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
RSS-Gen (I5) General Requirements for Radio Apparatus,
RSS-247 Issue 2: Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and License-Exempt Local Area Network (LE-LAN) Devices

for the

Neptune Technology Group

Model: R900

FCC ID: P2SR900CE
IC ID: 4171B-R900CE

UST Project: 20-0363

Issue Date: February 9, 2021

Total Pages:43

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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: February 9, 2021

NVLAP LAB CODE 200162-0

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MEASUREMENT TECHNICAL REPORT

Company Name:	Neptune Technology Group
Address:	1600 Alabama Hwy 229 Tallassee, AL 36078, USA
Model:	R900
FCC ID:	P2SR900CE
IC ID:	4171B-R900CE
Date:	February 9, 2021

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

Equipment type: 900 MHz ISM Radio Transceiver

Technical Information:

Radio Technology:	FHSS
Frequency of Operation (MHz):	911.08 – 919.07
Output Power (dBm):	18.32 (68 mW)
Type of Modulation:	OOK
Data/Bit Rate (M)bps:	1200 Baud
Antenna Gain (dBi):	See Table 5 & 6 below
Software used to program EUT:	PMIT v2.2.210208.74
EUT firmware:	2.3
Power setting:	248

Report prepared by:
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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 certification as an intentional transmitter device and public distribution according to FCC Rules and Regulations Part 15, Section 247 and Industry Canada RSS-247.

1.2 Characterization of Test Sample

The samples used for testing were received by US Tech on February 1, 2021 in good operating condition.

1.3 Product Description

The Equipment under Test (EUT) is the Neptune Technology Group, Model R900. 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 C63.10:2013, 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 v05r02 for Digital Transmission Systems Operating Under section 15.247.

Per FCC Parts 15.107 and 15.109, digital RF conducted and radiated emissions below 1 GHz were measured with the spectrum analyzer's resolution bandwidth (RBW) adjusted to 9 kHz and 120 kHz, respectively. All measurements performed above 1 GHz were made with a RBW of 1 MHz. All measurements are peak unless stated otherwise. The video filter associated with the spectrum analyzer was set to 3 times the RBW or as required per the standard throughout the evaluation process.

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

1.5 Test Facility

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

1.6 Related Submittal(s)/Grant(s)

The EUT is subject to the following FCC Equipment Authorizations:

a) Certification under section 15.207 and 15.209 as a transmitter.

b) SDoC under 15.101 as a digital device. The results of the required tests performed under this rule part are provided in a separate report: US Tech report number 20-0365.

Table 1. EUT and Peripherals

EUT MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	FCC/IC ID	CABLES P/D
EUT Neptune Technology Group, Inc.	R900 Cellular Endpoint	10AA40190060042	FCC ID: P2SR900CE IC: 4171B-R900CE	N/A
PERIPHERAL MANUFACTURER	**MODEL NUMBER**	**SERIAL NUMBER**	**FCC/IC ID**	**CABLES P/D**
2 AA Rechargeable Lithium Batteries Tenavolts	N/A	Engineering Sample	N/A	N/A
Test Fixture Neptune Technology Group	N/A	Engineering Sample	N/A	N/A
DC Pass Matching Transformer Mini-Circuits	Z7550-FFSF+	APUU1W102044	N/A	S/D
Interface Box (FCSA) Neptune Technology Group	N/A	Unit 2	N/A	S/D
Antenna See antenna details	--	--	--	--

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

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

DESCRIPTION OF CABLE	DETAILS OF CABLE			CABLE LENGTH
*SMA to Proprietary BNC	**Manufacturer**		**Part Number**	1.0 m
	Neptune Technology Group		Engineering sample	
	Shield Type	**Shield Termination**	**Back-shell**	
	B	360	MS/PS	
*USB to Serial	**Manufacturer**		**Part Number**	1.0 m
	FTDI		Engineering sample	
	Shield Type	**Shield Termination**	**Back-shell**	
	F	P	PU	

(*) Use for programming purpose only.

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

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

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

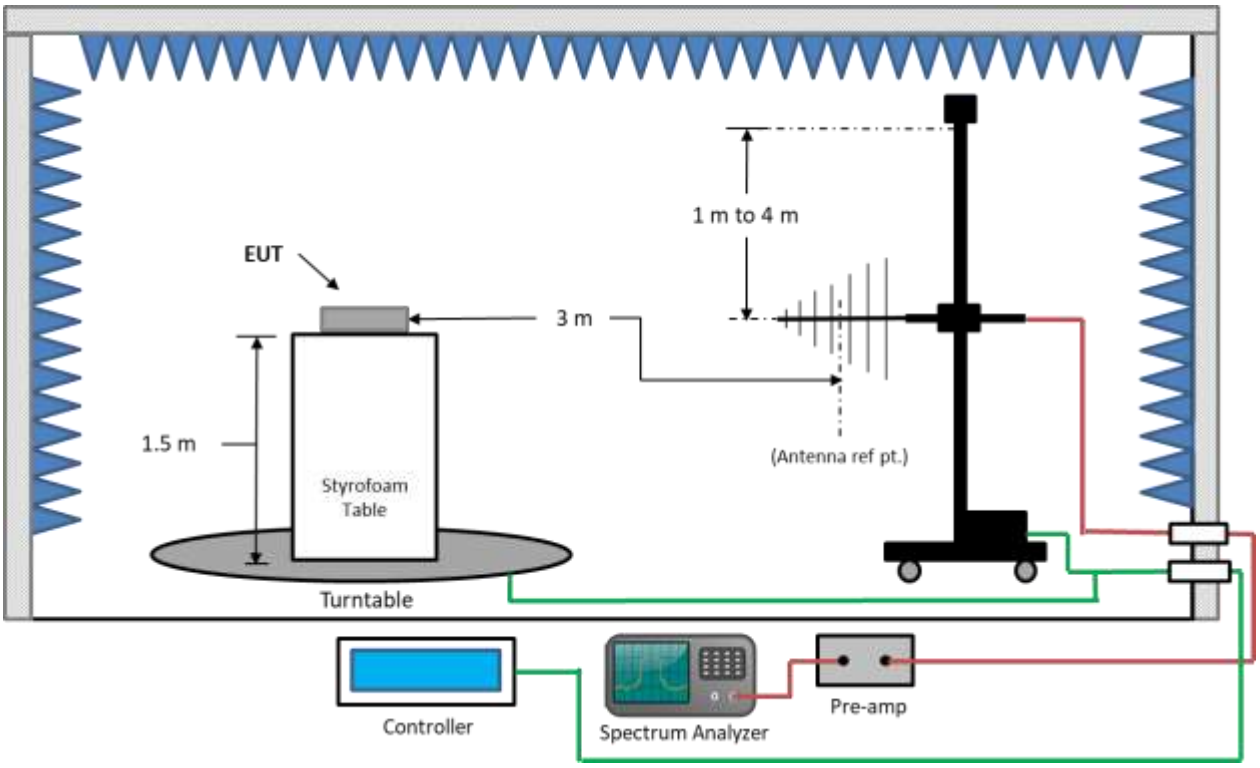


Figure 1. EUT Test Configuration Diagram

2 Tests and Measurements

2.1 Test Equipment

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

Table 3. Test Instruments

TEST INSTRUMENT	MODEL NUMBER	MANUFACTURER	SERIAL NUMBER	CALIBRATION DUE DATE
SPECTRUM ANALYZER	E4407B	AGILENT	US41442935	9/02/2022 2 yr.
RF PREAMP 100 kHz to 1.3 GHz	8447D	HEWLETT-PACKARD	1937A02980	5/13/2021
PREAMP 1.0 GHz to 26.0 GHz	8449B	HEWLETT-PACKARD	3008A00480	5/13/2021
LOOP ANTENNA	SAS-200/562	A. H. Systems	142	4/06/2022 2 yr.
BICONICAL ANTENNA	3110B	EMCO	9306-1708	6/07/2021 2 yr.
LOG PERIODIC ANTENNA	3146	EMCO	9305-3600	2/1/2021 2 yr
DOUBLE RIDGED HORN ANTENNA	SAS-571	A. H. Systems	605	2/28/2022 2 yr.
HIGH PASS FILTER	VHF-1320 15542	MINI-CIRCUITS, INC.	3 0843	5/11/2021
20 dB ATTENUATOR	4T-20	API/WEINSCHEL	59078	6/30/2021

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

2.2 Modifications to EUT Hardware

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

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

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

Table 4. Number of Test Frequencies for Intentional Radiators

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

The EUT operates over the range of 911.08 MHz to 919.07 MHz; therefore, two test frequencies were evaluated.

2.4 Frequency Range of Radiated Measurements (CFR 15.33)

2.4.1 Intentional Radiator

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

2.4.2 Unintentional Radiator

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

2.5 Measurement Detector Function and Bandwidth (CFR 15.35)

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

2.5.1 Detector Function and Associated Bandwidth

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

2.5.2 Corresponding Peak and Average Requirements

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

2.5.3 Pulsed Transmitter Averaging

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

2.6 Transmitter Duty Cycle (Part 15.35(c))

The Duty Cycle calculations are confidential and can be provided upon request by contacting Neptune Technology Group.

2.7 Restricted Bands of Operation (Part 15.205)

Only spurious emissions can fall in the frequency bands of CFR 15.205. The field strength of these emissions cannot exceed the limits of 15.209. Radiated harmonics and other spurious emissions are examined for this requirement see paragraph 2.10.

2.8 EUT Antenna Requirements (CFR 15.203)

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

Table 5. Internal Antenna

Manufacturer	Model	Type/Gain (dBi)	Connector
Neptune Technology Group	Internal integrated loop	-1.0	soldered

Table 6. External Antenna

Manufacturer	Model	Type/Gain (dBi)	Connector
Neptune Technology Group	13852-000	1.2	proprietary BNC twist lock RF connector

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

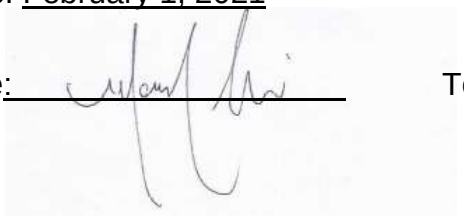
The EUT was programmed to operate at a normal operating output power across the bandwidth. For this test the normal operating output power of the radio was programmed to 248 in the radio's test firmware. A proprietary RF cable provided by Neptune Technology Group was connected between the EUT's antenna output port and spectrum analyzer. For protection, a 20 dB attenuator was connected to the RF input of the spectrum analyzer. The attenuator factor was accounted for in all antenna-port, conducted RF measurements.

Peak power within the band 911.08 MHz to 919.07 MHz was measured per FCC KDB Publication 558074v05r02 and ANSI C63.10-2013. The results are presented in Table 7.

Table 7. Peak Antenna Conducted Output Power per Part 15.247 (b)(3)

Frequency of Fundamental (MHz)	P_{Cond} (dBm)	P_{Cond} (mW)	FCC Limit (mW Maximum)
911.07	18.32	68.00	1000
919.08	15.37	34.00	1000

Test Date: February 1, 2021

Signature:  Test Engineer: Mark Afroozi

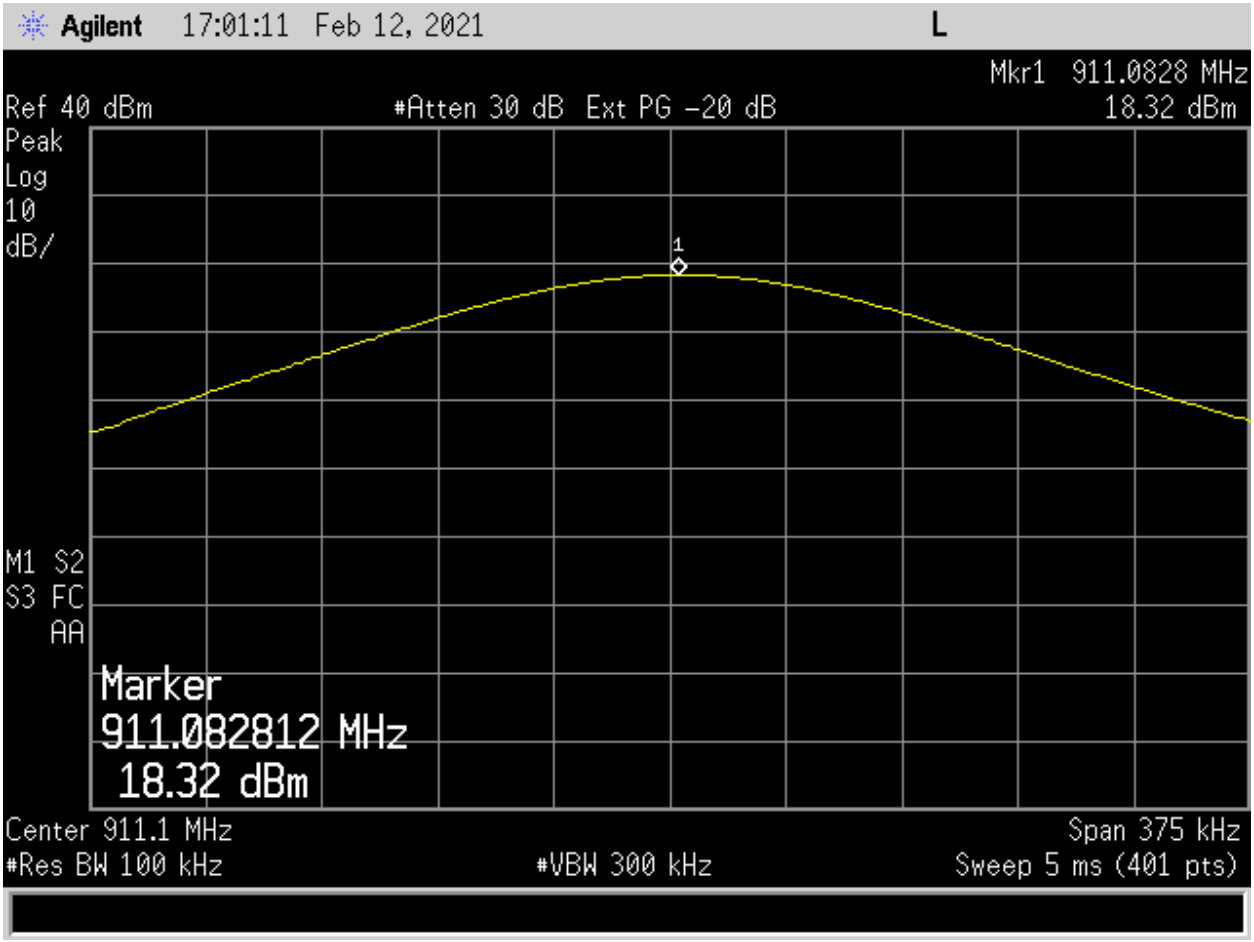


Figure 2. Peak Output Power – Low Channel

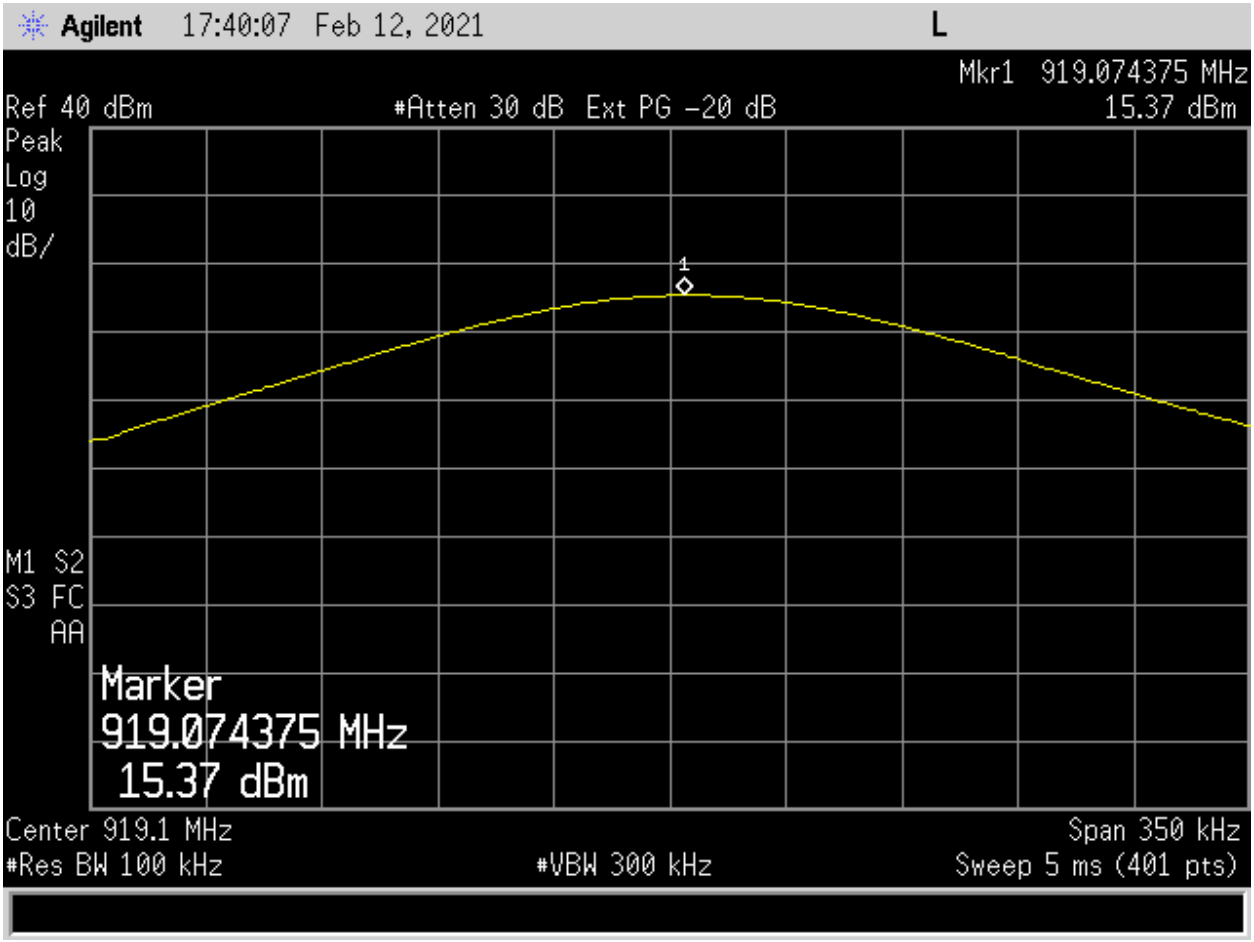


Figure 3. Peak Output Power - High Channel

2.10 Antenna Conducted Intentional and Spurious Emissions (CFR 15.209, 15.247(d)) (RSS-247 (5.5), RSS-Gen 8.9)

The EUT was put into a continuous-transmit mode of operation and tested per FCC KDB Publication 558074v05r02 for conducted out of band emissions radiating from the antenna port over the frequency range of 30 MHz to ten times the highest clock frequency generated or used in this case, 10 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 semi-anechoic chamber. The conducted emissions graphs are found in figures below. All spurious emissions must be at least 20 dB below the fundamental signal.

For antenna port, conducted RF scans from 30 MHz to 1 GHz, the RBW was set to 100 kHz, video bandwidth (VBW)> RBW. For antenna port, conducted RF scans above 1 GHz, the RBW was set to 1 MHz, video bandwidth (VBW)> RBW. All harmonics/spurs must be at least 20 dB down from the highest emission level within the authorized band.

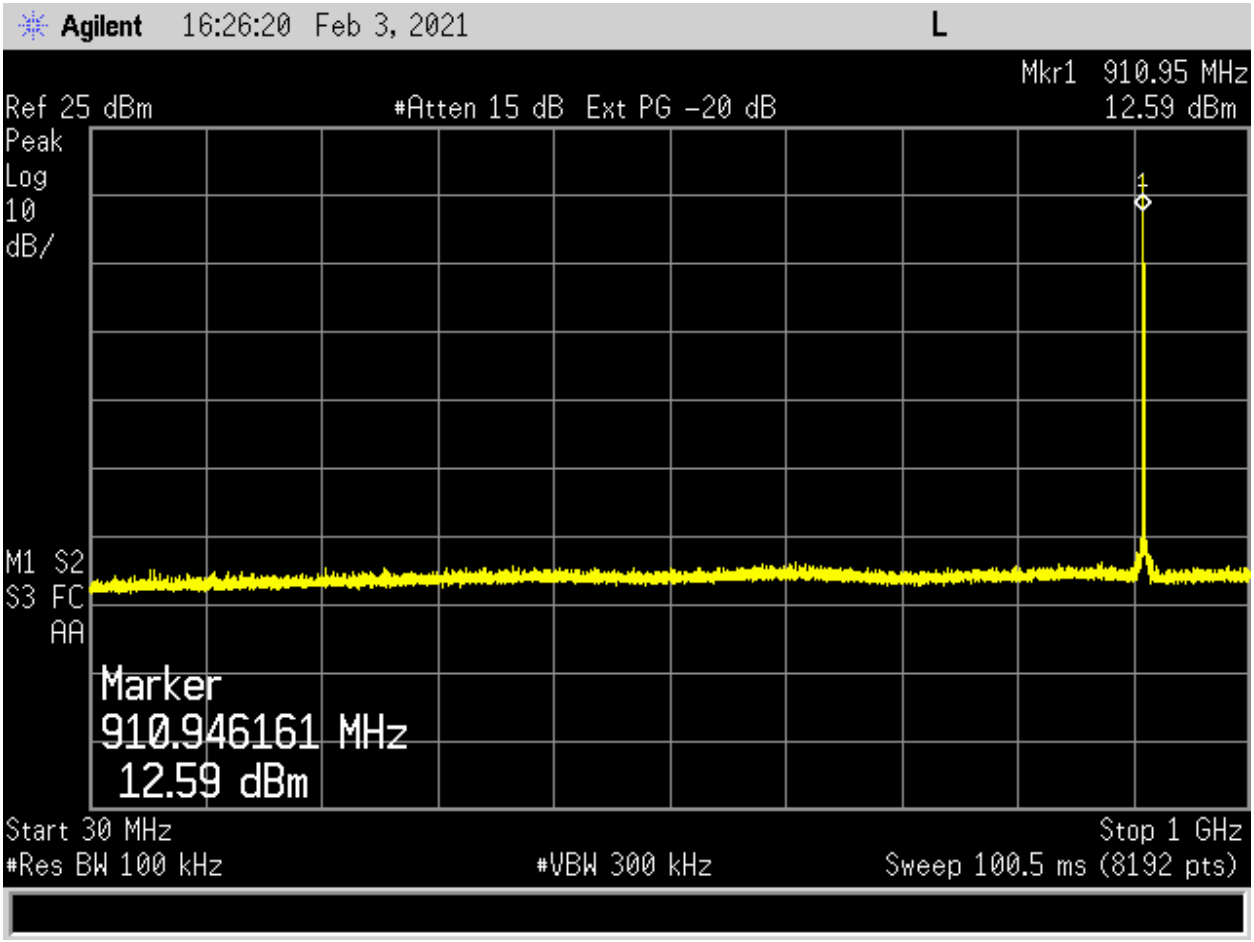


Figure 4. Conducted Spurious Emissions – Low Channel, 30 MHz – 1 GHz

.

Large Signal shown is fundamental frequency

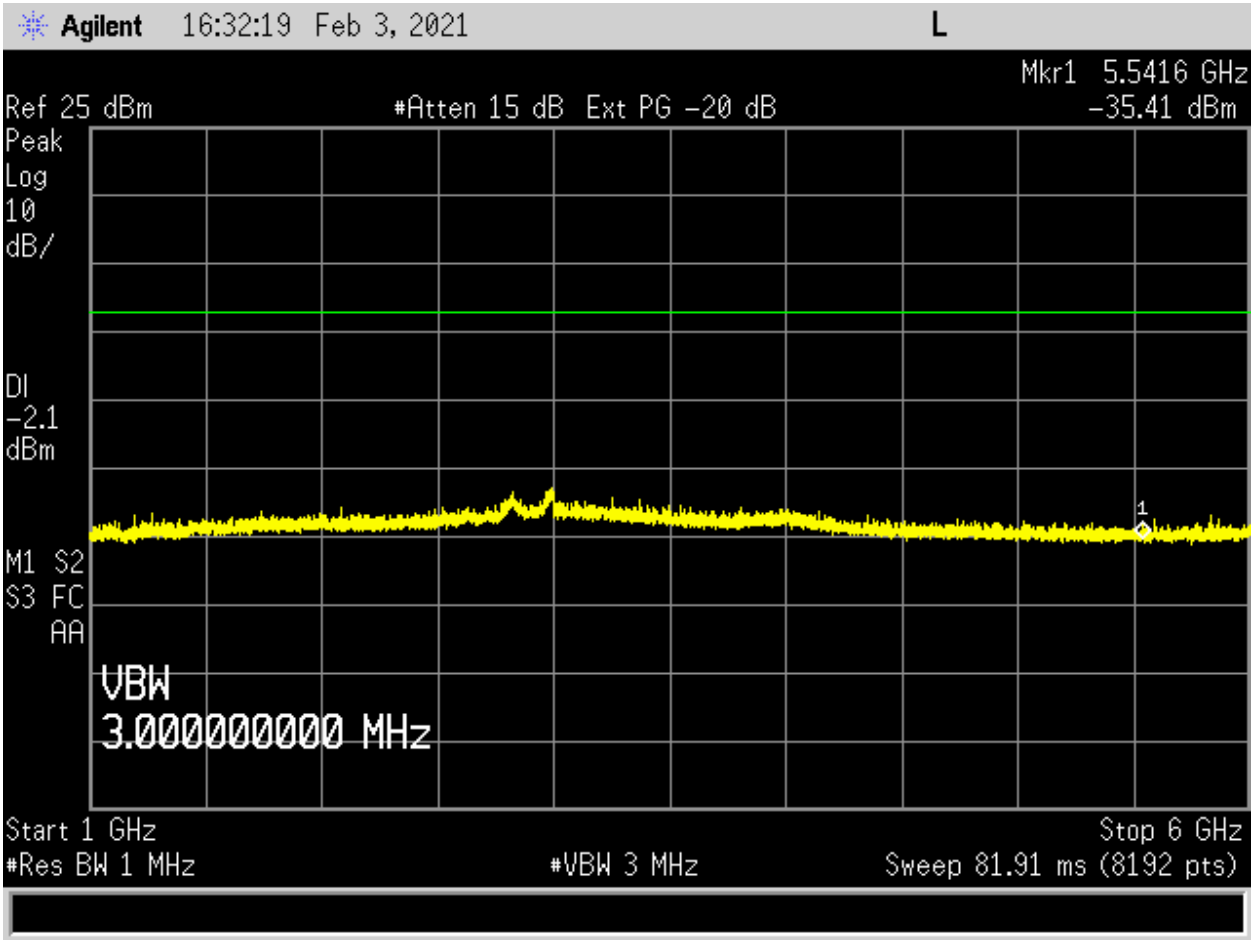


Figure 5. Conducted Spurious Emissions – Low Channel, 1 GHz – 6 GHz

Display Line represents 20 dB below peak of fundamental frequency

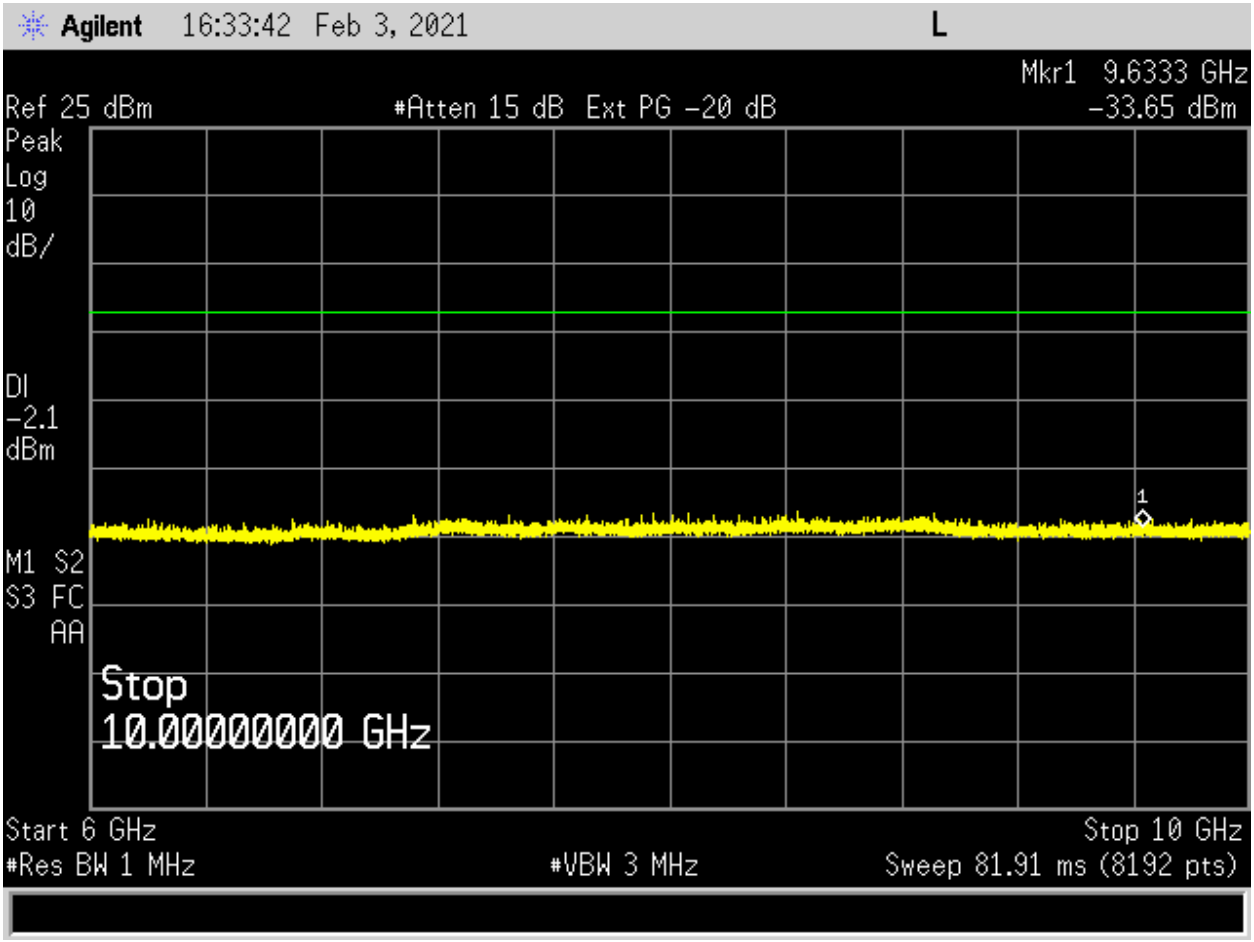


Figure 6. Conducted Spurious Emissions – Low Channel, 6 GHz - 10 GHz

Display Line represents 20 dB below peak of fundamental frequency

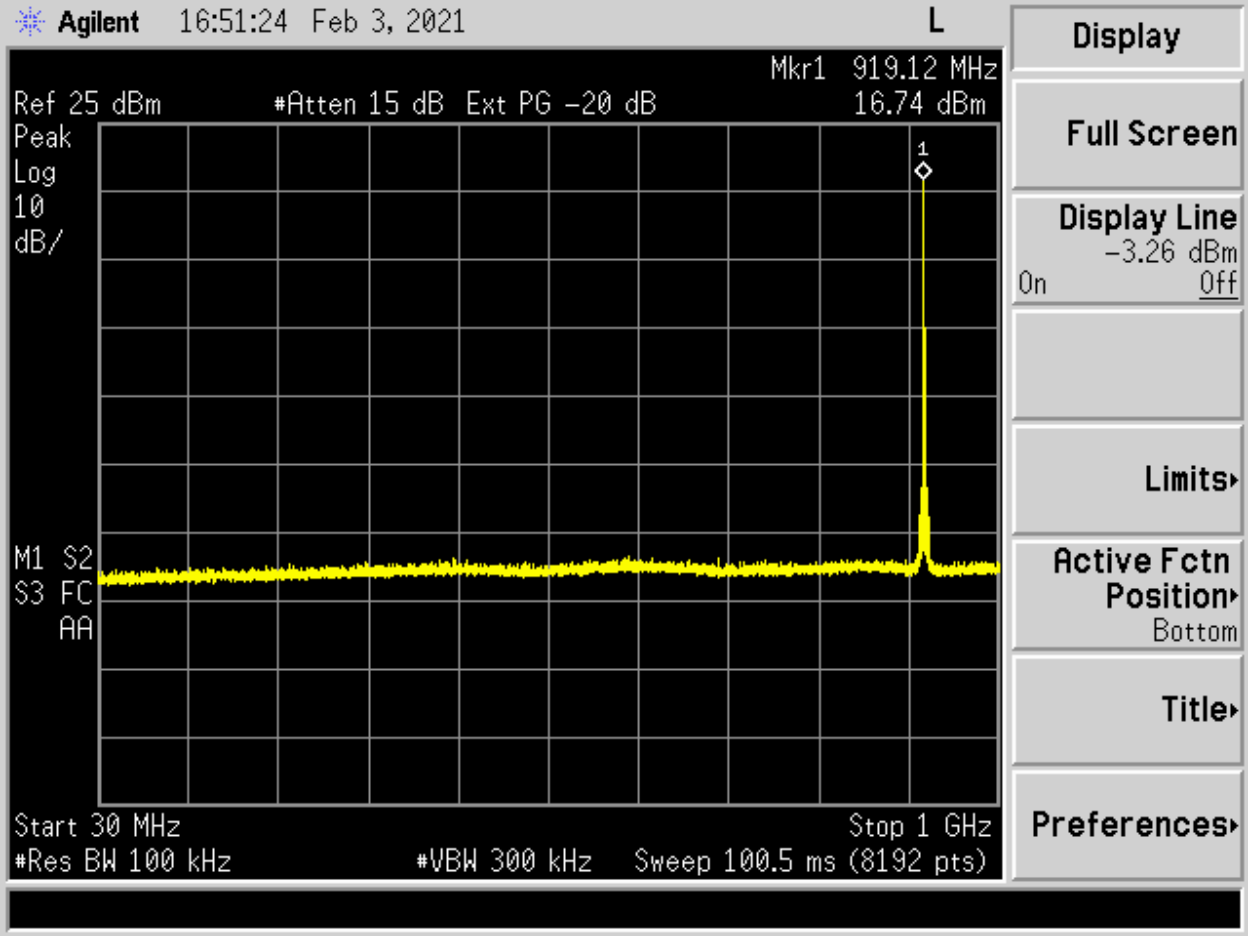


Figure 7. Conducted Spurious Emissions – High Channel, 30 MHz - 1 GHz

Large Signal shown is fundamental frequency

.

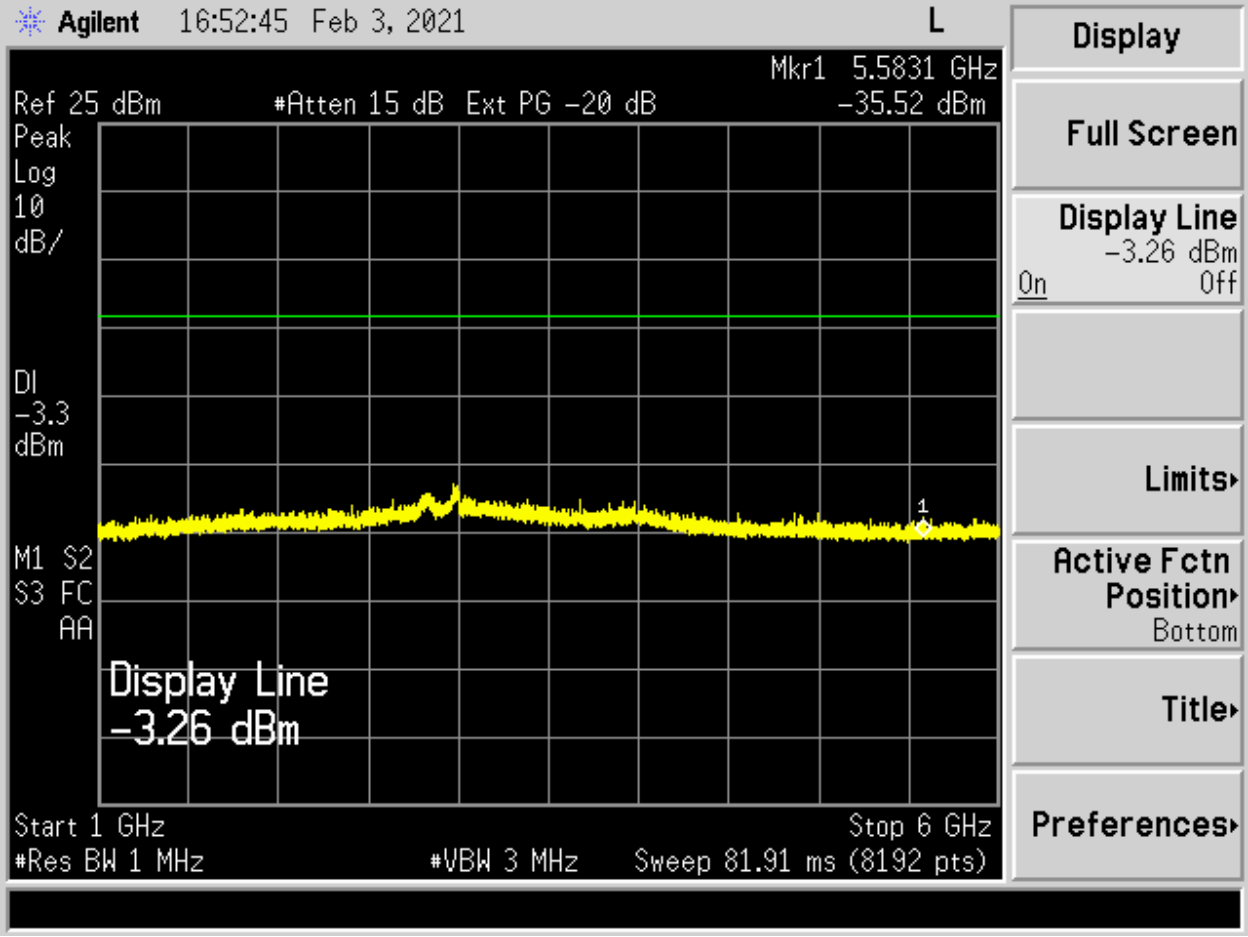


Figure 8. Conducted Spurious Emissions – High Channel, 1 GHz – 6 GHz

Display line represents 20 dB below peak of fundamental frequency.

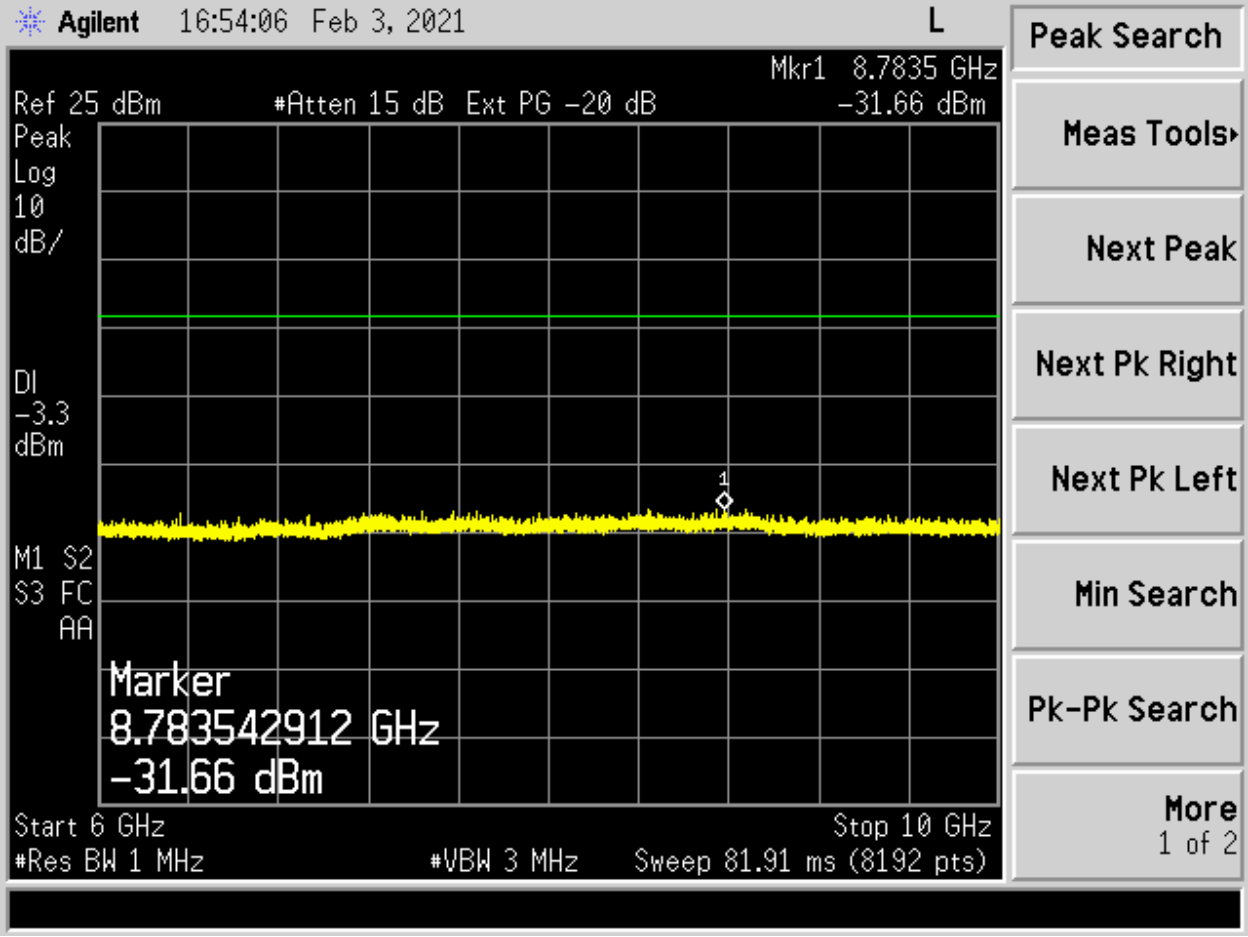


Figure 9. Conducted Spurious Emissions – High Channel, 6 GHz – 10 GHz

Display line represents 20 dB below peak of fundamental frequency.

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

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

The internal and external antenna configurations of the EUT were evaluated individually for worst case conditions.

2.11.1 Internal Antenna Configuration

On the test site, the EUT was placed on top of a polystyrene table, 80 cm above the ground plane, inside a semi-anechoic test chamber. The EUT was evaluated in each of its three axes (X/Y/Z) for worst-case condition. The position of the EUT determined to be worst-case was with the EUT positioned along its X axis.

2.11.2 External Antenna Configuration

On the test site, the EUT was mounted inside a test fixture housing the external antenna which connected to the EUT then placed on top of a polystyrene table 80 cm above the ground plane inside a semi-anechoic test chamber. Per manufacturer's recommendation, the external antenna can only be installed having the large, surface area of antenna facing up; therefore, this recommended antenna position in conjunction with the EUT positioned along its X axis was selected for worst-case condition.

.

Table 8. Peak Radiated Fundamental and Harmonic Emissions – Internal Antenna

Test: FCC Part 15.247 / 15.209								
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								
911.08	88.21	--	25.93	114.14	--	3.0m./HORZ	--	**PK**
2733.24	52.25	--	-4.59	47.66	74.0	3.0m./HORZ	26.3	**PK**
3644.33	53.03	--	-1.75	51.28	74.0	3.0m./VERT	22.7	**PK**
Note 1	--	--	--	--	--	--	--	**--**
High Channel								
919.07	91.61	--	25.90	117.51	--	3.0m./HORZ	--	**PK**
2757.21	52.06	--	-4.94	47.12	74.0	3.0m./HORZ	26.9	**PK**
3676.31	54.05	--	-1.71	52.34	74.0	3.0m./HORZ	21.7	**PK**
Note 1	--	--	--	--	--	--	--	**--**

Notes:
1. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic

Sample Calculation at 911.08 MHz:

Magnitude of Measured Frequency	88.21	dBuV
+Additional Factor	0.00	dB
+Antenna Factor + Cable Loss - Amplifier Gain	25.93	dB/m
Corrected Result	114.14	dBuV/m

Test Date: February 1, 2021

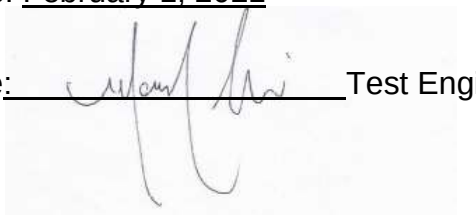
Signature:  Test Engineer: Mark Afroozi

Table 9. Average Radiated Fundamental and Harmonic Emissions – Internal Antenna

Test: FCC Part 15.247 / 15.209								
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								
2733.24	35.17	--	-4.59	30.58	54.0	3.0m./HORZ	23.4	**AVG**
3644.33	36.41	--	-1.75	34.66	54.0	3.0m./VERT	19.3	**AVG**
Note 1	--	--	--	--	--	--	--	**--**
High Channel								
2757.21	34.92	--	-4.94	29.98	54.0	3.0m./HORZ	24.0	**AVG**
3676.31	37.62	--	-1.71	35.91	54.0	3.0m./HORZ	18.1	**AVG**
Note 1	--	--	--	--	--	--	--	**--**

Notes:
1. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic.

Sample Calculation at 2733.24 MHz:

Magnitude of Measured Frequency	35.17	dBuV
+Additional Factor (Duty cycle correction)	0.00	dB
+Antenna Factor + Cable Loss - Amplifier Gain	-4.59	dB/m
Corrected Result	30.58	dBuV/m

Test Date: February 1, 2021

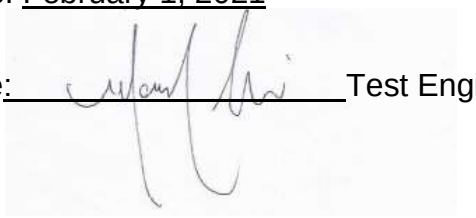
Signature:  Test Engineer: Mark Afroozi

Table 10. Peak Radiated Fundamental and Harmonic Emissions – External Antenna

Test: FCC Part 15.247 / 15.209								
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								
911.08	87.94	--	25.03	112.97	--	3.0m./VERT	--	**PK**
2733.24	51.81	--	-4.59	47.22	74.0	3.0m./HORZ	26.8	**PK**
3644.33	51.68	--	-1.75	49.93	74.0	3.0m./VERT	24.1	**PK**
Note 1	--	--	--	--	--	--	--	**--**
High Channel								
919.07	87.79	--	25.00	112.79	--	3.0m./VERT	--	**PK**
2757.21	52.16	--	-4.94	47.22	74.0	3.0m./VERT	26.8	**PK**
3676.31	52.17	--	-1.71	50.46	74.0	3.0m./VERT	23.5	**PK**
4595.35	51.36	--	4.15	55.51	74.0	3.0m./VERT	18.5	**PK**
Note 1	--	--	--	--	--	--	--	**--**

Notes:
1. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic

Sample Calculation at 911.08 MHz:

Magnitude of Measured Frequency	87.94	dBuV
+Additional Factor	0.00	dB
+Antenna Factor + Cable Loss – Amplifier Gain	25.03	dB/m
Corrected Result	112.97	dBuV/m

Test Date: February 1, 2021

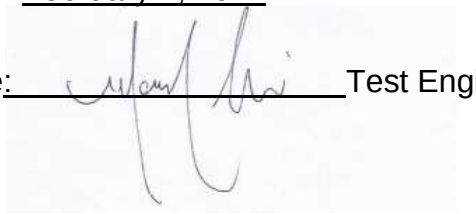
Signature:  Test Engineer: Mark Afroozi

Table 11. Average Radiated Fundamental and Harmonic Emissions – External Antenna

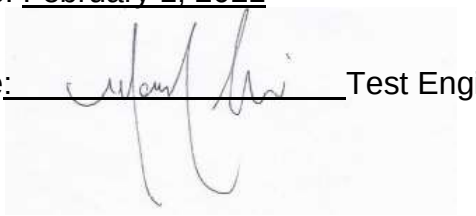
Test: FCC Part 15.247 / 15.209								
Frequency (MHz)	**Test Data (dBuV)**	**Additional Factor**	**AF+CL-PA (dB/m)**	**Corrected Results (dBuV/m)**	**Limits (dBuV/m)**	**Distance / Polarization**	**Margin (dB)**	**Detector**
Low Channel								
2733.24	35.09	--	-4.59	30.50	54.0	3.0m./HORZ	23.5	**AVG**
3644.33	35.88	--	-1.75	34.13	54.0	3.0m./VERT	19.9	**AVG**
Note 1	--	--	--	--	--	--	--	**--**
High Channel								
2757.21	36.11		-4.94	31.17	54.0	3.0m./VERT	22.8	**AVG**
3676.31	36.05		-1.71	34.34	54.0	3.0m./VERT	19.7	**AVG**
4595.35	33.16		4.15	37.31	54.0	3.0m./VERT	16.7	**AVG**
Note 1	--	--	--	--	--	--	--	**--**

Notes:
1. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic

Sample Calculation at 2733.24 MHz:

Magnitude of Measured Frequency	35.09	dBuV
+Additional Factor (Duty cycle correction)	0.00	dB
+Antenna Factor + Cable Loss - Amplifier Gain	-4.59	dB/m
Corrected Result	30.50	dBuV/m

Test Date: February 1, 2021

Signature:  Test Engineer: Mark Afroozi

2.12 Band Edge Measurements – (CFR 15.247(d))

Band Edge measurements are made following the guidelines in FCC KDB Publication No. 558074 v05r02 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). Conducted measurements are performed with RBW ≥1% of the frequency span. In all cases, the VBW is set ≥3 x RBW. See figures and calculations below for more detail.

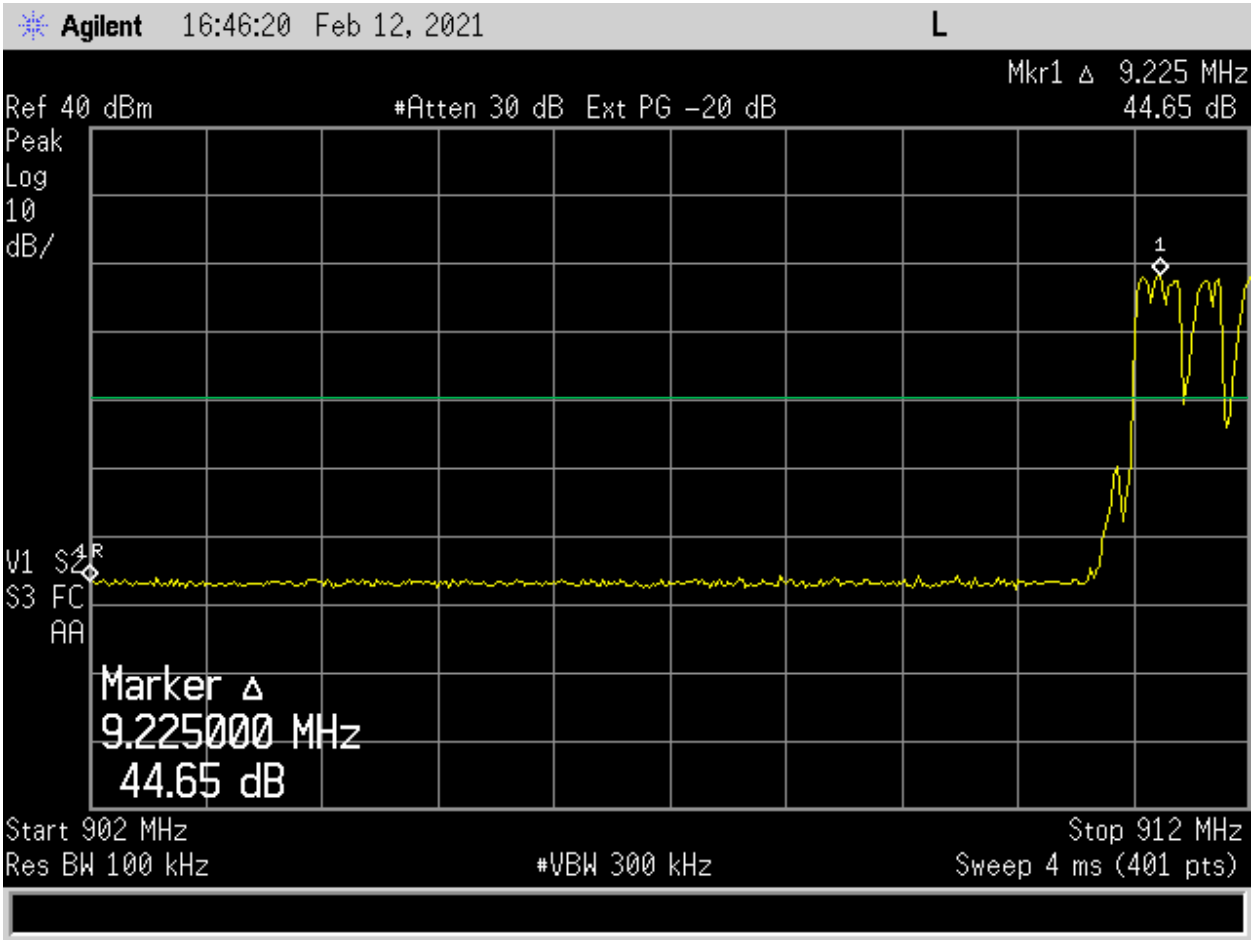


Figure 10. Band Edge Compliance – Low Channel (Hopping)

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

Measured Result	44.64	dB
Band Edge Limit	20.00	dB
Band Edge Margin	24.64	dB

Test Date: February 12, 2021

Signature: Test Engineer: Mark Afroozi

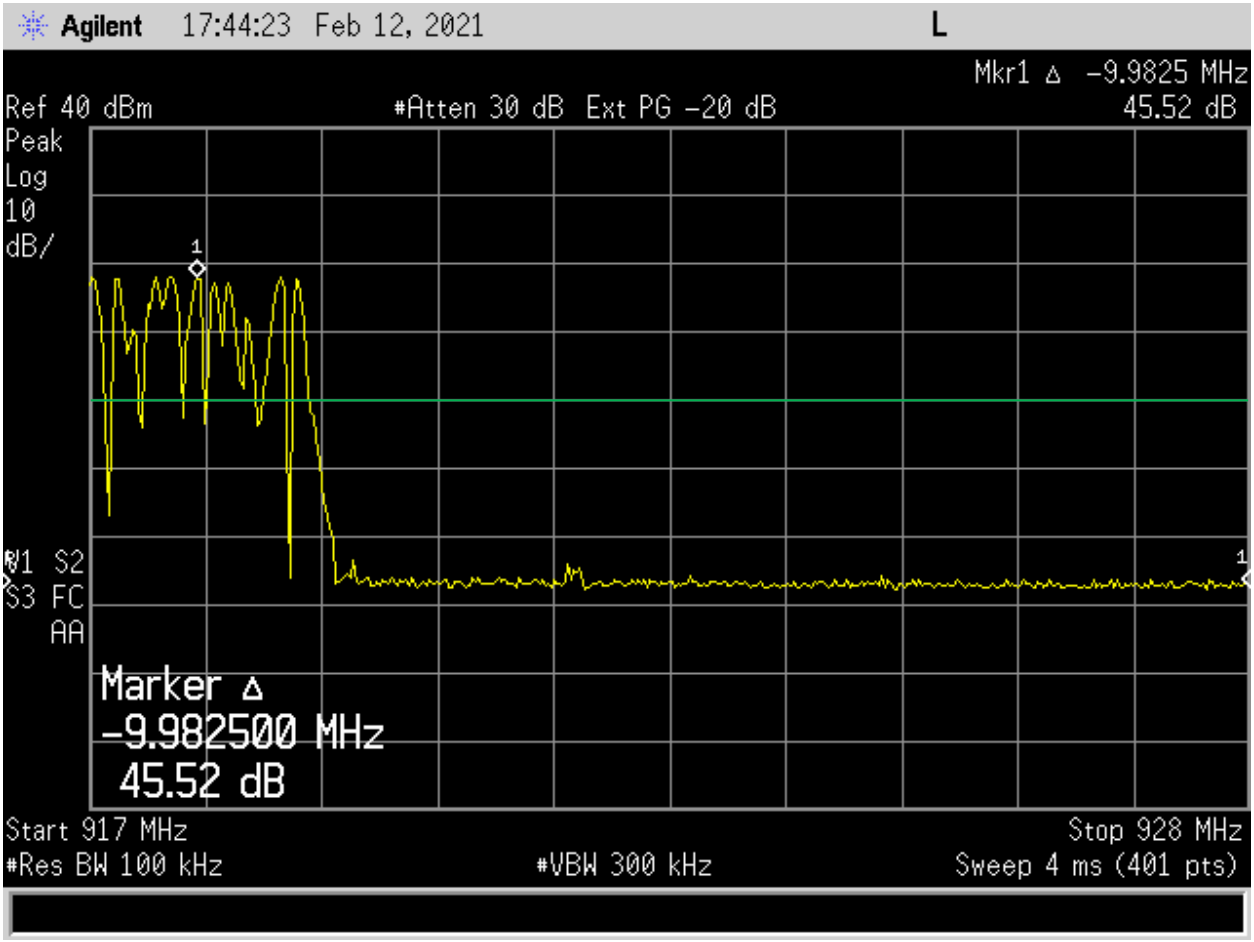


Figure 11. Band Edge Compliance – High Channel (Hopping)

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

Measured Result	45.52	dB
Band Edge Limit	20.00	dB
Band Edge Margin	25.52	dB

Test Date: February 12, 2021

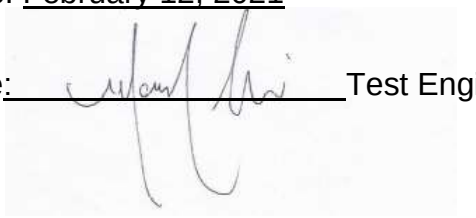
Signature: Test Engineer: Mark Afroozi

2.13 20 dB and 99% Occupied Bandwidth (CFR 2.1049 & RSS-Gen 6.7)

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. The RBW was set to 10 kHz and with the VBW ≥ RBW. The results of this test are given
in the Table and Figures following.

Frequency (MHz)	20 dB Bandwidth (kHz)	Maximum FCC Bandwidth (kHz)	99 % Occupied Bandwidth (kHz)
911.08	67.994	500	73.332
919.07	68.726	500	69.540

Test Date: February 12, 2021

Signature:  Test Engineer: Mark Afroozi

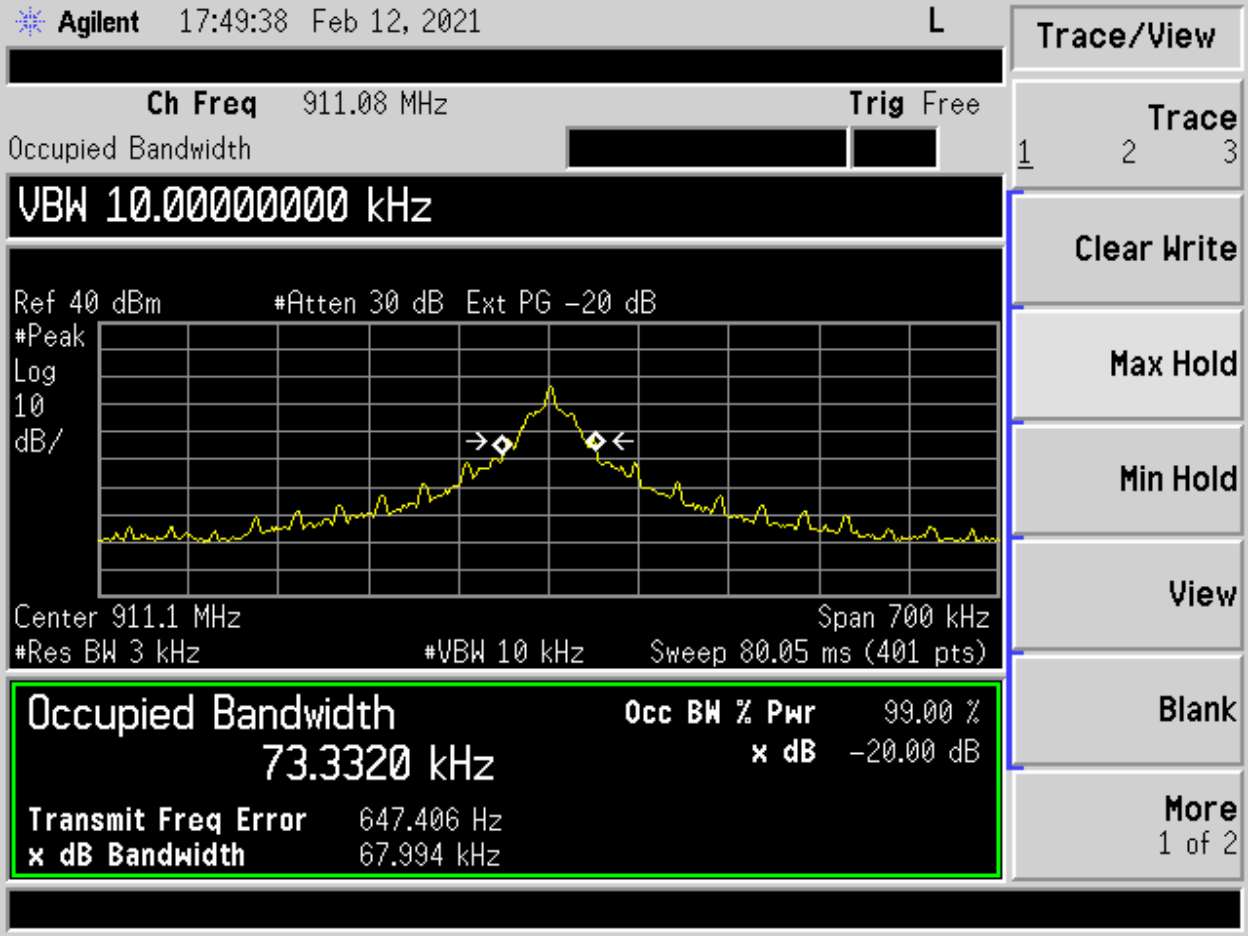


Figure 12. 20 dB and 99% Occupied Bandwidth – Low Channel

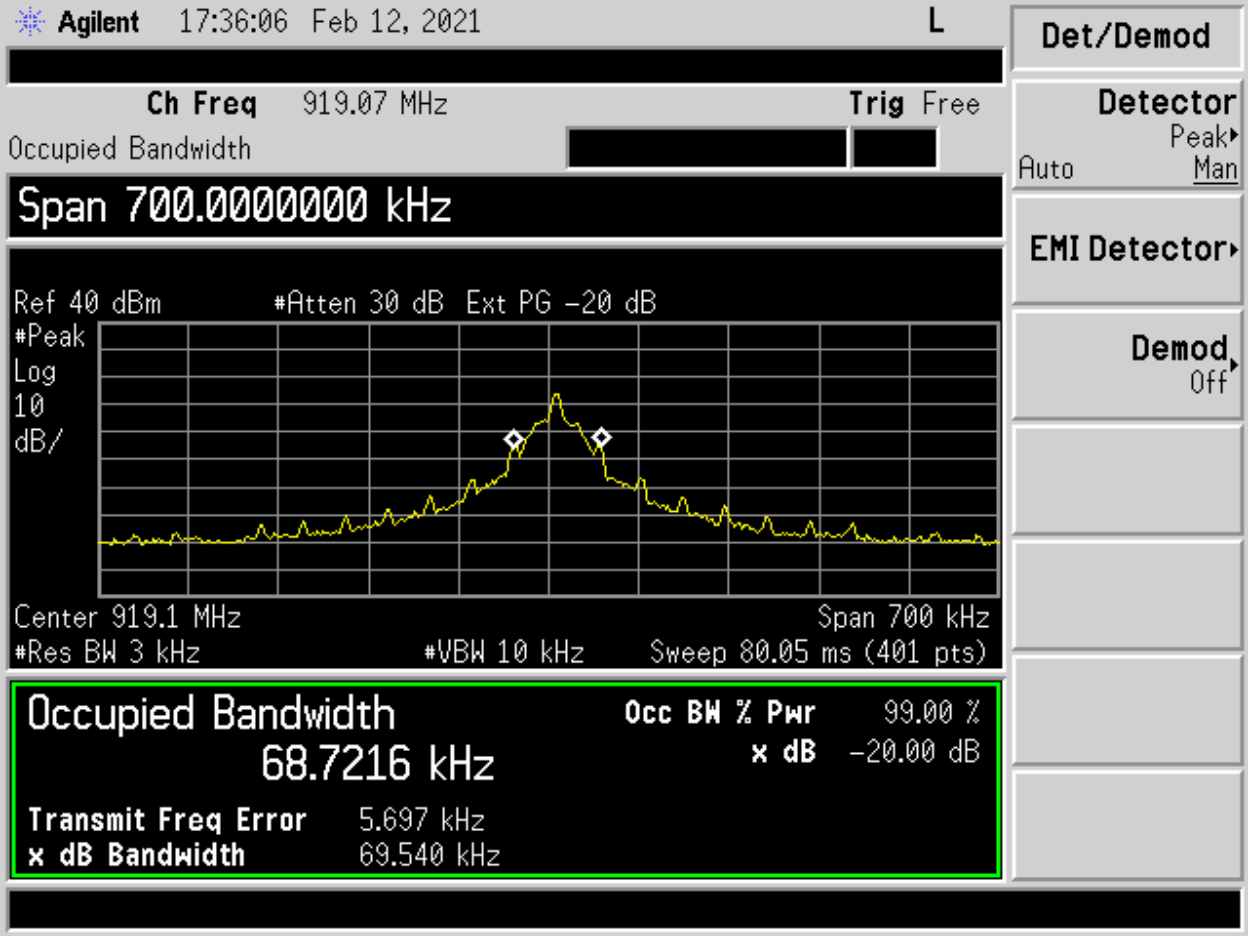


Figure 13. 20 dB and 99% Occupied Bandwidth – High Channel

2.14 Number of Hopping Frequencies (CFR 15.247 (a)(1) and RSS-247 5.1(c))

Frequency hopping systems operating 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. The EUT has a 20 dB bandwidth less than 250 kHz; therefore, at least 50 hopping frequencies shall be used.

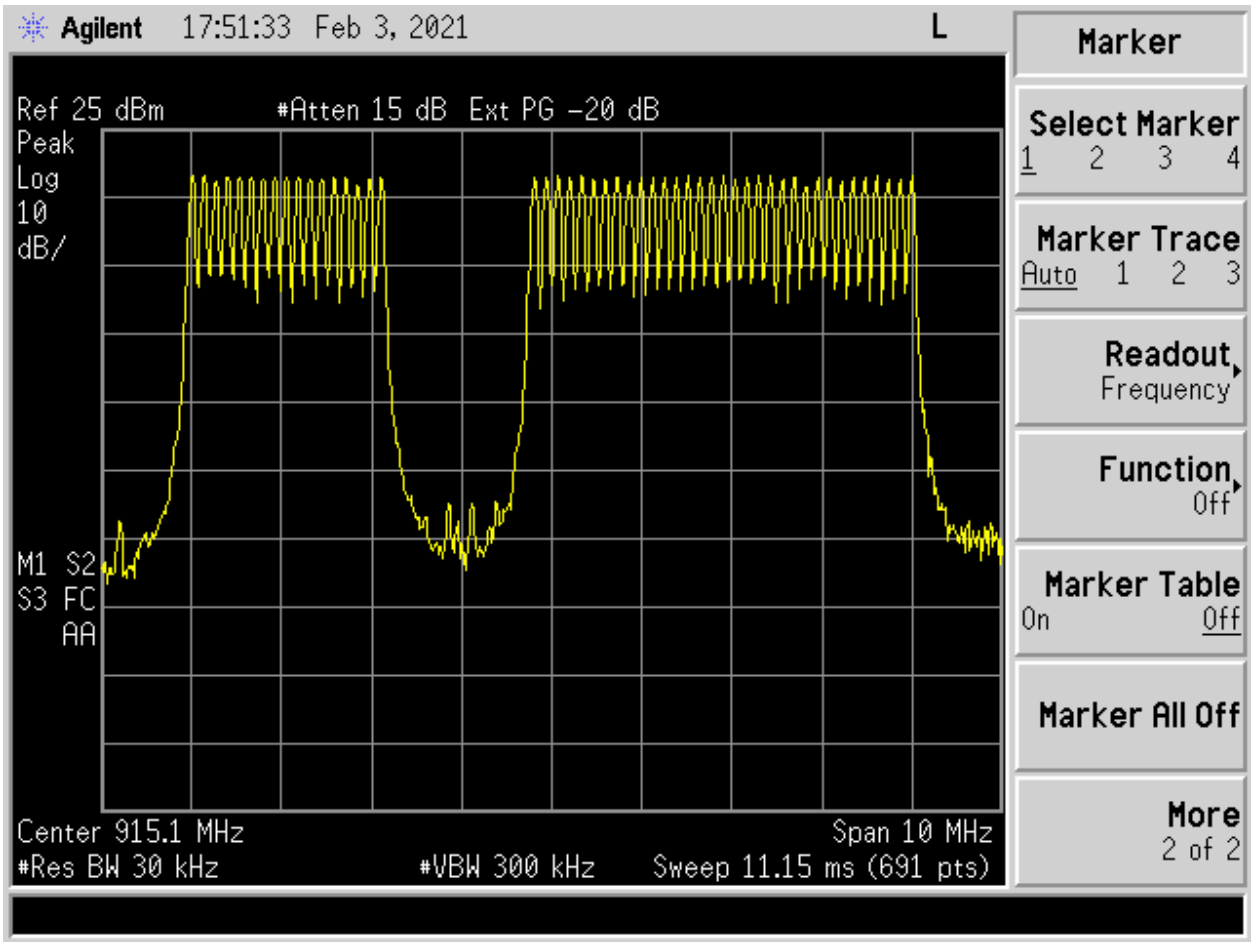


Figure 14. 50 Hopping Channels

2.15 Frequency Separation (CRF 15.247(a)(1) and RSS-247 5.1(a))

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 frequency hopping system is 69.54 kHz, which is greater than 25 kHz; therefore, the frequency separation must be greater than 69.54 kHz.

The test procedure outlined in ANSI C63.10-2013 was used to conduct measurements. The EUT hopping function was not enabled during the testing.

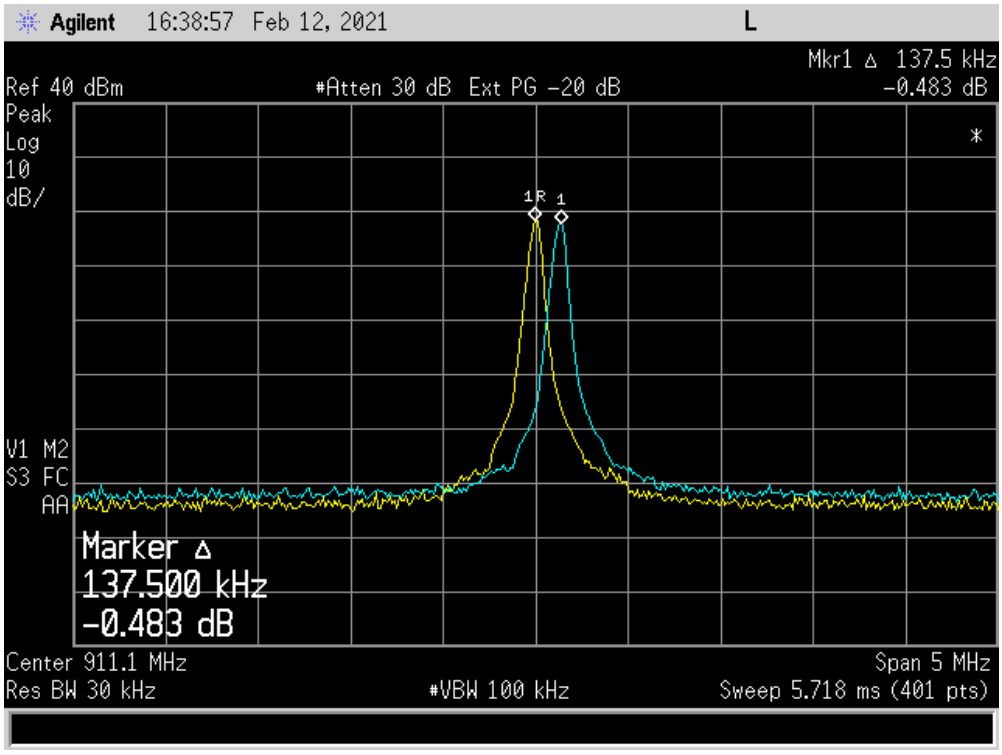


Figure 15. Frequency Separation

Measured Delta (Figure 16)	137.5 kHz
-Limit (20 dB Bandwidth)	69.5 kHz
Margin	68.0 kHz

2.16 Intentional Radiator Power Line Conducted Emissions (CFR 15.207)

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

2.17 Unwanted Emissions of the Intentional Radiator, (CFR 15.209 and 15.33(a))

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

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

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

Table 12. Spurious Radiated Emissions – Internal Antenna (9 kHz – 30 MHz)

9 kHz to 30 MHz with Class B Limits							
Test: FCC Part 15.109 / 15.209							
Frequency (MHz)	**Test Data (dBuV)**	**AF+CL-PA (dB/m)**	**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.							

Test Date: February 1, 2021

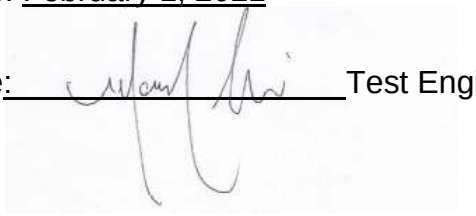
Signature:  Test Engineer: Mark Afroozi

Table 13. Spurious Radiated Emissions – External Antenna (9 kHz – 30 MHz)

9 kHz to 30 MHz with Class B Limits							
Test: FCC Part 15.109 / 15.209							
Frequency (MHz)	**Test Data (dBuV)**	**AF+CL-PA (dB/m)**	**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.							

Test Date: February 1, 2021

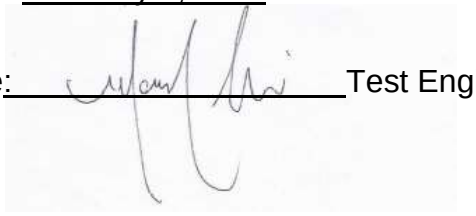
Signature:  Test Engineer: Mark Afroozi

Table 14. Spurious Radiated Emissions – Internal Antenna (30 MHz – 1 GHz)

30 MHz to 1 GHz with Class B Limits							
Test: FCC Part 15.109 / 15.209							
Frequency (MHz)	**Test Data (dBuV)**	**AF+CL-PA (dB)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Distance / Polarization**	**Margin (dB)**	**Detector PK / QP**
83.30	40.75	-16.96	23.79	40.0	3.0m./HORZ	16.2	**PK**
All other emissions were more than 20 dB below the applicable limit.							

Test Date: February 1, 2021

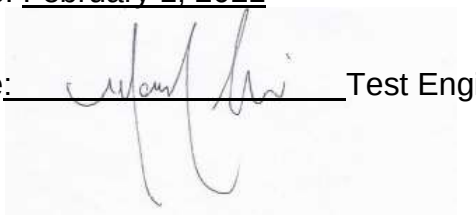
Signature:  Test Engineer: Mark Afroozi

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

30 MHz to 1 GHz with Class B Limits							
Test: FCC Part 15.109 / 15.209							
Frequency (MHz)	**Test Data (dBuV)**	**AF+CL-PA (dB/m)**	**Corrected Results (dBuV/m)**	**Limits (dBuV/m)**	**Distance / Polarization**	**Margin (dB)**	**Detector PK / QP**
All emissions were more than 20 dB below the applicable limit.							

Test Date: February 1, 2021

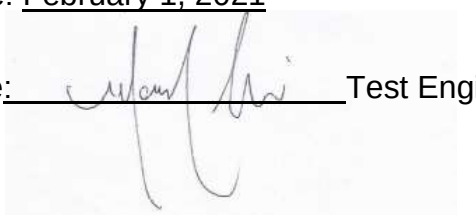
Signature:  Test Engineer: Mark Afroozi

Table 16. Spurious Radiated Emissions (1 GHz – 10 GHz) – Internal Antenna

1 GHz to 10 GHz with Class B Limits							
Test: FCC Part 15.109 / 15.209							
Frequency (MHz)	**Test Data (dBuV)**	**AF+CL-PA (dB)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Distance / Polarization**	**Margin (dB)**	**Detector PK / AVG**
1719.10	54.05	-8.75	45.30	54.0	3.0m./HORZ	8.7	**PK**
1728.10	53.49	-8.76	44.73	54.0	3.0m./VERT	9.3	**PK**
No additional emissions other than harmonics of the fundamental frequency were detected.							

Test Date: February 1, 2021

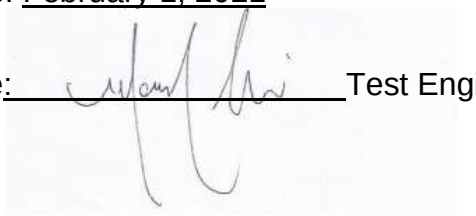
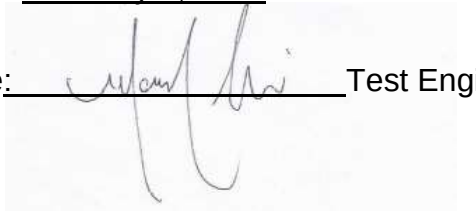
Signature:  Test Engineer: Mark Afroozi

Table 17. Spurious Radiated Emissions (1 GHz – 10 GHz) – External Antenna

1 GHz to 10 GHz with Class B Limits							
Test: FCC Part 15.109 / 15.209							
Frequency (MHz)	**Test Data (dBuV)**	**AF+CL-PA (dB)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Distance / Polarization**	**Margin (dB)**	**Detector PK / AVG**
No emissions other than harmonics of the fundamental frequency were detected.							

Test Date: February 1, 2021

Signature:  Test Engineer: Mark Afroozi

2.18 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%.

2.18.1 Conducted Emissions Measurement Uncertainty

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

2.18.2 Radiated Emissions Measurement Uncertainty

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

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

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

3 Test Results

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