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

Part 2, Subpart J, Verification
Per
Part 15, Subpart B, for Unintentional Radiators, section 15.101, 15.107 and 15.109

And

Industry Canada RSS-Gen, Issue 4 and RSS-247, Issue 2

For the

Cognosos, Inc.

Model: RT-300

FCC ID: 2AKFQ10016
IC: 22165-10016

UST Project: 19-0422
Issue Date: December 6, 2019

Total Pages in This Report: 44

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

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

US TECH (Agent Responsible For Test):

By: Alan Ghasiani

Name: 

Title: Compliance Engineer – President

Date December 6, 2019

TESTING
NVLAP LAB CODE 200162-0

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

Testing Tomorrow's Technology

MEASUREMENT TECHNICAL REPORT

COMPANY NAME: Cognosos, Inc.

MODEL: RT-300

FCC ID: 2AKFQ10016

IC: 22165-10016

DATE: December 6, 2019

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

Equipment type: 902-928 MHz ISM Radio

FCC Rule	Description of Test	Result
15.247(b)(3)	Peak Output Power	PASS
15.247(a)(2)	6 dB Bandwidth	PASS
15.247(d)	Conducted & Radiated Spurious Emissions	PASS
15.247(a)	Channel Separation	PASS
15.247(a)(i)	Number of Channels/ Occupancy Time	PASS
15.247(b)	Output power	PASS
15.209	Spurious Radiated Emissions	PASS
15.207	Power line Conducted Emissions	PASS

Table of Contents

List of Figures

Figures **Title** **Page**

List of Tables

List of Attachments

Agency Agreements
Application Forms
Letter of Confidentiality
Equipment Label(s)
Block Diagram(s)
Schematic(s)
Test Configuration Photographs
FCC to IC Cross Reference
Internal Photographs
External Photographs
Antenna Photographs
Theory of Operation
RF Exposure
User Manual

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 October 11, 2019 in good operating condition.

1.3 Product Description

The Equipment Under Test (EUT) is the Cognosos, Inc. model RT-300. The EUT is a battery powered RTLSL tag that senses when an asset is moved and transmits its location into the RadioCloud network. With its modular design and smart beacon software, the EUT provides a solution to a variety of asset tracking problems in multiple industries.

The EUT uses proprietary 902-928 MHz radio technology along with BLE technology. This report is written to evaluate the 902-928 MHz radio technology used within the device. This report covers only the 902-928 MHz radio technology. The BLE feature has been evaluated in a separate test report.

Antenna: Trace Antenna, -2 dBi Gain
Modulation: FHSS (902.075 - 927.950 MHz)
Maximum Output Power: 11.6 dBm (measured)

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* 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)*.

A list of the EUT and Peripherals is found in Table 1, following. A block diagram of the tested system is shown in Figure 1. Test configuration photographs are provided in separate Appendices.

1.5 Test Facility

Testing was performed at US Tech's measurement facility at 3505 Francis Circle, Alpharetta, GA 30004. This site has been fully described and registered with the FCC. Its designation number is 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 additional FCC/IC authorizations:

a) Certification under section 15.249/IC RSS-210 as a transmitter (reported under separate cover).
b) Verification under 15.101/ICES-003 as a digital device and receiver (included herein).

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

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, 15.101, 15.107, 15.109, 15.207, 15.209, 15.247, RSS GEN, and RSS-247.

Table 1. EUT and Peripherals

PERIPHERAL MANUFACTURER.	MODEL NUMBER	SERIAL NUMBER	FCC and IC ID	CABLES P/D
EUT Cognosos, Inc.	RT-300	Engineering Sample	2AKFQ10016 22165-10016 (Pending)	None

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

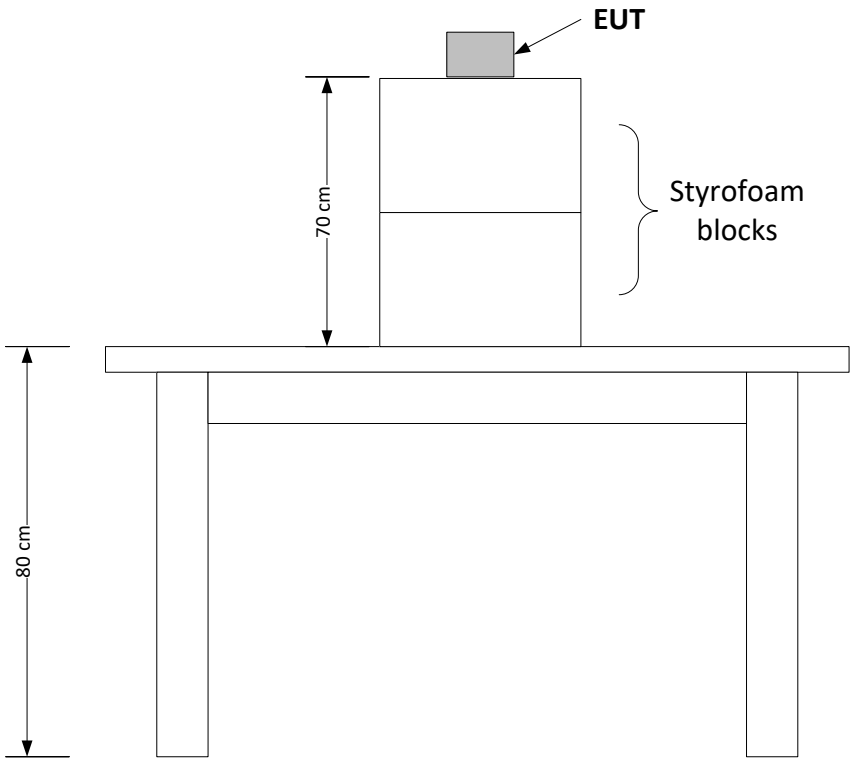


Figure 1. Block Diagram of Test Configuration

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 2 yr.
SPECTRUM ANALYZER	8593E	HEWLETT PACKARD	3205A00124	1/25/2020 extended
LOOP ANTENNA	6502	ETS LINDGREN	9810-3246	1/22/2020 2 yr.
BICONICAL ANTENNA	3110B	EMCO	9306-1708	6/27/2021 2 yr.
LOG PERIODIC ANTENNA	3146	EMCO	9305-3600	2/1/2021 2 yr
HORN ANTENNA	3115	EMCO	9107-3723	11/28/2020 2 yr
RF PREAMP 100 kHz to 1.3 GHz	8447E	HEWLETT-PACKARD	1937A01828	5/7/2020
RF PREAMP 1.0 GHz to 26.0 GHz	8449B	HEWLETT-PACKARD	3008A00480	4/8/2020
HIGH PASS FILTER	H3R020G2	MICROWAVE CHIRCUITS	001DC9528	4/2/2020

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

2.4 Frequency Range of Radiated Measurements (Part 15.33)

2.4.1 Intentional Radiator

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

2.4.2 Unintentional Radiator

For the digital device, an unintentional radiator, the frequency range shall be 30 MHz to 1000 MHz, or to 5 times the highest internal clock frequency.

2.5 Measurement Detector Function and Bandwidth (CFR 15.35)

The radiated and conducted emissions limits shown herein are based on the following:

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.

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.

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)

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
Antenna 1	Cognosos, Inc	Trace	None	-2.0	Trace

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

2.8 Transmitter Duty Cycle (CFR 15.35 (c))

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 the EUT operates for longer than 0.1 seconds therefore no duty cycle correction factor was used.

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

The EUT is powered by a 3.6 VDC Lithium battery**.** Since the EUT is battery powered, this test was not applicable. Due to the high duty cycles necessary for testing purposes battery life would be limited. Therefore, an external DC power supply was used to power the EUT during testing.

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

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 the orientation of normal operation because the device is designed to operate in a fixed 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 125 kHz, a resolution bandwidth (RBW) of 200 Hz was used. In the band from 125 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 can be installed with one of three possible antennas. For the intentional emissions measurements data was taken with all 3 antennas. Because the performance of the 2 pit antennas is similar, spurious emissions testing was performed using the wall antenna and the high gain pit antenna (antennas 2 and 3) only. The high gain antenna data for spurious emissions will be used to represent both pit antennas.

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.

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.

Table 5. Radiated Spurious Emissions (Fundamental and Harmonics)

Test: FCC Part 15, Para 15.209, 15.247(d)					**Client:** Cognosos, Inc			
Project: 19-0422					**Model:** RT-300			
Frequency (MHz)	**Test Data (dBuV)**	**Additional Factor (dB)**	**AF+CA -AMP (dB/m)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector Mode**
Low - Channel								
902.075	82.32	--	24.94	107.26	--	3m./VERT	--	**PK**
902.075	82.10	-20.00	24.94	87.04	--	3m./VERT	--	**AVG**
902.075	82.41	--	25.64	108.05	--	3m./HORZ	--	**PK**
902.075	82.22	-20.00	25.64	87.86	--	3m./HORZ	--	**AVG**
1804.16	60.80	--	-6.24	54.56	88.1	3.0m./HORZ	33.5	**PK**
1804.16	55.97	--	-6.24	49.73	68.1	3.0m./HORZ	18.4	**AVG**
1804.16	60.68	--	-6.22	54.46	88.1	3.0m./VERT	33.6	**PK**
1804.16	56.94	--	-6.22	50.72	68.1	3.0m./VERT	17.4	**AVG**
2706.24	51.19	--	-2.62	48.57	74.0	3.0m./VERT	25.4	**PK**
2706.24	34.91	--	-2.62	32.29	54.0	3.0m./VERT	21.7	**AVG**
2706.24	52.17	--	-2.52	49.65	74.0	3.0m./HORZ	24.4	**PK**
2706.24	37.33	--	-2.52	34.81	54.0	3.0m./HORZ	19.2	**AVG**
3608.32	47.65	--	2.81	50.46	74.0	3.0m./VERT	23.5	**PK**
3608.32	29.87	--	2.81	32.68	54.0	3.0m./VERT	21.3	**AVG**
3608.32	48.85	--	2.84	51.69	74.0	3.0m./HORZ	22.3	**PK**
3608.32	34.93	--	2.84	37.77	54.0	3.0m./HORZ	16.2	**AVG**
Mid - Channel								
915.08	77.10	--	24.99	102.09	--	3m./VERT	--	**PK**
915.08	76.82	-20.00	24.99	81.81	--	3m./VERT	--	**AVG**
915.08	77.35	--	25.69	103.04	--	3m./HORZ	--	**PK**
915.08	76.14	-20.00	25.69	81.83	--	3m./HORZ	--	**AVG**
1830.15	50.94	--	-6.28	44.66	82.1	3.0m./HORZ	37.4	**PK**
1830.15	33.15	--	-6.28	26.87	62.1	3.0m./HORZ	35.2	**AVG**
1830.15	53.12	--	-6.26	46.86	82.1	3.0m./VERT	35.2	**PK**
1830.15	34.22	--	-6.26	27.96	62.1	3.0m./VERT	34.1	**AVG**
2745.23	49.80	--	-2.82	46.98	74.0	3.0m./VERT	27.0	**PK**
2745.23	30.63	--	-2.82	27.81	54.0	3.0m./VERT	26.2	**AVG**
2745.23	49.38	--	-2.71	46.67	74.0	3.0m./HORZ	27.3	**PK**
2745.23	30.66	--	-2.71	27.95	54.0	3.0m./HORZ	26.1	**AVG**
High – Channel								
927.95	75.23	--	25.05	100.28	--	3m./VERT	--	**PK**
927.95	74.56	-20.00	25.05	79.61	--	3m./VERT	--	**AVG**
927.95	75.87	--	25.75	101.62	--	3m./HORZ	--	**PK**
927.95	74.91	-20.00	25.75	80.66	--	3m./HORZ	--	**AVG**
1855.90	49.39	--	-5.68	43.71	80.3	3.0m./HORZ	36.6	**PK**
1855.90	31.84	--	-5.68	26.16	60.3	3.0m./HORZ	34.1	**AVG**

1855.90	50.66	--	-5.74	44.92	80.3	3.0m./VERT	35.4	**PK**
1855.90	34.24	--	-5.74	28.50	60.3	3.0m./VERT	31.8	**AVG**
2783.85	50.06	--	-2.95	47.11	74.0	3.0m./VERT	26.9	**PK**
2783.85	31.77	--	-2.95	28.82	54.0	3.0m./VERT	25.2	**AVG**
2783.85	49.58	--	-2.85	46.73	74.0	3.0m./HORZ	27.3	**PK**
2783.85	32.01	--	-2.85	29.16	54.0	3.0m./HORZ	24.8	**AVG**
3711.80	49.66	--	3.58	53.24	74.0	3.0m./VERT	20.8	**PK**
3711.80	30.05	--	3.58	33.63	54.0	3.0m./VERT	20.4	**AVG**
3711.80	47.62	--	3.82	51.44	74.0	3.0m./HORZ	22.6	**PK**
3711.80	29.75	--	3.82	33.57	54.0	3.0m./HORZ	20.4	**AVG**

1. (*) Falls within the restricted bands of CFR 15.205.
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 meters using a factor of (-9.5 dB).
4. 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.
5. (@) Peak value was used to represent the AVG. The results were corrected by subtracting 20 dB from the Peak value.

Sample Calculation at 1804.16 MHz:

Magnitude of Measured Frequency	60.80	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	-6.24	dB/m
Corrected Result	54.56	dBuV/m

Test Date: November 01, 2019
Tested By
Signature: _____ Name: John Freeman

Conducted spurious emissions

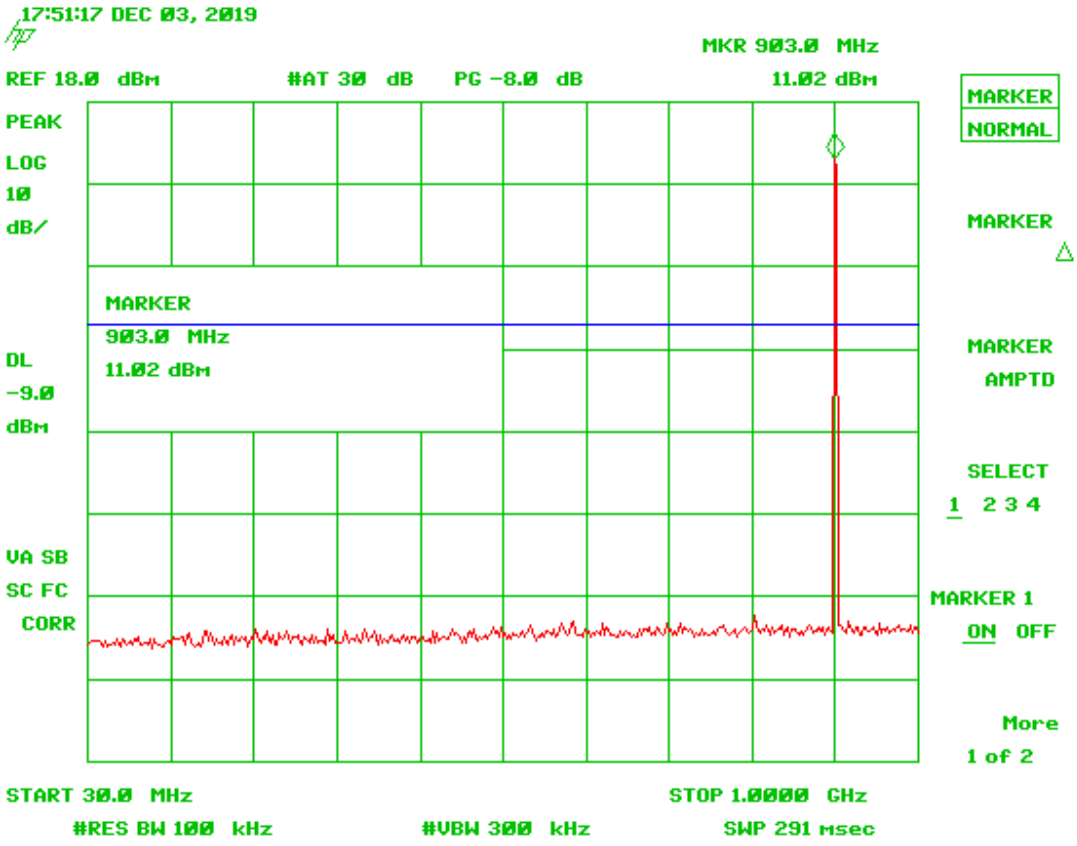


Figure 2. Antenna Conducted Emissions Low, 30 MHz to 1 GHz

Note: Large emission seen is the fundamental emission.

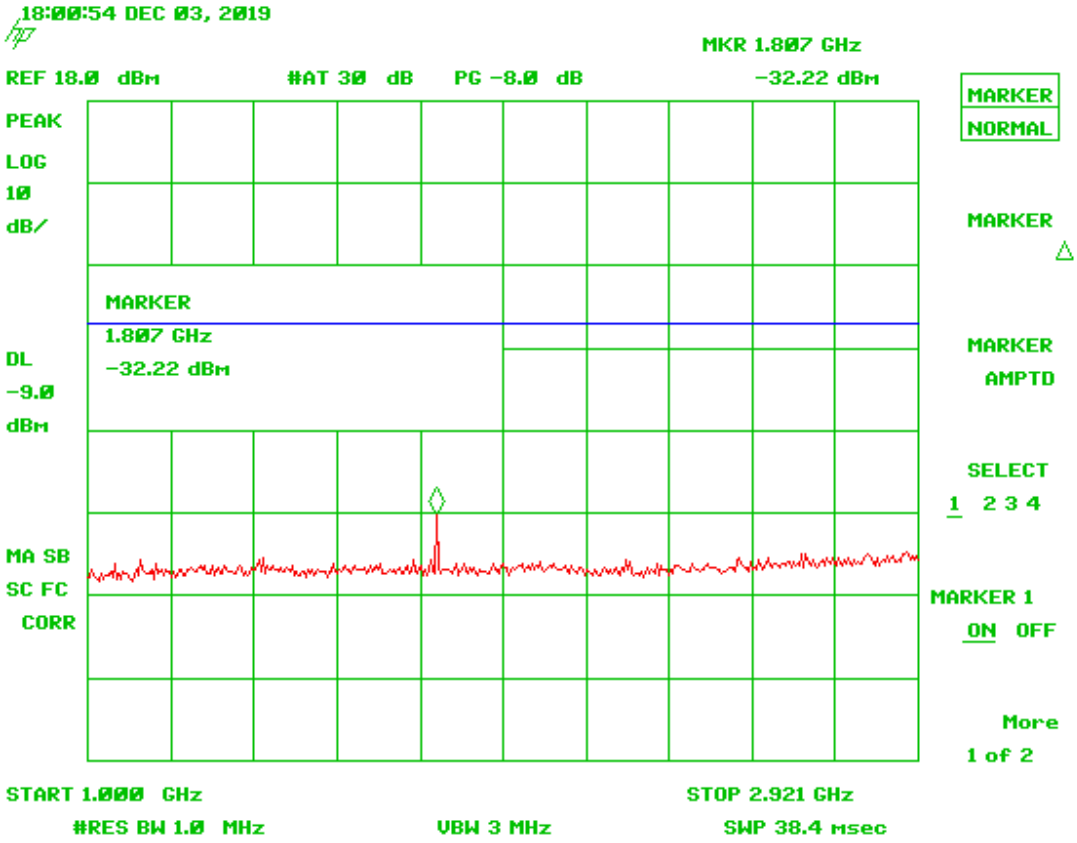


Figure 3. Antenna Conducted Emissions Mid, 1 to 2.9 GHz

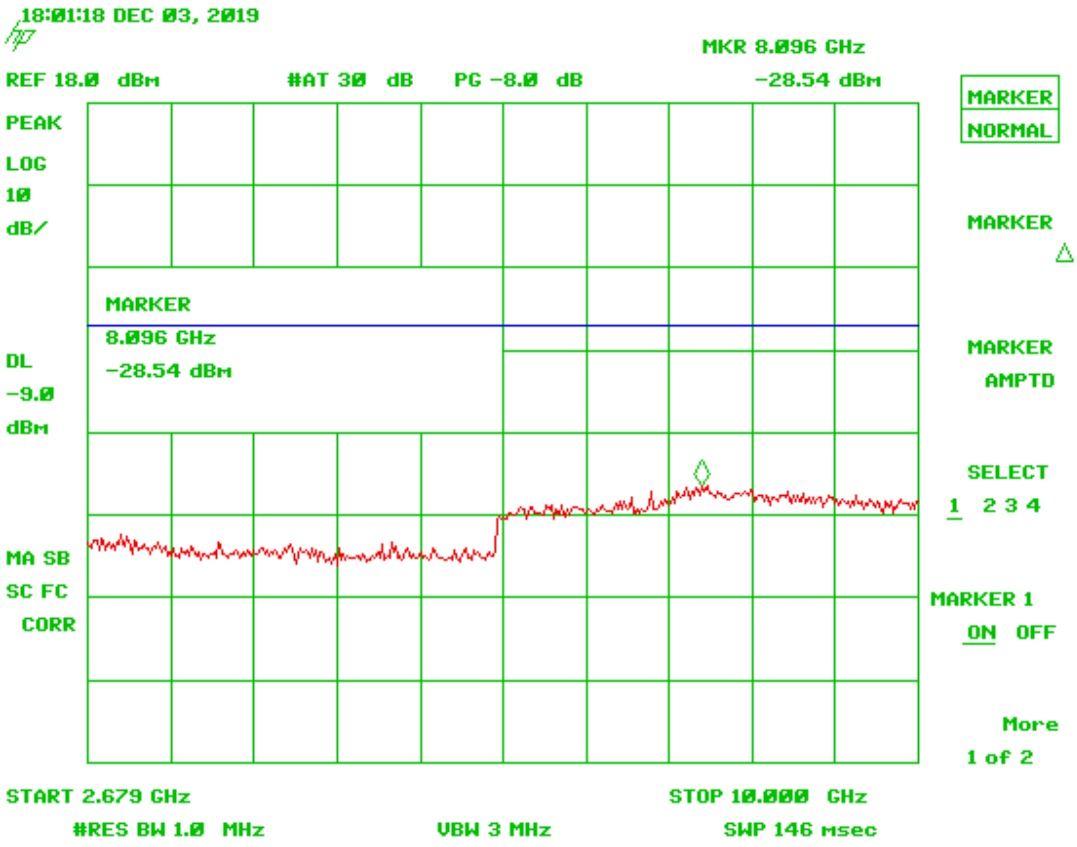


Figure 4. Antenna Conducted Emissions Low, 2.6 to 10 GHz

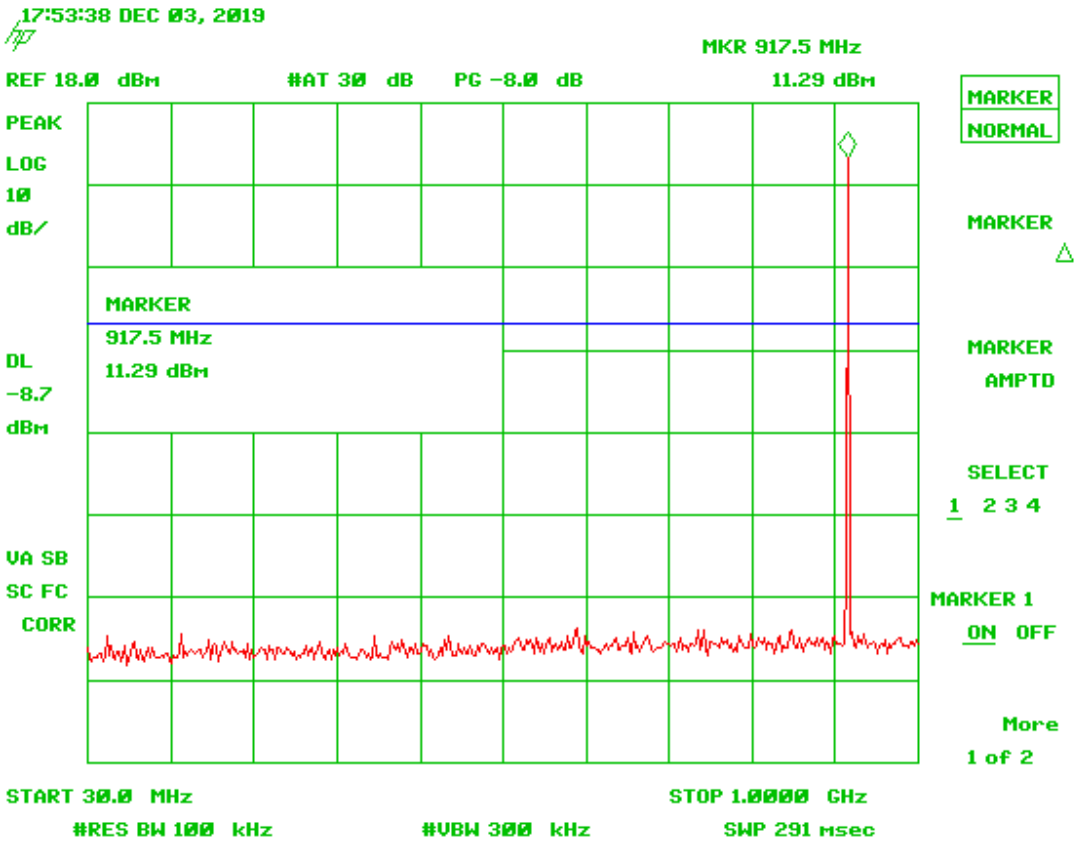


Figure 5. Antenna Conducted Emissions Mid, 30 MHz to 1 GHz

Note: Large emission seen is the fundamental emission.

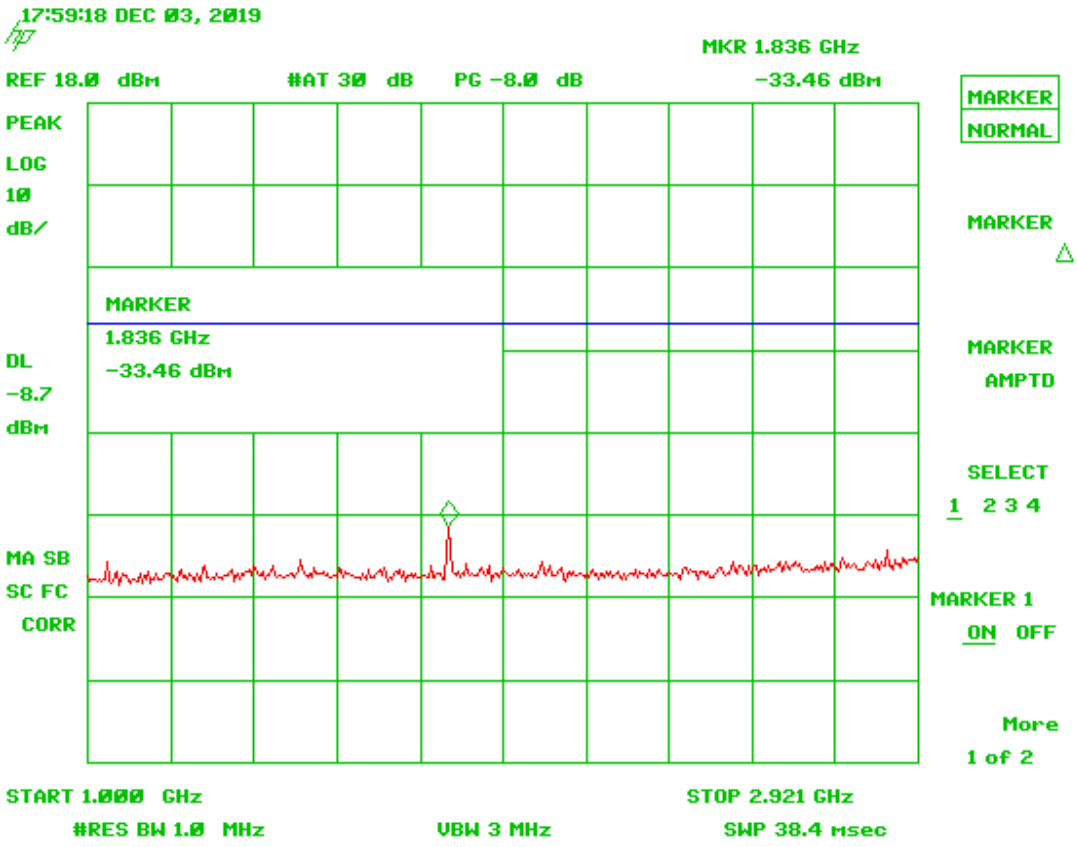


Figure 6. Antenna Conducted Emissions Mid, 1 to 2.9 GHz

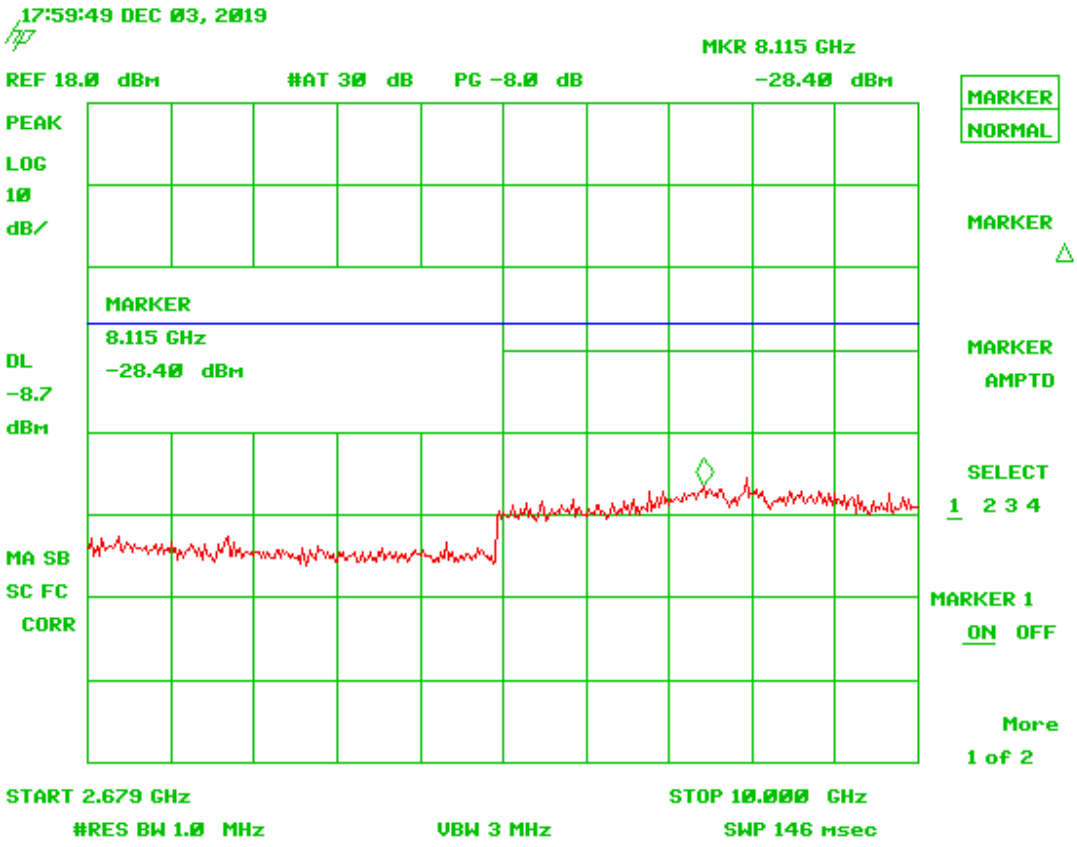


Figure 7. Antenna Conducted Emissions Mid, 2.6 to 10 GHz

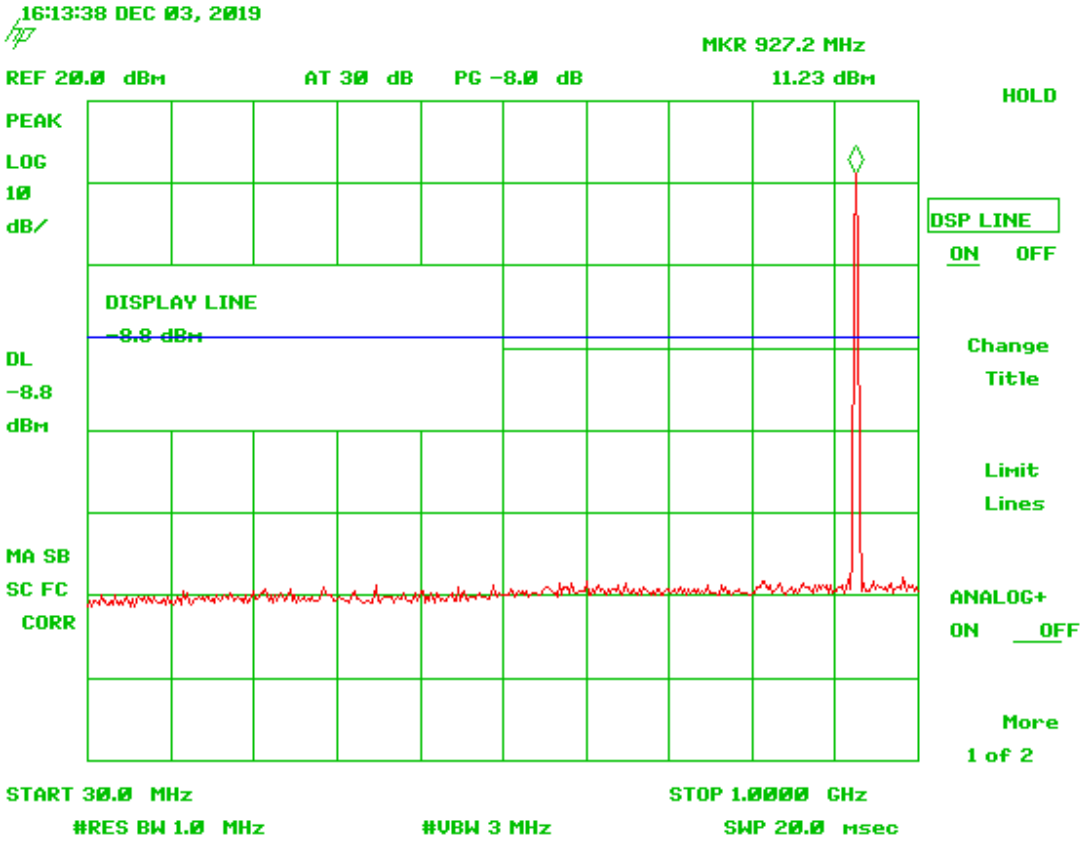


Figure 8. Antenna Conducted Emissions High, 30 MHz to 1 GHz

Note: Large emission seen is the fundamental emission.

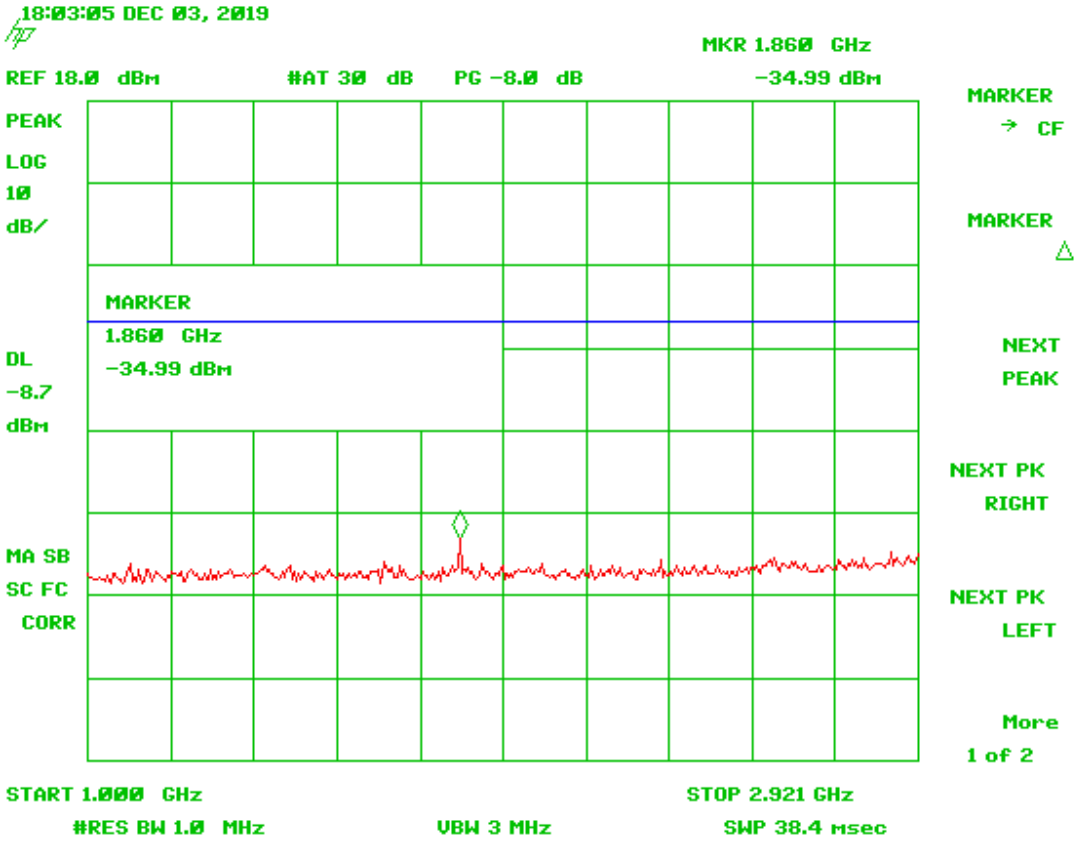


Figure 9. Antenna Conducted Emissions Mid, 1 to 2.9 GHz

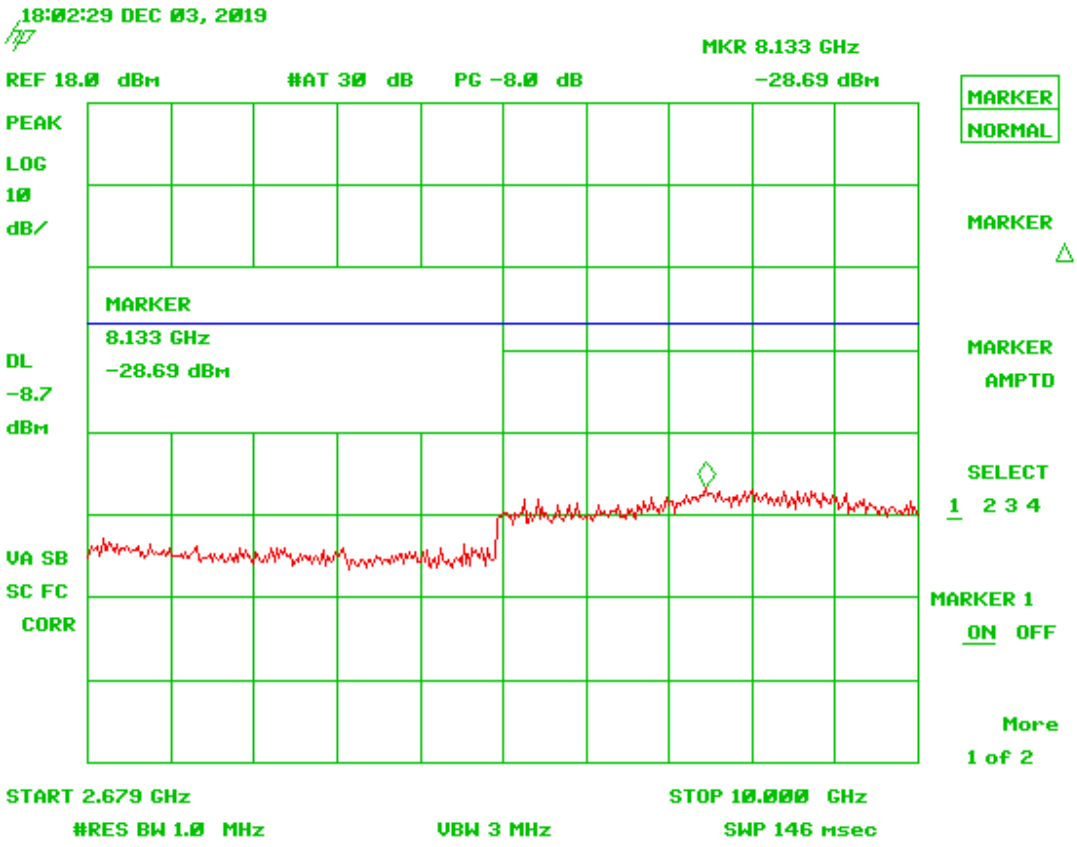


Figure 10. Antenna Conducted Emissions High, 2.6 to 10 GHz

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

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.

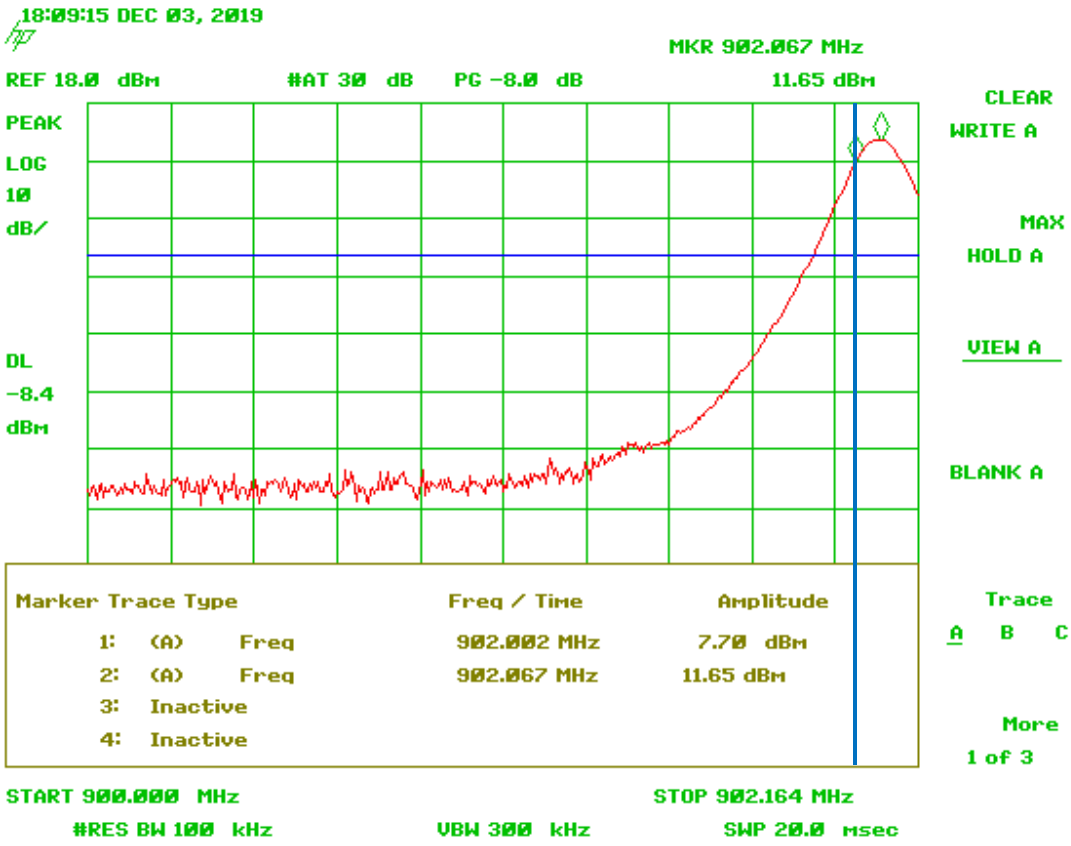


Figure 11. Band Edge Compliance, Low Channel Delta – Antenna 1

The emissions are contained within the allocated bandwidth. 902 MHz.

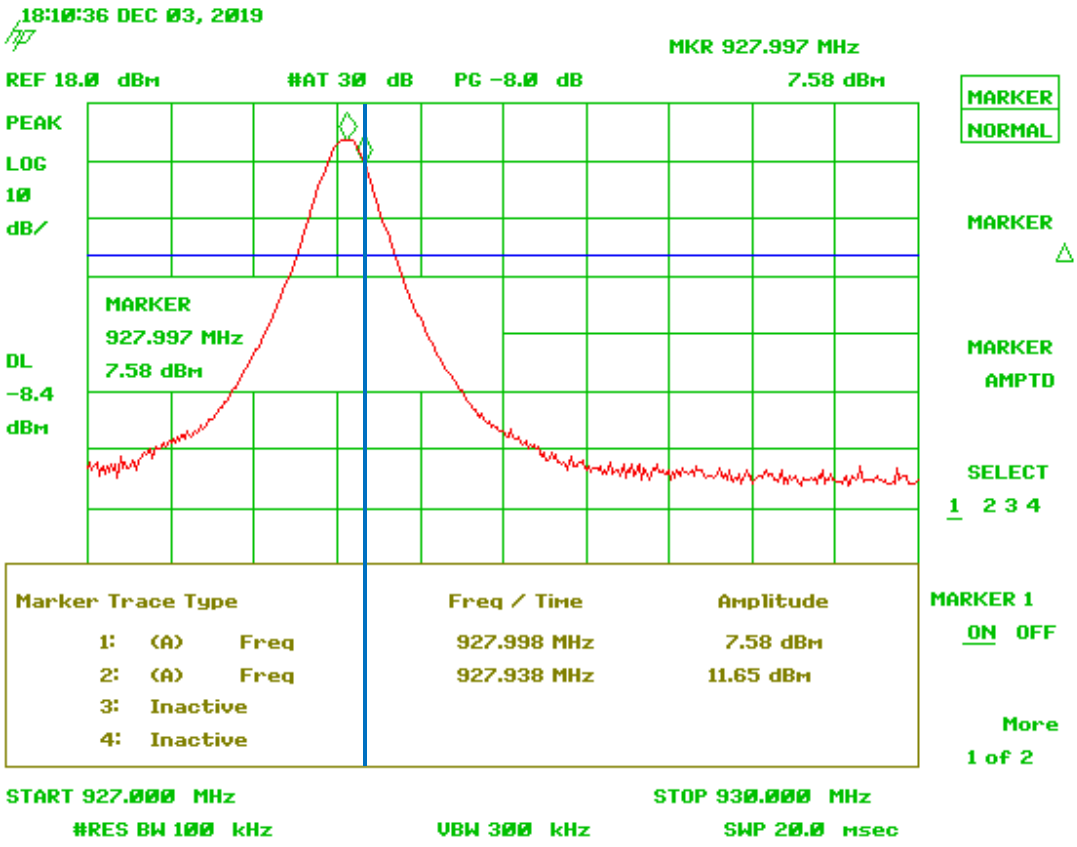


Figure 12. Band Edge Compliance, High Channel Delta – Antenna 1

The emissions are contained within the allocated bandwidth. 928 MHz.

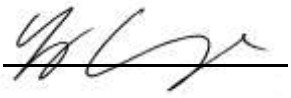
2.12 Maximum Peak Conducted Output Power (CFR 15.247 (b) (2))

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 64 hopping channels, the maximum peak conducted output power shall not exceed 1 watt.

Peak power within the band 902.3 MHz to 914.9 MHz was measured per ANSI C63.10-20113 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 using a 75 to 50 Ω adaptor. The setup losses were corrected by using a -6.4 dB offset in the analyzer measurements. Peak antenna conducted output power is tabulated in the table below.

Table 6. 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)
902.075	11.55	14.29	1000.00
915.075	11.49	14.09	1000.00
927.950	11.48	14.06	1000.00

Test Date: December 03, 2019
Tested By
Signature:  Name: George Yang

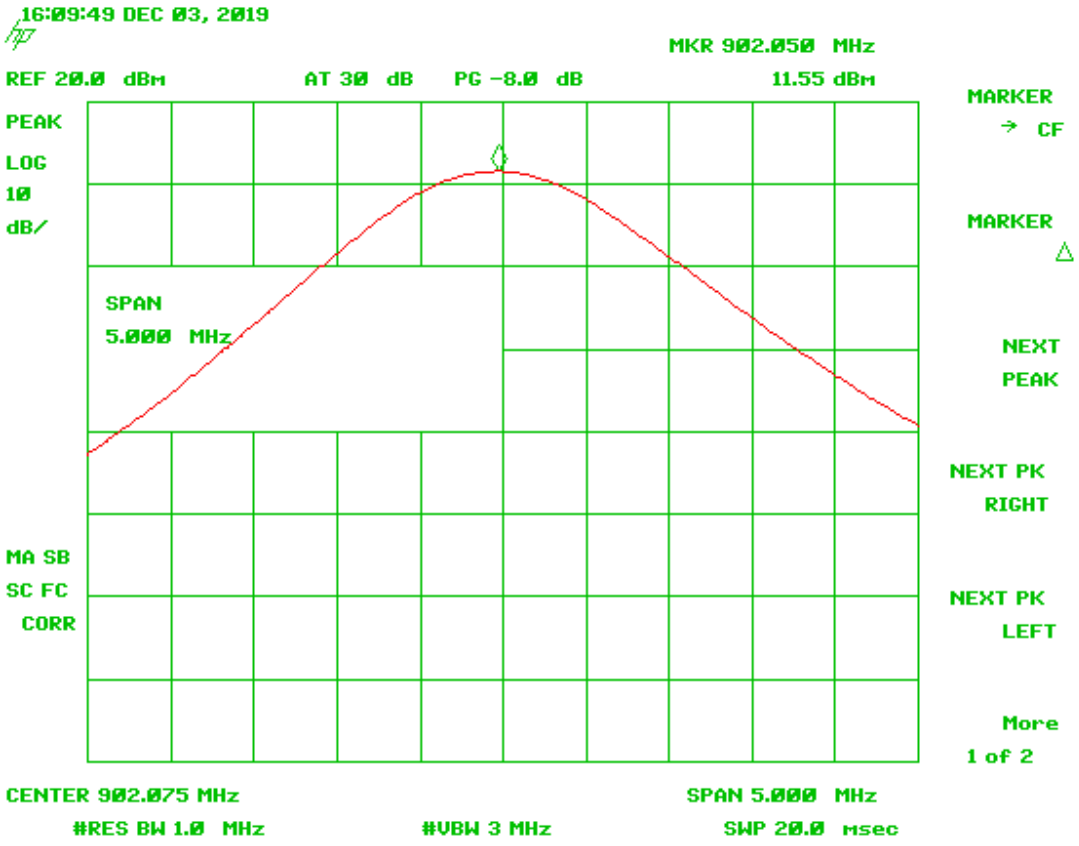


Figure 13. Peak Antenna Conducted Output Power, Low Channel

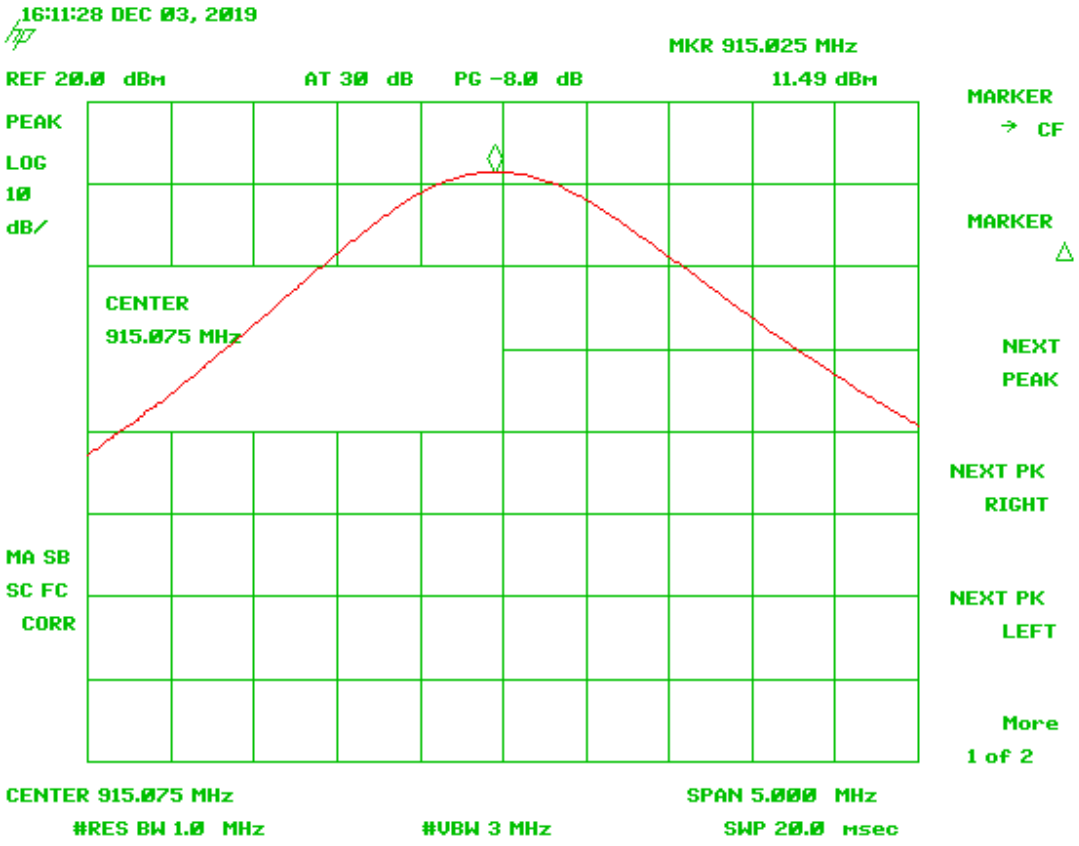


Figure 14. Peak Antenna Conducted Output Power, Mid Channel

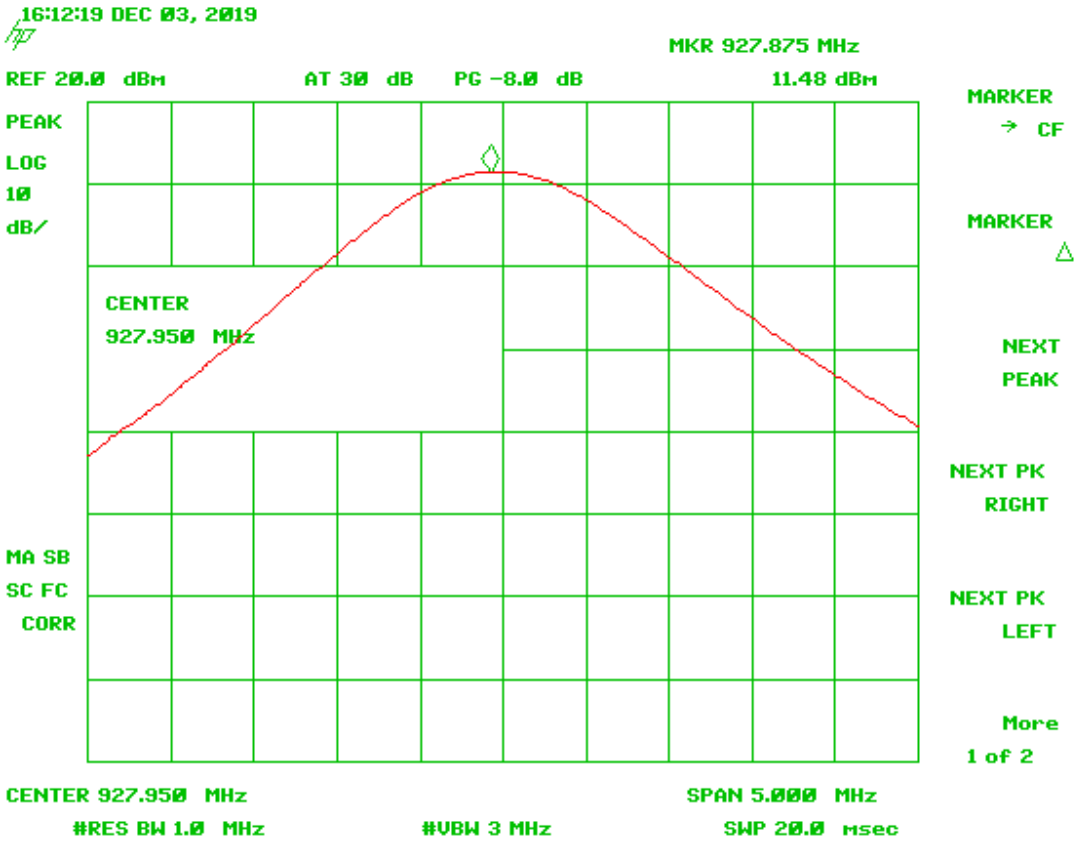


Figure 15. Peak Antenna Conducted Output Power, High Channel

2.13 20 dB and 99% Bandwidth (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 3 kHz and with the VBW ≥ RBW. The results of this test are given in Table and Figures following.

Table 7. Twenty (20) dB Bandwidth

Frequency (MHz)	20 dB Bandwidth (kHz)	Maximum Limit (kHz)	99% Occupied Bandwidth (kHz)
902.075	19.380	500.000	16.130
915.075	19.380	500.000	15.940
927.950	19.060	500.000	15.940

Test Date: December 03, 2019
Tested By
Signature:  Name: George Yang

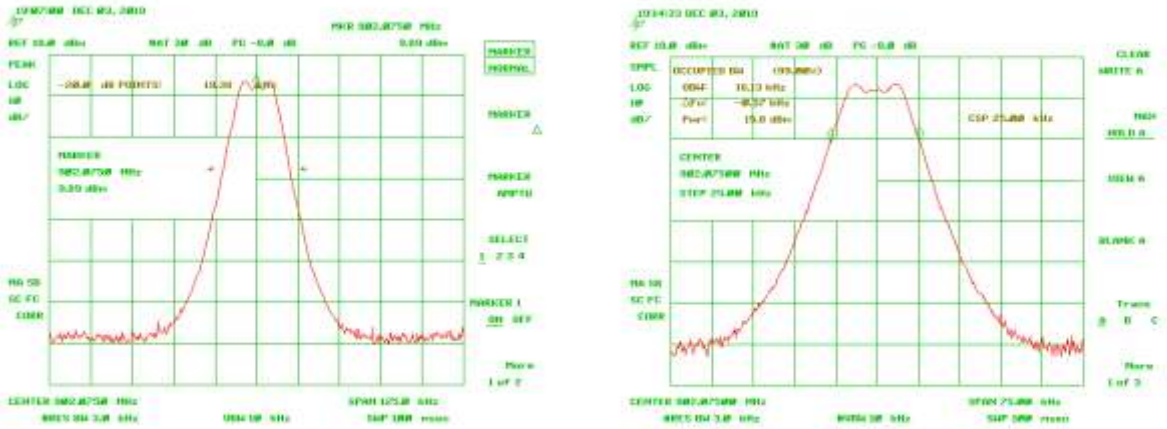


Figure 16. 20 dB & 99% Bandwidth – Low Channel

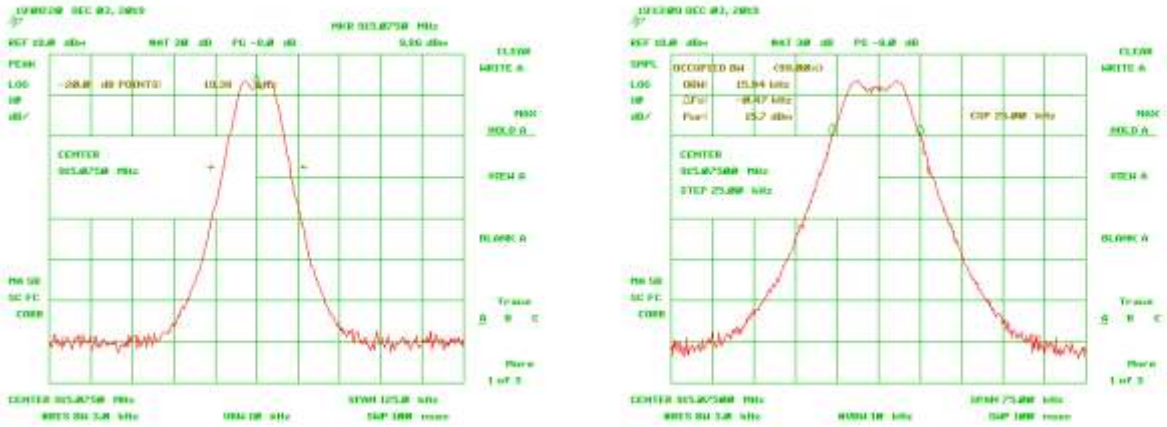


Figure 17. 20 dB & 99% Bandwidth – Mid Channel

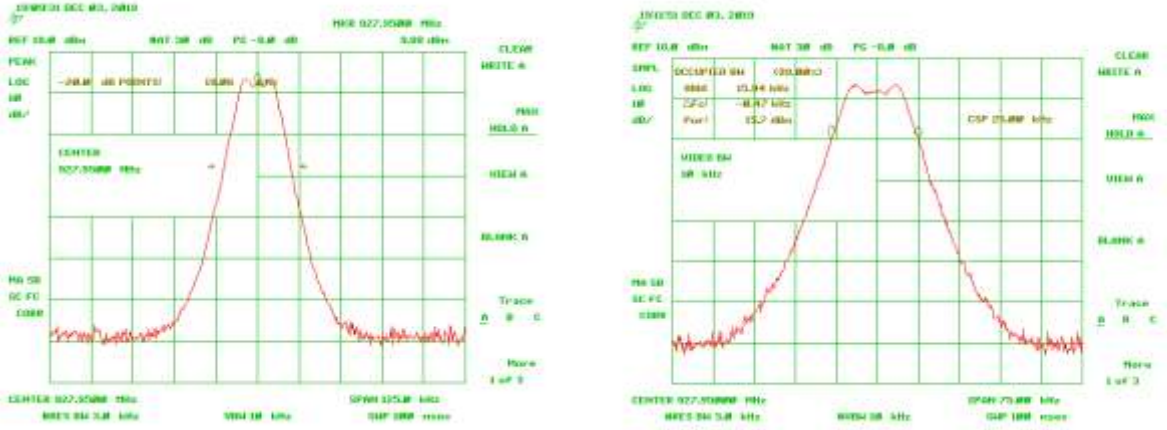


Figure 18. 20 dB & 99% Bandwidth – High Channel

2.14 Number of Hopping Frequencies (CFR 15.247 (a)(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 KDB 558074 D01 15.247 Meas Guide v05r02 were used to conduct measurements.

A table showing the applicable frequencies and how they are used is presented in the Theory of Operation exhibit for this device. The image below is same if the 50 channels that the EUT can transmit on during any broadcast.

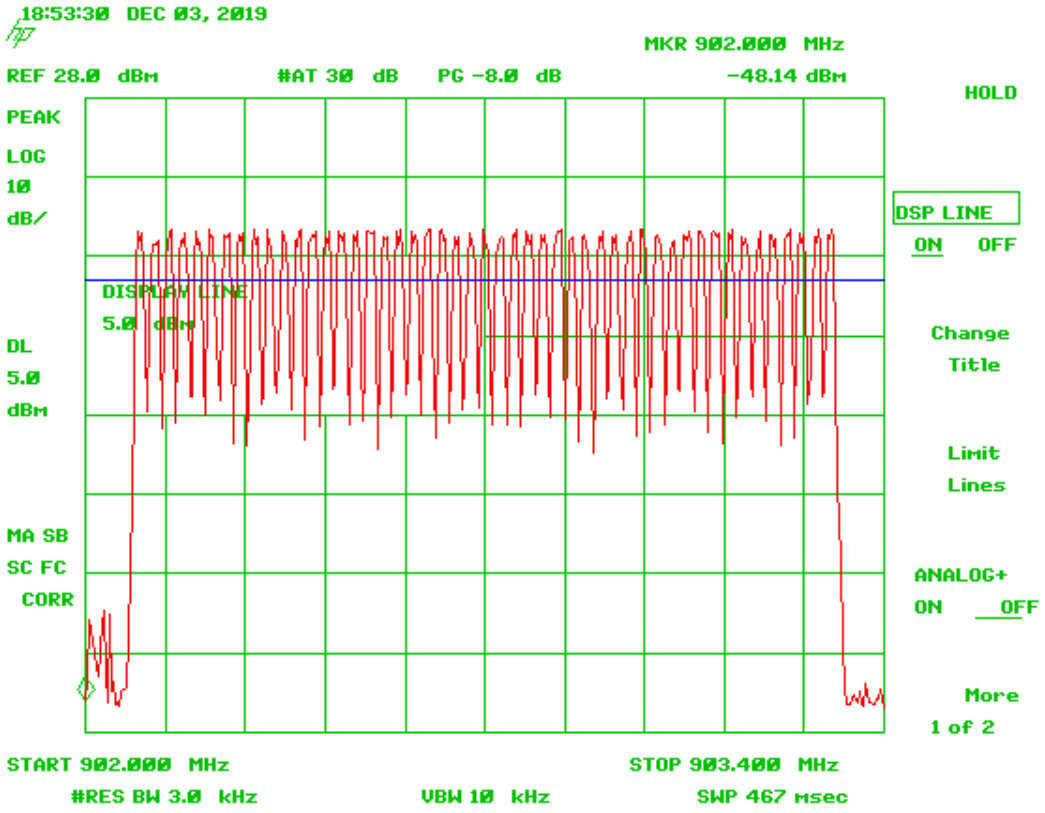


Figure 19. Number of hopping channels

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 hopping channel separation meets the 25 kHz minimum requirement.

The test procedures outlined in KDB 558074 D01 15.247 Meas Guide v05r02 were used to conduct measurements.

The EUT does meet the frequency separation requirement.

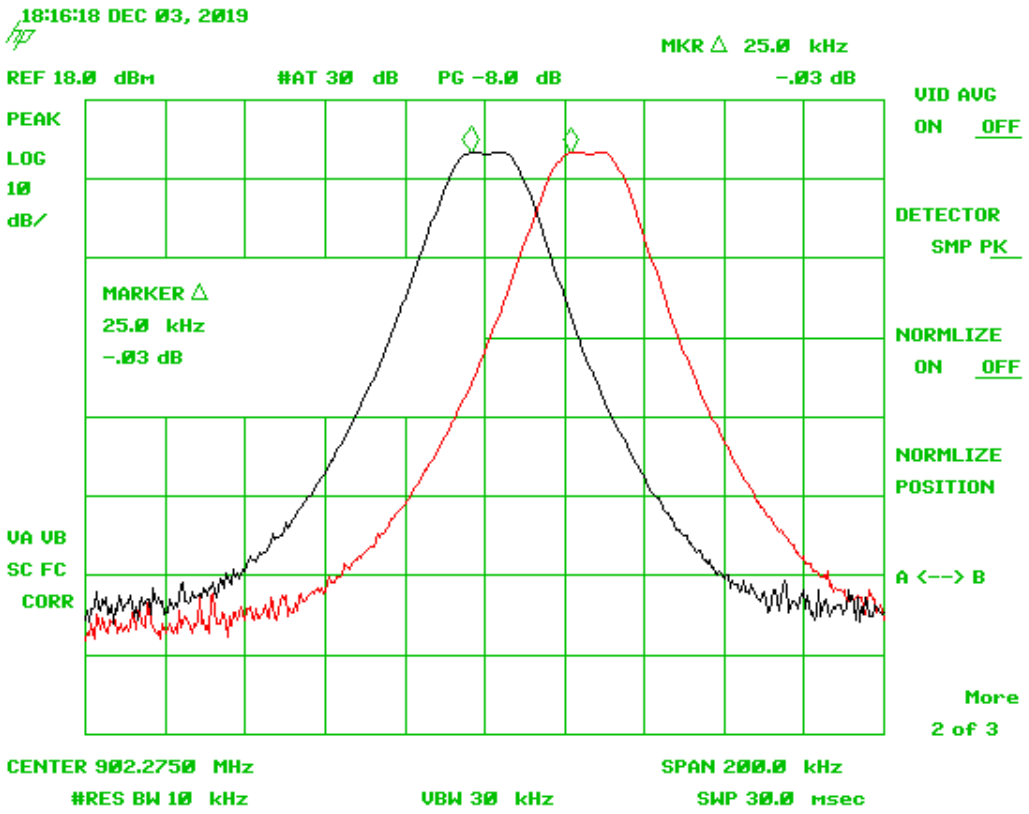


Figure 20. Channel Separation

2.16 Average Time of Occupancy (CFR 15.247(f))

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 radio uses 50 channels, therefore the maximum occupancy time is 0.4 seconds in a 20 second period.

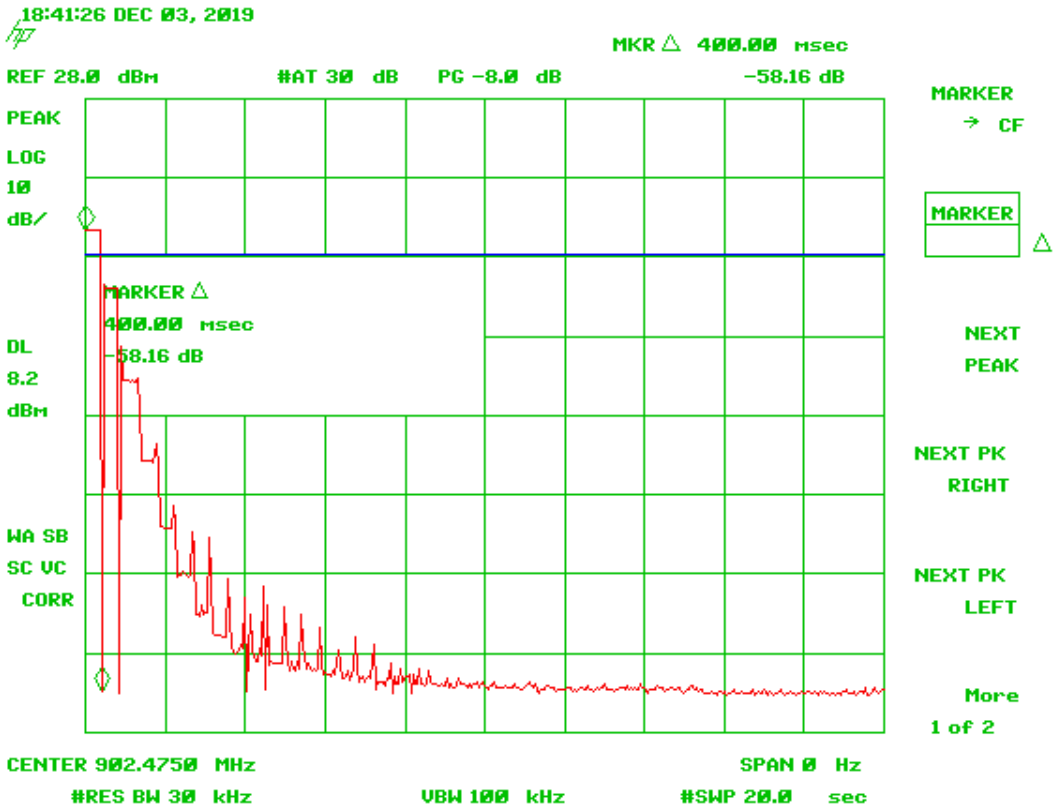


Figure 21. Time of Occupancy

Maximum occupancy = 400 mSeconds

2.17 Unintentional and Intentional Radiator, Powerline Emissions (CFR 15.107/15.207)

The EUT was battery powered; therefore this test was not applicable.

2.18 Unintentional and Intentional Radiator, Radiated Emissions (CFR 15.109, 15.209)

Radiated emissions disturbance measurements were performed with the transmitter turned OFF and the test was repeated with the intentional transmitter circuit ON. The worst case mode of operation is with the transmitter circuit ON. That test data is presented below to show compliance to both parts.

An instrument having both peak and quasi-peak detectors was used to perform the test over the frequency range of 30 MHz to five times the highest clock frequency. Measurements of the radiated emissions were made with the receiver antenna at a distance of 3 m from the boundary of the test unit.

The test antenna was varied from 1 m to 4 m in height while watching the analyzers' display for the maximum magnitude of the signal at the test frequency. The antenna polarization (horizontal or vertical) and test sample azimuth were varied during the measurements to find the maximum field strength readings to record.

All emissions seen were 20 dB or more below the Part 15.109 and Part 15.209 limit.

Note: For the purpose of co-location testing, both the 900 MHz radio and the 2.4 GHz BLE radio were on and exercising as they normally would. The radios do not share the same antenna. The emission generated as a result of both radio ON and transmitting is presented in the tables below.

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

30 kHz to 30 MHz							
Test: Radiated Emissions				**Client:** Cognosos, Inc.			
Project: 19-0422				**Model:** RT-300			
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 seen were 20 dB or more below the limit.							

Tested from 30 kHz to 30 MHz

SAMPLE CALCULATION: N/A

Test Date: November 01, 2019
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: Radiated Emissions				**Client:** Cognosos, Inc.			
Project: 19-0422				**Model:** RT-300			
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 seen were 20 dB or more below the limit.							

Tested from 30 MHz to 1 GHz

SAMPLE CALCULATION: N/A

Test Date: November 01, 2019
Tested By
Signature:  Name: John Freeman

Table 10. Unintentional and Intentional Radiator, Spurious Radiated Emissions (CFR 15.109, 15.209) 1 GHz – 10 GHz MHz (Antenna 2)

30 MHz to 1000 MHz with Class B Limits							
Test: Radiated Emissions				**Client:** Cognosos, Inc.			
Project: 19-0422				**Model:** RT-300			
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**
No other emissions beyond the emissions recorded in Table 5 above. All other emissions were 20 dB or more below the applicable limit.							

Tested from 1 GHz to 10 GHz

SAMPLE CALCULATION: N/A

Test Date: November 01, 2019
Tested By
Signature: _____ Name: John Freeman

2.19 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%.

Conducted Emissions Measurement Uncertainty

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

This test was not performed. The EUT is battery operated.

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.

END TEST REPORT