Testing Tomorrow's Technology

Application
For

Part 2, Subpart J, Paragraph 2.907 Equipment Authorization of Certification for an Intentional Radiator per Part 15, Subpart C Intentional Radiator, paragraphs 15.207, 15.209 and 15.247 Operation within the bands 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz.

For the

SwipeSense, Inc.

Model: Location Hub (HUB521)

FCC ID: 2AB5RHUB521

UST Project: 23-0081

Issue Date: June 27, 2023

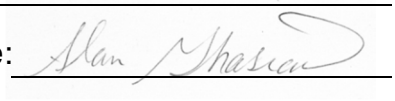
Total Pages: 48

3505 Francis Circle Alpharetta, GA 30004
PH: 770-740-0717 Fax: 770-740-1508
www.ustech-lab.com

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: June 27, 2023

NVLAP LAB CODE 200162-0

3505 Francis Circle Alpharetta, GA 30004
PH: 770-740-0717 Fax: 770-740-1508
www.ustech-lab.com

MEASUREMENT TECHNICAL REPORT

COMPANY NAME: SwipeSense, Inc.
MODEL: Location Hub
FCC ID: 2AB5RHUB521
DATE: June 27, 2020

This report concerns (check one): ☒Original grant □Class II change

Equipment type: 2.4 GHz BLE transmitter Device

Technical:
BLE
2402 MHz - 2480 MHz (Channels 0-39)
Type of modulation: GFSK
Data/Bit Rate: 1 MBPS
Antenna Gain: +1.15 dBi
Maximum Output Power: +3.64 dBm
Software used to program EUT: Nordic Microcontroller - nrfjprog
EUT firmware number: version 1.0
Power setting: Maximum level

Report prepared by:
US Tech
3505 Francis Circle
Alpharetta, GA30004

Table of Contents

List of Figures

Figures **Title** **Page**

List of Tables

List of Attachments

FCC Agency Agreement
FCC Application Forms
Letter of Confidentiality
Equipment Label(s)
Block Diagram(s)
Schematic(s)
External Photographs
Internal Photographs
Theory of Operation
RF Exposure
User's Manual
Test Configuration Photographs

1 General Information

1.1 Purpose of this Report

This report is prepared as a means of conveying test results and information concerning the suitability of this exact product for public distribution according to FCC Rules and Regulations Part 15, Section 247.

1.2 Characterization of Test Sample

The sample used for testing was received by US Tech on May 31, 2023 in good operating condition.

1.3 Product Description

The Equipment under Test (EUT) is the SwipeSense, Inc. Model Location Hub. This is a wall-mounted device that is placed inside each of the patient areas and non-patient areas. This device measures signal strength of badges located near it and transmits the information to the communication hub for processing. It also functions as a powered relay node for Hygiene and Entry Sensors installed beyond the range of the communication hub alone.

The EUT incorporates Bluetooth LE technology

The BLE radio details include:

Antenna Gain: 1.15 dBi
Bandwidth: 1 MHz bandwidth modulation
Maximum Output Power: +3.64 dBm

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 FCC KDB Publication number 558074 v03r05 for Digital Transmission Systems Operating Under section 15.247.

Digital RF conducted and radiated emissions data below 1 GHz were taken with the measuring receiver (or spectrum analyzer's) resolution bandwidth adjusted to 9 kHz and 120 kHz, respectively. All measurements performed above 1.0 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. 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 US5301.

1.6 Related Submittal(s)/Grant(s)

The EUT is subject to the following FCC Equipment Authorizations:

a) Certification of the transmitter incorporated within the EUT, see test data presented herein.

Table 1. EUT and Peripherals

PERIPHERAL MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	FCC/IC ID	CABLES P/D
EUT/ SwipeSense, Inc.	Location Hub	Engineering Sample	FCC ID: 2AB5RHUB521 (pending)	N/A
Laptop/ Acer	N20H1	NXVNDAA001017196E72N00	PD99560NG	PU/DU
Antenna See antenna details	--	--	--	--

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

2 Tests and Measurements

2.1 Test Equipment

The table below lists test equipment used to evaluate this product. Model numbers, serial numbers and their calibration status are included herein.

Table 2. Test Instruments

TEST INSTRUMENT	MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	CALIBRATION DUE DATE
Spectrum Analyzer	Agilent	E4407B	US41442935	9/21/2024 2 yr.
Spectrum Analyzer	Hewlett-Packard	8593E	3205A00124	2/28/2024 2 yr.
RF Preamp 100 kHz to 1.3 GHz	Hewlett-Packard	8447D	1937A02980	6/9/2023
RF Preamp 1.0 GHz to 26.0 GHz	Hewlett-Packard	8449B	3008A00480	3/3/2024
Loop Antenna	ETS Lindgren	6502	9810-3246	12/7/2024 2 yr.
Biconical Antenna	EMCO	3110B	9307-1431	1/13/2025 2 yr.
Log Periodic Antenna	EMCO	3146	9110-3236	12/13/2023 2 yr.
Horn Antenna	A. H. Systems	SAS-571	605	4/28/2024 2 yr.
High Pass Filter	Microwave Chircuits	H3R020G2	001DC9528	8/1/2023
Spectrum Analyzer	Rigol	DSA815	DSA8A180300138	1/6/2024 2 yr.
LISN	Solar Electronics	9247-50-TS-50-N	955824 and 955825	4/28/2024

Note 1: 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 requirements.

2.3 Number of Measurements for Intentional Radiators (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.

Table 3. 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

Because the EUT operates over 2.402 GHz to 2.480 GHz, 3 test frequencies will be used.

2.4 Frequency Range of Radiated Measurements (Part 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 following:

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, as measured using a peak detector, of 20 dB greater than the average limit. For all measurements above 1000 MHz the Resolution Bandwidth shall be at least 1 MHz .

2.6 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. Only the antenna(s) listed in Table 4 will be used with this module.

Table 4. Allowed Antenna(s)

REPORT REFERENCE	MANUFACTURER	TYPE OF ANTENNA	MODEL	GAIN dB_i	TYPE OF CONNECTOR
Antenna	SwipeSense, Inc.	Inverted F type	Stamped Steel Planar Inverted F-Antenna	1.15	Soldered

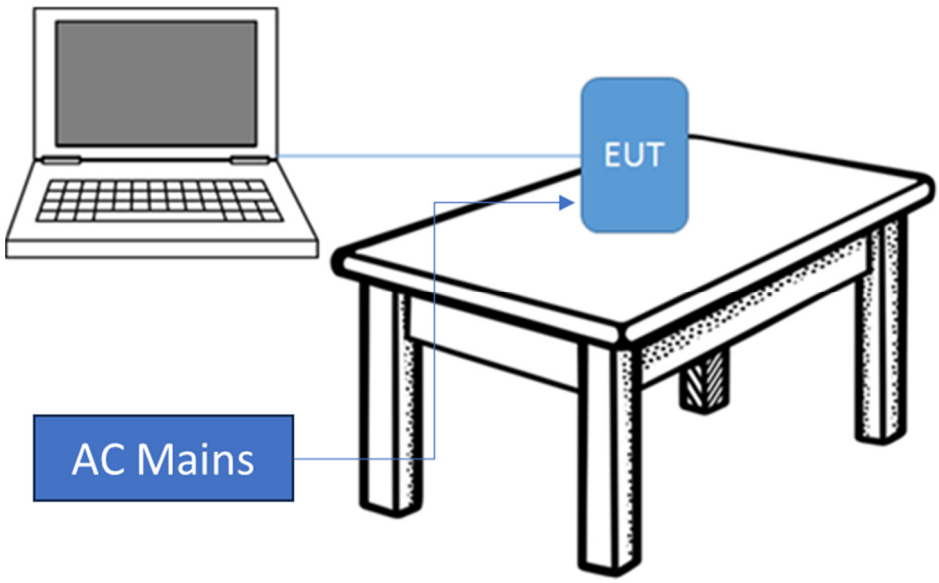


Figure 1. Block Diagram of Test Configuration

Note: PC used to program EUT for intentional spurious emissions and was not in the chamber during testing.

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 spurious cannot exceed the limits of 15.209. Radiated harmonics and other Spurious are examined for this requirement see paragraph 2.10.

2.8 Transmitter Duty Cycle (Part15.35 (c))

The EUT employs pulse transmission however for testing purpose the EUT was programmed to transmit at a rate >98%. The pulse transmission requirements of this subpart were acknowledged and considered during testing.

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.

2.9 Antenna Conducted Intentional and Spurious Emissions (CFR 15.209, 15.247(d))

The EUT was put into a continuous-transmit mode of operation and tested per ANSI C63.10-2013 for conducted out of band emissions emanating from the antenna port over the frequency range of 30 MHz to ten times the highest clock frequency generate or used in this case, 25 GHz. A conducted scan was performed on the EUT to identify and record spurious signals that were related to the transmitter. Antenna Conducted Emissions of a significant magnitude that fell within restricted bands were then measured as radiated emissions in the EMC Chamber. The conducted emissions graphs are found in the figures below. The limit for antenna conducted power is 1 Watt (30 dBm) per 15.247 (b)(3).

For Conducted RF antenna tests, the RBW was set to 100 kHz, video bandwidth (VBW)> RBW, scan up through the 10^{th} harmonic of the fundamental frequency. All harmonics/spurs must be at least 20 dB down from the highest emission level within the authorized band.

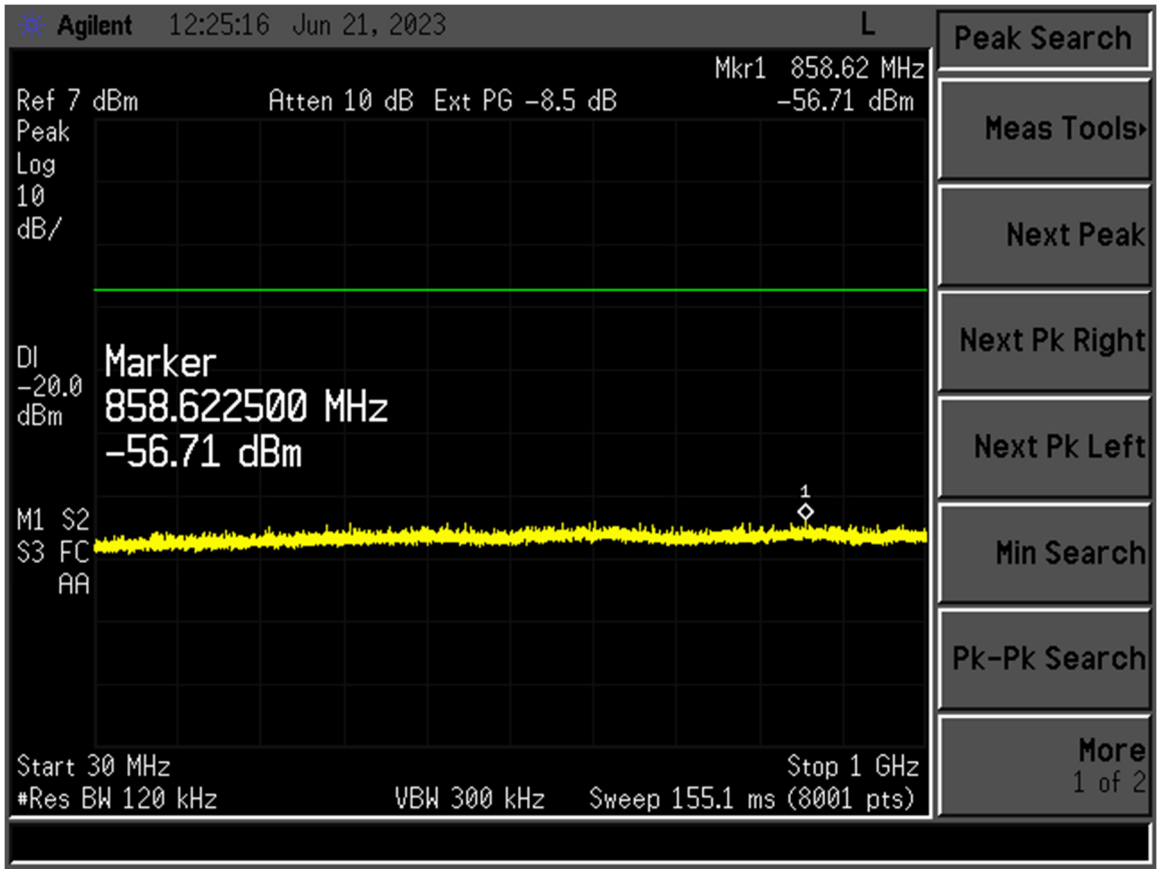


Figure 2. Channel 0, 30-1000 MHz

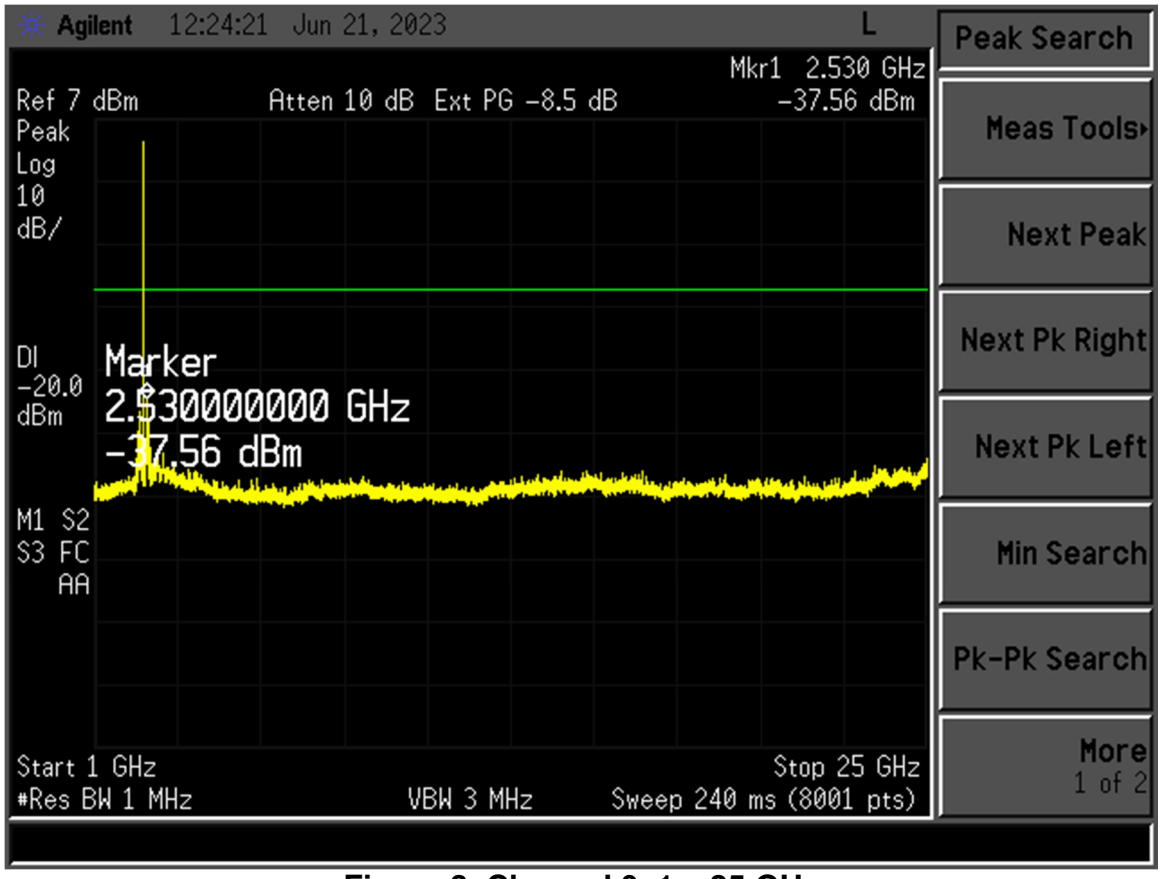


Figure 3. Channel 0, 1 – 25 GHz

(Note: Intentional Emission seen for radio operating at 2402 MHz)

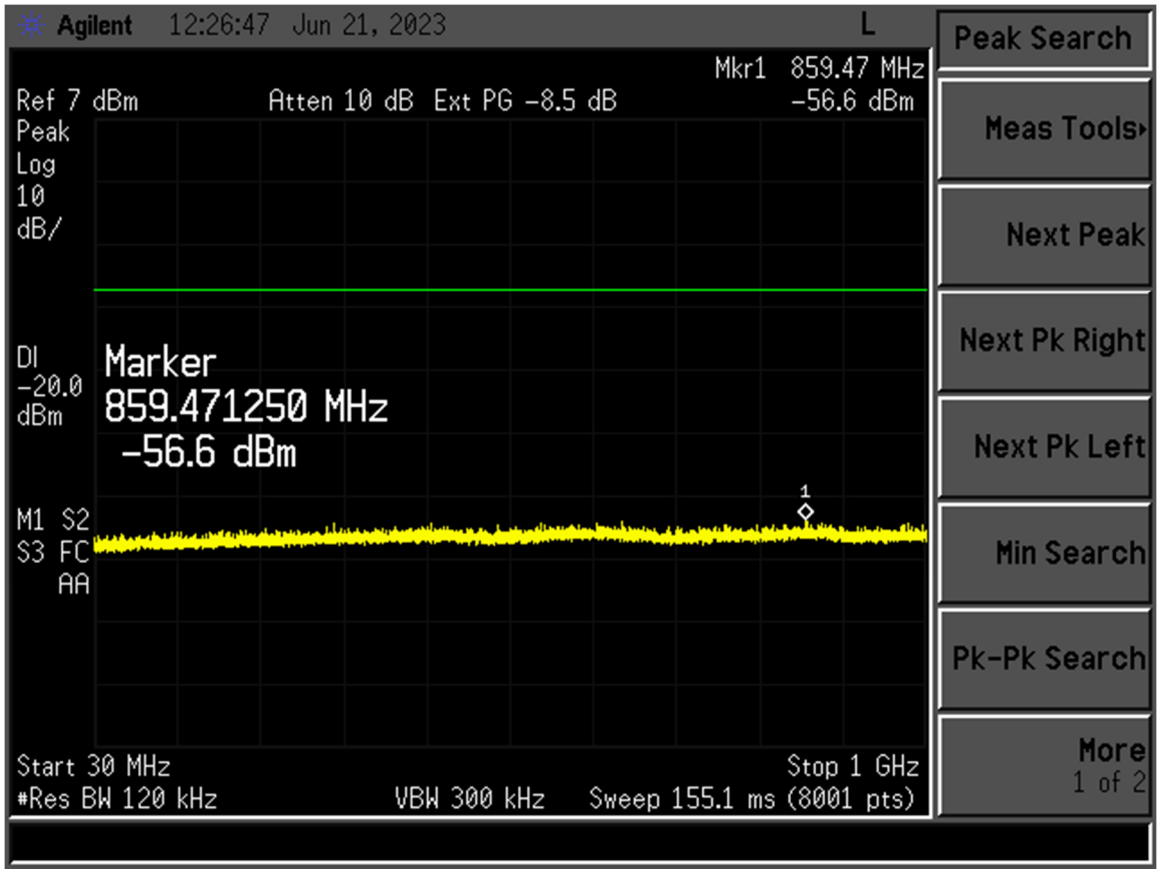


Figure 4. Channel 20, 30-1000 MHz

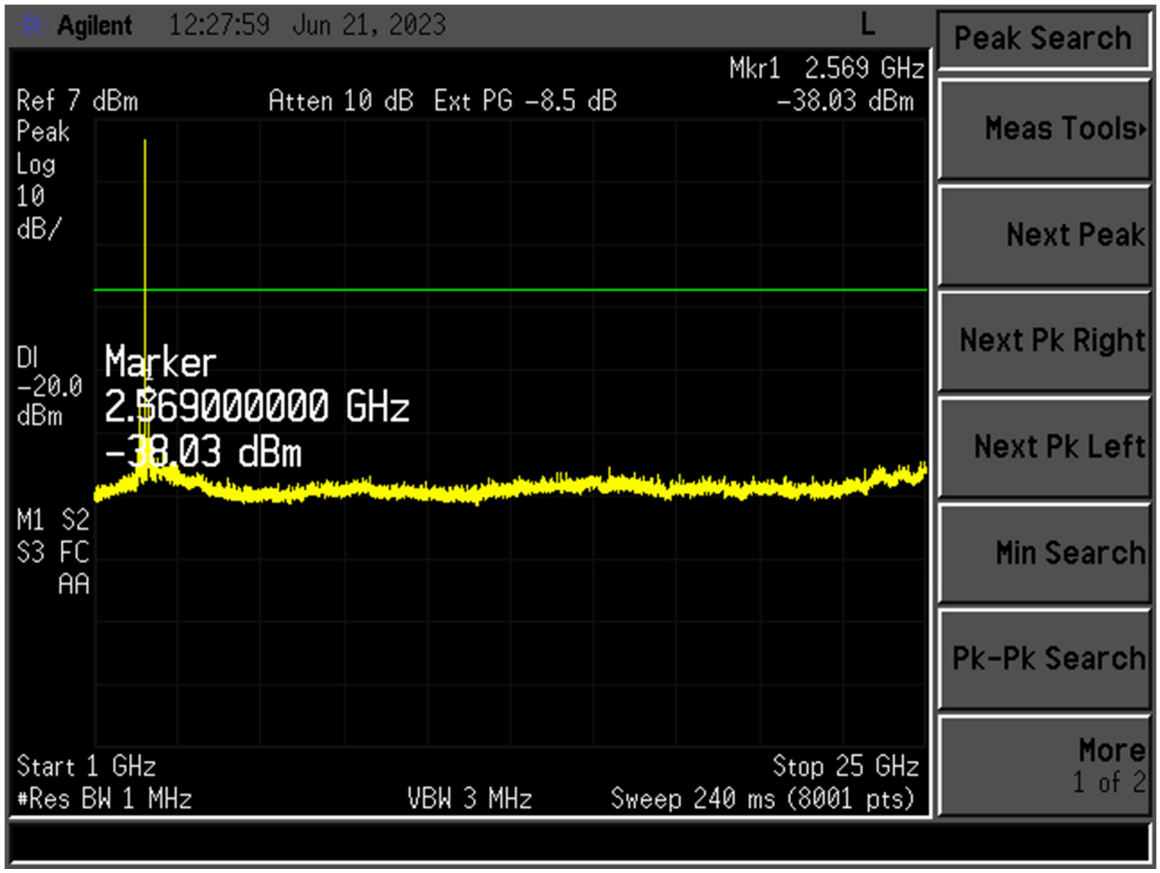


Figure 5. Channel 20, 1 – 25 GHz

(Note: Intentional Emission seen for radio operating at 2440 MHz)

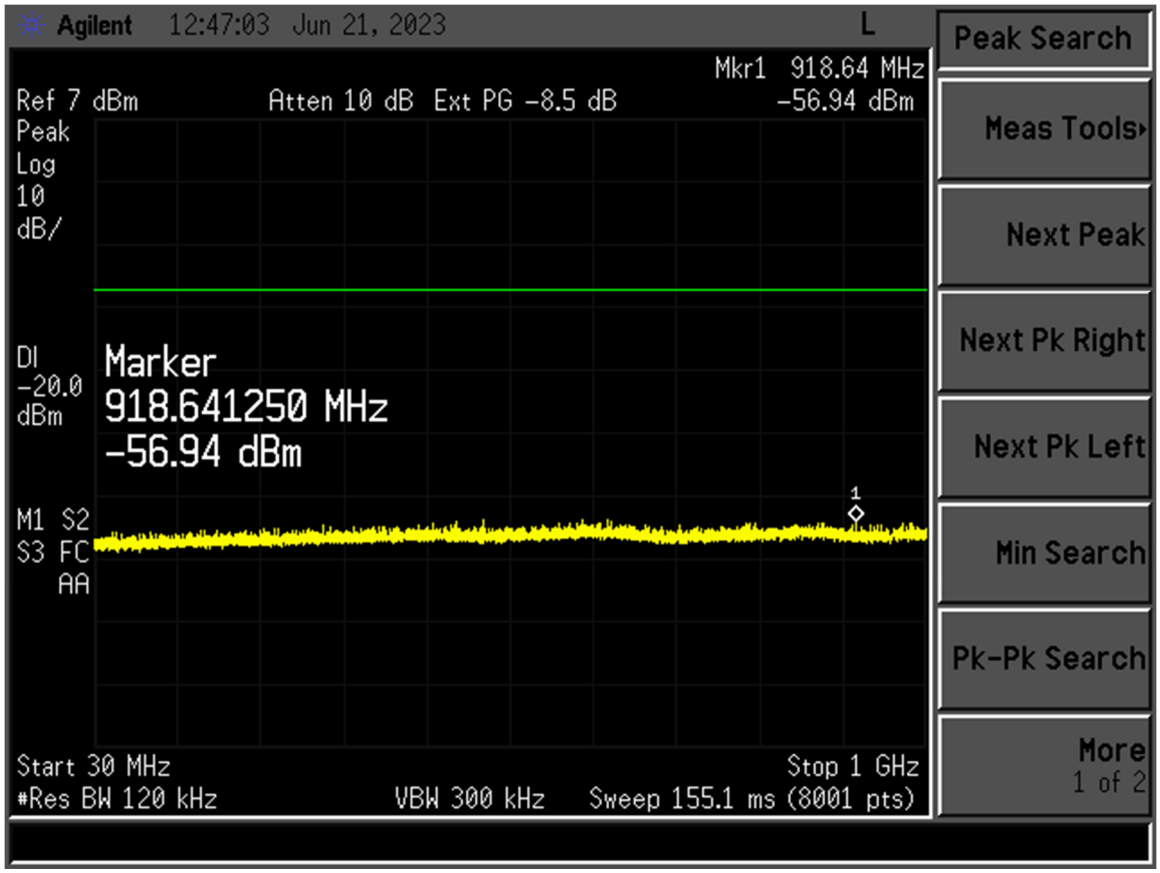


Figure 6. Channel 39, 30-1000 MHz

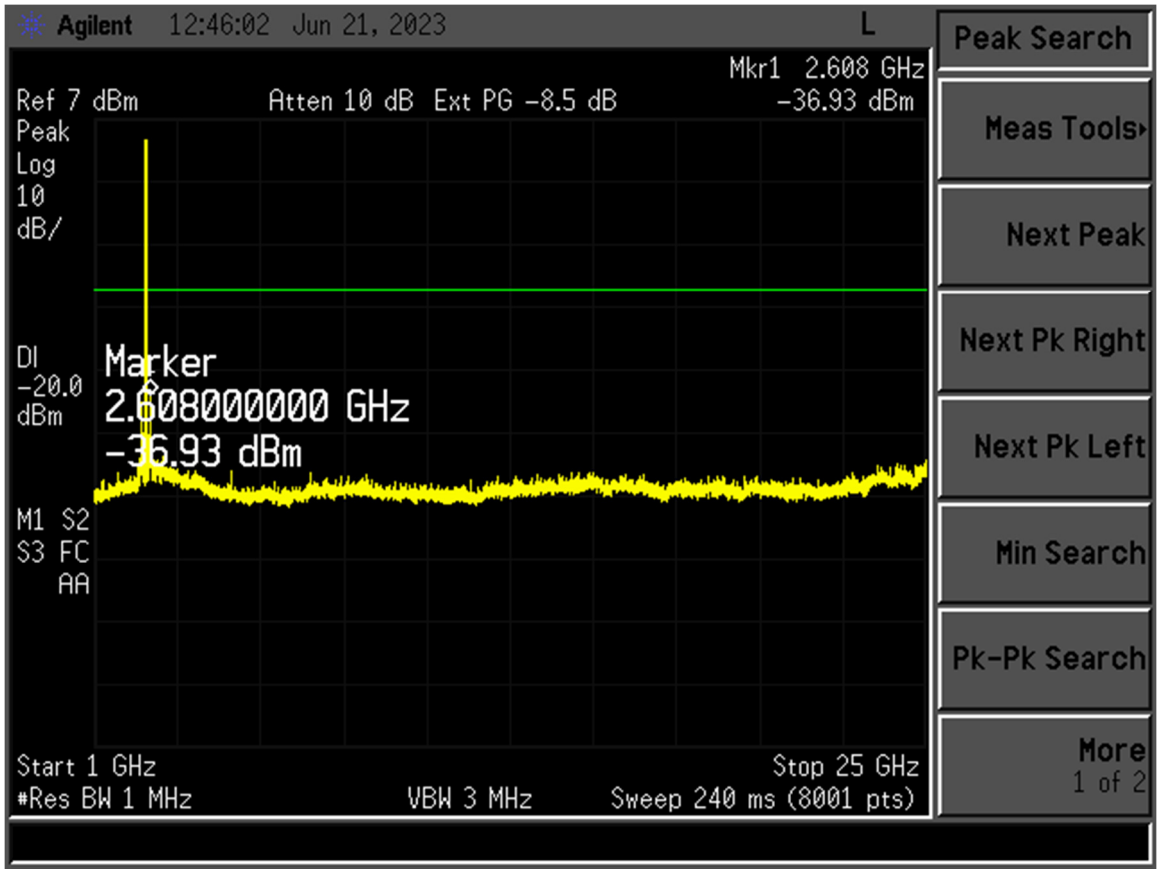


Figure 7. Channel 39, 1 - 25 GHz

(Note: Intentional Emission seen for radio operating at 2480 MHz)

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

On the test site, the EUT was placed on top of a non-conductive table, 80 cm above the floor for measurements below 1 GHz and 150 cm above the floor for measurements > 1 GHz. The EUT was also evaluated in three orthogonal positions to determine the worst-case position. The front of the EUT faced the measurement antenna located 3 meters away. Each signal measured was maximized by raising and lowering the receive antenna between 1 and 4 meters in height while monitoring the ever-changing spectrum analyzer display (with channel A in the Clear-Write mode and channel B in the Max-Hold mode) for the largest signal visible. That exact antenna height where the signal was maximized was recorded for reproducibility purposes. Also, the EUT was rotated about its Y-axis while monitoring the Spectrum Analyzer display for maximum. The EUT azimuth was recorded for reproducibility purposes. The EUT was measured when both maxima were simultaneously satisfied.

For radiated measurements, the EUT was set into a 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 ≥ RBW. The results of peak radiated spurious emissions falling within restricted bands are given in Table 6below.

For Average measurements above 1 GHz, the emissions were measured using RBW = 1 MHz and VBW = 10 Hz or the duty cycle correction factor was applied to the Peak recorded value.

Table 5. Peak Radiated Fundamental & Harmonic Emissions

Test: FCC Part 15,247(d)								
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 - PEAK								
2402.00	102.30	0.00	-5.98	96.32	--	3.0m./HORZ	--	**PK**
*4804.00	54.03	0.00	0.93	54.96	74.0	3.0m./HORZ	19.0	**PK**
*7206.00	62.86	-9.50	6.04	59.40	74.0	1.0m./HORZ	14.6	**PK**
Mid Channel – PEAK								
2442.00	102.90	0.00	-5.58	97.32	--	3.0m./HORZ	--	**PK**
*4884.00	48.53	0.00	0.93	49.46	74.0	3.0m./HORZ	24.5	**PK**
*7326.00	61.65	-9.50	6.70	58.85	74.0	1.0m./VERT	15.1	**PK**
High Channel– PEAK								
2480.00	102.18	0.00	-5.57	96.61	--	3.0m./HORZ	--	**PK**
*4960.00	57.35	0.00	1.41	58.76	74.0	3.0m./HORZ	15.2	**PK**
*7440.00	57.35	-9.50	5.62	53.47	74.0	1.0m./HORZ	20.5	**PK**

1. (*) Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209& 15.247.
2. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic
3. The EUT was placed in three orthogonal positions, tested while broadcasting from each antenna, and the transmitter was in constant broadcast mode, with a duty cycle of greater than 98%. The emissions were measured with the receive antenna in vertical and horizontal polarizations. The data listed in the above table was worst case.
4. Measurement at 1 meters corrected using inverse extrapolation factor of -9.5 dB to correct the value for 3 meter.

Sample Calculation at 2412.00 MHz:

Magnitude of Measured Frequency	102.30	dBuV
+Additional Factor	0.00	dB
+Antenna Factor + Cable Loss+ Amplifier Gain	-5.98	dB/m
Corrected Result	96.32	dBuV/m

Test Date: June 6, 2023

Tested By
Signature: Ian Charboneau Name: Ian Charboneau

Table 6. Average Radiated Fundamental & Harmonic Emissions

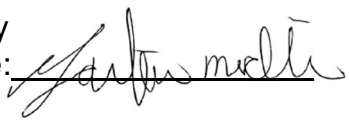
Test: FCC Part 15,247(d)								
Frequency (MHz)	**Test Data (dBuV)**	**Additional Factor**	**AF+CL-PA (dB/m)**	**Corrected Results (dBuV/m)**	**Limits (dBuV/m)**	**Distance / Polarization**	**Margin (dB)**	**Detector**
	Low Channel - Average							
2402.00	94.57	0.00	-5.98	88.59	--	3.0m./HORZ	--	**AVG**
*4824.00	39.88	0.00	0.93	40.81	54.0	3.0m./HORZ	13.2	**AVG**
*7206.00	45.74	-9.50	4.74	40.98	54.0	1.0m./HORZ	13.0	**AVG**
	Mid Channel–Average							
2442.00	95.66	0.00	-5.58	90.08	--	3.0m./HORZ	--	**AVG**
*4884.00	34.02	0.00	0.93	34.95	54.0	3.0m./HORZ	19.0	**AVG**
*7326.00	43.97	-9.50	6.70	41.17	54.0	1.0m./HORZ	12.8	**AVG**
	High Channel–Average							
2462.00	94.50	0.00	-5.57	88.93	--	3.0m./HORZ	--	**AVG**
*4924.00	33.32	0.00	1.41	34.73	54.0	3.0m./HORZ	19.3	**AVG**
*7440.00	43.84	-9.50	5.60	39.44	54.0	1.0m./HORZ	14.6	**AVG**

1. (*) Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209 CFR 15.35.
2. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic
3. The EUT was placed in three orthogonal positions, tested while broadcasting from each antenna, and the transmitter was in constant broadcast mode, with a duty cycle of greater than 98%. The emissions were measured with the receive antenna in vertical and horizontal polarizations. The data listed in the above table was worst case.
4. Measurement at 1 meters corrected using inverse extrapolation factor of -9.5 dB to correct the value for 3 meter.

Sample Calculation at 2402.00MHz:

Magnitude of Measured Frequency	94.57	dBuV
+Additional Factor (filter + duty cycle)	0.00	dB
+Antenna Factor + Cable Loss+ Amplifier Gain – Duty Cycle	-5.98	dB/m
Corrected Result	88.59	dBuV/m

Test Date: June 22, 2023

Tested By
Signature:  Name: Gabriel Medina

2.11 Band Edge Measurements (CFR 15.247(d))

Band Edge measurements are made following the guidelines in ANSI C63.10-2013 Clause 6.10 with the EUT initially operating on the Lowest Channel and then operating on the Highest Channel within its band of operation. Restricted band and band edge test is performed as radiated measurements. The test instrument used for testing has both Peak and Average detection. In consideration of Clause 5.8 of ANSI C63.10-2013, the EUT antenna is connected to its antenna port during testing. The EUT was set to its highest rated output power level during testing. The results are collected and presented below.

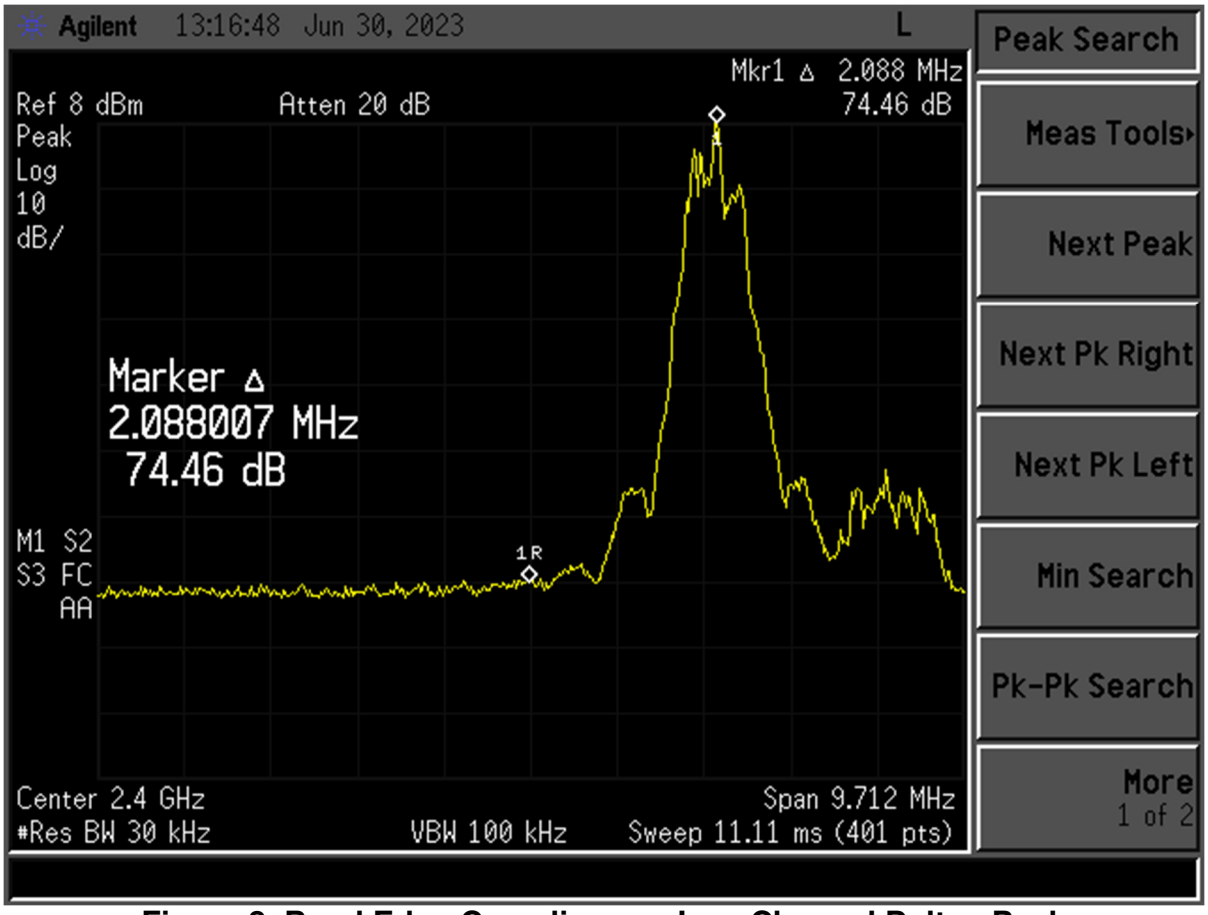


Figure 8. Band Edge Compliance – Low Channel Delta - Peak

Lower band edge must be 20 dB below the fundamental. This requirement is met.

Measured Result	74.46	dB
Band Edge Limit	20.00	dB
Band Edge Margin	54.46	dB

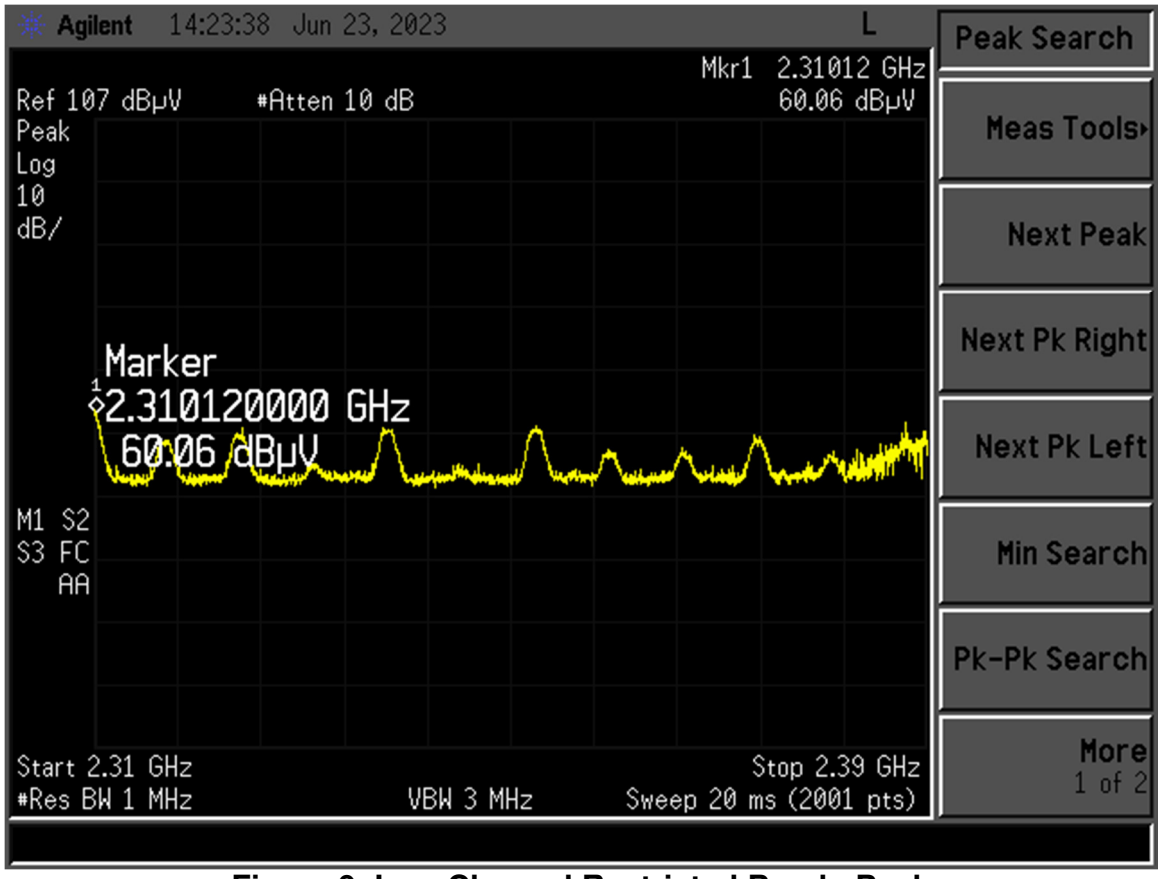


Figure 9. Low Channel Restricted Band - Peak

Frequency (MHz)	Test Data (dBuV)	AF+CA-MP+DC (dB/m)	Results (dBuV/m)	Limits (dBuV/m)	Distance / Polarization	Margin (dB)	Detector PK/QP/AVG
2310.12	60.06	-6.76	53.30	74.0	3.0m./HORZ	20.7	**PK**

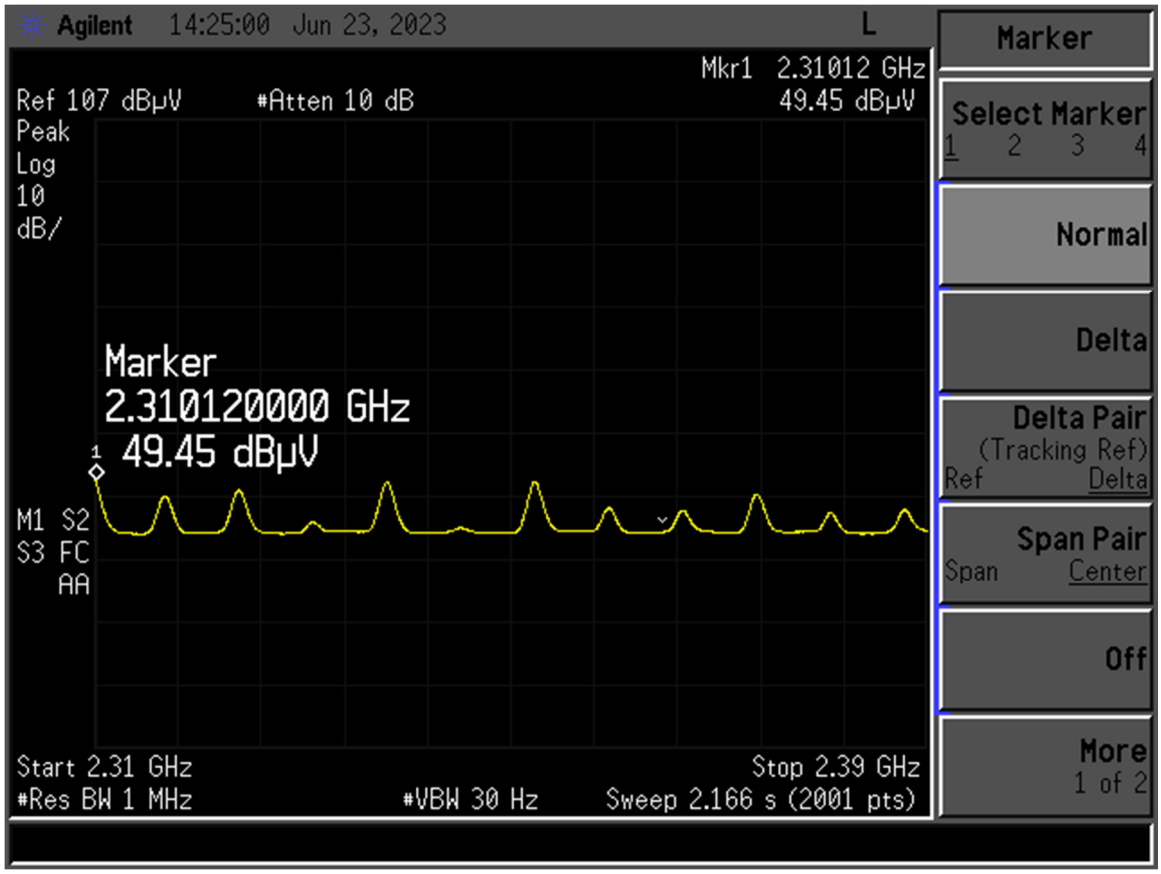


Figure 10. Low Channel Restricted Band - Peak

Frequency (MHz)	Test Data (dBuV)	AF+CA-MP+DC (dB/m)	Results (dBuV/m)	Limits (dBuV/m)	Distance / Polarization	Margin (dB)	Detector PK/QP/AVG
2310.12	49.45	-6.76	42.69	54.0	3.0m./HORZ	11.3	**AVG**

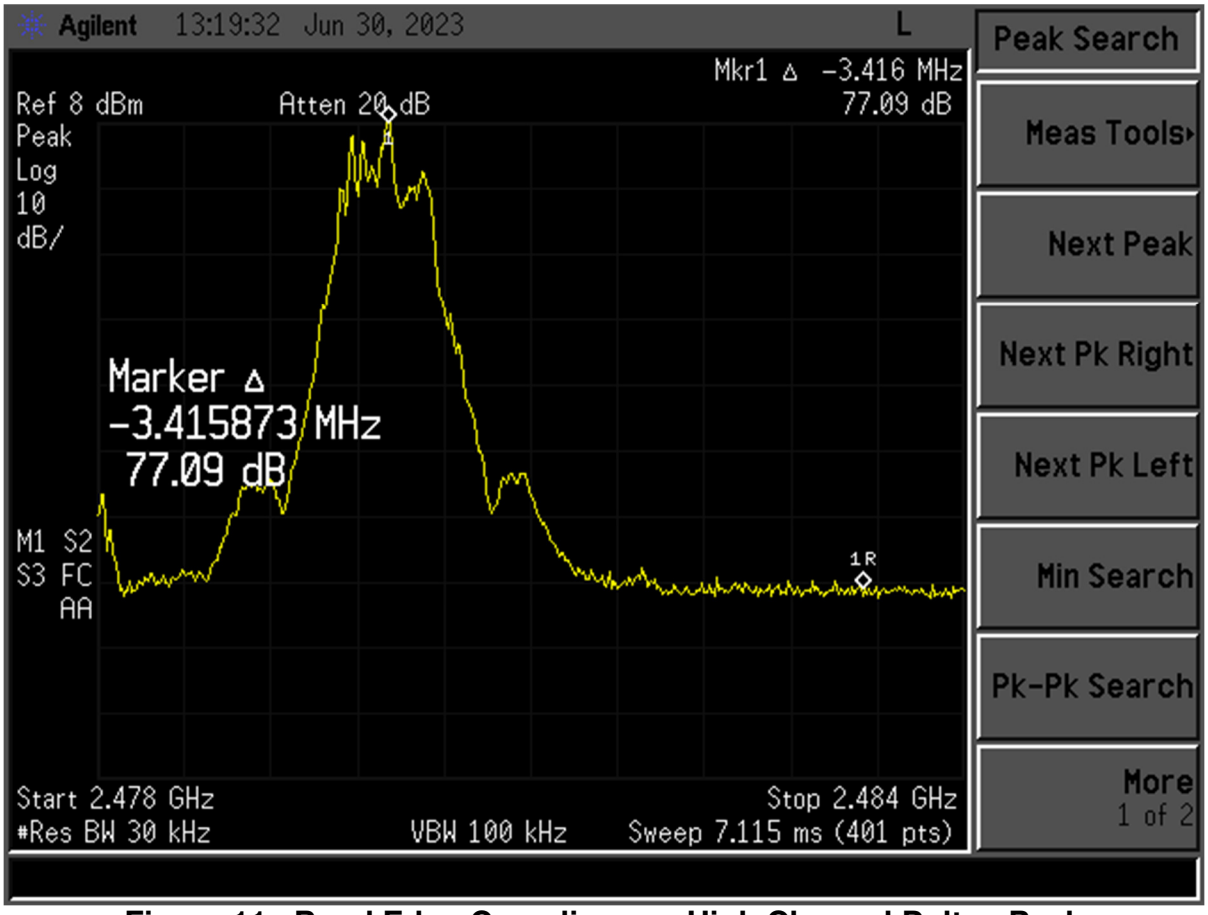


Figure 11. Band Edge Compliance – High Channel Delta - Peak

Higher band edge must be 20 dB below the fundamental. This requirement is met.

Measured Result	77.09	dB
Band Edge Limit	20.00	dB
Band Edge Margin	57.09	dB

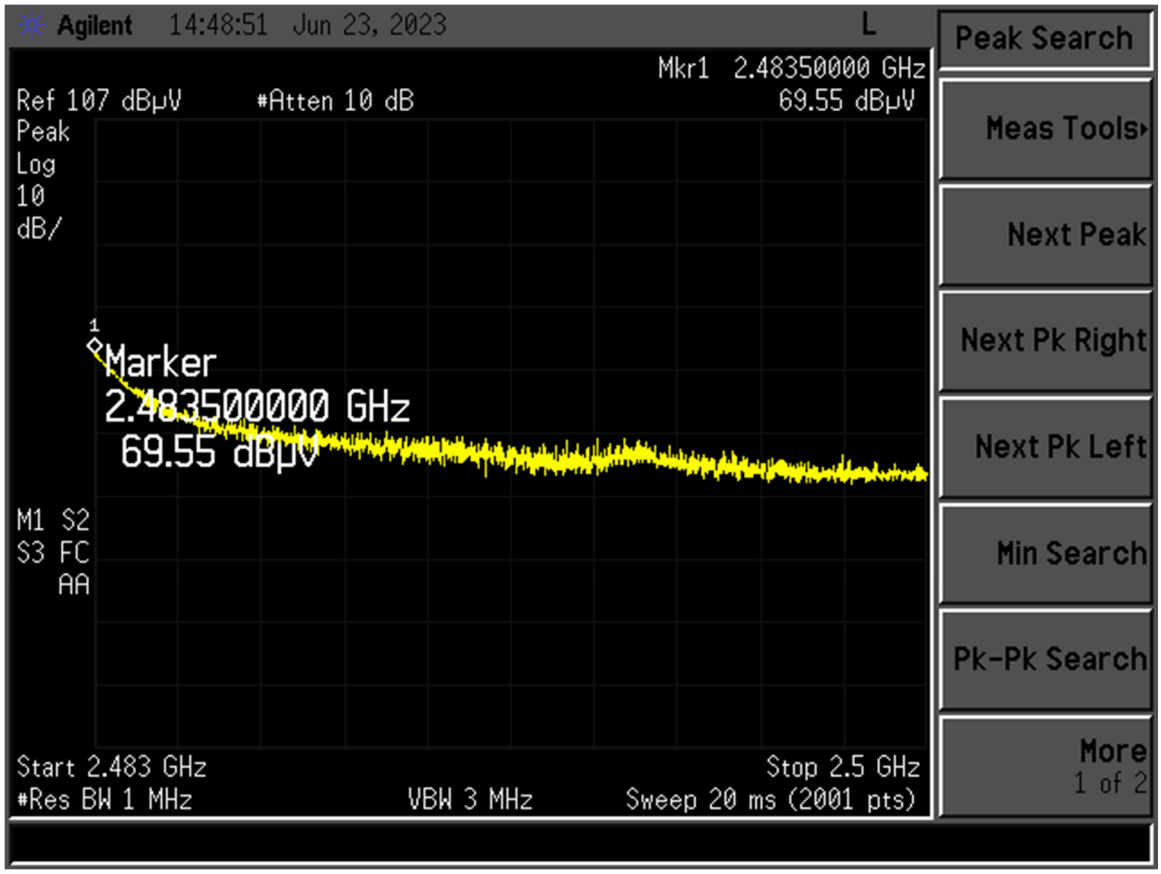


Figure 12. High Channel Restricted Band – Peak

Frequency (MHz)	Test Data (dBuV)	AF+CA-MP+DC (dB/m)	Results (dBuV/m)	Limits (dBuV/m)	Distance / Polarization	Margin (dB)	Detector PK/QP/AVG
2483.50	69.55	-5.57	63.98	74.0	3.0m./HORZ	10.0	**PK**

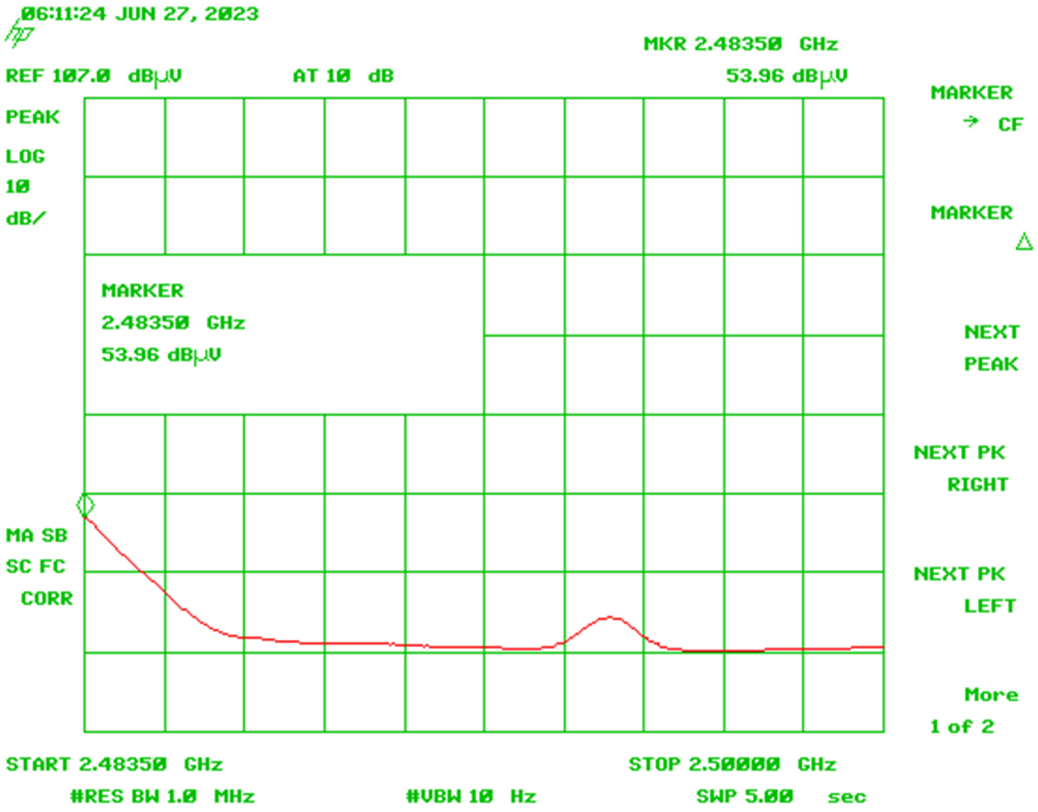


Figure 13. High Channel Restricted Band – Average

Frequency (MHz)	Test Data (dBuV)	AF+CA-MP+DC (dB/m)	Results (dBuV/m)	Limits (dBuV/m)	Distance / Polarization	Margin (dB)	Detector PK/QP/AVG
2485.30	53.96	-5.57	48.39	54.0	3.0m./HORZ	5.6	**AVG**

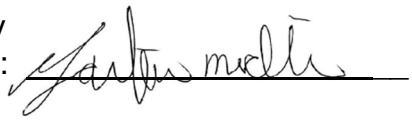
2.12 Six (6) dB Bandwidth (CFR 15.247(a)(2))

The EUT antenna port was connected to a spectrum analyzer having a 50 Ω input impedance. Measurements were performed per ANSI C63.10-2013, clause 11.8. The RBW was set to 100 kHz and the VBW ≥ RBW. The results of this test are given in the table below and figures below.

Table 7. Six (6) dB Bandwidth

Frequency (MHz)	6 dB Bandwidth (MHz)	Minimum FCC Bandwidth (MHz)
2402.0	0.750	0.5
2442.0	0.750	0.5
2480.0	0.750	0.5

Test Date: June 21, 2023

Tested By
Signature:  Name: Gabriel Medina

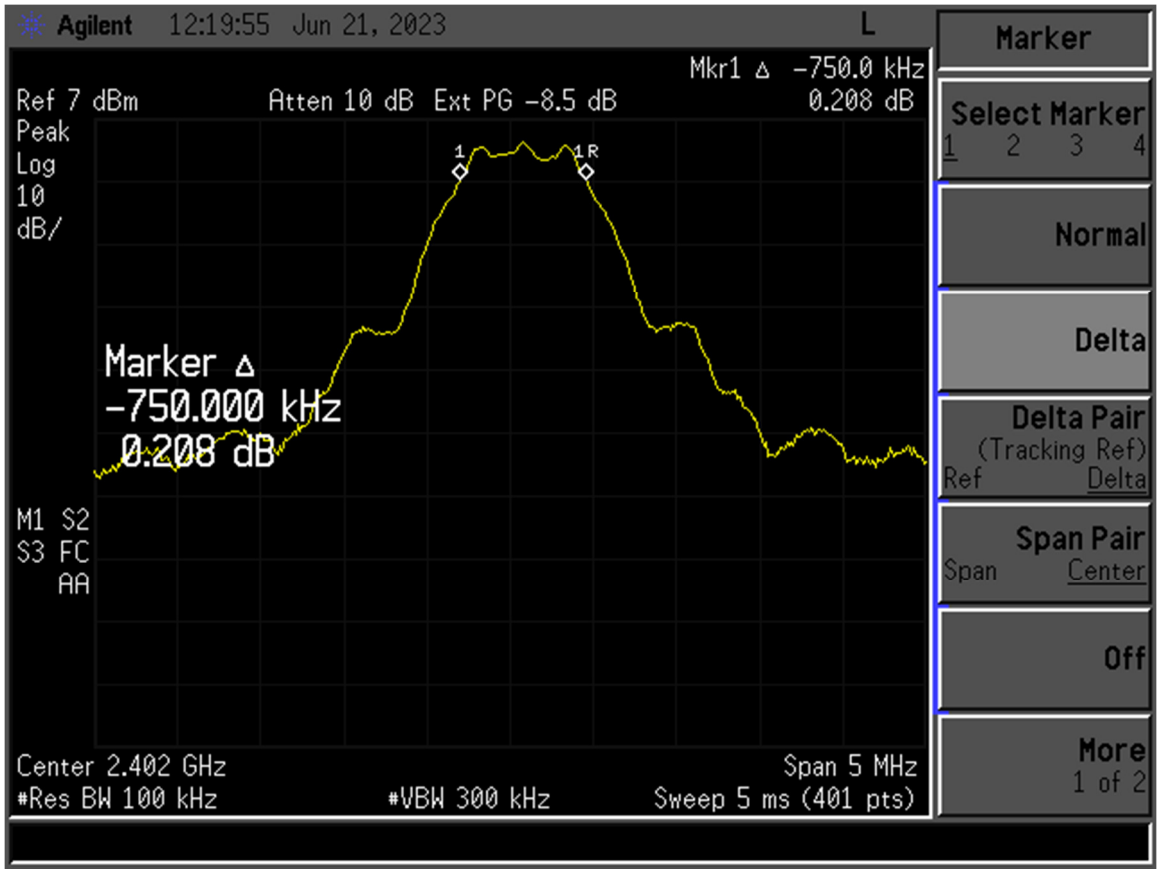


Figure 14. 6 dB Bandwidth Low Channel

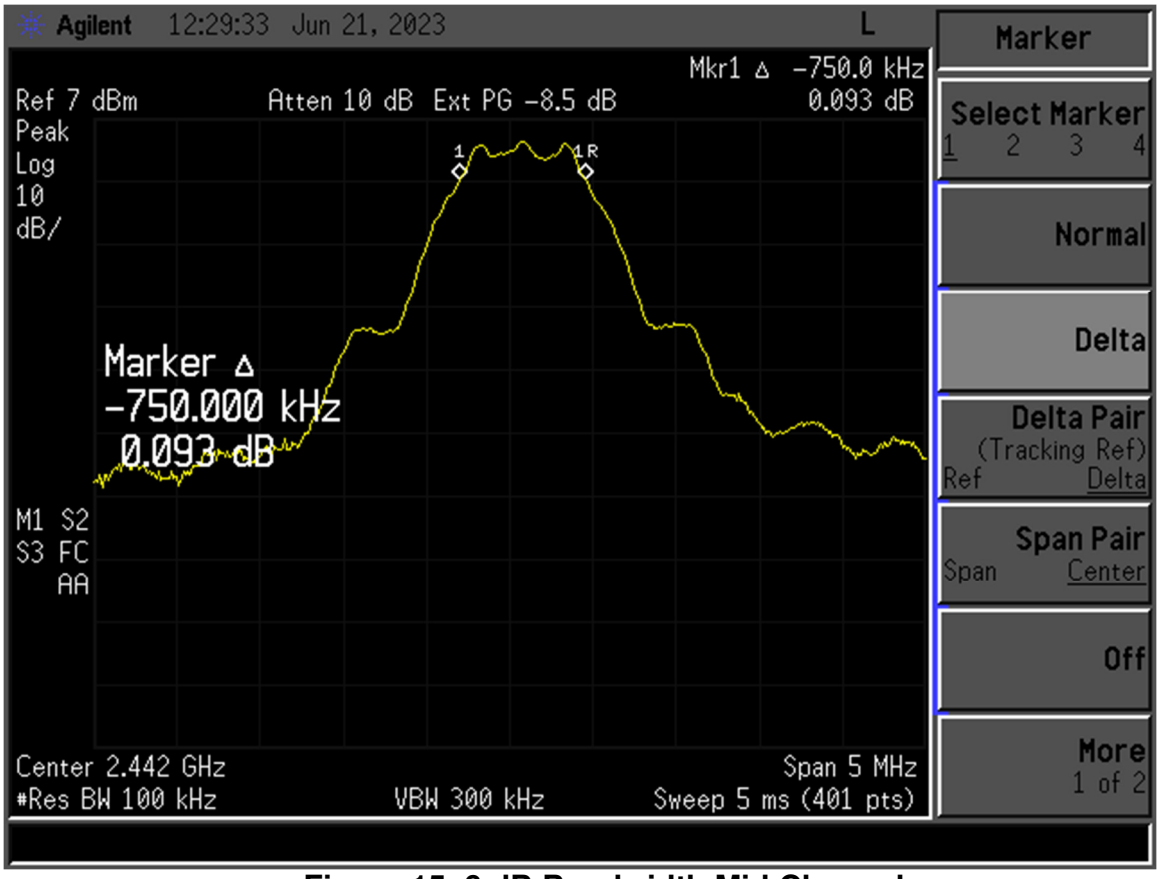


Figure 15. 6 dB Bandwidth Mid Channel

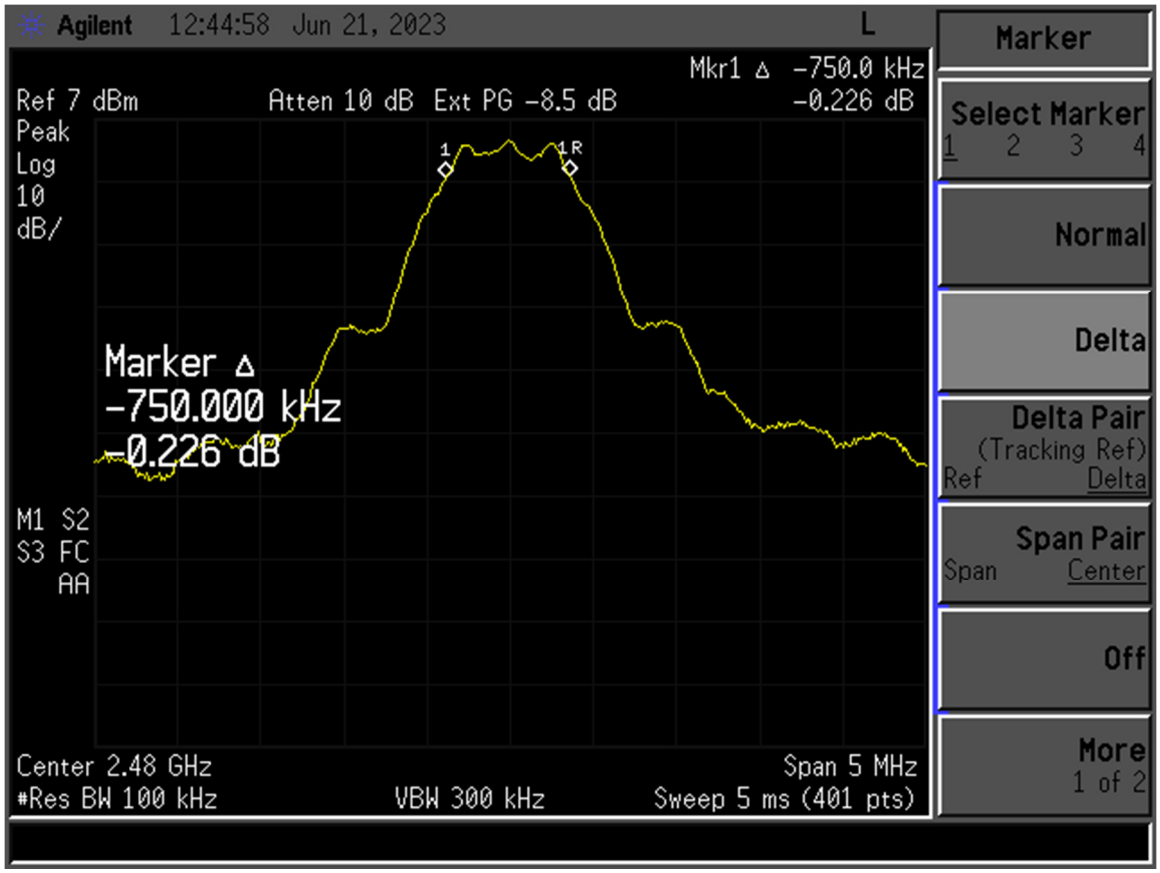


Figure 16. 6 dB Bandwidth High Channel

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

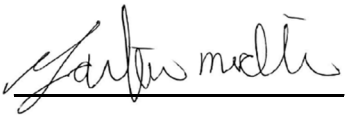
The transmitter was programmed to operate at a maximum output power across the bandwidth. For this test the output power of the radio was set to the maximum data rate, with 11Mbps for mode b, 54 Mbps for made g, and MSC-7 for mode n, in order to meet all test requirements.

Peak power within the band 2400 MHz to 2483.5 MHz was measured per ANSI C63.10-2013 as an Antenna Conducted test with a spectrum analyzer by connecting the spectrum analyzer directly, via a short RF cable, and attenuators to the antenna output terminals on the EUT. The spectrum analyzer was set to a RBW of1 MHz, and the VBW ≥ RBW. The integration method was used. Peak antenna conducted output power is tabulated in the table below.

Table 8. Peak Antenna Conducted Output Power per Part 15.247 (b)(3)

Frequency of Fundamental (MHz)	Raw Test Data dBm	Converted Data (mW)	FCC Limit (mW Maximum)
2402	3.33	2.15	1000
2442	3.60	2.29	1000
2480	3.64	2.31	1000

Test Date: June 21, 2023

Tested By
Signature:  Name: Gabriel Medina

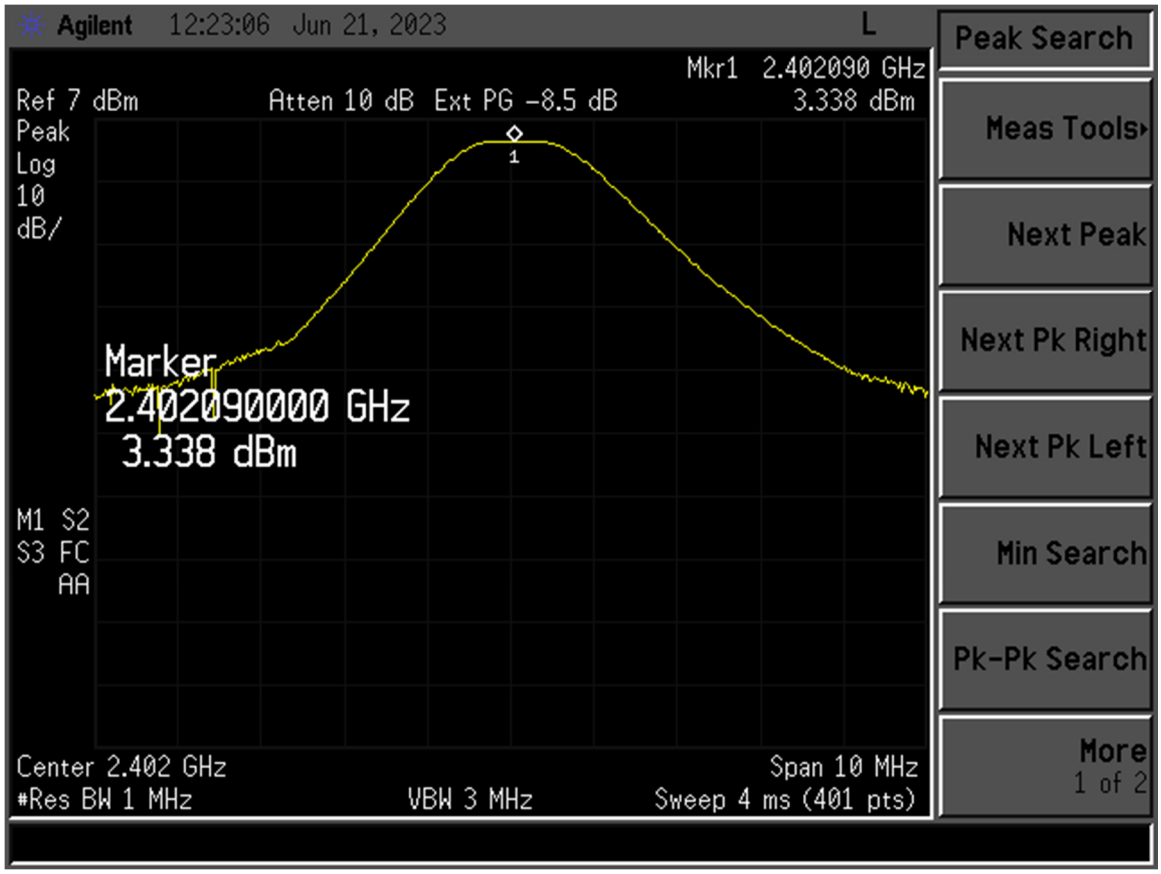


Figure 17. Peak Antenna Conducted Output Power, Low Channel

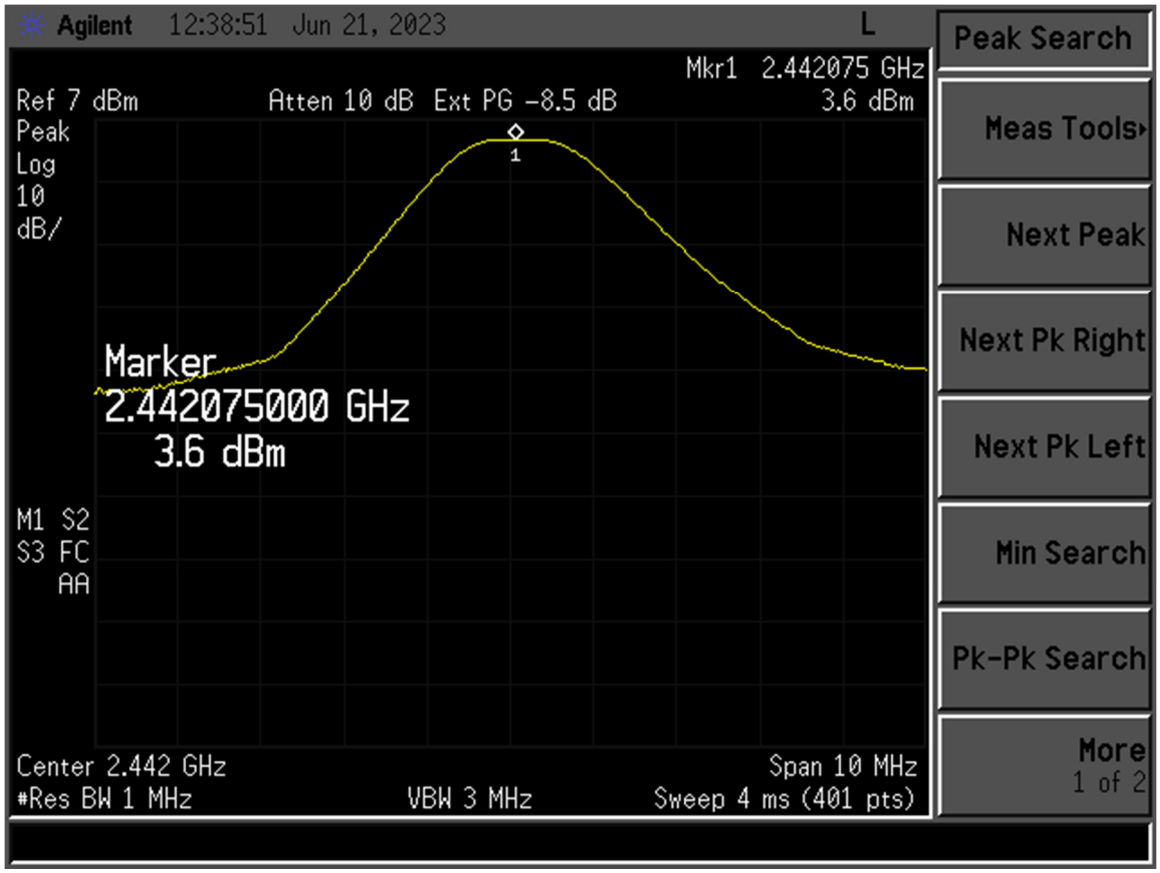


Figure 18. Peak Antenna Conducted Output Power, Mid Channel

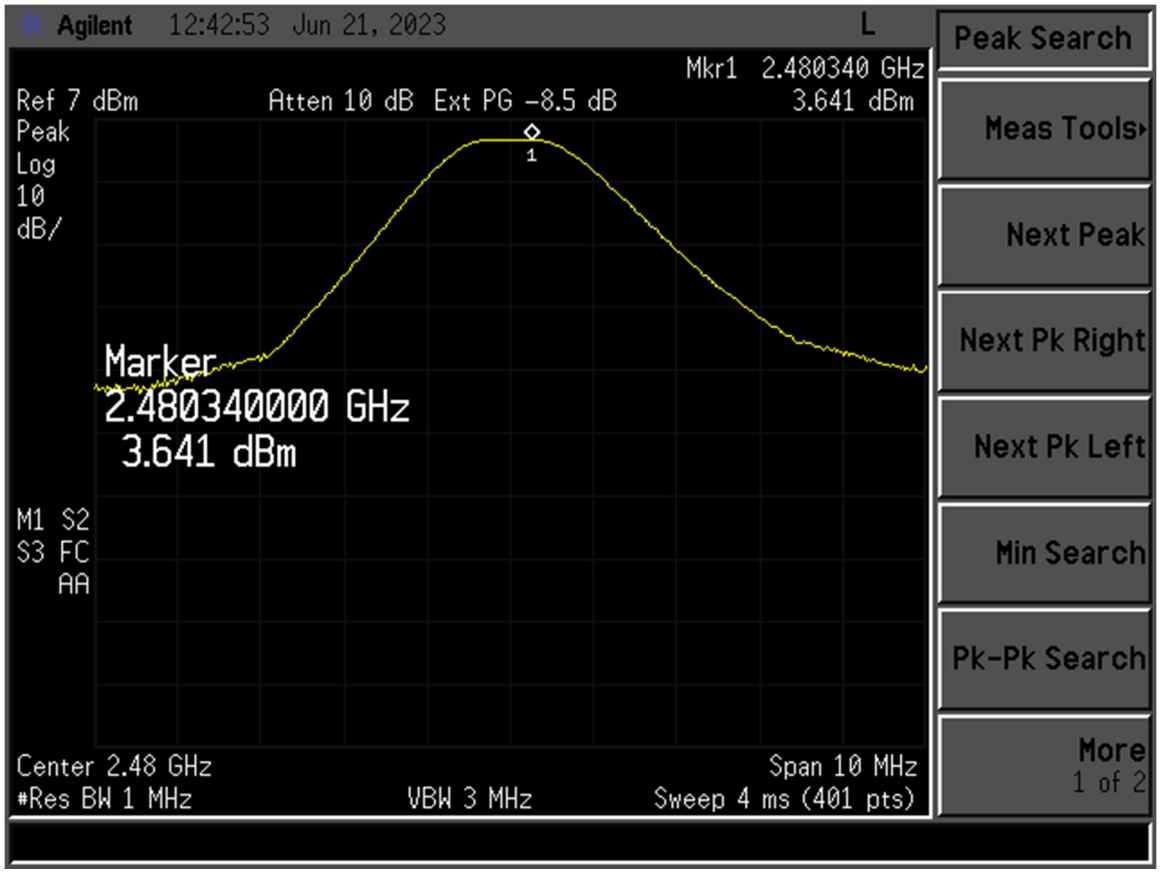


Figure 19. Peak Antenna Conducted Output Power, High Channel

2.14 Power Spectral Density (CFR 15.247(e))

The transmitter was placed into a continuous mode of operation at all applicable frequencies. The measurements were performed per the procedures of ANSI C63.10-2013. The RBW was set to 3 kHz and the Video Bandwidth was set to ≥ RBW. The trace capture time was set to (Span/3 kHz).

In accordance with 15.247 (e), the power spectral density shall be no greater than +8 dBm per any 3 kHz band.

Results are shown in the table below and figures below. All are less than +8 dBm per 3 kHz band. See figures below.

Table 9. Power Spectral Density for Low, Mid and High Bands

Frequency (MHz)	Measured Result (dBm/3kHz)	FCC Limit (dBm/3 kHz)
2402	-11.27	+8.0
2442	-11.05	+8.0
2480	-11.05	+8.0

Note: dBm/Hz correct to dBm/kHz using the following formula, 10 log RBW ref/RBW measured.

Test Date: June 21, 2023

Tested By
Signature:  Name: Gabriel Medina

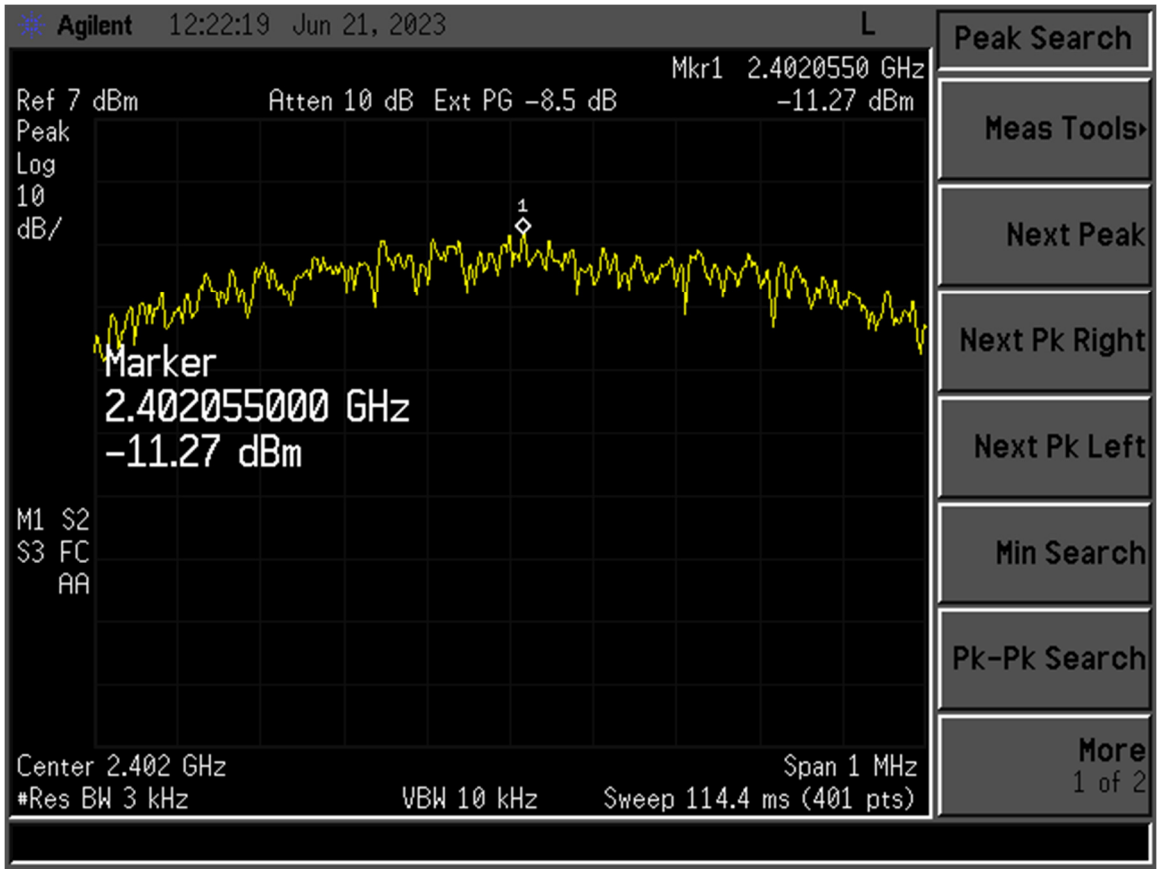


Figure 20. Power Spectral Density, Low Channel

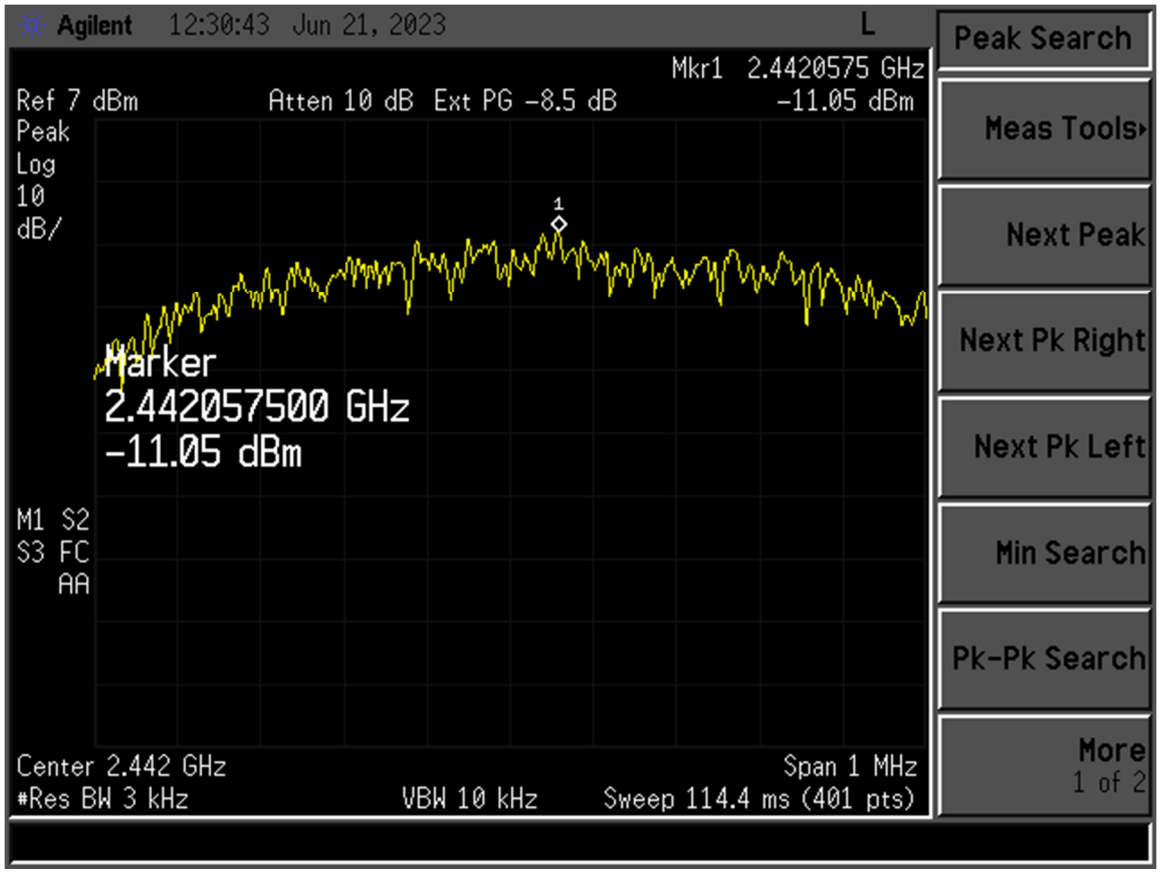


Figure 21. Power Spectral Density, Mid Channel

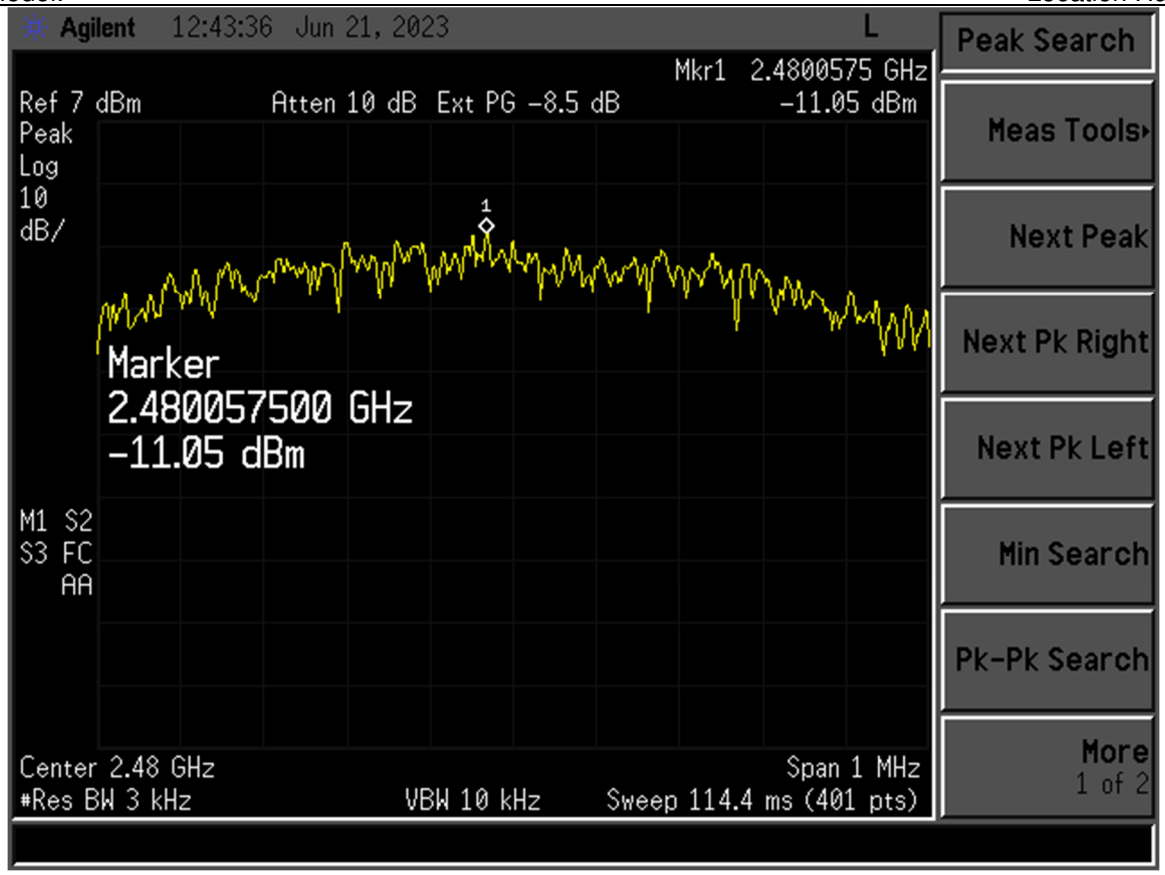


Figure 22. Power Spectral Density, High Channel

2.14 Intentional Radiator Power Lines Conducted Emissions (CFR 15.207)

The power line conducted voltage emission measurements have been carried out in accordance with CFR 15.207, per ANSI C63.10:2013, Clause 6.2, with a spectrum analyzer connected to an LISN and the EUT placed into a continuous mode of transmission.

The EUT is battery powered; therefore, this test is not applicable.

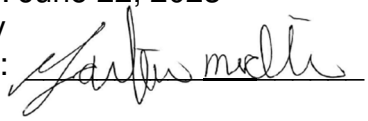
Table 10. Power Line Conducted Emissions

Conducted Emissions 150 kHz to 30 MHz						
Frequency (MHz)	**Test Data (dBuV)**	**LISN+CL (dB)**	**Corrected Results (dBuV)**	**AVG Limits (dBuV)**	**Margin (dB)**	**Detector**
120VAC, 60 Hz Neutral						
0.1850	47.16	0.13	47.29	54.3	7.0	**PK**
0.5150	31.61	0.07	31.68	46.0	14.3	**PK**
1.7800	30.70	0.61	31.31	46.0	14.7	**PK**
5.0917	28.42	0.56	28.98	50.0	21.0	**PK**
10.8333	29.58	0.72	30.30	50.0	19.7	**PK**
24.3667	25.58	1.69	27.27	50.0	22.7	**PK**
120VAC, 60 Hz Phase						
0.1611	48.73	0.08	48.81	55.4	6.6	**PK**
0.5000	38.28	2.68	40.96	46.0	5.0	**PK**
1.1200	30.32	0.87	31.19	46.0	14.8	**PK**
5.5500	28.89	0.23	29.12	50.0	20.9	**PK**
16.5333	26.77	0.83	27.60	50.0	22.4	**PK**
25.9667	26.92	1.35	28.27	50.0	21.7	**PK**

Note: (*) Indicates that the limit used is Quasi-Peak (QP)

Sample Calculation at 0.1850 MHz:

Magnitude of Measured Frequency	47.16	dBuV
+Correction Factors	0.13	dB
Corrected Result	47.29	dBuV

Test Date: June 22, 2023
Tested By
Signature:  Name: Gabriel Medina

2.15 Intentional Radiator, Radiated Emissions (CFR 15.209)

The test data provided herein is to support the verification requirement for radiated emissions coming for the EUT in a transmitting state per 15.209 and were investigated from 9kHz or the lowest operating clock frequency to 25 GHz and tested as detailed in ANSI C63.10:2013, Clause 6.4-6.6.

Radiated emissions within the band of 9 kHz to 30 MHz were investigated using a calibrated Loop Antenna and per the requirements of ANSI C63.10:2013.

Measurements were made with the analyzer's resolution bandwidth set to 120 kHz for measurements made below 1 GHz and 1 MHz for measurements made above 1 GHz. The video bandwidth was set to three times the resolution bandwidth; 1 MHz RBW and 3 MHz VBW. The test data were maximized for magnitude by rotating the turn-table through 360 degrees and raising and lowering the receiving antenna between 1 to 4 meters in height as a part of the measurement procedure.

The worst-case radiated emission was greater than 20.0 dB below the specification limit. The results are shown in the table following. These results are meant to show that this EUT has met the intentional transmitter requirements of CFR Part 15.209.

Table 11. Spurious Radiated Emissions (150 kHz-30MHz)

Test: FCC Part 15.209							
Frequency (MHz)	**Test Data (dBuV)**	**AF+CL-PA (dB)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Distance / Polarization**	**Margin (dB)**	**DETECTOR PK / QP/AVG**
All emissions were more than 20 dB below the applicable limit.							

AF = antenna factor.
CL = cable loss.
PA = preamplifier gain.

Sample Calculation: N/A

Test Date: June 6, 2023
Tested By
Signature: Ian Charboneau Name: Ian Charboneau

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

Test: FCC Part 15.209							
Frequency (MHz)	**Test Data (dBuV)**	**AF+CL-PA (dB)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Distance / Polarization**	**Margin (dB)**	**DETECTOR PK / QP/AVG**
All emissions were more than 20 dB below the applicable limit.							

AF is antenna factor.
CL is cable loss.
PA is preamplifier gain.

Sample Calculation: N/A

Test Date: June 6, 2023
Tested By
Signature: Ian Charboneau Name: Ian Charboneau

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

Test: FCC Part 15.209							
Frequency (MHz)	**Test Data (dBuV)**	**AF+CL-PA (dB)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Distance / Polarization**	**Margin (dB)**	**DETECTOR PK / QP/AVG**
All emissions outside of the fundamental and harmonics were more than 20 dB below the applicable limit.							

AF is antenna factor.
CL is cable loss.
PA is preamplifier gain.

Sample Calculation: N/A

Test Date: June 6, 2023
Tested By
Signature: Ian Charboneau Name: Ian Charboneau

2.16 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%.

2.16.1 Conducted Emissions Measurement Uncertainty

Measurement uncertainty (within a 95% confidence level) for this test is ± 2.85 dB.

2.16.2 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 ±5.2 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 ±5.2 dB.

The measurement uncertainty (with a 95% confidence level) for this test using a Horn Antenna is ±5.2 dB.

3 Conclusions

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