**TYPE OF EXHIBIT**: LIST OF ATTACHED EXIBITS

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

**MODEL**: DTX-154

**TYPE OF UNIT**: VHF-FM Transceiver

**FCC ID:** AIERIT12-150

**DATE:** September 15, 1999

The following exhibits are contained in this file. Other required exhibits were electronically filed as separate exhibits. This file may make reference to information contained in these separate exhibits. This includes, but is not limited to, schematic diagrams, drawings, and photographs.

| Description of Exhibit | FCC Rule(s) |
|---|---|
| Statement of Certifying Engineer | 2.947 |
| Manufacturer's Statement | 2.983 (a), (b), (c) |
| List of Test Equipment Used | 2.947 (d) |
| Description of Measurement Facility | 2.948 |
| Statement Certifying Spectrum Efficiency | 90.203 (j) (3) |
| Radio Frequency Power Output | 2.985 |
| Modulator Response | 2.987 (a), (b) |
| Clipper Filter Response | 2.987 (a) |
| Modulation Limiting Curves | 2.987 (b) |
| Occupied Bandwidth | 2.989 (c), 90.210 (b), 90.210 (d), 90.211 (a) |
| Spurious Emissions at Antenna Terminal | 2.991 |
| Field Strength of Spurious Radiation | 2.993 (b) |
| Frequency Stability vs. Temperature | 2.995 (a), 90.213 (a) |
| Frequency Stability vs. Supply Voltage | 2.995 (d) |
| Transient Frequency Behavior | 90.214 |

**TYPE OF EXHIBIT**: STATEMENT OF CERTIFYING ENGINEER

**FCC PART**: 2.947

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

**MODEL**: DTX-154

**TYPE OF UNIT**: VHF-FM Transceiver

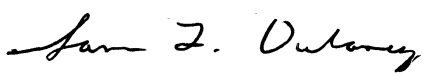
**FCC ID:** AIERIT12-150

**DATE:** September 15, 1999

I, Sam L. Dulaney, am now, and have been for the past year and a half, employed as an Engineering Group Manager with RITRON, Inc. I have been employed in the two-way radio industry for the last 15 years. I received a BSEE degree from West Virginia University in 1978 and an MSEE degree from West Virginia University in 1980.

I hereby certify that all the measurements and data herein were taken by me, or under my direct supervision and that they were obtained using sound and accepted engineering principles, and that they accurately reflect the performance and characteristics of the unit tested.

Further, I attest that manufacturing controls exist such that this data is representative of units which will be manufactured by RITRON.



Certifying Engineer: _____
Sam L. Dulaney – Group Manager

Date: 15 September 1999

**TYPE OF EXHIBIT**: MANUFACTURER'S STATEMENT

**FCC PART**: 2.983 (a) (b) (c)

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

**MODEL**: DTX-154

**TYPE OF UNIT**: VHF-FM Transceiver

**FCC ID:** AIERIT12-150

**DATE:** September 15, 1999

The RITRON model DTX-154 is a voice/data two-way radio designed for operation on either 12.5/15 kHz or 25/30 kHz channels in the 136-174 MHz frequency band. Its output power is variable from 1 watt to 6 watts.

This unit will be manufactured and marketed on a continuing basis in the United States of America by the applicant, RITRON, Inc. of Carmel, Indiana.

**EXIHIBIT**: TEST EQUIPMENT LIST

**FCC PART**: 2.947

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

**MODEL**: DTX-154

**TYPE OF UNIT**: VHF-FM Transceiver

**FCC ID:** AIERIT12-150

**DATE:** September 15, 1999

The measurements taken for this application were obtained using one or more of the following pieces of equipment.

| ITEM | MANUFACTURER | MODEL NO. | SERIAL NO. |
|---|---|---|---|
| DC Power Supply | Astron | VS 12M | 90071655 |
| Multimeter | Fluke | 45 | 6967029 |
| Multimeter | BK Precision | 2704A | 234-008455 |
| Wattmeter | Telewave | 612 | 15081 |
| RF Test Set | Hewlett-Packard | 8920A | R# 01498 |
| Spectrum Analyzer | Tektronix | 7L12 | R# 01334 |
| Spectrum Analyzer | Hewlett-Packard | 8559A | 2010A06979 |
| Spectrum Analyzer | Hewlett-Packard | 8560E | R# 01540 |
| Digital Storage Scope | Fluke/Philips | PM3335 | DM630034 |
| Plotter | Hewlett-Packard | 7585B | 2503A05509 |
| Temperature Chamber | Delta Design | 3900 CL | 0-52-R |
| Frequency Counter | Hewlett-Packard | 5383A | 1716A01417 |
| Function Generator | BK Precision | 4010 | 275-00280 |
| Modulation Analyzer | Hewlett-Packard | 8901A | 2426A03311 |
| Network Analyzer | Hewlett-Packard | 8753E | US37390503 |

**TYPE OF TEST**: DESCRIPTION OF MEASUREMENT FACILITY

**FCC PART**: 2.948

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

**MODEL**: DTX-154

**TYPE OF UNIT**: VHF-FM Transceiver

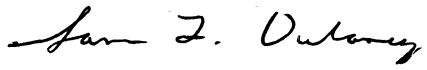
**FCC ID:** AIERIT-12-150

**DATE:** September 15, 1999

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

This site 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, Indiana.



**TYPE OF TEST**: RADIO FREQUENCY POWER OUTPUT

**FCC PART**: 2.985

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

**MODEL**: DTX-154

**TYPE OF UNIT**: VHF-FM Transceiver

**FCC ID:** AIERIT12-150

**DATE:** September 15, 1999

**PROCEDURE**:

1. The DTX-154 was aligned for transmitter operation on 148.025, 161.000 and 173.975 MHz at full rated power per the tune-up procedure outlined in the Preliminary Maintenance Manual.

2. Power was supplied to the DTX-154 by an Astron VS 12M Power Supply. The DTX-154 was connected at the RF Test Jack J401 to the input of a Bird 6154 Thermaline Wattmeter used to measure RF power of the carrier. The Wattmeter provides a resistive 50 ohm termination at the frequencies and power levels used for this test.

3. A B&K Digital Multimeter was connected in series with pin 3 of IC104 to measure the PA module final stage current. A Fluke 45 Digital Multimeter was used to measure the final stage voltage as well as the module power control voltage.

4. Measurements were taken with the power supply set as indicated in the table of results. The DTX-154 transmitter was then set to operate at various power levels from 1 watt to the maximum of 6 watts by varying the module control voltage.

**TYPE OF TEST**: RADIO FREQUENCY POWER OUTPUT

**FCC PART**: 2.985

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

**MODEL**: DTX-154

**TYPE OF UNIT**: VHF-FM Transceiver

**FCC ID:** AIERIT12-150

**DATE:** September 15, 1999

**TEST RESULTS**:

Nominal Supply Voltage = 7.5 VDC

| Frequency (MHz) | Output Power (W) | Final Stage Voltage (VDC) | Final Stage Current (IDC) | Control Voltage (VDC) |
|---|---|---|---|---|
| 148.025 | 1.0 | 7.17 | 0.66 | 1.42 |
| | 2.0 | 7.08 | 1.00 | 1.68 |
| | 3.0 | 6.99 | 1.32 | 1.90 |
| | 4.0 | 6.93 | 1.56 | 2.13 |
| | 5.0 | 6.85 | 1.86 | 2.67 |
| | 6.0 | 6.78 | 2.11 | 3.50 |
| 161.000 | 1.0 | 7.14 | 0.76 | 1.62 |
| | 2.0 | 7.04 | 1.12 | 1.87 |
| | 3.0 | 6.97 | 1.40 | 2.09 |
| | 4.0 | 6.91 | 1.61 | 2.29 |
| | 5.0 | 6.85 | 1.84 | 2.59 |
| | 6.0 | 6.78 | 2.07 | 3.09 |
| 173.975 | 1.0 | 7.15 | 0.75 | 1.72 |
| | 2.0 | 7.04 | 1.00 | 1.93 |
| | 3.0 | 6.99 | 1.24 | 2.18 |
| | 4.0 | 6.95 | 1.47 | 2.48 |
| | 5.0 | 6.88 | 1.69 | 3.05 |
| | 6.0 | 6.80 | 1.97 | 4.00 |

**TYPE OF TEST**: MODULATOR RESPONSE

**FCC PART**: 2.987 (a)

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

**MODEL**: DTX-154

**TYPE OF UNIT**: VHF-FM Transceiver

**FCC ID:** AIERIT12-150

**DATE:** September 15, 1999

**PROCEDURE**:

1. The DTX-154 was aligned for transmitter operation on 161.000 MHz at full rated power per the tune-up procedure outlined in the Preliminary Maintenance Manual.

2. The DTX-154's clipper filter was bypassed by setting analog switch IC303C to the bypass position. The output of a BK Precision Model 4010 Function Generator was connected to the Auxiliary input of the unit. The Auxiliary input has a frequency response which is flat well beyond 5000 Hz. The radio was connected to an HP8901 Modulation analyzer for measuring deviation.

3. The audio signal generator was set to a frequency of 1000 Hz and the output was adjusted to provide +/- 1.5 kHz deviation (60% rated system deviation for 12.5 kHz operation) as indicated by the HP8901.

4. With the audio generator output level fixed at the value in step 3 above, the frequency was varied from 100 – 10,000 Hz. Deviation was measured at various frequencies within this range and recorded on the accompanying chart.

5. The audio level was increased to produce 3 kHz deviation (60% rated system deviation for 25 kHz operation) at an audio frequency of 1000 Hz and steps 1 through 4 above were repeated. Since the results did not change with the change in deviation, only one plot is shown.

**TYPE OF TEST**: MODULATOR RESPONSE

**FCC PART**: 2.987 (a)

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

**MODEL**: DTX-154

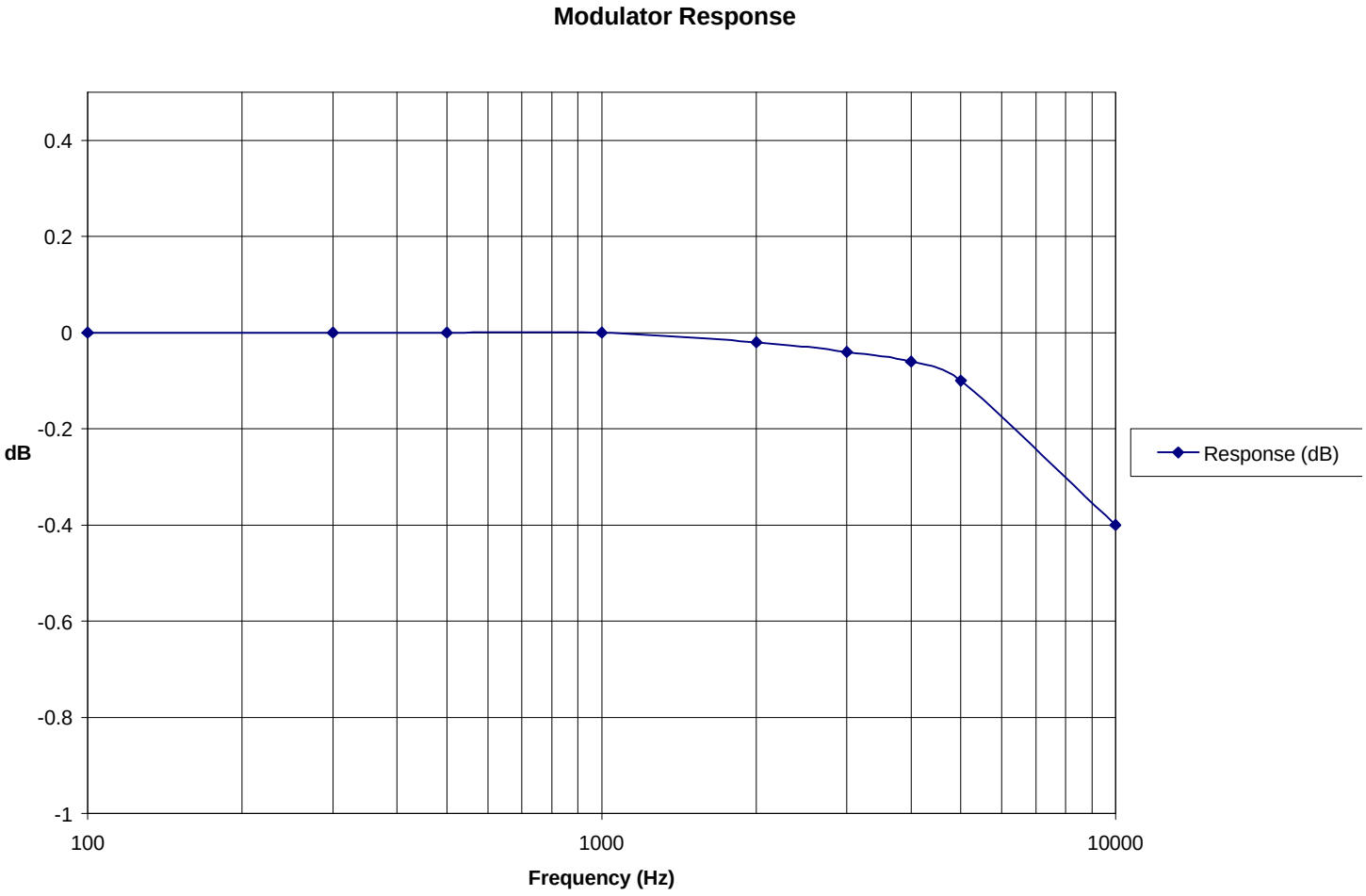
**TYPE OF UNIT**: VHF-FM Transceiver

**FCC ID:** AIERIT12-150

**DATE:** September 15, 1999

**TEST RESULTS**:

| Frequency (Hz) | Response (dB) |
|---|---|
| 100 | 0 |
| 300 | 0 |
| 500 | 0 |
| 1000 | 0 |
| 2000 | -0.02 |
| 3000 | -0.04 |
| 4000 | -0.06 |
| 5000 | -0.1 |
| 10000 | -0.4 |


Modulator Response
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
dB
100
1000
10000
Frequency (Hz)
Response (dB)

**TYPE OF TEST**: CLIPPER FILTER RESPONSE

**FCC PART**: 2.987 (a)

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

**MODEL**: DTX-154

**TYPE OF UNIT**: VHF-FM Transceiver

**FCC ID:** AIERIT12-150

**DATE:** September 15, 1999

**PROCEDURE**:

1. The stages of the DTX-154 speech amplifier prior to the low-pass filter were removed by disconnecting R346 from the output of TX mute switch IC303A. The output of a BK Precision Model 4010 Function Generator was applied to R346.

2. A Fluke Model 45 Dual Display Multimeter was used to measure the low-pass filter output at Pin 8 of IC310C. A DC offset of 2.5 volts was used to insure that the clipper filter operational amplifiers were biased properly.

3. The audio signal generator was set for a level of 1.6 VRMS to produce 0 dB at the output of the low-pass filter. This level was selected to prevent limiting or distortion at any frequency. The Fluke Model 45 Dual Display Multimeter was set to make all measurements relative to this reference level.

4. The frequency of the audio signal generator was varied from 100 Hz to 100 kHz with the output level constant. Measurements were recorded on the accompanying chart. All measurements were relative to the input signal level.

**TYPE OF TEST**: CLIPPER FILTER RESPONSE

**FCC PART**: 2.987 (a)

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

**MODEL**: DTX-154

**TYPE OF UNIT**: VHF-FM Transceiver

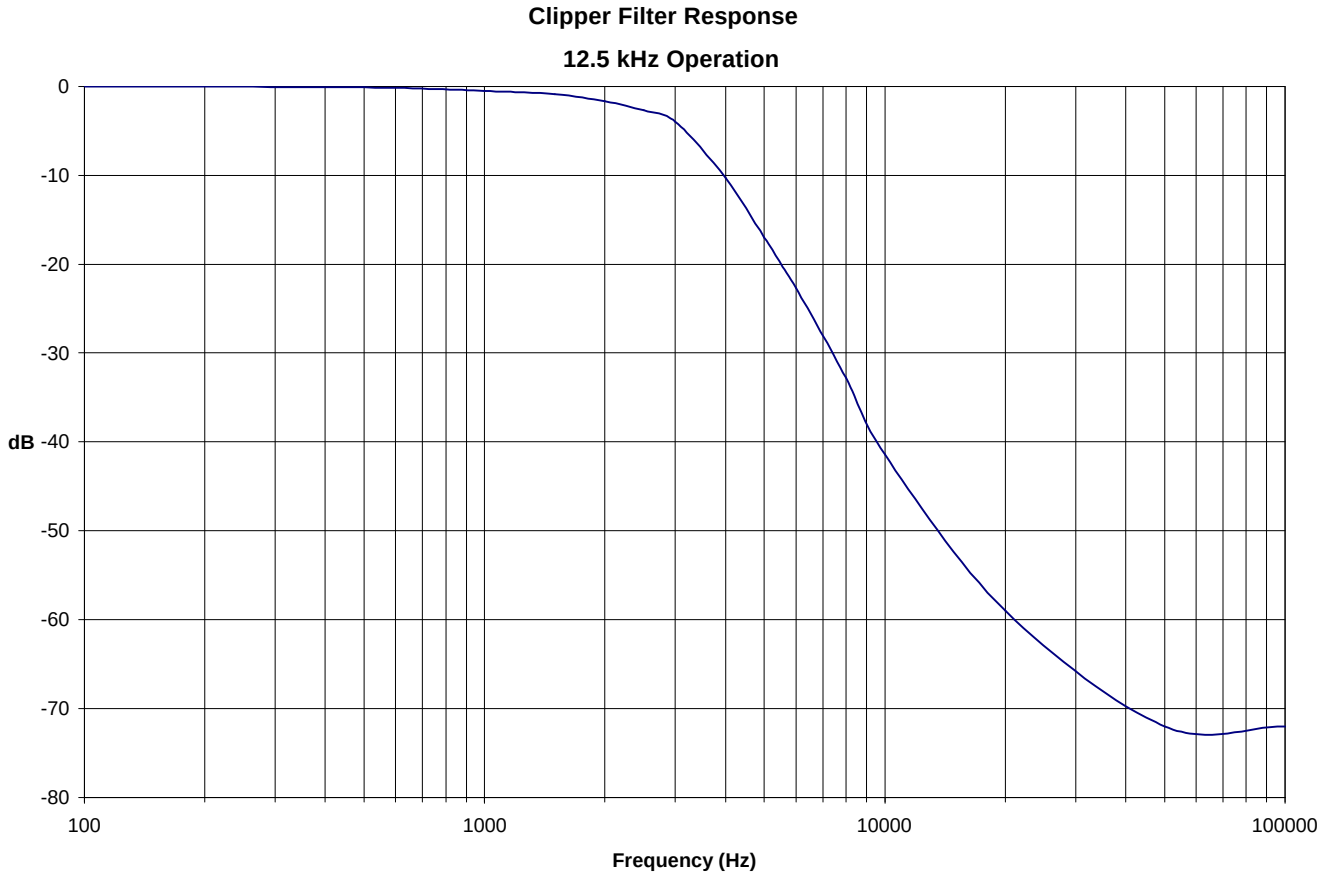
**FCC ID:** AIERIT12-150

**DATE:** September 15, 1999

**TEST RESULTS**:

| Frequency (Hz) | Response (dB) |
|---|---|
| 100 | 0 |
| 500 | -0.1 |
| 1000 | -0.5 |
| 1500 | -0.9 |
| 2000 | -1.7 |
| 2500 | -2.7 |
| 3000 | -4 |
| 4000 | -10.3 |
| 5000 | -17 |
| 6000 | -22.7 |
| 8000 | -32.8 |
| 10000 | -41.4 |
| 20000 | -59 |
| 50000 | -72 |
| 100000 | -72 |

Response relative to input level.


Clipper Filter Response
12.5 kHz Operation
0
-10
-20
-30
dB -40
-50
-60
-70
-80
100
1000
10000
100000
Frequency (Hz)

**TYPE OF TEST**: MODULATION LIMITING CURVES
Microphone Input

**FCC PART**: 2.987 (b)

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

**MODEL**: DTX-154

**TYPE OF UNIT**: VHF-FM Transceiver

**FCC ID:** AIERIT12-150

**DATE:** September 15, 1999

**PROCEDURE**:

1. The DTX-154 was aligned for transmitter operation on 161.000 MHz per the tune-up procedure outlined in the Preliminary Maintenance Manual.

2. The DTX-154 was connected to the RF input of an HP 8901 Modulation Analyzer set up to measure FM deviation.

3. The output of a BK Precision Model 4010 Function Generator was applied to the microphone input of the DTX-154 through pin 4 of J301. The output of the audio generator was set to an output level sufficient to drive the modulation limiter into limiting at any audio frequency.

4. A Fluke Model 45 Dual Display Multimeter was used to measure the amplitude of the signal applied to the microphone input.

5. The frequency of the audio generator was adjusted to find the frequency of maximum response. The DTX-154 deviation was adjusted for +/- 2.5 kHz for 12.5 kHz channel operation as outlined in the Preliminary Maintenance Manual.

6. The frequency of the audio signal generator was set to 300 Hz and the output level was adjusted to produce less than 500 Hz deviation, which is 20% of the rated modulation. The voltage level was then adjusted in amplitude from zero through a value at least 16 dB above that required to produce maximum deviation. Deviation was recorded at a number of increments of audio input amplitude and converted to percent deviation.

7. The input voltage was adjusted to a level 16 dB greater than that required to produce 50% maximum deviation. The maximum deviation was noted.

8. Steps 6 and 7 were repeated for frequencies of 1000 and 3000 Hz.

9. Since the curves do not change as a function of the actual deviation level, separate data were not provided for 25 kHz operation.

**TYPE OF TEST**: MODULATION LIMITING CURVES
Microphone Input

**FCC PART**: 2.987 (b)

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

**MODEL**: DTX-154

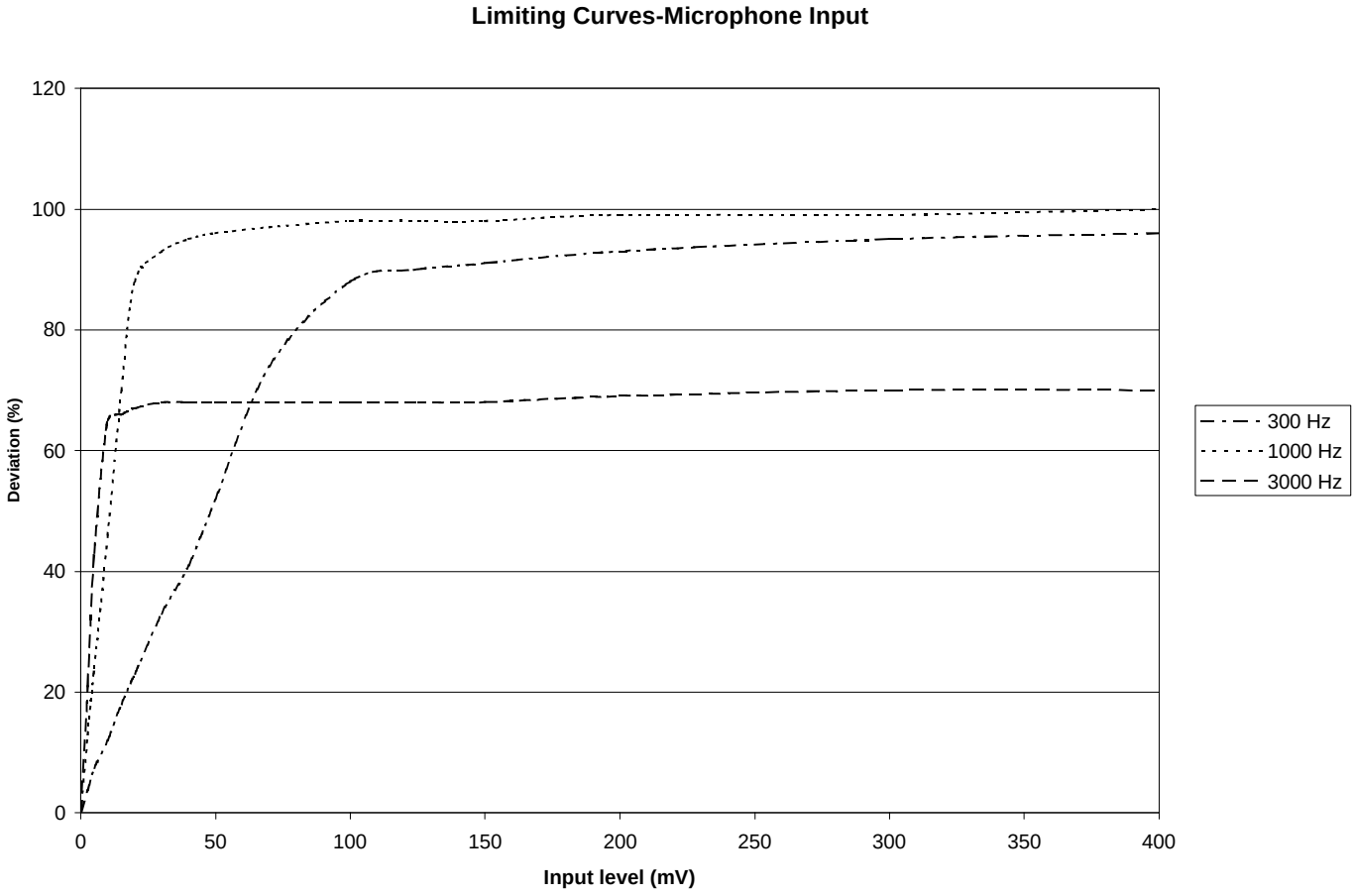
**TYPE OF UNIT**: VHF-FM Transceiver

**FCC ID:** AIERIT12-150

**DATE:** September 15, 1999

**TEST RESULTS**:

| | Deviation (%) | | |
|---|---|---|---|
| Input Level (mV) | 300 Hz | 1000 Hz | 3000 Hz |
| 0 | 0 | 0 | 0 |
| 2.5 | 3.7 | 13 | 21 |
| 5 | 7.4 | 24 | 43 |
| 10 | 12 | 46 | 65 |
| 15 | 18 | 70 | 66 |
| 20 | 23 | 88 | 67 |
| 30 | 33 | 93 | 68 |
| 40 | 41 | 95 | 68 |
| 50 | 52 | 96 | 68 |
| 70 | 74 | 97 | 68 |
| 100 | 88 | 98 | 68 |
| 125 | 90 | 98 | 68 |
| 150 | 91 | 98 | 68 |
| 200 | 93 | 99 | 69 |
| 300 | 95 | 99 | 70 |
| 400 | 96 | 100 | 70 |
| 16 dB above 50 % Deviation | 65 | 96 | 68 |


Limiting Curves-Microphone Input
120
100
80
60
40
20
0
Deviation (%)
0
50
100
150
200
250
300
350
400
Input level (mV)
300 Hz
1000 Hz
3000 Hz

**TYPE OF TEST**: MODULATION LIMITING CURVES
Auxiliary Input

**FCC PART**: 2.987 (b)

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

**MODEL**: DTX-154

**TYPE OF UNIT**: VHF-FM Transceiver

**FCC ID:** AIERIT12-150

**DATE:** September 15, 1999

**PROCEDURE**:

1. The DTX-154 was aligned for transmitter operation on 161.000 MHz per the tune-up procedure outlined in the Preliminary Maintenance Manual.

2. The DTX-154 was connected to the RF input of an HP 8901 Modulation Analyzer set up to measure FM deviation.

3. The output of a BK Precision Model 4010 Function Generator was applied to the microphone input of the DTX-154 through pin 7 of J301. The output of the audio generator was set to an output level sufficient to drive the modulation limiter into limiting at any audio frequency.

4. A Fluke Model 45 Dual Display Multimeter was used to measure the amplitude of the signal applied to the microphone input.

5. The frequency of the audio generator was adjusted to find the frequency of maximum response. The DTX-154 deviation was adjusted for +/- 2.4 kHz for 12.5 kHz operation as outlined in the Preliminary Maintenance Manual.

6. The frequency of the audio signal generator was set to 300 Hz and the output level was adjusted to produce less than 500 Hz deviation, which is 20% of the rated modulation. The voltage level was then adjusted in amplitude from zero through a value at least 16 dB above that required to produce 50 % maximum deviation. Deviation was recorded at a number of increments of audio input amplitude and converted to percent deviation.

7. The input voltage was adjusted to a level 16 dB greater than that required to produce 50% modulation. The maximum deviation was noted.

8. Steps 6 and 7 were repeated for frequencies of 1000 and 3000 Hz.

9. Since the curves do not change as a function of the actual deviation level, separate data were not provided for 25 kHz operation.

**TYPE OF TEST**: MODULATION LIMITING CURVES
Auxiliary Input

**FCC PART**: 2.987 (b)

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

**MODEL**: DTX-154

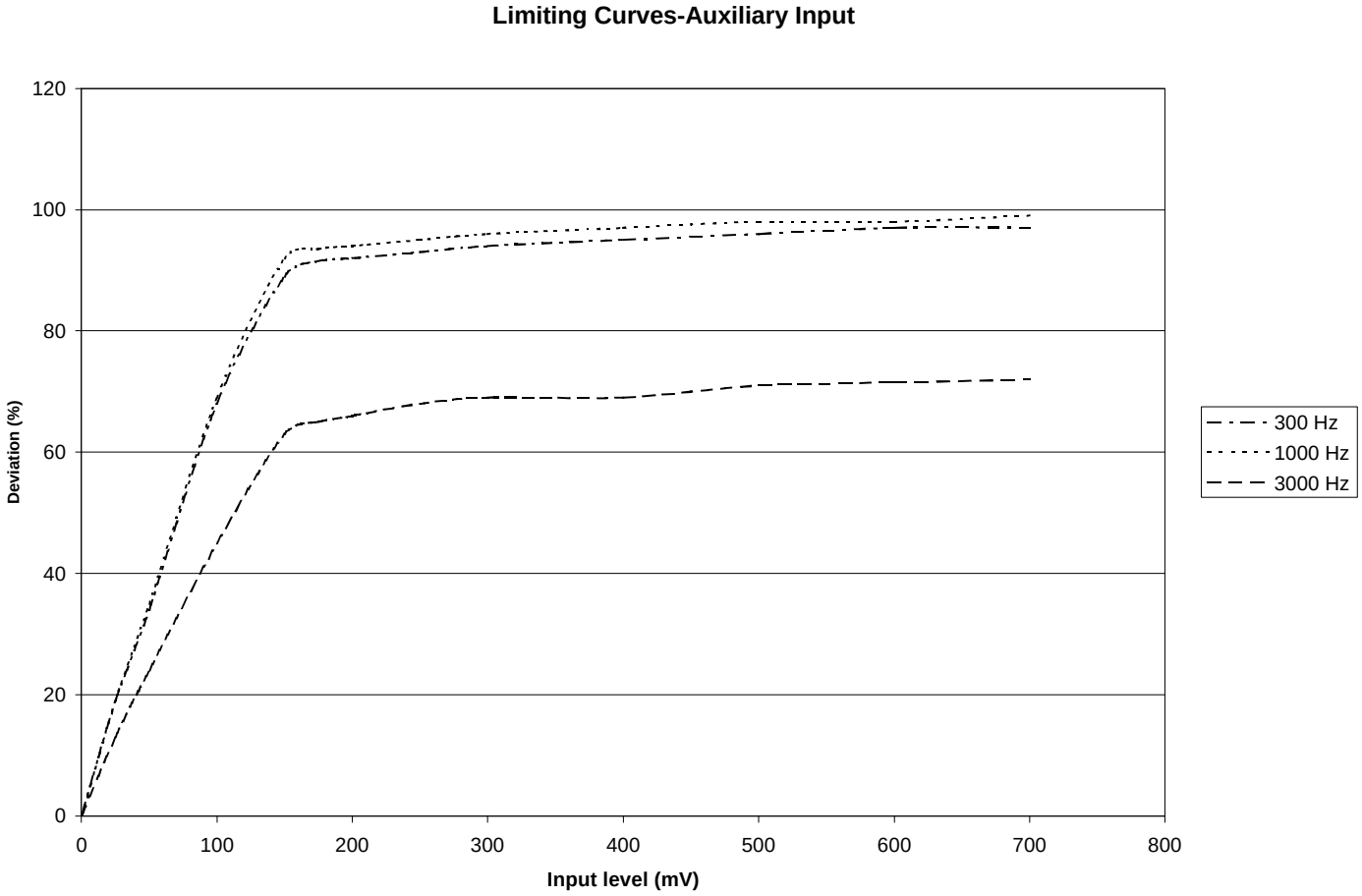
**TYPE OF UNIT**: VHF-FM Transceiver

**FCC ID:** AIERIT12-150

**DATE:** September 15, 1999

**TEST RESULTS**:

| | Deviation (%) | | |
|---|---|---|---|
| Input Level (mV) | 300 Hz | 1000 Hz | 3000 Hz |
| 0 | 0 | 0 | 0 |
| 25 | 19 | 19 | 13 |
| 50 | 34 | 35 | 24 |
| 100 | 68 | 69 | 45 |
| 150 | 89 | 92 | 63 |
| 175 | 91.5 | 93.5 | 65 |
| 200 | 92 | 94 | 66 |
| 250 | 93 | 95 | 68 |
| 300 | 94 | 96 | 69 |
| 400 | 95 | 97 | 69 |
| 500 | 96 | 98 | 71 |
| 600 | 97 | 98 | 71.5 |
| 700 | 97 | 99 | 72 |
| 16 dB above 50 % deviation | 96 | 98 | 71 |


Limiting Curves-Auxiliary Input
120
100
80
60
40
20
0
Deviation (%)
0
100
200
300
400
500
600
700
800
Input level (mV)
300 Hz
1000 Hz
3000 Hz

| | |
|---|---|
| **TYPE OF TEST**: | OCCUPIED BANDWIDTH<br>Microphone Input |
| **FCC PART**: | 2.989 (c) (1) per 90.210 (b) (d) |
| **MANUFACTURER**: | RITRON, INC.<br>505 West Carmel Drive<br>Carmel, IN 46032 |
| **MODEL**: | DTX-154 |
| **TYPE OF UNIT**: | VHF-FM Transceiver |
| **FCC ID:** | AIERIT12-150 |
| **DATE:** | September 15, 1999 |

**PROCEDURE**:

1. The DTX-154 was aligned for transmitter operation on 161.000 MHz at full rated power and the deviation was adjusted for +/- 2.4 kHz for 12.5 kHz operation as outlined in the Preliminary Maintenance Manual.

2. The RF Output Jack J101 was connected to the input of a Bird Model 8306-300-N 30 dB power attenuator. The output of the attenuator was connected to the input of a Tektronix 7L12 Spectrum Analyzer in a 7613 storage frame. The spectrum analyzer was set to:

   - 300 Hz Resolution
   - 3 kHz video bandwidth
   - 5 kHz per Horizontal Division
   - 10 dB per Vertical Division

3. The center frequency of the spectrum analyzer was set to the DTX-154 carrier frequency and the full scale reference line was set to the level of the unmodulated carrier.

4. The output of a BK Precision Model 4010 Function Generator was applied to the microphone input of the DTX-154 through pin 4 of J301. 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 audio frequency which produced the greatest deviation.

5. The spectrum analyzer readings of the emission levels in dBc were recorded and a graph of the spectrum analyzer output was plotted. All readings were rounded to the nearest dB.

6. Steps 3 – 5 were repeated at the lowest power setting of the radio.

7. The DTX-154 deviation was adjusted for +/- 4.8 kHz for 25 kHz operation as outlined in the Preliminary Maintenance Manual and steps 3 - 6 were repeated. The spectrum analyzer center frequency was then shifted +/-40 kHz and the spectrum was examined for emissions.

**TYPE OF TEST**: OCCUPIED BANDWIDTH
Microphone Input

**FCC PART**: 2.989 (c) (1) per 90.210 (b) (d)

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

**MODEL**: DTX-154

**TYPE OF UNIT**: VHF-FM Transceiver

**FCC ID:** AIERIT12-150

**DATE:** September 15, 1999

**TEST RESULTS**:

12.5 kHz Operation

| Frequency Offset (kHz) | Emission Level (dBc) | FCC Limit (dBc) |
|---|---|---|
| -12.5 | -71 | -70 |
| -10 | -57 | -52 |
| -7.5 | -40 | -34 |
| -5 | -24 | 0 |
| -2.5 | -9 | 0 |
| 0 | -2 | 0 |
| 2.5 | -9 | 0 |
| 5 | -24 | 0 |
| 7.5 | -40 | -34 |
| 10 | -57 | -52 |
| 12.5 | -71 | -70 |

Note: Emission levels did not change as a function of power level.

**TYPE OF TEST**: OCCUPIED BANDWIDTH
Microphone Input

**FCC PART**: 2.989 (c) (1) per 90.210 (b) (d)

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

**MODEL**: DTX-154

**TYPE OF UNIT**: VHF-FM Transceiver

**FCC ID:** AIERIT12-150

**DATE:** September 15, 1999

**TEST RESULTS**:

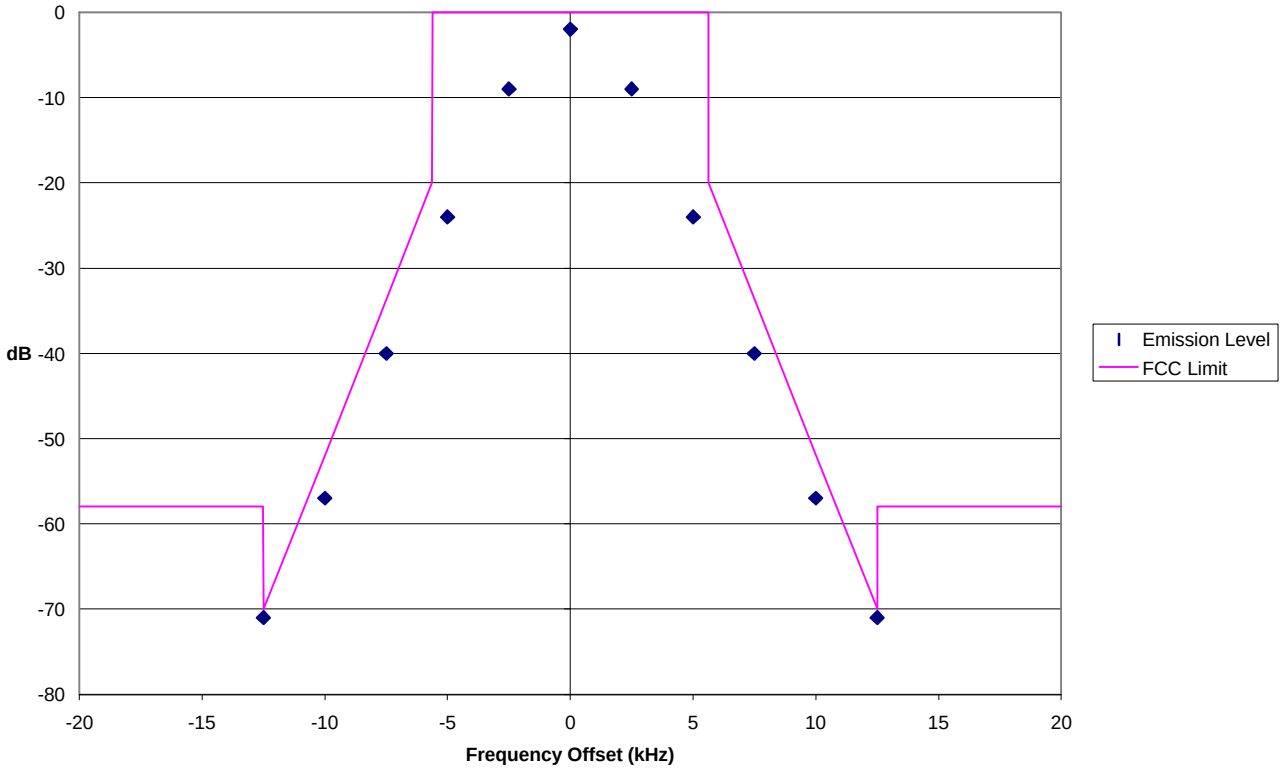
25 kHz Operation

| Frequency Offset (kHz) | Emission Level (dBc) | FCC Limit (dBc) |
|---|---|---|
| -15 | -65 | -25 |
| -12.5 | -50 | -25 |
| -10 | -36 | 0 |
| -7.5 | -23 | 0 |
| -5 | -12 | 0 |
| -2.5 | -5 | 0 |
| 0 | -7 | 0 |
| 2.5 | -5 | 0 |
| 5 | -12 | 0 |
| 7.5 | -23 | 0 |
| 10 | -36 | 0 |
| 12.5 | -50 | -25 |
| 15 | -65 | -25 |

Note: Emission levels did not change as a function of power level.

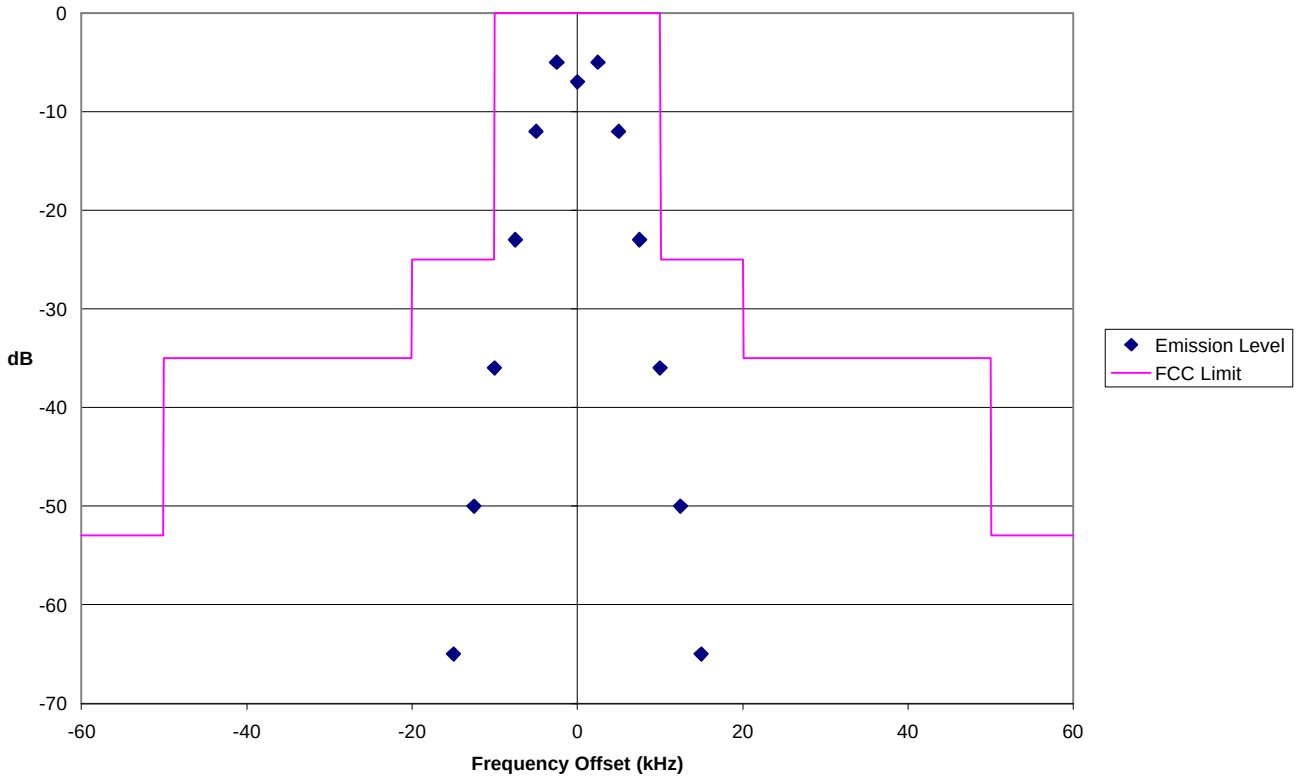
**Occupied Bandwidth**

**12.5 kHz Operation**




**Occupied Bandwidth**

**25 kHz Operation**



| | |
|---|---|
| **TYPE OF TEST**: | OCCUPIED BANDWIDTH<br>Auxiliary Input-Squarewave Input Signal |
| **FCC PART**: | 2.989 (c) (1) per 90.210 (b) (d) |
| **MANUFACTURER**: | RITRON, INC.<br>505 West Carmel Drive<br>Carmel, IN 46032 |
| **MODEL**: | DTX-154 |
| **TYPE OF UNIT**: | VHF-FM Transceiver |
| **FCC ID:** | AIERIT12-150 |
| **DATE:** | September 15, 1999 |

**PROCEDURE**:

1. The DTX-154 was aligned for transmitter operation on 161.000 MHz at full rated power and the deviation was adjusted for +/- 2.4 kHz for 12.5 kHz operation as outlined in the Preliminary Maintenance Manual.

2. The RF Output Jack J101 was connected to the input of a Bird Model 8306-300-N 30 dB power attenuator. The output of the attenuator was connected to the input of a Tektronix 7L12 Spectrum Analyzer in a 7613 storage frame. The spectrum analyzer was set to:

   - 300 Hz Resolution
   - 3 kHz video bandwidth
   - 5 kHz per Horizontal Division
   - 10 dB per Vertical Division

3. The center frequency of the spectrum analyzer was set to the DTX-154 carrier frequency and the full scale reference line was set to the level of the unmodulated carrier.

4. The output of a BK Precision Model 4010 Function Generator was applied to the auxiliary input of the DTX-154 through pin 7 of J301. The frequency of the audio signal generator was set to 2400 Hz (representing 4800 baud), the waveform set for square, and the output adjusted to a level such that the square wave was just reaching clipping in the DTX-154 clipper.

5. The spectrum analyzer readings of the emission levels in dBc were recorded and a graph of the spectrum analyzer output was plotted. All readings were rounded to the nearest dB.

6. Steps 3 – 5 were repeated at the lowest power setting of the radio.

**TYPE OF TEST**: OCCUPIED BANDWIDTH
Auxiliary Input-Squarewave Input Signal

**FCC PART**: 2.989 (c) (1) per 90.210 (b) (d)

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

**MODEL**: DTX-154

**TYPE OF UNIT**: VHF-FM Transceiver

**FCC ID:** AIERIT12-150

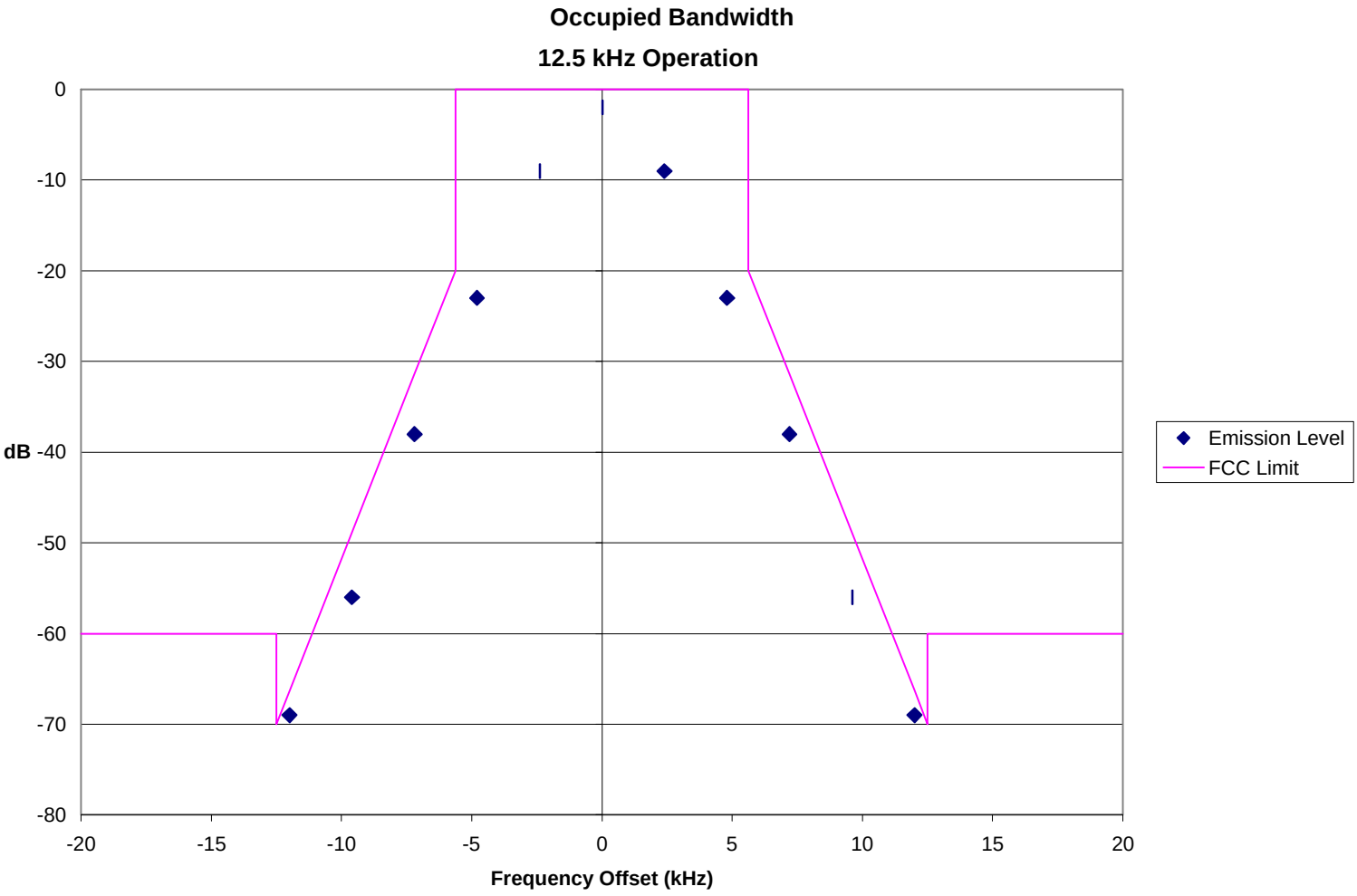
**DATE:** September 15, 1999

**TEST RESULTS**:

12.5 kHz Operation

| Frequency Offset (kHz) | Emission Level (dBc) | FCC Limit (dBc) |
|---|---|---|
| -12 | -69 | -66.3 |
| -9.6 | -56 | -48.9 |
| -7.2 | -38 | -31.4 |
| -4.8 | -23 | 0 |
| -2.4 | -9 | 0 |
| 0 | -2 | 0 |
| 2.4 | -9 | 0 |
| 4.8 | -23 | 0 |
| 7.2 | -38 | -31.4 |
| 9.6 | -56 | -48.9 |
| 12 | -69 | -66.3 |

Note: Emission levels did not change as a function of power level.


Occupied Bandwidth
12.5 kHz Operation
0
-10
-20
-30
dB -40
-50
-60
-70
-80
-20
-15
-10
-5
0
5
10
15
20
Frequency Offset (kHz)
Emission Level
FCC Limit

**TYPE OF TEST**: OCCUPIED BANDWIDTH

**FCC PART**: 2.989 (c) (1) per 90.210 (b) (d)

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

**MODEL**: DTX-154

**TYPE OF UNIT**: VHF-FM Transceiver

**FCC ID:** AIERIT12-150

**DATE:** September 15, 1999

**PROCEDURE:**

1. The analyzer readings in dBm were converted to power readings and then were summed to provide a MEAN REFERENCE POWER. The powers of the carrier and each sideband were calculated as a percentage of the reference power level. The percentages were added together starting with the carrier and expanding outward pair by sideband pair until greater than 99.0% of the total MEAN REFERENCE POWER was reached.

2. The occupied bandwidth is defined as having 99.0% of the total MEAN REFERENCE POWER existing within its limits.

**RESULTS:**

Microphone Input-2500 Hz tone:

| | |
|---|---|
| 12.5 kHz operation | 10 kHz |
| 25 kHz operation | 15 kHz |

Auxiliary Input-squarewave input:

| | |
|---|---|
| 12.5 kHz operation | 9.6 kHz |

**TYPE OF TEST**: OCCUPIED BANDWIDTH
Auxiliary Input-Pseudorandom Data Stream Input

**FCC PART**: 2.989 (c) (1) per 90.210 (b) (d)

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

**MODEL**: DTX-154

**TYPE OF UNIT**: VHF-FM Transceiver

**FCC ID:** AIERIT12-150

**DATE:** September 15, 1999

**PROCEDURE**:

1. The DTX-154 was aligned for transmitter operation on 161.000 MHz at full rated power and the deviation was adjusted for +/- 2.4 kHz for 12.5 kHz operation as outlined in the Preliminary Maintenance Manual.

2. The RF Output Jack J101 was connected to the input of a Bird Model 8306-300-N 30 dB power attenuator. The output of the attenuator was connected to the input of a Tektronix 7L12 Spectrum Analyzer in a 7613 storage frame. The spectrum analyzer was set to:

   - 300 Hz Resolution
   - 3 kHz video bandwidth
   - 5 kHz per Horizontal Division
   - 10 dB per Vertical Division

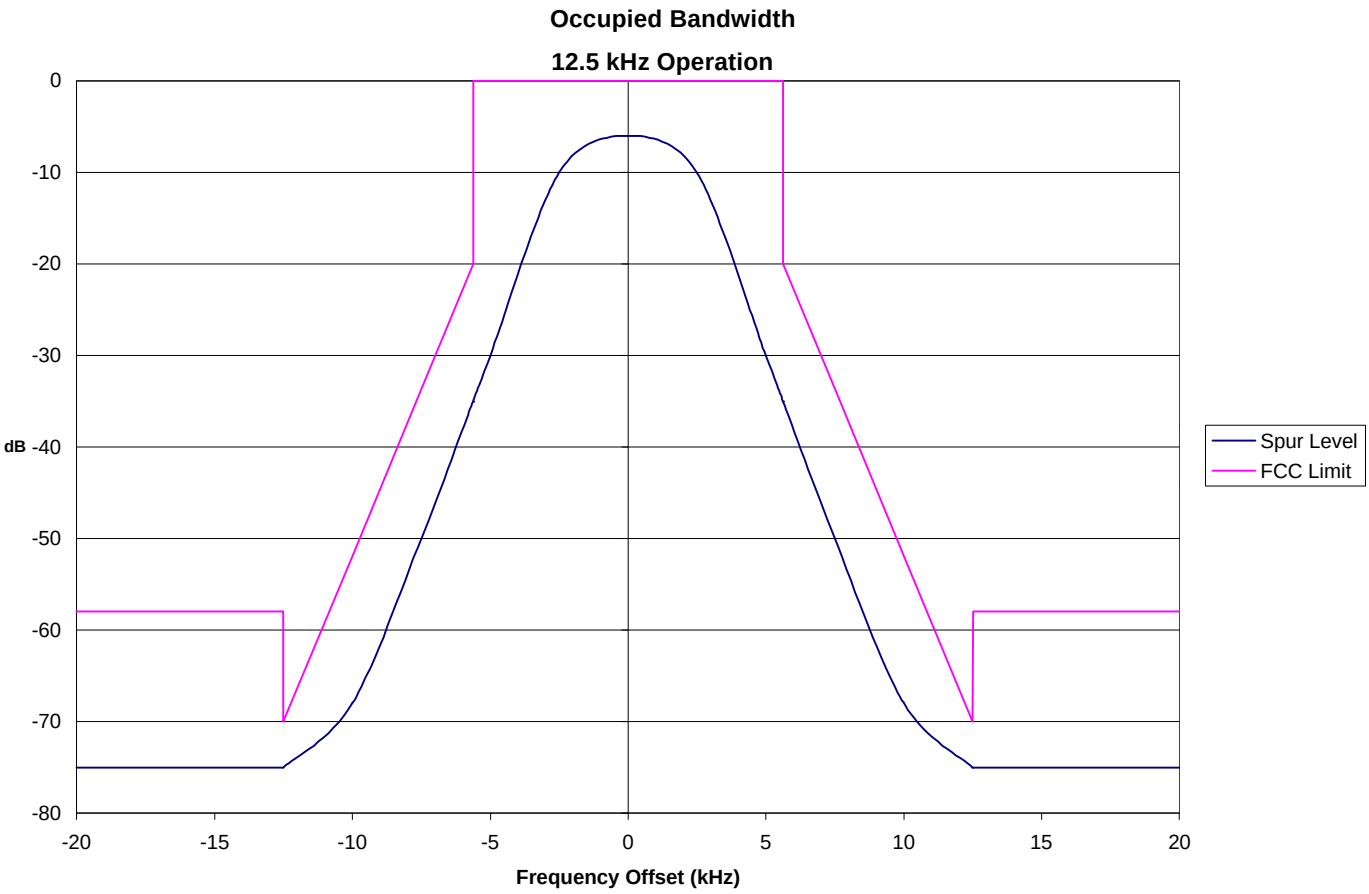
3. The center frequency of the spectrum analyzer was set to the DTX-154 carrier frequency and the full scale reference line was set to the level of the unmodulated carrier.

4. The output of a Pseudorandom data stream generator was applied to the auxiliary input of the DTX-154 through pin 7 of J301. The output of the pseudorandom generator was a four level pattern at 4800 baud (9600 bps). The output level was adjusted such that the outside two levels (0 and 3) were just at the edge of clipping in the DTX-154 clipper.

5. The spectrum analyzer result was recorded and a graph of the spectrum analyzer output was plotted.

6. Steps 3 – 5 were repeated for the lowest power setting of the radio.

7. The results are plotted on the following sheet.


Occupied Bandwidth
12.5 kHz Operation
0
-10
-20
-30
dB -40
-50
-60
-70
-80
-20
-15
-10
-5
0
5
10
15
20
Frequency Offset (kHz)
Spur Level
FCC Limit

**TYPE OF TEST**: SPURIOUS EMISSIONS AT ANTENNA TERMINALS

**FCC PART**: 2.991

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

**MODEL**: DTX-154

**TYPE OF UNIT**: VHF-FM Transceiver

**FCC ID:** AIERIT12-150

**DATE:** September 15, 1999

**PROCEDURE**:

1. The DTX-154 was aligned for transmitter operation on 161.000 MHz at full rated power per the tune-up procedure outlined in the Preliminary Maintenance Manual.

2. This test was conducted as specified in 2.991 “under the conditions specified in 2.989 as appropriate”, i.e. “when modulated by a 2500 Hz tone at an input level 16 dB greater than that necessary to produce 50 percent modulation” “... at the frequency of maximum response of the audio modulating circuit.”

3. The RF Output of the DTX-154 was connected to a 100 Watt, 50 Ohm, 30 dB attenuator, a VHF Notch Filter tuned to 161.000 MHz, and then to the input an Tektronix 7L12 Spectrum Analyzer. An Astron VS 12M power supply was connected to the power supply input. The voltage was set to the nominal voltage for the version tested.

4. For each emission frequency, the insertion loss of the interconnect cables and attenuator was measured using an HP 8753E Network Analyzer. The difference in insertion loss relative to that at the carrier frequency was used to correct the emission level value shown below.

5. The spectrum was searched from 8 MHz to the 10th harmonic of the operating frequency. All unreported emissions were more than 20 dB below the FCC limit of 50 + 10 log P, or -20 dBm absolute.

6. The tests were conducted at the minimum and maximum power settings of the unit and at the lower and upper band edge frequencies.

**TYPE OF TEST**: SPURIOUS EMISSIONS AT ANTENNA TERMINALS

**FCC PART**: 2.991

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

**MODEL**: DTX-154

**TYPE OF UNIT**: VHF-FM Transceiver

**FCC ID:** AIERIT12-150

**DATE:** September 15, 1999

**TEST RESULTS**:

Output Power = 1 Watt

| Frequency (MHz) | Spur Level (dBc) | FCC Limit (dBc) | Comments |
|---|---|---|---|
| 322.00 | -78 | -50 | 2nd harmonic of 161 MHz |
| 347.95 | -72 | -50 | 2nd harmonic of 173.975 MHz |

Output Power = 6 Watts

| Frequency (MHz) | Spur Level (dBc) | FCC Limit (dBc) | Comments |
|---|---|---|---|
| 322.00 | -78 | -58 | 2nd harmonic of 161 MHz |
| 347.95 | -78 | -58 | 2nd harmonic of 173.975 MHz |

**TYPE OF TEST**: FIELD STRENGTH OF SPURIOUS RADIATION

**FCC PART**: 2.993 (b)

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

**MODEL**: DTX-154

**TYPE OF UNIT**: VHF-FM Transceiver

**FCC ID:** AIERIT12-150

**DATE:** September 15, 1999

**PROCEDURE**:

1. The following measurements were taken at the RITRON, Inc. 3 meter test site. Measurements were made in accordance with FCC Rules & Regulations Part 2.947, using the procedures of IEC Publication 106.

2. The DTX-154 was aligned for transmitter operation on 161.000 MHz at full rated power per the tune-up procedure outlined in the Preliminary Maintenance Manual. The unit was then terminated at the antenna port with a non-radiating 50 ohm terminating load.

3. All field strength measurements were made with the Hewlett-Packard Model 8559A Spectrum Analyzer and the appropriate antenna for the frequency being measured. The antennas used were:

    - Electro-Metrics BDA-25 Dipole Antenna from 0 to 200 MHz
    - Electro-Metrics LP-25 Log Periodic Antenna from 200 to 1000 MHz
    - Polarad CA-BB Microwave Antenna from 1000 to 10,000 MHz

4. For each emission, the height and polarization of the field strength measuring antenna and orientation of the DTX-154 were varied to provide maximum field strength. The spectrum was searched from 4 MHz to the 10th harmonic of the transmit frequency. All unreported emissions were more than 20 dB below the FCC limits specified in Part 90.210(d)(3).

5. The DTX-154 was tested at 1 watt and at the maximum output power level.

**TYPE OF TEST**: FIELD STRENGTH OF SPURIOUS RADIATION

**FCC PART**: 2.993 (b)

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

**MODEL**: DTX-154

**TYPE OF UNIT**: VHF-FM Transceiver

**FCC ID:** AIERIT12-150

**DATE:** September 15, 1999

**EQUATIONS:**

Analyzer readings in dBm and the calibrated antenna factor were converted to field strength as follows:

$$P_{3m} = R + 107 + K$$
$$E_{3m} = \text{Log}^{-1} (P_{3m} / 20)$$

where:
$P_{3m}$ = Power output at 3 meters in dBm.
R = Direct reading from spectrum analyzer in dBm.
K = Antenna factor in dB at 3 meters.
$E_{3m}$ = Field strength at 3 meters in μV/m.

The reference level for a half wave dipole was computed as follows:

$$E_{ref} = 1000000 * \sqrt{} (49.2 * P) / D$$

where:
P = Transmitter power in Watts.
D = Distance in meters.

The amount, in dB, that the measured field strength is below the reference field strength was computed as follows:

$$E = 20 \text{ Log } (E_{3m} / E_{ref})$$

where:
E = The amount below reference level in dB.
$E_{3m}$ = Field strength at 3 meters in μV/m.
$E_{ref}$ = Reference field strength at 3 meters in μV/m.

**TYPE OF TEST**: FIELD STRENGTH OF SPURIOUS RADIATION

**FCC PART**: 2.993 (b)

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

**MODEL**: DTX-154

**TYPE OF UNIT**: VHF-FM Transceiver

**FCC ID:** AIERIT12-150

**DATE:** September 15, 1999

**TEST RESULTS:**

| Po (W) | Emission Frequency (MHz) | Measurement dBm | Antenna | Antenna Factor (dB) | Field Strength (uV/m) | FCC Limit (uV/m) | Margin dB |
|---|---|---|---|---|---|---|---|
| 1 | 483.00 | -67 | Log-Periodic | 22 | 1261 | 7394 | 15.4 |
| 6 | 483.00 | -65 | Log-Periodic | 22 | 1587 | 7394 | 13.4 |

**TYPE OF TEST**: FREQUENCY STABILITY VS. TEMPERATURE

**FCC PART**: 2.995 (a)

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

**MODEL**: DTX-154

**TYPE OF UNIT**: VHF-FM Transceiver

**FCC ID:** AIERIT12-150

**DATE:** September 15, 1999

**PROCEDURE**:

1. The DTX-154 was aligned for transmitter operation on 161.000 MHz at full rated power per the tune-up procedure outlined in the Preliminary Maintenance Manual.

2. The DTX-154 was placed in a Delta Design Model 3900 CL Temperature Chamber. The RF Output of the DTX-154 was connected through a 30 dB power attenuator to an HP 8353A Frequency Counter to monitor the transmitter frequency. An Astron VS 12M Power Supply was adjusted for a nominal voltage of 13.7 VDC and connected to the power supply input of the DTX-154. A Triplett Model 320-G/P Thermocouple was used to monitor the temperature inside the chamber.

3. The DTX-154 was heated to +50 degrees C and allowed to stabilize for 30 minutes for the 1st measurement and 30 minutes for each 10 degree decrement until the DTX-154 reached a temperature of -30 degrees C.

4. The frequency reading at each temperature was recorded and compared with the frequency at the nominal tune-up temperature (25 °C).

**TYPE OF TEST**: FREQUENCY STABILITY VS. TEMPERATURE

**FCC PART**: 2.995 (a)

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

**MODEL**: DTX-154

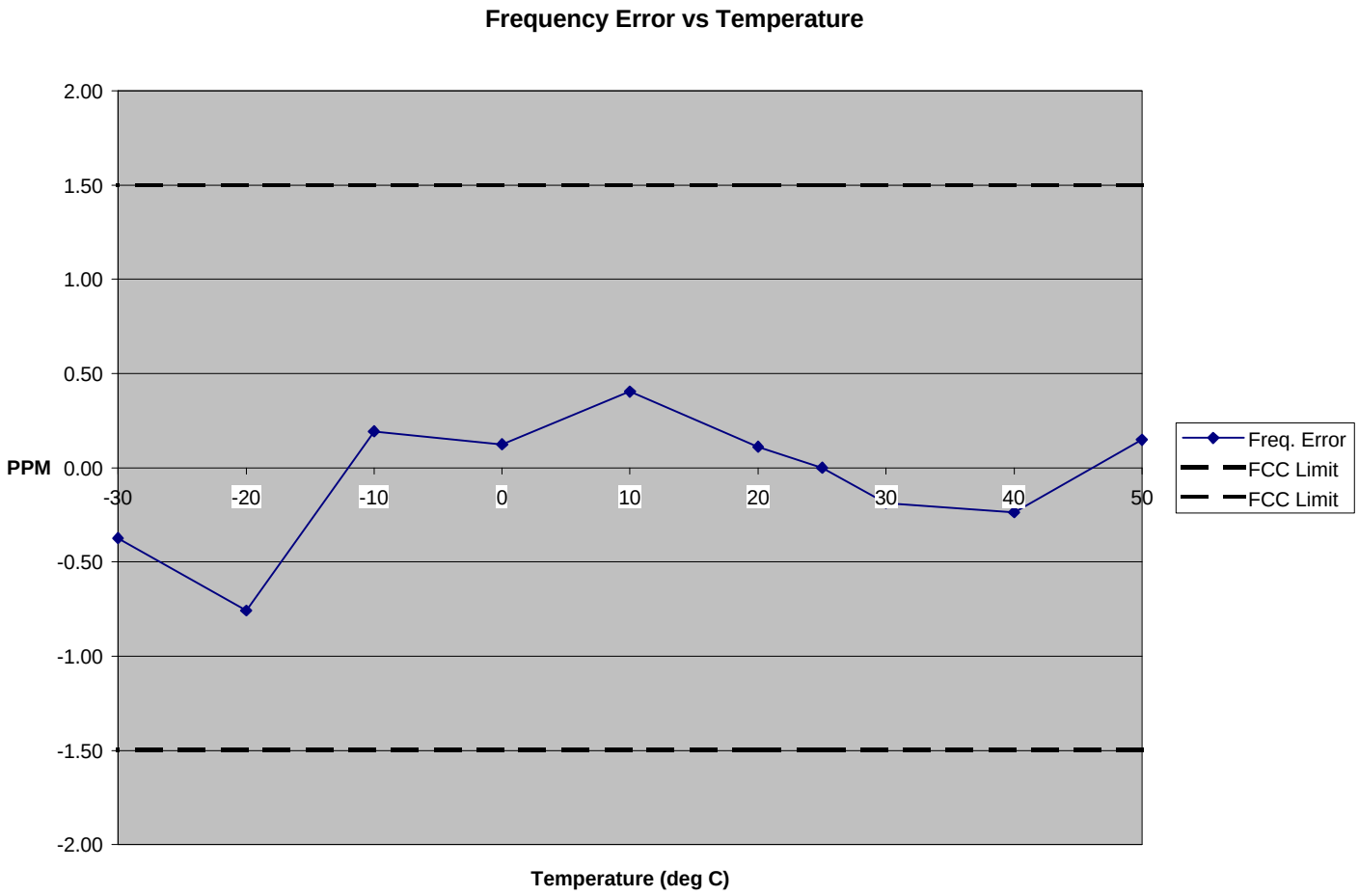
**TYPE OF UNIT**: VHF-FM Transceiver

**FCC ID:** AIERIT12-150

**DATE:** September 15, 1999

**TEST RESULTS**:

| Temp C | Frequency MHz | Freq. Error ppm | FCC Limit ppm |
|---|---|---|---|
| 50 | 161.000016 | 0.15 | +/-1.5 |
| 40 | 160.999954 | -0.24 | +/-1.5 |
| 30 | 160.999962 | -0.19 | +/-1.5 |
| 25 | 160.999992 | 0.00 | +/-1.5 |
| 20 | 161.000010 | 0.11 | +/-1.5 |
| 10 | 161.000057 | 0.40 | +/-1.5 |
| 0 | 161.000012 | 0.12 | +/-1.5 |
| -10 | 161.000023 | 0.19 | +/-1.5 |
| -20 | 160.999870 | -0.76 | +/-1.5 |
| -30 | 160.999932 | -0.37 | +/-1.5 |


Frequency Error vs Temperature
2.00
1.50
1.00
0.50
0.00
-0.50
-1.00
-1.50
-2.00
PPM
-30
-20
-10
0
10
20
30
40
50
Temperature (deg C)
Freq. Error
FCC Limit
FCC Limit

| | |
|---|---|
| **TYPE OF TEST**: | FREQUENCY STABILITY VS. SUPPLY VOLTAGE |
| **FCC PART**: | 2.995 (d) |
| **MANUFACTURER**: | RITRON, INC.<br>505 West Carmel Drive<br>Carmel, IN 46032 |
| **MODEL**: | DTX-154 |
| **TYPE OF UNIT**: | VHF-FM Transceiver |
| **FCC ID:** | AIERIT12-150 |
| **DATE:** | September 15, 1999 |

**PROCEDURE**:

1. The DTX-154 was aligned for transmitter operation on 161.000 MHz at full rated power per the tune-up procedure outlined in the Preliminary Maintenance Manual.

2. The RF Output Jack J101 of the DTX-154 was connected to the input of an HP 5383A Frequency Counter through a 30 dB power attenuator.

3. An Astron VS 12M Power Supply was connected to the power supply input of the DTX-154. The output of the power supply was adjusted between 85 % and 115 % of the nominal voltage and the carrier frequency was recorded.

**TYPE OF TEST**: FREQUENCY STABILITY VS. SUPPLY VOLTAGE

**FCC PART**: 2.995 (d)

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

**MODEL**: DTX-154

**TYPE OF UNIT**: VHF-FM Transceiver

**FCC ID:** AIERIT12-150

**DATE:** September 15, 1999

**TEST RESULTS**:

Output Power = 6 W @ 7.5 VDC

| Supply Voltage-%Nominal | Actual Voltage (VDC) | Frequency (MHz) | Frequency Error (ppm) |
|---|---|---|---|
| 85 | 6.375 | 161.999936 | 0.06 |
| 100 | 7.500 | 161.999926 | 0 |
| 115 | 8.625 | 161.999912 | -0.09 |

**TYPE OF TEST**: TRANSIENT FREQUENCY BEHAVIOR

**FCC PART**: 90.214

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

**MODEL**: DTX-154

**TYPE OF UNIT**: VHF-FM Transceiver

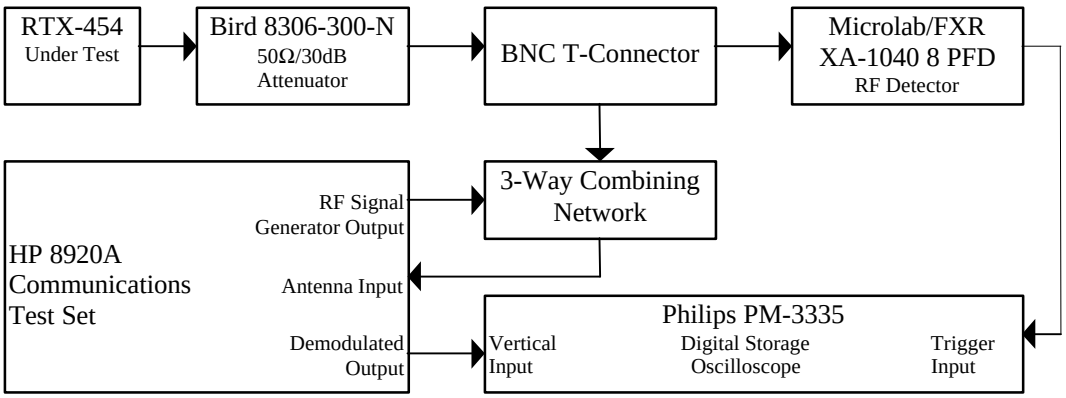
**FCC ID:** AIERIT12-150

**DATE:** September 15, 1999

**PROCEDURE**:

1. The DTX-154 was aligned for transmitter operation on 161.000 MHz at full rated power per the tune-up procedure outlined in the Preliminary Maintenance Manual. The following steps are per TIA./EIA-603.

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 DC to greater than 15 kHz with the RF frequency set to 461.750 MHz.

4. The DTX-154 transmitter under test was activated and the HP 8920A Spectrum Analyzer was used to measure the RF power level through the test network.

5. The DTX-154 transmitter was turned off. The HP 8920A RF Signal Generator was set to 161.000 MHz at an RF level 20 dB below that measured in step 3, modulated with a 1 kHz tone at +/-12.5 kHz deviation.

**TYPE OF TEST**: TRANSIENT FREQUENCY BEHAVIOR

**FCC PART**: 90.214

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

**MODEL**: DTX-154

**TYPE OF UNIT**: VHF-FM Transceiver

**FCC ID:** AIERIT12-150

**DATE:** September 15, 1999

**PROCEDURE** (continued):

6. 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 DTX-154 transmitter.

8. The DTX-154 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 in the same manner illustrated in EIA-603 Part 3.2.19.2. The resulting plot is labeled “Switch On Condition” and shows compliance with FCC Part 90.214.

9. 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 DTX-154 transmitter.

10. The DTX-154 transmitter was 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 Part 3.2.19.2. The resulting plot is labeled “Switch Off Condition” 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

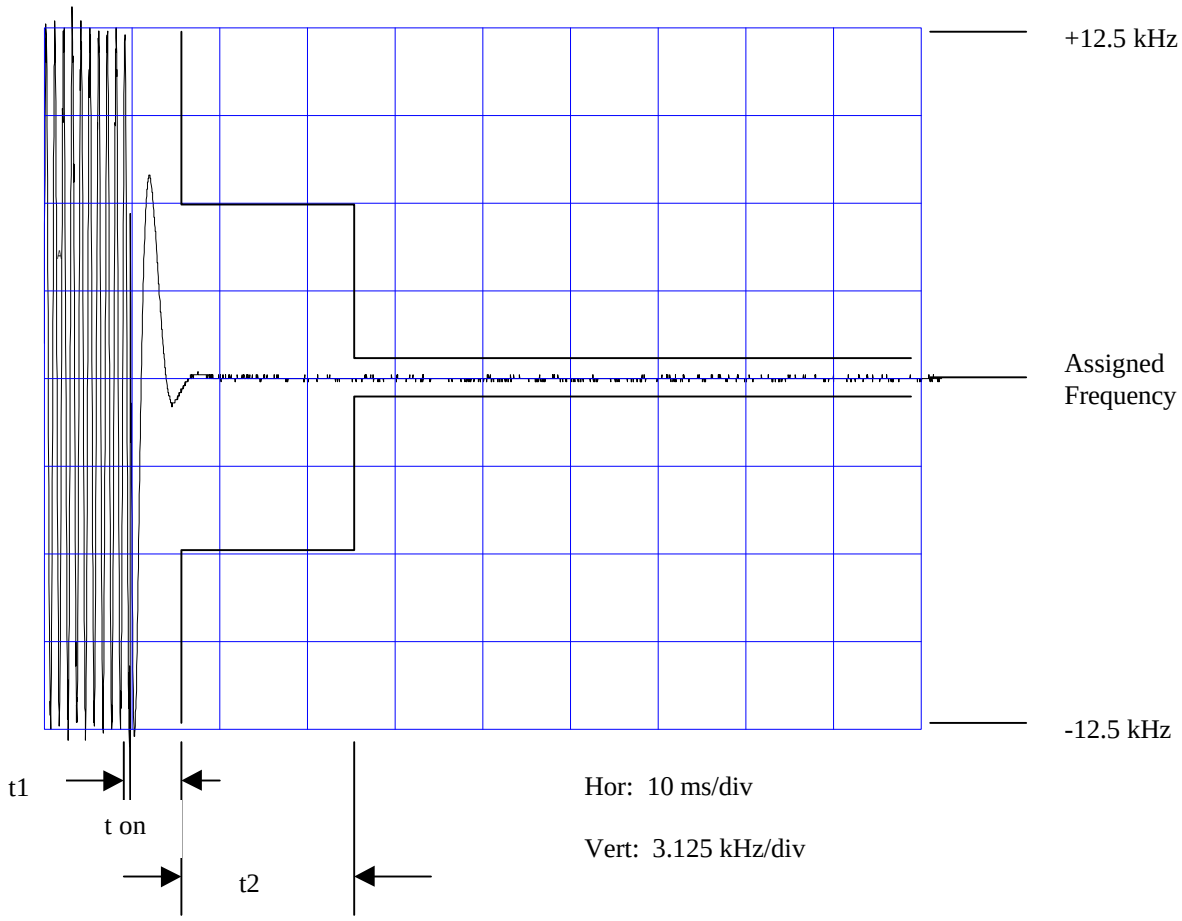
**MODEL**: DTX-154

**TYPE OF UNIT**: VHF-FM Transceiver

**FCC ID:** AIERIT12-150

**DATE:** September 15, 1999

Switch On Condition




**TYPE OF TEST**: TRANSIENT FREQUENCY BEHAVIOR

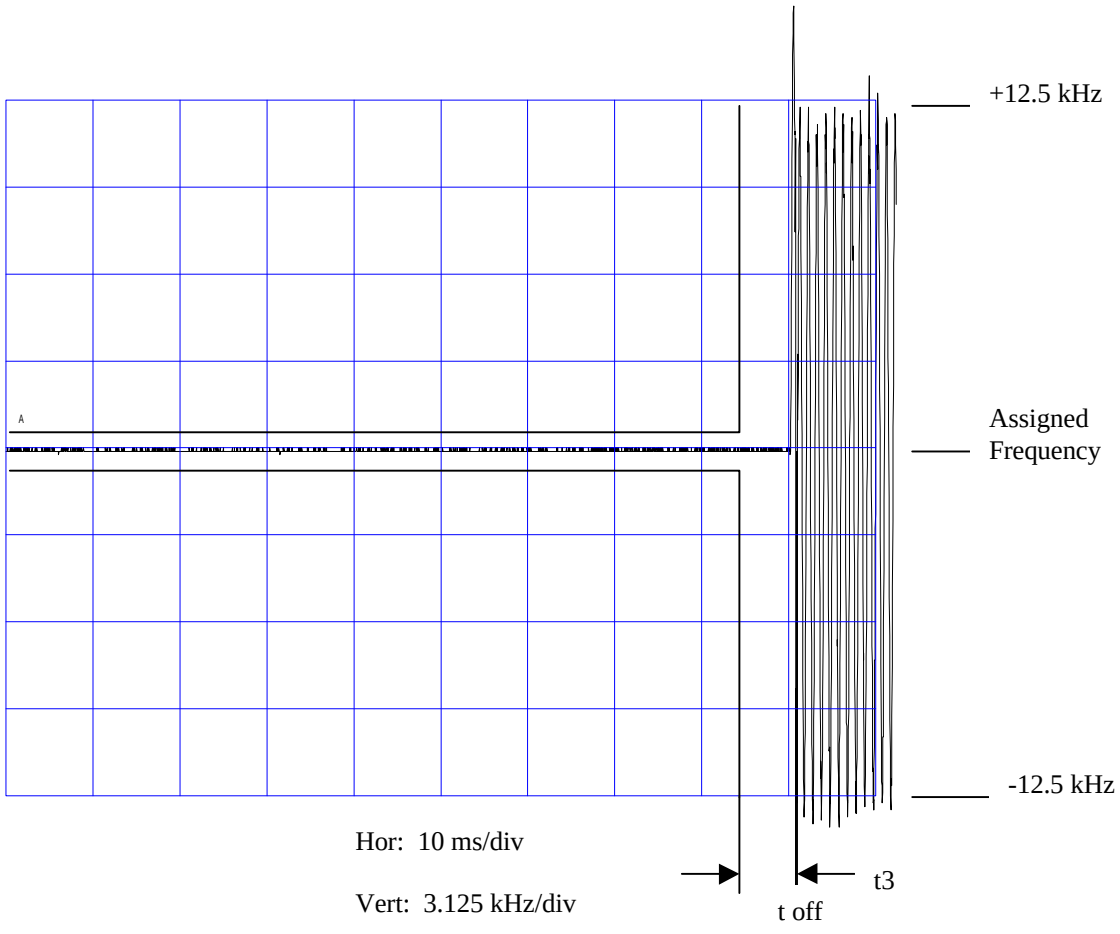
**FCC PART**: 90.214

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

**MODEL**: DTX-154

**TYPE OF UNIT**: VHF-FM Transceiver

**FCC ID:** AIERIT12-150

**DATE:** September 15, 1999

Switch Off Condition: