TYPE OF EXHIBIT: TABLE OF CONTENTS

FCC PART: 2.1033(c)(14)

MANUFACTURER: RITRON, Inc.

MODEL: RQX-417DMR

TYPE OF UNIT: UHF-FM Callbox 2-Way Radio

FCC ID: AIERIT43-417

DATE: April 10, 2017

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TYPE OF EXHIBIT: LIST OF TEST EQUIPMENT USED

FCC PART: 2.947(d)

MANUFACTURER: RITRON, Inc.

MODEL: RQX-417DMR

TYPE OF UNIT: UHF-FM Callbox 2-Way Radio

FCC ID: AIERIT43-417

DATE: April 12, 2017

<u>ITEM</u>	MAKE/MODEL	SERIAL NO.	CAL.	NEXT CAL.
DC Power Supply	ASTRON VS-20M	9201017	N/A	
Multimeter	HP3466A	N/A	N/A	
RF Test Set	HP8920A	3352A03633	10/31/2014	10/31/2017
RF Test Set	HP 3920B	1000681480	10/31/2014	10/31/2017
Signal Generator	Agilent N5181A	MY46240065	10/31/2014	10/31/2017
Spectrum Analyzer	Advantest R3265A	75060189	10/12/2016	10/12/2017
Storage Scope	Fluke PM3335	DM630034	N/A	N/A
Temp. Chamber	Delta Design 3900	0-52-R	N/A	N/A
Thermocouple	Triplett 320-G/P		N/A	N/A
Log Periodic	Electo-Metrics LPA	-25 8-102	04/30/2014	04/30/2017
Adjustable Dipoles	Ritron Inc.		04/30/2014	04/30/2017
Gain Horn	Emco #3105	2034	04/30/2014	04/30/2017

TYPE OF EXHIBIT: MEASUREMENT METHODS

FCC PART: 2.947

MANUFACTURER: RITRON, Inc.

MODEL: RQX-417DMR

TYPE OF UNIT: UHF-FM Callbox 2-Way Radio

FCC ID: AIERIT43-417

DATE: April 12, 2017

All of the measurements made on this device and included in this report were made per ANSI/TIA-603-C-2004.

Kevin G. Matson

Senior Project Manager

Kevin D. Matsin

RITRON, Inc.

TYPE OF EXHIBIT: DESCRIPTION OF MEASUREMENT FACILITY

FCC PART: 2.948

MANUFACTURER: RITRON, Inc.

MODEL: RQX-417DMR

TYPE OF UNIT: UHF-FM Callbox 2-Way Radio

FCC ID: AIERIT43-417

DATE: April 12, 2017

The Field Strength measurements filed with this application were made on a site certified by RITRON, Inc. Data pertaining to this side are on file with the FCC and Industry Canada and are current.

This site, located in Carmel IN, is used on a continuing basis exclusively by RITRON, Inc. and is utilized only for RF Field Strength measurements of equipment designed and manufactured by RITRON, Inc. It is not used for measurements by, or for, any other party on a contract basis or otherwise.

All other measurements were taken at RITRON's Engineering Laboratory in Carmel, IN.

The address for the Test Site and Laboratory is: Ritron, Inc.

P.O.Box 1998 505 West Carmel Dr. Carmel, IN. 46032

Kevin G. Matson

Senior Project Manager

Kevin D. Matom

RITRON, Inc.

TYPE OF EXHIBIT: RADIO FREQUENCY OUTPUT POWER

FCC PART: 2.1046(a)

MANUFACTURER: RITRON, Inc.

MODEL: RQX-417DMR

TYPE OF UNIT: UHF-FM Callbox 2-Way Radio

FCC ID: AIERIT43-417

DATE: April 12, 2017

PROCEDURE:

1. The RQX-417DMR was aligned for transmitter operation at two power levels per the tune-up procedure outlined in the Maintenance manual for frequencies at the lower, middle, and upper band edges.

- Power was supplied to the RQX-417DMR by an Astron VS-20M Power Supply.
 The RQX-417DMR was connected to a HP8920A Test Set used to measure the
 RF carrier power. The input to the Test Set provides a resistive 50-ohm
 termination at the frequencies and power levels used for this test.
- 3. The voltage across an internal shunt in series with the power supply lead of the RF Power device was used with an Fluke 45 Digital Multimeter to measure current (Id). A B&K 2704A was used to measure the RF Power output stage power control voltage (Vcon) and drain voltage (Vd).
- 4. Measurements were taken at power levels 0.75 watts with 4.5VDC input, and 2.5 watts with 12VDC input.

TYPE OF EXHIBIT: RADIO FREQUENCY OUTPUT POWER

FCC PART: 2.1046(a)

MANUFACTURER: RITRON, Inc.

MODEL: RQX-417DMR

TYPE OF UNIT: UHF-FM Callbox 2-Way Radio

FCC ID: AIERIT43-417

DATE: April 12, 2017

RESULTS:

4.5VDC Input

451.025 MHz: Pout(W)	Con(V)	Vd(V)	ld(A)	Eff (%)
0.75	1.1	4.5	0.7	23.8
460.025 MHz:				
Pout(W)	Con(V)	Vd(V)	ld(A)	Eff (%)
0.75	1.0	4.5	0.7	23.8
469.975 MHz:				
Pout(W)	Con(V)	Vd(V)	ld(A)	Eff (%)
0.74	1.1	4.5	0.65	25.3

12VDC Input

451.025 MHz: Pout(W) 2.50	Con(V) 2.1	Vd(V) 8.0	Id(A) 1.0	Eff (%) 35.0
460.025 MHz: Pout(W) 2.50	Con(V) 2.1	Vd(V) 8.0	Id(A) 1.0	Eff (%) 35.0
469.975 MHz: Pout(W) 2.47	Con(V) 2.1	Vd(V) 8.0	Id(A) 0.95	Eff (%) 32.5

TYPE OF EXHIBIT: OCCUPIED BANDWIDTH – D Mask

FCC PART: 2.1049(c)(1), 90.210(d), 90.210(e)

MANUFACTURER: RITRON, Inc.

MODEL: RQX-417DMR

TYPE OF UNIT: UHF-FM Callbox 2-Way Radio

FCC ID: AIERIT43-417

DATE: April 12, 2017

PROCEDURE:

- 1. For 12.5 kHz digital voice operation, an external digital voice (NXDN) circuit board was connected and the maximum output deviation of the C4FM signal was set to +/-2.4 kHz when a special test modulation input was applied. The analyzer was set to sweep +/-25 kHz of carrier with a reference level set to that observed when the resolution bandwidth and video bandwidth were set to 1 MHz. The C4FM board also was set to create a pn data sequence for data operation. Digital voice and data are indistinguishable when viewed on a spectrum analyzer and therefore, will be shown as one plot.
- 2. The occupied bandwidth plots are independent of carrier frequency, therefore, only the plots for 462.500 MHz are shown.

TYPE OF EXHIBIT: OCCUPIED BANDWIDTH-12.5 kHz CHANNELS

FCC PART: 2.1049(c)(1), 90.210(d)

MANUFACTURER: RITRON, Inc.

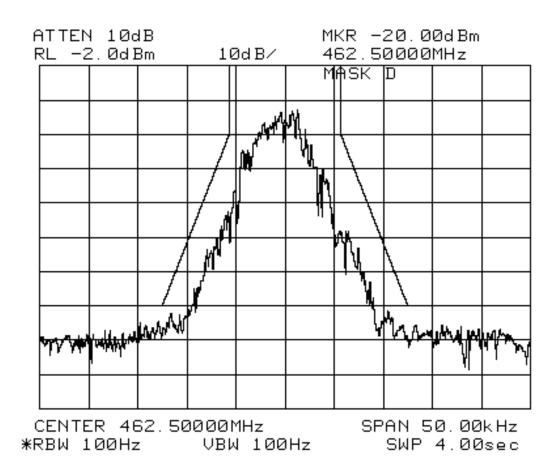
MODEL: RQX-417DMR

TYPE OF UNIT: UHF-FM Callbox 2-Way Radio

FCC ID: AIERIT43-417

DATE: April 12, 2017

RESULTS: 4FSK Digital Voice (9600 bps)



TYPE OF EXHIBIT: BANDWIDTH CALCULATION/MODULATION TYPE

FCC PART: 2.1049(c)(1), 90.210(d), 90.210(e)

MANUFACTURER: RITRON, Inc.

MODEL: RQX-417DMR

TYPE OF UNIT: UHF-FM Callbox 2-Way Radio

FCC ID: AIERIT43-417

DATE: April 12, 2017

RESULTS:

Modulation:

Data-4FSK

The 4FSK data stream is encoded into dibits at half the original data rate and used to create a 4-level audio signal which passes through a root-raised cosine filter and is then used to directly modulate the transmitter carrier. The maximum deviation is dependent upon the channel spacing.

TYPE OF EXHIBIT: BANDWIDTH CALCULATION/MODULATION TYPE

FCC PART: 2.1049(c)(1), 90.210(d), 90.210(e)

MANUFACTURER: RITRON, Inc.

MODEL: RQX-417DMR

TYPE OF UNIT: UHF-FM Callbox 2-Way Radio

FCC ID: AIERIT43-417

DATE: April 12, 2017

RESULTS:

By Carson's rule, the occupied bandwidth for an FM signal may be calculated by:

BW = $2(f_{\Delta} + f_{m})$ where f_{Δ} is the frequency deviation and f_{m} is the modulating frequency.

Modulation	f_Δ	<u>f</u> m	BW	Emissions Designator
Digital Voice				
12.5 kHz	2.10	1.90	8.0	7K60FXE

TYPE OF EXHIBIT: CONDUCTED SPURIOUS EMISSIONS

FCC PART: 2.1051, 90.210(d)

MANUFACTURER: RITRON, Inc.

MODEL: RQX-417DMR

TYPE OF UNIT: UHF-FM Callbox 2-Way Radio

FCC ID: AIERIT43-417

DATE: April 12, 2017

PROCEDURE:

- 1. The RQX-417DMR was aligned for transmitter operation at the center and band edges at a power level of 2.5 watts per the tune-up procedure outlined in the Maintenance manual. The transmitter was modulated in a manner consistent with the type of signal to be transmitted.
- 2. The RF output was connected to an R3265A spectrum analyzer through a 30 dB, 100 watt, 50-ohm RF attenuator. The center frequency of the spectrum analyzer was set to the transmitter frequency. The frequency span and resolution and video bandwidths were set to show spurious emissions at least 80 dB below the unmodulated carrier level. The transmitter was keyed and the reference level on the analyzer noted.
- 3. For the transmitter harmonics, an RF highpass filter was inserted into the path from the attenuator to the spectrum analyzer.
- 4. The transmitter was keyed and the output spectrum was examined from 9 kHz to 10 times the operating frequency, except within 100 kHz of the operating frequency. The attenuation of the highpass filter at the transmitter harmonic frequencies was measured and factored into the absolute dBm results.
- 5. All spurious above 20 dB below the FCC specification of -20 dBm were reported.

TYPE OF EXHIBIT: CONDUCTED SPURIOUS EMISSIONS

FCC PART: 2.1051, 90.210(d)

MANUFACTURER: RITRON, Inc.

MODEL: RQX-417DMR

TYPE OF UNIT: UHF-FM Callbox 2-Way Radio

FCC ID: AIERIT43-417

DATE: April 12, 2017

RESULTS:

451.025 MHz (2.5 Watts)

<u>Spur Freq(MHz)</u> <u>Harmonic</u> <u>Spur level(dBm)</u> <u>Rel. Spur(dBc)</u> <u>Limit(dBc)</u> 451.025 fund. 34.0 NA NA

All Spurious Harmonics were greater than 20dB below FCC Limit

460.025 MHz (2.5 Watts)

<u>Spur Freq(MHz)</u> <u>Harmonic</u> <u>Spur level(dBm)</u> <u>Rel. Spur(dBc)</u> <u>Limit(dBc)</u> 460.025 fund. 34.0 NA NA

All Spurious Harmonics were greater than 20dB below FCC Limit

469.975 MHz (2.5 Watts)

<u>Spur Freq(MHz)</u> <u>Harmonic</u> <u>Spur level(dBm)</u> <u>Rel. Spur(dBc)</u> <u>Limit(dBc)</u>

469.975 fund. 34.0 NA NA

All Spurious Harmonics were greater than 20dB below FCC Limit

TRANSMITTER

FCC PART: 2.1053(a), (b)

MANUFACTURER: RITRON, Inc.

MODEL: RQX-417DMR

TYPE OF UNIT: UHF-FM Callbox 2-Way Radio

FCC ID: AIERIT43-417

DATE: April 12, 2017

PROCEDURE:

1. The measurements for field strength of spurious emissions were taken at the RITRON, Inc. 3-meter test site, details of which are on file with the FCC and Industry Canada.

- 2. The RQX-417DMR was aligned and programmed for transmitter operation at the center and band edges of 450 MHz to 470 MHz at a 2.5 watt power level per the tune-up procedure outlined in the Maintenance manual.
- 3. The unit was then terminated at the antenna port with a non-radiating 50-ohm load.
- 4. All field strength measurements were made with the R3265A Spectrum Analyzer and a log periodic antenna.
- 5. The transmitter was keyed and the spectrum searched from 9 kHz to the 10th harmonic of the transmit carrier. When a spurious emission was found, the height and polarization of the field strength measurement antenna and orientation of the RQX-417DMR were varied to provide maximum field strength.
- 6. A substitution antenna, a calibrated dipole, was substituted for the RQX-417DMR at the RQX-417DMR's location. An RF signal generator was set for the frequency of the RQX-417DMR with the level at the substitution antenna noted.
- The polarization of the substitution antenna was adjusted for maximum signal strength at the field strength measuring antenna. The level at the field strength antenna was noted.

TRANSMITTER

FCC PART: 2.1053(a), (b)

MANUFACTURER: RITRON, Inc.

MODEL: RQX-417DMR

TYPE OF UNIT: UHF-FM Callbox 2-Way Radio

FCC ID: AIERIT43-417

DATE: April 12, 2017

EQUATIONS:

For an absolute level of the spur, the equation is:

Spur Level(dBm) = Pspur (dBm) - Pref (dBm) + Lcab (dB) - Pgen (dBm)

For radiated emissions testing, Pspur (dBm) is the spurious emissions level as measured at the range receiving antenna.

Where:

Pgen is the RF signal generator level at the substitution antenna input.

Lcab is the cable loss from the substitution signal generator to the substitution antenna.

Pref is the power level of the substitution antenna emission at the receiving antenna output.

TRANSMITTER

FCC PART: 2.1053(a), (b)

MANUFACTURER: RITRON, Inc.

MODEL: RQX-417DMR

TYPE OF UNIT: UHF-FM Callbox 2-Way Radio

FCC ID: AIERIT43-417

DATE: April 12, 2017

RESULTS:

For the three frequencies tested, the spurious response within 20 dB of the absolute FCC limit of -20 dBm (relative level of -54 dBc) are stated below:

451.025MHz: 2.5 Watts

Horizontal				Ver	tical		
	Max Spur	FCC	FCC		Max Spur	FCC	FCC
Freq(MHz) 902.050 2255.125 4059.225	ERP(dBm) -25.0 -34.1 -32.9	Limit(dBm) -20 -20 -20	Margin(dB) 5.0 14.1 12.9	Freq(MHz) 902.050 1353.075 2255.125	-21.2 -38.8 -33.8	-20 -20 -20	Margin(dB) 1.2 18.8 13.8
				4059.225	-28.0	-20	8.0

TRANSMITTER

FCC PART: 2.1053(a), (b)

MANUFACTURER: RITRON, Inc.

MODEL: RQX-417DMR

TYPE OF UNIT: UHF-FM Callbox 2-Way Radio

FCC ID: AIERIT43-417

DATE: April 12, 2017

RESULTS:

460.025MHz: 2.5 Watts

	Horiz	ontal			Ver	tical	
	Max Spur	FCC	FCC		Max Spur	FCC	FCC
Freq(MHz)	ERP(dBm)	Limit(dBm)	Margin(dB)	Freq(MHz)	ERP(dBm)	Limit(dBm)	Margin(dB)
920.050	-30.4	-20	10.4	920.050	-33.1	-20	13.1
1840.100	-39.4	-20	19.4	1380.075	-31.8	-20	11.8
3680.200	-29.1	-20	9.1	3680.200	-29.6	-20	9.6
4140.225	-36.7	-20	16.7	4140.225	-36.7	-20	16.7

TRANSMITTER

FCC PART: 2.1053(a), (b)

MANUFACTURER: RITRON, Inc.

MODEL: RQX-417DMR

TYPE OF UNIT: UHF-FM Callbox 2-Way Radio

FCC ID: AIERIT43-417

DATE: April 12, 2017

RESULTS:

469.975MHz: 2.5 Watts

Horizontal				Ver	tical		
	Max Spur	FCC	FCC		Max Spur	FCC	FCC
Freq(MHz)	ERP(dBm)	Limit(dBm)	Margin(dB)	Freq(MHz)	ERP(dBm)	Limit(dBm)	Margin(dB)
939.950	-34.4	-20	14.4	939.950	-32.5	-20	12.5
1879.900	-38.8	-20	18.8	1879.900	-38.1	-20	18.1
2349.875	-35.6	-20	15.6	2349.875	-32.6	-20	12.6
3759.800	-38.0	-20	18.0	3759.800	-26.9	-20	6.9
4229.775	-39.2	-20	19.2	4229.775	-35.9	-20	15.9

TYPE OF EXHIBIT: FREQUENCY STABILITY VS TEMPERATURE

FCC PART: 2.1055(a)(1), 90.213

MANUFACTURER: RITRON, Inc.

MODEL: RQX-417DMR

TYPE OF UNIT: UHF-FM Callbox 2-Way Radio

FCC ID: AIERIT43-417

DATE: April 12, 2017

PROCEDURE:

1. The RQX-417DMR was aligned for transmitter operation at 460.025 MHz at full rated power per the tune-up procedure outlined in the Maintenance manual.

- 2. The RQX-417DMR was placed in a Delta Design Model 3900 CL Temperature Chamber. The RF output of the RQX-417DMR was connected to an HP8920A Test Set to monitor the transmitter frequency. An Astron VS-20M Power Supply was adjusted for a nominal voltage of 12.5 VDC and connected to the DC power supply input of the RQX-417DMR. A Triplett Model 320-G/P Thermocouple was used to monitor the temperature inside the chamber.
- 3. The chamber and the RQX-417DMR were heated to 60 degrees C and allowed to stabilize for 60 minutes for the first measurement and then cooled for 30 minutes for each 10 degree increment in temperature until the unit reached a temperature of -30 degrees C.
- 4. The RF frequency at each temperature was recorded and compared with the frequency at 20 degrees C.
- 5. The RQX-417DMR was set for +/-12.5 kHz(narrow) mode and the carrier was unmodulated and also modulated. The frequency stability remained unchanged between being modulated and unmodulated, therefore, only the unmodulated data is shown.

TYPE OF EXHIBIT: FREQUENCY STABILITY VS TEMPERATURE

FCC PART: 2.1055(a)(1), 90.213

MANUFACTURER: RITRON, Inc.

MODEL: RQX-417DMR

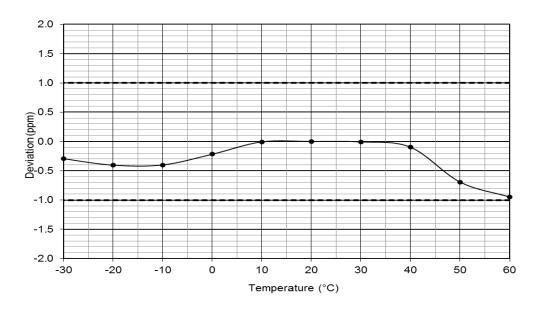
TYPE OF UNIT: UHF-FM Callbox 2-Way Radio

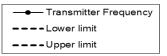
FCC ID: AIERIT43-417

DATE: April 12, 2017

RESULTS:

Temperature	Frequency	Deviation	Deviation
(°C)	(MHz)	(Hz)	(ppm)
60	460.024577	-436	-0.95
50	460.024694	-319	-0.69
40	460.024968	-45	-0.10
30	460.025010	-3	-0.01
20	460.025013	0	0.00
10	460.025010	-3	-0.01
0	460.024913	-100	-0.22
-10	460.024829	-184	-0.40
-20	460.024827	-186	-0.40
-30	460.024878	-135	-0.29





TYPE OF EXHIBIT: FREQUENCY STABILITY VS SUPPLY VOLTAGE

FCC PART: 2.1055(d)(1)

MANUFACTURER: RITRON, Inc.

MODEL: RQX-417DMR

TYPE OF UNIT: UHF-FM Callbox 2-Way Radio

FCC ID: AIERIT43-417

DATE: April 12, 2017

PROCEDURE:

1. The RQX-417DMR was aligned for transmitter operation at 460.025 MHz at full rated power per the tune-up procedure outlined in the Maintenance manual.

- 2. The RF output of the RQX-417DMR was connected to an HP8920A Test Set to monitor the transmitter frequency. An Astron VS-20M Supply was adjusted for a nominal voltage of 12.5 VDC and connected to the DC power supply input of the RQX-417DMR. The output frequency of the RQX-417DMR was noted and used as the reference for the results in paragraph 3 below.
- 3. The power supply voltage was set to 85% nominal and 115% nominal and the frequency noted.
- 4. An Astron VS-20M Supply was adjusted for a nominal voltage of 4.5 VDC and connected to the DC power supply input of the RQX-417DMR to simulate the use of (3) D Cell batteries internally. The output frequency of the RQX-417DMR was noted and used as the reference for the results in paragraph 5 below.
- 5. The power supply voltage was set to 85% nominal and 115% nominal and the frequency noted.

TYPE OF EXHIBIT: FREQUENCY STABILITY VS SUPPLY VOLTAGE

FCC PART: 2.1055(d)(1)

MANUFACTURER: RITRON, Inc.

MODEL: RQX-417DMR

TYPE OF UNIT: UHF-FM Callbox 2-Way Radio

FCC ID: AIERIT43-417

DATE: April 12, 2017

RESULTS:

% Nominal(%)	Voltage(VDC)	$\Delta F(Hz)$	<u>ΔF(ppm)</u>
85	10.6	-6	-0.01
100	12.5	0	0.00
115	14.4	7	0.02
85	3.8	-20	-0.04
100	4.5	0	0.00
115	5.2	-8	-0.02

FCC PART: 90.214

MANUFACTURER: RITRON, Inc.

MODEL: RQX-417DMR

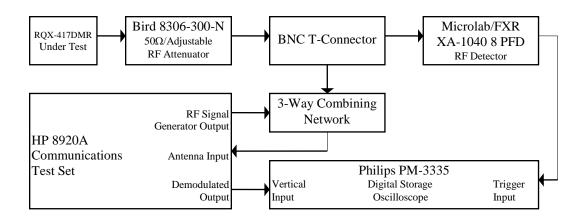
TYPE OF UNIT: UHF-FM Callbox 2-Way Radio

FCC ID: AIERIT43-417

DATE: April 12, 2017

PROCEDURE:

- 1. The RQX-417DMR was aligned for transmitter operation on 460.025 MHz at full rated power per the tune-up procedure outlined in the Maintenance Manual.
- 2. The test equipment was connected per the following diagram:



- 3. The HP 8920A Receiver was set to measure FM deviation with the audio bandwidth set at <50 Hz to greater than 15 kHz with the RF frequency set to 460.025 MHz. The attenuator was set for 10 dB.
- 4. The RQX-417DMR transmitter under test was activated and the HP 8920A Signal Generator was used to measure the RF power level through the test network.

FCC PART: 90.214

MANUFACTURER: RITRON, INC.

MODEL: RQX-417DMR

TYPE OF UNIT: UHF-FM Callbox 2-Way Radio

FCC ID: AIERIT43-417

DATE: April 12, 2017

PROCEDURE (continued):

- 5. The RQX-417DMR transmitter was turned off. The HP 8920A RF Signal Generator was set to 460.025 MHz at an RF level at the HP 8920A which was 30 dB below that measured in step 3 and modulated with a 1 kHz tone at +/-6.25 kHz deviation.
- The Philips PM-3335 Digital Oscilloscope Horizontal Sweep Rate was set to 10 msec/div. The Vertical Amplitude Control was adjusted to display the 1000 Hz demodulated audio from the Signal Generator at +/-4 divisions, vertically centered on the screen.
- 7. The Philips PM-3335 Digital Oscilloscope was set to trigger at 1 division from the left side of the display when the RF Detector sensed RF power from the RQX-417DMR transmitter.
- 8. The RQX-417DMR transmitter was activated and the resulting waveform on the oscilloscope display was stored and plotted. The FCC limits per Part 90.214 were added to the plot. The resulting plot is labeled "Switch On Condition" and shows compliance with FCC Part 90.214/IC RSS-119, section 6.5.
- The Philips PM-3335 Digital Oscilloscope was set to trigger at 1 division from the right side of the display when the RF Detector senses loss of RF power from the RQX-417DMR transmitter.
- 10. The RQX-417DMR transmitter was turned off and the resulting waveform on the oscilloscope display was stored and plotted. The limits per FCC Part 90.214/RSS-119, section 6.5 were added to the plot in the same manner illustrated in EIA-603 Part 3.2.19.2. The resulting plot is labeled "Switch Off Condition" and shows compliance.

FCC PART: 90.214

MANUFACTURER: RITRON, INC.

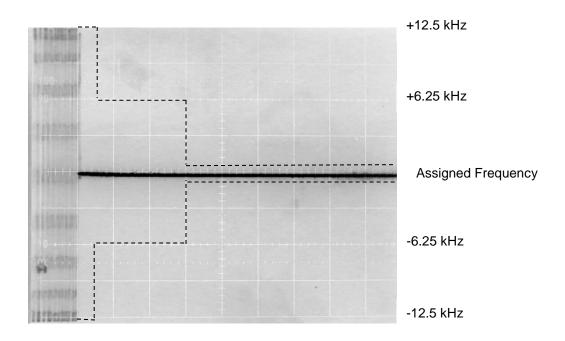
MODEL: RQX-417DMR

TYPE OF UNIT: UHF-FM Callbox 2-Way Radio

FCC ID: AIERIT43-417

DATE: April 12, 2017

RESULTS: Switch-On Condition



FCC PART: 90.214

MANUFACTURER: RITRON, INC.

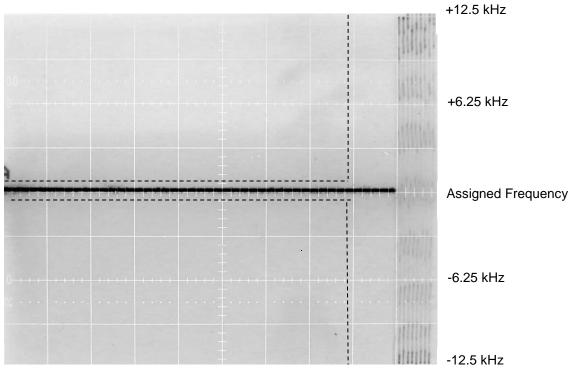
MODEL: RQX-417DMR

TYPE OF UNIT: UHF-FM Callbox 2-Way Radio

FCC ID: AIERIT43-417

DATE: April 12, 2017

RESULTS: Switch-Off Condition



10 ms/div