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

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

For the

Aria Lights, Inc.

Model: FDMX1

FCC ID: 2AV7F-FDMX1
IC: 26036-FDMX1

UST Project: 20-0153
Issue Date: May 4, 2020

Total Pages in This Report: 48

3505 Francis Circle Alpharetta, GA 30004
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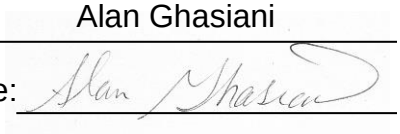
I certify that I am authorized to sign for the Test Agency and that all of the statements in this report and in the Exhibits attached hereto are true and correct to the best of my knowledge and belief:

US TECH (Agent Responsible For Test):

By: Alan Ghasiani

Name: 

Title: Compliance Engineer – President

Date May 4, 2020

TESTING
NVLAP LAB CODE 200162-0

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MEASUREMENT TECHNICAL REPORT

COMPANY NAME: Aria Lights, Inc.

MODEL: FDMX1

FCC ID: 2AV7F-FDMX1

IC: 26036-FDMX1

DATE: May 4, 2020

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

Equipment type: 900 MHz Transmitter Module

Deferred grant requested per 47 CFR 0.457(d)(1)(ii)? yes_____ No X

If yes, defer until: _____N/A_____
date
agrees to notify the Commission by N/A
date
of the intended date of announcement of the product so that the grant can be issued on that date.

Report prepared by:

US Tech
3505 Francis Circle
Alpharetta, GA 30004

Phone Number: (770) 740-0717
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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 Industry Canada RSS-247.

1.2 Characterization of Test Sample

The sample used for testing was received by US Tech on April 9, 2020 in good operating condition.

1.3 Product Description

The Aria Lights Forte DMX Transmitter, Model FDMX1 is designed to allow an unlimited number of Aria Forte Orchestra music stand lights to be dimmed wirelessly from a central lighting console. It serves as both a DMX decoder and a 900MHz wireless transmitter. Lights can be dimmed in up to eight separate banks and eight channels are available to prevent cross-talk from other nearby transmitters. 256 dimming levels allow fine control over lighting conditions.

The device uses a Frequency-Hopping Spread Spectrum (FHSS) radio on the unlicensed 902-928MHz ISM band. 50 hopping channels are employed and cycled twice per second during transmission. Packets are sent in bursts when changes to the dimming level are made (either manually by rotating the thumbwheel or through DMX control).

The Forte DMX Transmitter operates in three modes:

- DMX control mode – controlled by DMX commands from a lighting console
- Manual control mode – controlled by the thumbwheel
- Diagnostic mode – continuously transmitting a diagnostic pattern

Radio: Frequency-Hopping Spread Spectrum (FHSS)
Range: 902-928MHz ISM band
Modulation: FSK
RF Output Power: +8.2 dBm
Data Rate: Mbps (Max): 25 kbps
Channels: 50 (hopping)

1.4 Configuration of Tested System

The Test Sample was tested per *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 FCC subpart A Digital equipment Verification requirements. Also, *ANSI C63.10:2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices* was used as a test procedure guide.

A list of the 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 under designation number US5301. Additionally, this site has been fully described and submitted to Industry Canada (IC), and has been approved under file number 9900A-1.

1.6 Related Submittals

The Equipment under Test (EUT) is subject to the following FCC/IC authorizations:

a) Certification under section 15.247/IC RSS-247 as a transmitter.

1.7 Test Results

In our opinion, and as indicated by the test results documented following, when tested in the configuration as described in this report, the EUT meets the applicable requirements of FCC and IC, including: FCC Parts 2.902, 15.207, 15.209, 15.247, RSS GEN, and RSS-247.

Table 1. EUT and Peripherals

PERIPHERAL MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	FCC/IC ID:	CABLES P/D
EUT DMX Transmitter	FDMX1	Engineering Sample	FCC ID: 2AV7F-FDMX1 IC: 26036-FDMX1	P/U
Power Supply	NA010050020	Engineering Sample	None	P/U
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	MODEL NUMBER	MANUFACTURER	SERIAL NUMBER	CALIBRATION DUE DATE
SPECTRUM ANALYZER	E4407B	AGILENT	US41442935	8/17/2020
SPECTRUM ANALYZER	DSA815	RIGOL	DSA8A18030 0138	12/10/2021 2 yr.
LOOP ANTENNA	6502	EMCO	9810-3246	4/06/2022 2 yr
BICONICAL ANTENNA	3110B	EMCO	9306-1708	6/27/2021 2 yr
LOG PERIODIC ANTENNA	3146	EMCO	9305-3600	2/01/2021 2 yr
HORN ANTENNA	3115	EMCO	9107-3723	11/28/2020 2 yr
RF PREAMP 100 kHz to 1.3 GHz	8447D	HEWLETT-PACKARD	1937A02980	5/7/2020
PREAMP 1.0 GHz to 26.0 GHz	8449B	HEWLETT-PACKARD	3008A00480	7/08/2020 extended
HIGH PASS FILTER	VHF-1320 15542	Mini-circuits Inc	3-0843	7/02/2020 extended

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 (CFR 15.31(m),RSS-Gen 6.8)

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 902 to 928 MHz, 3 test frequencies were used.

2.4 Frequency Range of Radiated Measurements (CFR 15.33, RSS-Gen 6.13)

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, RSS-Gen 6.9)

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, RSS-Gen 6.7)

This equipment is not available to the general public and will only be installed by a professional installer working for an approved utility. The equipment therefore meets the intent of the above requirement. Only the antennas 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
1.7 Table. 1	Linx Technologies	½ Wave Dipole	ANT-916-OC-LG-RPS	+2.2	RP-SMA

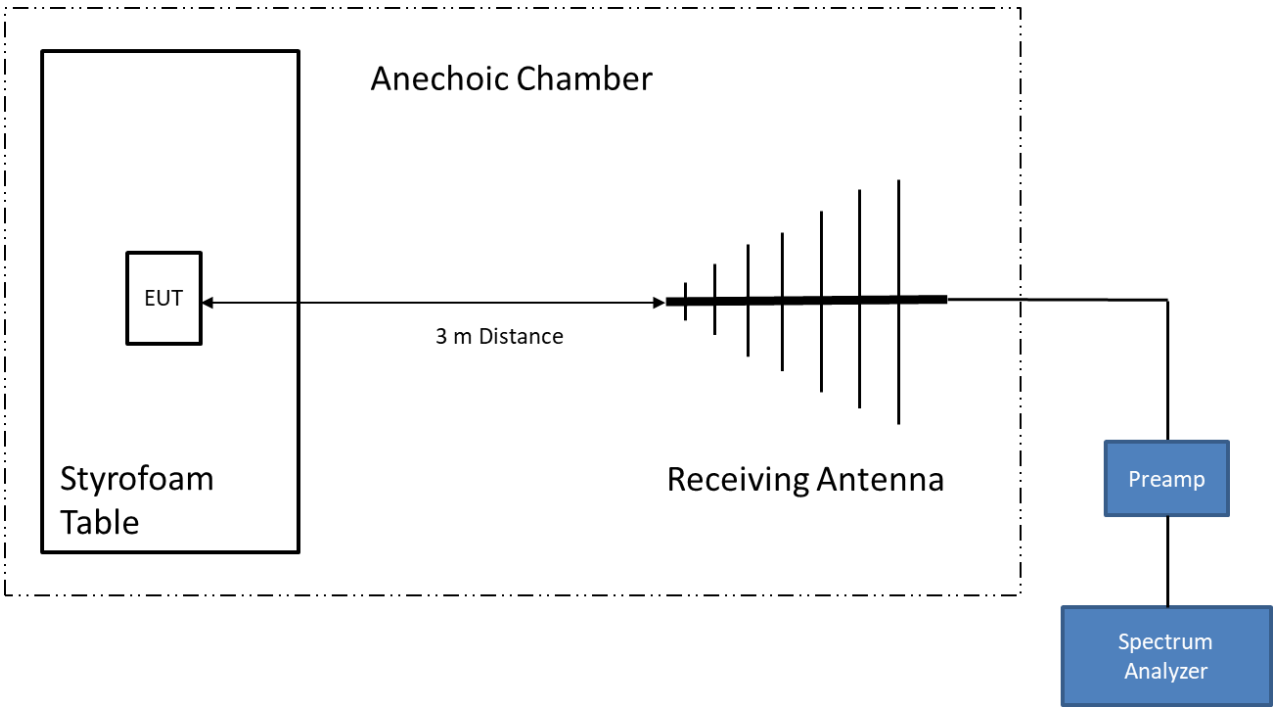


Figure 1. Block Diagram of Test Configuration

2.7 Restricted Bands of Operation (CFR 15.205, RSS-Gen 8.10)

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 emissions are examined for this requirement. See paragraph 2.10 of the test report.

2.8 Transmitter Duty Cycle (CFR 15.35 (c), RSS-Gen 6.10)

When the radiated emission limits are expressed in terms of the average value of the emission, and pulsed operation is employed, the measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. As an alternative (provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 second interval during which the field strength is at its maximum value. The exact method of calculating the average field strength shall be submitted with any application for certification.

In this case no duty cycle correction factor was used.

2.9 Intentional Radiator, Power Line Conducted Emissions (CFR 15.207, RSS-Gen 8.8)

The EUT was directly connected to the AC mains and evaluated for compliance to FCC 15.207, power line conducted emissions.

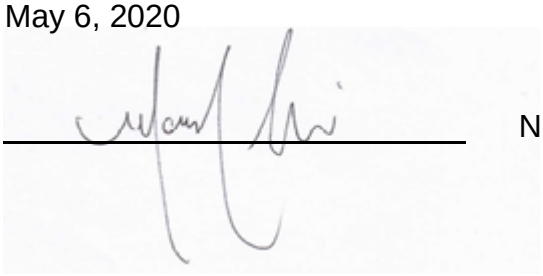
Table 5. Transmitter Power Line Conducted Emissions Test Data, Part 15.207

150 kHz to 30 MHz						
Test: FCC Part 15, Para 15.107				**Client:** Aria Lights		
Project: 20-0153				**Model:** FDMX1		
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						
0.4767	30.24	2.73	32.97	46.4	13.4	**QP**
0.5958	36.84	0.25	37.09	46.0	8.9	**PK**
1.3200	32.50	0.32	32.82	46.0	13.2	**PK**
8.7660	39.66	0.16	39.82	50.0	10.2	**PK**
10.1000	34.66	0.34	35.00	50.0	15.0	**PK**
24.2000	27.72	1.13	28.85	50.0	21.2	**PK**
120 Vac / 60 Hz, Neutral						
0.4983	34.23	0.10	34.33	46.0	11.7	**PK**
0.5708	35.50	0.53	36.03	46.0	10.0	**PK**
2.4133	31.52	0.03	31.55	46.0	14.5	**PK**
8.6583	40.31	0.42	40.73	50.0	9.3	**PK**
10.2160	33.91	0.55	34.46	50.0	15.5	**PK**
20.2160	24.79	1.27	26.06	50.0	23.9	**PK**

Sample Calculation at: 0.4767 MHz

Magnitude of Measured Frequency	30.24	dBuV
+Antenna Factor + Cable Loss	2.73	dB
Corrected Result	32.97	dBuV/m

Test Date: May 6, 2020
Tested By

Signature:  Name: Mark Afroozi

2.10 Intentional Radiator, Radiated Emissions (CFR 15.209, 15.247(d), RSS-247, 5.1,5.5)

Radiated Spurious measurements: The EUT was placed into a continuous transmit mode of operation (>98% or max level possible duty cycle) and tested per ANSI C63.10:2013. The EUT was tested in three orthogonal positions to find the maximum emission position.

Radiated measurements were conducted between the frequency range of 9 kHz (or lowest frequency used/generated by the device) up to the tenth harmonic of the device (not greater than 40 GHz). In the band below 150 kHz, a resolution bandwidth (RBW) of 200 Hz was used. In the band from 150 kHz to 30 MHz, a RBW of 9 kHz was used; emissions below 1 GHz were tested with a RBW of 100/120 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 per 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.

2.10.1 Fundamental and Harmonic emissions

Table 6. Average Radiated Fundamental & Harmonic Emissions (Chip Antenna)

Test: FCC Part 15, Para 15.209, 15.247(d)				**Client:** Aria Lights			
Project: 20-0153				**Model:** FDMX1			
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector Mode**
Low Channel – 903.440 MHz							
2710.32	33.21	-3.28	30.81	54.0	3.0m./HORZ	23.2	**AVG**
3613.76	31.68	1.51	33.40	54.0	3.0m./HORZ	20.6	**AVG**
4517.20	30.74	5.35	36.94	54.0	3.0m./HORZ	17.1	**AVG**
8130.96	32.27	14.00	46.27	54.0	1.0m./VERT	7.7	**AVG**
Mid Channel – 914.768 MHz							
2744.30	34.14	-3.53	30.61	54.0	3.0m./HORZ	23.4	**AVG**
3659.07	31.63	1.98	33.61	54.0	3.0m./HORZ	20.4	**AVG**
4573.84	30.75	5.39	36.14	54.0	3.0m./HORZ	17.9	**AVG**
7318.14	31.59	13.73	45.32	54.0	1.0m./HORZ	8.7	**AVG**
8232.91	31.41	14.16	45.57	54.0	1.0m./HORZ	8.4	**AVG**
9147.68	31.54	15.37	46.91	54.0	1.0m./HORZ	7.1	**AVG**
High Channel – 926.568 MHz							
2779.70	34.27	-3.66	30.61	54.0	3.0m./HORZ	23.4	**AVG**
4632.84	30.84	5.84	36.68	54.0	3.0m./HORZ	17.3	**AVG**
7412.54	31.03	13.33	44.36	54.0	3.0m./HORZ	9.6	**AVG**
8339.11	31.08	17.01	48.09	54.0	1.0m./HORZ	5.9	**AVG**

1. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic
2. The EUT was placed in its normal operating position and the transmitter was in constant broadcast mode, with a duty cycle of greater than 98% or max level possible. 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 2710.32 MHz:

Magnitude of Measured Frequency	33.21	dBuV
+Antenna Factor + Cable Loss - Amplifier Gain	-3.28	dB/m
Corrected Result	30.81	dBuV/m

Test Date: April 10, 2020
Tested By

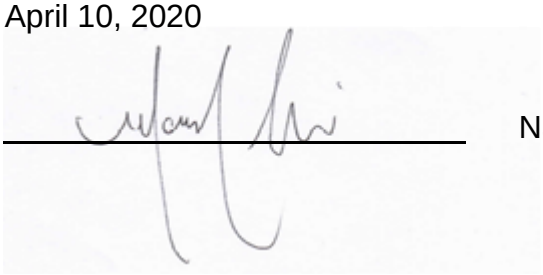
Signature:  Name: Mark Afroozi

Table 7. Peak Radiated Fundamental & Harmonic Emissions

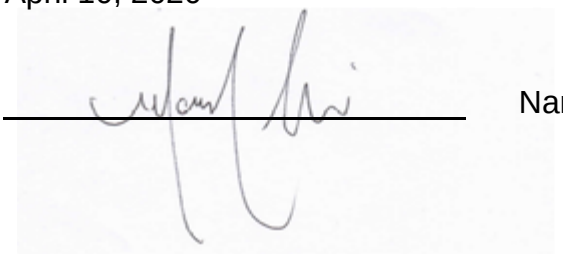
Test: FCC Part 15, Para 15.209, 15.247(d)				**Client:** Aria Lights			
Project: 20-0153				**Model:** FDMX1			
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector Mode**
Low Channel – 903.440 MHz							
2710.32	73.97	-3.28	70.69	74.0	3.0m./HORZ	3.3	**PK**
3613.76	58.26	1.51	59.77	74.0	3.0m./HORZ	14.2	**PK**
4517.20	62.27	5.35	67.62	74.0	3.0m./HORZ	6.4	**PK**
8130.96	47.25	14.00	61.25	74.0	1.0m./HORZ	12.7	**PK**
Mid Channel – 914.768 MHz							
2744.30	73.43	-3.53	69.90	74.0	3.0m./HORZ	4.1	**PK**
3659.07	51.18	1.98	53.16	74.0	3.0m./HORZ	20.8	**PK**
4573.84	53.62	5.39	59.01	74.0	3.0m./HORZ	15.0	**PK**
7318.14	48.08	13.73	61.81	74.0	1.0m./HORZ	12.2	**PK**
8232.91	46.33	14.16	60.49	74.0	1.0m./HORZ	13.5	**PK**
9147.68	46.71	15.37	62.08	74.0	1.0m./HORZ	11.9	**PK**
High Channel – 926.568							
2779.70	76.15	-3.66	72.49	74.0	3.0m./HORZ	1.5	**PK**
4632.84	52.83	5.84	58.67	74.0	3.0m./HORZ	15.3	**PK**
7412.54	47.81	13.33	61.14	74.0	3.0m./HORZ	12.9	**PK**
8339.11	46.76	17.01	63.77	74.0	1.0m./HORZ	10.2	**PK**

1. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic
2. The EUT was placed in its normal operating position and the transmitter was in constant broadcast mode, with a duty cycle of greater than 98% or max level possible. 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 2710.32 MHz:

Magnitude of Measured Frequency	73.97	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	-3.28	dB/m
Corrected Result	70.69	dBuV/m

Test Date: April 10, 2020
Tested By

Signature:  Name: Mark Afroozi

2.10.2 Spurious Emissions other than Fundamental and harmonics

The EUT was placed into a mode representative of normal operation and spurious emissions measurements were performed. The spurious emissions found are other than Fundamental and harmonic measurements. The antenna port was terminated with a 50 ohm load during testing.

Table 8. Intentional Radiator, Spurious Radiated Emissions (CFR 15.209), 9 kHz to 30 MHz

9 kHz to 30 MHz							
Test: FCC Part 15, Para 15.109				**Client:** Aria Lights			
Project: 20-0153				**Model:** FDMX1			
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 detected were more than 20 dB below the applicable limits.							

Tested from 9 kHz to 30 MHz

Test Date: April 17, 2020

Tested By

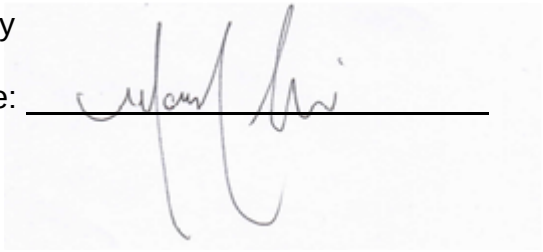
Signature:  Name: John Freeman

Table 9. Unintentional and Intentional Radiator, Spurious Radiated Emissions (CFR 15.109, 15.209) 30 MHz to 1000 MHz

30 MHz to 1000 MHz with Class B Limits							
Test: FCC Part 15, Para 15.109				**Client:** Aria Lights			
Project: 20-0153				**Model:** FDMX1			
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**
38.62	40.16	-14.25	25.91	40.0	3m./HORZ	14.1	**PK**
143.75	42.45	-13.22	29.23	43.5	3m./HORZ	14.3	**PK**
39.36	48.16	-15.35	32.81	40.0	3m./VERT	7.2	**PK**
91.59	42.61	-16.01	26.60	43.5	3m./VERT	16.9	**PK**
153.68	41.72	-12.11	29.61	43.5	3m./VERT	13.9	**PK**
192.61	34.29	-10.27	24.02	43.5	3m./VERT	19.5	**PK**

Tested from 30 MHz to 1 GHz

SAMPLE CALCULATION at 38.62 MHz:

Magnitude of Measured Frequency	40.16	dBuV
+ Cable Loss+Antenna Factor - Amp Gain	-14.25	dB
=Corrected Result	25.91	dBuV
Limit	40.00	dBuV
-Corrected Result	25.91	dBuV
Margin	14.09	dB

Test Date: April 10, 2020

Tested By

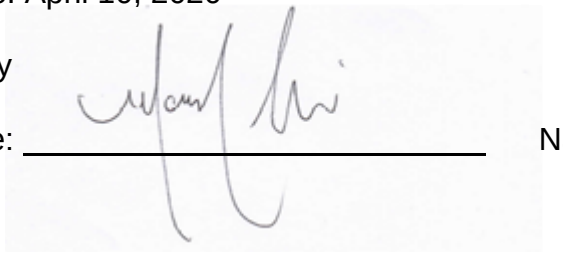
Signature:  Name: Mark Afroozi

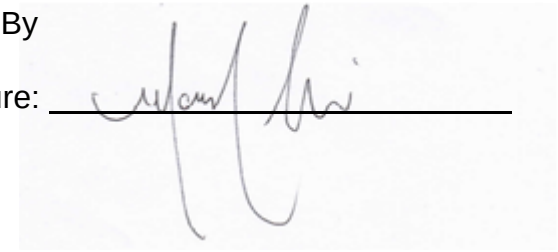
Table 10. Intentional Radiator, Spurious Radiated Emissions (CFR 15.109, 15.209) 1 GHz to 6 GHz

1 GHz to 12.5 GHz with Class B Limits							
Test: FCC Part 15, Para 15.109				**Client:** Aria Lights			
Project: 20-0153				**Model:** FDMX1			
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 detected were more than 20 dB below the applicable limits.							

*Measurements taken above 6 GHz are performed at a distance of 1m (vs. 3m). This correction includes an additional factor of -9.5 dB to account for this change.

Test Date: April 10, 2020

Tested By

Signature:  Name: Mark Afroozi

2.10.3 Conducted Spurious Emissions

Conducted Spurious measurements: The EUT was put into a continuous-transmit mode of operation (>98% or max level possible 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 9 kHz 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.

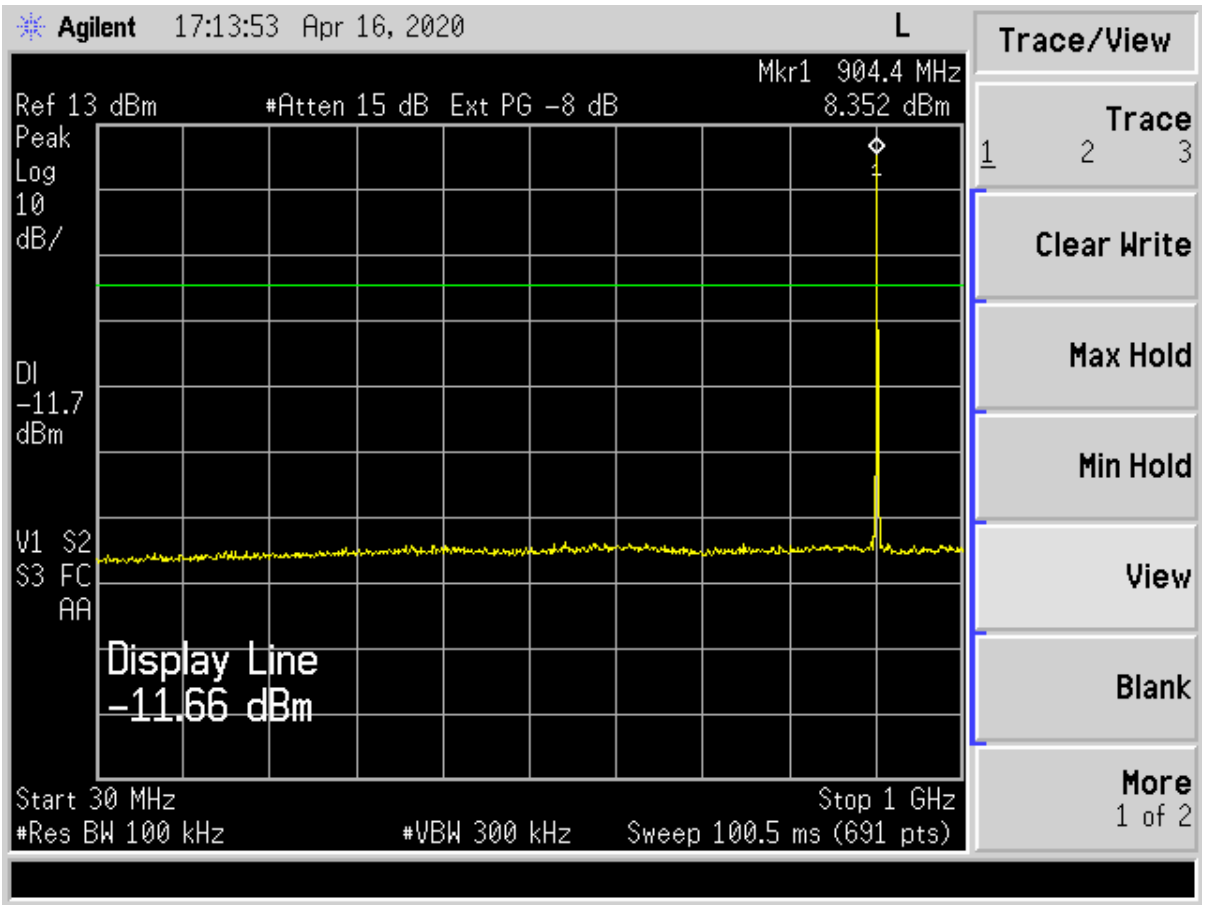


Figure 2. Conducted Spurious Emissions Low Channel, 30 MHz – 1 GHz

Note: Large emission seen is the fundamental emission.

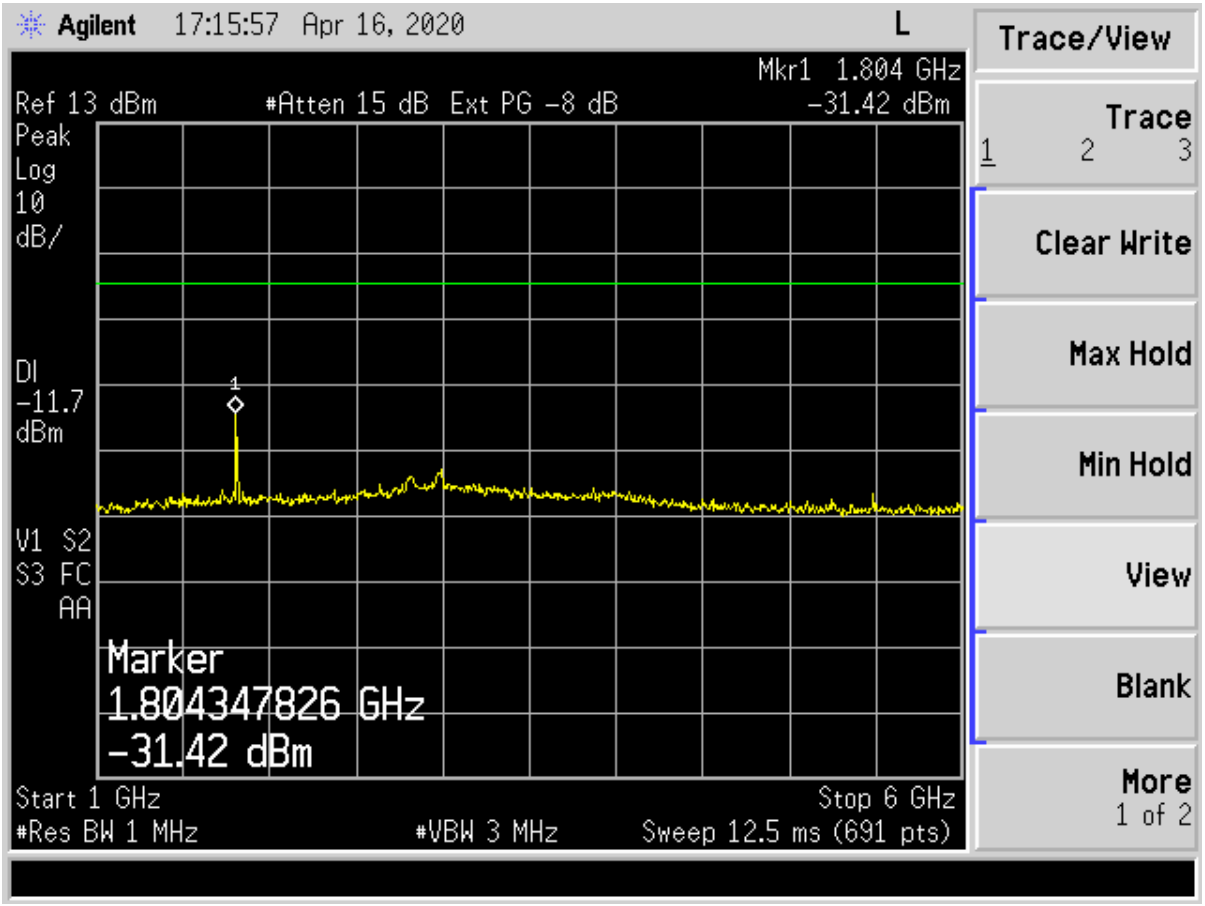


Figure 3. Conducted Spurious Emissions, Low Channel, 1 – 6 GHz

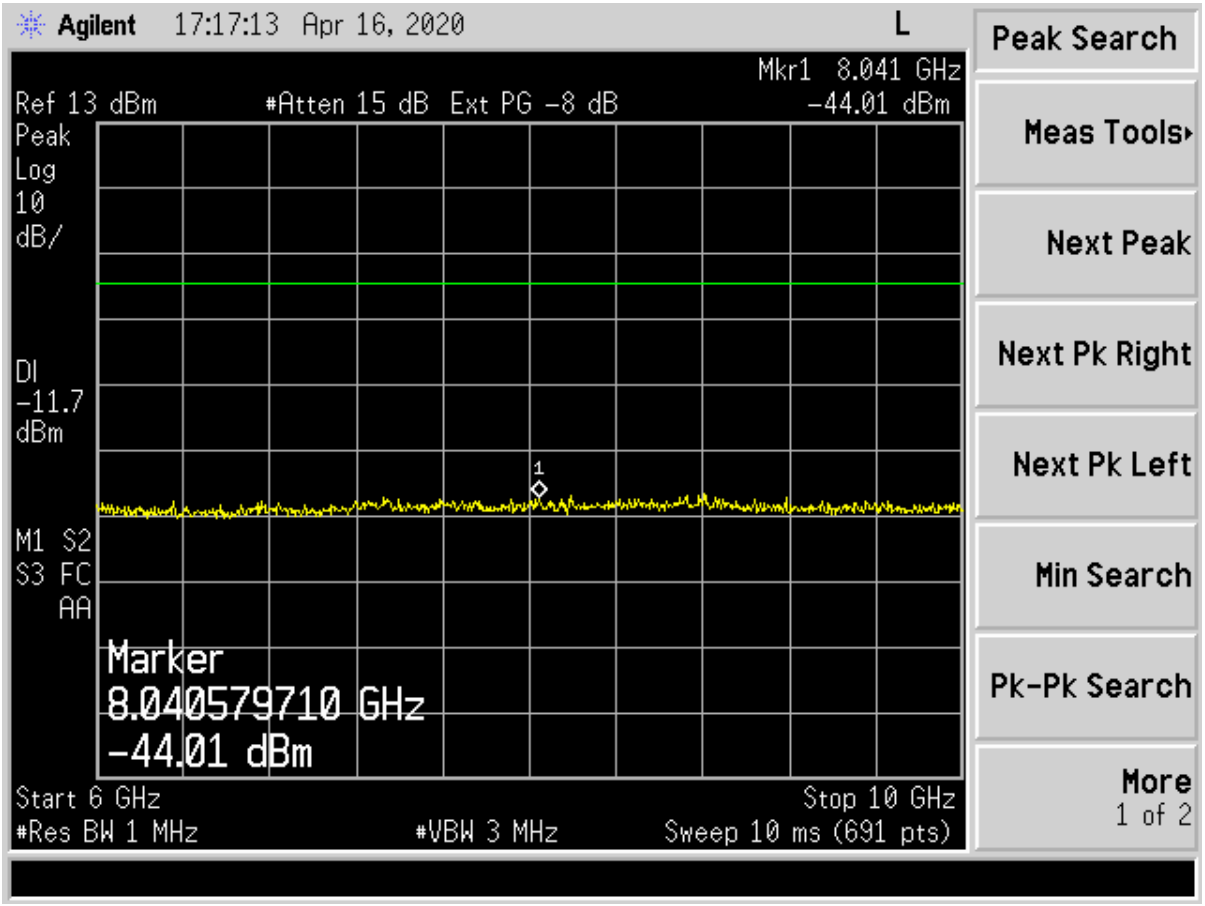


Figure 4. Conducted Spurious Emissions Low Channel, 6 – 10 GHz

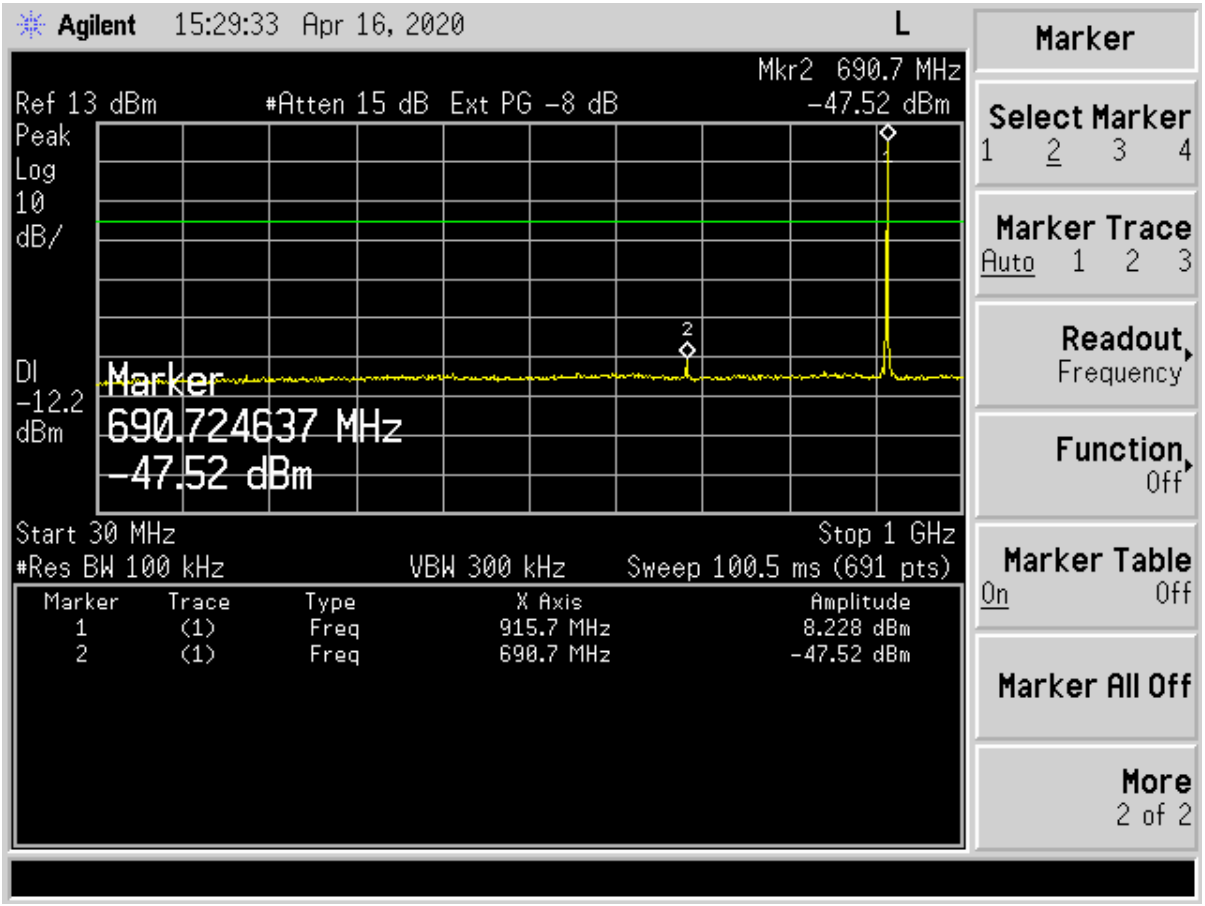


Figure 5. Conducted Spurious Emissions Mid Channel, 30 MHz – 1 GHz

Note: Large emission seen is the fundamental emission.

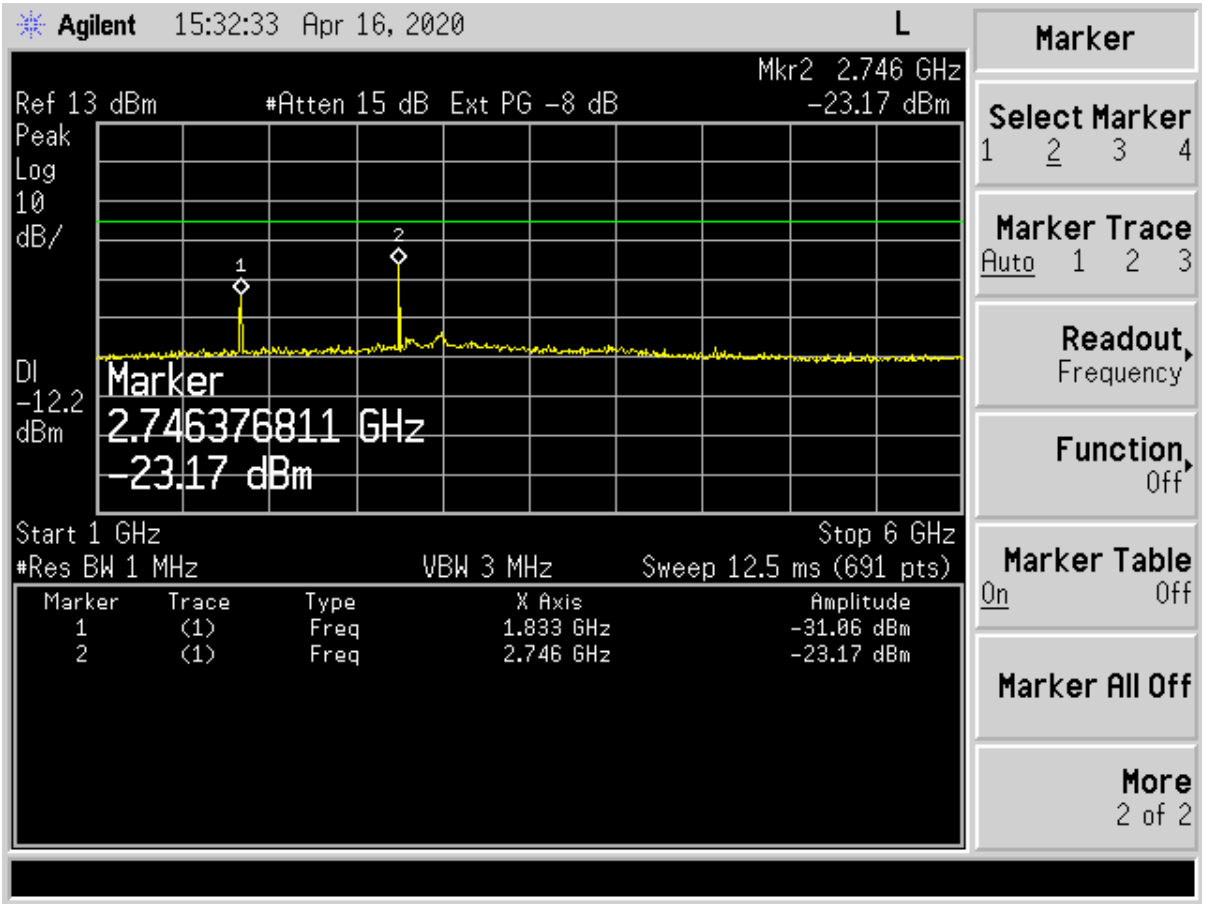


Figure 6. Conducted Spurious Emissions Mid Channel, 1 – 6 GHz

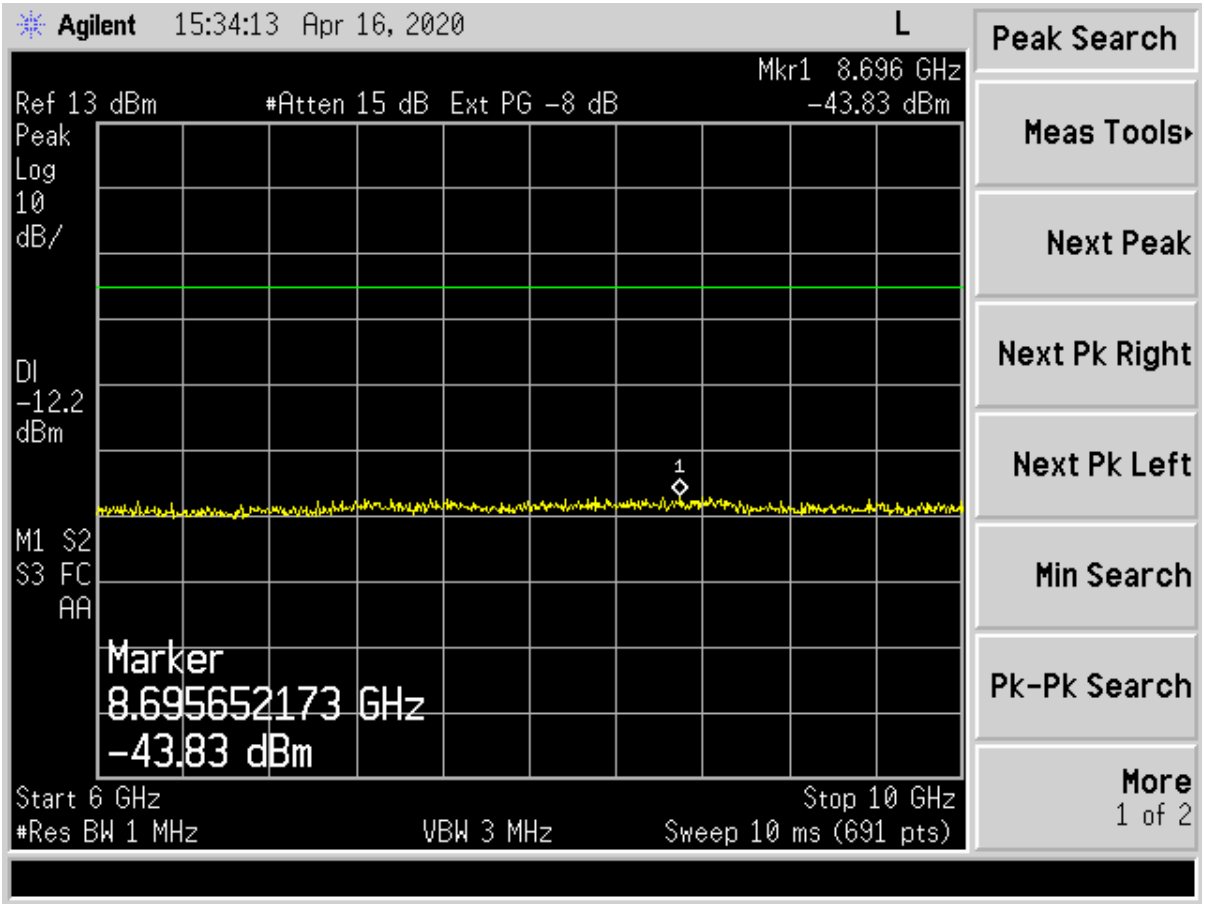


Figure 7. Conducted Spurious Emissions Mid Channel, 6 – 10 GHz

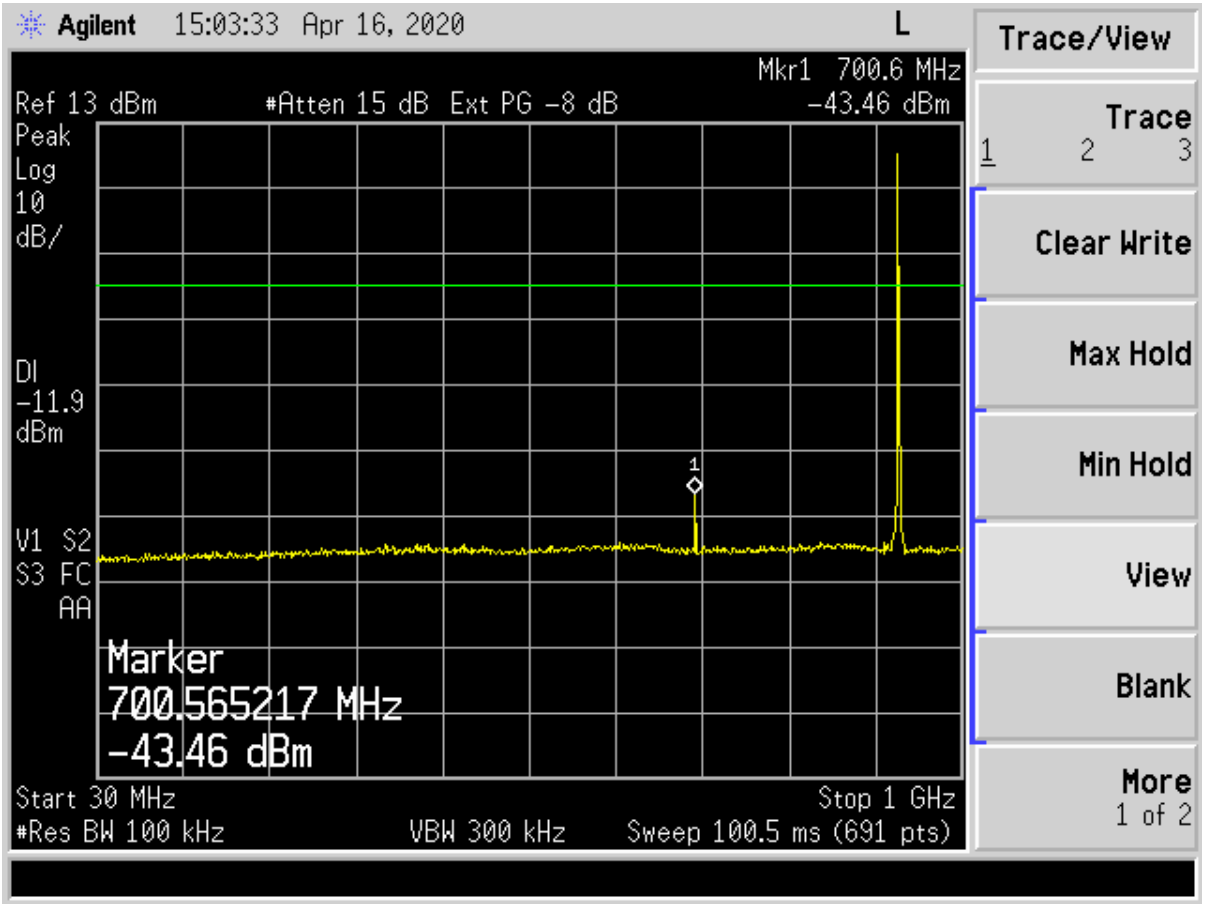


Figure 8. Conducted Spurious Emissions High, 30 MHz – 1 GHz

Note: Large emission seen is the fundamental emission.

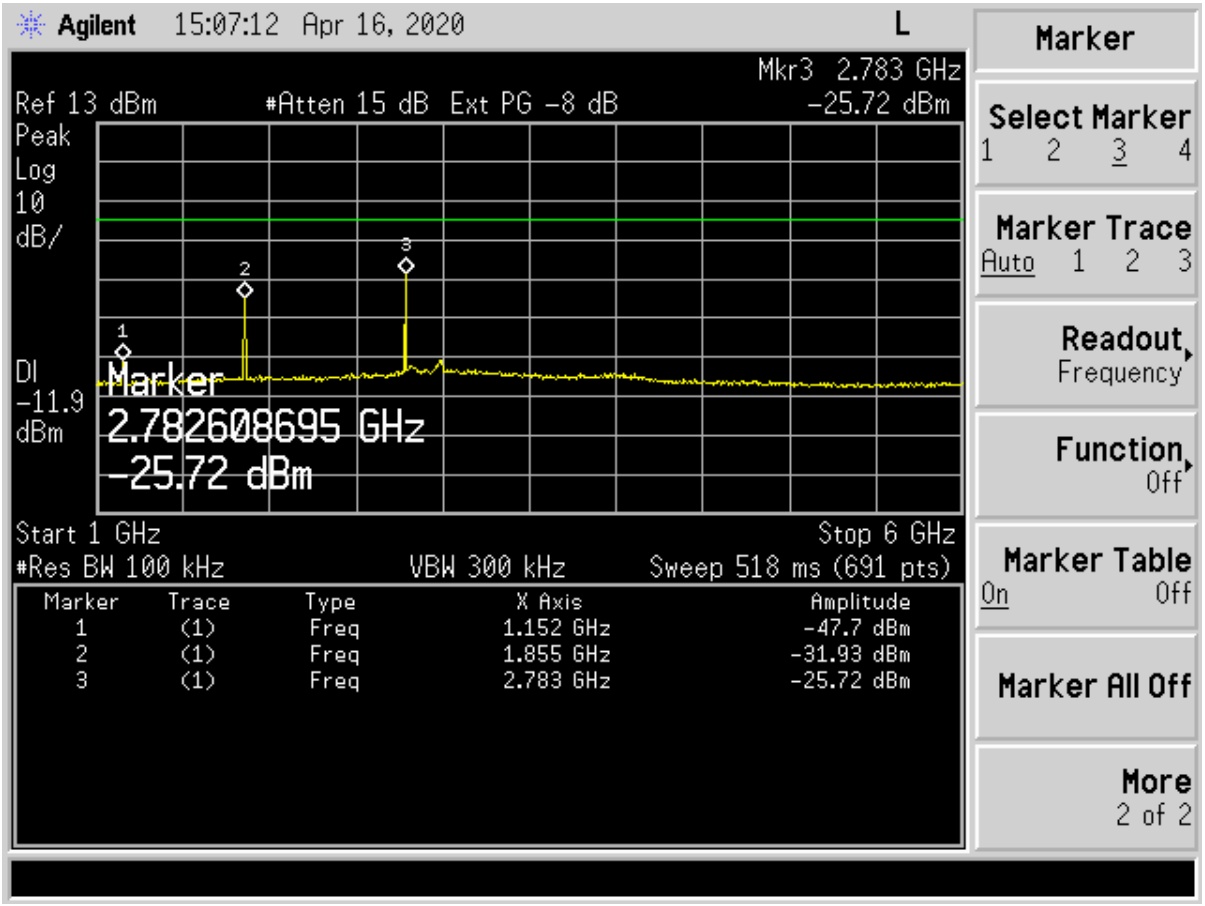


Figure 9. Conducted Spurious Emissions High Channel, 1 – 6 GHz

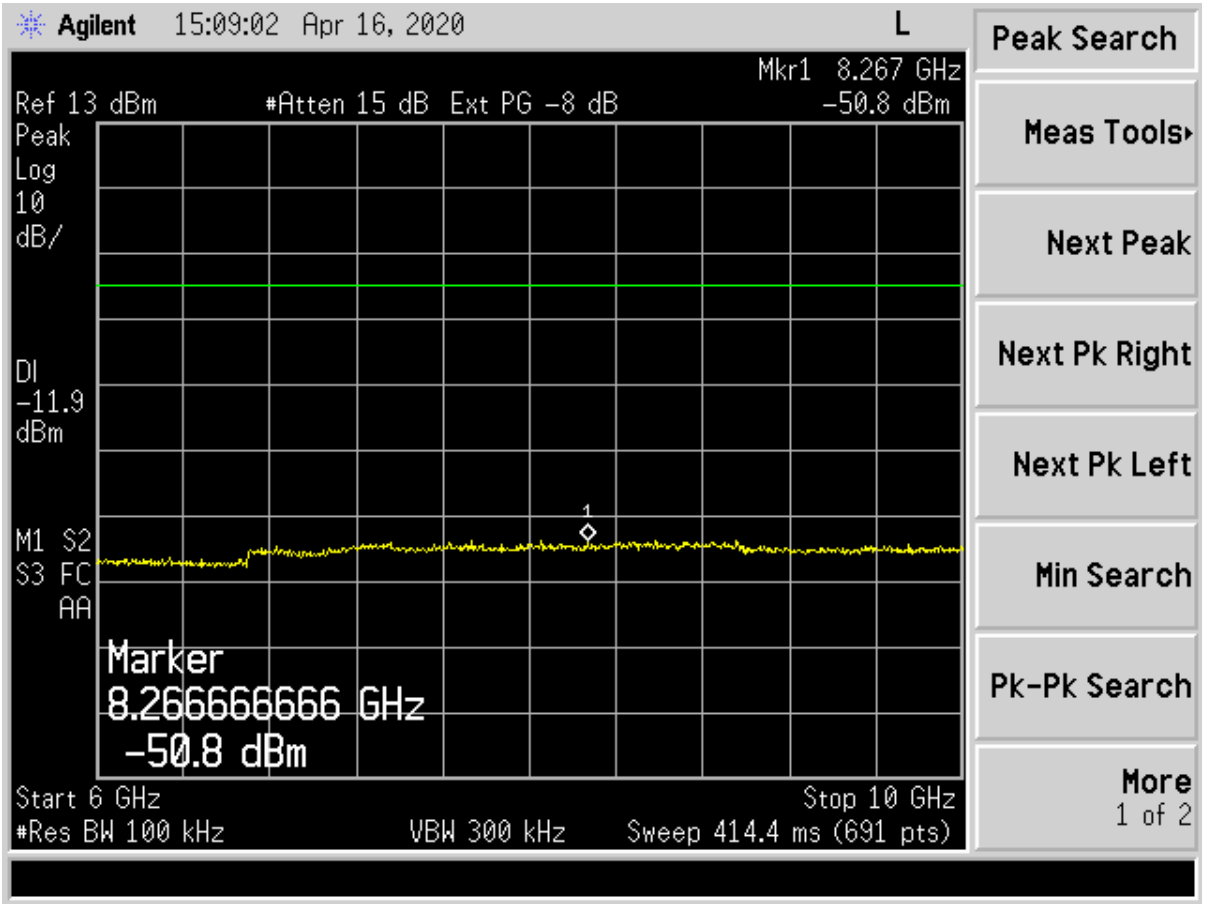


Figure 10. Conducted Spurious Emissions High Channel, 6 – 10 GHz

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 for the FHSS modulation, with the EUT initially operating on the Lowest Channel and then operating on the Highest Channel within its band of operation. Radiated measurements are performed for each antenna 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 2 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. Radiated measurements are performed with RBW = 100 kHz. The VBW is set ≥ RBW. See figure and calculations below for more detail.

Note: Hopping mode was enabled during testing.

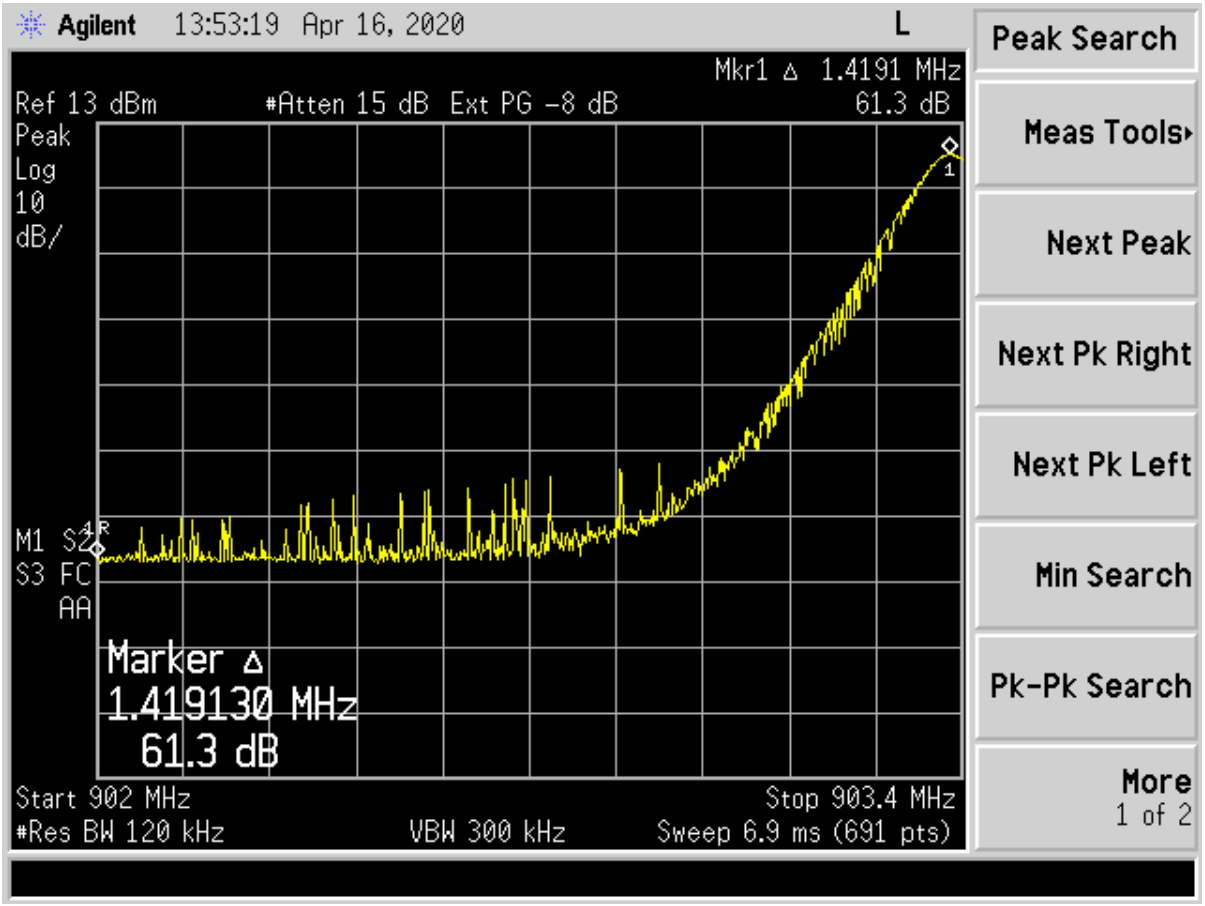


Figure 11. Band Edge Compliance, Low Channel Delta

Measured Delta (from Figure 11)	61.30	dBm
Limit (20 dB from fundamental)	20.00	dBm
Band Edge Margin	41.30	dB

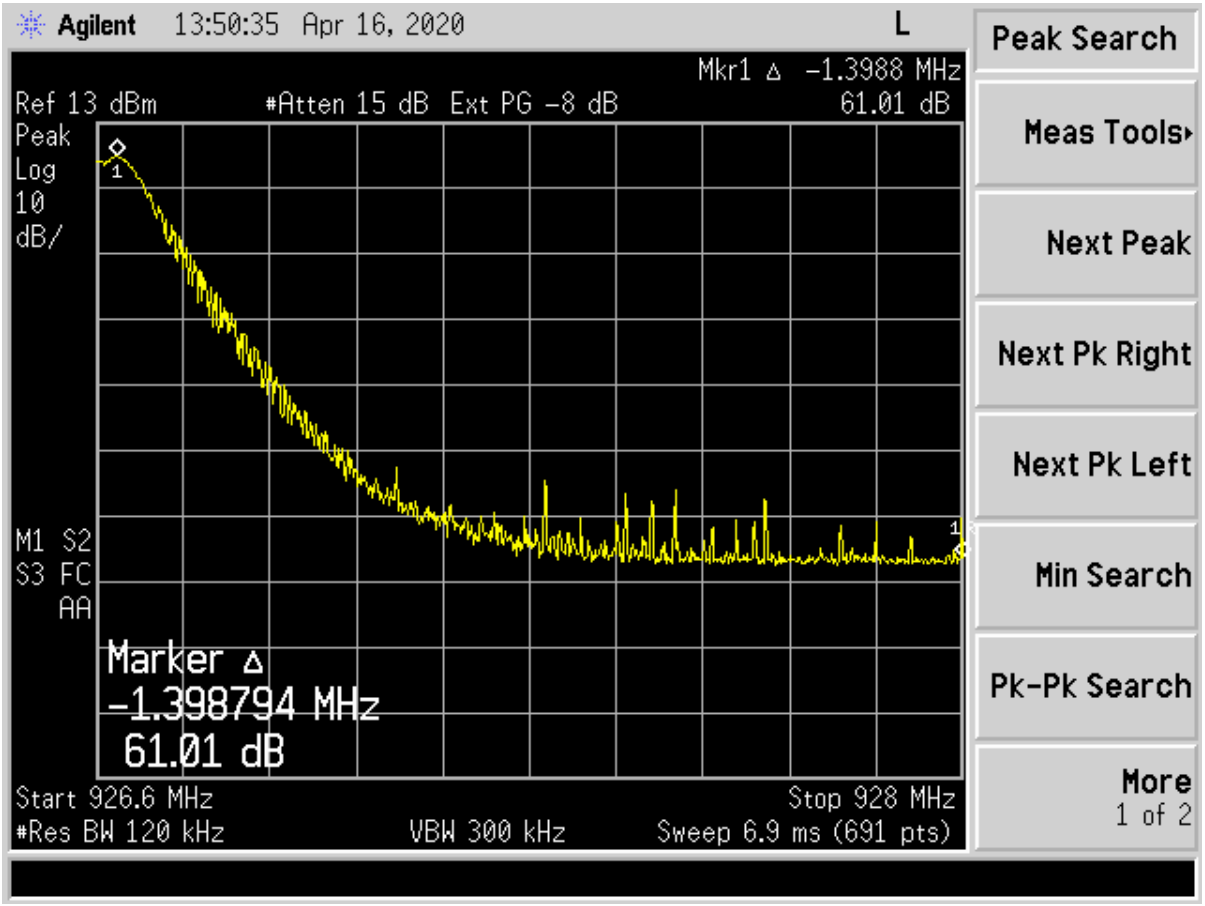


Figure 12. Band Edge Compliance, High Channel Delta

Measured Delta (from Figure 13)	61.01	dBm
Limit (20 dB from fundamental)	20.00	dBm
Band Edge Margin	41.01	dB

2.12 99% and 20 dB Bandwidth (CFR 15.247(a)(1)(i), RSS-Gen 6.6)

These measurements were performed while the EUT was in a constant transmit mode. The RBW was set to 100 kHz and with the VBW ≥ RBW. The results of this test are given in Table and Figures following.

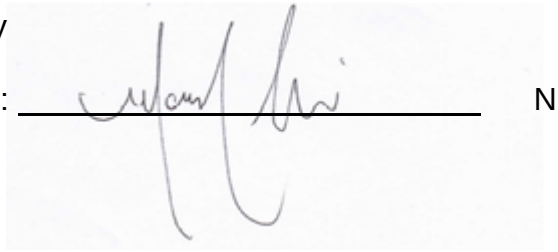
The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

Table 11. Occupied Bandwidth (99% & 20 dB)

Frequency (MHz)	20 dB Bandwidth (MHz)	CFR 15.247(a)(1)(i) Limit (MHz)	99% Occupied Bandwidth (MHz)
903.440	0.1156	0.500	0.1068
914.768	0.1153	0.500	0.1078
926.568	0.1153	0.500	0.1064

Test Date: April 14 & 16, 2020

Tested By

Signature:  Name: Mark Afroozi

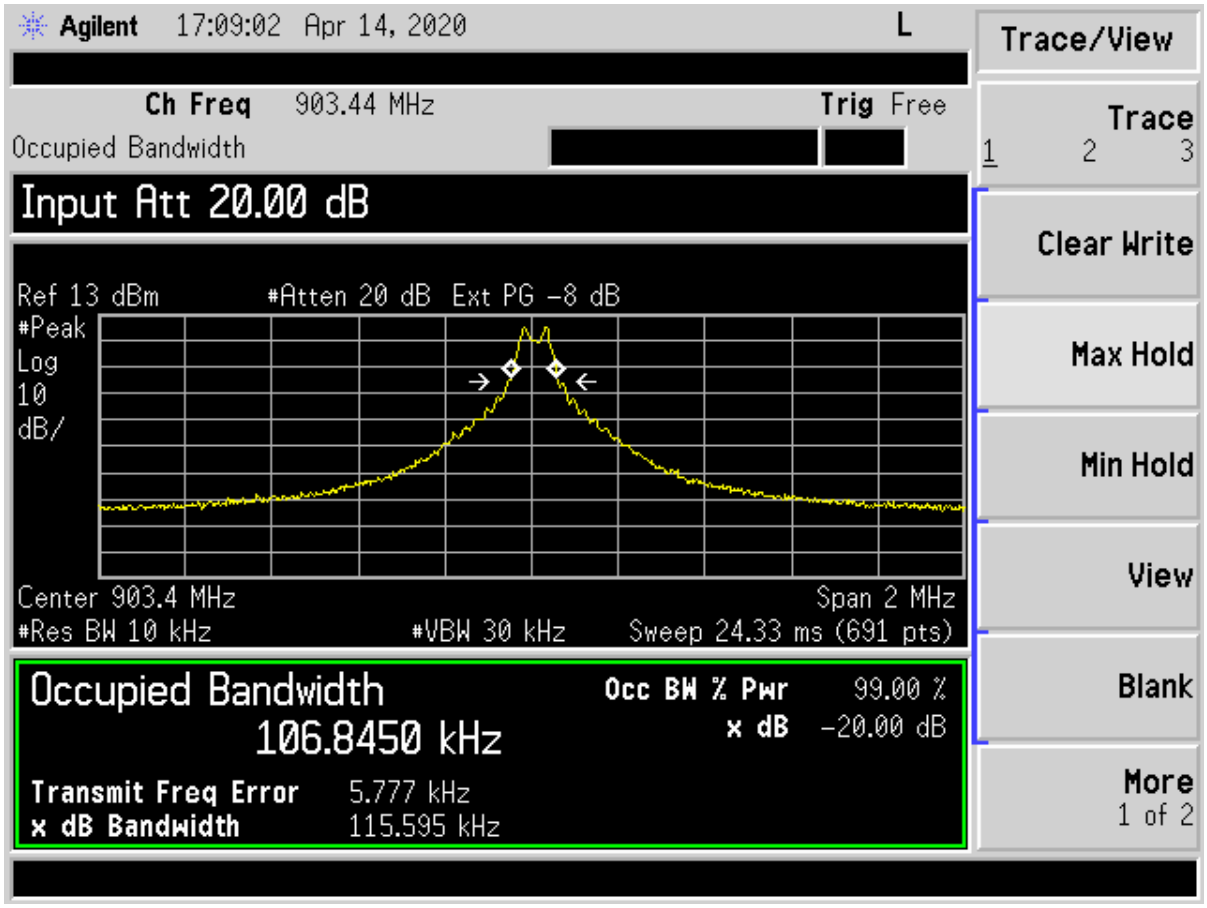


Figure 13. 99% & 20 dB Bandwidth – Low Channel

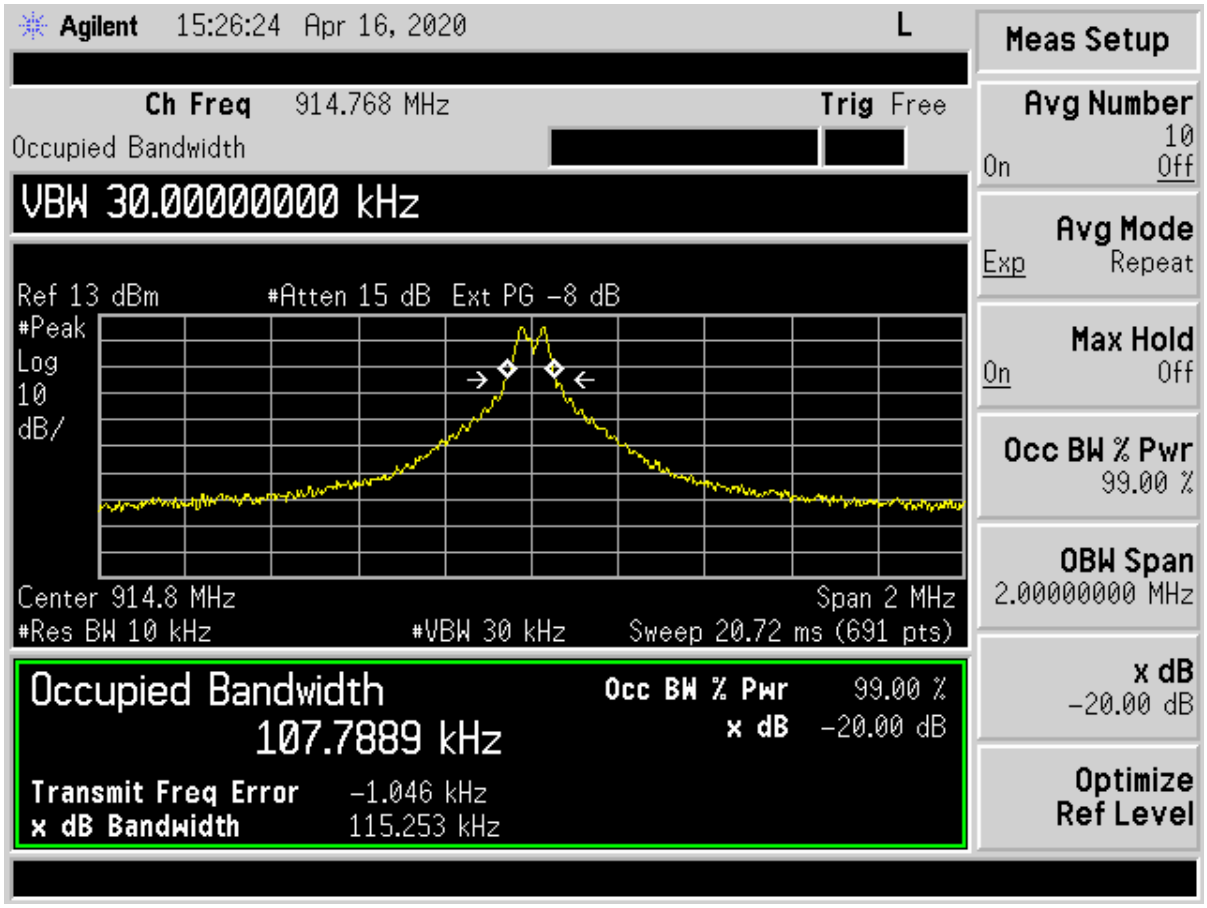


Figure 14. 99% & 20 dB Bandwidth – Mid Channel

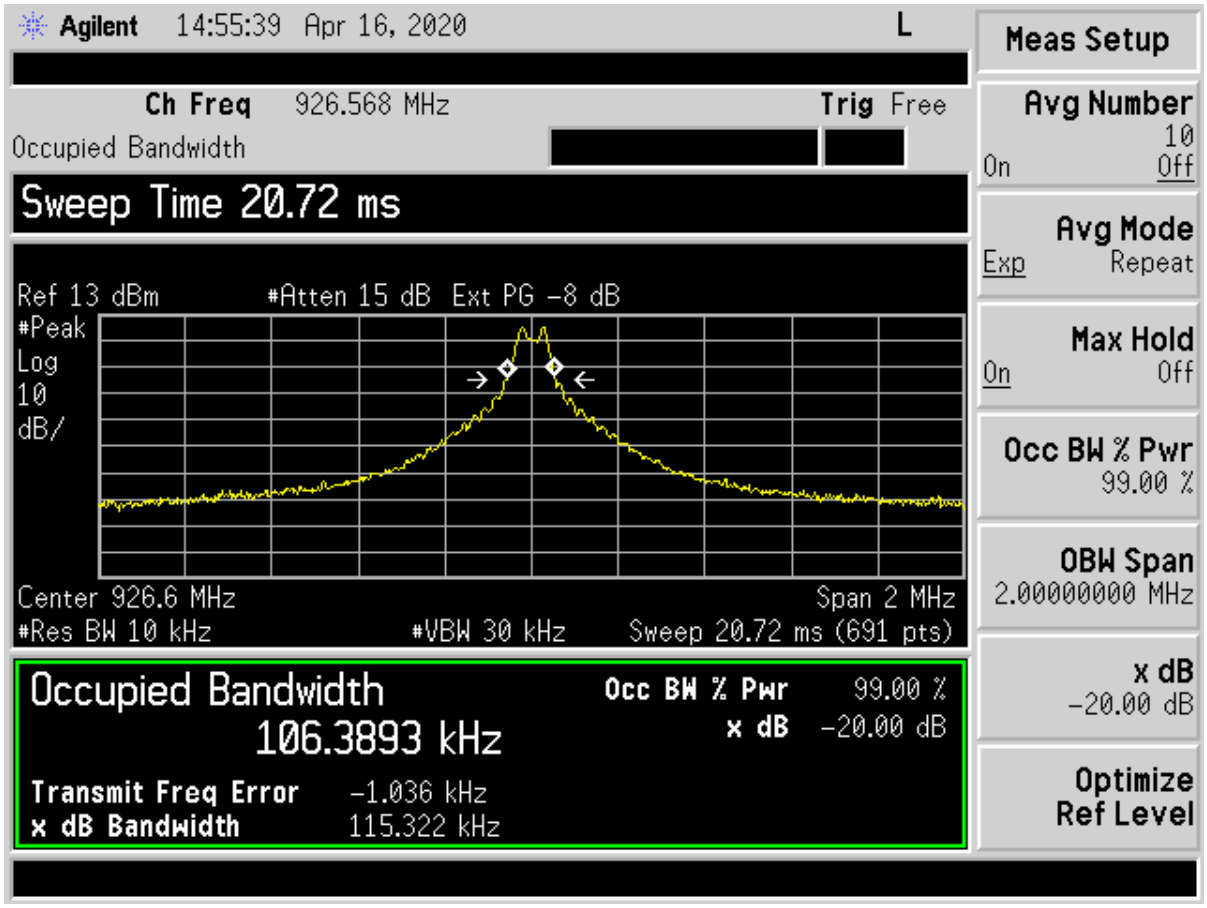


Figure 15. 99% & 20 dB Bandwidth – High Channel

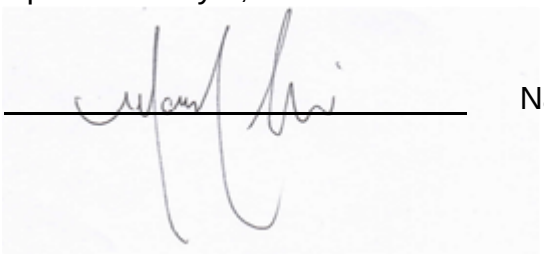
2.13 Maximum Peak Conducted Output Power (CFR 15.247(b)(1), RSS-247 5.1)

Peak power within the band 902 – 928 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 50 Ω input impedance. An 8 dB attenuator was used at the RF input port of the spectrum analyzer and attenuator loss was accounted for. Peak antenna conducted output power is tabulated in the table below.

Table 12. Peak Antenna Conducted Output Power per Part 15.247 (b) (2)

Frequency of Fundamental (MHz)	Raw Test Data dBm	Converted Data (mW)	FCC Limit (mW Maximum)
903.440	8.20	6.61	1000
914.768	8.14	6.52	1000
926.568	7.98	6.28	1000

Test Date: April 14 & May 6, 2020
Tested By

Signature:  Name: Mark Afroozi

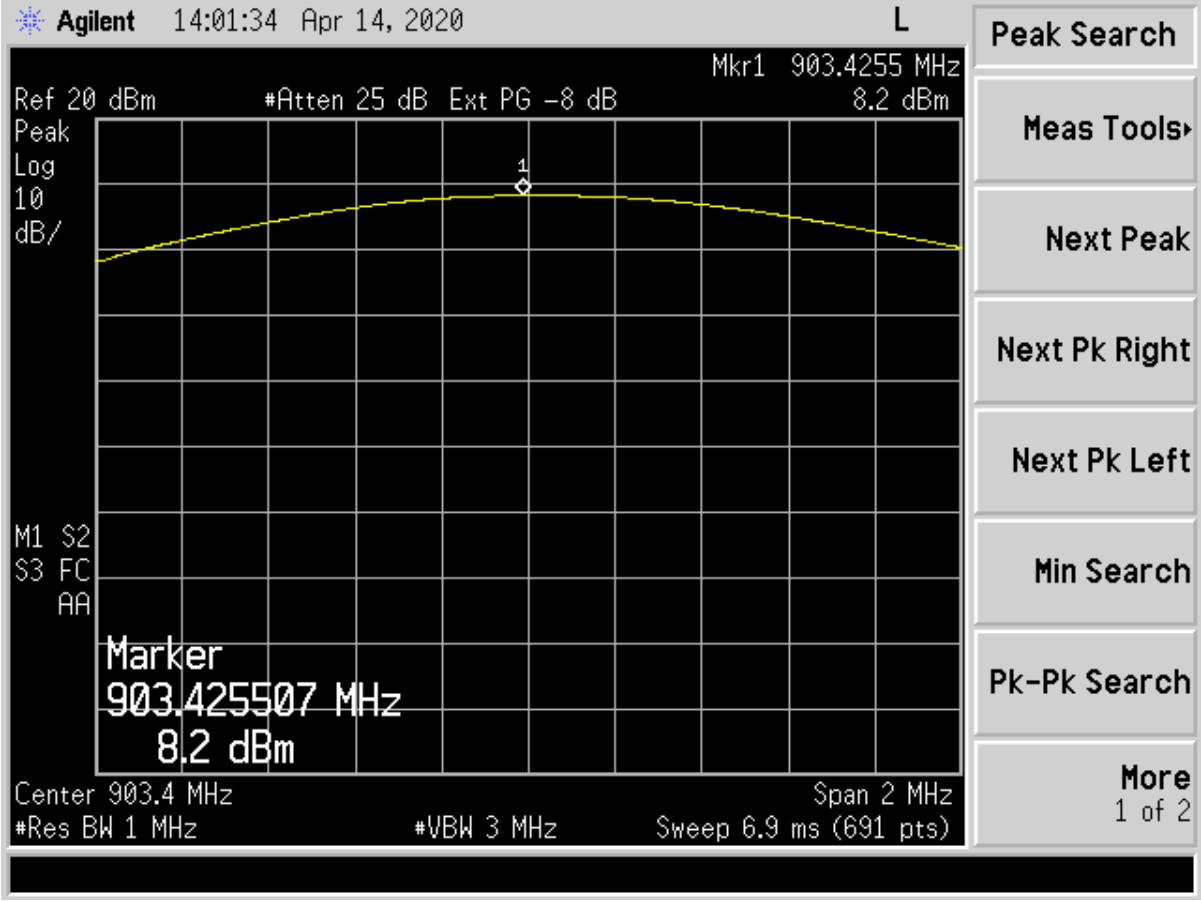


Figure 16. Peak Antenna Conducted Output Power, Low Channel

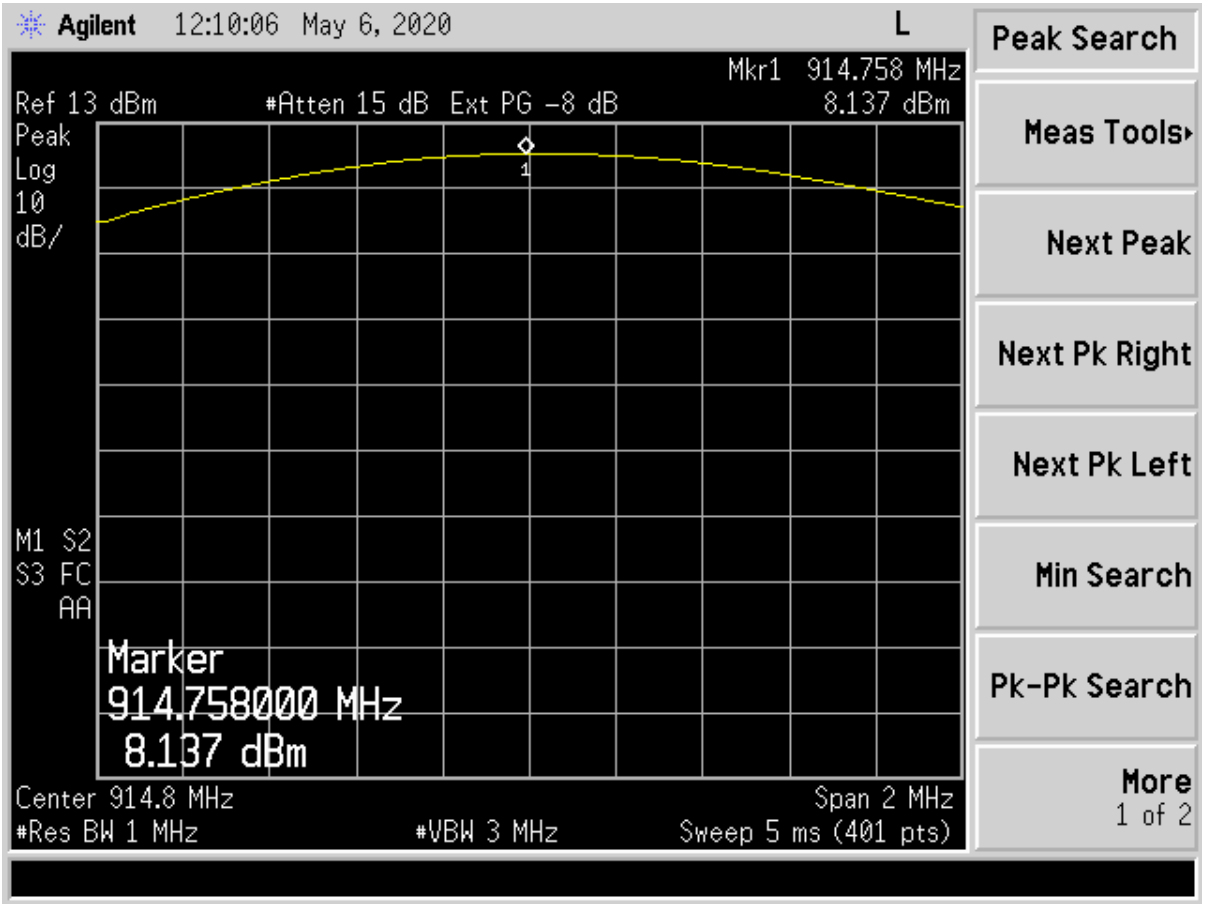


Figure 17. Peak Antenna Conducted Output Power, Mid Channel

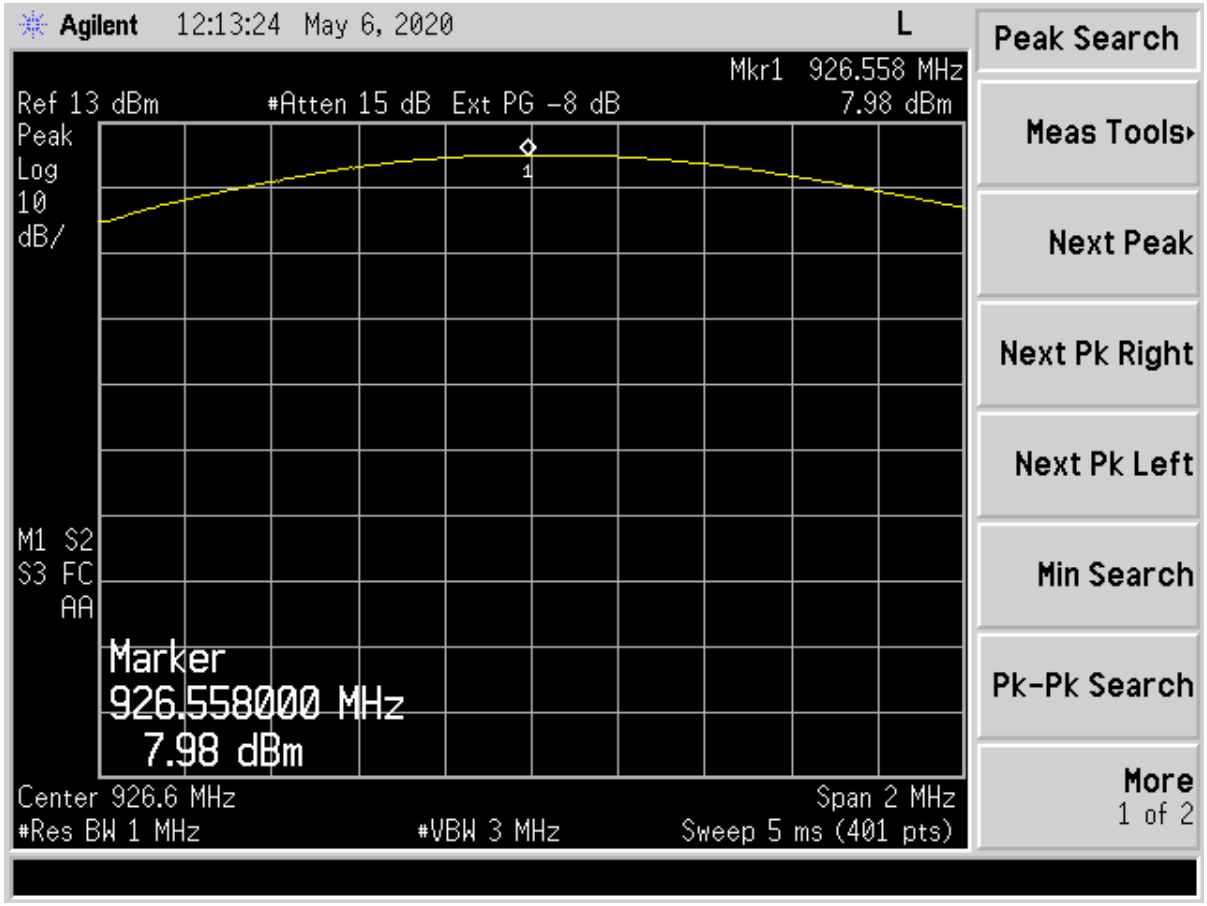


Figure 18. Peak Antenna Conducted Output Power, High Channel

2.14 Number of Hopping Frequencies (CFR 15.247(a), RSS-247 5.1)

The EUT employs 50 non overlapping channels. The test procedures outlined in FCC Public Notice DA 00-705 (2000) and ANSI C63.10-2013 were used to conduct measurements.

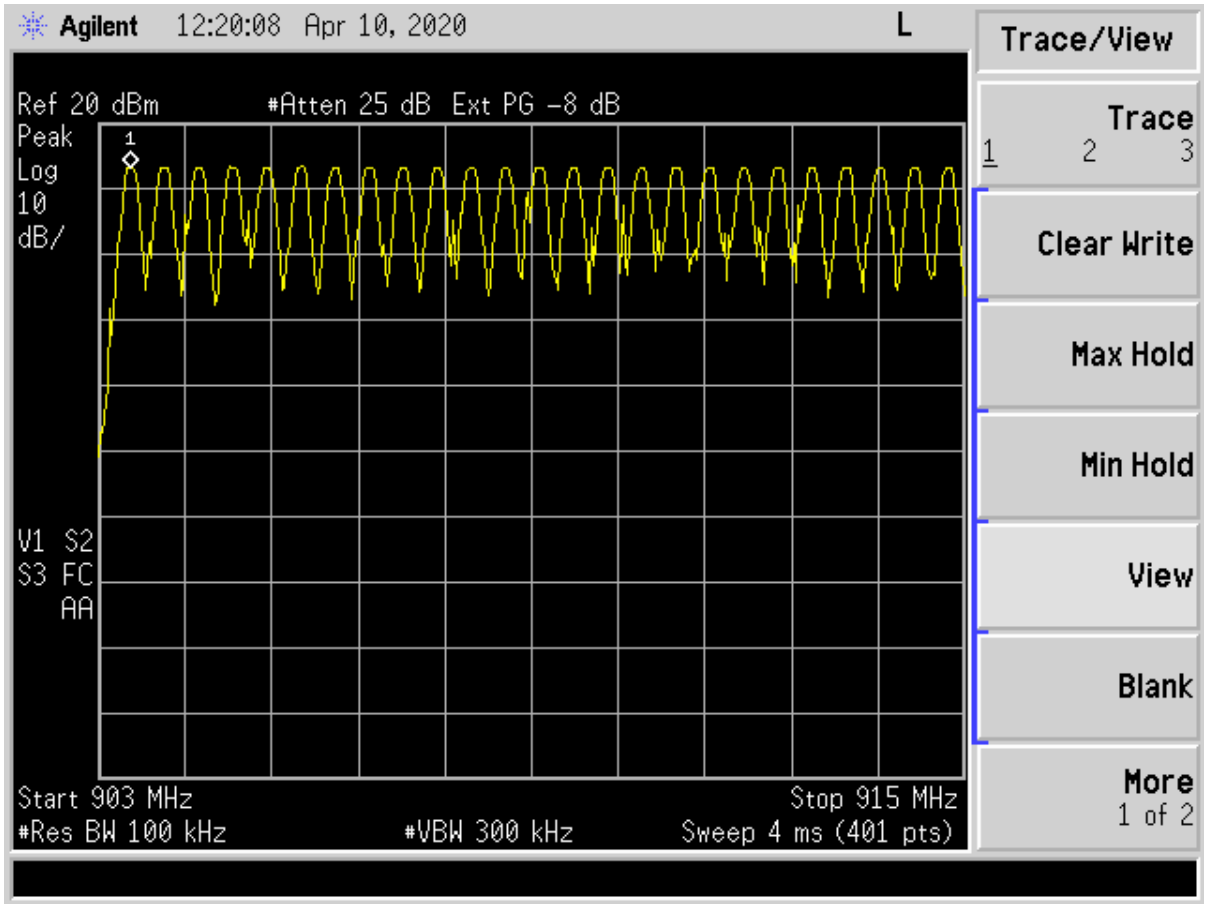


Figure 19. Hopping Channels 1 – 25

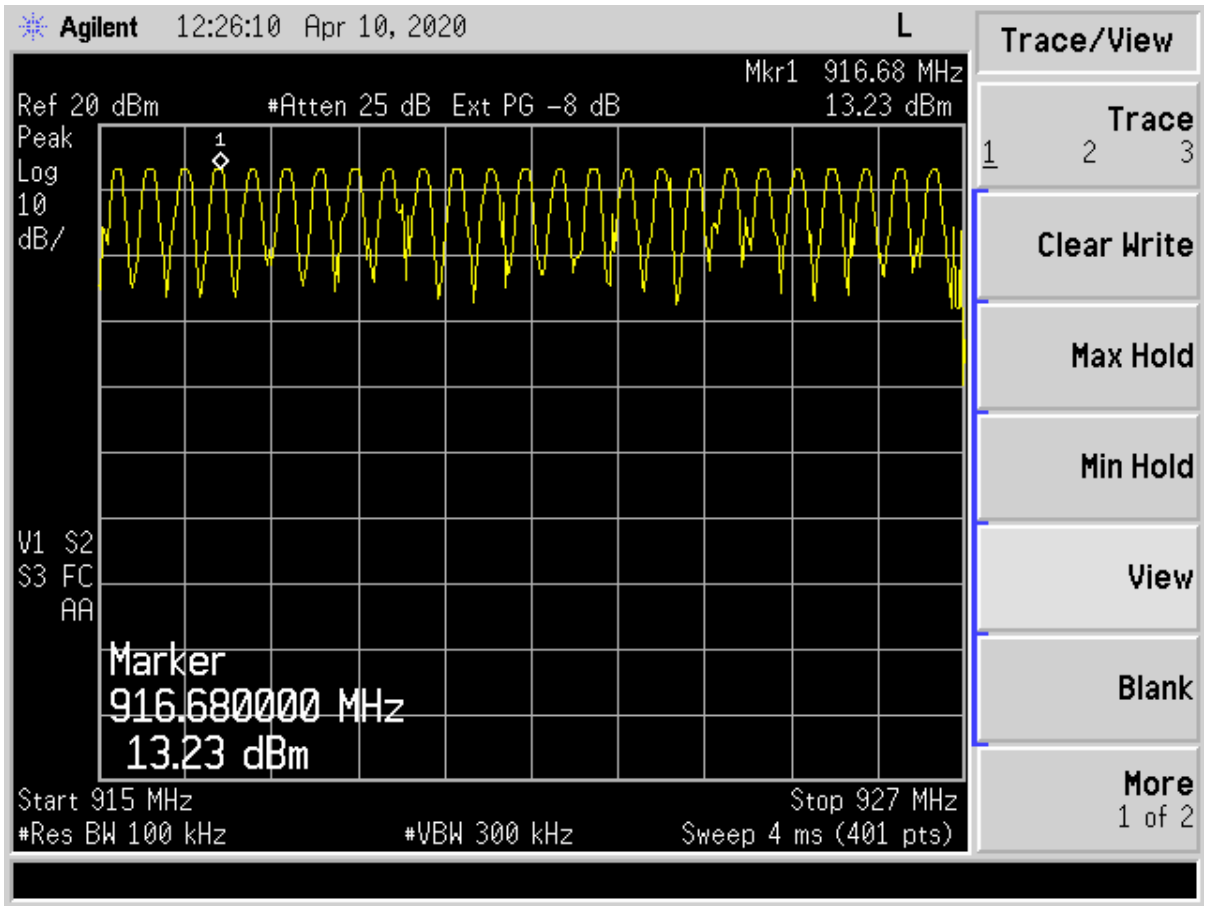


Figure 20. Hopping Channels 25 – 50

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

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 Frequency hopping system is greater than 25 kHz; therefore, the frequency separation must be greater than the 20 dB bandwidth of 115.3 kHz.

The EUT does meet the frequency separation requirement.

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

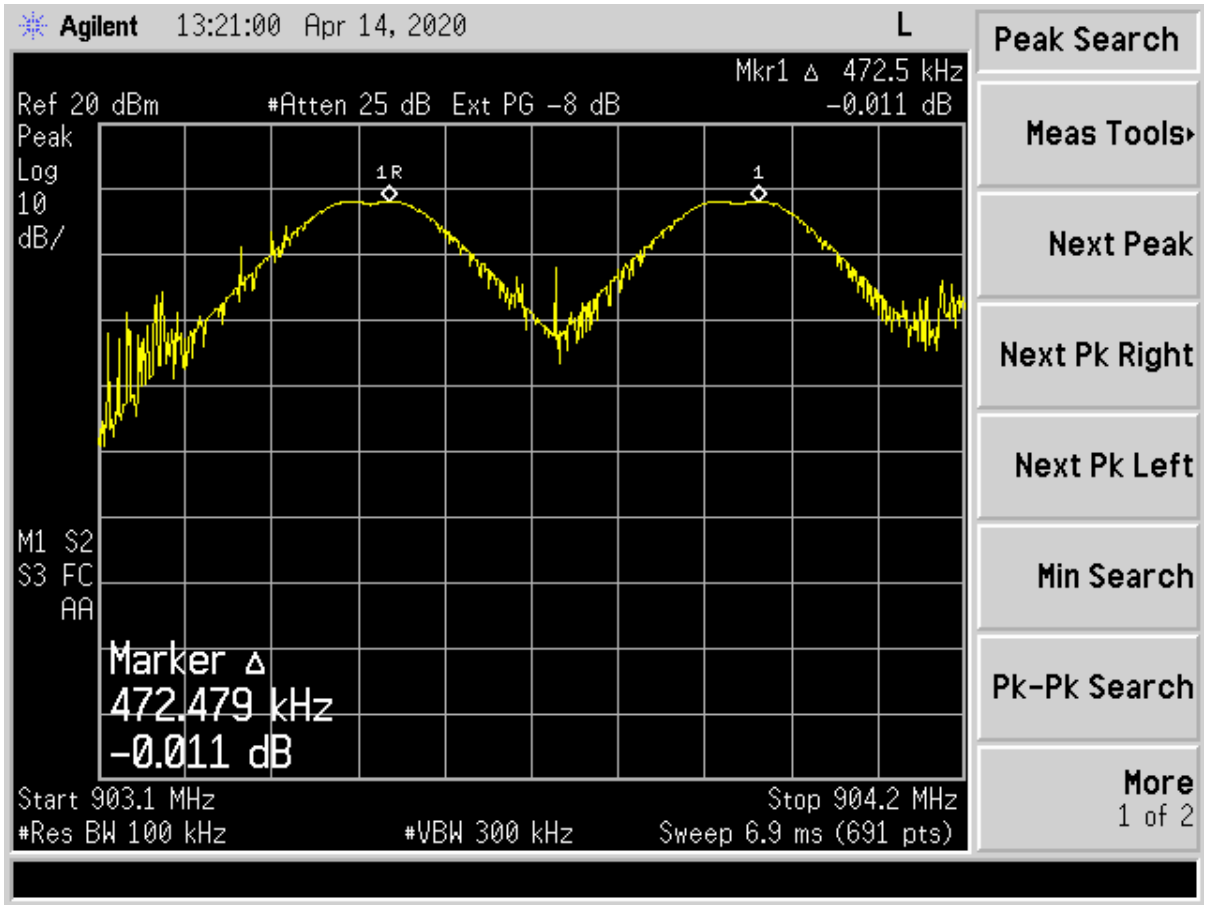


Figure 21. Channel Separation

Measured Delta (Figure 22 above)	472.5 kHz
-Limit (20 dB Bandwidth)	115.3 kHz
Margin	357.2 kHz

2.16 Average Time of Occupancy (CFR 15.247(a)(1), RSS-247 5.1)

For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

In this case the EUT hopping channel bandwidth is less than 250 kHz and the radio employs at least 50 channels.

Plot 1: 1 pulse= 5.072 ms
Plot 2: 19 pulses @ 10 secs (38 pulses @ 20 secs)
Dwell Time = 5.072 * 38= 193 ms < 400 ms

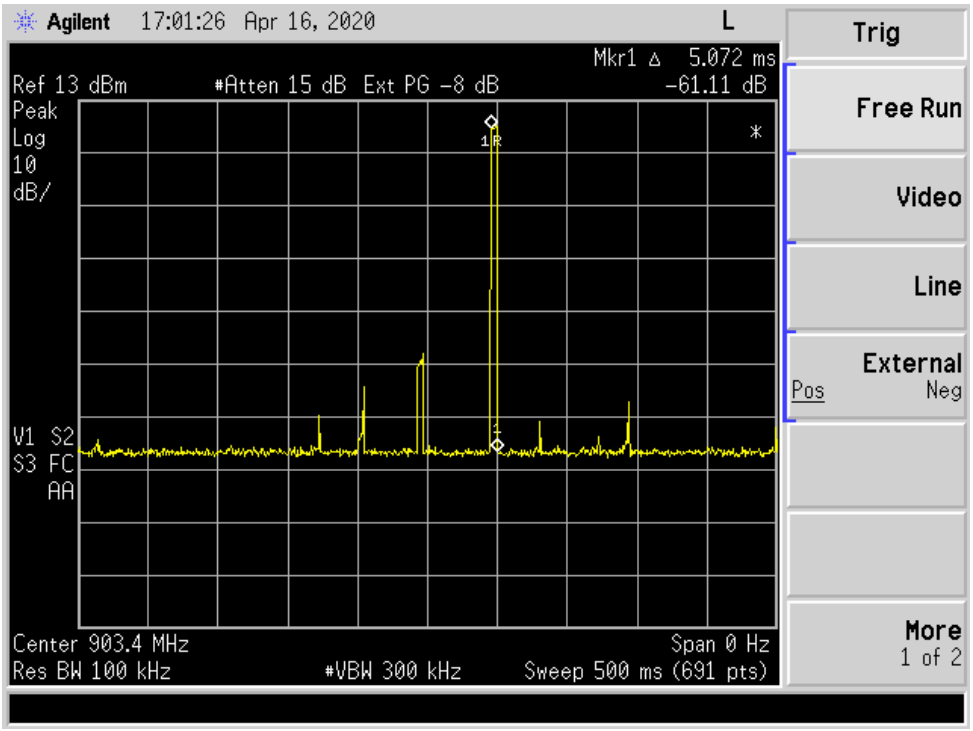


Figure 22. Time of Occupancy, Time Period of One Pulse

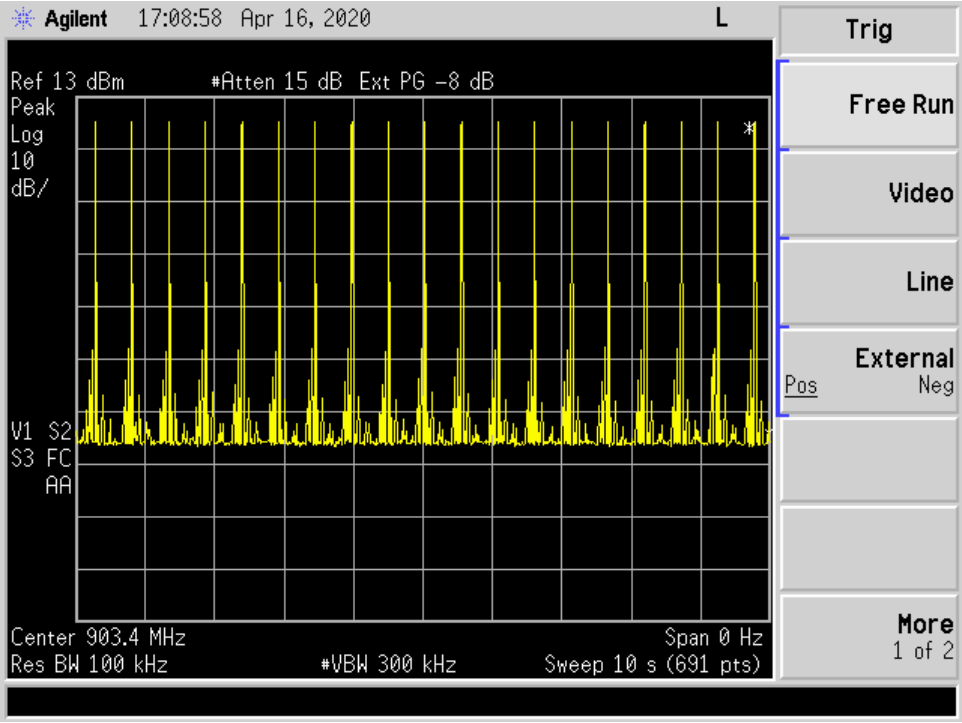


Figure 23. Time of Occupancy, Number of Pulses

2.17 Measurement Uncertainty

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

2.17.1 Conducted Emissions Measurement Uncertainty

Measurement Uncertainty (within a 95% confidence level) for this test is ± 1.95 dB.

2.17.2 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 ± 5.40 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 ± 5.19 dB.

The measurement uncertainty (with a 95% confidence level) for this test using a Horn Antenna is ± 5.08 dB.

3 Conclusions

The EUT meets the requirements of Part 15.247 and RSS-247 based on the test results presented in this test report.