TEST REPORT

Report Number: 104915573MPK-002
Project Numbers: G104915573, G104646874
Report Issue Date: February 28, 2022

Testing performed on
BIN-SENSE Live Remote Unit
Model Number: 106201

FCC ID: 2AUTY-106103RU-V06

to

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

For

Intragrain Technologies, Inc.

Test Performed by:	**Test Authorized by:**
Intertek	Intragrain Technologies, Inc.
1365 Adams Court	118 Husum Road
Menlo Park, CA 94025	RM of Sherwood, SK S4K0A4
USA	Canada

Prepared by: _____ **Date:** February 28, 2022
Anderson Soungpanya

Reviewed by: _____ **Date:** February 28, 2022
Krishna K Vemuri

Report No. 104915573MPK-002	
Equipment Under Test:	BIN-SENSE Live Remote Unit
Model Number:	106201
Applicant:	Intragrain Technologies, Inc.
Contact:	Grant Kerr
Address:	Intragrain Technologies, Inc. 118 Husum Road Bothell, WA 98021
Country:	Canada
Tel. Number:	(604) 528-8732
Email:	Grantkerr@intragrain.com
Applicable Regulation:	FCC Part 15 Subpart C (15.247) ISED RSS-247 Issue 2
Date of Test:	July 16, 2021 to February 21, 2022

We attest to the accuracy of this report:

Anderson Soungpanya
Senior Project Engineer

Krishna K Vemuri
EMC Manager

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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	Not Applicable – EUT is battery powered.
Antenna Requirement	15.203	RSS-GEN	Complies (Unique Coupling)

EUT receive date: July 15, 2021

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 16, 2021

Test completion date: February 22, 2022

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

2.0 General Information

2.1 Product Description

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

The BIN-SENSE Live is a wireless grain monitoring device that provides real time, easy to use temperature and moisture monitoring of stored grain(s). This device utilizes cellular machine to machine (M2M) technology to provide accurate, up-to-date data via text and/or email alerts. Features include Solar and battery power (included) with no AC power required, compatible with any device or computer, no software to buy or maintain.

The BIN-SENSE Live remote unit communicates with the master unit and powered by 3 AA battery. The Primary antenna is external, and the secondary antenna is mounted on the chassis inside the unit.

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

Information about the 2.4 GHz radio is presented below:

Applicant	Intragrain Technologies, Inc.
Model No.	106201
Type of transmission	Zigbee
Rated RF Output	18.94 dBm
Antenna(s) & Gain	Primary Antenna: W5001, Gain: +1.5 dBi Secondary Antenna: Laird Internal, Gain: +2.0 dBi
Frequency Range	2410 – 2465 MHz
Type of modulation/data rate	O-QPSK
Number of Channel(s)	12 (Channel 12-23)
Applicant Name & Address	Intragrain Technologies, Inc. 118 Husum Road RM of Sherwood, SK S4K0A4 Canada

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 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

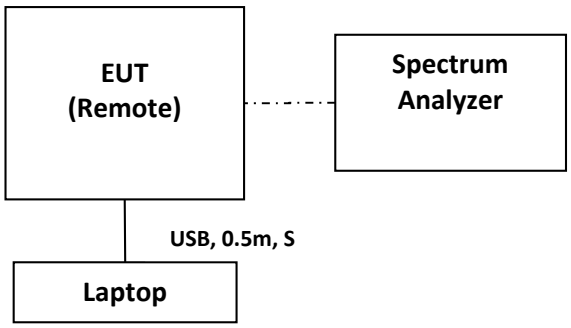
3.1 Support Equipment

Support Equipment		
Description	**Manufacturer**	**Model**
Sensor	Intragrain	Not Listed
Solar Panel	Voltiac	207104 - 3620
Laptop	Dell	Latitude 5400

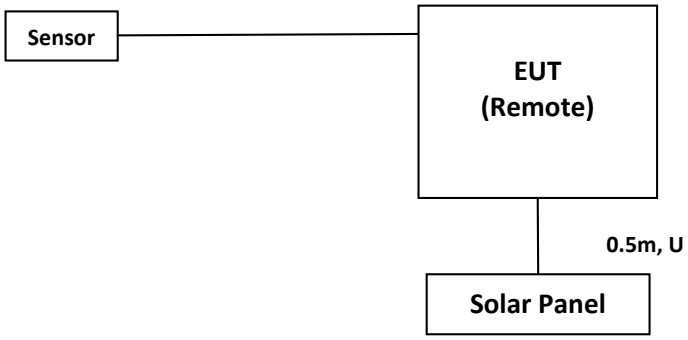
3.2 Block Diagram of Test Setup

Equipment Under Test			
Description	**Manufacturer**	**Model**	**Serial Number**
BIN-SENSE Live Remote Unit	Intragrain Technologies, Inc.	106201	618AFD

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

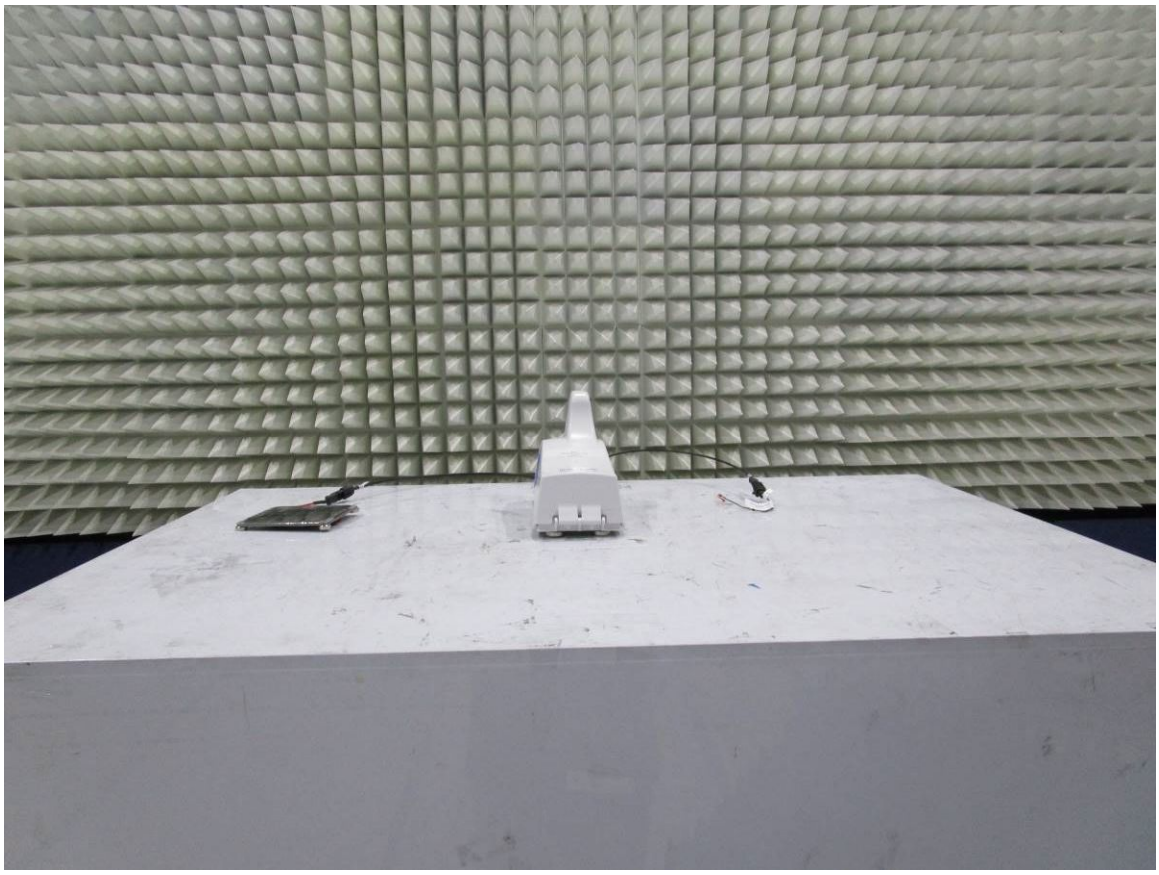


Radiated Measurements SETUP
Primary and Secondary Antennas are Integral



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 2.465 GHz.

3.4 Software Exercise Program

The EUT exercise program used during radiated and conducted testing was provided by Intragrain Technologies, 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 GUI power level was set to 6.

EUT was placed into transmit mode at the lowest (2410MHz) middle (2440MHz), and highest (2465MHz) 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.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) ≥ 3 x RBW.
3. Detector = Peak.
4. Trace mode = max hold.
5. Sweep = auto couple.
6. Allow the trace to stabilize.
7. Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

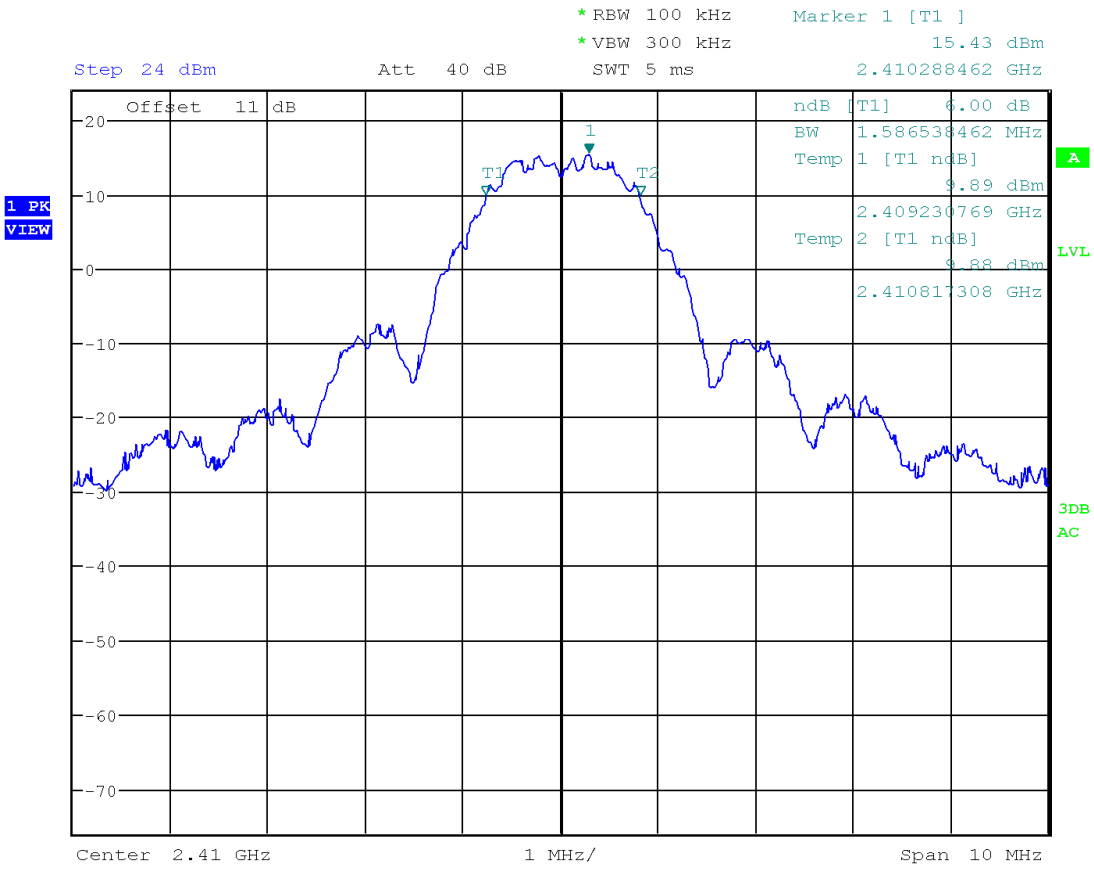
For 99% power bandwidth measurement, the bandwidth was determined by using the built-in 99% occupied bandwidth function of the spectrum analyzer. The resolution bandwidth is set to 1% of the selected span as is without being below 1%. The video bandwidth shall be set to 3 times the resolution bandwidth.

4.1.3 Test Result

Frequency (MHz)	6-dB bandwidth FCC 15.247 & RSS-GEN, MHz	Occupied bandwidth, RSS-GEN, MHz	Plot
2410	1.586	--	1.1
	--	2.435	1.4
2440	1.602	--	1.2
	--	2.435	1.5
2465	1.586	--	1.3
	--	2.419	1.6

Tested By	Test Date	Results
Minh Ly	August 11, 2021	Complies

Plot 1. 1



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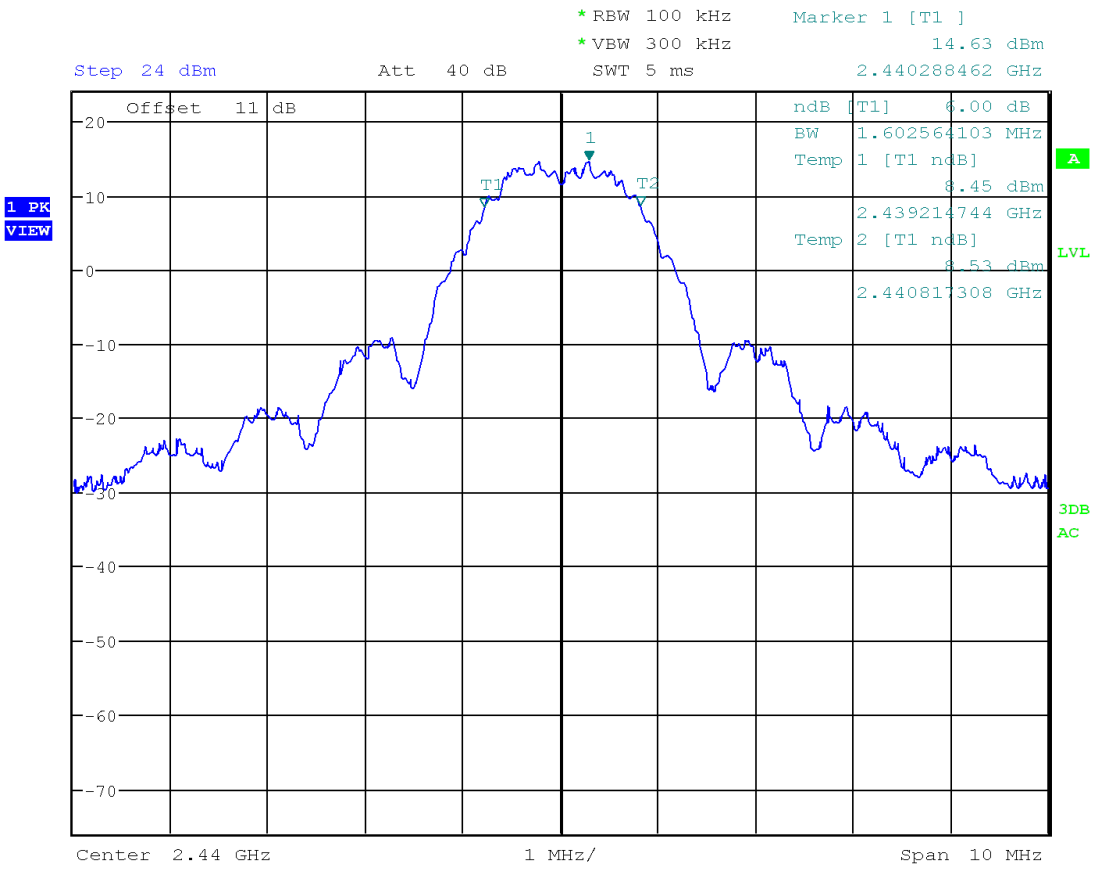
Plot 1. 2



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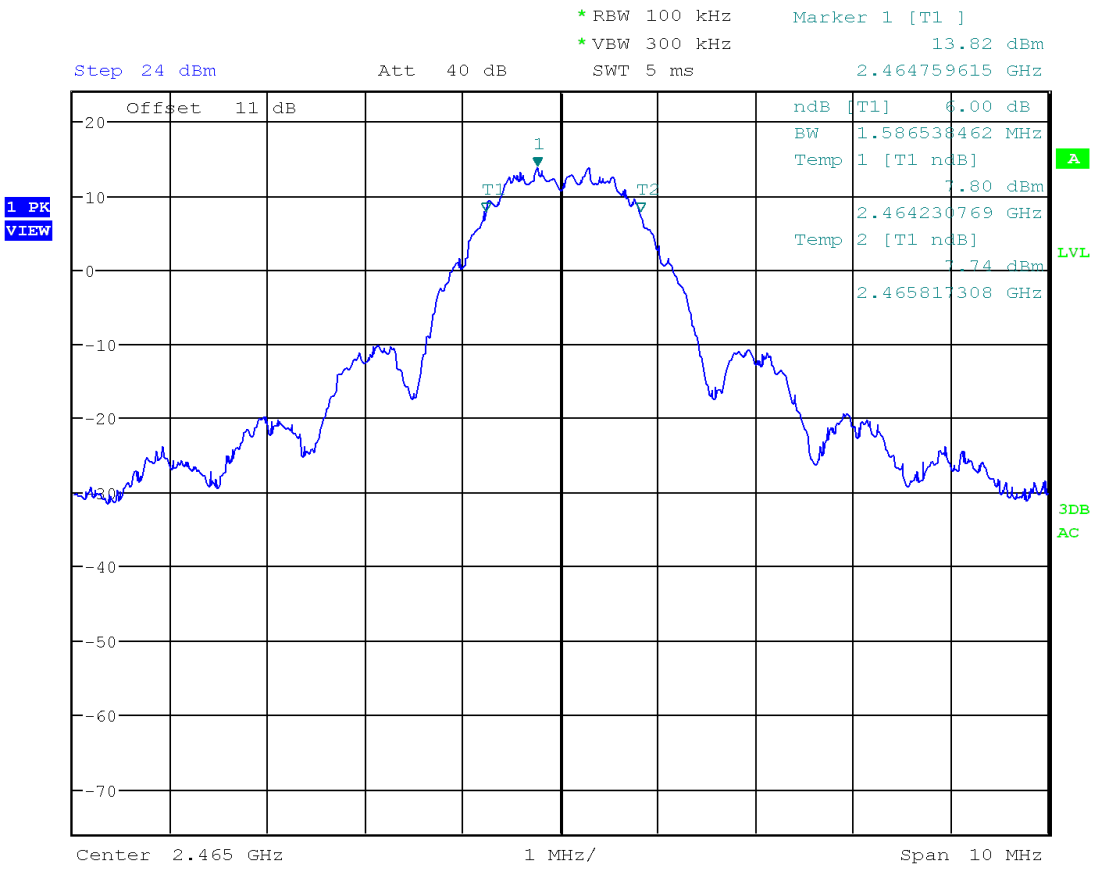
Plot 1. 3



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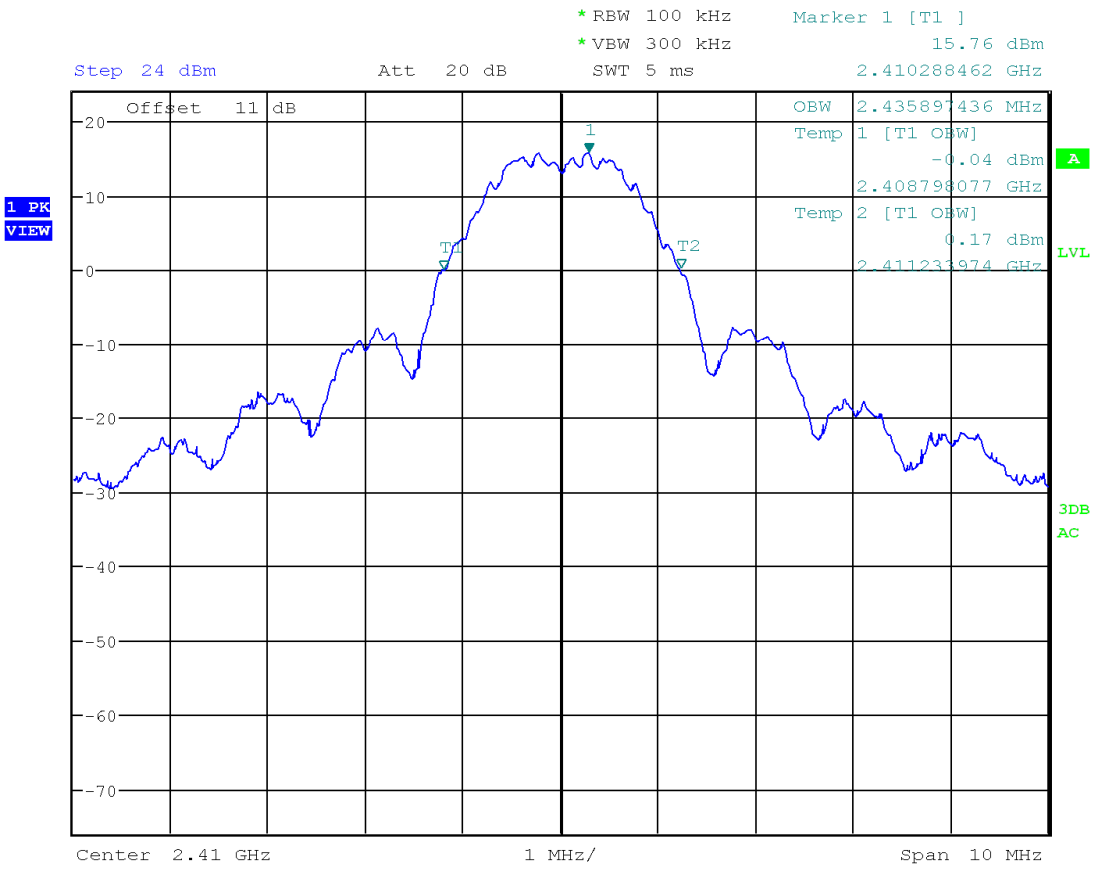
Plot 1. 4



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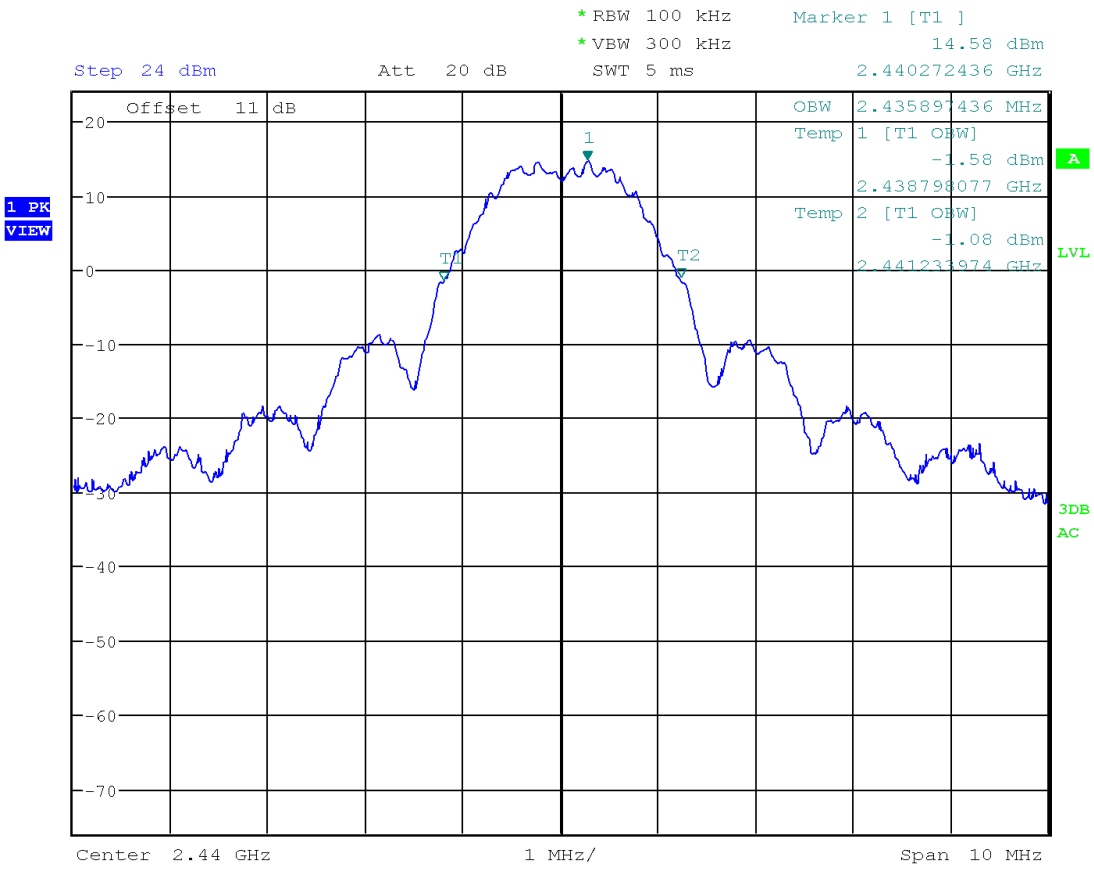
Plot 1.5



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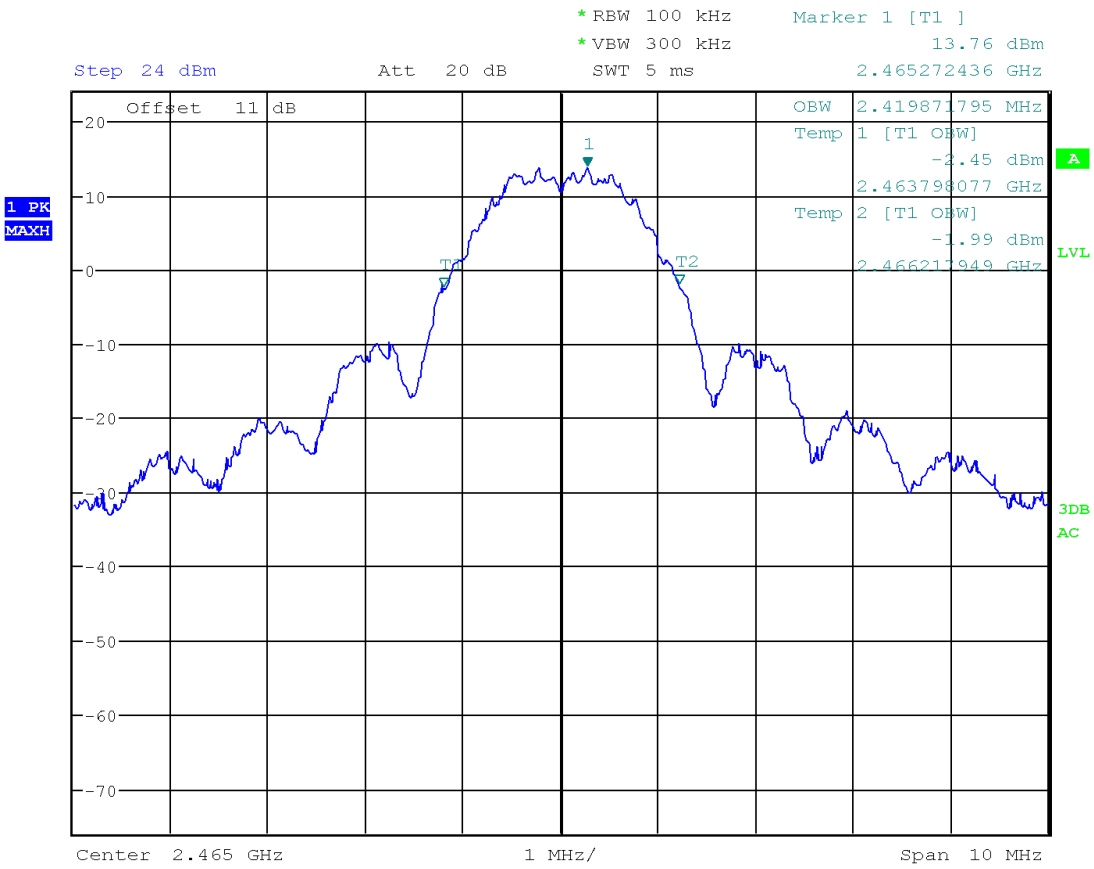
Plot 1.6



Date: 11.AUG.2021 18:57:12

Results	Complies

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 ≥ DTS bandwidth in ANSI 63.10.

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.

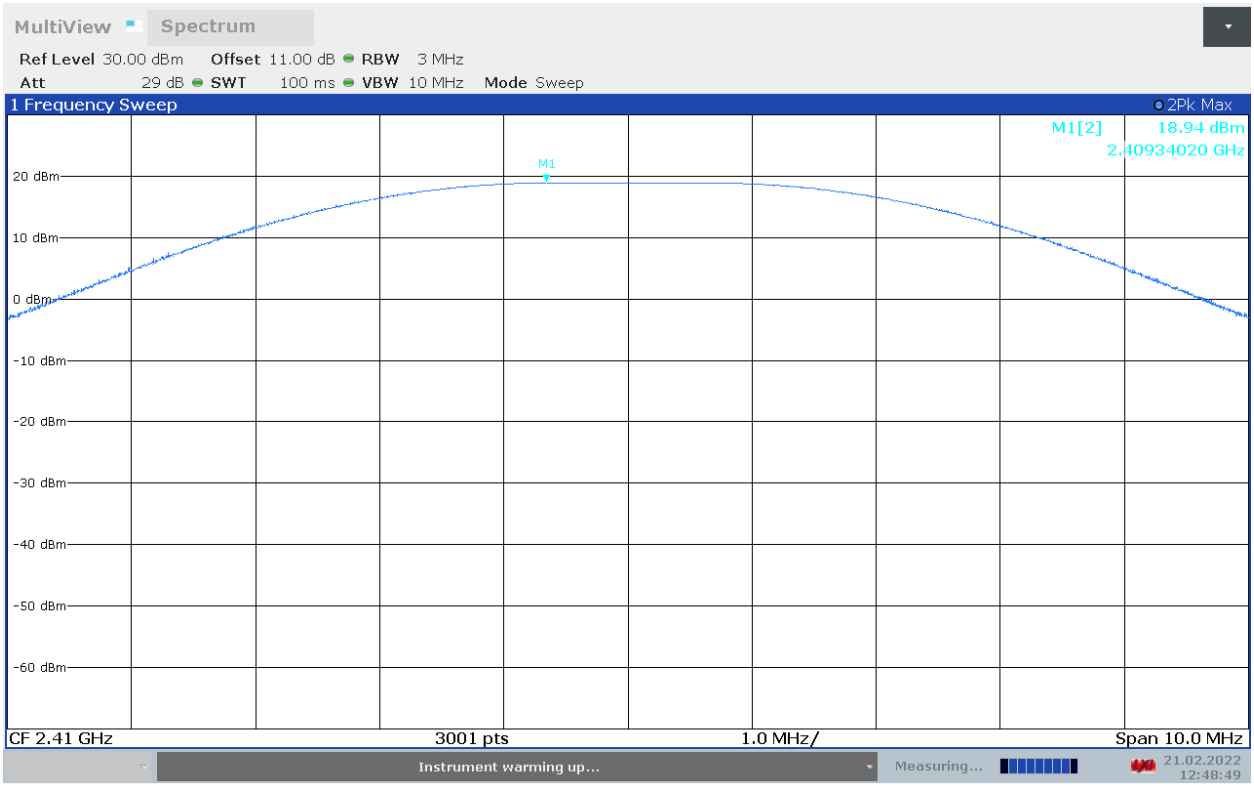
4.2.3 Test Result

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

Frequency	Conducted Power (peak)		Plot
MHz	dBm	W	
Primary Antenna			
2410	18.94	0.0783	2.1
2440	17.90	0.0617	2.2
2465	16.98	0.0499	2.3
Secondary Antenna			
2410	18.26	0.0670	2.4
2440	17.54	0.0568	2.5
2465	16.87	0.0486	2.6

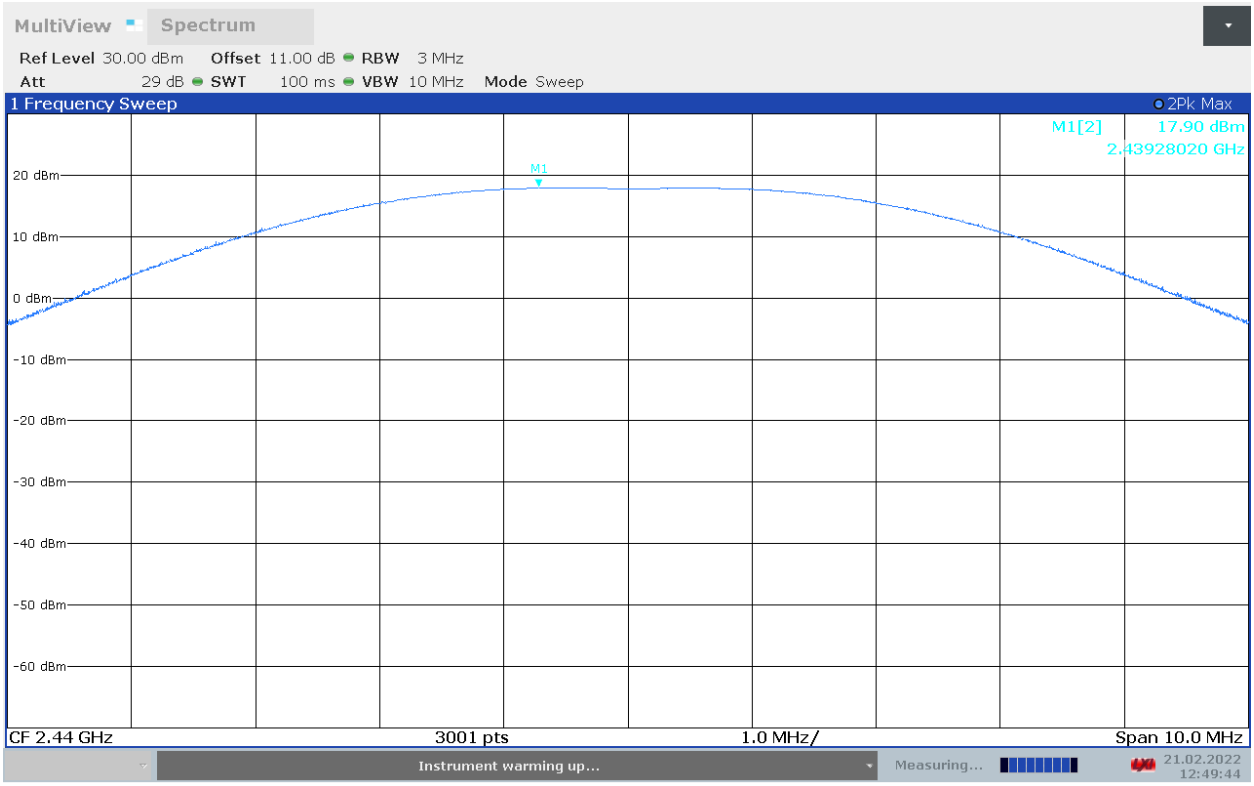
Tested By	Test Date	Results
Anderson Soungpanya	February 21, 2022	Complies

Plot 2. 1



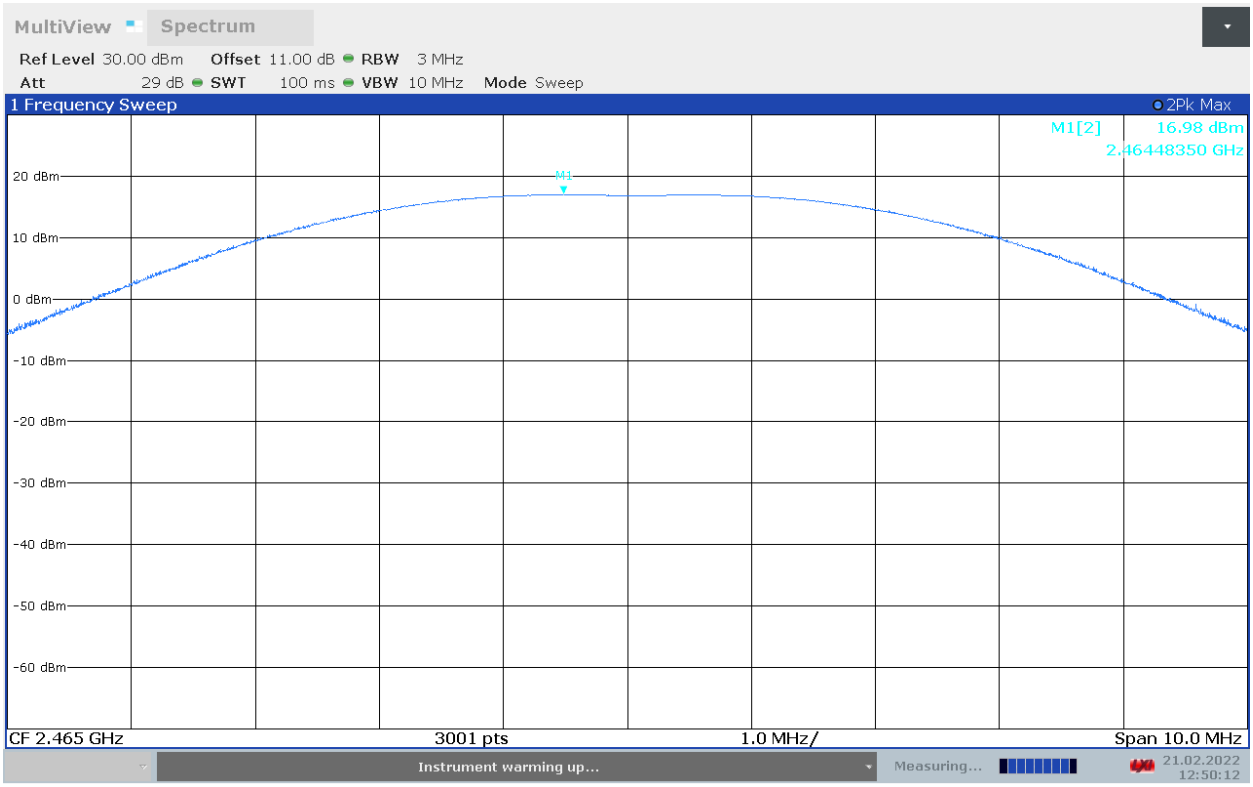
12:48:49 21.02.2022

Plot 2. 2



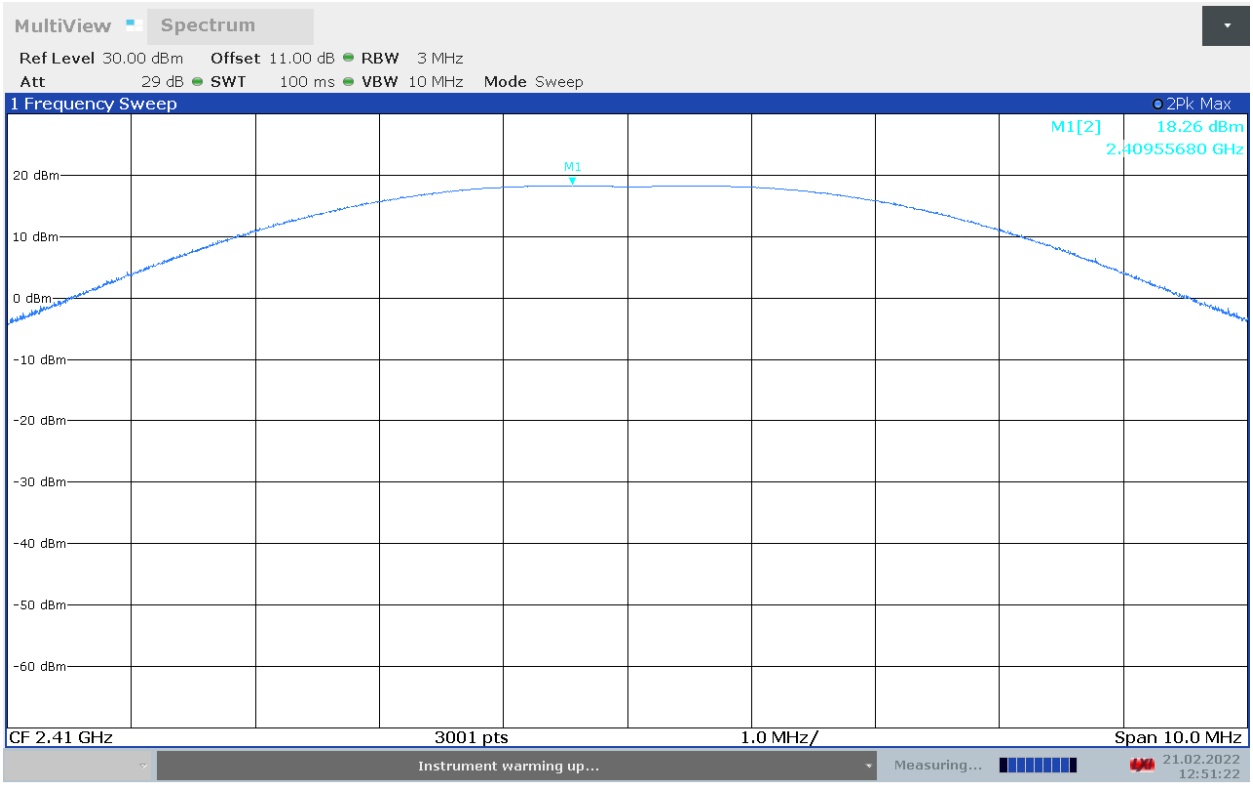
12:49:45 21.02.2022

Plot 2. 3



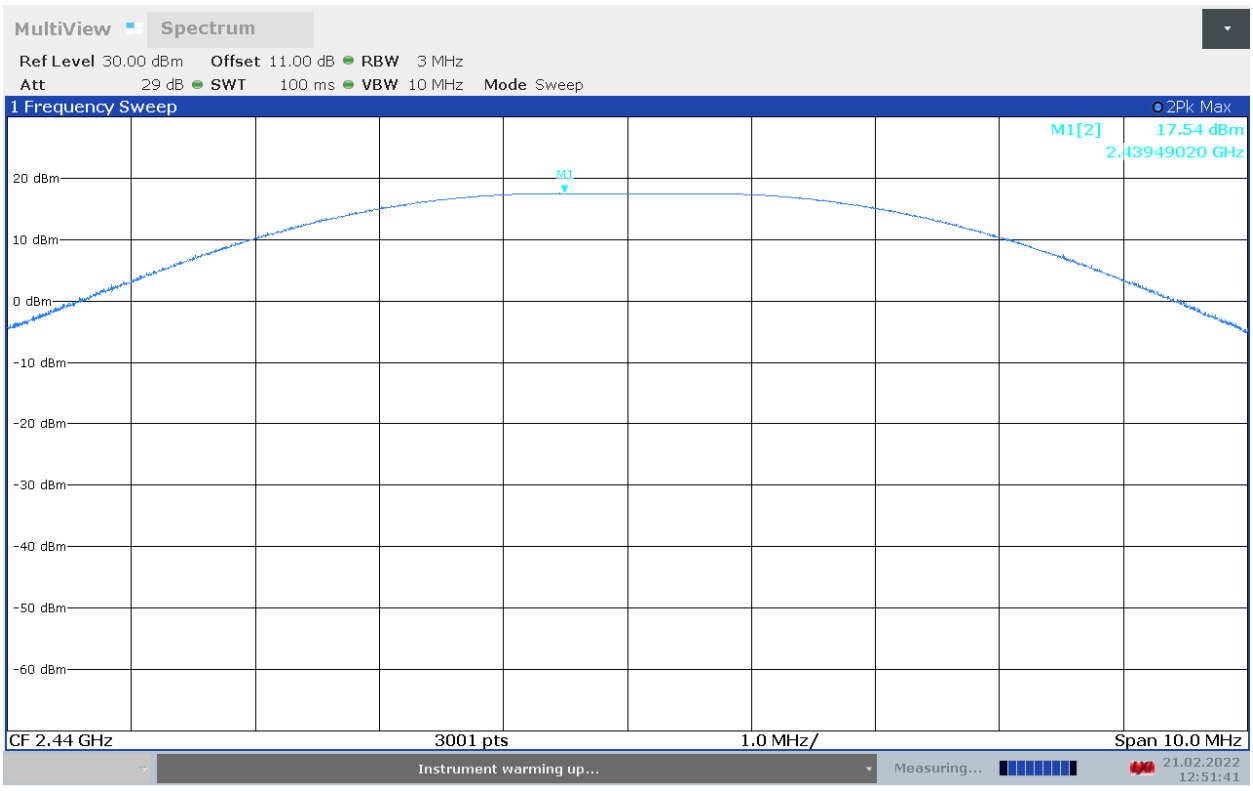
12:50:12 21.02.2022

Plot 2. 4



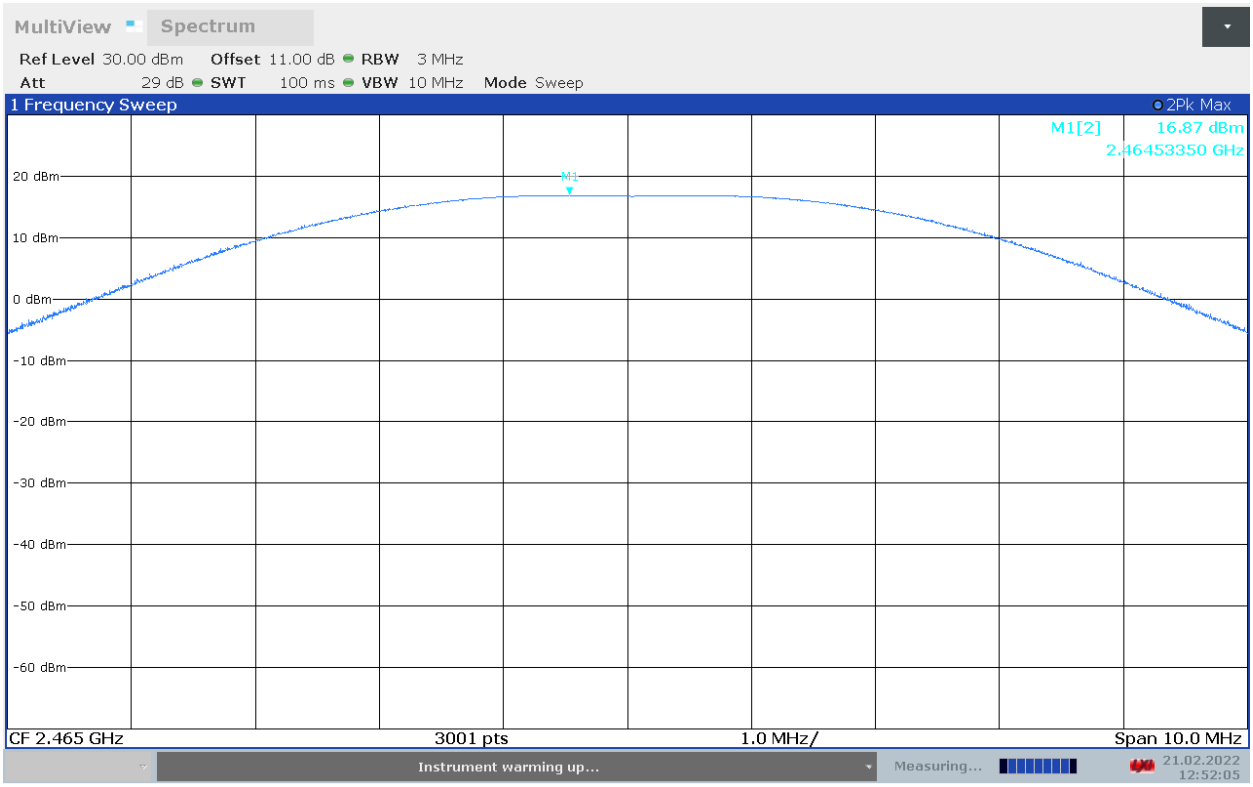
12:51:23 21.02.2022

Plot 2. 5



12:51:42 21.02.2022

Plot 2. 6



12:52:06 21.02.2022

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 kHz ≤ RBW ≤ 100 kHz.
4. Set the VBW ≥ 3 x RBW.
5. Detector = peak.
6. Sweep time = auto couple.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level within the RBW.
10. If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.

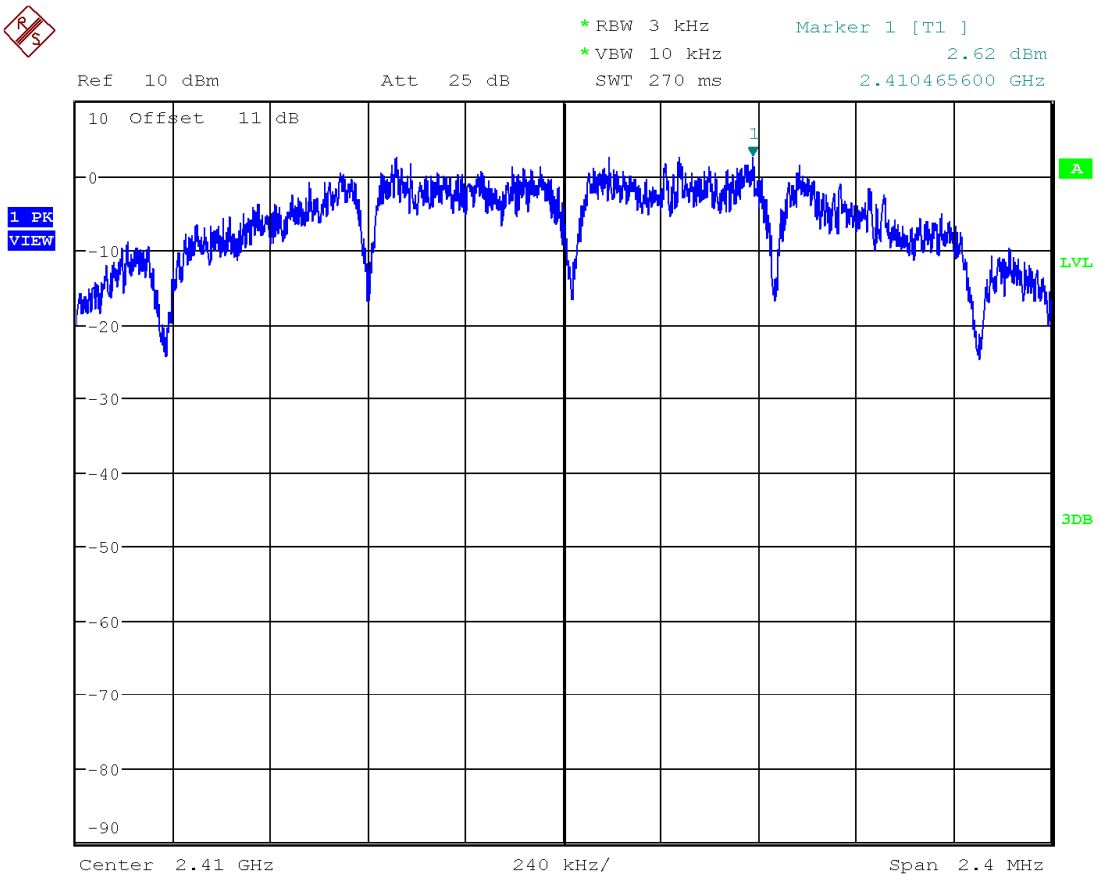
4.3.3 Test Result

Refer to the following plots for the test result

Frequency, MHz	Maximum Power Spectral Density, dBm	Maximum Power Spectral Density Limit, dBm	Margin, dB	Plot
Primary Antenna				
2410	2.62	8.0	-5.38	3.1
2440	1.39	8.0	-6.61	3.2
2465	1.92	8.0	-6.08	3.3
Secondary Antenna				
2410	1.83	8.0	-6.17	3.4
2440	1.68	8.0	-6.32	3.5
2465	0.81	8.0	-7.19	3.6

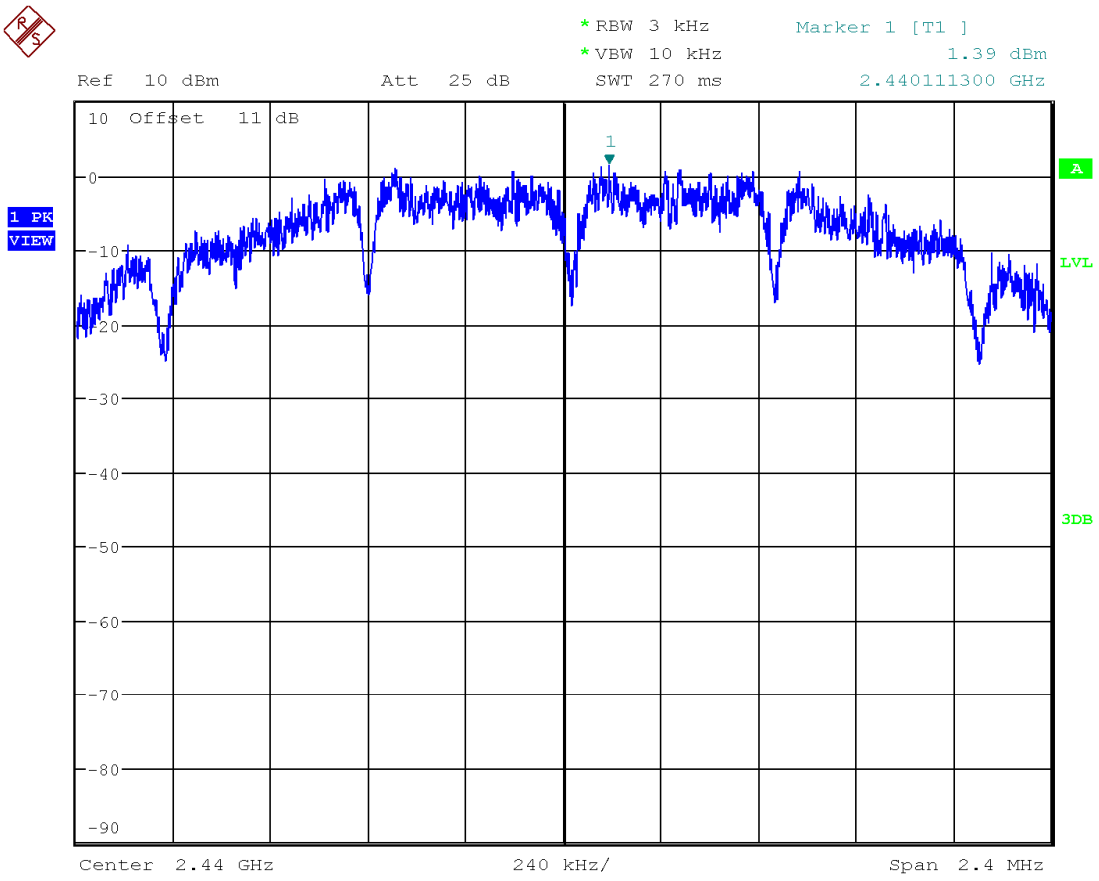
Tested By	Test Date	Results
Minh Ly	July 27 , 2021	Complies

Plot 3. 1



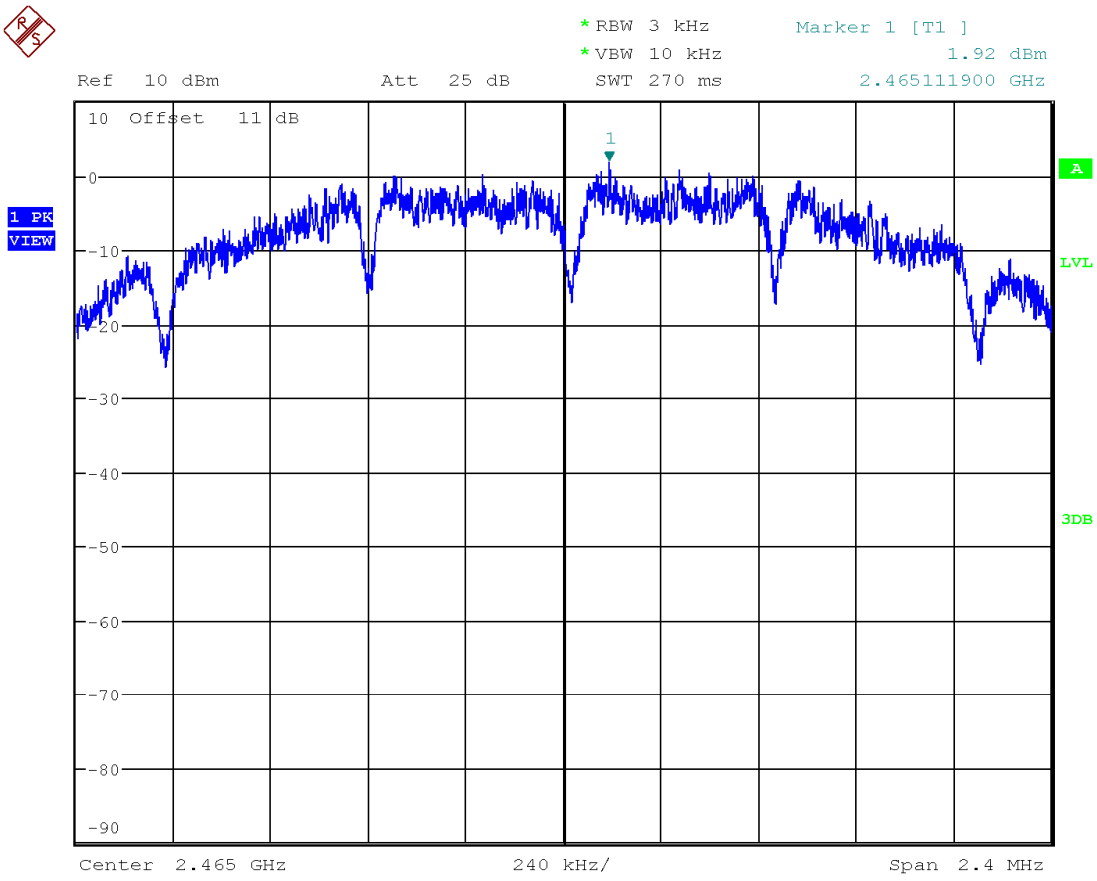
Date: 27.JUL.2021 14:26:58

Plot 3. 2



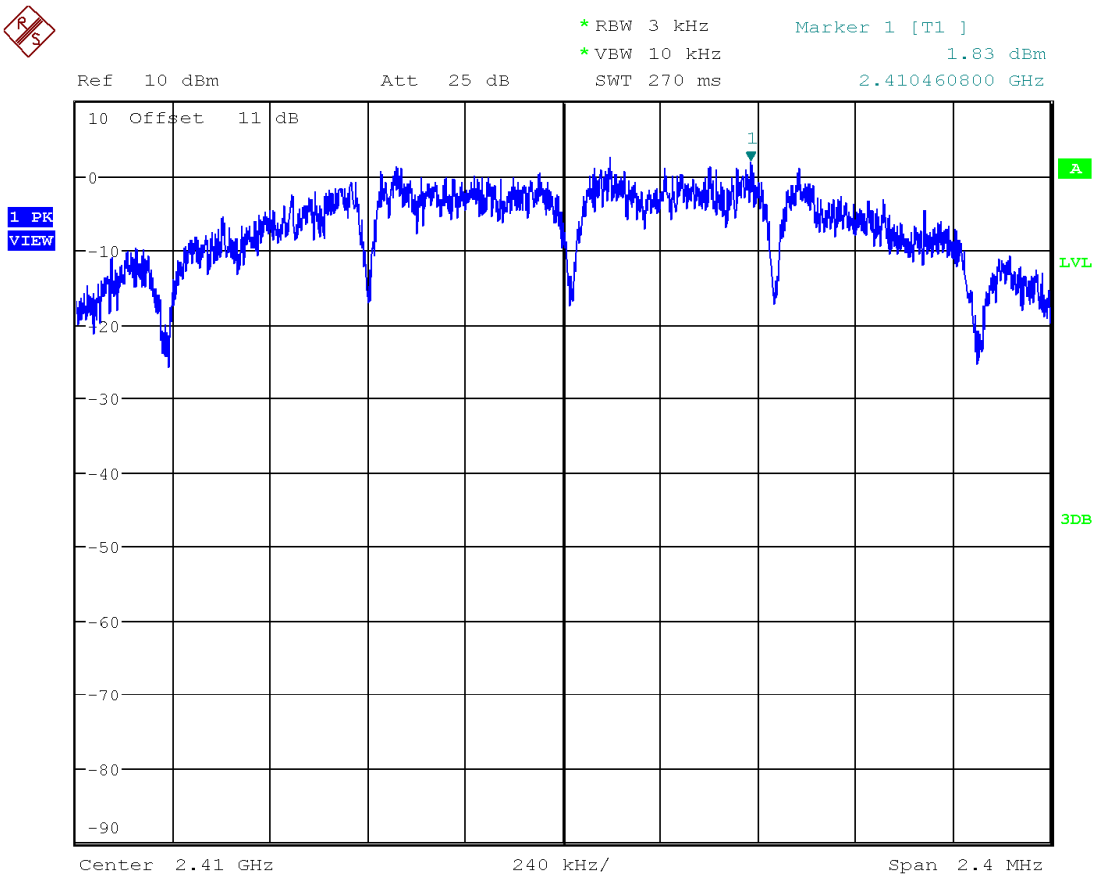
Date: 27.JUL.2021 14:27:40

Plot 3. 3



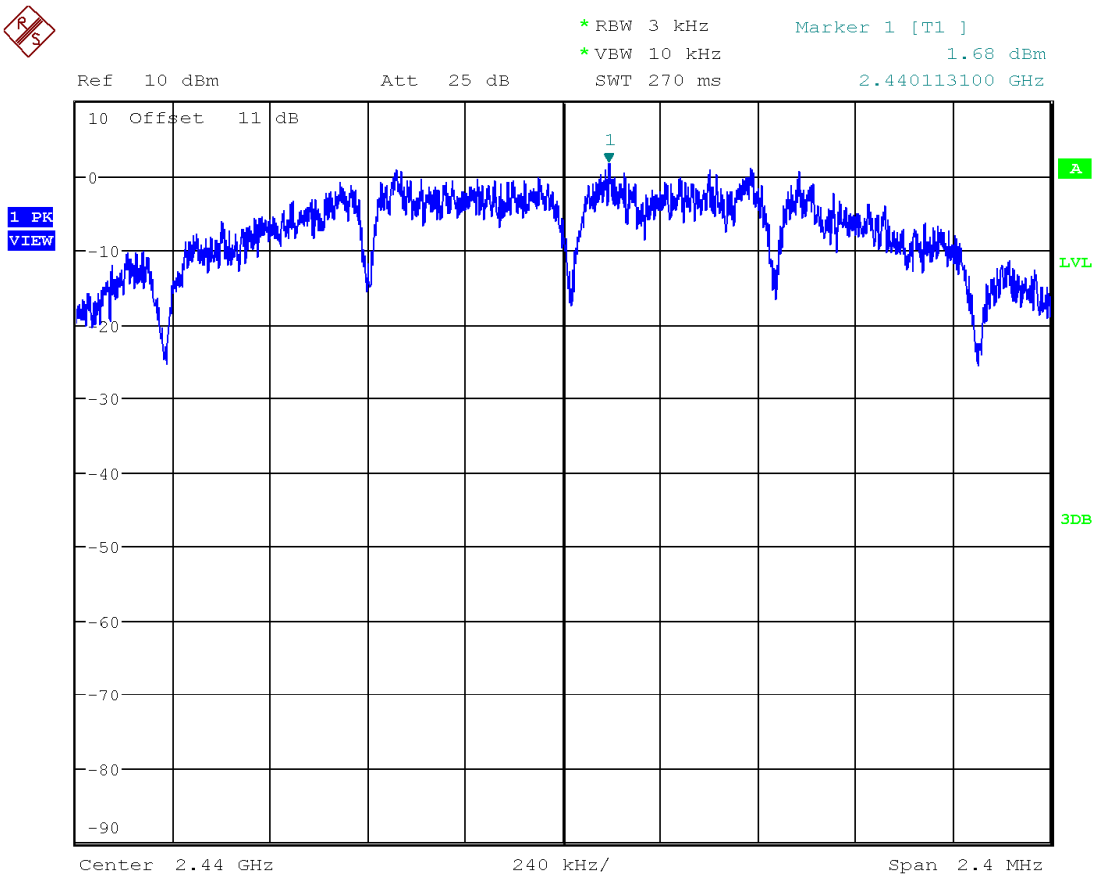
Date: 27.JUL.2021 14:26:12

Plot 3. 4



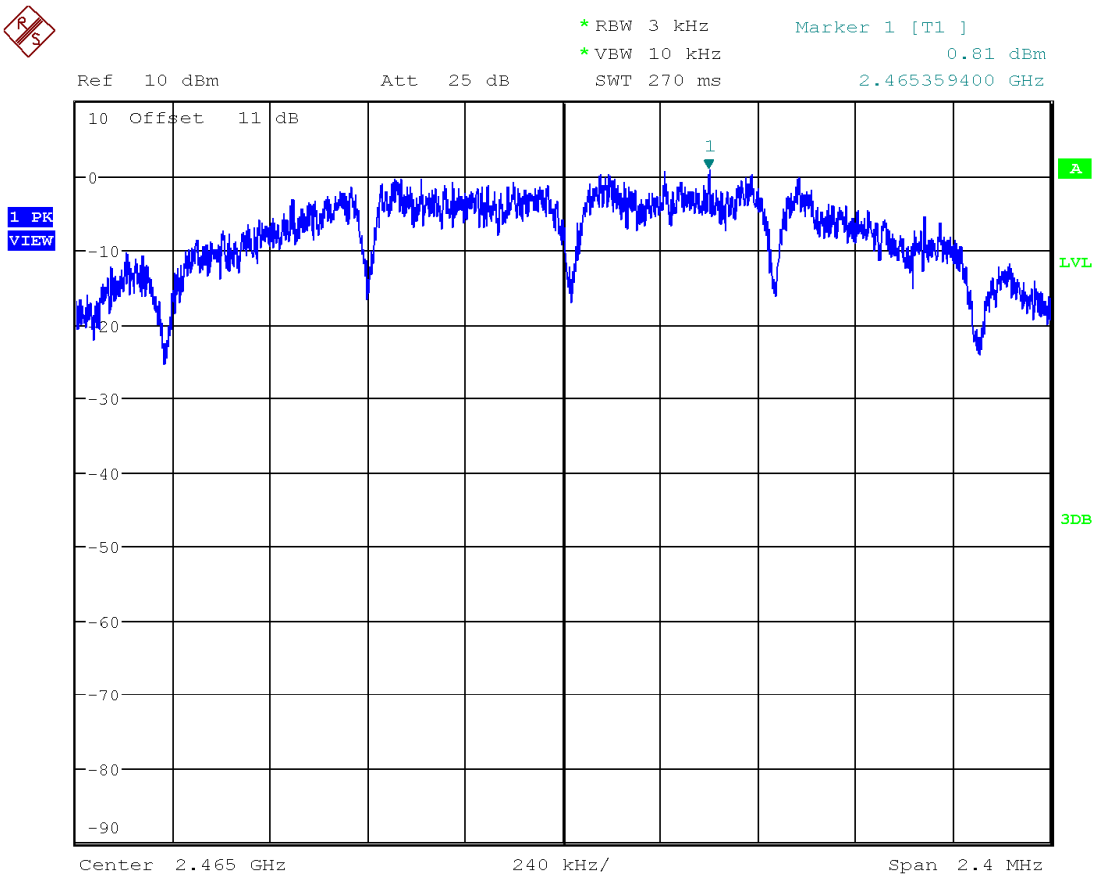
Date: 27.JUL.2021 14:32:26

Plot 3. 5



Date: 27.JUL.2021 14:33:10

Plot 3. 6



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 ≥ 3 x RBW.
3. Detector = peak.
4. Sweep time = auto couple.
5. Trace mode = max hold.
6. Allow trace to fully stabilize.
7. Use the peak marker function to determine the maximum amplitude level.

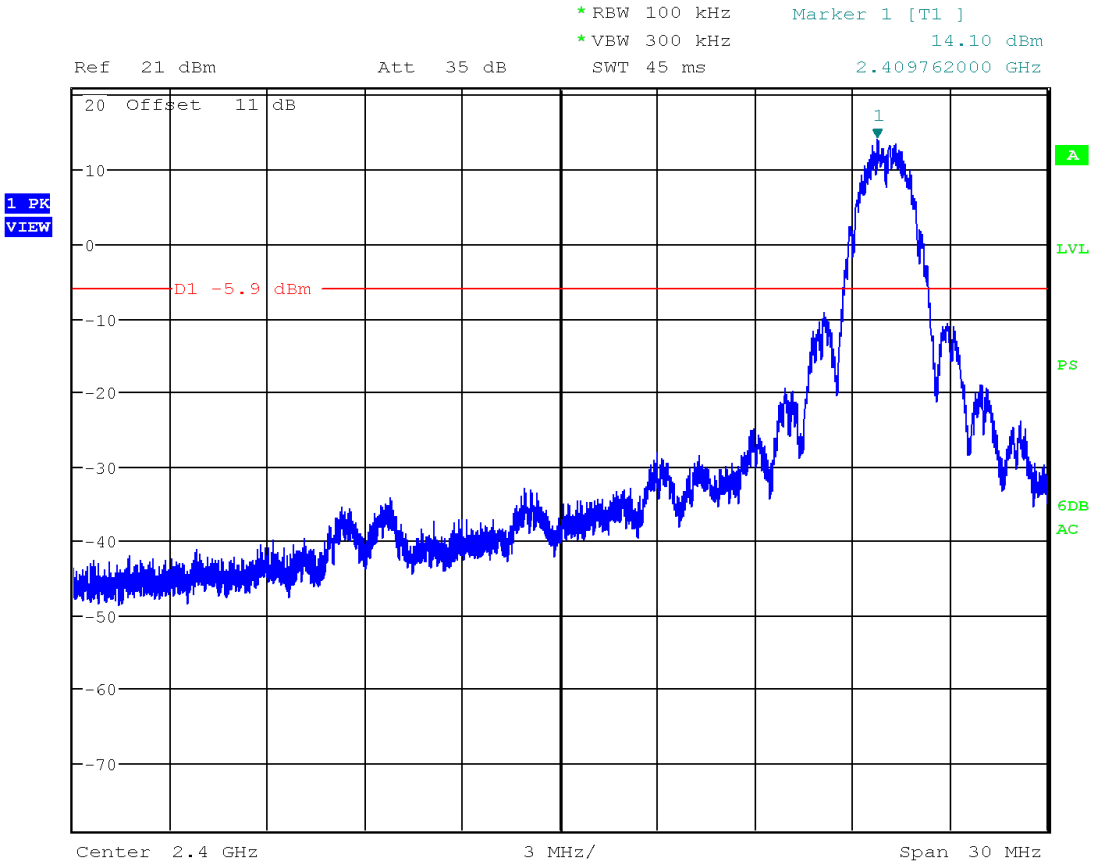
The unwanted emissions were measured from 30 MHz to 25 GHz. Plots below are corrected for cable loss and then compared to the limits.

4.4.3 Test Result

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

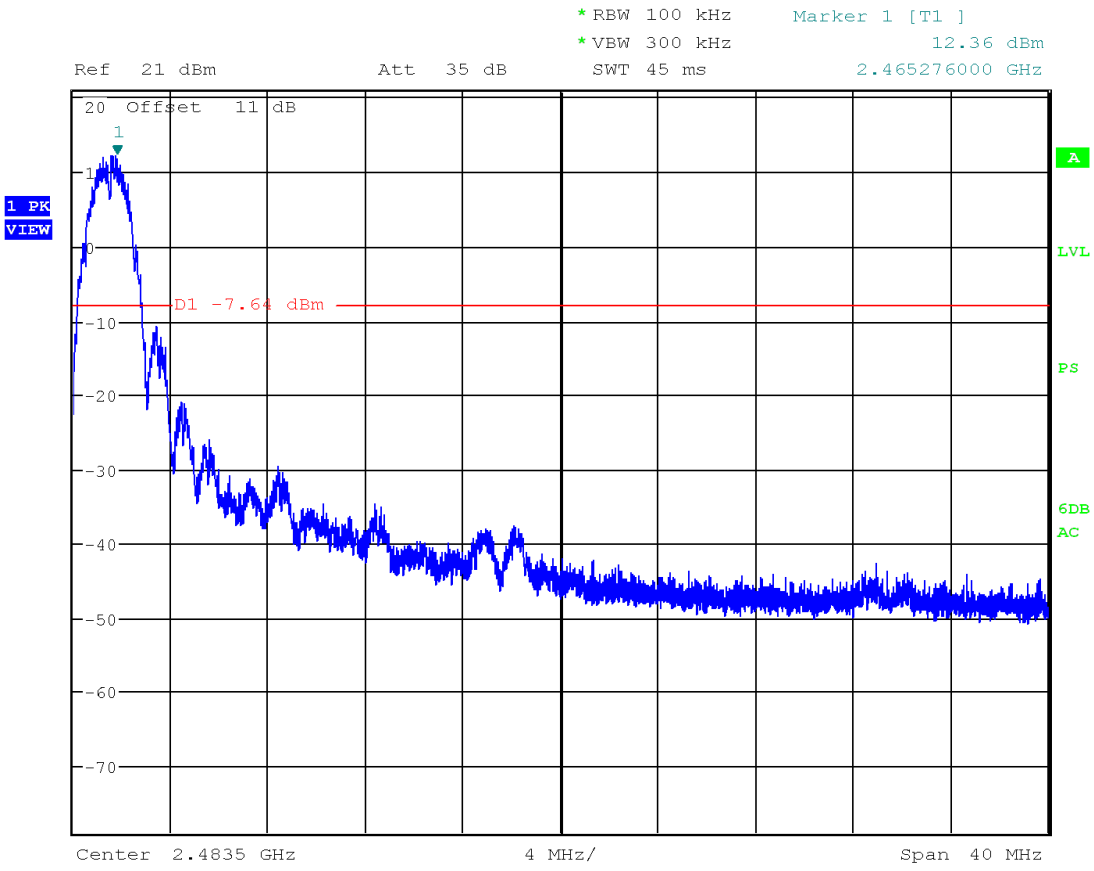
Tested By	Test Date	Results
Minh Ly	August 11-18, 2021	Complies

Tx @ Low Channel, 2400 MHz Band Edge
Plot 4.1



Date: 18.AUG.2021 20:50:23

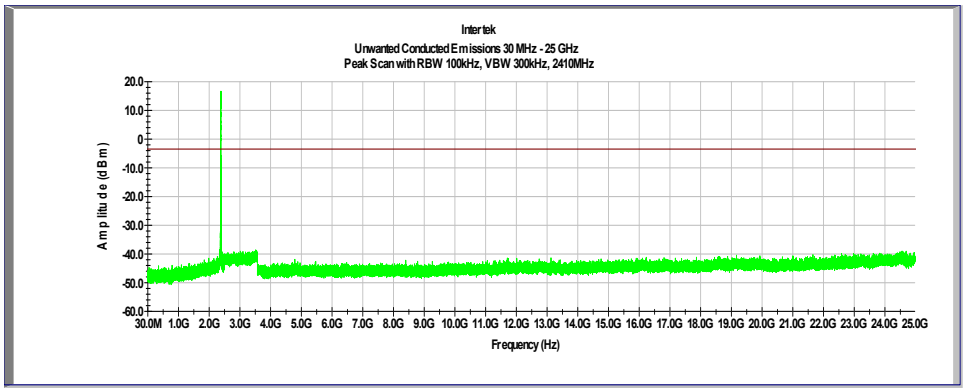
Tx @ High Channel, 2483.5 MHz Band Edge
Plot 4.2



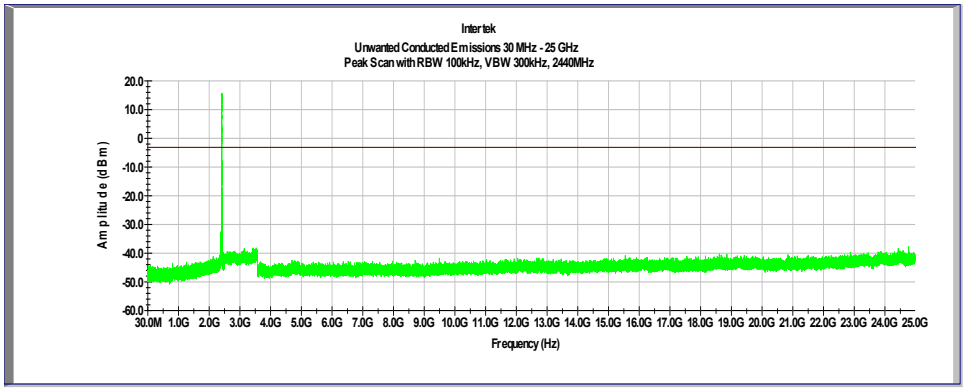
Date: 18.AUG.2021 20:46:12

Results	Complies

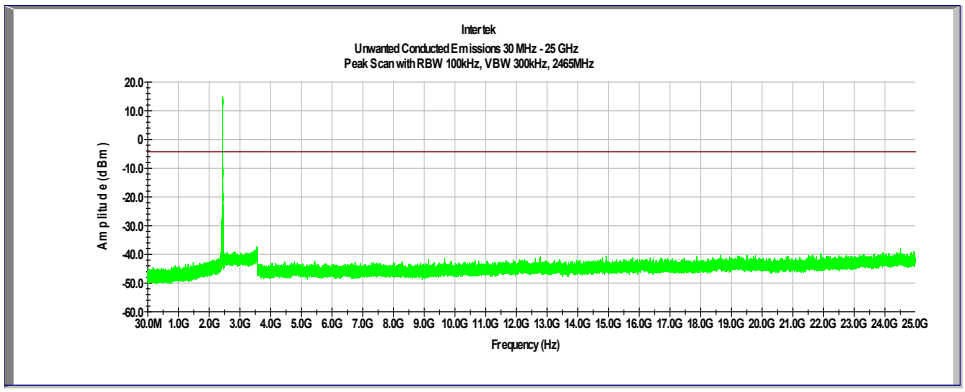
Primary Antenna, Tx @ Low Channel, 2410 MHz
30MHz -26GHz Conducted Spurious
Plot 4.3



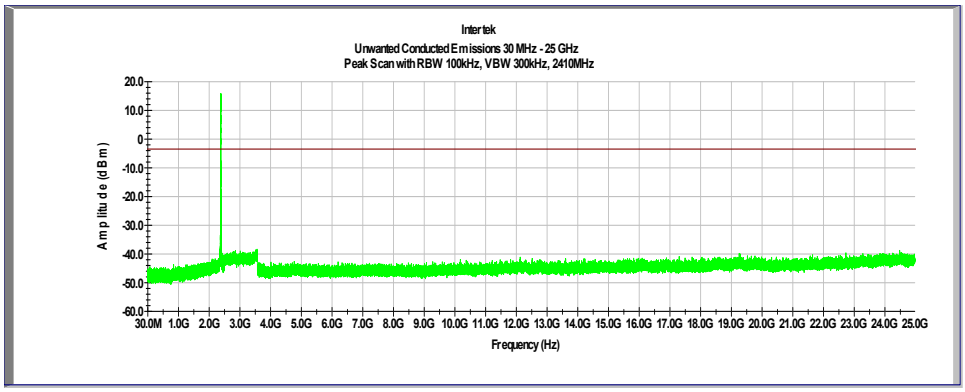
Primary Antenna, Tx @ Mid Channel, 2440 MHz
30MHz -26GHz Conducted Spurious
Plot 4.4



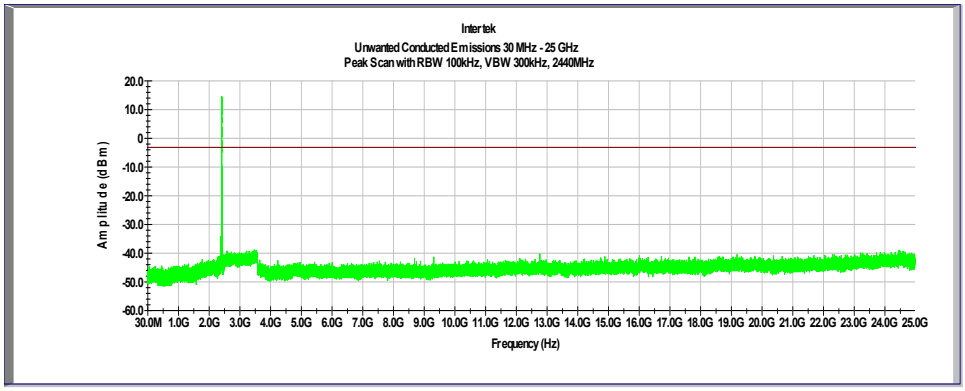
Primary Antenna, Tx @ High Channel, 2465 MHz
30MHz -26GHz Conducted Spurious
Plot 4.5



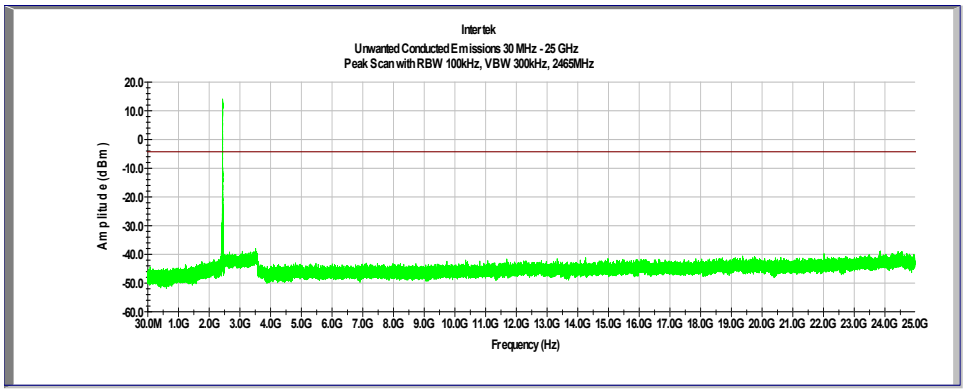
Secondary Antenna, Tx @ Low Channel, 2410 MHz
30MHz -26GHz Conducted Spurious
Plot 4.6



Secondary Antenna, Tx @ Mid Channel, 2440 MHz
30MHz -26GHz Conducted Spurious
Plot 4.7



Secondary Antenna, Tx @ High Channel, 2465 MHz
30MHz -26GHz Conducted Spurious
Plot 4.8



Results	Complies

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 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.

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.

4.5.3 Field Strength Calculation

Field Strength Calculation

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

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

Where FS = Field Strength in dB(μV/m)
RA = Receiver Amplitude (including preamplifier) in dB(μV); AF = Antenna Factor in dB(1/m)
CF = Cable Attenuation Factor in dB; AG = Amplifier Gain in dB

Assume a receiver reading of 52.0 dB(μV) is obtained. The antennas factor of 7.4 dB(1/m) and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving field strength of 32 dB(μV/m). This value in dB(μV/m) was converted to its corresponding level in μV/m.
RA = 52.0 dB(μV)
AF = 7.4 dB(1/m)
CF = 1.6 dB
AG = 29.0 dB
FS = 52.0+7.4+1.6-29.0 = 32 dB(μV/m).
Level in μV/m = Common Antilogarithm [(32 dBμV/m)/20] = 39.8 μV/m.

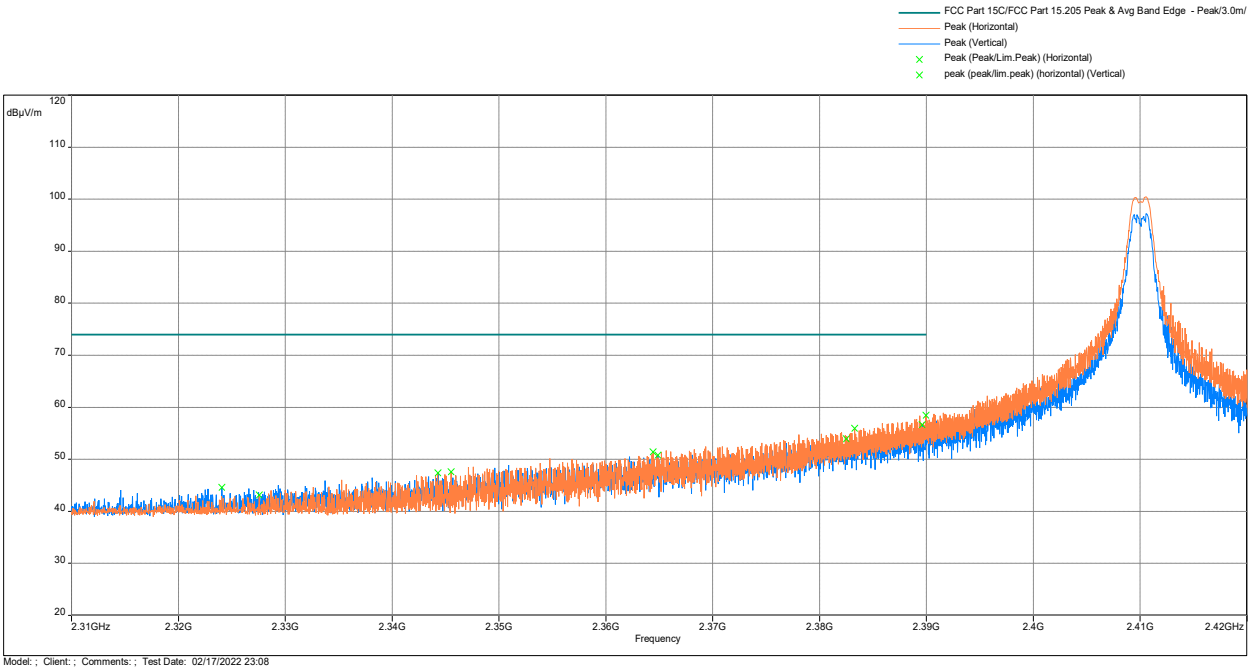
4.5.4 Test Results

All testing in this section were performed by radiated measurements.

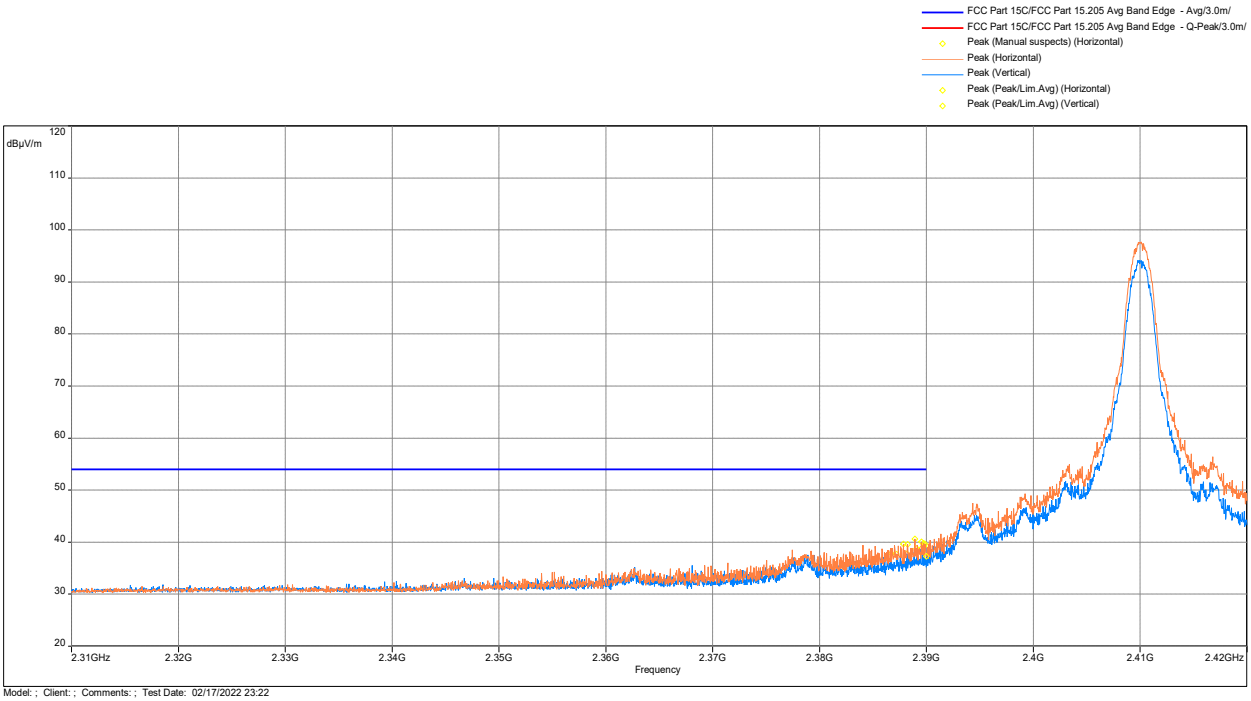
Tested By	Test Date	Results
Anderson Soungpanya & Aaron Chang	February 11 – 20, 2022	Complies

Test Results: 15.209/15.205 Radiated Restricted Band Emissions

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

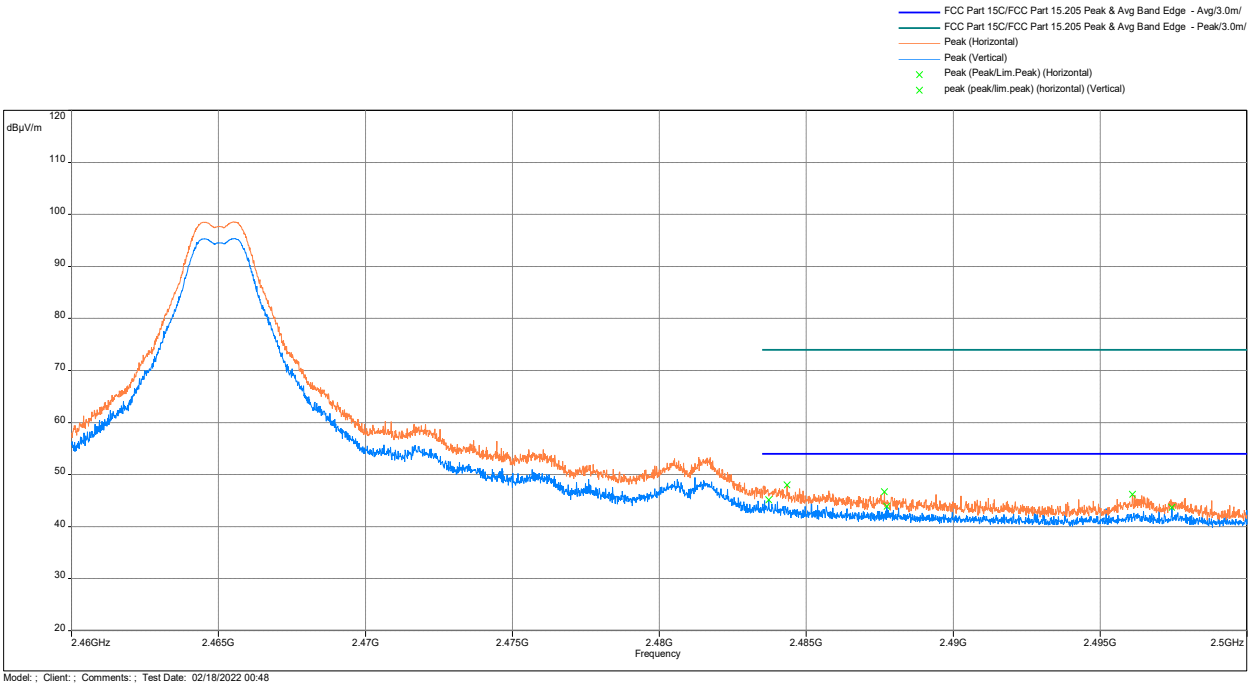


Primary Antenna
Out-of-Band Radiated spurious emissions at the Band-edge @3m distance
2310–2390 MHz, Average Scan with Average Limit



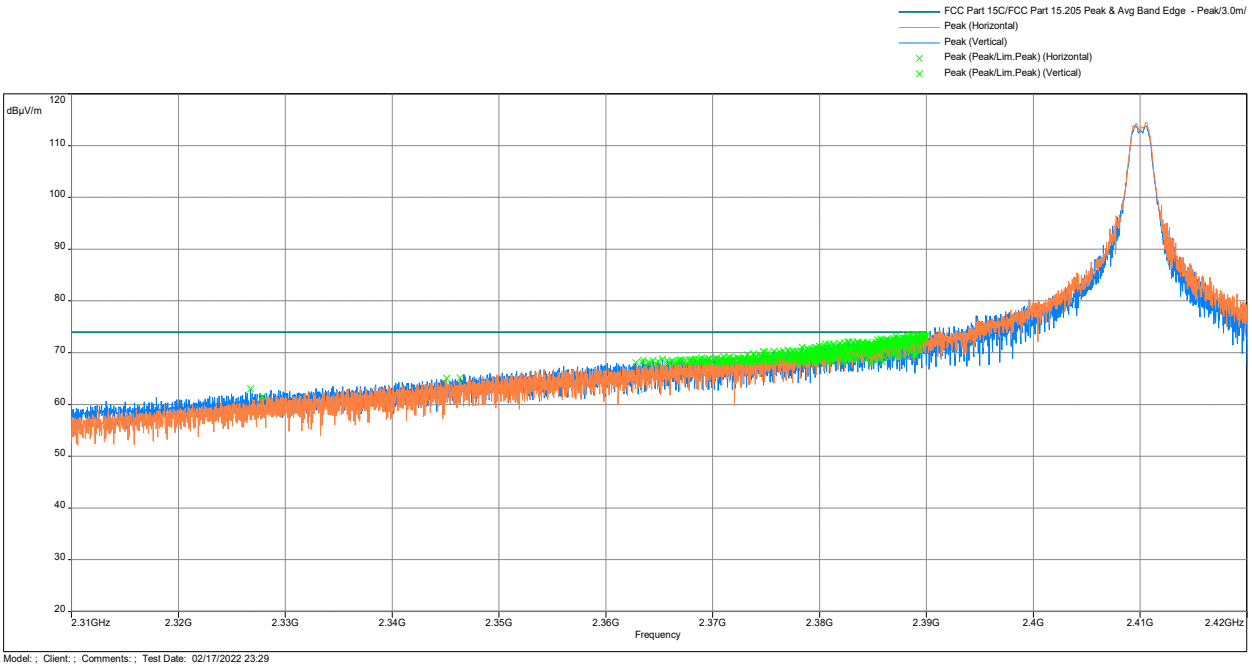
Freq. MHz	Avg @3m dB(uV/m)	Avg Limit dB(µV/m)	Margin dB	Height m	Azimuth deg	Polarity	Correction dB
2390.000	37.27	54	-16.73	1.26	56.5	Horizontal	21.46

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



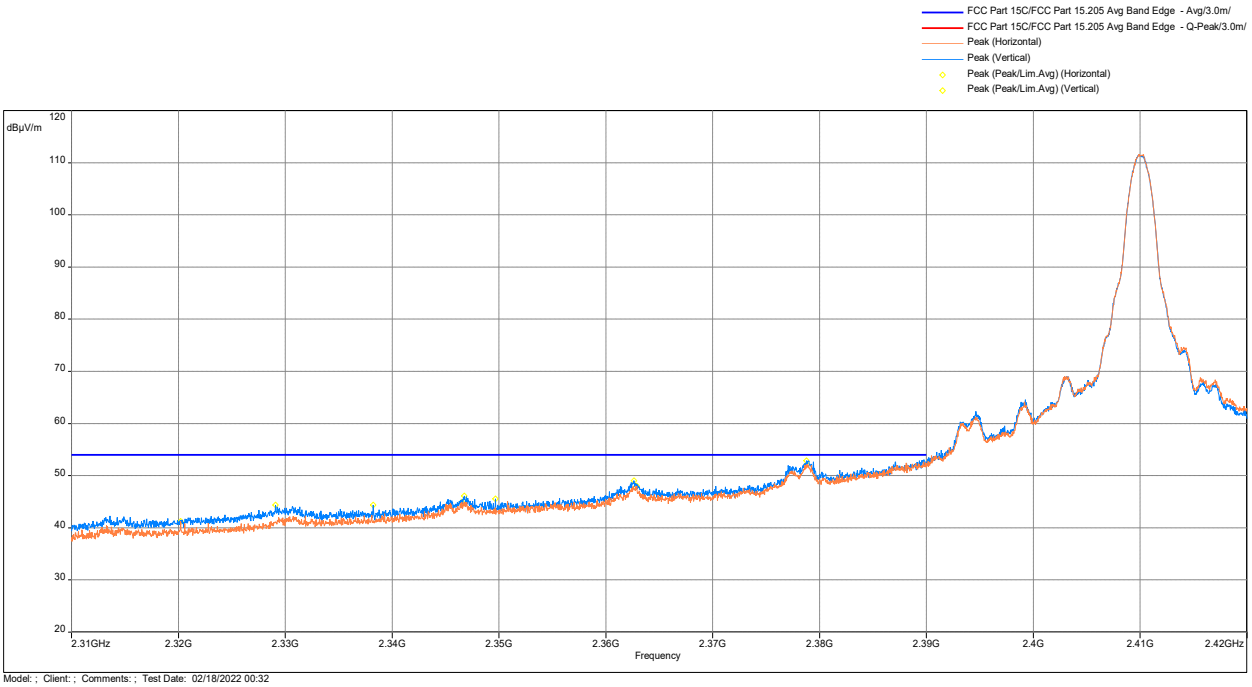
Freq. MHz	Peak @3m dB(uV/m)	Avg Limit dB(µV/m)	Margin dB	Height m	Azimuth deg	Polarity	Correction dB
2483.5	47.27	54	-6.73	1.01	221.75	Horizontal	21.78

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



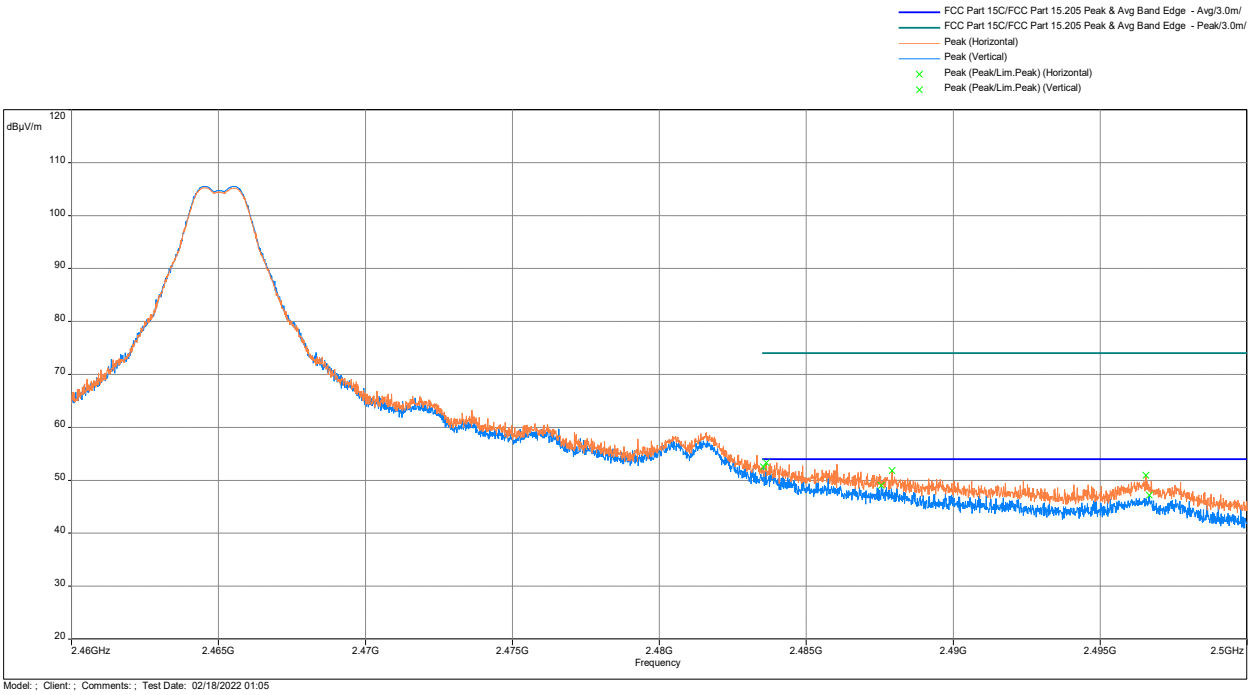
Freq. MHz	Peak @3m dB(uV/m)	Peak Limit dB(µV/m)	Margin dB	Height m	Azimuth deg	Polarity	Correction dB
2390.000	73.51	74	-0.49	1.24	333.75	Vertical	21.45
2389.464	73.40	74	-0.60	1.01	321	Vertical	21.46
2388.573	73.33	74	-0.67	1.01	321	Vertical	21.45
2387.220	72.82	74	-1.18	1.26	57	Horizontal	21.44
2386.934	72.70	74	-1.30	1.26	44.75	Horizontal	21.43
2385.702	72.66	74	-1.34	1.24	333.75	Vertical	21.42

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



Freq. MHz	Avg @3m dB(uV/m)	Avg Limit dB(µV/m)	Margin dB	Height m	Azimuth deg	Polarity	Correction dB
2390.000	51.76	54	-2.24	1.01	333.75	Vertical	21.46
2378.783	52.89	54	-1.11	1.01	333.75	Vertical	21.37

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

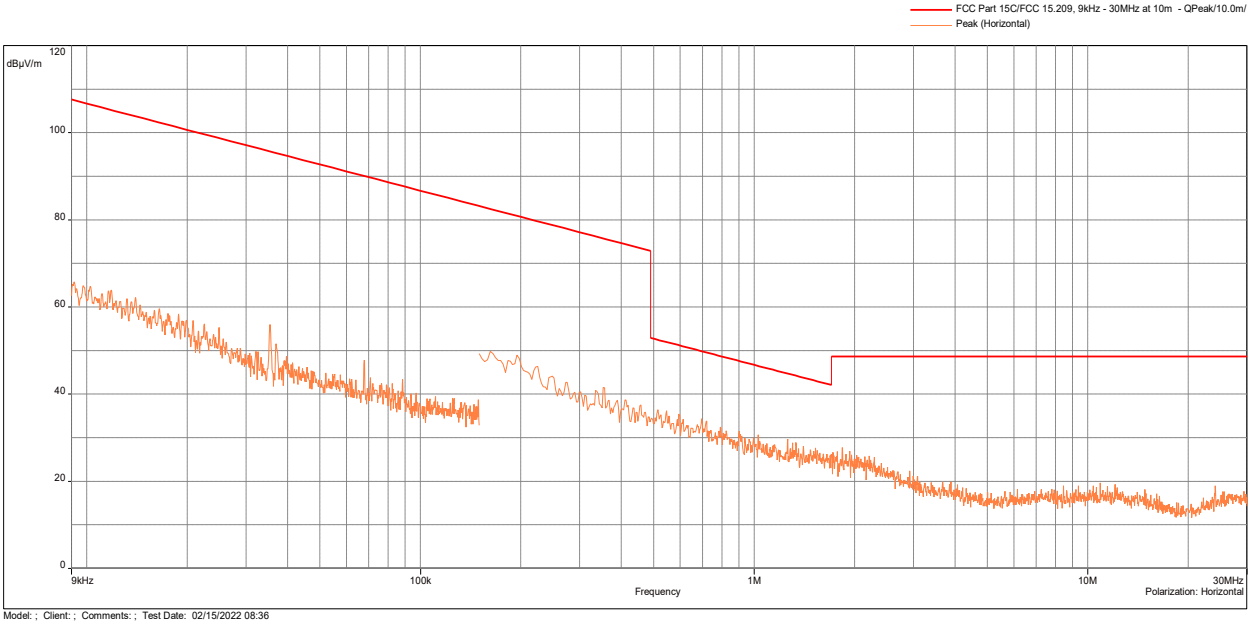


Freq. MHz	Peak @3m dB(uV/m)	Peak Limit dB(µV/m)	Margin dB	Height m	Azimuth deg	Polarity	Correction dB
2483.500	50.39	54	-3.61	1.01	76.25	Horizontal	21.78
2483.640	53.35	54	-0.65	1.01	229.5	Horizontal	21.78
2483.544	52.53	54	-1.47	1.01	329	Vertical	21.78
2487.916	51.80	54	-2.2	1.01	229.5	Horizontal	21.68
2496.556	50.90	54	-3.1	1.01	229.5	Horizontal	21.55

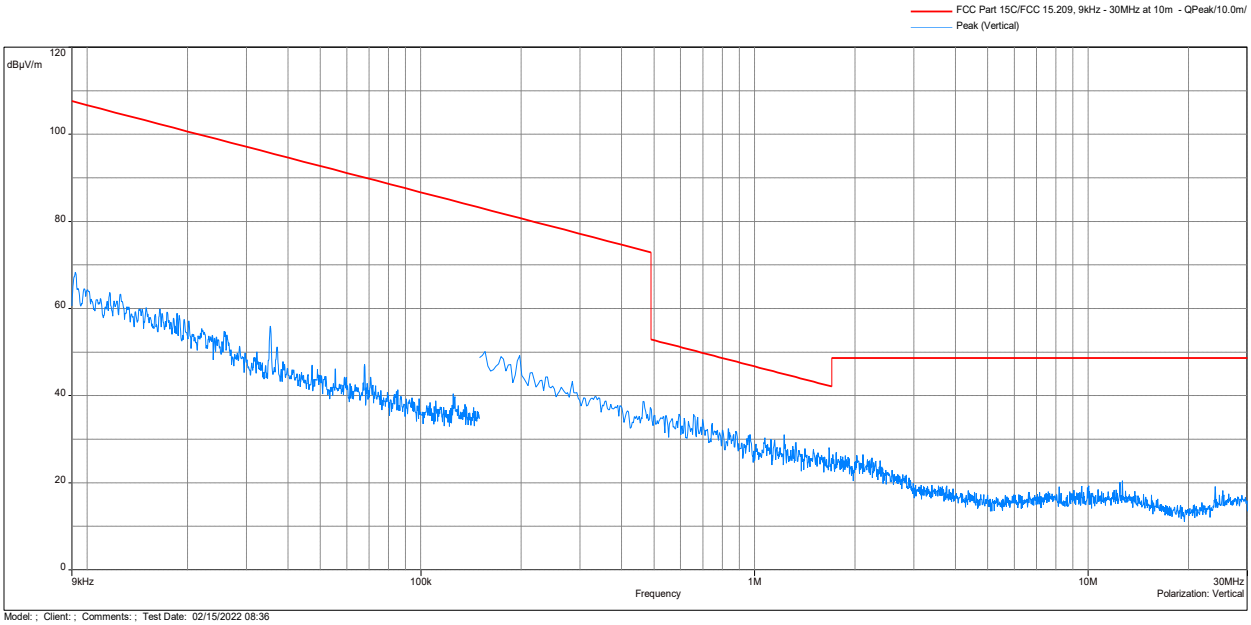
Results	**Complies**

Primary Antenna
Out-of-Band Radiated Spurious Emissions
Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 2410MHz

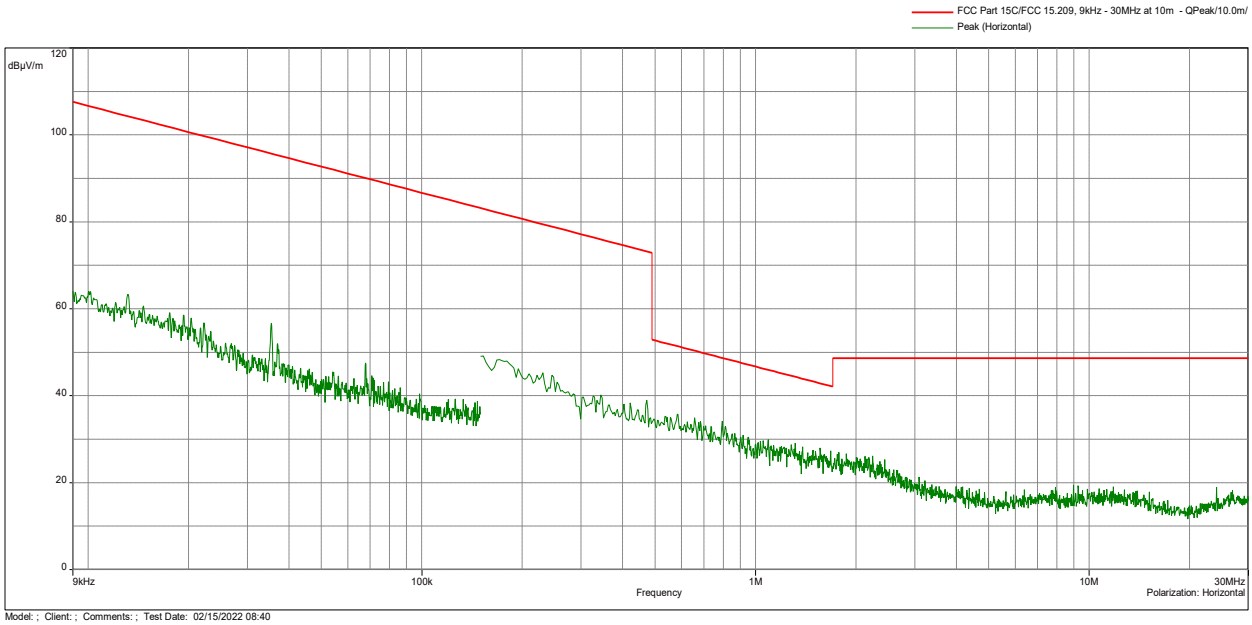
Radiated Spurious Emissions 9kHz - 30 MHz Parallel Antenna Polarization



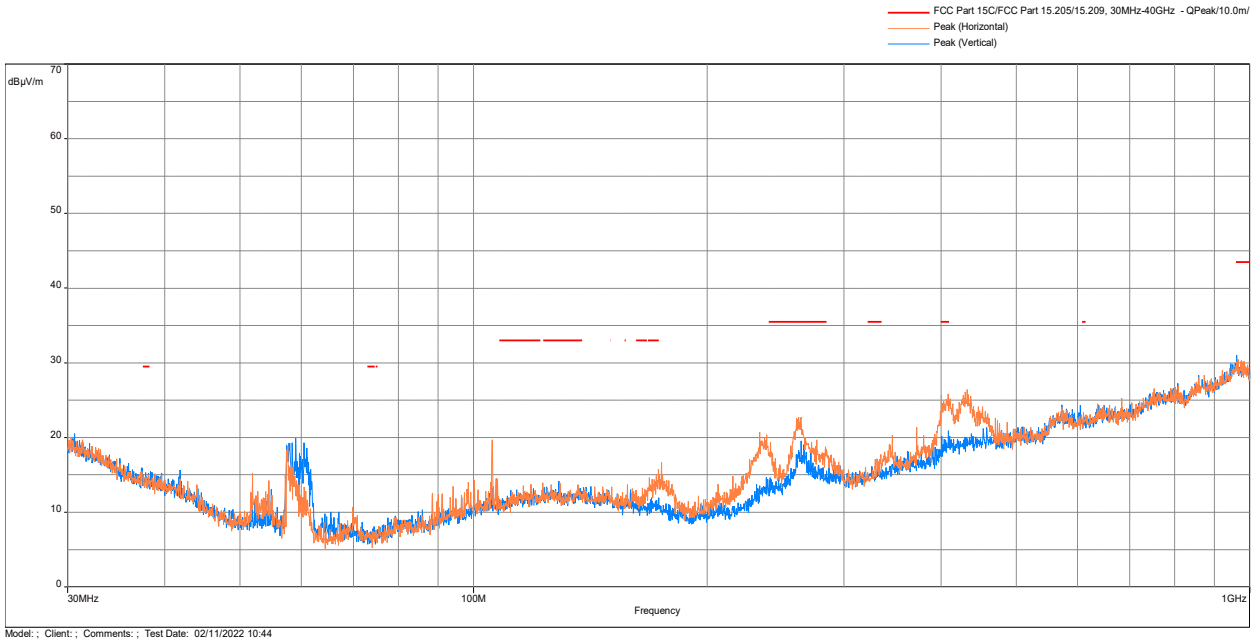
Radiated Spurious Emissions 9kHz - 30 MHz Perpendicular Antenna Polarization



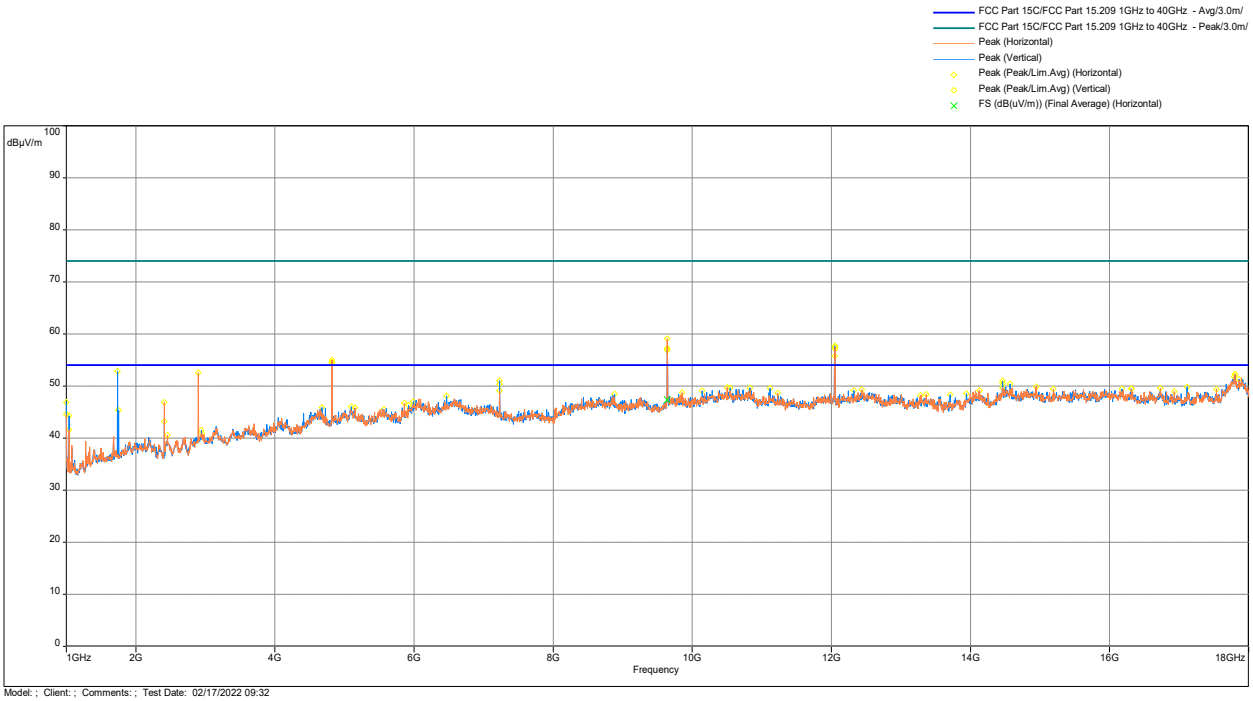
Radiated Spurious Emissions 9kHz - 30 MHz Horizontal Antenna Polarization



Radiated Spurious Emissions 30 MHz - 1000 MHz

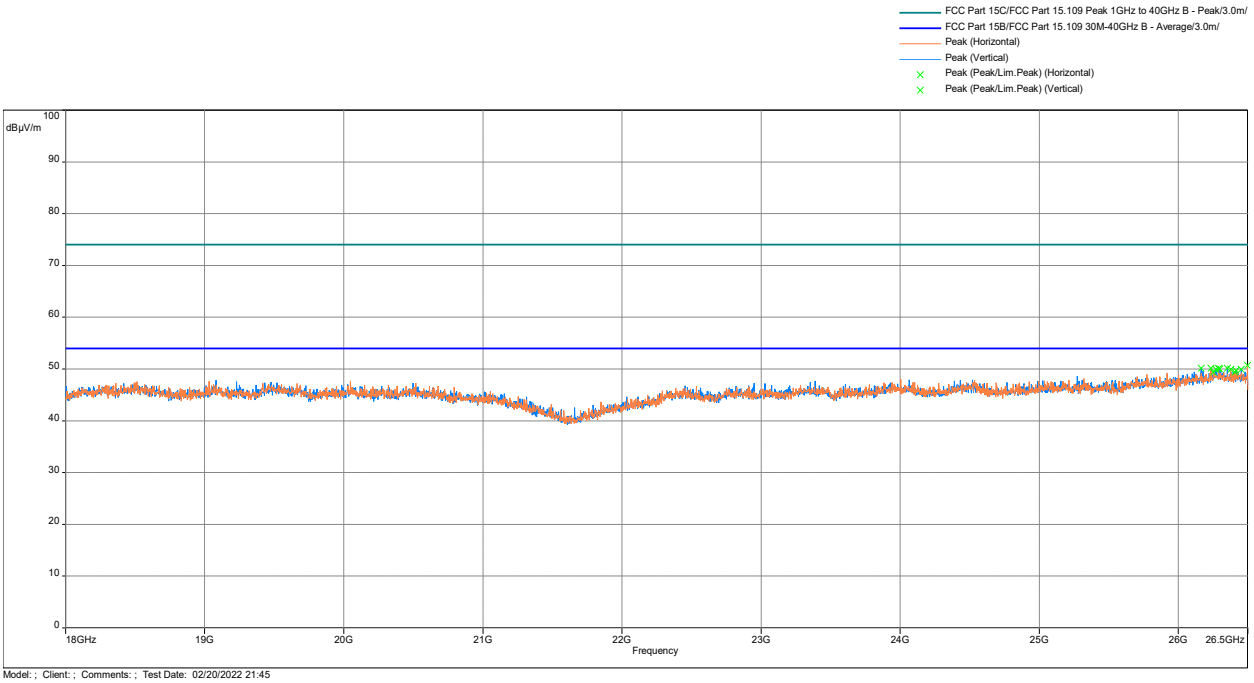


Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak & Average Limit



Model: ; Client: ; Comments: ; Test Date: 02/17/2022 09:32

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



Model: ; Client: ; Comments: ; Test Date: 02/20/2022 21:45

Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 2410MHz

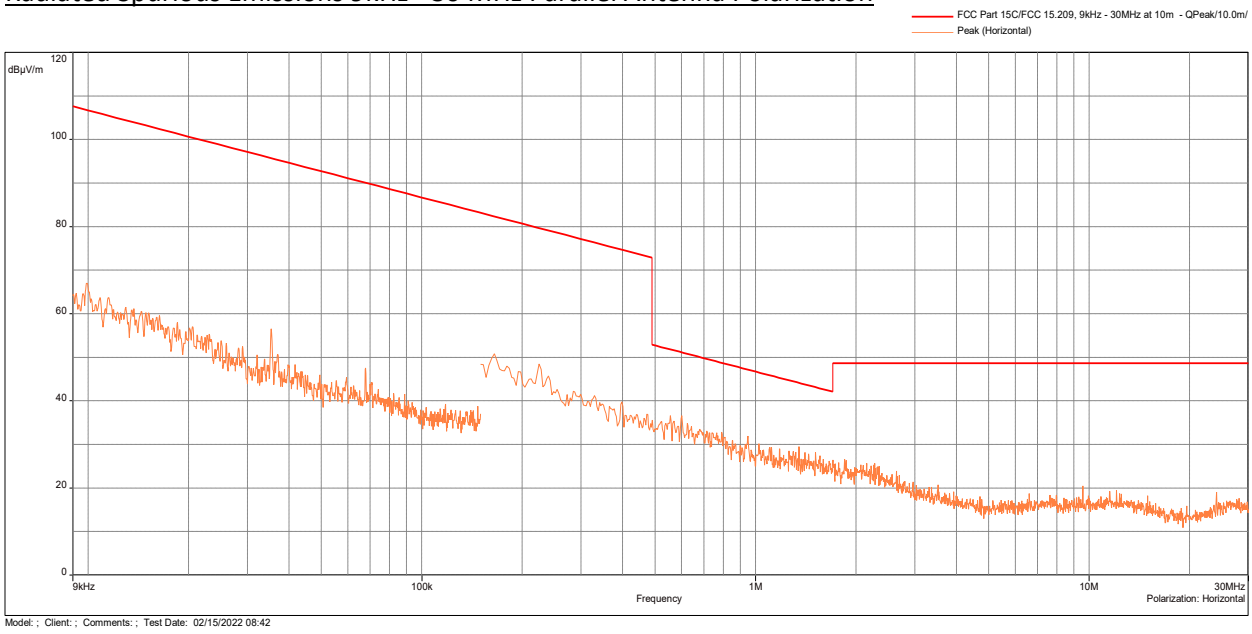
Frequency (MHz)	Peak @3m (dBµV/m)	Lim. Peak @3m (dBµV/m)	Margin dB)	Height (m)	Angle (°)	Comment	Correction (dB)
1667.862	52.83	74	-21.17	51	1.65	Vertical	-14.67
4821.046	55.50	74	-18.5	100	1.74	Horizontal	-5.26
9642.092	55.49	74	-18.51	48	1.60	Horizontal	0.48
7228.624	52.12	74	-21.88	52	1.54	Vertical	-2.74
12052.560	57.45	74	-16.55	54	1.52	Vertical	1.65

Frequency (MHz)	Ave @3m (dBµV/m)	Lim. Ave @3m (dBµV/m)	Margin dB)	Height (m)	Angle (°)	Comment	Correction (dB)
1667.862	52.83	54	-29.07	51	1.65	Vertical	-14.67
4821.046	47.06	54	-6.94	100	1.74	Horizontal	-5.26
9642.092	47.40	54	-6.60	48	1.60	Horizontal	0.48
7228.624	52.12	54	-1.88	52	1.54	Vertical	-2.74
12052.560	47.32	54	-6.68	54	1.52	Vertical	1.65

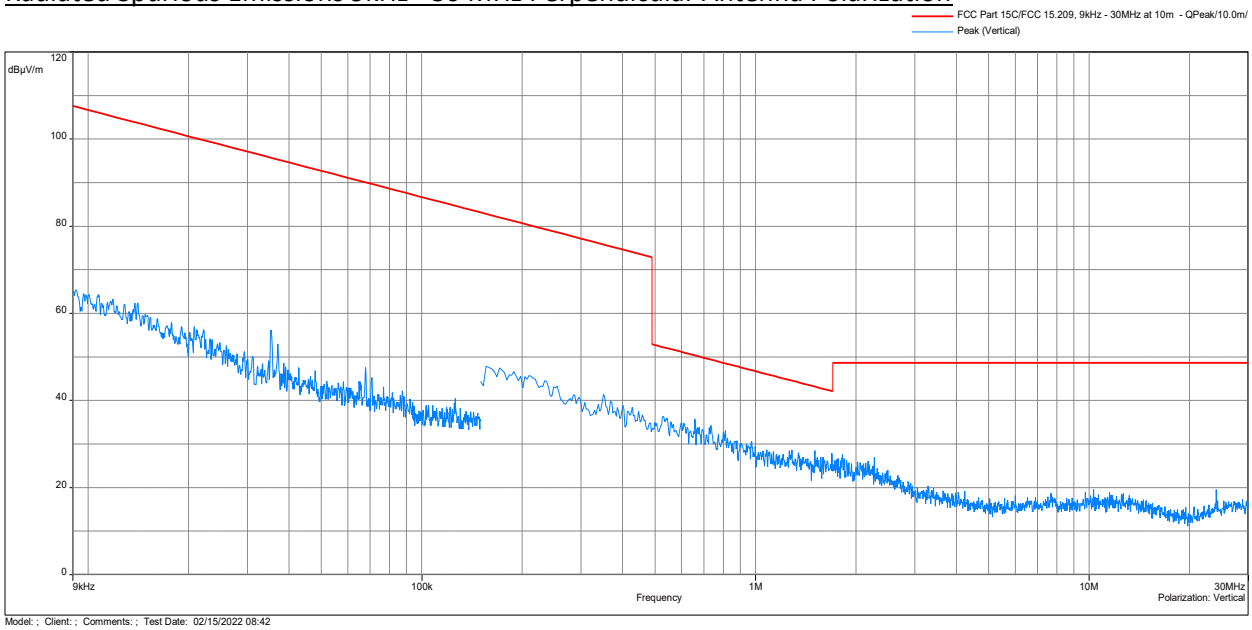
Note: Correction = AF + CF - Preamp

Results	Complies

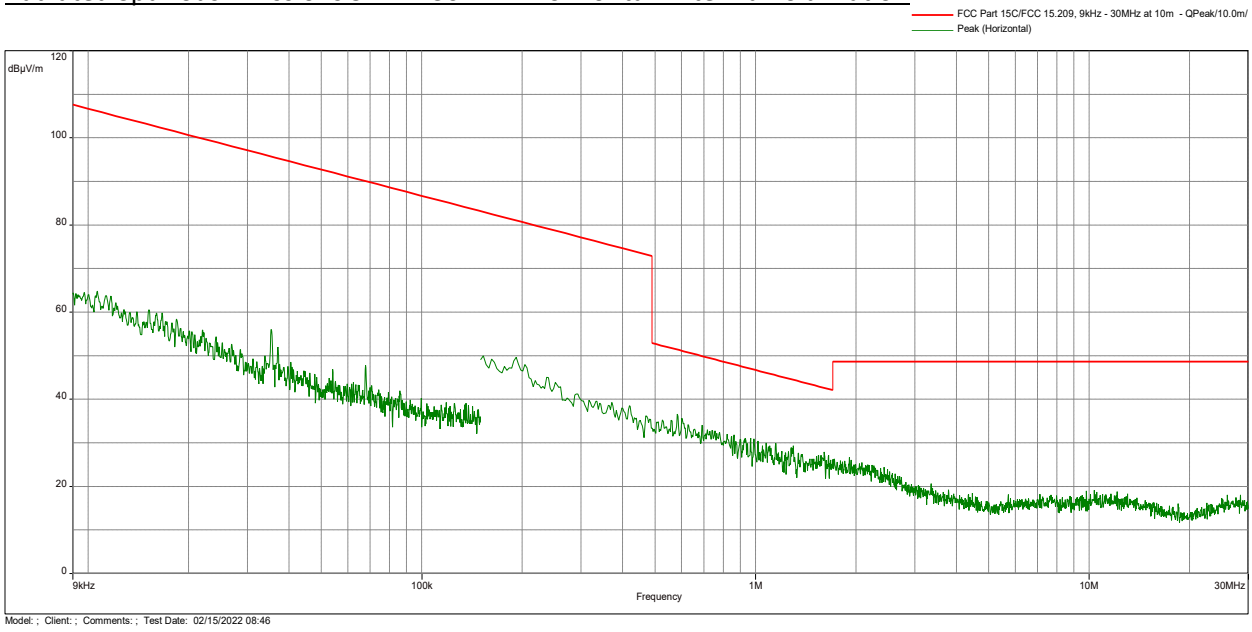
Radiated Spurious Emissions 9kHz - 30 MHz Parallel Antenna Polarization



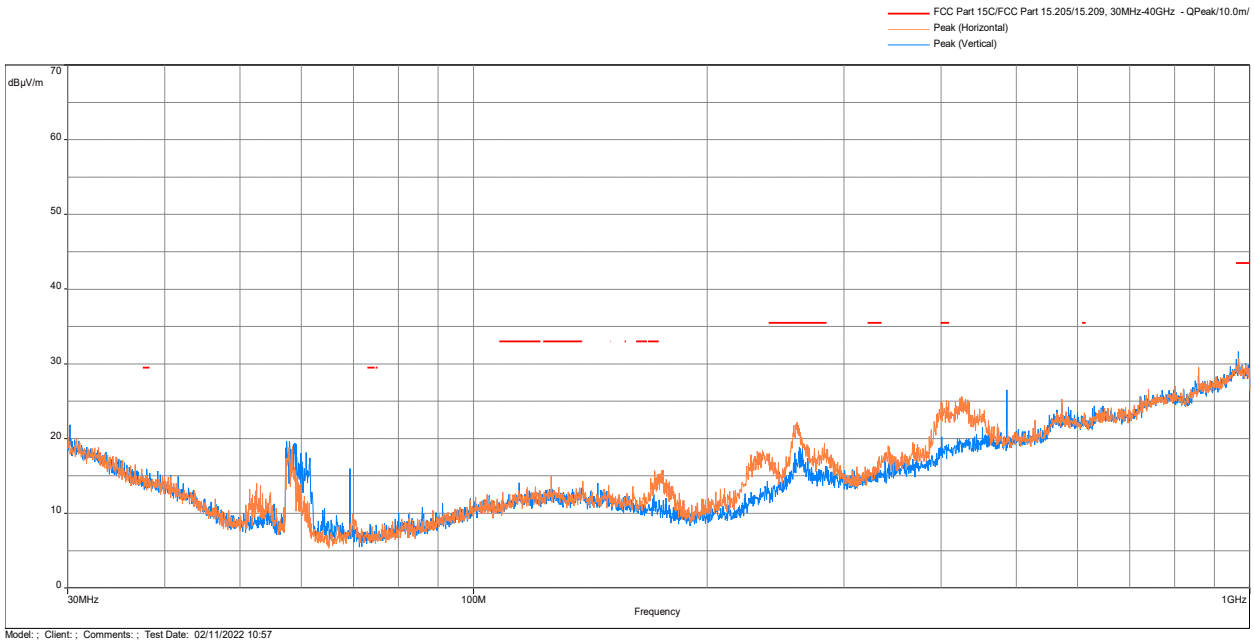
Radiated Spurious Emissions 9kHz - 30 MHz Perpendicular Antenna Polarization



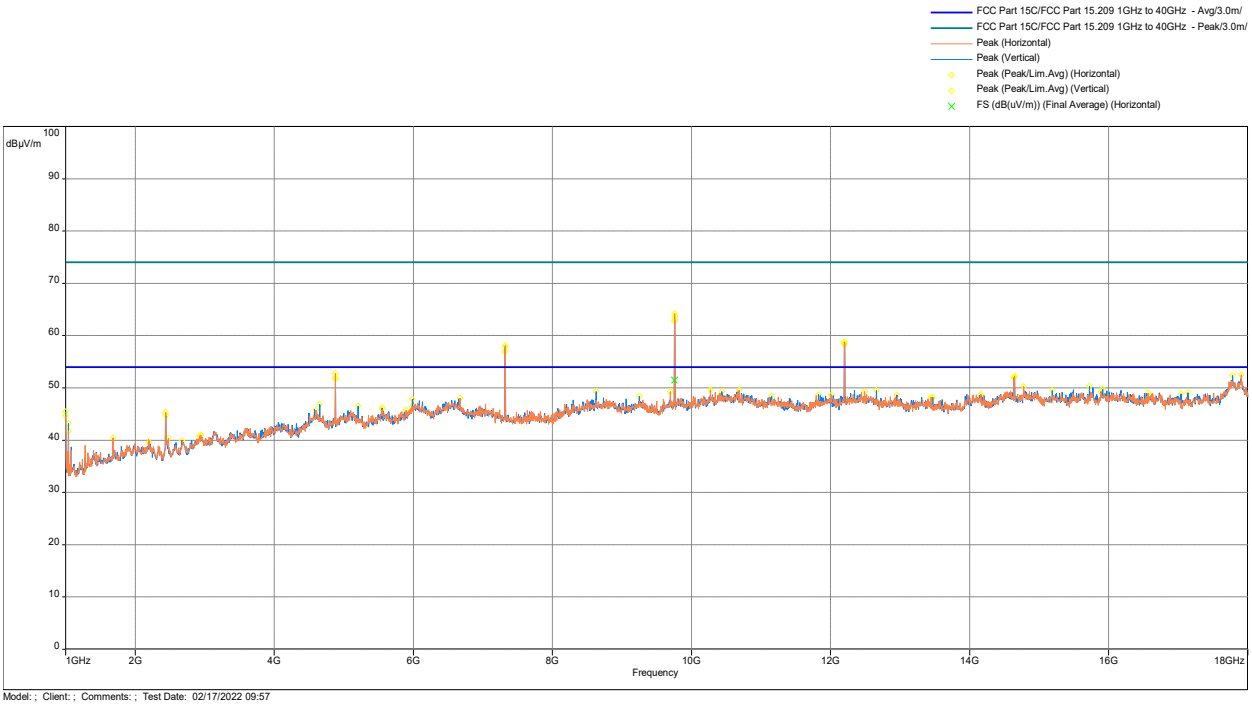
Radiated Spurious Emissions 9kHz - 30 MHz Horizontal Antenna Polarization



Radiated Spurious Emissions 30 MHz - 1000 MHz

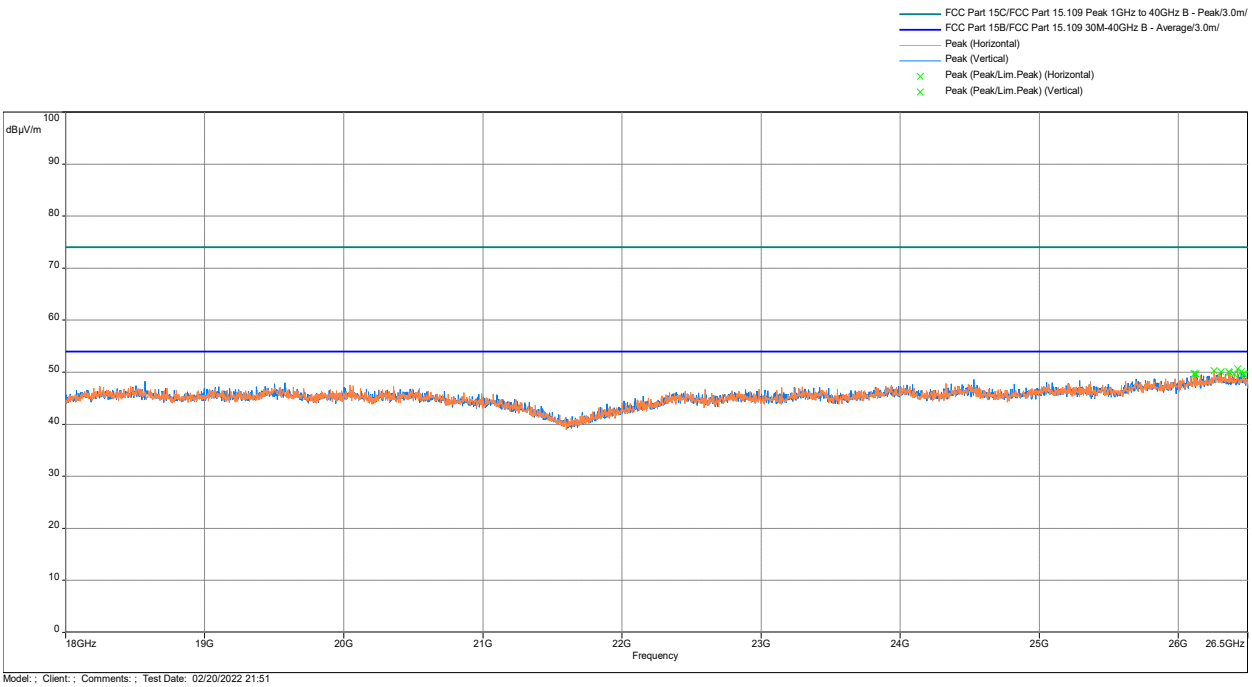


Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak & Average Limit



Model: ; Client: ; Comments: ; Test Date: 02/17/2022 09:57

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



Model: ; Client: ; Comments: ; Test Date: 02/20/2022 21:51

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

Frequency (MHz)	Peak @3m (dBµV/m)	Lim. Peak @3m (dBµV/m)	Margin dB)	Height (m)	Angle (°)	Comment	Correction (dB)
4821.046	53.10	74	-20.9	1.51	27	Horizontal	-5.26
7321.167	57.50	74	-16.5	2.57	39	Vertical	-2.74
9758.093	63.14	74	-10.86	2.52	26	Horizontal	0.98
12197.900	58.85	74	-15.15	3.50	260	Vertical	1.65

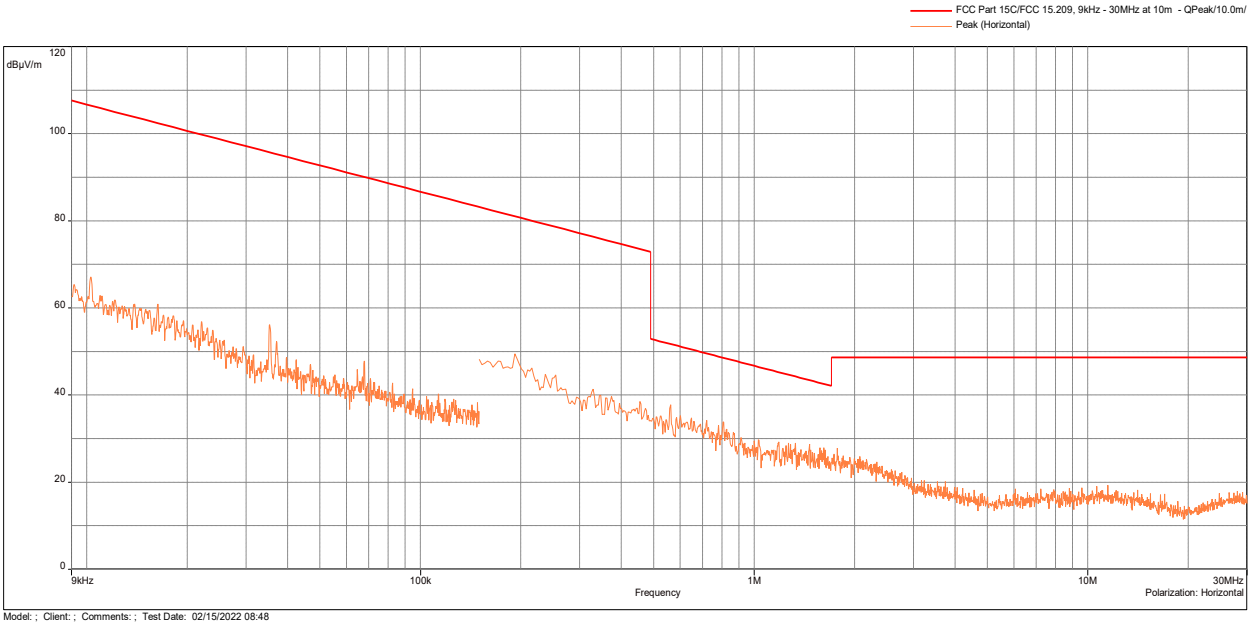
Frequency (MHz)	Ave @3m (dBµV/m)	Lim. Ave @3m (dBµV/m)	Margin dB)	Height (m)	Angle (°)	Comment	Correction (dB)
4821.046	53.10	54	-0.9	1.51	27	Horizontal	-5.26
7321.167	50.01	54	4.05	2.57	39	Vertical	-2.74
9758.093	51.50	54	-2.51	2.52	26	Horizontal	0.98
12197.900	50.39	54	4.8	3.50	260	Vertical	1.65

Note: Correction = AF + CF – Preamp

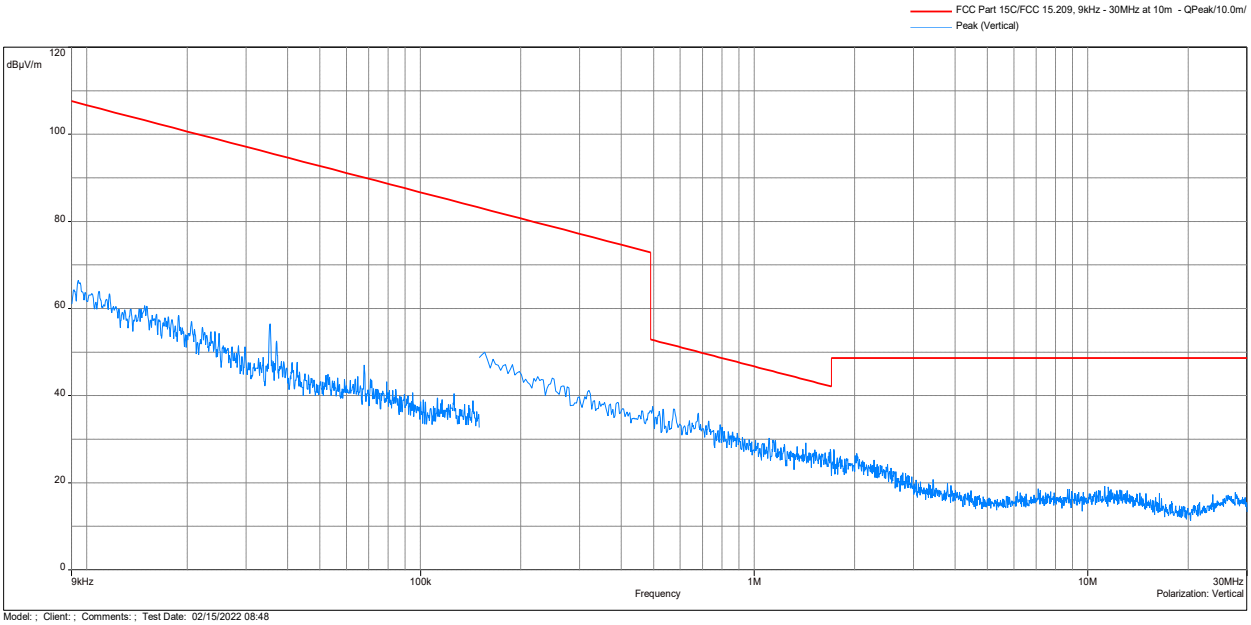
Results	Complies

Test Results: 15.209 Radiated Spurious Emissions High Channel, Tx at 2465MHz

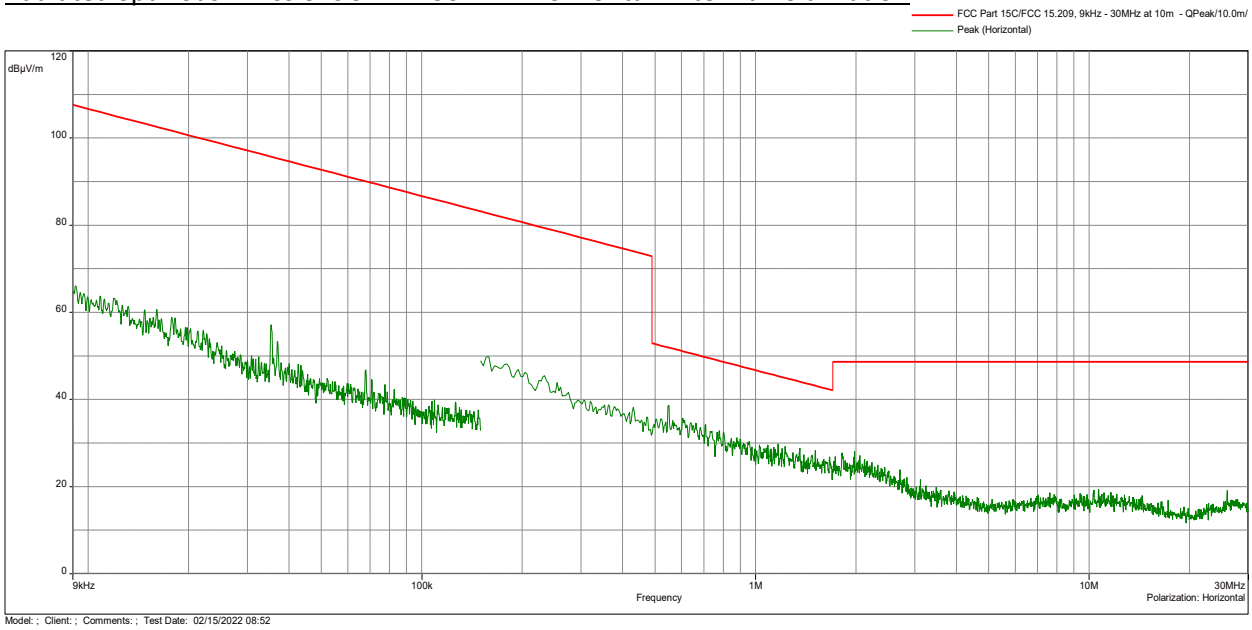
Radiated Spurious Emissions 9kHz - 30 MHz Parallel Antenna Polarization



Radiated Spurious Emissions 9kHz - 30 MHz Perpendicular Antenna Polarization

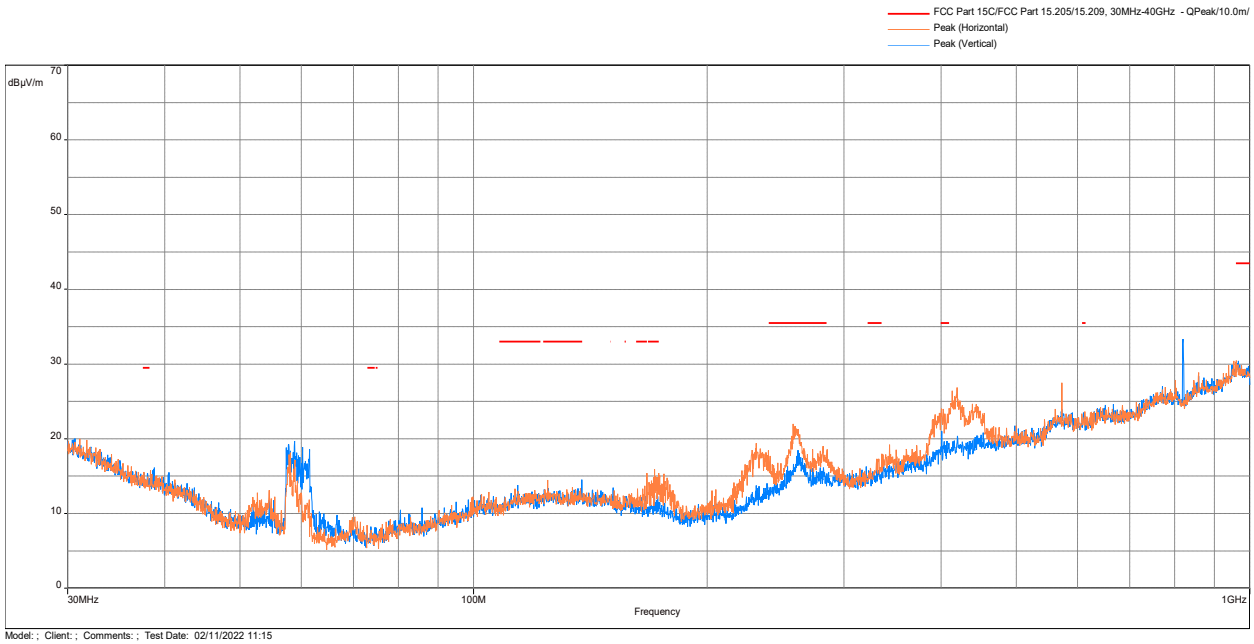


Radiated Spurious Emissions 9kHz - 30 MHz Horizontal Antenna Polarization



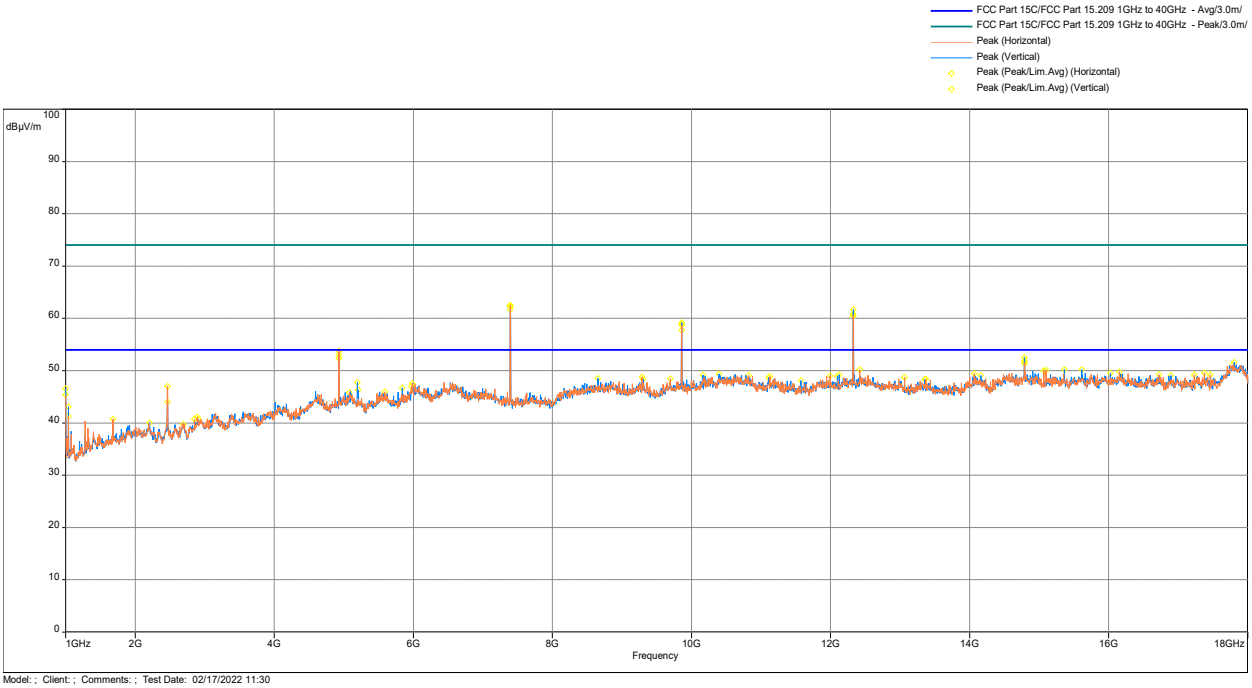
Model: ; Client: ; Comments: ; Test Date: 02/15/2022 08:52

Radiated Spurious Emissions 30 MHz - 1000 MHz



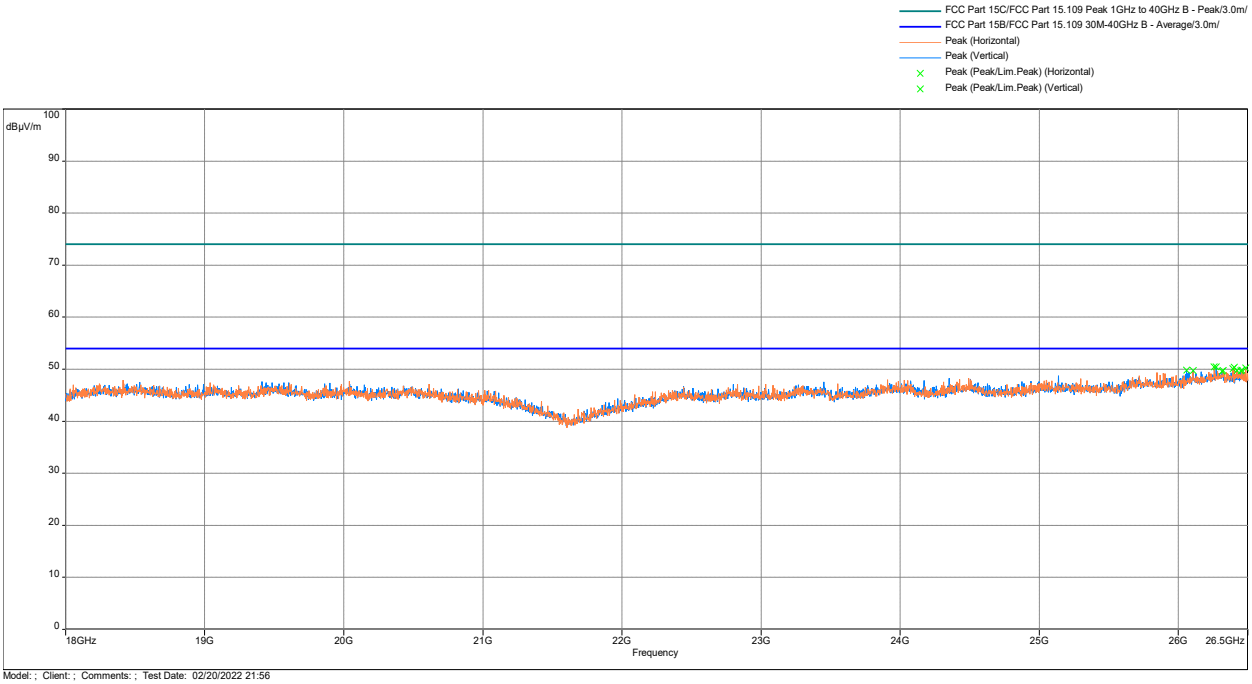
Model: ; Client: ; Comments: ; Test Date: 02/11/2022 11:15

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



Model: ; Client: ; Comments: ; Test Date: 02/17/2022 11:30

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



Model: ; Client: ; Comments: ; Test Date: 02/20/2022 21:56

Test Results: 15.209 Radiated Spurious Emissions High Channel, Tx at 2465MHz

Frequency (MHz)	Peak @3m (dBµV/m)	Lim. Peak @3m (dBµV/m)	Margin dB)	Height (m)	Angle (°)	Comment	Correction (dB)
4928.700	54.34	74	-19.66	1.53	165	Vertical	-4.83
7321.519	63.20	74	-10.80	1.69	221	Horizontal	-2.53
9858.133	59.44	74	-14.56	1.77	350	Vertical	0.82
12322.560	61.97	74	-12.03	1.49	136.5	Vertical	1.95

Frequency (MHz)	Ave @3m (dBµV/m)	Lim. Ave @3m (dBµV/m)	Margin dB)	Height (m)	Angle (°)	Comment	Correction (dB)
4928.700	47.88	54	-6.12	1.53	165	Vertical	-4.83
7321.519	53.57	54	-0.43	1.69	221	Horizontal	-2.53
9858.133	50.82	54	-3.18	1.77	350	Vertical	0.82
12322.560	53.40	54	-0.6	1.49	136.5	Vertical	1.95

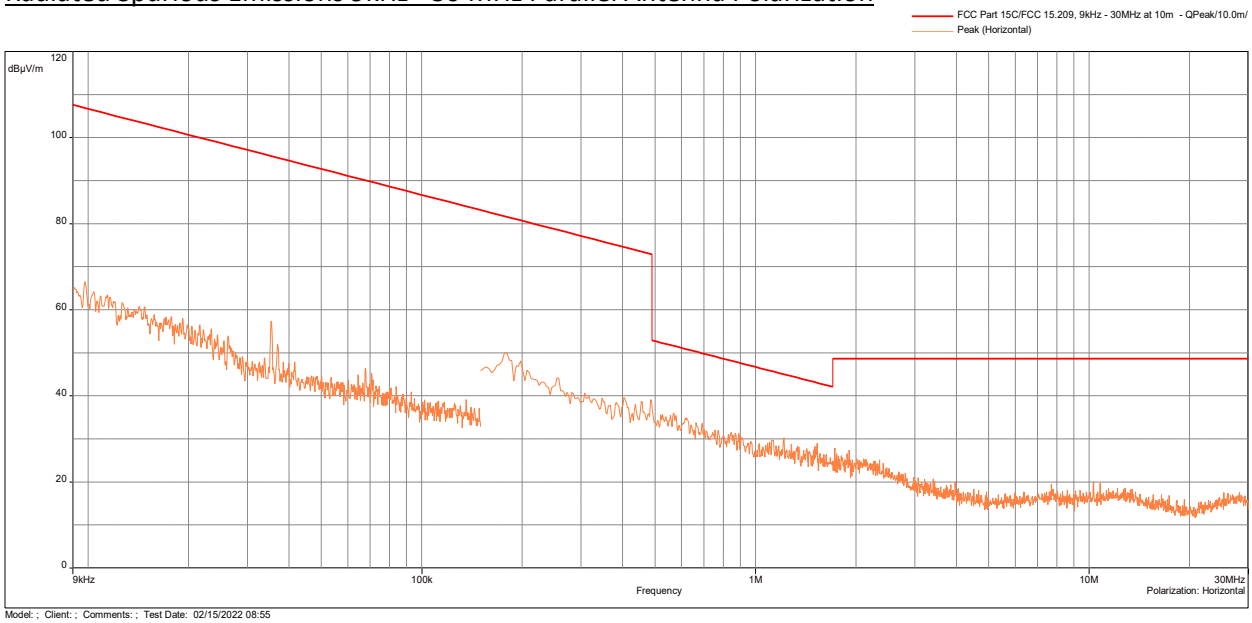
Note: Correction = AF + CF - Preamp

Results	Complies

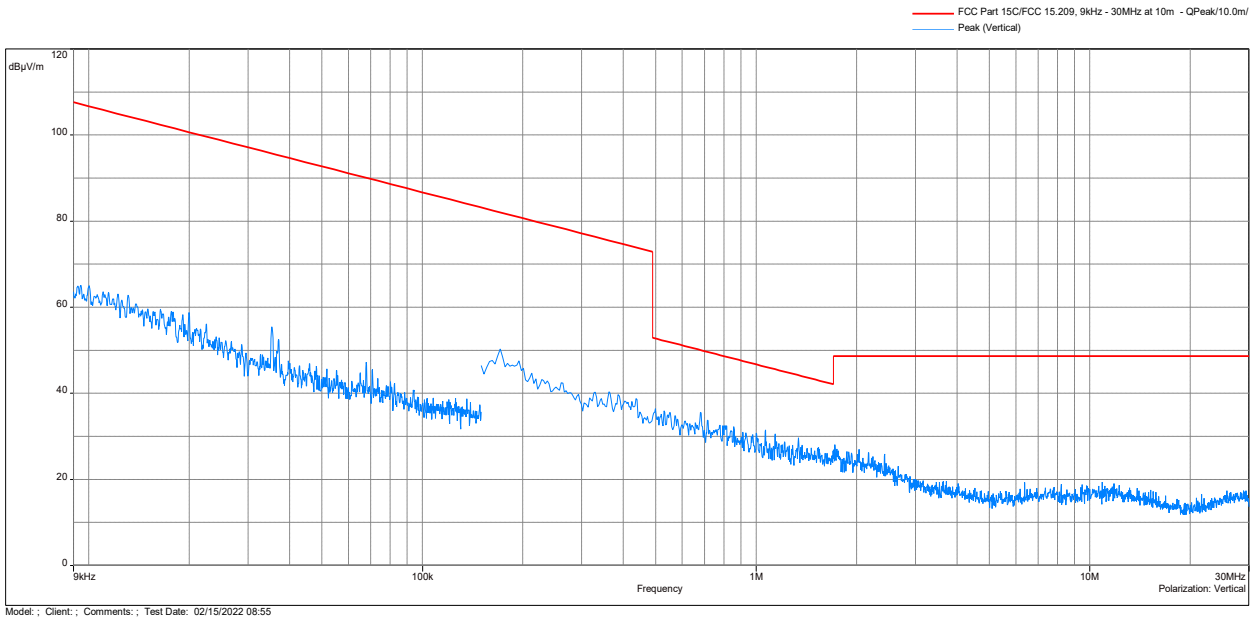
Secondary Antenna
Out-of-Band Radiated Spurious Emissions

Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 2410MHz

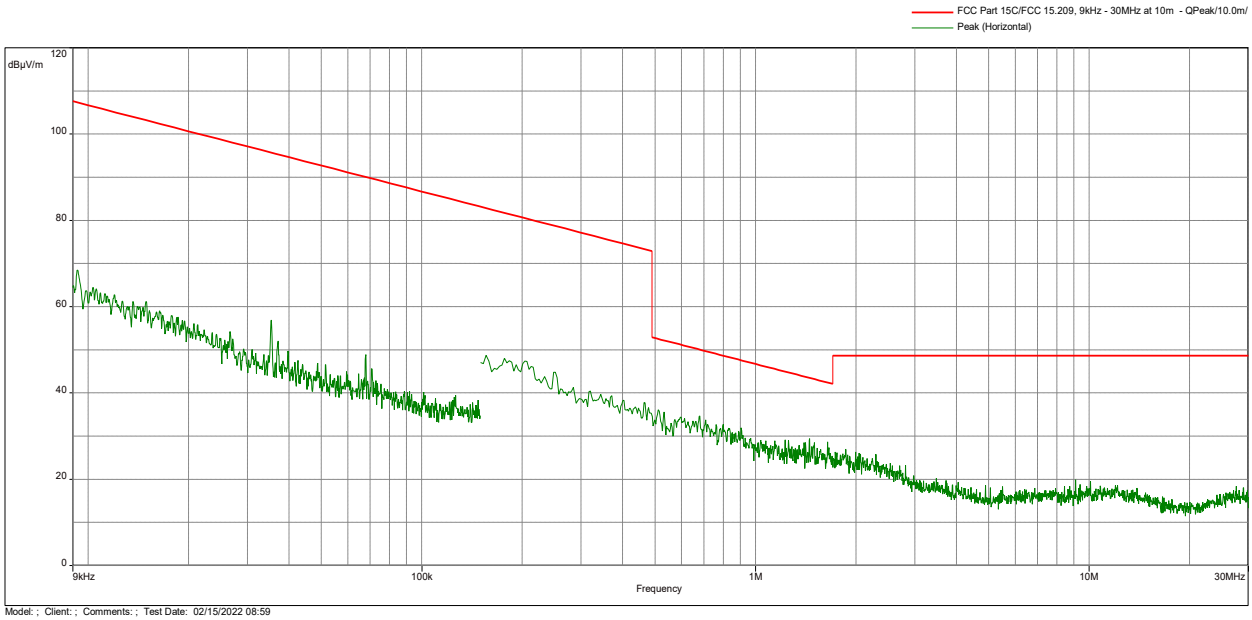
Radiated Spurious Emissions 9kHz - 30 MHz Parallel Antenna Polarization



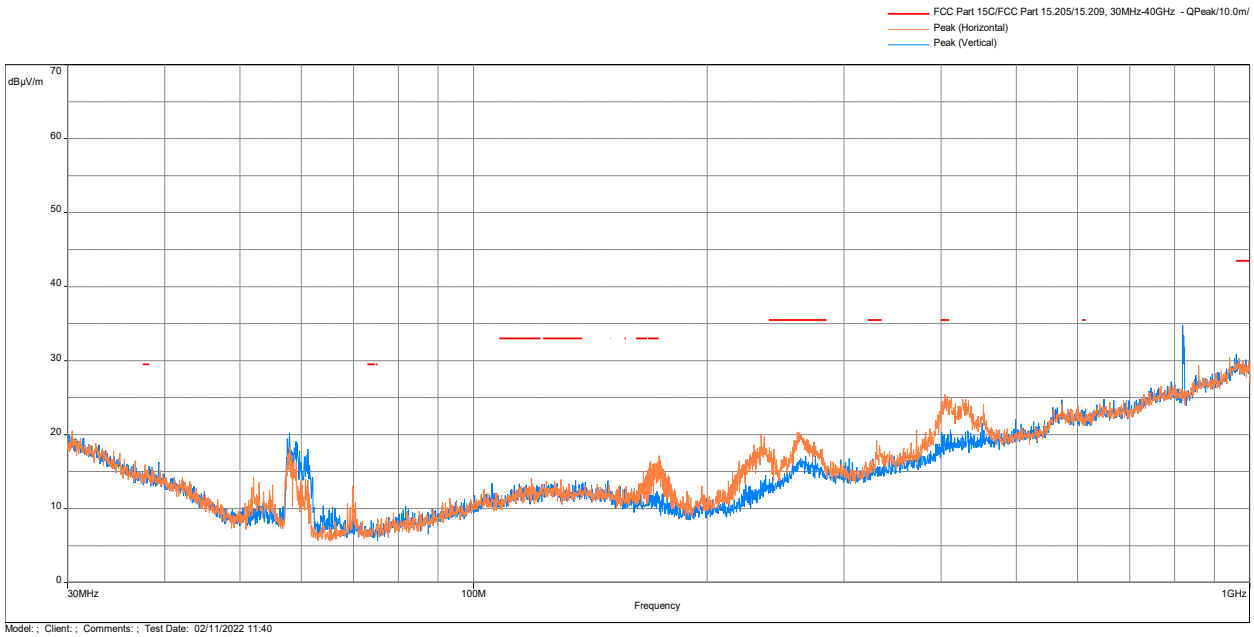
Radiated Spurious Emissions 9kHz - 30 MHz Perpendicular Antenna Polarization



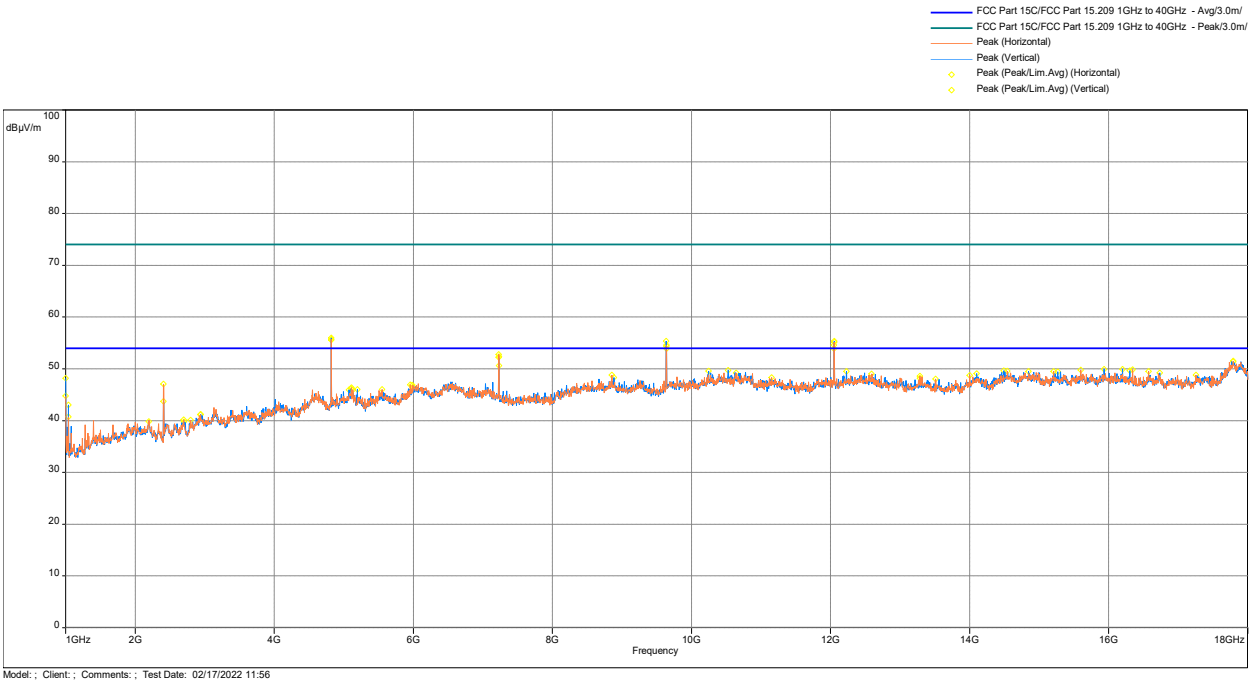
Radiated Spurious Emissions 9kHz - 30 MHz Horizontal Antenna Polarization



Radiated Spurious Emissions 30 MHz - 1000 MHz

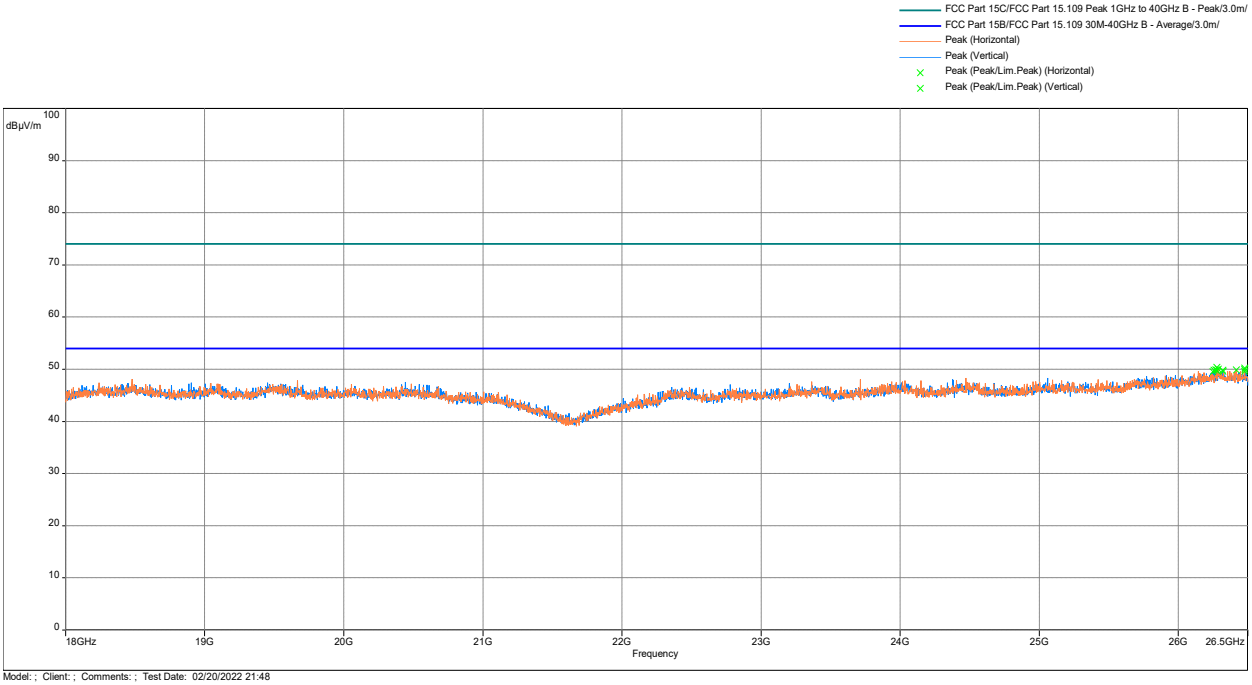


Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak & Average Limit



Model: ; Client: ; Comments: ; Test Date: 02/17/2022 11:56

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



Model: ; Client: ; Comments: ; Test Date: 02/20/2022 21:48

Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 2410MHz

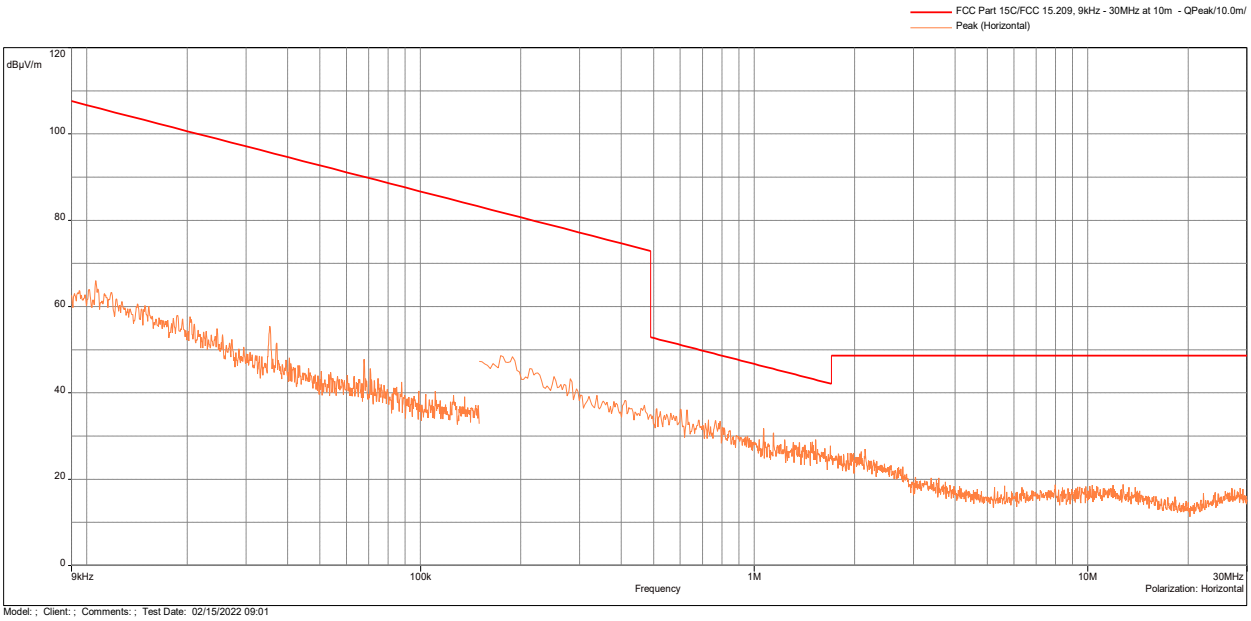
Frequency (MHz)	Peak @3m (dBµV/m)	Lim. Peak @3m (dBµV/m)	Margin dB)	Height (m)	Angle (°)	Comment	Correction (dB)
4821.046	55.98	74	-18.02	1.56	45	Vertical	-5.26
9642.092	53.12	74	-20.88	1.57	54	Horizontal	0.48
7228.624	55.17	74	-18.83	1.75	51	Horizontal	-2.74
12052.56	57.45	74	-16.55	1.84	122	Horizontal	1.65

Frequency (MHz)	Ave @3m (dBµV/m)	Lim. Ave @3m (dBµV/m)	Margin dB)	Height (m)	Angle (°)	Comment	Correction (dB)
4821.046	47.51	54	-6.49	1.56	45	Vertical	-5.26
9642.092	53.12	54	-0.88	1.57	54	Horizontal	0.48
7228.624	41.93	54	-12.07	1.75	51	Horizontal	-2.74
12052.56	47.32	54	-6.68	1.84	122	Horizontal	1.65

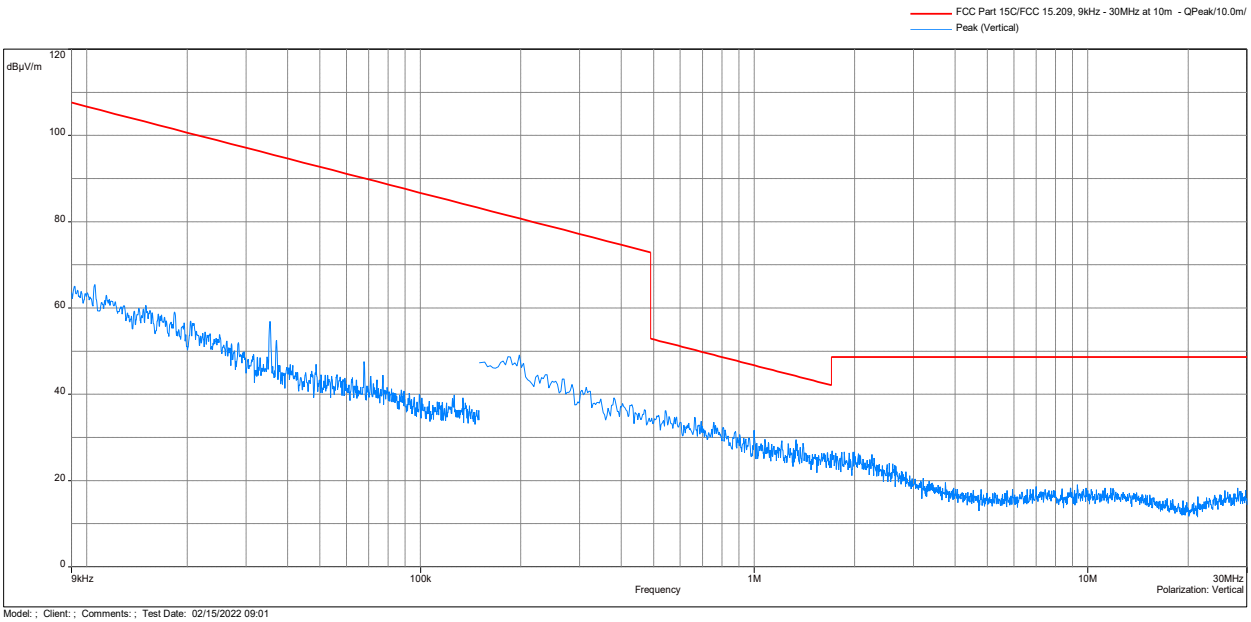
Note: Correction = AF + CF - Preamp

Results	Complies

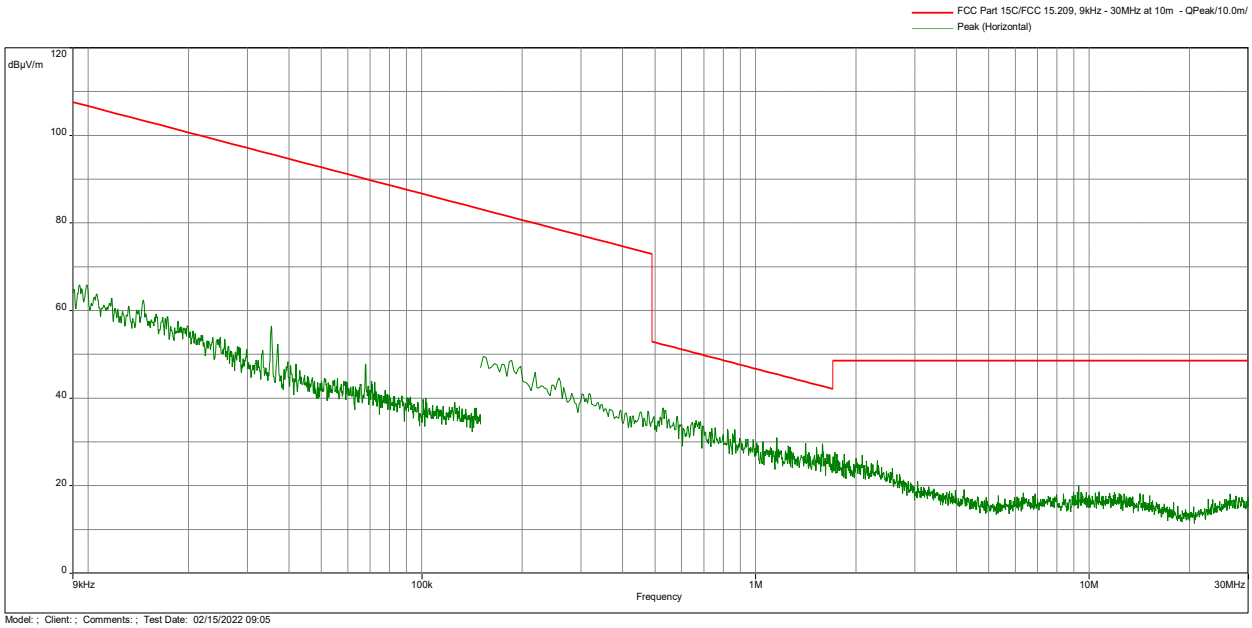
Radiated Spurious Emissions 9kHz - 30 MHz Parallel Antenna Polarization



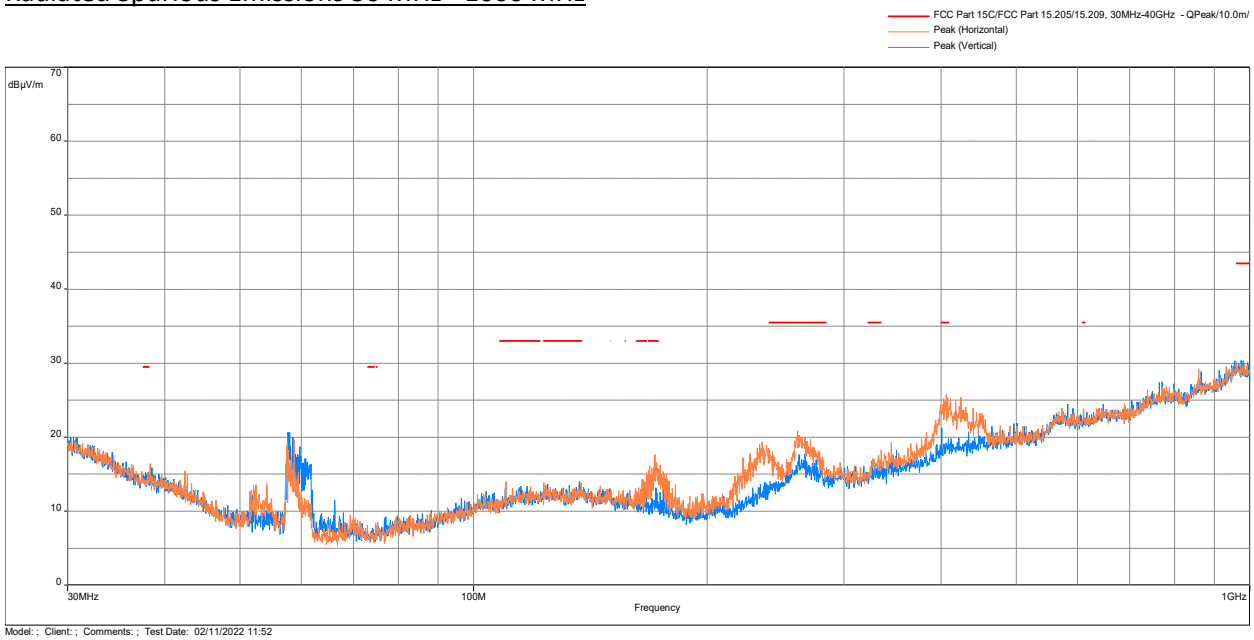
Radiated Spurious Emissions 9kHz - 30 MHz Perpendicular Antenna Polarization



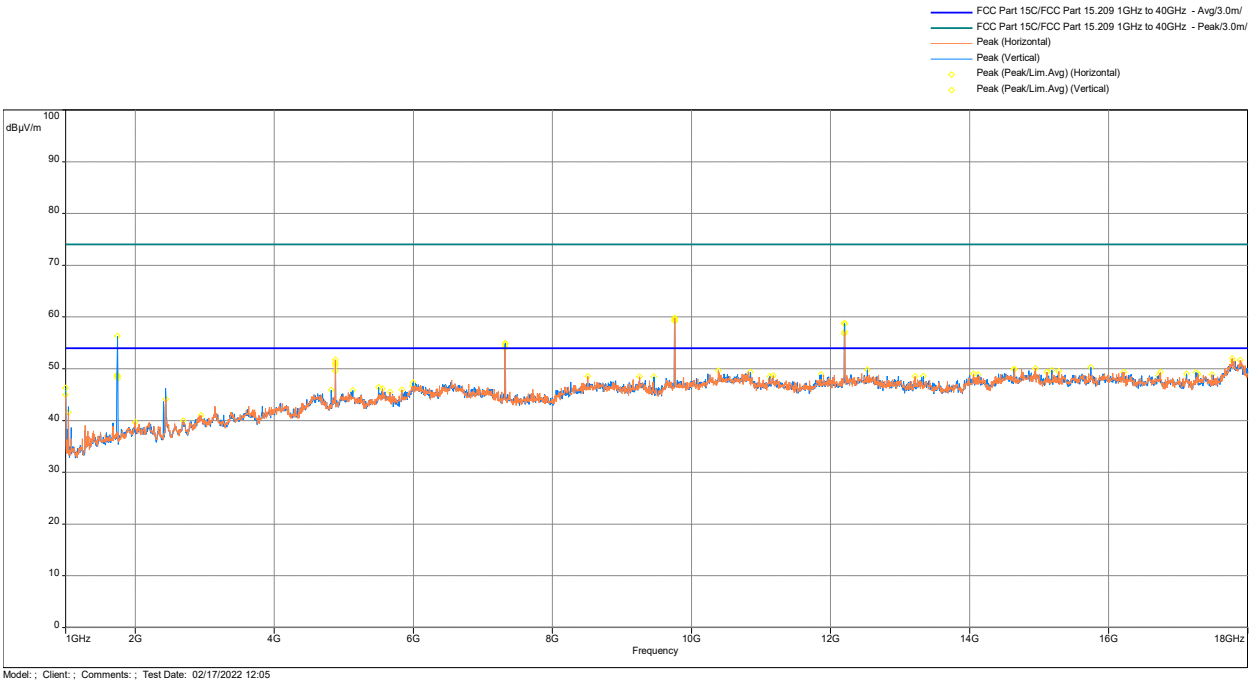
Radiated Spurious Emissions 9kHz - 30 MHz Horizontal Antenna Polarization



Radiated Spurious Emissions 30 MHz - 1000 MHz

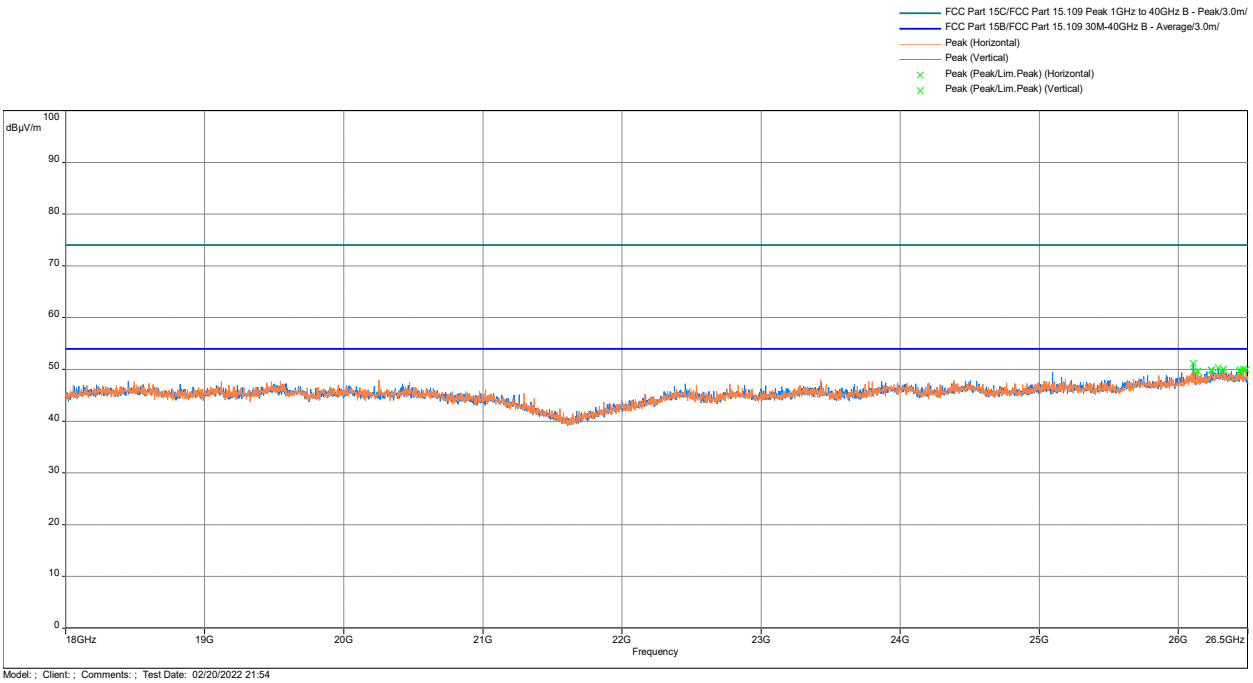


Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan vs Peak & Average Limit



Model: ; Client: ; Comments: ; Test Date: 02/17/2022 12:05

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



Model: ; Client: ; Comments: ; Test Date: 02/20/2022 21:54

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

Frequency (MHz)	Peak @3m (dBµV/m)	Lim. Peak @3m (dBµV/m)	Margin dB)	Height (m)	Angle (°)	Comment	Correction (dB)
4821.046	52.30	74	-21.70	1.65	33	Horizontal	-5.26
7321.167	42.01	74	-19.20	1.51	45	Vertical	-2.74
9758.093	52.18	74	-14.30	1.49	57	Horizontal	0.98
12197.9	50.09	74	-15.13	1.78	81	Vertical	1.65

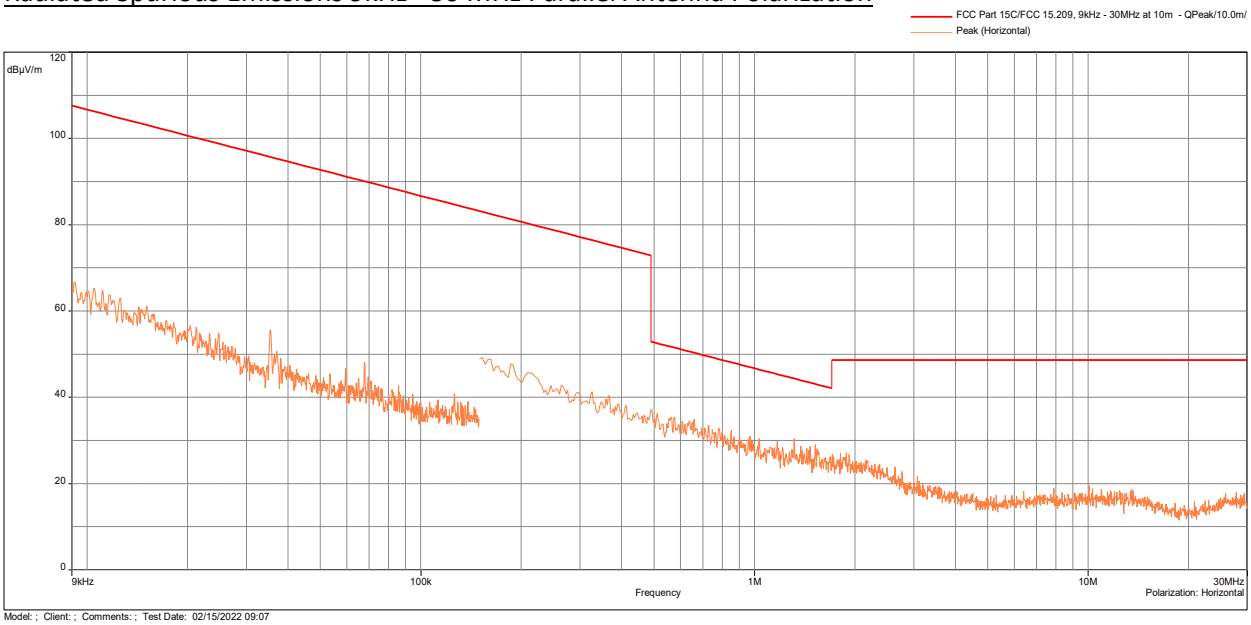
Frequency (MHz)	Ave @3m (dBµV/m)	Lim. Ave @3m (dBµV/m)	Margin dB)	Height (m)	Angle (°)	Comment	Correction (dB)
4821.046	52.30	54	-1.70	1.65	33	Horizontal	-5.26
7321.167	42.01	54	-11.99	1.51	45	Vertical	-2.74
9758.093	52.18	54	-1.82	1.49	57	Horizontal	0.98
12197.9	50.09	54	-3.91	1.78	81	Vertical	1.65

Note: Correction = AF + CF - Preamp
Note 2: 1745.167MHz was investigated and is a Transient Emission

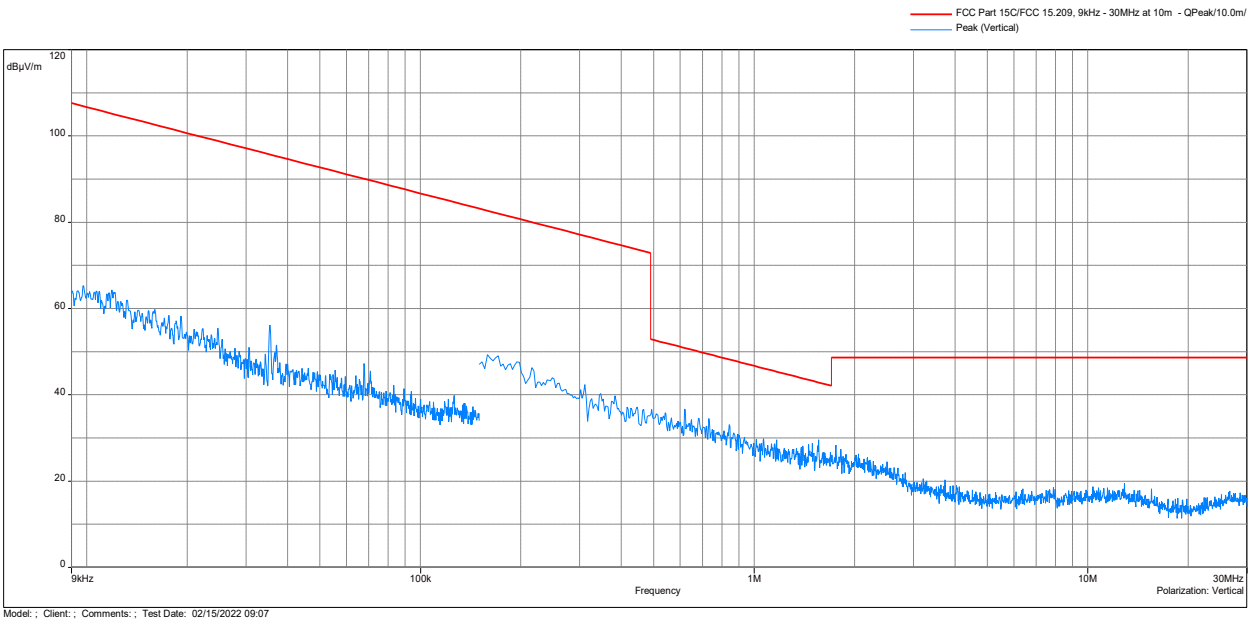
Results	Complies

Test Results: 15.209 Radiated Spurious Emissions High Channel, Tx at 2465MHz

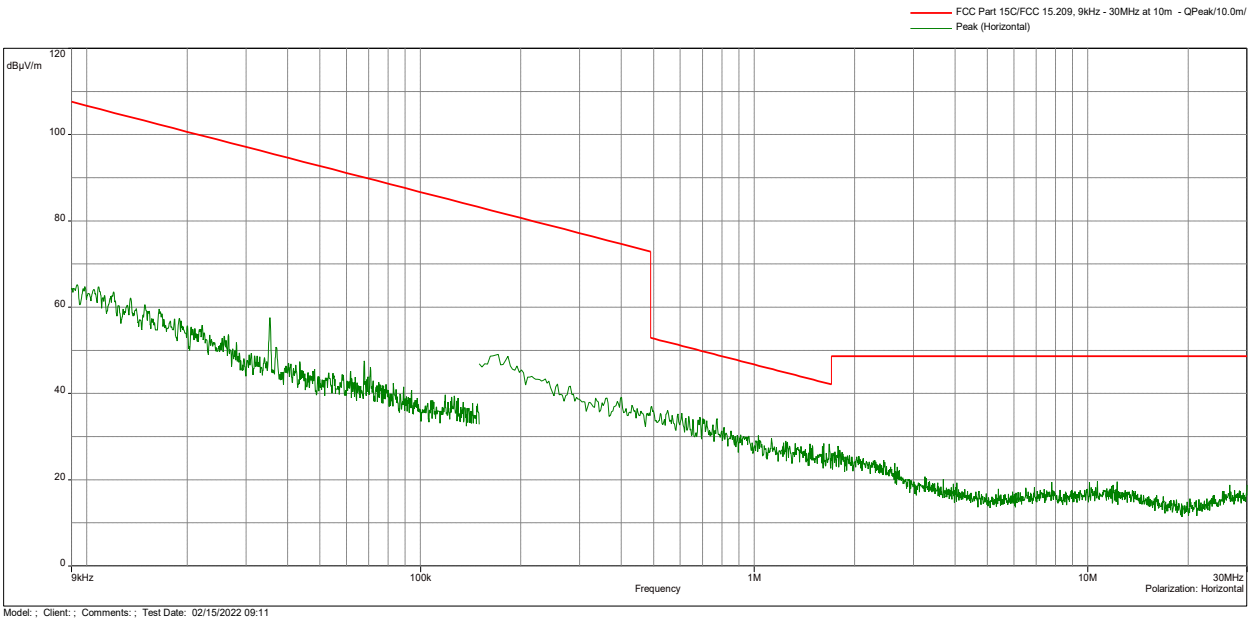
Radiated Spurious Emissions 9kHz - 30 MHz Parallel Antenna Polarization



Radiated Spurious Emissions 9kHz - 30 MHz Perpendicular Antenna Polarization

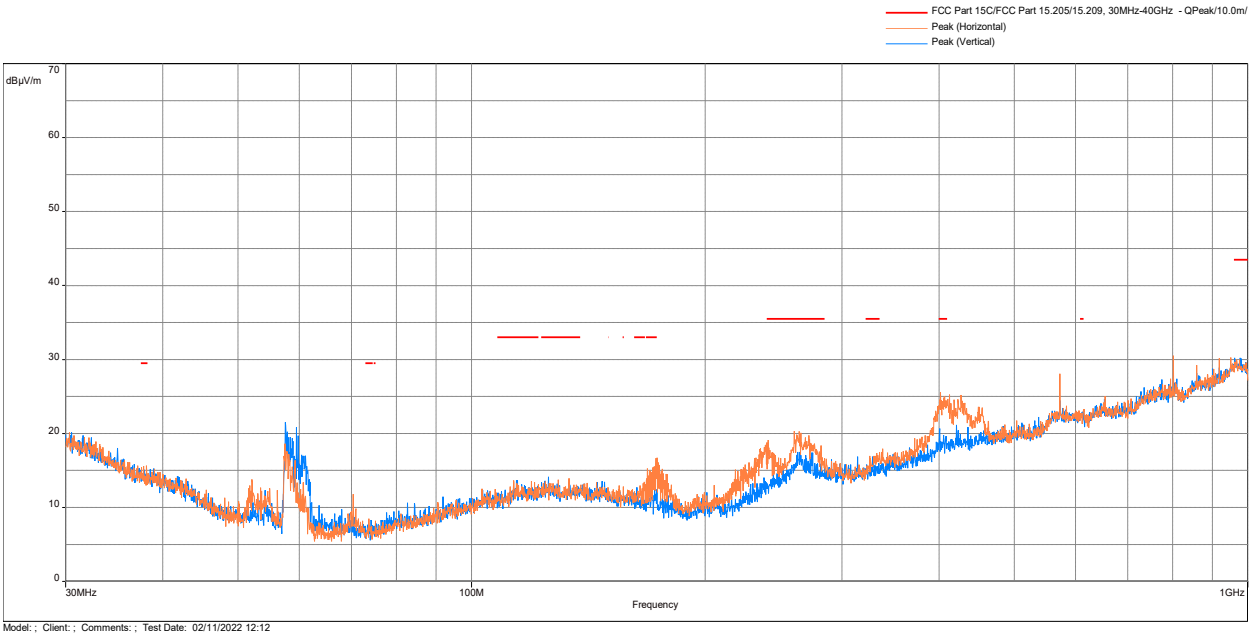


Radiated Spurious Emissions 9kHz - 30 MHz Horizontal Antenna Polarization



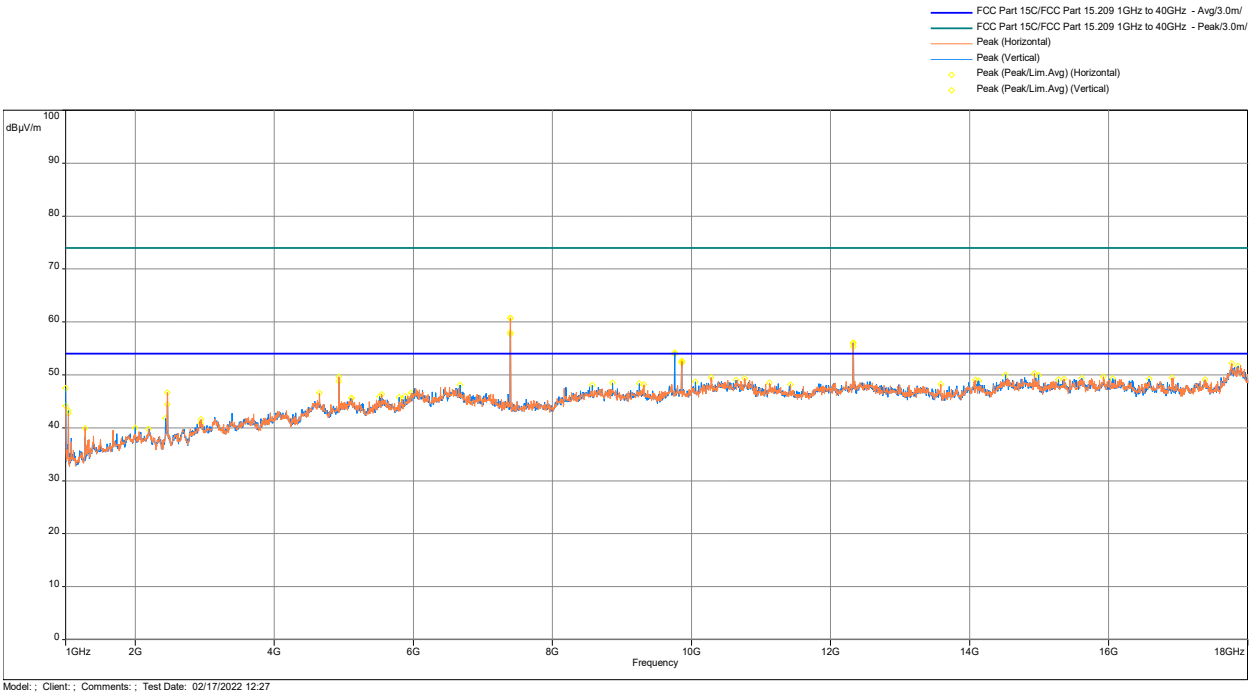
Model: ; Client: ; Comments: ; Test Date: 02/15/2022 09:11

Radiated Spurious Emissions 30 MHz - 1000 MHz



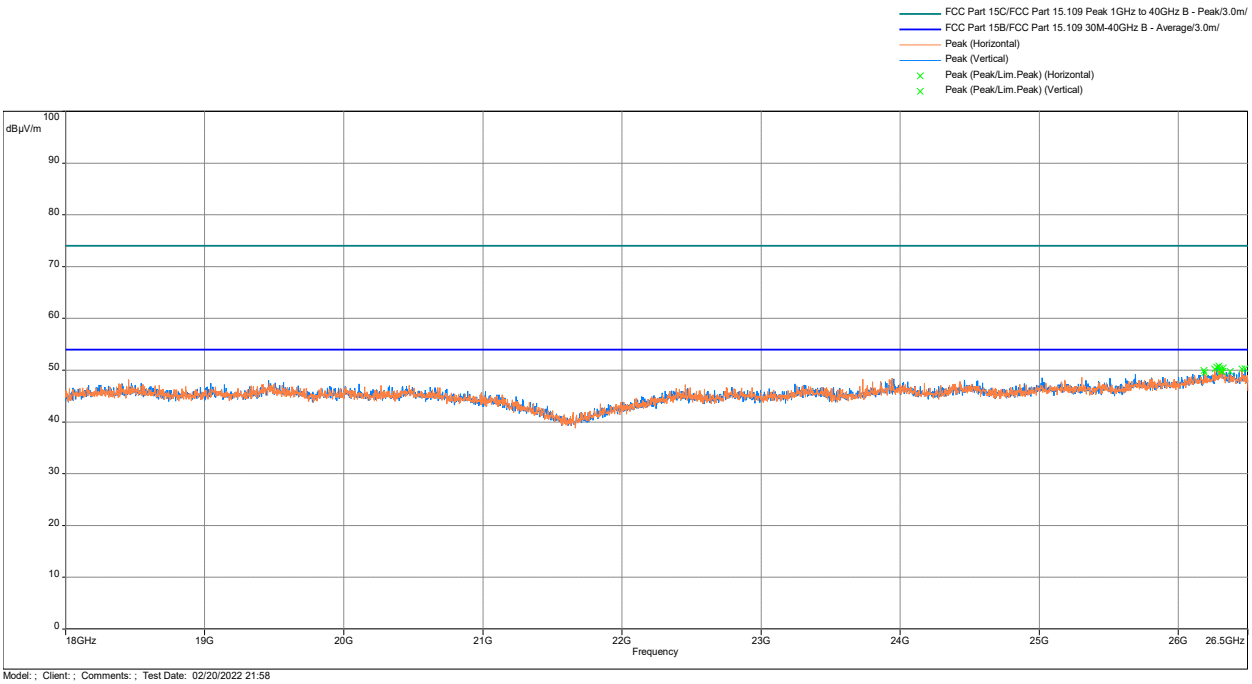
Model: ; Client: ; Comments: ; Test Date: 02/11/2022 12:12

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



Model: ; Client: ; Comments: ; Test Date: 02/17/2022 12:27

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



Model: ; Client: ; Comments: ; Test Date: 02/20/2022 21:58

Test Results: 15.209 Radiated Spurious Emissions High Channel, Tx at 2465MHz

Frequency (MHz)	Peak @3m (dBµV/m)	Lim. Peak @3m (dBµV/m)	Margin dB)	Height (m)	Angle (°)	Comment	Correction (dB)
4928.700	50.25	74	-23.75	1.53	165	Horizontal	-4.83
7321.519	61.10	74	-12.90	1.69	221	Horizontal	-2.53
9858.133	52.23	74	-21.77	1.77	350	Vertical	0.82
12322.560	56.07	74	-17.93	1.49	136	Horizontal	1.95
9761.800	54.40	74	-19.60	1.49	45	Horizontal	0.82

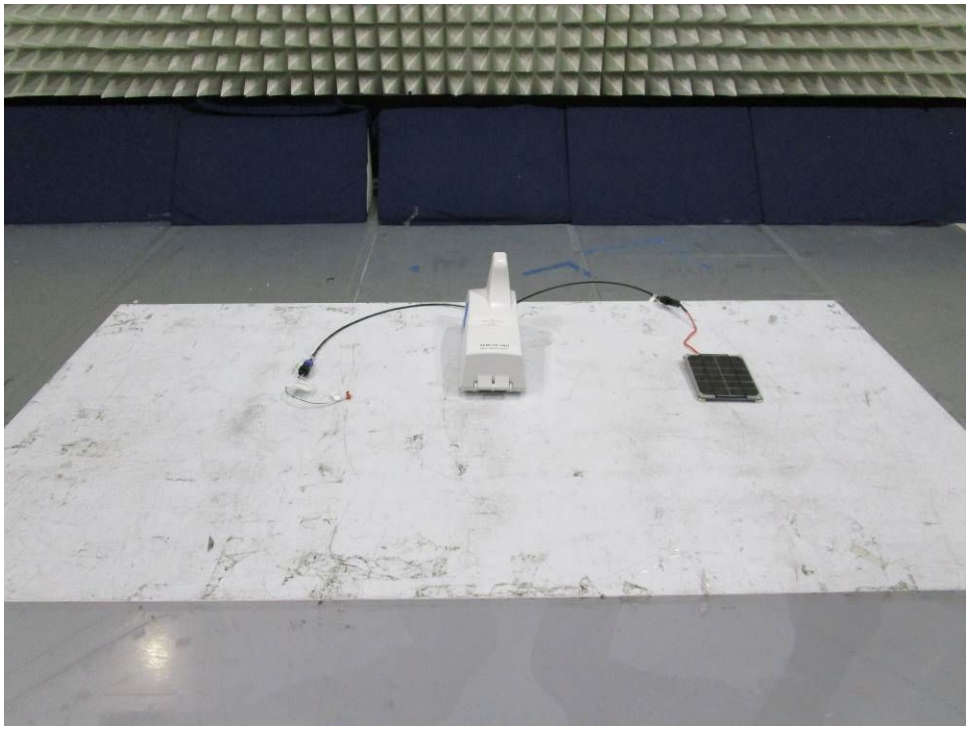
Frequency (MHz)	Ave @3m (dBµV/m)	Lim. Ave @3m (dBµV/m)	Margin dB)	Height (m)	Angle (°)	Comment	Correction (dB)
4928.700	50.25	54	-3.75	1.53	165	Horizontal	-4.83
7321.519	51.77	54	-2.23	1.69	221	Horizontal	-2.53
9858.133	52.23	54	-1.77	1.77	350	Vertical	0.82
12322.560	47.60	54	-6.40	1.49	136	Horizontal	1.95
9761.800	38.27	54	-15.73	1.49	45	Horizontal	0.82

Note: Correction = AF + CF – Preamp

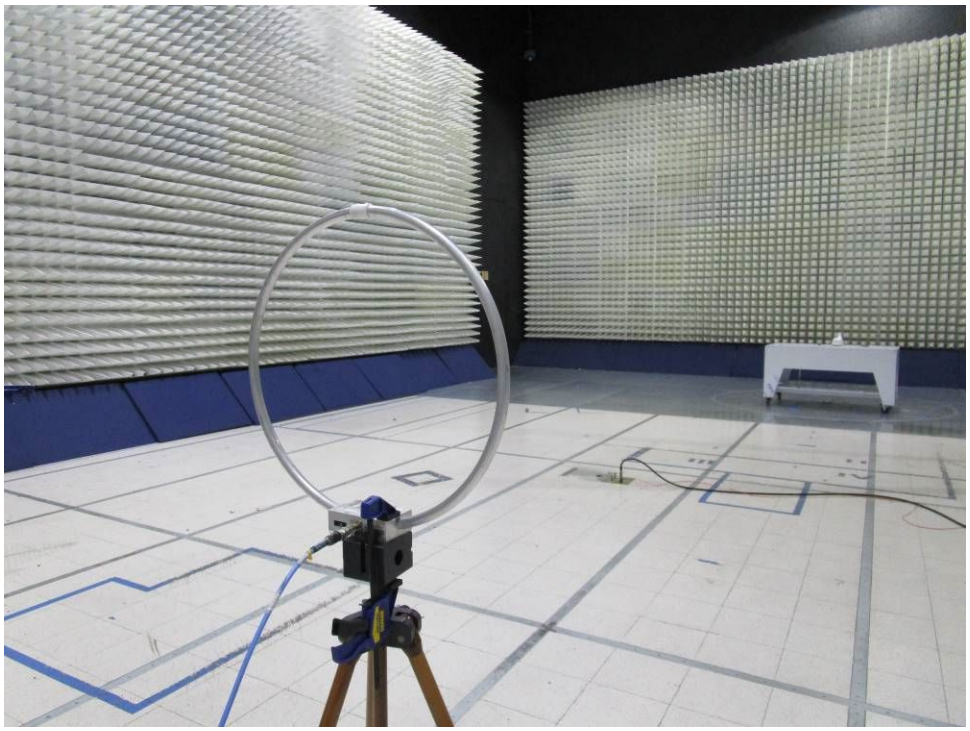
Results	Complies

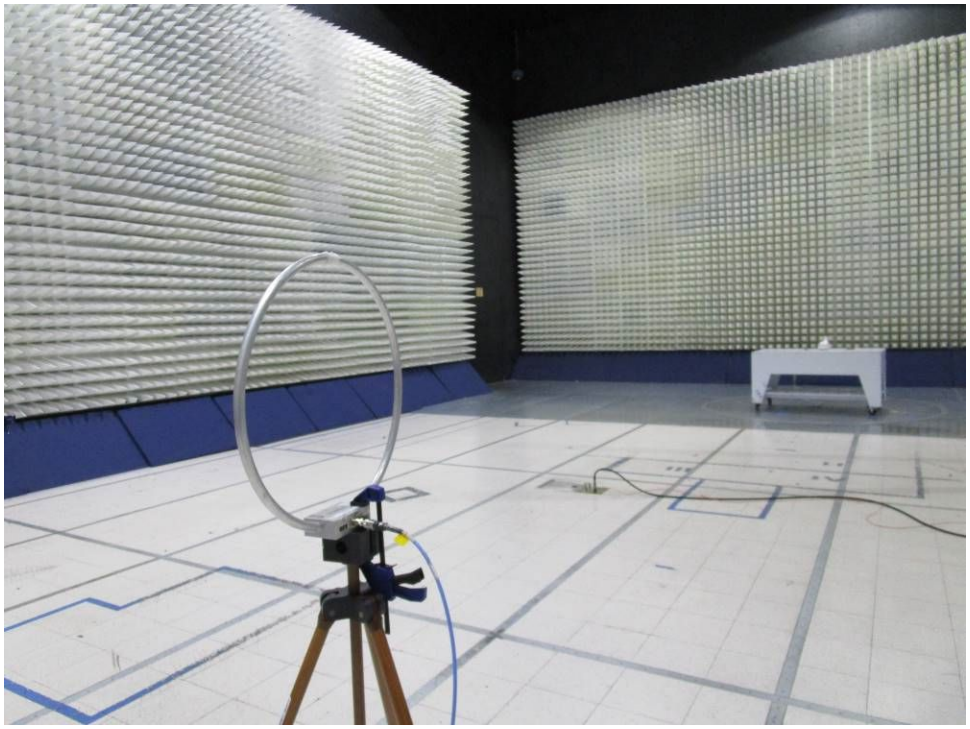
4.5.5 Test Setup Configuration

The following photographs show the testing configurations used.

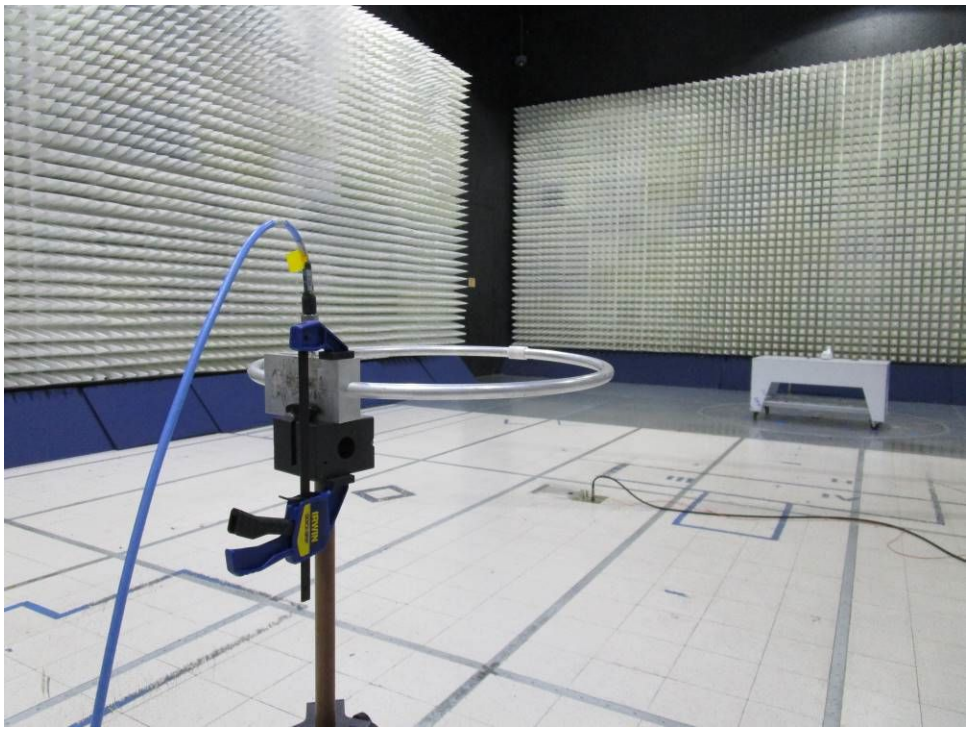


4.5.5 Test Setup Configuration (Continued)

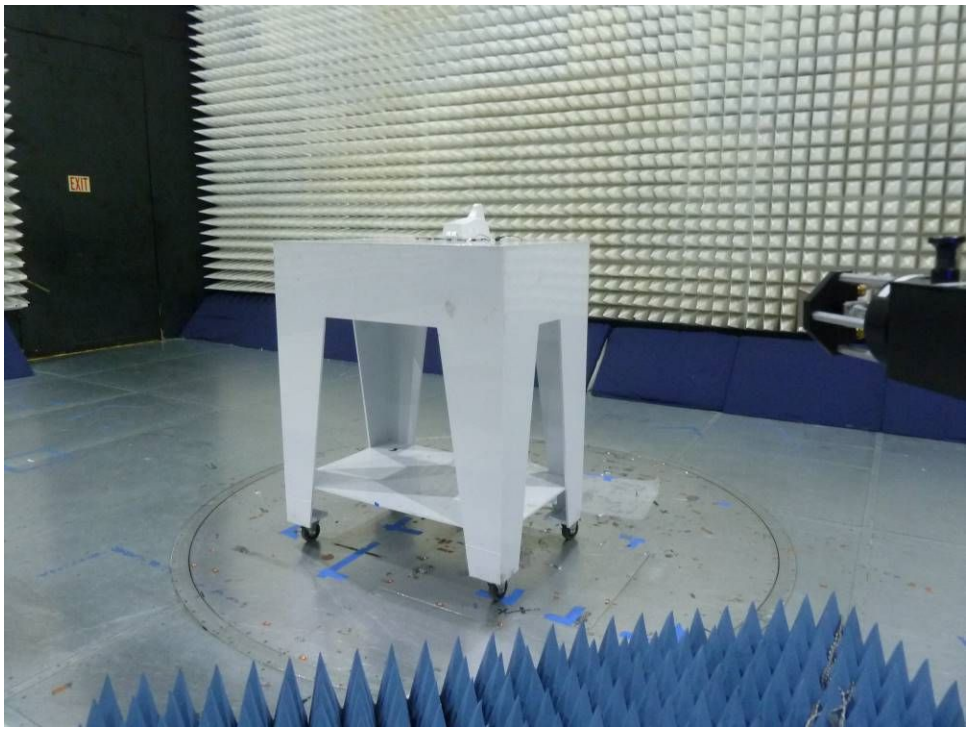




4.5.5 Test Setup Configuration (Continued)



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(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.*

4.6.2 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

Not applicable. The EUT is battery powered only.

5.0 List of Test Equipment

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

Equipment	Manufacturer	Model/Type	Asset #	Cal Int	Cal Due
Spectrum Analyzer	Rohde and Schwarz	FSW43	ITS 01818	12	07/16/2022
Spectrum Analyzer	Rohde and Schwarz	FSU	ITS 00913	12	05/24/2022
EMI Receiver	Rohde and Schwarz	ESU40	ITS 00961	12	03/09/2022
Active Horn Antenna (1-18GHz)	ETS-Lindgren	3117-PA	ITS 01365	12	04/20/2022
Horn Antenna (1-18GHz)	ETS-Lindgren	3115	ITS 00982	12	05/13/2022
Pyramidal Horn Antenna	EMCO	3160-09	ITS 00571	#	#
18-40GHz Preamp	uComp Nordic	MCNS-50-18004000335P	ITS 01799	12	01/11/2023
Loop Antenna	EMCO	6512	ITS 01598	12	06/21/2022
BI-Log Antenna	Teseq	CBL 6111D	ITS 01505	12	03/22/2022
Pre-Amplifier	Sonoma Instrument	310N	ITS 00415	12	04/28/2022
RF Cable	TRU Corporation	TRU CORE 300	ITS 01465	12	09/14/2022
RF Cable	TRU Corporation	TRU CORE 300	ITS 01470	12	09/14/2022
RF Cable	TRU Corporation	TRU CORE 300	ITS 01342	12	09/14/2022
RF Cable	Mega Phase	EMC1-K1K1-236	ITS 01484	12	06/29/2022
Notch Filter	MICRO-TRONICS	BRM50702	ITS 01166	12	06/29/2022
RF Cable	Mega Phase	TM40-K1K1-59	ITS 01655	12	01/11/2023
RF Cable	Mega Phase	TM40-K1K1-19	ITS 01155	12	04/28/2022

No Calibration required

Software used for emission compliance testing utilized the following:

Name	Manufacturer	Version	Template/Profile
BAT-EMC	Nexio	3.20.0.4	Intragrain.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 / G104646874, G104915573	AS	KV	February 28, 2022	Original document

END OF REPORT