Testing Tomorrow's Technology

Class 2 Permissive Change Test Report

For

Part 2, Subpart J, Paragraph 2.907 Equipment Authorization of Certification for an Intentional Radiator per Part 15, Subpart C, paragraphs 15.207, 15.209 and 15.247

And

RSS-247 Issue 2: Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and License-Exempt Local Area Network (LE-LAN) Devices

For the

Murata Electronics North America

Model: WIT2410NF

FCC ID: HSW-2410NF
IC ID: 4492A-2410NF

UST Project: 22-0208

Issue Date: August 26, 2022

Total Pages: 41

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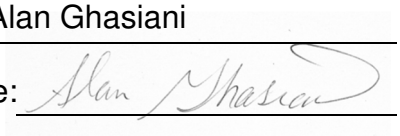
Testing Tomorrow's Technology

I certify that I am authorized to sign for the Test Agency and that all of the statements in this report and in the Exhibits attached hereto are true and correct to the best of my knowledge and belief:

US TECH (Agent Responsible For Test):

By: Alan Ghasiani

Name: 

Title: Compliance Engineer – President

Date: August 26, 2022

NVLAP TESTING

NVLAP LAB CODE 200162-0

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MEASUREMENT TECHNICAL REPORT

Company Name:	Murata Electronics North America
Address:	2200 Lake Park Dr Smyrna, GA 30080 USA
Model:	WIT2410NF
FCC ID:	HSW-2410NF
IC ID:	4492A-2410NF
Date:	August 26, 2022

This report concerns (check one): ☐ Original ☒ Class II Permissive Change

Equipment type: 2.4 GHz ISM Radio Transceiver

Technical Information:

Radio Technology:	FHSS
Frequency of Operation (MHz):	2401.6896-2469.888
Output Power (dBm):	17.10 dBm (measured)
Type of Modulation:	FSK
Data/Bit Rate (M)bps:	460 kbps
Antenna Gain (dBi):	Refer to Tables 5 and 6
Software used to program EUT:	Wincom 3.11
EUT firmware:	3.11
Power setting:	wp1

Report prepared by:

US Tech

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1 General Information

1.1 Purpose of this Report

The purpose of this report is to file for a Class II Permissive change for the following reasons:

Murata has made changes to the radio module board. The reason for the changes is due to components becoming obsolete. The changes effect several radio functions such as Demod, IF Amp, Demod Comparator, Digital Reset, Digital Clock, some receiver functions and some transmit and receive function components. The changes do not constitute a complete transmitter chip replacement therefore a Class 2 Permissive Change Request is being applied. See schematic drawing number 800852 (original layout) and 801173 (new layout). All other components and circuits on board remain the same.

Due to the changes above, the equipment was re-evaluated for continued compliance with Part 15.247, 15.209 and RSS-247 requirements. Based on the changes above the following test were performed:

- Intentional Radiated emissions Part 15.247(d)
- Spurious Radiated emissions Part 15.209
- Bandedge and Restricted band measurements
- Output Power measurements

All other test were deemed to be not affected by the changes. The test data has been collected and is presented herein for consideration.

1.2 Characterization of Test Sample

The samples used for testing were received by US Tech on July 29, 2021 in good operating condition.

1.3 Product Description

The EUT remains the same as previously tested: The Equipment under Test (EUT) is the Murata Electronics North America Model WIT2410NF. The EUT is a transceiver capable of FHSS modulation. The radio is designed to be a modular radio for use within different types of host devices and products.

1.4 Configuration of Tested System

The Test Sample was tested per *ANSI C63.10:2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices* for the intentional radiator aspect of the device and *ANSI C63.4:2014, Methods of Measurement of Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (2014)* for the unintentional radiator aspect of the device as well as FCC subpart B and C of Part 15 and per RSS-247 Issue 2 for ISED compliance.

Radiated emissions below 1 GHz were measured with the spectrum analyzer's resolution bandwidth (RBW) adjusted to 9 kHz and 120 kHz, respectively. All measurements performed above 1 GHz were made with a RBW of 1 MHz. All measurements are peak unless stated otherwise. The video filter associated with the spectrum analyzer was set to 3 times the RBW or as required per the standard throughout the evaluation process.

A list of EUT and Peripherals is found in Table 1 below. A block diagram of the tested system is shown in Figure 1. Test configuration photographs for spurious and fundamental emissions are provided in separate Appendices.

1.5 Test Facility

Testing was performed at US Tech's measurement facility at 3505 Francis Circle, Alpharetta, GA 30004. This site has been fully described and registered with the FCC. Its designation number is 186022. Additionally, this site has also been fully described and submitted to Industry Canada (IC), and has been approved under file number 9900A-1.

1.6 Related Submittal(s)/Grant(s)

There are no related submittals or grants.

Table 1. EUT and Peripherals

EUT MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	FCC/IC ID	CABLES P/D
Murata Electronics North America.	WIT2410NF	Engineering Sample	FCC ID: HSW-2410NF IC: 4492A-2410NF	P
PERIPHERAL MANUFACTURER	**MODEL NUMBER**	**SERIAL NUMBER**	**FCC/IC ID**	**CABLES P/D**
Murata Electronics North America Evaluation Board	WIT608B & WIT2420 Support Board	Engineering Sample	None	D
Lenovo Laptop	V14-ADA	PF2FRG6Z	FCC ID: PPD-QCNFA344AH IC:4104A-QCNFA344A	D, P
Antenna See antenna details	--	--	--	--

S= Shielded, U= Unshielded, P= Power, D= Data

Table 2. Details of I/O Cables Attached to EUT

DESCRIPTION OF CABLE	DETAILS OF CABLE			CABLE LENGTH
Ribbon Cable	**Manufacturer**		**Part Number**	0.25 m
	Generic		Various	
	Shield Type	**Shield Termination**	**Back-shell**	
	N/A	N/A	N/A	

Shield Type
N/A = None
F = Foil
B = Braided
2B = Double Braided
CND = Could Not Determine

Shield Termination
N/A = None
360 = 360 Degrees
P = Pigtail/Drain Wire
CND = Could Not Determine
MU = Metal Unshielded

Back-shell
N/A = Not Applicable
PS = Plastic Shielded
PU = Plastic Unshielded
MS = Metal Shielded

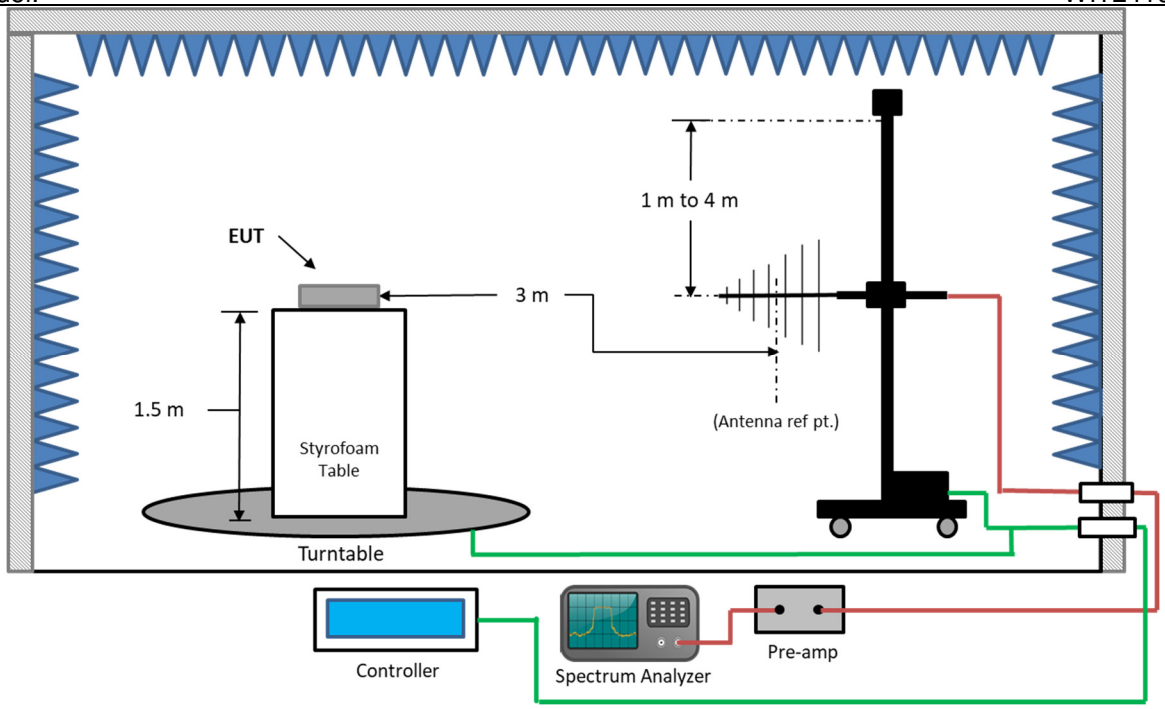


Figure 1. EUT Test Configuration Diagram

2 Tests and Measurements

2.1 Test Equipment

The table below lists test equipment used to evaluate this product.

Table 3. Test Instruments

TEST INSTRUMENT	MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	CALIBRATION DUE DATE
Spectrum Analyzer	Agilent	E4407B	US41442935	9/02/2022 2 yr.
RF Preamp 100 KHz To 1.3 GHz	Hewlett-Packard	8447D	1937A02980	6/9/2023
Preamp 1.0 GHz To 26.0 GHz	Hewlett-Packard	8449B	3008A00914	2/11/2023
Biconical Antenna	EMCO	3110B	9306-1708	8/17/2023 2 yr.
Log Periodic Antenna	EMCO	3146	9110-3236	12/13/2023 2 yr.
Double Ridged Horn Antenna	A. H. Systems	SAS-571	605	4/28/2024 2 yr.
High Pass Filter	Mini-Circuits, Inc.	H3R020G2	001DC9528	8/01/2023
8 dB Attenuator	Mini-Circuits Inc.	VAT-8 15542	3 0519	8/02/2023

Note: The calibration interval of the above test instruments are 12 months unless stated otherwise and all calibrations are traceable to NIST/USA.

2.2 Modifications to EUT Hardware

No modifications were made by US Tech to bring the EUT into compliance with FCC Part 15.247 and RSS-247 requirements.

2.3 Number of Measurements for Intentional Radiators (CFR 15.31(m))

Measurements of intentional radiators or receivers shall be performed and reported for each band in which the device can be operated, with the device operating at the number of frequencies in each band specified in Table 3 as follows:

Table 4. Number of Test Frequencies for Intentional Radiators

Frequency Range over which the Device Operates	Number of Frequencies	Location in the Range of Operation
1 MHz or less	1	Middle
1 to 10 MHz	2	1 near the top 1 near the bottom
Greater than 10 MHz	3	1 near top 1 near middle 1 near bottom

The EUT operates over the range of 2401.69 to 2469.888; therefore three test frequencies were evaluated.

2.4 Frequency Range of Radiated Measurements (CFR 15.33)

2.4.1 Intentional Radiator

The spectrum shall be investigated for the intentional radiator from the lowest RF signal generated in the EUT, without going below 9 kHz to the 10th harmonic of the highest fundamental frequency generated or 40 GHz, whichever is the lowest.

2.4.2 Unintentional Radiator

For the digital device, an unintentional radiator, the frequency range shall be 30 MHz to 1000 MHz, or to the range specified in 2.4.1 above; whichever is the higher range of investigation.

2.5 Measurement Detector Function and Bandwidth (CFR 15.35)

The radiated and conducted emissions limits shown herein are based on the parameters listed in the following paragraphs.

2.5.1 Detector Function and Associated Bandwidth

On frequencies below 1000 MHz, the limits herein are based upon measurement equipment employing a CISPR quasi-peak detector function and related measurement bandwidths (i.e. 9 kHz from 150 kHz to 30 MHz and 120 kHz from 30 MHz to 1000 MHz). Alternatively, measurements may be made with equipment employing a peak detector function as long as the same bandwidths specified for the quasi-peak device are used.

2.5.2 Corresponding Peak and Average Requirements

Above 1000 MHz, radiated limits are based on measuring instrumentation employing an average detector function. When average radiated emissions are specified there is also a corresponding peak requirement that is measured using a peak detector. The peak limit shall be 20 dB greater than the average limit. For all measurements above 1000 MHz, the Resolution Bandwidth shall be at least 1 MHz.

2.5.3 Pulsed Transmitter Averaging

When the radiated emissions limit is expressed as an average value, and the transmitter is pulsed, the measured field strength shall be determined by applying a Duty Cycle Correction Factor based upon dividing the total ON time during the first 100 ms period by 100 ms (or by the period if less than 100 ms). The duty cycle may also be expressed logarithmically in dB. In this case, the Duty Cycle Correction Factor was determined from the manufacturer's claim.

2.6 Transmitter Duty Cycle (Part 15.35(c))

For average radiated measurements using a 5.56% duty cycle, the measured level was reduced by a factor 25.1 dB. The duty cycle correction factor is determined using the formula: 20 log (5.56/100) = 25.1 dB.

A detail explanation of the duty cycle is provided in the original certification report.

2.7 Restricted Bands of Operation (Part 15.205)

Only spurious emissions can fall in the frequency bands of CFR 15.205. The field strength of these emissions cannot exceed the limits of 15.209. Radiated harmonics and other spurious emissions are examined for this requirement see test data below.

2.8 EUT Antenna Requirements (CFR 15.203)

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The antenna details are as follows:

Table 5. Antenna 1

Manufacturer	Model	Type	Gain (dBi)	Connector
RFM or equivalent	RWA249R	dipole	+2.0	mmxc
Mobile Mark or equivalent	SCR12-2400	corner reflector	+12.0	N Jack (F)

2.9 Maximum Peak Conducted Output Power (CFR 15.247(b)(3))

The EUT was programmed to operate at a normal operating output power across the bandwidth. The radio output level was set to "wp1" using the radio's test firmware. A low loss, less than 0.1 dB, RF cable was connected between the EUT's antenna output port and spectrum analyzer. For protection, a 20 dB attenuator was connected to the RF input of the spectrum analyzer. The attenuator factor was accounted for in all antenna-port, conducted RF measurements.

Peak power within the band 2401.69 to 2469.888 MHz was measured per FCC KDB Publication 558074v05r02 and ANSI C63.10-2013. The results are presented in Table 7.

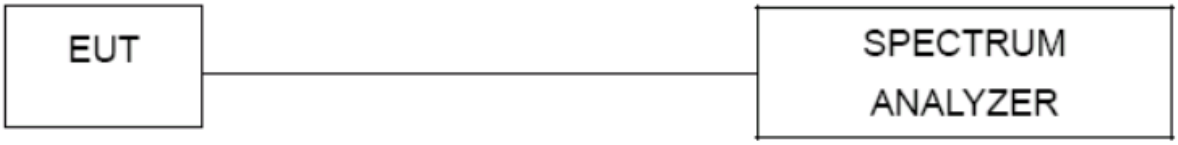


Figure 2. Conducted Radio Setup

Table 6. Peak Antenna Conducted Output Power per Part 15.247 (b)(3)

Frequency of Fundamental (MHz)	P_{Cond} (dBm)	P_{Cond} (mW)	FCC Limit (mW Maximum)
2401.61	16.85	48.42	1000
2435.86	16.93	49.32	1000
2469.69	17.10	51.29	1000

Test Date: August 23, 2022

Tested by
Signature: Ian Charboneau Test Engineer: Ian Charboneau

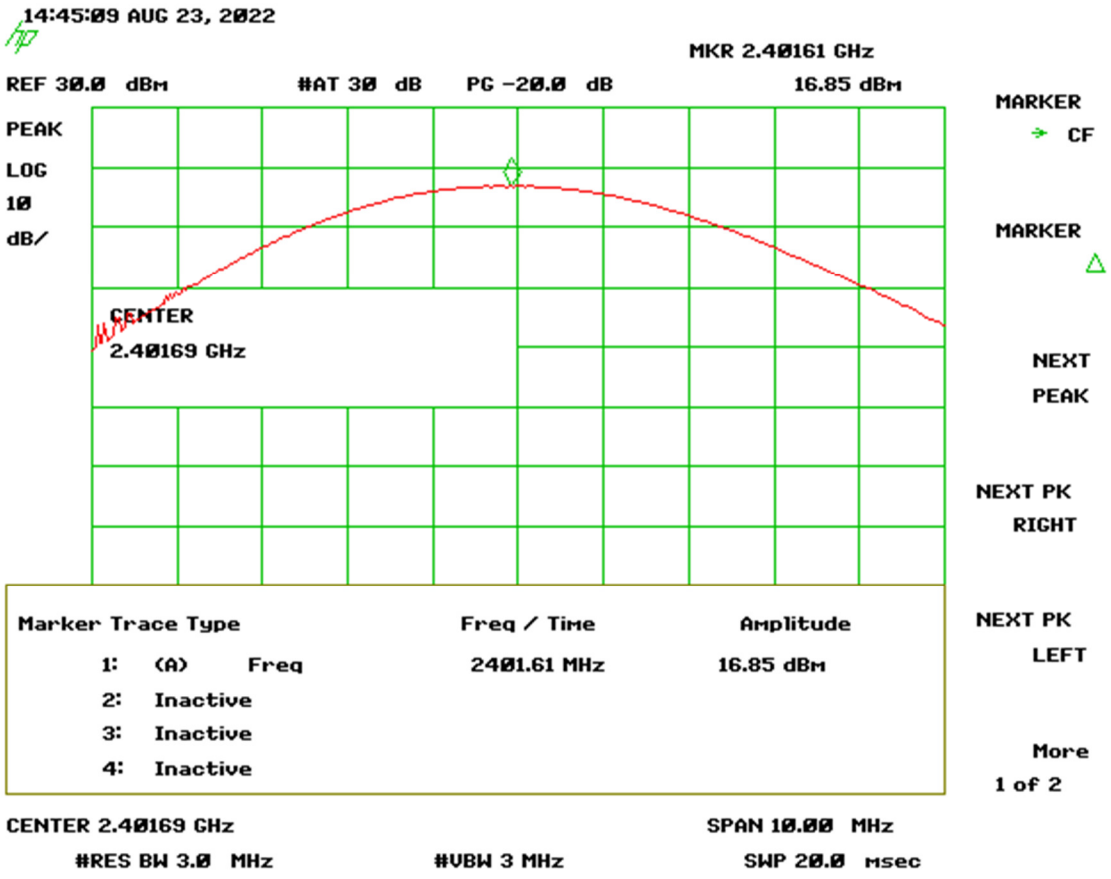


Figure 3. Peak Output Power – Low Channel

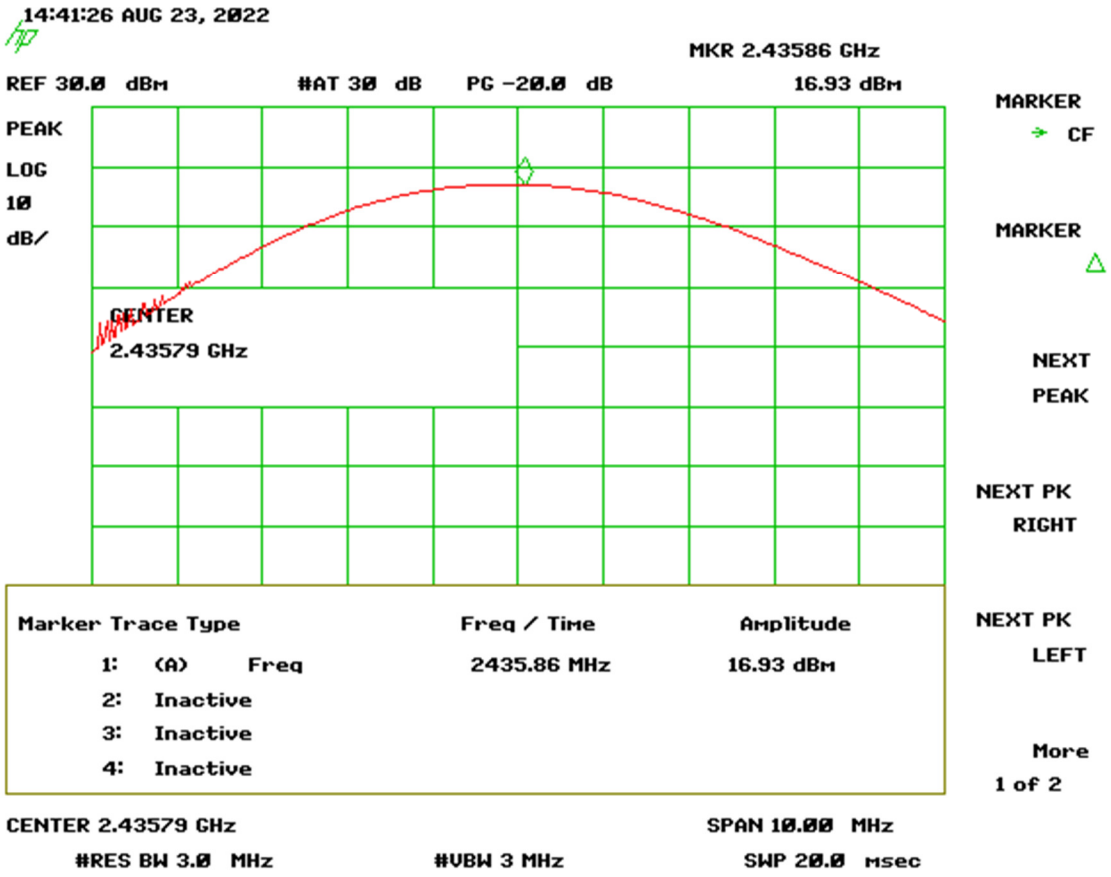


Figure 4. Peak Output Power – Mid Channel

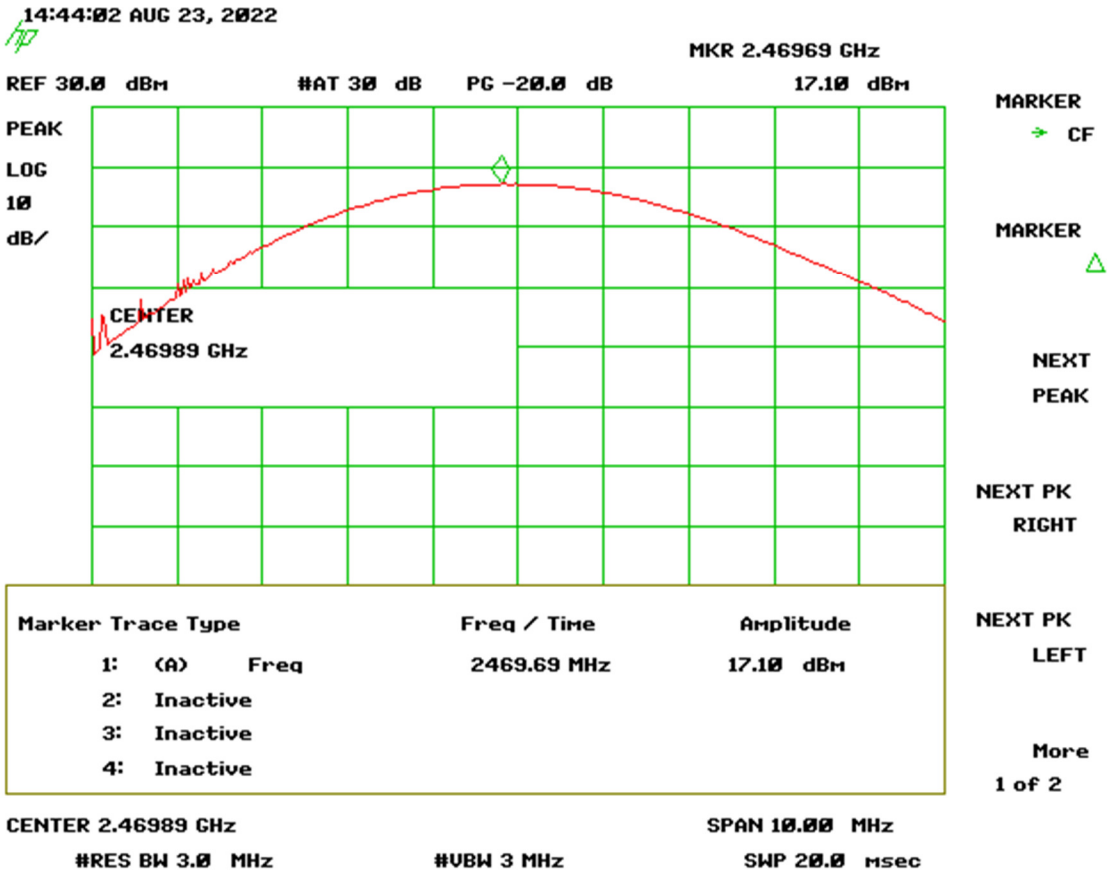


Figure 5. Peak Output Power - High Channel

2.10 Intentional Radiator, Radiated Emissions (CFR 15.209, 15.247(d))

For radiated measurements, the EUT was set into a collocated continuous transmission mode. Below 1 GHz, the RBW of the measuring instrument was set equal to 120 kHz. Peak measurements above 1 GHz were measured using a RBW = 1 MHz, with a VBW ≥ 3 x RBW. The results of peak radiated spurious emissions falling within restricted bands are given in Table 5 below. For average measurements above 1 GHz, the emissions were measured using an average detector. The measurement of each signal detected was maximized by rotating the turntable 360° clockwise and counterclockwise and raising and lowering the receive antenna between 1 and 4 meters in height while monitoring the ever changing spectrum analyzer display with Trace A in the Max-Hold mode and Trace B in the Clear-Write mode for the largest signal visible. The emission from the EUT was measured and recorded when both maxima were simultaneously satisfied.

2.10.1 Radiated Emissions, Fundamental and Harmonics (CFR 15.247(d))

On the test site, the EUT was placed on top of a polystyrene table 80 cm or 150 cm above the ground plane (depending on measurements below 1 GHz or above 1 GHz respectively) inside a semi-anechoic test chamber. The EUT was evaluated in each of its three axes (X/Y/Z) while transmitting on the channel that produced the highest output power for worst case condition. The position of the EUT determined to be worst case was with the EUT positioned flat in the X axis and antenna vertical for Dipole antenna or facing the receiver antenna for the Corner antenna. The worst case test results of the fundamental and harmonics are presented in the table below.

Radiated Emissions measurements were conducted starting at 30 MHz up to 10 times the highest clock frequency. Emissions below 30 MHz were not reassessed for this permissive change.

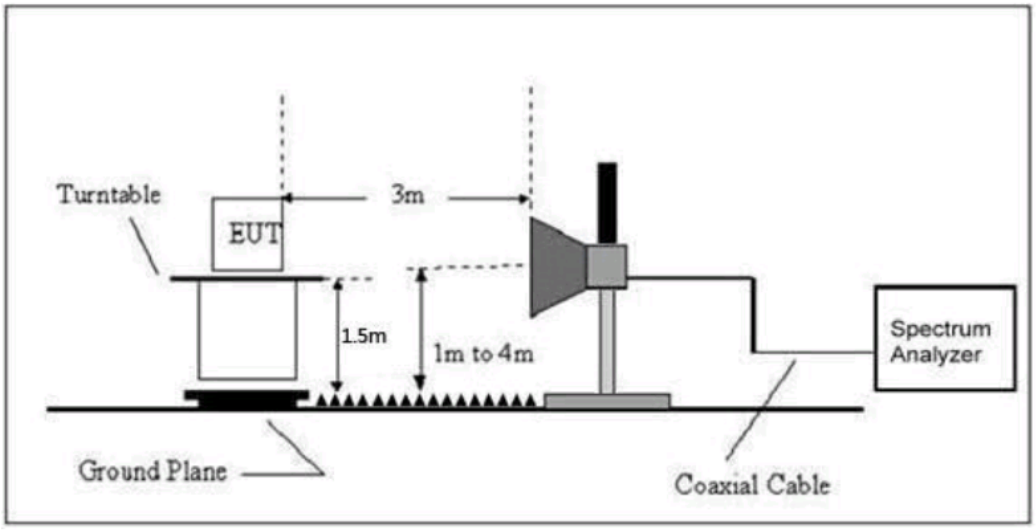


Figure 6. Radiated Emissions Test Setup (above 1 GHz)

Table 7. Radiated Fundamental and Harmonic Emissions (Antenna #1)

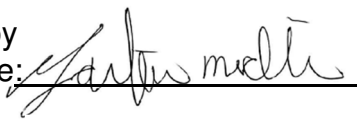
Test: FCC Part 15.247, RSS-247								
Frequency (MHz)	**Test Data (dBuV)**	**Additional Factor**	**AF+CL-PA (dB/m)**	**Corrected Results (dBuV/m)**	**Limits (dBuV/m)**	**Distance / Polarization**	**Margin (dB)**	**Detector**
Low Channel								
2401.80	81.00	0.0	32.49	113.49	--	3.0m./VERT	--	**PK**
2401.80	59.50*	0.0	32.49	91.99	--	3.0m./VERT	--	**AVG**
4803.40	69.76	0.0	-0.53	69.23	74.0	3.0m./VERT	4.8	**PK**
4803.40	44.66*	0.0	-0.53	44.13	54.0	3.0m./VERT	9.9	**AVG**
7204.00	61.09	0.0	6.48	67.57	74.0	3.0m./VERT	6.4	**PK**
7204.00	39.59*	0.0	6.48	46.07	54.0	3.0m./VERT	7.9	**AVG**
9606.00	62.55	0.0	7.23	69.78	74.0	3.0m./VERT	4.2	**PK**
9606.00	37.45*	0.0	7.23	44.68	54.0	3.0m./VERT	9.3	**AVG**
12007.90	50.56	0.0	10.22	60.78	74.0	3.0m./VERT	13.2	**PK**
12007.90	25.46*	0.0	10.22	35.68	54.0	3.0m./VERT	18.3	**AVG**
14409.40	49.75	0.0	13.89	63.64	74.0	3.0m./VERT	10.4	**PK**
14409.40	24.65*	0.0	13.89	38.54	54.0	3.0m./VERT	15.5	**AVG**
Mid Channel								
2435.64	82.00	0.0	32.49	114.49	--	3.0m./VERT	--	**PK**
2435.64	56.90*	0.0	32.49	89.39	--	3.0m./VERT	--	**AVG**
4871.74	70.76	0.0	-1.24	69.52	74.0	3.0m./VERT	4.5	**PK**
4871.74	34.37	0.0	-1.24	33.13	54.0	3.0m./VERT	20.9	**AVG**
7307.60	61.23	0.0	6.53	67.76	74.0	3.0m./VERT	6.2	**PK**
7307.60	33.27	0.0	6.53	39.80	54.0	3.0m./VERT	14.2	**AVG**
9742.50	61.90	0.0	5.99	67.89	74.0	3.0m./VERT	6.1	**PK**
9742.50	33.50	0.0	5.99	39.49	54.0	3.0m./VERT	14.5	**AVG**
12179.00	50.29	0.0	10.97	61.26	74.0	3.0m./VERT	12.7	**PK**
12179.00	25.19*	0.0	10.97	36.16	54.0	3.0m./VERT	17.8	**AVG**
High Channel								
2469.93	82.82	0.0	32.69	115.51	--	3.0m./VERT	--	**PK**
2469.93	57.72*	0.0	32.69	90.41	--	3.0m./VERT	--	**AVG**
4939.70	71.02	0.0	-1.04	69.98	74.0	3.0m./VERT	4.0	**PK**
4939.70	45.92*	0.0	-1.04	44.88	54.0	3.0m./VERT	9.1	**AVG**
7409.62	63.97	0.0	5.60	69.57	74.0	3.0m./VERT	4.4	**PK**
7409.62	38.87*	0.0	5.60	44.47	54.0	3.0m./VERT	9.5	**AVG**
9879.28	58.96	0.0	5.93	64.89	74.0	3.0m./VERT	9.1	**PK**
9879.28	32.80	0.0	5.93	38.73	54.0	3.0m./VERT	15.3	**AVG**
12348.77	50.14	0.0	11.12	61.26	74.0	3.0m./VERT	12.7	**PK**
12348.77	29.32	0.0	11.12	40.44	54.0	3.0m./VERT	13.6	**AVG**

Notes:
1. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic
2. (*)= Calculated duty cycle applied to PK value to determine AVG value.
3. Vertical polarity is the worst case

Sample Calculation at 4803.40 MHz:

Magnitude of Measured Frequency	69.76	dBuV
+Additional Factor	0.00	dB
+Antenna Factor + Cable Loss - Amplifier Gain	-0.53	dB/m
Corrected Result	69.23	dBuV/m

Test Date: July 29, 2022

Tested by
Signature:  Test Engineer: Gabriel Medina

Tested by
Signature:  Test Engineer: Ian Charboneau

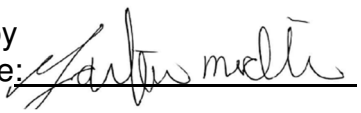
Table 8. Radiated Fundamental and Harmonic Emissions (Antenna #2)

Test: FCC Part 15.247, RSS-247								
Frequency (MHz)	**Test Data (dBuV)**	**Additional Factor**	**AF+CL-PA (dB/m)**	**Corrected Results (dBuV/m)**	**Limits (dBuV/m)**	**Distance / Polarization**	**Margin (dB)**	**Detector**
Low Channel								
2401.60	90.49	0.0	32.19	122.68	--	3.0m./VERT	--	**PK**
2401.60	65.39*	0.0	32.19	97.58	--	3.0m./VERT	--	**AVG**
4803.40	71.66	0.0	1.70	73.36	74.0	3.0m./VERT	0.6	**PK**
4803.40	34.48	0.0	1.70	36.18	54.0	3.0m./VERT	17.8	**AVG**
7204.70	56.91	0.0	6.17	63.08	74.0	3.0m./VERT	10.9	**PK**
7204.00	31.81	0.0	6.17	37.98	54.0	3.0m./VERT	16.0	**AVG**
9607.20	56.07	0.0	6.42	62.49	74.0	3.0m./VERT	11.5	**PK**
9607.20	30.97	0.0	6.42	37.39	54.0	3.0m./VERT	16.6	**AVG**
12006.90	51.54	0.0	11.23	62.77	74.0	3.0m./VERT	11.2	**PK**
12006.90	26.44	0.0	11.23	37.67	54.0	3.0m./VERT	16.3	**AVG**
Mid Channel								
2435.80	90.86	0.0	32.18	123.04	--	3.0m./VERT	--	**PK**
2435.80	65.76*	0.0	32.18	97.94	--	3.0m./VERT	--	**AVG**
4871.40	71.65	0.0	1.40	73.05	74.0	3.0m./VERT	0.9	**PK**
4871.40	34.41	0.0	1.40	35.81	54.0	3.0m./VERT	18.2	**AVG**
7307.80	57.51	0.0	7.02	64.53	74.0	3.0m./VERT	9.5	**PK**
7307.80	32.41*	0.0	7.02	39.43	54.0	3.0m./VERT	14.6	**AVG**
9743.60	56.66	0.0	6.55	63.21	74.0	3.0m./VERT	10.8	**PK**
9743.60	31.56*	0.0	6.55	38.11	54.0	3.0m./VERT	15.9	**AVG**
12179.60	51.32	0.0	12.23	63.55	74.0	3.0m./VERT	10.4	**PK**
12179.60	26.22*	0.0	11.65	37.87	54.0	3.0m./VERT	16.1	**AVG**
High Channel								
2469.90	90.97	0.0	32.36	123.33		3.0m./VERT		**PK**
2469.90	65.87*	0.0	32.36	98.23		3.0m./VERT		**AVG**
4939.70	71.98	0.0	1.68	73.66	74.0	3.0m./VERT	0.3	**PK**
4939.70	33.66	0.0	1.68	35.34	54.0	3.0m./VERT	18.7	**AVG**
7409.00	57.38	0.0	6.64	64.02	74.0	3.0m./VERT	10.0	**PK**
7409.00	32.28	0.0	6.64	38.92	54.0	3.0m./VERT	15.1	**AVG**
9879.00	55.76	0.0	7.06	62.82	74.0	3.0m./VERT	11.2	**PK**
9879.00	30.66	0.0	7.06	37.72	54.0	3.0m./VERT	16.3	**AVG**
12348.00	51.27	0.0	13.16	64.43	74.0	1.0m./VERT	9.6	**PK**
12348.00	26.17	0.0	13.16	39.33	54.0	1.0m./VERT	14.7	**AVG**

Notes:
4. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic
5. (*)= Calculated duty cycle applied to PK value to determine AVG value.
6. Vertical polarity is the worst case

Sample Calculation at 4803.40 MHz:		
Magnitude of Measured Frequency	71.66	dBuV
+Additional Factor	0.00	dB
+Antenna Factor + Cable Loss - Amplifier Gain	1.76	dB/m
Corrected Result	73.36	dBuV/m

Test Date: July 29, 2022

Tested by
Signature:  Test Engineer: Gabriel Medina

Tested by
Signature:  Test Engineer: Ian Charboneau

2.11 Bandedge and Restricted Band (CFR 15.247(d))

The EUT was investigated at the lowest and highest channel available to determine bandedge and restricted band compliance.

2.11.1 Bandedge Compliance

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits.

In this case conducted measurement was used.

Figure 7. Conducted Bandedge Test Configuration

Test Date: August 23, 2022

Tested by
Signature: Ian Charboneau Test Engineer: Ian Charboneau

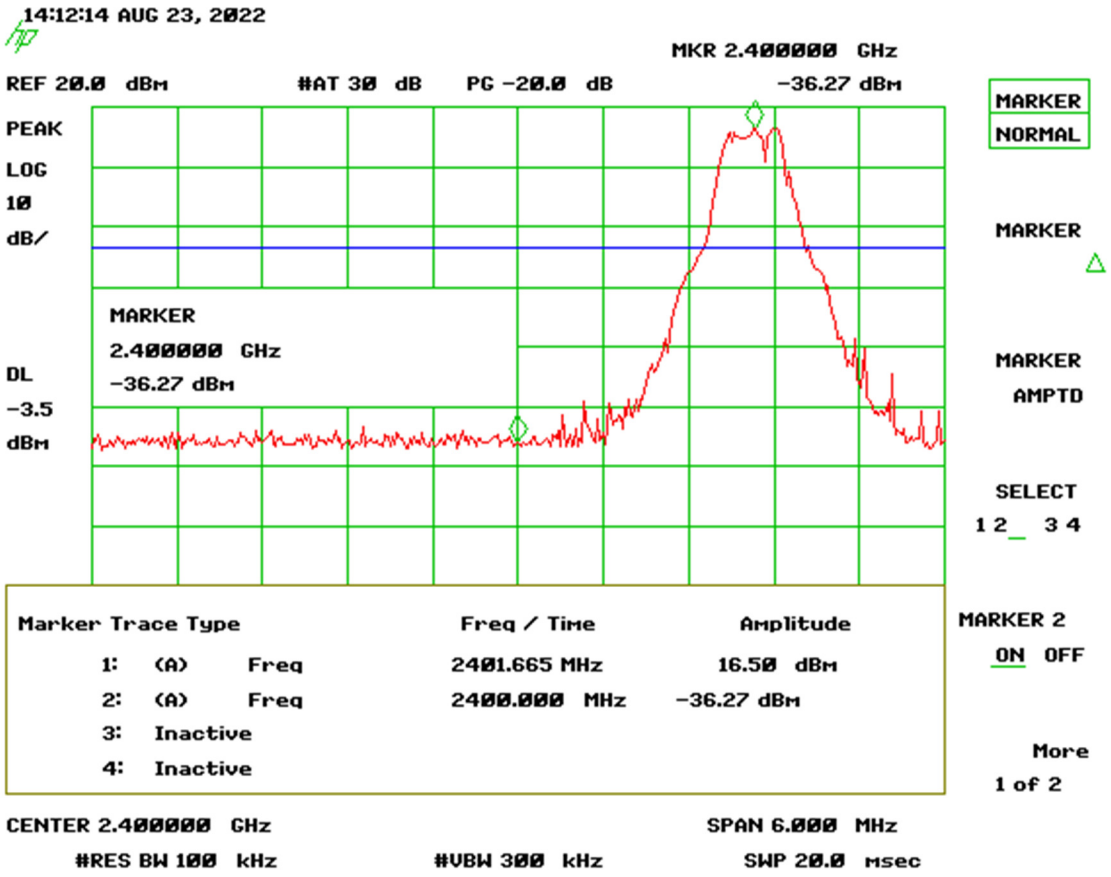


Figure 8. Low Channel, No Hopping

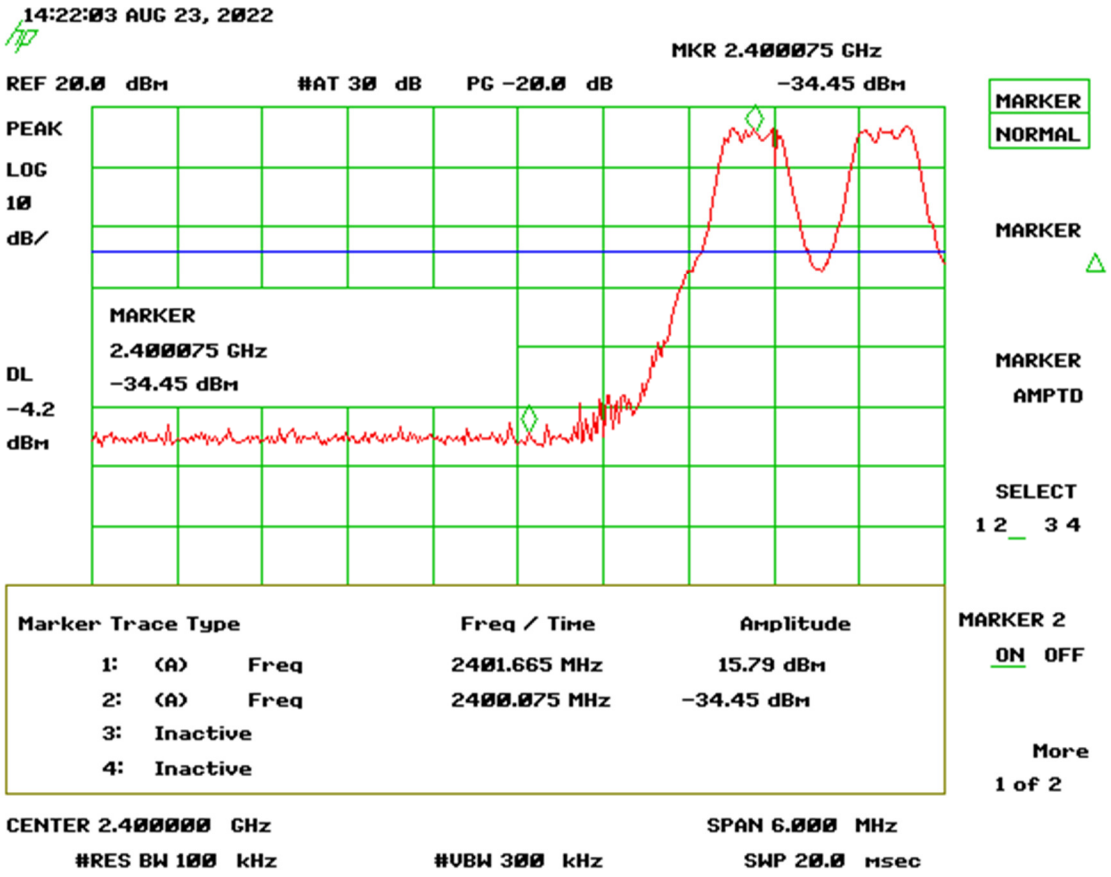


Figure 9. Low Channel, Hopping

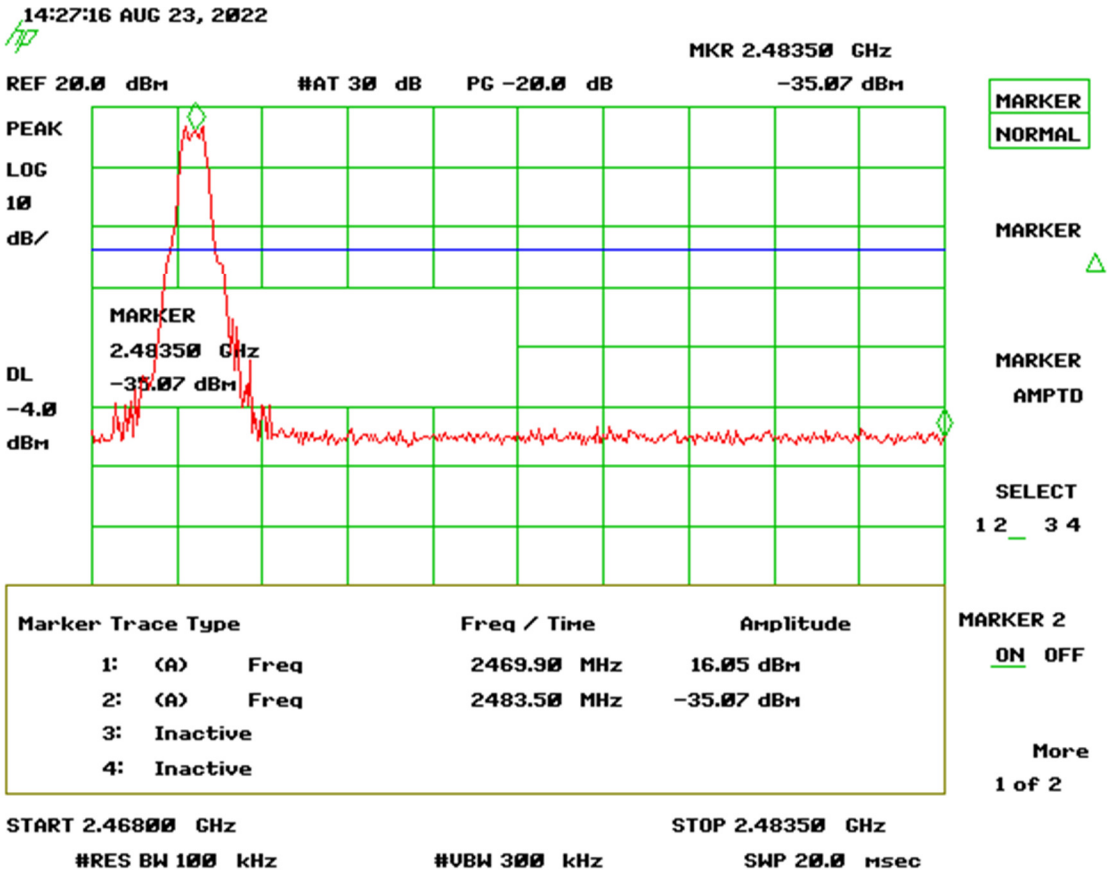


Figure 10. High Channel, No Hopping

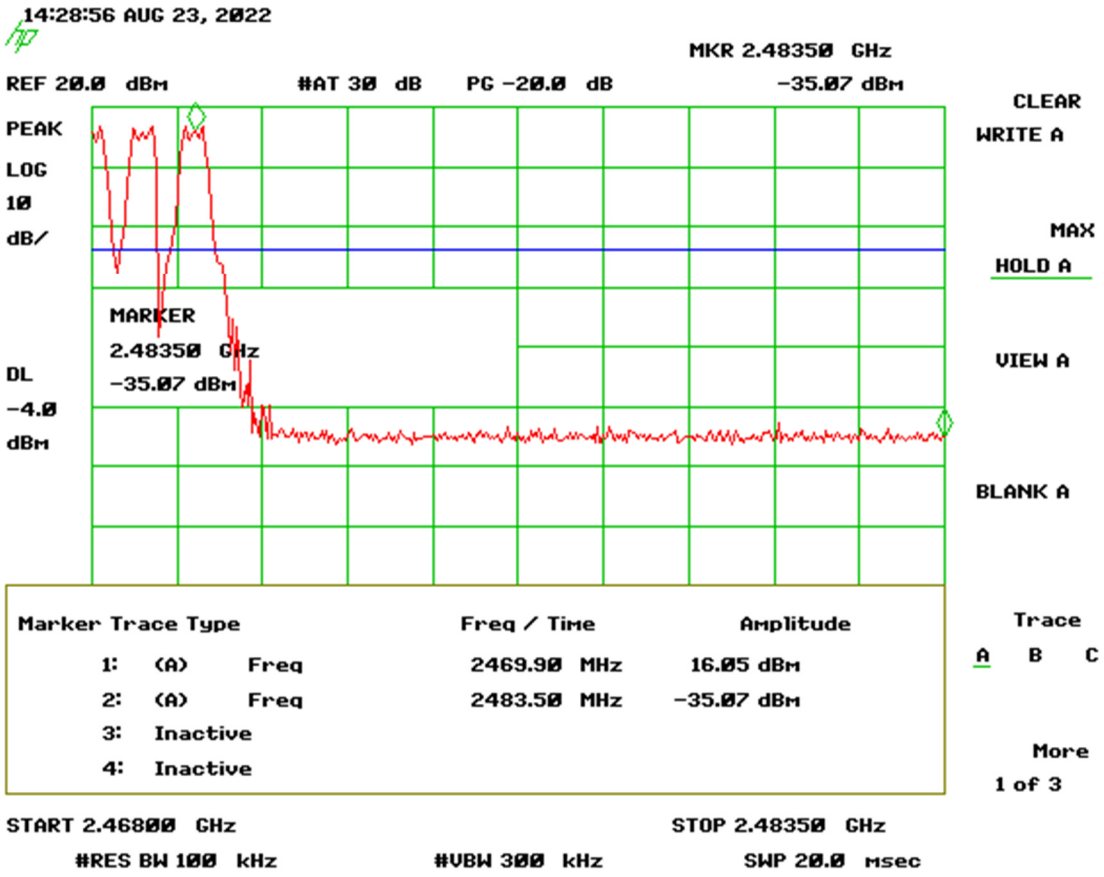


Figure 11. High Channel, Hopping

2.11.2 Restricted band

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

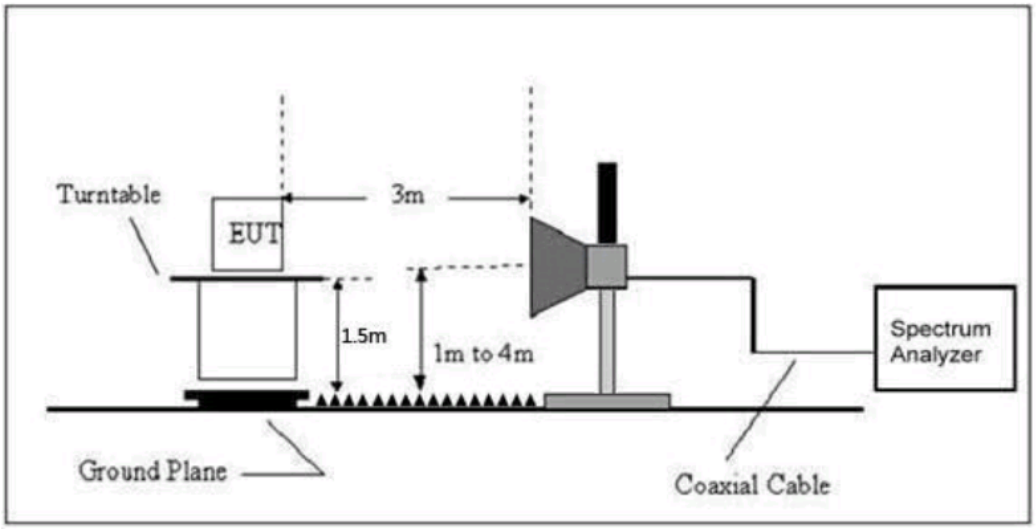


Table 9. Restricted Band Test Configuration

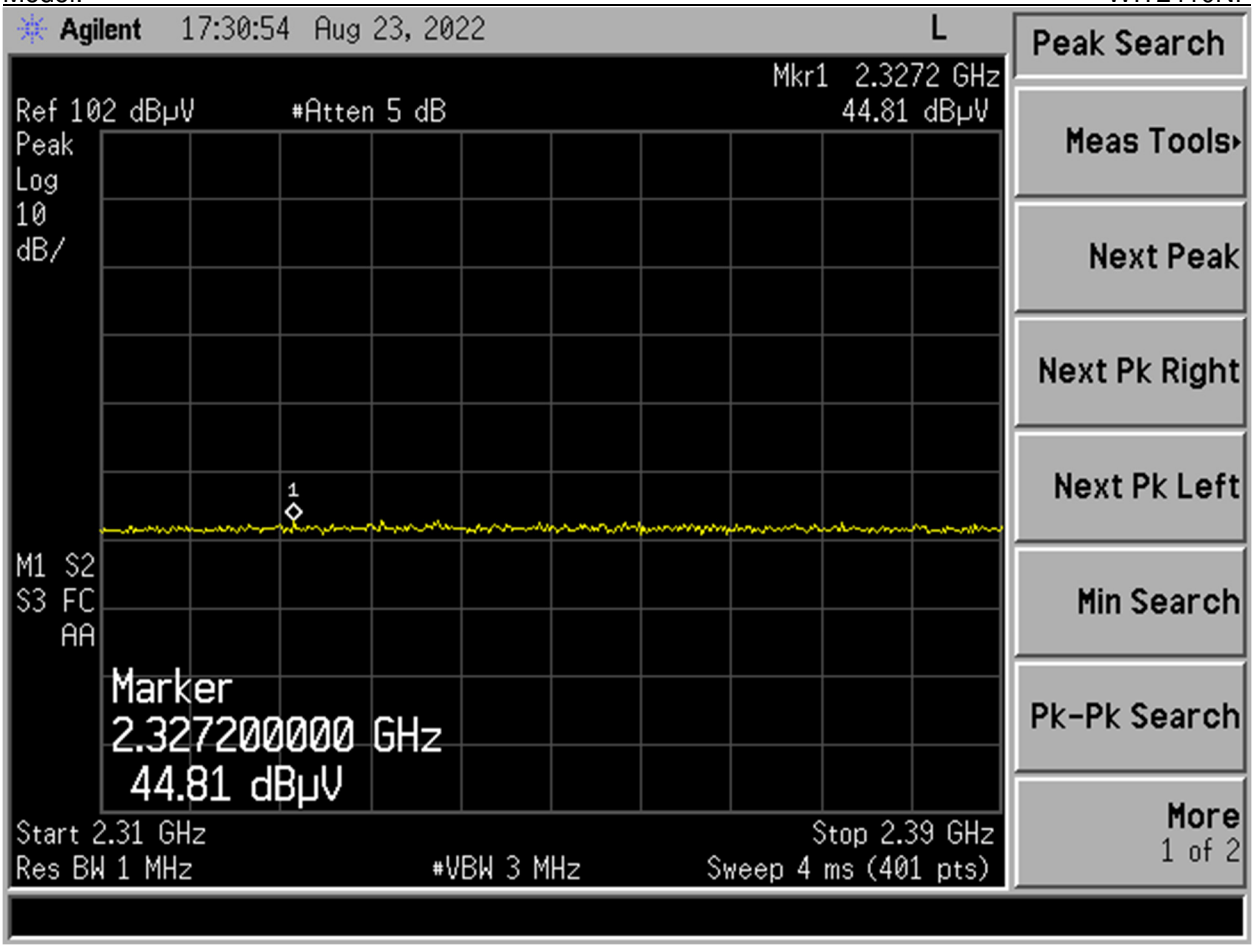


Figure 12. Antenna #1, Low Channel

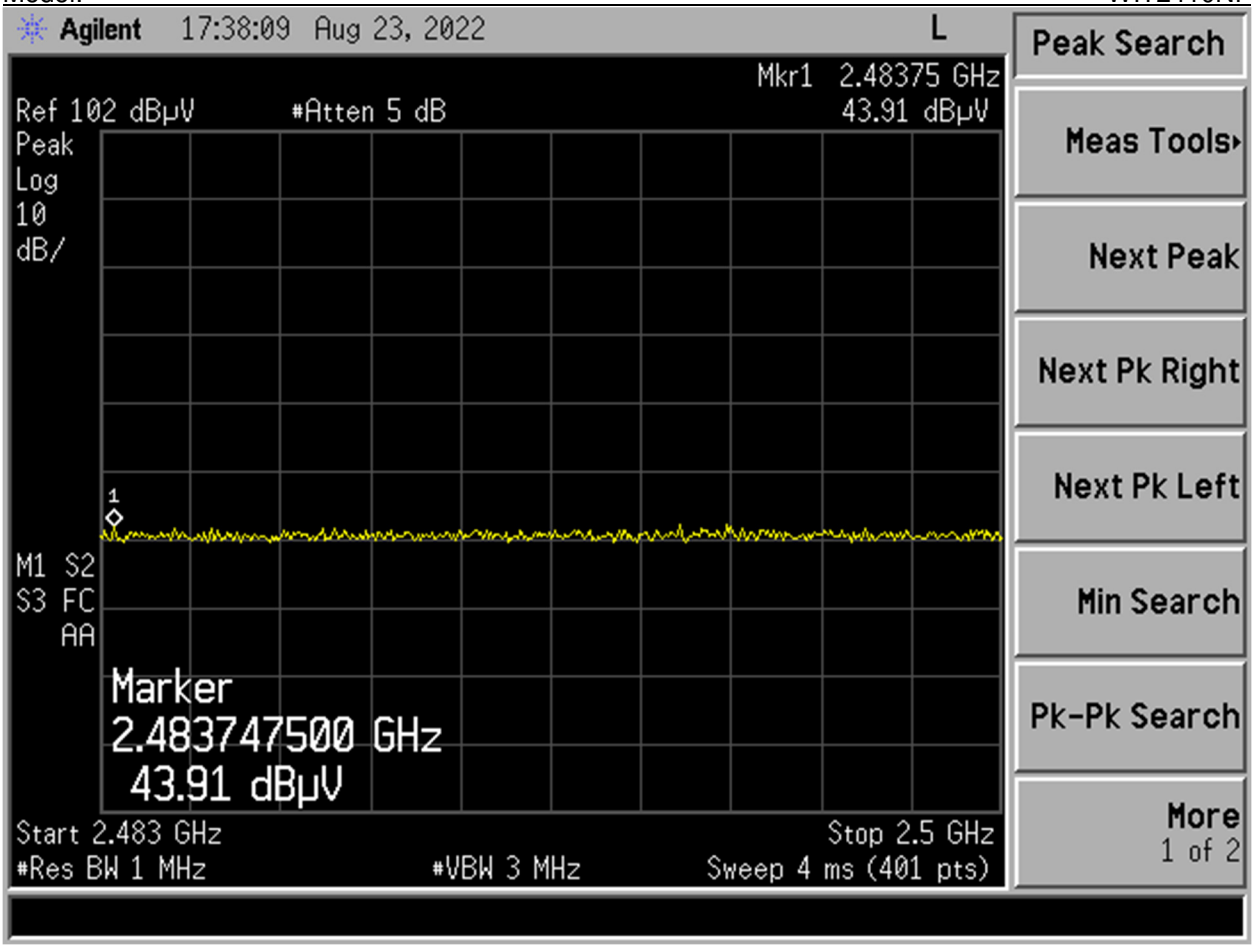


Figure 13. Antenna #1, High Channel

Table 10. Restricted Band Emissions

Test: FCC Part 15.247, RSS-247								
Frequency (MHz)	**Test Data (dBuV)**	**Additional Factor**	**AF+CL-PA (dB/m)**	**Corrected Results (dBuV/m)**	**Limits (dBuV/m)**	**Distance / Polarization**	**Margin (dB)**	**Detector**
Low Channel								
No emissions seen more than 6 dB above the noise floor.								

Test Date: August 23, 2022

Tested by
Signature: Test Engineer: Ian Charboneau

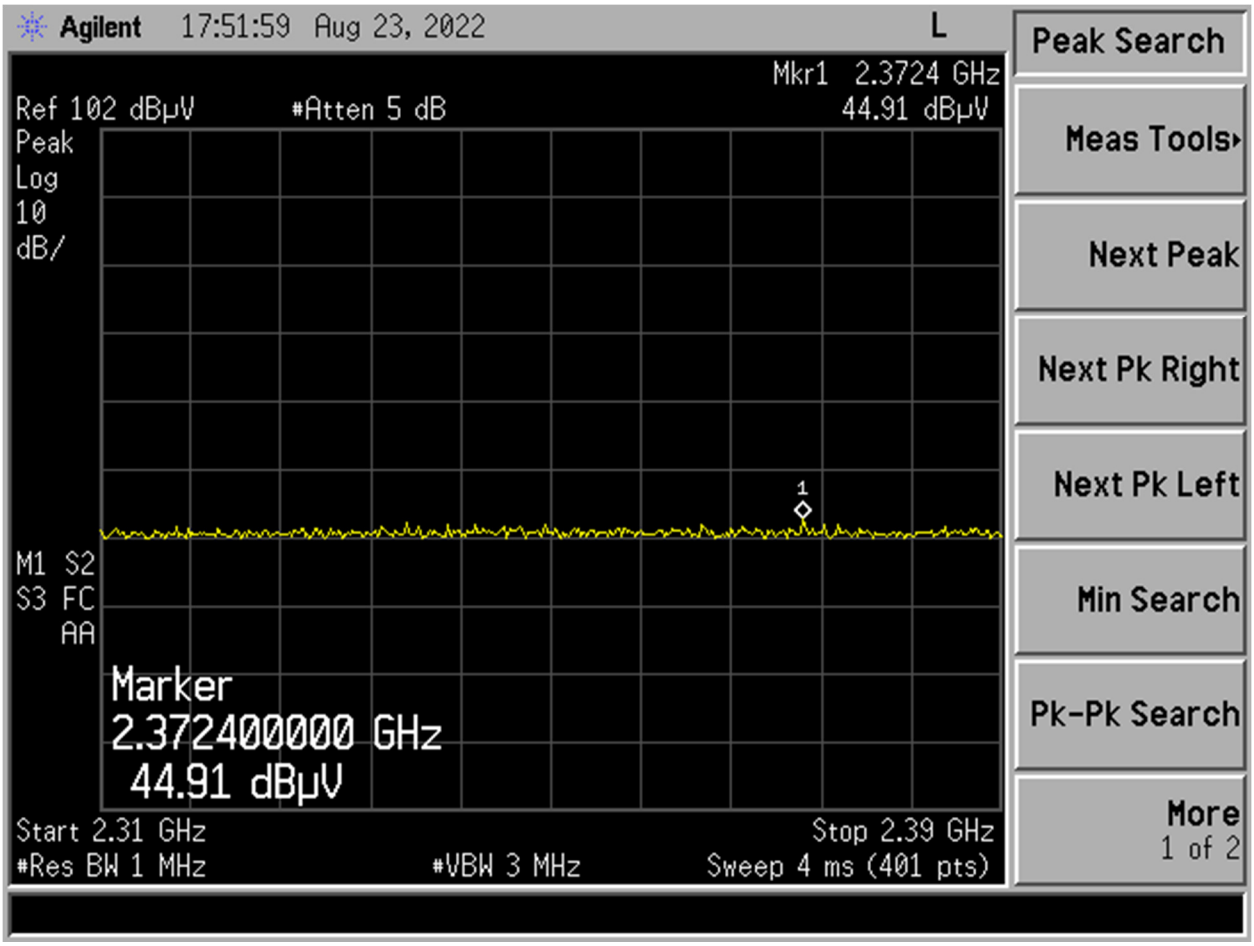


Figure 14. Antenna #2, Low Channel

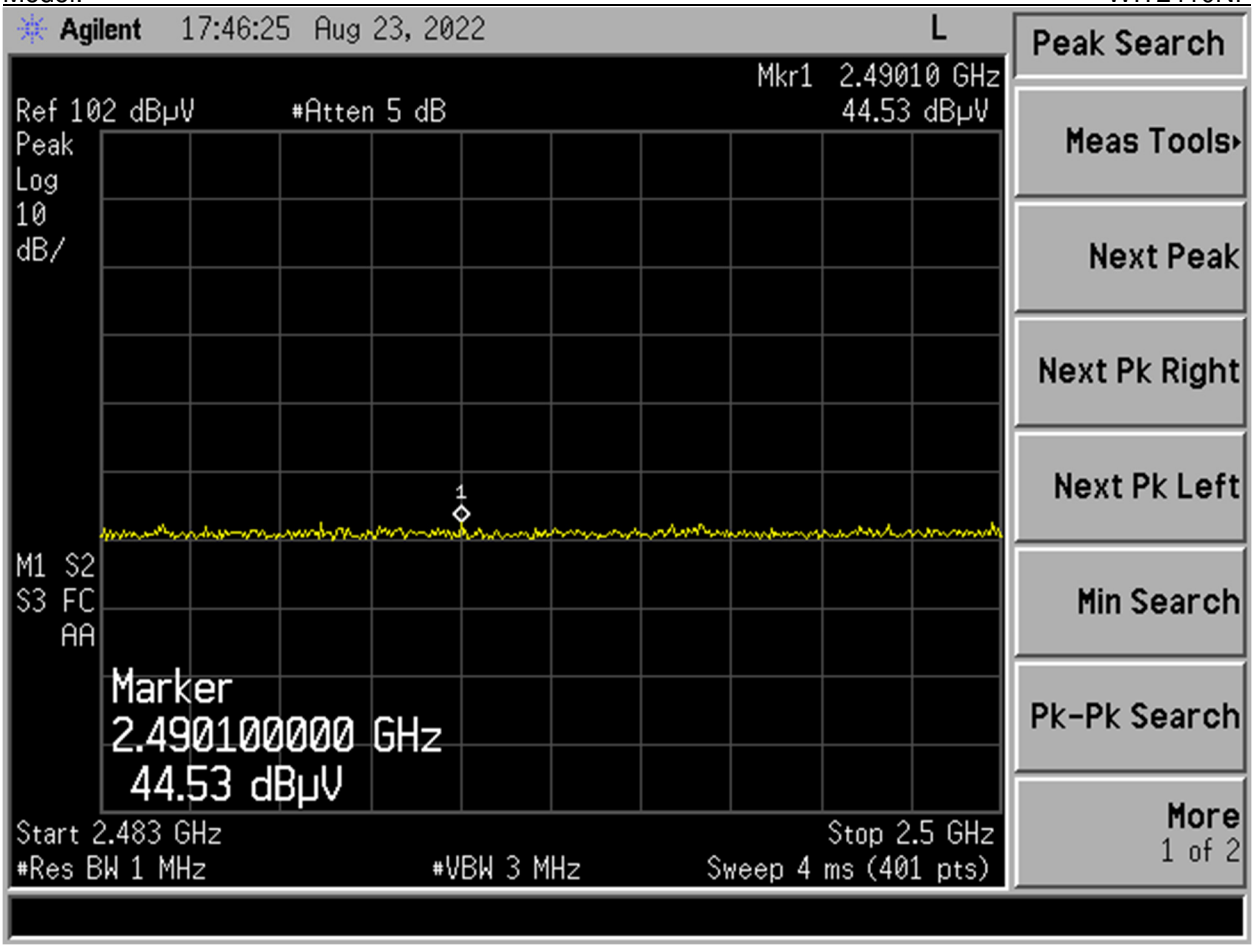


Figure 15. Antenna #2, High Channel

Table 11. Restricted Band Emissions

Test: FCC Part 15.247, RSS-247								
Frequency (MHz)	**Test Data (dBuV)**	**Additional Factor**	**AF+CL-PA (dB/m)**	**Corrected Results (dBuV/m)**	**Limits (dBuV/m)**	**Distance / Polarization**	**Margin (dB)**	**Detector**
Low Channel								
No emissions seen more than 6 dB above the noise floor.								

Test Date: August 23, 2022

Tested by
Signature: Test Engineer: Ian Charboneau

2.12 Unwanted Emissions of the Intentional Radiator, (CFR 15.209, 15.247(d) and 15.33(a))

The test data provided herein is to support the verification requirement for unwanted radiated emissions coming from the EUT in a transmitting state per 15.209 and was investigated from 9 kHz or the lowest operating clock frequency to the tenth harmonic of the highest operating clock frequency. The EUT was put into a continuous transmit mode of operation, the RF port was terminated with a 50 ohm load and tested as detailed in ANSI C63.10:2013, Clause 6.4.6. Data is presented in the table below.

The measurement bandwidths for each frequency scan that was evaluated were set as follows:

Frequency Span	RBW / VBW
9 kHz – 150 kHz	300 Hz / 1 kHz
150 kHz – 30 MHz	9 kHz / 30 kHz
30 MHz – 1 GHz	120 kHz / 300 kHz
Above 1 GHz	1 MHz / 3 MHz

Note: Based on the modification made to the EUT the frequency of investigation was conducted starting at 30 MHz and above.

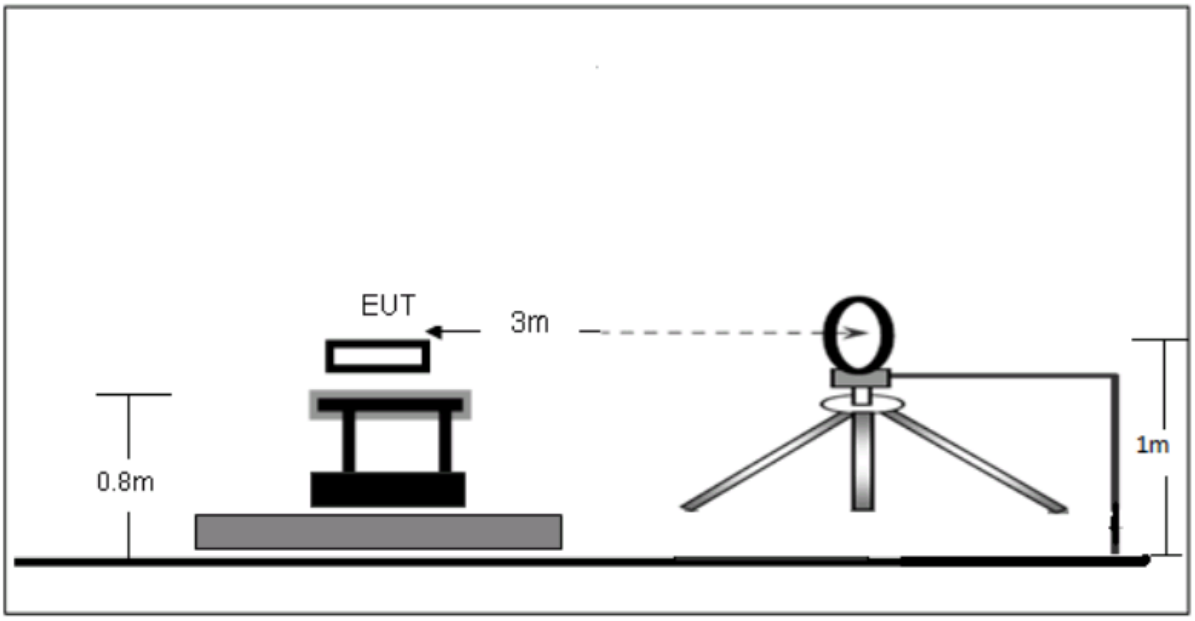


Figure 16. Radiated Emissions below 30 MHz

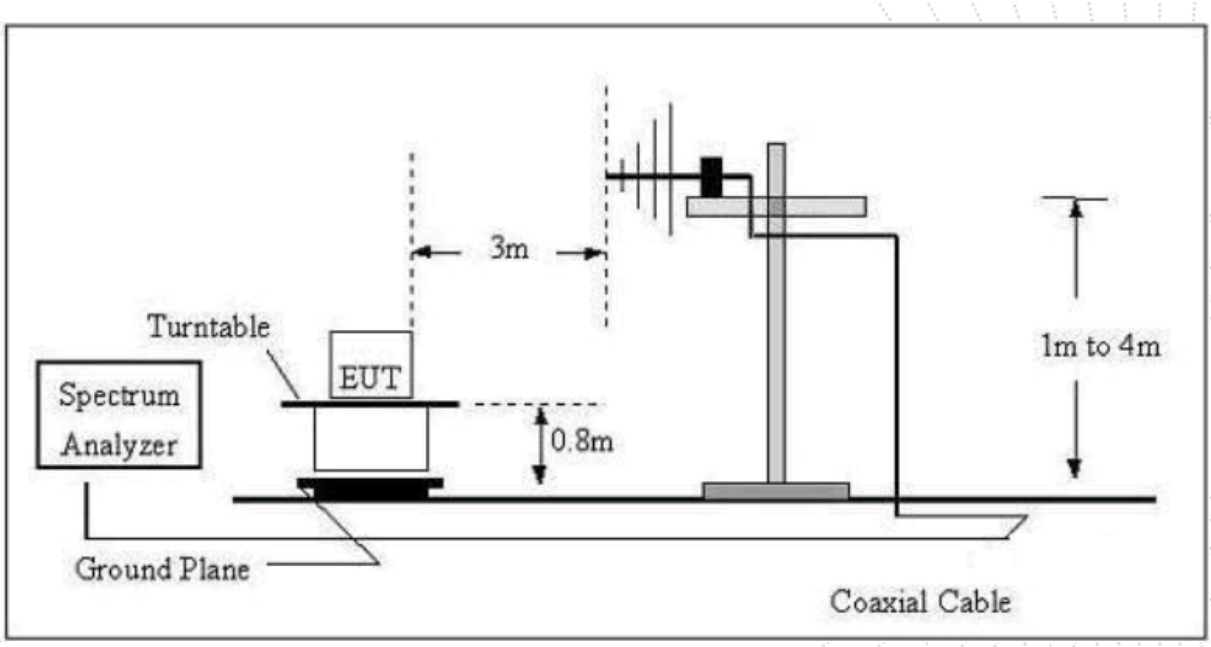


Figure 17. Radiated Emissions below 1000 MHz

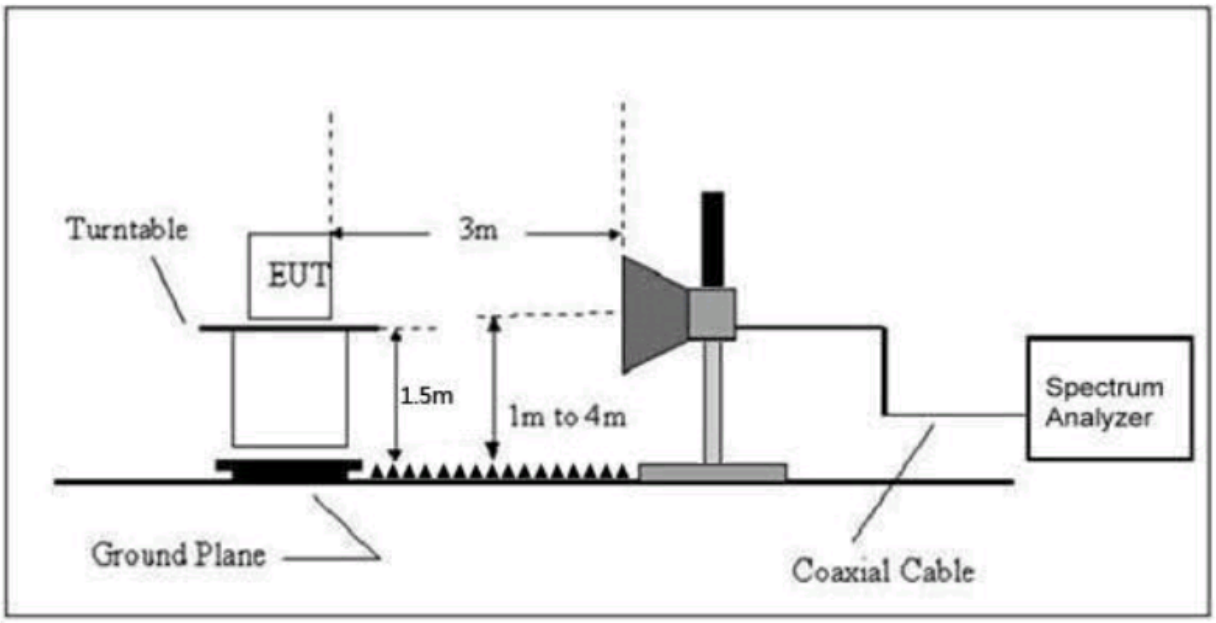


Figure 18. Radiated Emissions above 1 GHz

Table 12. Spurious Radiated Emissions (30 MHz – 1 GHz)

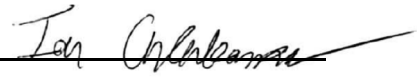
30 MHz to 1 GHz **Test:** FCC Part 15.209, 15.247(d)							
Frequency (MHz)	**Test Data (dBuV)**	**AF+CL-PA (dB)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Distance / Polarization**	**Margin (dB)**	**Detector PK / QP**
99.90	47.21	-17.56	29.65	43.5	3m./HORZ	13.8	**PK**
118.50	44.85	-15.84	29.01	43.5	3m./HORZ	14.5	**PK**
182.13	40.35	-12.67	27.68	43.5	3m./HORZ	15.8	**PK**
213.86	43.94	-14.52	29.42	43.5	3m./HORZ	14.1	**PK**
228.56	46.44	-14.32	32.12	46.0	3m./HORZ	13.9	**PK**
588.14	42.06	-6.48	35.58	46.0	3m./HORZ	10.4	**PK**
849.96	42.22	-3.29	38.93	46.0	3m./HORZ	7.1	**PK**
31.02	46.06	-14.54	31.52	40.0	3m./VERT	8.5	**PK**
51.60	48.43	-17.99	30.44	40.0	3m./VERT	9.6	**PK**
99.90	48.11	-16.66	31.45	43.5	3m./VERT	12.0	**PK**
118.56	47.35	-15.24	32.11	43.5	3m./VERT	11.4	**PK**
147.46	42.33	-13.27	29.06	43.5	3m./VERT	14.4	**PK**
228.56	42.89	-15.32	27.57	46.0	3m./VERT	18.4	**PK**
617.36	41.92	-7.41	34.51	46.0	3m./VERT	11.5	**PK**
882.52	41.83	-4.86	36.97	46.0	3m./VERT	9.0	**PK**

Note: In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. Attenuation below the general limits specified in § 15.209(a) is not required.

Sample Calculation at 99.90 MHz:

Magnitude of Measured Frequency	47.21	dBuV
+Antenna Factor + Cable Loss - Amplifier Gain	-17.56	dB/m
Corrected Result	29.65	dBuV/m

Test Date: August 1, 2022

Tested by
Signature:  Test Engineer: Ian Charboneau

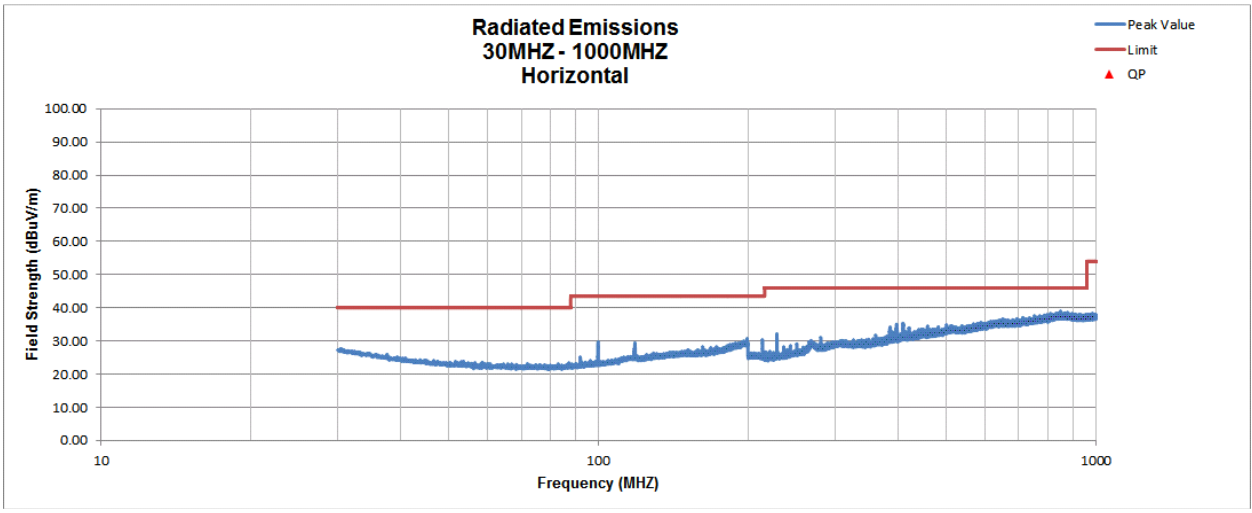


Figure 19. Horizontal Spurious Emissions, 30-1000 MHz

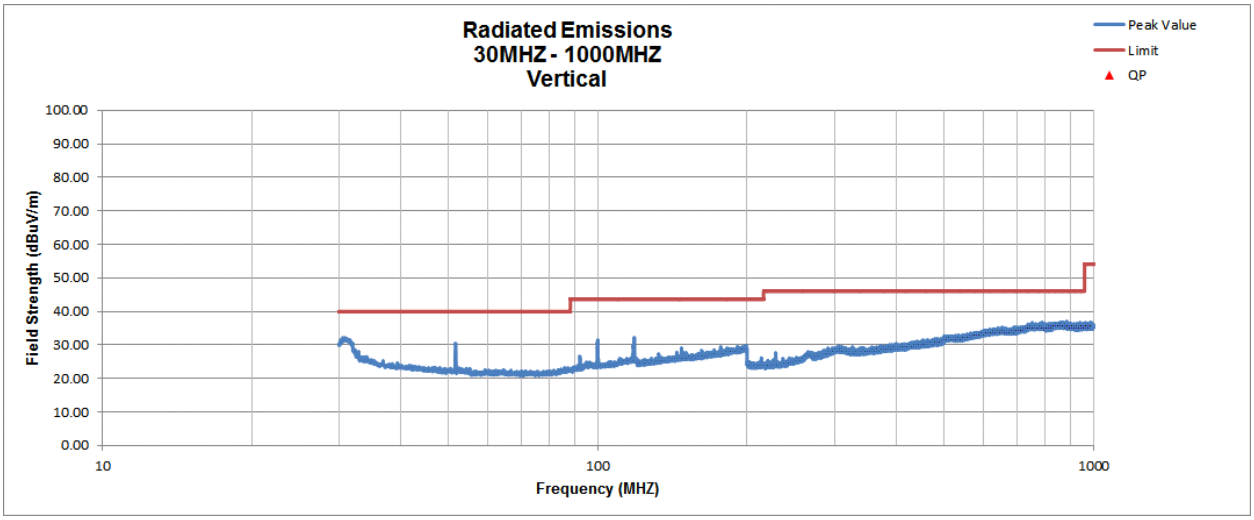


Figure 20. Vertical Spurious Emissions, 30-1000 MHz

Table 13. Spurious Radiated Emissions (1 GHz – 25 GHz)

Test: FCC Part 15.209, 15.247(d)							
Frequency (MHz)	**Test Data (dBuV)**	**AF+CL-PA (dB)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Distance / Polarization**	**Margin (dB)**	**Detector PK / AVG**
1860.00	34.32	-9.16	25.16	54.0	3.0m./HORZ	18.8	**AVG**
1064.50	34.51	-14.47	20.04	54.0	3.0m./VERT	24.0	**AVG**
1660.50	36.76	-10.49	26.27	54.0	3.0m./VERT	27.0	**AVG**
No additional emissions other than harmonics of the fundamental frequency were detected.							

Note: In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. Attenuation below the general limits specified in § 15.209(a) is not required.

Sample Calculation at 1860.00 MHz:

Magnitude of Measured Frequency	34.32	dBuV
+Antenna Factor + Cable Loss - Amplifier Gain	-9.16	dB/m
Corrected Result	25.16	dBuV/m

Test Date: August 1, 2022

Tested by
Signature: Test Engineer: Ian Charboneau

2.13 Measurement Uncertainty

The measurement uncertainties given were calculated using the method detailed in CISPR 16-4-2:2011. A coverage factor of k=2 was used to give a level of confidence of approximately 95%.

2.13.1 Conducted Emissions Measurement Uncertainty

Measurement Uncertainty (within a 95% confidence level) for this test is ±2.78 dB.

2.13.2 Radiated Emissions Measurement Uncertainty

For a measurement distance of 3 m the measurement uncertainty (with a 95% confidence level) for this test using a Biconical Antenna (30 MHz to 200 MHz) is ±5.3 dB. This value includes all elements of measurement.

The measurement uncertainty (with a 95% confidence level) for this test using a Log Periodic Antenna (200 MHz to 1000 MHz) is ±5.1 dB.

The measurement uncertainty (with a 95% confidence level) for this test using a Horn Antenna (Above 1000 MHz) is ±5.1 dB.

3 Test Results

The EUT is deemed to have met the requirements of the standards cited within the test report when tested as detailed in the test report.

END TEST REPORT