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 Innovation, Science, and Economic Development Canada
Certification Per
IC RSS-Gen General Requirements for Radio Apparatus
And
RSS-247Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSS) and License-Exempt Local Area Network (LE-LAN) Devices

For the

Radio Systems Corporation

Model: STD00-17812 and STD00-17811

FCC ID: KE3-30034451

IC:2721A-30034451

UST Project: 23-0105, 23-0107

Issue Date: July 11, 2023

Total Pages in This Report: 48

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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 July 11, 2023

NVLAP LAB CODE 200162-0

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MEASUREMENT TECHNICAL REPORT

COMPANYS NAME: Radio Systems Corporation

MODEL: STD00-17812 and STD00-17811

FCC ID: KE3-30034451

IC: 2721A-30034451

DATE: July 11, 2023

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

Equipment type: FHSS Transmitter Module

Technical:

Radio Technology:	FHSS
Frequency of Operation (MHz):	905-925
Output Power (dBm):	+27.35
Type of modulation:	GFSK
Data/Bit Rate (M)bps:	N/A
Antenna Gain	Refer to Table 5
Software used to program EUT:	Silicon Labs Simplicity Commander
EUT firmware number:	820-575_SDFS_HandHeld_v02.hex
Maximum Power Setting (dBm)	30
Power Setting:	92

Report prepared by:

US Tech
3505 Francis Circle
Alpharetta, GA 30004

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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 2.

1.2 Characterization of Test Sample

The sample used for testing was received by US Tech on May 22, 2023 in good operating condition.

1.3 Product Description

The Equipment under Test (EUT) is the Radio Systems Corporation Model STD00-17812and STD00-17811. The EUT is a fully functional training e-collar that also monitors the dogs health. The collar's built-in sensor will detect the dog's vitals and the handheld will alert you when there has been a serious change. The handheld is used to communicate with the collar by setting the static charge from 1-7 (1 being the lowest and 7 being the highest charge). The V/T setting is used to charge the sensitivity of the health alert function of the collar.

The handheld controller is available in two different operating ranges. Model: STD00-17812 is the 1-mile variant of this EUT and Model: STD00-17811 is the 0.5-mile variant. The only difference between these to units is the antenna used. All other components and radios are the exact same between each variant.

For all radio testing performance presented herein was performed on the 1-mile EUT. We have included the intentional radiator radiated emissions for both the 1-mile and 0.5-mile EUT to show that both unit are in compliance with the applicable limits.

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.

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. 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.

Table 1. EUT and Peripherals

PERIPHERAL MANUFACTURER.	MODEL NUMBER	SERIAL NUMBER	FCC ID:	CABLES P/D
Radio Systems Corporation (EUT)	STD00-17812	124C00045B	FCC ID: KE3-30034451 IC: 2721A-30034451 Contains FCC ID: QOQ-GM240S IC: 5123A-GM240S	P
Radio Systems Corporation (EUT)	STD00-17811	124C0004AE	FCC ID: KE3-30034451 IC: 2721A-30034451 Contains FCC ID: QOQ-GM240S IC: 5123A-GM240S	P
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 NEXT CALIBRATION
Spectrum Analyzer	RIGOL	DSA815	DSA8A180300138	1/6/2024 2 yr.
Spectrum Analyzer	Advantest	U3772	1806001039	1/25/2025 2 yr.
Spectrum Analyzer	Agilent	E4407B	US41442935	9/21/2024 2 yr.
Spectrum Analyzer	Hewlett-Packard	8593E	3205A00124	2/28/2024 2 yr.
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.
Pre-Amplifier	Hewlett-Packard	8449B	3008A00914	3/3/2024
Pre-Amplifier	Hewlett-Packard	8447D	1937A02980	Extended 9/9/2023
LISN x 2	Solar Electronics	9247-50-TS-50-N	955824 and 955825	4/28/2024

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 905 MHz to 924 MHz, 3 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 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, RSS-Gen 6.9, 6.13)

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
1-Mile Antenna	Radio Systems Corporation	Monopole	W1910-M	+1.0	SMA
0.5-mile Antenna	Radio Systems Corporation	PCB	PC91.07.0100A	+2.7	SMA

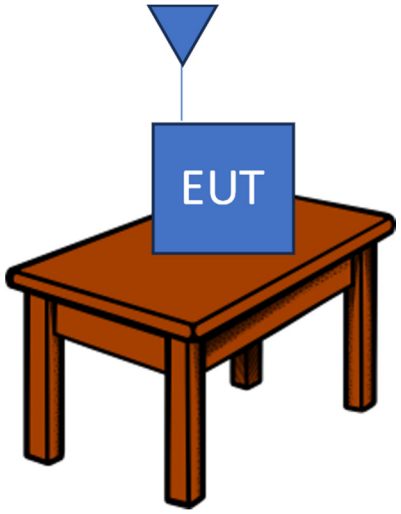


Figure 1. Block Diagram of Test Configuration

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))

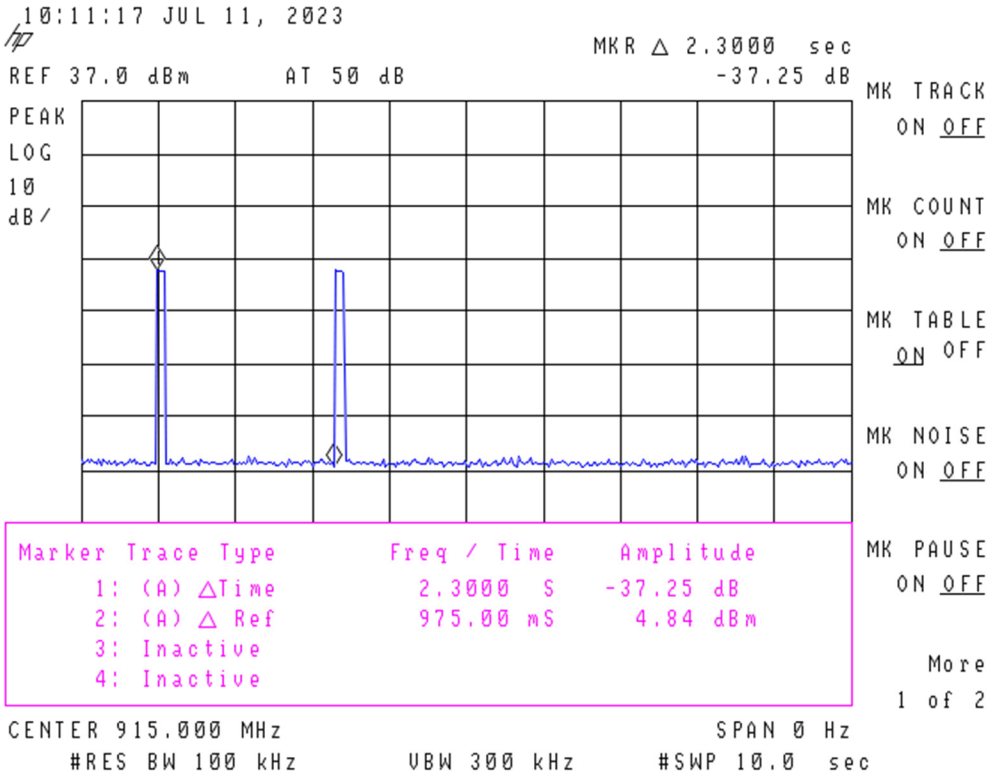


Figure 2. Duty Cycle 10s Sweep

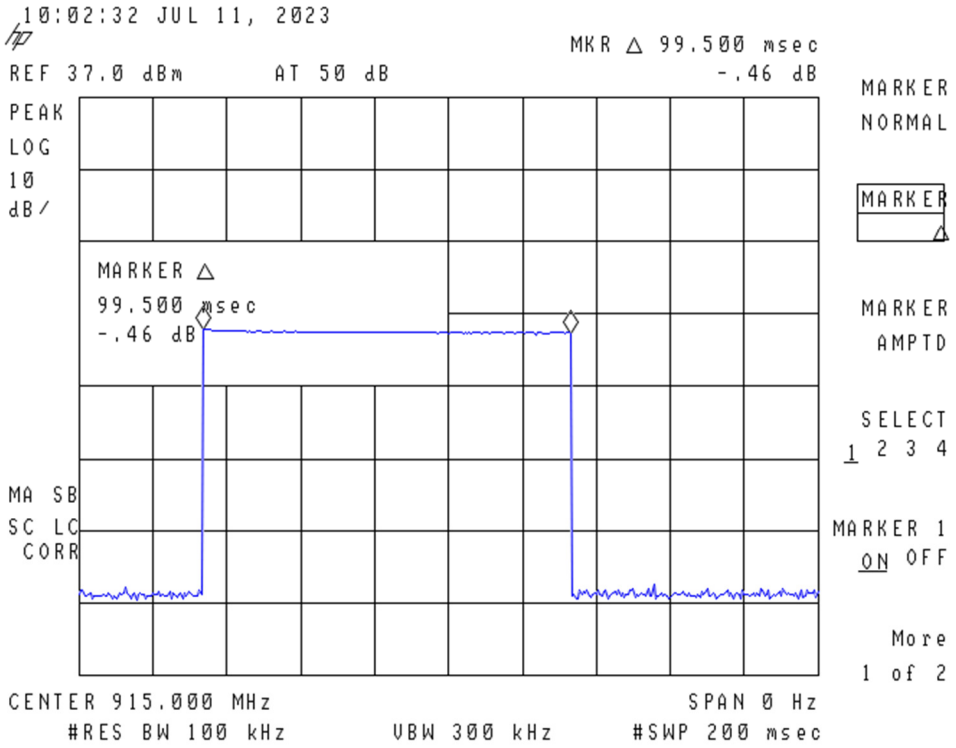


Figure 3. Transmitter Pulse Width

Total Pulse Train from Figure 2 = 2.3s = 2300 ms (Pulse Train)
Total Time On from Figure 3 = 99.5 ms (Transmitter Pulse Width)

(A ms Total Time On)/(B ms Total Pulse Train) = 99.5 ms/2300 Numeric Duty Cycle
Duty Cycle = 20 Log (99.5/2300) = -27.27 dB

NOTE: 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. Duty cycle used throughout this test report -20 dB

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

Power line conducted emissions testing was performed to ensure that with the EUT in operation (exercising all transmitter functions), the complete system continues to meet the applicable requirements for CFR 15.207. These measurements were completed and are displayed along with the 15.107 power line test data in the sections below.

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 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 worst 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.

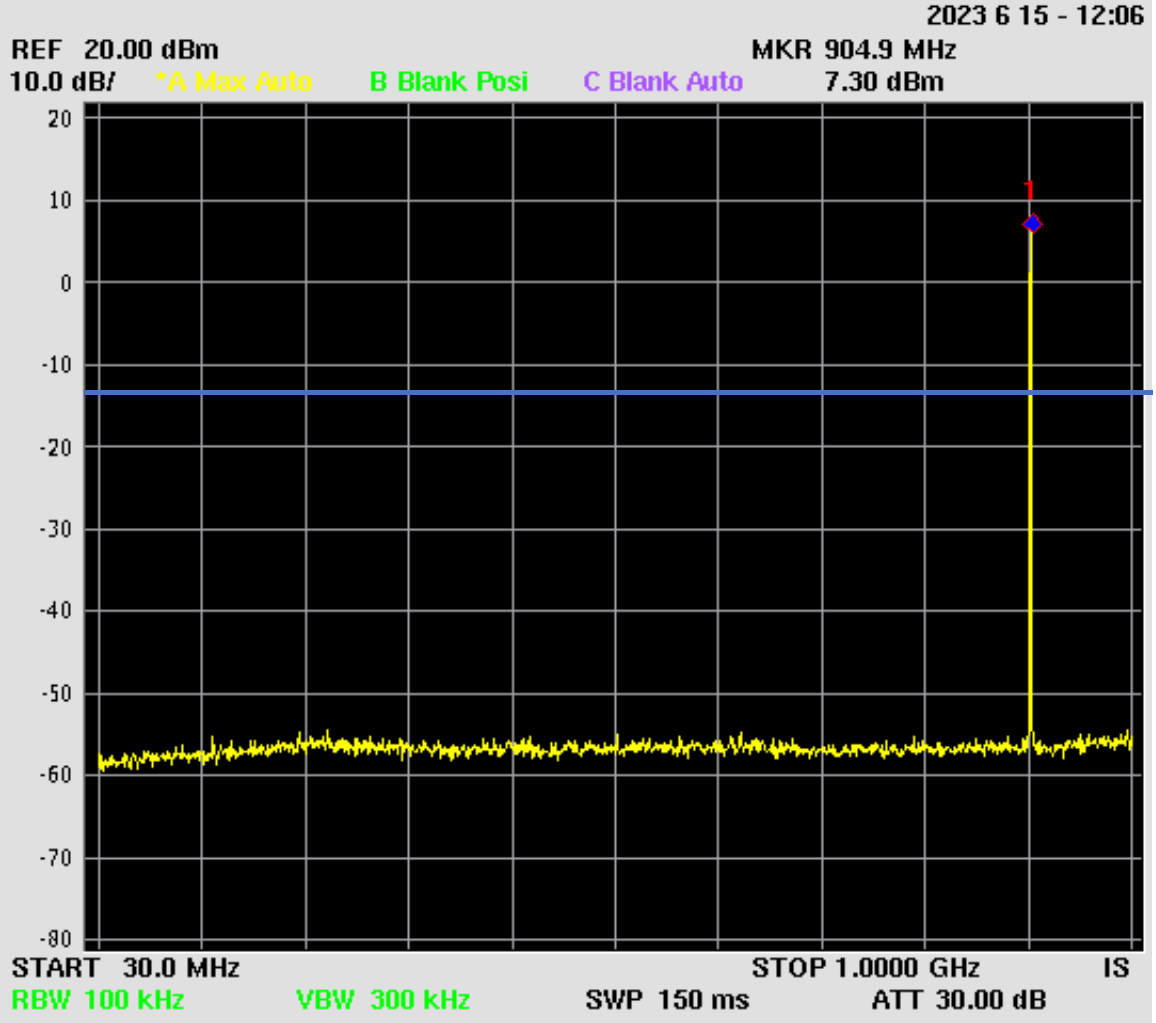


Figure 4. Conducted Emissions, Channel 00, 30 MHz – 1000 MHz

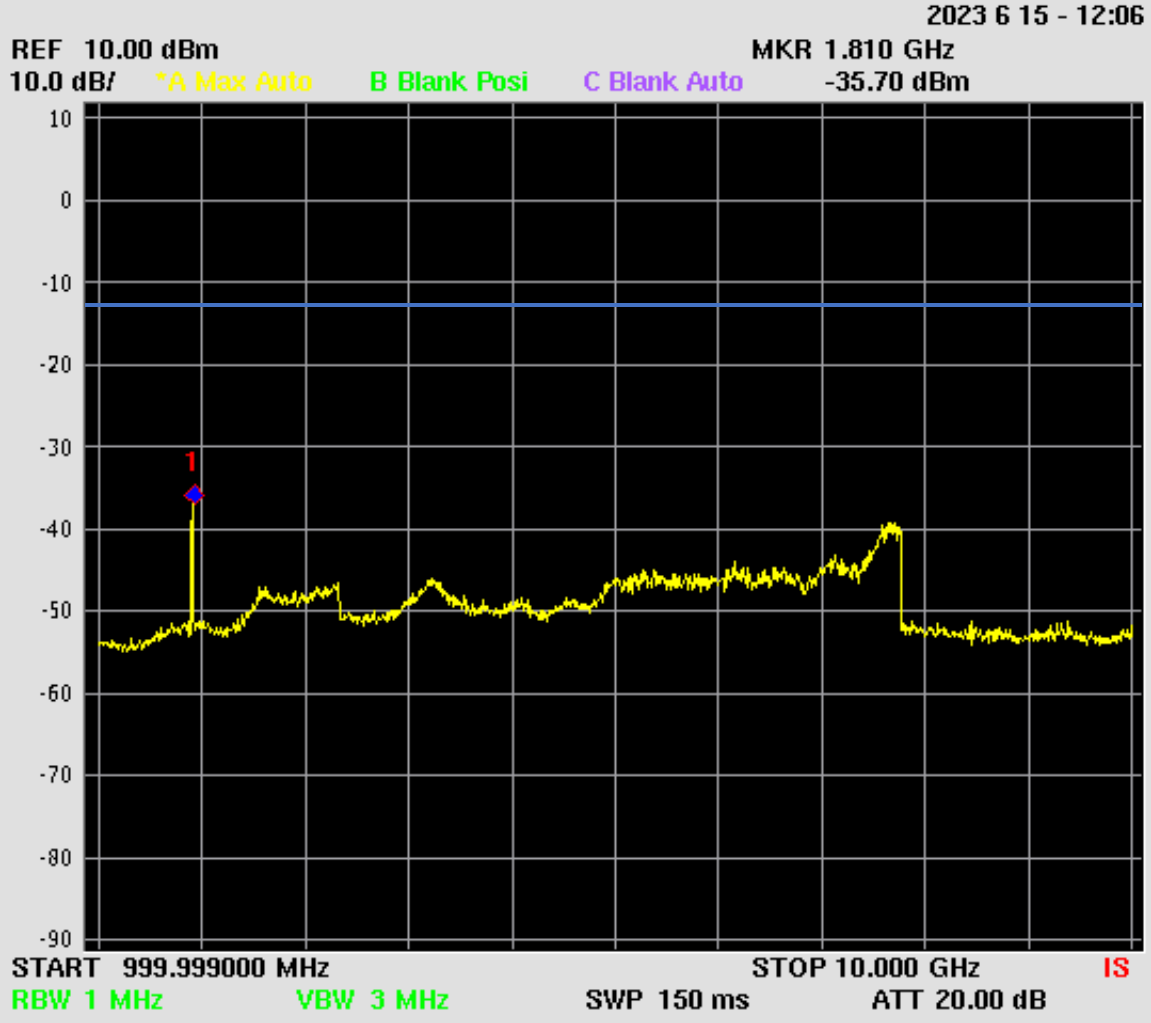


Figure 5. Conducted Emissions, Channel 00, 1 GHz – 10 GHz

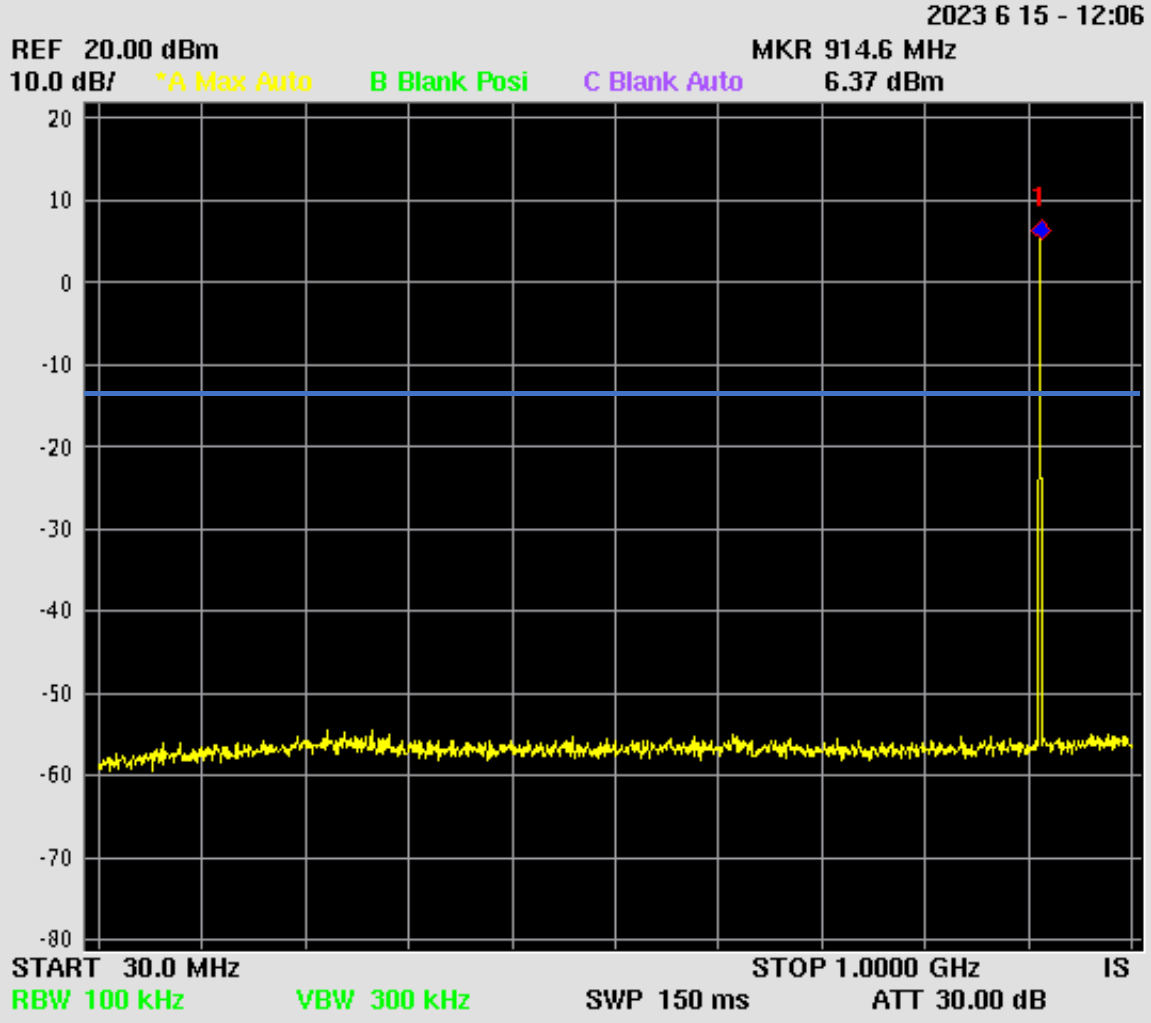


Figure 6. Conducted Emissions, Channel 24, 30 MHz – 1000 MHz

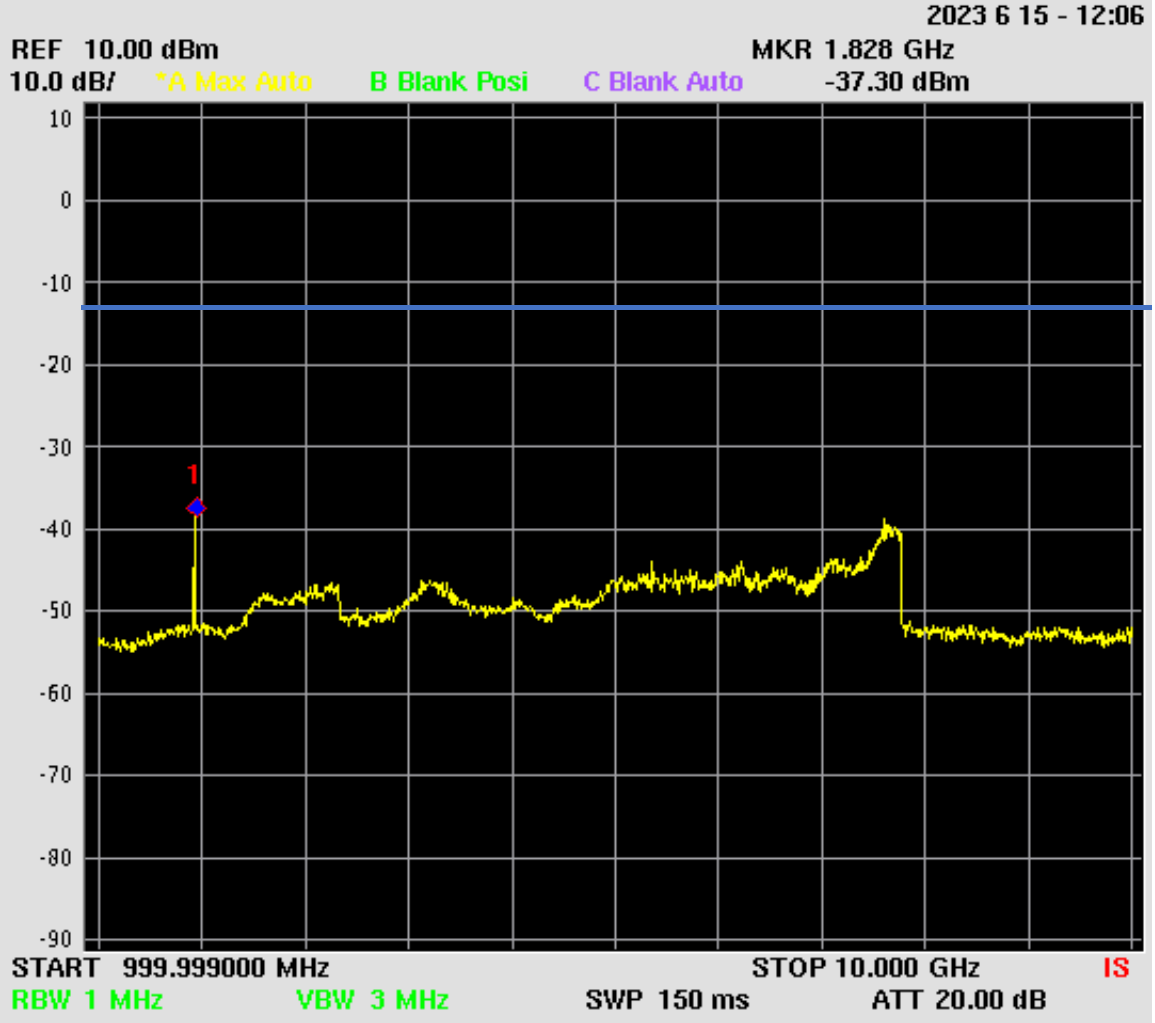


Figure 7. Conducted Emissions, Channel 24, 1 GHz – 10 GHz

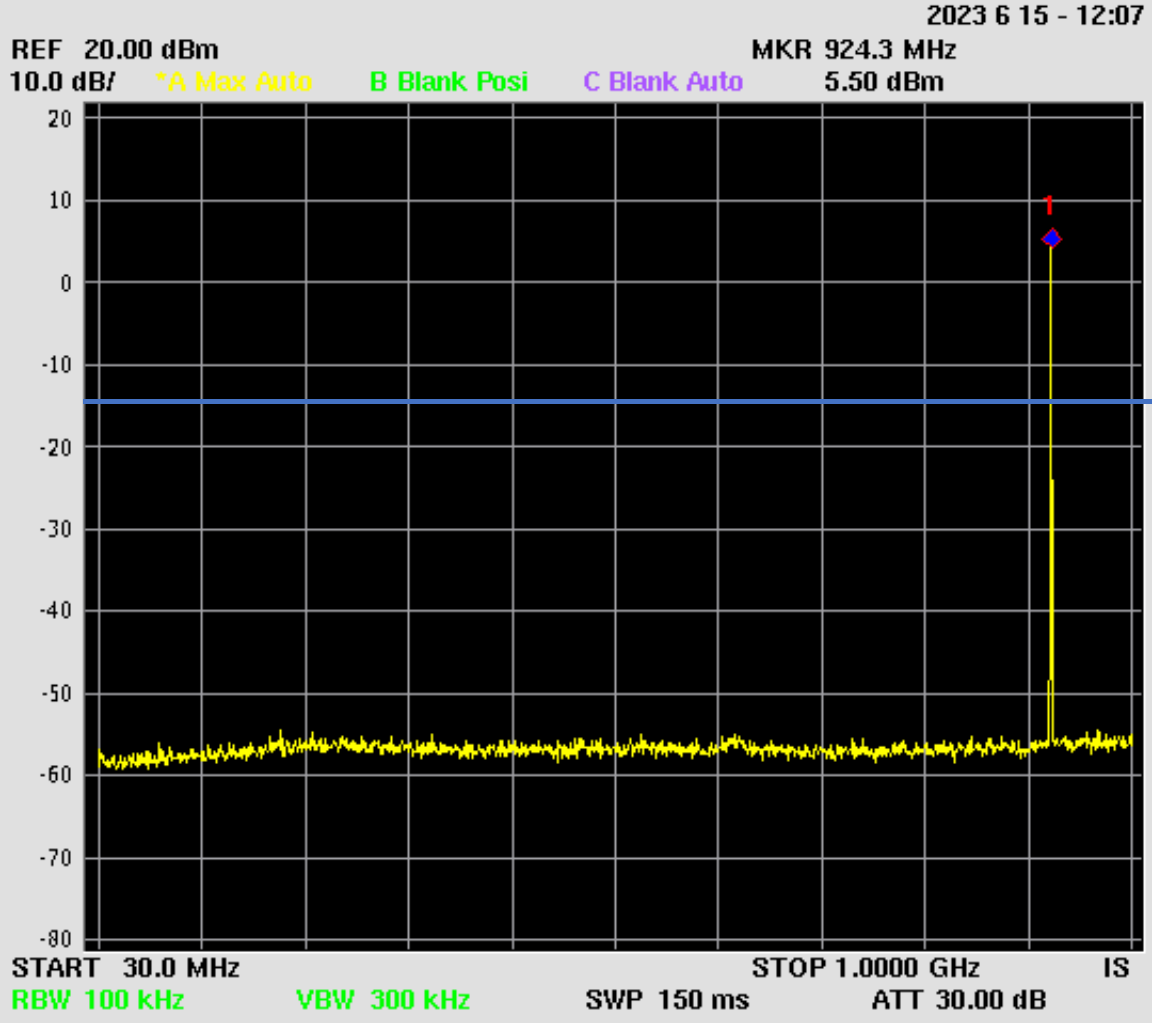


Figure 8. Conducted Emissions, Channel 49, 30 MHz – 1000 MHz

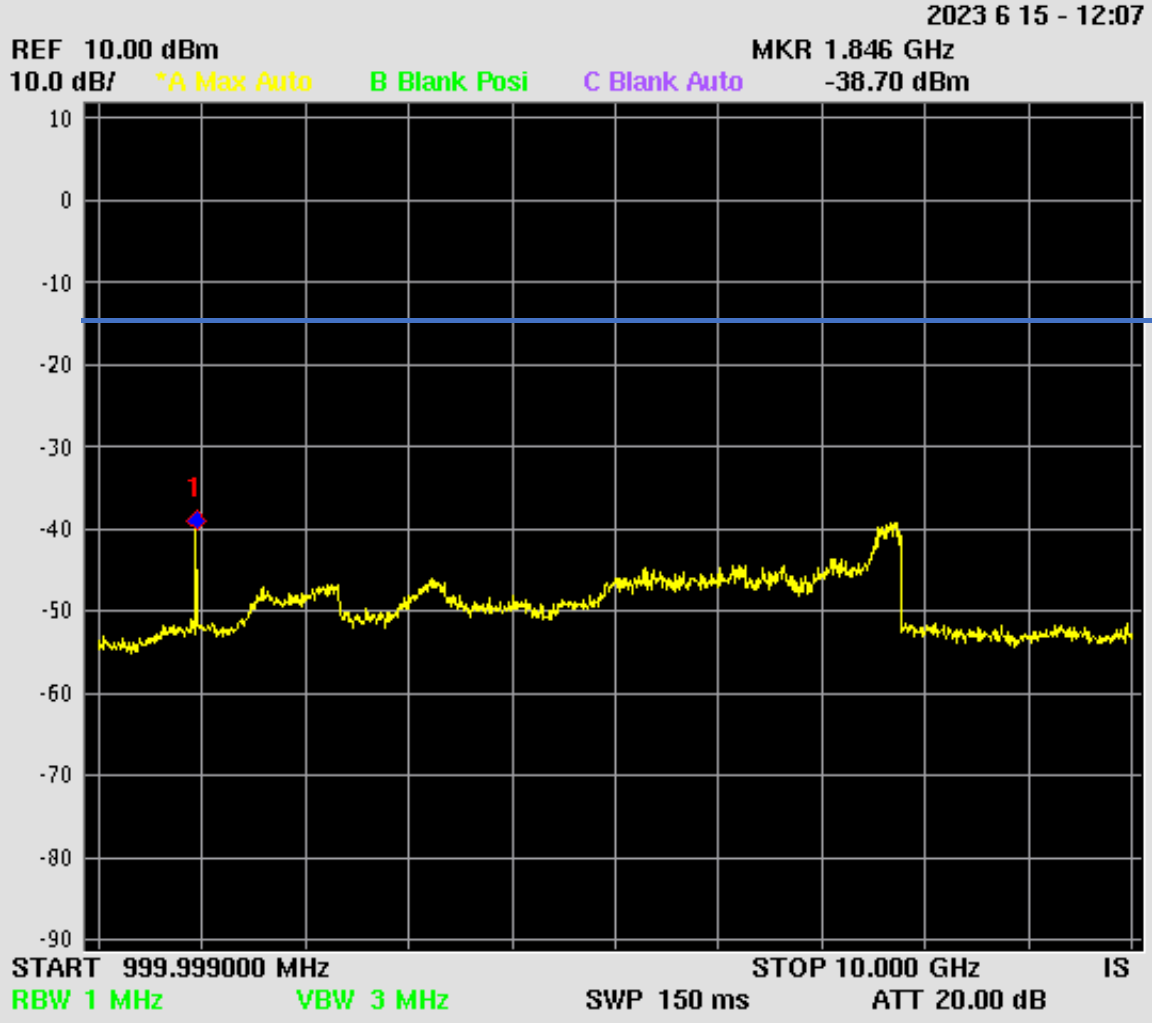


Figure 9. Conducted Emissions, Channel 49, 1 GHz – 10 GHz

Table 5. Peak Radiated Fundamental & Harmonic Emissions

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 – Peak								
905.01	120.21	0.00	23.79	144.00	--	3m./VERT	--	**PK**
1809.99	69.55	0.00	-9.22	60.33	74.0	3.0m./VERT	13.7	**PK**
2714.97	67.11	0.00	-4.94	62.17	74.0	3.0m./VERT	11.8	**PK**
Mid Channel – Peak								
914.58	119.83	0.00	23.79	143.62	--	3m./VERT	--	**PK**
1829.18	72.28	0.00	-9.02	63.26	74.0	3.0m./VERT	10.7	**PK**
2743.83	69.10	0.00	-4.94	64.16	74.0	3.0m./VERT	9.8	**PK**
High Channel - Peak								
924.57	124.92	0.00	25.69	150.61	--	3m./HORZ	--	**PK**
1849.16	70.92	0.00	-8.94	61.98	74.0	3.0m./VERT	12.0	**PK**
2773.70	60.01	0.00	-5.00	55.01	74.0	3.0m./VERT	19.0	**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 905.01 MHz:

Magnitude of Measured Frequency	120.21	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	23.79	dB/m
+Additional Factors	0.00	dB
Corrected Result	144.00	dBuV/m

Test Date: June 14, 2033
Tested By
Signature: Ian Charboneau Name: Ian Charboneau

Table 6. Average Radiated Fundamental & Harmonic Emissions

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 – Average								
905.01	120.21	-20.0	23.79	124.00	--	3m./VERT	--	**PK**
1809.99	69.55	-20.0	-9.22	40.33	54.0	3.0m./VERT	13.7	**AVG**
2714.97	67.11	-20.0	-24.94	42.17	54.0	3.0m./VERT	11.8	**AVG**
Mid Channel – Average								
914.58	119.83	-20.0	23.79	123.62	--	3m./VERT	--	**PK**
1829.18	72.28	-20.0	-9.02	43.23	54.0	3.0m./VERT	10.8	**AVG**
2743.83	69.10	-20.0	-4.94	44.16	54.0	3.0m./VERT	9.8	**AVG**
High Channel - Average								
924.57	124.92	-20.0	25.69	130.61	--	3m./HORZ	--	**PK**
1849.16	70.92	-20.0	-8.94	41.98	54.0	3.0m./VERT	12.0	**AVG**
2773.70	60.01	-20.0	-5.00	35.01	54.0	3.0m./VERT	19.0	**AVG**

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 905.01 MHz:

Magnitude of Measured Frequency	120.21	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	23.79	dB/m
+Additional Factors	-20.00	dB
Corrected Result	124.00	dBuV/m

Test Date: June 14, 2033
Tested By
Signature: Ian Charboneau Name: Ian Charboneau

2.11 Band Edge Measurements – (CFR 15.247 (d), RSS-247, 5.5)

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. Antenna port 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).

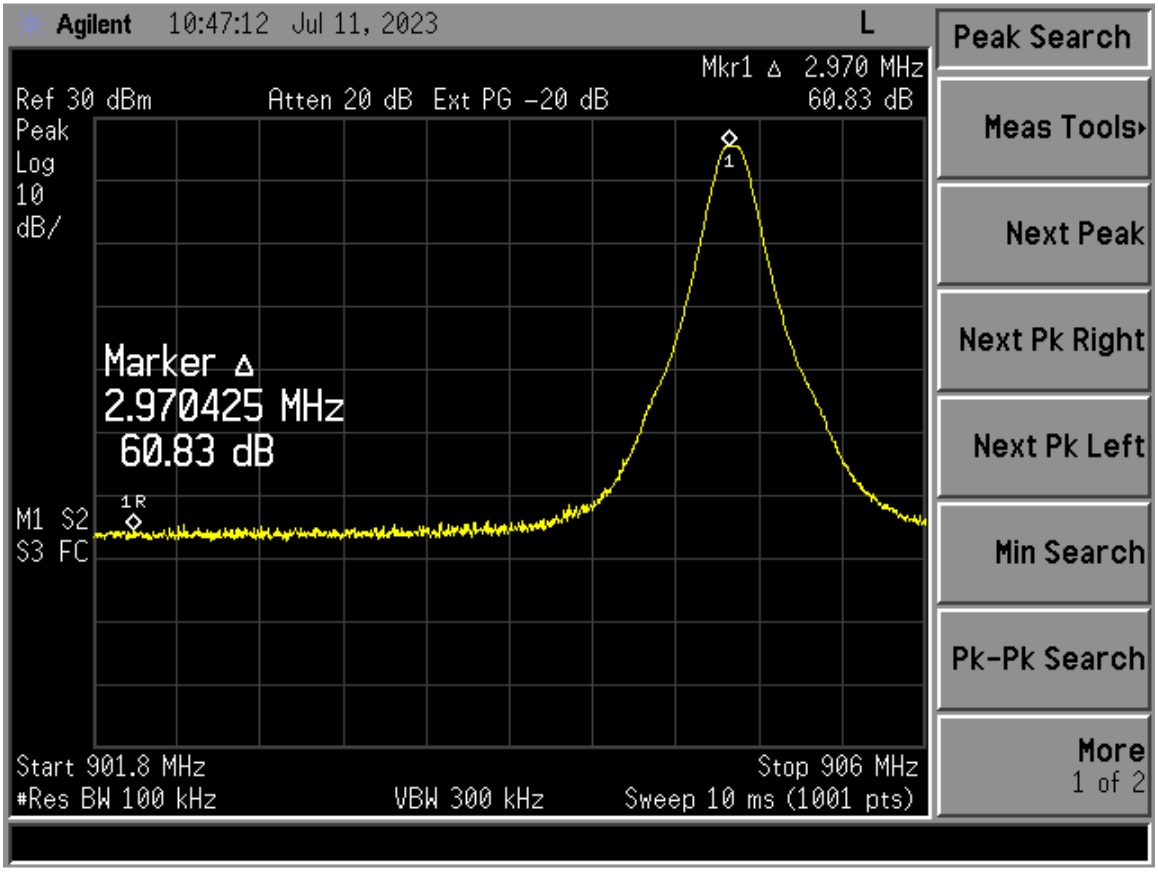


Figure 10. Band Edge Compliance, Low Channel Delta - Peak

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

Measured Result	60.83	dB
Band Edge Limit	20.00	dB
Band Edge Margin	40.83	dB

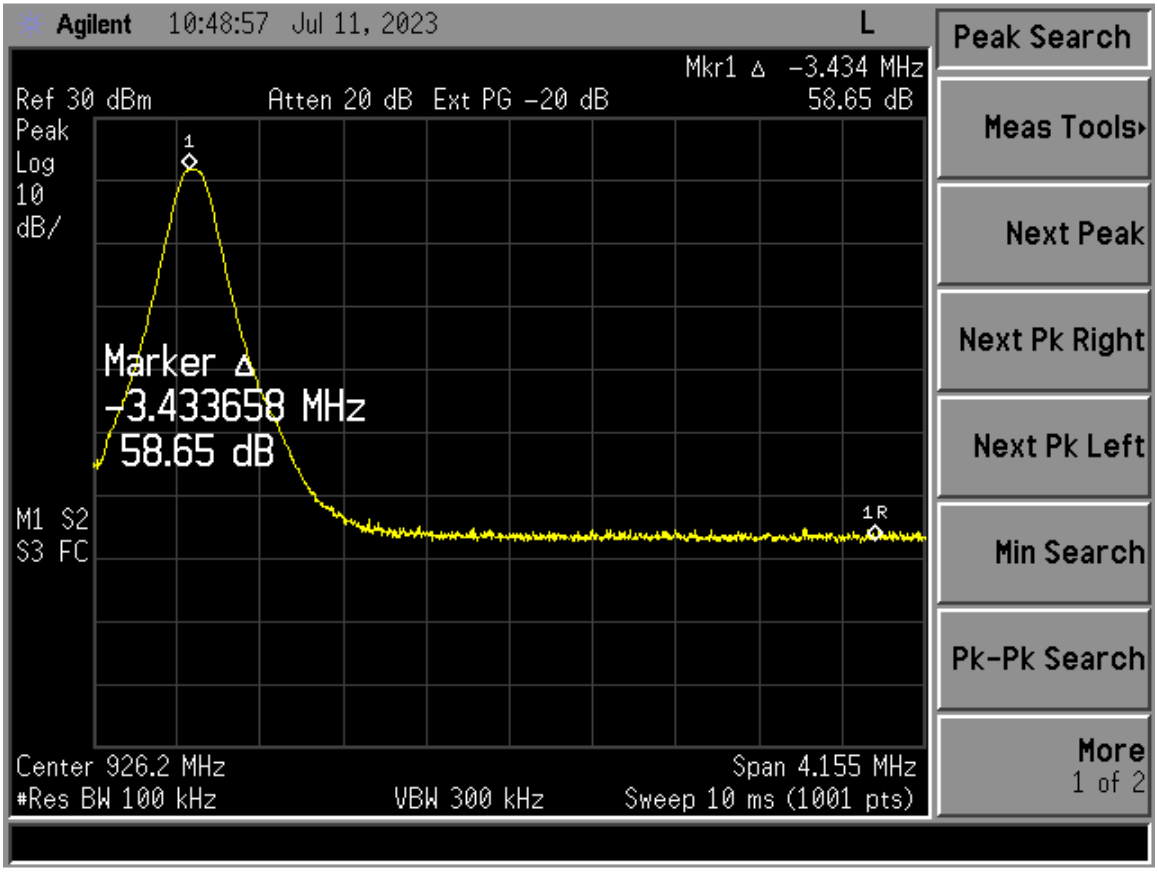


Figure 11. Band Edge Compliance, High Channel Delta – Peak

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

Measured Result	58.65	dB
Band Edge Limit	20.00	dB
Band Edge Margin	38.65	dB

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 7. 20 dB Bandwidth and 99% Occupied Bandwidth

Frequency (MHz)	20 dB Bandwidth (kHz)	99% Occupied Bandwidth (kHz)	Maximum Limit (kHz)
905	49.0	46.9	500
914	48.9	46.4	500
925	48.2	46.4	500

Test Date: June 16, and July 11, 2023
Tested By
Signature: Name: Ian Charboneau

Signature: Name: Gabriel Medina

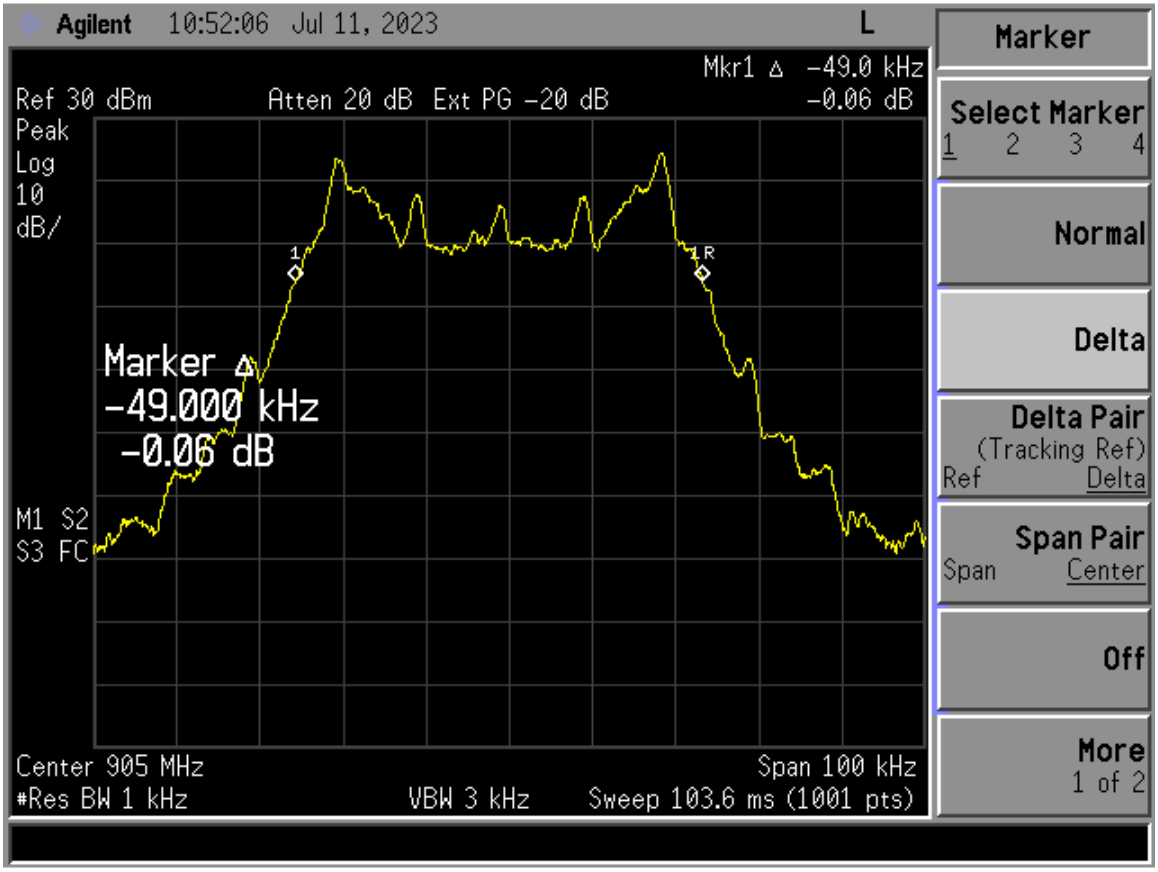


Figure 12. Twenty dB Bandwidth – Low Channel

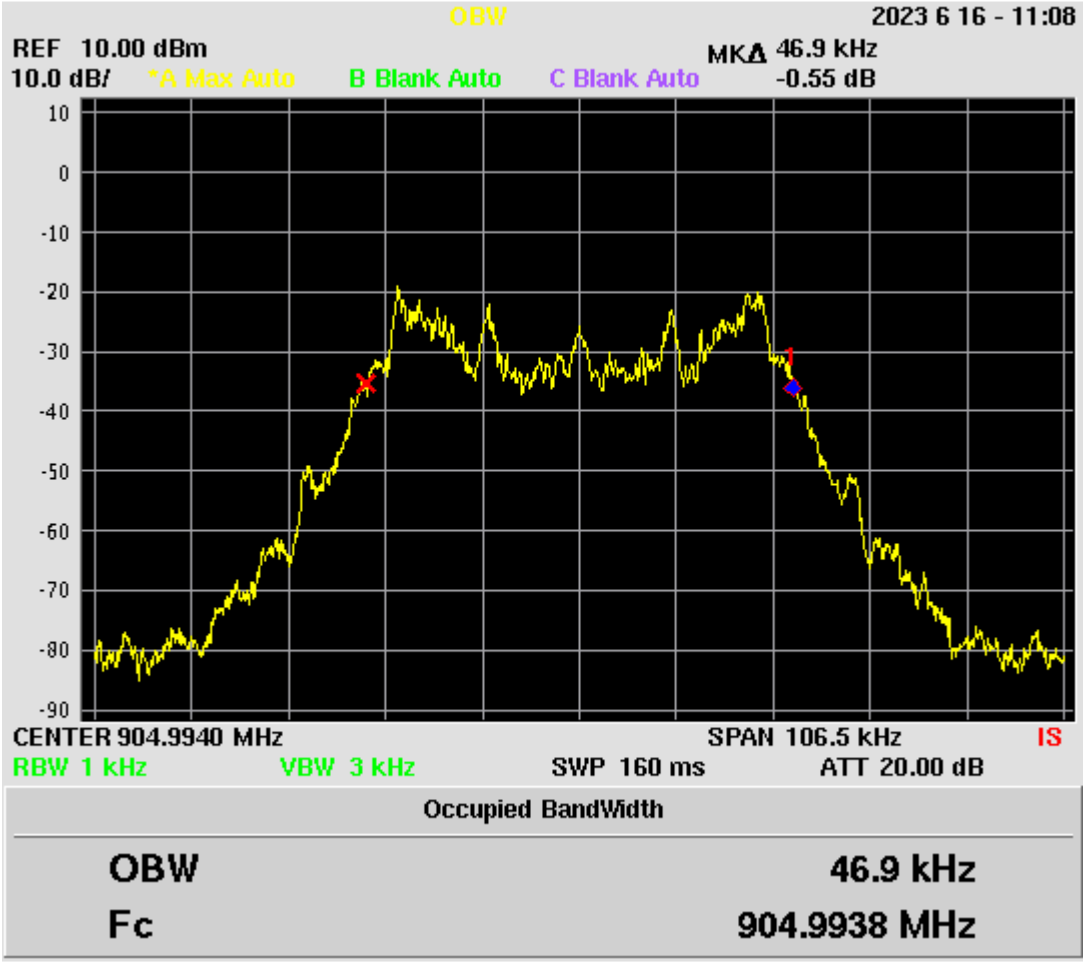


Figure 13. 99% Occupied Bandwidth – Low Channel

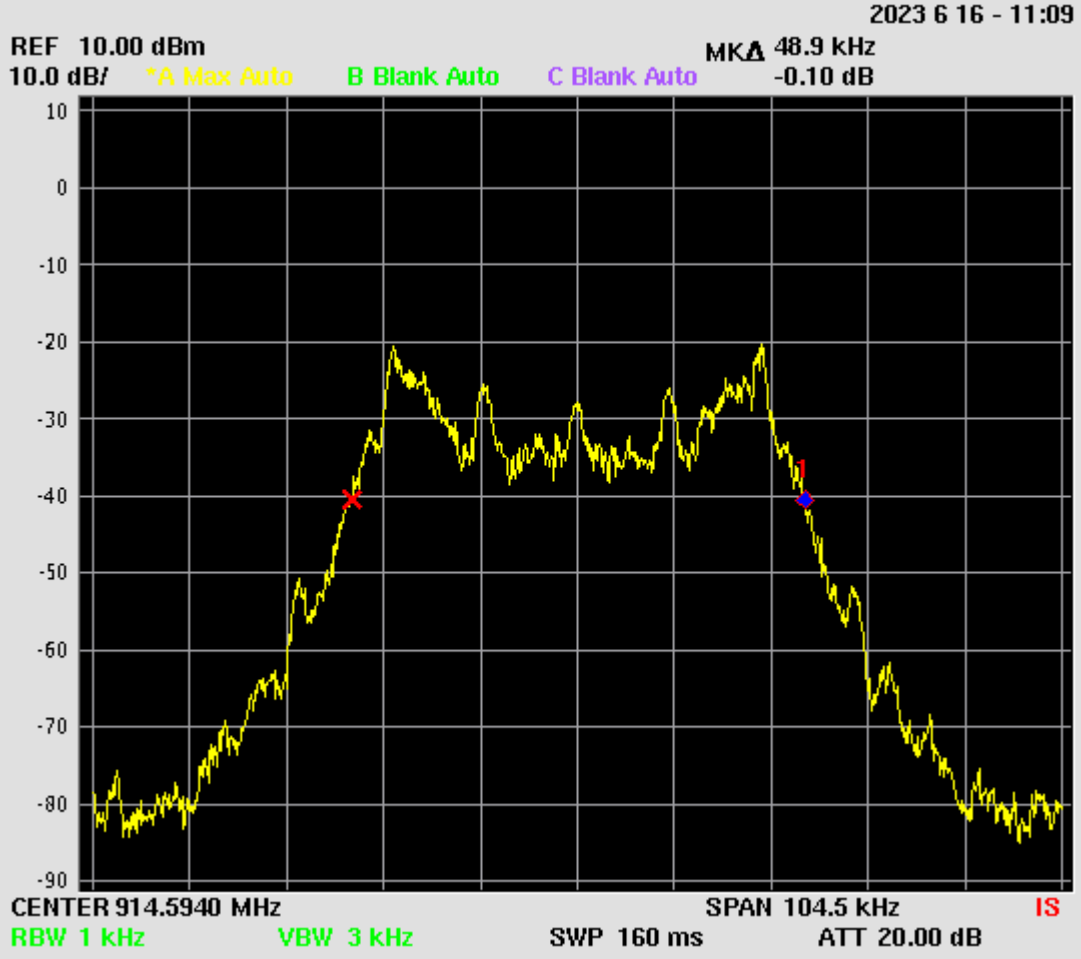


Figure 14. Twenty dB Bandwidth – Mid Channel

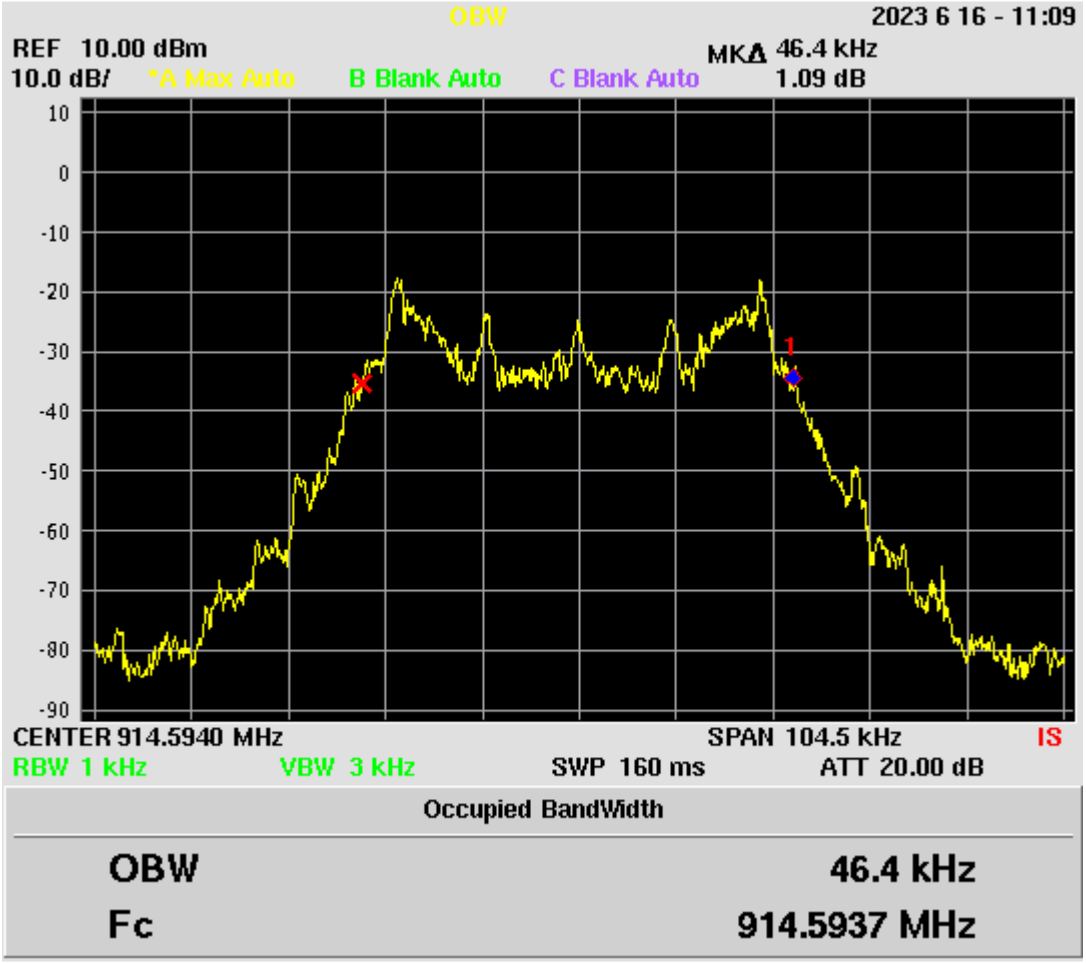


Figure 15. 99% Occupied Bandwidth – Mid Channel

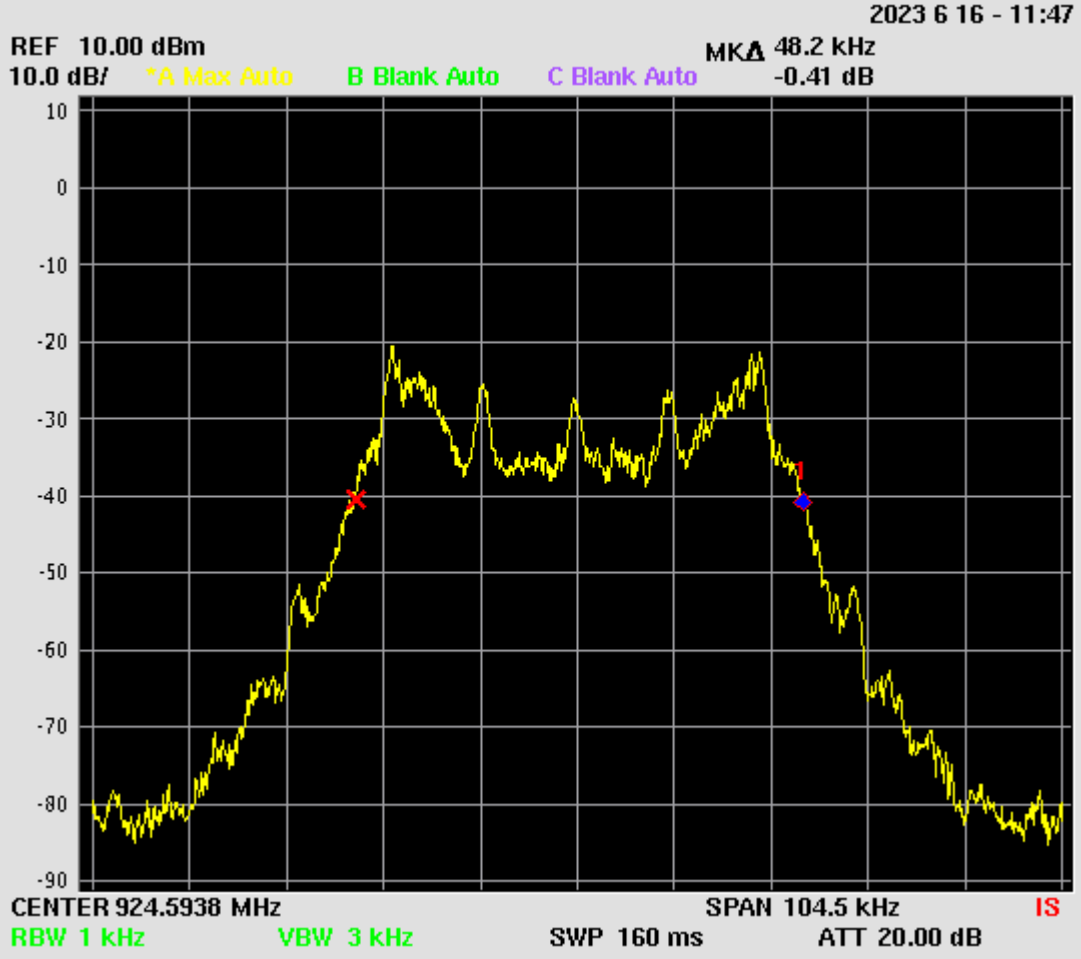


Figure 16. Twenty dB Bandwidth – High Channel

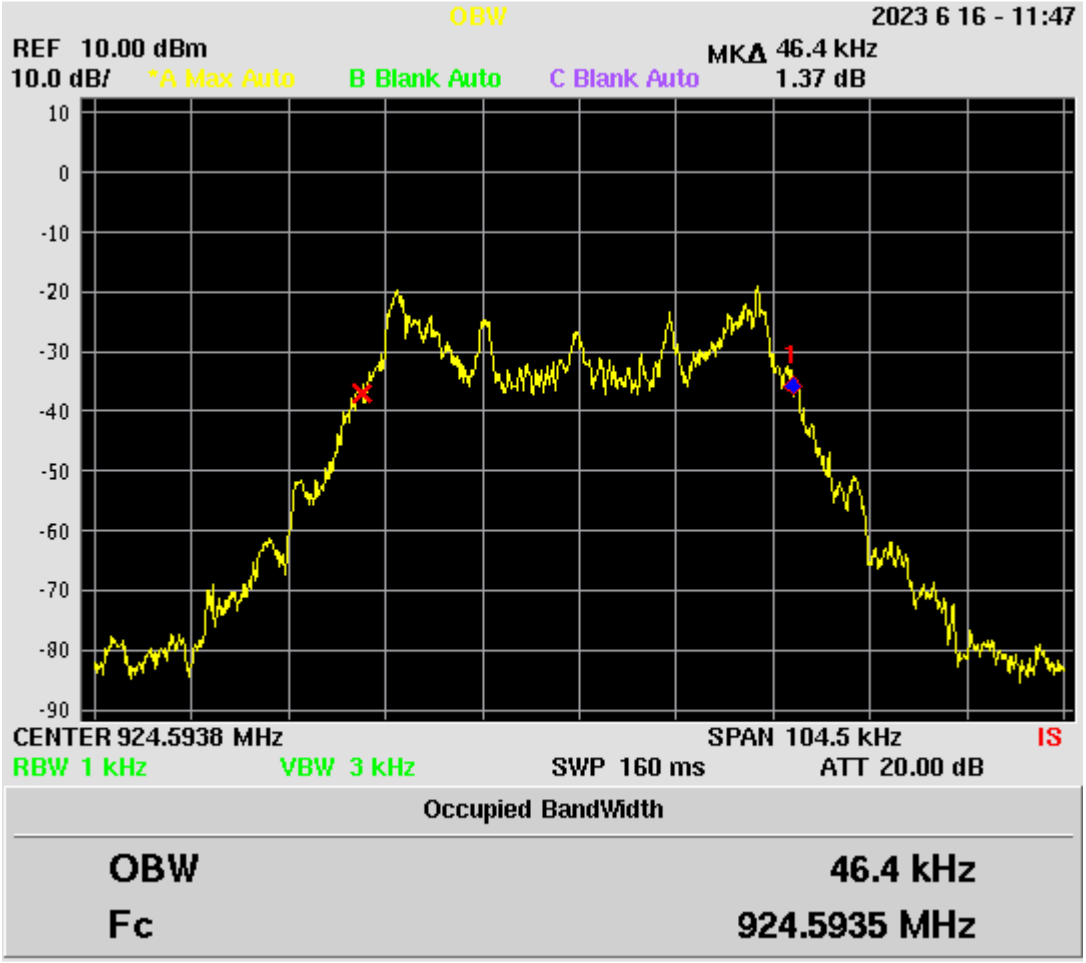


Figure 17. 99% Occupied Bandwidth – High Channel

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 if 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.

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

The table below lists all available channels. There are a total of 50 channels.

Number of Channels Used	Channel Number	RF Center Frequency (MHz)
1	0	905
2	1	905.4
3	2	905.8
4	3	906.2
5	4	906.6
6	5	907
7	6	907.4
8	7	907.8
9	8	908.2
10	9	908.6
11	10	909
12	11	909.4
13	12	909.8
14	13	910.2
15	14	910.6
16	15	911
17	16	911.4
18	17	911.8
19	18	912.2
20	19	912.6
21	20	913
22	21	913.4
23	22	913.8
24	23	914.2
25	24	914.6
26	25	915
27	26	915.4
28	27	915.8
29	28	916.2
30	29	916.6
31	30	917
32	31	917.4
33	32	917.8
34	33	918.2
35	34	918.6
36	35	919
37	36	919.4
38	37	919.8
39	38	920.2
40	39	920.6
41	40	921
42	41	921.4
43	42	921.8
44	43	922.2
45	44	922.6
46	45	923
47	46	923.4
48	47	923.8
49	48	924.2
50	49	924.6

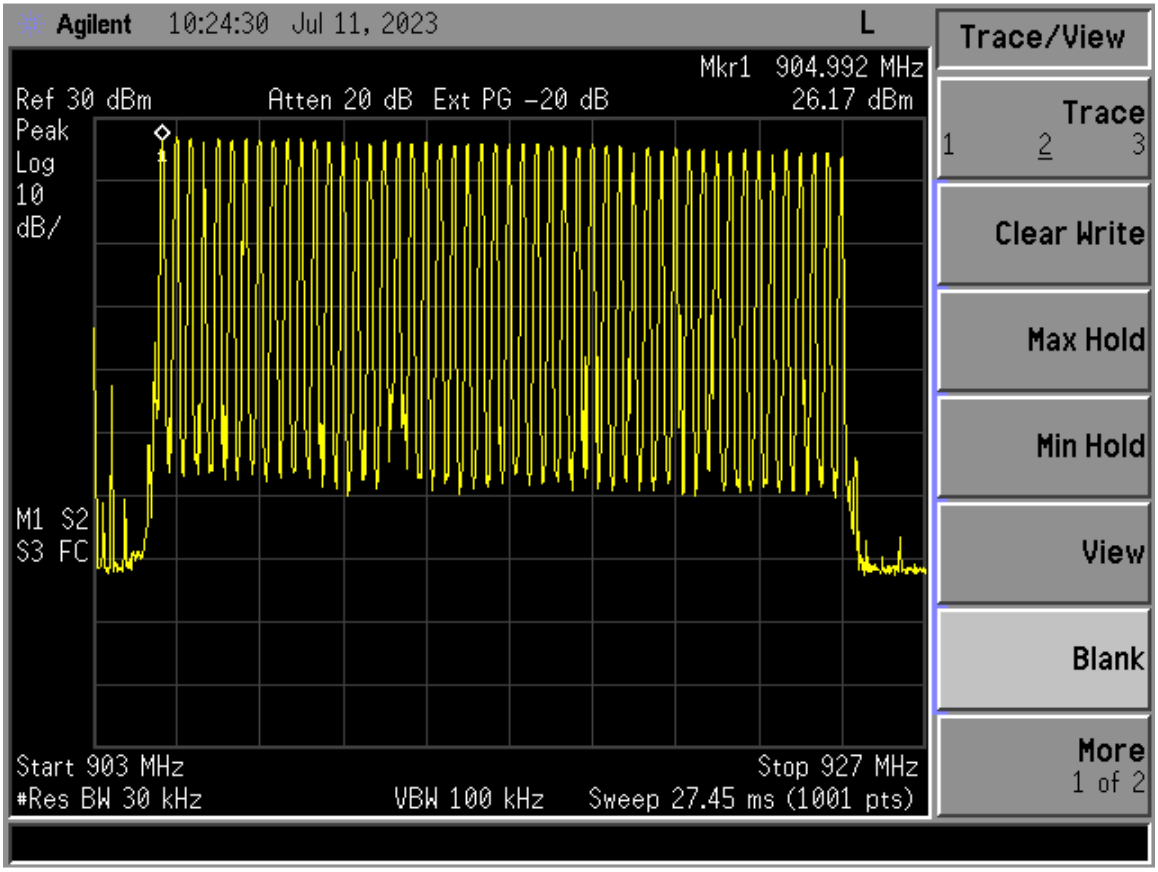


Figure 18. Hopping Channels 0 through 49

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 904 MHz to 925 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 50W input impedance. The setup losses were corrected by using a -20dB offset in the analyzer measurements. 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)
905	27.35	543.2	1000
914	26.24	420.7	1000
925	25.33	341.2	1000

Test Date: June 15, 2023
Tested By
Signature: Name: Gabriel Medina

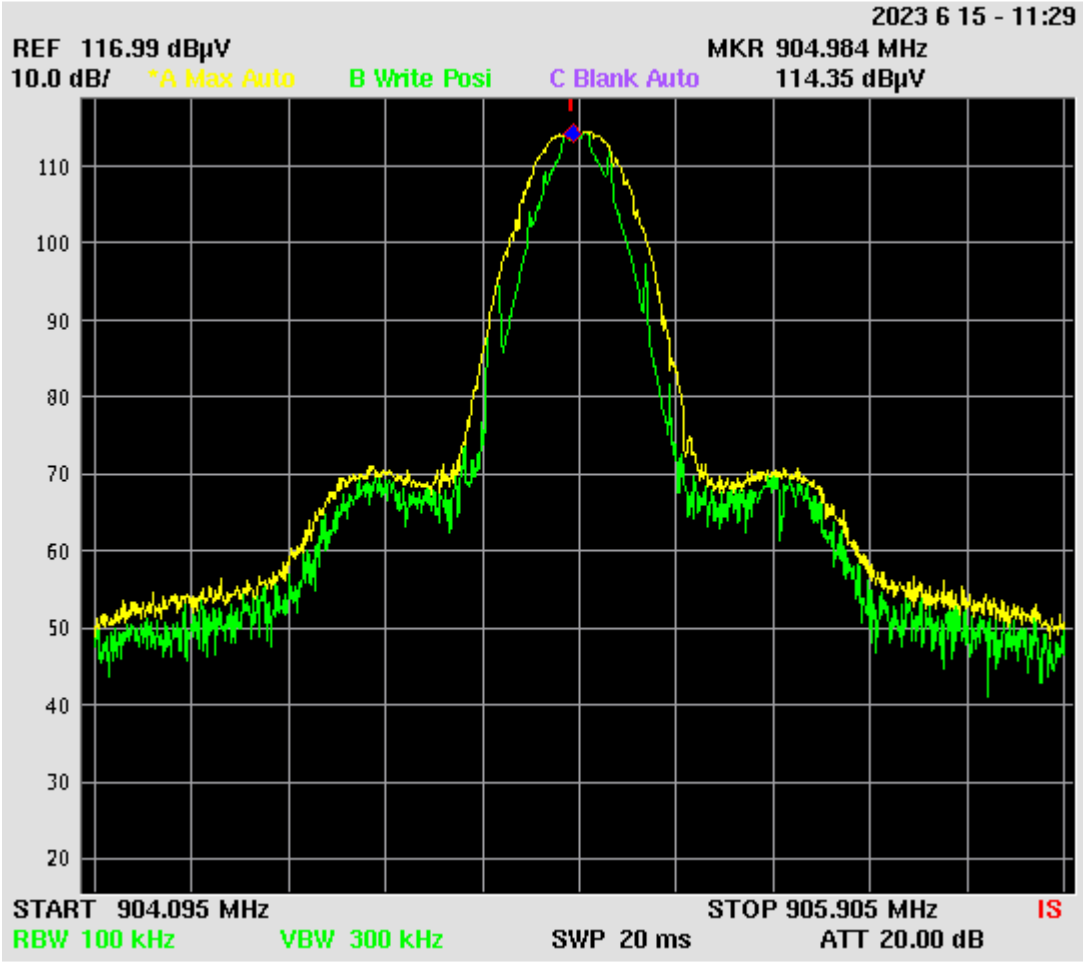


Figure 19. Conducted Output Power, Low Channel

Conversion from dBuV to dBm = dBuV – 107 = dBm
Low channel = 114.35 (dBuV) – 107 = 7.35 dBm
Additional +20 dB external attenuator factor

Corrected Output power = +27.35 dBm

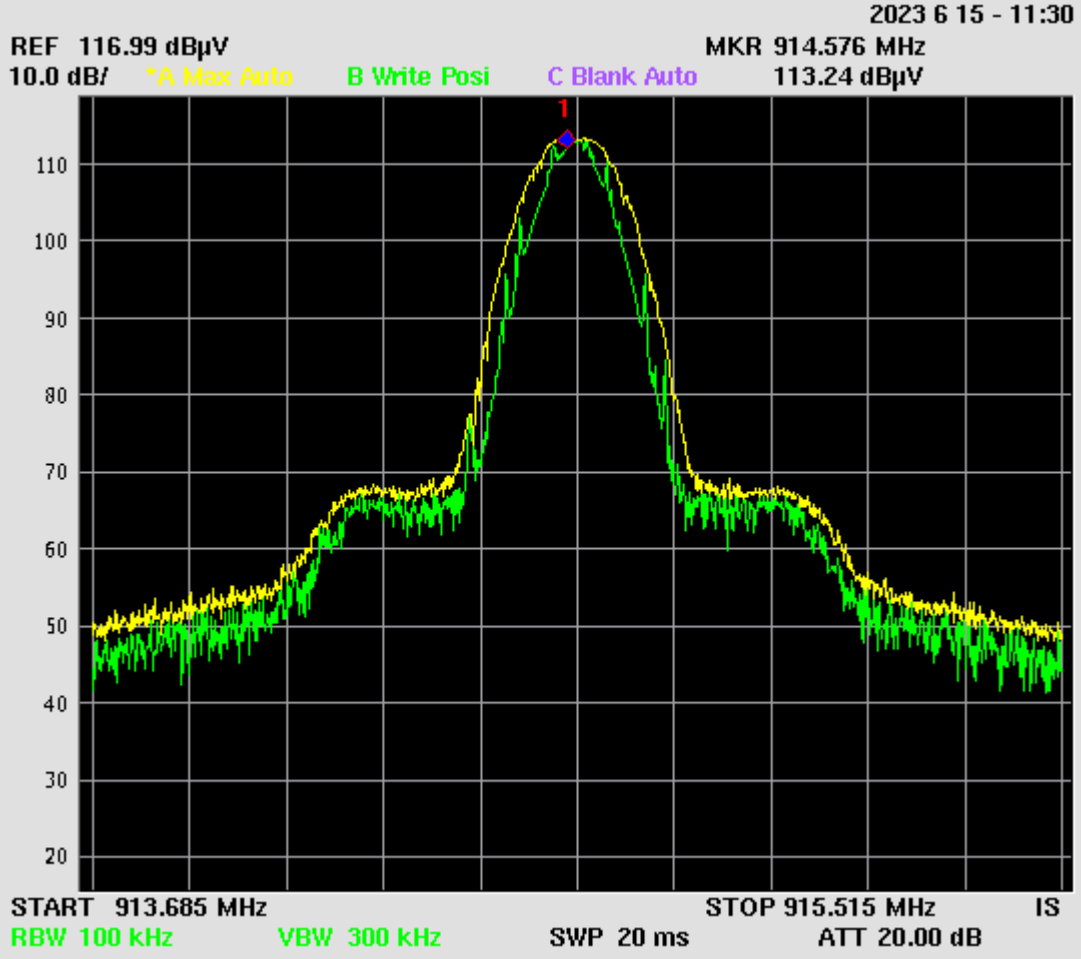


Figure 20. Conducted Output Power, Mid Channel

Conversion from dBuV to dBm = dBuV – 107 = dBm
Mid channel = 113.24 (dBuV) – 107 = 6.24 dBm
Additional +20 dB external attenuator factor

Corrected Output power = +26.24 dBm

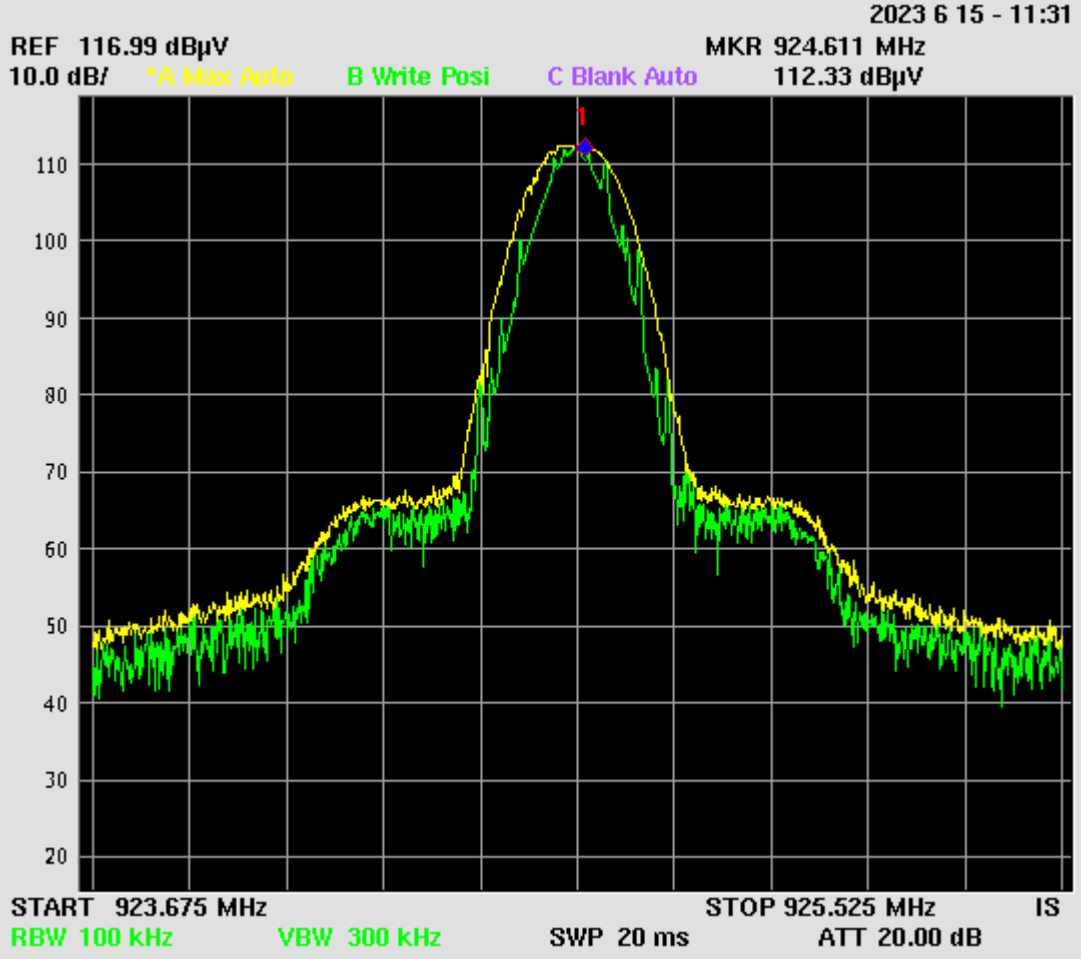


Figure 21. Conducted Output Power, High Channel

Conversion from dBuV to dBm = dBuV – 107 = dBm
Low channel = 112.33 (dBuV) – 107 = 5.33 dBm
Additional +20 dB external attenuator factor

Corrected Output power = +25.33 dBm

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 47 kHz.

The EUT met the frequency separation requirement.

The test procedure outlined in ANSI C63.10-2013 was used to conduct measurements. The EUT hopping function was enabled during the testing.

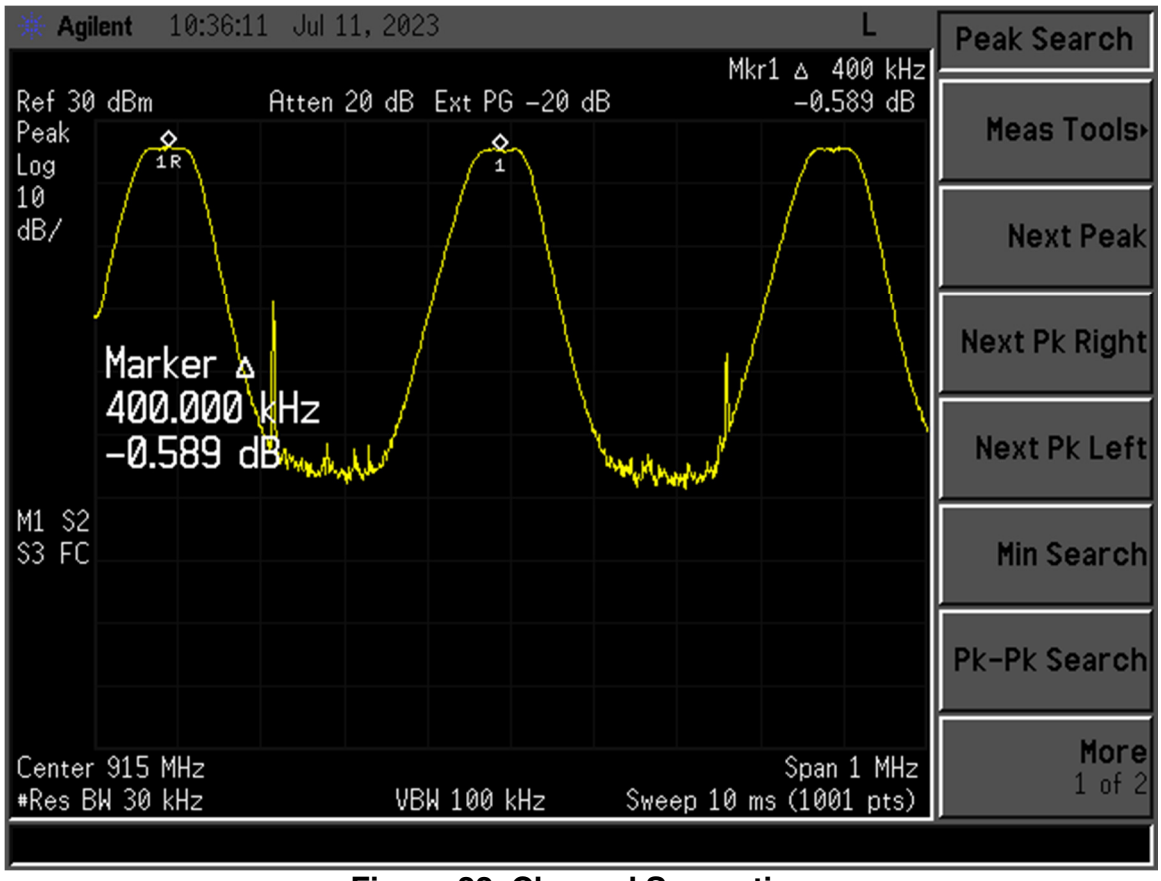


Figure 22. Channel Separation

Measured Delta (Figure 22)	400.00	kHz
-Limit(**20 dB Bandwidth**)	47.00	kHz
Margin	353.00	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 within a 20 second period.

The test procedure outlined in ANSI C63.10-2013 was used to conduct measurements. The EUT hopping function was enabled during the testing.

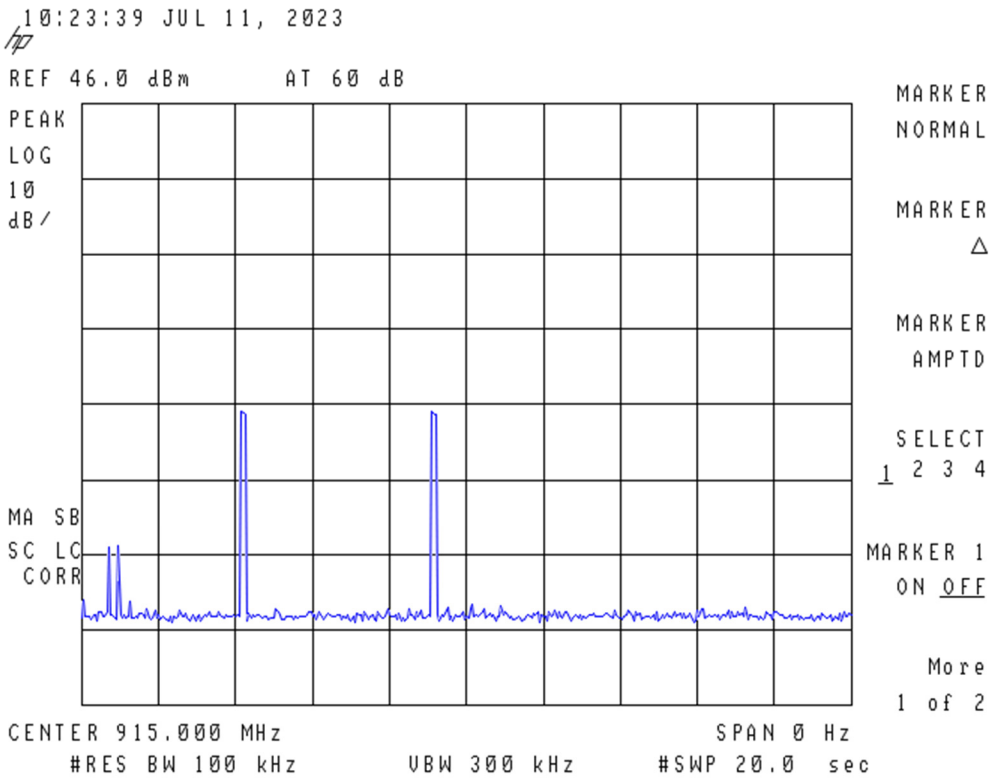


Figure 23. Average Time of Occupancy

Total time = Pulse width (Figure 3) * number of occurrences =	99.5 ms *2 = 199	ms
Limit	400.00	ms
-Total Time on	199.00	ms
Margin	201.00	ms

2.17 Intentional Radiator, Powerline Emissions (CFR 15.107, RSS-Gen 8.8)

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 worst-case results for conducted emissions were determined to be produced when the EUT was operating under continuous transmission. The worst-case measurement occurred on the neutral line at 0.77 MHz . The emission level was 5.6 dB from the applicable limit. All other emissions were at least 6.0 dB from the limit. Those results are given in the table following.

NOTE: The test data provided in this section is to support the Verification and co-location requirement for the digital apparatus and the radios within.

Table 9. Transmitter Power Line Conducted Emissions Test Data

150KHz to 30 MHz with Class B Limits						
Frequency (MHz)	**Test Data (dBuv)**	**LISN+CL-PA (dB)**	**Results (dBuV)**	**AVG Limits (dBuV)**	**Margin (dB)**	**Detector PK, QP, or AVG**
120 VAC, 60 Hz Phase						
0.3366	43.23	0.04	43.27	49.3	6.0	**PK**
0.6075	38.43	0.51	38.94	46.0	7.1	**PK**
2.4800	39.38	0.12	39.50	46.0	6.5	**PK**
5.2000	32.35	0.31	32.66	50.0	17.3	**PK**
16.0600	39.57	1.18	40.75	50.0	9.2	**PK**
24.0000	31.54	1.64	33.18	50.0	16.8	**PK**
120VAC, 60 Hz Neutral						
0.1582	46.50	0.08	46.58	55.6	9.0	**PK**
0.7733	40.13	0.24	40.37	46.0	5.6	**PK**
1.1600	38.89	0.87	39.76	46.0	6.2	**PK**
5.6500	32.82	0.23	33.05	50.0	17.0	**PK**
16.0500	40.76	0.83	41.59	50.0	8.4	**PK**
24.1000	31.72	1.19	32.91	50.0	17.1	**PK**

Sample Calculation at 0.3366 MHz:

Magnitude of Measured Frequency	43.23	dBuV
+Correction Factors	0.04	dB
Corrected Result	43.27	dBuV

Test Date: May 25, 2023
Tested by
Signature: _____ Name: Gabriel Medina

2.18 Intentional Radiator, Radiated Emissions (CFR 15.209, RSS-Gen, 8.9)

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 outside the fundamental and harmonic were less than 6 dB above the noise floor. The results are shown in the following tables. These results are meant to show that this EUT has met the intentional transmitter requirements of CFR Part 15.209.

NOTE: The test data provided in this section is to support the Verification and co-location requirement for the digital apparatus and the radios within.

Table 10. Intentional Radiator, Radiated Emissions, 9 kHz to 30 MHz – 1-mile

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.							

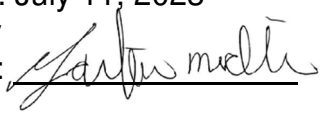
Test Date: July 11, 2023
Tested By
Signature:  Name: Gabriel Medina

Table 11. Intentional Radiator, Radiated Emissions, 30 MHz to 1000 MHz – 1-mile

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 outside of the fundamental were less than 6 dB above the noise floor.							

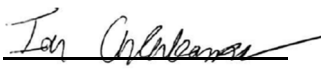
Test Date: June 26, 2023
Tested By
Signature:  Name: Ian Charboneau

Table 12. Intentional Radiator, Peak Radiated Emissions, 1 GHz to 12 GHz – 1.0 mile

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**
All emissions outside of the Harmonics were less than 6 dB above the noise floor.							

Test Date: June 26, 2023
Tested By
Signature:  Name: Ian Charboneau

Table 13. Intentional Radiator, Radiated Emissions, 9 kHz to 30 MHz – 0.5-mile

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.							

Test Date: June 26, 2023
Tested By
Signature: Ian Charboneau Name: Ian Charboneau

Table 14. Intentional Radiator, Radiated Emissions, 30 MHz to 1000 MHz – 0.5-mile

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 outside of the fundamental were less than 6 dB above the noise floor.							

Test Date: June 26, 2023
Tested By
Signature: Ian Charboneau Name: Ian Charboneau

Table 15. Intentional Radiator, Peak Radiated Emissions, 1 GHz to 12 GHz – 0.5-mile

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**
All emissions outside of the Harmonics were less than 6 dB above the noise floor.							

Test Date: June 26, 2023
Tested By
Signature: Ian Charboneau Name: Ian Charboneau

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

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

The data listed in this test report does have sufficient margin to negate the effects of uncertainty. Therefore, the EUT unconditionally meets this requirement.

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.

The data listed in this test report does have sufficient margin to negate the effects of uncertainty. Therefore, the EUT unconditionally meets this requirement.