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DTX-442 Test Results

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MANUFACTURER: RITRON, INC.
505 West Carmel Drive
Carmel, IN 46032

MODEL: DTX-442

TYPE OF UNIT: UHF-FM Two Way Radio Transceiver Module

FCC ID: AIERIT17-442

DATE: Nov 5, 2003

The following is a list of attached exhibits required by the Federal Communications Commission for the application to and grant of FCC Type Acceptance.

TYPE OF EXHIBIT: TEST EQUIPMENT LIST

FCC PART: 2.947 (d)

MANUFACTURER: RITRON, INC.
505 West Carmel Drive
Carmel, IN 46032

MODEL: DTX-442

TYPE OF UNIT: UHF-FM Two Way Radio Transceiver Module

FCC ID: AIERIT17-442

DATE: Nov 5, 2003

The measured data in this report was obtained using one or more of the following pieces of equipment. The particular equipment used in any one test is detailed in the procedure for that test.

ITEM	MANUFACTURER	MODEL NO.	SERIAL NO.
Communications Test Set	Hewlett-Packard	HP8920A	3352A03633
Signal generator	Hewlett-Packard	HP8657B	3315V04378
Spectrum Analyzer	Hewlett-Packard	8559A	2010A 06979
Spectrum Analyzer	Hewlett-Packard	8560E	3720A02980
Power Supply	BK/Precision	1730	263-023610
Function Generator	BK Precision	4010	275-00280
Digital Oscilloscope	Philips	PM-3335	DM630034
Dual Display Multimeter	Protek	506	
Log Periodic Antenna	Electro-Metrics	LPA-25	8-102
Temperature Chamber	Delta Design	3900CL	0-52-R
Thermocouple	Triplet	320-G/O	
900 MHz high pass filter	Ritron		
Calibration Dipole set	Electro-Metrics	EM-6924	255

TYPE OF TEST: RADIO FREQUENCY POWER OUTPUT

FCC PART: 2.1046

MANUFACTURER: RITRON, INC.
505 West Carmel Drive
Carmel, IN 46032

MODEL: DTX-442

TYPE OF UNIT: UHF-FM Two Way Radio Transceiver Module

FCC ID: AIERIT17-442

DATE: Nov 5, 2003

POWER OUTPUT RANGE:

The UHF DTX-442 is designed to operate with output power ranging from 1 watt to 5 watts. The following data shows measured values under conditions of varying supply voltage and power adjustment.

PROCEDURE: The supply is varied in one volt steps from 8 to 15 volts. The HP8920A wattmeter measured the RF output power at the different supply voltages.

RESULTS:

Power Supply (VDC)	Transmit Power (watts)	Transmit Current (Amps)	Radio TX Efficiency (%)
8	0.67	0.43	19.5
9	1.60	0.55	32.3
10	2.40	0.68	35.3
11	3.24	0.77	38.3
12	4.11	0.85	40.3
13	4.64	0.89	40.1
14	4.92	0.89	39.5
15	5.00	0.85	39.2

PROCEDURE: A fixed supply voltage of 13.8 VDC was applied to the DTX-442. The power output potentiometer R222 was adjusted to obtain various output powers. The following table shows results.

RESULTS:

Transmit Power (watts)	Transmit Current (Amps)	Radio TX Efficiency (%)
1	0.45	16.1
2	0.57	25.4
3	0.67	32.4
4	0.77	37.6
5	0.89	40.7

TYPE OF TEST: FINAL RF POWER TRANSISTOR CURRENT

FCC PART: 2.1033

MANUFACTURER: RITRON, INC.
505 West Carmel Drive
Carmel, IN 46032

MODEL: DTX-442

TYPE OF UNIT: UHF-FM Two Way Radio Transceiver Module

FCC ID: AIERIT17-442

DATE: Dec 16, 2003

PROCEDURE:

In order to measure the final transistor Q208 current, one end of the ferrite bead L207 was lifted and an ammeter was placed in series The following currents and voltage exist in the final RF power transistor Q208 with 13.8 VDC applied to the radio. The power is set by adjusting R222.

RESULTS:

Transmit Power (watts)	Gate Voltage (volts)	Drain Voltage (volts)	Transmit Current (Amps)	Q208 Efficiency (%)
1	1.0	13.6	0.28	26.3
2	1.2	13.5	0.40	37.1
3	1.4	13.4	0.52	43.1
4	1.5	13.3	0.64	47.1
5	1.8	13.2	0.76	50.0

TYPE OF TEST: TRANSMITTER AUDIO OVERALL RESPONSE

FCC PART: 2.1047 (a)

MANUFACTURER: RITRON, INC.
505 West Carmel Drive
Carmel, IN 46032

MODEL: DTX-442

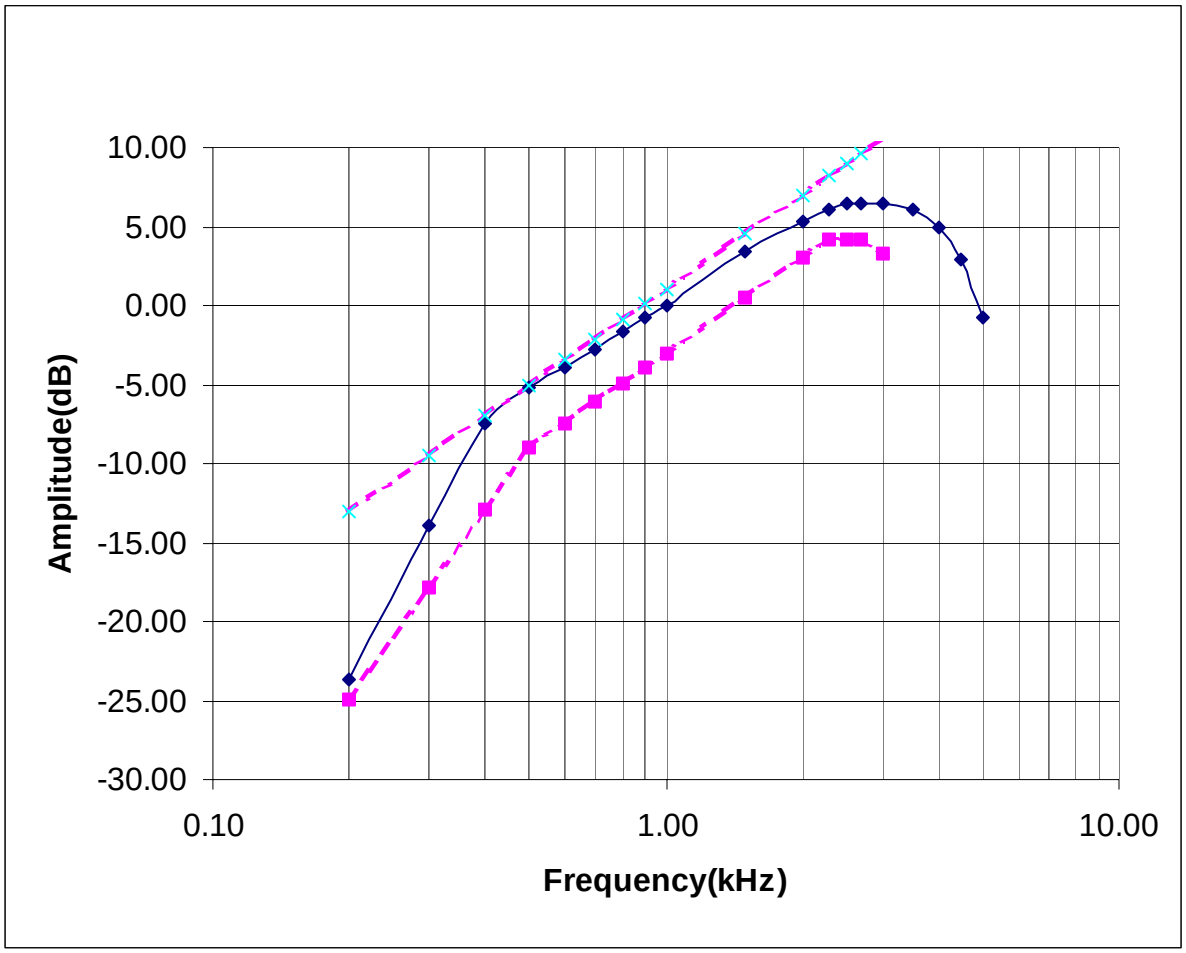
TYPE OF UNIT: UHF-FM Two Way Radio Transceiver Module

FCC ID: AIERIT17-442

DATE: Nov 5, 2003

PROCEDURE: The constant deviation approach to measuring transmitter frequency response was used here (TIA-603-B). The HP8920A was used to generate and measure the audio tones. A constant deviation of 1.0 kHz was maintained by adjusting the input voltage amplitude. The output frequency response was calculated as –20 log(Vin/Vref) where the reference is 1 kHz. A 35 dB attenuator was used inserted in the microphone line to allow more accurate input measurements. TIA-603-B frequency response limits are shown.

RESULTS:



TYPE OF TEST: TRANSMITTER LOW PASS FILTER

FCC PART: 2.1047 (a)

MANUFACTURER: RITRON, INC.
505 West Carmel Drive
Carmel, IN 46032

MODEL: DTX-442

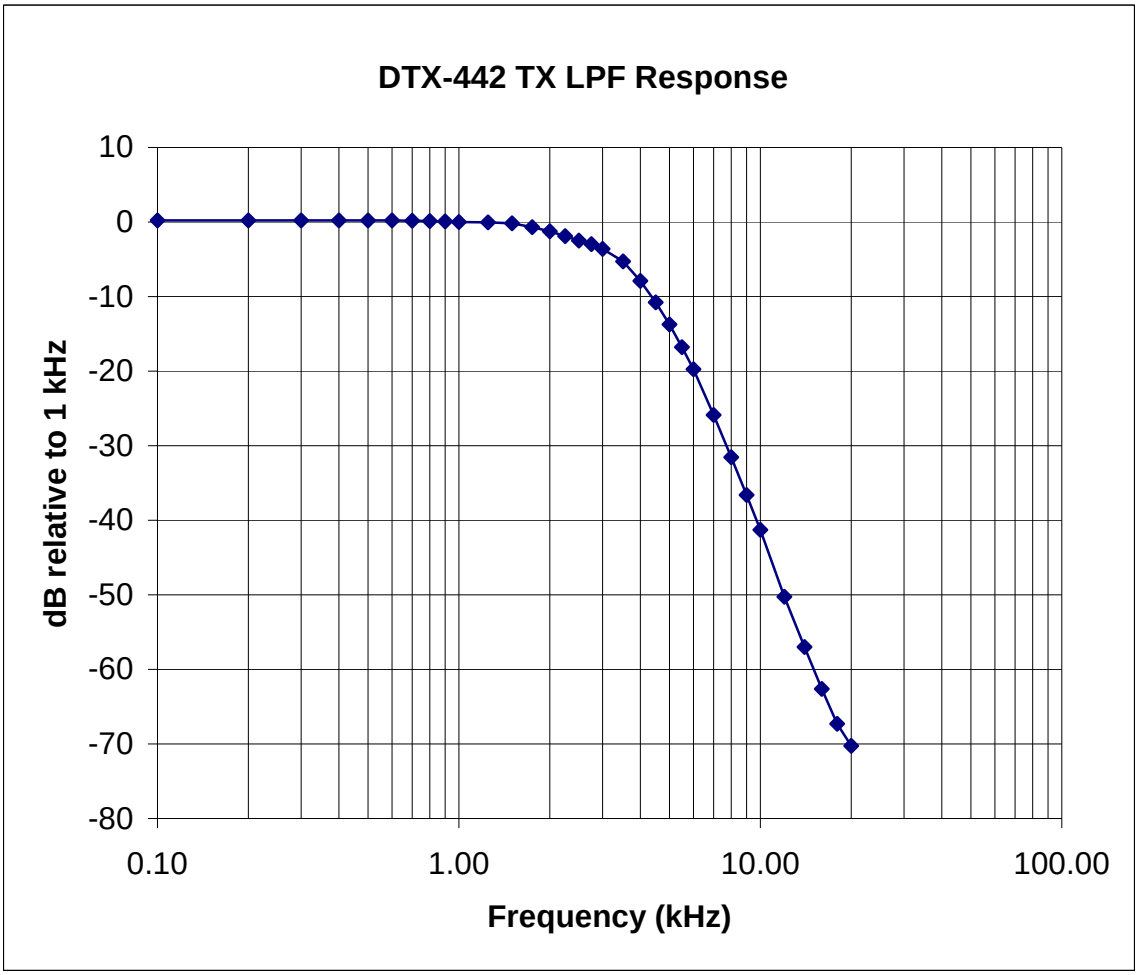
TYPE OF UNIT: UHF-FM Two Way Radio Transceiver Module

FCC ID: AIERIT17-442

DATE: Nov 5, 2003

PROCEDURE: An audio tone ranging from 100 Hz to 20 kHz was inserted at the input of the DTX-442 low pass filter through a 100 uF cap at the junction of R369 and R378. The audio test tone amplitudes were fixed at 1200 mV rms keeping the filter in an unsaturated mode. The clipper filter output signal at R385 was then read on the HP8920A. The response was then calculated as 20 log(Vin/Vref).

RESULTS:



TYPE OF TEST: MODULATION LIMITING

FCC PART: 2.1047 (b)

MANUFACTURER: RITRON, INC.
505 West Carmel Drive
Carmel, IN 46032

MODEL: DTX-442

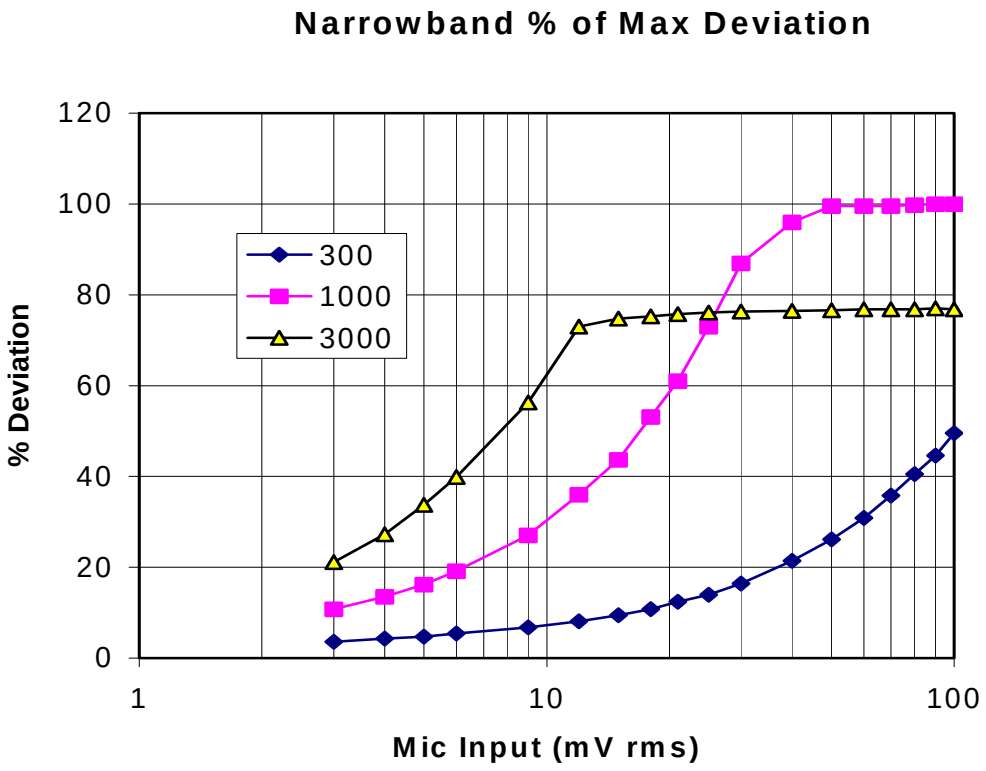
TYPE OF UNIT: UHF-FM Two Way Radio Transceiver Module

FCC ID: AIERIT17-442

DATE: Nov 18, 2003

PROCEDURE: The output of the HP8920A audio generator was applied to the microphone input of the DTX-442. The output of the generator was adjusted from 3 mV to 100 mV rms at frequencies from 300 to 3000 Hz. The deviations were normalized to the maximum deviation, which occurred at 1000 Hz. The first plot shows narrowband and the second wideband response.

RESULTS for NARROWBAND:



TYPE OF TEST: MODULATION LIMITING

FCC PART: 2.1047 (b)

MANUFACTURER: RITRON, INC.
505 West Carmel Drive
Carmel, IN 46032

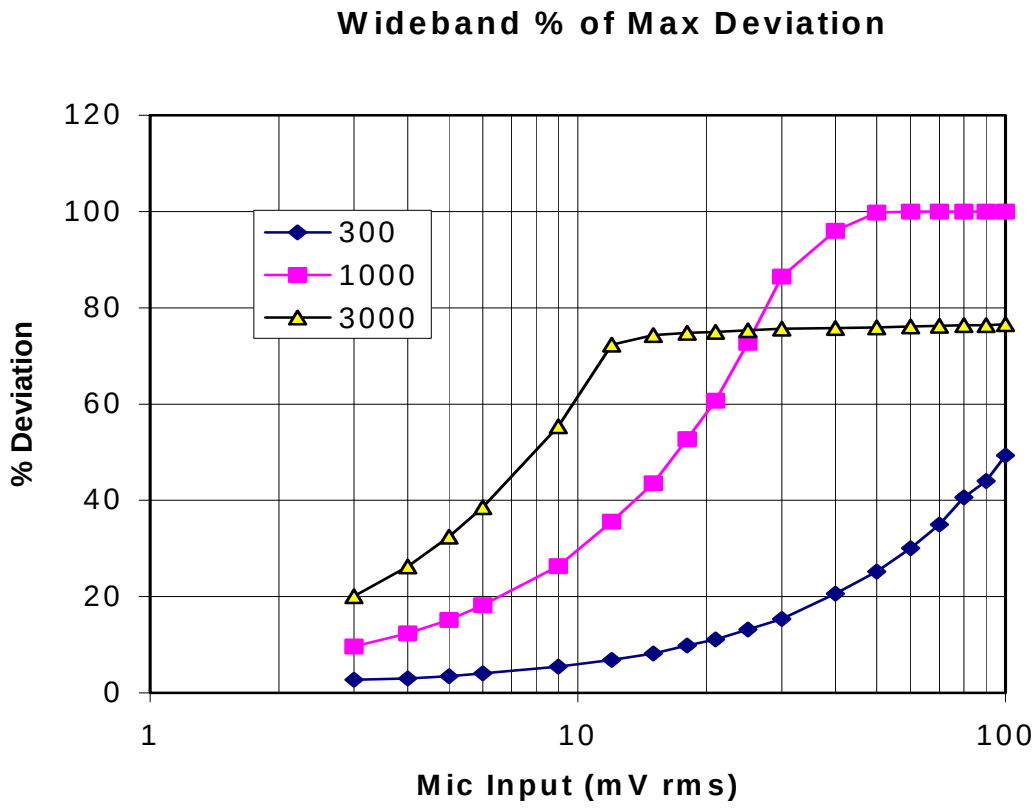
MODEL: DTX-442

TYPE OF UNIT: UHF-FM Two Way Radio Transceiver Module

FCC ID: AIERIT17-442

DATE: Nov 18, 2003

RESULTS for WIDEBAND:



TYPE OF TEST: EMISSIONS DESIGNATOR

MANUFACTURER: RITRON, INC.
505 West Carmel Drive
Carmel, IN 46032

MODEL: DTX-442

TYPE OF UNIT: UHF-FM Two Way Radio Transceiver Module

FCC ID: AIERIT17-442

DATE: May 30, 2003

CALCULATIONS:

The necessary bandwidth as determined by Carson's rule for a wideband voice channel is:

Maximum modulation frequency (M) in kHz	= 3
Maximum deviation (D) in kHz	= 4.6
Constant K	= 1
Necessary bandwidth for **wideband** in kHz	= (2xM) + (2xDxK) = 15.2

Wideband emissions designator applied for is 15K2F3E.

The necessary bandwidth for the narrowband voice channel is:

Maximum modulation frequency (M) in kHz	= 3
Maximum deviation (D) in kHz	= 2.3
Constant K	= 1
Necessary bandwidth for **narrowband** in kHz	= (2xM) + (2xDxK) = 10.6

Narrowband emissions designator applied for is 10K6F3E.

The necessary bandwidth for the narrowband data channel is:

Maximum modulation frequency (M) in kHz	= 2.4
Maximum deviation (D) in kHz	= 2.3
Constant K	= 1
Necessary bandwidth for **narrowband** in kHz	= (2xM) + (2xDxK) = 9.4

Narrowband emissions designator applied for is 9K4F1D.

TYPE OF TEST: OCCUPIED BANDWIDTH

FCC PART: 2.1049 (c)(1) per 90.210 (b)(d)

MANUFACTURER: RITRON, INC.
505 West Carmel Drive
Carmel, IN 46032

MODEL: DTX-442

TYPE OF UNIT: UHF-FM Two Way Radio Transceiver Module

FCC ID: AIERIT17-442

DATE: Nov 13, 2003

PROCEDURE:

1. The DTX-442 was programmed for transmitter operation on 460.100 MHz. The transmitter was adjusted for a deviation of +/- 4.6 kHz at 1000 Hz for wideband channels or +/- 2.3 kHz at 1000 Hz for narrowband channels. The first plot shows the occupied bandwidth for 12.5 kHz bandwidth operation with a 2500 Hz audio tone. The second plot shows the occupied bandwidth for 25 kHz wide band operation with a 2500 Hz tone. The third plot shows the narrowband data occupied bandwidth with a four level pseudo-random code at 2400 bits/sec. This is the typical spectrum for a 9600 bits/sec channel. The fourth plot shows the narrowband data occupied bandwidth with a square wave at 2400 bits/sec. This is the worse case spectrum for a 9600 bits/sec channel.

2. The RF output of the DTX-442 was measured with a HP8920A communications test set wattmeter at 5.0 watts. Power was supplied to the DTX-442 via a BK1730 power supply set at +15 VDC.

3. The antenna was connected to the HP8560E spectrum analyzer via a 20 dB power attenuator.

4. The output of the HP8920A audio function generator was applied to the microphone input of the DTX-442. The frequency of the audio signal generator was set to 2500 Hz and the output adjusted to a level 16 dB greater than that necessary to produce 50% of the rated system deviation at the frequency of maximum response.

5. The spectrum analyzer was centered on 460.100 MHz and the sidebands were read. The appropriate narrow or wide band emission mask was also superimposed.

TYPE OF TEST: 12.5 kHz VOICE OCCUPIED BANDWIDTH

FCC PART: 2.1049 (c)(1) per 90.210 (b)(d)

MANUFACTURER: RITRON, INC.
505 West Carmel Drive
Carmel, IN 46032

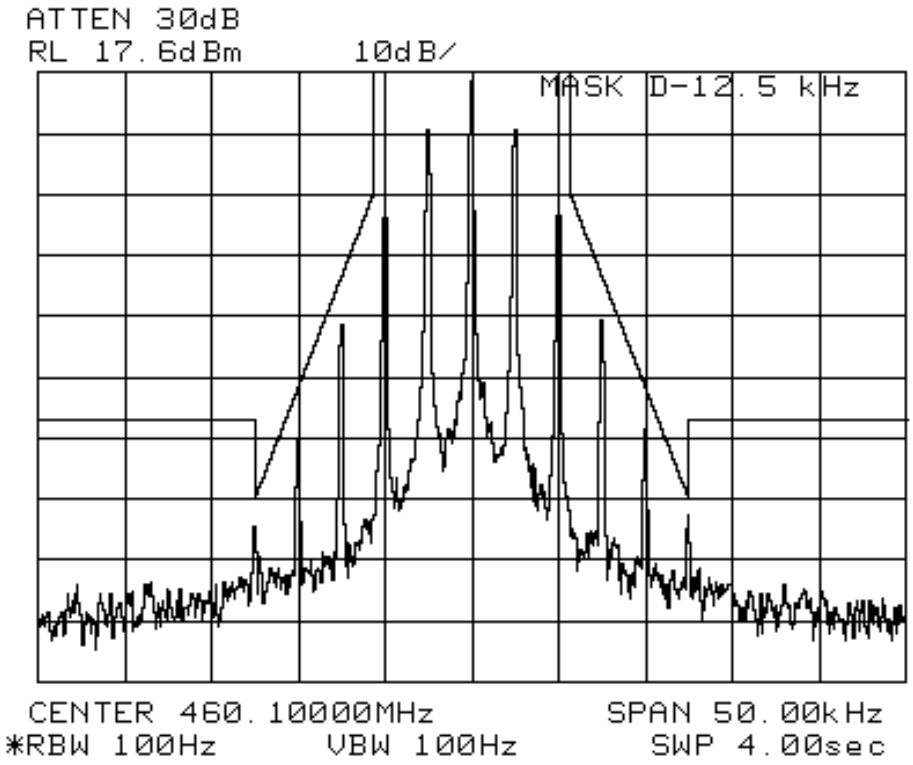
MODEL: DTX-442

TYPE OF UNIT: UHF-FM Two Way Radio Transceiver Module

FCC ID: AIERIT17-442

DATE: Nov 13, 2003

DATA: Narrowband voice channel with 2500 Hz tone.



TYPE OF TEST: 25 kHz VOICE OCCUPIED BANDWIDTH

FCC PART: 2.1049 (c)(1) per 90.210 (b)(d)

MANUFACTURER: RITRON, INC.
505 West Carmel Drive
Carmel, IN 46032

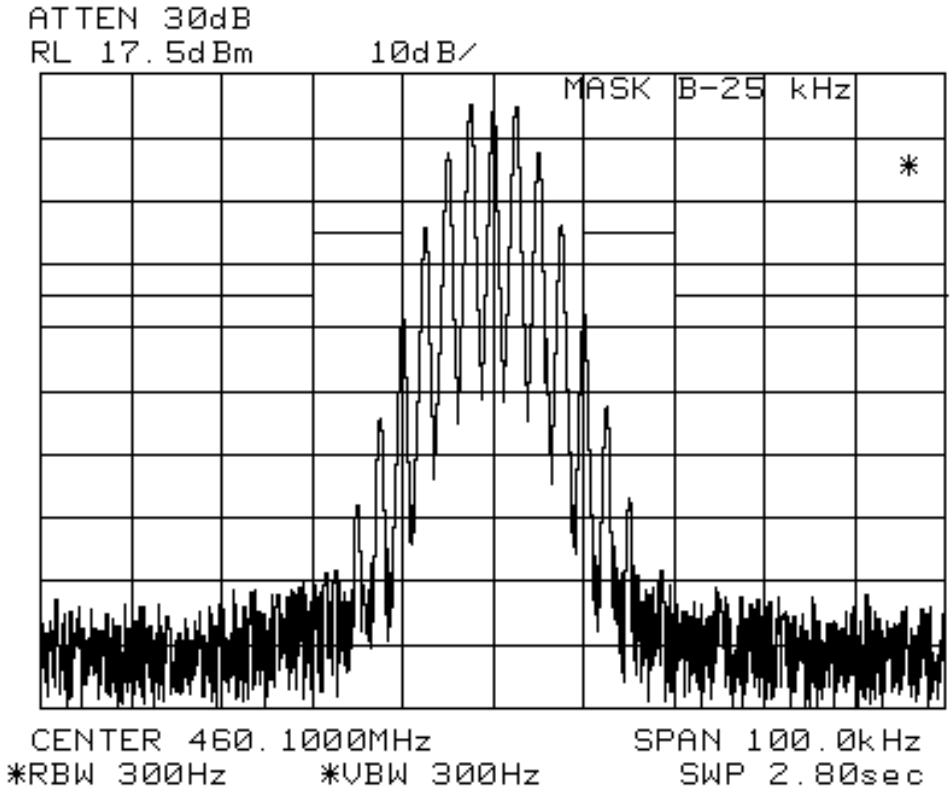
MODEL: DTX-442

TYPE OF UNIT: UHF-FM Two Way Radio Transceiver Module

FCC ID: AIERIT17-442

DATE: Nov 13, 2003

DATA: Wideband voice with 2500 Hz tone.



TYPE OF TEST: 12.5 kHz RANDOM DATA OCCUPIED BANDWIDTH

FCC PART: 2.1049 (c)(1) per 90.210 (b)(d)

MANUFACTURER: RITRON, INC.
505 West Carmel Drive
Carmel, IN 46032

MODEL: DTX-442

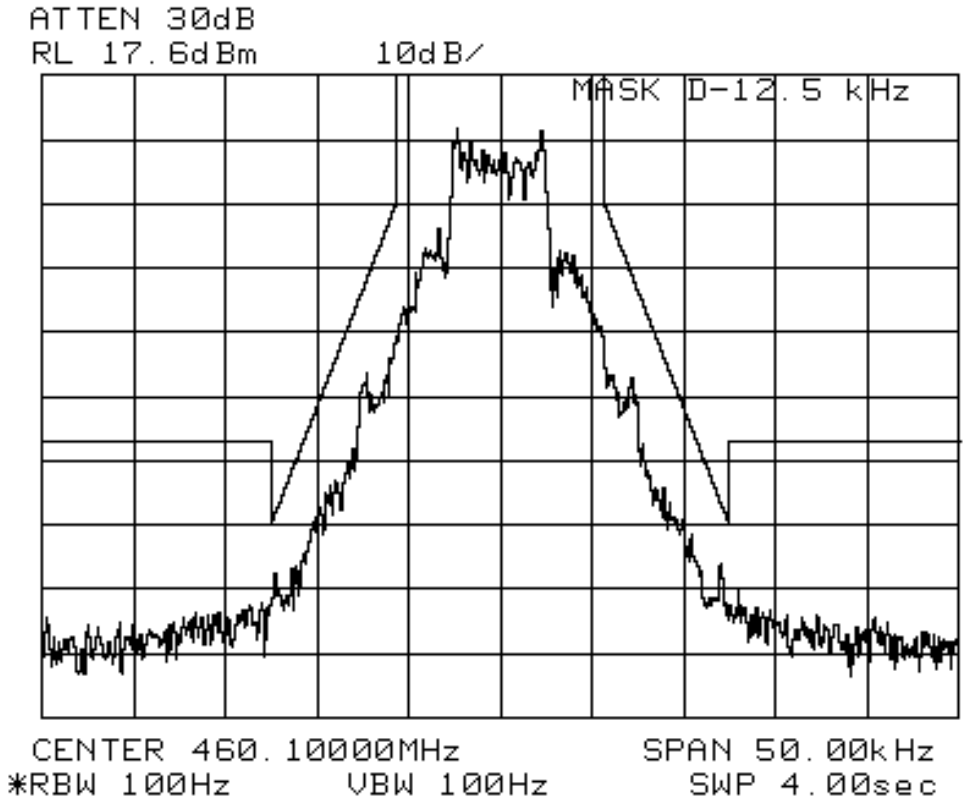
TYPE OF UNIT: UHF-FM Two Way Radio Transceiver Module

FCC ID: AIERIT17-442

DATE: Nov 13, 2003

PROCEDURE: An 11 bit pseudo-random (PN) code generator producing 4-level data stream at 9600bps was connected to the AUX_IN port of the DTX-442. The following plot shows the occupied bandwidth well within the narrowband FCC limits.

DATA:



TYPE OF TEST: 12.5 kHz UNIFORM DATA OCCUPIED BANDWIDTH

FCC PART: 2.1049 (c)(1) per 90.210 (b)(d)

MANUFACTURER: RITRON, INC.
505 West Carmel Drive
Carmel, IN 46032

MODEL: DTX-442

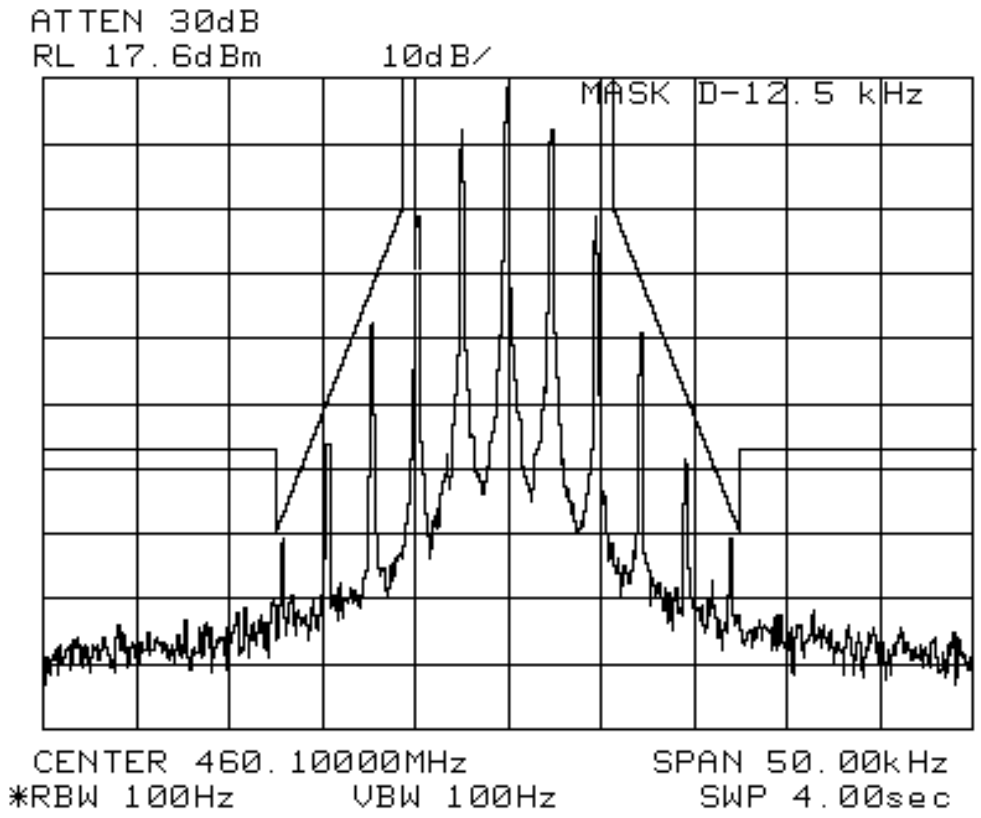
TYPE OF UNIT: UHF-FM Two Way Radio Transceiver Module

FCC ID: AIERIT17-442

DATE: Nov 13, 2003

PROCEDURE: A 2400 Hz square wave generator was connected to the AUX_IN port of the DTX-442. The following plot shows the occupied bandwidth within the narrowband FCC limits.

DATA:



TYPE OF TEST: SPURIOUS EMISSIONS AT ANTENNA TERMINALS

FCC PART: 2.1051

MANUFACTURER: RITRON, INC.
505 West Carmel Drive
Carmel, IN 46032

MODEL: DTX-442

TYPE OF UNIT: UHF-FM Two Way Radio Transceiver Module

FCC ID: AIERIT17-442

DATE: Oct 29, 2003

PROCEDURE:

The DTX-442 was programmed for transmitter operation 460.100 MHz. Power was supplied to the DTX-442 by a BK Precision Model 1730 Power Supply. The supply voltage was set to 15 VDC. The transmitter was modulated by a 2500 Hz tone at an input level 16 dB greater than that necessary to produce 50 percent modulation as specified in FCC Part 2.1049 (c)(1). The DTX-442 antenna terminal was connected to the input of a 20 dB power attenuator. After the attenuator and before a Hewlett-Packard Model 8559A Spectrum Analyzer a 900 MHz high pass filter was inserted. The measured insertion loss of the external attenuator and HPF is listed on the data sheet. The spectrum was searched from 8 MHz to the 10th harmonic of the operating frequency. All unreported emissions are more than 20 dB below the FCC limit.

RESULTS:

Carrier Frequency:	460.100	**MHz**
Power Output:	5.00	**Watts**

Multiple of Carrier	Emmission Frequency (MHz)	Analyzer Reading (dBm)	Atten/HPF Correction Factor(dB)	Spurious Power (dBm)	FCC Limit (dBm)	dB below FCC Limit
2	920.2000	-54	21	-33	-20	13
3	1380.3000	-58	21	-37	-20	17

TYPE OF TEST: FIELD STRENGTH OF SPURIOUS RADIATION

FCC PART: 2.1053

MANUFACTURER: RITRON, INC.
505 West Carmel Drive
Carmel, IN 46032

MODEL: DTX-442

TYPE OF UNIT: UHF-FM Two Way Radio Transceiver Module

FCC ID: AIERIT17-442

DATE: Oct 22, 2003

PROCEDURE:

Field strength of spurious radiation of the DTX-442 was taken on the RITRON three meter test range using the substitution method. The following procedure was used.

1. The DTX-442 was programmed to transmit at 5.0 watts on 460.050 MHz powered by a BK Precision 1730 power supply at 15 volts.

2. The DTX-442 was then terminated at the antenna port with 50 ohm power load.

3. All field strength measurements were made with the Hewlett-Packard Model 8560E or 8559A Spectrum Analyzer connected to the Electro-Metrics LPA-25 log periodic or dipole receiving antenna.

4. A tuned Electro-Metrics dipole was substituted at the radio side of the range driven by a known power level from the HP8657B to produce a known ERP at each harmonic. The receiving antenna was oriented both vertically and horizontally and reference measurements were taken at each harmonic. Cable loss from generator to the dipole was taken into account.

5. For each emission, the height and polarization of the field strength measuring antenna and orientation of the DTX-442 were varied to find maximum field strength.

6. The spectrum was searched up to the 10th harmonic of the transmit frequency. All non-harmonics were less than 20 dB below the FCC limits specified in Part 90.210(d)(3). All harmonics with greater than 20 dB margin were not reported.

TYPE OF TEST: FIELD STRENGTH OF SPURIOUS RADIATION

FCC PART: 2.1053

MANUFACTURER: RITRON, INC.
505 West Carmel Drive
Carmel, IN 46032

MODEL: DTX-442

TYPE OF UNIT: UHF-FM Two Way Radio Transceiver Module

FCC ID: AIERIT17-442

DATE: Oct 22, 2003

DATA:

Test Frequency:	460.05	MHz
Test Power:	5.0	watts

DTX-442 horizontal

harmonic	freq(GHz)	Substitution power(dBm)	Reference cable loss (dB)	Sub horz reading(dBm)	Max Horz (dBm)	Max Spur ERP(dBm)	FCC limit(dBm)	FCC margin(dB)
3	1.38015	0	4.3	-53.2	-87.00	-38.1	-20	18
4	1.8402	0	5.4	-64.0	-95.17	-36.6	-20	17
5	2.30025	-20	6.2	-79.7	-86.10	-32.6	-20	13

DTX-442 vertical

harmonic	freq(GHz)	Substitution power(dBm)	Reference cable loss (dB)	Sub Vert reading(dBm)	Max Vert (dBm)	Max Spur ERP(dBm)	FCC limit(dBm)	FCC margin(dB)
3	1.38015	0	4.3	-53.0	-83	-34.6	-20	15
4	1.8402	0	5.4	-62.2	-93	-35.9	-20	16
5	2.30025	-20	6.2	-80.3	-87	-32.5	-20	13

TYPE OF TEST: FREQUENCY STABILITY VS. TEMPERATURE

FCC PART: 2.1055 (a)(1)

MANUFACTURER: RITRON, INC.
505 West Carmel Drive
Carmel, IN 46032

MODEL: DTX-442

TYPE OF UNIT: UHF-FM Two Way Radio Transceiver Module

FCC ID: AIERIT17-442

DATE: Oct 28, 2003

PROCEDURE:

1. The DTX-442 was programmed for operation at 5.0 watts on 460.050 MHz.

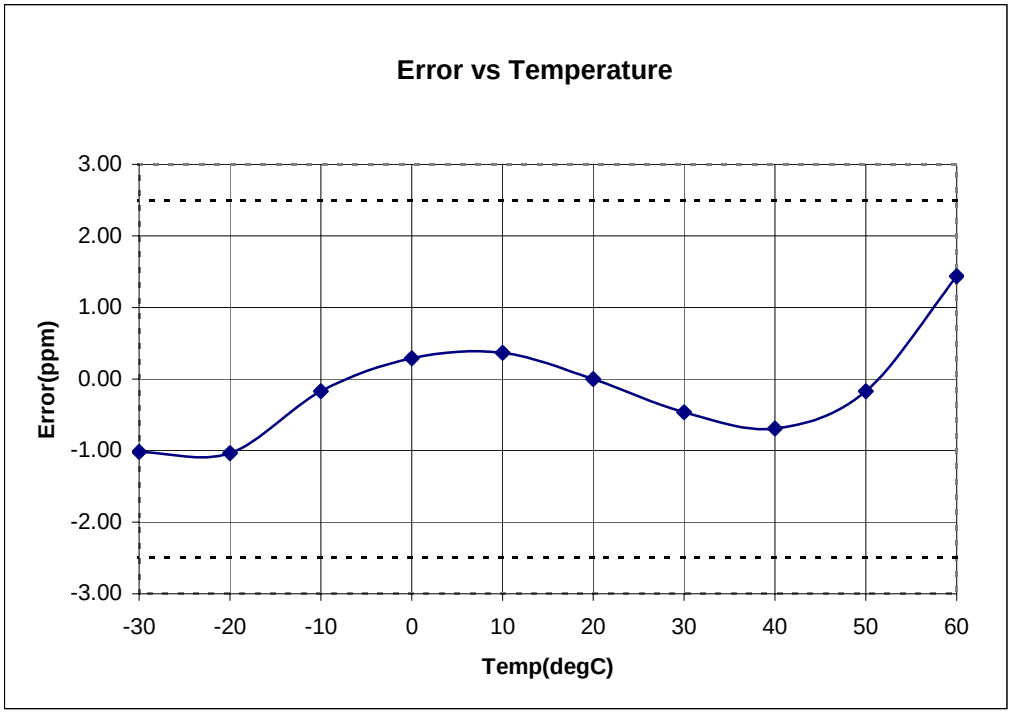
2. Power was supplied to the DTX-442 by a BK Precision Model 1730 power supply set to the nominal operating voltage of 15 VDC. The DTX-442 antenna terminal was connected to the input of an HP8920A RF communications test set used to measure frequency of the carrier.

2. Temperature was measured with a Triplet thermocouple. The reference of 20°C was used.

4. The temperature was raised to +60°C and allowed to stabilize for 30 minutes. The transmitter was activated and the frequency output recorded. The temperature was lowered in 10°C increments down to -30°C, allowing 20 minutes to stabilize at each temperature.

5. The frequency remained within the 2.5 ppm specified.

RESULTS:



TYPE OF TEST: FREQUENCY STABILITY VS. VOLTAGE

FCC PART: 2.1055 (d)(2)

MANUFACTURER: RITRON, INC.
505 West Carmel Drive
Carmel, IN 46032

MODEL: DTX-442

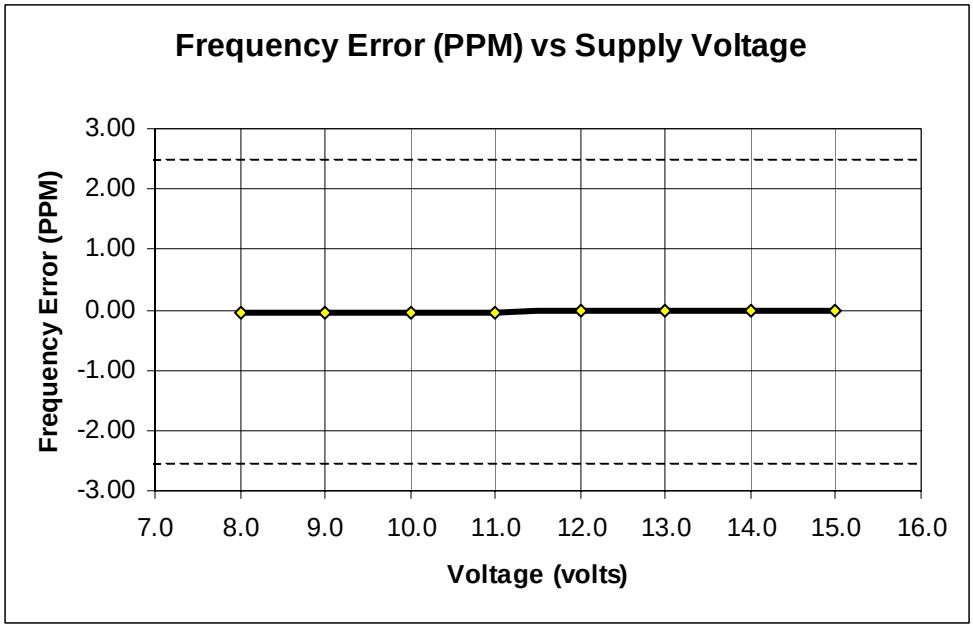
TYPE OF UNIT: UHF-FM Two Way Radio Transceiver Module

FCC ID: AIERIT17-442

DATE: Oct 28, 2003

PROCEDURE:

1. The DTX-442 was programmed for operation at 5 watts at 460.000 MHz.
2. Power was supplied to the DTX-442 by a BK Precision Model 1730 power supply set at 15 VDC.
3. The DTX-442 antenna terminal was connected to the input of an HP8920A communications test set, used to measure frequency of the carrier.
4. The radio was put into transmit mode and the measured frequency at 15 VDC was used as a reference.
4. Frequency measurements were made at +22°C with supply varied in 1 volt steps down to 8 volts.
5. The following plot shows the frequency error within the +/- 2.5 PPM limits.



TYPE OF TEST: TRANSIENT FREQUENCY BEHAVIOR

FCC PART: 90.214

MANUFACTURER: RITRON, INC.
505 West Carmel Drive
Carmel, IN 46032

MODEL: DTX-442

TYPE OF UNIT: UHF-FM Two Way Radio Transceiver Module

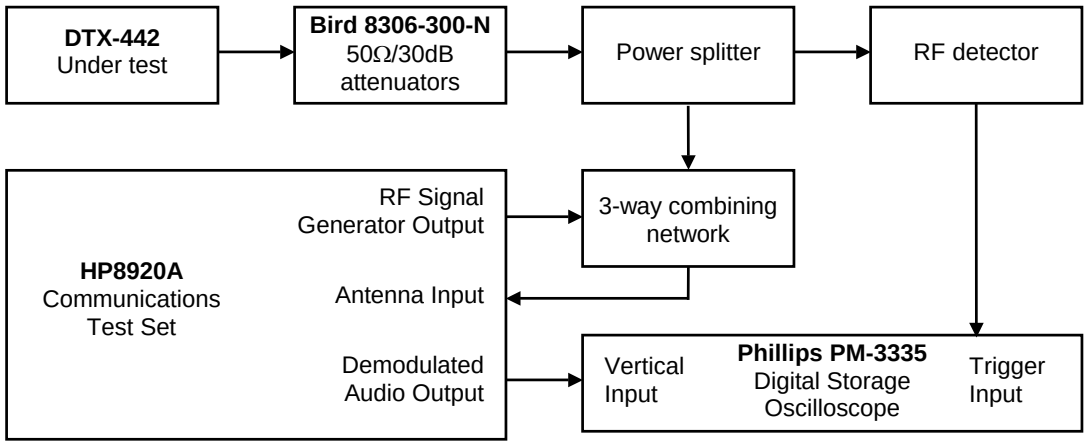
FCC ID: AIERIT17-442

DATE: Nov 5, 2003

PROCEDURE:

The DTX-442 was aligned for transmitter operation on 460.1 MHz at 5.0 watts.

1. The test equipment was connected per the following diagram:



2. The HP8920A receiver was set to measure FM deviation with the audio bandwidth set at ≤ 20 Hz to 15 KHz and the RF frequency set to 460.100 MHz.

3. The DTX-442 transmitter under test was turned on and the HP8920A Spectrum Analyzer was used to measure the RF power level through the test network.

4. The DTX-442 transmitter was turned off.

5. The HP8920A RF signal generator was set to 460.100 MHz at an RF level 30 dB below that measured in step 3, modulated with a 1 kHz tone at ± 12.5 kHz deviation.

6. The Phillips PM-3335 digital oscilloscope horizontal sweep rate was set to 10 mS per division. The vertical amplitude control was adjusted to display the 1000 Hz demodulated audio from the signal generator at ± 4 divisions (3.125 kHz/div), vertically centered on the screen.

7. The Phillips PM-3335 digital oscilloscope was set to trigger at 1 division from the left side of the display when the RF detector senses RF power from the DTX-442 transmitter.

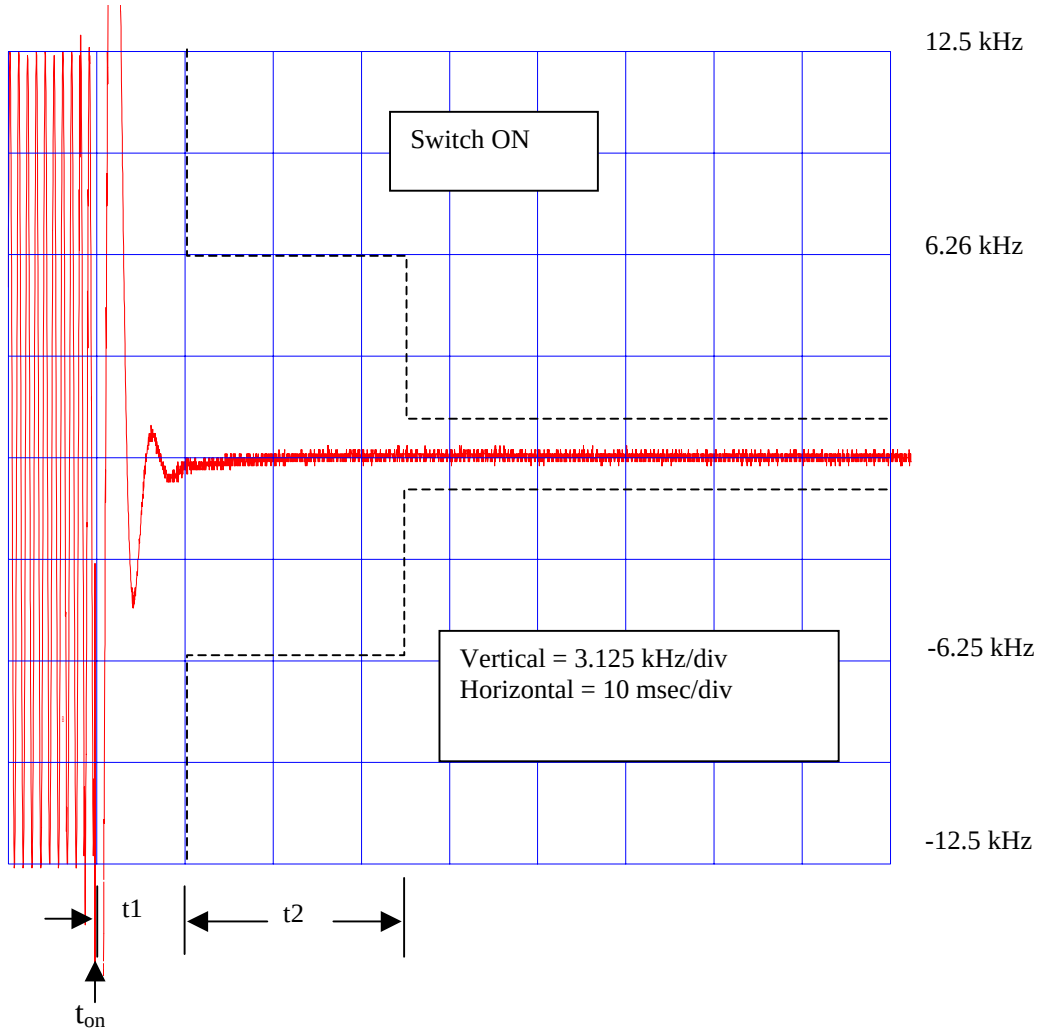
8. The DTX-442 transmitter is turned on and the resulting waveform on the oscilloscope display was stored and plotted. The FCC limits per Part 90.214 were added to the plot in the same manner illustrated in EIA-603-B Part 2.2.19.3. The resulting plot is labeled “switch on” and shows compliance with FCC Part 90.214.

9. The Phillips 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 DTX-442 transmitter.

10. The DTX-442 transmitter is turned off and the resulting waveform on the oscilloscope display was stored and plotted. The FCC limits per Part 90.214 were added to the plot in the same manner illustrated in EIA-603-B Part 2.2.19.3. The resulting plot is labeled “switch off” and shows compliance with FCC Part 90.214.

TYPE OF TEST:	TRANSIENT FREQUENCY BEHAVIOR
FCC PART:	90.214
MANUFACTURER:	RITRON, INC. 505 West Carmel Drive Carmel, IN 46032
MODEL:	DTX-442
TYPE OF UNIT:	UHF-FM Two Way Radio Transceiver Module
FCC ID:	AIERIT17-442
DATE:	Dec 8, 2003

SWITCH ON CONDITION t_{on}, t_1, and t_2



TYPE OF TEST: TRANSIENT FREQUENCY BEHAVIOR

FCC PART: 90.214

MANUFACTURER: RITRON, INC.
505 West Carmel Drive
Carmel, IN 46032

MODEL: DTX-442

TYPE OF UNIT: UHF-FM Two Way Radio Transceiver Module

FCC ID: AIERIT17-442

DATE: Dec 8, 2003