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 4 and RSS-210 Issue 8

For the

Radio Systems

Model: RIG00-15265

FCC ID: KE3-3003057
IC: 2721A-3003057

UST Project: 15-0262
Issue Date: November 19, 2015

Total Pages in This Report: 24

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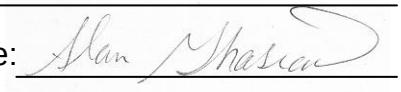
I certify that I am authorized to sign for the Test Agency and that all of the statements in this report and in the Exhibits attached hereto are true and correct to the best of my knowledge and belief:

US TECH (Agent Responsible For Test):

By: Alan Ghasiani

Name: 

Title: Compliance Engineer – President

Date November 19, 2015

NVLAP LAB CODE 200162-0

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MEASUREMENT TECHNICAL REPORT

COMPANY NAME: Radio Systems

MODEL: RIG00-15265

FCC ID: KE3-3003057

IC: 2721A-3003057

DATE: November 19, 2015

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

Equipment type: 433.92 MHz Transmitter

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

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

Report prepared by:

US Tech
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Alpharetta, GA 30004

Phone Number: (770) 740-0717
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1 General Information

1.1 Purpose of this Report

This report is prepared as a means of conveying test results and information concerning the suitability of this exact product for public distribution according to the FCC Rules and Regulations Part 15, Section 207 and 209, and IC RSS 210 Issue 8.

1.2 Characterization of Test Sample

The sample used for testing was received by US Tech on November 2, 2015 in good operating condition.

1.3 Product Description

The Equipment Under Test (EUT) is the Radio Systems Corporation Model RIG00-15265, sold under the marketing name Boundary Plus R23.

The EUT is a pet containment collar that, when receiving a 7 kHz or 10 kHz coded signal, will either deliver a static correction or emit a 433.92 MHz transmission to open a pet door.

1.4 Configuration of Tested System

The Test Sample was tested per *ANSI C63.4:2009 and ANSI C63.4:2014, Methods of Measurement of Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (2009)* for FCC subpart A Digital equipment Verification requirements and per *ANSI C63.10-2014, 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 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 186022. 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 EUT is subject to the following FCC authorizations:

a) Certification under section 15.207 and 15.209 as a transmitter.
b) Verification under 15.101 as a digital device.

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 (Parts 15.107 and 15.109) for the EUT is included herein.

Table 1. EUT and Peripherals

PERIPHERAL MANUFACTURER.	MODEL NUMBER	SERIAL NUMBER	FCC ID: IC:	CABLES P/D
Wireless Transmitter Radio Systems Corporation	RIG00-15265	Engineering Sample	FCC ID: KE3-3003057 (pending) IC: 2721A-3003057 (pending)	N/A
Antenna See antenna details	--	--	--	--

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

2 Tests and Measurements

2.1 Test Equipment

The table below lists test equipment used to evaluate this product. Model numbers, serial numbers and their calibration status are indicated.

Table 2. Test Instruments

TEST INSTRUMENT	MODEL NUMBER	MANUFACTURER	SERIAL NUMBER	DATE OF LAST CALIBRATION
SPECTRUM ANALYZER	E4407B	AGILENT	US41442935	1/28/2015
LOOP ANTENNA	SAS-200/562	A.H. Systems	142	9/28/2015 2 yr.
BICONICAL ANTENNA	3110B	EMCO	9306-1708	11/24/2014 2 yr.
LOG PERIODIC ANTENNA	3146	EMCO	9110-3236	11/19/2014 2 yr.
HORN ANTENNA	SAS-571	A.H. Systems	605	8/25/2015 2 yr.
PRE-AMPLIFIER	8449B	HEWLETT-PACKARD	3008A00480	12/5/2014
PRE-AMPLIFIER	8447D	HEWLETT-PACKARD	1937A02980	12/4/2014

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

Because the EUT operates at only 433.99 MHz, therefore only 1 test frequency could be 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 10^{th} 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.

2.5.4 Transmitter Duty Cycle (47 CFR 15.35 (c))

The duty cycle de-rating factor used in the calculation of average radiated limits (per CFR 15.209 and 15.35(c)) is described below. This factor was calculated by first determining the worst case scenario for system operation. With the worst case operating scenario, the transmission duty cycle is calculated as:

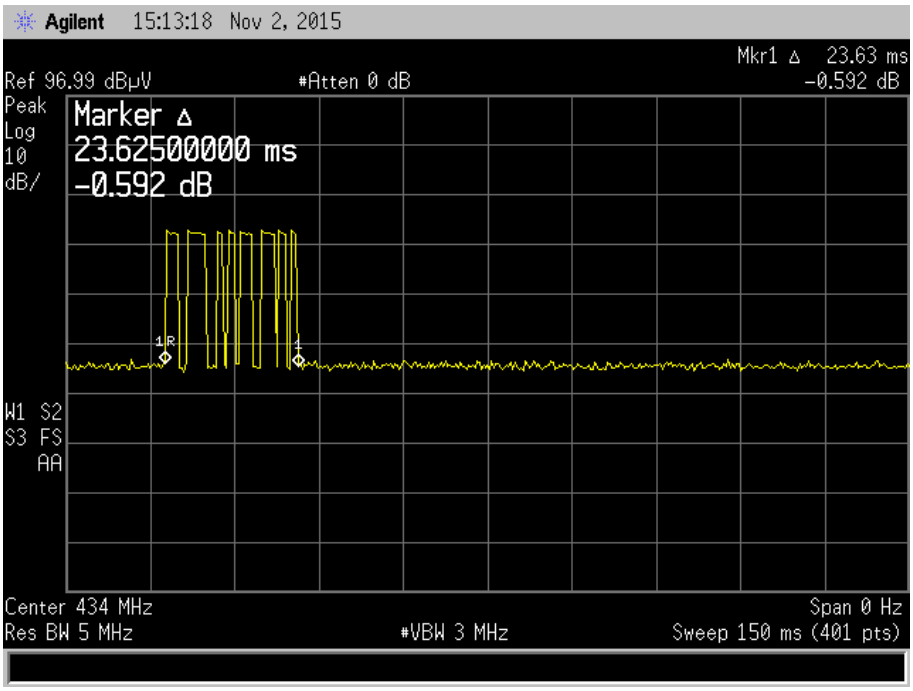


Figure 1. Duty Cycle

Total Time On from Figure 2. = 23.625 ms

(23.625 ms Total Time On)/(100ms FCC Standard) = 0.236 Numeric Duty Cycle
Duty Cycle = 20 Log (.236) = -12.53 dB

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 product.

Table 4. Allowed Antenna(s)

REPORT REFERENCE	MANUFACTURER	TYPE OF ANTENNA	MODEL	GAIN dB_i	TYPE OF CONNECTOR
Antenna	Radio Systems Corp	Inductor	39nH 0805 SMT inductor	N/A	solder

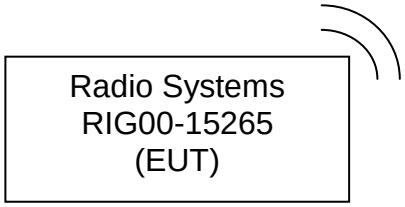


Figure 2. Block Diagram of Test Configuration

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)

The EUT is battery-powered only and does not connect to the AC mains. This test was deemed not applicable.

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.

The test data is detailed below for this section. 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. There were no test failures.

The worst-case radiated emission in the range of 9 kHz to 5 GHz was 1.9 dB below the limit at 1736.00 MHz. This signal is found in the tables below. All other radiated emissions were 3.4 dB or more below the limit.

Table 5. Peak Radiated Emissions 9 kHz to 30 MHz

Test: FCC Part 15, Para 15.209				**Client:** Radio Systems			
Project: 15-0262				**Model:** RIG00-15265			
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector Mode**
All emissions detected in this range were 20 dB or more from the applicable limit.							

Sample Calculations: N/A

Test Date: November 3, 2015
Tested By
Signature: _____ Name: Carrie Ingram

Table 6. Average Radiated Emissions 9 kHz to 30 MHz

Test: FCC Part 15, Para 15.209				**Client:** Radio Systems			
Project: 15-0262				**Model:** RIG00-15265			
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector Mode**
All emissions detected in this range were 20 dB or more from the applicable limit.							

Sample Calculations: N/A

Test Date: November 3, 2015
Tested By
Signature: _____ Name: Carrie Ingram

NOTE: Measurements above 30 MHz are presented in Table 10.

Table 7. Spurious Radiated Emissions (CFR 15.209), 30 MHz to 1000 MHz

30 MHz to 1000 MHz with Class B Limits							
Test: Radiated Emissions				**Client:** Radio Systems Corporation			
Project: 15-0262				**Model:** RIG00-15265			
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**
433.92	27.01	20.62	47.63		3m./VERT		**PK**
433.92	39.00	-7.69	31.31	46.0	3m./VERT	14.7	**QP**
433.92	25.27	21.32	46.59		3m./HORZ		**PK**
433.92	40.50	-6.99	33.51	46.0	3m./HORZ	12.5	**QP**

Tested from 30 MHz to 1 GHz

SAMPLE CALCULATION at 433.92 MHz:

Magnitude of Measured Frequency	39.00	dBuV
+ Antenna Factor + Cable Loss-Amp Gain	-7.69	dB
=Corrected Result	31.31	dBuV/m
Limit	46.00	dBuV/m
-Corrected Result	31.31	dBuV
Margin	14.70	dB

Test Date: November 4, 2015
Tested By
Signature: _____ Name: Carrie Ingram

Table 8. Spurious Radiated Emissions (CFR 15.209), 1 GHz to 5 GHz

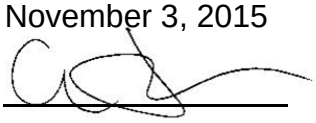
1 GHz to 5 GHz							
Test: Radiated Emissions				**Client:** Radio Systems Corporation			
Project: 15-0262				**Model:** RIG00-15265			
Frequency (MHz)	**Test Data (dBuv)**	**AF+CA-AMP (dB/m)**	**Results (dBuV/m)**	**AVG Limits (dBuV/m)**	**Antenna Distance/ Polarization**	**Margin (dB)**	**Detector PK, or AVG**
1302.00	49.60	-21.29	28.31	54.0	3.0m./VERT	25.7	**AVG**
1302.00	49.22	-21.30	27.92	54.0	3.0m./HORZ	26.1	**AVG**
1736.00	57.15	-19.01	38.14	54.0	3.0m./VERT	15.9	**AVG**
1736.00	58.60	-18.99	39.61	54.0	3.0m./HORZ	14.4	**AVG**
2170.00	51.30	-16.31	34.99	54.0	3.0m./VERT	19.0	**AVG**
2170.00	48.30	-16.30	32.00	54.0	3.0m./HORZ	22.0	**AVG**
2604.00	47.14	-13.92	33.22	54.0	3.0m./VERT	20.8	**AVG**
2604.00	48.00	-13.99	34.01	54.0	3.0m./HORZ	20.0	**AVG**

Note: Duty Cycle of -12.5 dB applied.

Tested from 1 GHz to 5 GHz

SAMPLE CALCULATION at 1302.00 MHz:

Magnitude of Measured Frequency	49.60	dBuV
+ Antenna Factor + Cable Loss-Amp Gain	-21.29	dB
=Corrected Result	28.31	dBuV/m
Limit	54.00	dBuV/m
-Corrected Result	28.31	dBuV
Margin	25.70	dB

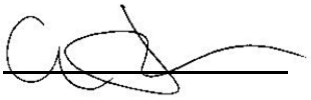
Test Date: November 3, 2015
Tested By
Signature:  Name: Carrie Ingram

2.10 99% Occupied Bandwidth (IC RSS 210, A8.1)

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 approximately 1/100 of the manufacturers claimed RBW and with the VBW ≥ RBW. The results of this test are given in Table 7 and Figure 2.

Table 9. 20 dB Bandwidth and 99% Occupied Bandwidth

Frequency (MHz)	20 dB Bandwidth (kHz)	99% Occupied Bandwidth (kHz)
433.9	N/A	308.78

Test Date: November 2, 2015
Tested By
Signature:  Name: Carrie Ingram

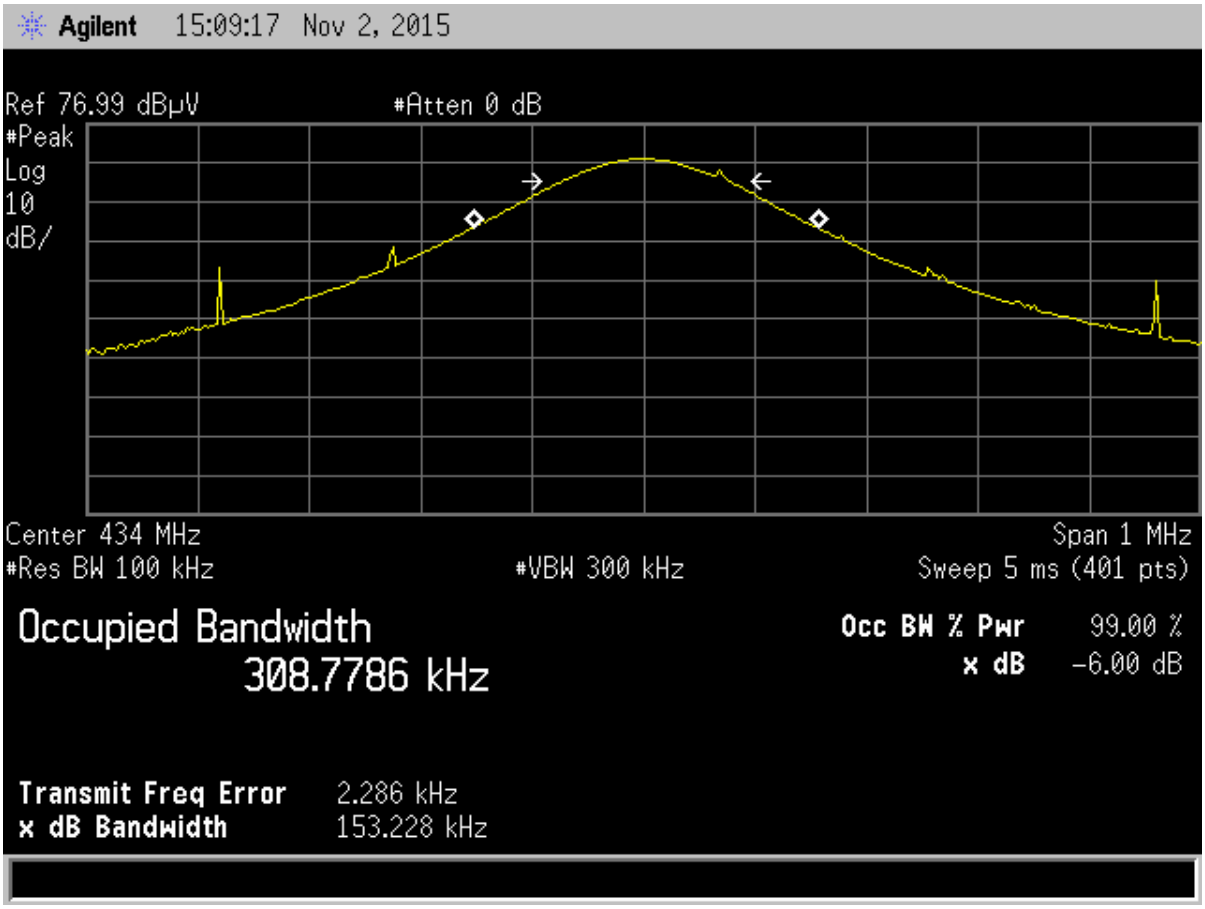


Figure 3. 20 dB & 99% Bandwidth

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 C63.4:2009 and ANSI C63.4:2014, Paragraph 7, with a spectrum analyzer connected to a LISN and the EUT placed into a continuous mode of transmission.

The EUT is battery operated only. It is not designed to either directly or indirectly be connected to the AC mains. This test was deemed not necessary and therefore not performed.

Table 10. Transmitter Power Line Conducted Emissions Test Data, (15.107 and 15.207)

150 KHz to 30 MHz with Class B Limits						
Test: Power Line Conducted Emissions				**Client:** Radio Systems		
Project: 15-0262				**Model:** RIG00-15265		
Frequency (MHz)	**Test Data (dBuv)**	**LISN+CL-PA (dB)**	**Results (dBuV)**	**AVG Limits (dBuV)**	**Margin (dB)**	**Detector PK, QP, or AVG**
The EUT is battery operated ONLY. This test was deemed not applicable.						

Note: (*) denotes QP Limit used.

SAMPLE CALCULATION N/A

Test Date: November 3, 2015
Tested By
Signature: _____ Name: Carrie Ingram

2.12 Spurious Radiated Emissions (CFR 15.109)

Radiated emissions disturbance Measurements were performed with an instrument having both peak and quasi-peak detectors over the frequency range of 30 MHz to five time the highest clock frequency generated or used by the EUT. The provisions of CFR 15.109 were followed. 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.

The worst-case radiated emission in the range of 30 MHz to 5 GHz was 14.2 dB below the limit at 177.48 MHz. This signal is found in the tables below. All other radiated emissions were 15.6 dB or more below the limit.

Table 11. Unintentional Radiated Emissions (CFR 15.109), 30 MHz to 1000 MHz

30 MHz to 1000 MHz with Class B Limits							
Test: Radiated Emissions				**Client:** Radio Systems Corporation			
Project: 15-0262				**Model:** RIG00-15265			
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**
169.59	40.17	-12.25	27.92	43.5	3m./HORZ	15.6	**PK**
177.48	39.91	-10.57	29.34	43.5	3m./VERT	14.2	**PK**
110.56	41.63	-14.79	26.84	43.5	3m./VERT	16.7	**PK**
412.80	27.67	-7.34	20.33	46.0	3m./HORZ	25.7	**PK**
823.18	26.30	1.93	28.23	46.0	3m./HORZ	17.8	**PK**
432.57	26.52	-7.22	19.30	46.0	3m./VERT	26.7	**PK**
823.00	25.17	1.13	26.30	46.0	3m./VERT	19.7	**PK**

Tested from 30 MHz to 1 GHz

SAMPLE CALCULATION at 169.59 MHz:

Magnitude of Measured Frequency	40.17	dBuV
+ Antenna Factor + Cable Loss-Amp Gain	-12.25	dB
=Corrected Result	27.92	dBuV/m
Limit	43.50	dBuV/m
-Corrected Result	27.92	dBuV
Margin	15.60	dB

Test Date: November 4, 2015
Tested By
Signature: _____ Name: Carrie Ingram

Table 12. Unintentional Radiated Emissions (CFR 15.109), 1 GHz to 5 GHz

1 GHz to 5 GHz							
Test: Radiated Emissions				**Client:** Radio Systems Corporation			
Project: 15-0262				**Model:** RIG00-15265			
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 QP**
No emission seen greater than 20 dB from the applicable limit.							

Tested from 1 GHz to 5 GHz

SAMPLE CALCULATION: N/A

Test Date: November 3, 2015
Tested By
Signature: _____ Name: Carrie Ingram

2.13 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%.

2.13.1 Conducted Emissions Measurement Uncertainty

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

This test was not performed.

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 ± 5.39 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 (1 GHz to 18 GHz) is ± 5.15 dB.

The data listed in this test report does not have sufficient margin to negate the effects of uncertainty. Therefore, the EUT conditionally meets this requirement.