Resolution Products, Inc.

RE524X Wireless to Wireless Translator
FCC ID: U5X-RE524X

Certification Test Report

February 17, 2016

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1. Introduction

The RE524X is a universal translator intended for use in a wireless security system. The unit is powered by a 12VDC power supply. 24 hour battery backup is provided by a 6V 800mAH NiMh battery pack. The device measures 8.5" x 5" x 1.5" and weighs approximately 16 ounces.

The device retransmits security sensor messages for the purpose of alerting a security system. The RE524X was designed to be compatible with several popular security system sensors. An internal rotary encoder switch is used to select a mode of operation compatible with the desired sensors. The sensor selection setting determines both the receive protocol and frequency. There are five possible sensor selection settings: GE®, 2GIG®, HW®, NAPCO®, and DSC®. Depending on the sensor selection setting, the receiver will operate at either 319.5 MHz, 345 MHz, or 433.92 MHz. The receiver is monitored by a PIC16LF1527 microcontroller for valid messages from security sensors. For a message to be considered valid, it must pass several very stringent requirements.

1. At each receiver frequency setting, the receiver is narrow-band, with a 3dB bandwidth of 180 kHz.
2. The message must have the correct modulation type. The correct modulation type is determined by the sensor selection setting.
3. The message must have the correct modulated edge-to-edge bit timing for every bit in the message. The correct modulated edge-to-edge bit timing is determined by the sensor selection setting.
4. The message must have the correct preamble and start bit pattern. The correct preamble and start bit pattern is determined by the sensor selection setting.
5. The message must have the correct number of total valid packet bits. The correct number of total valid packet bits is determined by the sensor selection setting.
6. The message error detection value must resolve correctly.

When a valid message is received from a security sensor, the RE524X retransmits the message. The device also transmits packets which indicate the status of two internal tamper switch inputs. A PIC16LF1527 microcontroller is used to monitor these inputs for changes. When a valid change is detected on either of these tamper switch inputs, the device transmits eight packets. In the absence of tamper switch activity, a set of three supervision packets is sent by the device every 60 to 90 minutes.

The RE524X was designed to be compatible with several popular security system panels. An internal rotary encoder switch is used to select a mode of operation compatible with the desired panel. The panel selection determines both the transmit protocol and carrier frequency. There are four possible settings: GE®, 2GIG®, HW®, and DSC®. Depending on the panel selection setting, the transmitter will operate at either 319.5 MHz, 345 MHz, or 433.92 MHz.

The RE524X transmitter circuit consists of a Silicon Labs SI4460 transceiver chip, 32 MHz crystal, and associated passives. Circuitry within the SI4460 transceiver chip is used to provide ASK modulation of the transmitted carrier. The RF signal is then radiated by one of two wire antennas. The antenna from which to transmit is selected by the PIC16LF1527 microcontroller.

Regardless of sensor or panel selection settings, precautions are taken in the firmware to ensure there is at least 100mS between packets, and that the transmissions cease within 5 seconds as required.

Certification is requested under FCC Rules, Part 15, Subpart C, Paragraph 15.231.

2. Statement of Compliance

Specific sections of FCC Rules Part 2 that require information or listing are given below.

2.1. FCC Part 2 §2.907

This is an application for certification of original equipment

2.2. FCC Part 2 §2.911

a) This application has been filed electronically using form 731.
b) All required information has been supplied in this application and its attachments.
c) This application has been electronically signed by an officer of Resolution Products, Inc.
d) The technical test data has been signed by the agency performing the testing.
e) Signature supplied in appropriate block on form 731.
f) Processing fee has been paid.

g) Signatures have been supplied electronically.

2.3. FCC Part 2 §2.913

a) This application has been filed electronically.
b) Appropriate fees have been filed electronically.
c) Equipment samples shall be supplied as requested.

2.4. FCC Part 2 §2.915

We are requesting a grant of certification. This application shows compliance with the technical standards.

2.5. FCC Part 2 §2.925

A label shall be affixed to each piece of equipment, showing the FCC identifier. The label shall read "FCC ID: U5X-RE524X". See Exhibit B for a photograph showing the label and location on the device.

2.6. FCC Part 2 §2.943, 2.945

Sample production equipment shall be submitted to the FCC upon request.

2.7. FCC Part 2 §2.947

a) Measurement procedure follows ANSI C63.4: 2009.
b) A description of utilized test equipment is contained in the report.

2.8. FCC Part 2 §2.948

Radiated measurements were taken at the following FCC-approved facility:

Rhein Tech Laboratories, Inc.
360 Herndon Parkway, Suite 1400
Herndon, VA 20170 USA
Contact: Rick McMurray
703-689-0368

Photographs of the test site are shown in Exhibit J.

2.9. FCC Part 2 §2.1033

a) Form 731 has been filed electronically.
b) The technical report, along with its exhibits, contains the information as follows:
(1) full name and mailing address of the manufacturer of the device and the applicant for certification:

Resolution Products, Inc.
1402 Heggen St.
Hudson, WI 54016

(2) FCC Identifier is U5X-RE524X
(3) Copy of the installation/user instructions is furnished as Exhibit E.
(4) A brief description of the device and operation is furnished in Exhibit F. Schematic is furnished in Exhibit G.
(5) Block diagram furnished in Exhibit H.
(6) This document constitutes a technical test report.
(7) Internal and external photographs have been furnished in Exhibits A and C.
(8) Not applicable. There are no peripheral or accessory devices used with this device. It is a standalone device.
(9) This application not pursuant to the transition rules of section 15.37
(10) Not applicable. This device does not include a scanning receiver.
(11) Not applicable.
(12) Not applicable.
c) Not applicable. This device shall operate under Part 15 of the rules.

d) Not applicable.
e) Not applicable. This is not a composite system.

3. Discussion of Laboratory Measurements and Rules Compliance

3.1. FCC Part 15 §15.231(a)(1)

This transmitter is activated via one of two internal tamper switches, or by the reception of a valid security sensor message. When a valid security sensor message is received, or a tamper switch activation is detected, the device transmits eight packets. Depending on the panel selection, the packets vary in length from 16.35mS to 26.5mS. The spacing between each packet is randomized from 100mS to 240mS. For 2GIG® and HW® panel selections, a 1-second space is used between the 4th and 5th packets. Upon completion of these packets, the device enters sleep mode and will not transmit until another activation is detected, or another valid security sensor message is received. In the absence of tamper switch activity, a set of three supervision packets is sent by the device every 60 to 90 minutes.

The plots that follow (made using a Hewlett Packard Model 8594E Spectrum Analyzer) show the packet transmissions occurring in a 5 second window resulting from one activation. The packets are shown to conclude within the 5-second window regardless of panel selection.

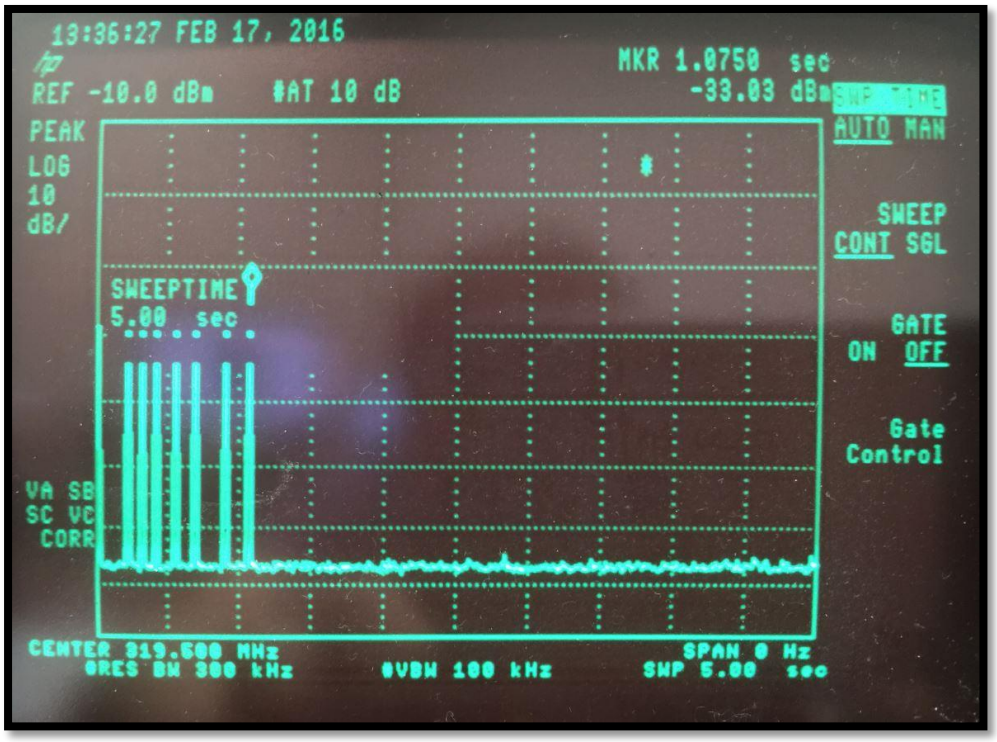

Figure 1: 5-Second Window (GE® Panel Selection)

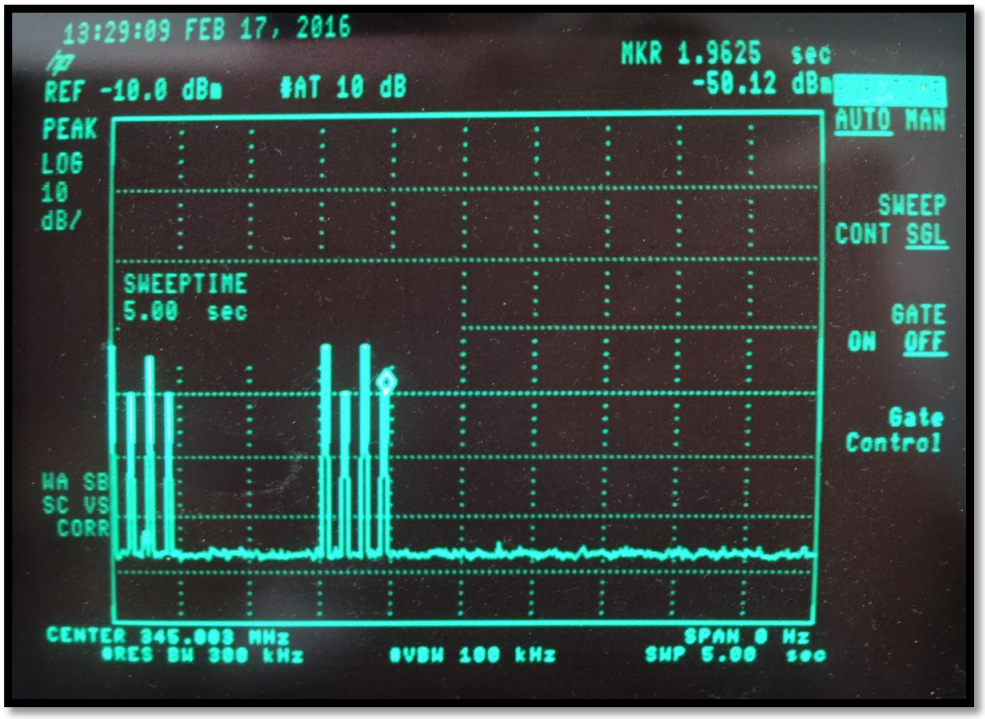

Figure 2: 5-Second Window (2GIG® Panel Selection)

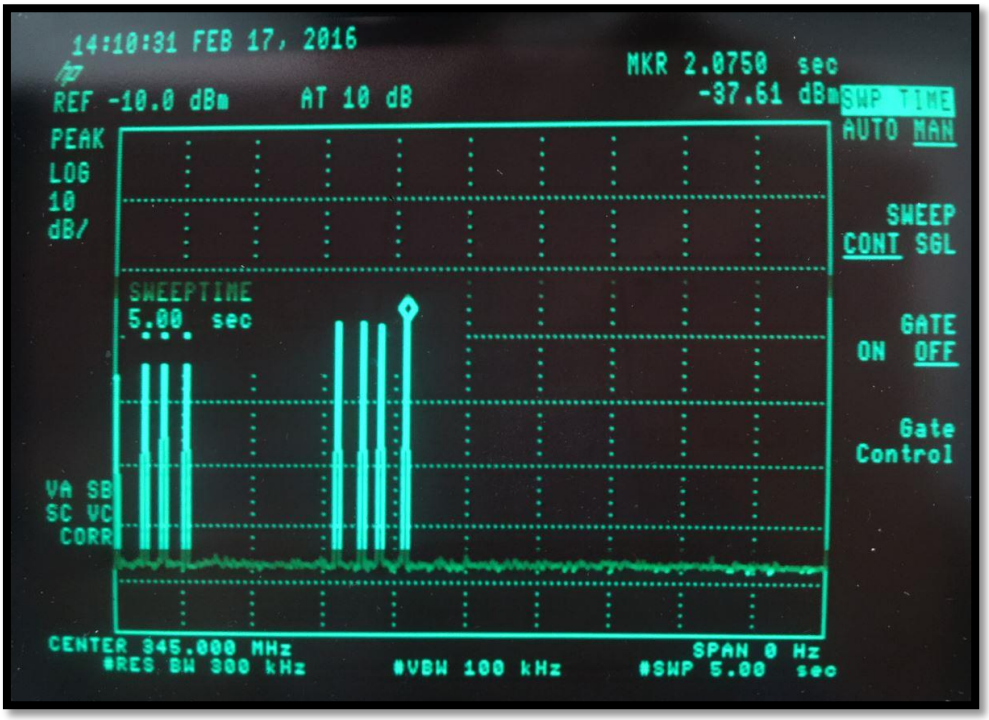

Figure 3: 5-Second Window (HW® Panel Selection)

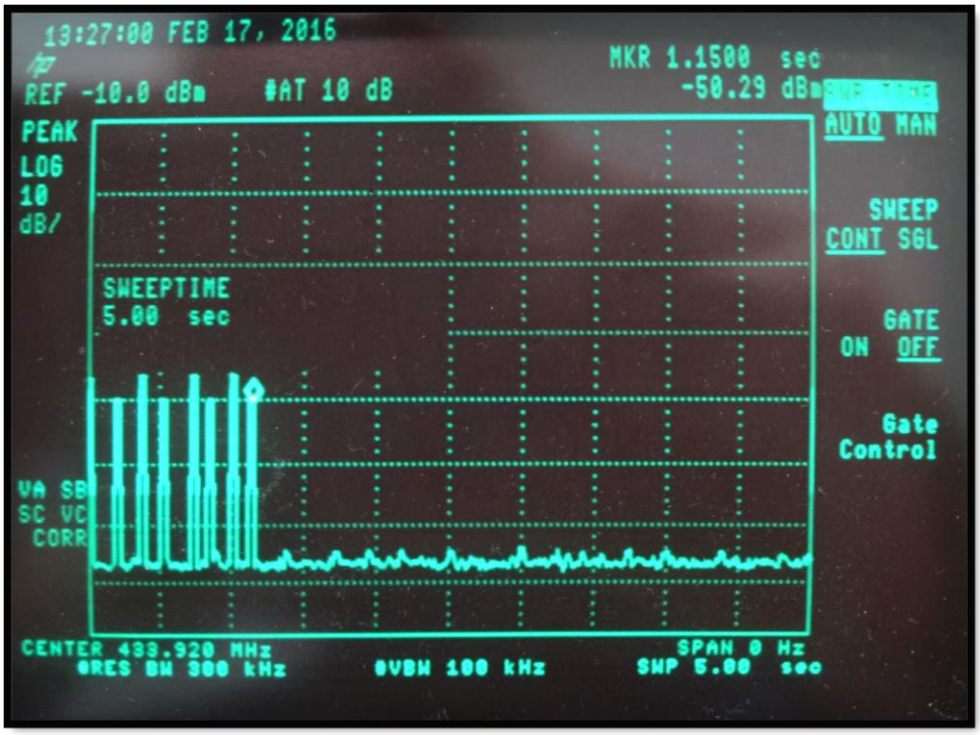

Figure 4: 5-Second Window (DSC® Panel Selection)

3.2. FCC Part 15 §15.231(a)(3)

Depending on panel selection, the supervision interval ranges from 60 to 90 minutes. If no tamper switch activations have been detected within this supervision interval, a set of three supervision packets is transmitted. Regardless of panel selection, the total transmission time resulting from these supervision transmissions is well under the allowed 2 seconds per hour. Each set of three supervision packets conclude within the required 5-second window.

3.3. FCC Part 15 §15.231(a)(4)

Device does not continue transmitting beyond the packets resulting from each activation.

3.4. FCC Part 15 §15.231(a)(5)

There is no setup information transmitted with this device.

3.5. FCC Part 15 §15.231(b)

3.5.1. Raw Field Strength Limits

Interpolation performed on the data in the §15.231(b) table yields raw field strength limits as shown in *Table 1*.

Carrier Frequency	Fundamental	Spurious
319.50 MHz	75.900 dBuV/m	55.900 dBuV/m
345.00 MHz	77.250 dBuV/m	57.250 dBuV/m
433.92 MHz	80.825 dBuV/m	60.825 dBuV/m

Table 1: Raw Field Strength Limits

Certain harmonics of the transmitted signal fall in the restricted bands of §15.205. Regardless of panel selection, these harmonics are all above 960MHz and have the following limit as given in §15.209:

Restricted band limit = 500uV/m = 54dBuV/m.

3.5.2. Duty Cycle Correction Factor and Resulting Limits

The RE524X was designed to be compatible with several popular security system panels and sensors. Two internal rotary encoder switches are used to select a mode of operation compatible with the desired panel and security sensors. The panel selection determines both the transmit protocol and the carrier frequency. There are four possible settings: GE®, 2GIG®, HW®, and DSC®. Depending on the panel selection setting, the transmitter will operate at either 319.5 MHz, 345 MHz, or 433.92 MHz.

A summary of the duty cycle correction factor, and resulting limits for each panel selection setting, is shown in *Table 2*. Sections 3.5.2.1 through 3.5.2.4 provide supporting documentation, calculations, and plots pertaining to each panel selection setting.

Panel Selection	Carrier (MHz)	100mS Duty Cycle (%)	Duty Cycle Correction Factor (dB)	Raw Field Strength Limits			Resulting Corrected Field Strength Limits		
				Fundamental (dBuV/m)	Spurious (dBuV/m)	Restricted Band (dBuV/m)	Fundamental (dBuV/m)	Spurious (dBuV/m)	Restricted Band (dBuV/m)
GE®	319.50	7.93%	-22.01	75.90	55.90	54.00	95.90	75.90	74.00
2Gig®	345.00	8.64%	-21.27	77.25	57.25	54.00	97.25	77.25	74.00
HW®	345.00	8.64%	-21.27	77.25	57.25	54.00	97.25	77.25	74.00
DSC®	433.92	8.50%	-21.41	80.825	60.825	54.00	100.825	80.825	74.00

Table 2: Duty Cycle Correction Factor Summary and Resulting Limits

3.5.2.1. GE® Panel Selection - 319.5 MHz

The following pertains to the RE524X transmitter operation using the GE® panel selection. In this mode the transmitter uses ASK modulation. 63 bits are transmitted in each packet, and the “on” time for each bit is 122uS, except for one bit which has an "on" time of 366uS. The resulting “on” time per packet is 7.93mS. The transmitted packets are limited to one packet in a 100mS period. The transmitter duty cycle over a 100mS time period is therefore 7.93/100 = 7.93%.

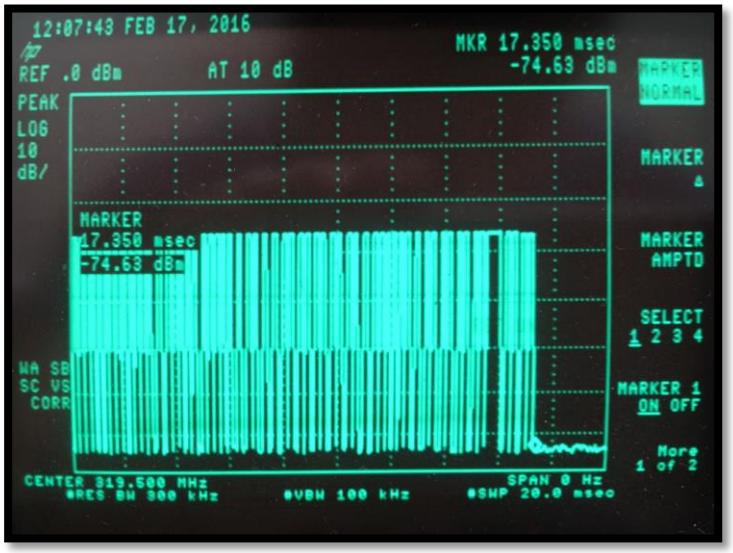

Figure 5: Packet Width Plot (GE® Panel Selection)

Calculating the allowed duty cycle correction factor as given in §15.35(c):

20log(7.93/100) = -22.01dB

This transmitter therefore qualifies for the maximum duty cycle correction factor allowed in §15.35(c). The maximum duty cycle correction factor allowed is 20dB. Resulting radiated field strength limits are as calculated as follows:

Fundamental:	75.9 dBuV/m + 20 dBuV/m	**= 95.9 dBuV/m**
Spurious:	55.9 dBuV/m + 20 dBuV/m	**= 75.9 dBuV/m**
Restricted Band:	54.0 dBuV/m + 20 dBuV/m	**= 74.0 dBuV/m**

3.5.2.2. 2GIG® Panel Selection - 345 MHz

The following pertains to the RE524X transmitter operation using the 2GIG® panel selection. In this mode the transmitter uses ASK modulation. 64 bits are transmitted in each packet, and the "on" time for each bit is 135uS. The resulting "on" time per packet is 8.64mS. The transmitted packets are limited to one packet in a 100mS period. The transmitter duty cycle over a 100ms time period is therefore 8.64/100 = 8.64%.

Figure 6: Packet Width Plot (2GIG® Panel Selection)

Calculating the allowed duty cycle correction factor as given in §15.35(c):

20log(8.64/100) = -21.27dB

This transmitter therefore qualifies for the maximum duty cycle correction factor allowed in §15.35(c). The maximum duty cycle correction factor allowed is 20dB. Resulting radiated field strength limits are as calculated as follows:

Fundamental:	77.25 dBuV/m + 20 dBuV/m	**= 97.25 dBuV/m**
Spurious:	57.25 dBuV/m + 20 dBuV/m	**= 77.25 dBuV/m**
Restricted Band:	54.00 dBuV/m + 20 dBuV/m	**= 74.00 dBuV/m**

3.5.2.3. HW® Panel Selection - 345 MHz

The following pertains to the RE524X transmitter operation using the HW® panel selection. In this mode the transmitter uses ASK modulation. 64 bits are transmitted in each packet, and the "on" time for each bit is 135uS. The resulting "on" time per packet is 8.64mS. The transmitted packets are limited to one packet in a 100mS period. The transmitter duty cycle over a 100ms time period is therefore 8.64/100 = 8.64%.

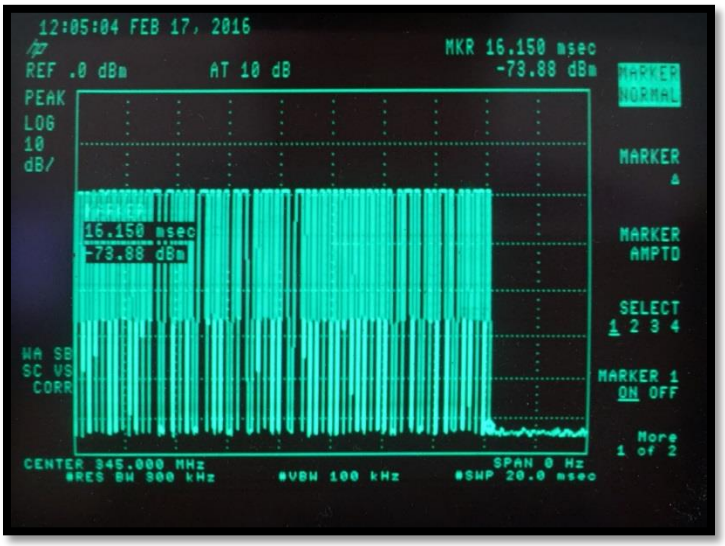

Figure 7: Packet Width Plot (HW® Panel Selection)

Calculating the allowed duty cycle correction factor as given in §15.35(c):

20log(8.64/100) = -21.27dB

This transmitter therefore qualifies for the maximum duty cycle correction factor allowed in §15.35(c). The maximum duty cycle correction factor allowed is 20dB. Resulting radiated field strength limits are as calculated as follows:

Fundamental:	77.25 dBuV/m + 20 dBuV/m	**= 97.25 dBuV/m**
Spurious:	57.25 dBuV/m + 20 dBuV/m	**= 77.25 dBuV/m**
Restricted Band:	54.00 dBuV/m + 20 dBuV/m	**= 74.00 dBuV/m**

3.5.2.4. DSC® Panel Selection – 433.92 MHz

The following pertains to the RE524X transmitter operation using the DSC® panel selection. In this mode the transmitter uses ASK modulation. The packet begins with a 2.5mS "high time." This is followed by 48 bits of data, each of which is 500uS long. A "zero" bit is low for the entire bit. A "one" bit is high for 250uS, and then low for 250uS. Therefore, the average "high time" in a data packet is 2.5mS + (0.250 * 24) = 8.5mS. The transmitter duty cycle over a 100ms time period is therefore 8.5/100 = 8.5%.

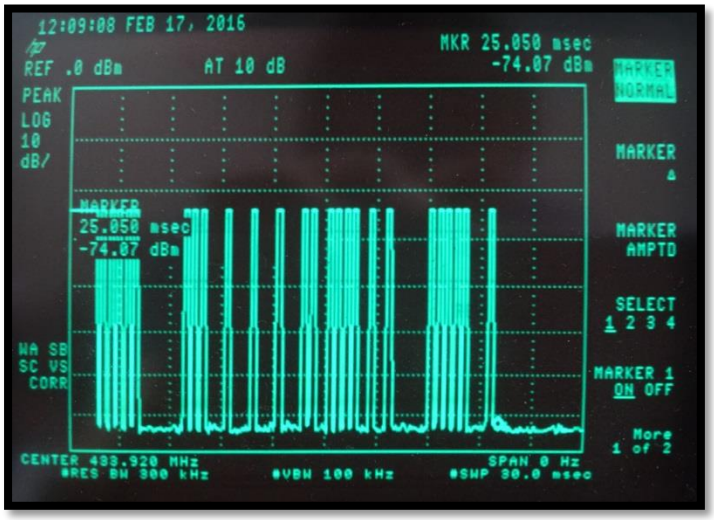

Figure 8: Packet Width Plot (DSC® Panel Selection)

Calculating the allowed duty cycle correction factor as given in §15.35(c):

20log(8.5/100) = -21.411dB

This transmitter therefore qualifies for the maximum duty cycle correction factor allowed in §15.35(c). The maximum duty cycle correction factor allowed is 20dB. Resulting radiated field strength limits are as calculated as follows:

Fundamental:	80.825 dBuV/m + 20 dBuV/m	**= 100.825 dBuV/m**
Spurious:	60.825 dBuV/m + 20 dBuV/m	**= 80.825 dBuV/m**
Restricted Band:	54.000 dBuV/m + 20 dBuV/m	**= 74.000 dBuV/m**

3.5.3. Measured Radiated Field Strength Data

Radiated fundamental and spurious emissions were tested at three meters. The EUT was tested in the three orthogonal planes with the receive antenna in both polarities. The emissions were maximized per ANSI C63.4:2003 8.3.1.2; that is, the measurement antenna height was varied between 1 and 4m, and the EUT was rotated through 360 degrees on a rotating turntable until the maximum emissions were found. Both horizontal and vertical measurement antenna polarizations were used. A resolution bandwidth of 100kHz was used for frequencies less than 1000MHz, and a resolution bandwidth of 1MHz was used for frequencies greater than or equal to 1000MHz. The video bandwidth was set to a value at least three times greater than the resolution bandwidth.

All spurious emissions in the applicable frequency range were investigated.

The EUT was adapted to continuously transmit for testing purposes.

Sections 3.5.3.1 through 3.5.3.3 provide a summary of the measured radiated field strength data for both antennas at 319.5 MHz, 345 MHz and 433.92 MHz respectively. Further measured radiated field strength data is shown in Exhibit I.

3.5.3.1. Field Strength Data - 319.5 MHz

Top Antenna:
The fundamental signal, at 93.7dBuV/m, passed by 2.2dB
The highest spurious signal was the fifth harmonic, which passed by 14.9dB.

Side Antenna:
The fundamental signal, at 95.3dBuV/m, passed by 0.6dB
The highest spurious signal was the fifth harmonic, which passed by 15dB.

3.5.3.2. Field Strength Data - 345 MHz

Top Antenna:
The fundamental signal, at 95.5dBuV/m, passed by 1.8dB
The highest spurious signal was the fifth harmonic, which passed by 16.1dB.

Side Antenna:
The fundamental signal, at 96.9dBuV/m, passed by 0.4dB
The highest spurious signal was the fifth harmonic, which passed by 17.6dB.

3.5.3.3. Field Strength Data - 433 MHz

Top Antenna:
The fundamental signal, at 96.7dBuV/m, passed by 4.1dB
The highest spurious signal was the third harmonic, which passed by 10.6dB.

Side Antenna:
The fundamental signal, at 99.7dBuV/m, passed by 1.1dB
The highest spurious signal was the third harmonic, which passed by 13.8dB.

3.6. FCC Part 15 §15.231(c)

3.6.1. Bandwidth Summary

The allowed 20dB bandwidth of the transmitted signal is 0.25% of the carrier frequency. A summary of the allowed vs measured 20dB bandwidth at carrier frequencies of 319.5 MHz, 345 MHz and 433.92 MHz can be found in *Table 3*. Sections 3.6.1.1 through 3.6.1.3 provide supporting calculations and measured bandwidth plots of the modulated signal for all three possible carrier frequencies. The plots were made using a Hewlett Packard Model 8594E Spectrum Analyzer.

Carrier (MHz)	Allowed 20dB Bandwidth		Measured 20dB Bandwidth		Margin	
	MHz	kHz	MHz	kHz	MHz	kHz
319.50	0.799	799	0.1508	150.8	-0.6482	-648.2
345.00	0.8625	862.5	0.147	147.0	-0.7155	-715.5
433.92	1.0848	1084.8	0.1418	141.8	-0.943	-943

Table 3: Allowed vs Measured 20dB Bandwidth Summary

3.6.1.1. Bandwidth Measurements – 319.5 MHz

For a GE® panel selection, the carrier is 319.5 MHz. The allowed 20dB bandwidth of the transmitted signal is 0.25% of the carrier frequency.

BW Limit = 0.0025 * 319.5 MHz
BW Limit = 0.799 MHz

The bandwidth of the modulated signal is 150.8 kHz or 0.1508 MHz. These measurements show compliance with the bandwidth requirements.

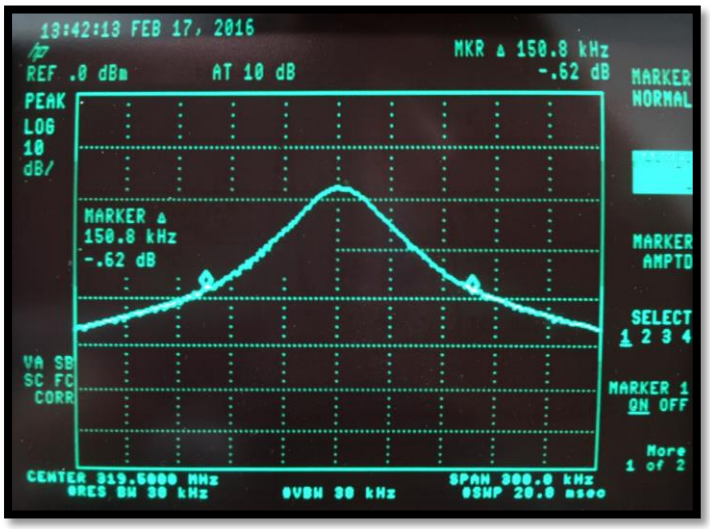

Figure 9: Bandwidth Plot (319.5 MHz)

3.6.1.2. Bandwidth Measurements – 345 MHz

For a HW® and 2GIG® panel selections, the carrier is 345 MHz. The allowed 20dB bandwidth of the transmitted signal is 0.25% of the carrier frequency.

BW Limit = 0.0025 * 345 MHz
BW Limit = 0.8625 MHz

The bandwidth of the modulated signal is 147 kHz or 0.147 MHz. These measurements show compliance with the bandwidth requirements.

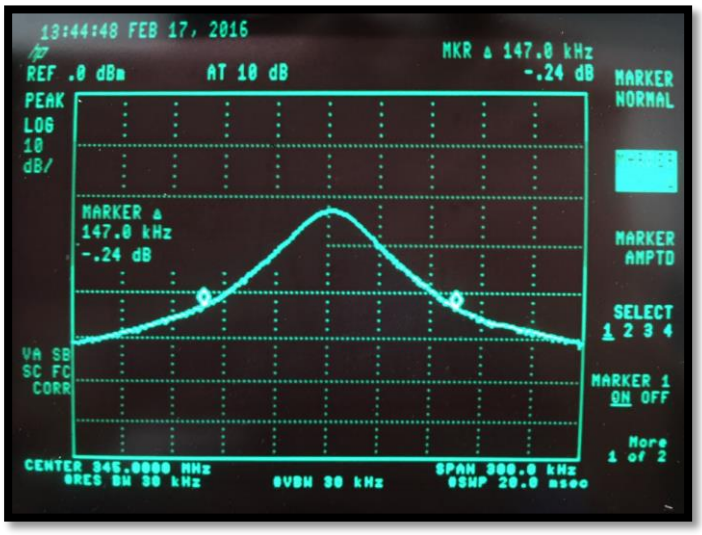

Figure 10: Bandwidth Plot (345 MHz)

3.6.1.1. Bandwidth Measurements – 433.92 MHz

For a DSC® panel selection, the carrier is 433.92 MHz. The allowed 20dB bandwidth of the transmitted signal is 0.25% of the carrier frequency.

BW Limit = 0.0025 * 433.92 MHz
BW Limit = 1.0848 MHz

The bandwidth of the modulated signal is 141.8 kHz or 0.1418 MHz. These measurements show compliance with the bandwidth requirements.

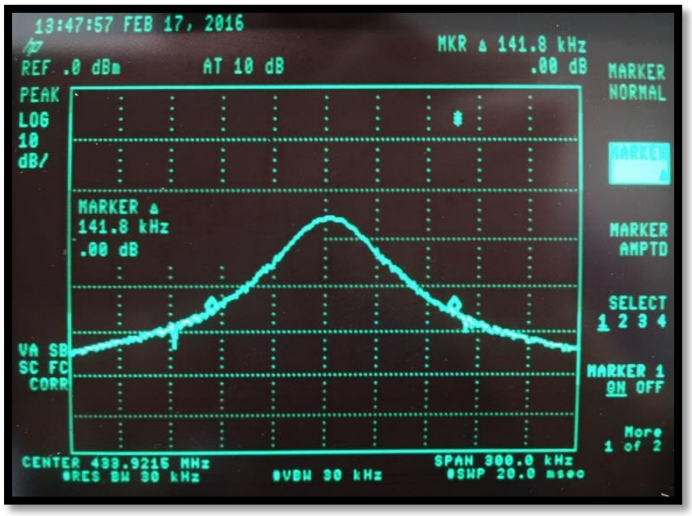

Figure 11: Bandwidth Plot (433.92 MHz)

3.7. FCC Part 15 §15.207

Conducted line emissions are shown in Exhibit I and show compliance with the limits.