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, paragraphs 15.207, 15.209 and 15.247

And

IC Radio Standards Specification: RSS-247, Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and License-Exempt Local Area Network (LE-LAN) Devices (I3)

For the

Neptune Technology Group, Inc.

Model: R900CEM

FCC ID: P2SR900CEM
IC: 4171B-R900CEM

UST Project: 24-0386
Issue Date: January 6, 2025

Total Pages in This Report: 42

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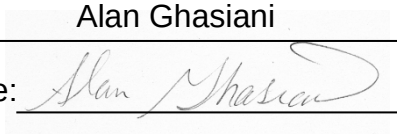
Testing Tomorrow's Technology

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 January 6, 2025

NVLAP TESTING

NVLAP LAB CODE 200162-0

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MEASUREMENT TECHNICAL REPORT

COMPANYS NAME:	Neptune Technology Group, Inc.
ADDRESS:	1600 Alabama Hwy 229, Tallassee AL 36078 USA
MODEL:	R900CEM
FCC ID:	P2SR900CEM
IC:	4171B-R900CEM
DATE:	January 6, 2025

This report concerns (check one): Original grant [X]
Class II change

Equipment type: 902-928 MHz ISM Radio

Technical Information:

Radio Technology:	FHSS
Frequency of Operation (MHz):	911.08 – 919.08
Output Power (dBm):	1819 dBm (65.9 mW)
Type of Modulation:	OOK
Data/Bit Rate (M)bps:	1200 Baud
Antenna Gain (dBi):	Refer to Table 5
Software used to program EUT:	ETi 81-00 Client/TSW-1024 v.1.0.0 R900 Test v.2.0.2023.0209
EUT firmware:	Pilot Release Candidate, v.50.1.230327.3584
Power setting:	"39*" (*)Power is adjusted at the manufacturing facility to match measured/granted output power for every unit.

Report prepared by:

US Tech
3505 Francis Circle
Alpharetta, GA 30004

Phone Number: (770) 740-0717
Fax Number: (770) 740-1508

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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 the FCC Rules and Regulations Part 15, Section 247 and IC RSS 247 Issue 8.

1.2 Characterization of Test Sample

The sample used for testing was received by US Tech on December 12, 2024 in good operating condition.

1.3 Product Description

The Equipment under Test (EUT) is the Neptune Technology Group, Inc. Model R900CEM. The EUT is a network endpoint that collects meter reading data from an encoder register. It then transmits the data for collection using LTE-M cellular technology. The collection data is stored and downloaded into the utility billing system for processing. The R900 cellular endpoint has three different options for covers so that it can be installed on a wall or in a pit application. It operates on the AT&T and FirstNet LTE-M networks and contains an FCC and ISED Certified LTE Module bearing FCC ID: RI7ME310G1WW and IC:5131A-ME310G1WW.

1.4 Configuration of Tested System

The Test Sample was tested per *ANSI C63.4:2009, Methods of Measurement of Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (2009)* for FCC subpart A Digital equipment Verification requirements and per FCC Public Notice DA 00-705 released March 30, 2000 Under section 15.247. Also, FCC, KDB Publication No. DA 00-705 was used as a test procedure guide.

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 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 Submittals

1.6.1 The EUT is subject to the following FCC authorizations:

a) Certification under section 15.247 as a transmitter.
b) Verification under 15.101 as a digital device and receiver.

1.6.2 Verification of the Digital apparatus

The Verification requirement shares many common report elements with the Certification report. Therefore, though this report is mostly intended to provide data for the Certification process, the Verification authorization report (part 15.107 and 15.109) for the EUT is included herein.

Table 1. EUT and Peripherals

PERIPHERAL MANUFACTURER.	MODEL NUMBER	SERIAL NUMBER	FCC ID:	CABLES P/D
Neptune Technology Group, Inc.	R900CEM	Engineering Sample	FCC ID: P2SR900CEM IC:4171B-R900CEM Contains: FCC ID:RI7ME310G1WW IC:5131A-ME310G1WW	None
Antenna See antenna details	--	--	--	--

U= Unshielded
S= Shielded
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 indicated.

Table 2. Test Instruments

TEST INSTRUMENT	MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	DATE OF LAST CALIBRATION
Spectrum Analyzer	Agilent	E4440A	MY45304803	7/21/2025 2 yr.
EMC RF Cable	Times Microwave Systems	LMR-600	N/A	3/05/2025
EMC RF Cable (short)	US Tech	N/N 60cm	N/A	7/23/2025
RF filter	Mini-Circuits Inc.	VHF-1320 15542	30843	7/02/2025
Loop Antenna	A.H. Systems	SAS-200/562	142	11/15/2026 2 yr.
Biconical Antenna	EMCO	3110B	9307-1431	1/13/2025 2 yr.
Log Periodic Antenna	EMCO	3146	9110-3236	11/15/2026 2 yr.
Horn Antenna	EMCO	3115	9107-3723	3/13/2025 2 yr.
Pre-Amplifier	Hewlett-Packard	8449B	3008A00914	3/4/2025
Pre-Amplifier	Hewlett-Packard	8447D	1937A01611	6/17/2025
Attenuator	Mini-Circuits Inc.	VAT-8 15542	30519	7/02/2025

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 physical modifications were made by US Tech in order to bring the EUT into compliance with FCC Part 15, Subpart C Intentional Radiator Limits for the transmitter portion of the EUT or the Subpart B Unintentional Radiator Limits (Receiver and Digital Device) 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 below.

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 at 911.08 MHz to 919.08 MHz, 2 test frequencies were 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 5 times the highest internal clock frequency.

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.

2.5.3 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 be expressed logarithmically in dB.

NOTE: If the transmitter was programmed to transmit at >98% duty cycle, then, wherever applicable (where the detection mode was AVG) the duty cycle factor calculated will be applied.

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
High Gain Antenna	Neptune Technology Group, Inc.	Pit Antenna	Standard Plus Antenna	6.0	Proprietary BNC Twist-lock RF connector
Low Gain Antenna	Neptune Technology Group, Inc.	Pit Antenna	4.5 in Pit Lid Antenna	-0.8	Proprietary BNC Twist-lock RF connector

Figure 1. Test Configuration

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 2.1

2.8 Transmitter Duty Cycle (CFR 35 (c))

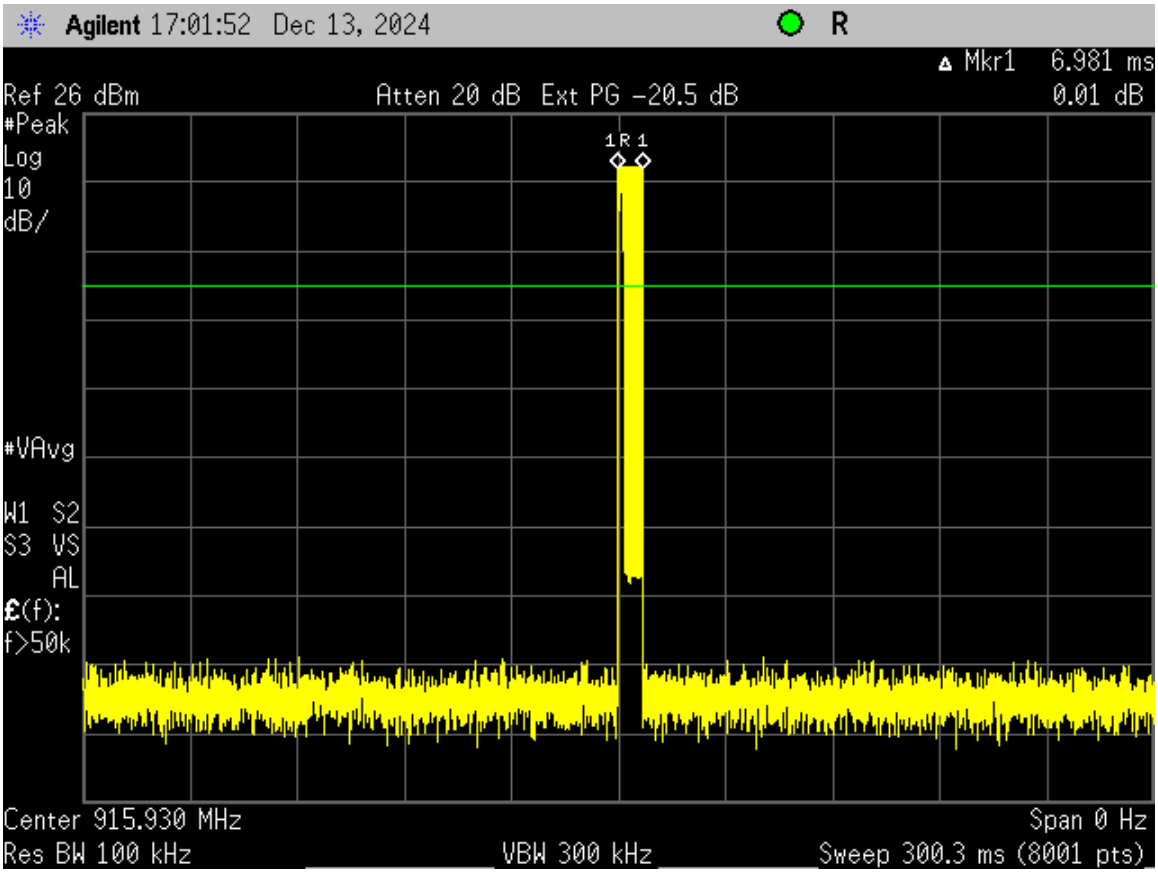


Figure 2. Duty Cycle 100ms Sweep

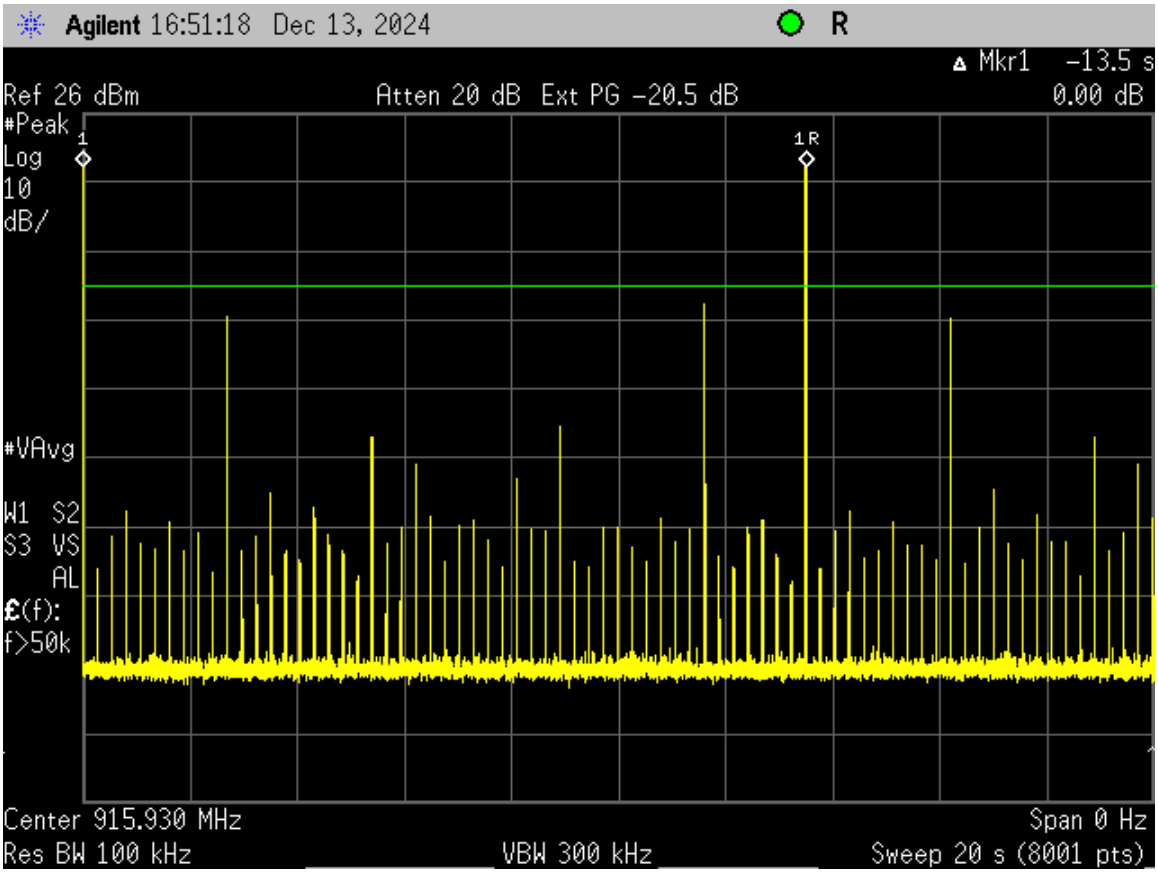


Figure 3. Transmitter Pulse Width

Total Time On from Figure 2 (A) = 6.981 ms (Transmitter Pulse Width)
Total Pulse Train from Figure 3 (B) = 13.5 sec (Pulse Train), exceeds 0.1 Sec

(A ms Total Time On)/(100 mSec) = 6.981/100
Duty Cycle = 20 Log (A/B) = -23.12 dB

NOTE 1: Duty cycle correction greater than -20 dB therefore -20 dB was used as the correction factor in this report.

NOTE 2: The transmitter was programmed to transmit at >98% duty cycle, therefore wherever applicable (where the detection mode was AVG) the duty cycle factor calculated above will be applied.

2.9 Intentional Radiator, Power Line Conducted Emissions (CFR 15.207)

The EUT is battery powered; this test was not applied.

2.10 Intentional Radiator, Radiated Emissions (CFR 15.209, 15.247(d)) (IC RSS 247 5.1 & 5.2)

Radiated Spurious measurements: The EUT was placed into a continuous transmit mode of operation (>98%) duty cycle) and tested per FCC Public Notice DA 00-705 and ANSI C63.10:2013. A preliminary scan was performed on the EUT to find signal frequencies that were caused by the transmitter part of the device. A preliminary scan was performed on the EUT to find the worse case results the EUT was tested in X, Y, and Z axes or in the orientation of normal operation if the device is designed to operate in a fixed position.

Radiated measurements were then conducted between the frequency range of 9 kHz (or lowest frequency used/generated by the device) up to the tenth harmonic of the device (no greater than 40 GHz). In the band below 30 MHz a resolution bandwidth (RBW) of 9 kHz was used, emissions below 1 GHz were tested with a RBW of 120 kHz and emissions above 1 GHz were tested with a RBW of 1 MHz. All video bandwidth settings were at least three times the RBW value.

The EUT was investigated to CFR 15.209, General requirements for unwanted spurious emissions. The conducted spurious method as described below was used to investigate all other emissions emanating from the antenna port.

Conducted Spurious measurements: The EUT was put into a continuous-transmit mode of operation (>98% duty cycle) 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 or lowest operating clock frequency to ten times the highest operating clock frequency. A conducted scan was performed on the EUT to identify and record the spurious signals that were related to the transmitter.

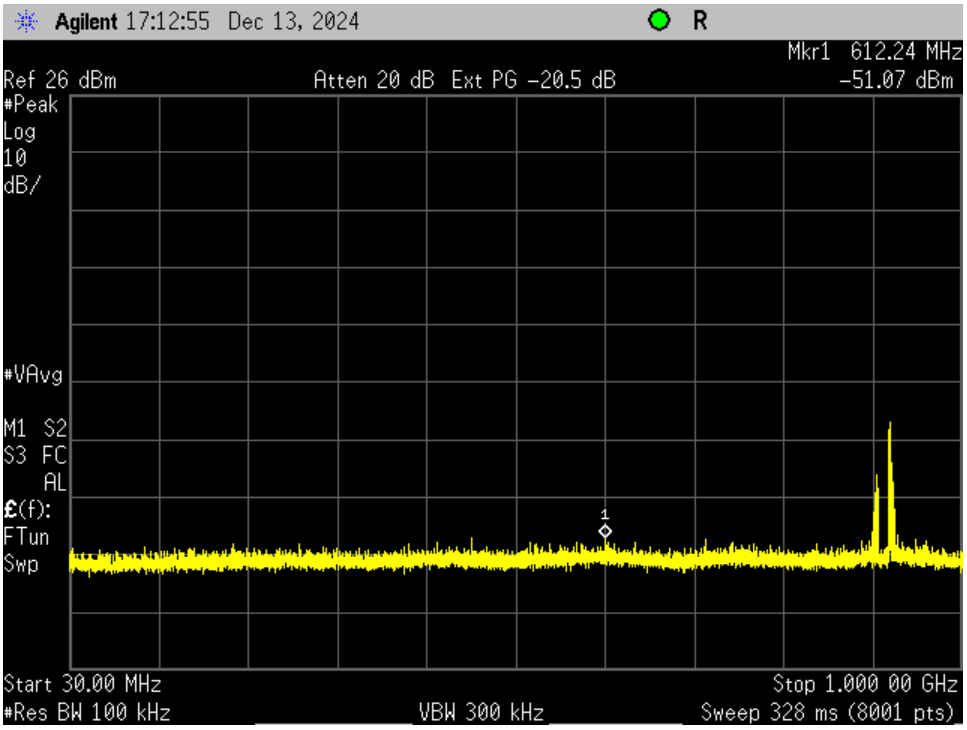


Figure 4. Antenna Conducted Emissions Frequency Hopping, 30 MHz – 1 GHz

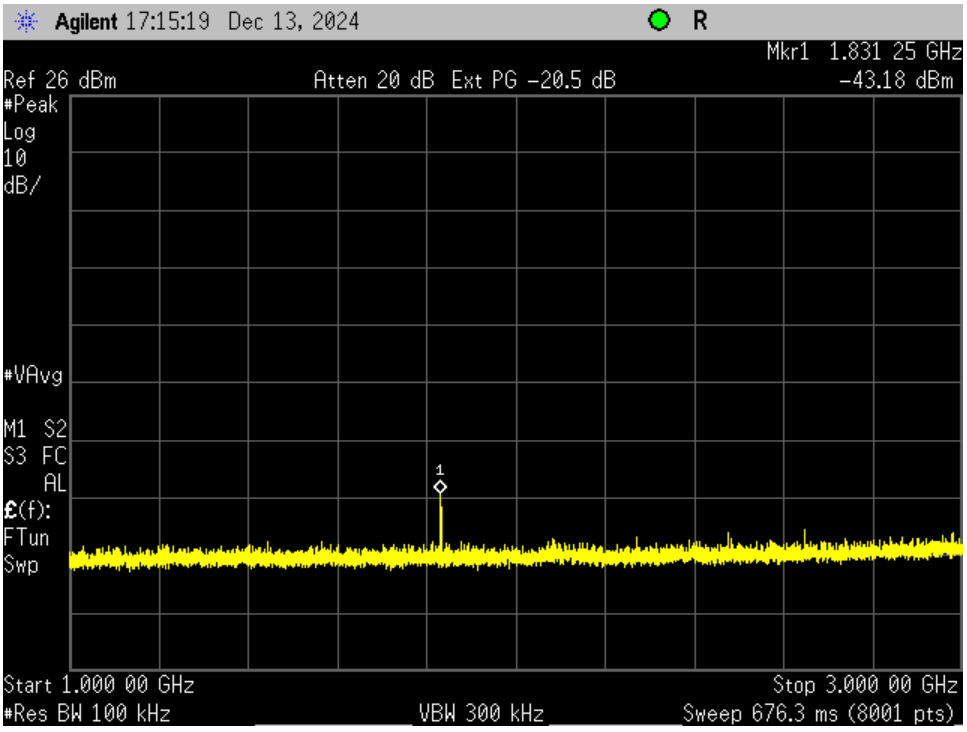


Figure 5. Antenna Conducted Emissions Frequency Hopping, 1 GHz – 3 GHz

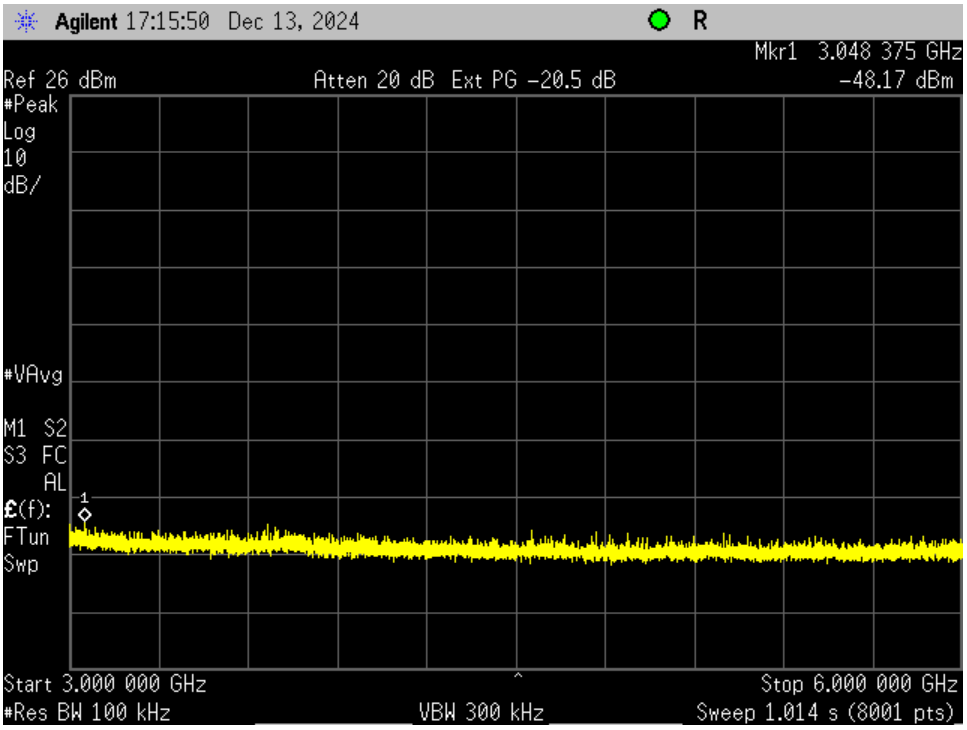


Figure 6. Antenna Conducted Emissions Frequency Hopping, 3 GHz – 6 GHz

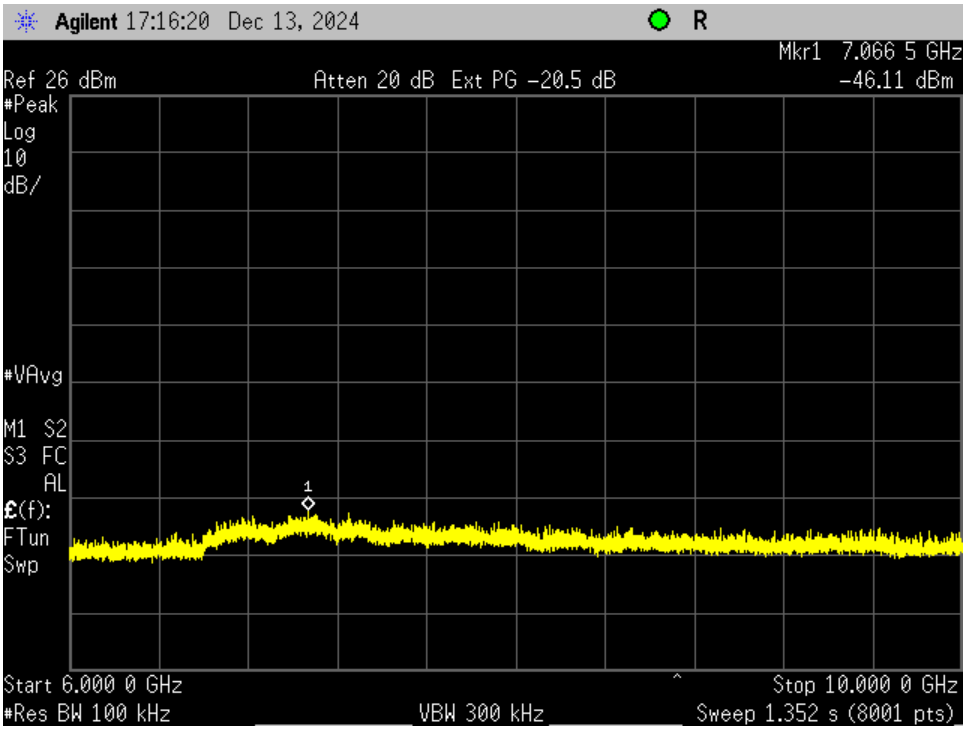


Figure 7. Antenna Conducted Emissions Frequency Hopping, 6 GHz – 10 GHz

Table 5. Peak Radiated Fundamental & Harmonic Emissions – High Gain Antenna

Test: FCC Part 15, Para 15.209, 15.247(d)								
Frequency (MHz)	**Test Data (dBuV)**	**Factor (dB)**	**AF+CA -AMP (dB/m)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector Mode**
Low Channel								
3644.40*	47.37	0.00	-0.22	47.15	74.0	3.0m/VERT	26.85	**PK**
High Channel								
3676.33*	49.00	0.00	-0.40	48.60	74.0	3.0m./VERT	25.4	**PK**
2757.50*	45.55	0.00	-4.62	40.94	74.0	3.0m./VERT	33.1	**PK**
4595.46*	41.88	0.00	2.44	44.32	74.0	3.0m./VERT	29.7	**PK**
5514.16*	42.74	0.00	3.87	46.61	74.0	3.0m./VERT	27.4	**PK**

1. (*) Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209 & 20 dB relaxation for peak measurements of CFR 15.35.
2. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic
3. (~)Measurements taken at 1 meter were extrapolated to 3 meter using a factor of (-9.5 dB).
4. The EUT was placed in three orthogonal positions 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.

Sample Calculation at 3644.40 MHz:

Magnitude of Measured Frequency	47.37	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	-0.22	dB/m
Corrected Result	47.15	dBuV/m

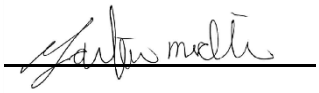
Test Date: December 12, 2024
Tested By
Signature:  Name: Gabriel Medina

Table 6. Average Radiated Fundamental & Harmonic Emissions – High Gain Antenna

Test: FCC Part 15, Para 15.209, 15.247(d)								
Frequency (MHz)	**Test Data (dBuV)**	**Factor (dB)**	**AF+CA -AMP (dB/m)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector Mode**
Low Channel								
3644.40*	47.37	0.00	-0.22	47.15	54.0	3.0m/VERT	6.8	**PK**
High Channel								
3676.33*	49.00	0.00	-0.40	48.60	54.0	3.0m./VERT	5.4	**PK**
2757.50*	45.55	0.00	-4.62	40.94	54.0	3.0m./VERT	13.1	**PK**
4595.46*	41.88	0.00	2.44	44.32	54.0	3.0m./VERT	9.7	**PK**
5514.16*	42.74	0.00	3.87	46.61	54.0	3.0m./VERT	7.4	**PK**

1. (*) Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209 & 20 dB relaxation for **peak** measurements of CFR 15.35.
2. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic
3. (~)Measurements taken at 1 meter were extrapolated to 3 meter using a factor of (-9.5 dB).
4. The EUT was placed in three orthogonal positions 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.

Sample Calculation at 3644.40 MHz:

Magnitude of Measured Frequency	47.37	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain – Duty Cycle	-0.22	dB/m
Corrected Result	47.15	dBuV/m

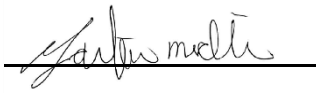
Test Date: December 12, 2024
Tested By
Signature:  Name: Gabriel Medina

Table 7. Peak Radiated Fundamental & Harmonic Emissions – Low Gain Antenna

Test: FCC Part 15, Para 15.209, 15.247(d)								
Frequency (MHz)	**Test Data (dBuV)**	**Factor (dB)**	**AF+CA -AMP (dB/m)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector Mode**
Low Channel								
2733.50*	48.28	0.00	-4.60	43.68	74.0	3.0m./HORZ	30.3	**PK**
3644.40*	45.87	0.00	-0.21	45.66	74.0	3.0m./HORZ	28.3	**PK**
High Channel								
2757.00*	48.34	0.00	-4.33	44.01	74.0	3.0m./VERT	30.0	**PK**
3676.33*	49.40	0.00	-0.40	49.00	74.0	3.0m./VERT	25.0	**PK**
5514.16*	39.75	0.00	3.87	43.62	74.0	3.0m./VERT	30.4	**PK**

1. (*) Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209 & 20 dB relaxation for peak measurements of CFR 15.35.
2. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic
3. (~)Measurements taken at 1 meter were extrapolated to 3 meter using a factor of (-9.5 dB).
4. The EUT was placed in three orthogonal positions 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.

Sample Calculation at 3644.40 MHz:

Magnitude of Measured Frequency	47.37	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	-0.22	dB/m
Corrected Result	47.15	dBuV/m

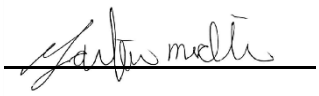
Test Date: December 12, 2024
Tested By
Signature:  Name: Gabriel Medina

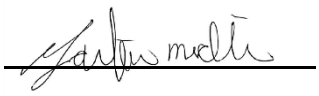
Table 8. Average Radiated Fundamental & Harmonic Emissions – Low Gain Antenna

Test: FCC Part 15, Para 15.209, 15.247(d)								
Frequency (MHz)	**Test Data (dBuV)**	**Factor (dB)**	**AF+CA -AMP (dB/m)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector Mode**
Low Channel								
2733.50*	48.28	0.00	-4.60	43.68	54.0	3.0m./HORZ	10.3	**PK**
3644.40*	45.87	0.00	-0.21	45.66	54.0	3.0m./HORZ	8.3	**PK**
High Channel								
2757.00*	48.34	0.00	-4.33	44.01	54.0	3.0m./VERT	10.0	**PK**
3676.33*	49.40	0.00	-0.40	49.00	54.0	3.0m./VERT	5.0	**PK**
5514.16*	39.75	0.00	3.87	43.62	54.0	3.0m./VERT	10.4	**PK**

1. (*) Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209 & 20 dB relaxation for **peak** measurements of CFR 15.35.
2. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic
3. (~)Measurements taken at 1 meter were extrapolated to 3 meter using a factor of (-9.5 dB).
4. The EUT was placed in three orthogonal positions 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.

Sample Calculation at 3644.40 MHz:

Magnitude of Measured Frequency	47.37	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain – Duty Cycle	-0.22	dB/m
Corrected Result	47.15	dBuV/m

Test Date: December 12, 2024
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 63.10-2013, with the EUT initially operating on the Lowest Channel and then operating on the Highest Channel within its band of operation. Conducted measurements are performed to demonstrate compliance with the requirement of 15.247(d) that all emissions outside of the band edges be attenuated by at least 20 dB when compared to its highest in band value (contained in a 100 kHz band).

To capture the band edge set the Spectrum Analyzer frequency span large enough (usually around 3 MHz) to capture the peak level of the emission operating on the channel closest to the band edge as well as any modulation products falling outside of the authorized band of operation. Conducted measurements are performed with RBW ≥1% of the frequency span. In all cases, the VBW is set ≥ RBW. See figure and calculations below for more detail. This measurement was performed with the EUT continuously transmitting on the low and high channels as well as in normal use mode (frequency hopping ON).

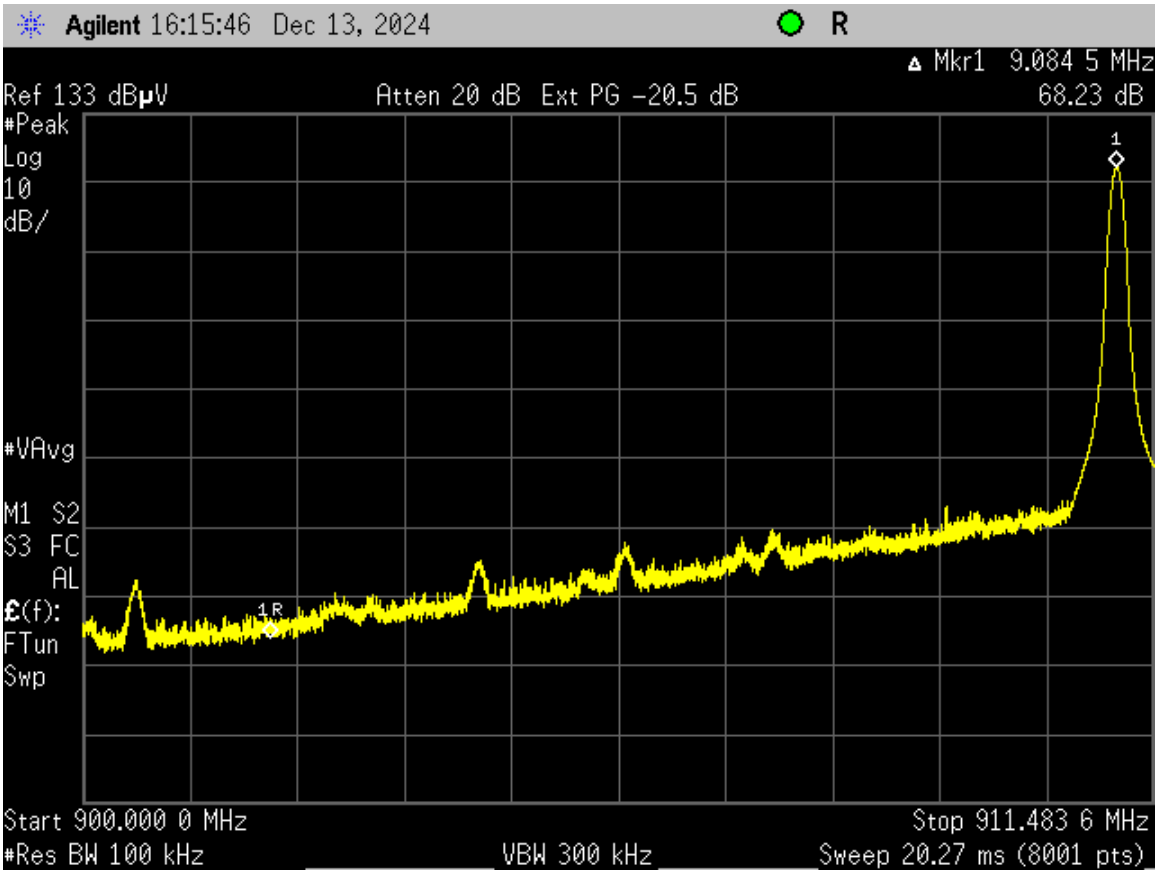


Figure 8. Band Edge Compliance, Low Channel Delta – Hopping Off

Measured Delta	68.23 dBuV/m
Limit(20 dB from fundamental)	20.00 dBuV/m
Band Edge Margin	48.23 dBuV/m

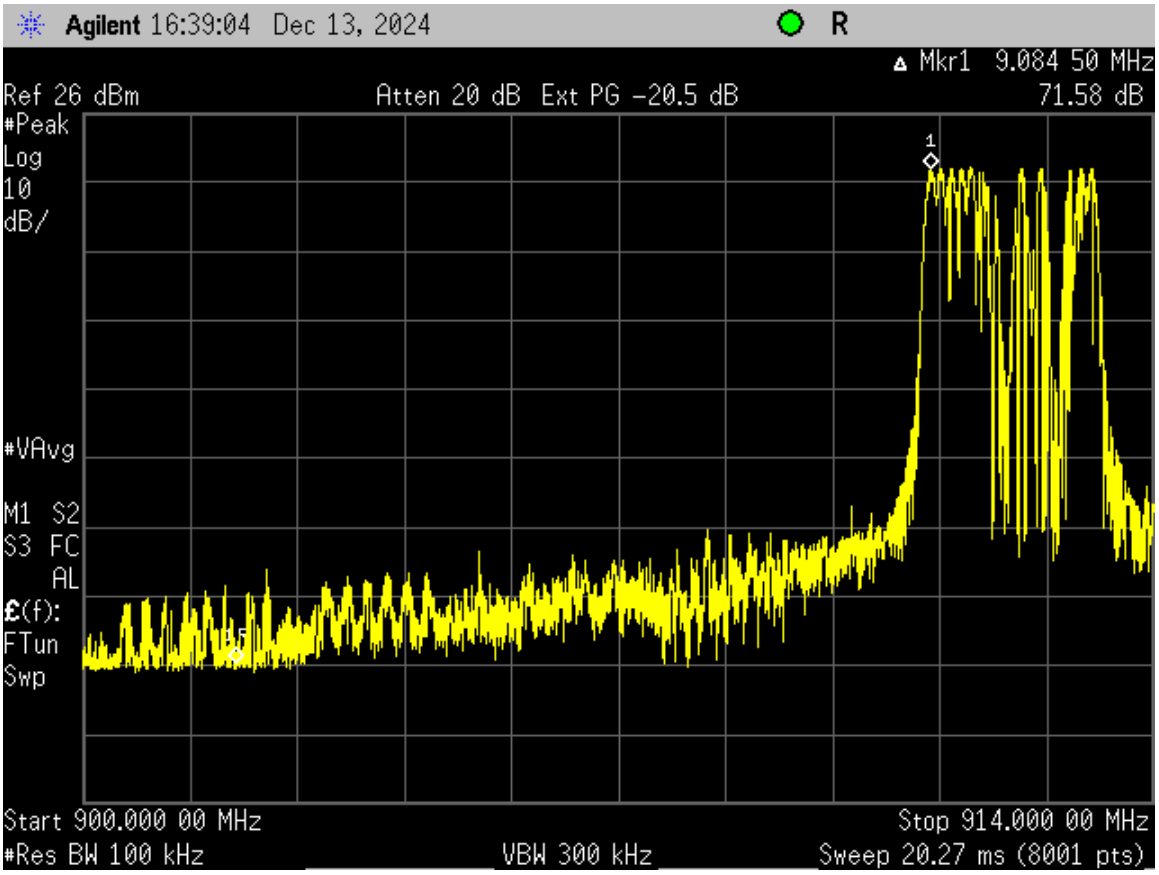


Figure 9. Band Edge Compliance, Low Channel Delta – Hopping On

Measured Delta	71.58 dBuV/m
Limit(20 dB from fundamental)	20.00 dBuV/m
Band Edge Margin	51.58 dBuV/m

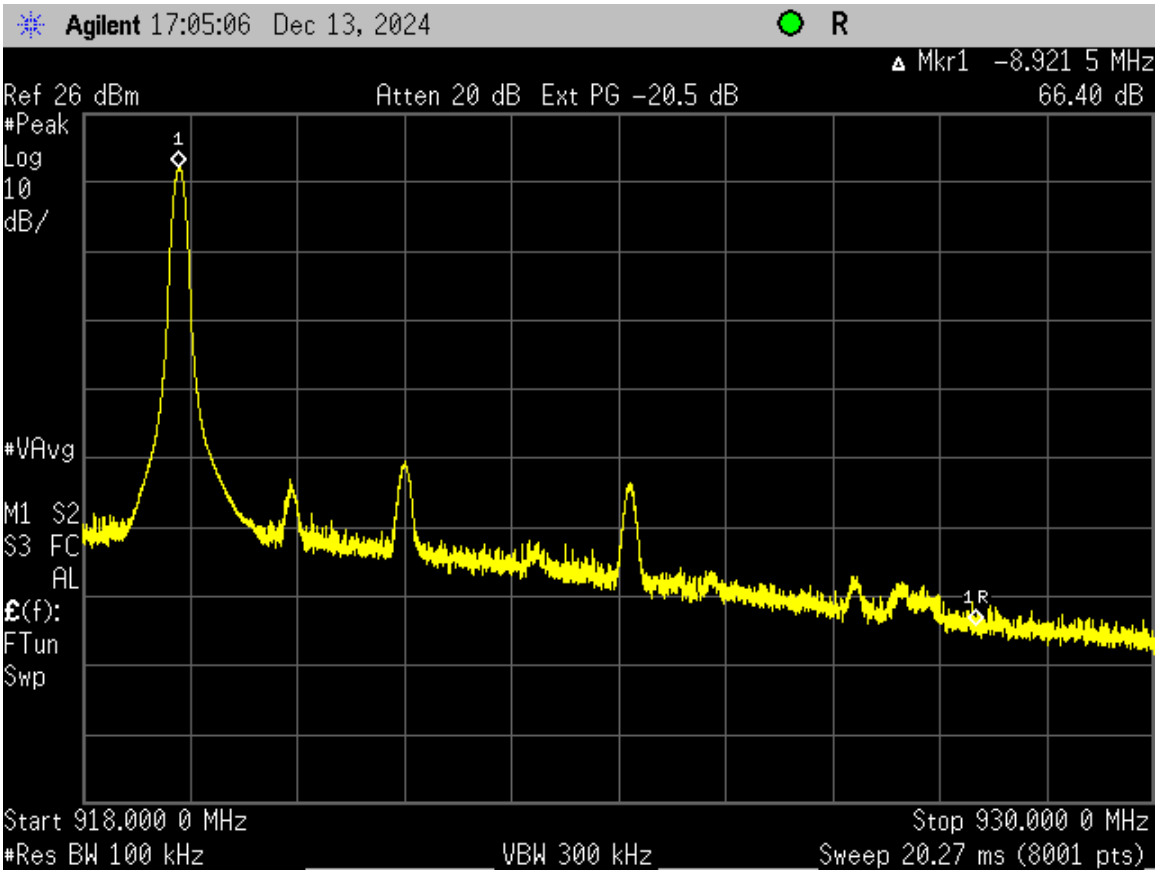


Figure 10. Band Edge Compliance, High Channel Delta – Hopping Off

Measured Delta	66.40 dBuV/m
Limit(20 dB from fundamental)	20.00 dBuV/m
Band Edge Margin	46.40 dBuV/m

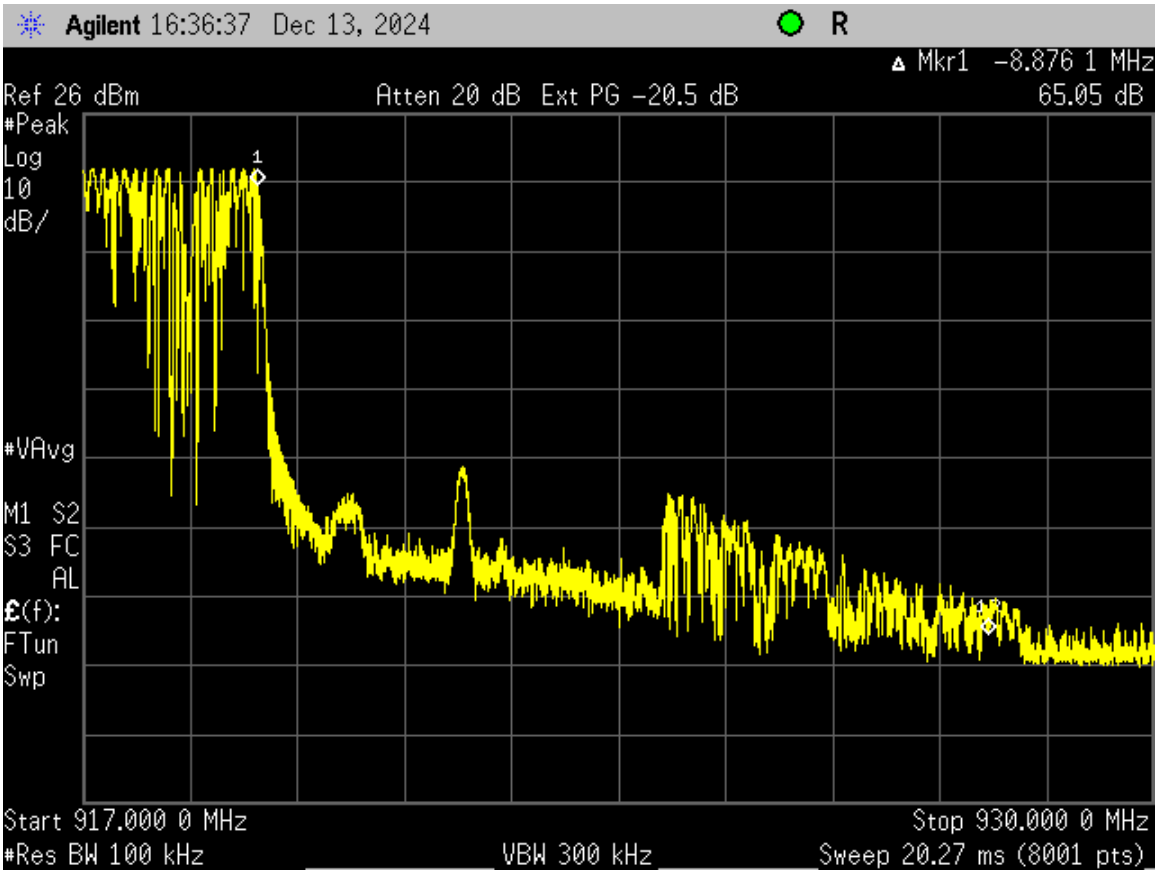


Figure 11. Band Edge Compliance, High Channel Delta – Hopping On

Measured Delta	65.05 dBuV/m
Limit(20 dB from fundamental)	20.00 dBuV/m
Band Edge Margin	45.05 dBuV/m

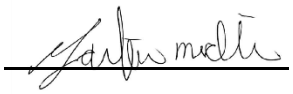
2.12 99% Occupied Bandwidth (IC RSS 247 5.1 & 5.2,CFR 15.247 (a) (1))

For frequency hopping systems operating in the 902-928 MHz band the maximum allowed 20 dB bandwidth is 500 kHz.

These measurements were performed while the EUT was in a constant transmit mode. A method similar to the marker delta method was used to capture the points. The RBW was set to approximately 1/100 of the manufacturers claimed RBW and with the VBW ≥ RBW. The results of this test are given in Table 12 and Figures 21-23.

Table 9. 20 dB Bandwidth and 99% Occupied Bandwidth

Frequency (MHz)	20 dB Bandwidth (MHz)	99% Occupied Bandwidth (MHz)
911.08	67.94	66.60
919.08	66.64	68.08

Test Date: December 13, 2024
Tested By
Signature:  Name: Gabriel Medina

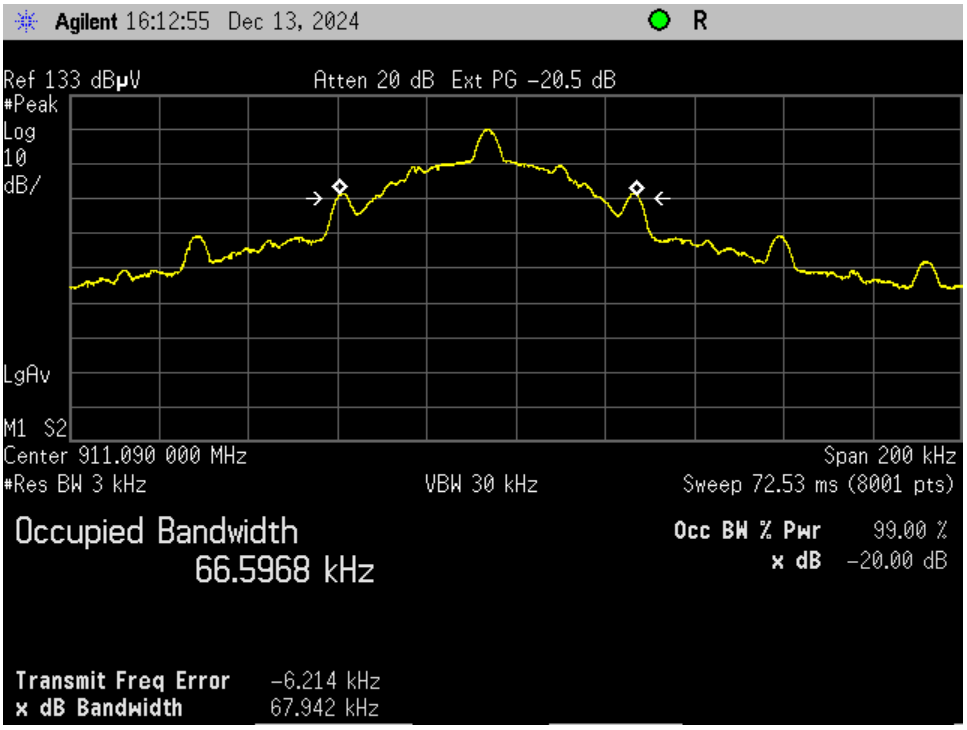


Figure 12. Twenty dB Bandwidth - IC RSS 247, A8.1– Low Channel

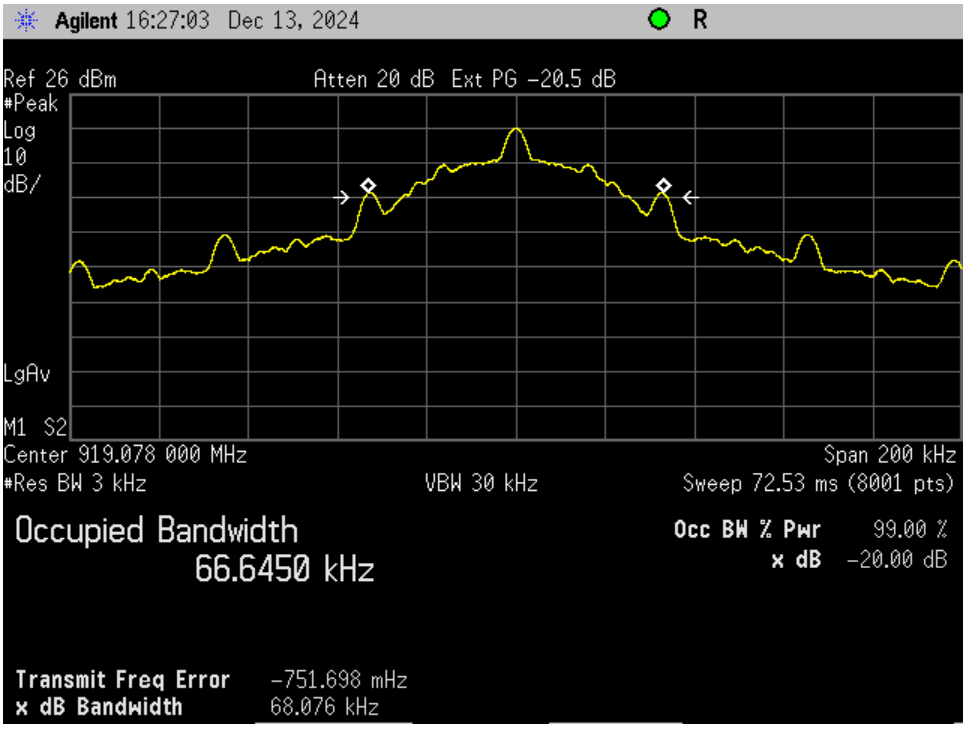


Figure 13. Twenty dB Bandwidth -IC RSS 247, A8.1 – High Channel

2.13 Number of Hopping Frequencies (CFR 15.247 (a)(1)) (CRF 15.247(b)(1))

Frequency hopping systems in the 902-928 MHz band shall have at least 50 hopping frequencies is the 20 dB bandwidth is less than 250 kHz. If the 20 dB bandwidth is 250 kHz or greater, then the system shall have at least 25 hopping frequencies. Since the EUT has a 20 dB bandwidth less than 250 kHz, then at least 50 hopping frequencies shall be used.

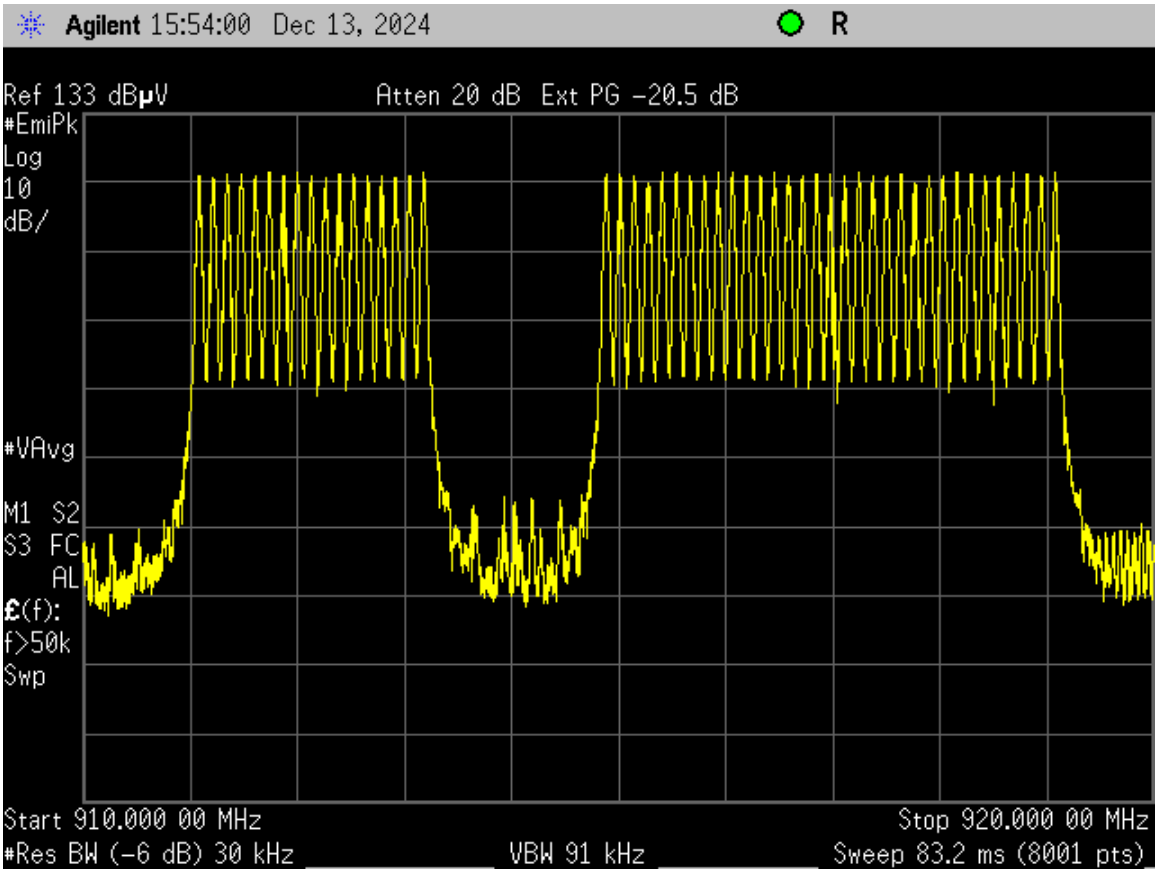


Figure 14. Hopping Channels 0 through 50

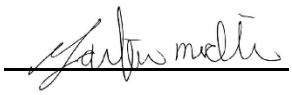
2.14 Maximum Peak Conducted Output Power (CFR 15.247 (b) (3))

For frequency hopping systems in the 902-928 MHz band with at least 50 hopping channels, the maximum peak conducted output power of the intentional radiator shall not exceed 1 watt. Systems with less than 50 hopping channels, but at least 25 hopping channels, the maximum peak conducted output power of the intentional radiator shall not exceed .25 watts. Since the EUT has 50 hopping channels, the maximum peak conducted output power shall not exceed 1 Watt

Peak power within the band 911.1 MHz to 919.1 MHz was measured per ANSI C63.10-2013 as an Antenna Conducted test with a spectrum analyzer. For these measurements the EUT antenna port was connected to a spectrum analyzer having a 50Ω input impedance. The setup losses were corrected by using a -20.5 dB offset in the analyzer measurements. Peak antenna conducted output power is tabulated in the table below.

Table 10. 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)
911.08	18.19	65.91	1000
919.08	18.09	64.42	1000

Test Date: December 13, 2024
Tested By
Signature:  Name: Gabriel Medina

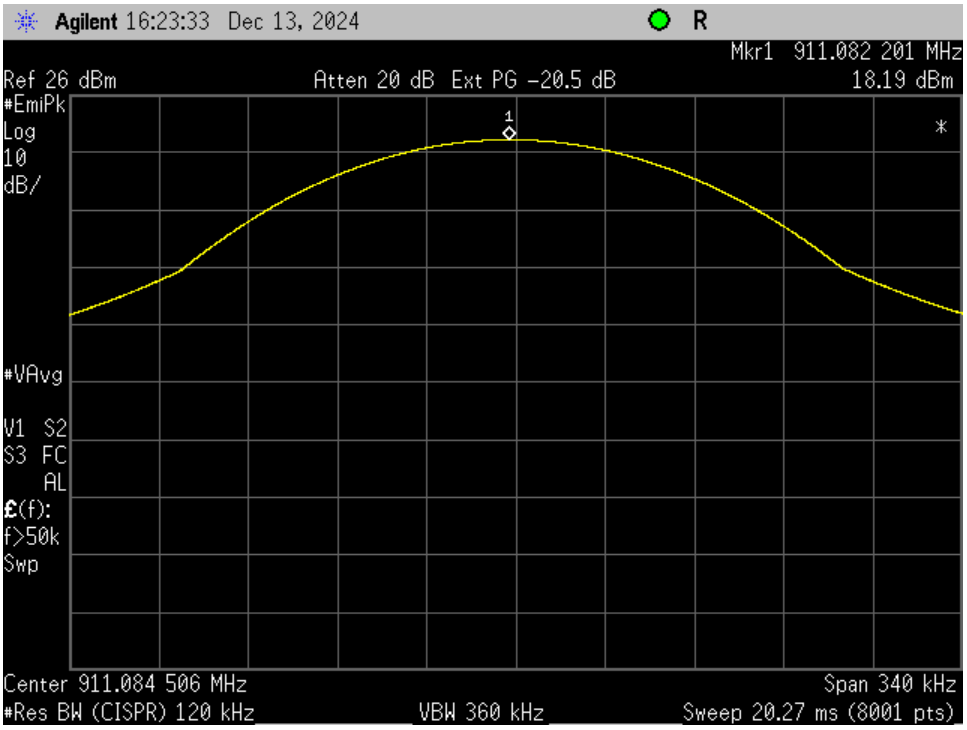


Figure 15. Peak Antenna Conducted Output Power, Low Channel

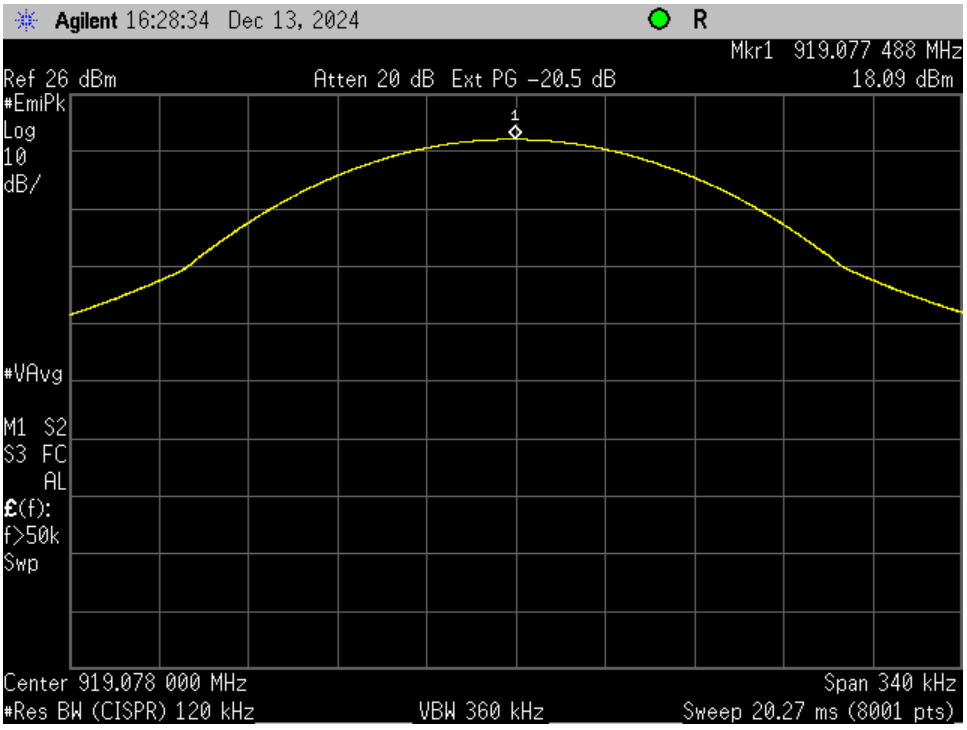


Figure 16. Peak Antenna Conducted Output Power, High Channel

2.15 Frequency Separation (CRF 15.247(a)(1))

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. In this case, the 20 dB bandwidth of the hopping channel is greater than the 25 kHz, so the minimum requirement used was the 68.07 kHz**.**

The EUT met the frequency separation requirement.

The test procedures outlined in ANSI C63.10-2013 were used to conduct measurements.

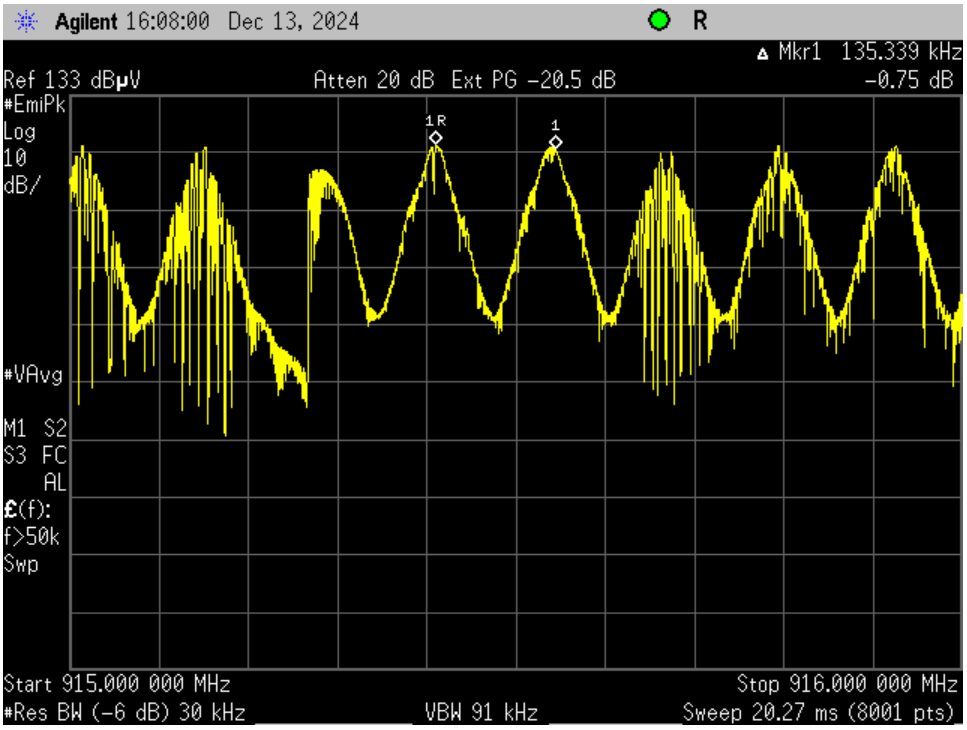


Figure 17. Channel Separation

Measured Delta	135.33 kHz
-Limit(20 dB Bandwidth or 25 kHz)	68.07 kHz
Margin	67.26 kHz

2.16 Average Time of Occupancy (CFR 15.247(a)(1))

Frequency hopping system in the 902-928 MHz bands with a 20 dB bandwidth less than 250 kHz shall have an average time occupancy not greater than 0.4 seconds within a 20 second period. If the 20 dB bandwidth of the hopping channels is 250 kHz or greater, than the average time of occupancy shall not be greater than 0.4 seconds within a 10 second period. In this case, since the 20 dB bandwidth was less than 250 kHz the average time of occupancy shall not be greater than 0.4 seconds.

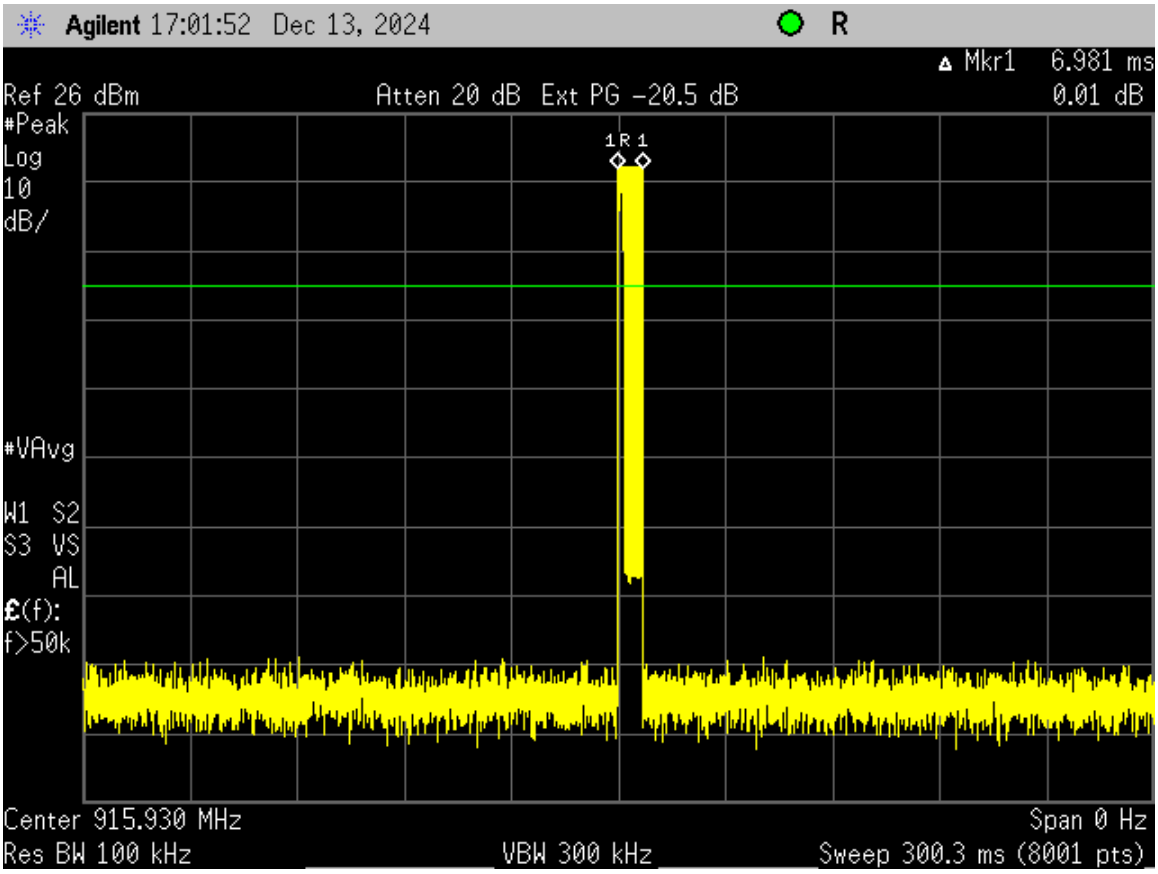


Figure 18.Time On

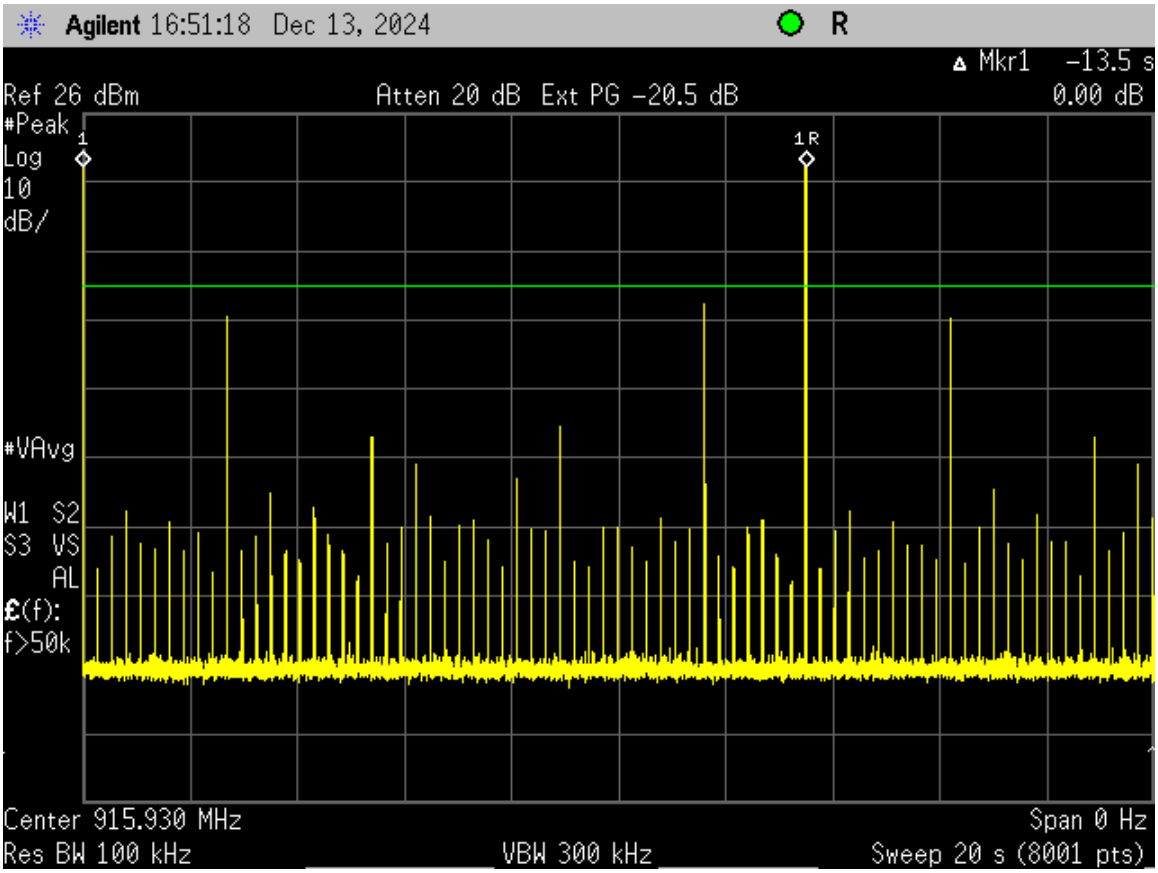


Figure 19. Average Time of Occupancy

Limit	400 ms
-Total Time on (Figure 29)	13.96 ms
Margin	386.04 ms

2.17 Unintentional and Intentional Radiator, Powerline Emissions (CFR 15.107)

The EUT was battery powered; therefore, this test was not applied.

2.18 Unintentional and Intentional Radiator, Radiated Emissions (CFR 15.109)

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 7.8.

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.

Table 11. Spurious Radiated Emissions (150kHz – 30MHz) – High Gain Antenna

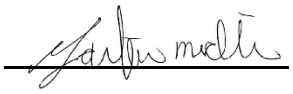
Test: FCC Part 15.209							
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**QP Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector PK, or QP**
All emissions were less than 6 dB above the noise floor or emissions were more than 20 dB below the applicable limit							

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

Test: FCC Part 15.209							
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**QP Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector PK, or QP**
175.60	42.48	-10.56	31.92	43.5	3m./HORZ	11.6	**PK**
462.87	35.96	-5.09	30.87	46.0	3m./HORZ	15.1	**PK**
877.51	39.44	1.76	41.20	46.0	3m./HORZ	4.8	**QP**
181.60	35.16	-9.07	26.09	43.5	3m./VERT	17.4	**PK**
531.91	35.08	-4.81	30.27	46.0	3m./VERT	15.7	**PK**
877.51	36.77	0.46	37.23	46.0	3m./VERT	8.8	**QP**

Sample Calculation at 175.60 MHz:

Magnitude of Measured Frequency	42.48 dBuV
+ Cable Loss+ LISN Loss	-10.56 dB
=Corrected Result	31.92 dBuV

Test Date: December 12, 2024
Tested By
Signature:  Name: Gabriel Medina

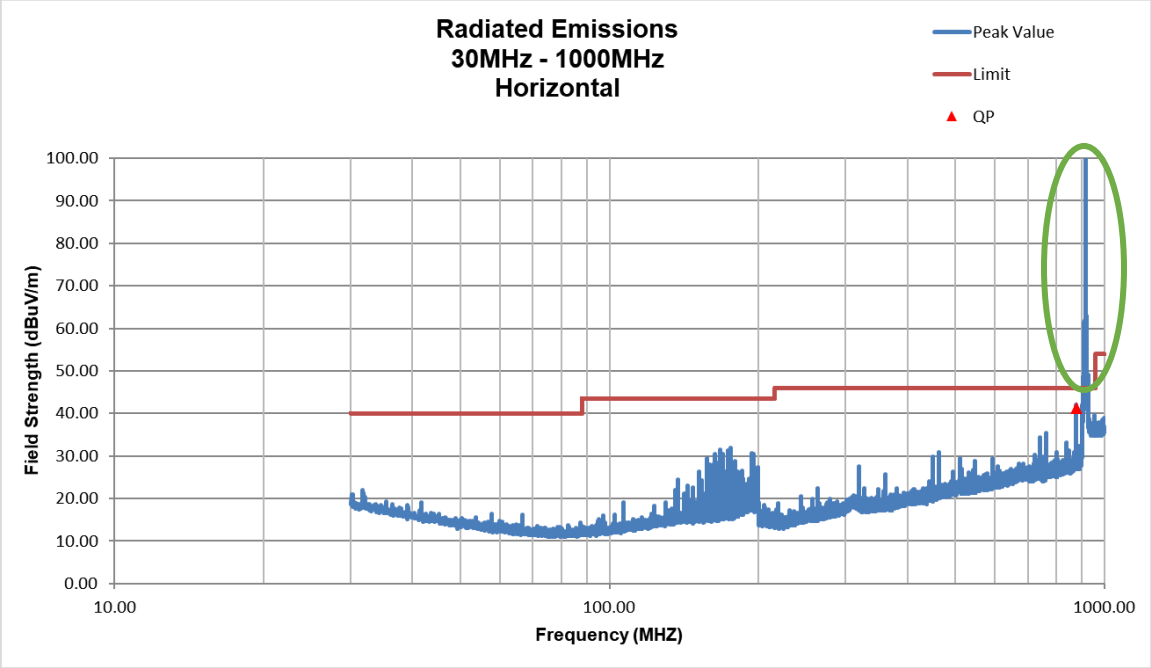


Figure 20. Radiated Emissions, Horizontal 30 MHz - 1 GHz

Note: Circled in green is the fundamental of the radio

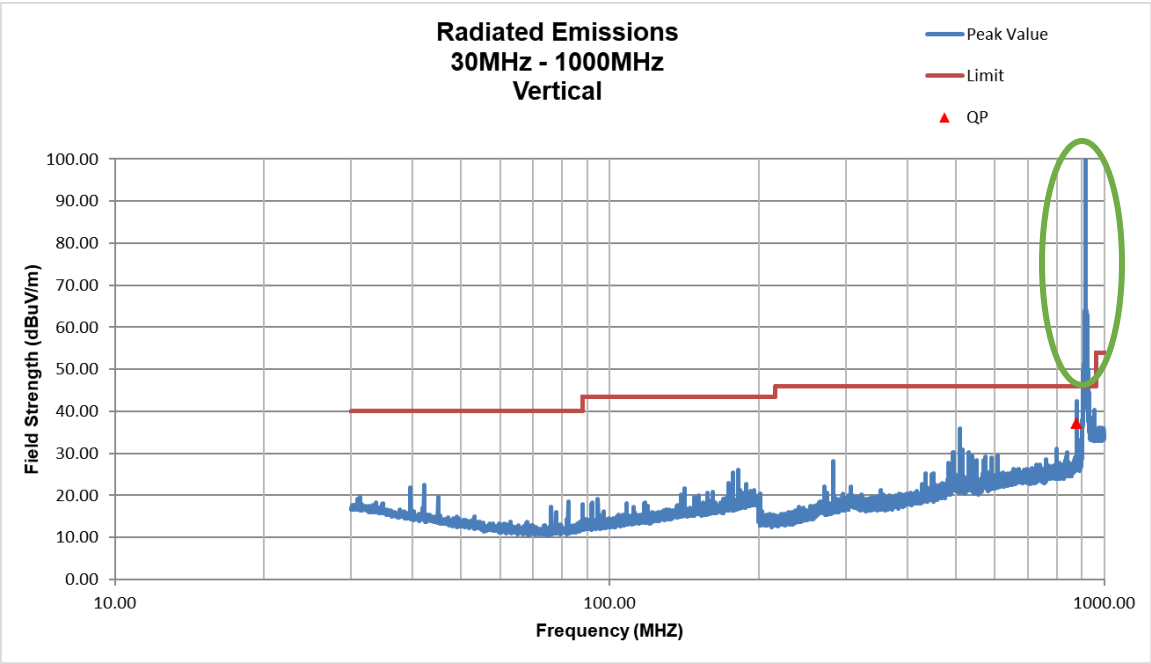


Figure 21. Radiated Emissions, Vertical 30 MHz - 1 GHz

Note: Circled in green is the fundamental of the radio

Table 13. Spurious Radiated Emissions (Above 1 GHz) – High Gain Antenna

Test: FCC Part 15.209							
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**AVG Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector PK, or AVG**
Except for harmonics of the fundamental emissions as reported in Section 2.10 above, all other emissions seen were more than 20 dB below the limit.							

Sample Calculation: N/A

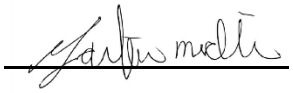
Test Date: December 12, 2024
Tested By
Signature:  Name: Gabriel Medina

Table 14. Spurious Radiated Emissions (150kHz – 30MHz) – Low Gain Antenna

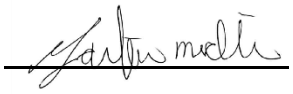
Test: FCC Part 15.209							
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**QP Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector PK, or QP**
All emissions were less than 6 dB above the noise floor or emissions were more than 20 dB below the applicable limit							

Table 15. Spurious Radiated Emissions (30MHz – 1 GHz) – Low Gain Antenna

Test: FCC Part 15.209							
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**QP Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector PK, or QP**
165.60	44.12	-11.10	33.02	43.5	3m./HORZ	10.5	**PK**
482.82	39.65	-4.99	34.66	46.0	3m./HORZ	11.3	**PK**
877.00	41.65	1.36	43.01	46.0	3m./HORZ	3.0	**QP**
69.85	36.92	-15.02	21.90	40.0	3m./VERT	18.1	**PK**
482.82	37.07	-5.59	31.48	46.0	3m./VERT	14.5	**PK**
877.51	39.71	0.46	40.17	46.0	3m./VERT	5.8	**PK**

Sample Calculation at 165.6 MHz:

Magnitude of Measured Frequency	44.12 dBuV
+ Cable Loss+ LISN Loss	-11.10 dB
=Corrected Result	33.02 dBuV

Test Date: December 12, 2024
Tested By
Signature:  Name: Gabriel Medina

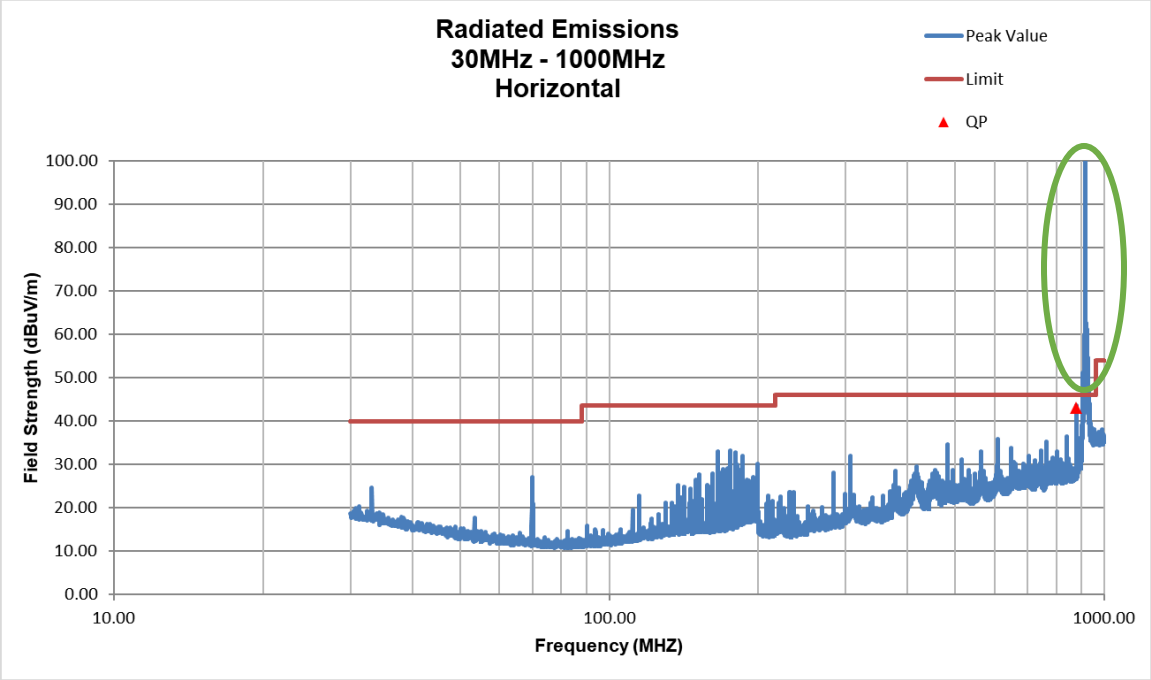


Figure 22. Radiated Emissions, Horizontal 30 MHz - 1 GHz

Note: Circled in green is the fundamental of the radio

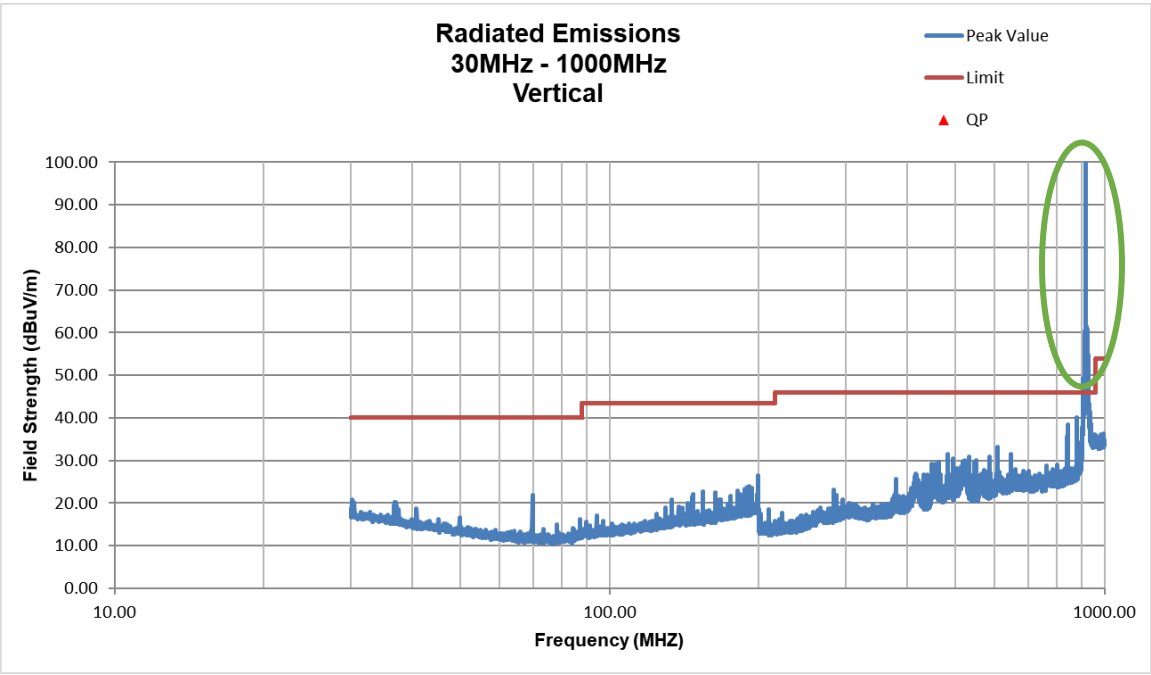


Figure 23. Radiated Emissions, Vertical 30 MHz - 1 GHz

Note: Circled in green is the fundamental of the radio

Table 16. Spurious Radiated Emissions (Above 1 GHz) – Low Gain Antenna

Test: FCC Part 15.209							
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**AVG Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector PK, or AVG**
Except for harmonics of the fundamental emissions as reported in Section 2.10 above, all other emissions seen were more than 20 dB below the limit.							

Sample Calculation: N/A

Test Date: December 12, 2024
Tested By
Signature: _____ Name: Gabriel Medina

2.19 Measurement Uncertainty

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

219.1 Conducted Emissions Measurement Uncertainty

The EUT was battery powered; therefore, this test was not applied.

2.19.2 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 ± 5.39 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 ± 5.18 dB.

The measurement uncertainty (with a 95% confidence level) for this test using a Horn Antenna is ± 5.21dB.

3. Conclusion

The Equipment under Test is deemed to have meet all the applicable requirements of Part 15.247 and RSS-247 for this type of intentional radiator as tested and presented in this test report.