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TEST REPORT

Report Number: 104799910MPK-007
Project Numbers: G104799910
Original Issue Date: November 12, 2021
Revision Date: February 7, 2022

Testing performed on the
Minibadge
Model Number: C1000

FCC ID: QGZC1000
IC: 4362A-C1000

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

For

Vocera Communications, Inc.

Test Performed by:	Test Authorized by:
Intertek	Vocera Communications, Inc.
1365 Adams Court	1844 Carnegie Ave
Menlo Park, CA 94025 USA	Santa Ana, CA 92705 USA

Prepared by: _____ **Date:** February 7, 2022
Minh Ly

Reviewed by: _____ **Date:** February 7, 2022
Krishna K Vemuri

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Report No. 104799910MPK-007	
Equipment Under Test:	Minibadge
Model Number:	C1000
Applicant:	Vocera Communications, Inc.
Contact:	Prakash Guda
Address:	Vocera Communications, Inc. 525 Race St, Ste 150 San Jose, CA 95126
Country:	USA
Tel. Number:	(408) 882-5100
Email:	Pguda@vocera.com
Applicable Regulation:	FCC Part 15 Subpart C (15.247) ISED RSS-247 Issue 2
Date of Test:	October 04 – 22, 2021

We attest to the accuracy of this report:

Minh Ly
Senior Project Engineer

Krishna K Vemuri
EMC Manager

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1.0 Summary of Tests

TEST	Reference FCC	Reference ISED	RESULTS
RF Output Power	15.247(b)	RSS-247, 5.4.b)	Complies
20-dB Bandwidth	15.247(a)(1)	RSS-247, 5.1.a)	Complies
Channel Separation	15.247(a)(1)	RSS-247, 5.1.b)	Complies
Number of Hopping Channels	15.247(a)(1)	RSS-247, 5.1.d)	Complies
Average Channel Occupancy Time	15.247(a)(1)	RSS-247, 5.1.d)	Complies
Out-of-Band Antenna Conducted Emission	15.247(d)	RSS-247, 5.5	Complies
Transmitter Radiated Emissions	15.247(d), 15.209, 15.205	RSS-GEN	Complies
RF Exposure	15.247(i)	RSS-102	Complies
Antenna Requirement	15.203	RSS-GEN	Complies (Permanently Mounted Internal Antenna)

EUT receive date: October 04, 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: October 06, 2021

Test completion date: October 22, 2021

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

2.0 General Description

2.1 Product Description

Vocera Communications, Inc. supplied the following description of the EUT:

A small, lightweight, wearable communication device designed to simplify hospital communication and workflow and improve staff safety. A user can "wake up" and operate the device using only their voice, to stay connected even under restrictive PPE. They can make and receive calls; listen and respond to messages and alarm notifications. Visual indicators enable fast triaging of events. A dedicated panic button provides a direct connection to security personnel. The device can be used as a smartphone companion, or by itself. For more information, see user's manual provided by the manufacturer.

This test report covers only the 2.4GHz FHSS radio.

Information about the 2.4 GHz radio is presented below:

Applicant	Vocera Communications, Inc.
Model No.	C1000
FCC Identifier	QGZC1000
IC Identifier	4362A-C1000
Type of Transmission	Frequency Hopping Spread Spectrum
Rated RF Output	3.17 dBm or 2.079 mW
Antenna(s) & Gain	Internal Antenna, Gain: 1.45 dBi
Frequency Range	2402 – 2480 MHz
Number of Channel(s)	0-78, 79 Channels
Modulation Type	GFSK, π/4-DQPSK, 8-DPSK
Data Rate	DH1, DH3, DH5
Applicant Name & Address	Vocera Communications, Inc. 1844 Carnegie Ave Santa Ana, CA 92705 USA

2.2 Related Submittal(s) Grants

None.

2.3 Test Methodology

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

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

Following is the channel test plan:

Channels in 2.4 GHz band			
Test Channel		**Frequency, MHz**	**Tested**
Low	0	2402	√
Middle	40	2441	√
High	78	2480	√
Hopping Mode	0-78	2402 - 2480	√

2.4 Test Facility

The test site used to is located at 1365 Adams Court, Menlo Park, California, 94025. This test facility and site measurement data have been fully placed on file with the FCC, IC and A2LA accredited.

3.0 System Test Configuration

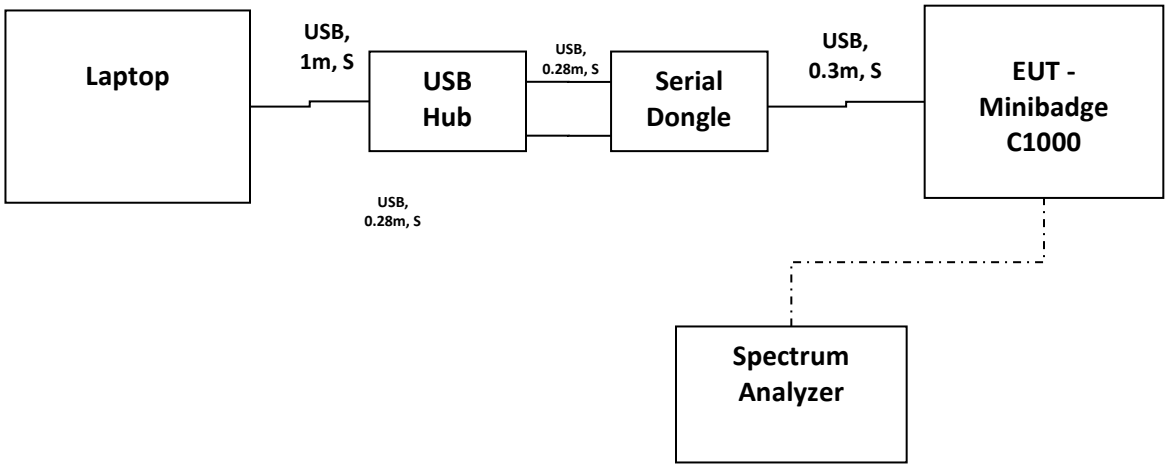
3.1 Support Equipment

Support Equipment		
Description	**Manufacturer**	**Model**
Laptop	Lenovo	T440P
USB Hub	Tendak	CP-029-BK
Serial Dongle	Vocera	210-01516-B04

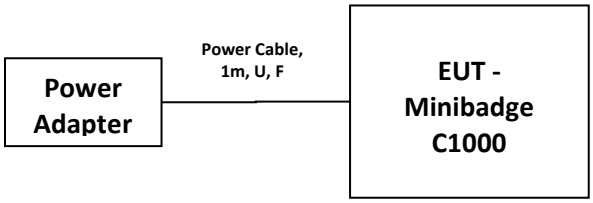
3.2 Block Diagram of Test Setup

Equipment Under Test			
Description	**Manufacturer**	**Model**	**Serial Number/ID**
Minibadge – Conducted Unit	Vocera Communications, Inc.	C1000	AA3301J26008A6
Minibadge – Radiated Unit	Vocera Communications, Inc.	C1000	AA3301J2600878
Power Adapter	Vocera	WB-10E05R	D0714N55000843
Wired Headset	Vocera	V5000 Headset	230-02162

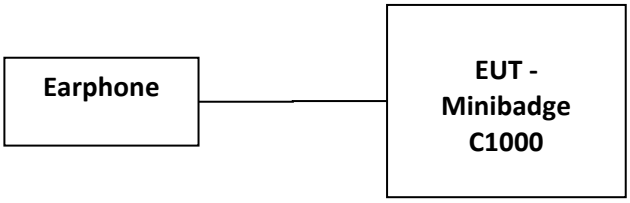
Antenna was removed and co-axial connector was installed for Conducted Measurements.



Radiated Measurements
Charging Mode



Radiated Measurements
Normal Mode



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

3.3 Justification

For radiated emission measurements the EUT is placed on a non-conductive table. The EUT was configured to continuously transmit. Different orientation of the EUT were tested and only the worse-case emissions were reported.

The EUT was tested in 2 configurations with EUT in horizontal and upright positions:

A/ Charging mode: tested with power adapter
B/ Normal mode: tested in battery mode and earphone.

3.4 Mode of Operation During Test

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

3.5 Modifications Required for Compliance

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

3.6 Additions, Deviations and Exclusions from Standards

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

4.0 Emissions Measurement Results

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

4.1.1 Procedure

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

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

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

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

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

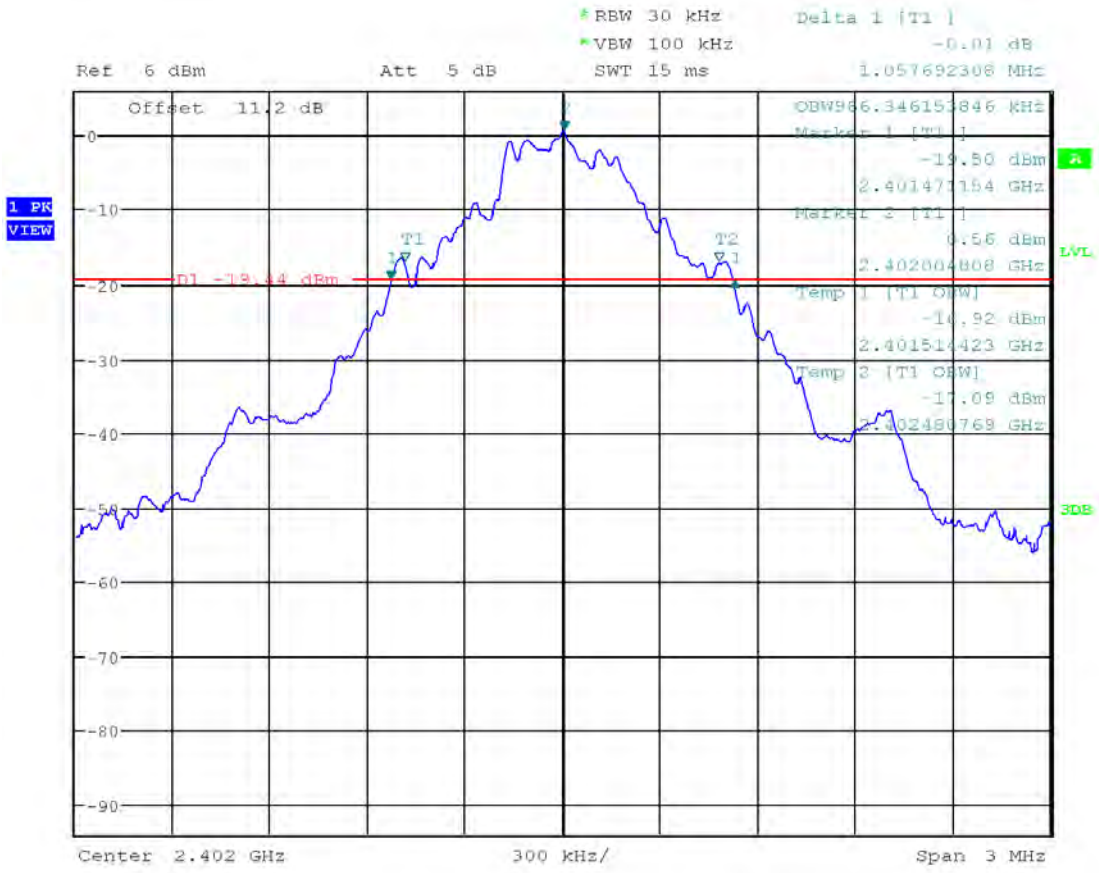
Tested By	Test Date
Minh Ly	October 19, 2021

4.1.2 Test Result

Mode	Frequency MHz	20 dB FCC Bandwidth, MHz	99% Bandwidth, MHz	Plot #
GFSK	2402	1.057	0.966	1.1
	2441	1.057	0.966	1.2
	2480	1.052	0.966	1.3
π/4-DQPSK	2402	1.341	1.216	1.4
	2441	1.341	1.216	1.5
	2480	1.341	1.216	1.6
8-DPSK	2402	1.326	1.211	1.7
	2441	1.331	1.216	1.8
	2480	1.307	1.187	1.9

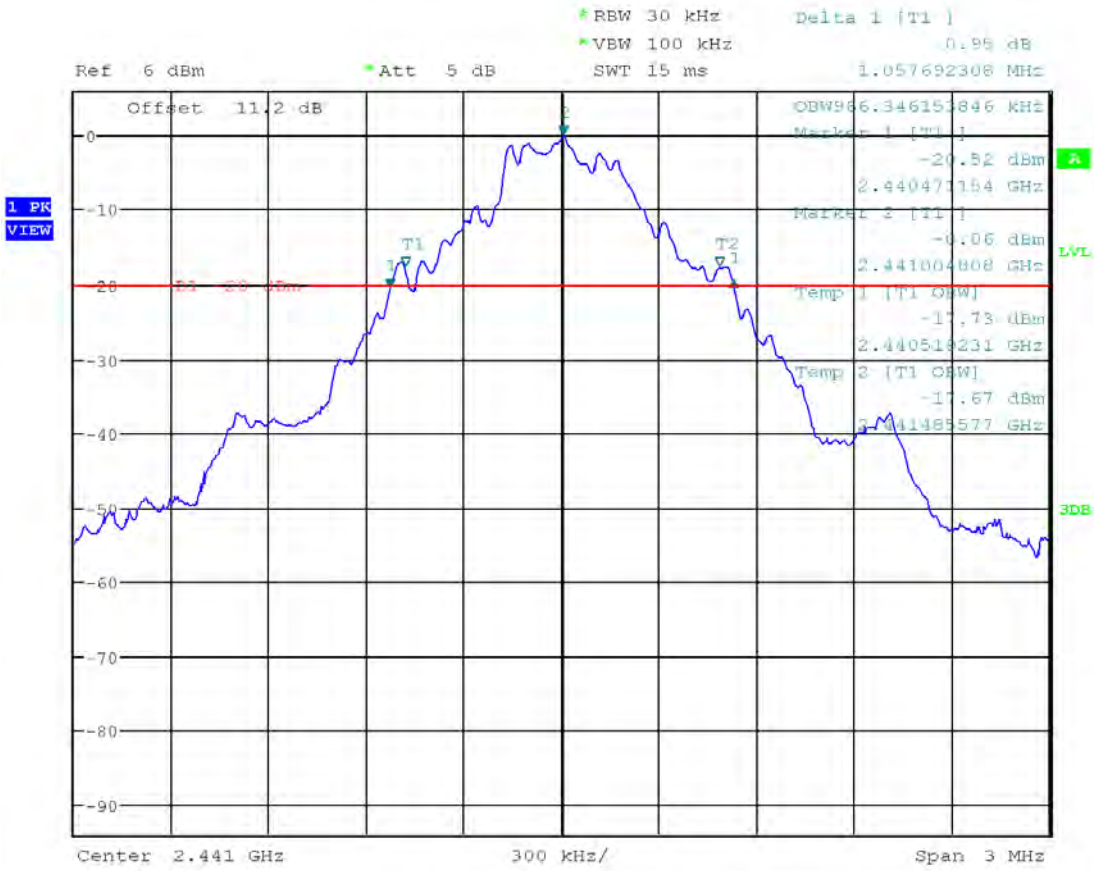
Results	Complies

Plot 1.1– 20dB Bandwidth and 99% Bandwidth, GFSK, 2402 MHz



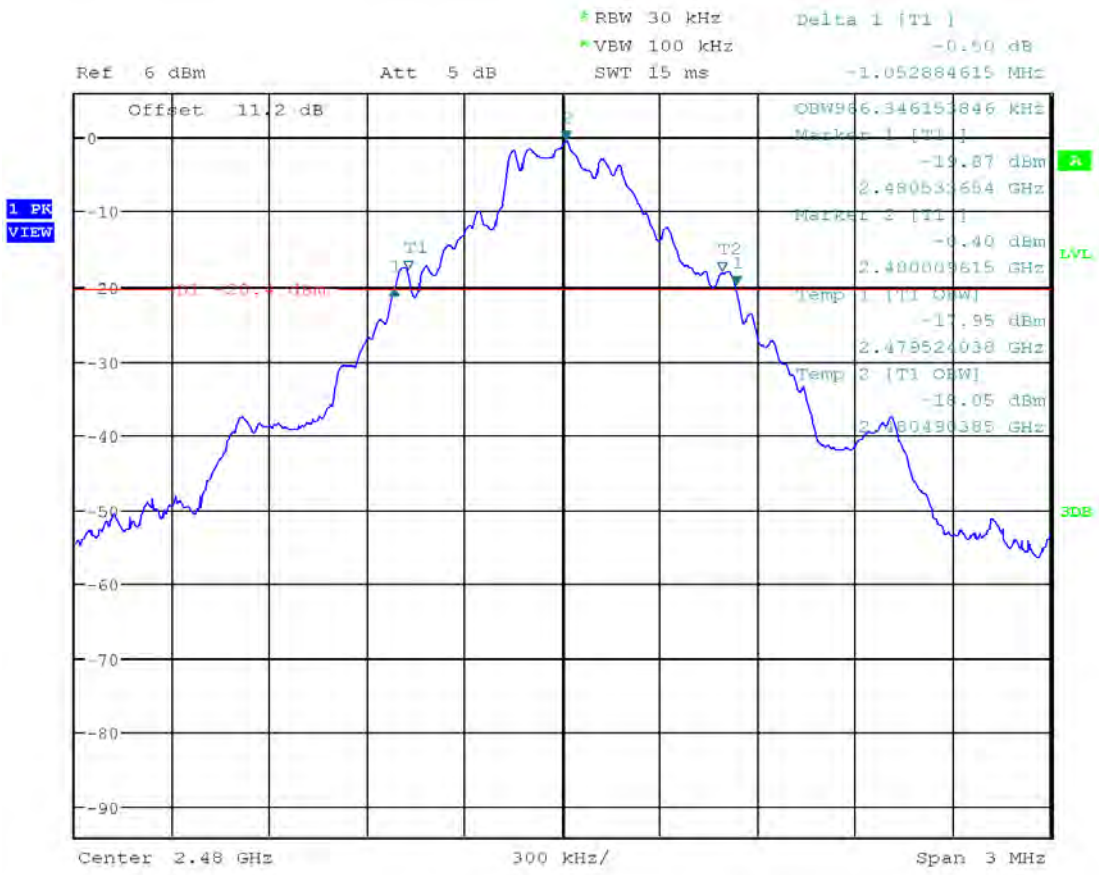
Date: 19.OCT.2021 22:05:30

Plot 1.2 – 20dB Bandwidth and 99% Bandwidth, GFSK, 2441 MHz



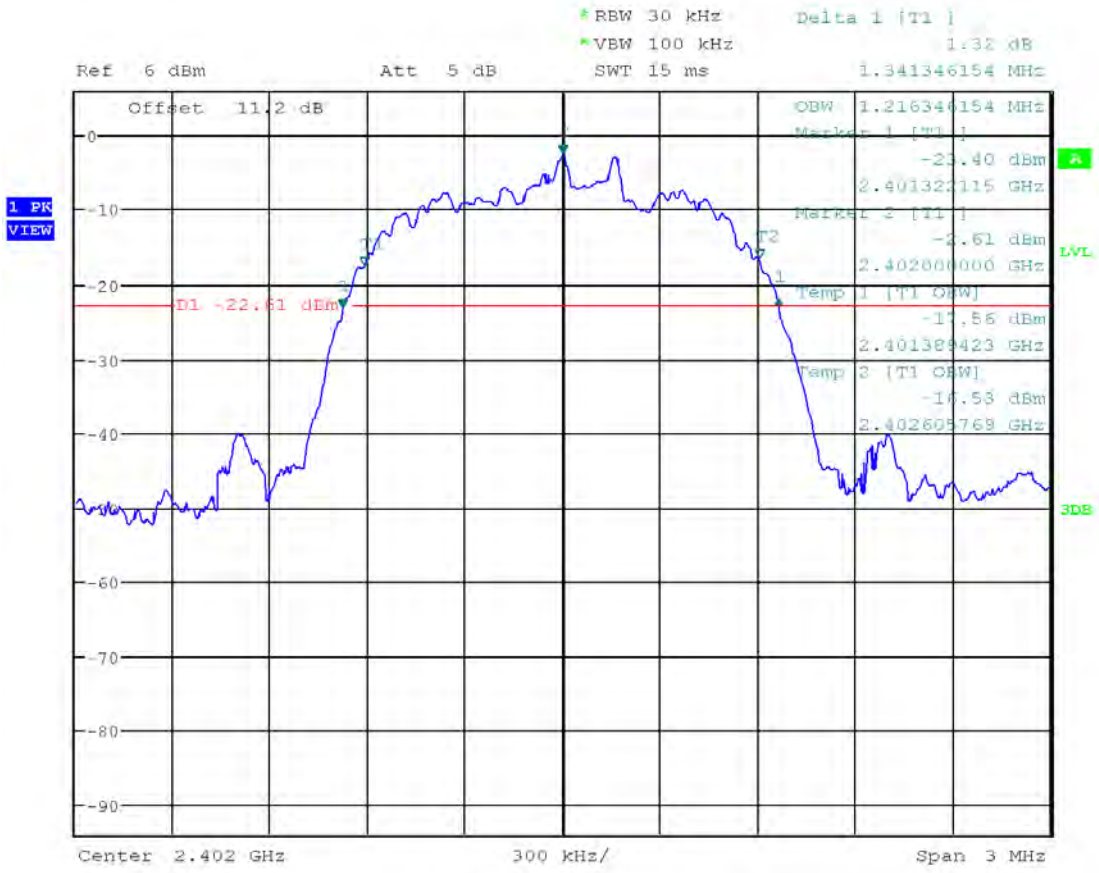
Date: 29.OCT.2021 21:00:08

Plot 1.3 – 20dB Bandwidth and 99% Bandwidth, GFSK, 2480 MHz



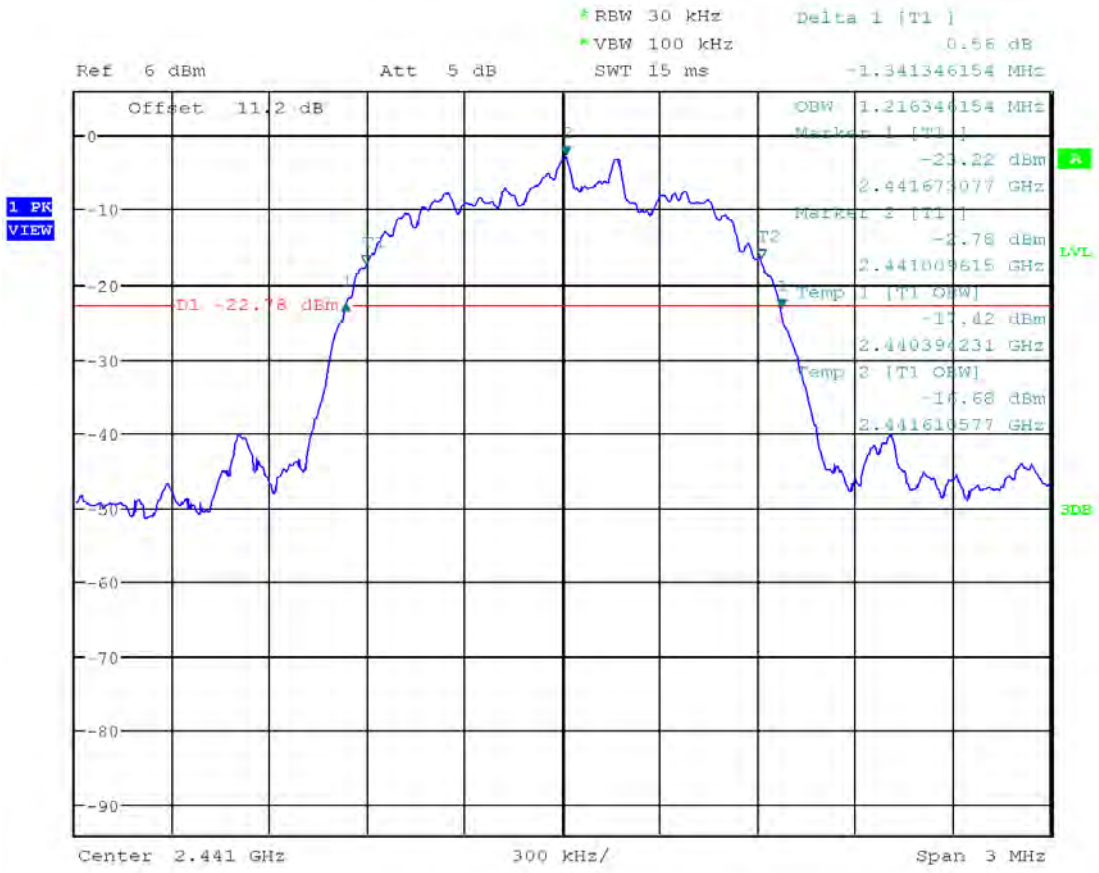
Date: 19.OCT.2021 22:11:40

Plot 1.4 – 20dB Bandwidth and 99% Bandwidth, π/4-DQPSK, 2402 MHz



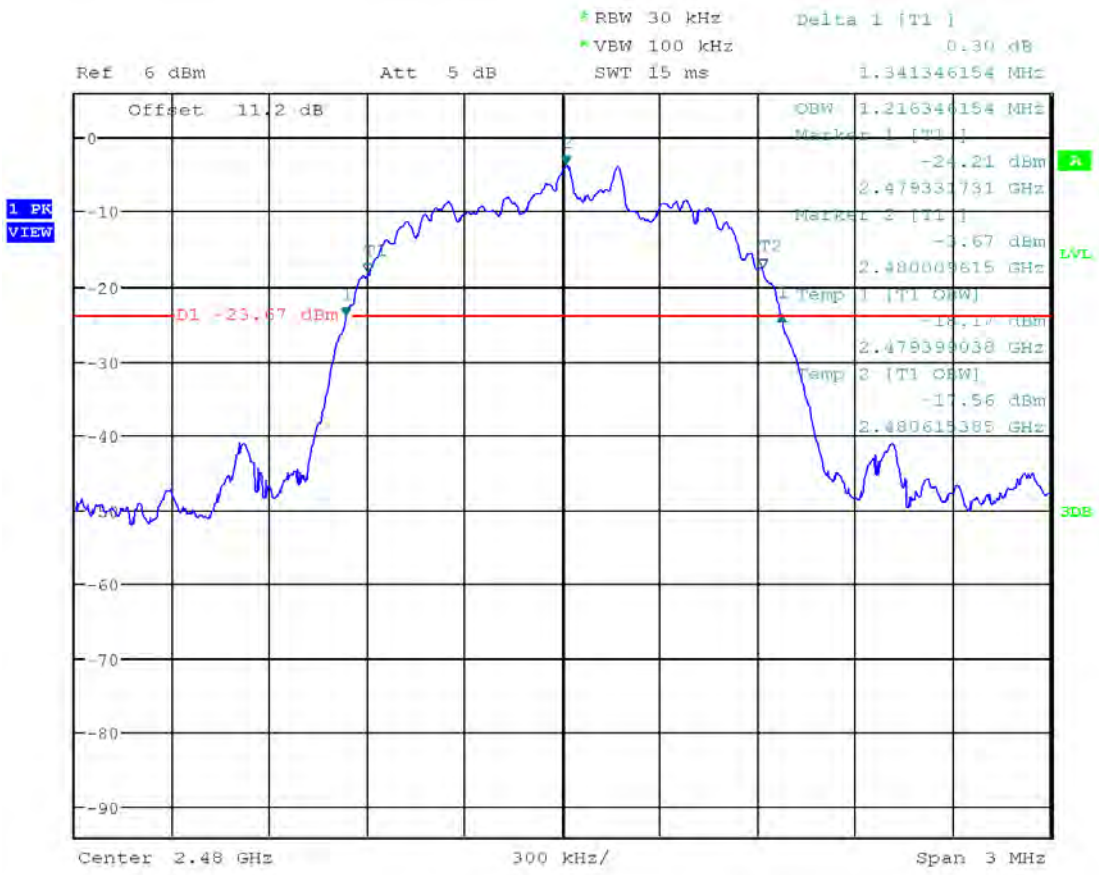
Date: 19.OCT.2021 22:19:24

Plot 1.5 – 20dB Bandwidth and 99% Bandwidth, π/4-DQPSK, 2441 MHz



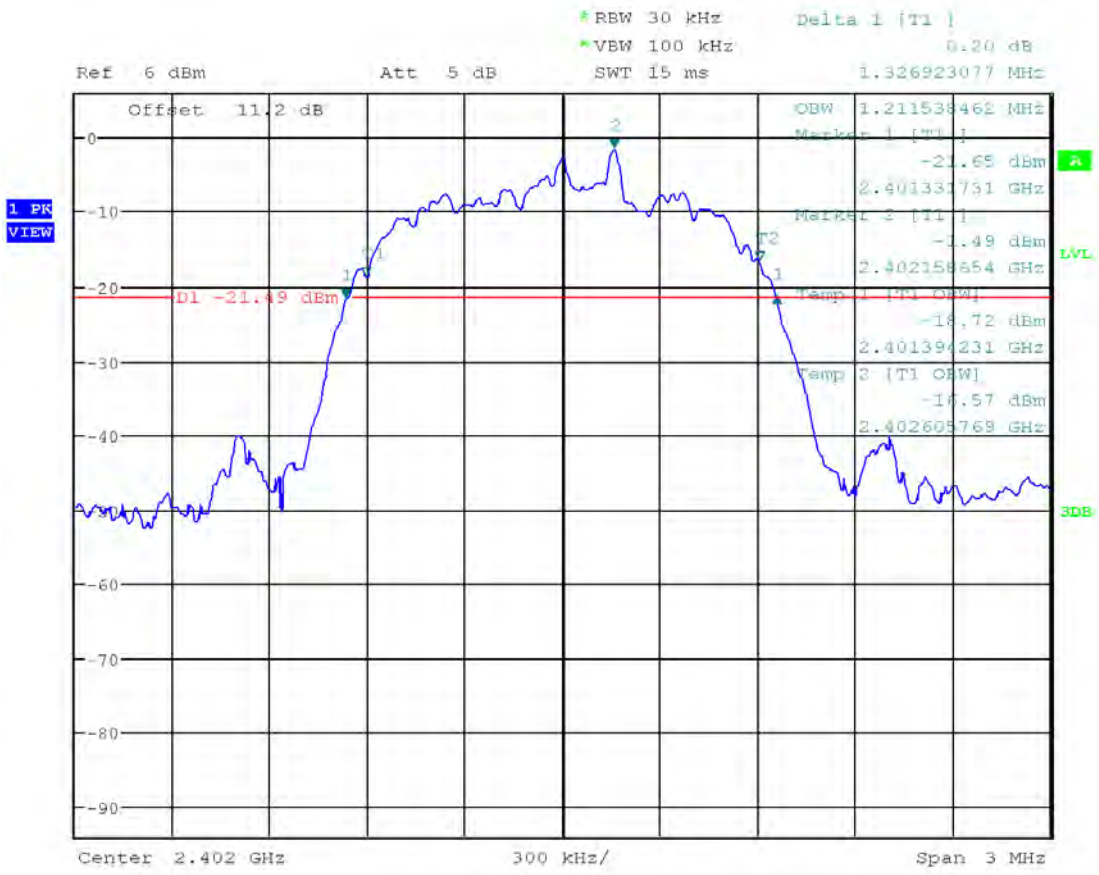
Date: 19.OCT.2021 22:21:07

Plot 1.6 – 20dB Bandwidth and 99% Bandwidth, π/4-DQPSK, 2480 MHz



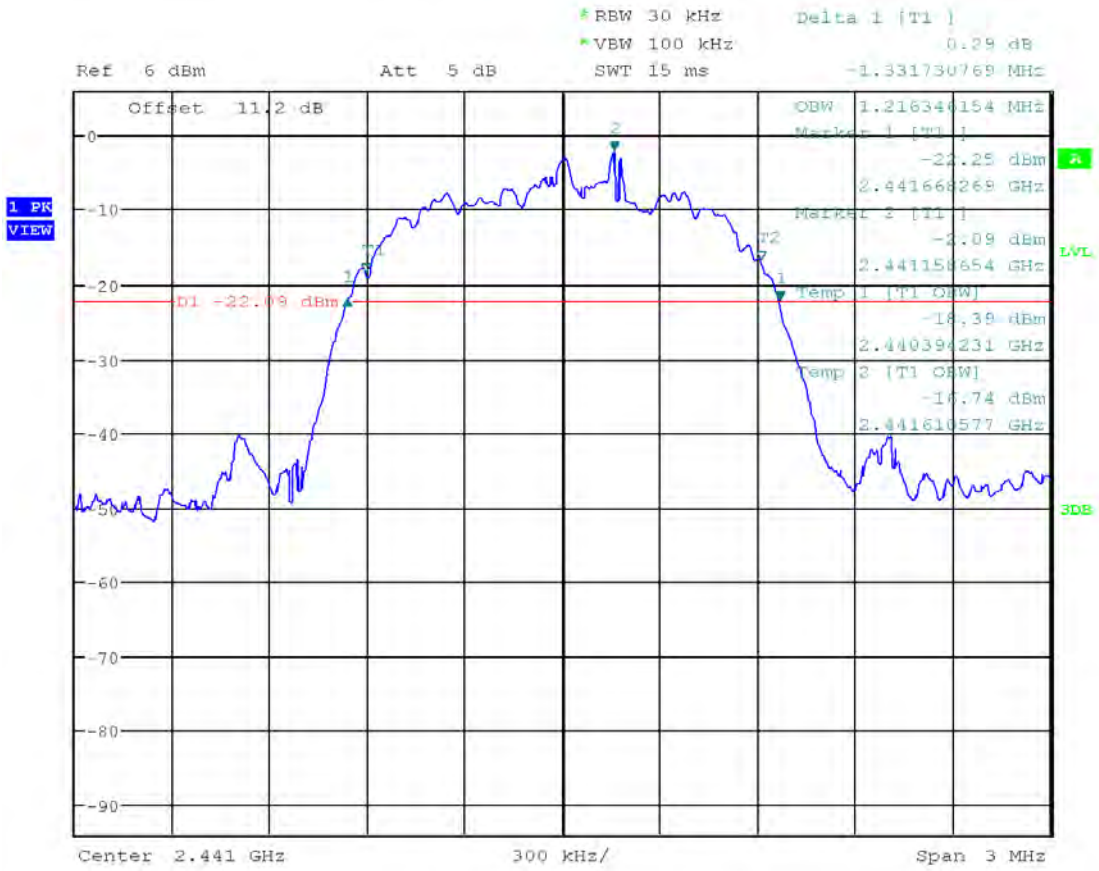
Date: 19.OCT.2021 22:22:18

Plot 1.7 – 20dB Bandwidth and 99% Bandwidth, 8-DPSK, 2402 MHz



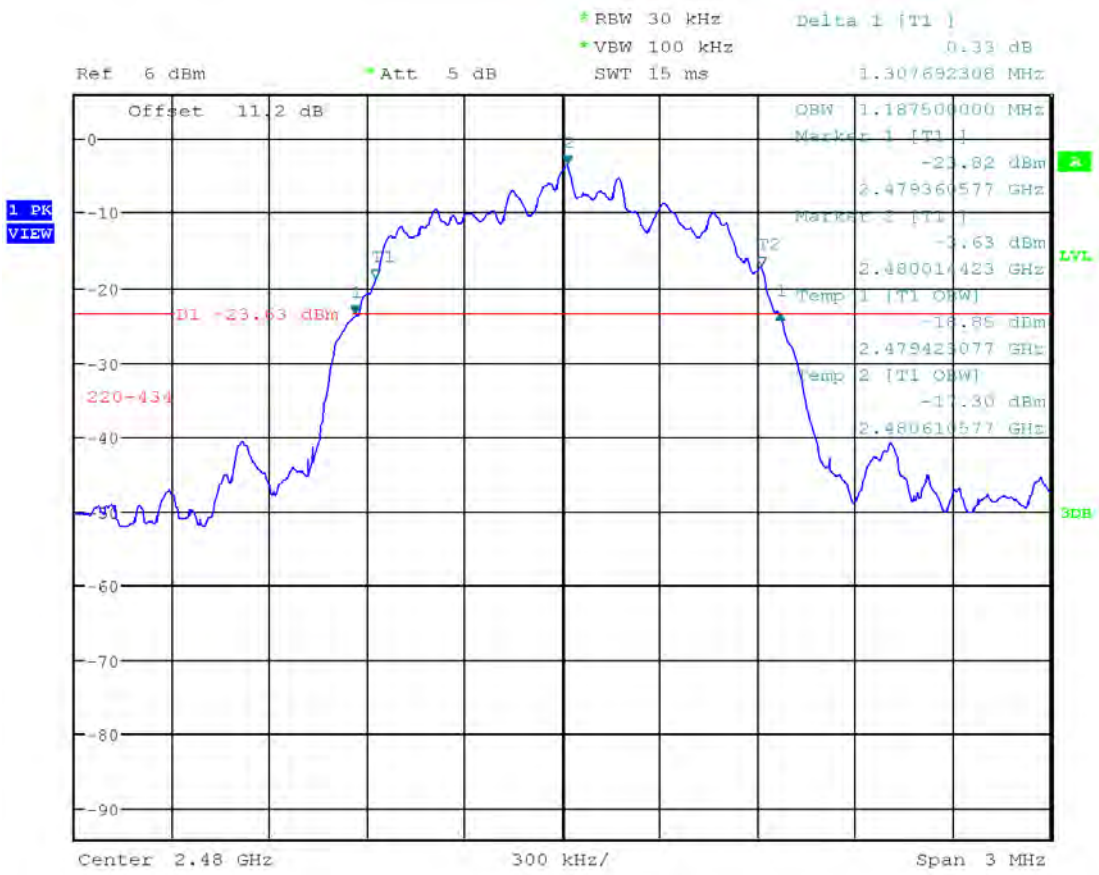
Date: 19.OCT.2021 22:23:26

Plot 1.8 – 20dB Bandwidth and 99% Bandwidth, 8-DPSK, 2441 MHz



Date: 19.OCT.2021 22:25:20

Plot 1.9 – 20dB Bandwidth and 99% Bandwidth, 8-DPSK, 2480 MHz



Date: 29.OCT.2021 21:05:58

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

4.2.1 Requirement

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

4.2.2 Procedure

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

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

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

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

Tested By	Test Date
Minh Ly	October 21, 2021

4.2.3 Test Result

Refer to the following plots for the test result:

Mode	Frequency MHz	Conducted Peak Power dBm	Conducted Peak Power mW	Plot #
GFSK	2402	3.17	2.079	2.1
	2441	2.85	1.977	2.2
	2480	2.27	1.690	2.3
π/4-DQPSK	2402	2.72	1.875	2.4
	2441	2.56	1.807	2.5
	2480	1.79	1.513	2.6
8-DPSK	2402	3.18	2.084	2.7
	2441	2.97	1.986	2.8
	2480	2.23	1.675	2.9

Results	Complies

Plot 2.1– Output Power, GFSK, 2402 MHz

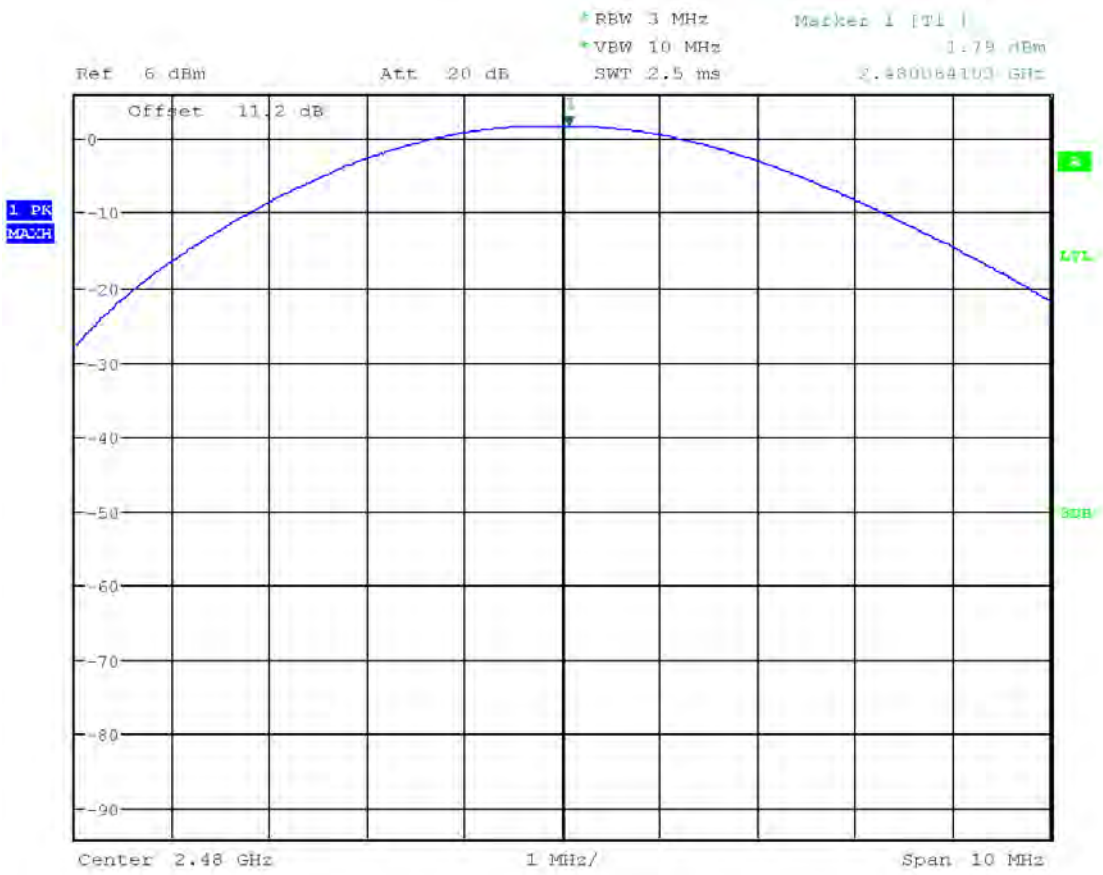
Plot 2.2 – Output Power, GFSK, 2441 MHz

Plot 2.3 – Output Power, GFSK, 2480 MHz

Plot 2.4 – Output Power, π/4-DQPSK, 2402 MHz

Plot 2.5 – Output Power, π/4-DQPSK, 2441 MHz

Plot 2.6 – Output Power, π/4-DQPSK, 2480 MHz



Plot 2.7 – Output Power, 8-DPSK, 2402 MHz

Date: 21.OCT.2021 23:01:11

Plot 2.8 – Output Power, 8-DPSK, 2441 MHz

Plot 2.9 – Output Power, 8-DPSK, 2480 MHz

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

4.3.1 Requirement

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

4.3.2 Procedure

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

- The EUT must have its hopping function enabled
- Span = wide enough to capture the peaks of two adjacent channels
- Resolution (or IF) Bandwidth (RBW) = 1% of the span
- Video (or Average) Bandwidth (VBW) = 3 x RBW
- Sweep = auto
- Detector function = peak
- Trace = max hold

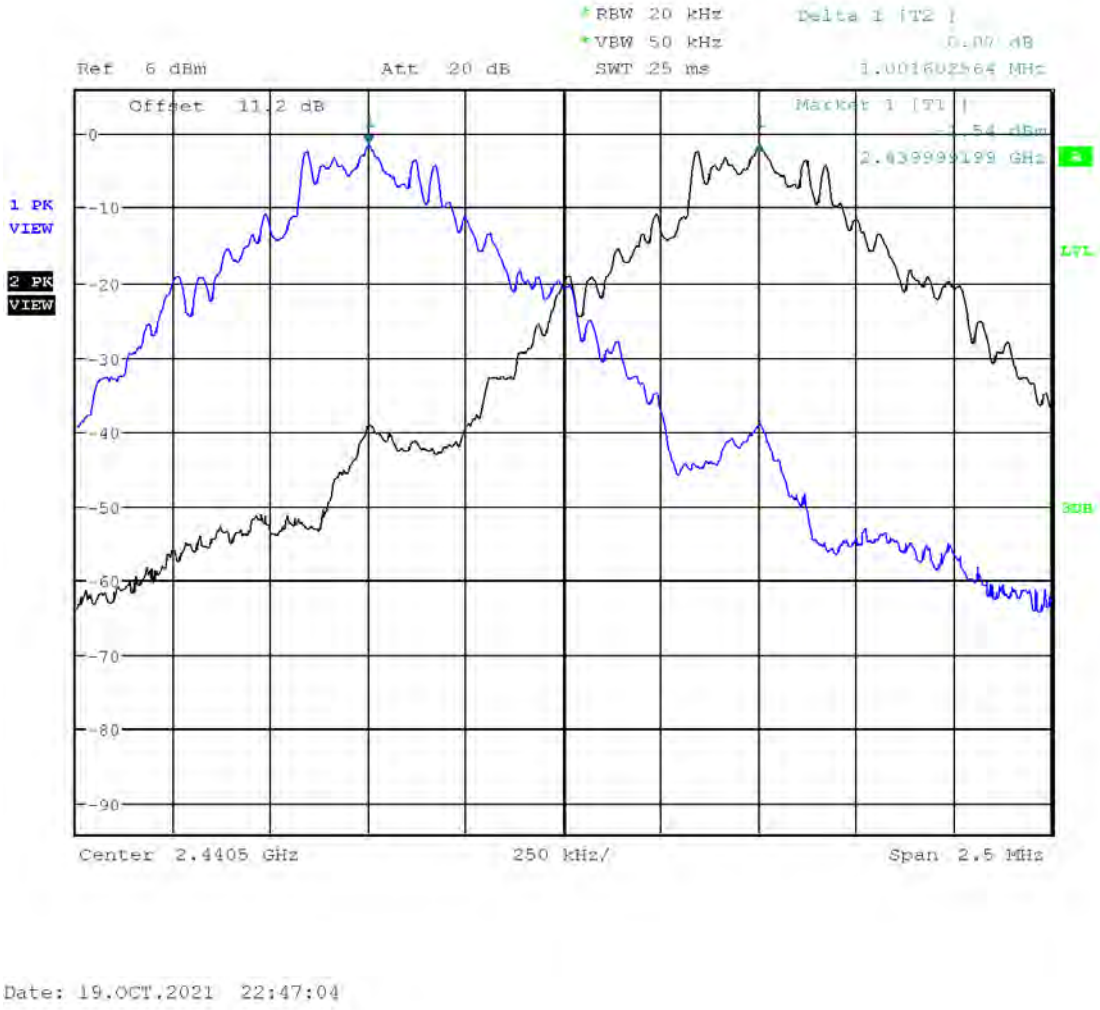
Allow the trace to stabilize. Use the marker-delta function to determine the separation between the peaks of the adjacent channels.

Tested By	Test Date
Minh Ly	October 19, 2021

4.3.3 Test Result

The highest measured GFSK 20dB Bandwidth is 1.057 MHz, therefore the minimum Carrier Frequency Separation shall be greater than two thirds of the 20dB bandwidth; 704.6 kHz. The measured channel separation is 1.002 MHz. Carrier Frequency Separation meets the minimum requirement. Please refer to spectrum analyzer Plot 3.1 below for the test result.

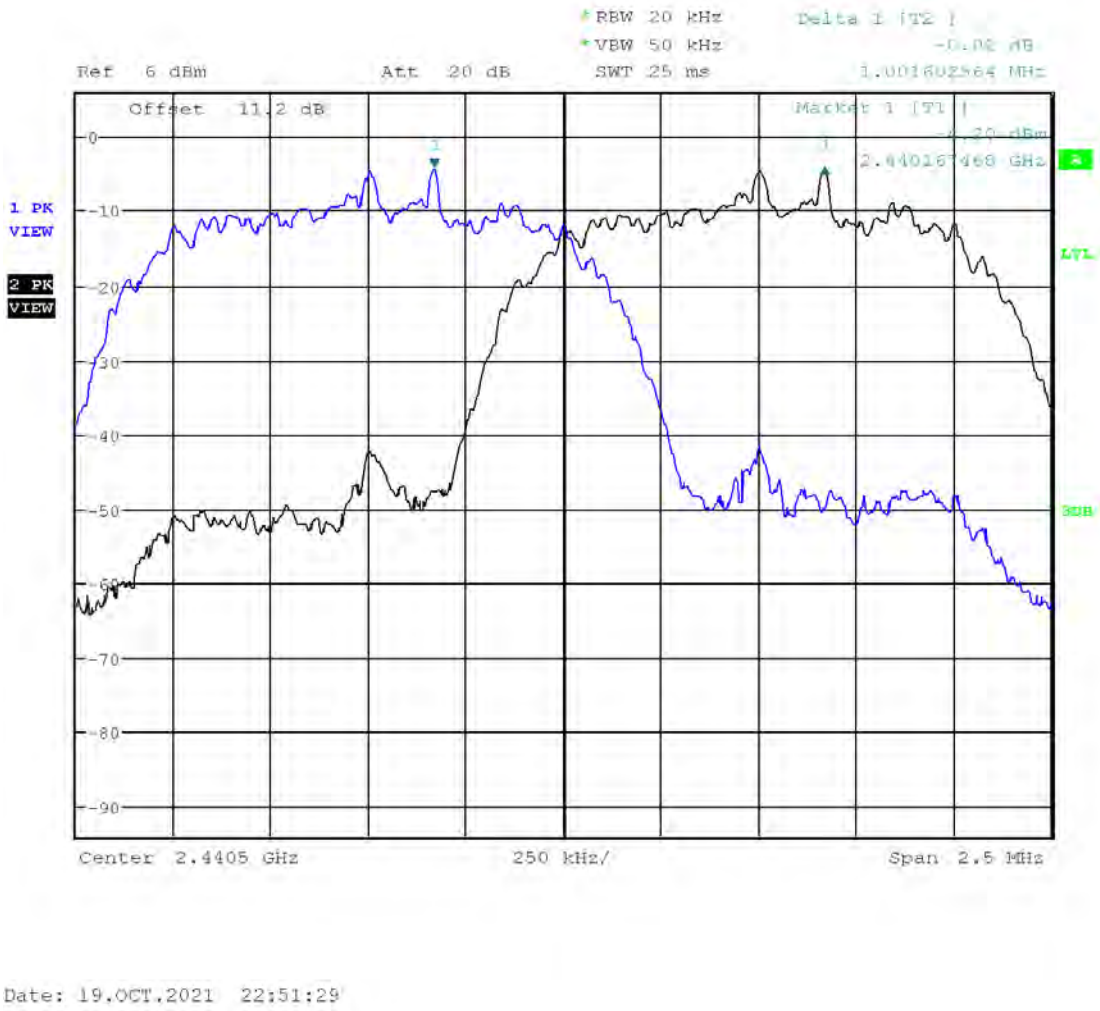
Plot 3.1– Channel Separation, GFSK



Results	Complies

The highest measured π/4-DQPSK 20dB Bandwidth is 1341 kHz, therefore the minimum Carrier Frequency Separation shall be greater than two thirds of the 20dB bandwidth; 894.0 kHz. The measured channel separation is 1.002 MHz. Carrier Frequency Separation meets the minimum requirement. Please refer to spectrum analyzer Plot 3.2 below for the test result.

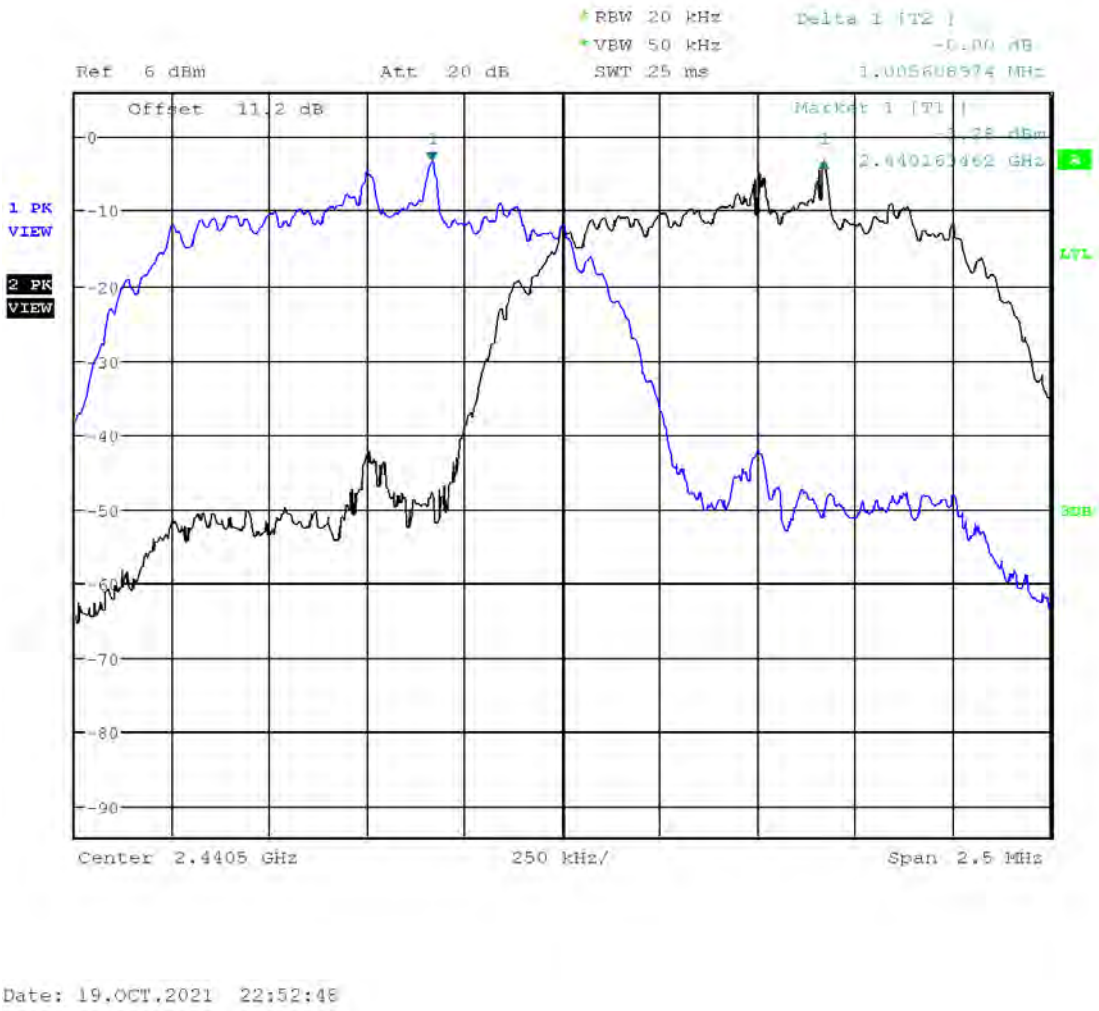
Plot 3.2– Channel Separation, π/4-DQPSK



Results	Complies

The highest measured 8-DPSK 20dB Bandwidth is 1331 kHz, therefore the minimum Carrier Frequency Separation shall be greater than two thirds of the 20dB bandwidth; 887.3 kHz. The measured channel separation is 1.006 MHz. Carrier Frequency Separation meets the minimum requirement. Please refer to spectrum analyzer Plot 3.2 below for the test result.

Plot 3.3– Channel Separation, 8-DPSK



Results	Complies

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

4.4.1 Requirement

For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

4.4.2 Procedure

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

- The EUT must have its hopping function enabled.
- Span = the frequency band of operation
- RBW = 1% of the span
- VBW = 3 x RBW
- Sweep = auto
- Detector function = peak
- Trace = max hold

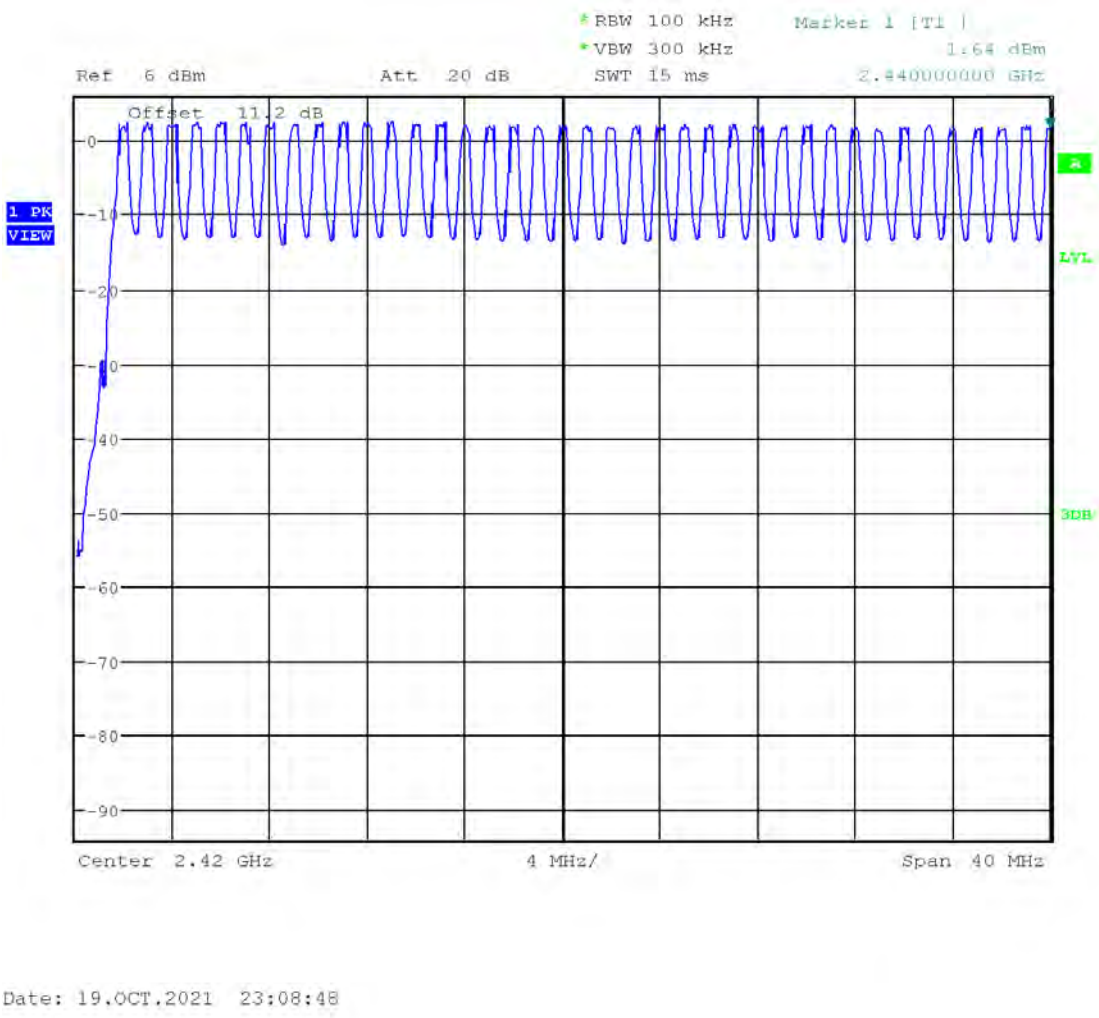
Allow the trace to stabilize. It may prove necessary to break the span up to sections, in order to clearly show all of the hopping frequencies.

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

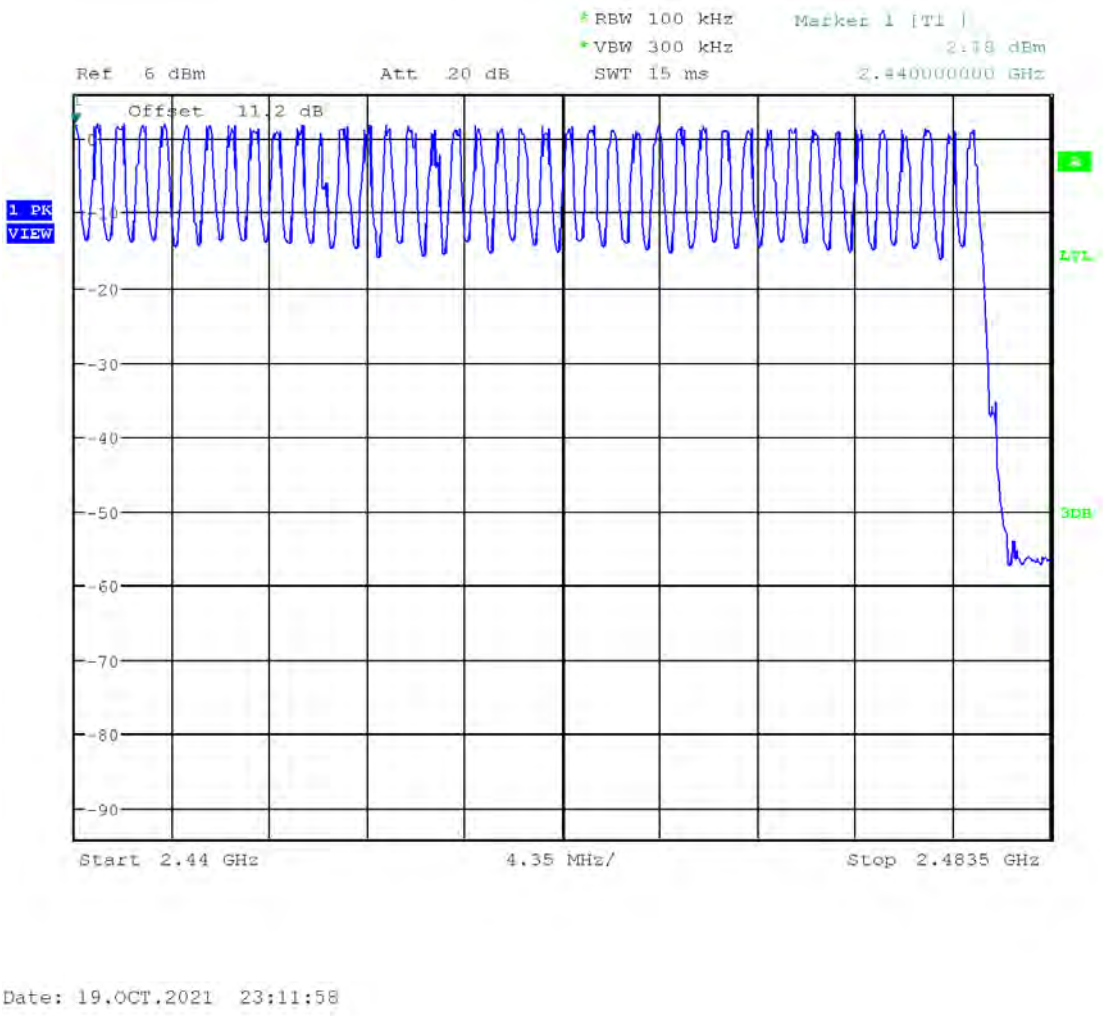
Tested By	Test Date
Minh Ly	October 19, 2021

4.4.3 Test Result

Plot 4.1 - Number of hopping channels, 2400 – 2440 MHz



Plot 4.2 - Number of hopping channels, 2440 – 2483.5 MHz



Results	Complies, 79 Channels

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

4.5.1 Requirement

For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

4.5.2 Procedure

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

- The EUT must have its hopping function enabled.
- Span = zero span, centered on a hopping channel
- RBW = 1 MHz
- VBW = 3 x RBW
- Sweep = as necessary to capture the entire dwell time per hopping channel
- Detector function = peak
- Trace = max hold

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

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

Tested By	Test Date
Minh Ly	October 21, 2021

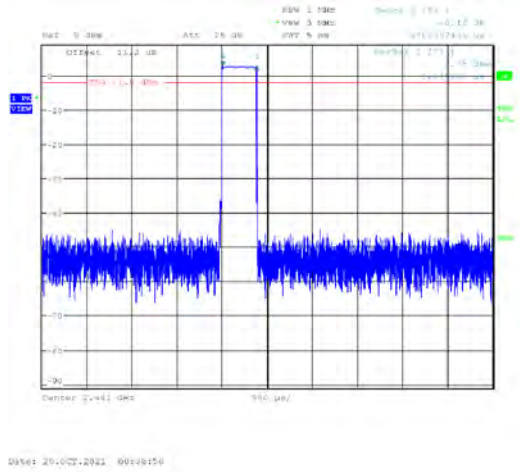
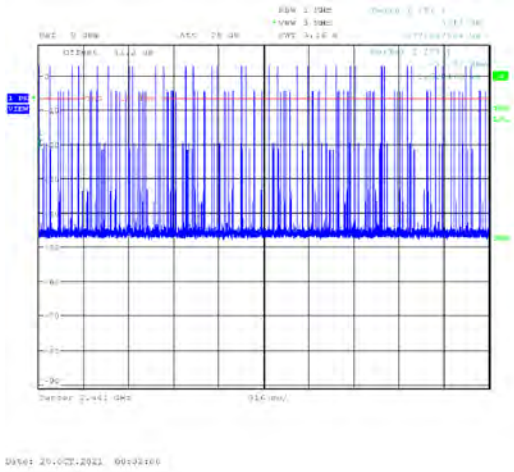
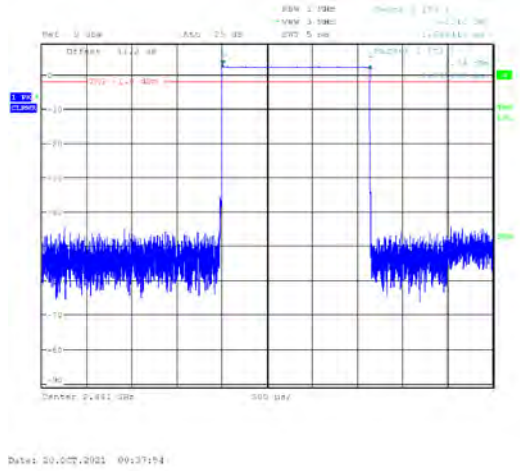
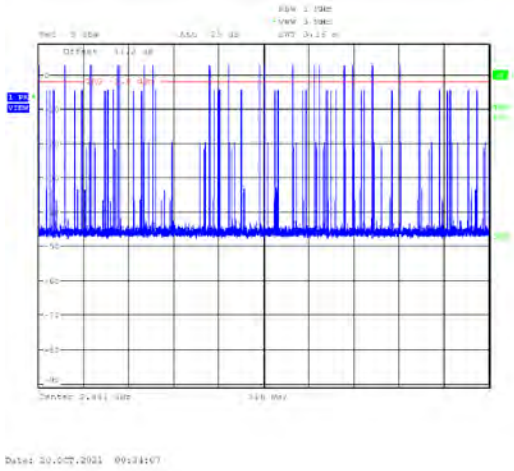
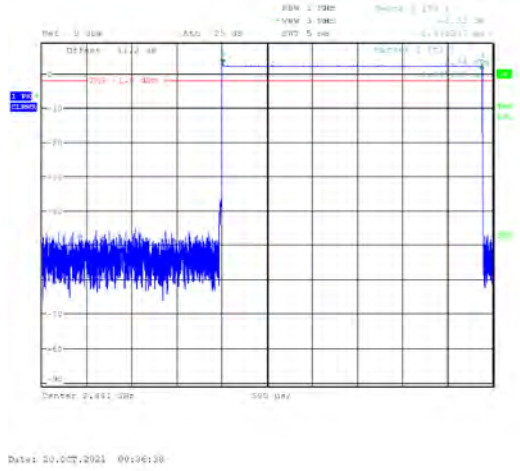
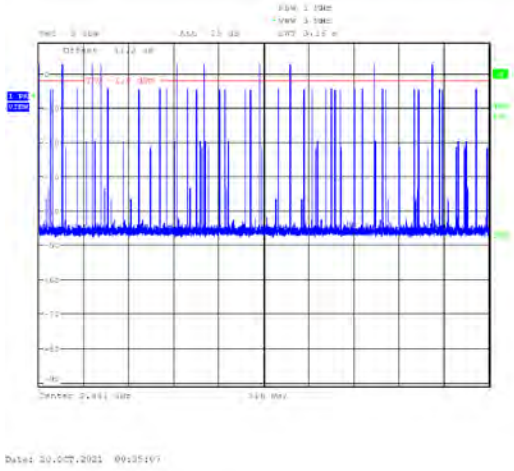
4.5.3 Test Results

Mode	Data Rate	Burst On Time (ms)	No. of Burst in 3.16 seconds	Dwell Time (ms) (Burst Time * No. of Burst * 10)	Dwell Time limit (ms)
GFSK	DH1	0.38	33	122	400
	DH3	1.63	17	277	400
	DH5	2.88	9	259	400
π/4-DQPSK	DH1	0.38	32	122	400
	DH3	1.63	15	245	400
	DH5	2.88	8	230	400
8-DPSK	DH1	0.38	32	122	400
	DH3	1.63	17	277	400
	DH5	2.88	12	346	400

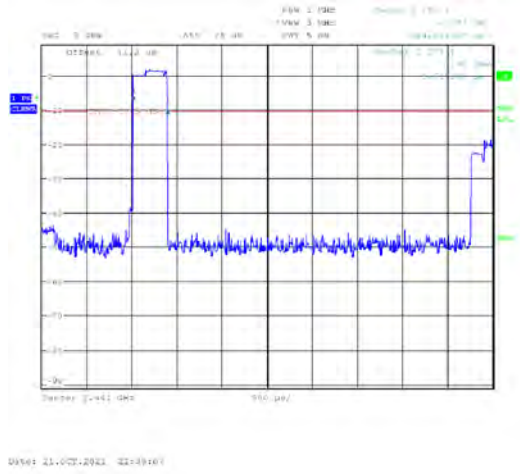
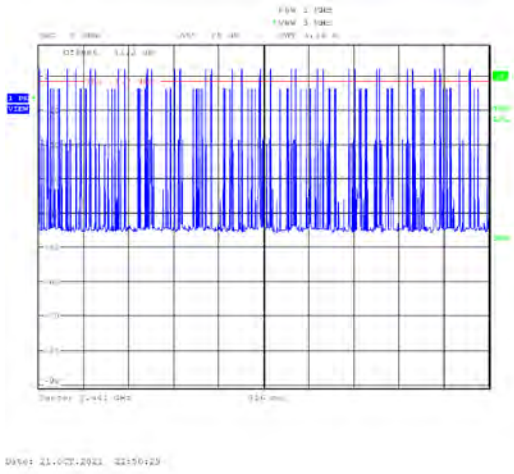
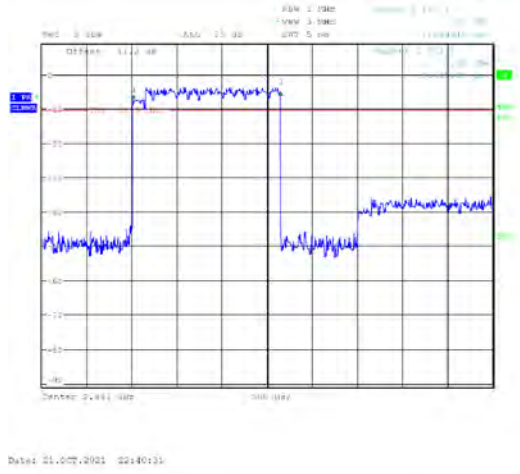
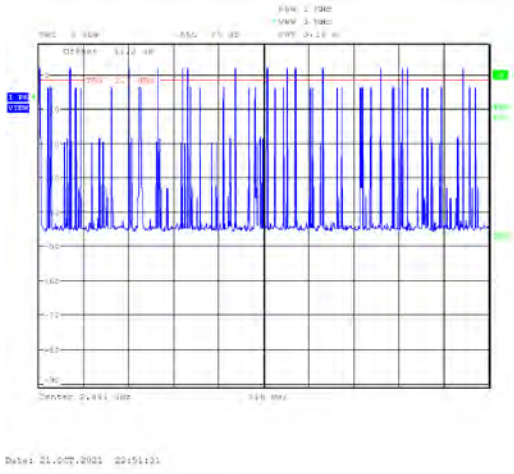
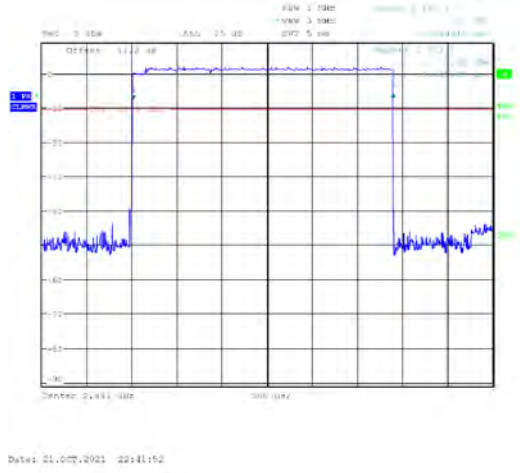
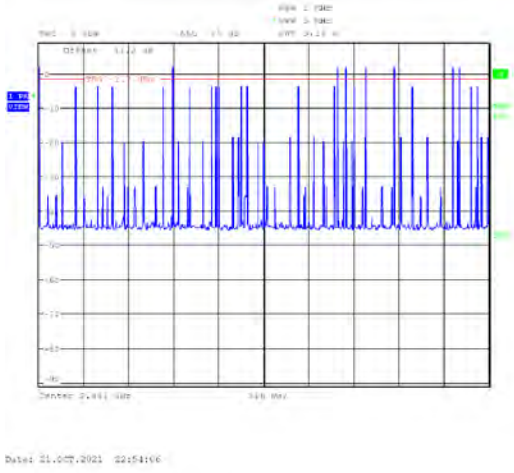
The 20-dB bandwidth of the hopping channel is greater than 250 kHz, the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a period of the number of channels (79) multiplied by 0.4 second (31.6 seconds).

Results	Complies

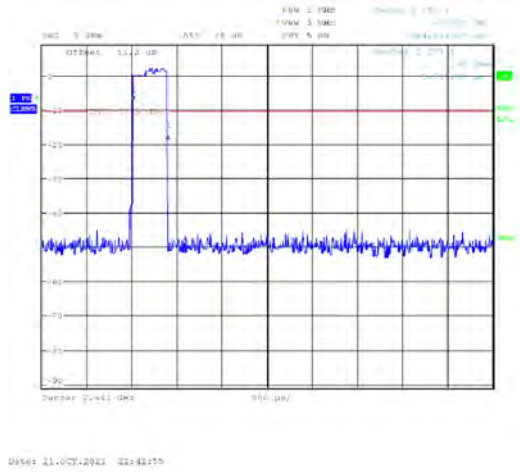
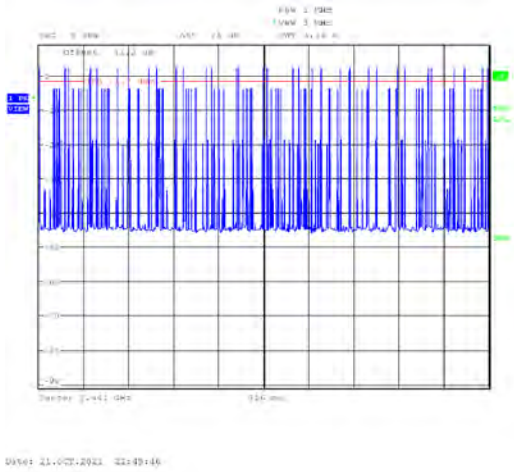
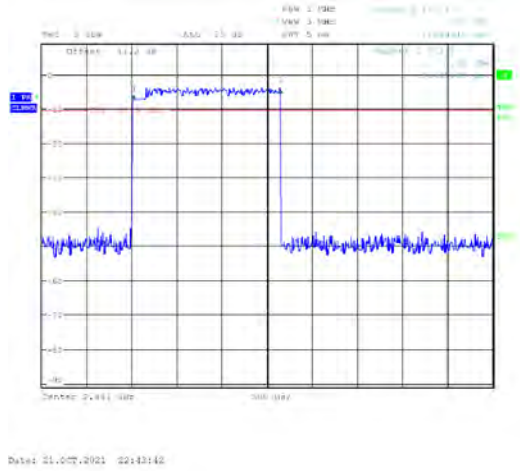
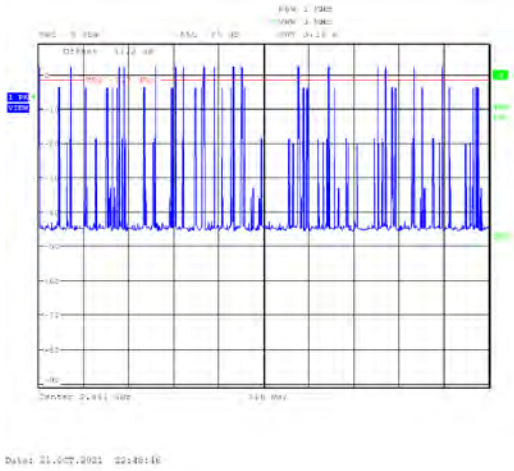
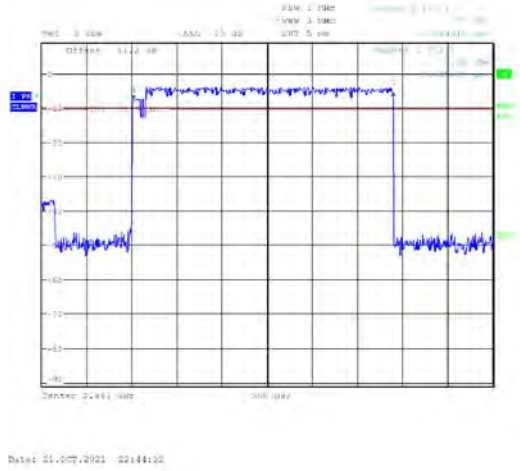
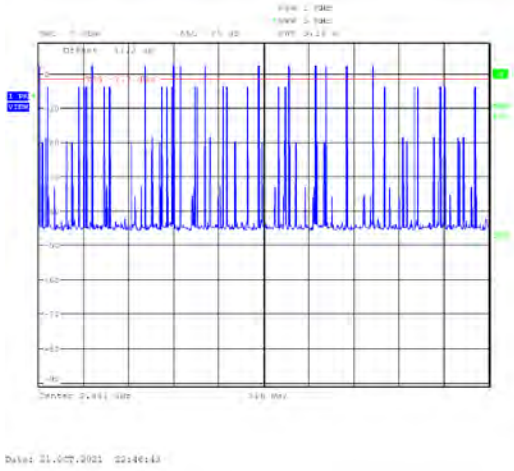
GFSK

DH1, Burst Time	DH1, # of Bust in 3.16s Sweep
	
DH3, Burst Time	**DH3, # of Bust in 3.16s Sweep**
	
DH5, Burst Time	**DH5, # of Bust in 3.16s Sweep**
	

π/4-DQPSK

DH1, Burst Time	DH1, # of Bust in 3.16s Sweep
	
DH3, Burst Time	**DH3, # of Bust in 3.16s Sweep**
	
DH5, Burst Time	**DH5, # of Bust in 3.16s Sweep**
	

8-DPSK

DH1, Burst Time	DH1, # of Bust in 3.16s Sweep
	
DH3, Burst Time	**DH3, # of Bust in 3.16s Sweep**
	
DH5, Burst Time	**DH5, # of Bust in 3.16s Sweep**
	

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

4.6.1 Requirement

In any 100 kHz bandwidths outside the EUT pass-band, the RF power shall be at least 20dB (peak) or 30 dB (average) below that of the maximum in-band 100 kHz emissions.

4.6.2 Procedure

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

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

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

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

Tested By	Test Date
Minh Ly	October 21, 2021

4.6.3 Test Result

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

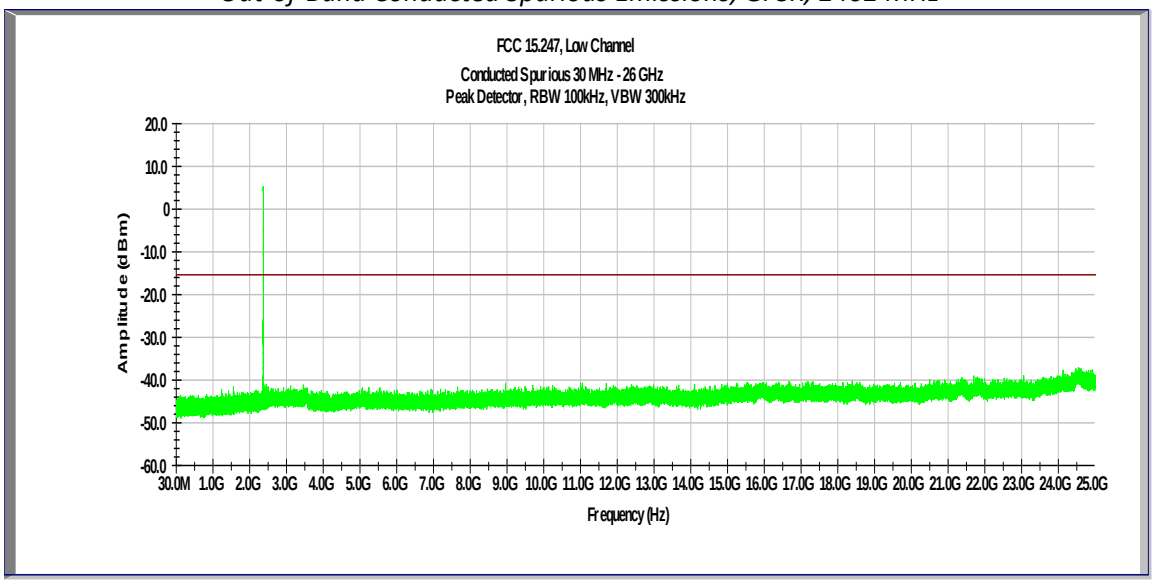
Out-of-Band Conducted Spurious Emissions

Mode	Frequency MHz	Description	Results
GFSK	2402	Scan 30 MHz – 26 GHz	Complies, Greater than 20dB
	2441	Scan 30 MHz – 26 GHz	Complies, Greater than 20dB
	2480	Scan 30 MHz – 26 GHz	Complies, Greater than 20dB
π/4-DQPSK	2402	Scan 30 MHz – 26 GHz	Complies, Greater than 20dB
	2441	Scan 30 MHz – 26 GHz	Complies, Greater than 20dB
	2480	Scan 30 MHz – 26 GHz	Complies, Greater than 20dB
8-DPSK	2402	Scan 30 MHz – 26 GHz	Complies, Greater than 20dB
	2441	Scan 30 MHz – 26 GHz	Complies, Greater than 20dB
	2480	Scan 30 MHz – 26 GHz	Complies, Greater than 20dB

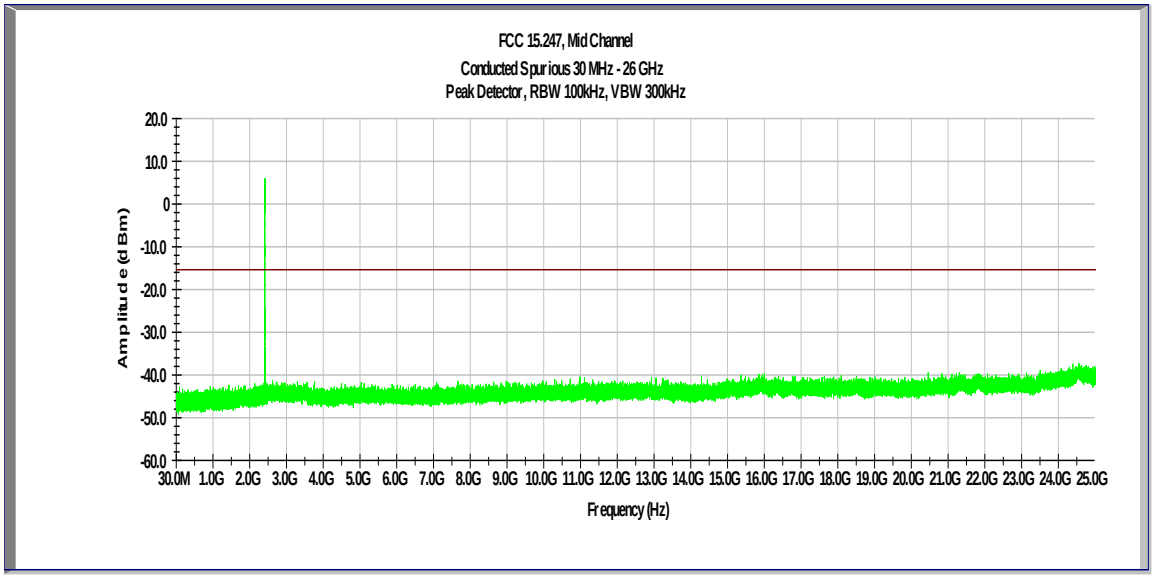
Out-of-Band Conducted Spurious Emissions at the Band-Edge:

Mode	Channel	Frequency MHz	Results
GFSK	0	2402	Complies, Greater than 20dB
	Hopping	Low Band Edge	Complies, Greater than 20dB
	78	2480	Complies, Greater than 20dB
	Hopping	High Band Edge	Complies, Greater than 20dB
π/4-DQPSK	0	2402	Complies, Greater than 20dB
	Hopping	Low Band Edge	Complies, Greater than 20dB
	78	2480	Complies, Greater than 20dB
	Hopping	High Band Edge	Complies, Greater than 20dB
8-DPSK	0	2402	Complies, Greater than 20dB
	Hopping	Low Band Edge	Complies, Greater than 20dB
	78	2480	Complies, Greater than 20dB
	Hopping	High Band Edge	Complies, Greater than 20dB

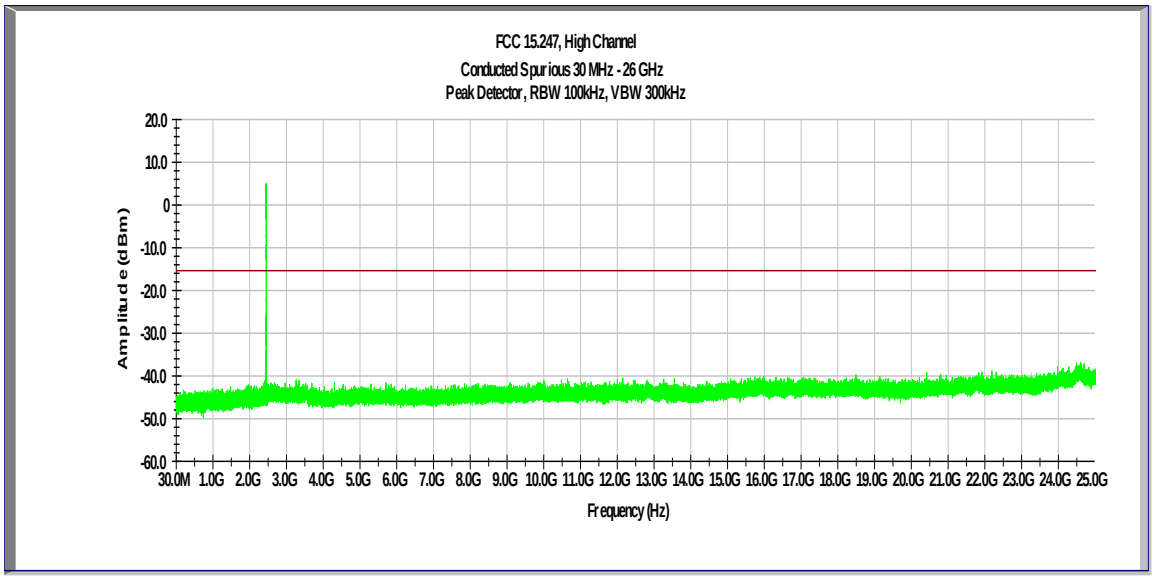
Out-of-Band Conducted Spurious Emissions, GFSK, 2402 MHz



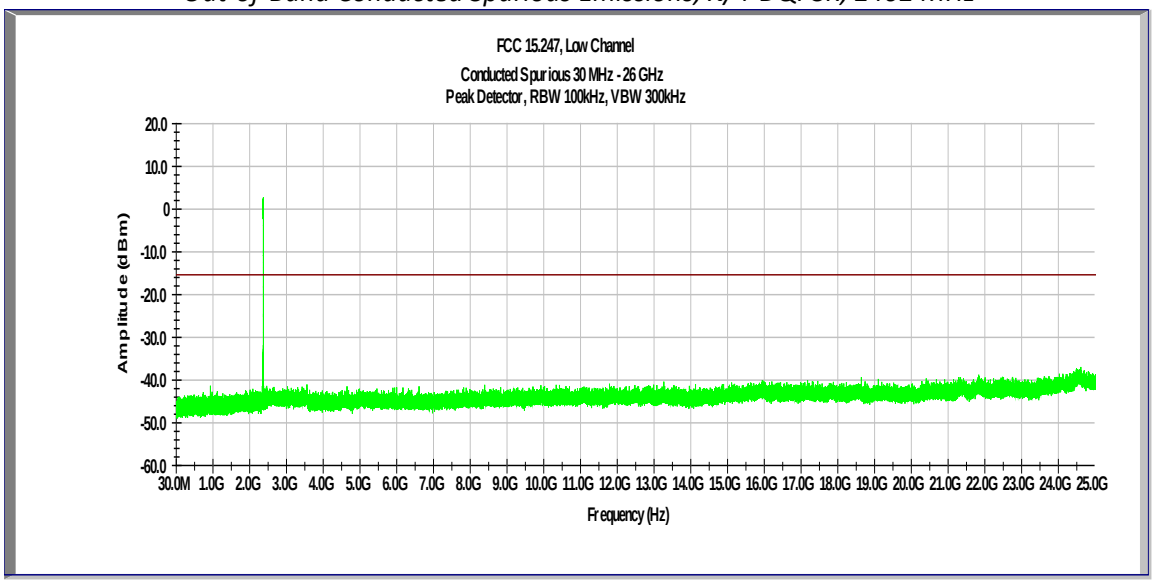
Out-of-Band Conducted Spurious Emissions, GFSK, 2441 MHz



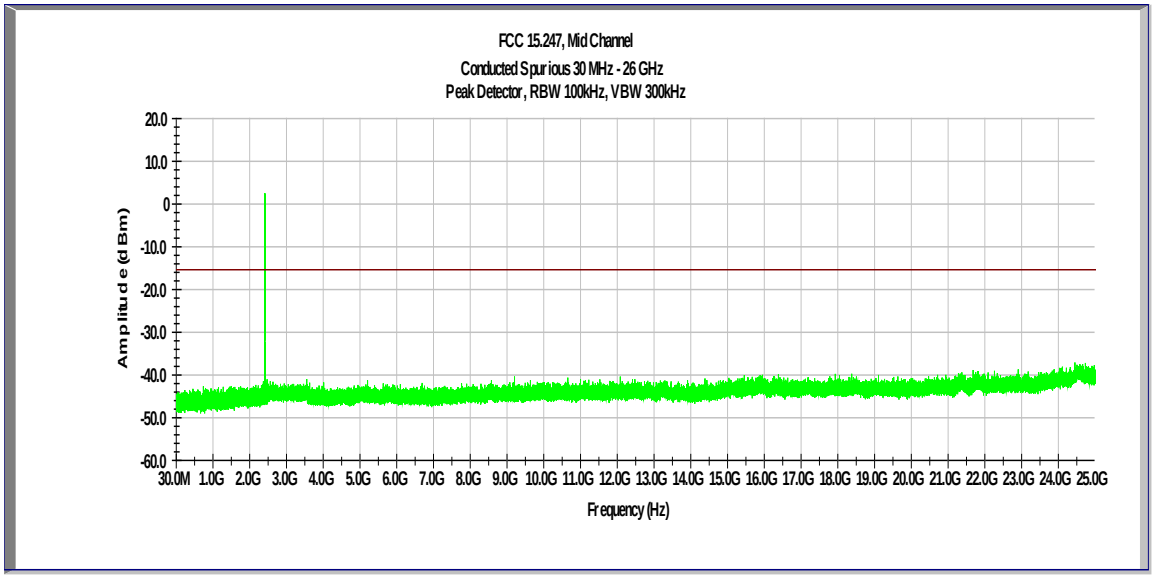
Out-of-Band Conducted Spurious Emissions, GFSK, 2480 MHz



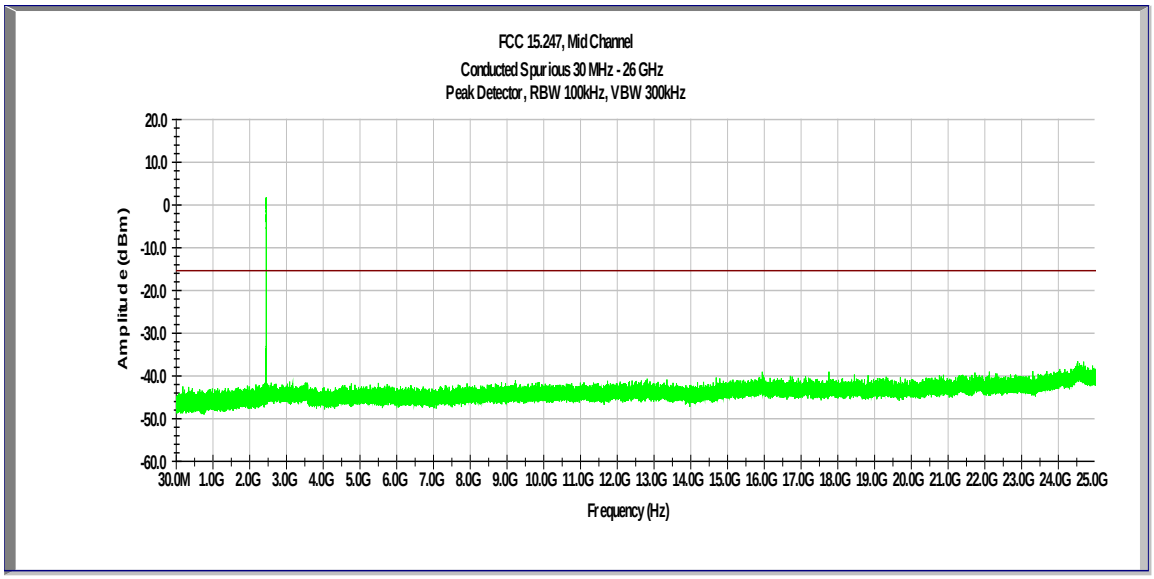
Out-of-Band Conducted Spurious Emissions, π/4-DQPSK, 2402 MHz



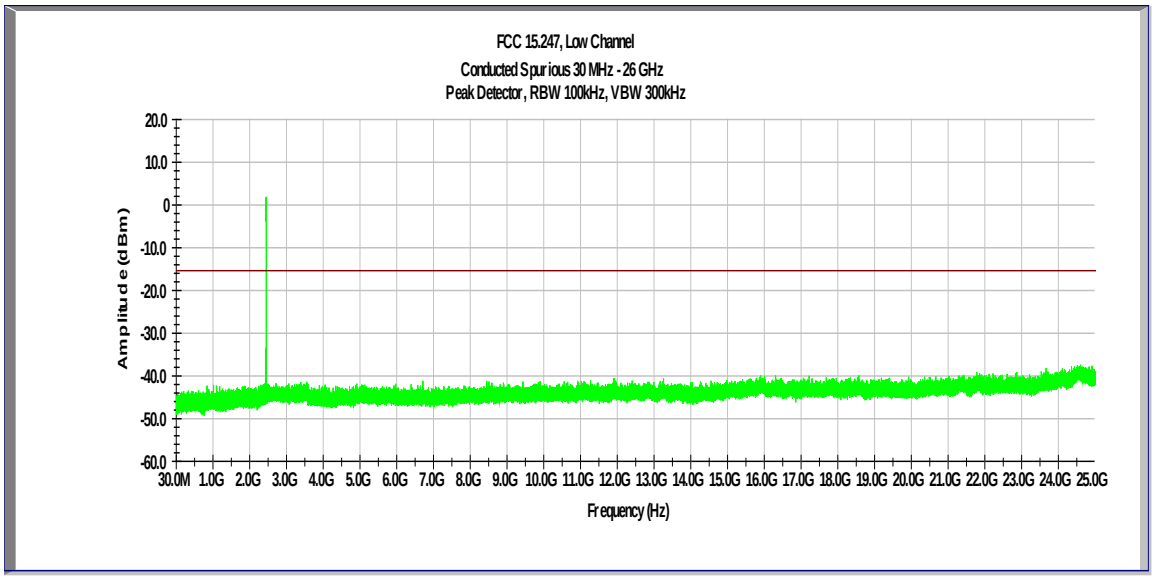
Out-of-Band Conducted Spurious Emissions, π/4-DQPSK, 2441 MHz



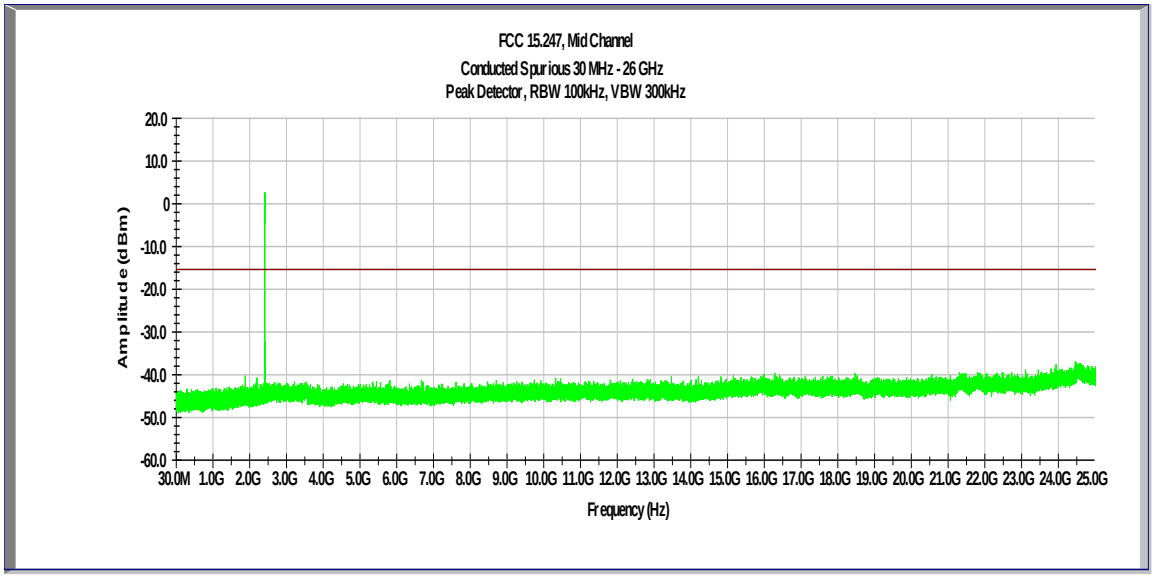
Out-of-Band Conducted Spurious Emissions, π/4-DQPSK, 2480 MHz



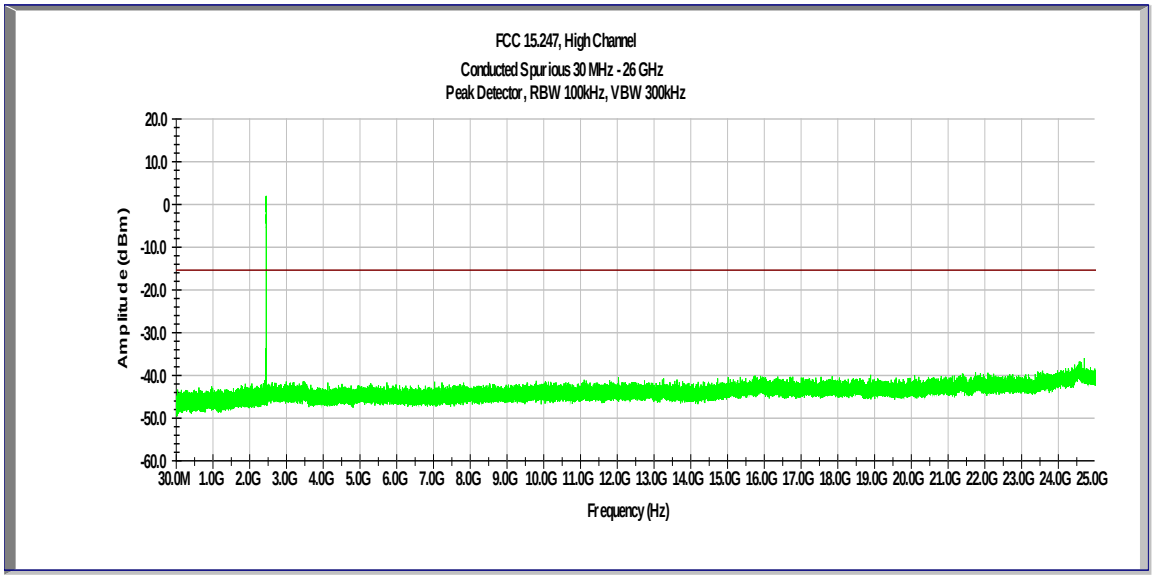
Out-of-Band Conducted Spurious Emissions, 8-DPSK, 2402 MHz



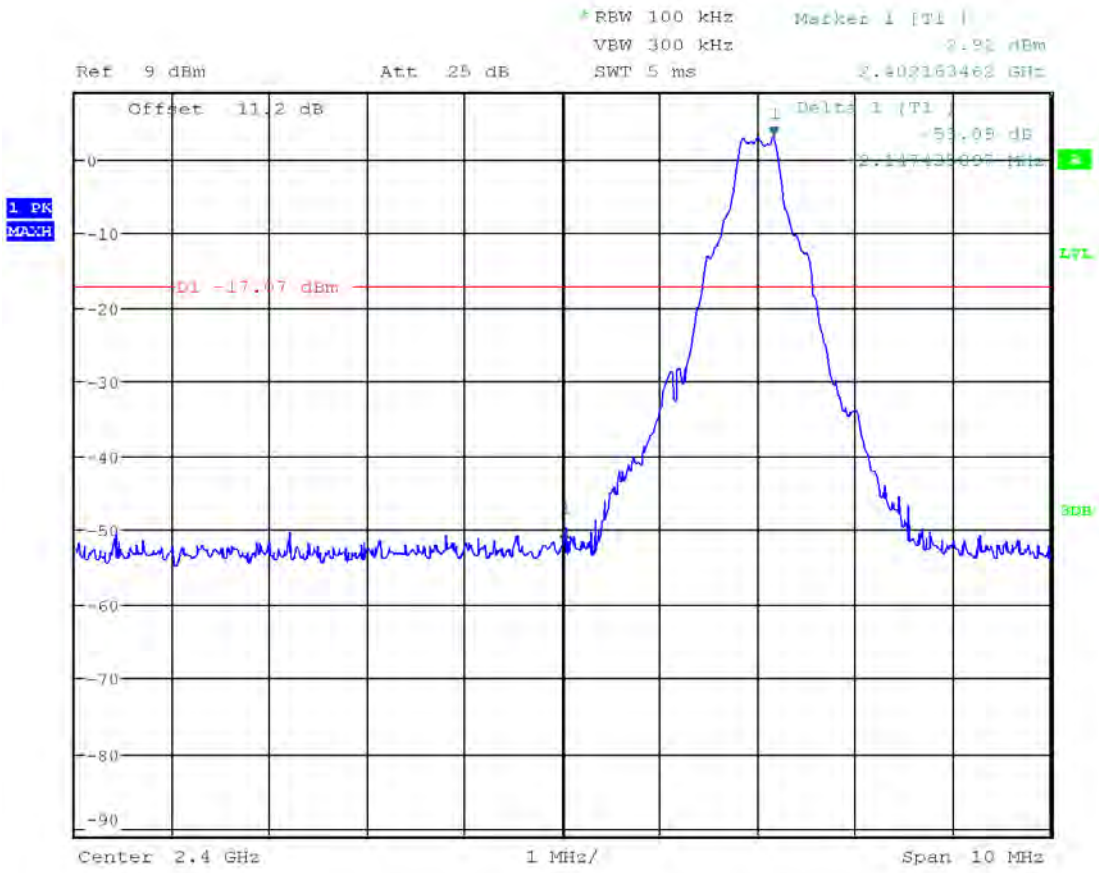
Out-of-Band Conducted Spurious Emissions, 8-DPSK, 2441 MHz



Out-of-Band Conducted Spurious Emissions, 8-DPSK, 2480 MHz

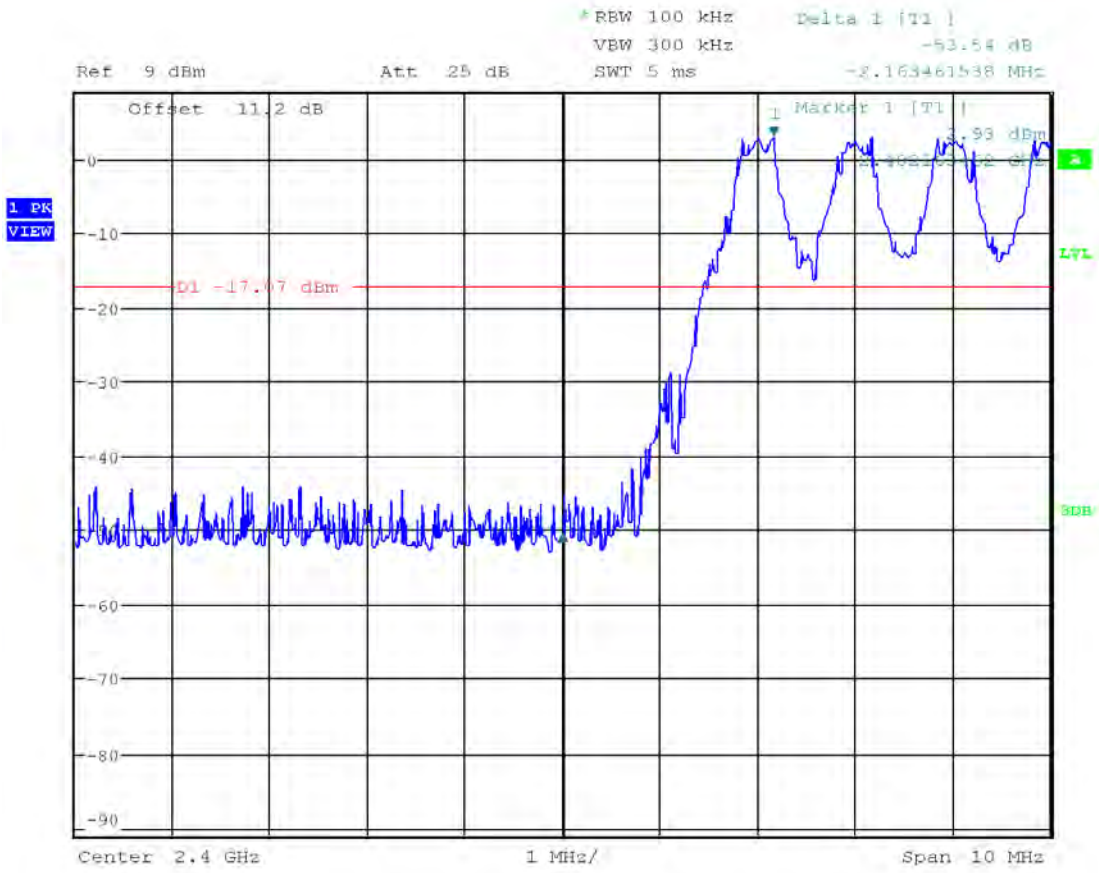


GFSK
Conducted Band Edge, Low Channel

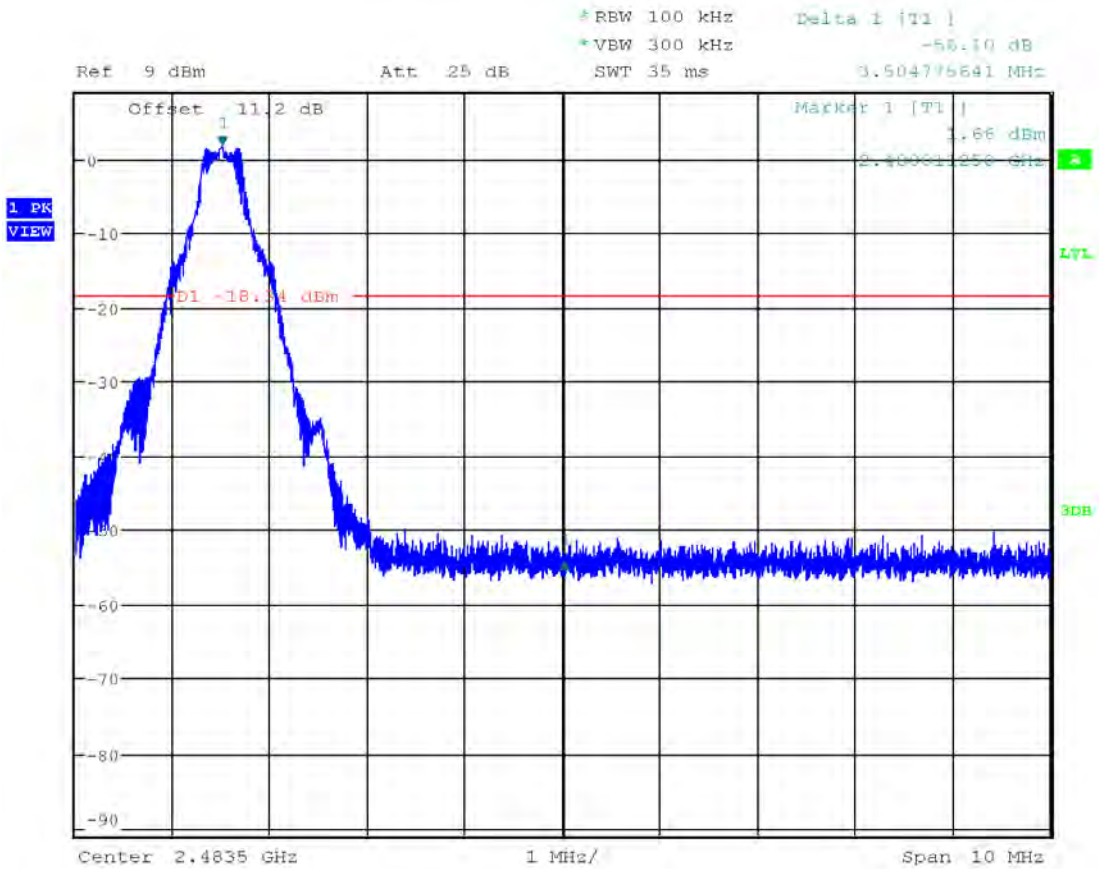


Date: 21.OCT.2021 22:33:38

GFSK
Conducted Band Edge (Hopping)



GFSK
Conducted Band Edge, High Channel



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GFSK
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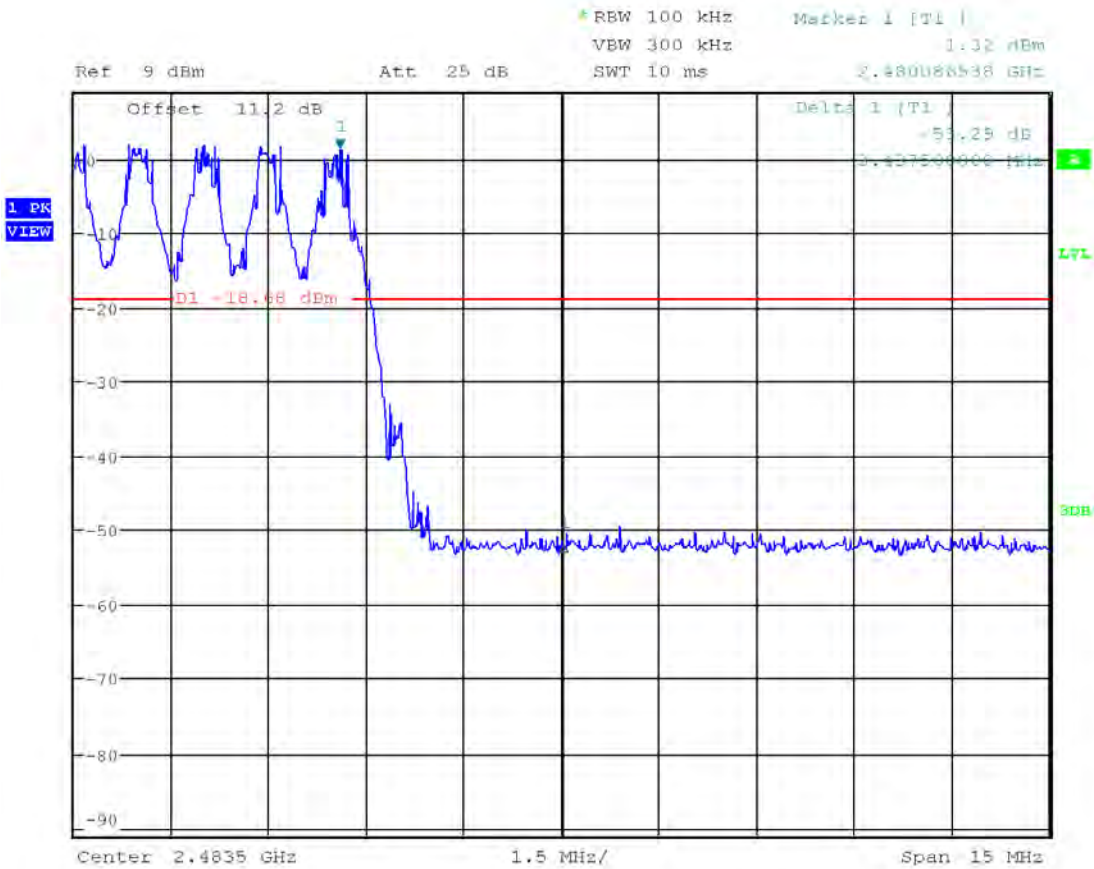
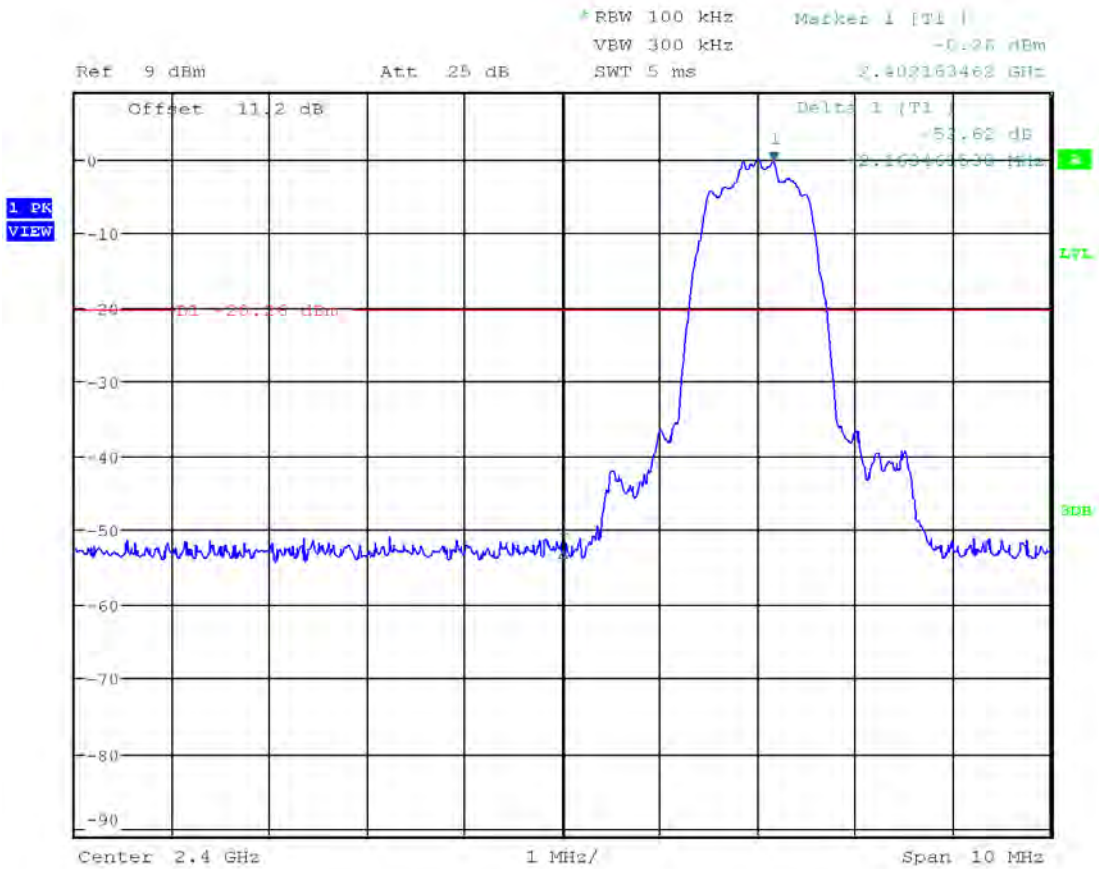


Date: 21.OCT.2021 22:21:00

π/4-DQPSK
Conducted Band Edge, Low Channel



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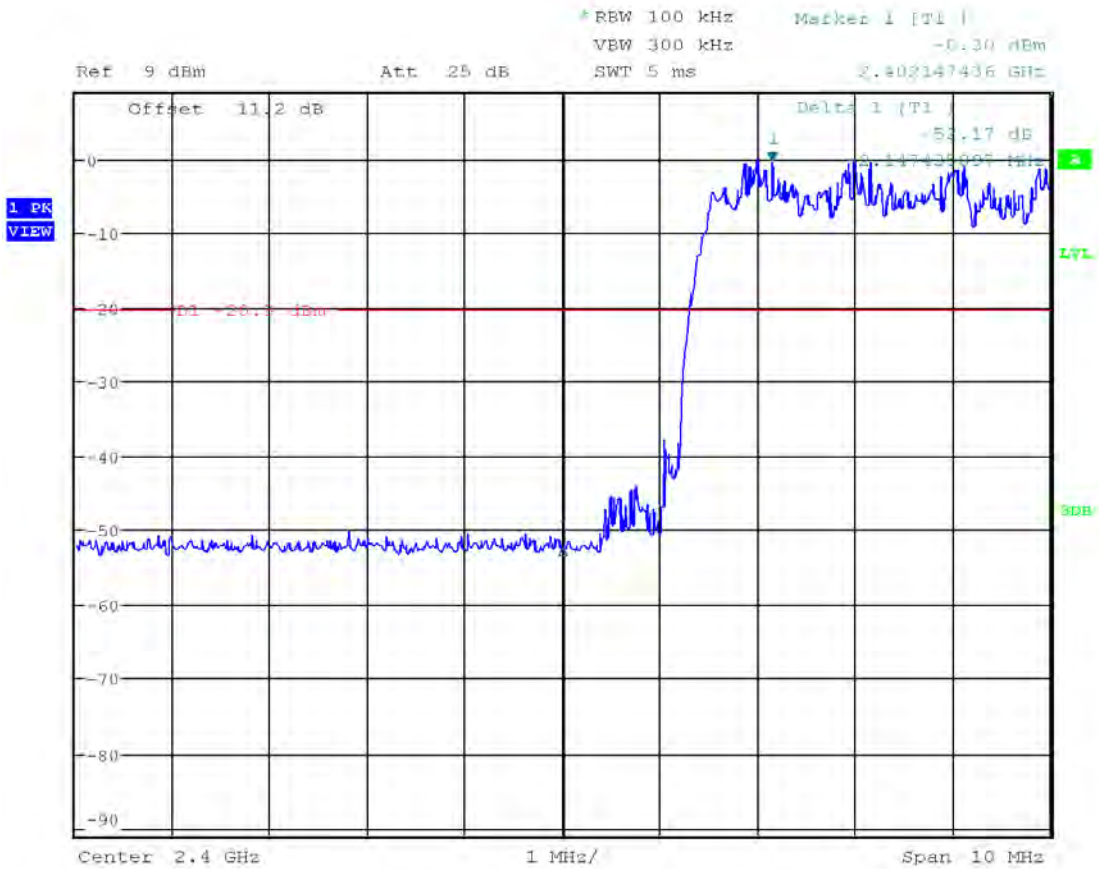
π/4-DQPSK
Conducted Band Edge (Hopping)



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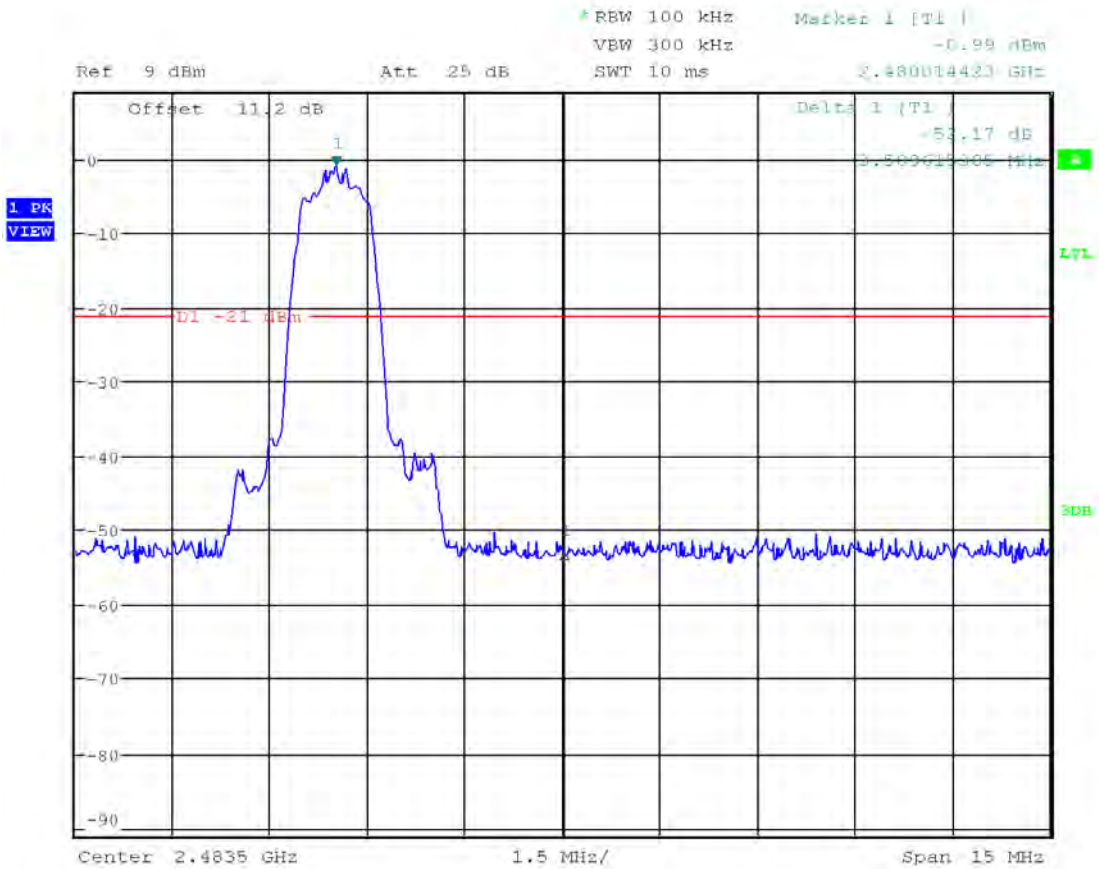
π/4-DQPSK
Conducted Band Edge, High Channel



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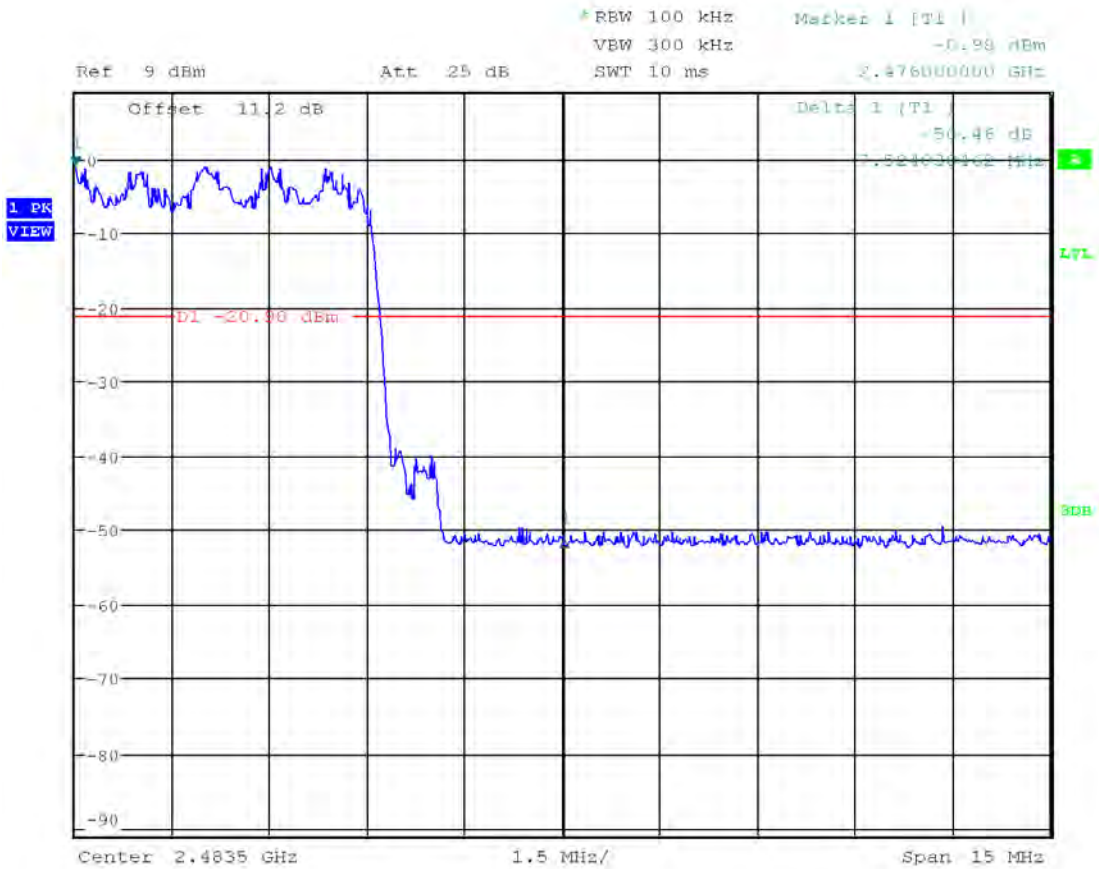
π/4-DQPSK
Conducted Band Edge (Hopping)



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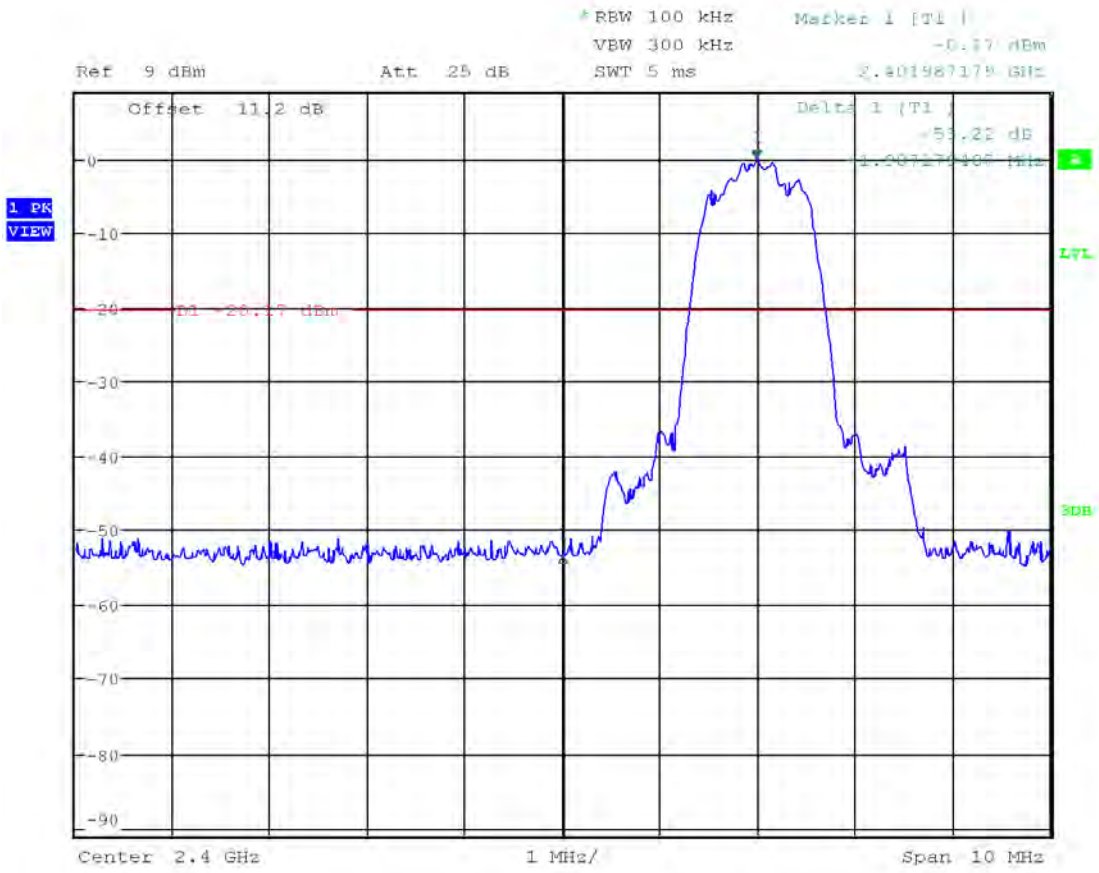
8-DPSK
Conducted Band Edge, Low Channel



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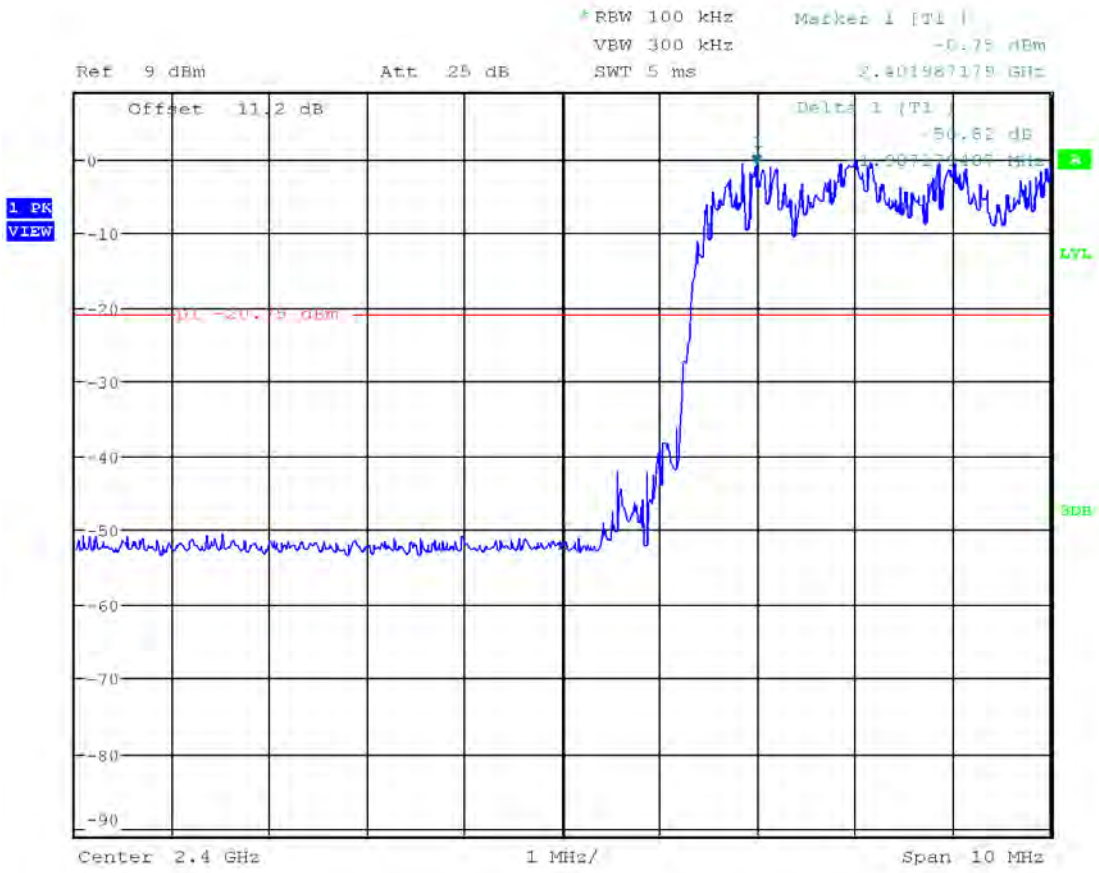
8-DPSK
Conducted Band Edge (Hopping)



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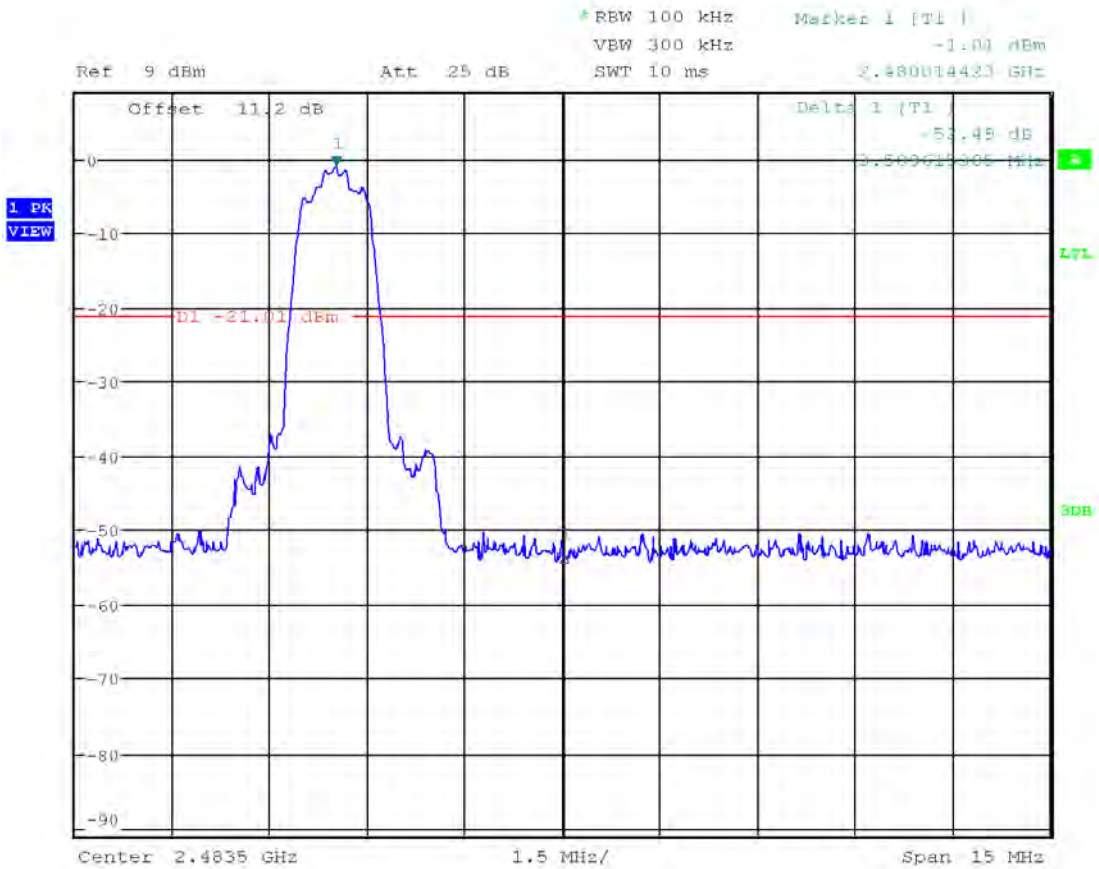
8-DPSK
Conducted Band Edge, High Channel



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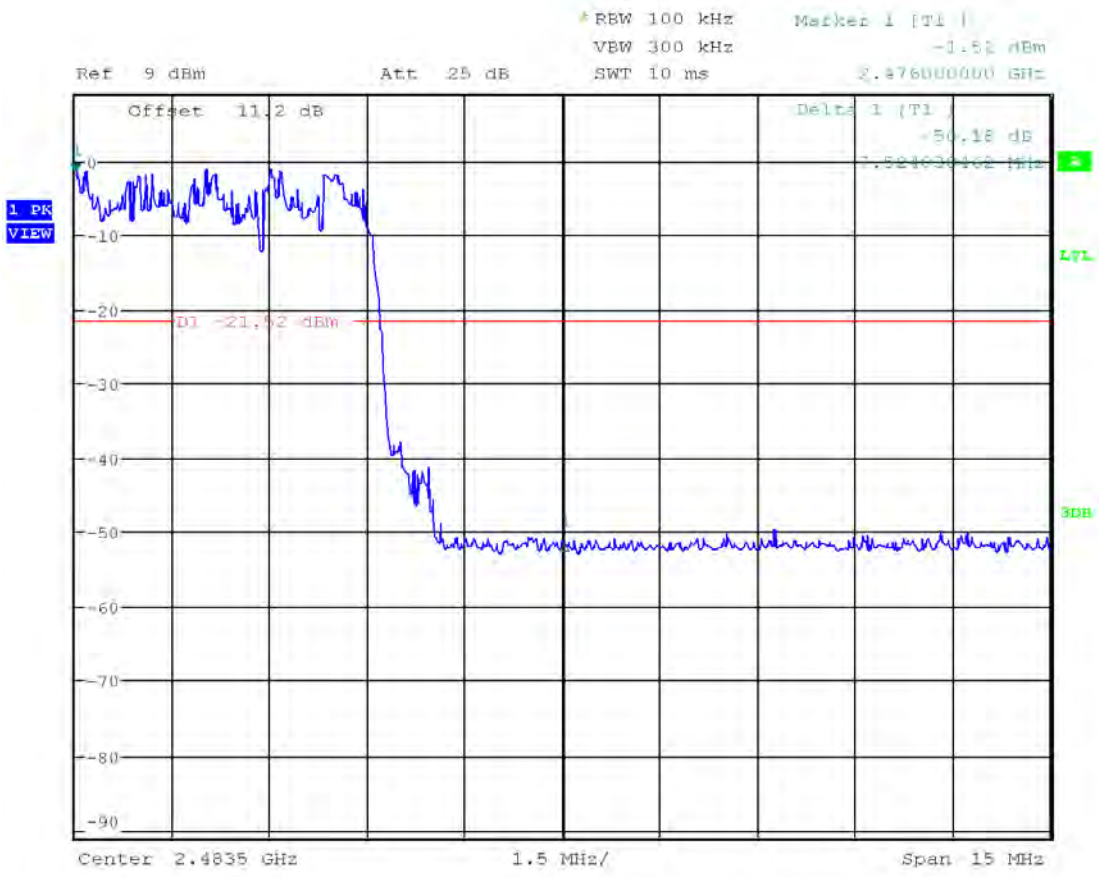
8-DPSK
Conducted Band Edge (Hopping)



Date: 21.OCT.2021 22:29:22

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

4.7.1 Requirement

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

For out of band radiated emissions (except for frequencies in restricted bands), in any 100 kHz bandwidths outside the EUT pass-band, the RF power shall be at least 20dB (peak) or 30 dB (average) below that of the maximum in-band 100 kHz emissions.

4.7.2 Procedure

Radiated emission measurements were performed from 9kHz to 25GHz. Spectrum Analyzer Resolution Bandwidth is 100 kHz or greater for frequencies 30 MHz to 1000 MHz, 1 MHz for frequencies above 1000 MHz.

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.

Spurious measurements are made with a preamp from 9kHz MHz to 25 GHz.

Measurements may be made with a Peak Detector and compared to QP limits for 9kHz – 1 GHz and Average limits for 1 GHz – 25 GHz.

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.

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

4.7.3 Field Strength Calculation

Field Strength Calculation

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

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

Where FS = Field Strength in dB(μV/m)
RA = Receiver Amplitude (including preamplifier) in dB(μV); 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.

4.7.4 Antenna-port conducted measurements

Antenna-port conducted measurements may also be used as an alternative to radiated measurements for demonstrating compliance in the restricted frequency bands. If conducted measurements are performed, then proper impedance matching must be ensured and an additional radiated test for cabinet/case spurious emissions is required.

4.7.5 General Procedure for conducted measurements in restricted bands

a) Measure the conducted output power (in dBm) using the detector specified for determining quasi-peak, peak, and average conducted output power, respectively.

b) Add the maximum transmit antenna gain (in dBi) to the measured output power level to determine the EIRP level (see 12.2.5 for guidance on determining the applicable antenna gain)

c) Add the appropriate maximum ground reflection factor to the EIRP level (6 dB for frequencies ≤ 30 MHz, 4.7 dB for frequencies between 30 MHz and 1000 MHz, inclusive and 0 dB for frequencies > 1000 MHz).

d) For devices with multiple antenna-ports, measure the power of each individual chain and sum the EIRP of all chains in linear terms (*e.g.*, Watts, mW).

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

4.7.6 Test Results

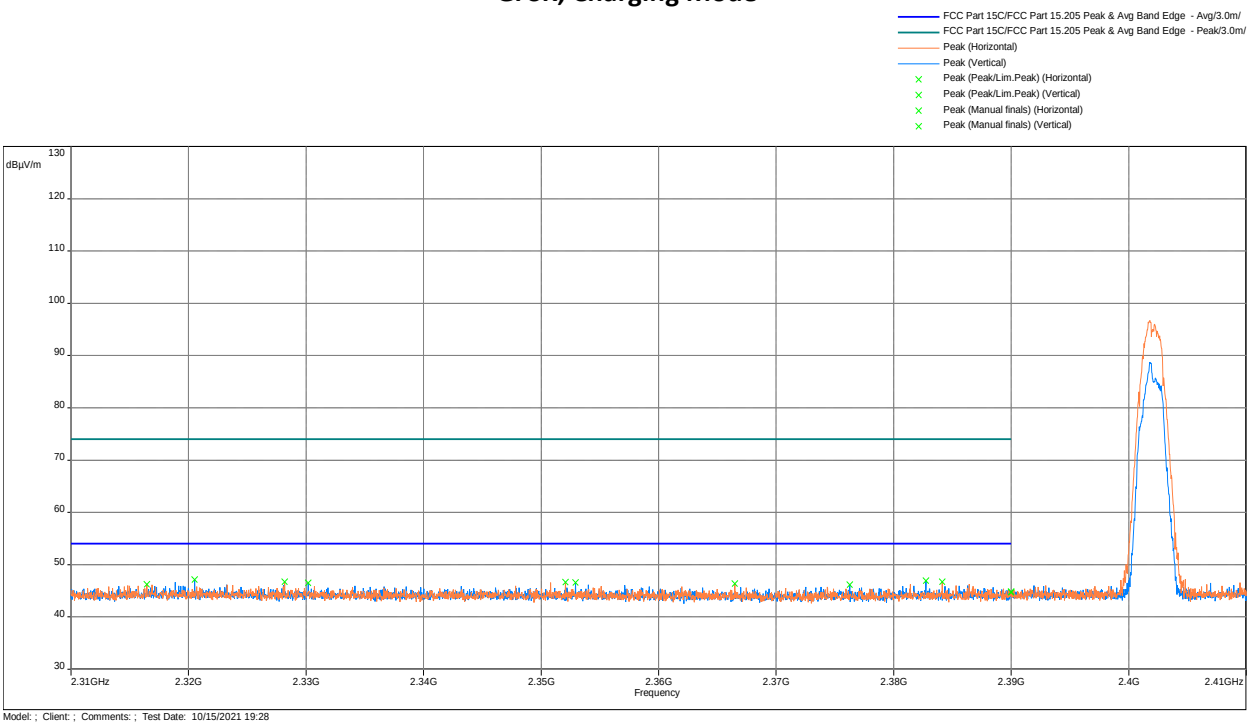
Tested By	Test Date
Minh Ly	October 18 - 19, 2021

These measurements were performed with Antenna in place.

4.7.6 Test Results (Continued)

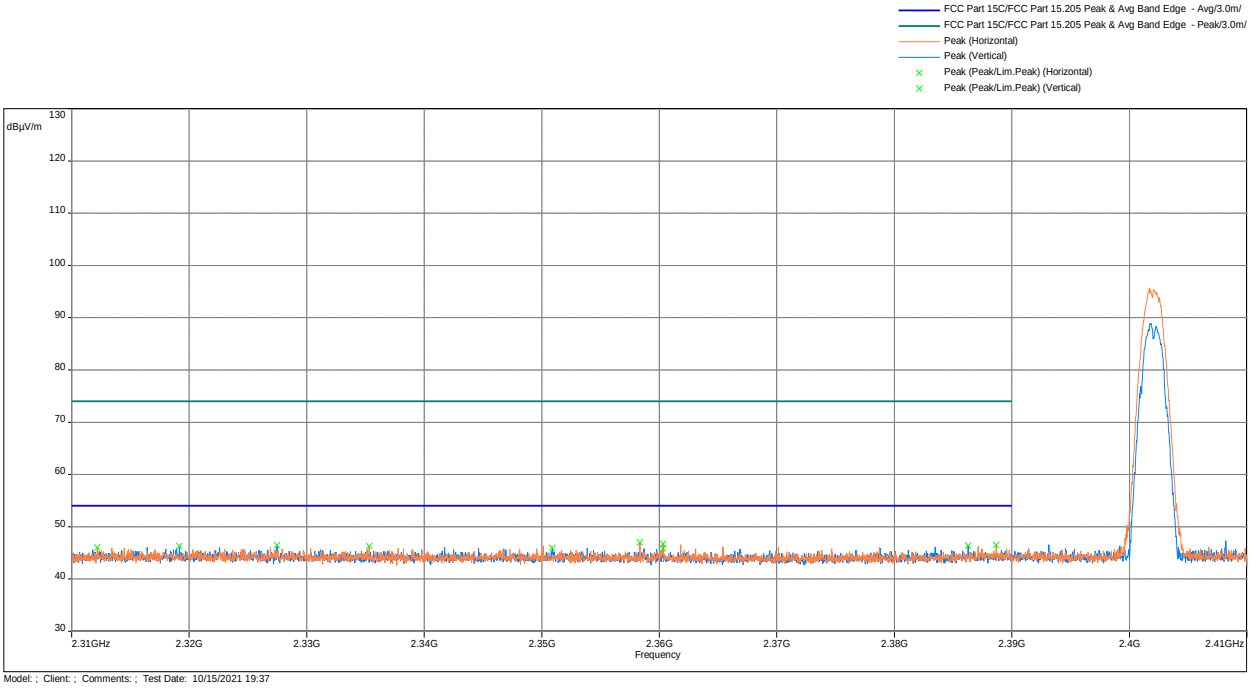
Test Results: 15.209/15.205 Radiated Restricted Band Emissions

Out-of-Band Radiated spurious emissions at the Band-edge @1m distance
2310–2390 MHz, Peak Scan with Peak Limit and Average Limit
GFSK, Charging Mode



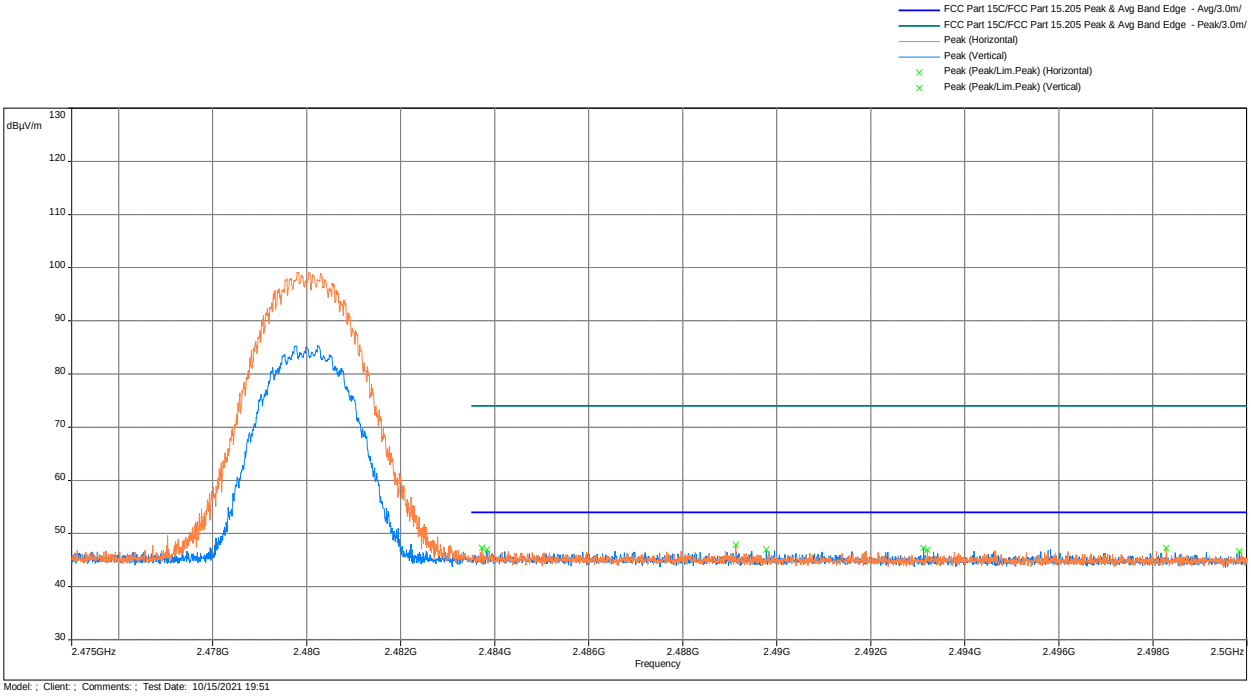
Frequency (MHz)	Peak@3m dB(uV/m)	Ave Limit dB(µV/m)	Margin dB	Height (m)	Angle (°)	Polarity	Correction (dB)
2390.0	44.8	54.0	-9.2	2.0	103.0	Vertical	21.6
2390.0	44.7	54.0	-9.3	2.0	306.3	Horizontal	21.6

Out-of-Band Radiated spurious emissions at the Band-edge @1m distance
2310–2390 MHz, Peak Scan with Peak Limit and Average Limit
GFSK, Normal Mode



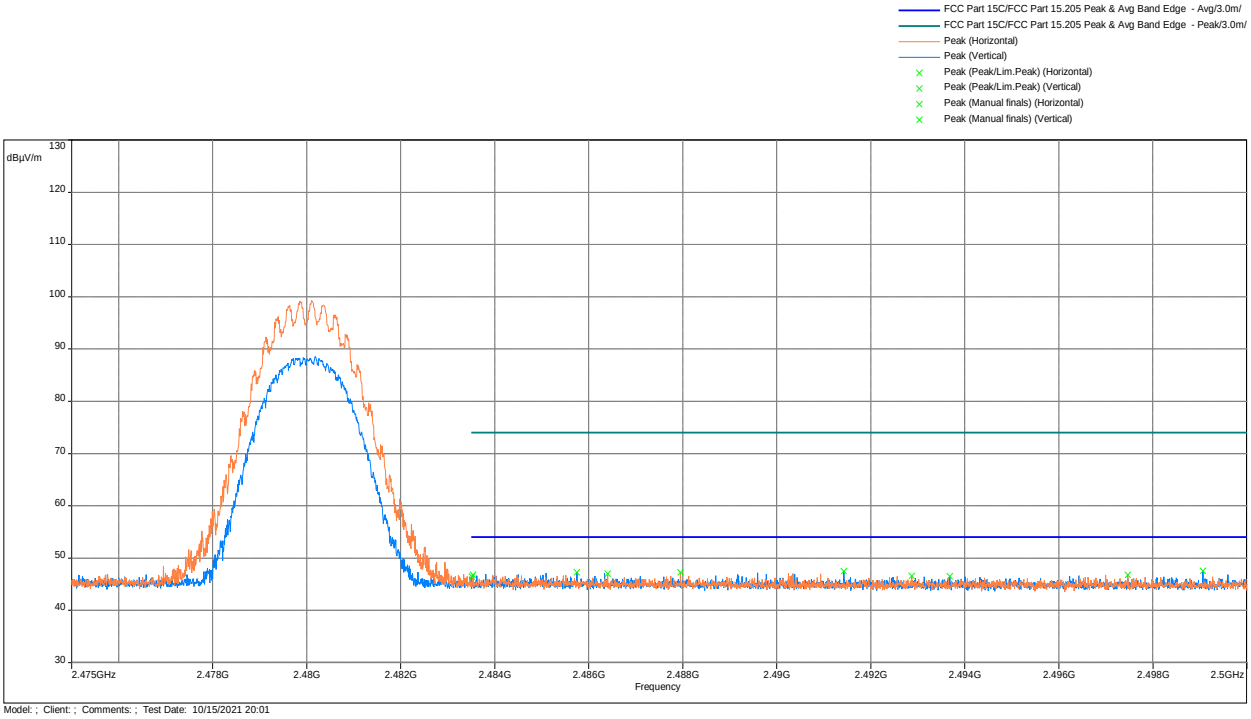
Frequency (MHz)	Peak@3m dB(uV/m)	Ave Limit dB(µV/m)	Margin dB	Height (m)	Angle (°)	Polarity	Correction (dB)
2389.8	45.4	54.0	-8.6	2.0	0.3	Vertical	21.6
2389.8	45.6	54.0	-8.4	2.0	25.0	Horizontal	21.6

Out-of-Band Radiated spurious emissions at the Band-edge @1m distance
2483.5–2500 MHz, Peak Scan with Peak Limit and Average Limit
GFSK, Charging Mode



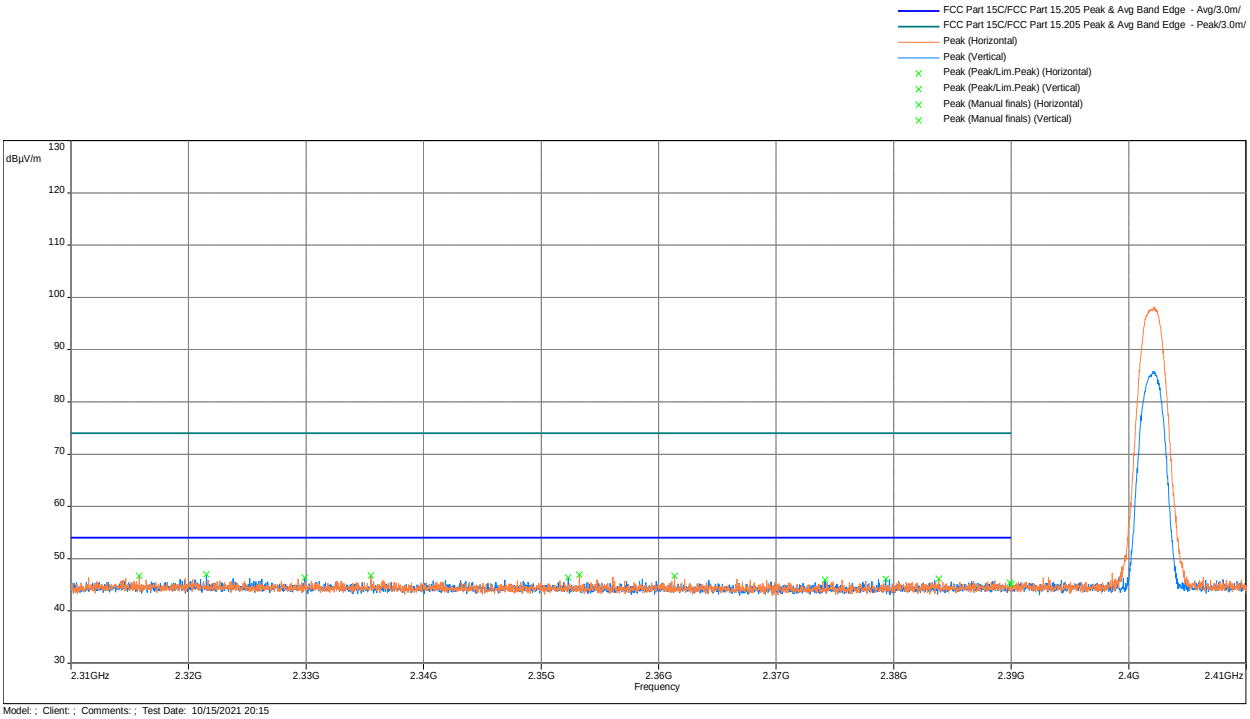
Frequency (MHz)	Peak@3m dB(uV/m)	Ave Limit dB(µV/m)	Margin dB	Height (m)	Angle (°)	Polarity	Correction (dB)
2483.5	46.2	54.0	-7.8	1.5	153.0	Horizontal	22.0
2483.5	46.1	54.0	-7.9	2.0	259.0	Vertical	22.0

Out-of-Band Radiated spurious emissions at the Band-edge @1m distance
2483.5–2500 MHz, Peak Scan with Peak Limit and Average Limit
GFSK, Normal Mode



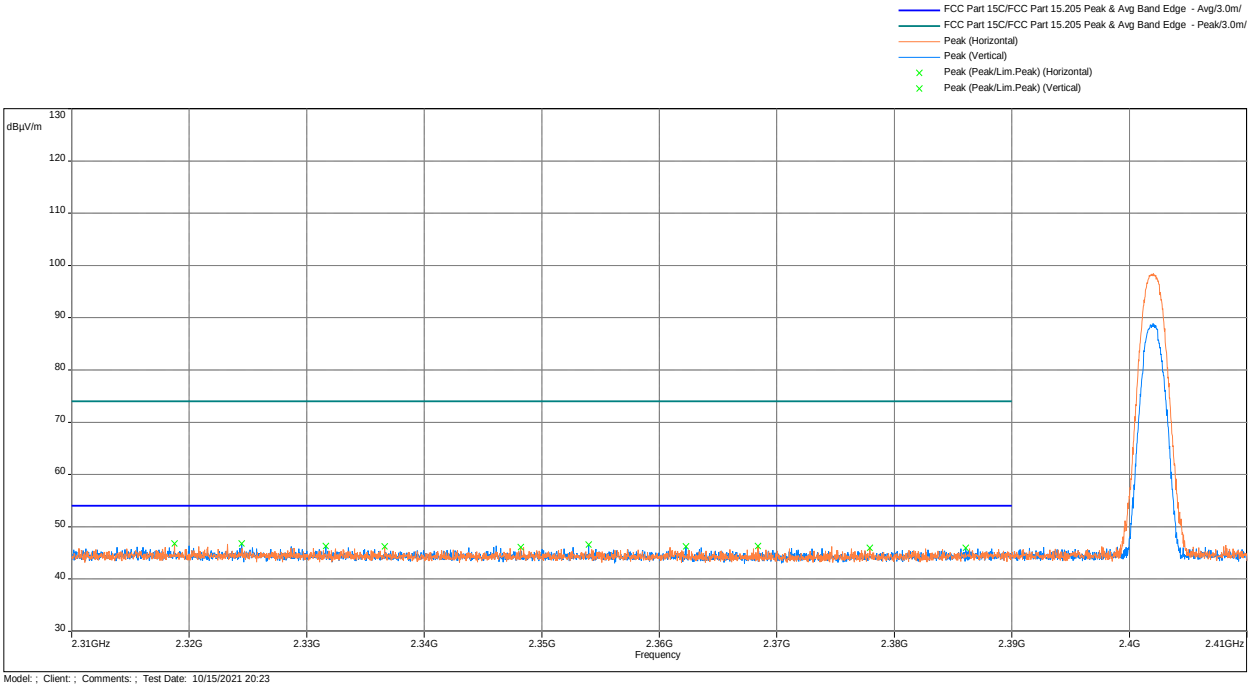
Frequency (MHz)	Peak@3m dB(uV/m)	Ave Limit dB(µV/m)	Margin dB	Height (m)	Angle (°)	Polarity	Correction (dB)
2483.5	46.5	54.0	-7.6	1.5	280.0	Vertical	22.0
2483.5	46.8	54.0	-7.2	1.5	199.0	Horizontal	22.0

Out-of-Band Radiated spurious emissions at the Band-edge @1m distance
2310–2390 MHz, Peak Scan with Peak Limit and Average Limit
π/4-DQPSK, Charging Mode



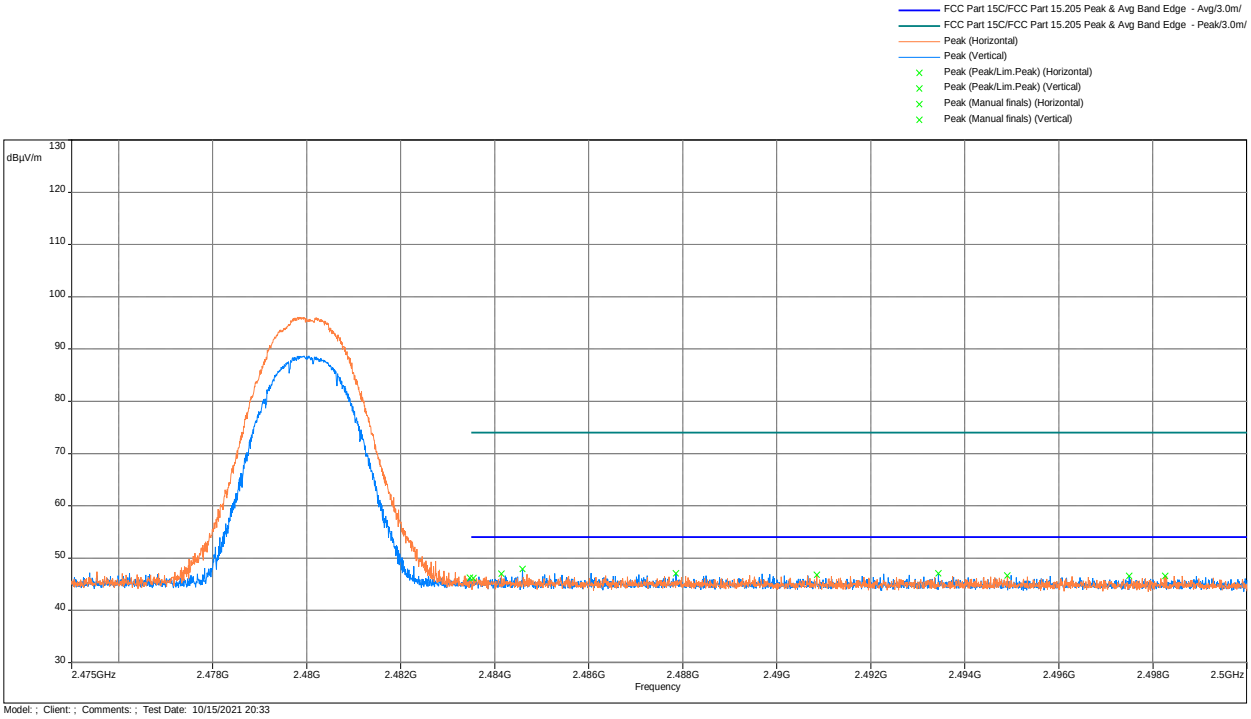
Frequency (MHz)	Peak@3m dB(uV/m)	Ave Limit dB(µV/m)	Margin dB	Height (m)	Angle (°)	Polarity	Correction (dB)
2390.0	45.4	54.0	-8.6	1.5	101.0	Vertical	21.6
2390.0	45.1	54.0	-8.9	1.5	71.3	Horizontal	21.6

Out-of-Band Radiated spurious emissions at the Band-edge @1m distance
2310–2390 MHz, Peak Scan with Peak Limit and Average Limit
π/4-DQPSK, Normal Mode



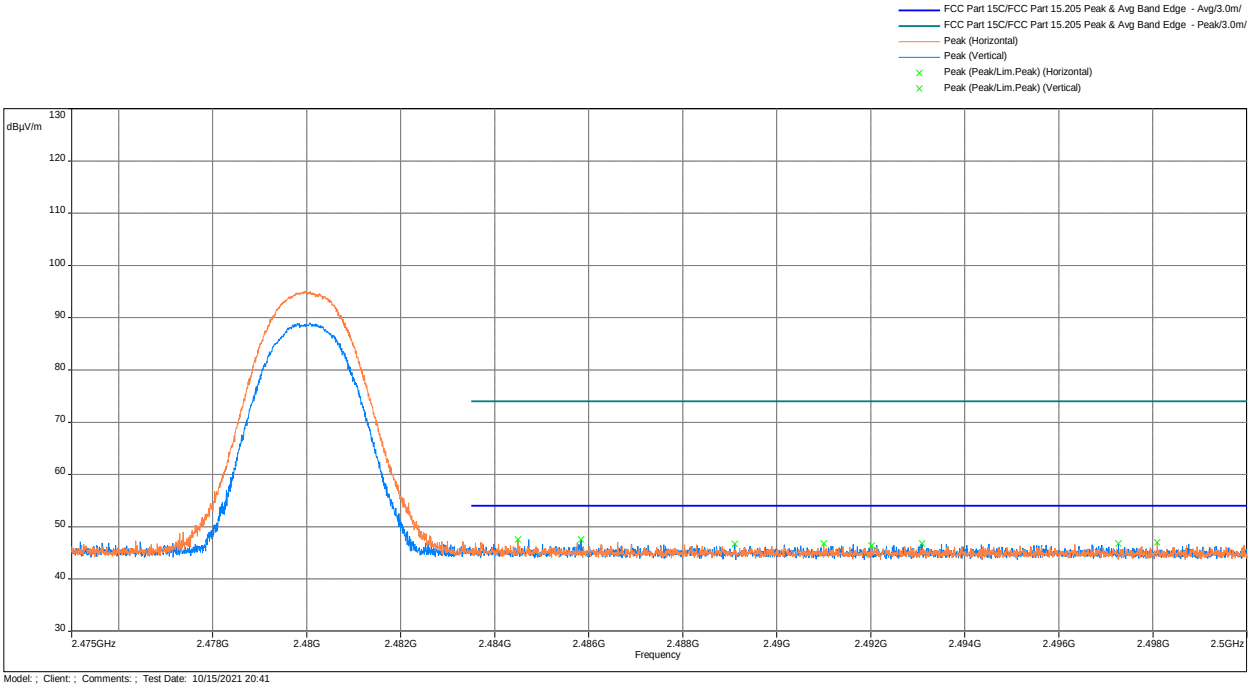
Frequency (MHz)	Peak@3m dB(uV/m)	Ave Limit dB(µV/m)	Margin dB	Height (m)	Angle (°)	Polarity	Correction (dB)
2390.0	45.2	54.0	-8.8	1.5	39.8	Horizontal	21.6
2390.0	45.0	54.0	-9.0	1.5	188.5	Vertical	21.6

Out-of-Band Radiated spurious emissions at the Band-edge @1m distance
2483.5–2500 MHz, Peak Scan with Peak Limit and Average Limit
π/4-DQPSK, Charging Mode



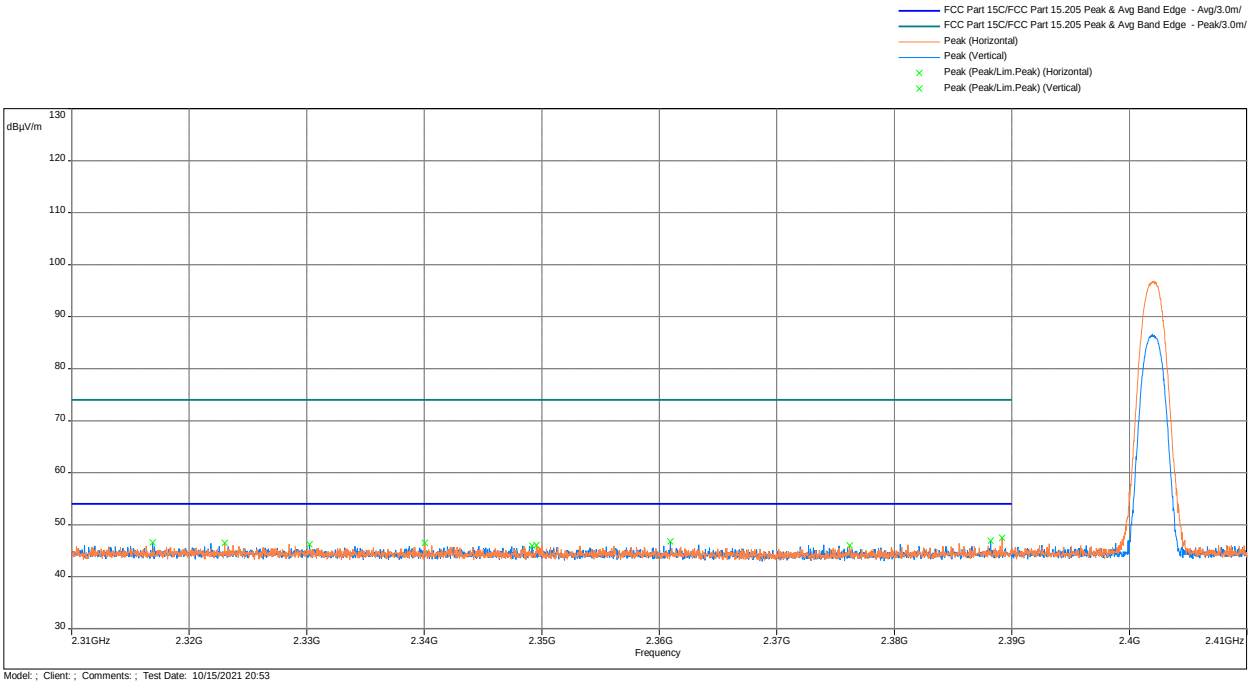
Frequency (MHz)	Peak@3m dB(uV/m)	Ave Limit dB(µV/m)	Margin dB	Height (m)	Angle (°)	Polarity	Correction (dB)
2483.5	46.2	54.0	-7.8	2.0	342.5	Vertical	22.0
2483.5	46.2	54.0	-7.8	1.5	348.0	Horizontal	22.0

Out-of-Band Radiated spurious emissions at the Band-edge @1m distance
2483.5–2500 MHz, Peak Scan with Peak Limit and Average Limit
π/4-DQPSK, Normal Mode



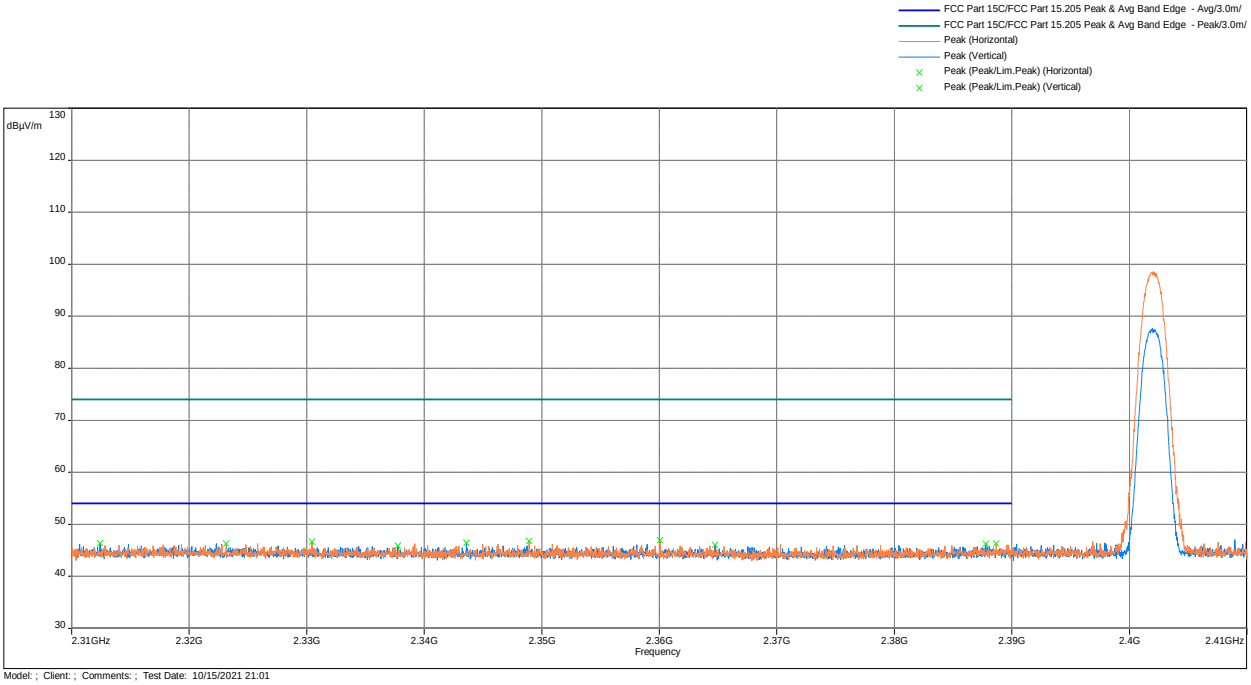
Frequency (MHz)	Peak@3m dB(uV/m)	Ave Limit dB(µV/m)	Margin dB	Height (m)	Angle (°)	Polarity	Correction (dB)
2483.5	46.2	54.0	-7.8	1.5	233.3	Vertical	22.0
2483.6	47.0	54.0	-7.1	2.0	78.0	Horizontal	22.0

Out-of-Band Radiated spurious emissions at the Band-edge @1m distance
2310–2390 MHz, Peak Scan with Peak Limit and Average Limit
8-DPSK, Charging Mode



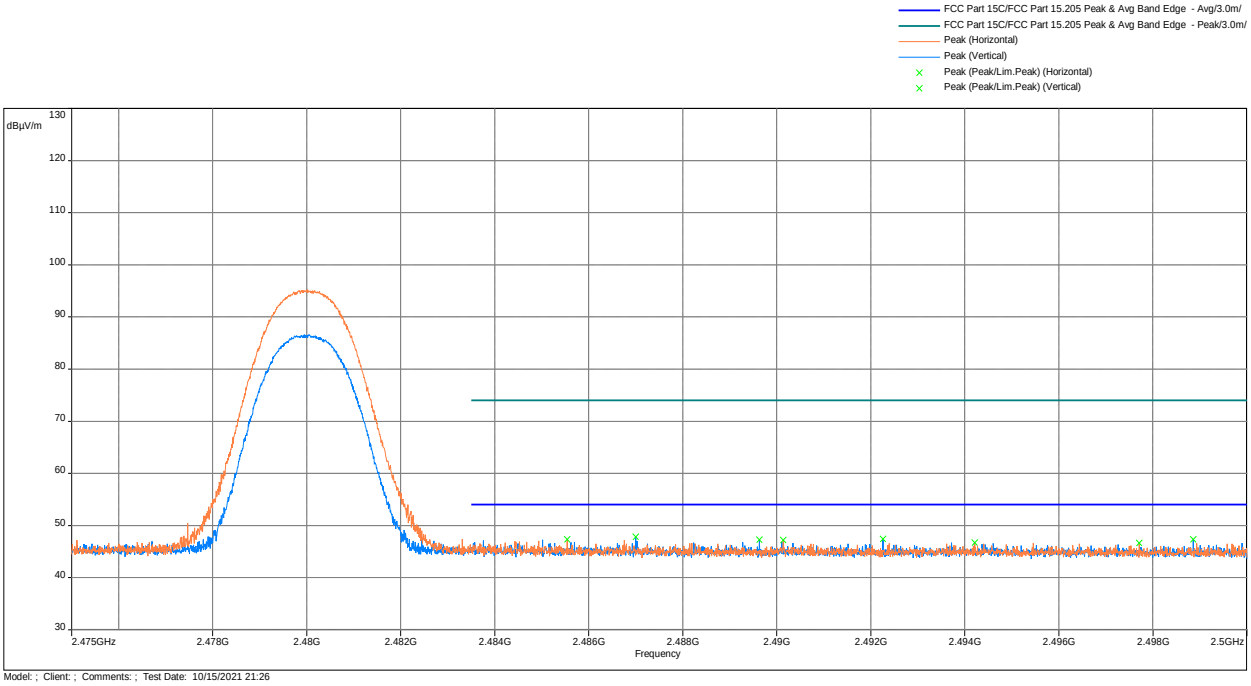
Frequency (MHz)	Peak@3m dB(uV/m)	Ave Limit dB(µV/m)	Margin dB	Height (m)	Angle (°)	Polarity	Correction (dB)
2390.0	47.5	54.0	-6.5	1.5	216.3	Horizontal	21.6
2390.0	46.9	54.0	-7.1	1.5	147.3	Vertical	21.6

Out-of-Band Radiated spurious emissions at the Band-edge @1m distance
2310–2390 MHz, Peak Scan with Peak Limit and Average Limit
8-DPSK, Normal Mode



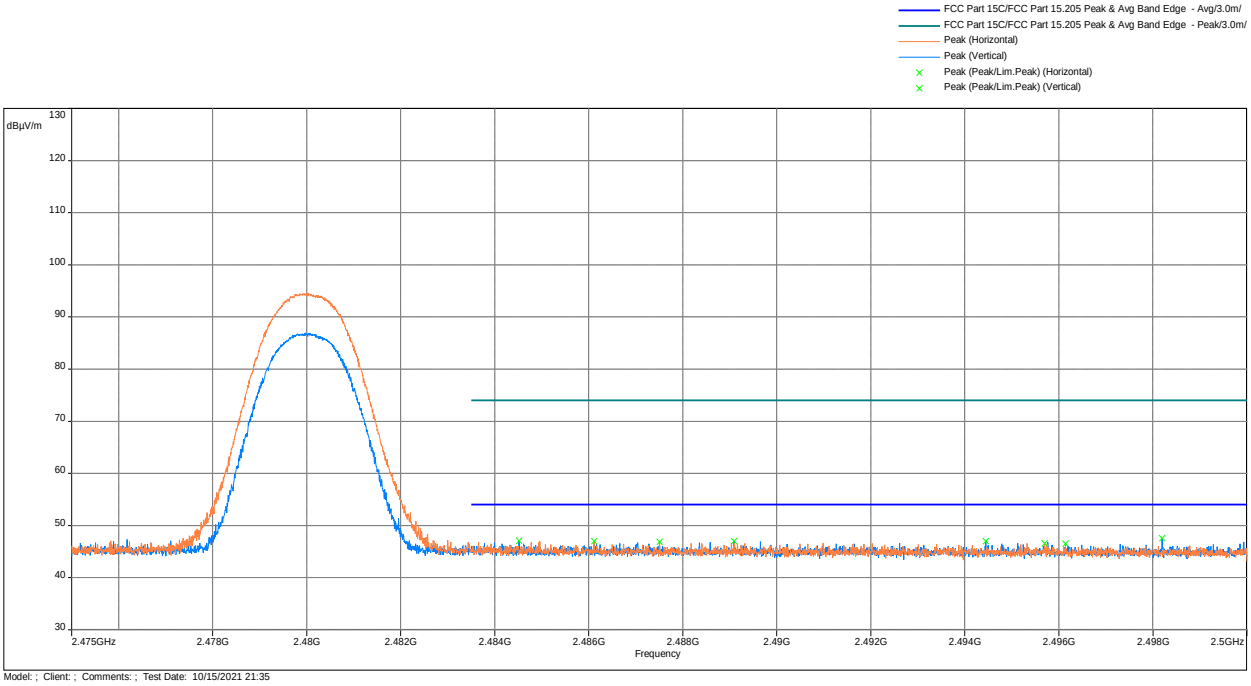
Frequency (MHz)	Peak@3m dB(uV/m)	Ave Limit dB(µV/m)	Margin dB	Height (m)	Angle (°)	Polarity	Correction (dB)
2390.0	46.1	54.0	-7.9	2.0	311.5	Horizontal	21.6
2390.0	46.3	54.0	-7.8	2.0	168.0	Vertical	21.6

Out-of-Band Radiated spurious emissions at the Band-edge @1m distance
2483.5–2500 MHz, Peak Scan with Peak Limit and Average Limit
8-DPSK, Charging Mode



Frequency (MHz)	Peak@3m dB(uV/m)	Ave Limit dB(µV/m)	Margin dB	Height (m)	Angle (°)	Polarity	Correction (dB)
2483.5	46.3	54.0	-7.7	1.5	48.3	Horizontal	22.0
2483.6	46.8	54.0	-7.2	1.5	261.5	Vertical	22.0

Out-of-Band Radiated spurious emissions at the Band-edge @1m distance
2483.5–2500 MHz, Peak Scan with Peak Limit and Average Limit
8-DPSK, Normal Mode



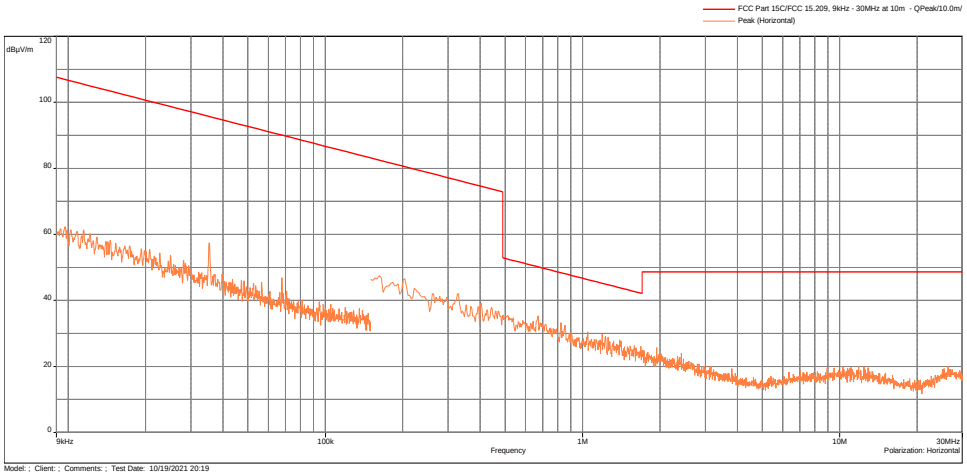
Frequency (MHz)	Peak@3m dB(uV/m)	Ave Limit dB(µV/m)	Margin dB	Height (m)	Angle (°)	Polarity	Correction (dB)
2483.5	46.3	54.0	-7.7	1.5	0.0	Horizontal	22.0
2483.5	46.1	54.0	-7.9	1.5	128.0	Vertical	22.0

Out-of-Band Radiated Spurious Emissions

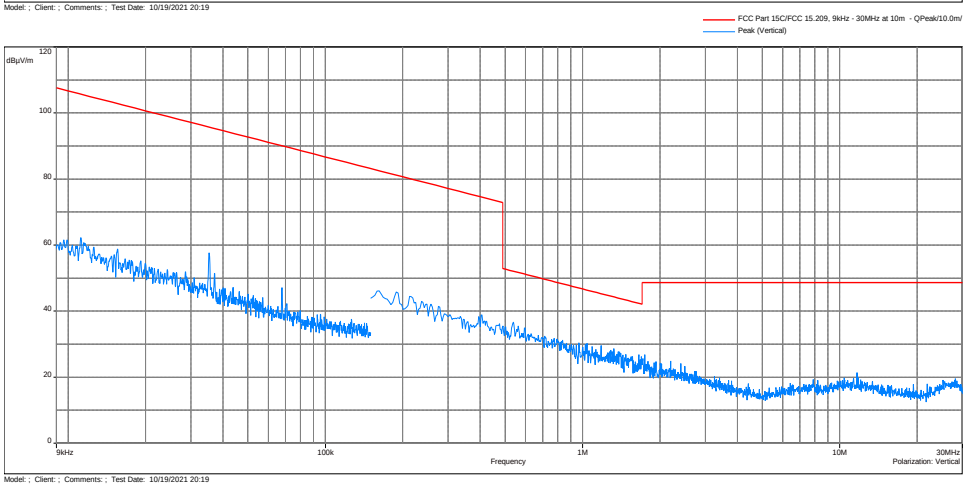
Test Results: 15.209 Radiated Spurious Emissions, GFSK

Radiated Spurious Emissions 9 kHz to 30 MHz, Peak Scan vs QP Limit

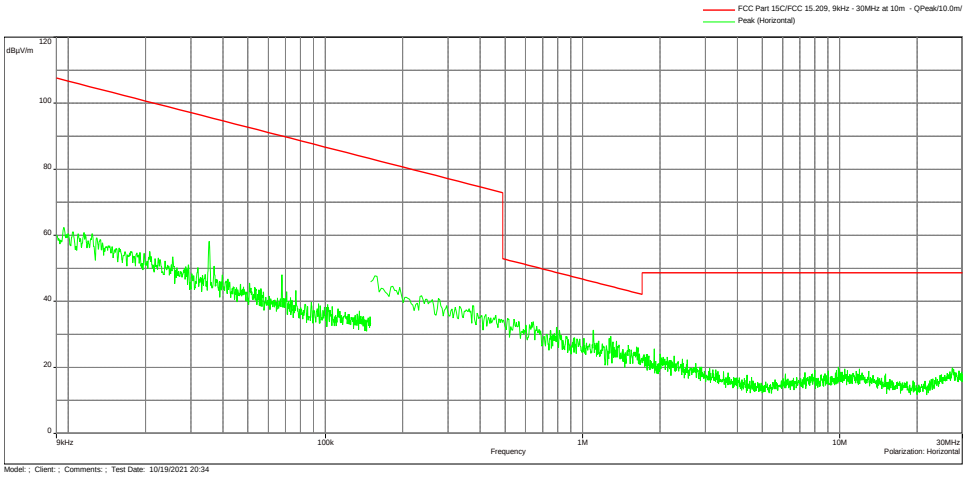
Antenna Position - Coaxial



Antenna Position - Coplanar

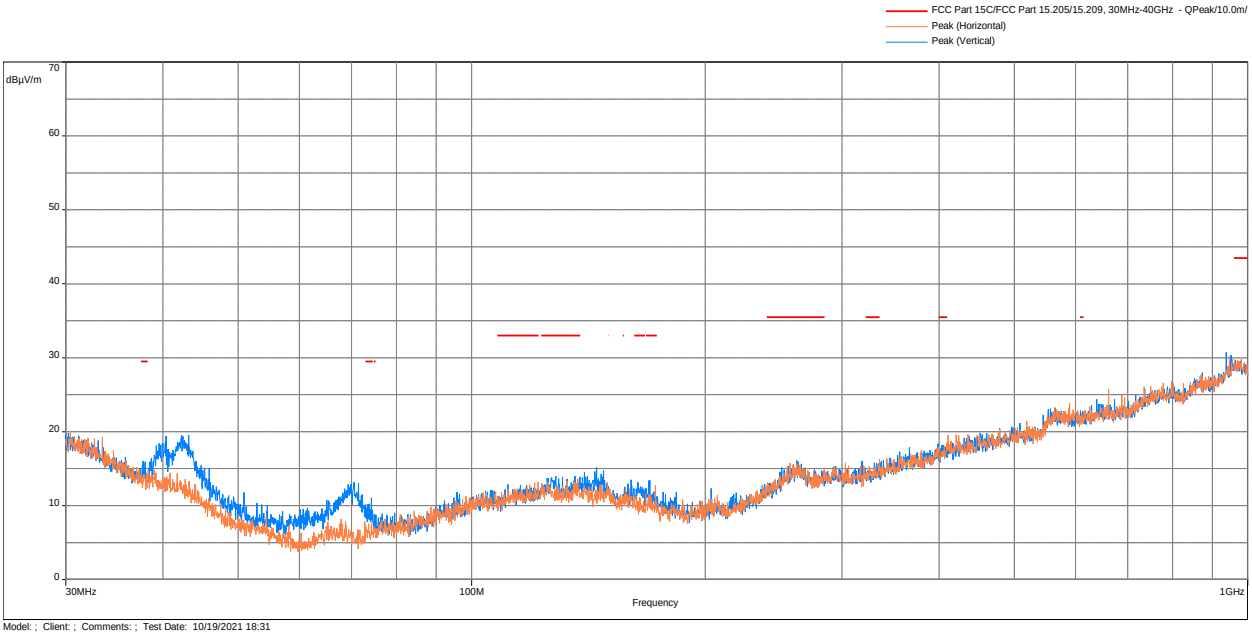


Antenna Position - Horizontal



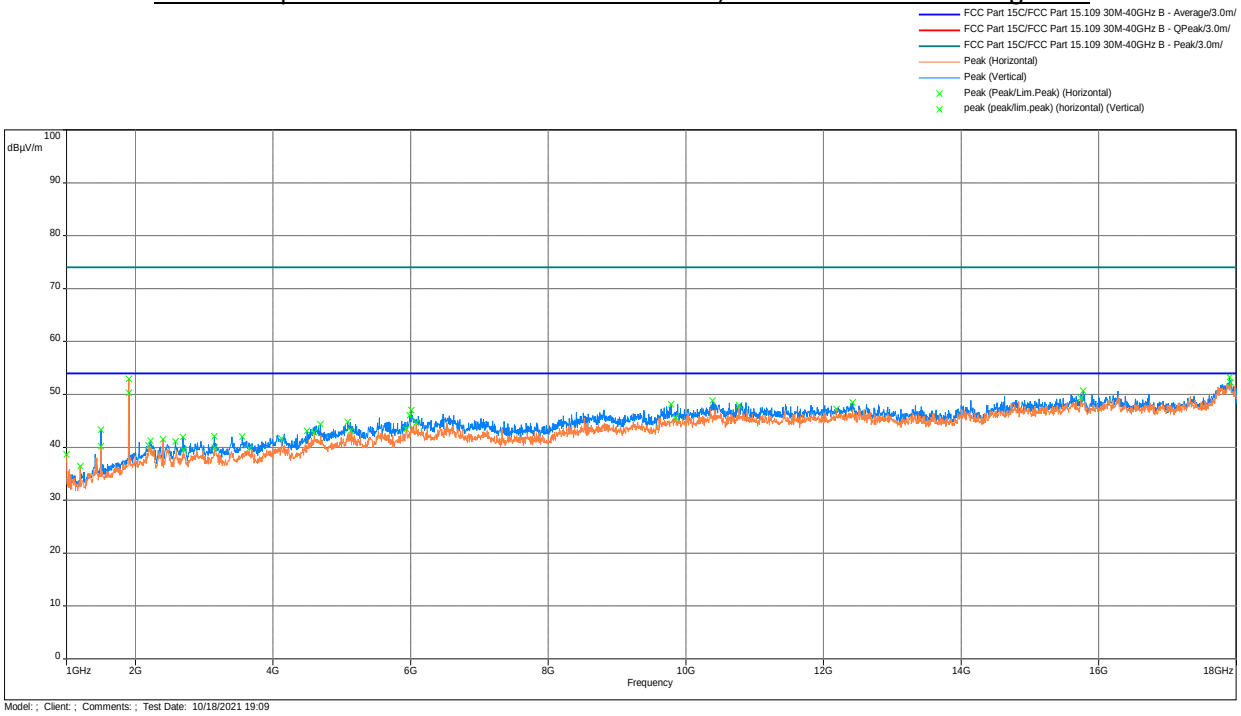
Test Results: Test Results: 15.209 Radiated Spurious Emissions, GFSK Tx at 2402MHz

Out-of-Band Radiated Spurious Emissions - 30 MHz to 1000 MHz



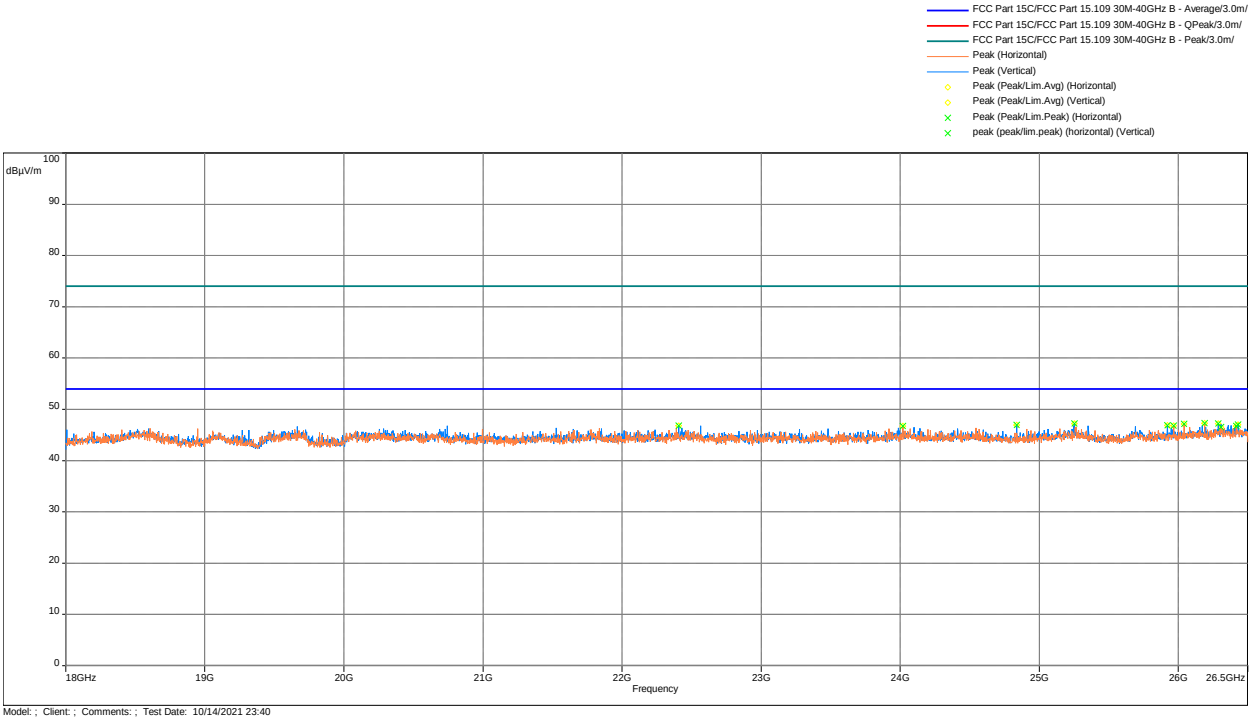
Model: ; Client: ; Comments: ; Test Date: 10/19/2021 18:31

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



Model: ; Client: ; Comments: ; Test Date: 10/18/2021 19:09

Radiated Spurious Emissions 18000 - 26000 MHz, Peak Scan vs Peak & Avg Limit



Frequency (MHz)	QP@10m (dBµV/m)	Limit@10m (dB(uV/m))	Margin (dB)	Height (m)	Azimuth (deg)	Polarity	Correction (dB)
130.9	13.9	33.0	-19.1	1.0	188.8	Vertical	-14.7
962.5	29.7	43.5	-13.8	3.0	49.0	Vertical	4.0

Note: Correction = AF + CF – Preamp

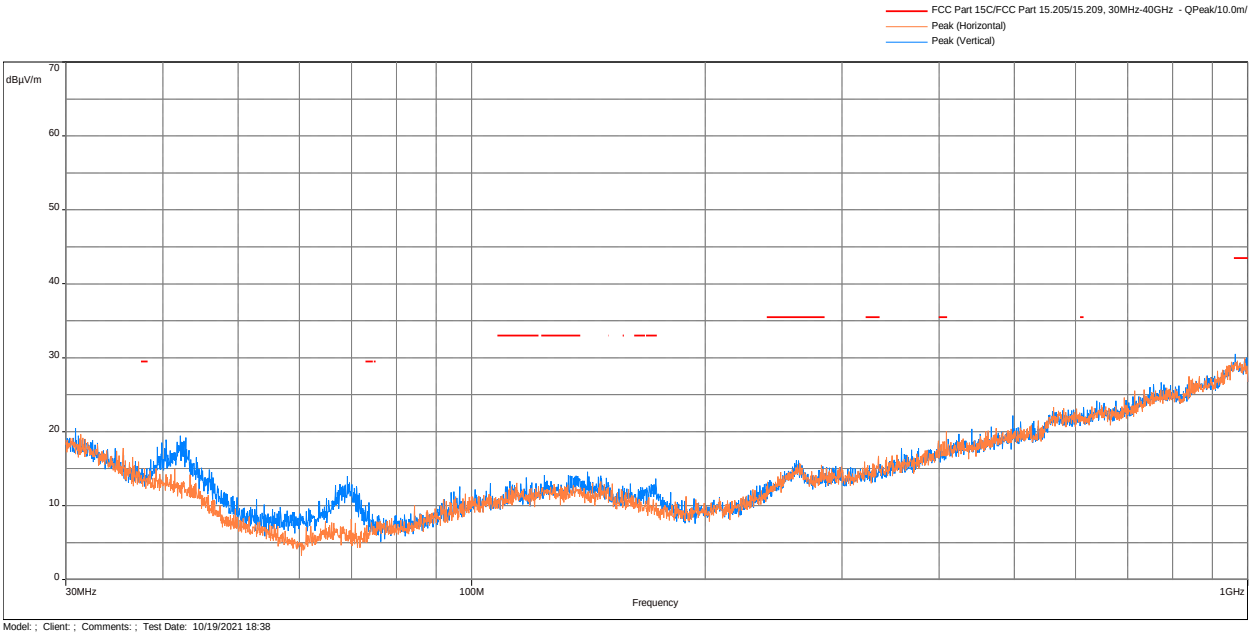
Frequency (MHz)	Peak@3m (dBµV/m)	Av Limit@3m (dB(uV/m))	Margin (dB)	Height (m)	Azimuth (deg)	Polarity	Correction (dB)
1905.0	53.0	54.0	-1.0	2.5	140.0	Horizontal	-11.8
1908.9	50.3	54.0	-3.7	1.5	14.5	Vertical	-11.8
17898.0	53.3	54.0	-0.8	1.5	347.5	Vertical	10.2
17913.3	52.2	54.0	-1.8	3.5	0.0	Horizontal	10.1

Note: Correction = AF + CF - Preamp

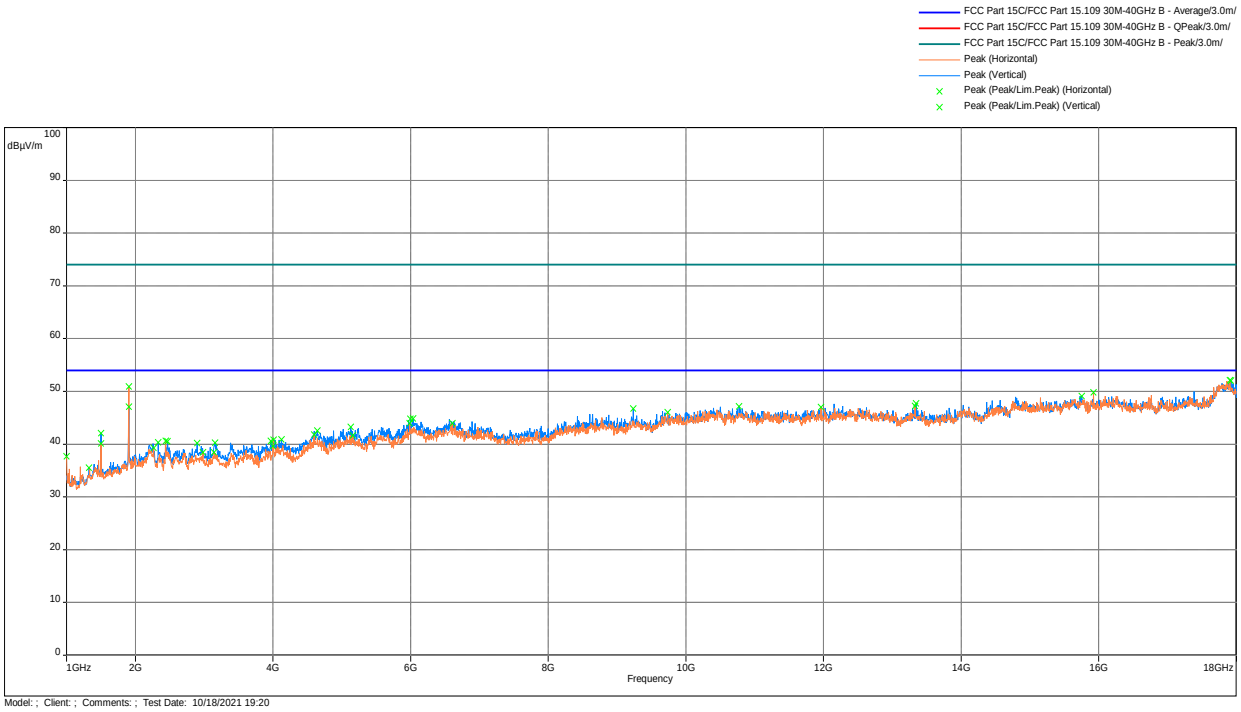
Results	**Complies**

Test Results: Test Results: 15.209 Radiated Spurious Emissions, GFSK Tx at 2441MHz

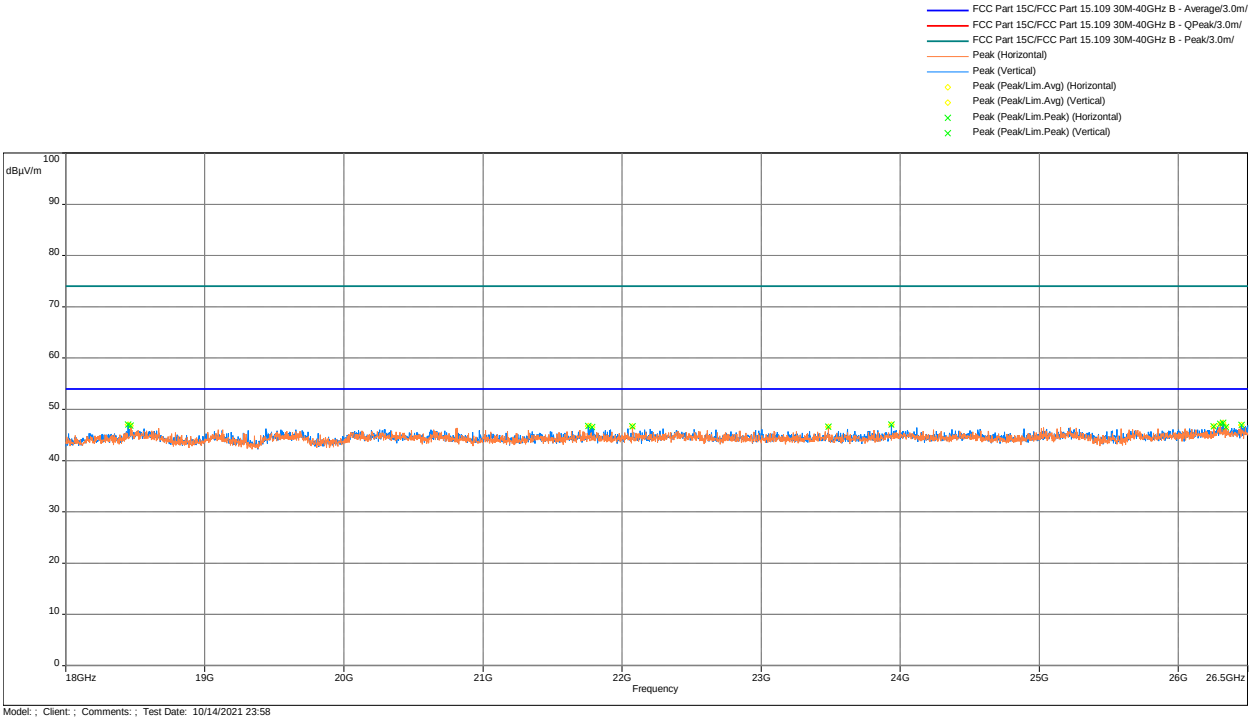
Out-of-Band Radiated Spurious Emissions - 30 MHz to 1000 MHz



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



Radiated Spurious Emissions 18000 - 26000 MHz, Peak Scan vs Peak & Avg Limit



Frequency (MHz)	QP@10m (dBµV/m)	Limit@10m (dB(uV/m))	Margin (dB)	Height (m)	Azimuth (deg)	Polarity	Correction (dB)
124.0	14.1	33.0	-18.9	1.0	83.5	Vertical	-14.6
963.2	30.5	43.5	-13.0	3.0	83.5	Vertical	4.0

Note: Correction = AF + CF – Preamp

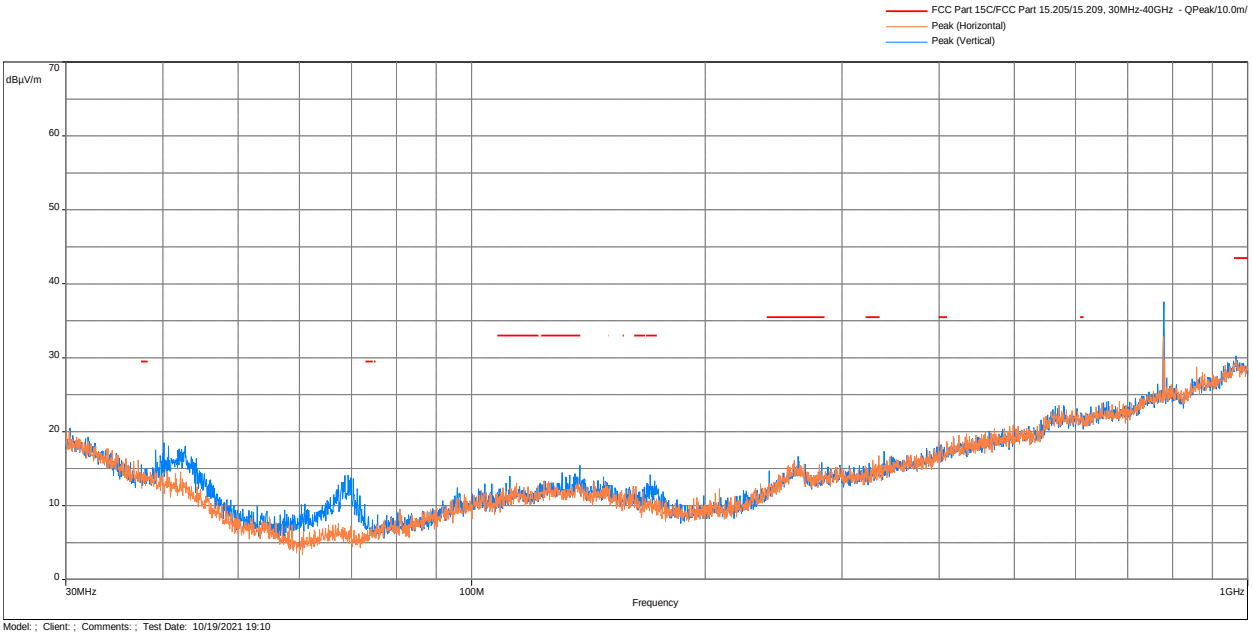
Frequency (MHz)	Peak@3m (dBµV/m)	Av Limit@3m (dB(uV/m))	Margin (dB)	Height (m)	Azimuth (deg)	Polarity	Correction (dB)
1906.1	47.1	54.0	-6.9	3.5	245.0	Vertical	-11.8
1907.2	50.9	54.0	-3.1	1.5	273.0	Horizontal	-11.8
17903.1	52.1	54.0	-1.9	1.5	185.3	Horizontal	10.2
17922.4	52.0	54.0	-2.0	1.5	323.5	Vertical	10.0

Note: Correction = AF + CF – Preamp

Results	**Complies**

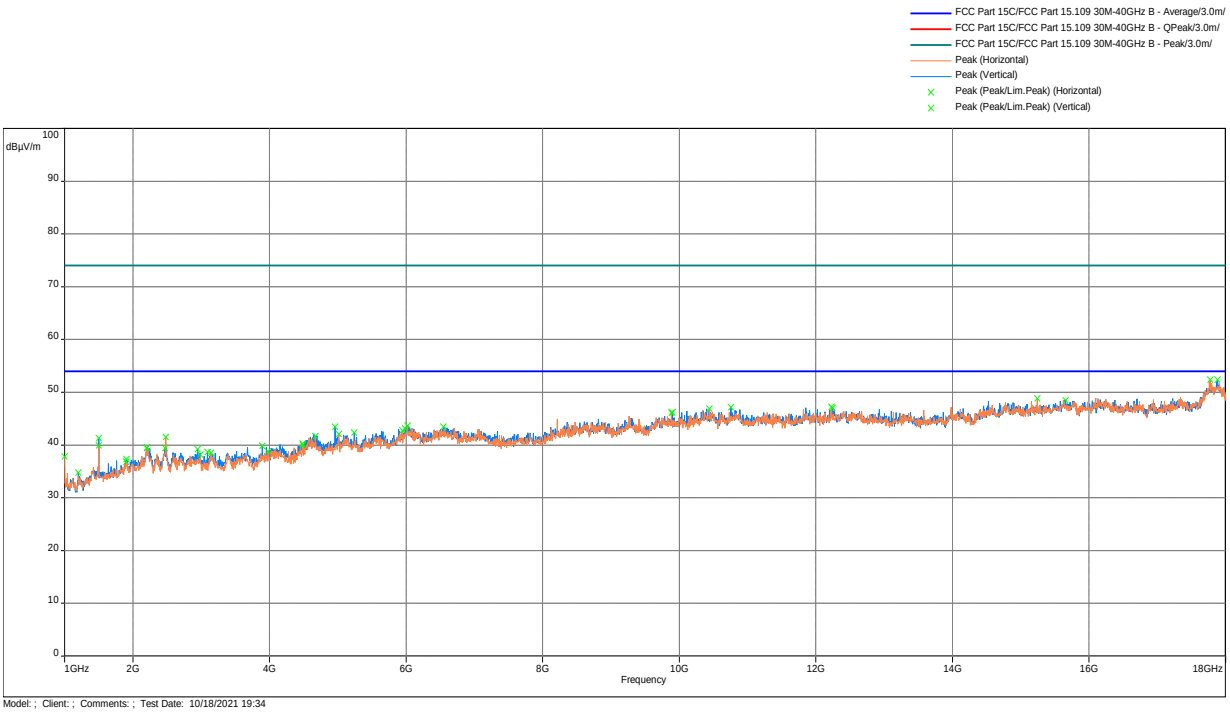
Test Results: Test Results: 15.209 Radiated Spurious Emissions, GFSK Tx at 2480MHz

Out-of-Band Radiated Spurious Emissions - 30 MHz to 1000 MHz



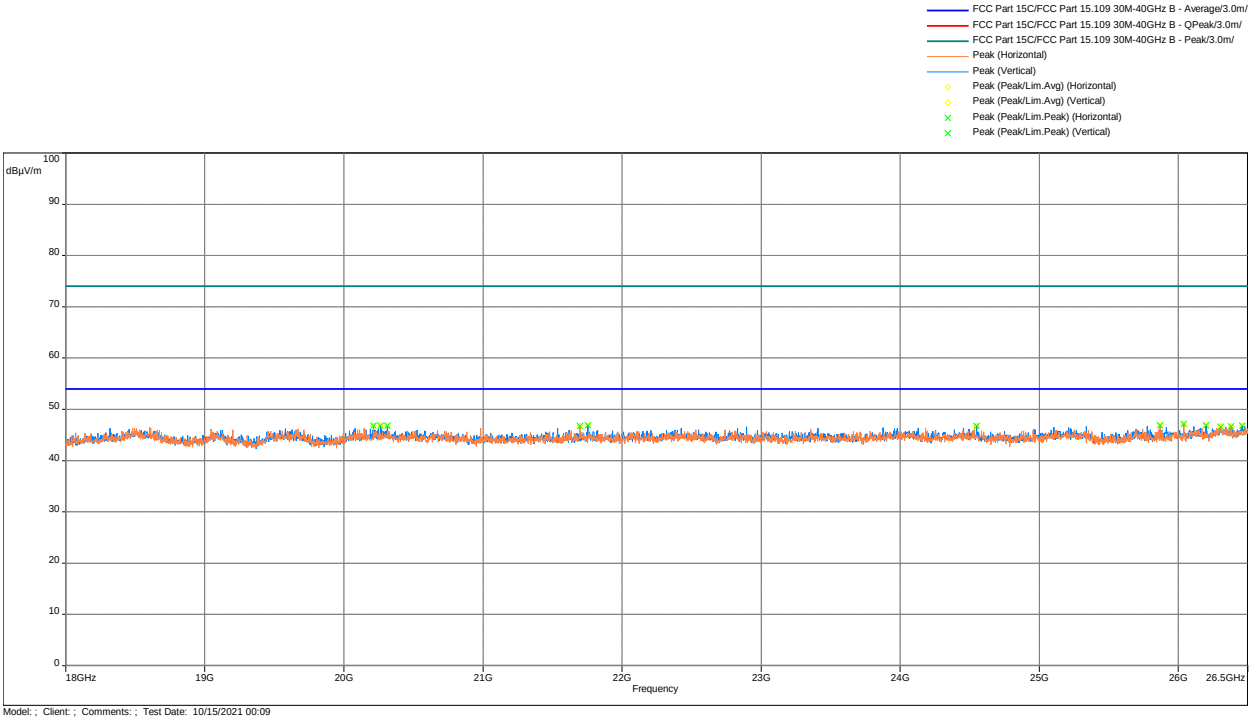
Model: ; Client: ; Comments: ; Test Date: 10/19/2021 19:10

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



Model: ; Client: ; Comments: ; Test Date: 10/18/2021 19:34

Radiated Spurious Emissions 18000 - 26000 MHz, Peak Scan vs Peak & Avg Limit



Frequency (MHz)	QP@10m (dBµV/m)	Limit@10m (dB(uV/m))	Margin (dB)	Height (m)	Azimuth (deg)	Polarity	Correction (dB)
112.1	14.0	33.0	-19.0	3.0	337.8	Vertical	-15.3
966.0	30.3	43.5	-13.2	1.0	359.5	Vertical	4.1

Note: Correction = AF + CF – Preamp

Frequency (MHz)	Peak@3m (dBµV/m)	Av Limit@3m (dB(uV/m))	Margin (dB)	Height (m)	Azimuth (deg)	Polarity	Correction (dB)
1199.5	34.8	54.0	-19.2	2.5	0.0	Vertical	-16.2
1499.8	41.3	54.0	-12.7	2.5	0.0	Vertical	-14.5
1899.9	36.9	54.0	-17.1	1.5	0.0	Horizontal	-11.8
17772.8	52.4	54.0	-1.6	1.5	68.5	Horizontal	10.1
17880.4	52.3	54.0	-1.7	1.5	84.5	Vertical	10.2

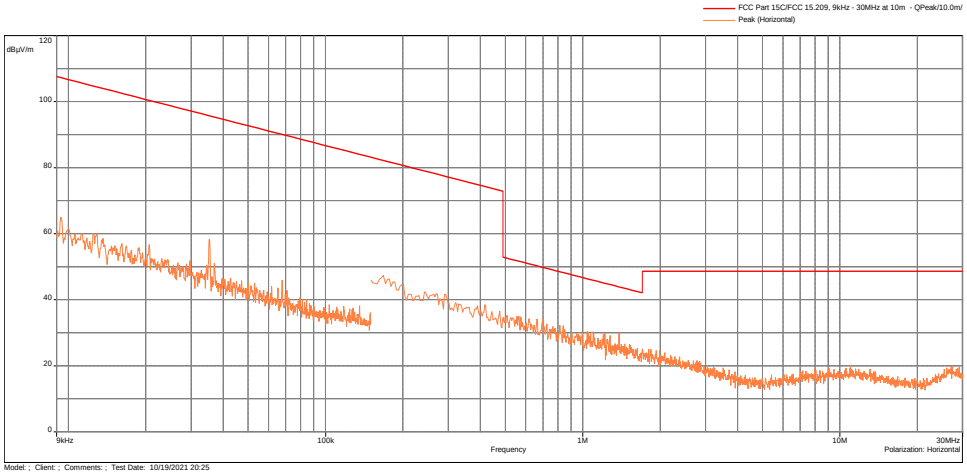
Note: Correction = AF + CF – Preamp

Results	**Complies**

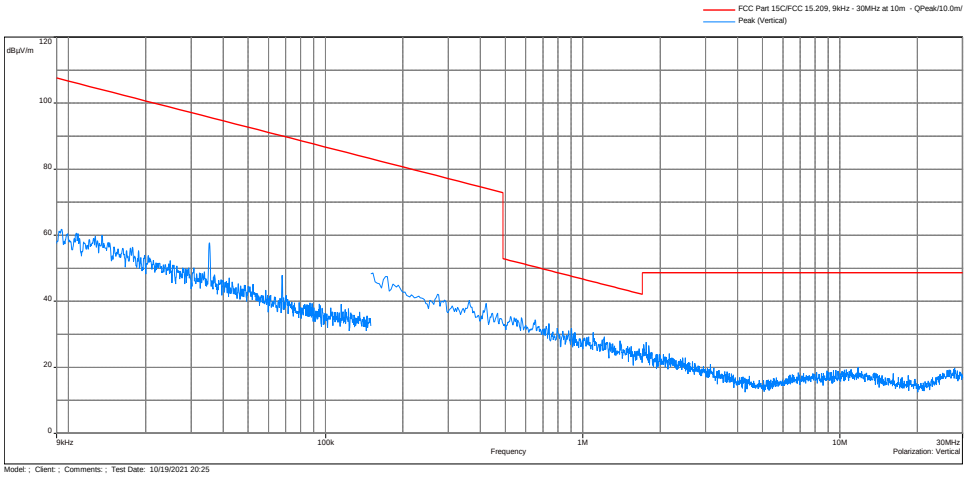
Test Results: 15.209 Radiated Spurious Emissions, π/4-DQPSK

Radiated Spurious Emissions 9 kHz to 30 MHz, Peak Scan vs QP Limit

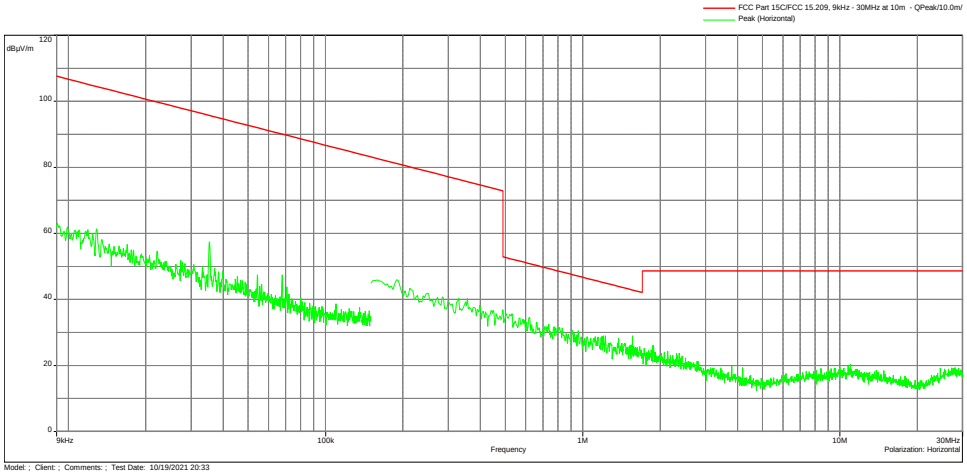
Antenna Position - Coaxial



Antenna Position - Coplanar

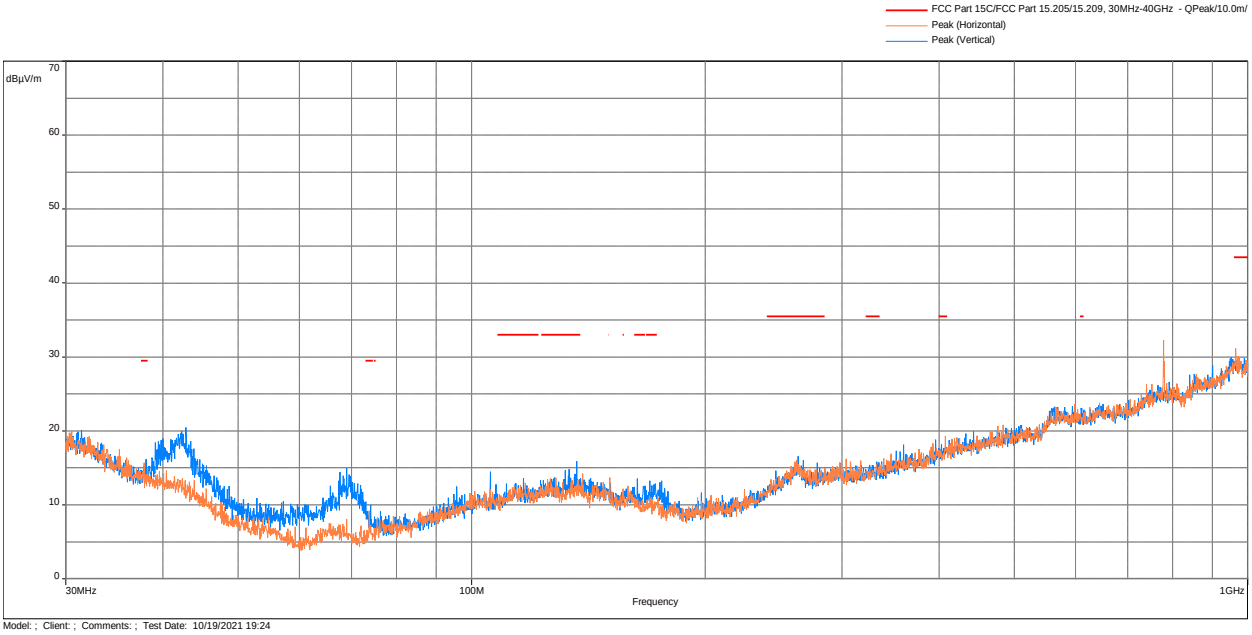


Antenna Position - Horizontal



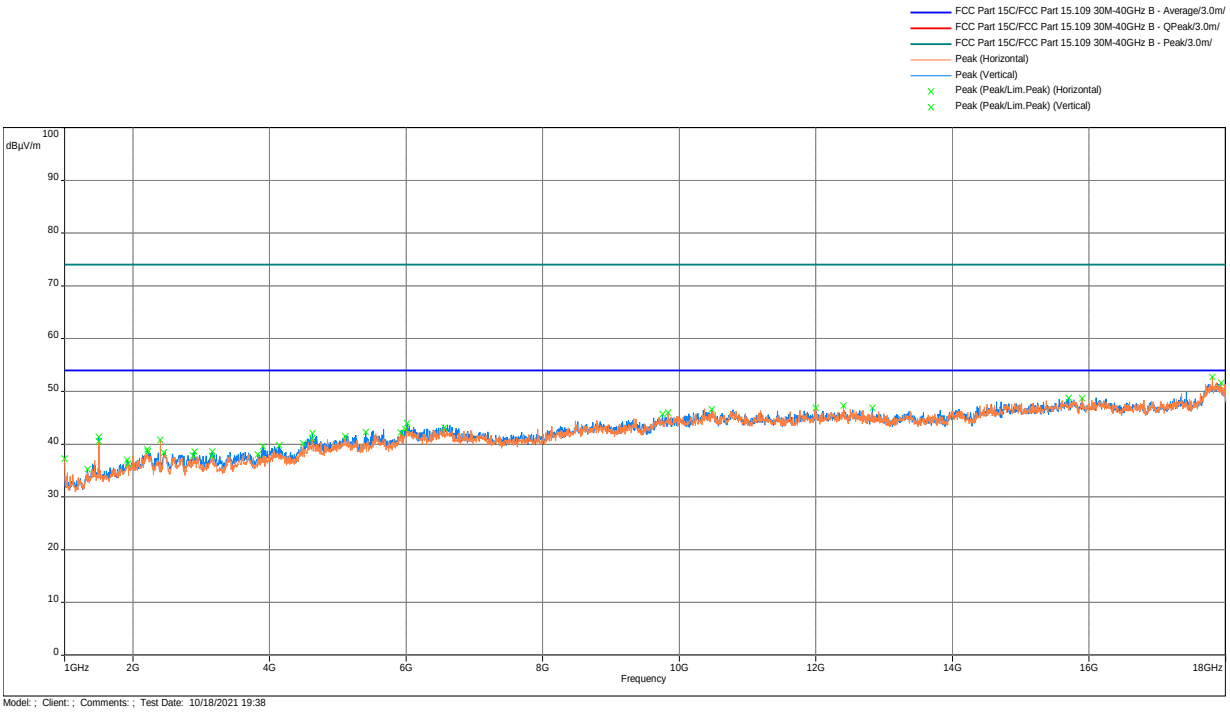
Test Results: Test Results: 15.209 Radiated Spurious Emissions, π/4-DQPSK Tx at 2402MHz

Out-of-Band Radiated Spurious Emissions - 30 MHz to 1000 MHz



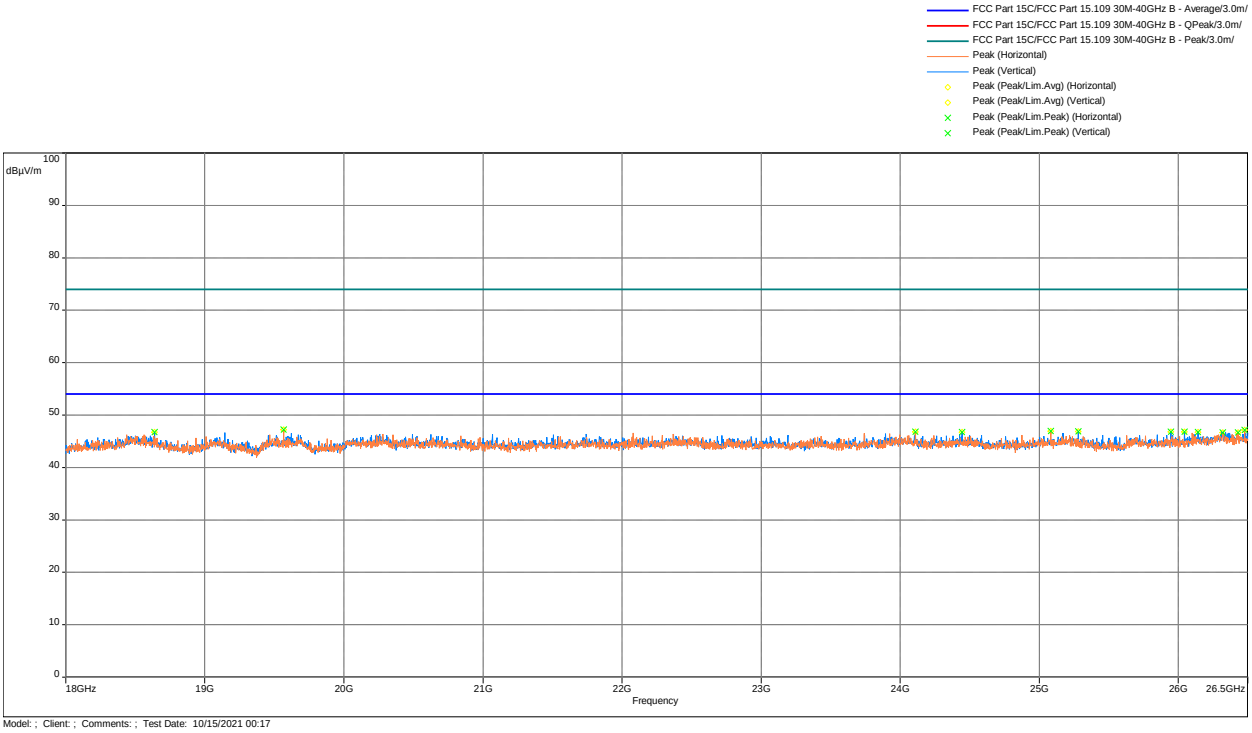
Model: ; Client: ; Comments: ; Test Date: 10/19/2021 19:24

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



Model: ; Client: ; Comments: ; Test Date: 10/18/2021 19:38

Radiated Spurious Emissions 18000 - 26000 MHz, Peak Scan vs Peak & Avg Limit



Frequency (MHz)	QP@10m (dBµV/m)	Limit@10m (dB(uV/m))	Margin (dB)	Height (m)	Azimuth (deg)	Polarity	Correction (dB)
128.4	13.7	33.0	-19.3	4.0	153.0	Horizontal	-14.6
964.7	31.1	43.5	-12.4	3.0	312.0	Horizontal	4.0

Note: Correction = AF + CF – Preamp

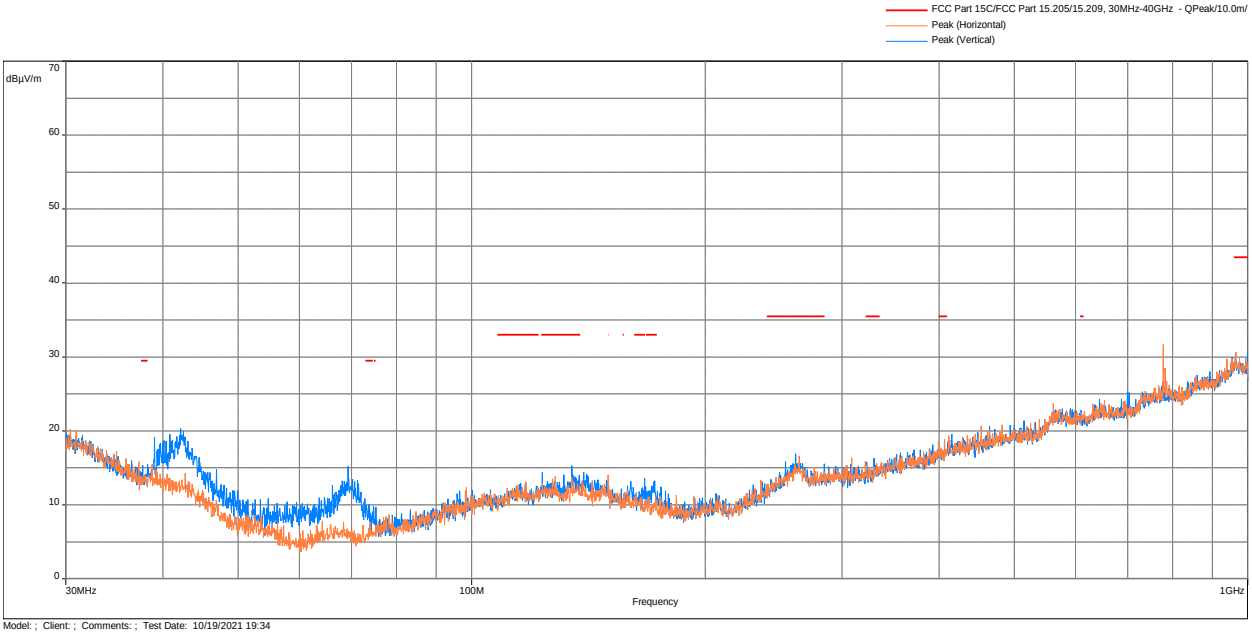
Frequency (MHz)	Peak@3m (dBµV/m)	Av Limit@3m (dB(uV/m))	Margin (dB)	Height (m)	Azimuth (deg)	Polarity	Correction (dB)
1499.8	41.3	54.0	-12.7	1.5	274.8	Vertical	-14.5
1499.8	40.6	54.0	-13.5	1.5	24.3	Horizontal	-14.5
17803.4	52.7	54.0	-1.3	1.5	98.0	Horizontal	10.2
17936.0	51.6	54.0	-2.4	2.5	0.0	Vertical	9.8

Note: Correction = AF + CF – Preamp

Results	**Complies**

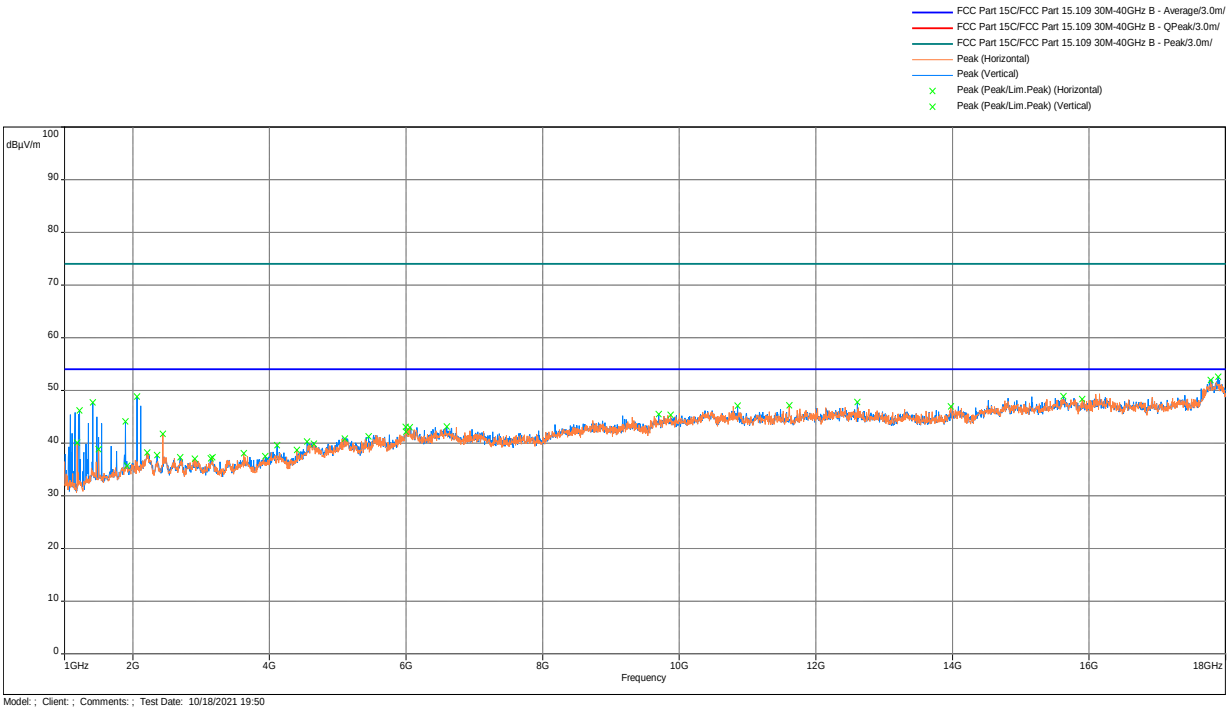
Test Results: Test Results: 15.209 Radiated Spurious Emissions, π/4-DQPSK Tx at 2441MHz

Out-of-Band Radiated Spurious Emissions - 30 MHz to 1000 MHz



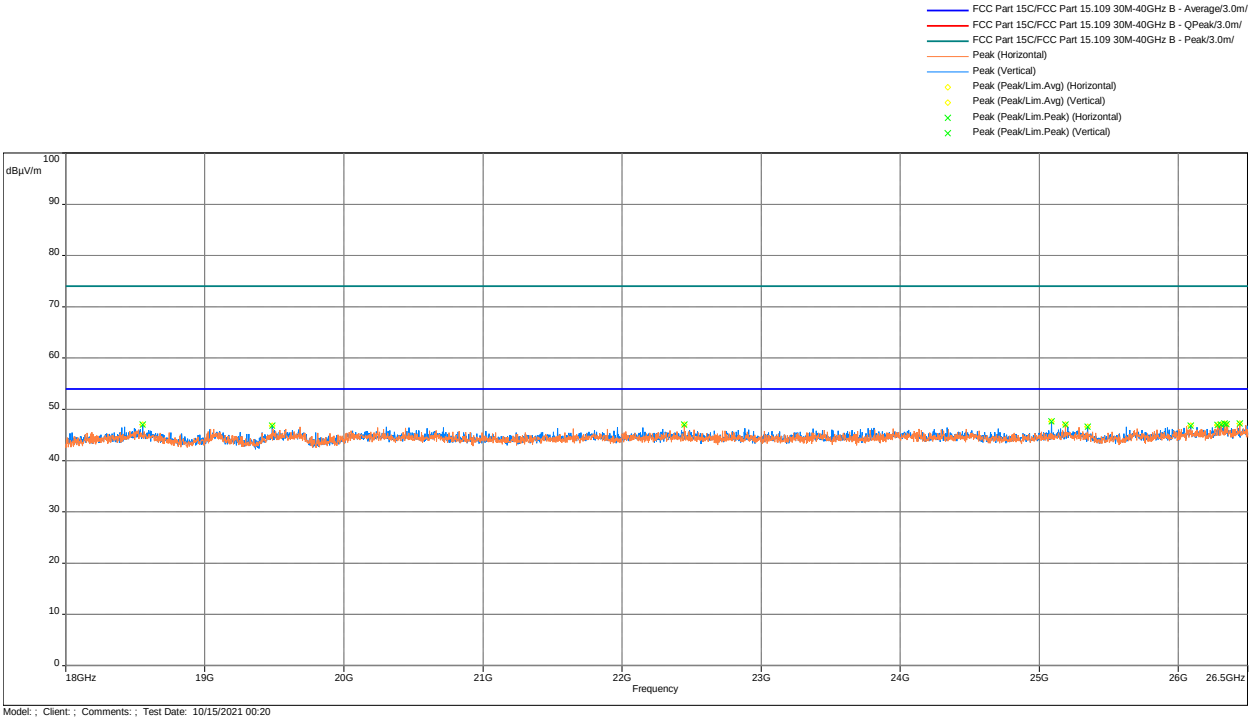
Model: ; Client: ; Comments: ; Test Date: 10/19/2021 19:34

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



Model: ; Client: ; Comments: ; Test Date: 10/18/2021 19:50

Radiated Spurious Emissions 18000 - 26000 MHz, Peak Scan vs Peak & Avg Limit



Frequency (MHz)	QP@10m (dBµV/m)	Limit@10m (dB(uV/m))	Margin (dB)	Height (m)	Azimuth (deg)	Polarity	Correction (dB)
134.6	15.3	33.0	-17.7	1.0	180.0	Vertical	-14.6
965.9	30.7	43.5	-12.8	3.0	48.8	Horizontal	4.1

Note: Correction = AF + CF – Preamp

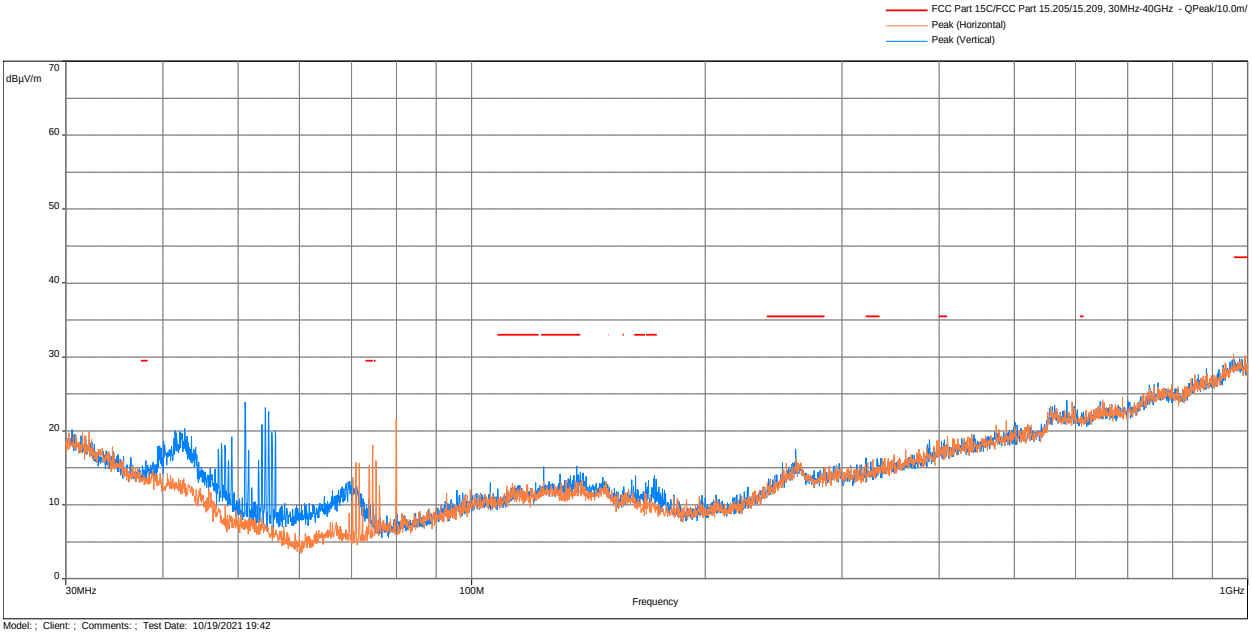
Frequency (MHz)	Peak@3m (dBµV/m)	Av Limit@3m (dB(uV/m))	Margin (dB)	Height (m)	Azimuth (deg)	Polarity	Correction (dB)
1217.6	46.2	54.0	-7.8	1.5	0.0	Vertical	-16.0
1412.0	47.7	54.0	-6.3	1.5	0.0	Vertical	-14.1
2063.1	48.8	54.0	-5.2	2.5	143.0	Vertical	-11.3
17780.7	51.9	54.0	-2.1	1.5	335.3	Horizontal	10.2
17890.6	52.6	54.0	-1.4	2.5	24.5	Vertical	10.2

Note: Correction = AF + CF – Preamp

Results	**Complies**

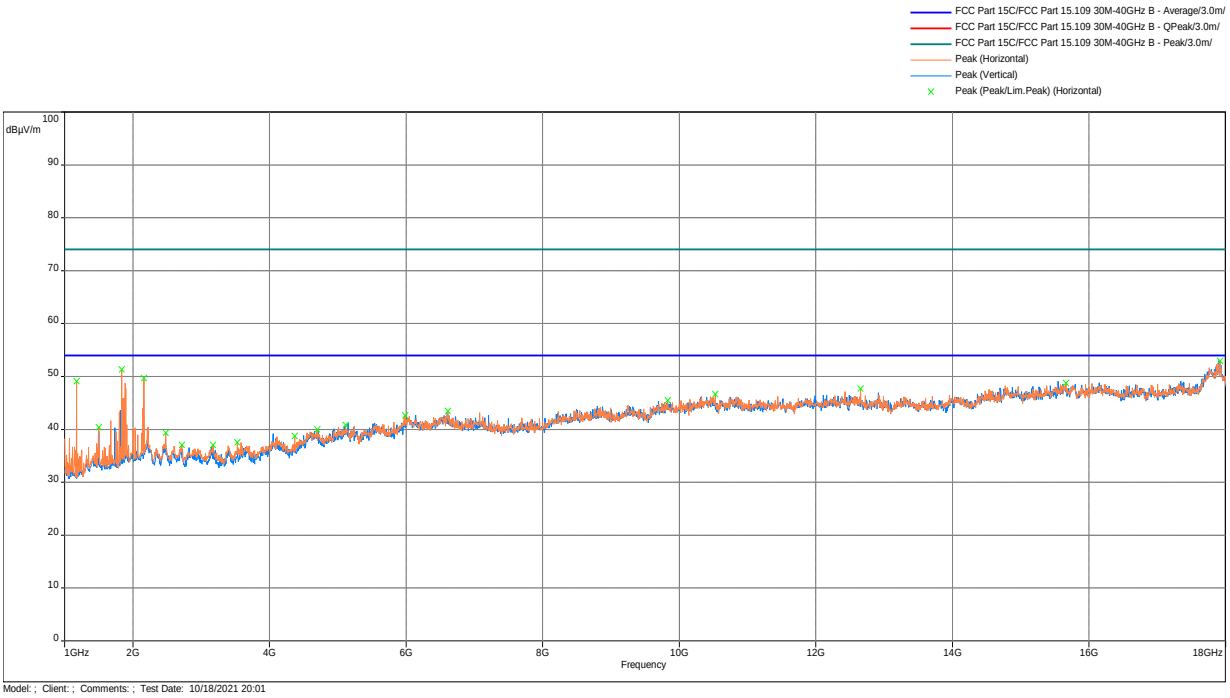
Test Results: Test Results: 15.209 Radiated Spurious Emissions, π/4-DQPSK Tx at 2480MHz

Out-of-Band Radiated Spurious Emissions - 30 MHz to 1000 MHz



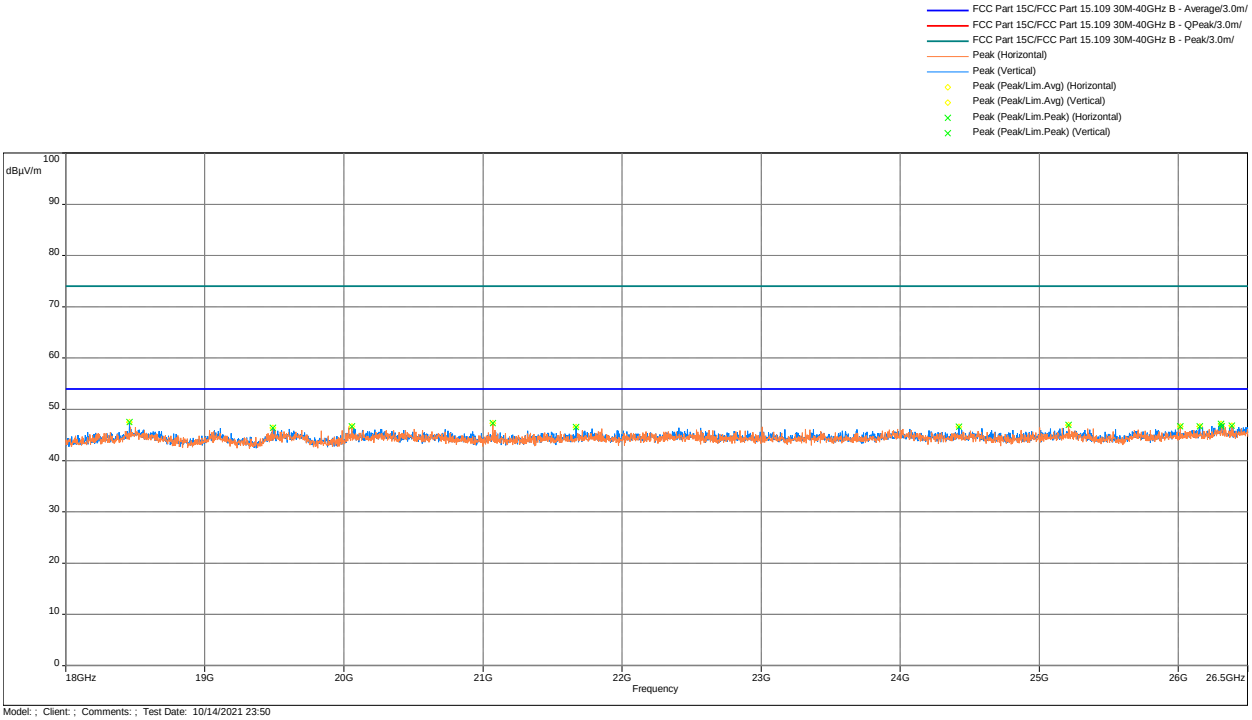
Model: ; Client: ; Comments: ; Test Date: 10/19/2021 19:42

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



Model: ; Client: ; Comments: ; Test Date: 10/18/2021 20:01

Radiated Spurious Emissions 18000 - 26000 MHz, Peak Scan vs Peak & Avg Limit



Frequency (MHz)	QP@10m (dBµV/m)	Limit@10m (dB(uV/m))	Margin (dB)	Height (m)	Azimuth (deg)	Polarity	Correction (dB)
74.6	18.1	29.5	-11.4	2.0	293.8	Horizontal	-19.9
123.8	15.2	33.0	-17.8	3.0	8.3	Vertical	-14.6

Note: Correction = AF + CF – Preamp

Frequency (MHz)	Peak@3m (dBµV/m)	Av Limit@3m (dB(uV/m))	Margin (dB)	Height (m)	Azimuth (deg)	Polarity	Correction (dB)
1175.7	49.1	54.0	-4.9	2.5	70.5	Horizontal	-16.2
1834.7	51.4	54.0	-2.6	1.5	101.5	Horizontal	-12.7
2162.8	49.7	54.0	-4.4	1.5	101.5	Horizontal	-10.1
17919.0	53.0	54.0	-1.1	2.5	98.8	Horizontal	10.0

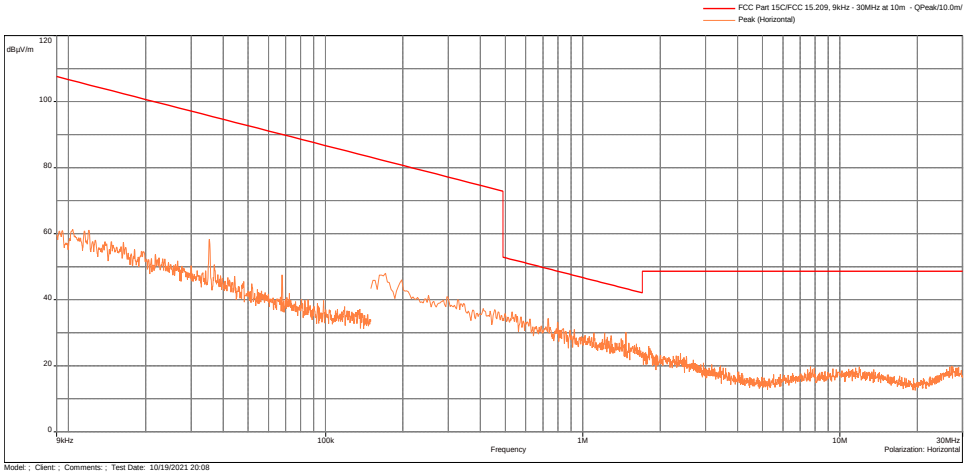
Note: Correction = AF + CF – Preamp

Results	**Complies**

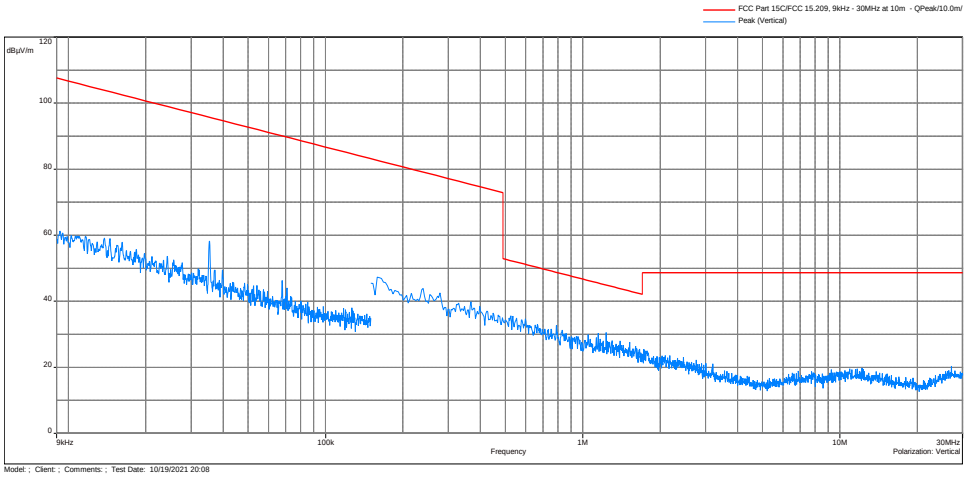
Test Results: 15.209 Radiated Spurious Emissions, 8-DPSK

Radiated Spurious Emissions 9 kHz to 30 MHz, Peak Scan vs QP Limit

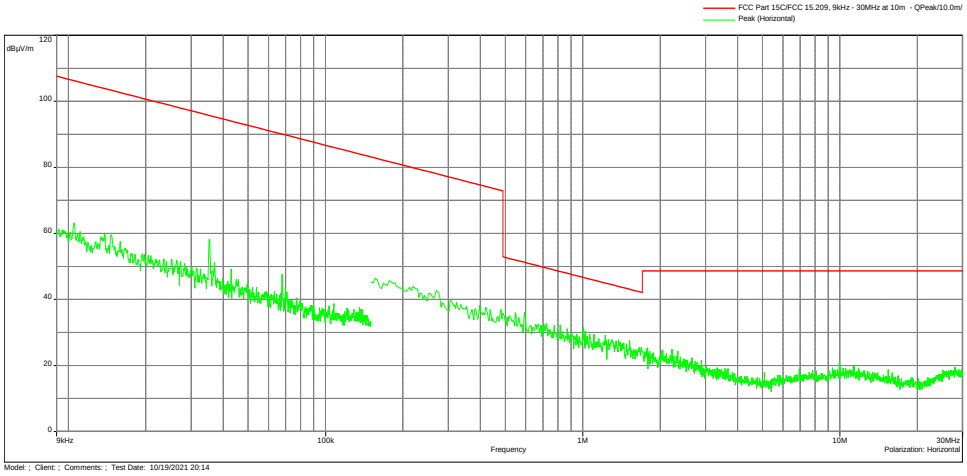
Antenna Position - Coaxial



Antenna Position - Coplanar

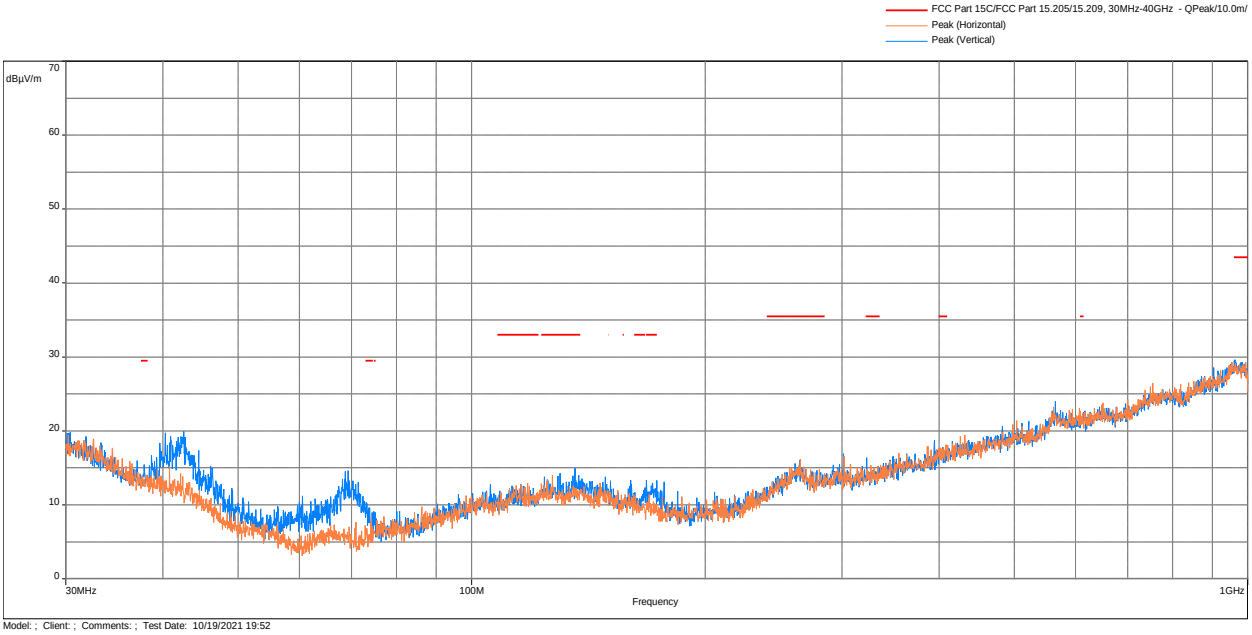


Antenna Position - Horizontal



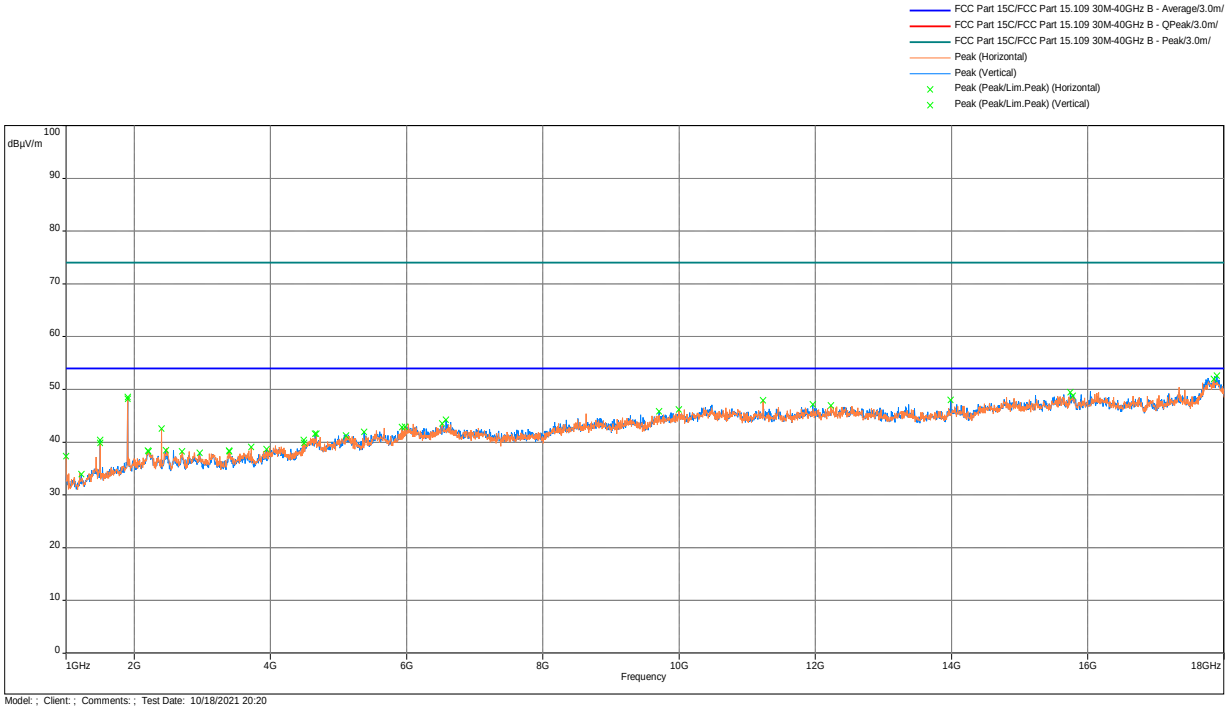
Test Results: Test Results: 15.209 Radiated Spurious Emissions, 8-DPSK Tx at 2402MHz

Out-of-Band Radiated Spurious Emissions - 30 MHz to 1000 MHz



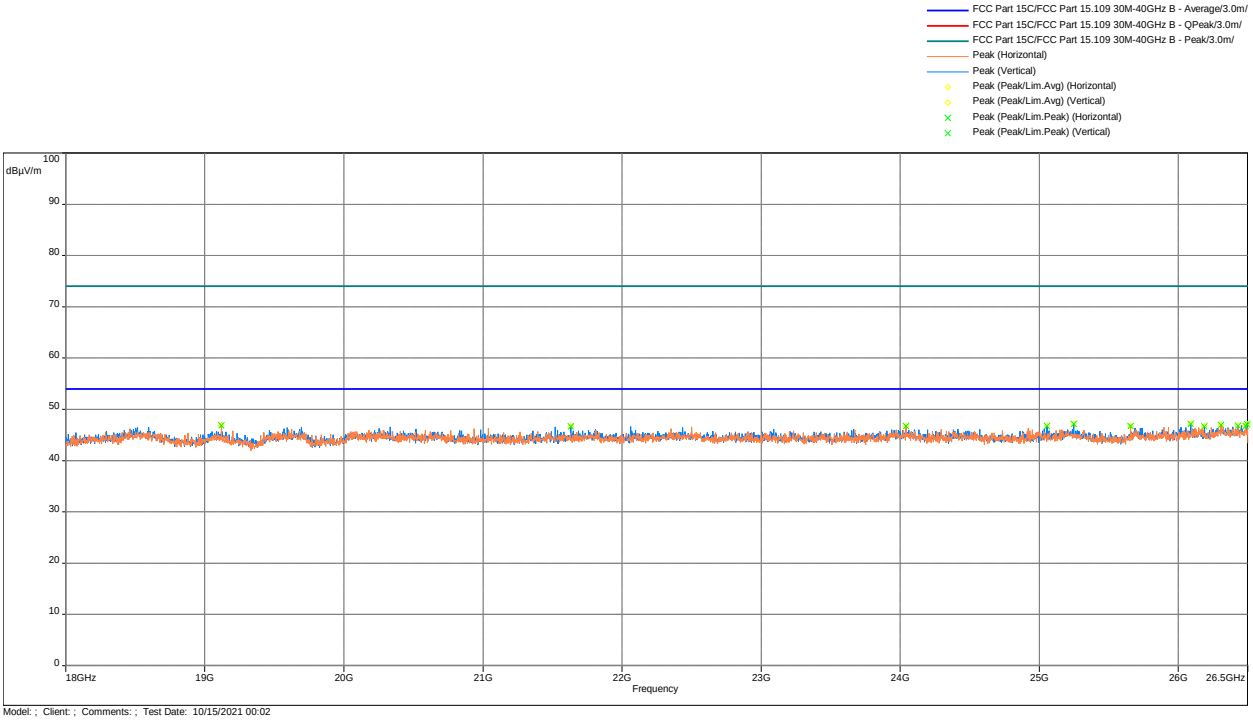
Model: ; Client: ; Comments: ; Test Date: 10/19/2021 19:52

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



Model: ; Client: ; Comments: ; Test Date: 10/18/2021 20:20

Radiated Spurious Emissions 18000 - 26000 MHz, Peak Scan vs Peak & Avg Limit



Frequency (MHz)	QP@10m (dBµV/m)	Limit@10m (dB(uV/m))	Margin (dB)	Height (m)	Azimuth (deg)	Polarity	Correction (dB)
264.5	16.0	35.5	-19.5	2.0	353.5	Vertical	-11.3
962.8	29.6	43.5	-13.9	2.0	48.8	Vertical	4.0

Note: Correction = AF + CF – Preamp

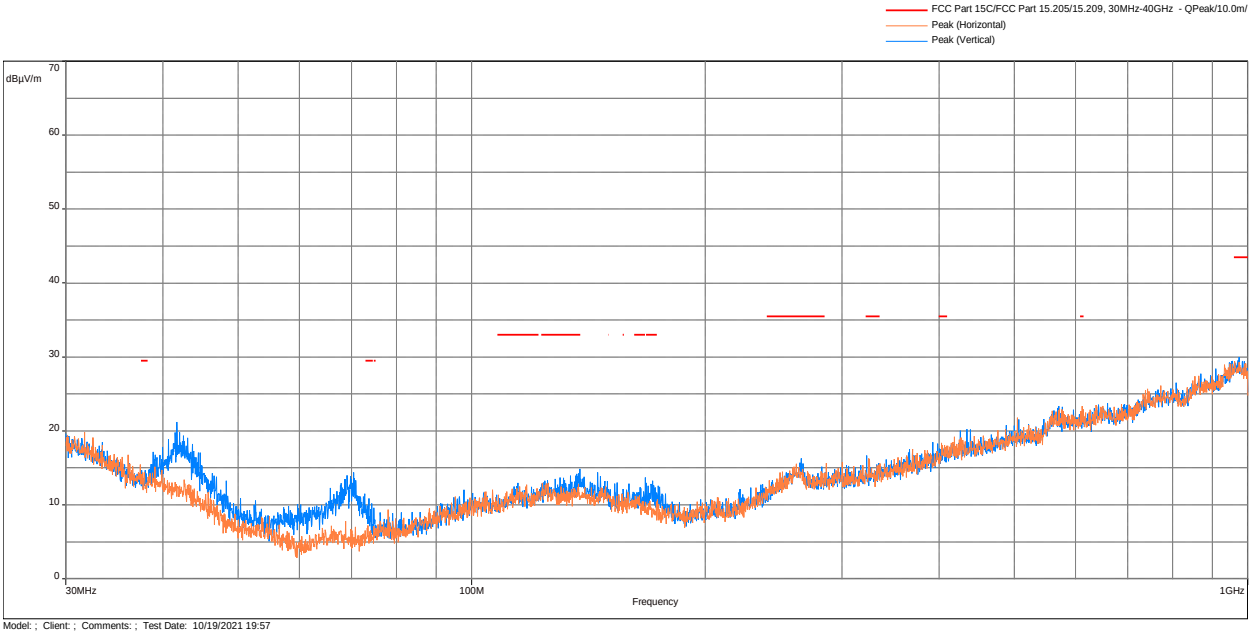
Frequency (MHz)	Peak@3m (dBµV/m)	Av Limit@3m (dB(uV/m))	Margin (dB)	Height (m)	Azimuth (deg)	Polarity	Correction (dB)
1905.5	48.6	54.0	-5.5	2.5	61.0	Horizontal	-11.8
1907.8	48.2	54.0	-5.8	1.5	0.0	Vertical	-11.8
17847.6	51.9	54.0	-2.1	2.5	158.3	Horizontal	10.1
17897.4	52.6	54.0	-1.5	1.5	253.0	Vertical	10.2

Note: Correction = AF + CF – Preamp

Results	**Complies**

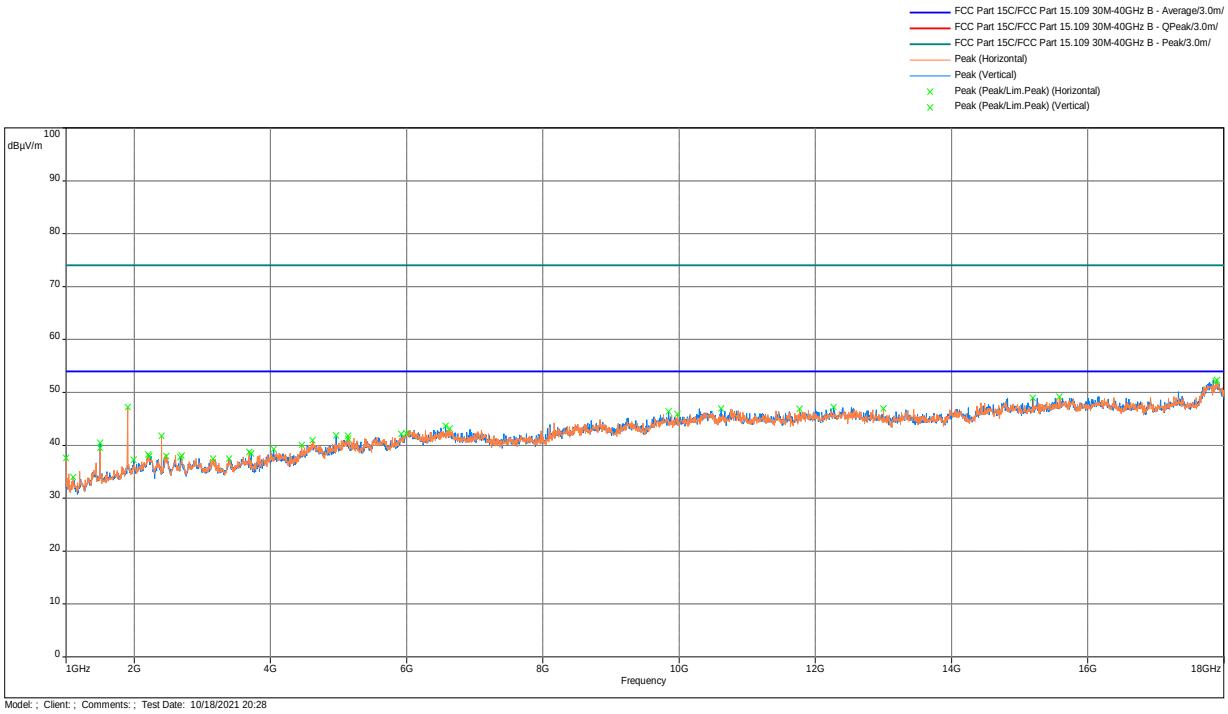
Test Results: Test Results: 15.209 Radiated Spurious Emissions, 8-DPSK Tx at 2441MHz

Out-of-Band Radiated Spurious Emissions - 30 MHz to 1000 MHz



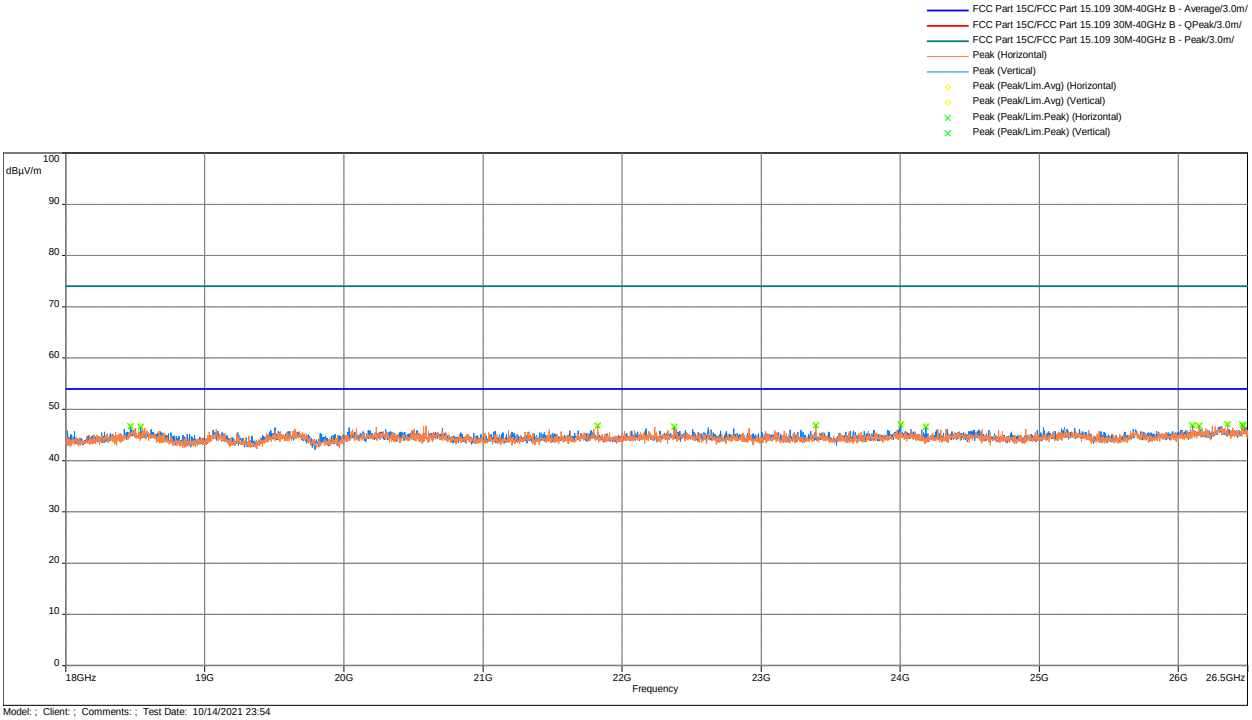
Model: ; Client: ; Comments: ; Test Date: 10/19/2021 19:57

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



Model: ; Client: ; Comments: ; Test Date: 10/18/2021 20:28

Radiated Spurious Emissions 18000 - 26000 MHz, Peak Scan vs Peak & Avg Limit



Frequency (MHz)	QP@10m (dBµV/m)	Limit@10m (dB(uV/m))	Margin (dB)	Height (m)	Azimuth (deg)	Polarity	Correction (dB)
137.8	14.9	33.0	-18.1	2.0	241.5	Vertical	-14.7
974.9	30.0	43.5	-13.5	2.0	303.3	Vertical	3.8

Note: Correction = AF + CF – Preamp

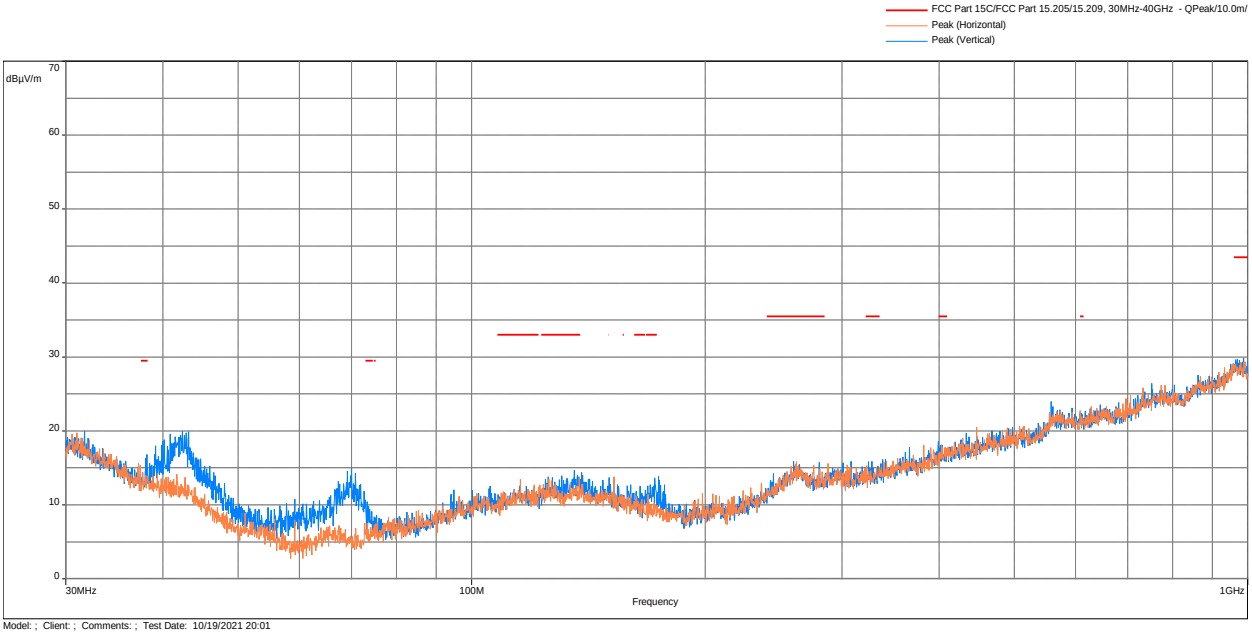
Frequency (MHz)	Peak@3m (dBµV/m)	Av Limit@3m (dB(uV/m))	Margin (dB)	Height (m)	Azimuth (deg)	Polarity	Correction (dB)
1499.8	40.5	54.0	-13.6	1.5	90.8	Vertical	-14.5
1907.8	47.2	54.0	-6.8	1.5	359.5	Horizontal	-11.8
15580.9	49.2	54.0	-4.8	1.5	85.5	Horizontal	5.5
17873.6	52.1	54.0	-1.9	1.5	204.0	Horizontal	10.3
17895.7	52.3	54.0	-1.7	1.5	260.0	Vertical	10.2

Note: Correction = AF + CF – Preamp

Results	**Complies**

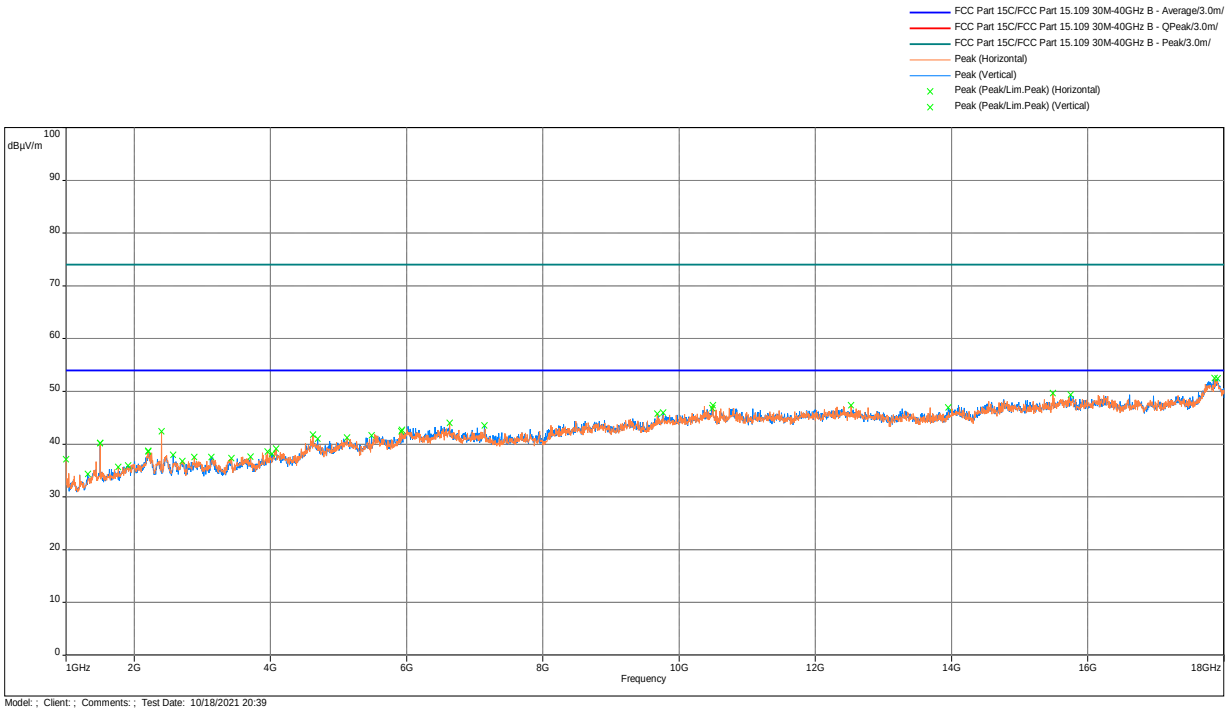
Test Results: Test Results: 15.209 Radiated Spurious Emissions, 8-DPSK Tx at 2480MHz

Out-of-Band Radiated Spurious Emissions - 30 MHz to 1000 MHz



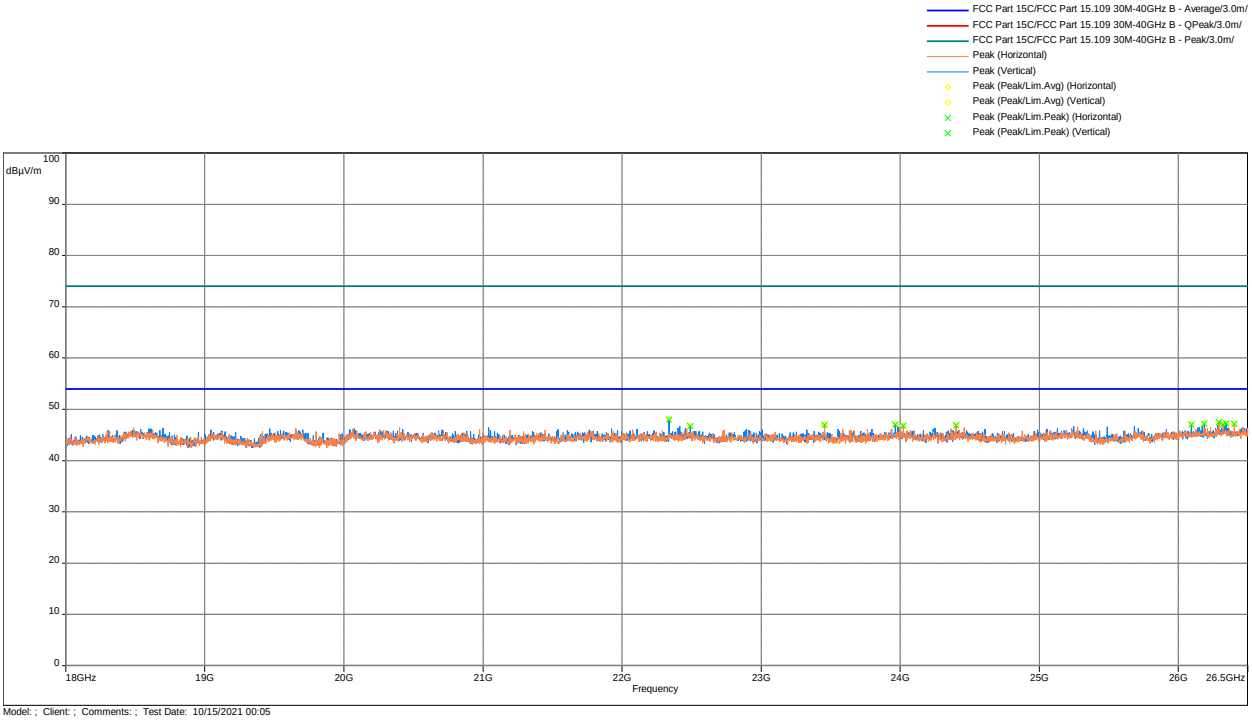
Model: ; Client: ; Comments: ; Test Date: 10/19/2021 20:01

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



Model: ; Client: ; Comments: ; Test Date: 10/18/2021 20:39

Radiated Spurious Emissions 18000 - 26000 MHz, Peak Scan vs Peak & Avg Limit



Frequency (MHz)	QP@10m (dBµV/m)	Limit@10m (dB(uV/m))	Margin (dB)	Height (m)	Azimuth (deg)	Polarity	Correction (dB)
115.5	13.5	33.0	-19.5	2.0	197.8	Horizontal	-15.0
125.8	13.6	33.0	-19.5	2.0	171.0	Horizontal	-14.6

Note: Correction = AF + CF – Preamp

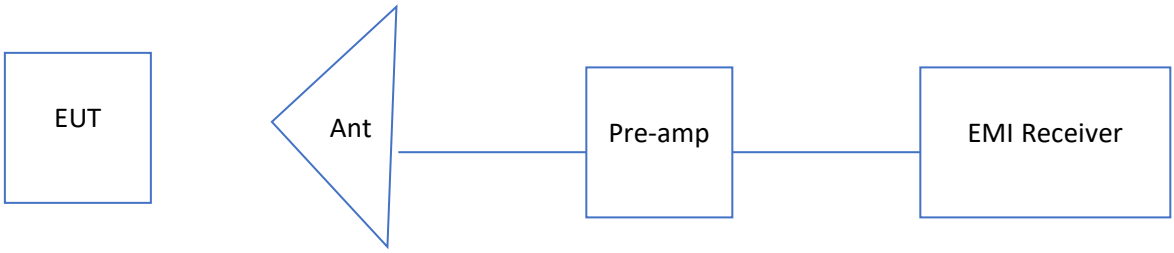
Frequency (MHz)	Peak@3m (dBµV/m)	Av Limit@3m (dB(uV/m))	Margin (dB)	Height (m)	Azimuth (deg)	Polarity	Correction (dB)
1499.8	40.2	54.0	-13.8	1.5	0.0	Vertical	-14.5
1499.8	40.2	54.0	-13.8	1.5	0.0	Horizontal	-14.5
17861.2	52.5	54.0	-1.5	2.5	238.8	Horizontal	10.2
17906.5	52.5	54.0	-1.5	1.5	124.8	Vertical	10.1

Note: Correction = AF + CF – Preamp

Results	**Complies**

4.7.7 Test Setup Photographs

The following photographs show the testing configurations used.



4.8 AC Line Conducted Emission
FCC: 15.207; RSS-GEN

4.8.1 Requirement

Frequency Band MHz	FCC Part 15.207 Limits	
	Quasi-Peak	Average
0.15-0.50	66 to 56 *	56 to 46 *
0.50-5.00	56	46
5.00-30.00	60	50

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

4.8.2 Procedure

Measurements are carried out using quasi-peak and average detector receivers in accordance with CISPR 16. An AMN is required to provide a defined impedance at high frequencies across the power feed at the point of measurement of terminal voltage and also to provide isolation of the circuit under test from the ambient noise on the power lines. An AMN as defined in CISPR 16 shall be used.

The EUT is located so that the distance between the boundary of the EUT and the closest surface of the AMN is 0.8m.

Where a flexible mains cord is provided by the manufacturer, this shall be 1m long or if in excess of 1m, the excess cable is folded back and forth as far as possible so as to form a bundle not exceeding 0.4m in length.

The EUT is arranged and connected with cables terminated in accordance with the product specification.

Conducted disturbance is measured between the phase lead and the reference ground, and between the neutral lead and the reference ground. Both measured values are reported.

The EUT, where intended for tabletop use, is placed on a table whose top is 0.8m above the ground plane. A vertical, metal reference plane is placed 0.4m from the EUT. The vertical metal reference-plane is at least 2m by 2m. The EUT shall be kept at least 0.8m from any other metal surface or other ground plane not being part of the EUT. The table is constructed of non-conductive materials. Its dimensions are 1m by 1.5m, but may be extended for larger EUT.

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

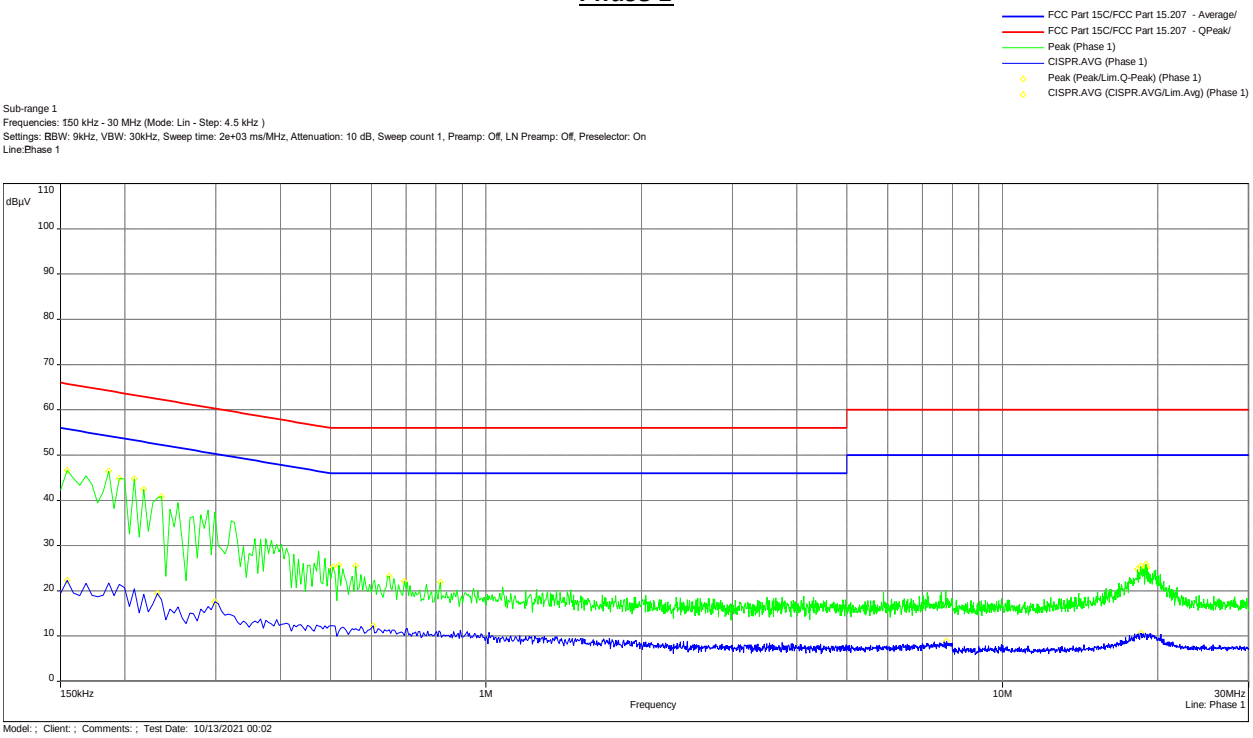
Equipment setup for conducted disturbance tests followed the guidelines of ANSI C63.10-2013.

Tested By	Test Date
Minh Ly	October 12, 2021

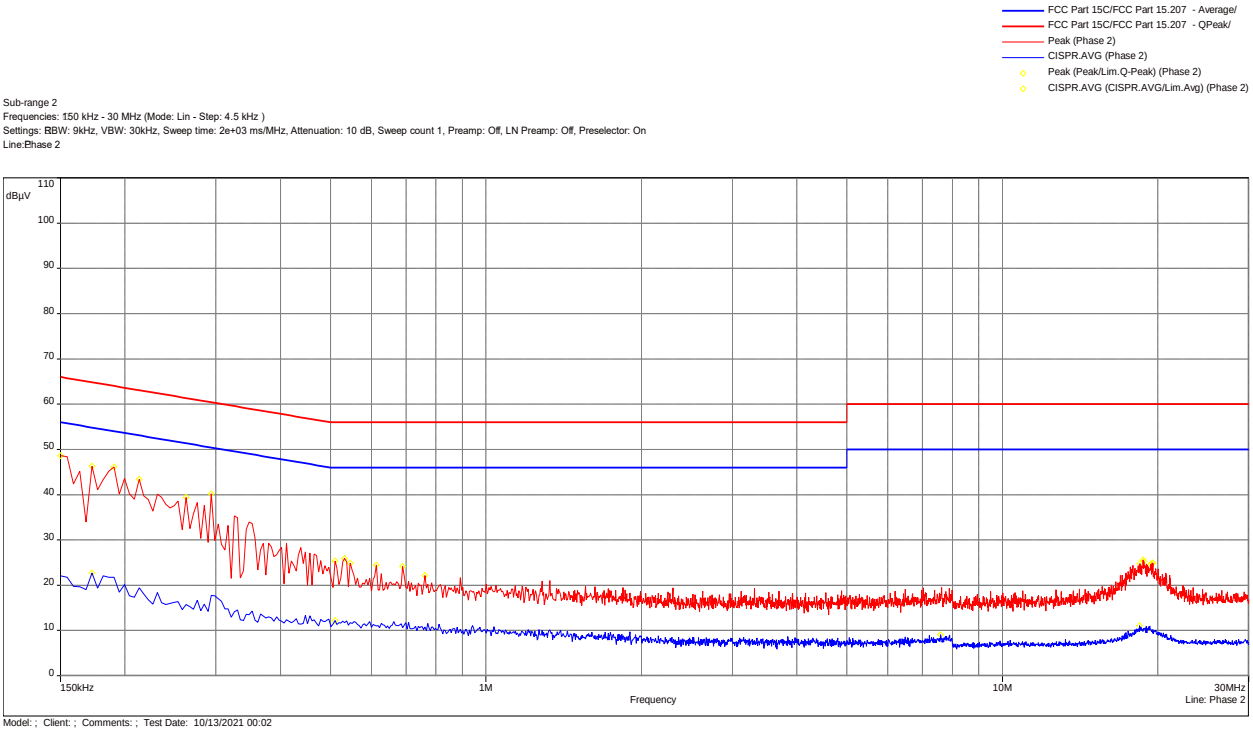
4.8.3 Test Results

15.207: Conducted Emissions 120VAC 60Hz

Phase 1



Phase 2



4.8.3 Test Results (Continued)

Frequency (MHz)	Q-Peak (dBµV)	Limit Q-Peak (dBµV)	Margin Q-Peak (dB)	Line	Correction (dB)
0.150	48.7	66.0	-17.4	Phase 2	11.0
0.155	46.6	65.8	-19.2	Phase 1	11.0
0.173	46.3	64.8	-18.6	Phase 2	11.0
0.186	46.5	64.2	-17.7	Phase 1	11.0
0.191	46.1	64.0	-17.9	Phase 2	10.9
0.195	44.8	63.8	-19.0	Phase 1	11.0
0.209	44.8	63.3	-18.5	Phase 1	11.0

Frequency (MHz)	CISPR AVG (dBµV)	Limit Avg (dBµV)	Margin Avg (dB)	Line	Correction (dB)
0.155	22.3	55.8	-33.5	Phase 1	11.0
0.173	22.7	54.8	-32.2	Phase 2	11.0
0.231	19.4	52.4	-33.0	Phase 1	11.0
0.299	17.6	50.3	-32.7	Phase 1	11.0
0.510	12.2	46.0	-33.8	Phase 2	11.0
0.605	12.3	46.0	-33.7	Phase 1	11.0
7.598	9.1	50.0	-40.9	Phase 2	11.3

Results: **Complies** by 17.4 dB

5.0 List of Test Equipment

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

Equipment	Manufacturer	Model/Type	Asset #	Cal Int	Cal Due
EMI Receiver	Rohde and Schwarz	ESU40	ITS 00961	12	03/09/22
LISN	FCC	FCC-LISN-50-50	ITS 00551	12	11/16/21
Horn Antenna	ETS Lindgren	3117PA	ITS 01636	12	12/17/21
18-40GHz Preamp	uComp Nordic	MCNS-50-18004000335P	ITS 01799	12	03/19/22
Pyramidal Horn Antenna	EMCO	3160-09	ITS 00571	#	#
Loop Antenna	EMCO	6512	ITS 01598	12	11/03/21
BI-Log Antenna	Teseq	CBL 6111D	ITS 01505	12	03/22/22
Pre-Amplifier	Sonoma Instrument	310N	ITS 00942	12	04/19/22
RF Cable	Mega Phase	TM40-K1K1-59	ITS 01655	12	10/05/21
RF Cable	Mega Phase	TM40-K1K1-19	ITS 01155	12	04/28/22
Notch Filter	MICRO-TRONICS	BRM50702	ITS 01166	12	06/29/22
RF Cable	Mega Phase	EMC1-K1K1-236	ITS 01484	12	06/29/22
10m Semi-anechoic chamber	Panashield	10m Chamber	ITS 00984	36	07/29/23

Calibration not required.

Software used for emission compliance testing utilized the following:

Name	Manufacturer	Version	Template/Profile
BAT-EMC	Nexio	3.20.0.14	ESU and ESR Intertek Emissions Template
Tile	Quantum Change	3.4.K.22	Conducted Spurious_30M-26GHz
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 / G104799910	ML	KV	November 12, 2021	Original Document
1.1 / G104799910	AS	KV	February 7, 2022	Updated Block Diagram

END OF REPORT