Testing Tomorrow's Technology

Application

For

Title 47 USC Part 2, Subpart J, Paragraph 2.907 Equipment Authorization of Certification for an Intentional Radiator per Part 15, Subpart C, Paragraphs 15.207 and 15.209

And

Industry Canada, Radio Standards Specifications: RSS Gen Issue 5 and RSS-210 Issue 10

For the

Radio Systems Corporation

Invisible Fence Brand Smart Doorman 2.0

Model: RAC00-17202

FCC ID: KE3-3003679

IC ID: 2721A-3003679

Issue Date: October 30, 2020

Test Dates: October 19, 20 & 22, 2020

UST Project No.: 20-0276

Total Pages in This Report : 21

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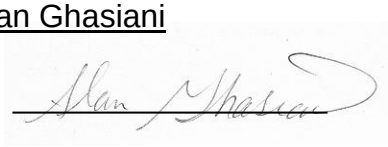
I, Alan Ghasiani, certify that I am authorized to sign for the Test Agency and that all of the statements in this report and in the Exhibits attached hereto are true and correct to the best of my knowledge and belief:

US TECH (Agent Responsible For Test):

Name: Alan Ghasiani

Signature: 

Title: Compliance Engineer – President

Date: October 30, 2020

TESTING
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MEASUREMENT TECHNICAL REPORT

COMPANY NAME: Radio Systems Corporation
MODEL: RAC00-17202
FCC ID: KE3-3003679
IC ID: 2721A-3003679
DATE: October 30, 2020

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

Equipment type: Low Power Transmitter General Field Limits (9 kHz–30 MHz)

Transmitter details:
Frequency of operation: 25 kHz
Type of modulation: OOK
Data/Bit Rate: 1250 bps
Antenna Gain: Internal integral loop antenna
Maximum Output Power: 100.96 dBuV/m @ 3 meters
Software used to program: EUT820-507_BP2_SlaveTx_1v117.txt
EUT firmware number: 820-511_BP2_DoormanHost_0v135.txt

Power setting: Maximum level

Collocated Transmitter:
151.82 MHz MURS transmitter – FCC ID: KE3-3003679 (pending)
IC: 2721A-3003679 (pending)

Summary of Test Results

FCC & ISED Rule	Description of Test	Result
RSS-Gen 6.7	99% Occupied Bandwidth	PASS
15.209 & RSS-Gen 6.13, RSS-210, 7.2	Spurious Radiated Emissions	PASS
15.207 & RSS-Gen 8.8, RSS-210, 7.2	Power line Conducted Emissions	PASS

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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, Sections 207 and 209, and IC RSS 210 Issue 10.

1.2 Characterization of Test Sample

The sample used for testing was received by US Tech on September 8, 2020 in good operating condition.

1.3 Product Description

The Equipment under Test (EUT) is the Radio Systems, Invisible Fence Brand Smart Doorman 2.0, Model RAC00-17202. The system is made up of two parts. The Electronic Module part number: RAC00-17202 and the doorframe part number RAC00-17200. Together they make up the Smart Door. The door is designed to allow the pet access to go outside when needed without assistance. It contains an electro-mechanical automatic pet door and coil transmitter (contained within the Electronic Module) that can serve as both an appliance proximity transmitter and as an avoidance transmitter. The unit is installed at the desired pet door location. The EUT may operate at one of the following fundamental frequencies: 15kHz, 20kHz, or 25kHz. For this test the EUT was programmed for 25 kHz. Magnetic field detection range for a compatible receiver is also controllable and may be set from 1.5 to 2.5 feet in one-half foot increments.

The EUT also utilizes the MURS band for data communications between units. The MURS transceiver is predominantly off. This unit communicates with a central data collection point at a very low duty cycle. It includes an internal loop antenna for MURS communications. Example use cases of the MURS channel are to report the internal battery level, a pet's entry or exit, alarms, and read/write the operating parameters of the coil transmitter. Typical line of sight communication range between a Doorman Host and a central data collection unit is 500 feet. The EUT may be powered by either a rechargeable 4.2V Li-Ion battery or AC/DC power supply.

This report conveys test results related to the Low Frequency, Low Power transmitter. The MURS transceiver has been tested and evaluated in a separate test report.

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 B Unintentional Radiators requirements and per *ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices* for FCC subpart C Intentional Radiators.

A list of 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 also been fully described and submitted to Industry Canada (IC), and has been approved under file number 9900A-1.

1.6 Related Submittals

The EUT is subject to the additional following FCC authorizations:

a) Certification under Section 95 Subpart J as a MURS device.
b) SDoC under Section 15 Subpart B as an Unintentional Radiator.

Table 1. EUT and Peripherals

EUT/ MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	FCC/ IC ID	CABLES P/D
Doorman 2.0 Radio Systems Corp.	RAC00-17202	Engineering sample	FCC ID: KE3-3003679 IC ID: 2721A-3003679	P U
PERIPHERAL/ MANUFACTURER	**MODEL NUMBER**	**SERIAL NUMBER**	**FCC/ IC ID**	**CABLES P/D**
Plug In AC/DC Adapter/ Radio Systems Corp.	RAC00-13701	Engineering Sample	N/A	P U
Li-Ion Battery Radio Systems Corp.	610-3901	Engineering Sample	N/A	N/A

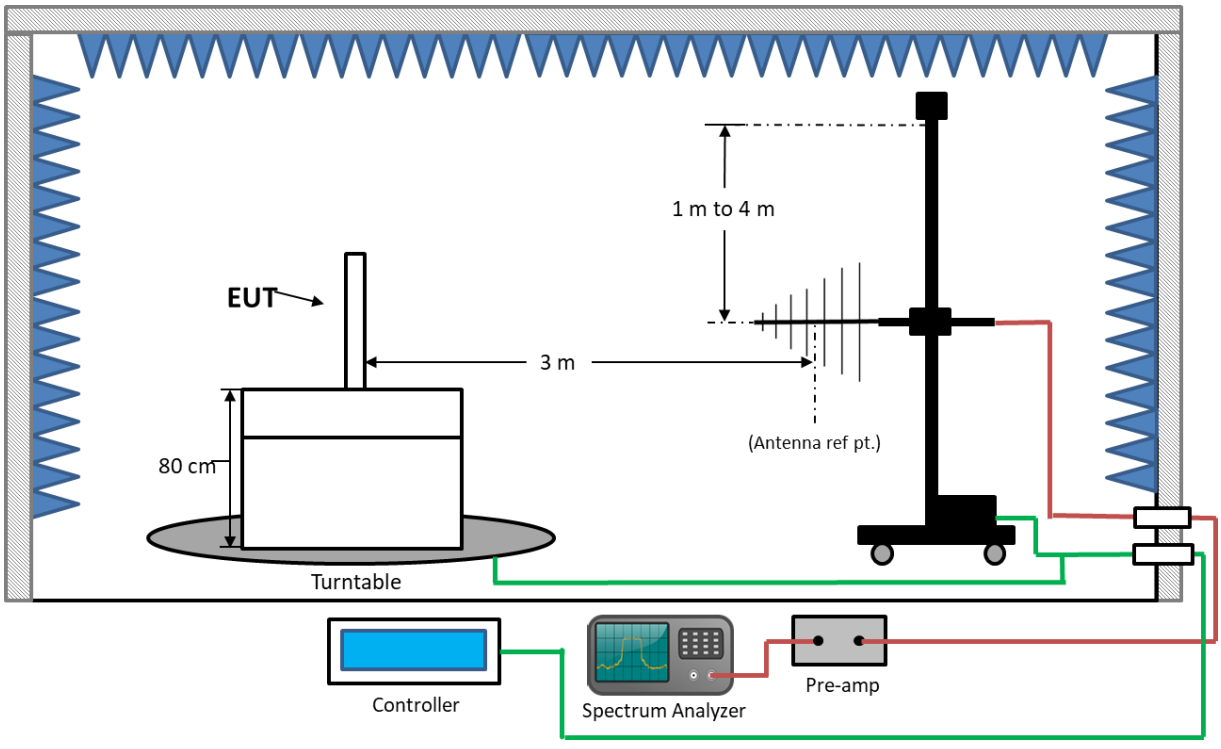


Figure 1. EUT Test Configuration – Radiated Emissions

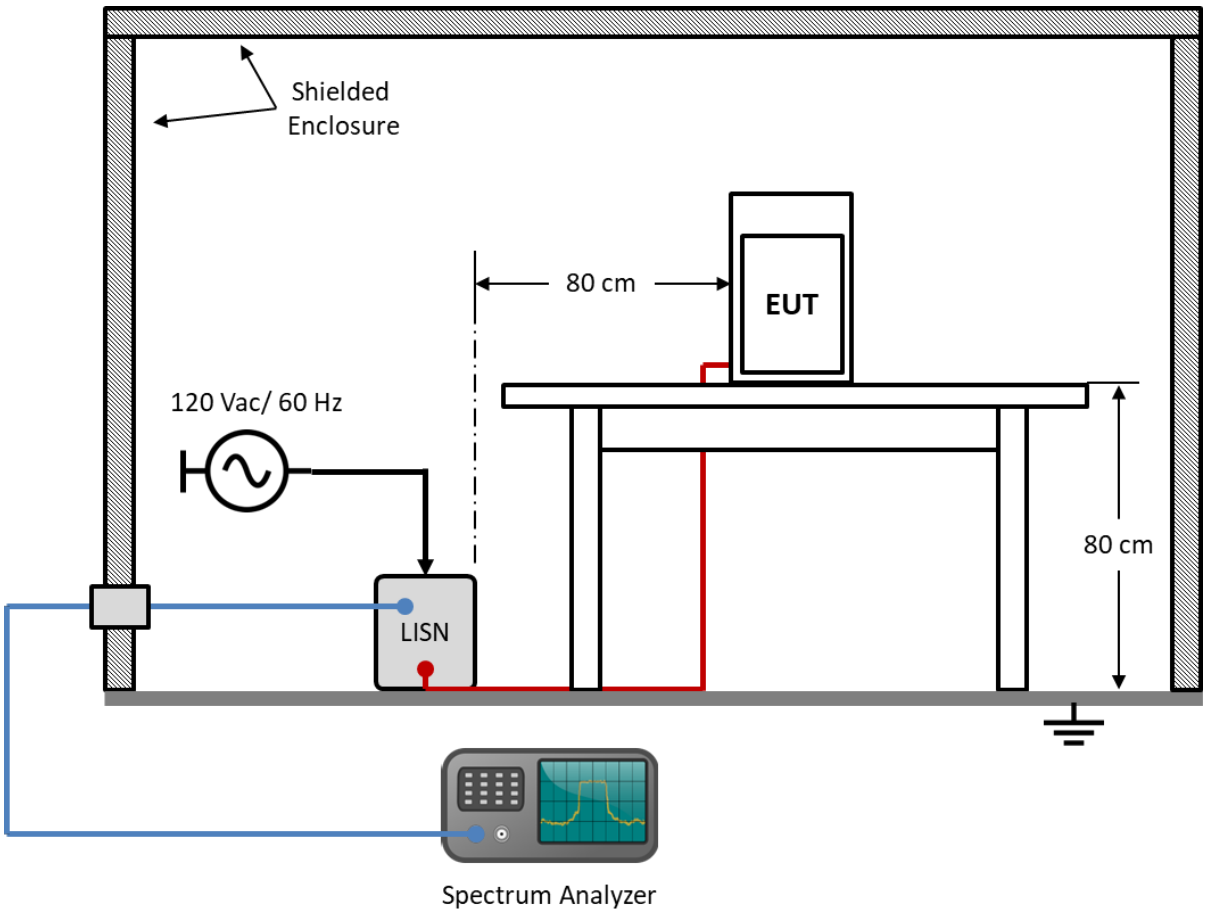


Figure 2. EUT Test Configuration – AC Power Line Conducted Emissions

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	9/02/2022 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	9110-3236	8/22/2021 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	5/13/2021
PREAMP 1.0 GHz to 26.0 GHz	8449B	HEWLETT-PACKARD	3008A00480	5/13/2021
LISN x2	9247-50-TS-50-N	Solar Electronics	955824 and 955825	5/11/2021

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 to the EUT during testing.

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

The EUT operates at 25 kHz; therefore, one test frequency was used.

2.4 Frequency Range of Radiated Measurements (Part 15.33)

2.4.1 Intentional Radiator

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

2.4.2 Unintentional Radiator

For the digital device, an unintentional radiator, the frequency range shall be 30 MHz to 1000 MHz, or to 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:

2.5.1 Detector Function and Associated Bandwidth

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

2.5.2 Corresponding Peak and Average Requirements

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

2.5.3 Pulsed Transmitter Averaging

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

NOTE: If the transmitter was programmed to transmit at >98% duty cycle, then, wherever applicable (where the detection mode was AVG) the duty cycle factor calculated will be applied.

2.6 EUT Antenna Requirements (CFR 15.203)

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. Only the antenna(s) listed in Table 4 will be used with this module.

Table 4. Allowed Antenna(s)

REPORT REFERENCE	MANUFACTURER	TYPE OF ANTENNA	MODEL	TYPE OF CONNECTOR
Antenna 1	Radio Systems Corp	Inductive Loop	Inductive coil loop antenna	screw on PCB

Note: This antenna is internally mounted and not user replaceable without damaging the device.

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 emissions cannot exceed the limits of 15.209. Radiated Harmonics and other Spurious Emissions are examined for this requirement; see paragraph 2.1.

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

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

2.9 Intentional Radiator, Radiated Emissions (CFR 15.209, (IC RSS 210))

Radiated Radio measurements: The EUT was placed into a continuous transmit mode of operation and a preliminary scan was performed on the EUT to find signal frequencies that were caused by the transmitter part of the product. To obtain the worst case results, the EUT was placed on a table top of a non-conductive table, 80 cm above the ground floor. The EUT was positioned 3 meters away from the receiving antenna during testing (1 meter at frequencies above 6 GHz and if the emissions were less than 6 dB from the noise floor). The EUT was tested in X, Y and Z axes or the position of normal operation to determine the worst case orientation. Radiated measurements below 30 MHz were tested with a RBW = 9 kHz; emissions below 1 GHz were tested with a RBW = 120 kHz and radiated measurements above 1 GHz were measured using a RBW =1 MHz. VBW was set to three times the RBW value.

For radiated emissions, any emission that was greater than 20 dB from the applicable limit was not recorded. If radiated emissions above 1 GHz were measured at a distance of 1 meter, the measured value at 1 meter was extrapolated to the results at 3 meters using an inverse distance extrapolation factor of -20 dB/decade. Results are displayed along with the 15.109 test data in the sections below.

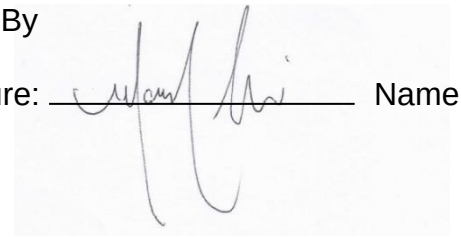
2.10 99% Occupied Bandwidth (IC RSS Gen, 6.7)

According to RSS-Gen, 6.7: The occupied bandwidth or the "99% emission bandwidth" is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.

Table 5. 99% Occupied Bandwidth

Frequency (kHz)	99% Occupied Bandwidth (kHz)
25.00	8.3592

Test Date: October 16, 2020
Tested By

Signature:  Name: Mark Afroozi

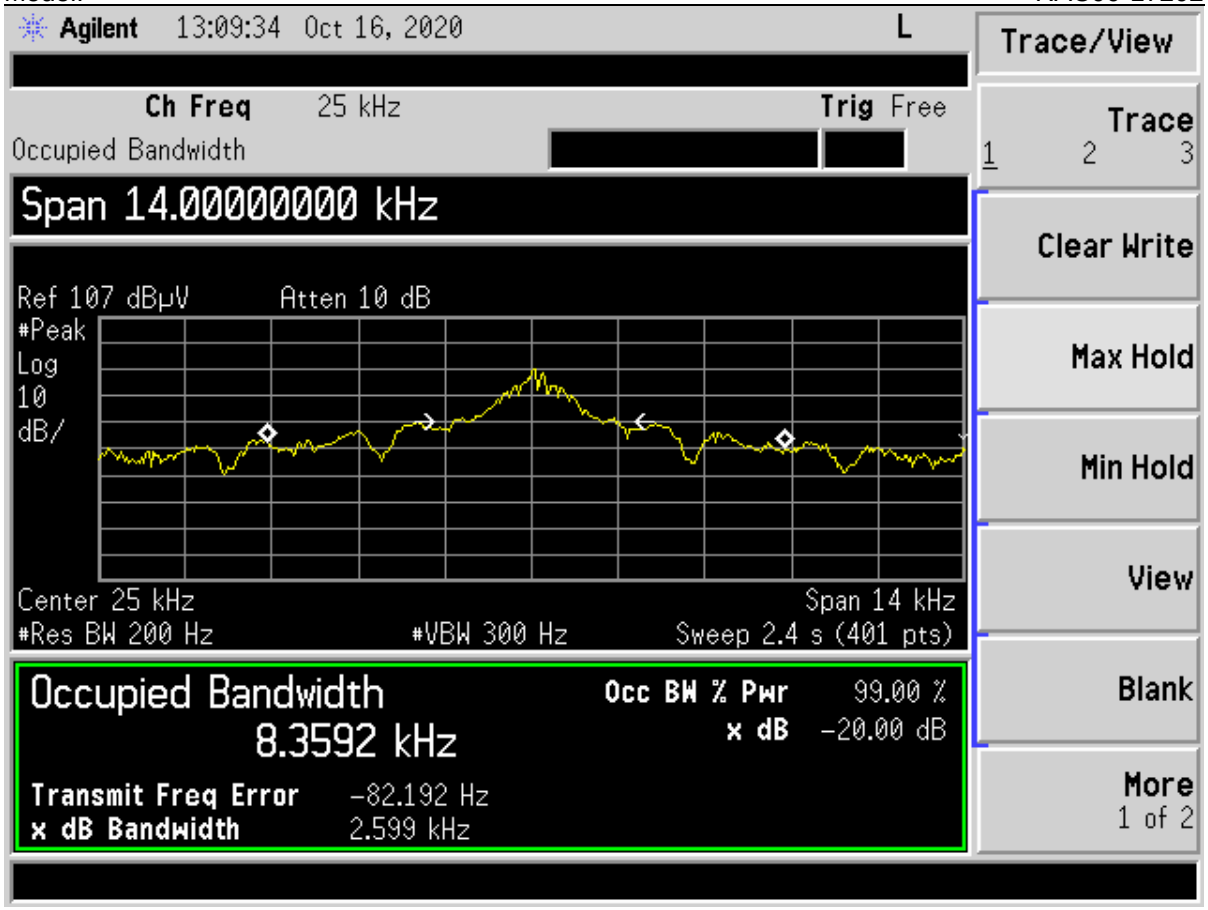


Figure 3. 99% Occupied Bandwidth

2.11 Unintentional/Intentional Radiator, Power line Emissions (CFR 15.107 and 15.207)

The power line conducted voltage emissions measurements have been carried out in accordance with CFR 15.107, per ANSI C63.4:2014 and ANSI C63.4:2013, Paragraph 7, with a spectrum analyzer connected to a LISN and the EUT placed into a continuous mode of transmission.

Table 6. AC Power Line Conducted Emissions Test Data, (15.207)

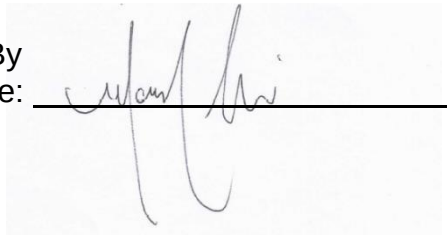
150 kHz to 30 MHz						
Test: FCC Part 15, Para 15.207				**Client:** Radio Systems Corporation		
Project: 20-0276				**Model:** RAC00-17202		
Frequency (MHz)	**Test Data (dBuv)**	**LISN+CL (dB)**	**Results (dBuV)**	**AVG Limits (dBuV)**	**Margin (dB)**	**Detector PK, QP, or AVG**
120 Vac / 60 Hz, Phase						
0.1535	31.23	0.08	31.31	55.8	24.5	**PK**
0.9025	27.99	0.59	28.58	46.0	17.4	**PK**
2.1333	29.98	0.12	30.10	46.0	15.9	**PK**
5.9500	27.17	0.31	27.48	50.0	22.5	**PK**
13.2330	25.11	0.88	25.99	50.0	24.0	**PK**
24.2000	28.47	1.19	29.66	50.0	20.3	**PK**
120 Vac / 60 Hz, Neutral						
0.3128	28.60	0.04	28.64	49.9	21.3	**PK**
0.6133	29.67	0.51	30.18	46.0	15.8	**PK**
1.5066	30.08	0.20	30.28	46.0	15.7	**PK**
7.3416	26.45	0.51	26.96	50.0	23.0	**PK**
10.5666	26.24	0.69	26.93	50.0	23.1	**PK**
22.9830	25.51	1.51	27.02	50.0	23.0	**PK**

*QP limits were used.

Sample Calculation at 0.1535 MHz:

Magnitude of Measured Frequency	31.23	dBuV
+ LISN + Cable Loss	0.08	dB
Corrected Result	31.31	dBuV/m

Test Date: October 21, 2020

Tested By
Signature:  Name: Mark Afroozi

2.12 Intentional Radiator, Spurious Radiated Emissions (CFR 15.209)

Radiated emissions disturbance Measurements were performed with EUT in constant transmit mode and using an instrument having both peak and quasi-peak detectors over the frequency range of 9 kHz to 1 GHz. 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 analyzer's display for the maximum magnitude of the signal at the test frequency. The antenna polarization (horizontal and vertical) and test sample azimuth were varied during the measurements to find the maximum field strength readings to record.

2.13 Radiated Emission Limits - General Requirements

(a) Except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100**	3
88-216	150**	3
216-960	200**	3
Above 960	500	3

**Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permltted under other sections of this part, e.g., §§15.231 and 15.241.

Fundamental Limit calculation:
at 25 kHz = 2400/25 = 96 uV/m @ 300 m
Conversion from uV/m to dBuV/m = 20 log(96) = 39.65 dBuV/m
Conversion from 300 to 3 m = 40 log (300/3)= 80
Limit at 3 meter = 39.65 + 80 = 119.65 dBuV/m

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Table 7. Radiated Emissions 9 kHz to 30 MHz (15.209)

Test: FCC Part 15, Para 15.209				**Client:** Radio Systems Corp.			
Project: 20-0276				**Model:** RAC00-17202			
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**AVG Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector Mode**
0.025	87.50	13.46	100.96	119.6	3 m./LOOP	18.7	**PK**
0.050	49.56	12.56	62.12	113.6	3 m./LOOP	51.5	**PK**
0.075	70.28	12.46	82.74	110.1	3 m./LOOP	27.3	**PK**
0.100	62.15	12.16	74.31	107.6	3 m./LOOP	33.3	**PK**
0.125	62.18	12.16	74.34	105.7	3 m./LOOP	31.3	**PK**
0.150	53.63	12.16	65.79	104.1	3 m./LOOP	38.3	**PK**
0.175	62.73	12.16	74.89	102.7	3 m./LOOP	27.9	**PK**
0.200	46.70	12.06	58.76	101.6	3 m./LOOP	42.8	**PK**
0.225	58.96	12.06	71.02	100.6	3 m./LOOP	29.5	**PK**
0.250	45.83	12.06	57.89	99.6	3 m./LOOP	41.8	**PK**

1. (*) Falls within the restricted bands of CFR 15.205. Limits based on CFR15.209 & 20 dB relaxation for peak measurements of CFR 15.35.
2. No other signals detected within 20 dB of specification limit. Harmonics investigated up to the 10th harmonic

Sample Calculation at 0.025 MHz:

Magnitude of Measured Frequency	87.50	dBuV
+ Antenna Factor + Cable Loss - Amplifier Gain	13.46	dB/m
Corrected Result	100.96	dBuV/m

Test Date: October 16, 2020
Tested By:

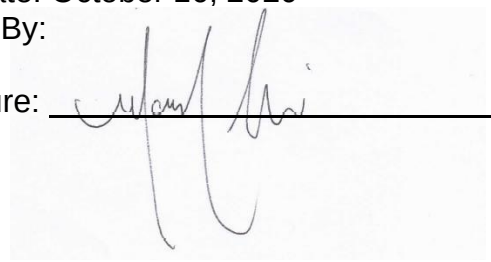
Signature:  Name: Mark Afroozi

Table 8. Spurious Radiated Emissions (CFR 15.209), 30 - 1000 MHz

30 MHz to 1000 MHz with Class B Limits							
Test: FCC Part 15, Para 15.209				**Client:** Radio Systems Corp.			
Project: 20-0276				**Model:** RAC00-17202			
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 emissions other than fundamental and harmonics of 151.82 MHz MURS transceiver (pending approval) were detected.							

Tested By:

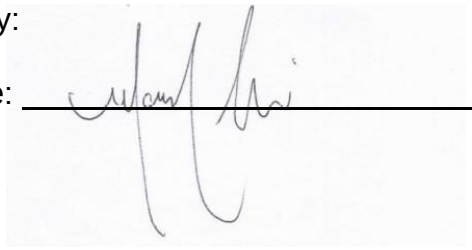
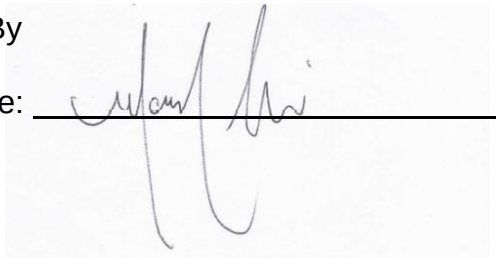
Signature:  Name: Mark Afroozi

Table 9. Spurious Radiated Emissions (CFR 15.209), Above 1000 MHz

Above 1000 MHz with Class B Limits							
Test: FCC Part 15, Para 15.209				**Client:** Radio Systems Corp.			
Project: 20-0276				**Model:** RAC00-17202			
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**
1366.00	63.40	-10.50	52.90	54.0	3.0m./VERT	1.1	**PK**
1366.00	34.12	-10.50	23.62	54.0	3.0m./VERT	30.4	**AVG**
1518.00	56.72	-9.38	47.34	54.0	3.0m./HORZ	6.7	**PK**
All other emissions were more than 20 dB below the limit.							

Test Date: October 15, 2020

Tested By

Signature:  Name: Mark Afroozi

2.14 Measurement Uncertainty

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

2.14.1 Conducted Emissions Measurement Uncertainty

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

2.14.2 Radiated Emissions Measurement Uncertainty

30 MHz to 200 MHz at 3 m:

The measurement uncertainty (with a 95% confidence level) for this test using a Biconical Antenna is ± 5.40 dB.

200 MHz to 1000 MHz at 3 m:

The measurement uncertainty (with a 95% confidence level) for this test using a Log Periodic Antenna is ± 5.19 dB.

1000 MHz to 6000 MHz at 3 m:

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 15.207/209 of Subpart C and RSS-Gen and RSS-210 based on the test results presented in this test report.