Engineering and Testing for EMC and Safety Compliance

TYPE CERTIFICATION REPORT

E F Johnson
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507-835-6276 (John Oblak)

MODEL: 242-5110 / 242-5111
FCC ID: ATH2425110

October 12, 2001

STANDARDS REFERENCED FOR THIS REPORT	
PART 2: 1999	FREQUENCY ALLOCATIONS AND RADIO TREATY MATTERS; GENERAL RULES AND REGULATIONS
PART 15: 1999	§15.109: RADIATED EMISSIONS LIMITS
PART 90: 1998	PRIVATE LAND MOBILE RADIO SERVICES
ANSI C63.4-1992	STANDARD FORMAT MEASUREMENT/TECHNICAL REPORT PERSONAL COMPUTER AND PERIPHERALS
ANSI/TIA/EIA603- 1992	LAND MOBILE FM OR PM COMMUNICATIONS EQUIPMENT MEASUREMENT AND PERFORMANCE STANDARDS
ANSI/TIA/EIA 603-1-1998	ADDENDUM TO ANSI/TIA/EIA 603-1992
RSS-119, Issue 6 2000	LAND MOBILE AND FIXED RADIO TRANSMITTERS AND RECEIVERS 27.41 TO 960.0 MHZ
RSS-102, Issue 1 1999	EVALUATION PROCEDURE FOR MOBILE AND PORTABLE RADIO TRANSMITTERS WITH RESPECT TO HEALTH CANADA'S SAFETY CODE 6 FOR EXPOSURE OF HUMANS TO RADIO FREQUENCY FIELDS

Frequency Range	Output Power (W)	Freq. Tolerance	Emission Designator
136-174 MHz	5.8	2.5 ppm	11K0F3E
136-174 MHz	5.8	2.5 ppm	16K0F3E
136-174 MHz	1.2	2.5 ppm	11K0F3E
136-174 MHz	1.2	2.5 ppm	16K0F3E
136-174 MHz	5.8	2.5 ppm	8K10F1E
136-174 MHz	1.2	2.5 ppm	8K10F1E

REPORT PREPARED BY:

Test Engineer: Daniel Baltzell
Administrative Writer: Melissa Fleming

Document Number: 2001258 / QRTL01-252

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1 GENERAL INFORMATION

The following Report of an Application for Certification, is prepared on behalf of E. F. Johnson, Inc.. in accordance with the Federal Communications Commissions Regulations and Industry Canada Standards. The Equipment Under Test (EUT) was the Model ***242-5110 VHF Radio*; FCC ID: ATH2425110**. The test results reported in this document relate only to the item that was tested.
The digital interface portion of this transceiver, including the receiver, was tested and found in compliance with Part 15 Class B limits. A DoC report was prepared and is available upon request.

All measurements contained in this application were conducted in accordance with FCC Rules and Regulations CFR 47, and ANSI C63.4 Methods of Measurement of Radio Noise Emissions, 1992. The instrumentation utilized for the measurements conforms to the ANSI C63.4 standard for EMI and Field Strength Instrumentation. Calibration checks are performed regularly on the instruments, and all accessories including high pass filter, coaxial attenuator, preamplifier and cables.

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 and approved by the Federal Communication Commission to perform AC line conducted and radiated emissions testing (ANSI C63.4 1992).

1.2 RELATED SUBMITTAL(S)/GRANT(S)

This is an original application for Certification

1.3 FCC PART 2.202: NECESSARY BANDWIDTH AND EMISSION BANDWIDTH

Type of Emission: F3E; F1E

Necessary Bandwidth and Emission Bandwidth:
12.5kHz (NB channel) : Bn = 11K0F3E
25kHz (WB channel): Bn = 16K0F3E
P25 Digital: Bn=8K10F1E

Calculation:
Max modulation(M) in kHz : 3
Max deviation (D) in kHz: 2.5 (NB) and 5 (BB)
Constant factor (K) : 1
Bn = 2xM+2xDK

1.4 CONFORMANCE STATEMENT

STANDARDS REFERENCED FOR THIS REPORT	
PART 2: 1999	FREQUENCY ALLOCATIONS AND RADIO TREATY MATTERS; GENERAL RULES AND REGULATIONS
PART 15: 1999	§15.109: RADIATED EMISSIONS LIMITS
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136-174 MHz	5.8	2.5 ppm	8K10F1E
136-174 MHz	1.2	2.5 ppm	8K10F1E

We, the undersigned, hereby declare that the equipment tested and referenced in this report conforms to the identified standard(s) as described in this attached test record. No modifications were made to the equipment during testing in order to achieve compliance with these standards.

Furthermore, there was no deviation from, additions to or exclusions from the standards identified in this report.

Signature: _____ Date: October 12, 2001

Typed/Printed Name: Bruno Clavier Position: Vice President of Operations (NVLAP Signatory)

Signature: _____ Date: October 12, 2001

Typed/Printed Name: Daniel Baltzell Position: Test Engineer

NVLAP *Accredited by the National Voluntary Accreditation Program for the specific scope of accreditation under Lab Code 200061-0.*

Note: This report may not be used by the client to claim product endorsement by NVLAP or any agency of the U.S. Government.

1.5 TESTED SYSTEM DETAILS

Listed below is the identifiers and descriptions of all equipment, cables, and internal devices used with the EUT for this test, as applicable.

TABLE 1-1: EQUIPMENT UNDER TEST (EUT)

PART	MANUFACTURER	MODEL	SERIAL NUMBER	FCC ID	BARCODE NUMBER
PORTABLE RADIO	EF JOHNSON	242-5110	51101A361A-10001	ATH2425110	013673

TABLE 1-2: EXTERNAL COMPONENTS OF TEST CONFIGURATION

PART	MANUFACTURER	MODEL	SERIAL NUMBER	FCC ID	BARCODE NUMBER
HEADSET	OTTO COMMUNICATIONS	V4-BA2M41	N/A	SAMPLE	013679
MICROPHONE	OTTO COMMUNICATIONS	V1-10172	N/A	SAMPLE	013678
ADAPTER	OTTO COMMUNICATIONS	AUDIO ACCESSORY	N/A	SAMPLE	013677
SPEAKER/MIC	OTTO COMMUNICATIONS	V2-10031-0131	N/A	SAMPLE	013676
BATTERY CHARGER	MOTOROLA, INC.	AA16740	1123335648	N/A	013675
ANTENNA	EF JOHNSON	6" WHIP	RED	N/A	013674
ANTENNA (136-151 MHZ)	MOTOROLA CORP.	501-0017-101	N/A	N/A	N/A
ANTENNA (151-162 MHZ)	MOTOROLA CORP.	501-0017-103	N/A	N/A	N/A
ANTENNA (162-174 MHZ)	MOTOROLA CORP.	501-0017-105	N/A	N/A	N/A
BATTERY	ALEXANDER TECH	7.5V	H8294	N/A	013672
BATTERY	ALEXANDER TECH	7.5V	H8295	N/A	013671

1.6 CONFIGURATION OF TESTED SYSTEM

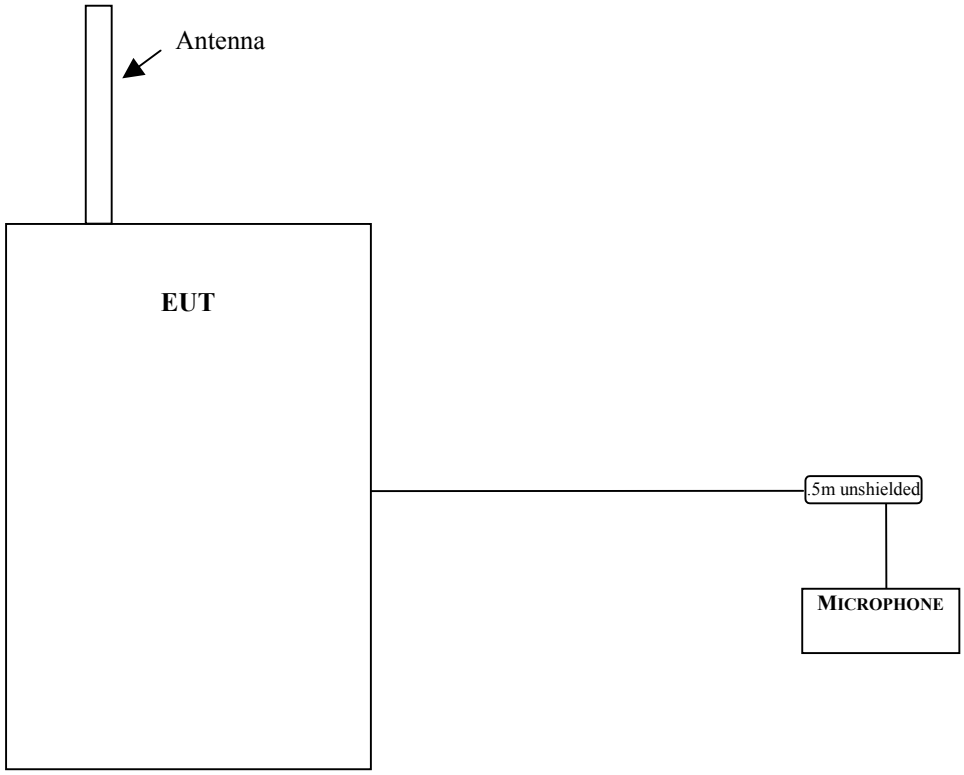


FIGURE 1-1: TEST CONFIGURATION

1.7 FIELD STRENGTH CALCULATION

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:

FI(dBuV/m) = SAR(dBuV) + SCF(dB/m)
FI = Field Intensity
SAR = Spectrum Analyzer Reading
SCF = Site Correction Factor

The Site Correction Factor (SCF) used in the above equation is determined empirically, and is expressed in the following equation:

SCF(dB/m) = - PG(dB) + AF(dB/m) + CL(dB)

SCF = Site Correction Factor
PG = Pre-amplifier Gain
AF = Antenna Factor
CL = Cable Loss

The field intensity in microvolts per meter can then be determined according to the following equation:

$$FI(uV/m) = 10^{FI(dBuV/m)/20}$$

For example, assume a signal at a frequency of 125 MHz has a received level measured as 49.3 dBuV. The total Site Correction Factor (antenna factor plus cable loss minus preamplifier gain) for 125 MHz is
-11.5 dB/m. The actual radiated field strength is calculated as follows:

49.3 dBuV - 11.5 dB/m = 37.8 dBuV/m

$$10^{37.8/20} = 10^{1.89} = 77.6 \text{ uV/m}$$

2 FCC PART 2 §2.1046 (A): RF POWER OUTPUT: CONDUCTED

2.1 RF POWER OUTPUT: CONDUCTED TEST PROCEDURE

ANSI/TIA/EIA-603-1992, section 2.2.1

The EUT was connected to a coaxial attenuator having a 50 Ω load impedance.

2.2 RF POWER OUTPUT: CONDUCTED TEST DATA

The following channel (in MHz) were tested: 136.0; 155.0; 174.0. The worst-case Output Power (highest) levels are shown.

TABLE 2-1: CARRIER OUTPUT POWER (UNMODULATED)

Channel	Frequency (MHz)	Level (dBm)	Level (W)	Mode
1	136.0	37.64	5.8	25 kHz Analog
2	155.0	37.54	5.7	25 kHz Analog
3	174.0	37.54	5.7	25 kHz Analog
4	136.0	37.62	5.8	12.5 kHz Analog
5	155.0	37.53	5.7	12.5 kHz Analog
6	174.0	37.55	5.7	12.5 kHz Analog
7	136.0	37.62	5.8	P25 Digital
8	155.0	37.59	5.7	P25 Digital
9	174.0	37.60	5.8	P25 Digital
10	136.0	30.77	1.2	25 kHz Analog
11	155.0	30.66	1.2	25 kHz Analog
12	174.0	30.67	1.2	25 kHz Analog
13	136.0	30.87	1.2	12.5 kHz Analog
14	155.0	30.74	1.2	12.5 kHz Analog
15	174.0	30.80	1.2	12.5 kHz Analog
16	155.0	30.73	1.2	P25 Digital

*Measurement accuracy: +/- 3%

TABLE 2-2: RATED POWER:

Rated Power (W)	
High Power	Low Power
5.0	1.0

TEST PERSONNEL:

DANIEL BALTZELL		OCTOBER 12, 2001
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

2.3 TEST EQUIPMENT

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
900770	Hewlett Packard	437B	Power Meter	2949A02966	02/16/02
901055	Hewlett Packard	8901A Opt. 002-003	Modulation Analyzer	2545A04102	07/31/02
900769	Hewlett Packard	8481B	Power Sensor	2702A05059	02/09/02

3 FCC PART 2 §2.1051: SPURIOUS EMISSIONS AT ANTENNA TERMINALS

3.1 SPURIOUS EMISSIONS AT ANTENNA TERMINALS TEST PROCEDURE

ANSI/TIA/EIA-603-1992, Section 2.2.13

The transmitter is terminated with a 50 Ω load and interfaced with a spectrum analyzer.
The transmitter is modulated with a 2,500 Hz sine wave at an input level 16 dB greater than that required producing 50% of the rated system deviation at 1000 Hz.

3.2 SPURIOUS EMISSIONS AT ANTENNA TERMINALS TEST DATA

Frequency range of measurement per Part 2.1057: 9kHz to 10 x Fc

Limits: Mask D (dBm): P(dBm) – (50+10xLOG P(W))

The following channel (in MHz) were investigated: 136.0, 155.0, 174.0 MHz

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.

TABLE 3-1: CONDUCTED SPURIOUS EMISSIONS - CHANNEL 4 (136.0 MHZ)
5.8 Watt; 12.5 kHz Channel Bandwidth: Mask D (Limit 57.6dBc)

Frequency (MHz)	Level Measured (dBc)	Margin (dB)
272.000	83.6	26.0
408.000	94.3	36.7
544.000	121.7	64.1
680.000	122.3	64.7
816.000	122.8	65.2
952.000	120.6	63.0
1088.000	119.7	62.1
1224.000	115.7	58.1
1360.000	97.9	40.3

TEST PERSONNEL:

DANIEL BALTZELL		OCTOBER 12, 2001
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

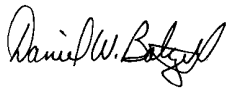
TABLE 3-2: CONDUCTED SPURIOUS EMISSIONS - CHANNEL 5 (155.0 MHZ)
5.7 Watt; 12.5 kHz Channel Bandwidth: Mask D (Limit 57.5 dBc)

Frequency (MHz)	Level Measured (dBc)	Margin (dB)
310.000	85.5	28.0
465.000	118.2	60.7
620.000	124.7	67.2
775.000	125.1	67.6
930.000	113.8	56.3
1085.000	113.4	55.9
1240.000	112.0	54.5
1395.000	99.0	41.5
1550.000	104.4	46.9

TABLE 3-3: CONDUCTED SPURIOUS EMISSIONS - CHANNEL 6 (174.0 MHZ)
5.7 Watt; 12.5 kHz Channel Bandwidth: Mask D (Limit 57.6 dBc)

Frequency (MHz)	Level Measured (dBc)	Margin (dB)
348.000	83.6	26.0
522.000	87.4	29.8
696.000	119.9	62.3
870.000	119.3	61.7
1044.000	105.6	48.0
1218.000	121.5	63.9
1392.000	101.9	44.3
1566.000	117.5	59.9
1740.000	124.9	67.3

TEST PERSONNEL:



DANIEL BALTZELL — TEST TECHNICIAN/ENGINEER | SIGNATURE | OCTOBER 12, 2001 — DATE OF TEST

3.3 SPURIOUS EMISSIONS AT ANTENNA TERMINALS TEST EQUIPMENT

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
901020	Hewlett Packard	8564E	Portable Spectrum Analyzer (9 kHz - 40 GHz)	3943A01719	06/07/02
901057	Hewlett Packard	3336B	Synthesizer/Level Generator	2514A02585	07/13/02
901054	Hewlett Packard	HP 3586B	Selective Level Meter	1928A01892	07/16/02
900913	Hewlett Packard	85462A	EMI Receiver RF Section (9 KHz – 6.5 GHz)	3325A00159	11/07/01

4 FCC PART 2 §2.1053 (A): FIELD STRENGTH OF SPURIOUS RADIATION

4.1 FIELD STRENGTH OF SPURIOUS RADIATION TEST PROCEDURE

ANSI/TIA/EIA-603-1992, section 2.2.12

The transmitter is terminated with a 50 Ω 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 1000 Hz.

4.2 FIELD STRENGTH OF SPURIOUS RADIATION TEST DATA

The worst-case emissions test data are shown. The magnitude of emissions attenuated more than 20 dB below the FCC limit need not be recorded.

TABLE 4-1: FIELD STRENGTH OF SPURIOUS RADIATION – CHANNEL 4 (136.0 MHZ)
5.8 W; 12.5 kHz channel bandwidth; Mask D (Substitution Method) (Limit 57.6 dBc)

Frequency (MHz)	Signal Generator Level (dBm)	Site Factor (dB)*	Corrected Signal Generator Level (dBc)	Margin (dB)
272.0	-74.4	-1.0	93.4	35.8
408.0	-59.2	-1.1	78.3	20.7
544.0	-69.0	-1.6	88.7	31.1
680.0	-74.8	-2.0	94.7	37.1
816.0	-72.8	-2.4	92.8	35.2
952.0	-59.1	-2.5	78.1	20.5
1088.0	-60.8	1.5	75.8	18.2
1224.0	-65.6	3.0	78.0	20.4
1360.0	-64.2	4.4	78.3	20.7

*This insertion loss corresponds to the cable connecting the RF Signal Generator to the ½ wave dipole antenna and difference in gain (ref. To a 1/2 wave dipole)

TEST PERSONNEL:

DANIEL BALTZELL		OCTOBER 12, 2001
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

TABLE 4-2: FIELD STRENGTH OF SPURIOUS RADIATION – CHANNEL 5 (155.0 MHZ)
5.7 W; 12.5 Channel bandwidth; Mask D (Substitution Method) (Limit 57.5 dBc)

Frequency (MHz)	Signal Generator Level (dBm)	Site Factor (dB)*	Corrected Signal Generator Level (dBc)	Margin (dB)
310.0	-65.9	-1.0	97.4	39.9
465.0	-65.7	-1.3	97.4	39.9
620.0	-68.7	-2.0	101.2	43.7
775.0	-71.3	-2.3	103.8	46.3
930.0	-71.1	-2.5	100.6	43.1
1085.0	-68.1	1.5	95.5	38.0
1240.0	-71.6	3.2	95.7	38.2
1395.0	-73.6	4.7	99.8	42.3
1550.0	-77.3	5.8	102.4	44.9

*This insertion loss corresponds to the cable connecting the RF Signal Generator to the ½ wave dipole antenna and difference in gain (ref. To a 1/2 wave dipole)

TEST PERSONNEL:

DANIEL BALTZELL		OCTOBER 12, 2001
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

TABLE 4-3: FIELD STRENGTH OF SPURIOUS RADIATION – CHANNEL 6 (174.0 MHZ)
5.7 W; 12.5 Channel bandwidth; Mask D (Substitution Method) (Limit 57.6 dBc)

Frequency (MHz)	Signal Generator Level (dBm)	Site Factor (dB)*	Corrected Signal Generator Level (dBc)	Margin (dB)
348.0	-65.4	-0.8	90.1	32.5
522.0	-58.2	-1.5	83.6	26.0
696.0	-71.8	-2.1	97.6	40.0
870.0	-69.2	-2.3	94.3	36.7
1044.0	-60.6	1.1	82.2	24.6
1218.0	-64.4	2.9	82.8	25.2
1392.0	-75.8	4.7	95.5	37.9
1566.0	-82.4	5.8	100.9	43.3
1740.0	-85.5	6.0	103.8	46.2

*This insertion loss corresponds to the cable connecting the RF Signal Generator to the ½ wave dipole antenna and difference in gain (ref. To a 1/2 wave dipole)

TEST PERSONNEL:

DANIEL BALTZELL		OCTOBER 12, 2001
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

4.3 FIELD STRENGTH OF SPURIOUS RADIATION TEST EQUIPMENT

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
900791	Schaffner@Chase	CBL6112	Anetenna (25MHz – 2GHz)	2099	08/23/2002
900932	Hewlett Packard	8449B OPT H02	Preamplifier (1-26.5 GHz)	3008A00505	N/A
901020	Hewlett Packard	8564E	Portable Spectrum Analyzer (9 kHz - 40 GHz)	3943A01719	06/07/02
900917	Hewlett Packard	8648C	Synthesized. Signal Generator (9 KHz to 3200 MHz)	3537A01741	04/10/02
900928	Hewlett Packard	83752A	Synthesized Sweeper, 0.01 to 20 GHz	3610A00866	05/11/02

5 FCC PART 2 §2.1049 (C) (1): OCCUPIED BANDWIDTH

OCCUPIED BANDWIDTH - COMPLIANCE WITH THE EMISSION MASKS

5.1 OCCUPIED BANDWIDTH TEST PROCEDURE

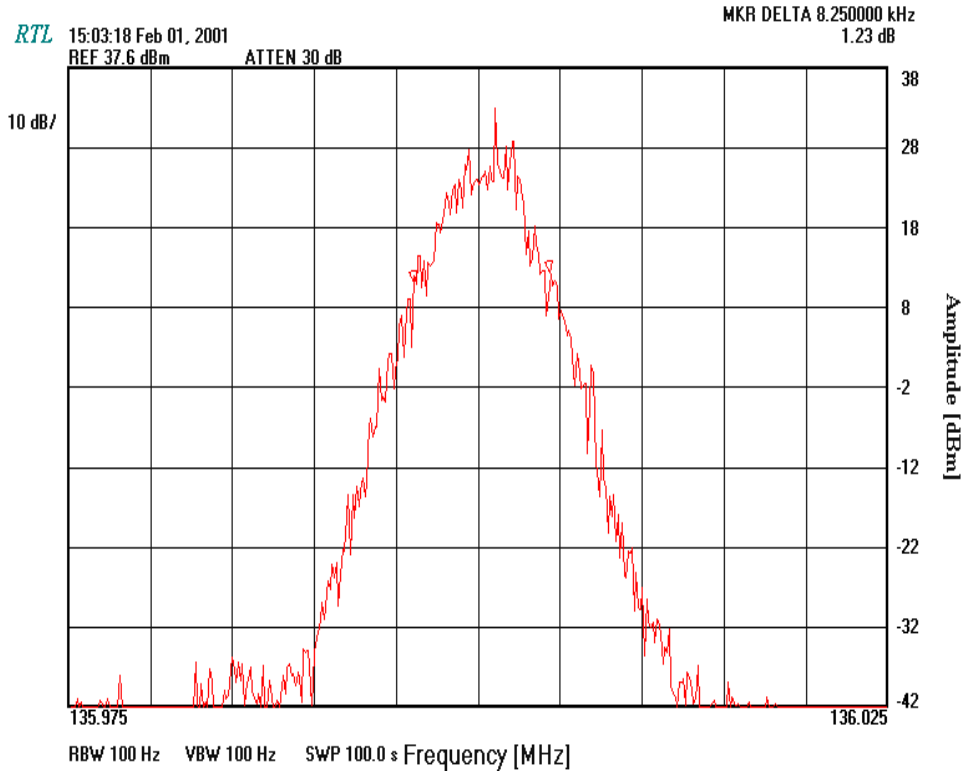
ANSI/TIA/EIA-603-1992, section 2.2.11
EIA/TIA – TSB102.CAAA

Device with audio modulation: Transmitter is modulated with a 2500 Hz sine wave at an input level of 16 dB greater than that required to produce 50% of rated system deviation at 1000 Hz. Device with digital modulation: modulated per manufacturer specifications to its maximum extent.

5.2 OCCUPIED BANDWIDTH TEST DATA

PLOT 5-1: OCCUPIED BANDWIDTH: CHANNEL 7 (136 MHZ): 8.25 KHZ; PROJECT 25 DIGITAL (5W)

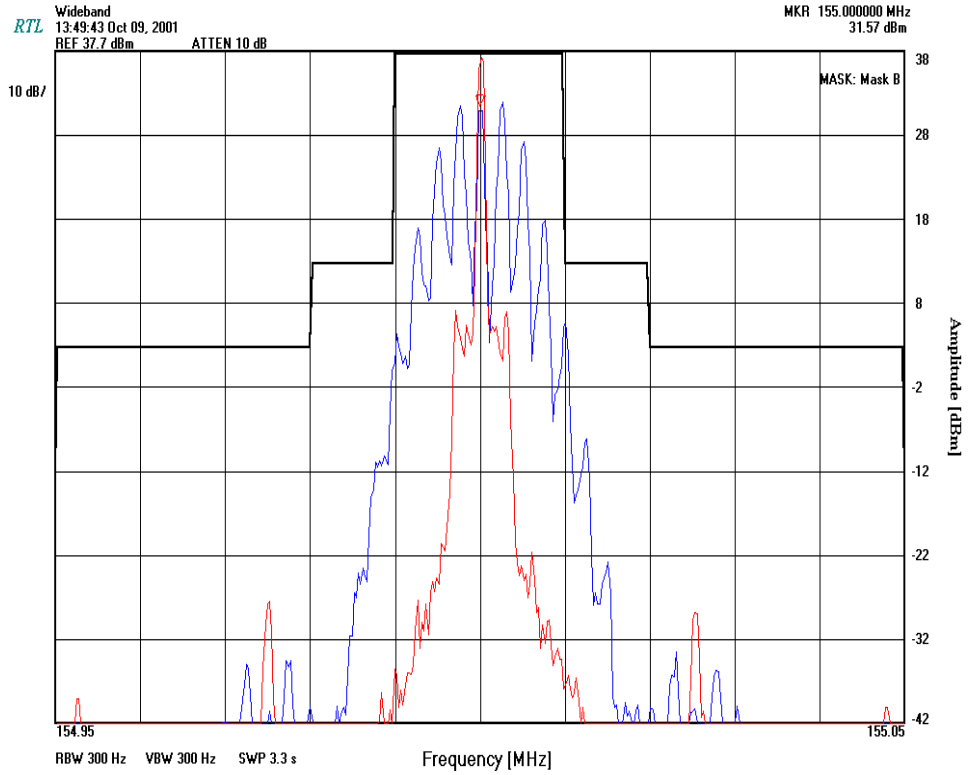
Reference level was set at 30k resolution and video bandwidths and peak max hold as required in EIA/TIA – 102.CAAA



TEST PERSONNEL:

DANIEL BALTZELL		OCTOBER 12, 2001
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

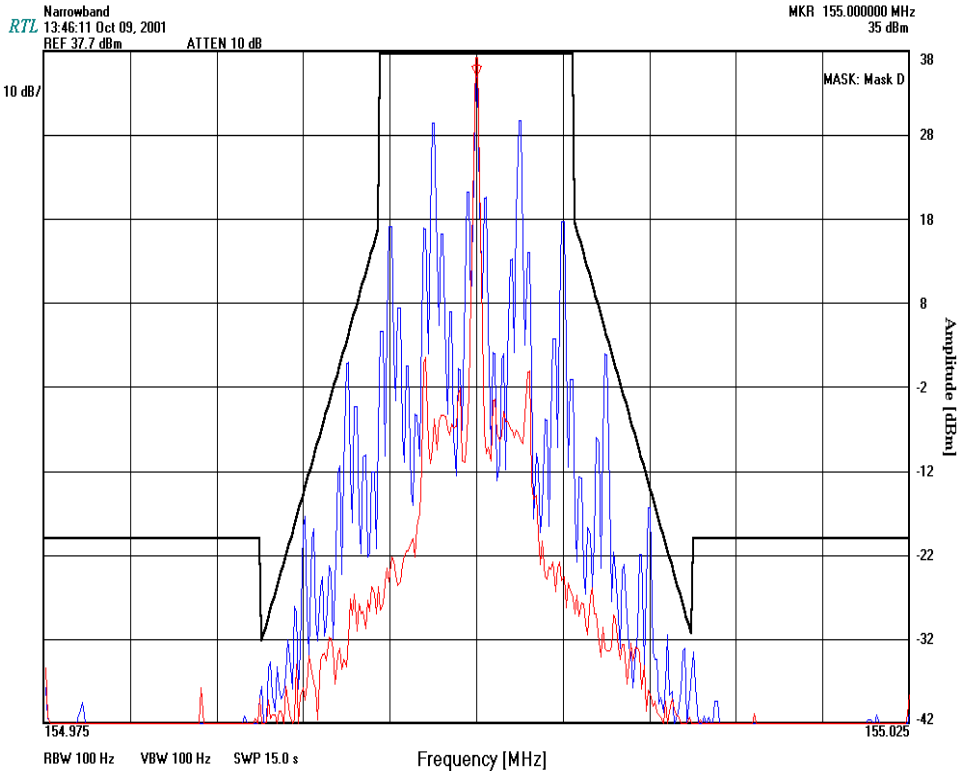
PLOT 5-2: OCCUPIED BANDWIDTH – WIDEBAND: CHANNEL 2: 5W, 25 KHZ CHANNEL BANDWIDTH: MASK B (AUDIO MODULATION: 2,500 HZ)



TEST PERSONNEL:

DANIEL BALTZELL		OCTOBER 12, 2001
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

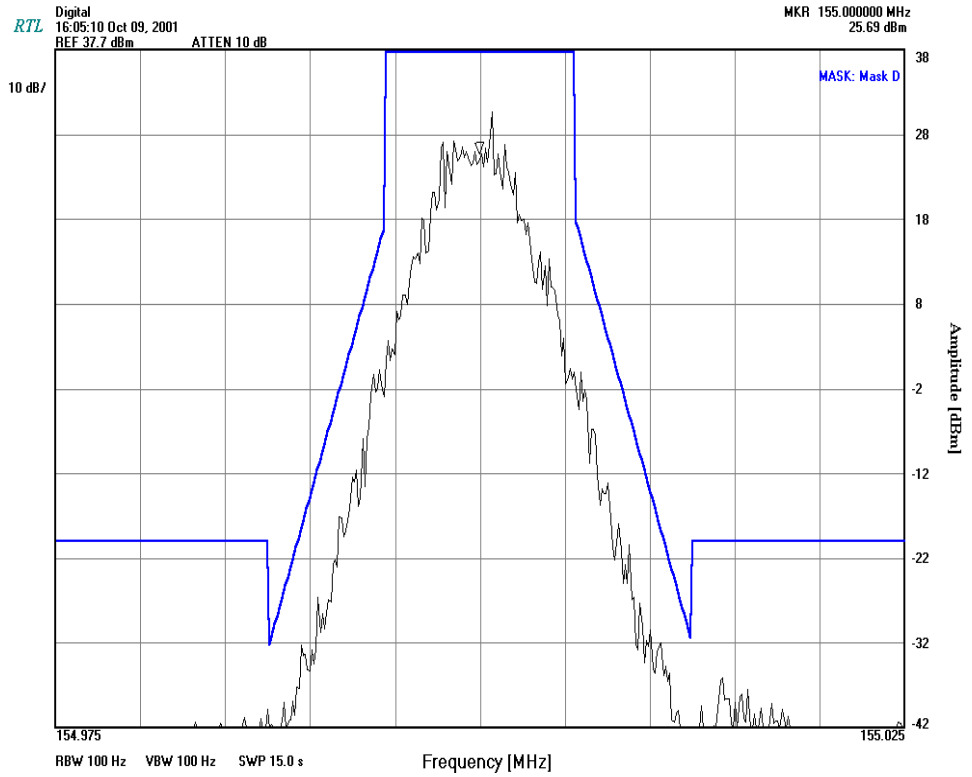
PLOT 5-3: OCCUPIED BANDWIDTH – NARROWBAND: CHANNEL 5: 5W, 12.5 KHZ CHANNEL BANDWIDTH: MASK D (AUDIO MODULATION: 2,500 HZ)



TEST PERSONNEL:

DANIEL BALTZELL		OCTOBER 12, 2001
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

PLOT 5-4: OCCUPIED BANDWIDTH – DIGITAL: CHANNEL 8: 5W, MASK D (DIGITAL MODULATION P25)



TEST PERSONNEL:

DANIEL BALTZELL		OCTOBER 12, 2001
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

TABLE 5-1: OCCUPIED BANDWIDTH TEST EQUIPMENT

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
901020	Hewlett Packard	8564E	Portable Spectrum Analyzer (9 kHz - 40 GHz)	3943A01719	03/06/02

6 FCC PART 2 §2.1055: FREQUENCY STABILITY

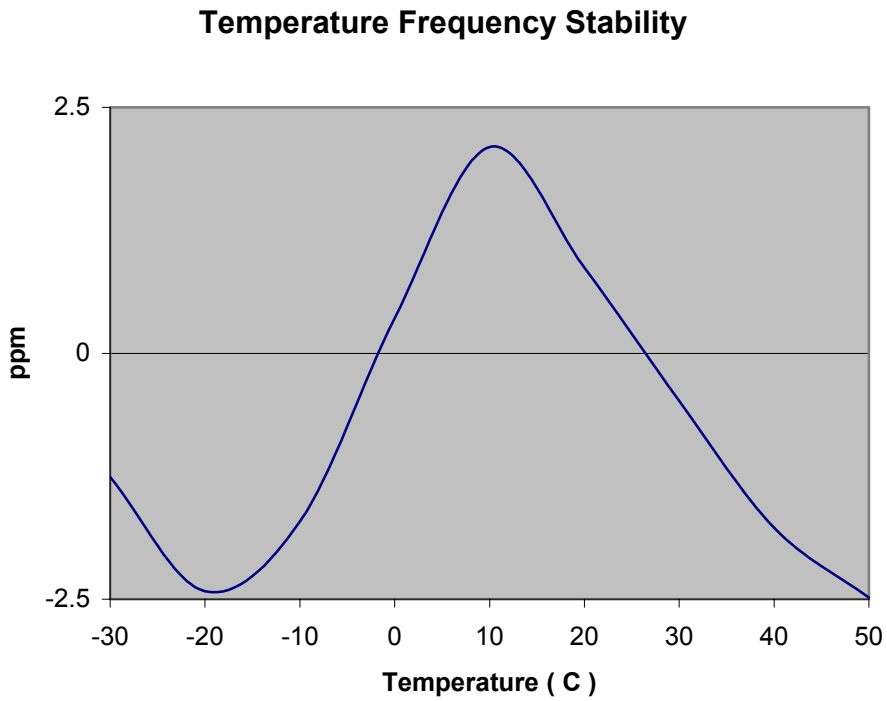
6.1 FREQUENCY STABILITY TEST PROCEDURE

ANSI/TIA/EIA-603-1992, 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 +50°C. The temperature was initially set to -30°C and a 2-hour period was observed 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 degrees centigrade through the range. A ½ an 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 85% to 115% of the nominal voltage. The worst-case test data are shown.

6.2 FREQUENCY STABILITY TEST DATA

PLOT 6-1: FREQUENCY STABILITY/FREQUENCY VARIATION

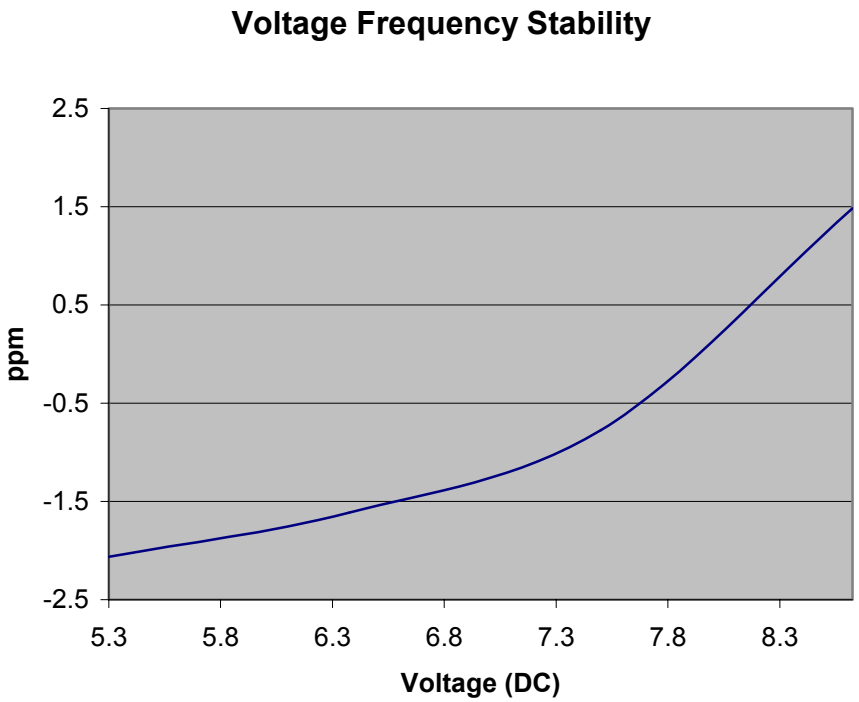


TEST PERSONNEL:

DANIEL BALTZELL		OCTOBER 12, 2001
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

PLOT 6-2: FREQUENCY STABILITY/VOLTAGE VARIATION

Battery end-point = 5.3 VDC



TEST PERSONNEL:

DANIEL BALTZELL		OCTOBER 12, 2001
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

TABLE 6-1: FREQUENCY STABILITY/VOLTAGE VARIATION TEST EQUIPMENT

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
900946	Tenney Engineering, Inc.	TH65	Temperature Chamber with Humidity	11380	11/07/01
901055	Hewlett Packard	8901A Opt. 002-003	Modulation Analyzer	2545A04102	06/08/01

7 FCC PART 2 §2.1047 (A): MODULATION CHARACTERISTICS

7.1 AUDIO FREQUENCY RESPONSE TEST PROCEDURE

ANSI/TIA/EIA-603-1992, section 2.2.6

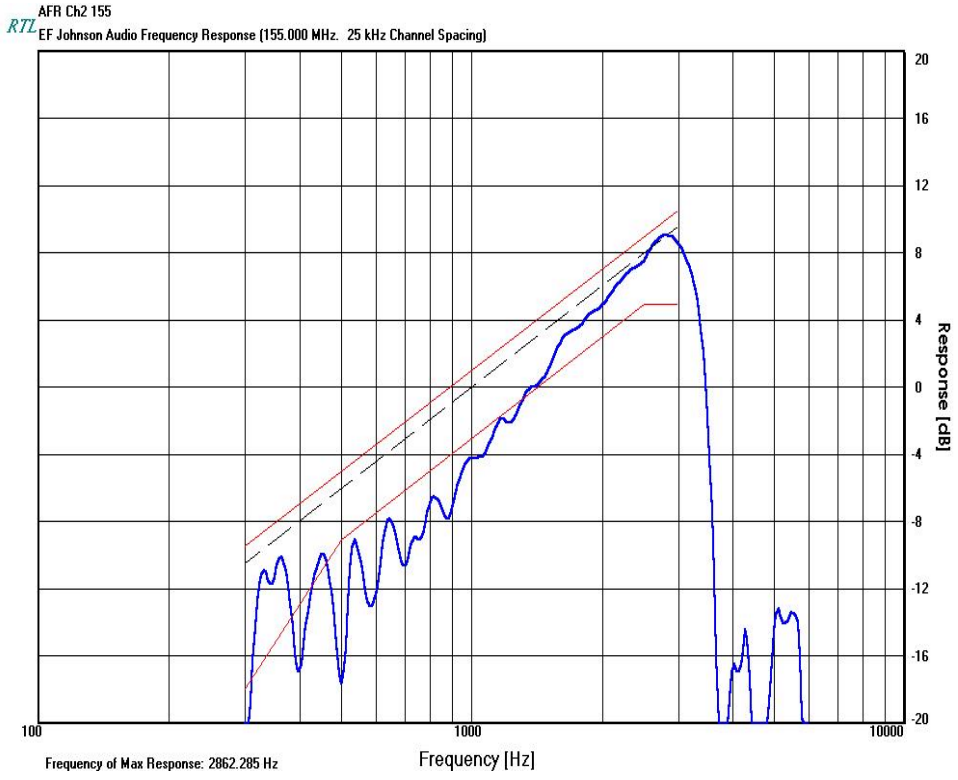
The audio frequency response is the degree of closeness to which the frequency deviation of the transmitter follows a prescribed characteristic.

The input audio level at 1000 Hz is 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 100Hz to 5kHz 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)

7.2 AUDIO FREQUENCY RESPONSE TEST DATA

PLOT 7-1: AUDIO FREQUENCY RESPONSE – 155.0 MHZ {25 KHZ CHANNEL SPACING}



TEST PERSONNEL:

DANIEL BALTZELL		OCTOBER 12, 2001
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

7.3 AUDIO LOW PASS FILTER RESPONSE TEST PROCEDURE

ANSI/TIA/EIA-603-1992, 2.2.15

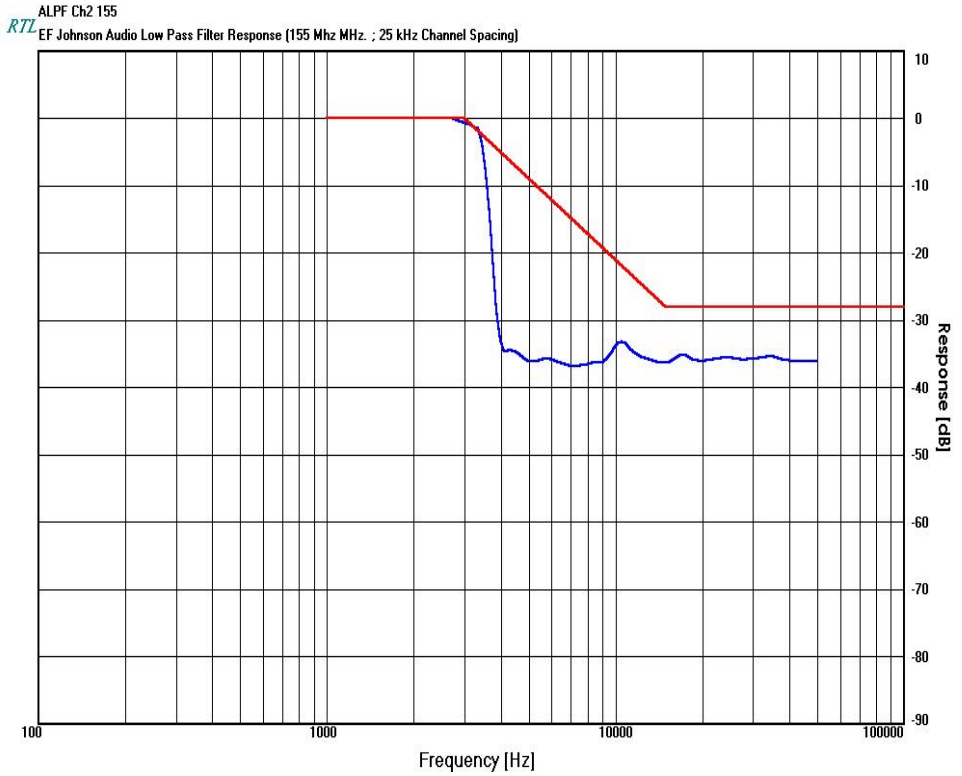
The Audio Low Pass Filter Response is the frequency response of the post limiter low pass filter circuit above 3000 Hz.

7.4 AUDIO LOW PASS FILTER RESPONSE TEST TEST DATA

Note: The vertical scale is in dB relative to 1 kHz.

25 kHz channel bandwidth:

PLOT 7-2: AUDIO LOW PASS FILTER RESPONSE – 155.0 MHZ {25 KHZ CHANNEL SPACING}



TEST PERSONNEL:

DANIEL BALTZELL		OCTOBER 12, 2001
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

TABLE 7-1: MODULATION CHARACTERISTICS TEST EQUIPMENT

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
901057	Hewlett Packard	3336B	Synthesizer/Level Generator	2514A02585	06/21/01
901055	Hewlett Packard	8901A Opt. 002-003	Modulation Analyzer	2545A04102	06/08/01

8 FCC PART 2 §2.1047 (B): MODULATION CHARACTERISTICS - MODULATION LIMITING

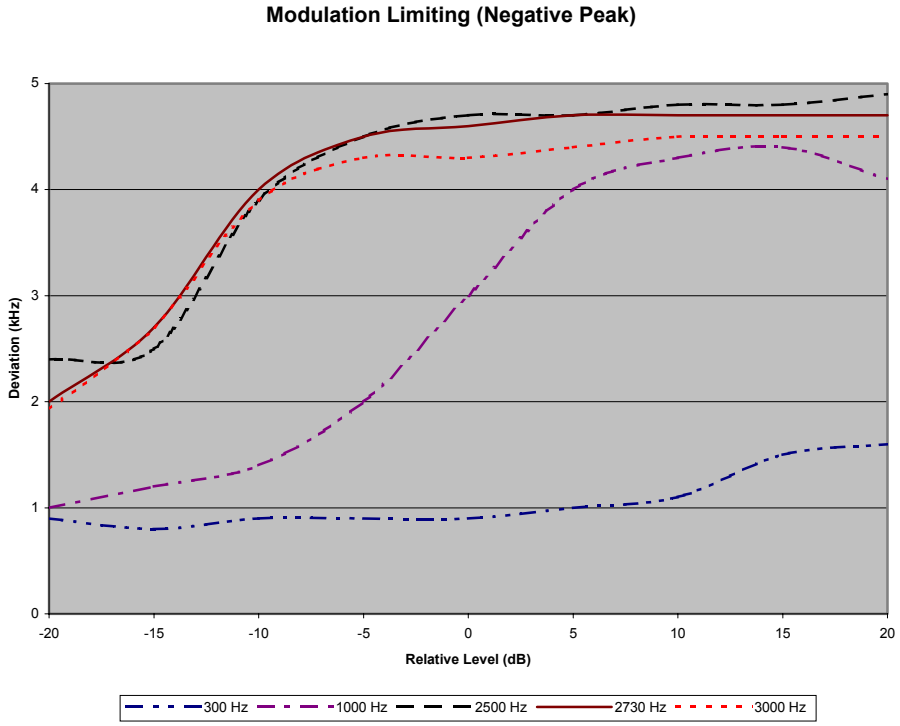
8.1 MODULATION LIMITING TEST PROCEDURE

ANSI/TIA/EIA-603-1992, section 2.2.3

The transmitter is adjusted for full rated system deviation. The audio input level is adjusted for 60% of rated system deviation at 1000Hz. Using this level as a reference (0dB) the audio input level is varied from the reference to a level +20 dB above it and –20 dB under it, for modulation frequencies of 300Hz, 1,000Hz, and 2,500Hz. The system deviation obtained as a function of the input level is recorded.
Both Positive and Negative Peak deviations were recorded.

8.2 MODULATION LIMITING TEST DATA

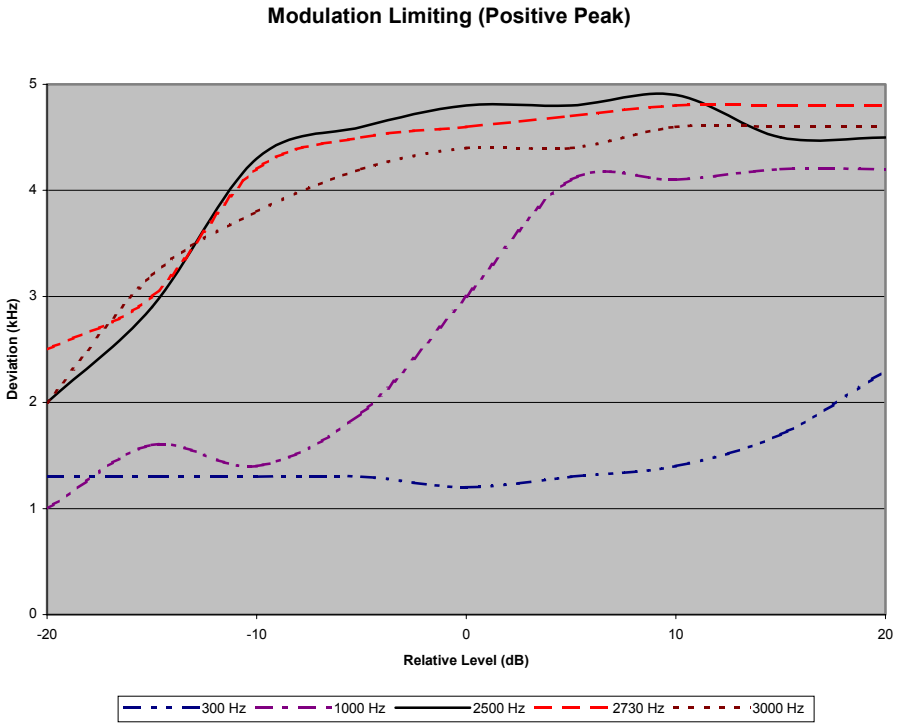
PLOT 8-1: MODULATION LIMITING RESPONSE – 155.0 MHZ {25 KHZ CHANNEL SPACING} NEGATIVE PEAK



TEST PERSONNEL:

DANIEL BALTZELL		OCTOBER 12, 2001
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

PLOT 8-2: MODULATION LIMITING RESPONSE – 155.0 MHZ {25 KHZ CHANNEL SPACING} POSITIVE PEAK



TEST PERSONNEL:

DANIEL BALTZELL		OCTOBER 12, 2001
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

TABLE 8-1: MODULATION LIMITING TEST EQUIPMENT

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
901057	Hewlett Packard	3336B	Synthesizer/Level Generator	2514A02585	06/21/01
901055	Hewlett Packard	8901A Opt. 002-003	Modulation Analyzer	2545A04102	06/08/01

9 FCC PART 90 §90.214: TRANSIENT FREQUENCY BEHAVIOR

9.1 TRANSIENT FREQUENCY BEHAVIOR TEST PROCEDURE

ANSI/TIA/EIA-603-1992, section 2.2.19

9.2 TRANSIENT FREQUENCY BEHAVIOR TEST DATA

Limits:

TABLE 9-1: REQUIREMENTS FOR EUT WITH 25 KHZ CHANNEL SPACING:

Time Intervals (*)(**)	Maximum Frequency Difference (***)	150-174 MHz	421-512 MHz
t1(****)	± 25 kHz	5.0 mSec	10.0 mSec
t2	± 12.5 kHz	20.0 mSec	25.0 mSec
t3(****)	± 25 kHz	5.0 mSec	10.0 mSec

TABLE 9-2: REQUIREMENTS FOR EUT WITH 12.5 KHZ CHANNEL SPACING:

Time Intervals (*)(**)	Maximum Frequency Difference(***)	150-174 MHz	421-512 MHz
t1(****)	± 12.5 kHz	5.0 mSec	10.0 mSec
t2	± 6.25 kHz	20.0 mSec	25.0 mSec
t3(****)	± 12.5 kHz	5.0 mSec	10.0 mSec

(*) t on is the instant when a 1 kHz test signal is completely suppressed, including any capture time due to phasing.
t 1 is the time period immediately following ton.
t2 is the time period immediately following t1.
t3 is the time period from the instant when the transmitter is turned off until toff.
toff is the instant when the 1 kHz test signal starts to rise.
(**) During the time from the end of t2 to the beginning of t3, the frequency difference must not exceed the limits specified in § 90.213.
(***) Difference between the actual transmitter frequency and the assigned transmitter frequency.
(****) If the transmitter carrier output power rating is 6 watts or less, the frequency difference during this time period may exceed the maximum frequency difference for this time period.

Maximum frequency difference between time T2 and T3: Calculation for Channel 5:
The frequency stability is required to be 2.5 ppm.
Calculation for Channel 5:
4 div. on scope represent 12.5kHz for narrow band channel.
Therefore, 145.525 MHz times 2.5 ppm times +/- 4 Divisions divided by 12.5kHz equals about +/- 0.12 division. 0.12 Div. correspond to 1.213 kHz

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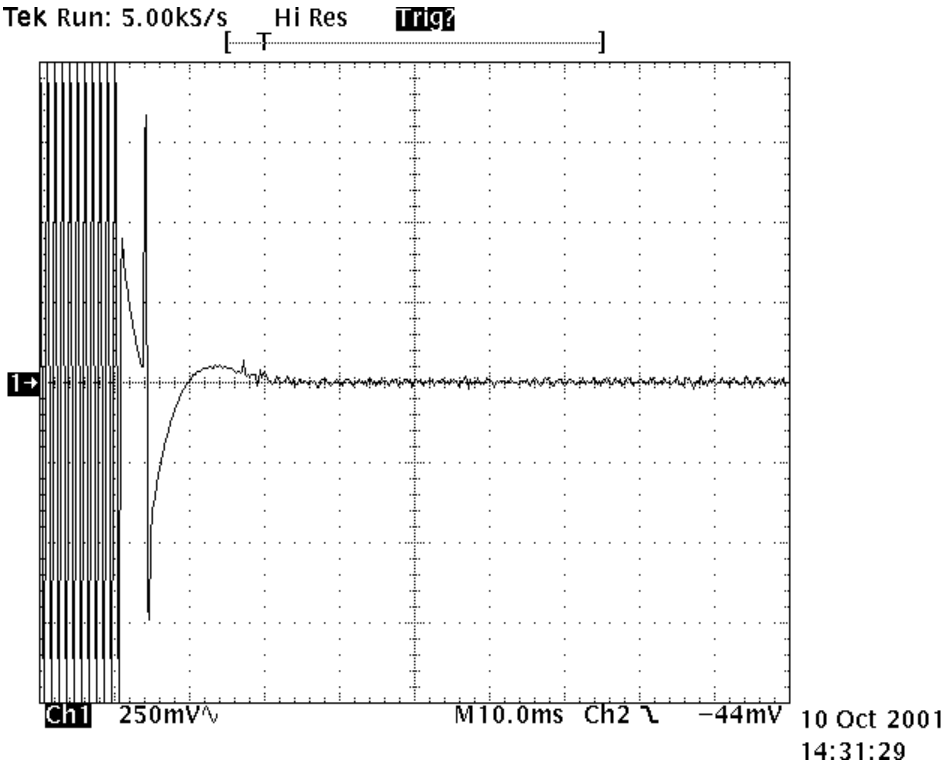
PLOT 9-1: TRASIENT FREQUENCY BEHAVIOR (ON TIME) – CHANNEL 5: 155.0 MHZ {12.5 KHZ NARROW BAND}



Carrier ON time:
High Power: 5 W rated
Channel 5 : 155.0 MHz NB(12.5kHz)
RF Signal Generator: Modulation 12.5kHz deviation

Timebase: 10 ms/div
Trigger: On negative edge of Ch5, level –44mV
Ch1: 250mV/div, Probe 1.000:1
Vertical scale: +/- 4 div. corresponds to +/- 12.5 kHz

TEST PERSONNEL:

DANIEL BALTZELL		OCTOBER 12, 2001
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

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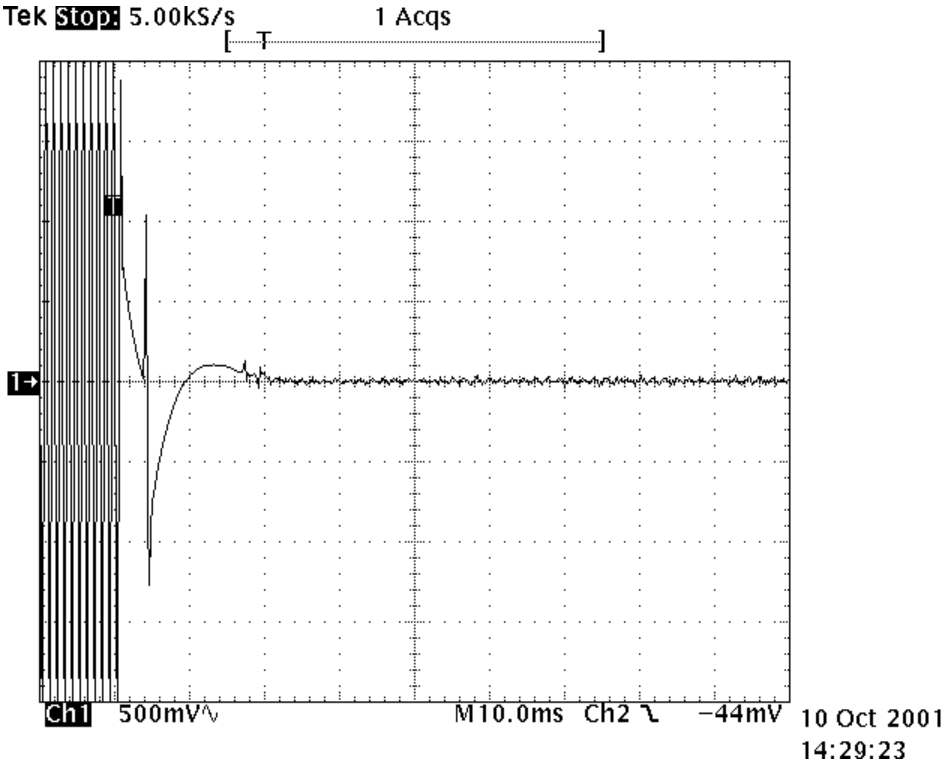
PLOT 9-2: TRASIENT FREQUENCY BEHAVIOR (ON TIME) – CHANNEL 2: 155.0 MHZ {25 KHZ WIDE BAND}



Carrier ON time:
High Power: 5 W rated
Channel 2 : 155.0 MHz WB(25kHz)
RF Signal Generator: Modulation 25kHz deviation

Timebase: 10 ms/div
Trigger: On negative edge of Ch2, level –44mV
Ch1: 500mV/div, Probe 1.000:1
Vertical scale: +/- 4 div. corresponds to +/- 25 kHz

TEST PERSONNEL:

DANIEL BALTZELL		OCTOBER 12, 2001
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

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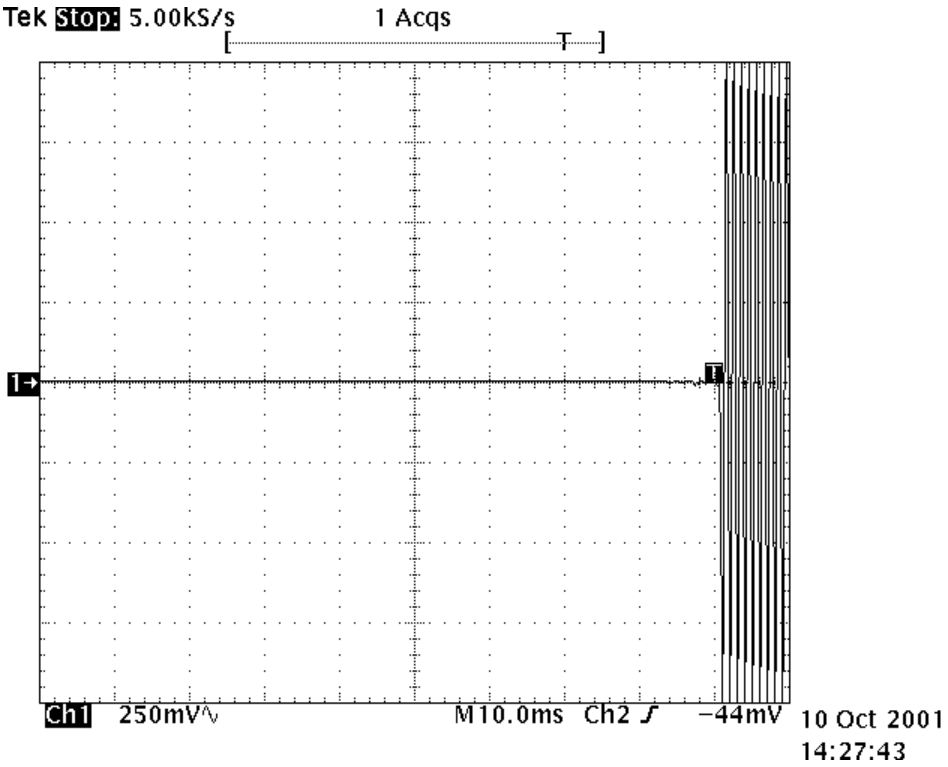
PLOT 9-3: TRASIENT FREQUENCY BEHAVIOR (OFF TIME) – CHANNEL 5: 155.0 MHZ {12.5 KHZ NARROW BAND}



Carrier OFF time:
High Power: 5 W rated
Channel 5 : 155.0 MHz NB(12.5kHz)
RF Signal Generator: Modulation 12.5kHz deviation

Timebase: 10 ms/div
Trigger: On negative edge of Ch2, level -44mV
Ch1: 250 mV/div, Probe 1.000:1
Vertical scale: +/- 4 div. corresponds to +/- 12.5 kHz

TEST PERSONNEL:

DANIEL BALTZELL		OCTOBER 12, 2001
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

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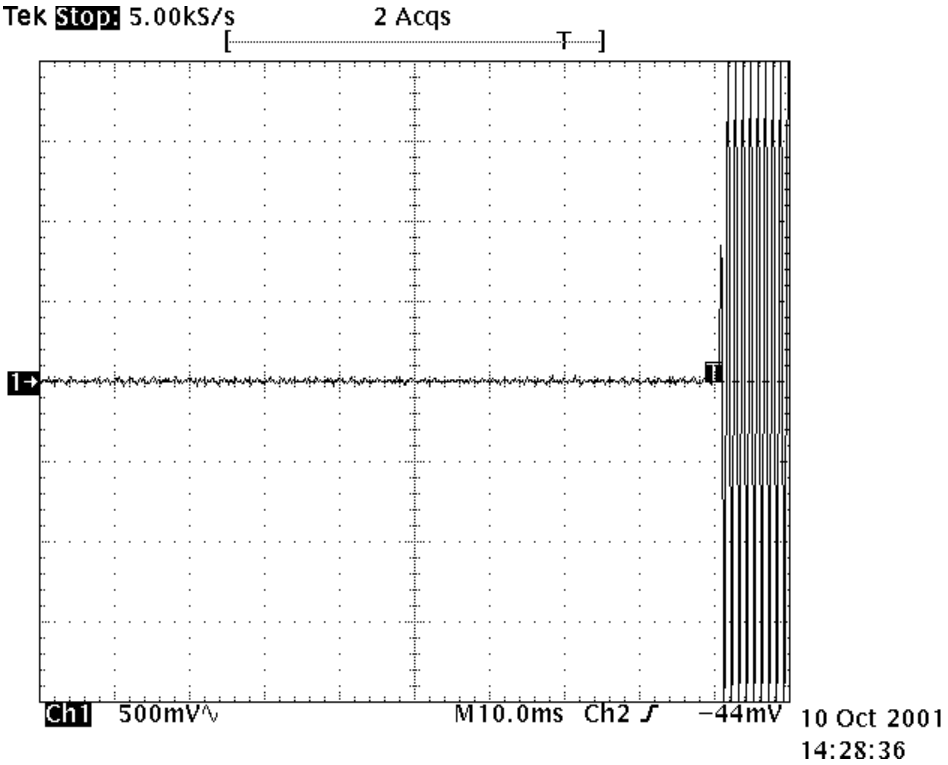
PLOT 9-4: TRASIENT FREQUENCY BEHAVIOR (OFF TIME) – CHANNEL 2: 155.0 MHZ {25 KHZ WIDE BAND}



Carrier OFF time:
High Power: 5 W rated
Channel 2 : 155.0 MHz WB(25kHz)
RF Signal Generator: Modulation 25kHz deviation

Timebase: 10 ms/div
Trigger: On negative edge of Ch2, level –44 mV
Ch1: 500 mV/div, Probe 1.000:1
Vertical scale: +/- 4 div. corresponds to +/- 25 kHz

TEST PERSONNEL:

DANIEL BALTZELL		OCTOBER 12, 2001
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

TABLE 9-3: TRASIENT FREQUENCY BEHAVIOR TEST EQUIPMENT

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
900917	Hewlett Packard	8648C	Synthesized. Signal Generator (9 KHz to 3200 MHz)	3537A01741	04/10/02
901055	Hewlett Packard	8901A Opt. 002-003	Modulation Analyzer	2545A04102	06/08/01
900561	TEKTRONIX	TDS540A	OSCILLOSCOPE	B020129	11/02/2001
900913	HEWLETT PACKARD	85462A	EMI Receiver RF Section, 9 KHz - 6.5 GHz	3325A00159	11/07/2001
901214	Hewlett Packard	HP8471D	Detector	2952A19822	N/A

10 CONDUCTED AC LINE EMISSIONS

10.1 CONDUCTED MEASUREMENT – CFR 47 PART 15

The EUT is operated with a battery. Power lines conducted emissions were measured when the radio was in transmit mode and while using a battery charger AC/DC powered from the mains.

The power line conducted emission measurements were performed in a Series 81 type shielded enclosure manufactured by Rayproof. The EUT was assembled on a wooden table 80 centimeters high. Power was fed to the EUT through a 50 ohm / 50 microhenry Line Impedance Stabilization Network (EUT LISN). The EUT LISN was fed power through an A.C. filter box on the outside of the shielded enclosure. The filter box and EUT LISN housing are bonded to the ground plane of the shielded enclosure. A second LISN, the peripheral LISN, provides isolation for the EUT test peripherals. This peripheral LISN was also fed A.C. power. A metal power outlet box, which is bonded to the ground plane and electrically connected to the peripheral LISN, powers the EUT host peripherals.

The spectrum analyzer was connected to the A.C. line through an isolation transformer. The 50-ohm output of the EUT LISN was connected to the spectrum analyzer input through a Solar 400 kHz high-pass filter. The filter is used to prevent overload of the spectrum analyzer from noise below 400 kHz. Conducted emission levels were measured on each current-carrying line with the spectrum analyzer operating in the CISPR quasi-peak mode (or peak mode if applicable). The analyzer's 6 dB bandwidth was set to 9 kHz. No video filter less than 10 times the resolution bandwidth was used. Average measurements are performed in linear mode using a 10 kHz resolution bandwidth, a 1 Hz video bandwidth, and by increasing the sweep time in order to obtain a calibrated measurement. The emission spectrum was scanned from 450 kHz to 30 MHz. The highest emission amplitudes relative to the appropriate limit were measured and have been recorded in this report.

10.2 CONDUCTED EMISSION TEST DATA

TABLE 10-1: CONDUCTED EMISSIONS NEUTRAL SIDE (LINE 1) (TEMPERATURE: 31°F; HUMIDITY: 23%)

Emission Frequency (MHz)	Test Detector	Analyzer Reading (dBuV)	Site Correction Factor (dB)	Emission Level (dBuV)	Limit (dBuV)	Margin (dB)
0.467	Pk	42.2	0.9	43.1	48.0	-4.9
1.915	Qp	34.2	1.4	35.6	48.0	-12.4
3.075	Pk	37.4	1.5	38.9	48.0	-9.1
6.615	Pk	29.3	2.2	31.5	48.0	-16.5
21.240	Pk	27.5	4.0	31.5	48.0	-16.5
24.280	Pk	25.2	4.2	29.4	48.0	-18.6

TABLE 10-2: CONDUCTED EMISSIONS HOT SIDE (LINE 2) (TEMPERATURE: 31°F; HUMIDITY: 23%)

Emission Frequency (MHz)	Test Detector	Analyzer Reading (dBuV)	Site Correction Factor (dB)	Emission Level (dBuV)	Limit (dBuV)	Margin (dB)
0.486	Pk	34.3	0.9	35.2	48.0	-12.8
0.718	Pk	31.1	0.9	32.0	48.0	-16.0
9.145	Pk	17.1	2.5	19.6	48.0	-28.4
17.190	Pk	26.0	3.6	29.6	48.0	-18.4
20.260	Pk	26.7	3.8	30.5	48.0	-17.5
24.270	Pk	25.2	4.3	29.5	48.0	-18.5

TEST PERSONNEL:

DANIEL BALTZELL		OCTOBER 12, 2001
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

TABLE 10-3: CONDUCTED EMISSIONS TEST EQUIPMENT

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
900931	HP	8566B	Spectrum Analyzer (100 Hz - 22 GHz)	3138A07771	05/16/02
900070	Solar		LISN		N/A

11 DIGITAL-RECEIVER RADIATED EMISSIONS

11.1 RADIATED MEASUREMENT – CFR 47 PART 15

Before final measurements of radiated emissions were made on the open-field three meter range, the EUT was scanned indoors at a three meter distance in order to determine its emissions spectrum signature. The physical arrangement of the test system and associated cabling was varied in order to determine the effect on the EUT's emissions in amplitude, direction and frequency. This process was repeated during final radiated emissions measurements on the open-field range, at each frequency, in order to insure that maximum emission amplitudes were attained.

Final radiated emissions measurements were made on the three-meter, open-field test site. The EUT was placed on a nonconductive turntable approximately 0.8 meters above the ground plane.

At each frequency, the EUT was rotated 360 degrees, and the antenna was raised and lowered from one to four meters in order to determine the maximum emission levels. Measurements were taken using both horizontal and vertical antenna polarizations.

Note: Rhein Tech Laboratories, Inc. has implemented procedures to minimize errors that occur from test instruments, calibration, procedures, and test setups. Test instrument and calibration errors are documented from the manufacturer or calibration lab. Other errors have been defined and calculated within the Rhein Tech quality manual, section 6.1. Rhein Tech implements the following procedures to minimize errors that may occur: yearly as well as daily calibration methods, technician training, and emphasis to employees on avoiding error.

11.2 RADIATED EMISSION DATA

The local oscillator was determined from the intermediate frequency 45.15MHz and was investigated to the third harmonic. No level was measurable or visible for these values.

TABLE 11-1: RADIATED EMISSIONS (TEMPERATURE: 50°F; HUMIDITY: 59%)

Emission Frequency (MHz)	Test Detector	Antenna Polarity (H/V)	Turntable Azimuth (deg)	Antenna Height (m)	Analyzer Reading (dBuV)	Site Correction Factor (dB/m)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)
140.027	Qp	V	45	1.0	57.1	-18.0	39.1	43.5	-4.4
150.045	Qp	V	10	1.0	58.9	-18.7	40.2	43.5	-3.3
200.045	Qp	V	0	1.0	60.1	-19.9	40.2	43.5	-3.3
210.051	Qp	V	350	1.0	59.5	-19.5	40.0	43.5	-3.5
220.051	Qp	V	15	1.0	61.1	-19.6	41.5	46.0	-4.5
340.067	Qp	V	170	1.3	58.3	-14.8	43.5	46.0	-2.5
420.085	Qp	V	190	1.2	56.3	-11.5	44.8	46.0	-1.2
500.095	Qp	V	10	1.0	55.0	-10.3	44.7	46.0	-1.3

TEST PERSONNEL:

DANIEL BALTZELL — TEST TECHNICIAN/ENGINEER | SIGNATURE | OCTOBER 12, 2001 — DATE OF TEST

TABLE 11-2: RADIATED EMISSIONS TEST EQUIPMENT

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
900931	HP	8566B	Spectrum Analyzer (100Hz – 22 GHz)	3138A07771	05/16/02
901215	HP	8596EM Analyzer	Spectrum Analyzer (9KHz - 12.5GHz)	3826A00144	
901053	Schaffner@Chase	CBL6112B	Bilog antenna (20 MHz - 2 GHz)	2648	05/22/02
900321	EMCO	3161-03	Horn Antennas (4-8,2GHz)	9508-1020	N/A
900323	EMCO	3161-03	Horn Antennas (4-8,2GHz)	9508-1020	N/A
900772	Electro Metrics	RGA 60	Horn Antenna	2310	N/A
900889	HP	85685A	RF Preselector for HP 8566B or 8568B (20Hz-2GHz)	3146A01309	11/14/01
900800	EMCO	3301B	Active monopole antenna (30 Hz – 50 MHz)	9809-4071	05/24/02