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 Doorman 1.5 Electronic Pet Door Electronic module

Model: RAC00-17201

FCC ID: KE3-3003678
IC: 2721A-3003678

Issue Date: October 29, 2020

Test Dates: October 14, 15, 16 & 27, 2020

UST Project No.: 20-0274

Total Pages in This Report : 20

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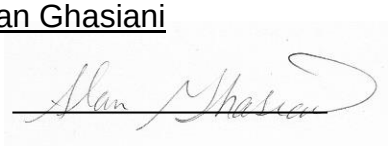
I, Alan Ghasiani, certify that I am authorized to sign for the Test Agency and that all of the statements in this report and in the Exhibits attached hereto are true and correct to the best of my knowledge and belief:

US TECH (Agent Responsible For Test):

Name: Alan Ghasiani

Signature: 

Title: Compliance Engineer – President

Date: October 29, 2020

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MEASUREMENT TECHNICAL REPORT

COMPANY NAME: Radio Systems Corporation
MODEL: RAC00-17201
FCC ID: KE3-3003678
IC ID: 2721A-3003678
DATE: October 29, 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: 10.7 kHz
Type of modulation: OOK
Data/Bit Rate: 3 Hz
Antenna Gain: integral antenna
Maximum Output Power: 96.75 dBuV/m @ 3 meter
Software used to program EUT: N/A
EUT firmware number: 820-357 Rev. 105
Power setting: Maximum setting

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	N/A

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Theory of Operation
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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 October 13, 2020 in good operating condition.

1.3 Product Description

The Equipment under Test (EUT) is the Radio Systems, Invisible Fence® Brand Doorman 1.5™ Electronic Pet Door, Electronic Module model: RAC00-17201. The module is part of the overall pet door system. The door is made up of two main components the door frame model RAC00-17200 and the electronic module model RAC00-17201. This electronic pet door is designed to allow the pet access to go outside when needed without assistance. A collar is worn by the pet to activate the door. The pet door has 3 basic modes of operation: Auto, Locked, and Unlocked. These modes can be set manually at any time or controlled by a timed schedule.

The electronic module houses the intentional transmitter circuits. The module transmits an On-Off-Keyed (OOK) magnetic signal at either 7.5 kHz or 10.7 kHz +/- 2% at a repeat rate of ~3 Hz.

The unit only transmits magnetic transmission and listens for an RF reply if in the Auto mode and at least one pet collar has been “Learned” into it. The RF receiver is tuned to 433.92 MHz (300 kHz bandwidth) by a digitally controlled PLL inside the RF receiver IC.

When in Auto (locked) mode, if a RF reply from the pet collar is detected, the door will unlock and stay unlocked until the pet moves out of range for 10 seconds. After the pet is out of range for 10 seconds the door will begin to lock. It takes about 1 second to unlock, however it takes ~7 seconds to lock again.

The EUT operates on four, 1.5 V, type C-cell, alkaline batteries each having 8350 mAh capacity. This report conveys test results related to the 10.7 kHz magnetic coil transmitter.

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 below. A test configuration 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) SDoC under Section 15 Subpart B as an Unintentional Radiator; this report is provided under separate cover.

Table 1. EUT and Peripherals

EUT/ MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	FCC/ IC ID	CABLES P/D
Doorman 1.5 (Electronic Module) Radio Systems Corp.	RAC00-17201	Engineering sample	Pending FCC ID: KE3-3003678 IC ID: 2721A-3003678	P U
PERIPHERAL/ MANUFACTURER	**MODEL NUMBER**	**SERIAL NUMBER**	**FCC/ IC ID**	**CABLES P/D**
Doorman 1.5 (Door frame) Radio Systems Corp.	RAC00-17200	Production Sample	None	N/A
Alkaline C-cell Battery (x4) Duracel	None	Engineering Sample	N/A	N/A

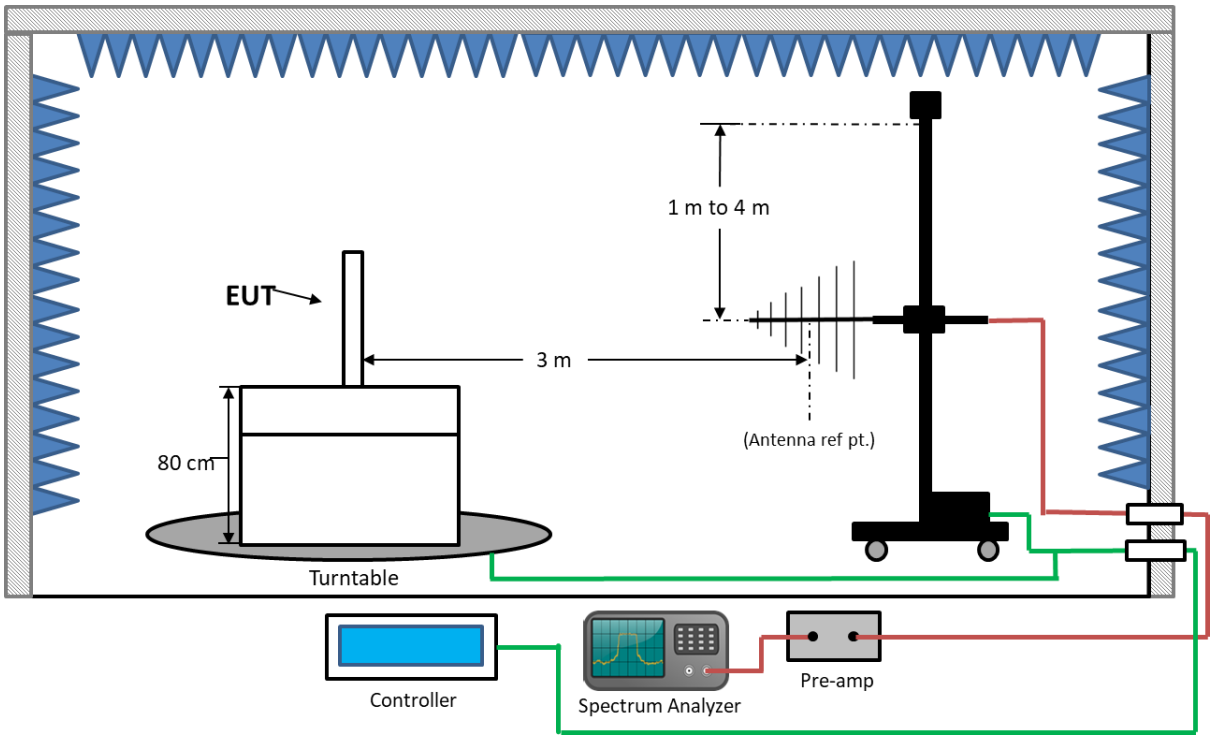


Figure 1. EUT Test Configuration – Radiated Emissions

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.
SPECTRUM ANALYZER	8593E	HEWLETT-PACKARD	3205A00124	1/29/2022 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

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 10.7 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 parameters described in the following sections.

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.	Integrated Loop	Integrated loop antenna	solder

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.

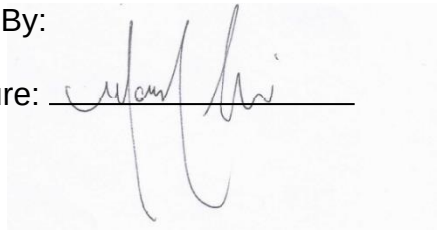
2.10 99% Occupied Bandwidth (IC RSS Gen, 6.7)

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)
10.7	2.20

Test Date: October 27, 2020
Tested By:

Signature:  Name: Mark Afroozi

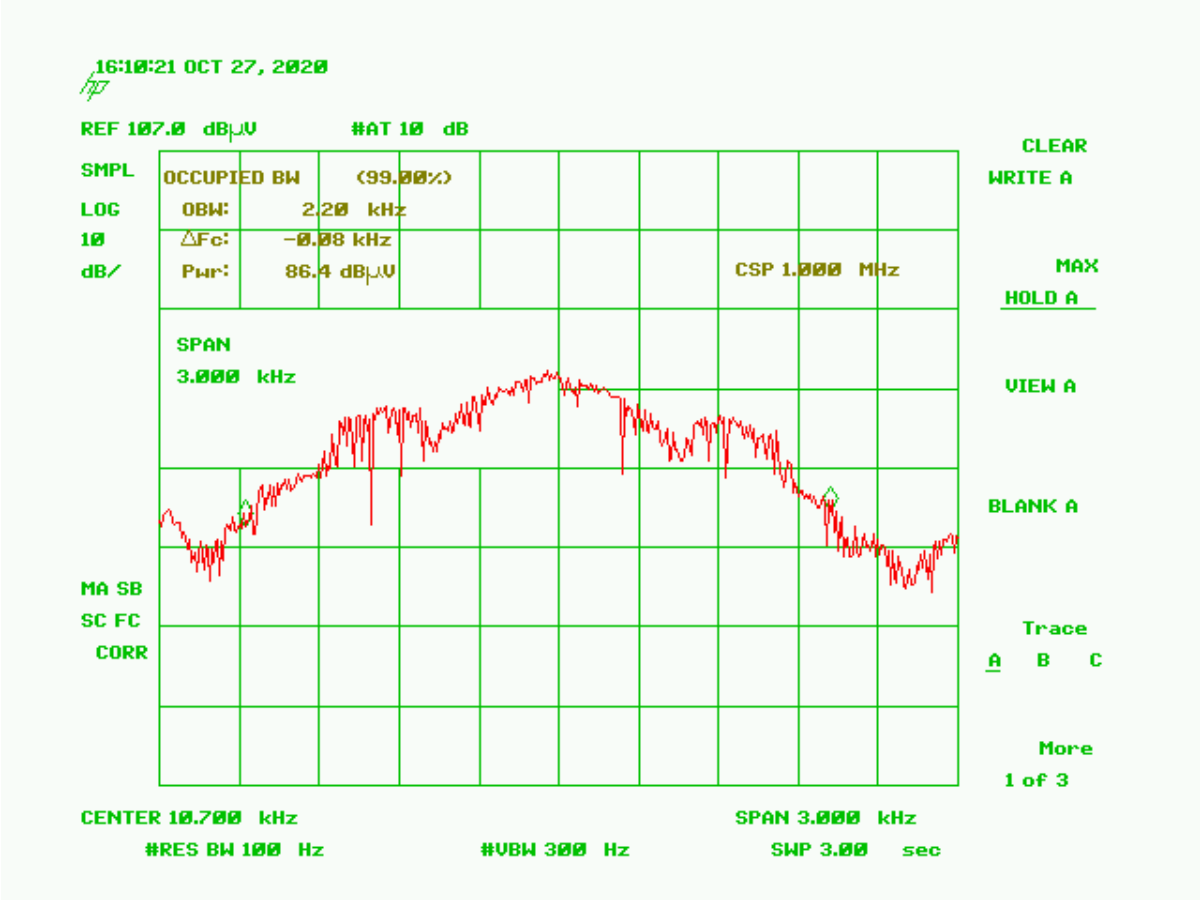


Figure 2. 99% Occupied Bandwidth

2.11 AC Power line Emissions (CFR 15.207)

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

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 permitted under other sections of this part, e.g., §§15.231 and 15.241.

Fundamental Limit calculation:

at 10.7 kHz = 2400/25 = 224.3 uV/m @ 300 m
Conversion from uV/m to dBuV/m = 20 log(224.3) = 47.02 dBuV/m
Conversion from 300 to 3 m = 40 log (300/3)= 80
Limit at 3 meter = 47.02 + 80 = 127.02 dBuV/m

Table 6. Radiated Emissions 9 kHz to 30 MHz (15.209)

Test: FCC Part 15, Para 15.209				**Client:** Radio Systems Corp.			
Project: 20-0274				**Model:** RAC00-17201			
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**AVG Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector Mode**
0.0107	80.89	15.86	96.75	127.0	3m./LOOP	30.3	**PK**
0.0321	65.26	13.96	79.22	117.4	3m./LOOP	38.2	**PK**
0.0534	58.00	12.56	70.56	113.1	3m./LOOP	42.5	**PK**
0.0749	53.18	12.46	65.64	110.1	3m./LOOP	44.5	**PK**
0.0963	45.96	12.56	58.52	107.9	3m./LOOP	49.4	**PK**
18.7500	30.06	10.85	40.91	69.5	3m./LOOP	28.6	**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 0.0107 MHz:

Magnitude of Measured Frequency	80.89	dBuV
+ Antenna Factor + Cable Loss - Amplifier Gain	15.86	dB/m
Corrected Result	96.75	dBuV/m

Test Date: October 16, 2020
Tested By:

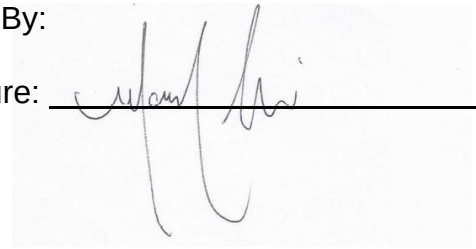
Signature:  Name: Mark Afroozi

Table 7. 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: 20-0274				**Model:** RAC00-17201			
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**
78.09	51.33	-17.16	34.17	40.0	3m./VERT	5.8	**PK**
104.05	54.05	-15.29	38.76	43.5	3m./VERT	4.7	**PK**
145.90	47.70	-12.92	34.78	43.5	3m./VERT	8.7	**PK**
156.00	23.84	-12.27	11.57	43.5	3m./VERT	31.9	**QP**
188.55	49.34	-11.16	38.18	43.5	3m./HORZ	5.3	**PK**
212.46	49.61	-14.46	35.15	43.5	3m./VERT	8.4	**PK**

Sample Calculation at 78.09 MHz:

Magnitude of Measured Frequency	51.33	dBuV
+ Antenna Factor + Cable Loss - Amplifier Gain	-17.16	dB/m
Corrected Result	34.17	dBuV/m

Test Date: October 14, 2020
Tested By:

Signature: _____ Name: Mery Alemu

Table 8. 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: 20-0274				**Model:** RAC00-17201			
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**
No emissions were detected above 1000 MHz.							

Test Date: October 15, 2020
Tested By:

Signature: _____ Name: Mery Alemu

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

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.

Above 1 GHz 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.