Engineering and Testing for EMC and Safety Compliance

Accredited under A2LA certificate # 2653.01

FCC Certification Report

E.F. Johnson
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Model: 242-511B VHF Portable Radio

FCC ID: ATH2425112

February 15, 2008

Standards Referenced for this Report	
Part 2: 2007	Frequency Allocations and Radio Treaty Matters; General Rules and Regulations
Part 90: 2007	Private Land Portable Radio Services
ANSI TIA-603-C-2004	Land Portable FM or PM Communications Equipment - Measurement and Performance Standards

Frequency Range (MHz)	Transmit Power (W) (Conducted)	Frequency Tolerance (ppm)	Emission Designator
136-174	6.4	1.5	16K0F3E
136-174	6.4	1.5	11K0F3E
136-174	6.4	1.5	8K10F1D
136-174	6.4	1.5	8K10F1E

Report Prepared by Test Engineer: Rick McLay

Document Number: 2008024

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1 General Information

This following Certification Report is prepared on behalf of **EF Johnson** in accordance with the Federal Communications Commission and Industry Canada Rules and Regulations. The Equipment Under Test (EUT) was the **242-511B VHF Portable Radio; FCC ID: ATH2425112**.

All measurements contained in this application were conducted in accordance with the applicable portions of the FCC Rules and Regulations CFR 47 Parts 2 and 90. Calibration checks are performed regularly on the instruments, and all accessories including high pass filter, coaxial attenuator, preamplifier and cables.

Per client request, additional testing was performed on two non-Part 90 frequencies (136 and 174 MHz) due to use of an expanded band by U.S. Federal, Military and other approved users.

1.1 Test Facility

The open area test site and conducted measurement facility used to collect the radiated data is located on the parking lot of Rhein Tech Laboratories, Inc. 360 Herndon Parkway, Suite 1400, Herndon, Virginia 20170. This site has been fully described in a report submitted to and approved by the Federal Communications Commission to perform AC line conducted and radiated emissions testing.

1.2 Related Submittal(s)/Grant(s)

This is an original application report.

1.3 Product Description

The 242-511B VHF portable radio is a handheld transceiver for use in the Public Safety VHF band between 136 MHz and 174 MHz.

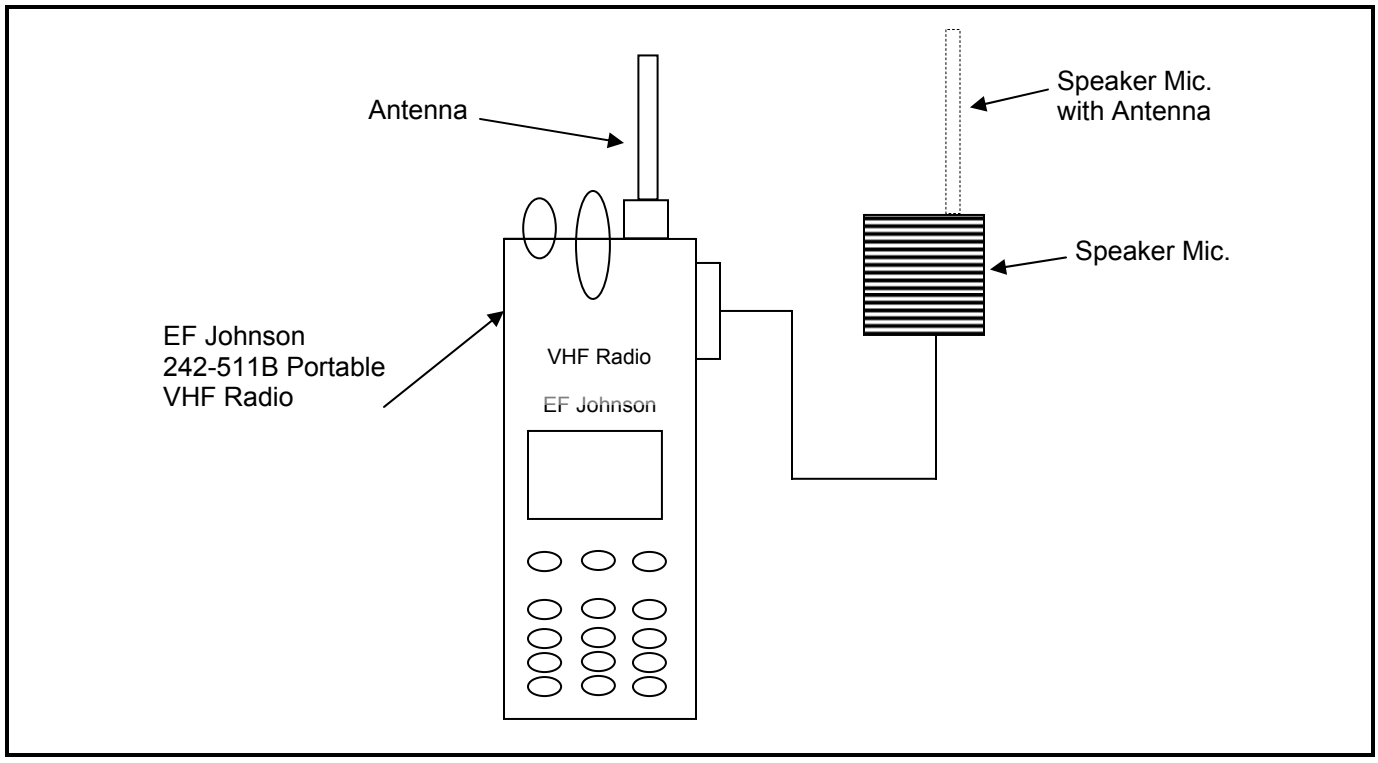
2 Tested System Details

The test sample was received on January 31, 2008. Listed below are the identifiers and descriptions of all equipment, cables, and internal devices used with the EUT for this testing, as applicable.

Table 2-1: Equipment under Test (EUT)

Part	Manufacturer	Model	PN/SN	FCC ID	RTL Bar Code
Radio	E.F. Johnson	242-511B	5110G4807C	ATH2425112	18281
Battery	E.F. Johnson	587-5100-360	12405SYJCH	N/A	18282
Battery	E.F. Johnson	587-5100-360	12405SYJCH	N/A	18283
Antenna	E.F. Johnson	Spring Whip	N/A	N/A	18284
Microphone	OTTO Communications	N/A	N/A	N/A	15068

Figure 2-1: Configuration of Tested System



3 FCC Rules and Regulations Part 2 §2.1033(c)(8) Voltages and Currents Through The Final Amplifying Stage

DC Voltages:

NiMH: 7.5 nom.
Current: 1.2 A

4 FCC Rules and Regulations Part 2 §2.1046(a): RF Power Output

4.1 Test Procedure

ANSI TIA-603-C-2004, section 2.2.1

The EUT was connected with a power sensor/meter through an appropriate 50 ohm attenuator. Attenuator loss was accounted for.

4.2 Test Data

Table 4-1: RF Power Output (High Power): Carrier Output Power (Unmodulated)

Frequency (MHz)	RF Power Measured (Watt)*
136	6.4
155	6.0
174	5.8

Table 4-2: RF Power Output (Low Power): Carrier Output Power (Unmodulated)

Frequency (MHz)	RF Power Measured (Watt)*
136	1.0
155	1.1
174	1.0

Table 4-3: RF Power Output (Rated Power)

Frequency (MHz)	High Power Rated (W)	Low Power Rated (W)*
136–174	5.5	1.0

Table 4-4: Test Equipment for Testing RF Power Output - Conducted

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due
901184	Agilent Technologies	E4416A	EPM-P Power Meter, Single Channel	GB41050573	10/24/08
900937	Agilent Technologies	8482H	Power Sensor	3318A08961	05/08/08
900819	Weinschel Corporation	BF0830	Attenuator 10 db	N/A	12/02/08

Test Personnel:

Rick McLay		February 1, 2008
Test Engineer	Signature	Date Of Test

5 FCC Rules and Regulations Part 2 §2.1051: Spurious Emissions at Antenna Terminals; Part 90 §90.210: Emissions Masks

5.1 Test Procedure

ANSI TIA-603-C-2004, Section 2.2.13.

The transmitter was interfaced with a spectrum analyzer through an appropriate 50 ohm attenuator. The transmitter was operated at maximum power. Attenuator and cable losses were accounted for.

Analog Modulation: The transmitter is terminated with a 50 ohm load and is modulated with a 2,500 Hz sine wave at an input level 16 dB greater than that required to produce 50% of the rated system deviation at 1,000 Hz.

Digital Modulation: Modulated to its maximum extent using a pseudo random data sequence.

5.2 Test Data

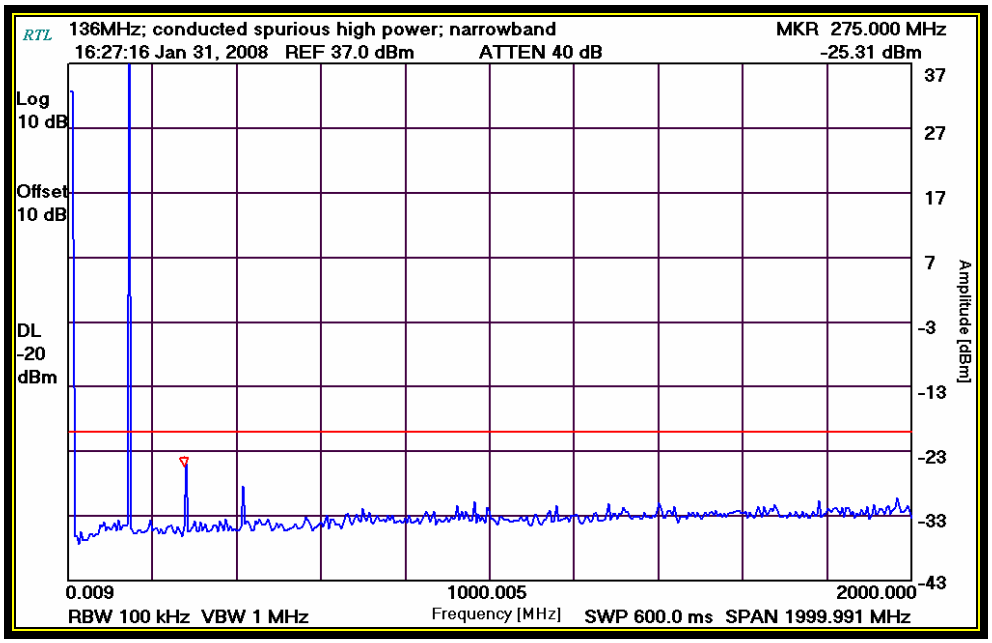
Frequency range of measurement per Part 2.1057: 9 kHz to 10xFc.

Limit = 50 + 10 Log (P) dB or 70 dB, whichever is greater.

The worst case (unwanted emissions) channels are shown. The magnitude of emissions attenuated more than 20 dB below the FCC limit need not be recorded.

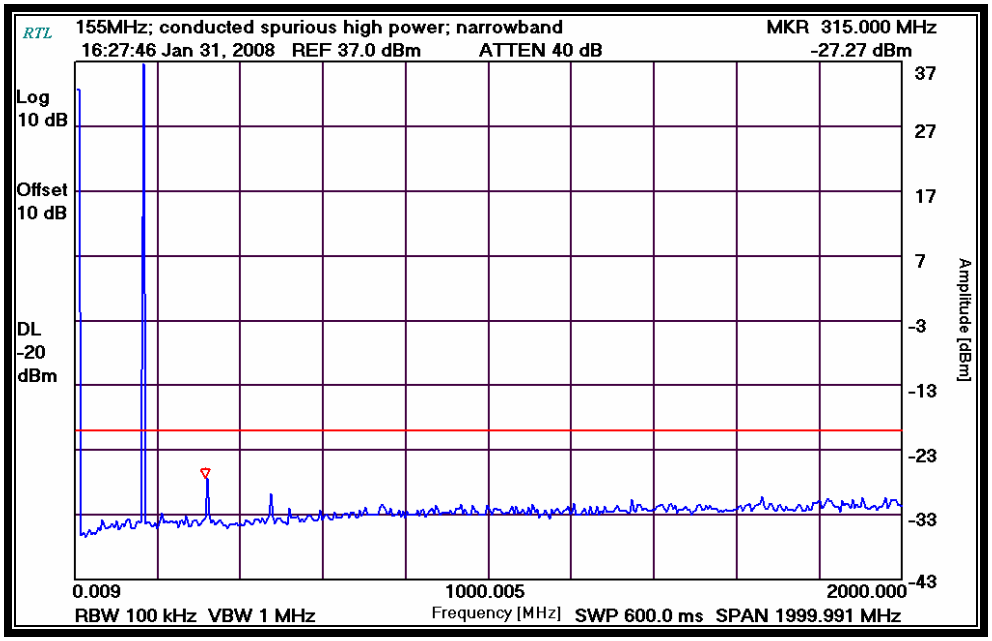
Plot 5-1: Conducted Spurious Emissions –136 MHz; Narrow Band; High Power

Freq = 136 MHz - Limit = 50 + 10 Log P = 58.1 dBc - Conducted Power = 38.1 dBm = 6.4 W



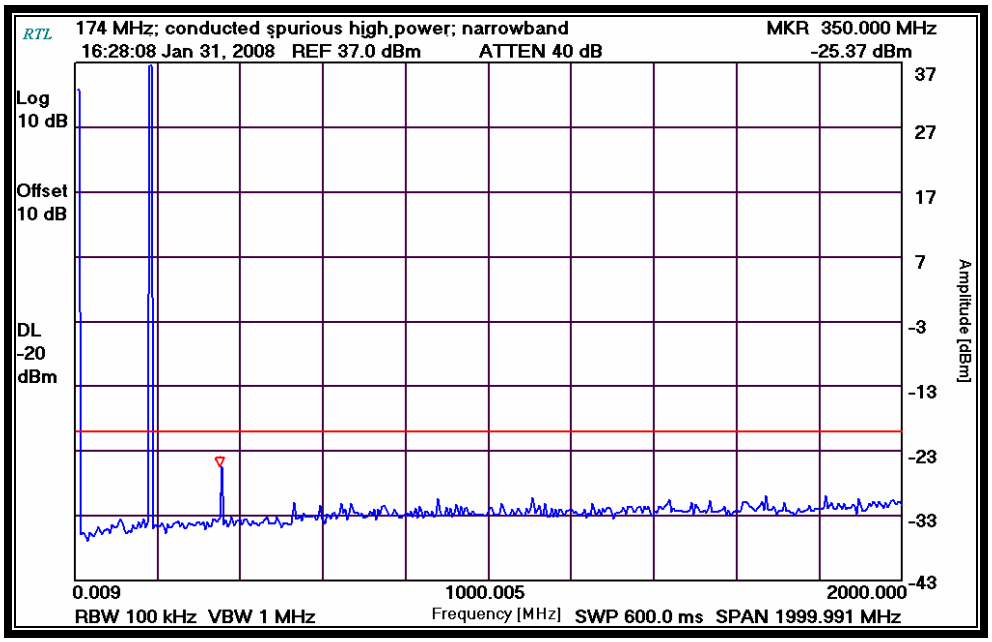
Plot 5-2: Conducted Spurious Emissions –155 MHz; Narrow Band; High Power

Freq = 155 MHz - Limit = 50 + 10 Log P = 57.8 dBc - Conducted Power = 37.8 dBm = 6.0 W



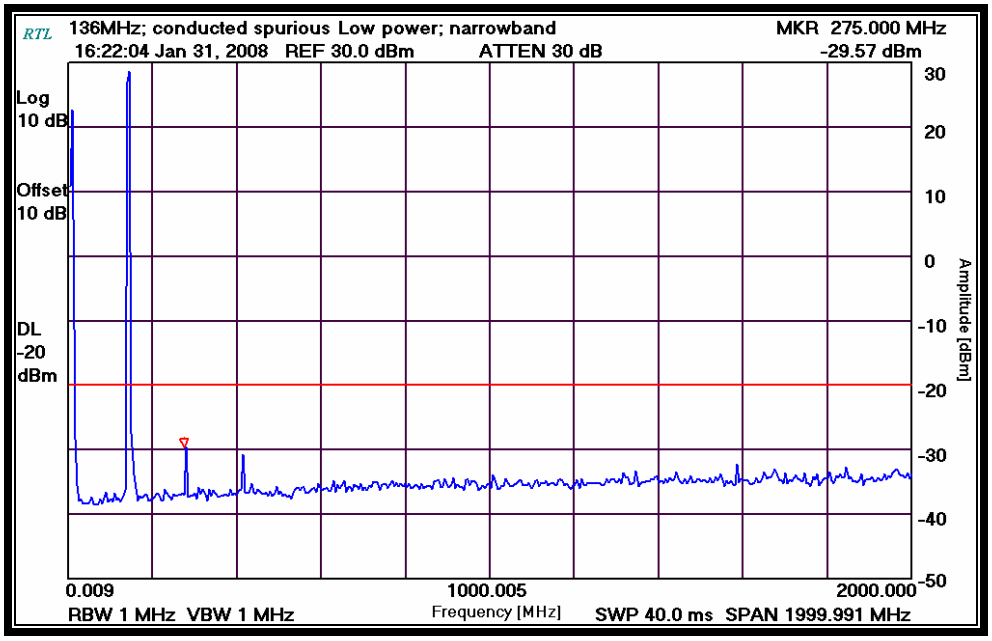
Plot 5-3: Conducted Spurious Emissions –174 MHz; Narrow Band; High Power

Freq = 174 MHz - Limit = 50 + 10 Log P = 57.6 dBc - Conducted Power = 37.6 dBm = 5.8 W



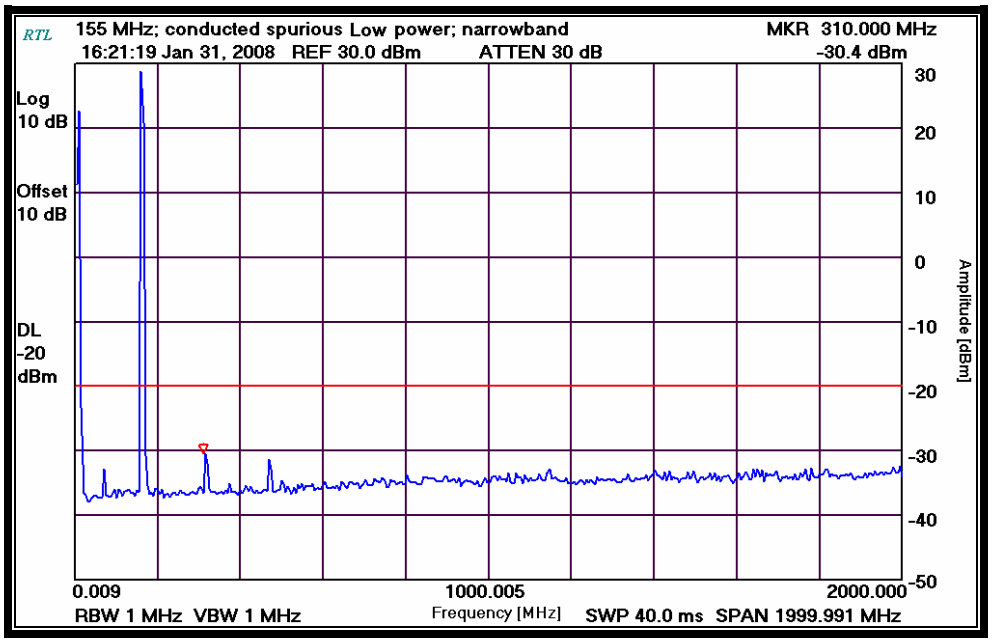
Plot 5-4: Conducted Spurious Emissions –136 MHz; Narrow Band; Low Power

Freq = 136 MHz - Limit = 50 + 10 Log P = 50.0 dBc - Conducted Power = 30.0 dBm = 1.0 W



Plot 5-5: Conducted Spurious Emissions –155 MHz; Narrow Band; Low Power

Freq = 155 MHz - Limit = 50 + 10 Log P = 50.4 dBc - Conducted Power = 30.4 dBm = 1.1 W



Plot 5-6: Conducted Spurious Emissions –174 MHz; Narrow Band; Low Power

Freq = 174 MHz - Limit = 50 + 10 Log P = 50.0 dBc - Conducted Power = 30.0 dBm = 1.0 W

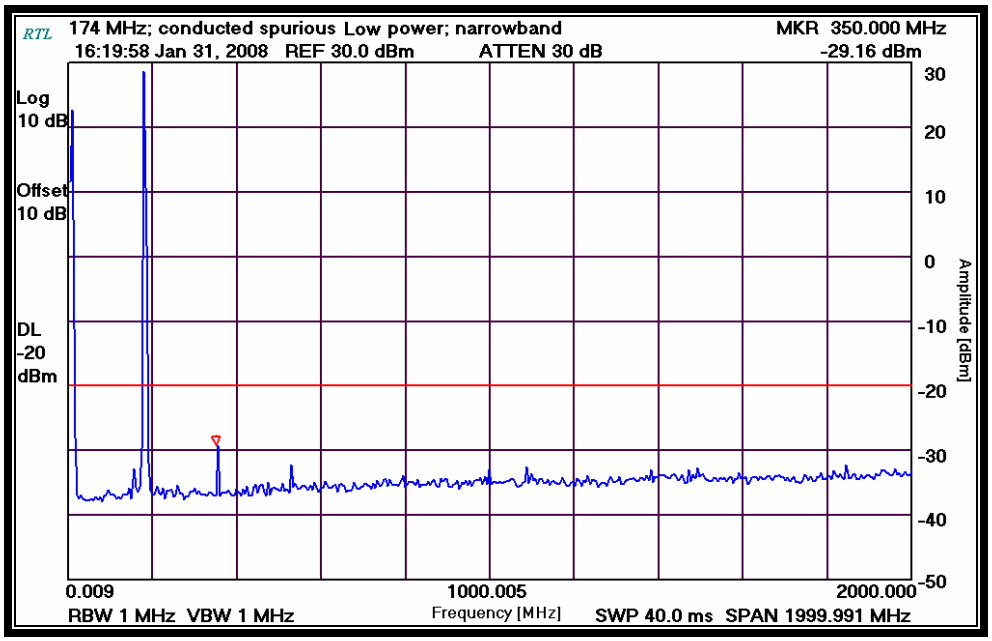


Table 5-1: Test Equipment for Testing Conducted Spurious Emissions

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due
900913	Hewlett Packard	85462A	EMI Receiver RF Section, 9 kHz – 6.5 GHZ	3325A00159	03/21/08
900914	Hewlett Packard	85460A	RF Filter Section, 100 kHz - 6.5 GHz	3330A00107	03/21/08
900819	Weinschel Corporation	BF0830	Attenuator 10 db	N/A	12/02/08

Test Personnel:

Rick McLay		January 31, 2008
Test Engineer	Signature	Date Of Test

6 FCC Rules and Regulations Part 2 §2.1053(a): Field Strength of Spurious Radiation

6.1 Test Procedure

ANSI TIA-603-C-2004, Section 2.2.12.

Analog Modulation: The transmitter is terminated with a 50 ohm load and is modulated with a 2,500 Hz sine wave at an input level 16 dB greater than that required to produce 50% of the rated system deviation at 1,000 Hz.

Digital Modulation: Modulated to its maximum extent using a pseudo random data sequence – 9600 bps.

The spurious emissions levels were measured and the device under test was replaced by a substitution antenna connected to a signal generator. This signal generator level was then corrected by subtracting the cable loss from the substitution antenna to the signal generator, and the gain of the antenna was further corrected to a half wave dipole.

P_d(dBm) = P_g(dBm) – cable loss (dB) + antenna gain (dB)

where:

P_d is the dipole equivalent power
P_g is the generator output power into the substitution antenna

6.2 Test Data

6.2.1 CFR 47 Part 90.210 Requirements

Limit = 50 + 10 Log (P) dB or 70 dB, whichever is greater. The worst case emissions test data, high power, are shown. The magnitude of emissions attenuated more than 20 dB below the FCC limit need not be recorded.

Table 6-1: Field Strength of Spurious Radiation – 155 MHz; Narrow Band; High Power

Freq = 155 MHz - Limit = 50 + 10 Log P = 57.8 dBc - Conducted Power = 37.8dBm = 6.0 W

Frequency (MHz)	Spectrum Analyzer Level (dBuV)	Signal Generator Level (dBm)	Cable Loss from Signal Generator (dB)	Transmitting Antenna Gain (dBd)	Corrected Signal Generator Level (dBc)	Margin (dB)
310.0	29.3	-56.6	3.5	-0.5	98.4	-40.6
465.0	33.9	-46.9	4.2	-0.6	89.5	-31.7
620.0	30.7	-45.4	4.8	-1.0	89.0	-31.2
775.0	33.0	-42.2	5.4	-0.8	86.2	-28.4
930.0	36.0	-38.2	5.9	-1.0	82.9	-25.1
1085.0	37.0	-36.8	6.3	3.3	77.6	-19.8
1240.0	37.0	-34.4	6.8	3.9	75.1	-17.3
1395.0	37.0	-34.5	7.1	4.6	74.8	-17.0
1550.0	36.0	-32.0	7.5	5.1	72.2	-14.4

Table 6-2: Test Equipment for Testing Field Strength of Spurious Radiation

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due
901053	Schaffner Chase	CBL6112B	Bi-Log Antenna (20 MHz-2 GHz)	2648	12/20/08
900814	Electro-Metrics	EM-6961 (RGA-60)	Double Ridges Guide Antenna (1-18 GHz)	2310	03/30/09
901215	Hewlett Packard	8596EM	EMC Analyzer (9 kHz–12.8 GHz)	3826A00144	10/17/08
901424	Insulated Wire Inc.	KPS-1503-360-KPS	RF cable 36"	NA	10/05/08
901425	Insulated Wire, Inc.	KPS-1503-2400-KPS	RF cable, 20'	NA	10/05/08
901426	Insulated Wire Inc.	KPS-1503-3600-KPS	RF cable, 30'	NA	10/05/08
900158	Compliance Design	Roberts Dipole	Adjustable Elements Dipole Antenna (30 MHz-1000 MHz)	N/A	02/04/09
900928	Hewlett Packard	83752A	Synthesized Sweep Generator (10 MHz-20 GHz)	3610A00866	09/07/08

Test Personnel:

Rick McLay		February 5, 2008
Test Engineer	Signature	Date Of Test

7 FCC Rules and Regulations Part 2 §2.1049: Occupied Bandwidth; Part 90 §90.210(i) & (j): Emissions Masks

7.1 Test Procedure

ANSI TIA-603-C-2004, Section 2.2.11.

The transmitter was interfaced with a spectrum analyzer through an appropriate 50 ohm attenuator and a notch filter. The transmitter was operated at maximum power. Attenuator losses were accounted for.

Analog Modulation: The transmitter is terminated with a 50 ohm load and is modulated with a 2,500 Hz sine wave at an input level 16 dB greater than that required to produce 50% of the rated system deviation at 1,000 Hz.

The device uses digital modulation modulated to its maximum extent using a pseudo-random data sequence of 9600 bps.

Limit Mask B:

(1) On any frequency removed from the assigned frequency by more than 50%, but not more than 100% of the authorized bandwidth: **at least 25 dB**;
(2) On any frequency removed from the assigned frequency by more than 100%, but not more than 250% of the authorized bandwidth: **at least 35 dB**;
(3) On any frequency removed from the assigned frequency by more than 250% of the authorized bandwidth: **at least 43 + 10 log (P) dB**.

Limit Mask C:

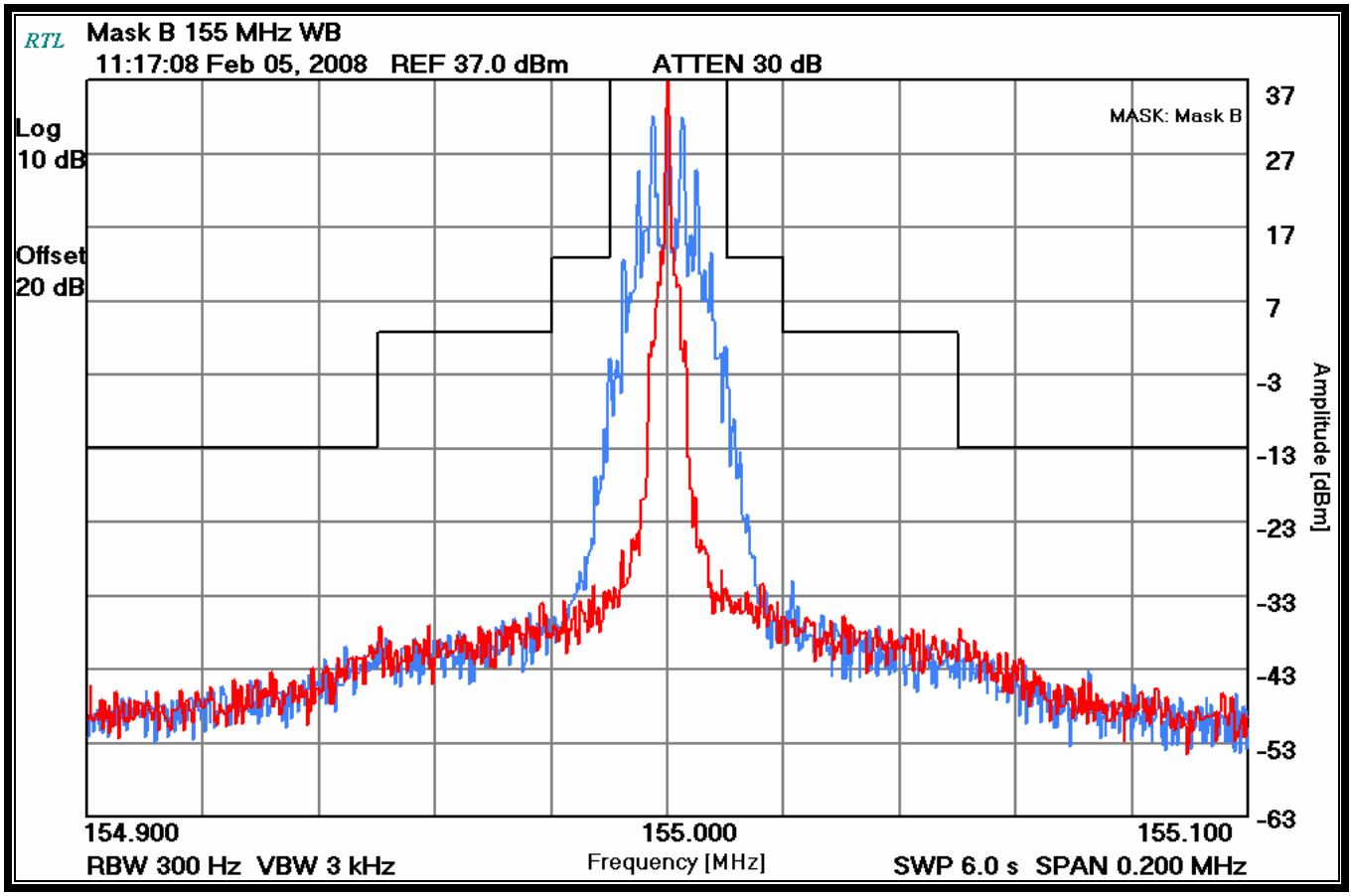
(1) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 5 kHz, but not more than 10 kHz: **at least 83 log (fd/5) dB**;
(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 10 kHz, but not more than 250% of the authorized bandwidth: **at least 29 log (fd^2/11) dB or 50 dB, whichever is the lesser attenuation**;
(3) On any frequency removed from the center of the authorized bandwidth by more than 250% of the authorized bandwidth: **at least 43 + 10 log (P) dB**.

Limit Mask D:

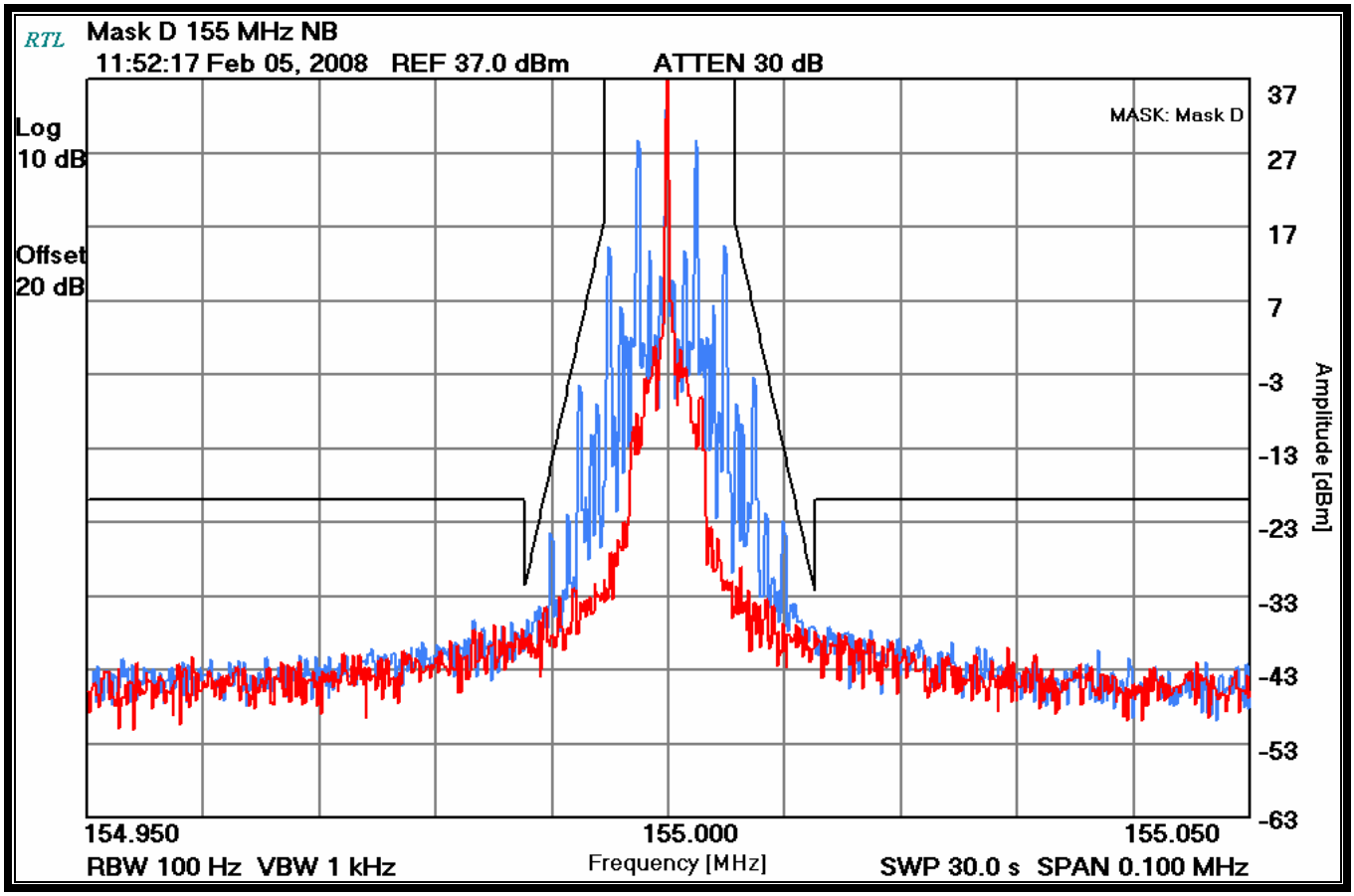
(1) On any frequency removed from the center of the authorized bandwidth f_0: **zero dB**;
(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 5.625 kHz, but not more than 12.5 kHz: **at least 7.27(fd-2.88 kHz) dB**;
(3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 12.5 kHz: **at least 50 + 10 log (P) dB or 70 dB, whichever is the lesser attenuation**.

7.2 Test Data

Plot 7-1: Occupied Bandwidth – 155 MHz; Mask B; WB Analog; High Power



Plot 7-2: Occupied Bandwidth – 155 MHz; Mask D; NB Analog; High Power



Plot 7-3: Occupied Bandwidth – 155 MHz; Mask D; 4-level C4FM (P25 mode); 4800 SPS

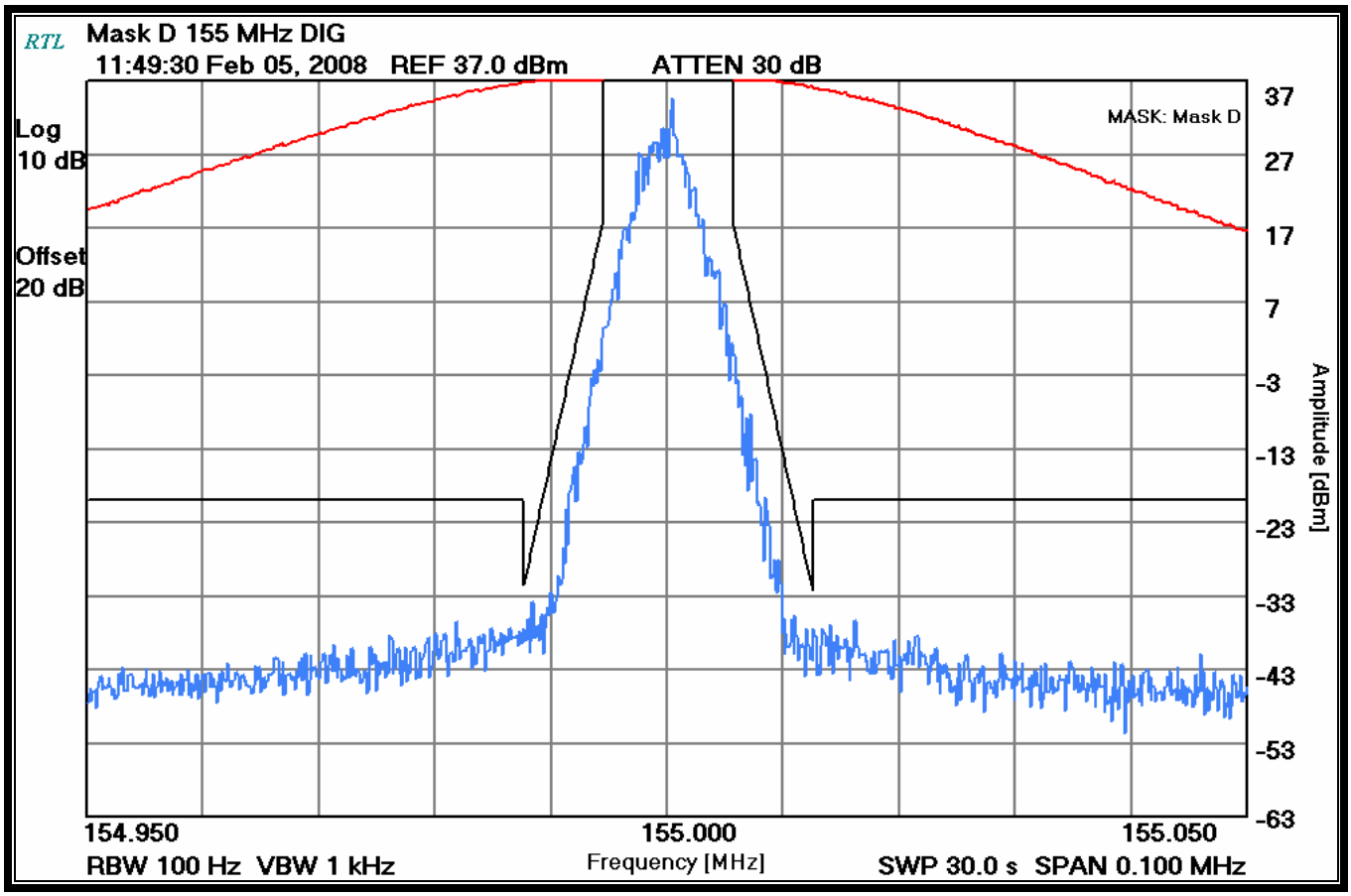


Table 7-1: Test Equipment for Testing Masks

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due
901413	Agilent Technologies	E4448A	PSA Series Spectrum Analyzer	US44020346	06/13/08
901139	Weinschel Corporation	48-20-34	Attenuator 20 dB	BK5859	12/09/08
900931	Hewlett Packard	8566B	Spectrum Analyzer	3138A07771	05/22/08

Test Personnel:

Rick McLay		February 5, 2008
Test Engineer	Signature	Date of Tests

8 FCC Rules and Regulations Part 90 §90.213 and Part 2 §2.1055: Frequency Stability

8.1 Test Procedure

ANSI TIA-603-C-2004, section 2.2.2.

The carrier frequency stability is the ability of the transmitter to maintain an assigned carrier frequency.

The EUT was evaluated over the temperature range -30°C to +60°C.

The temperature was initially set to -30°C and an hour elapsed for stabilization of the EUT. The frequency stability was measured within one minute after application of primary power to the transmitter. The temperature was raised at intervals of 10°C through the range. A ½ hour period was observed to stabilize the EUT at each measurement step, and the frequency stability was measured within one minute after application of primary power to the transmitter. Additionally, the power supply voltage of the EUT was varied from the battery operating end point to +/-15% of nominal value.

The worst-case test data are shown below in Table 8-1 and Table 8-2.

8.2 Test Data

8.2.1 CFR 47 Part 90.213 Requirements

For mobile transmitters over 2 Watts output power:

150-174 MHz band: 5.0 ppm

Note: In the 150–174 MHz band, mobile stations designed to operate with a 12.5 kHz channel bandwidth, or designed to operate on a frequency specifically designated for itinerant use, or designed for low-power operation of two watts or less, must have a frequency stability of 5.0 ppm. Mobile stations designed to operate with a 6.25 kHz channel bandwidth must have a frequency stability of 2.0 ppm.

8.2.2 Frequency Stability/Temperature Variation

Plot 8-1: Temperature Frequency Stability – 155 MHz Channel

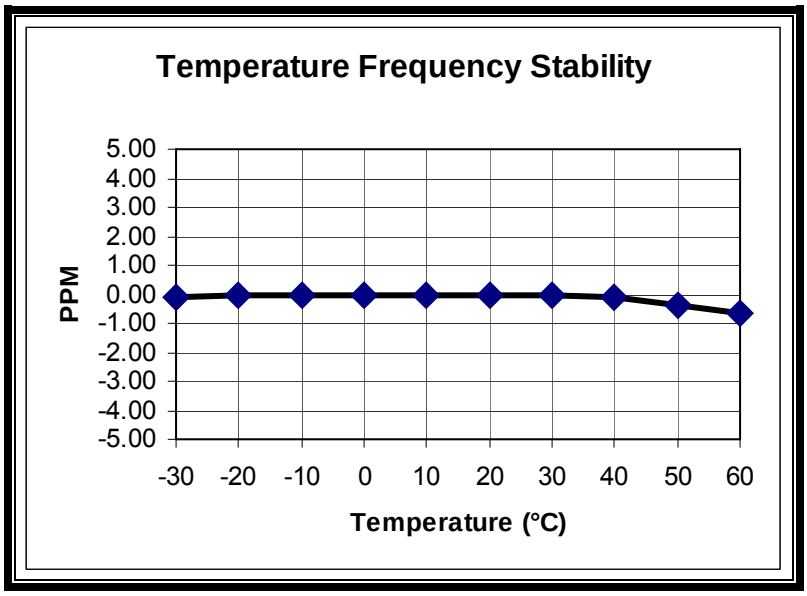


Table 8-1: Frequency Stability/Temperature Variation – 155 MHz

Temperature °C	Measured Frequency (MHz)	ppm
-30	154.999942	-0.10
-20	154.999950	-0.05
-10	154.999958	0.00
0	154.999950	-0.05
10	154.999950	-0.05
20	154.999950	-0.05
30	154.999958	0.00
40	154.999942	-0.10
50	154.999900	-0.37
60	154.999858	-0.65

8.2.3 Frequency Stability/Voltage Variation

Plot 8-2: Voltage Frequency Stability – 155 MHz Channel

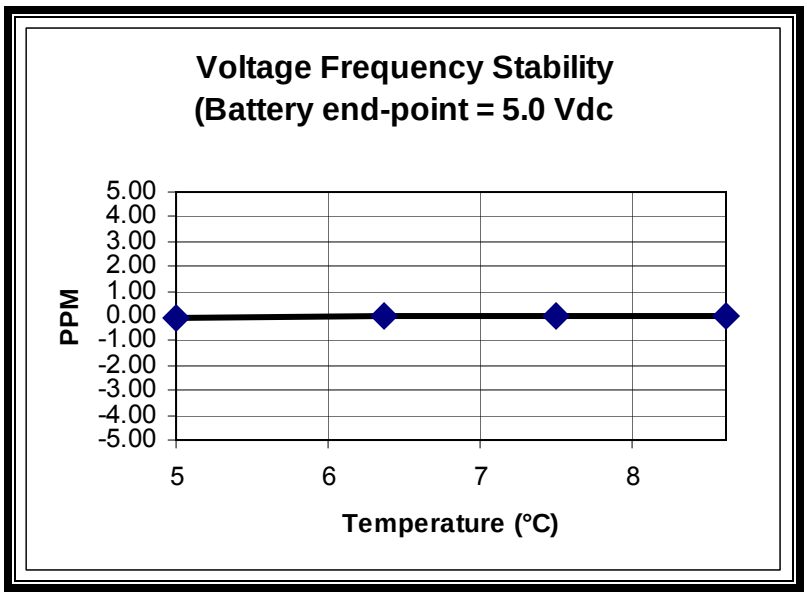


Table 8-2: Frequency Stability/Voltage Variation – 155 MHz

Voltage (VDC)	Measured Frequency (MHz)	ppm
5.000*	154.999958	0.058
6.375	154.999967	0
7.500	154.999967	0
8.625	154.999967	0

*measured battery end-point

Table 8-3: Test Equipment for Testing Frequency Stability

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due
901413	Agilent Technologies	E4448A	PSA Series Spectrum Analyzer	US44020346	06/13/08
901139	Weinschel Corporation	48-20-34	Attenuator 20 dB	BK5859	12/09/08
901428	Meterman	33XR	Digital Multimeter	050401946	09/05/08
900946	Tenney Engineering, Inc.	TH65	Temperature Chamber with Humidity	11380	01/20/08

Test Personnel:

Rick McLay		February 4, 2008
Test Engineer	Signature	Date Of Test

9 FCC Rules and Regulations Part 2 §2.1047(a): Modulation Characteristics - Audio Frequency Response

9.1 Test Procedure

ANSI TIA-603-C-2004, section 2.2.6.

The audio frequency response is the degree of closeness to which the frequency deviation of the transmitter follows a prescribed characteristic. The input audio level at 1000 Hz was set to produce 20% of the rated system deviation. This point is shown as the 0 dB reference level, noted DEVref. The audio signal generator was varied from 100 Hz to 5 kHz with the input level held constant. The deviation in kHz was recorded using a modulation analyzer as DEVfreq. The response in dB relative to 1 kHz was calculated as follows:

Audio Frequency Response = 20 LOG (DEVfreq/DEVref)

9.2 Test Data

Plot 9-1: Modulation Characteristics - Audio Frequency Response

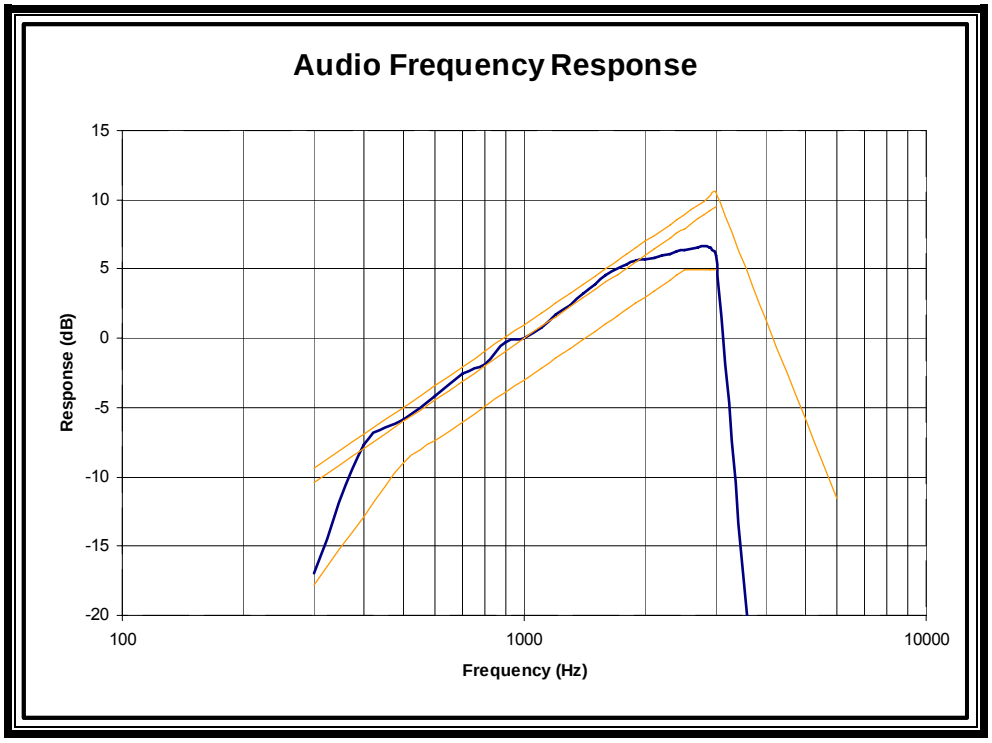


Table 9-1: Test Equipment for Testing Audio Frequency Response

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due
901057	Hewlett Packard	3336B	Synthesizer/Level Generator	2514A02585	12/12/08
901118	Hewlett Packard	8901A	Modulation Analyzer	2406A00178	07/21/08
901139	Weinschel Corporation	48-20-34	Attenuator 20 dB	BK5859	12/09/08

Test Personnel:

Rick McLay		February 4, 2008
Test Engineer	Signature	Date Of Test

10 FCC Rules and Regulations Part 2 §2.1047(a): Modulation Characteristics – Audio Low Pass Filter

10.1 Test Procedure

2.1047(a) Voice modulated communication equipment: a curve or equivalent data showing the frequency response of the audio modulating circuit over a range of 100 to 5000 Hz shall be submitted. For equipment required to have an audio low-pass filter, a curve showing the frequency response of the filter, or of all circuitry installed between the modulation limiter and the modulated stage, shall be submitted.

ANSI TIA-603-C-2004, 2.2.15

The Audio Low Pass Filter Response is the frequency response of the post limiter low pass filter circuit above 3000 Hz.

10.2 Test Data

Plot 10-1: Modulation Characteristics – Audio Low Pass Filter

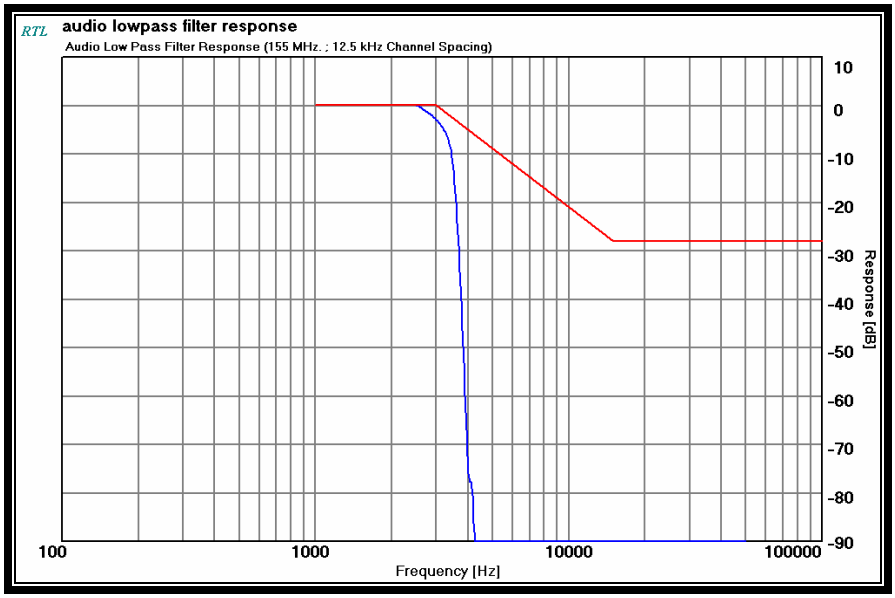


Table 10-1: Test Equipment for Testing Audio Low Pass Filter

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due
901057	Hewlett Packard	3336B	Synthesizer/Level Generator	2514A02585	12/12/08
901118	Hewlett Packard	8901A	Modulation Analyzer	2406A00178	07/21/08
901139	Weinschel Corporation	48-20-34	Attenuator 20 dB	BK5859	12/09/08

Test Personnel:

Rick McLay		February 4, 2008
Test Engineer	Signature	Date Of Test

11 FCC Rules and Regulations Part 2 §2.1047(b): Modulation Characteristics - Modulation Limiting

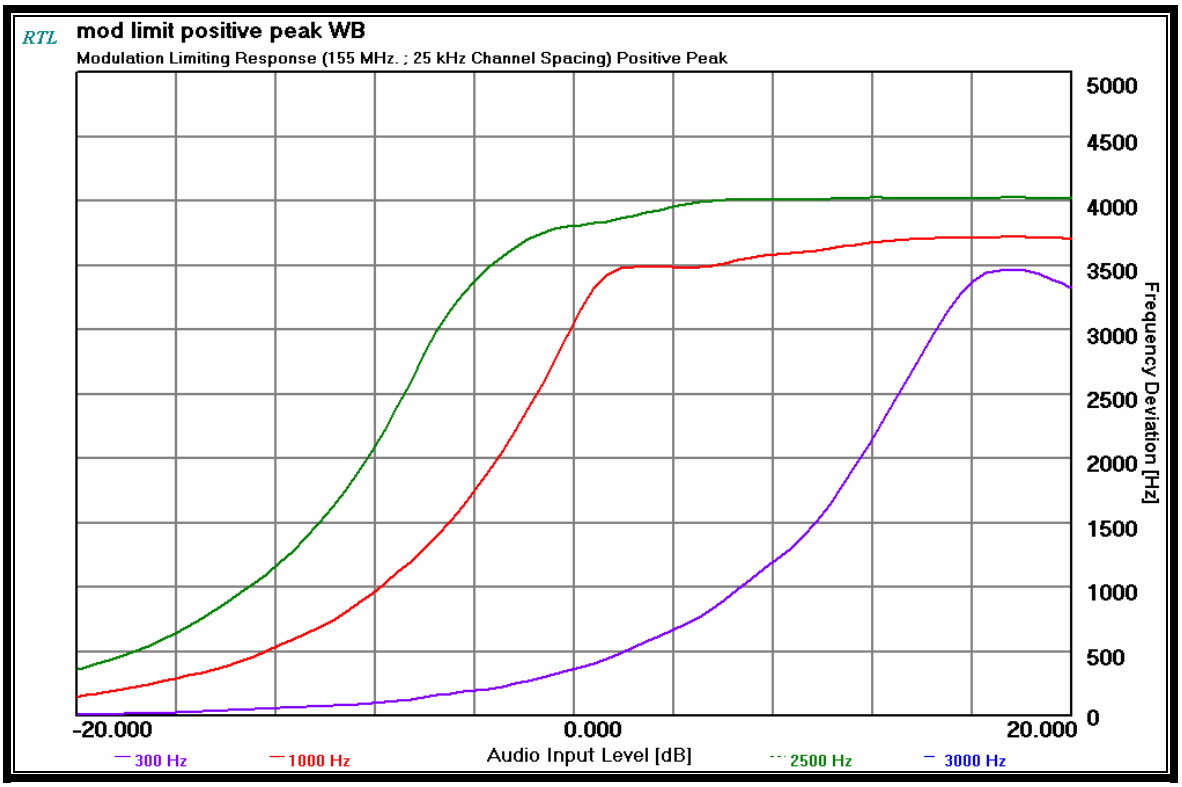
11.1 Test Procedure

ANSI TIA-603-C-2004, section 2.2.3.

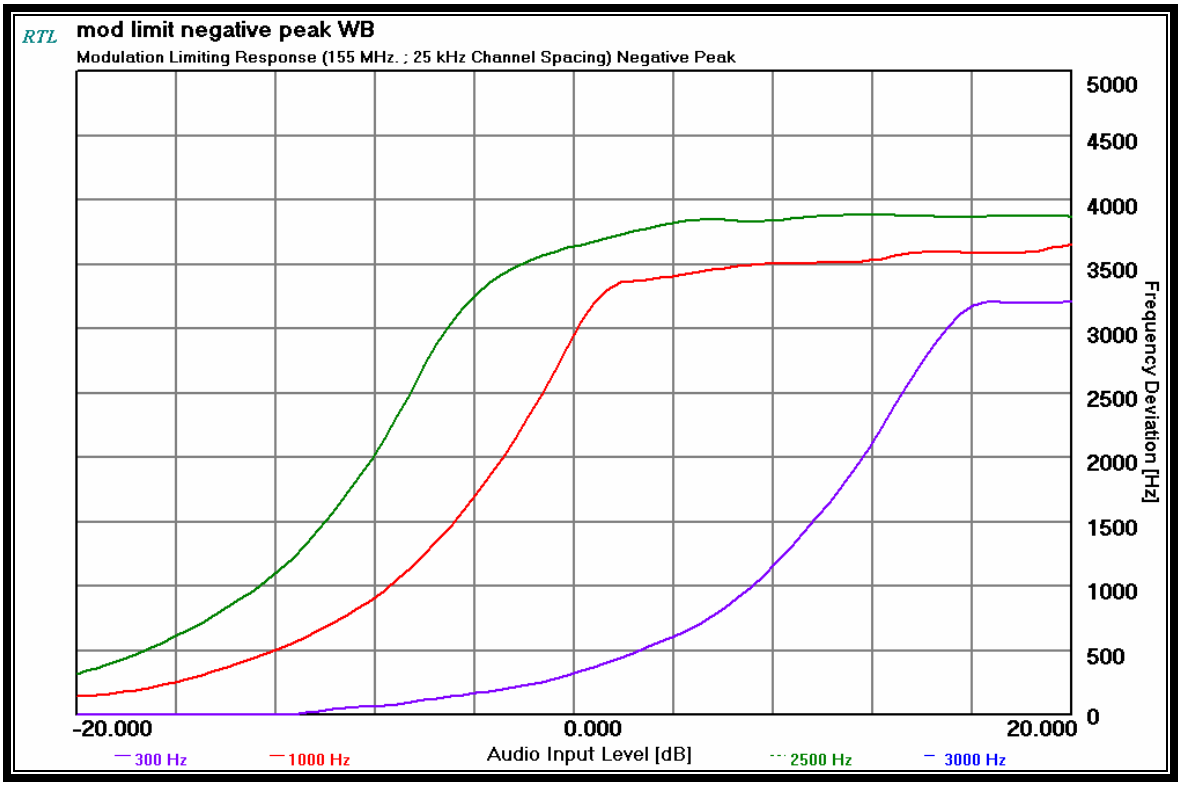
The transmitter was adjusted for full rated system deviation. The audio input level was adjusted for 60% of rated system deviation at 1000 Hz. Using this level as a reference (0 dB), the audio input level was varied from the reference +/-20 dB for modulation frequencies of 300 Hz, 1,000 Hz, and 2,500 Hz. The system deviation obtained as a function of the input level was recorded. Both positive and negative peak deviations were recorded.

11.2 Test Data

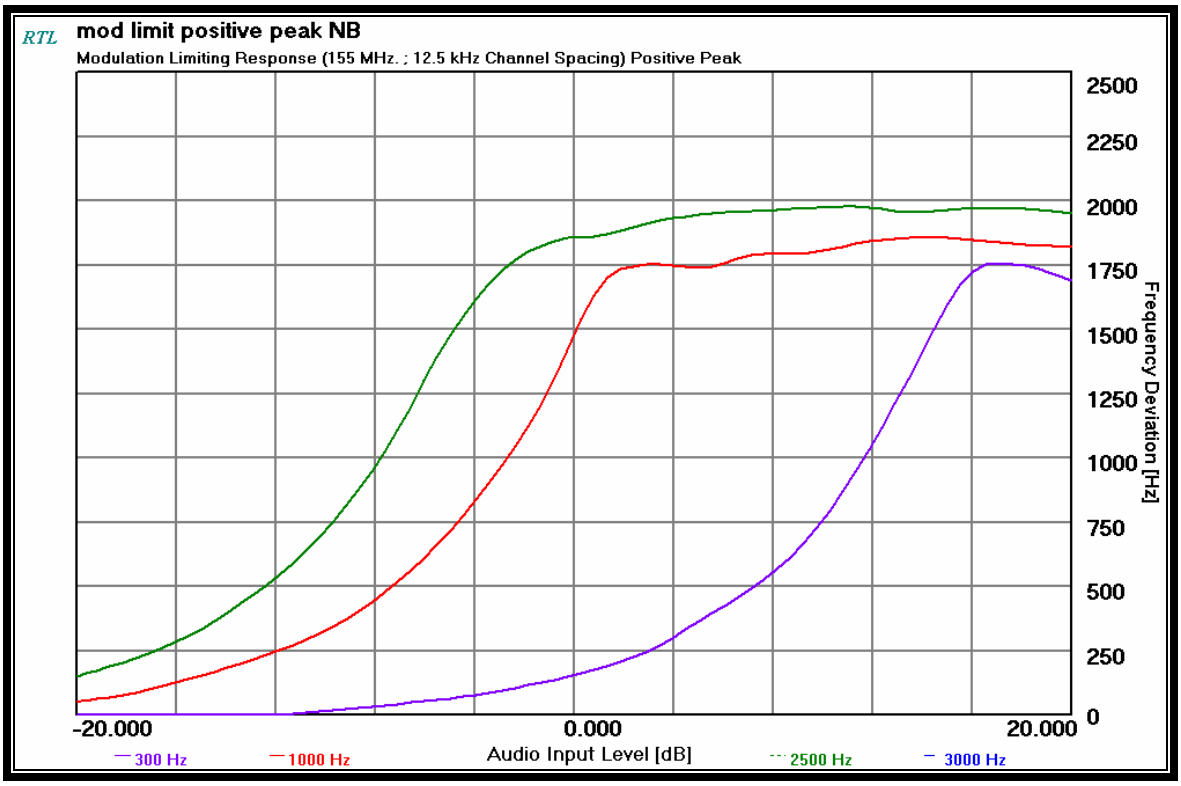
Plot 11-1: Modulation Characteristics – Modulation Limiting: 155 MHz; WB; Positive Peak



Plot 11-2: Modulation Characteristics – Modulation Limiting: 155 MHz; WB; Negative Peak



Plot 11-3: Modulation Characteristics – Modulation Limiting: 155 MHz; NB; Positive Peak



Plot 11-4: Modulation Characteristics – Modulation Limiting: 155 MHz; NB; Negative Peak

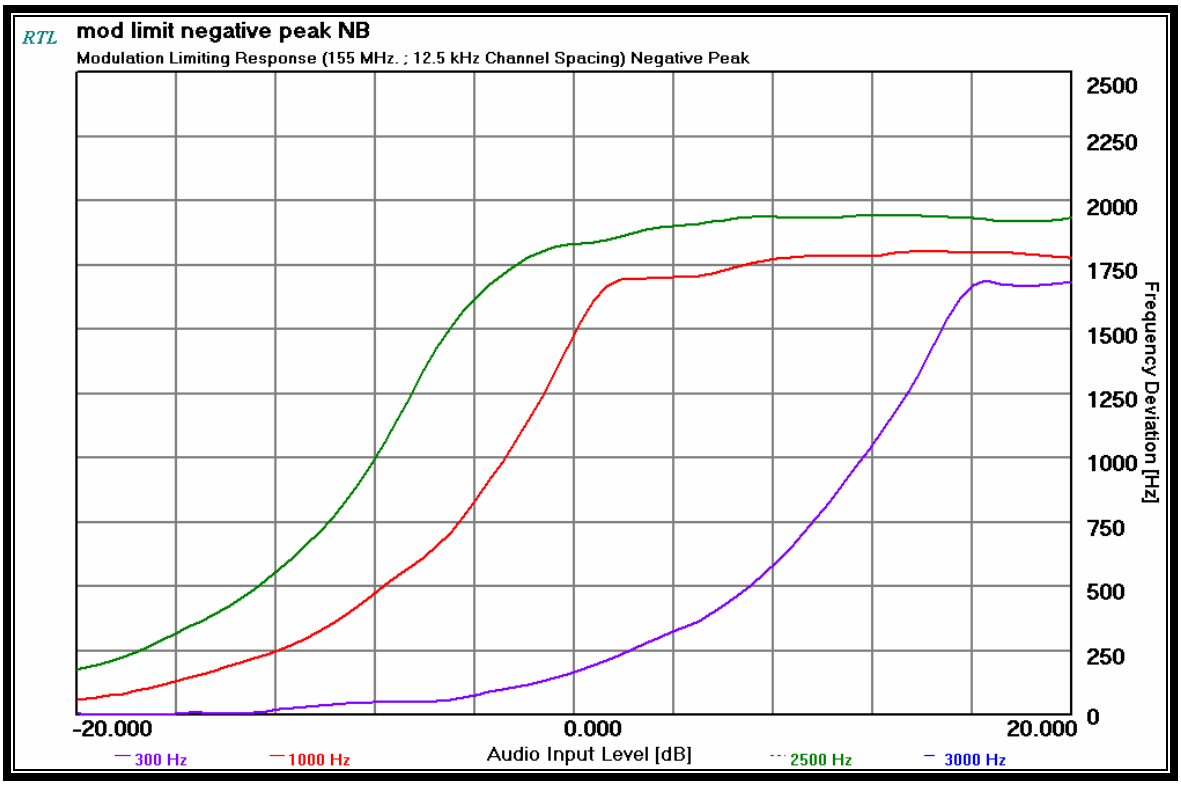


Table 11-1: Test Equipment for Testing Modulation Limiting

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due
901057	Hewlett Packard	3336B	Synthesizer/Level Generator	2514A02585	12/12/08
901118	Hewlett Packard	8901A Opt. 002-003	Modulation Analyzer	2406A00178	07/21/08

Test Personnel:

Rick McLay		February 4, 2008
Test Technician/Engineer	Signature	Date Of Tests

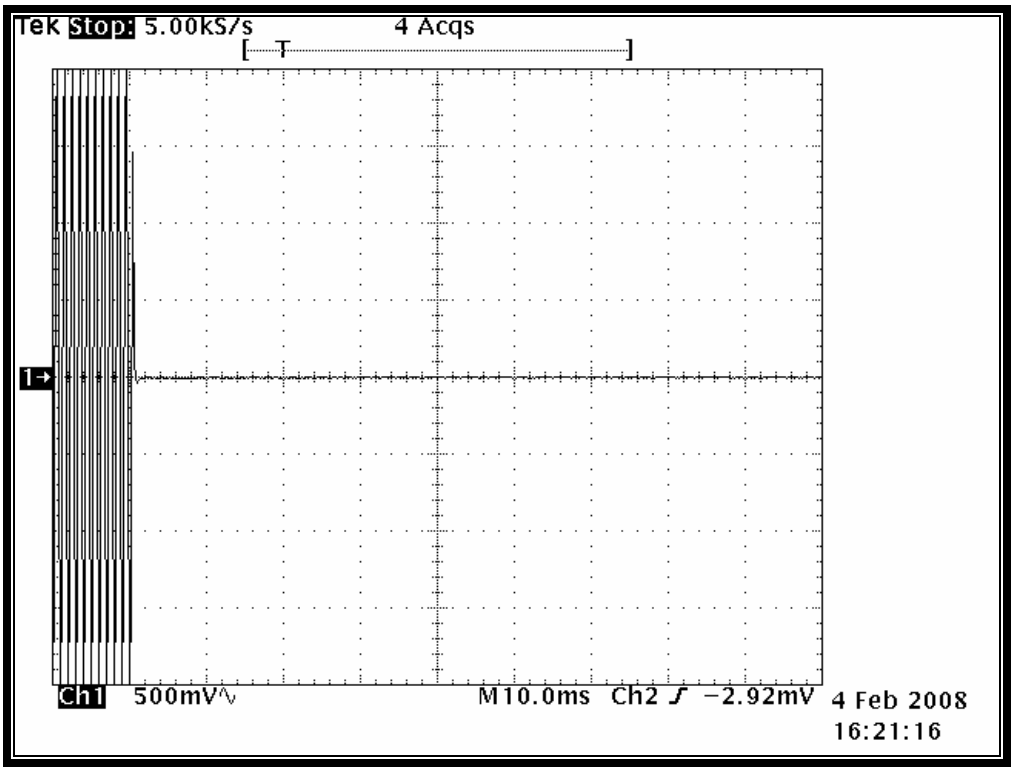
12 FCC Rules and Regulations Part 90 §90.214: Transient Frequency Behavior

12.1 Test Procedure

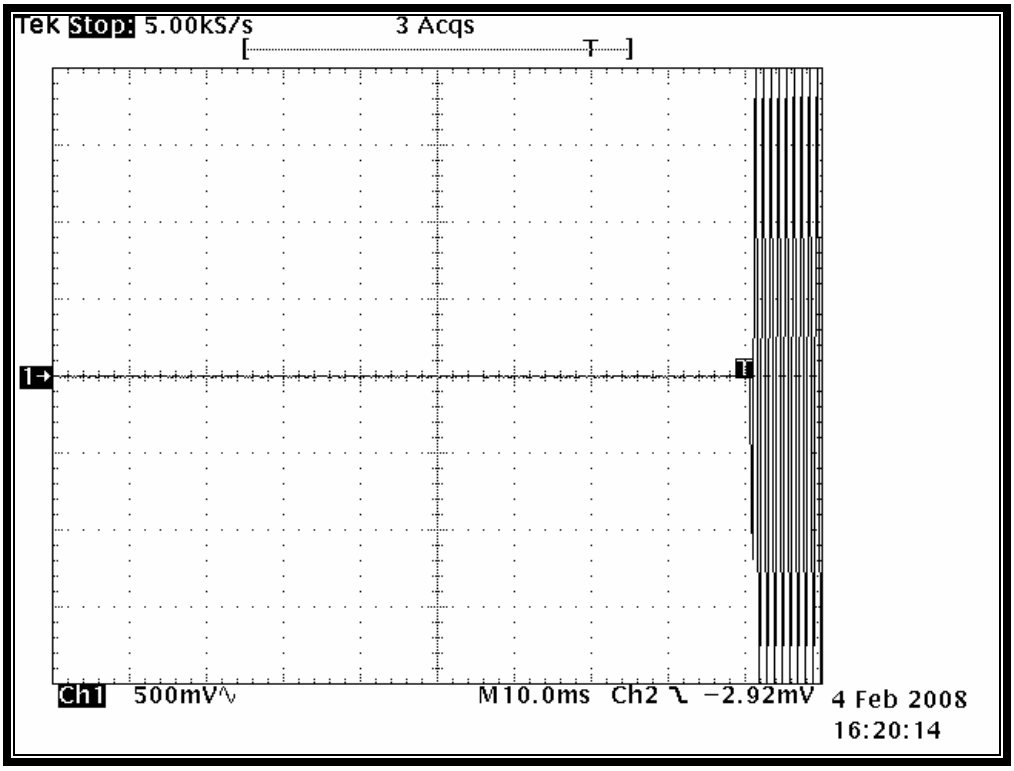
ANSI TIA-603-C-2004, section 2.2.19.

12.2 Test Data

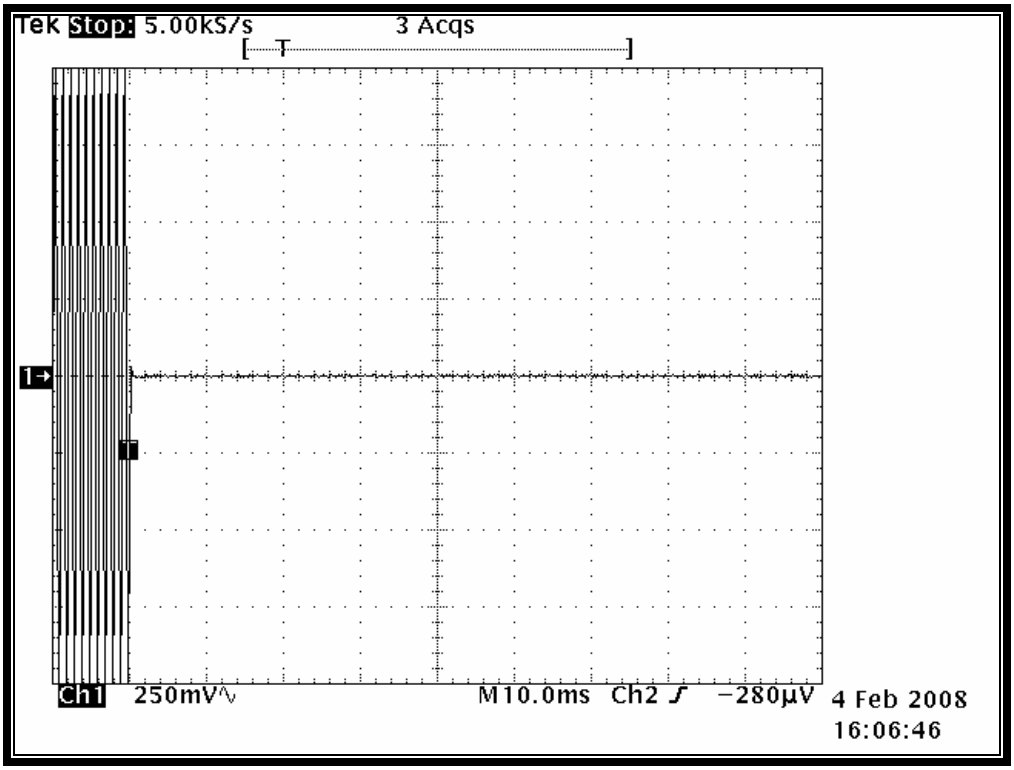
Plot 12-1: Transient Frequency Behavior – Carrier On Time Wideband



Plot 12-2: Transient Frequency Behavior – Carrier Off Time Wideband



Plot 12-3: Transient Frequency Behavior – Carrier On Time Narrowband



Plot 12-4: Transient Frequency Behavior – Carrier Off Time Narrowband

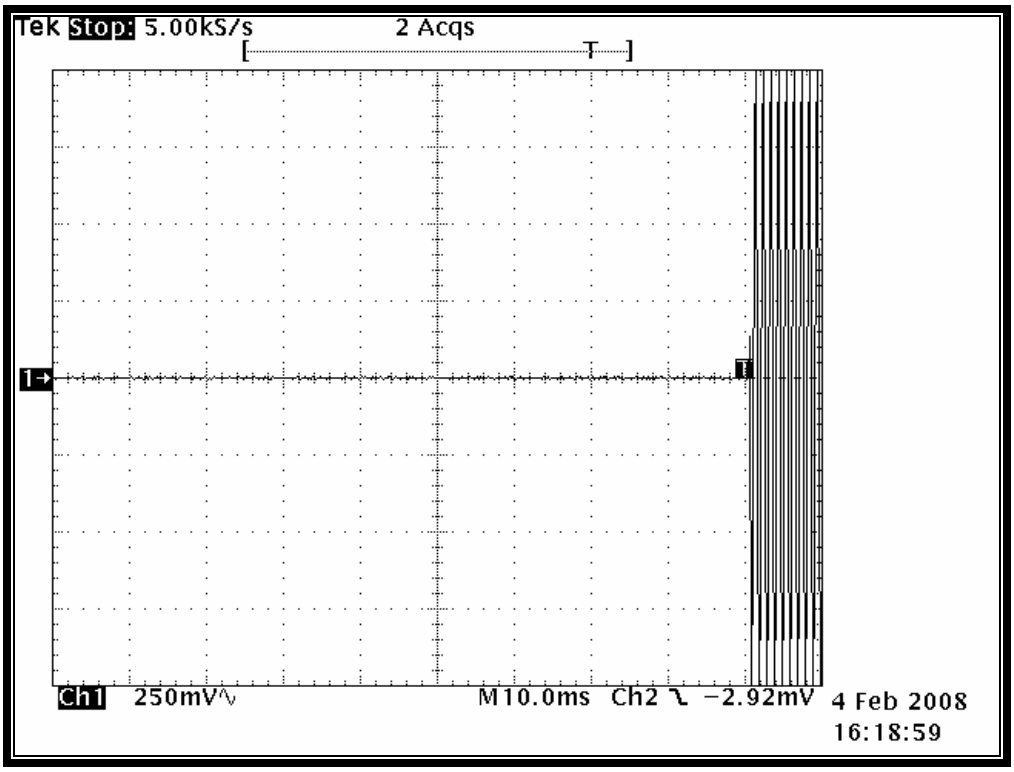


Table 12-1: Test Equipment for Testing Transient Frequency Behavior

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
900917	Hewlett Packard	8648C	Signal Generator	3537A01741	09/05/08
901118	Hewlett Packard	8901A Opt. 002-003	Modulation Analyzer	2406A00178	08/21/08
900561	Tektronix	TDS540B	Oscilloscope	B020129	03/20/08
900352	Werlatone	C1795	Directional Coupler	4989	N/A

Test Personnel:

Rick McLay		February 4, 2008
Test Engineer	Signature	Date Of Test

13 FCC Rules and Regulations Part 2 §2.202: Necessary Bandwidth and Emission Bandwidth

Type of Emission: F3E, F1D, F1E

Voice – Wide Band; 25 kHz Channel Spacing
Calculation:
Max modulation (M) in kHz: 3.0
Max deviation (D) in kHz: 5.0
Constant factor (K): 1 (assumed)
Bn = 2xM+2xDK = 16.0 kHz
Emission designator: 16K0F3E

Voice – Narrow Band; 12.5 kHz Channel Spacing
Calculation:
Max modulation (M) in kHz: 3.0
Max deviation (D) in kHz: 2.5
Constant factor (K): 1 (assumed)
Bn = 2xM+2xDK = 11.0 kHz
Emission designator: 11K0F3E

Digital Data – 4 level C4FM (P25 Standard); 9600 bps @ 2 bits/symbol=4800 sps; Narrow Band; 12.5 kHz Channel Spacing
Calculation:
Data rate in sps (R) = 4800
Peak deviation of carrier (D) = +/-1.65 kHz
Number of states in each symbol (S) = 2
Bn = $[4800/\log_2(2) + 2(1800)(1)]$ = 8.1 kHz
Emission designator: 8K10F1D, 8K10F1E

14 Conclusion

The data in this measurement report shows that the **E.F. Johnson** Model **242-511B VHF Portable Radio, FCC ID: ATH2425112,** complies with all the applicable requirements of Parts 2 and 90 of the FCC Rules and Regulations.