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

for the

Radio Systems Corporation

Model: RFA-499

UST Project: 13-0211
Issue Date: July 24, 2013

Number of Pages in this report: 26

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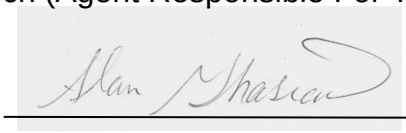
I certify that I am authorized to sign for the test facility and that all of the statements in this report and in the Exhibits attached hereto are true and correct to the best of my knowledge and belief:

US Tech (Agent Responsible For Test):

By: 

Name: Alan Ghasiani

Title: President – Consulting Engineer

Date: July 24, 2013

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MEASUREMENT/TECHNICAL REPORT

COMPANY NAME: **Radio Systems Corporation**

MODEL: **RFA-499 Transmitter**

FCC ID: **KE3-3002646**
IC: **2721A-3002646**

DATE: **July 24, 2013**

This report concerns (check one): Original grant X
Class II change_____

Equipment type: 433 MHz Transmitter

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

If yes, defer until:_____
date

N.A. 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

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1. General Information

The information contained in this report is presented for the FCC Equipment Authorization of Certification of the Equipment Under Test (EUT).

1.1 Product Description

The Equipment Under Test (EUT) is the Radio Systems Model RFA-499. The EUT is the Transmitter portion of the Radio Systems, Train and Praise PDT00-13649, which is designed to assist in controlling pets and rewarding them with a treat. When the animal performs the correct behavior, the Remote Transmitter sends a signal to activate the Receiver to dispense a treat. The fundamental frequency of operation for the EUT is 433.46 MHz.

Because the periodic rate does not exceed the requirement of paragraph (a), paragraph (e) is not invoked.

1.2 Characterization of Test Sample

The sample used for testing was received by US Tech on July 15, 2013 in good operating condition.

1.3 Related Submittal(s)/Grant(s)

The EUT will be used to wirelessly transmit data.

1.4 The EUT is subject to the following authorizations:

a) Certification of the Transmitter.
b) Verification of the non-transmitter part of the EUT as a Digital Device.

2. Tests and Measurements

2.1 Configuration of Tested System

The Test sample was tested per *ANSI C63.4:2003, Methods of Measurement from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (2003).* Radiated emissions data were taken according to paragraph 8.0 with the test receiver or spectrum analyzer's resolution bandwidth adjusted to 9 kHz and 120 kHz, respectively. All measurements are peak unless stated otherwise. The video filter associated with the spectrum analyzer was 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 documented in this test report. A block diagram of the tested system is shown in Figure 1. All test configuration photographs are shown in the Test Configuration Annex.

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 2982A-1 and is also a NVLAP accredited test lab; lab code 200162-0.

2.3 Test Equipment

Table 1. EUT and Peripherals

PERIPHERAL AND MANUFACTURER	MODEL NUMBER	SERIAL NUMBER	FCC ID and IC ID:	CABLES P/D
Transmitter Radio Systems Corp (EUT)	RFA-499	Engineering Sample	Pending: KE3-3002646 2721A-3002646	N/A

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

Table 2. Test Instruments

TYPE	MANUFACTURER	MODEL	SN.	Cal Date.
SPECTRUM ANALYZER	HEWLETT-PACKARD	8566B	3205A00124	11-21-12
SPECTRUM ANALYZER	AGILENT	E4407B	US41442935	10-29-12
RF PREAMP	HEWLETT-PACKARD	8447D	2944A07436	03-04-13
RF PREAMP	HEWLETT-PACKARD	8449B	3008A00480	03-04-13
HORN ANTENNA	EMCO	3115	9107-3723	08-10-11 2 yrs
BICONICAL ANTENNA	EMCO	3110B	9307-1431	02-11-13
LOOP ANTENNA	AH Systems	SAS-200/562	142	08-09-11 2 yrs
LISN X 2	Solar Electronics	8028-50-TS24-BNC	910495-910494	03-01-13
LOG PERIODIC ANTENNA	EMCO	3146	9110-3632	06-05-12 2 yrs
TEMPERATURE CHAMBER	THERMOTRON	SM16	17095	04-24-13
CALCULATION PROGRAM	N/A	N/A	EMCCALC	N/A

2.4 Modifications to Equipment

No modifications were needed to bring the EUT into compliance with the FCC Part 15.209, radiated emissions limits for an intentional radiator, 15.231, *Periodic Operation in the Band 40.66 – 40.70 MHz and above 70 MHz.*

2.5 Test Procedure

The EUT was configured as shown in the following block diagram(s) and photograph(s). The sample was tested per ANSI C63.4:2003, Methods of Measurement for Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz (2003) following US Tech's procedures paragraph 7 for conducted measurements and paragraph 8 for radiated measurements. Conducted and radiated emissions data was taken with the test receiver or spectrum analyzer's resolution bandwidth adjusted to 9 kHz and 120 kHz, respectively. All measurements are peak unless stated otherwise. The video filter on the spectrum analyzer was OFF 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.

2.5.1 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 as follows:

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

2.5.2 Frequency Range of Radiated Measurements

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.

Unintentional Radiator

For the digital device, an unintentional radiator, the frequency range shall be 30 MHz to 1000 MHz, or to the range specified in 2.4.1 above, whichever is the higher range of investigation and according to the table in 47 CFR 15.33(b).

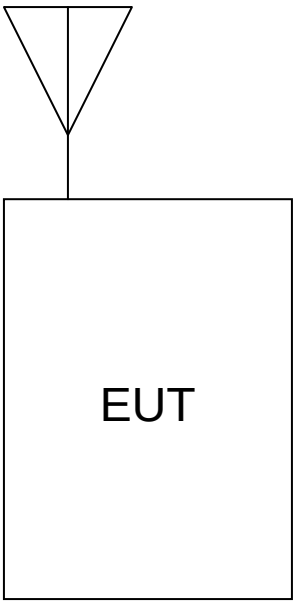


Figure 1. Test Configuration

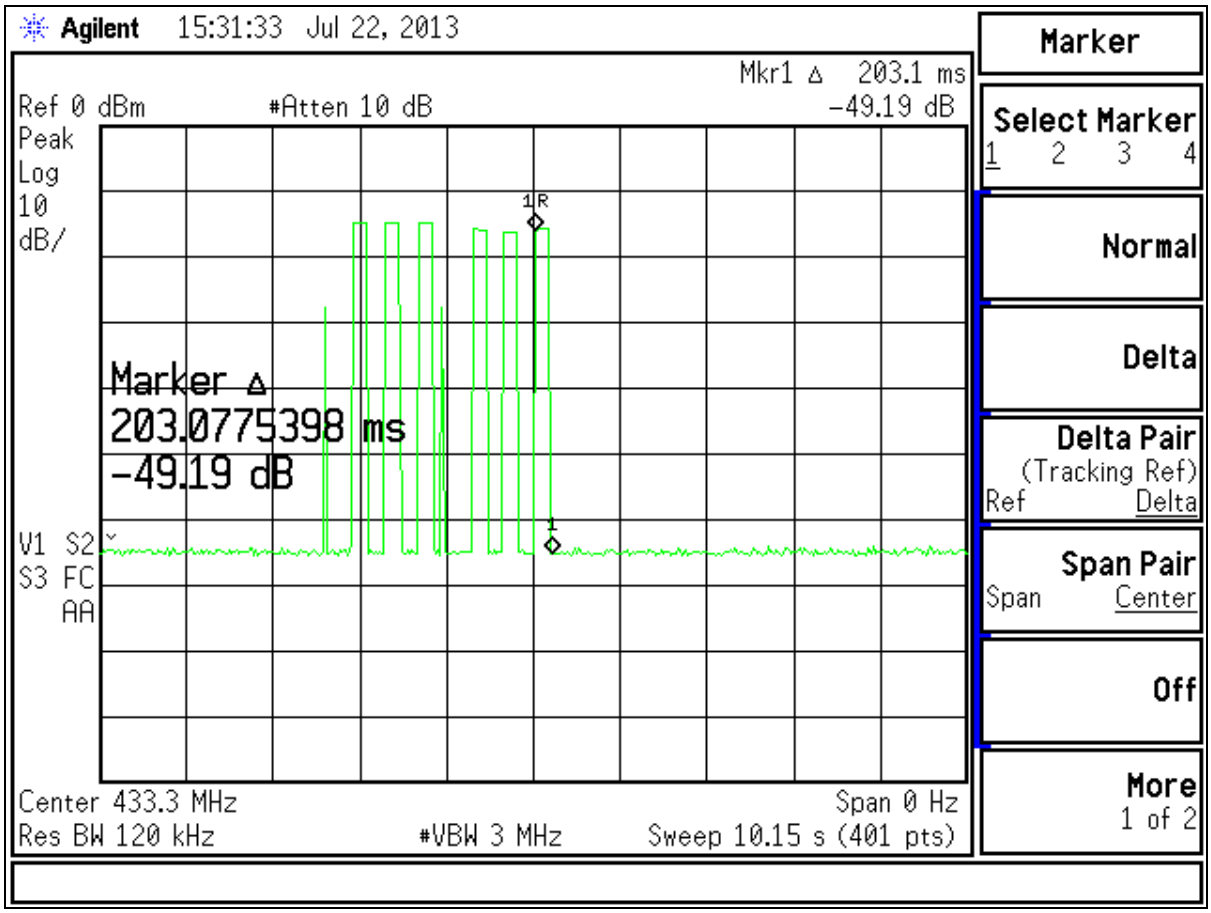


Figure 2. Deactivation per 15.231(a)(1)

Note: The EUT deactivates within 5 seconds.

2.6 EUT Antenna Description (FCC Sec. 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.

Radio Systems Corporation RFA-499 transmitter incorporates the following antenna only.

Table 4. Antenna Description

MANUFACTURER	TYPE	MODEL	GAIN dB_i
Radio Systems Corporation	Printed Copper Trace	Integral	-20

2.7 Intentional Radiator, Power Lines Conducted Emissions (47 CFR 15.207)

The power line conducted voltage emission measurements have been carried out in accordance with CFR 15.207, per ANSI C63.4:2003, Paragraph 7, with a spectrum analyzer connected to an LISN and the EUT placed into a continuous mode of transmission.

The EUT is battery operated and does not connect to the Mains.

Table 5. Conducted Emissions (Powerline), Intentional Emissions

CONDUCTED EMISSIONS						
Tested By: GY	Test: FCC Part 15.107 Class B		Project No.: 13-0211	Manufacturer: Radio Systems Corporation		
				Model: RFA-499 Transmitter		
Frequency (MHz)	**Test Data (dBuV)**	**LISN+CL-PA (dB)**	**Corrected Results (dBuV)**	**Avg Limits (dBuV)**	**Margin (dB)**	**Detector**
EUT is battery operated; this test not applicable.						

Test Date: July 22 , 2013
Tested By
Signature: _____ Name: George Yang

2.8 Field Strength of Fundamental (47 CFR 15.231(b))

The results of the measurements for peak fundamental emissions are given in Table 5. The EUT emissions measurement was started by setting up the Log-periodic Antenna (L-pA) or generally, any 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 packages' 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 suspicious signal is found, center the signal on the screen and raise the L-pA to the 4-meter height while observing the SA display for changes to the max-hold and free-running display. Next, the antenna is lowered to 1 meter height above the ground plane while observing the channel A and B displays. The display having max-hold shows the maximum signal seen across the height range of 1 to 4 meters. The next action is to raise or lower the antenna until the free-running display matches the Max-hold display's magnitude on the SA screen. When this occurs, the signal is maximized for antenna height. Record the antenna height on the data sheet corresponding to the present frequency.

When the antenna height has been maximized, the next step in the measurement process is to maximize the EUT direction with respect to the receiving antenna. Rotate the turn-table through 360 degrees with one SA channel set for max-hold and the other channel in free-run mode. The object is to find that azimuth direction where the free-running indication just matches the greatest max-hold indication. This is the direction where the signal is peaked for azimuth. Record the direction on the data sheet next to the frequency.

When all signals have been maximized for antenna height and direction, the EUT case 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 allows a maximized signal to be read from the display, then that signals' magnitude is recorded on the data sheet for that particular frequency.

Next, re-orient the measurement antenna to Horizontal polarization at 1 meter height and repeat the above antenna and directional maximization processes for the greatest signals found across the frequency spectrum of interest. Record all signals within 6 dB of the limit.

Finally, Input the collected data 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))

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

Table 6. Intentional and Unintentional Radiation Limits at 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
470 and above	12,500	1,250
* Linear Interpolation		

Note: formula 1: $limit_1$ in uV/m = Y= 41.667(Frequency in MHz) – 7083.5
2: $limit_2$ in uV/m = Y= 4.1667(Frequency in MHz) – 708.35

The frequency spectrum above the fundamental to its 10^{th} harmonic shall be 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 apply. Spurious and harmonics shall meet the requirements of the above table or the requirements of 15.209, whichever requirement permits a higher field strength.

Table 7. Intentional Radiated Emissions (Peak)

Intentional Radiator Radiated Emissions							
Test By:	Test: Part 15B, Part 15.231			Client: Radio Systems Corporation			
KM	Project: 13-0211	Class: B		Model: RFA-499 Transmitter			
Frequency (MHz)	**Peak Test Data (dBuV)**	**AF+CL-PA (dB/m)**	**Peak Corrected Results (dBuV/m)**	**Limits (dBuV/m)**	**Application Test Distance/ Polarization**	**Margin (dB)**	**Detector Used**
433.46	69.10	16.71	85.81	101.0	1LP3mV	15.2	**PK**
866.92	48.00	22.81	70.81	81.0	1LP3mV	10.2	**PK**
1300.20	60.73	-11.84	50.39	74.0	1HN3mV	23.6	**PK**
1733.36	64.78	-11.34	54.94	81.0	1HN3mV	26.1	**PK**
2167.39	56.47	-10.29	47.68	81.0	1HN3mV	33.3	**PK**
2600.74	67.26	-8.89	59.87	81.0	1HN3mV	21.1	**PK**
3034.22	63.00	-7.57	56.93	81.0	1HN3mV	24.1	**PK**
3466.73	58.20	-6.67	53.03	81.0	1HN3mV	28.0	**PK**
3901.55	54.98	-5.16	51.32	74.0	1HN3mV	22.7	**PK**
4334.57	54.50	-6.23	49.77	74.0	1HN3mV	24.2	**PK**
Measurements were made over the frequency range of fundamental to 10th harmonic							

Tested from Fundamental to 10th Harmonic

SAMPLE CALCULATIONS: At 433.46 MHz = 69.10 + (16.71) = 85.81 dBuV

Test Date: July 17, 2013

Tested by
Signature: _____ Name: John C. Wynn

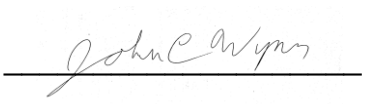
Table 8. Intentional Radiated Emissions (AVG)

Intentional Radiator Radiated Emissions							
Test By:	Test: Part 15B, Part 15.231			Client: Radio Systems Corporation			
JW	Project: 13-0211		Class: B	Model: RFA-499 Transmitter			
Frequency (MHz)	**Peak Test Data (dBuV)**	**AF+CL-PA (dB/m)**	**Peak Corrected Results (dBuV/m)**	**Limits (dBuV/m)**	**Application Test Distance/ Polarization**	**Margin (dB)**	**Detector Used**
433.46	65.00	8.77	73.77	81.0	1lp3mv	7.2	**AVG**
866.70	37.20	14.87	52.07	61.0	1lp3mv	1.0	**AVG**
1300.20	52.15	-19.78	33.87	54.0	1hn3mv	12.2	**AVG**
1733.36	58.29	-19.28	40.51	61.0	1hn3mv	12.6	**AVG**
2167.39	48.51	-18.23	31.78	61.0	1hn3mv	21.3	**AVG**
2600.74	58.68	-16.83	43.35	61.0	1hn3mv	9.7	**AVG**
3034.22	53.84	-15.51	39.83	61.0	1hn3mv	13.2	**AVG**
3466.73	48.92	-14.61	35.81	61.0	1hn3mv	17.2	**AVG**
3901.55	45.23	-13.10	33.63	54.0	1hn3mv	12.4	**AVG**
4334.55	43.93	-14.17	31.26	54.0	1hn3mv	14.8	**AVG**
Measurements were made over the frequency range of fundamental to 10th harmonic							

Note: Duty Cycle factored into the test data (DC= -7.94 dB).
Tested from Fundamental to 10th Harmonic

SAMPLE CALCULATIONS: At 866.70 MHz = 37.20 + 14.87 = 52.07 dBuV

Test Date: July 17, 2013

Tested by
Signature:  Name: John C. Wynn

2.10 Peak Radiated Spurious Emissions, 30 MHz to 1000 MHz

The peak radiated spurious emissions were measured over the frequency range of 30 MHz to 5 GHz. The spurious emissions have been recorded and can be seen in the Test Table herein.

2.11 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:

Under worst case conditions, the maximum duration of each transmission is as follows: the transmitter stays on for 150ms (Marker 2 – Marker 1 or 526.1ms - 376.1ms). The transmitter is off for 223.9ms (Marker 3 – Marker 2 or 750ms – 526.1ms) see plot below.

The total period is 373.9ms (Marker 3 – Marker 1 or 750ms – 376.1ms). Thus, the duty cycle is 40.1% (On Period/Total Period or 150ms/373.9ms). In terms of logarithmic voltage: dB = 20 log (0.401) = **-7.94** this is the Duty Cycle Factor.

See the plot below for details.

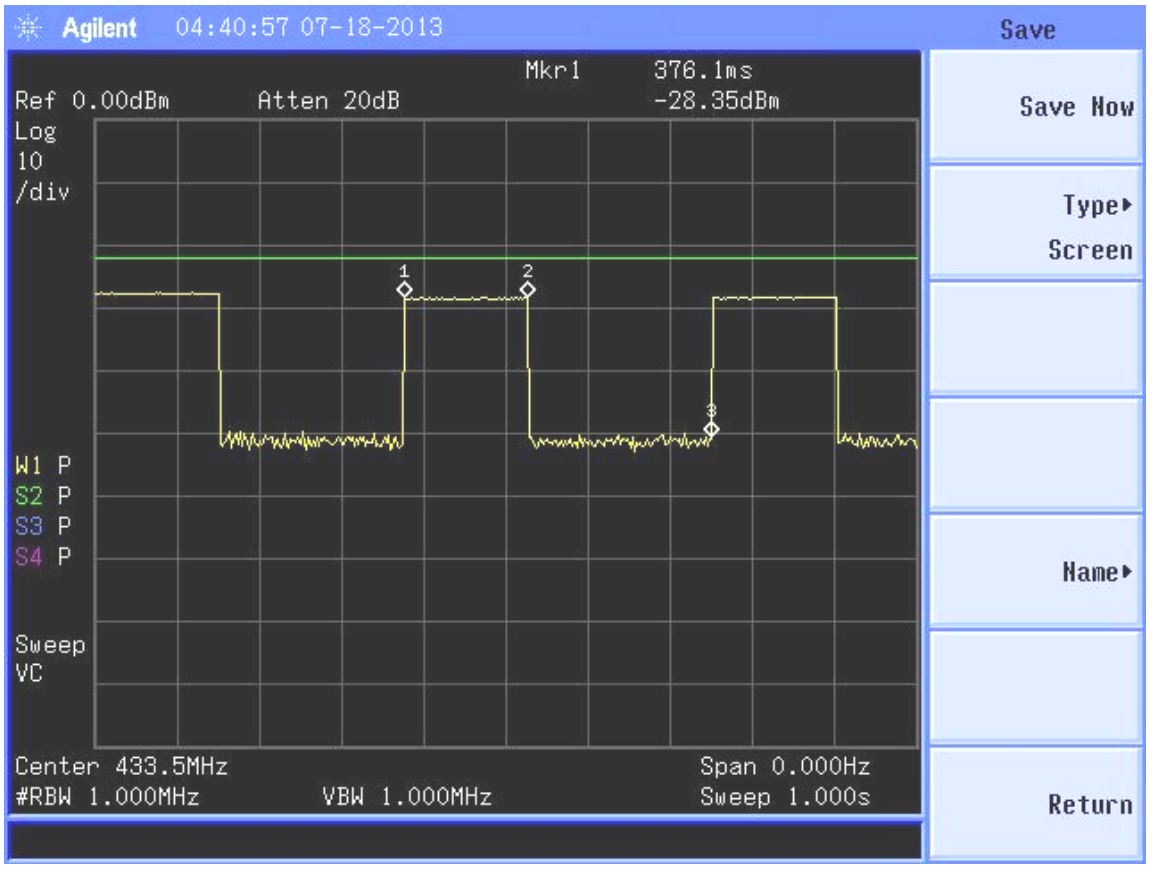


Figure 3. Duty Cycle

2.12 Bandwidth of Fundamental (CFR15.231 (c))

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

0.0025 x 433.46 MHz = 1.08365 MHz

The measured 20 dB bandwidth is **433.01 kHz**.
The measured 99% Occupied bandwidth is **375.452 kHz**.

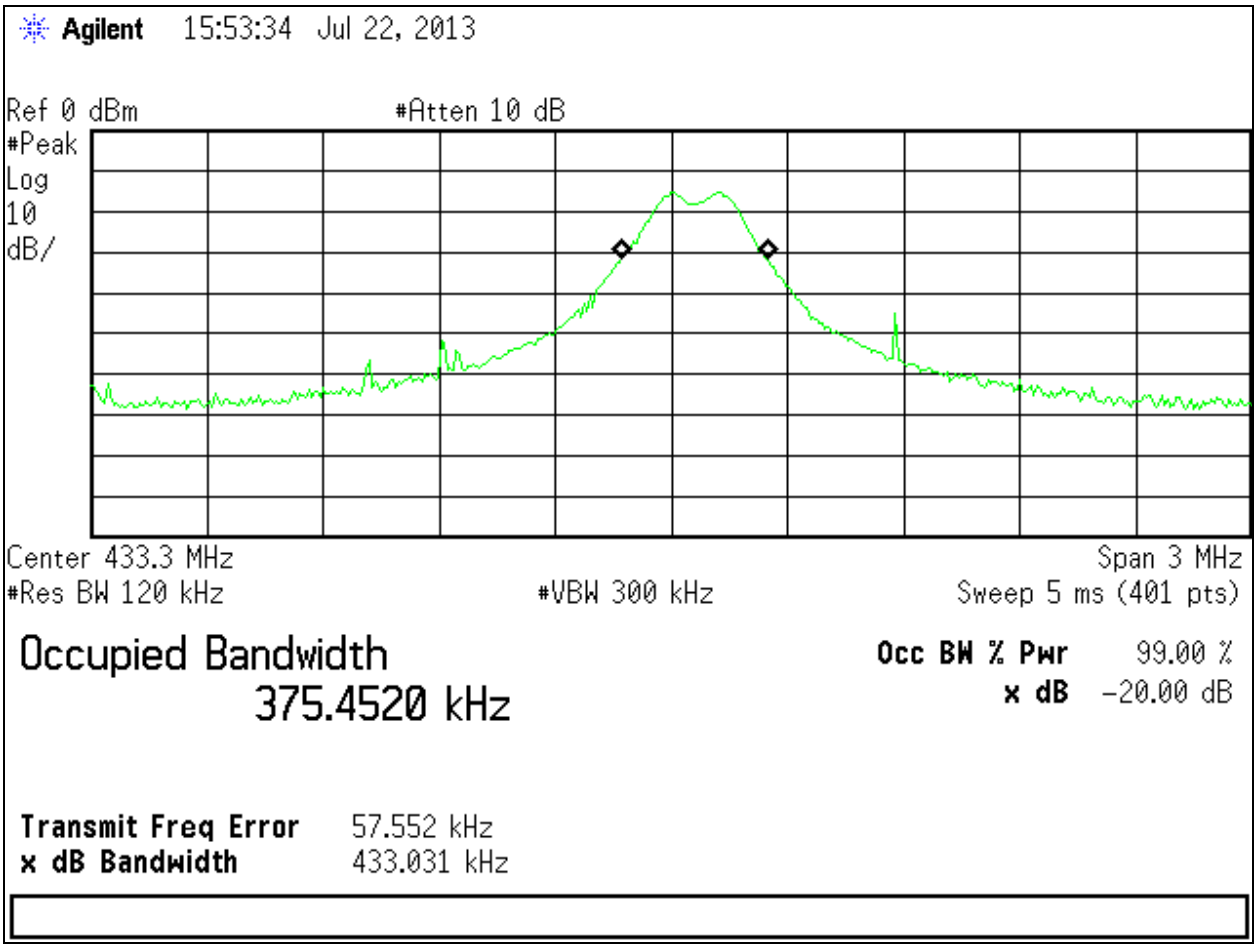


Figure 4. 20 dB and Occupied Bandwidth Plot

2.13 Power Line Conducted Emissions for Transmitter, Unintentional Emissions

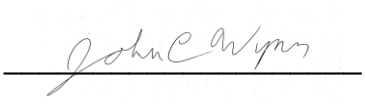
The power line conducted voltage emission measurements have been carried out in accordance with CFR 15.207, per ANSI C63.4:2003, Paragraph 7, with a spectrum analyzer connected to an LISN and the EUT placed into a continuous mode of transmission.

The EUT is battery operated and does not connect to the Mains.

Table 9. Conducted Emissions (Powerline), Unintentional Emissions

CONDUCTED EMISSIONS						
Tested By: GY	Test: FCC Part 15.107 Class B		Project No.: 13-0211	Manufacturer: Radio Systems Corporation		
				Model: RFA-499 Transmitter		
Frequency (MHz)	**Test Data (dBuV)**	**LISN+CL-PA (dB)**	**Corrected Results (dBuV)**	**Avg Limits (dBuV)**	**Margin (dB)**	**Detector**
EUT is battery operated. This test not applicable.						

Test Date: July 17, 2013

Tested by
Signature:  Name: John C. Wynn

2.14 Unintentional Radiator Radiated Emissions (47 CFR 15.33(a); 15.109(a))

The test data provided herein is to support the Verification requirement for digital devices. Radiated emissions coming from the EUT in a non-transmit state were evaluated from 1.705 MHz or the lowest emissions generated by the EUT up to 30 MHz per 47 CFR 15.33a and 30 MHz to 2 GHz per ANSI C63.4:2003, Paragraph 8.

Radiated emissions within the band of 9 kHz to 30 MHz were investigated using a calibrated Loop Antenna and per the requirements of ANSI C63.4:2003. The resolution bandwidth was set to 9 kHz, the video bandwidth was set to three times the resolution bandwidth.

For measurements above 30 MHz the measurements were made with the analyzer's resolution bandwidth set to 120 kHz for measurements made below 1 GHz and 1 MHz for measurements made above 1 GHz. The video bandwidth was set to three times the resolution bandwidth. The test data were maximized for magnitude by rotating the turn-table through 360 degrees and raising and lowering the receiving antenna between 1 to 4 meters in height as a part of the measurement procedure. All measured signals were at least 6 db below the specification limit.

Table 10. Unintentional Radiated Emissions

Unintentional Radiator Radiated Emissions							
Test By: JCW	Test: Part 15B, Para 15.33, 15.109			Client: Radio Systems Corporation			
	Project: 13-0211	Class: B		Model: RFA-499 Transmitter			
Frequency (MHz)	**Peak Test Data (dBuV)**	**AF+CL-PA (dB/m)**	**Peak Corrected Results (dBuV/m)**	**Average Limits (dBuV/m)**	**Application Test Distance/ Polarization**	**Margin (dB)**	**Detector Used**
Measurements were made over the frequency range of 150 kHz – 2.5 GHz							
3901.1900	47.02	1.89	48.91	54.0	3m/Vert	5.1	**PK**
4334.7250	41.20	-7.96	33.24	54.0	1m/Horz	20.8	**PK**
4334.8000	37.55	-8.03	29.52	54.0	1m/Vert	24.5	**PK**
No other emissions found greater than 20 dB below the limit.							

Note 1: Tested from 150 kHz to 19 GHz

SAMPLE CALCULATIONS: At 3901.19 MHz = 47.02 + (1.89) = 48.91 dBuV

Test Date: July 23, 2013

Tested by
Signature: _____ Name: John C. Wynn

2.15 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%.

2.15.1 Conducted Emissions

Measurement Uncertainty (within a 95% confidence level) for this test is ±2.8 dB.

The EUT is DC power and does not connect directly or indirectly to the AC mains. This test is not applicable.

2.15.2 Radiated Emissions

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 ±5.3 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 ±5.1 dB.

The measurement uncertainty (with a 95% confidence level) for this test using a Horn Antenna is ±2.45 dB.

The data listed in this test report does have sufficient margin to negate the effects of uncertainty; therefore, the EUT unconditionally passes this requirement.

2.16 Carrier Frequency Stability (RSS-210, A1.2.3.2(4))

The carrier frequency shall be maintained to ±0.002% (±20 ppm)

Table 11. Frequency Stability @ 3.0VDC

Frequency Stability vs. Temperature (At Startup) 3.0VDC		
Measured		
Temperature (degrees C)	Frequency (MHz)	Deviation (ppm)
-30	433.3313	-13.3
-20	433.3375	1.2
-10	433.3350	-4.6
0	433.3313	-13.3
10	433.3380	2.3
20	433.3370	0.0
30	433.3455	19.6
40	433.3431	14.0
50	433.3371	0.3
Actual TX Frequency was:		433.4815

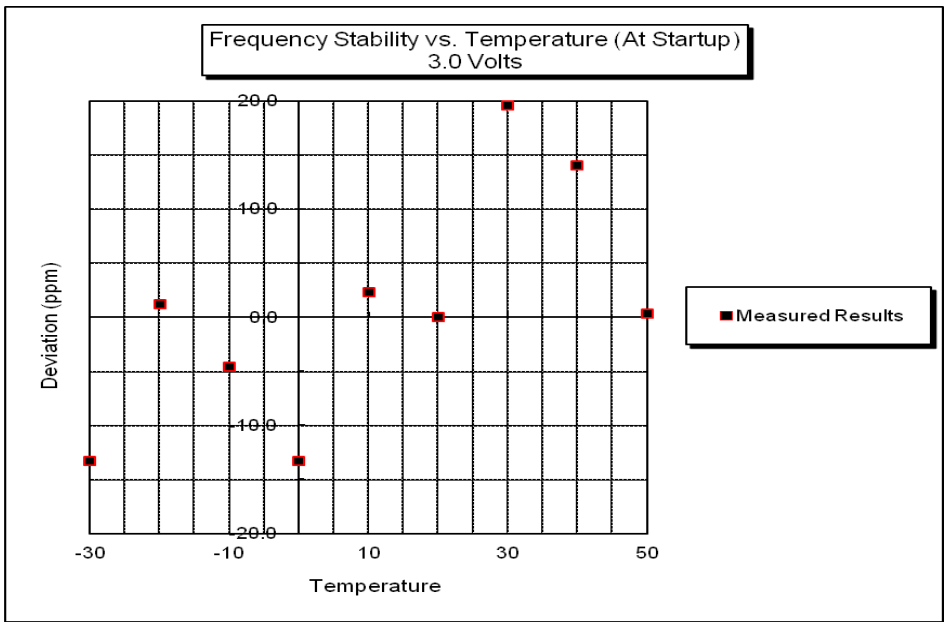


Figure 5. Frequency Stability Plot @ 3.0VDC

Table 12. Frequency Stability @ 2.5VDC

Frequency Stability vs. Temperature (At Startup) 2.5VDC		
Measured		
Temperature (degrees C)	**Frequency (MHz)**	**Deviation (ppm)**
-30	433.3313	-13.3
-20	433.3340	-6.9
-10	433.3363	-1.7
0	433.3300	-16.2
10	433.3386	3.7
20	433.3370	0.0
30	433.3431	14.1
40	433.3436	15.2
50	433.3374	1.0
Actual TX Frequency was:		433.3370

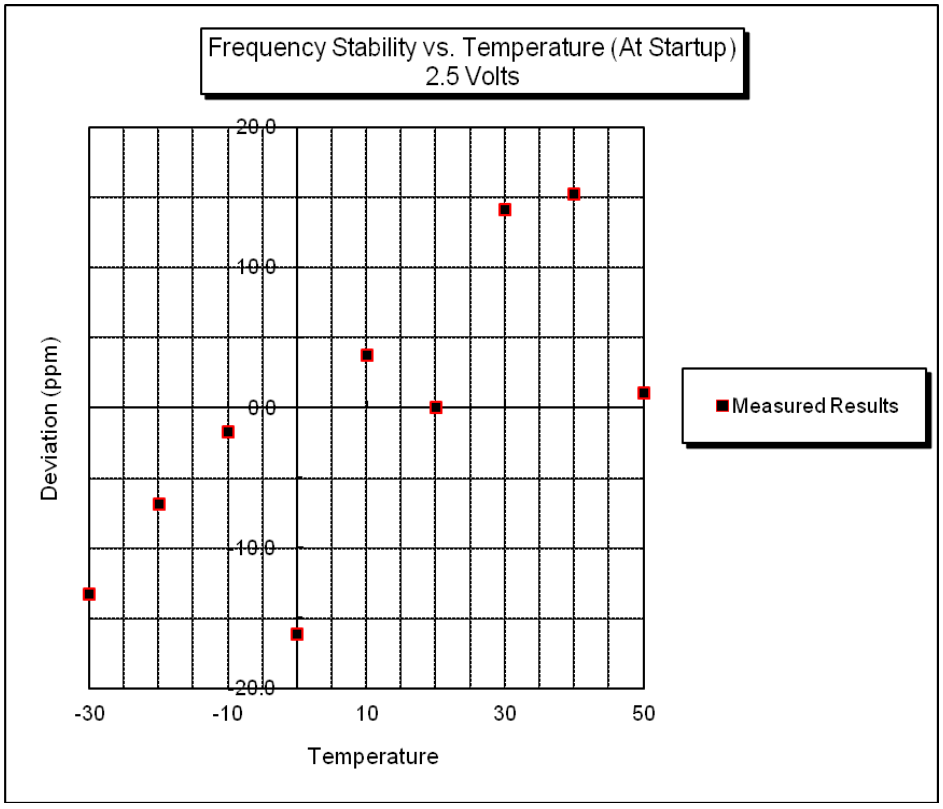


Figure 6. Frequency Stability Plot @ 2.5VDC