



Testing Tomorrow's Technology

Application for Certification

Per

Title 47 USC Part 2, Subpart J, Equipment Authorization Procedures, Paragraph 2.907, Certification and Part 15, Subpart C, Intentional Radiators, Paragraph 15.231, Periodic Operation in the band 40.66 MHz to 40.70 MHz and above 70 MHz

And

Innovation, Science, and Economic Development Canada

Certification Per

ICRSS-Gen General Requirements for Radio Apparatus

And

RSS-210 License-Exempt Radio Apparatus: Category I Equipment

For the

Radio Systems Corporation

Model: RFA-615

UST Project: 22-0168

Issue Date: July 12, 2022

Number of Pages in this report: 19


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Testing Tomorrow's Technology

I certify that I am authorized to sign for the test facility 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: 

Name: Alan Ghasiani

Title: President – Consulting Engineer

Date: July 12, 2022



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RFA-615

MEASUREMENT TECHNICAL REPORT

Company Name:	Radio Systems Corporation
Address:	10427 PetSafe Way Knoxville, TN 37932
Model:	RFA-615
FCC ID:	KE3-3003698
IC:	2721A-3003698
Date:	July 12, 2022

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

Equipment type: 433.92 MHz UHF transceiver

Technical Information:

Radio Technology:	
Frequency of Operation (MHz):	433.92 MHz
Output Power (AVG):	69.10 dBuV/m @ 3m
Type of Modulation:	OOK
Data/Bit Rate (M)bps:	-
Antenna Gain (dB):	-
Software used to program EUT:	MPLAB X IPE
EUT firmware:	820-559_R000
Power setting:	max level selected

Report prepared by:

US Tech

3505 Francis Circle Alpharetta, GA 30004

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IC Agency Agreement	External Photographs
FCC Agency Agreement	Internal Photographs
Application Forms	Confidential Schematics
Canadian Representative Letter	Confidential Theory of Operation
IC Cover Letter	Confidential Block Diagram
IC RSS to 15.231 Cross Reference	User Manual
Confidentiality Request Letter	Sample Label
Test Configuration Photographs	

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1. General Information

This report is prepared as a means of presenting test data to be used by a Telecom Certification Body in determination of whether this product is permitted for unlicensed dissemination to the general public according to the Innovation, Science, and Economic Development Canada and FCC Rules and Regulations for RF Devices Intentional Radiators.

1.1 Product Description

The Equipment under Test (EUT) is the Radio Systems Corp. Teach and Treat Remote Reward Trainer handheld remote transmitter model RFA-615. This remote is a push button remote used to trigger the Teach and Treat base station to dispense a pet treat to reward a pet. The EUT has a fundamental operating frequency of 433.92MHz . The EUT is battery operated without the capability to be recharged.

1.2 Characterization of Test Sample

The sample used for testing was received by US Tech on June 16, 2022 in good operating condition.

1.3 Related Submittal(s)/Grant(s)

The EUT is subject to the following FCC Equipment Authorizations:

- a) Certification of the EUT as an intentional transmitter under Part 15 Subpart C, paragraph 15.231 (this test report)
- b) Verification of the EUT under Part 15 Subpart B (SDoC), UST # 21-0170.

2. Tests and Measurements

2.1 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* to show compliance to CFR 47, Part 15.231.

All measurements are peak unless stated otherwise. The video filter associated with the spectrum analyzer was set to 3 times the resolution bandwidth or off throughout the evaluation process. There were no interconnecting cables to manipulate in an attempt to maximize emissions; however, the physical position of the EUT was varied through the three mutually exclusive orthogonal planes in an attempt to maximize the emissions. The worst case position is the position used for final measurements and is gathered in this test report. A block diagram of the tested system is shown in Figure 1.

2.2 Test Facility

Testing was performed at US Tech's measurement facility at 3505 Francis Circle, Alpharetta, GA. This site has been fully described and registered with the FCC, under site registration number 186022. Additionally this site has also been fully described and submitted to Industry Canada (IC), and has been approved under file number 9900A-1 and is also a NVLAP accredited test lab; lab code 200162-0.

2.3 Test Equipment

Table 1. EUT and Peripherals

MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	FCC/IC ID:	CABLES P/D
Radio Module/ Radio Systems Corp. (EUT)	RFA-615	Engineering Sample	Pending: FCC ID: KE3- 3003698 IC: 2721A-3003698	P

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

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Table 2. Test Instruments

TEST INSTRUMENT	MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	CALIBRATION DUE
Spectrum Analyzer	Agilent	E4407B	US41442935	9/22/2022 2 yr.
Biconical Antenna	EMCO	3110B	9307-1431	11/11/2022 2 yr.
Log Periodic Antenna	EMCO	3146	9305-3600	6/3/2023 2 yr.
Horn Antenna	EMCO	3115	9107-3723	2/3/2023 2 yr.
RF Preamp 100 kHz To 1.3 GHz	Hewlett-Packard	8447D	1937A02980	6/9/2022
RF Preamp 1.0 GHz To 26.0 GHz	Hewlett-Packard	8449B	3008A00480	6/25/2022

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

2.4 EUT Antenna Description (FCC Sec. 15.203, RSS-Gen 6.7)

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 Radio Systems Corp., Model RFA-615 Incorporates the antennas detailed in Table 3.

Table 3. Antenna Description

REPORT REFERENCE	MANUFACTURER	TYPE OF ANTENNA	MODEL	GAIN dB	TYPE OF CONNECTOR
None	Radio Systems Corp.	PCB trace antenna	433 MHz Trace	N/A	Permanent

2.5 Modifications to Equipment

No modifications were needed to bring the EUT into compliance with the FCC Part or IC RSS requirements.

2.6 Test Procedure

The EUT was configured as shown in the following block diagram(s) and photograph(s). The sample was tested per ANSI C63.10:2013. Conducted and radiated emissions data were taken with the test receiver or spectrum analyzer's resolution bandwidth adjusted to 9 kHz and 120 kHz depending on the frequency range of testing, 150 kHz-30 MHz or 30 MHz to 1000 MHz, respectively. All measurements are peak unless stated otherwise. The video filter on the spectrum analyzer was OFF or set to 3x the RBW throughout the evaluation process. Interconnecting cables were manipulated as necessary to maximize emissions. The EUT was rotated 360 degrees with the turntable to maximize emissions. The physical position of the EUT was varied through the three mutually exclusive orthogonal planes in an attempt to maximize the emissions. The final setup description is found in the test section of this report.

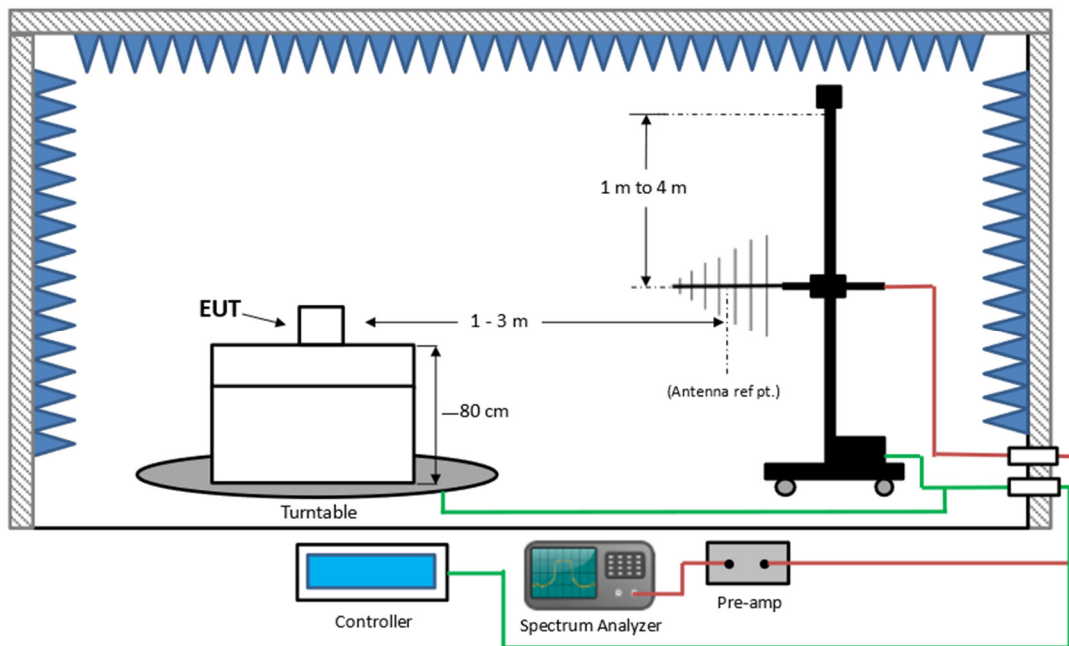


Figure 1. Block Diagram of Test Configuration

2.7 Compliance to CFR 15.231(a), RSS-210, A.1.1(a) Transmitter Activation/Deactivation

According to CFR 15.231(a) The provisions of this section are restricted to periodic operation within the band 40.66-40.70 MHz and above 70 MHz . Except as shown in paragraph (e) of this section, the intentional radiator is restricted to the transmission of a control signal such as those used with alarm systems, door openers, remote switches, etc. Continuous transmissions, voice, video and the radio control of toys are not permitted. Data is permitted to be sent with a control signal. The following conditions shall be met to comply with the provisions for this periodic operation:

(1) A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released.

The transmitter is not a manually operated transmitter.

(2) A transmitter activated automatically shall cease transmission within 5 seconds after activation.

The transmitter is classified as an automatically activated transmitter and the transmitter does comply with transmissions ceasing after 5 seconds. See Figure 2 below.

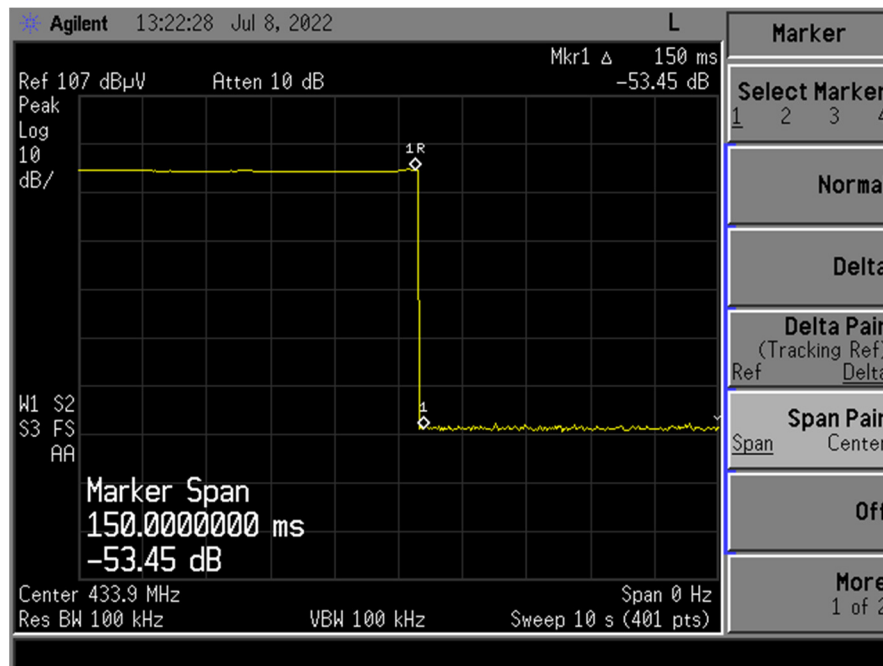


Figure 2. Deactivation per 15.231(a)(1), RSS-210, A.1.1(a)

Note 1: The EUT deactivates within 5 seconds.

(3) Periodic transmissions at regular predetermined intervals are not permitted. However, polling or supervision transmissions, including data, to determine system integrity of transmitters used in security or safety applications are allowed if the total duration of transmissions does not exceed more than two seconds per hour for each transmitter. There is no limit on the number of individual transmissions, provided the total transmission time does not exceed two seconds per hour.

This does not apply; the transmitter does not have periodic transmissions at pre-determined intervals, and does not have polling or supervision transmissions to determine system integrity.

(4) Intentional radiators which are employed for radio control purposes during emergencies involving fire, security, and safety of life, when activated to signal an alarm, may operate during the pendency of the alarm condition.

This does not apply; the transmitter is not employed for radio control purposes during emergencies.

(5) Transmission of set-up information for security systems may exceed the transmission duration limits in paragraphs (a)(1) and (a)(2) of this section, provided such transmissions are under the control of a professional installer and do not exceed ten seconds after a manually operated switch is released or a transmitter is activated automatically. Such set-up information may include data.

This does not apply; the transmitter is not used for security systems.

2.8 Field Strength of Fundamental (47 CFR 15.231(b), RSS-210, A.1.2(b))

The results of the measurements for peak fundamental emissions are given in Table 4. The EUT emissions measurement was started by setting up the Antenna in the vertical orientation at a distance of 3 meters from the EUT and at a height of 1.0 meters above the ground. The EUT's major axis was set normal to the direction of the measuring antenna.

The Spectrum Analyzer (SA) displays were set to: Channel A free-running, Channel B to Max-Hold. Choose a frequency or frequency range and scan it at a coupled rate. When a signal is detected, raise and lower the antenna to maximize the signal.

When the signal has been maximized, the antenna height is fixed the turn-table is rotated through 360 degrees to further maximize the signal.

When all signals have been maximized for antenna height and direction, the EUT is carefully maneuvered in each of the three mutually exclusive orthogonal planes while observing the same Max-hold/free-running SA display indication. When the EUT position is found that further maximizes the signal, record the antenna height, rotation orientation, EUT orthogonal position and signal strength on the data sheet for that particular frequency.

Next, the measurement antenna is re-oriented to a Horizontal polarization at 1 meter height and the process described above is repeated. All signals within 6 dB of the limit are recorded.

Finally, the collected data is input into the calculation spread sheet. The spread sheet is designed to calculate for the true value that is collected. The spread sheet takes into account the SA reading, the antenna correction factor, cable losses and duty cycle factors. See the data tables herein.

2.9 Limits for Operation in the Band above 70 MHz (CFR15.231 (b), RSS-210, A.1.2(b))

This limit versus frequency table is as follows (test distance = 3.0 meters):

Fundamental Frequency (MHz)	Limit Fundamental (Average) uV/m	Limit Harmonics and other spurious (Average) uV/m
260 to 470	3750 to 12500 ^{*,1}	375 to 1250 ^{*,2}
* Linear Interpolations		

Note: formula 1: $\text{limit}_1 = E = 41.667F - 7083.5$

2: $\text{limit}_2 = E = 4.1667F - 708.35$

E= Electric field strength

F= fundamental frequency in MHz

The frequency spectrum above the fundamental to its 10th harmonic was examined and measured for signals falling into the restricted bands of 15.205. If average emissions measurements are employed, the provisions in 15.35 for averaging pulsed emissions and for limiting peak emissions were applied. Spurious and harmonics signals meet the requirements of the above table or the requirements of 15.209, whichever requirement permits higher field strength.

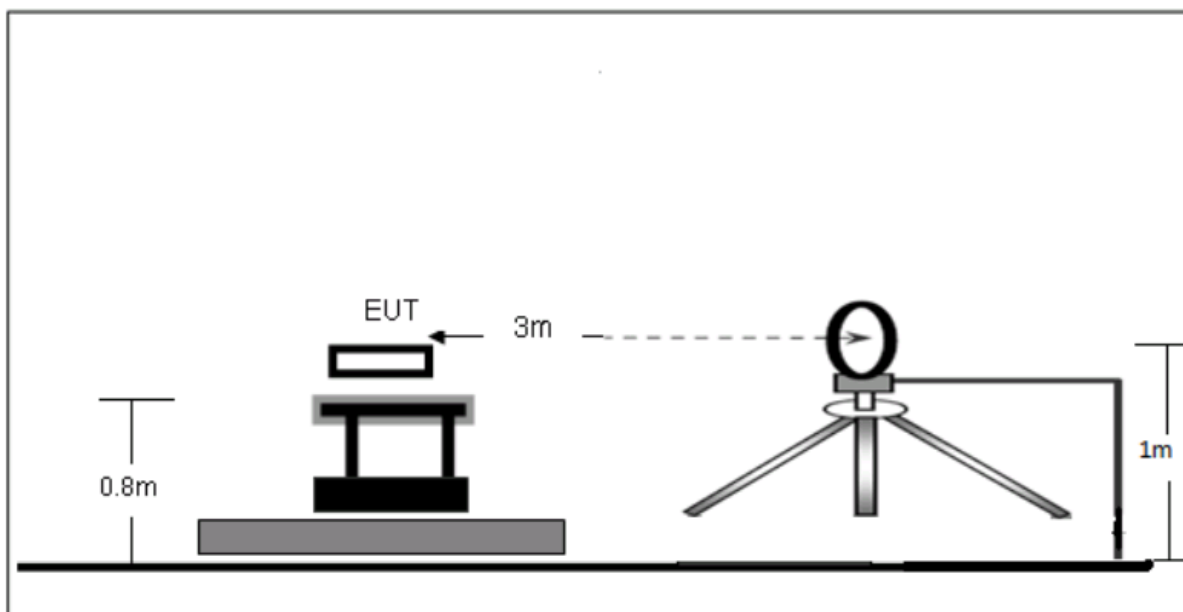


Figure 3. Radiated Emissions Below 30 MHz

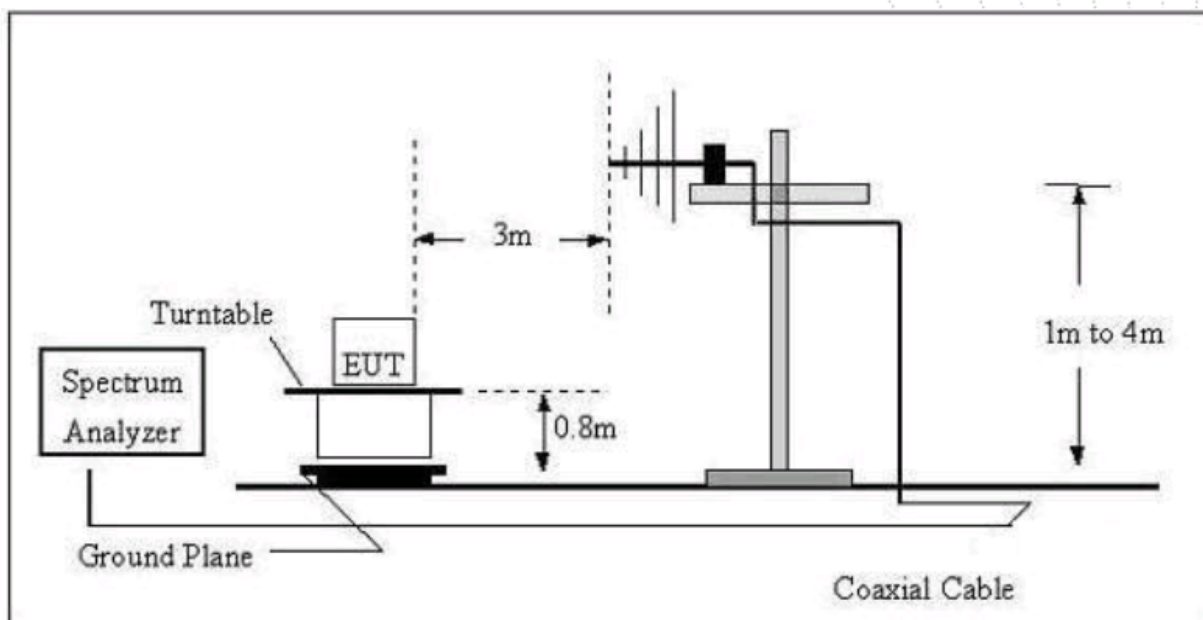


Figure 4. Radiated Emissions 30 MHz to 1 GHz

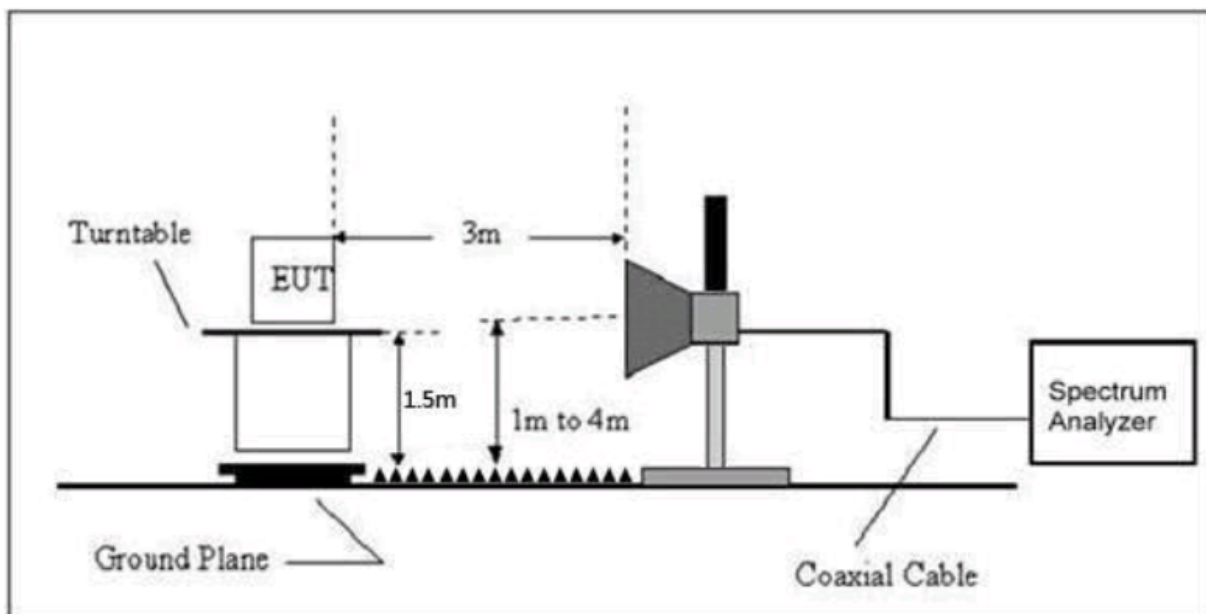


Figure 5. Radiated Emissions above 1 GHz

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Table 4. Intentional Radiated Emissions Measurements

Part 15C, Para 15.231/RSS-210, A.1.2(b)(TA.1)							
Frequency (MHz)	Test Data (dBuV)	AF+CL-PA (dB/m)	Corrected Results (dBuV/m)	AVG Limits (dBuV/m)	Distance / Polarization	Margin (dB)	Detection Method
433.91*	77.77	17.10	94.87	100.8*	3m./HORZ	5.9	PK
433.91	52.00	17.10	69.10	80.8	3m./HORZ	10.7	AVG
867.90	49.90	-3.41	46.49	60.8	3m./HORZ	14.3	PK
1301.83	56.95	-5.00	51.95	60.8	3m./HORZ	8.9	PK
No other emissions found less than 20 dB from the applicable limit.							

1. (*) Peak Detection compared to Peak Limit.
2. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic

Sample Calculation at 433.92:

Magnitude of Measured Frequency	77.77	dBuV
+Antenna Factor + Cable Loss+ Amplifier Gain	17.10	dB/m
Corrected Result	94.87	dBuV/m

Test Date: 6/24/2022

Tested By

Signature: 

Name: Ian Charboneau

US Tech Test Report:
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2.10 Power Line Conducted Emissions and Radiated Spurious Emissions (CFR 15.207, 15.209, RSS-Gen 8.8, 8.9)

The EUT was placed in a state representative of how the device will function under normal operation. The power line conducted emissions were measured over the frequency range of 150 kHz to 30 MHz. Measurements were recorded from the LISN RF port. The radiated spurious emissions were measured over the frequency range of 9 KHz to 30MHz and 30 MHz to the 10th harmonic of the fundamental frequency of the intentional transmitter. The test results are shown below.

Table 5. Conducted Emissions, 150kHz - 30MHz

150kHz to 30MHz, 15.207 limits/RSS-Gen 8.8 (T4)							
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 AVG
Not Applicable. EUT is battery operated and does not connect to AC mains.							

Sample Calculation: N/A

Test Date: June 24, 2022

Tested By

Signature: Ian Charboneau

Name: Ian Charboneau

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Table 6. Radiated Emissions, 9 kHz - 30 MHz

9kHz to 30MHz, 15.209 limits/RSS-Gen 8.9 (T6)							
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 AVG
All emissions seen were more than 20 dB below the applicable limit.							

Sample Calculation: N/A

Test Date: June 24, 2022

Tested By

Signature: Ian Charboneau

Name: Ian Charboneau

Table 7. Radiated Emissions other than Fundamental & Harmonics

Above 30MHz, 15.209 Limits/RSS-Gen 8.9 (T5)							
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 AVG
97.07	50.67	-26.39	24.28	57.0	3m./VERT	32.7	PK
650.90	43.99	-15.37	28.62	57.0	3m./HORZ	28.4	PK
All emissions seen were more than 20 dB below the applicable limit.							

Sample Calculation at 97.07MHz:

Magnitude of Measured Frequency	50.67	dBuV
+Antenna Factor + Cable Loss - Amplifier Gain	-26.39	dB/m
Corrected Result	24.28	dBuV/m

Test Date: June 27, 2022

Tested By

Signature: Ian Charboneau

Name: Ian Charboneau

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2.12 Bandwidth of Fundamental (CFR15.231(c), RSS-210, A.1.3)

The bandwidth of the emission shall be no wider than 0.25% of the center frequency for devices operating above 70MHz and below 900MHz. Bandwidth is determined by those frequencies that are at least 20 dB down on either side of the center frequency of the pulse.

$$\text{Bandwidth of Fundamental} = 0.0025 \times 433.92 \text{ MHz} = 1.085 \text{ MHz}$$

The measured bandwidth is 165.17 kHz, well within the limit. See the figure below.

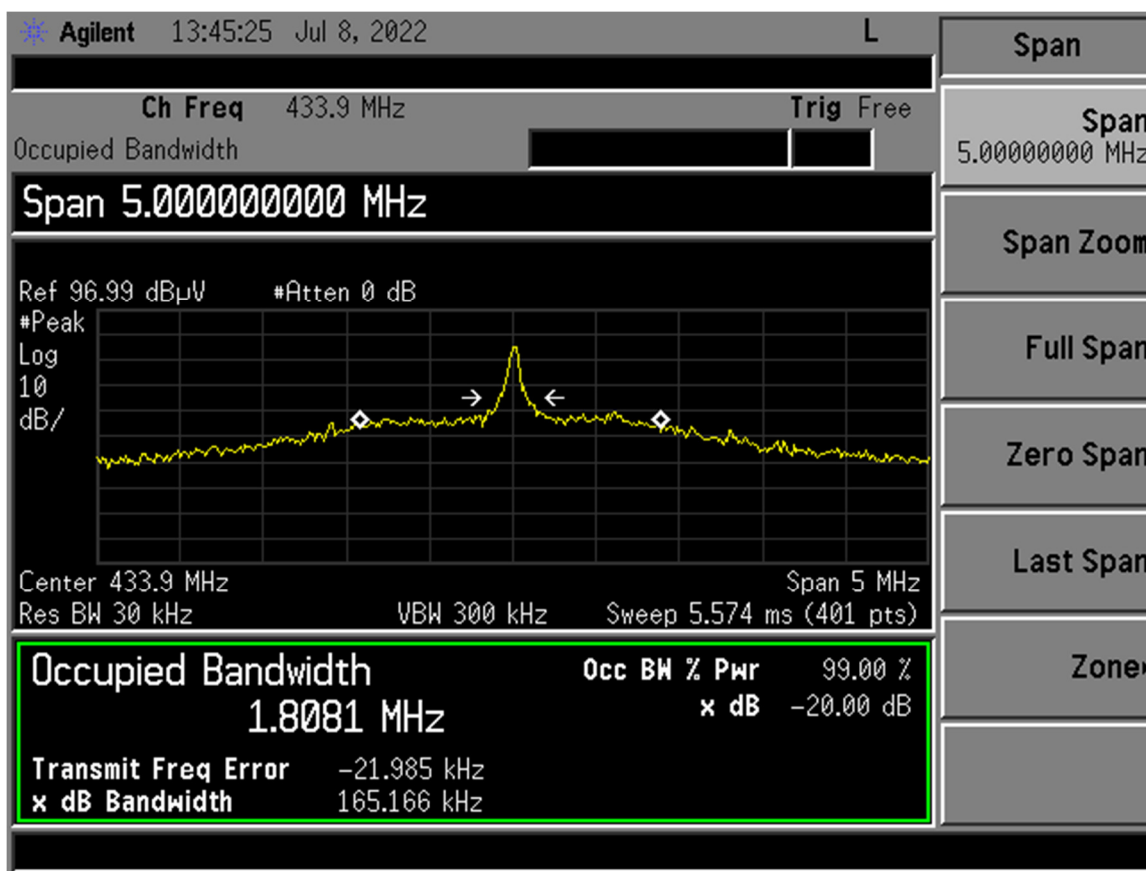


Figure 6. Occupied Bandwidth (20 dB BW)

Test Date: July 8, 2022

Tested By

Signature: Ian Charboneau

Name: Ian Charboneau

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2.13 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%.

2.13.1 Conducted Emissions Measurement Uncertainty

Measurement Uncertainty (within a 95% confidence level) for this test is ± 2.85 dB.

2.13.2 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.

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 REPORT