSI 63.10.

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.

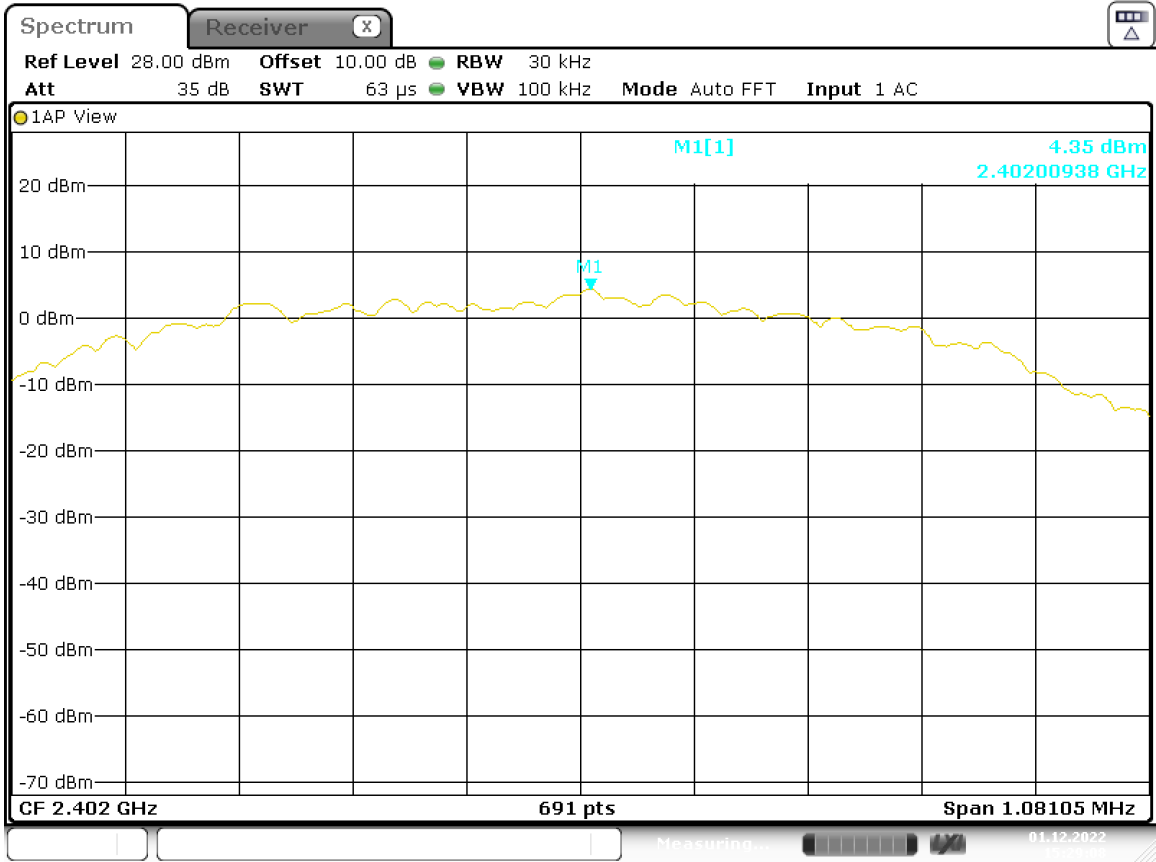
4.3.3 Test Result

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	4.35	8.0	-3.65	3.1
2440	4.22	8.0	-3.78	3.2
2480	4.07	8.0	-3.93	3.3

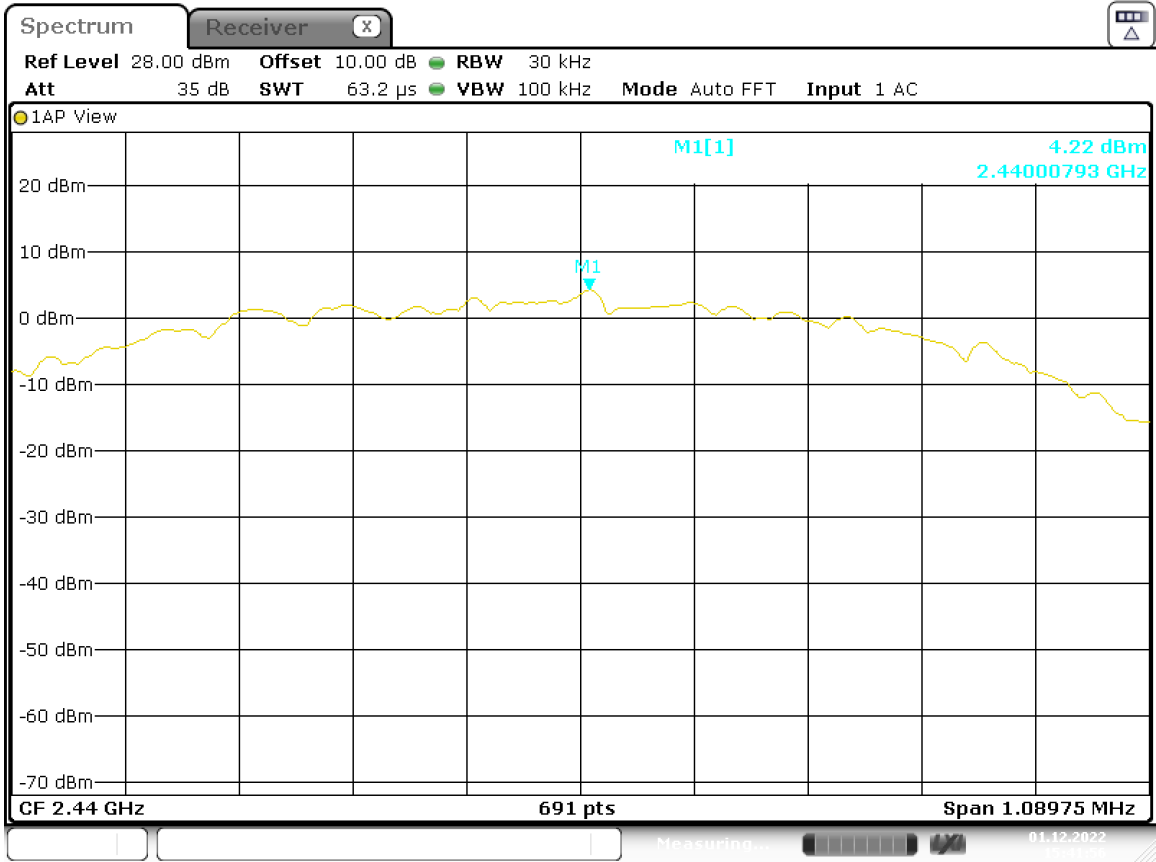
Tested By	Test Date	Results
Erica Chan	December 1, 2022	Complies

Plot 3. 1



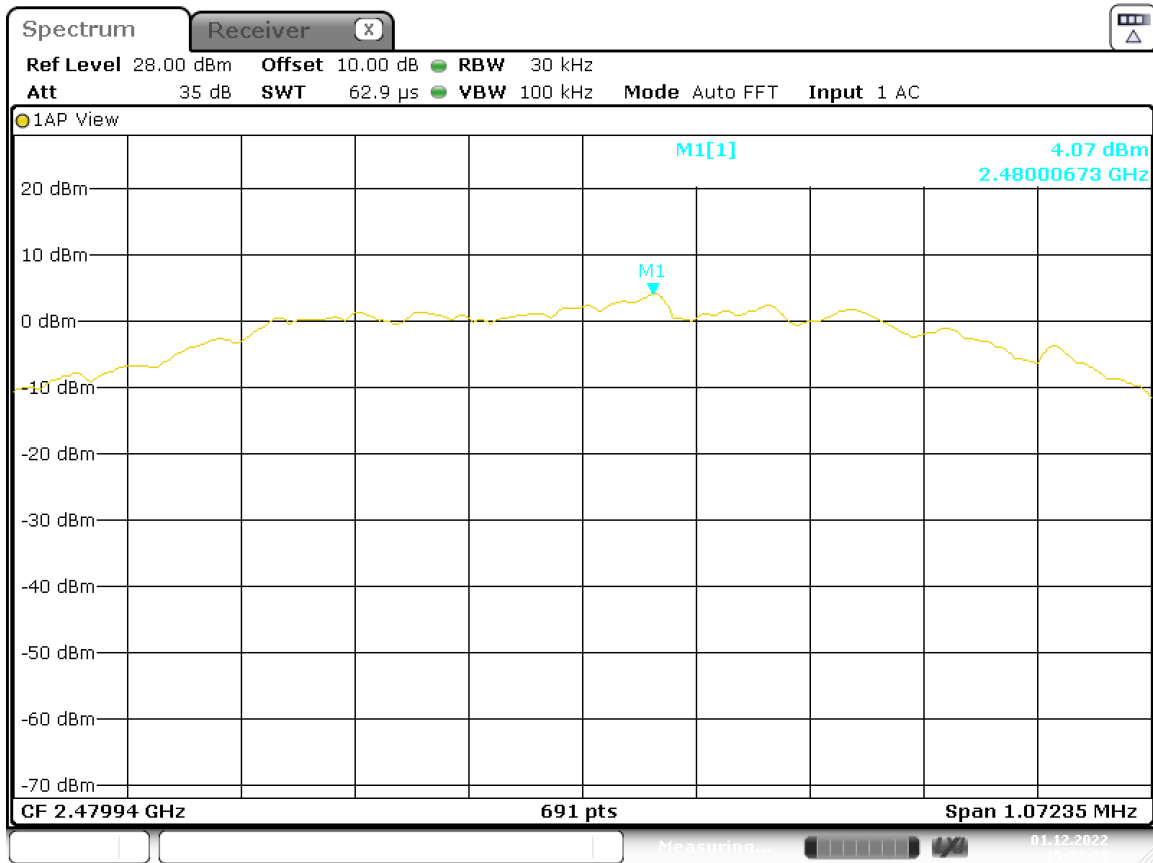
Date: 1.DEC.2022 15:29:08

Plot 3.2



Date: 1.DEC.2022 15:41:56

Plot 3.3



Date: 1.DEC.2022 15:37:25

Results **Complies**

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 KDB 558074 D01 Meas Guidance v05r02, specifically section 11.11 DTS Emissions in non-restricted frequency bands of ANSI 63.10.

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.

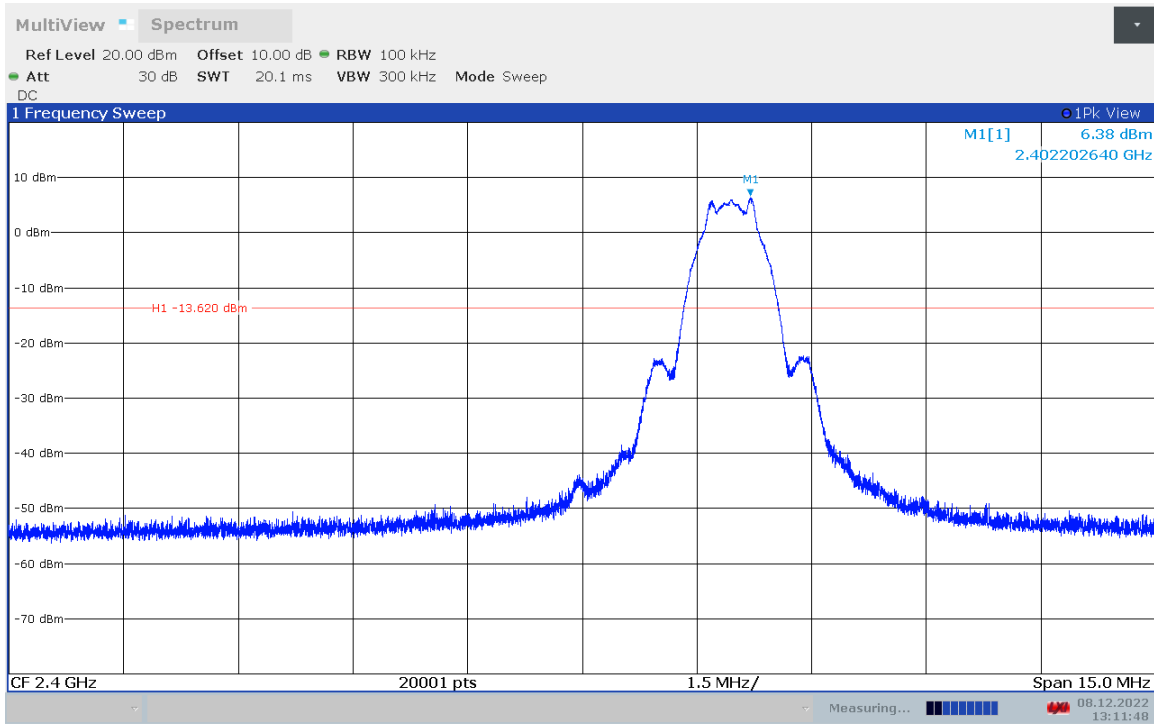
The unwanted emissions were measured from 30 MHz to 25 GHz. Plots below are corrected for cable loss and then compared to the limits.

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.

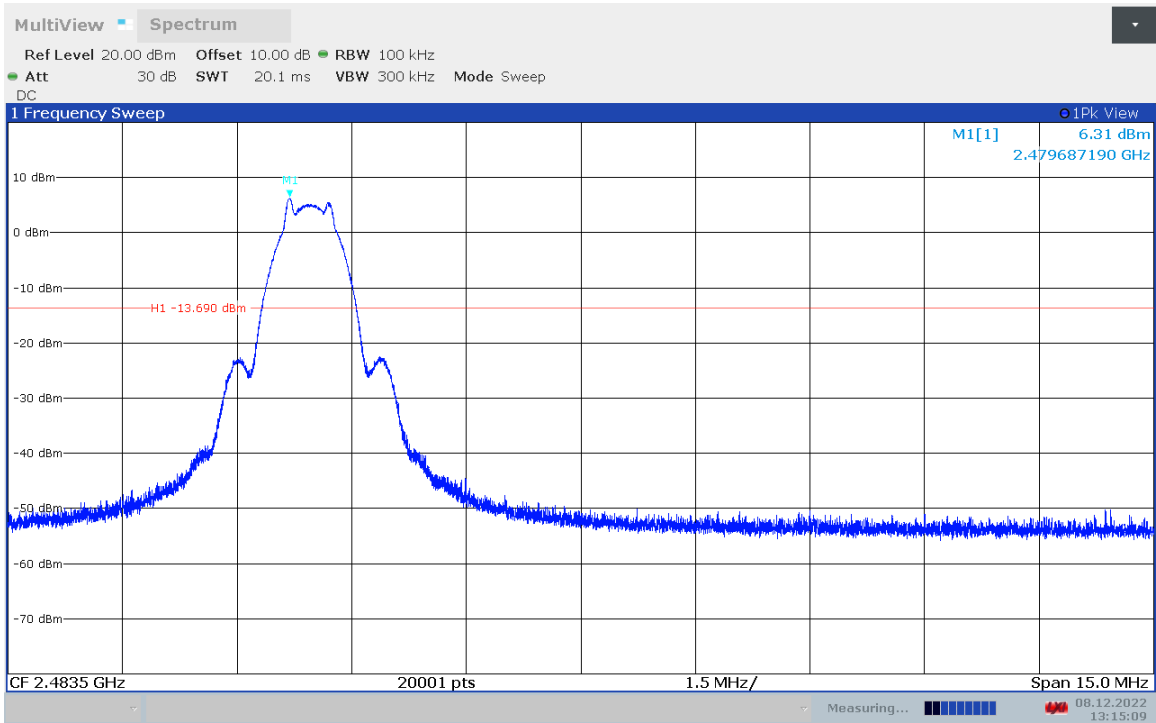
Tested By	Test Date	Results
Erica Chan	December 12, 2022	Complies

Tx @ Low Channel, 2402 MHz Band Edge
Plot 4.1



13:11:49 08.12.2022

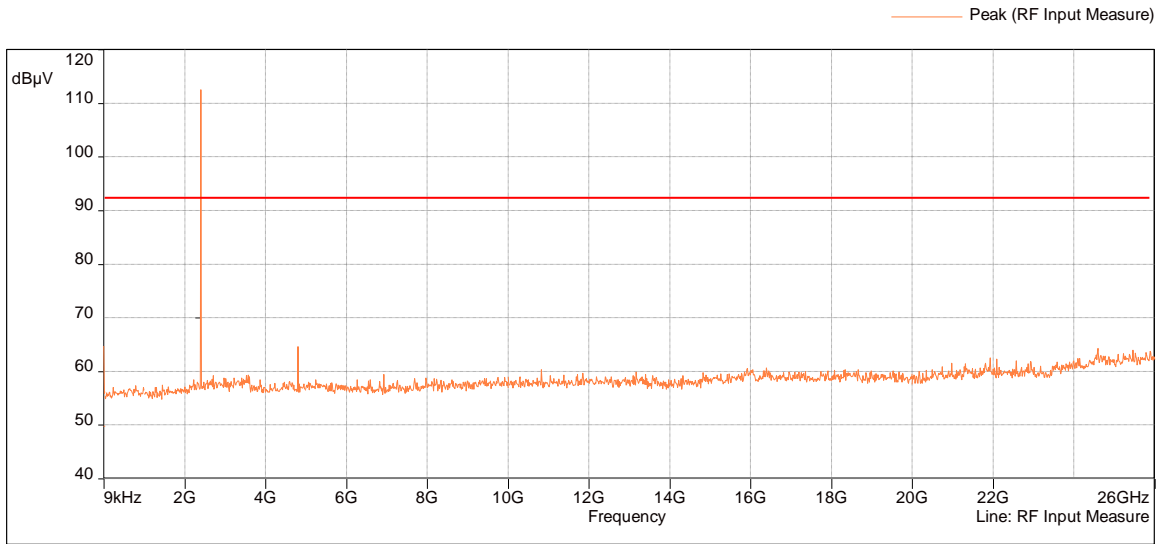
Tx @ High Channel, 2480 MHz Band Edge
Plot 4.2



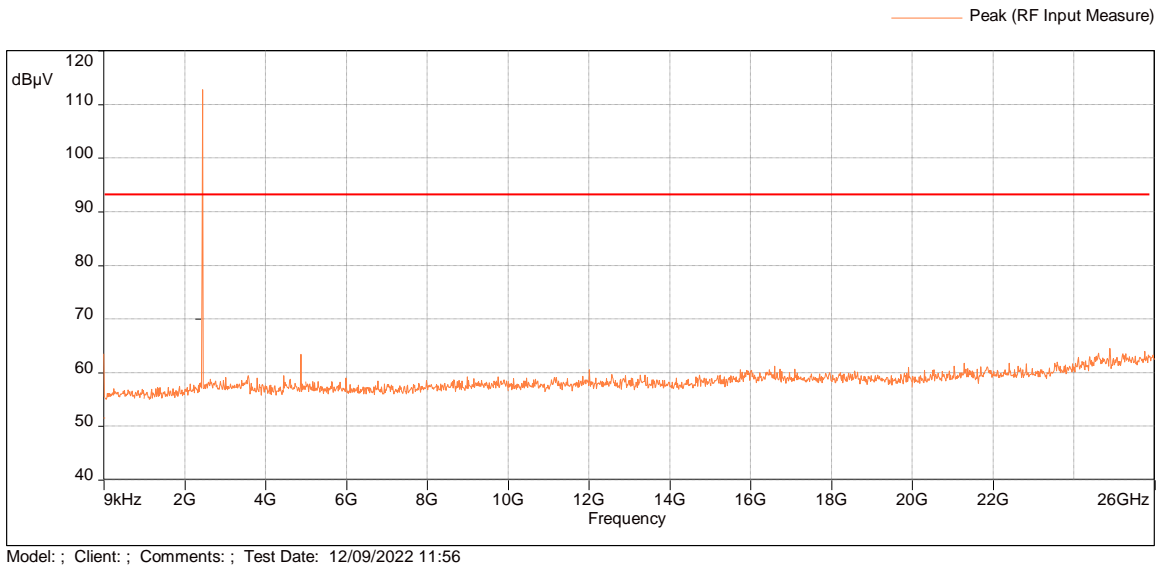
13:15:10 08.12.2022

Results	Complies
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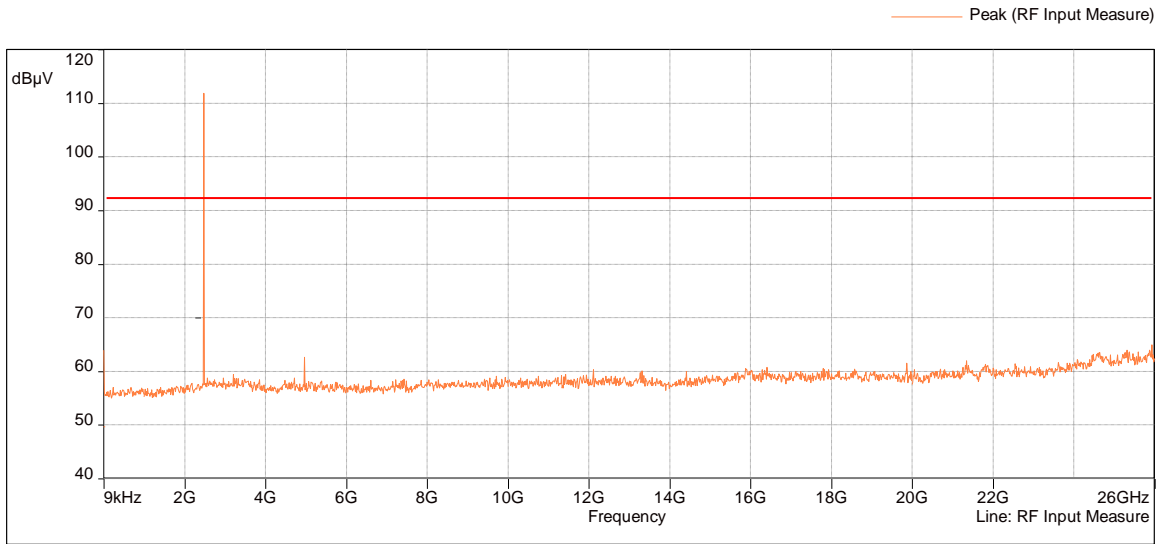
Tx @ Low Channel, 2402 MHz
9kHz -26GHz Conducted Spurious
Plot 4.3



Tx @ Mid Channel, 2440 MHz
9kHz -26GHz Conducted Spurious
Plot 4.4



Tx @ High Channel, 2480 MHz
9kHz -26GHz Conducted Spurious
Plot 4.5



Results	Complies
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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 9 kHz to 26.5 GHz according to the procedure described in ANSI C63.10: 2013. Spectrum Analyzer Resolution Bandwidth is 300Hz for frequencies 9kHz to 150kHz, 9kHz for frequencies 150kHz to 30MHz, 120 kHz 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 9kHz to 26.5GHz.

All measurements were made with a Peak Detector and compared to QP limits for 30MHz – 1GHz and Average limits for 1GHz – 26.5GHz.

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.

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 $dB(\mu V/m)$

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

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

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

$RA = 52.0\text{ dB}(\mu V)$

$AF = 7.4\text{ dB}(1/m)$

$CF = 1.6\text{ dB}$

$AG = 29.0\text{ dB}$

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

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

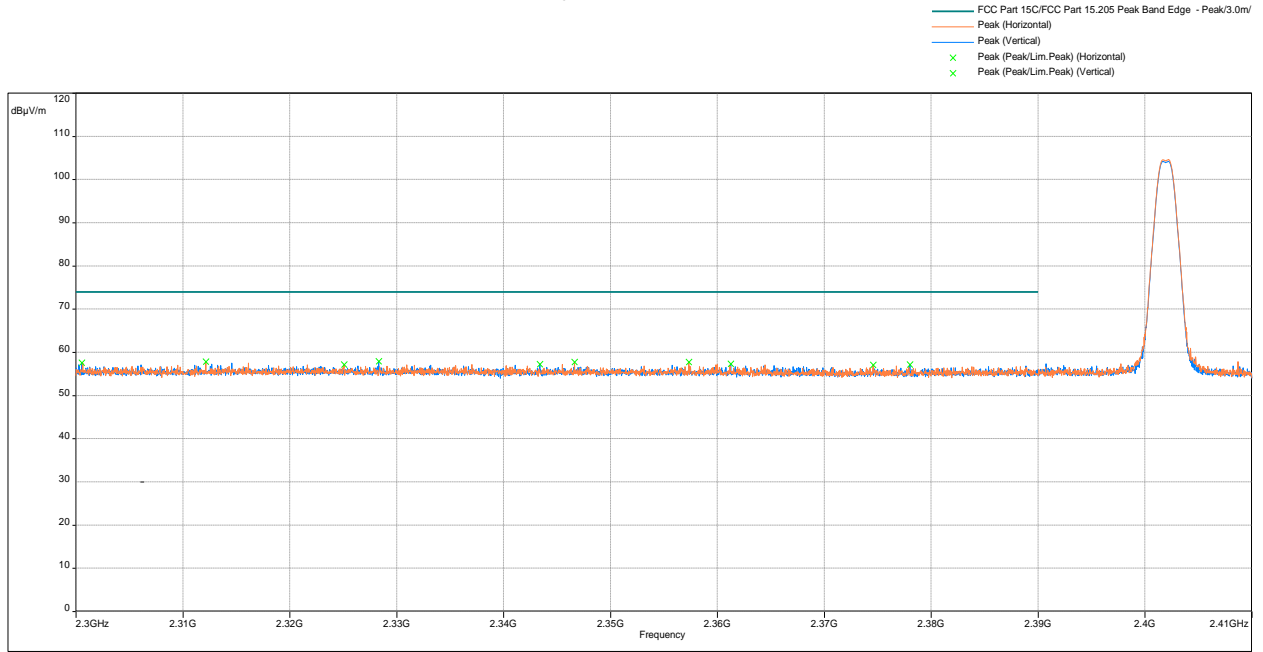
4.5.4 Test Results

All testing in this section were performed by radiated measurements.

Tested By	Test Date	Results
Erica Chan	November 30 – December 5, 2022	Complies

Test Results: 15.209/15.205 Radiated Restricted Band Emissions

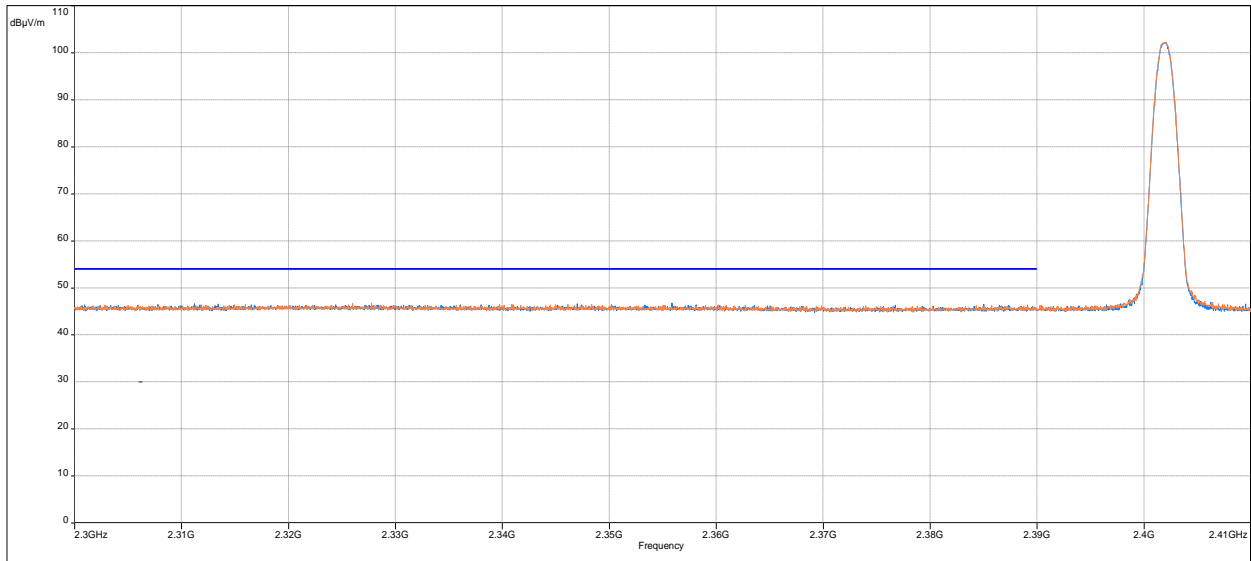
**Out-of-Band Radiated spurious emissions at the Band-edge @3m distance
2310–2390 MHz, Peak Scan with Peak Limit**



Freq. MHz	Peak@3m dB(µV/m)	Peak Limit dB(µV/m)	Margin dB	Height m	Azimuth deg	Polarity	Correction dB
2390	57.8	74.0	-16.2	1.75	232.5	Horizontal	8.8

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

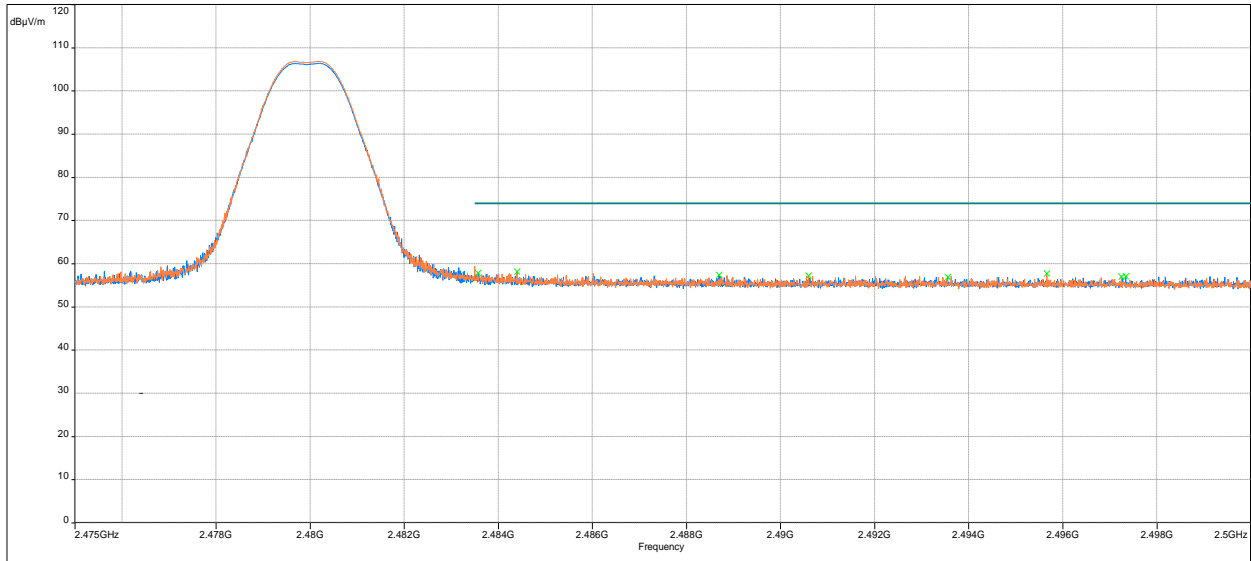
— FCC Part 15C/FCC Part 15.205 Avg Band Edge - Avg/3.0m/
— FCC Part 15C/FCC Part 15.205 Avg Band Edge - Q-Peak/3.0m/
— Peak (Horizontal)
— Peak (Vertical)



Freq. MHz	Average@3m dB(µV/m)	Average Limit dB(µV/m)	Margin dB	Height m	Azimuth deg	Polarity	Correction dB
2390	45.7	54.0	-8.3	1.75	232.5	Horizontal	8.8

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

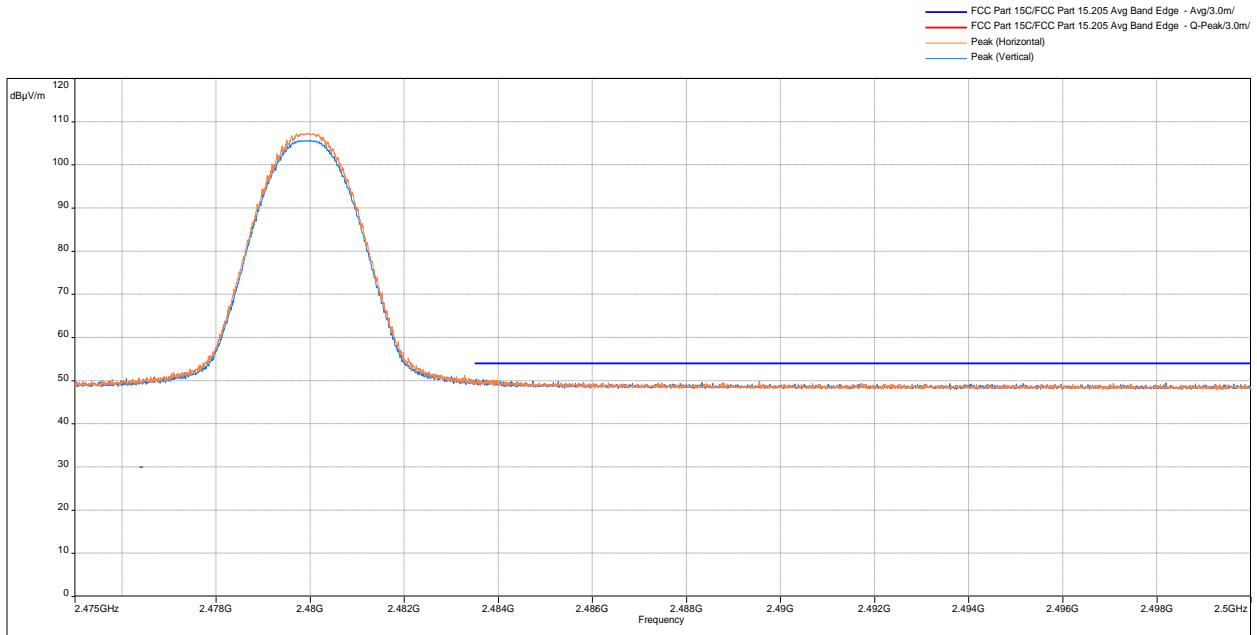
— FCC Part 15C/FCC Part 15.205 Peak Band Edge - Peak/3.0m/
— Peak (Horizontal)
— Peak (Vertical)
x Peak (Peak/Lim.Peak) (Horizontal)
x Peak (Peak/Lim.Peak) (Vertical)



Model: ; Client: ; Comments: ; Test Date: 12/05/2022 15:35

Freq. MHz	Peak@3m dB(µV/m)	Peak Limit dB(µV/m)	Margin dB	Height m	Azimuth deg	Polarity	Correction dB
2483.5	58.1	74.0	-15.9	1.80	196.0	Horizontal	9.1

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



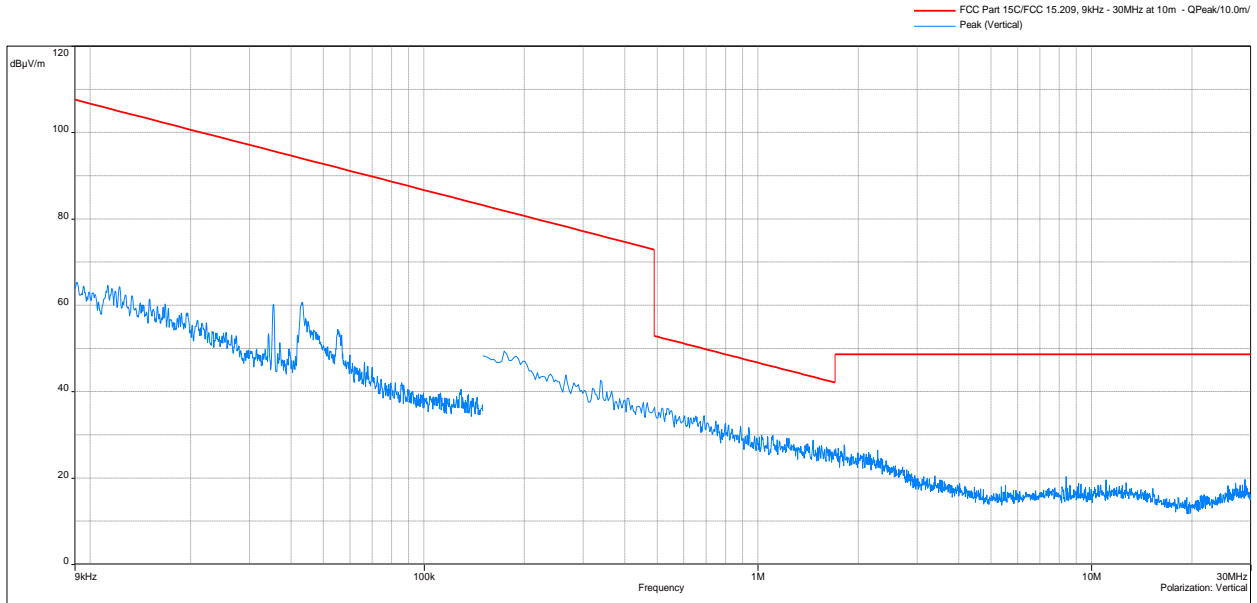
Freq. MHz	Peak@3m dB(uV/m)	Peak Limit dB(µV/m)	Margin dB	Height m	Azimuth deg	Polarity	Correction dB
2483.5	50.3	54.0	-3.7	1.80	196.0	Horizontal	9.1

Results **Complies**

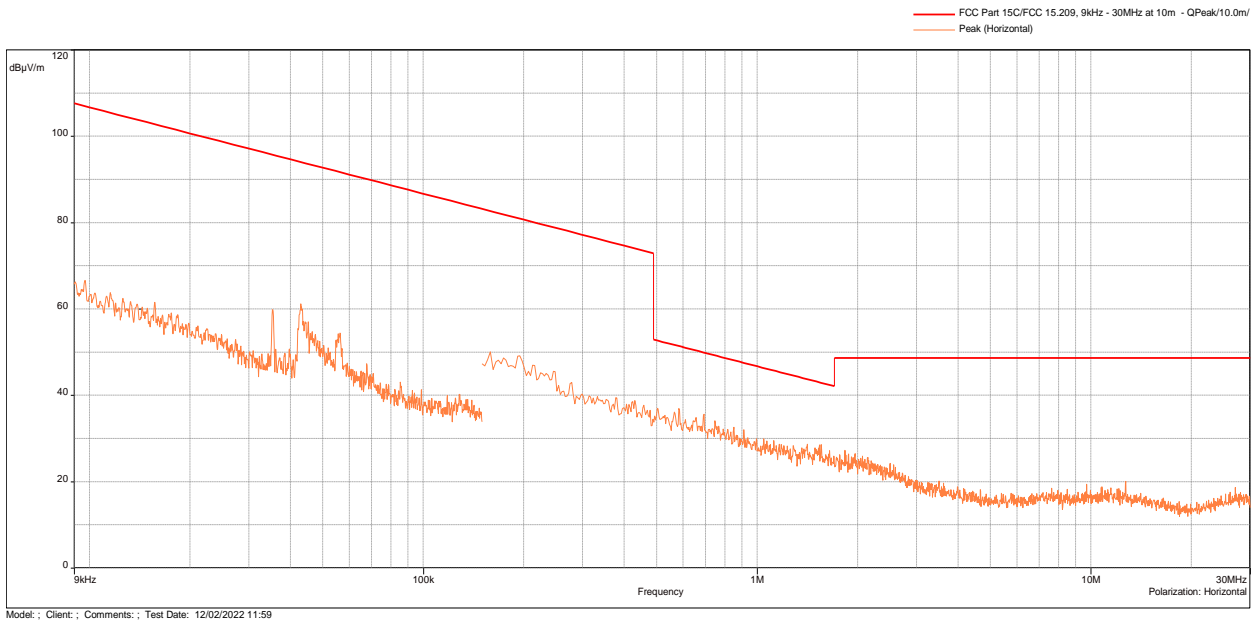
Out-of-Band Radiated Spurious Emissions

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

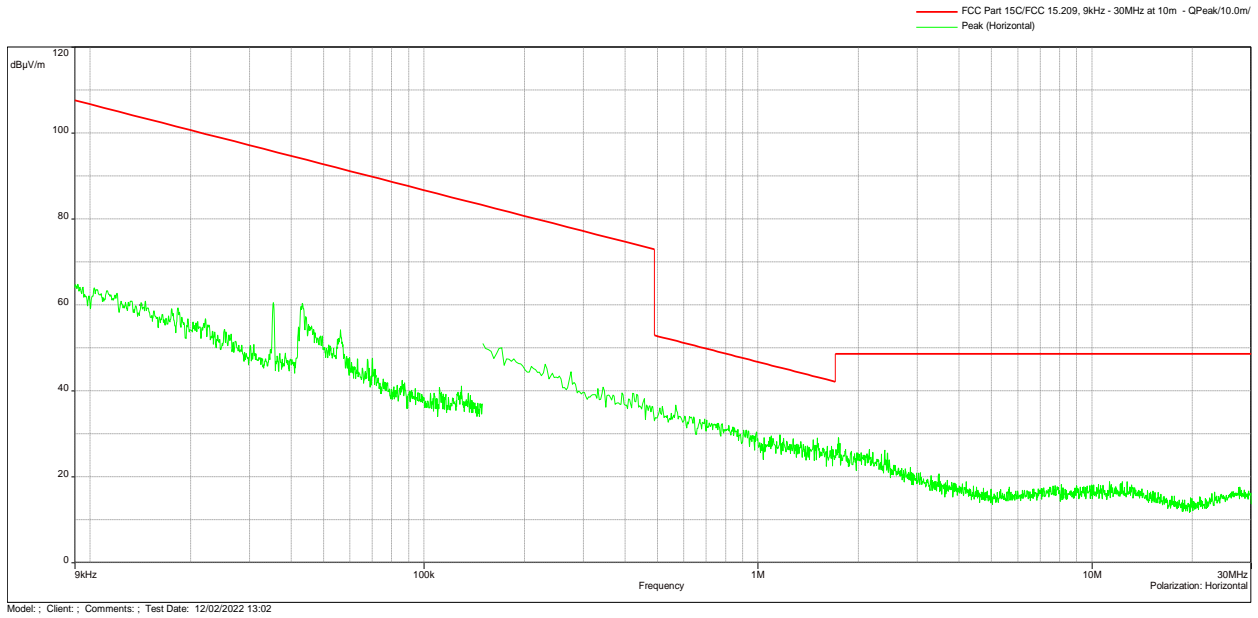
Radiated Spurious Emissions 9kHz - 30 MHz Parallel Antenna Polarization



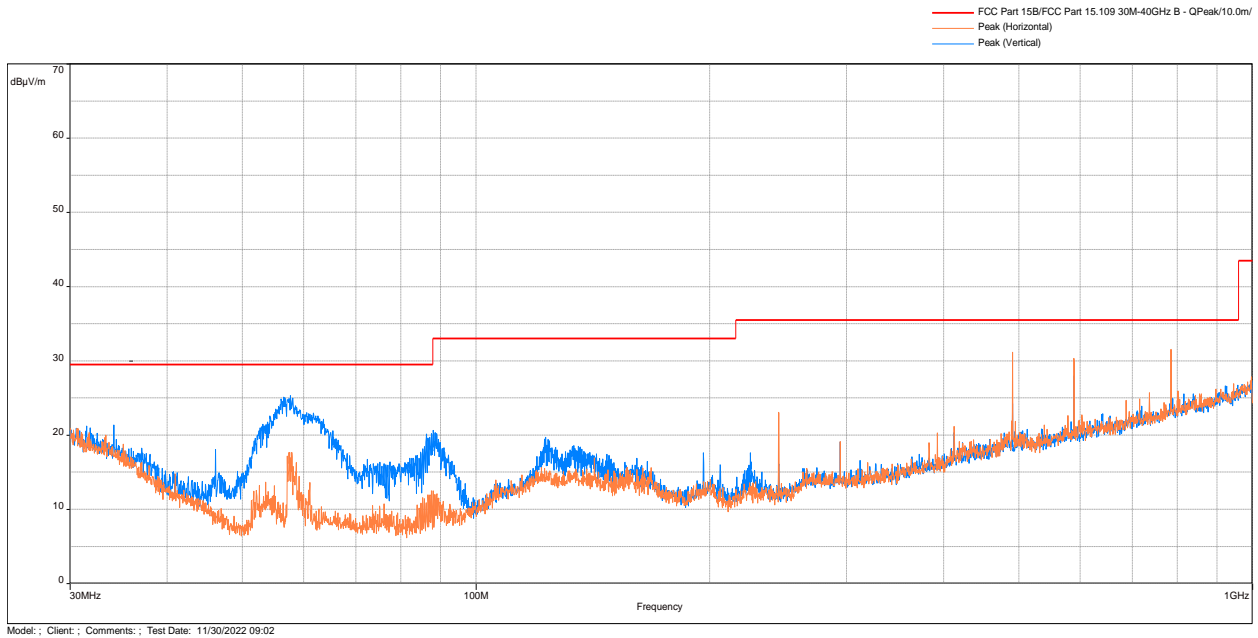
Radiated Spurious Emissions 9kHz - 30 MHz Perpendicular Antenna Polarization



Radiated Spurious Emissions 9kHz - 30 MHz Horizontal Antenna Polarization

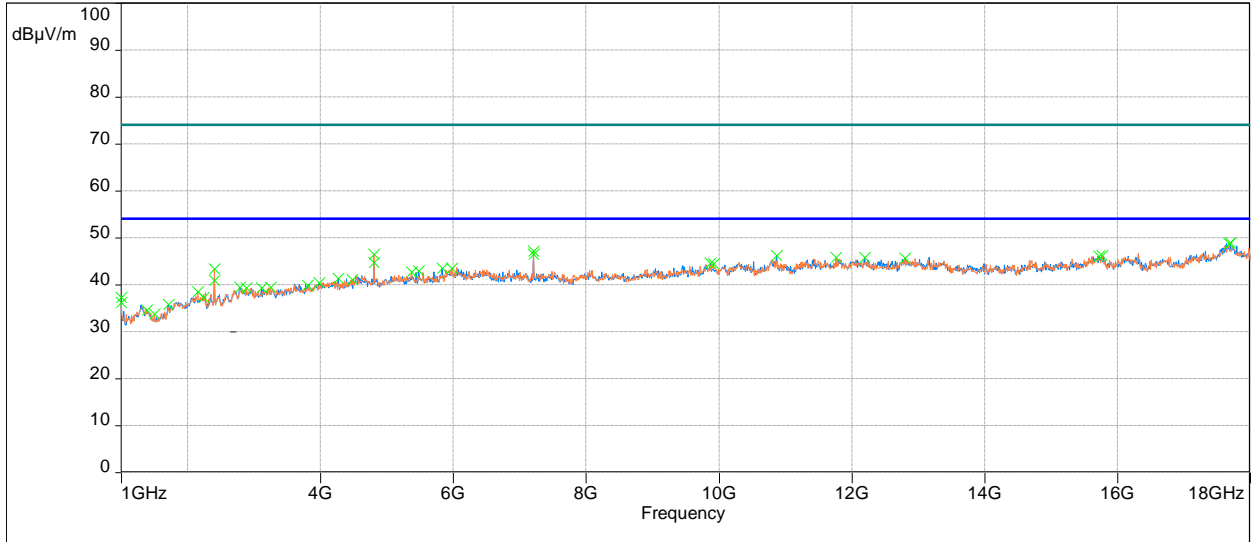


Radiated Spurious Emissions 30 MHz - 1000 MHz



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

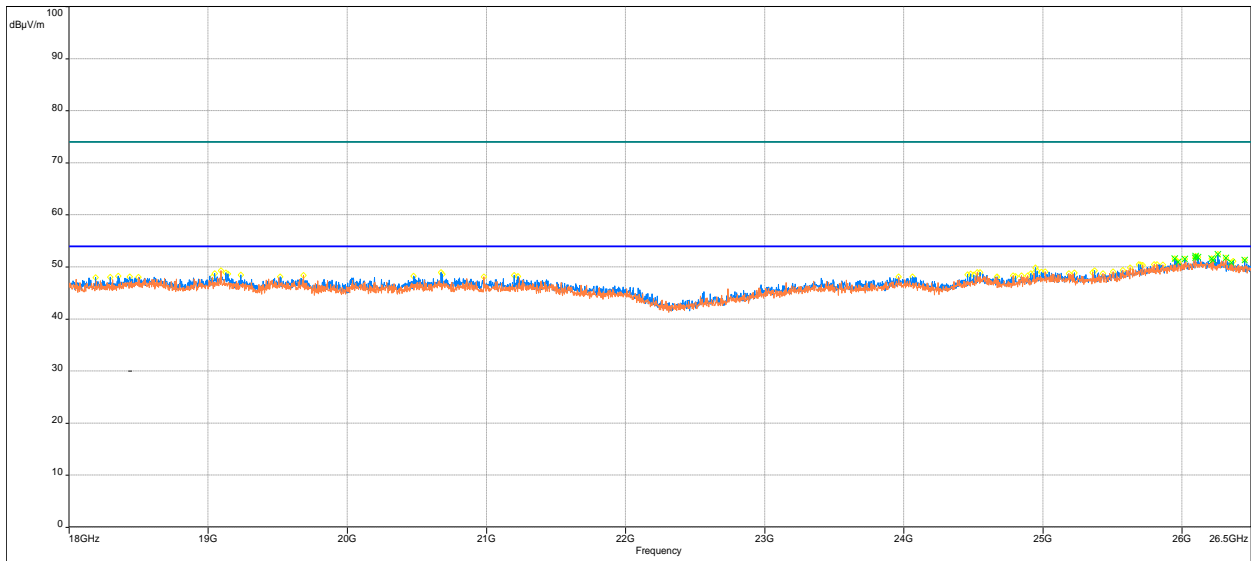
- FCC Part 15C/FCC Part 15.109 30M-40GHz B - Peak/3.0m/
- FCC Part 15C/FCC Part 15.209 1GHz to 40GHz - Avg/3.0m/
- Peak (Horizontal)
- Peak (Vertical)
- × Peak (Peak/Lim.Peak) (Horizontal)
- × Peak (Peak/Lim.Peak) (Vertical)



Model: ; Client: ; Comments: ; Test Date: 12/02/2022 16:51

Radiated Spurious Emissions 18 – 26.5 GHz, Peak Scan vs Peak & Average Limit

- FCC Part 15C/FCC Part 15.209 1GHz to 40GHz - Average/3.0m/
- FCC Part 15C/FCC Part 15.209 1GHz to 40GHz - Peak/3.0m/
- Peak (Horizontal)
- Peak (Vertical)
- ◇ Peak (Peak/Lim.Avg) (Horizontal)
- ◇ Peak (Peak/Lim.Avg) (Vertical)
- × Peak (Peak/Lim.Peak) (Horizontal)
- × peak (peak/lim.peak) (horizontal) (Vertical)



Model: ; Client: ; Comments: ; Test Date: 12/07/2022 12:39

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

Frequency (MHz)	QPeak @10m (dBµV/m)	Lim. QPeak @10m (dBµV/m)	Margin (dB)	Height (m)	Angle (°)	Comment	Correction (dB)
785.436	31.5	35.5	-4.0	0.99	331.25	Horizontal	-2.48
57.645	25.3	29.5	-4.2	0.98	352.75	Vertical	-19.8
490.879	31.2	35.5	-4.3	2	26.5	Horizontal	-7.29
589.076	30.3	35.5	-5.2	2	39.75	Horizontal	-6.2
34.171	21.3	29.5	-8.2	0.98	237.5	Vertical	-9.3
945.842	26.9	35.5	-8.6	0.99	316.75	Horizontal	0.2

Note: Correction = AF + CF - Preamp

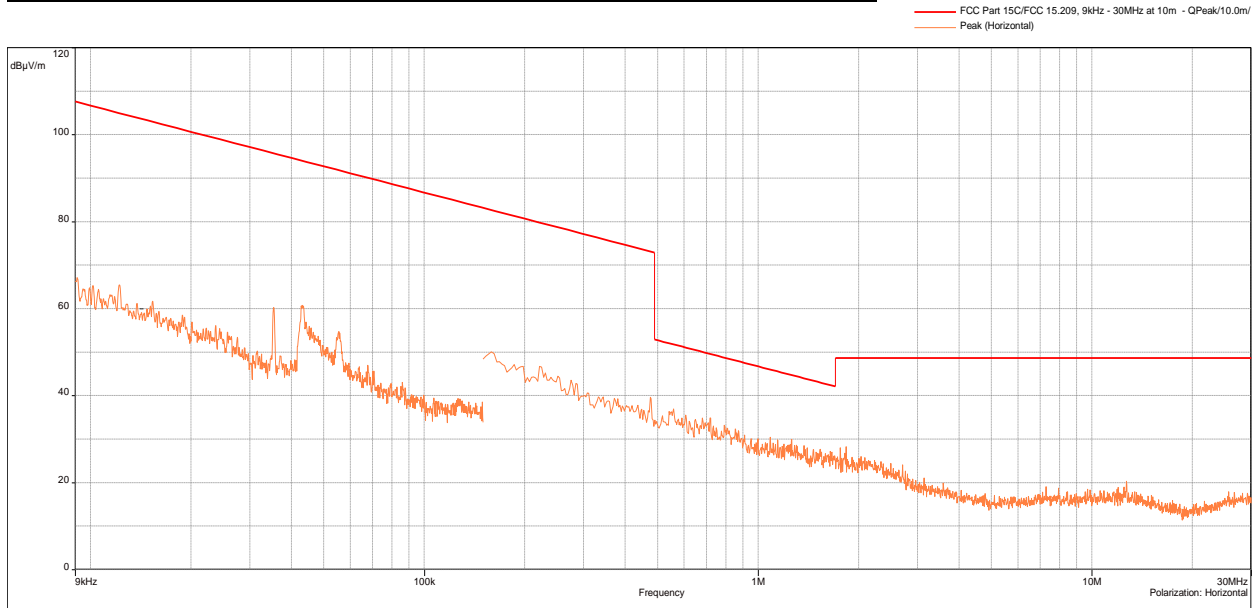
Frequency (MHz)	Peak @3m (dBµV/m)	Lim. Ave @3m (dBµV/m)	Margin dB	Height (m)	Angle (°)	Comment	Correction (dB)
4804.033	46.4	54.0	-7.6	1.01	0.0	Horizontal	-7.7
7206.700	47.1	54.0	-6.9	2.99	195.8	Horizontal	-5.3
17705.333	48.9	54.0	-5.1	1.01	58.8	Vertical	6.0
19091.967	52.4	74.0	-1.6	3.99	144.25	Vertical	2.7
26257.467	49.3	74.0	-4.7	3.99	70.25	Horizontal	-3.3

Note: Correction = AF + CF - Preamp

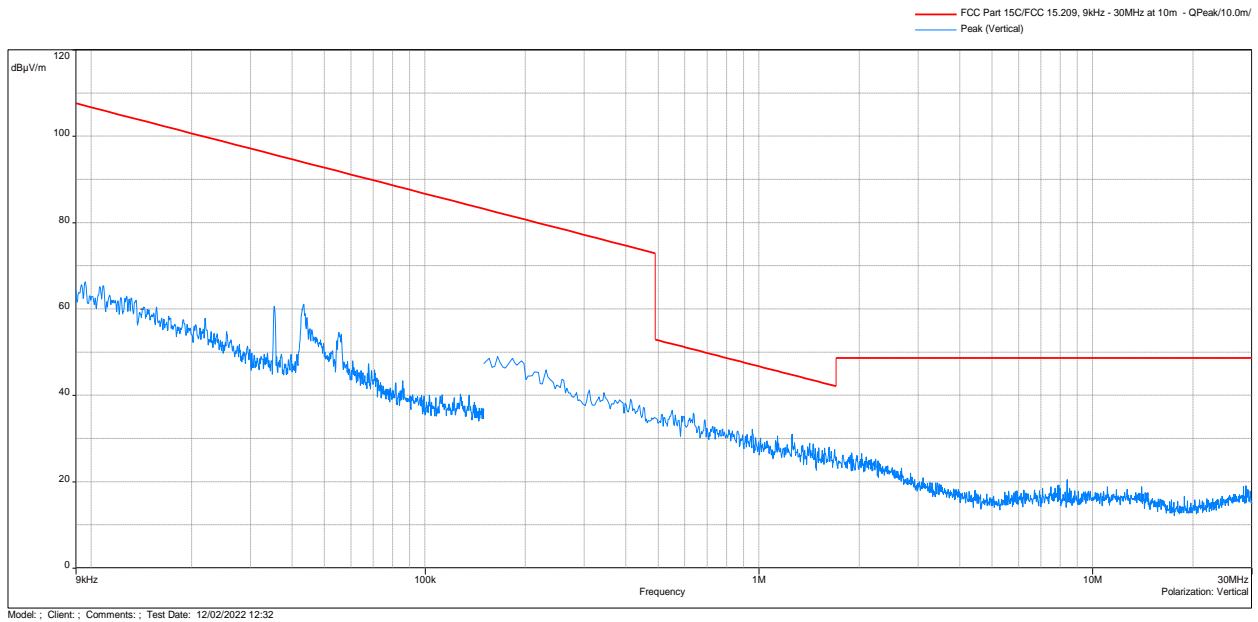
Results	Complies
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Test Results: 15.209 Radiated Spurious Emissions Mid Channel, Tx at 2440 MHz

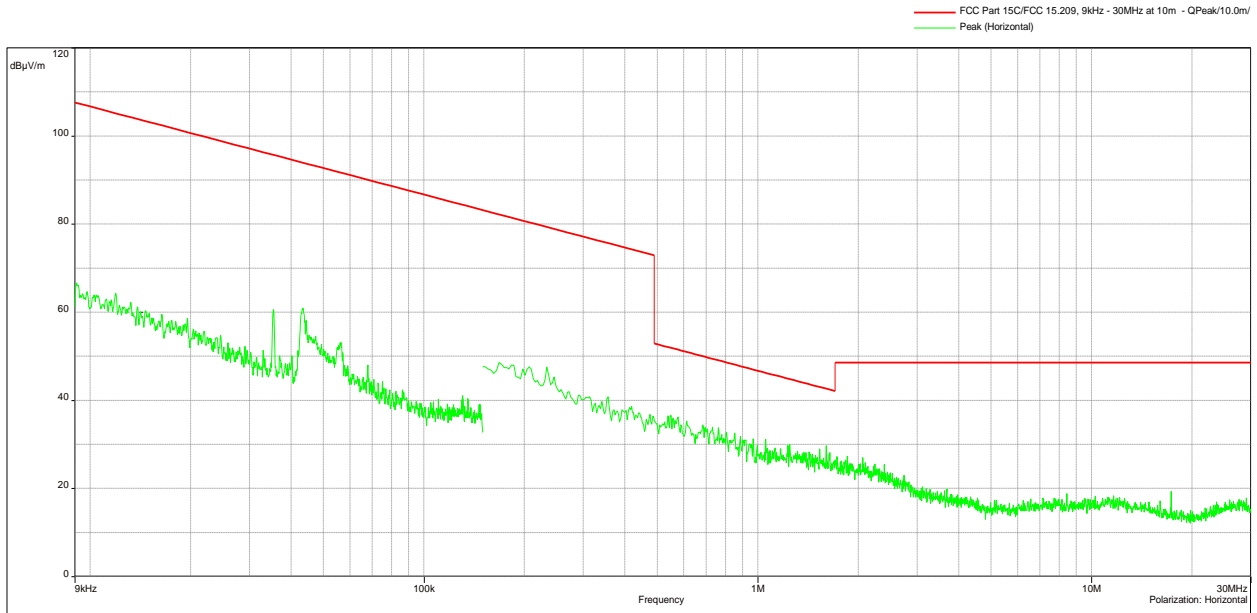
Radiated Spurious Emissions 9kHz - 30 MHz Parallel Antenna Polarization



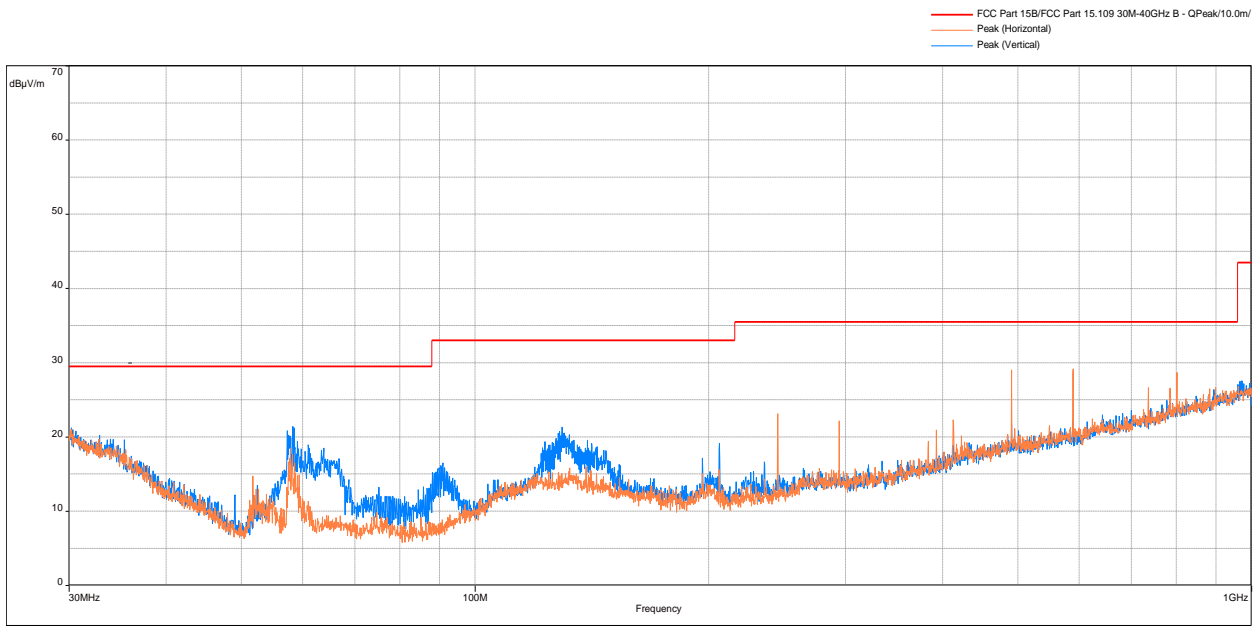
Radiated Spurious Emissions 9kHz - 30 MHz Perpendicular Antenna Polarization



Radiated Spurious Emissions 9kHz - 30 MHz Horizontal Antenna Polarization

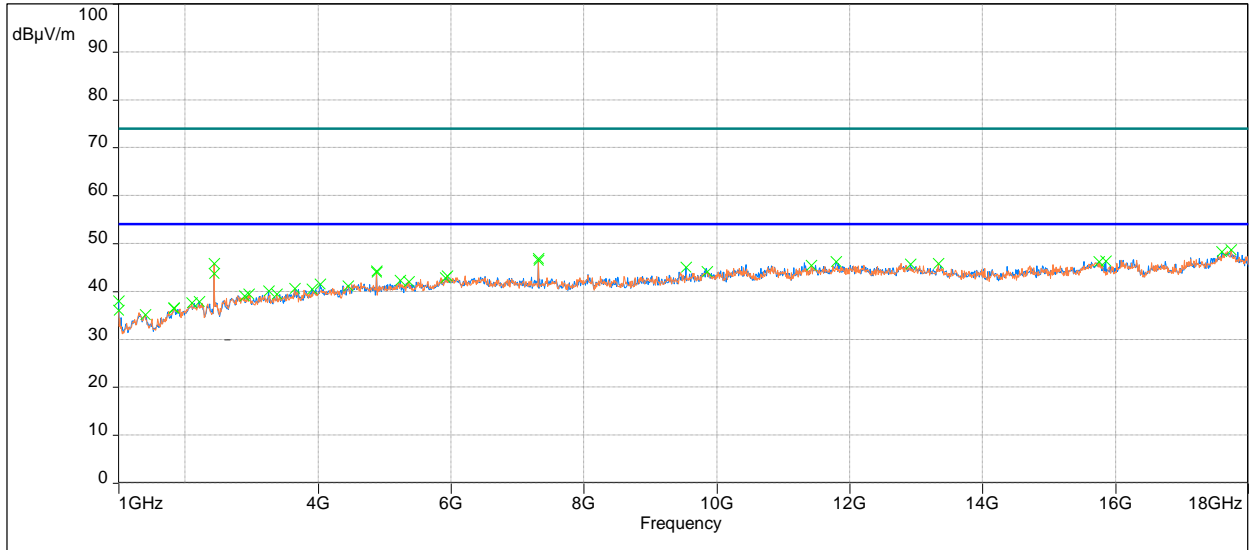


Radiated Spurious Emissions 30 MHz - 1000 MHz



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

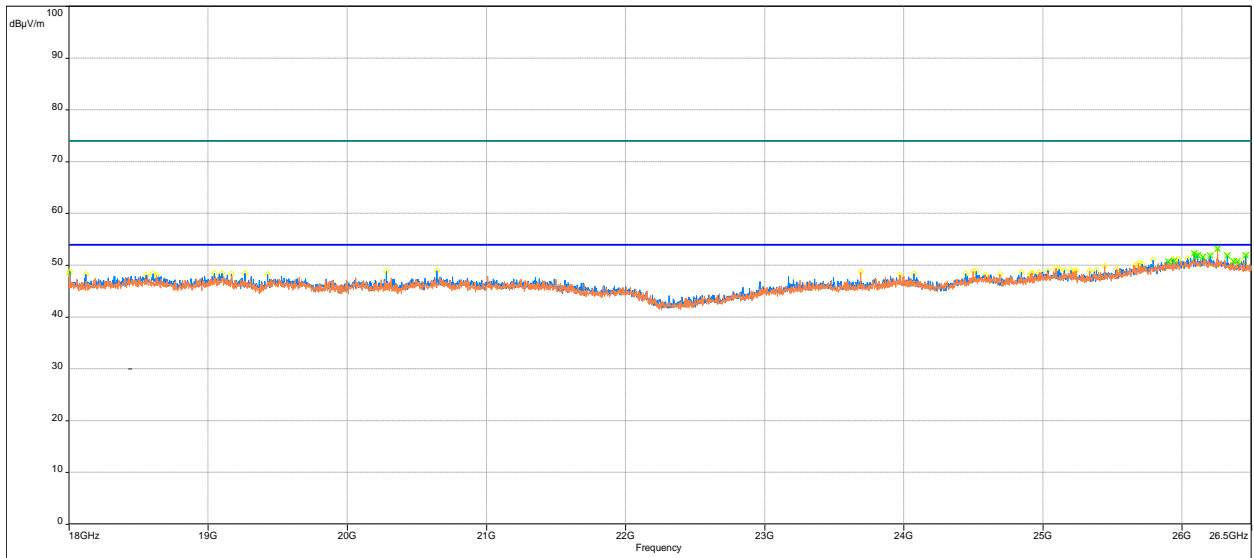
- FCC Part 15C/FCC Part 15.109 30M-40GHz B - Peak/3.0m/
- FCC Part 15C/FCC Part 15.209 Only, 30MHz-40GHz - Avg/3.0m/
- FCC Part 15C/ FCC Part 15.209 Peak & Avg B - Q-Peak/3.0m/
- Peak (Horizontal)
- Peak (Vertical)
- × Peak (Peak/Lim.Peak) (Horizontal)
- × Peak (Peak/Lim.Peak) (Vertical)



Model: ; Client: ; Comments: ; Test Date: 12/02/2022 16:27

Radiated Spurious Emissions 18 – 26.5 GHz, Peak Scan vs Peak & Average Limit

- FCC Part 15C/FCC Part 15.209 1GHz to 40GHz - Average/3.0m/
- FCC Part 15C/FCC Part 15.209 1GHz to 40GHz - Peak/3.0m/
- Peak (Horizontal)
- Peak (Vertical)
- Peak (Peak/Lim.Avg) (Horizontal)
- Peak (Peak/Lim.Avg) (Vertical)
- × Peak (Peak/Lim.Peak) (Horizontal)
- × Peak (Peak/Lim.Peak) (Vertical)



Model: ; Client: ; Comments: ; Test Date: 12/07/2022 12:54

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

Frequency (MHz)	QPeak @10m (dBμV/m)	Lim. QPeak @10m (dBμV/m)	Margin (dB)	Height (m)	Angle (°)	Comment	Correction (dB)
589.108	29.2	35.5	-6.3	3.00	0.0	Horizontal	-6.2
490.912	29.0	35.5	-6.5	2.00	59.3	Horizontal	-7.3
801.861	28.7	35.5	-6.8	0.96	352.5	Horizontal	-2.5
58.259	21.4	29.5	-8.1	3.00	36.3	Vertical	-19.8
30.226	21.2	29.5	-8.3	2.00	117.0	Vertical	-6.5
898.732	26.7	35.5	-8.9	4.00	234.5	Horizontal	-0.5
736.386	26.6	35.5	-8.9	0.96	334.5	Horizontal	-3.5

Note: Correction = AF + CF – Preamp

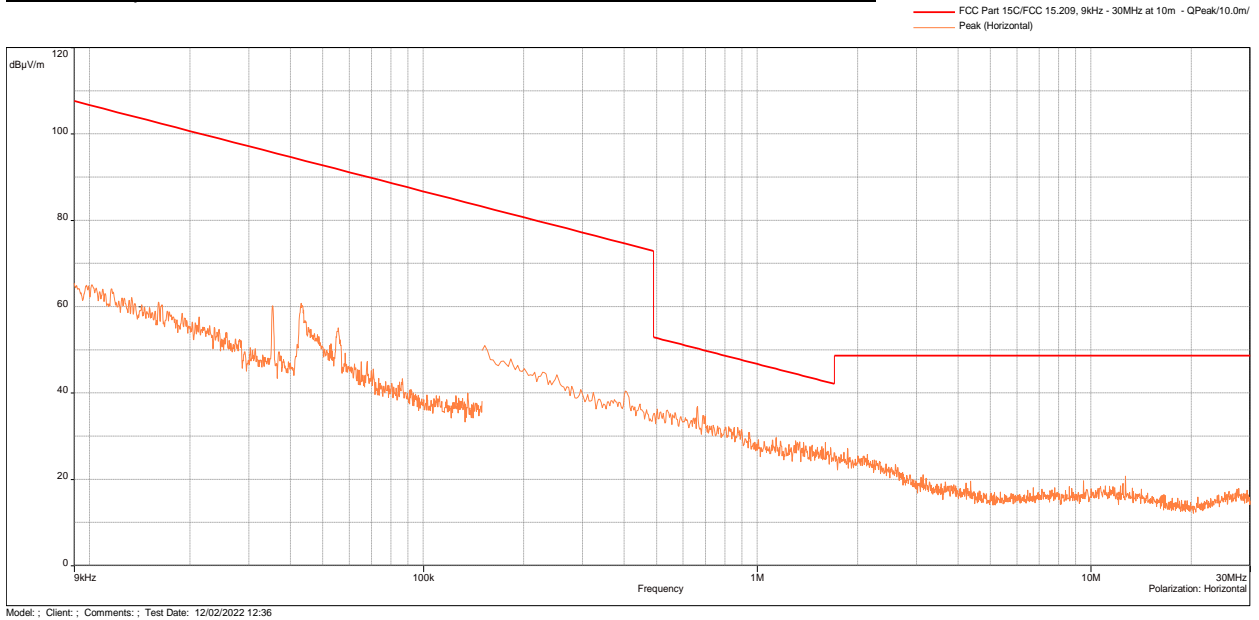
Frequency (MHz)	Peak @3m (dBμV/m)	Lim. Ave @3m (dBμV/m)	Margin dB	Height (m)	Angle (°)	Comment	Correction (dB)
1000.000	38.0	54.0	-36.0	1.00	19.0	Vertical	-17.0
4879.400	44.3	54.0	-29.7	3.01	300.5	Horizontal	-7.7
7318.900	46.8	54.0	-27.2	3.01	197.5	Horizontal	-5.0
17737.067	48.7	54.0	-25.3	2.01	359.8	Horizontal	5.9
20281.400	48.8	54.0	-5.2	1.01	9.5	Vertical	-3.9
26086.333	52.3	54.0	-1.7	3.99	123.0	Vertical	3.2
26256.050	53.2	54.0	-0.8	3.01	117.5	Horizontal	2.7

Note: Correction = AF + CF - Preamp

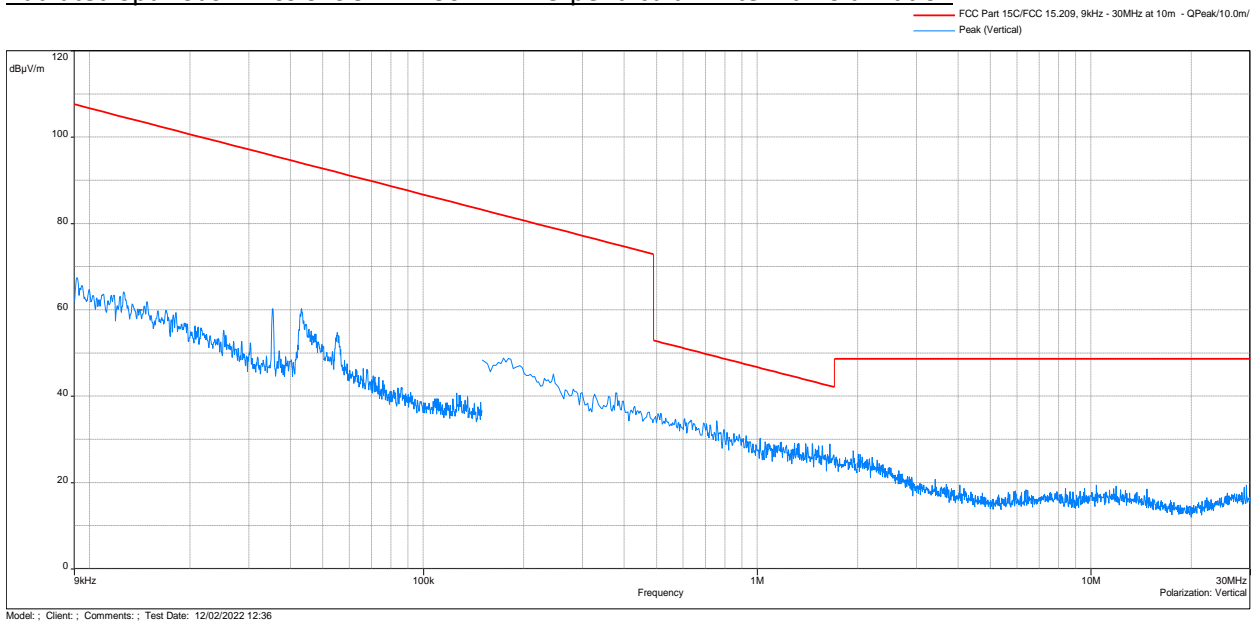
Results	Complies
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Test Results: 15.209 Radiated Spurious Emissions High Channel, Tx at 2480MHz

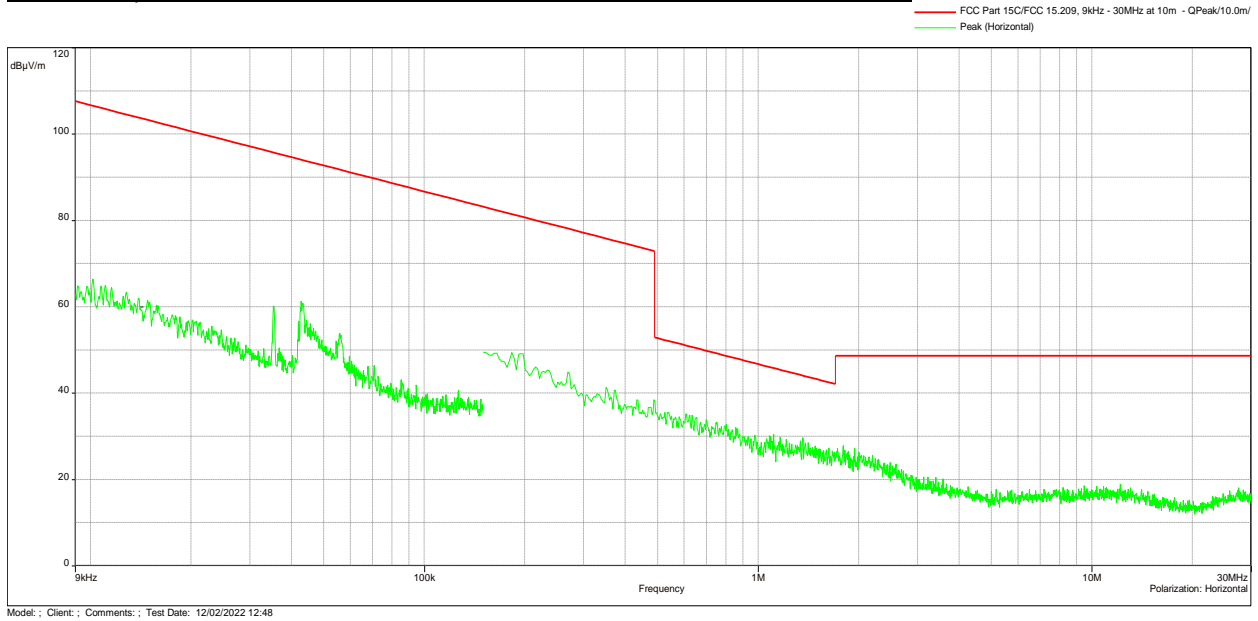
Radiated Spurious Emissions 9kHz - 30 MHz Parallel Antenna Polarization



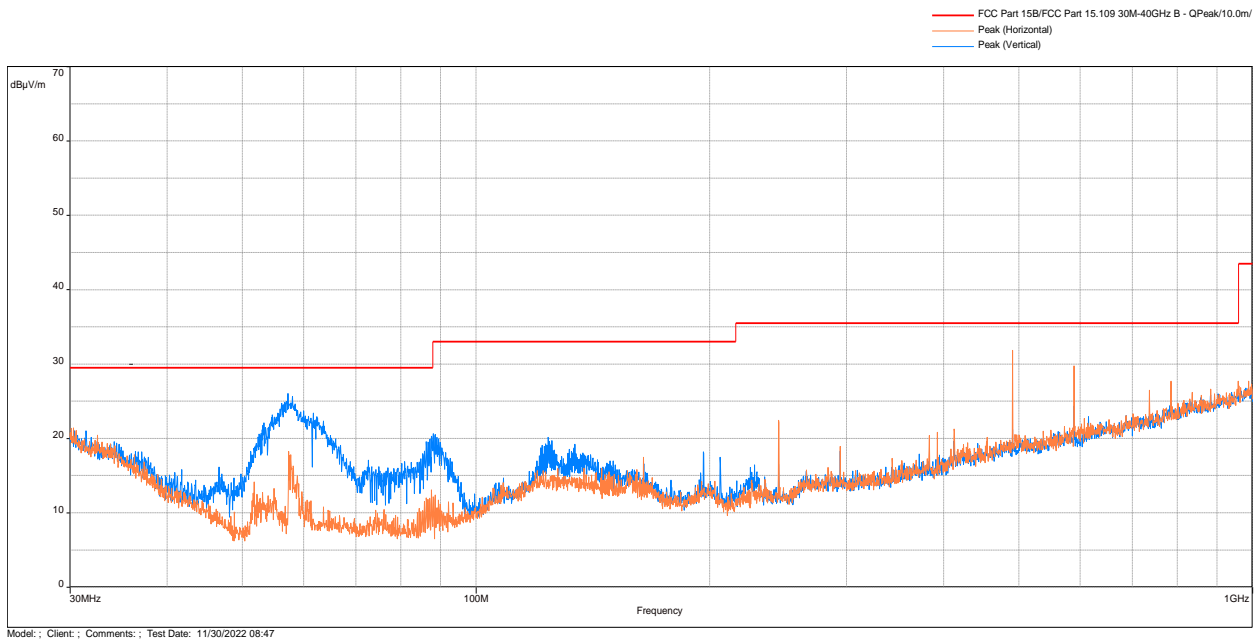
Radiated Spurious Emissions 9kHz - 30 MHz Perpendicular Antenna Polarization



Radiated Spurious Emissions 9kHz - 30 MHz Horizontal Antenna Polarization

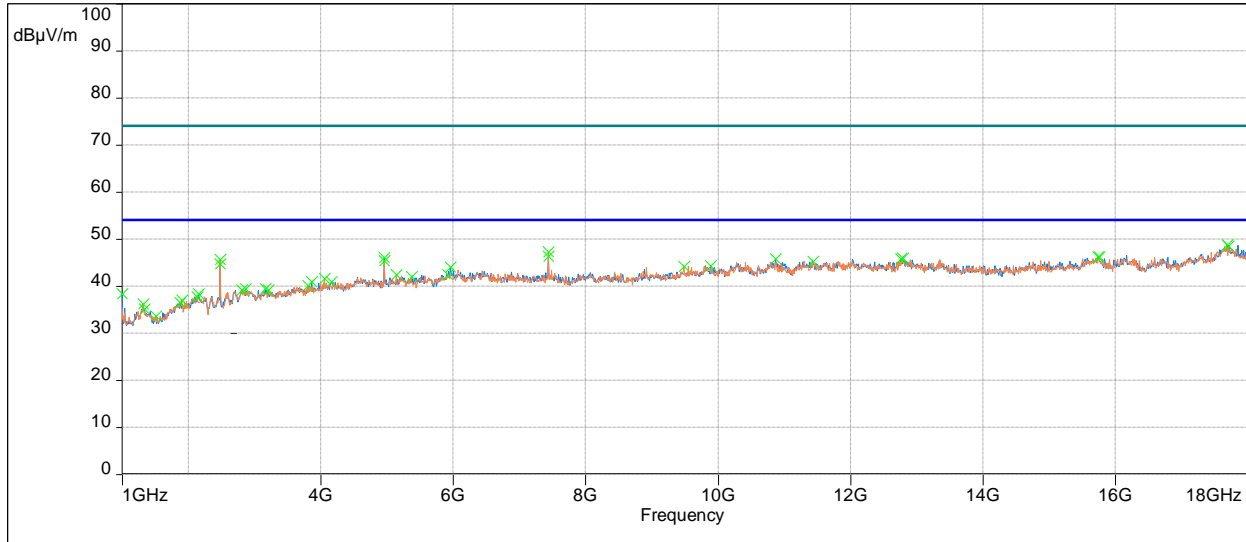


Radiated Spurious Emissions 30 MHz - 1000 MHz



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

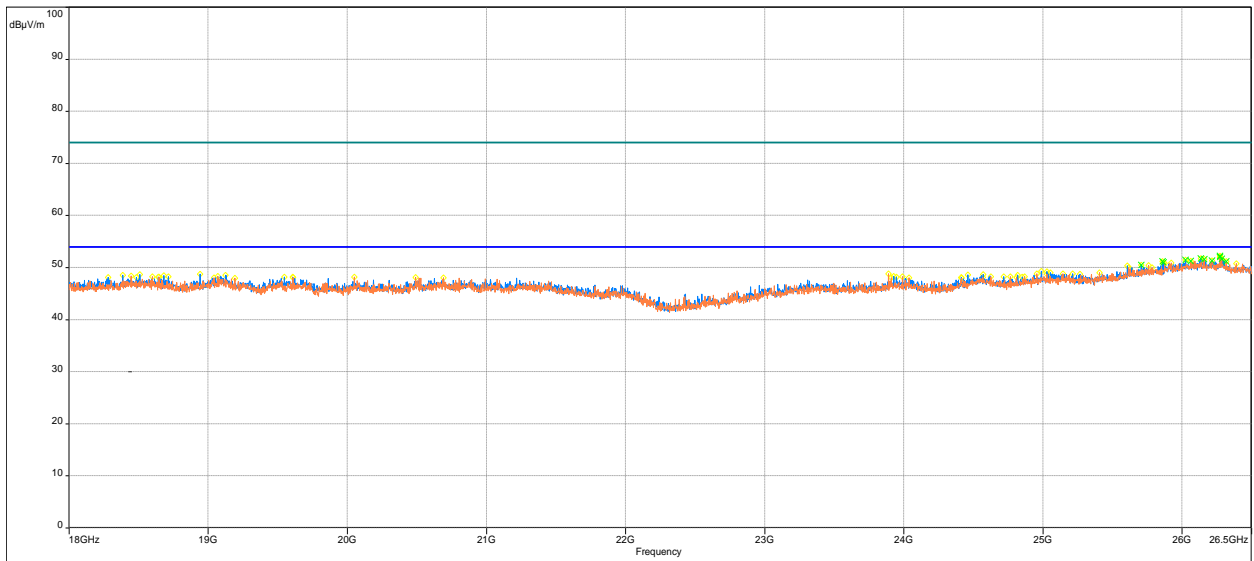
- FCC Part 15C/FCC Part 15.109 30M-40GHz B - Peak/3.0m/
- FCC Part 15C/FCC Part 15.209 Only, 30MHz-40GHz - Avg/3.0m/
- Peak (Horizontal)
- Peak (Vertical)
- × Peak (Peak/Lim.Peak) (Horizontal)
- × Peak (Peak/Lim.Peak) (Vertical)



Model: ; Client: ; Comments: ; Test Date: 12/02/2022 17:10

Radiated Spurious Emissions 18 - 26 GHz, Peak Scan vs Peak & Average Limit

- FCC Part 15C/FCC Part 15.209 1GHz to 40GHz - Average/3.0m/
- FCC Part 15C/FCC Part 15.209 1GHz to 40GHz - Peak/3.0m/
- Peak (Horizontal)
- Peak (Vertical)
- ◇ Peak (Peak/Lim.Avg) (Horizontal)
- ◇ Peak (Peak/Lim.Avg) (Vertical)
- × Peak (Peak/Lim.Peak) (Horizontal)
- × Peak (Peak/Lim.Peak) (Vertical)



Model: ; Client: ; Comments: ; Test Date: 12/07/2022 13:07

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

Frequency (MHz)	QPeak @10m (dBµV/m)	Lim. QPeak @10m (dBµV/m)	Margin (dB)	Height (m)	Angle (°)	Comment	Correction (dB)
30.323	21.4	29.5	-8.1	1.00	312.5	Horizontal	-6.6
57.289	26.0	29.5	-3.5	4.00	188.0	Vertical	-19.8
490.879	31.8	35.5	-3.7	1.98	48.5	Horizontal	-7.3
589.076	29.8	35.5	-5.8	1.00	234.3	Horizontal	-6.2
785.468	27.7	35.5	-7.8	3.01	340.3	Horizontal	-2.5
958.322	27.7	35.5	-7.8	3.01	206.0	Horizontal	0.6

Note: Correction = AF + CF – Preamp

Frequency (MHz)	Ave @3m (dBµV/m)	Lim. Ave @3m (dBµV/m)	Margin (dB)	Height (m)	Angle (°)	Comment	Correction (dB)
1000.000	38.4	54.0	-15.6	1.01	177	Vertical	-17.0
4959.867	46.1	54.0	-7.9	1.99	190.5	Vertical	-7.6
7439.033	47.3	54.0	-6.7	3.01	214.5	Horizontal	-4.6
17694.000	48.8	54.0	-5.2	1.01	0	Vertical	6.0
18941.800	48.8	54.0	-5.2	1.99	76.3	Vertical	-3.1
26273.617	52.3	54.0	-1.8	3.99	192.8	Vertical	2.6

Note: Correction = AF + CF - Preamp

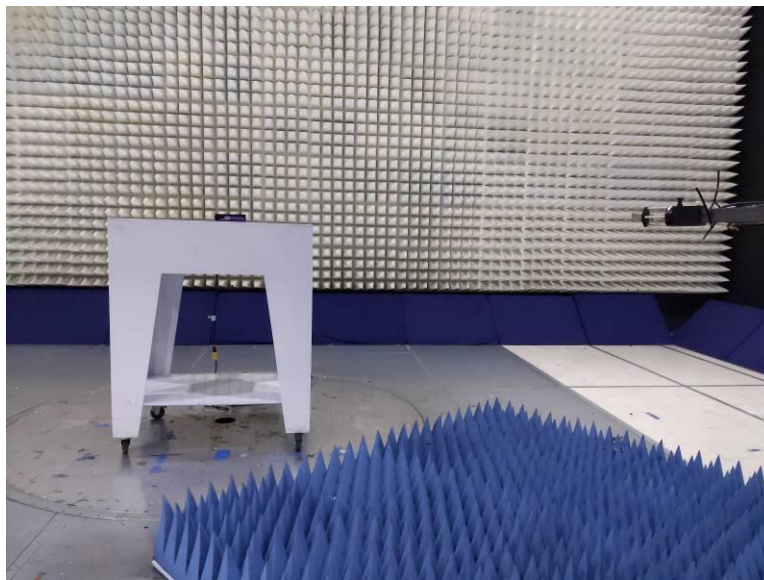
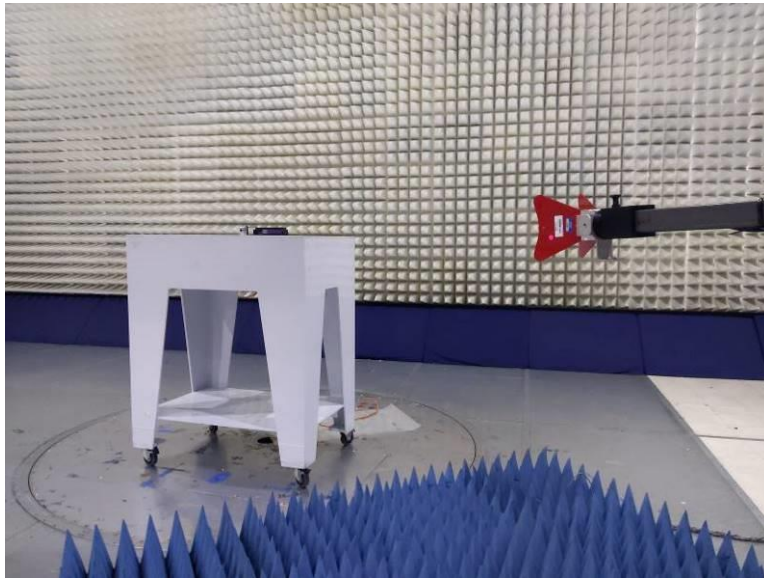
Results	Complies
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4.5.5 Test Setup Configuration

The following photographs show the testing configurations used.



4.5.5 Test Setup Configuration (Continued)



4.6 AC Line Conducted Emission

FCC: 15.207; RSS-GEN;

4.6.1 Requirement

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

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

4.6.2 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.

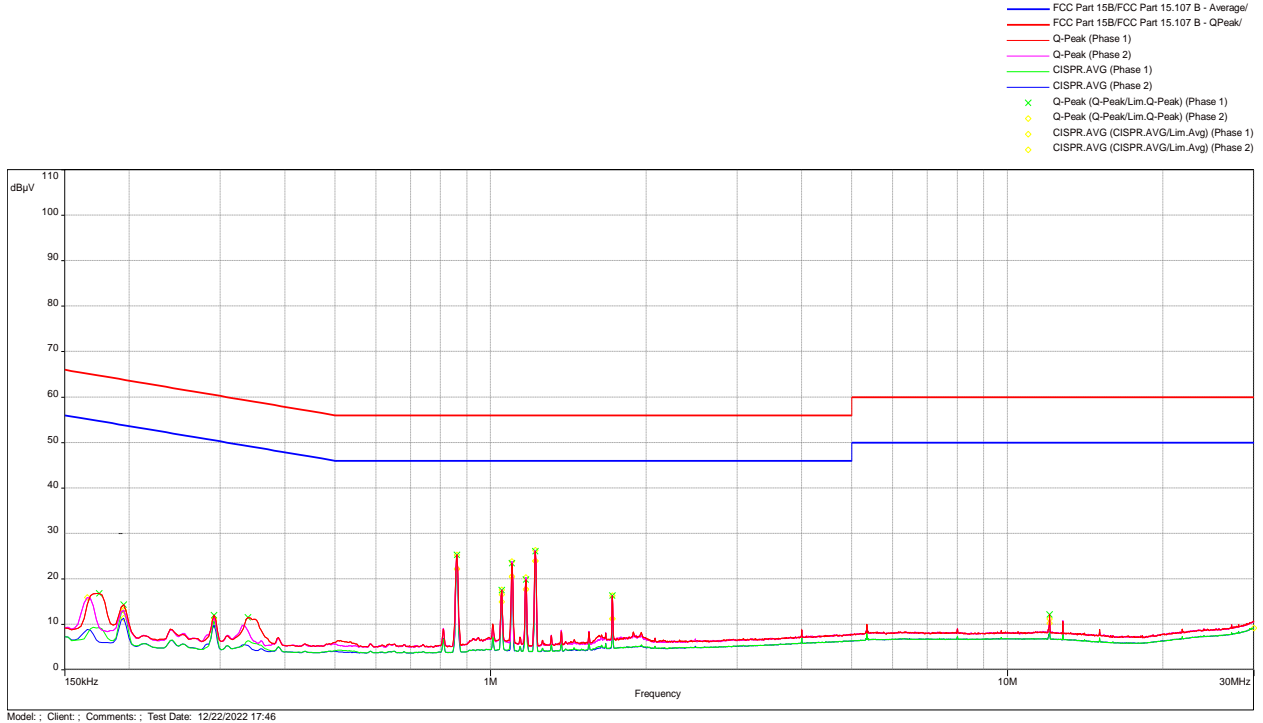
Floor standing EUT are placed on a horizontal metal ground plane and isolated from the ground plane by resting on an insulating material. The metal ground plane extends at least 0.5m beyond the boundaries of the EUT and has minimum dimensions of 2m by 2m.

Equipment setup for conducted disturbance tests followed the guidelines of ANSI C63.10-2013.

4.6.3 Test Result

FCC Part 15.207 Conducted Disturbances, 120V 60Hz

Conducted Emissions, 150kHz – 30 MHz, Low Channel, Tx at 2402 MHz



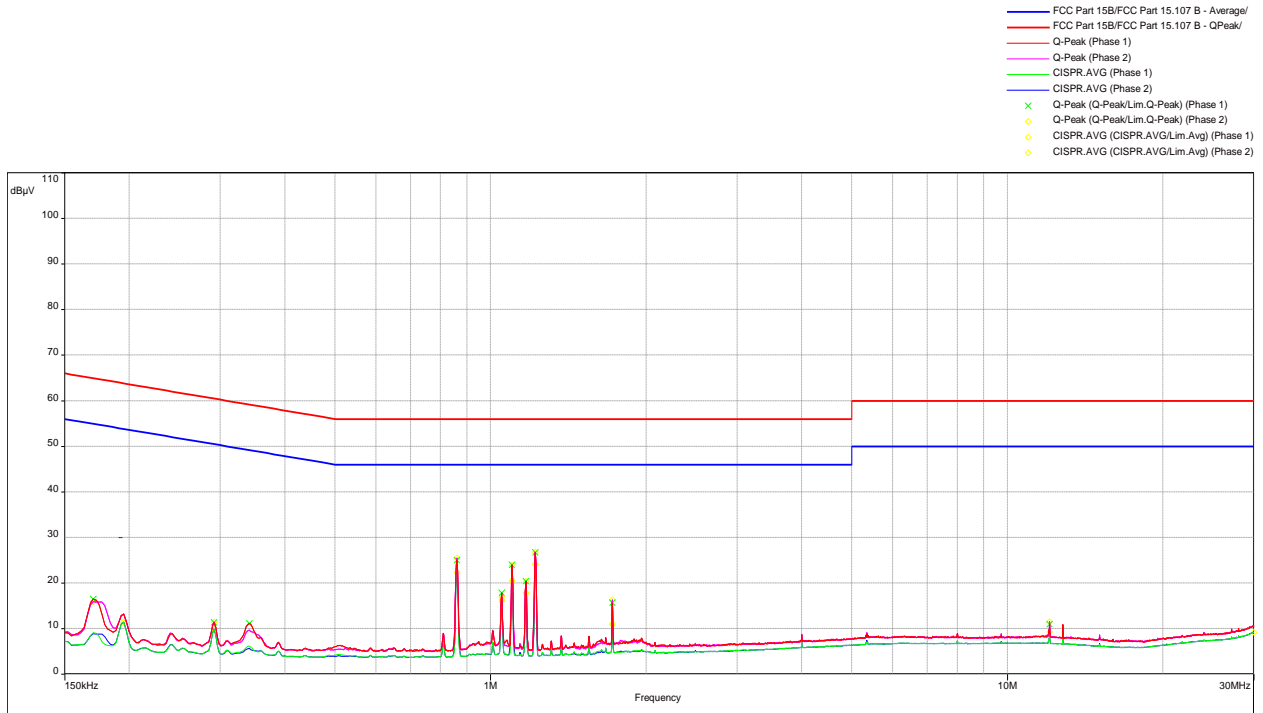
Quasi Peak

Freq. MHz	QP dB(μV)	QP Limit dB(μV/m)	Margin dB	Line	Correction dB
1.221	26.3	56.0	-29.7	Phase 2	10.6
1.221	26.1	56.0	-29.9	Phase 1	10.6
0.861	25.3	56.0	-30.7	Phase 1	10.6
0.861	25.2	56.0	-30.8	Phase 2	10.6
1.100	23.8	56.0	-32.2	Phase 2	10.6
1.100	23.4	56.0	-32.6	Phase 1	10.6
1.169	20.3	56.0	-35.7	Phase 2	10.6
1.169	19.9	56.0	-36.1	Phase 1	10.6
1.050	17.6	56.0	-38.4	Phase 2	10.6
1.050	17.5	56.0	-38.5	Phase 1	10.6
1.721	16.4	56.0	-39.7	Phase 1	10.6
1.721	16.3	56.0	-39.7	Phase 2	10.6

CISPR Average

Freq. MHz	CISPR Avg dB(μV)	Avg Limit dB(μV/m)	Margin dB	Line	Correction dB
1.221	24.0	46.0	-22.0	Phase 2	10.6
1.221	23.9	46.0	-22.1	Phase 1	10.6
0.861	22.3	46.0	-23.7	Phase 2	10.6
0.861	22.2	46.0	-23.9	Phase 1	10.6
1.100	20.6	46.0	-25.4	Phase 1	10.6
1.100	20.5	46.0	-25.5	Phase 2	10.6
1.169	17.8	46.0	-28.2	Phase 2	10.6
1.169	17.7	46.0	-28.3	Phase 1	10.6
1.050	16.6	46.0	-29.5	Phase 1	10.6
1.050	15.0	46.0	-31.1	Phase 2	10.6
1.721	11.3	46.0	-34.7	Phase 1	10.6
1.721	11.2	46.0	-34.8	Phase 2	10.6

Conducted Emissions, 150kHz – 30 MHz, Mid Channel, Tx at 2440 MHz



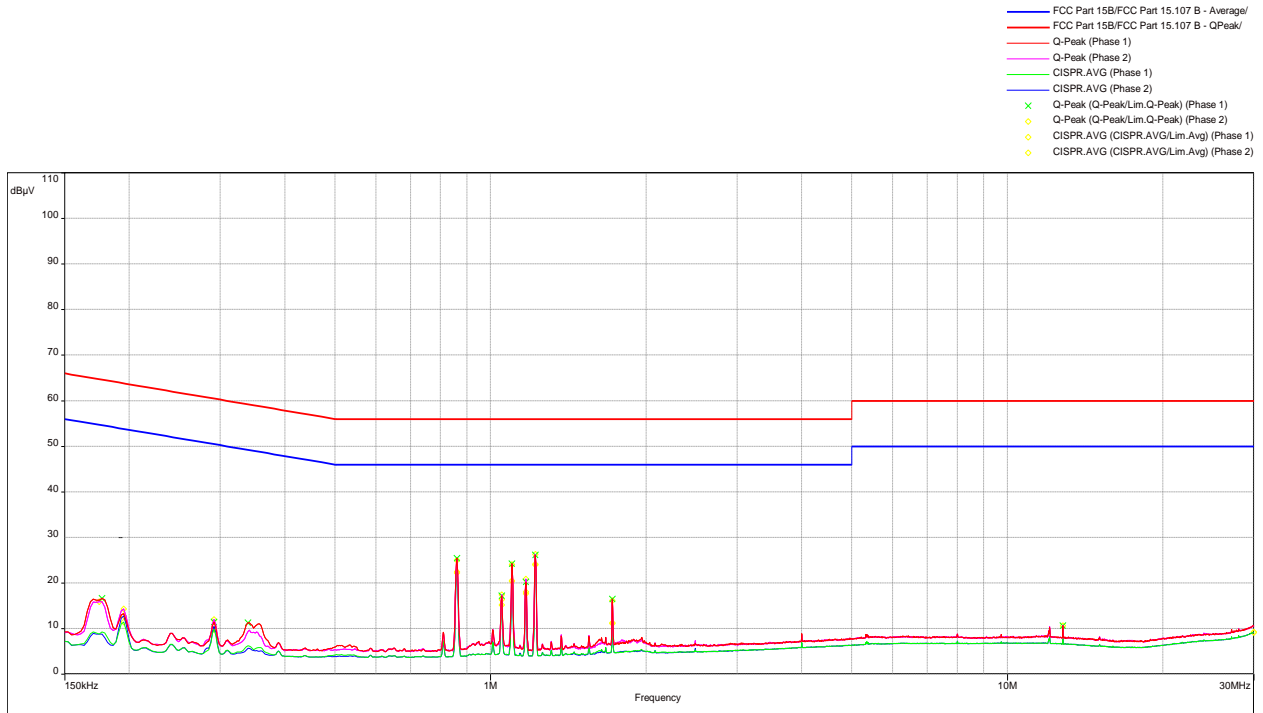
Quasi Peak

Freq. MHz	QP dB(μV)	QP Limit dB(μV/m)	Margin dB	Line	Correction dB
1.221	26.8	56.0	-29.2	Phase 2	10.6
1.221	26.7	56.0	-29.3	Phase 1	10.6
0.861	25.5	56.0	-30.5	Phase 2	10.6
0.861	25.1	56.0	-31.0	Phase 1	10.6
1.100	24.0	56.0	-32.0	Phase 1	10.6
1.100	23.9	56.0	-32.1	Phase 2	10.6
1.169	20.4	56.0	-35.6	Phase 2	10.6
1.169	20.4	56.0	-35.6	Phase 1	10.6
1.050	17.9	56.0	-38.2	Phase 1	10.6
1.050	16.9	56.0	-39.1	Phase 2	10.6
1.721	16.4	56.0	-39.7	Phase 2	10.6
1.721	15.6	56.0	-40.4	Phase 1	10.6

CISPR Average

Freq. MHz	CISPR Avg dB(μV)	Avg Limit dB(μV/m)	Margin dB	Line	Correction dB
1.221	24.1	46.0	-21.9	Phase 1	10.6
1.221	24.1	46.0	-21.9	Phase 2	10.6
0.861	22.3	46.0	-23.7	Phase 2	10.6
0.861	22.3	46.0	-23.7	Phase 1	10.6
1.100	20.5	46.0	-25.5	Phase 2	10.6
1.100	20.3	46.0	-25.7	Phase 1	10.6
1.169	17.8	46.0	-28.2	Phase 1	10.6
1.169	17.7	46.0	-28.3	Phase 2	10.6
1.050	16.4	46.0	-29.6	Phase 1	10.6
1.050	16.1	46.0	-29.9	Phase 2	10.6
1.721	11.1	46.0	-35.0	Phase 2	10.6
1.721	10.9	46.0	-35.2	Phase 1	10.6

Conducted Emissions, 150kHz – 30 MHz, High Channel, Tx at 2480 MHz



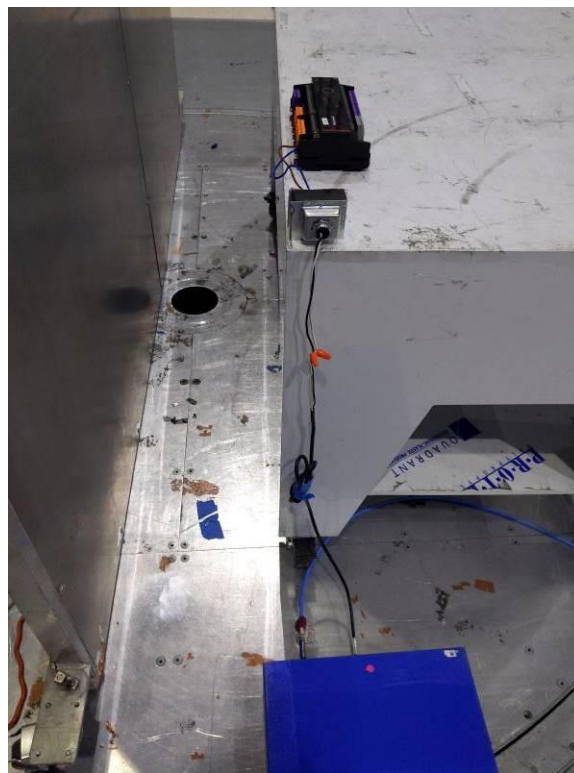
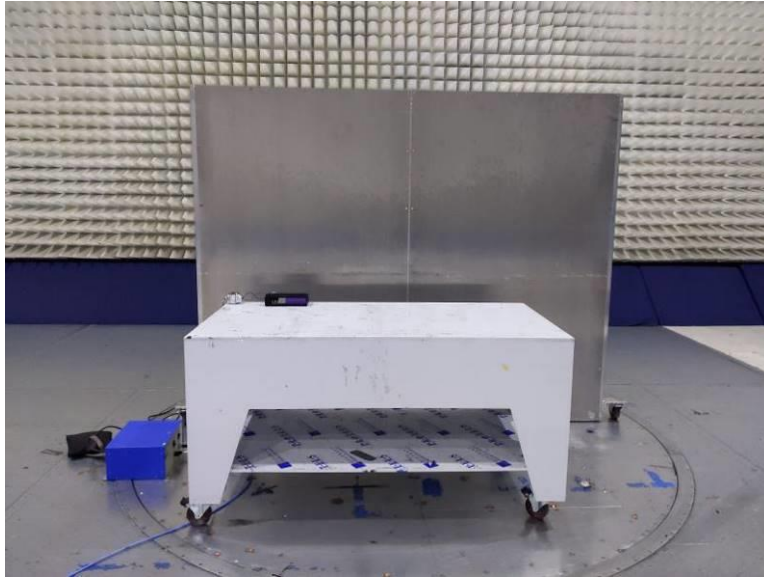
Quasi Peak

Freq. MHz	QP dB(μV)	QP Limit dB(μV/m)	Margin dB	Line	Correction dB
1.221	26.3	56.0	-29.7	Phase 2	10.6
1.221	26.2	56.0	-29.8	Phase 1	10.6
0.861	25.4	56.0	-30.6	Phase 1	10.6
0.861	25.0	56.0	-31.0	Phase 2	10.6
1.100	24.2	56.0	-31.8	Phase 1	10.6
1.100	24.1	56.0	-31.9	Phase 2	10.6
1.169	20.9	56.0	-35.2	Phase 2	10.6
1.169	20.2	56.0	-35.8	Phase 1	10.6
1.050	17.5	56.0	-38.5	Phase 2	10.6
1.050	17.2	56.0	-38.8	Phase 1	10.6
1.721	16.5	56.0	-39.5	Phase 1	10.6
1.721	16.2	56.0	-39.8	Phase 2	10.6

CISPR Average

Freq. MHz	CISPR Avg dB(μV)	Avg Limit dB(μV/m)	Margin dB	Line	Correction dB
0.195	11.4	53.8	-42.4	Phase 1	10.5
0.195	12.8	53.8	-41.0	Phase 2	10.5
0.292	9.9	50.5	-40.6	Phase 1	10.5
0.292	10.5	50.5	-40.0	Phase 2	10.5
0.861	22.4	46.0	-23.6	Phase 1	10.6
0.861	22.2	46.0	-23.8	Phase 2	10.6
1.050	15.2	46.0	-30.8	Phase 1	10.6
1.050	16.4	46.0	-29.6	Phase 2	10.6
1.100	20.5	46.0	-25.5	Phase 1	10.6
1.100	20.5	46.0	-25.5	Phase 2	10.6
1.169	17.7	46.0	-28.3	Phase 1	10.6
1.169	18.1	46.0	-27.9	Phase 2	10.6

4.6.4 Test Setup Configuration



5.0 List of Test Equipment

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

Asset #	Equipment	Manufacturer	Model/Type	Cal Int	Cal Due
00984	10 Meter Chamber	Panashield	10 Meter	9/22/2022	9/22/2024
01713	9kHz-1GHz Pre-amplifier	Sonoma	310N	02/17/2022	02/17/2023
01340	2 meter RF Cable	TRU Corp.	TRU Core 300	07/21/2022	07/21/2023
01461	6 meter RF Cable	TRU Corp.	TRU Core 300	09/21/2022	09/21/2023
01467	2 meter RF Cable	TRU Corp.	TRU Core 300	09/21/2022	09/21/2023
01470	15 meter RF Cable	TRU Corp.	TRU Core 300	09/21/2022	09/21/2023
00961	EMI Test Receiver	Rohde & Schwarz	ESU40	03/10/2022	03/10/2023
01993	Bilog Antenna	SunAR RF Motion	JB1	11/01/2022	11/01/2023
01460	6 meter RF Cable (N-Type)	TRU Corp.	TRU Core 300	07/21/2022	07/21/2023
01470	15 meter RF Cable	TRU Corp.	TRU Core 300	09/21/2022	09/21/2023
01573	9kHz-30MHz Loop Antenna	ETS Lindgren	6512	11/21/2022	11/21/2023
00571	18 - 26.5GHz Horn Antenna	EMCO	3160-09	#	#
01799	18-40GHz Preamp	uComp Nordic	MCNS-50-18004000335P	03/24/2022	03/24/2023
01365	1-18GHz Active Horn Antenna	ETS Lindgren	3117-PA	05/04/2022	05/04/2023
01330	2 meter RF Cable	TRU Corp.	TRU Core 300	08/25/2022	08/25/2023
01885	RF Cable SMA to SMA	MEGA PHASE	EMC1-K1K1-236	04/25/2022	04/25/2023
01166	NOTCH FILTER	MICRO-TRONICS	BRC50702	06/24/2022	06/24/2023
00913	Spectrum Analyzer	Rohde & Schwarz	FSU	05/17/2022	05/17/2023
01818	Spectrum Analyzer	Rohde & Schwarz	FSW43	07/19/2022	07/19/2023
01335	11 meter RF Cable	TRU Corp.	TRU Core 300	09/21/2022	09/21/2023
01339	2 meter RF Cable	TRU Corp.	TRU Core 300	09/21/2022	09/21/2023
01284	LISN	COM-POWER	LIN-115A	07/18/2022	07/18/2023
01607	EMI Test Receiver	Rohde & Schwarz	ESR7	11/17/2022	11/17/2023
01329	Digital Multimeter	Fluke	87 V	11/10/2022	11/10/2023
01155	RF CABLE 0.5 METER	MEGA PHASE	TM40-K1K1-19	04/25/2022	04/25/2023
01156	RF CABLE 1 METER	MEGA PHASE	TM40-K1K1-59	08/25/2022	08/25/2023

No Calibration required

Software used for emission compliance testing utilized the following:

Name	Manufacturer	Version	Template/Profile
BAT-EMC	Nexio	3.20.0.23	Honeywell G105214557.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 / G105214557	EC	AS	January 04, 2023	Original document
1.1 / G105245638	EC	AS	February 10, 2023	Per client request, added variant models: UN-RL1644ESB24NM (C/D), UN-RL1644ESB24NM, UN-RL1644ESB24NM (C/D)
1.2 / G105245638	EC	AS	March 7, 2023	Updated plot 4.2 and added RBW values to section 4.5.2.

END OF REPORT