Engineering and Testing for EMC and Safety Compliance

TYPE CERTIFICATION REPORT

Topaz3, L.L.C.
10828 NW Air World Drive
Kansas City, MO 64153

MODEL: PL2415/PL2215 Mobile Radio

FCC ID: O7KPL150

October 15, 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
PART 95 (A): 1998	GENERAL 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

Frequency Range	Output Power (W) Conducted	Freq. Tolerance	Emission Designator
148-174 MHz	2.4	2.5	11K0F3E
148-174 MHz	2.4	5	16K0F3E

REPORT PREPARED BY:

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Document Number: 2001142 / QRTL01-120

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1 GENERAL INFORMATION

The following Report of a Type Certification, is prepared on behalf of **Topaz3, L.L.C.** in accordance with the Federal Communications Commissions and Industry Canada Rules and Regulations. The Equipment Under Test (EUT) was the **PL2415 and PL2215 Mobile Radios; FCC ID: O7KPL150**. The test results reported in this document relate only to the item that was tested.

All measurements contained in this application were conducted in accordance with FCC Rules and Regulations CFR 47, Industry Canada RSS-119, 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 dated March 3, 1994, submitted to 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 report.

1.3 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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Frequency Range	Output Power (W)	Freq. Tolerance	Emission Designator
148-174 MHz	2.2	2.5	11K0F3E
148-174 MHz	2.3	5	16K0F3E

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 above standards for Certification methodology.

Signature: 

Date: October 25, 2001

Typed/Printed Name: Bruno Clavier

Position: Vice President of Operations
(NVLAP Signatory)

Signature: 

Date: October 25, 2001

Typed/Printed Name: Daniel W. 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.

1.4 TESTED SYSTEM DETAILS

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

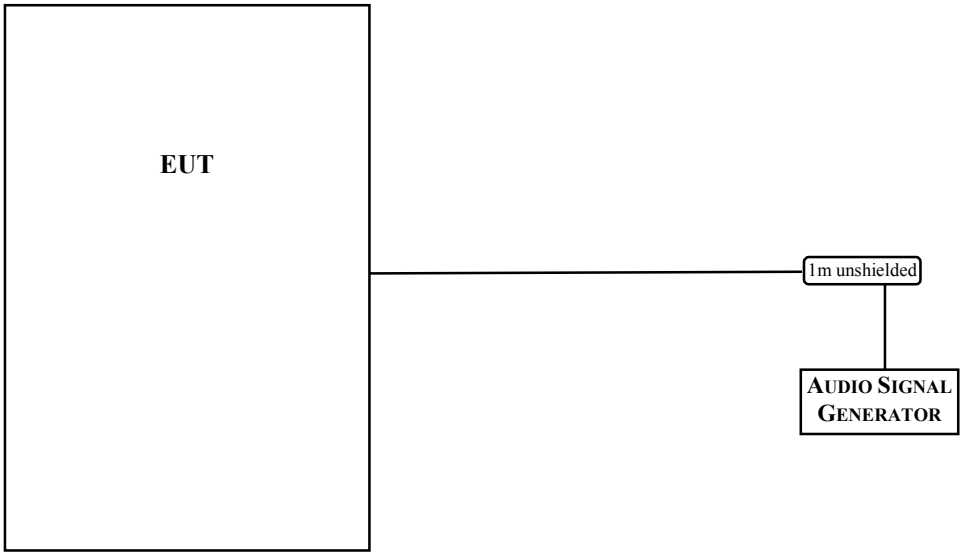
TABLE 1-1: EQUIPMENT UNDER TEST (EUT)

PART	MANUFACTURER	MODEL	SERIAL NUMBER	FCC ID	CABLE DESCRIPTION	RTL BAR CODE
MOBILE RADIO	TOPAZ3, L.L.C.	PL2415 & PL2215	N/A	O7KPL150	N/A	013359

TABLE 1-2: External Components Used In Test Configuration

PART	MANUFACTURER	MODEL	SERIAL NUMBER	FCC ID	CABLE DESCRIPTION	RTL BAR CODE
BATTERY	TOPAZ3, L.L.C.	N/A	N/A	N/A	N/A	013360
ANTENNA	TOPAZ3, L.L.C.	WHIP ANTENNA	N/A	N/A	N/A	013364
BATTERY CHARGER	TOPAZ3, L.L.C.	N/A	N/A	N/A	N/A	013355

FIGURE 1-1: CONFIGURATION OF TESTED SYSTEM



2 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

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

3 CONDUCTED EMISSIONS

3.1 CONDUCTED MEASUREMENT

The EUT is operated with a battery. Power lines conducted emissions were measured when the radio is operated 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.

3.2 TEST DATA: FCC PART 15 §15.107 (A): CHANNEL 1 148.025MHZ

Conducted Emissions (Class B Limits)

TABLE 3-1: CONDUCTED EMISSIONS (CLASS B LIMITS) NEUTRAL SIDE (LINE 1)

Emission Frequency (MHz)	Test Detector	Analyzer Reading (dBuV)	Site Correction Factor (dB)	Emission Level (dBuV)	Limit (dBuV)	Margin (dB)
0.980	Pk	16.1	0.6	16.7	48.0	-31.3
5.980	Pk	17.8	1.9	19.7	48.0	-28.3
8.720	Pk	16.6	2.3	18.9	48.0	-29.1
13.480	Pk	17.5	2.3	19.8	48.0	-28.2
21.670	Pk	17.9	3.4	21.3	48.0	-26.7
26.370	Pk	16.6	4.0	20.6	48.0	-27.4

TABLE 3-2: CONDUCTED EMISSIONS (CLASS B LIMITS) HOT SIDE (LINE 2)

Emission Frequency (MHz)	Test Detector	Analyzer Reading (dBuV)	Site Correction Factor (dB)	Emission Level (dBuV)	Limit (dBuV)	Margin (dB)
0.630	Pk	16.7	0.7	17.4	48.0	-30.6
4.350	Pk	17.1	1.6	18.7	48.0	-29.3
6.710	Pk	16.6	2.0	18.6	48.0	-29.4
10.410	Pk	17.5	2.3	19.8	48.0	-28.2
17.150	Pk	17.7	3.3	21.0	48.0	-27.0
25.390	Pk	16.9	4.0	20.9	48.0	-27.1

TEST PERSONNEL:

DANIEL BALTZELL — TEST TECHNICIAN/ENGINEER

SIGNATURE

MAY 31, 2001 — DATE OF TEST

TABLE 3-3: TEST EQUIPMENT USED FOR TESTING (CONDUCTED EMISSIONS)

RTL Asset #	Manufacturer	Model	Part Type	Serial Number
900931	HP	8566B	Spectrum Analyzer (100 Hz - 22 GHz)	3138A07771
900070	Solar		LISN	

4 RADIATED EMISSIONS

4.1 RADIATED MEASUREMENT

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.

4.2 TEST DATA: FCC PART 15 §15.109 (A): RADIATED EMISSIONS (CLASS B LIMITS)

TABLE 4-1: RADIATED EMISSIONS CLASS B LIMITS

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)
55.830	Qp	H	1	1.0	33.7	-21.7	12.0	40.0	-28.0
64.020	Qp	H	45	1.0	42.0	-23.2	18.8	40.0	-21.2
72.000	Qp	H	180	1.0	40.8	-22.7	18.1	40.0	-21.9
79.980	Qp	V	225	1.5	39.1	-22.3	16.8	40.0	-23.2
200.109	Qp	H	270	1.0	34.9	-17.8	17.1	43.5	-26.4
400.235	Qp	H	390	1.0	34.9	-9.9	25.0	46.0	-21.0
600.361	Qp	H	300	1.2	36.2	-5.8	30.4	46.0	-15.6
800.486	Qp	H	30	1.0	35.2	-2.8	32.4	46.0	-13.6
1000.612	Av	H	30	1.0	35.7	-2.8	32.9	54.0	-21.1

TEST PERSONNEL:

DANIEL BALTZELL — TEST TECHNICIAN/ENGINEER

SIGNATURE

MAY 31, 2001 — DATE OF TEST

TABLE 4-2: TEST EQUIPMENT USED FOR TESTING (RADIATED EMISSIONS)

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Calibration Due Date
900931	HP	8566B	Spectrum Analyzer (100Hz – 22 GHz)	3138A07771	03/27/02
900999	HP	8596EM Analyzer	Spectrum Analyzer (9KHz - 12.5GHz)	3826A00144	03/25/02
901053	Schaffner@Chase	CBL6112B	Bilog antenna (20 MHz - 2 GHz)	2648	05/24/02
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	03/25/02
900889	HP	85685A	RF Preselector for HP 8566B or 8568B (20Hz-2GHz)	3146A01309	11/08/01
900800	EMCO	3301B	Active monopole antenna (30 Hz – 50 MHz)	9809-4071	05/02/02

5 FCC RULES AND REGULATIONS PART 2 §2.1046 (A): RF POWER OUTPUT: CONDUCTED

5.1 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.

5.2 TEST DATA

The following channels (in MHz) were tested: 148.025, 155.025, 165, 025, and 173.980
The worst-case Output Power (highest) levels are shown.

CARRIER OUTPUT POWER (UNMODULATED)

TABLE 5-1: RF POWER OUTPUT (HIGH POWER)

Channel	Frequency (MHz)	RF Power measured (Watt)*
1	148.025	2.16
2	155.025	2.39
3	165.025	2.40
4	173.980	2.10

* Measurement accuracy: +/- 3%

TABLE 5-2: RF POWER OUTPUT (RATED POWER)

Rated Power (W)
2

TEST PERSONNEL:

DANIEL BALTZELL — TEST TECHNICIAN/ENGINEER
SIGNATURE
MAY 15, 2001 — DATE OF TEST

TABLE 0-1: TEST EQUIPMENT USED FOR TESTING (RF POWER OUTPUT - CONDUCTED)

RTL Asset #	Manufacturer	Model	Part Type	Serial Number
900770	Hewlett Packard	437B	Power Meter	2949A02966
901055	Hewlett Packard	8901A Opt. 002-003	Modulation Analyzer	2545A04102
900769	Hewlett Packard	8481B	Power Sensor	2702A05059
901055	Hewlett Packard	8901A Opt. 002-003	Modulation Analyzer	2545A04102

6 FCC RULES AND REGULATIONS PART 2 §2.1033 (C)(8): DC VOLTAGE AND CURRENT AT FINAL AMPLIFIER STAGE

TABLE 6-1: DC VOLTAGE AND CURRENT AT FINAL AMPLIFIER STAGE

DC Voltage	7.17
Current	0.59

TEST PERSONNEL:

DANIEL BALTZELL		OCTOBER 25, 2001
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

7 PART 2.1046 (A) RF POWER OUTPUT: RADIATED - ERP

7.1 TEST PROCEDURE

Substitution Method:

The EUT was setup at an antenna to EUT distance of 3 meters on an open area test site. The EUT was placed on a nonconductive turntable approximately 0.8 meters above the ground plane. The physical arrangement of the EUT and associated cabling was varied in order to determine the effect on the EUT's emissions in amplitude, direction and frequency. 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. The worst-case, maximum radiated emission was recorded and used as reference for the ERP measurement. The EUT was then replaced by an ½ wave dipole antenna and polarized in accordance with the EUT's antenna polarization. The ½ wave dipole antenna was connected to a RF signal generator with a coaxial cable. The search antenna height, and search antenna polarity was set to levels that produced the maximum reading obtained in step 3. The signal generator was adjusted to a level that produced the radiated emission level obtained in step 3. The signal generator level was recorded and corrected by the power loss in the cable between the generator and the antenna and further corrected for the gain of the substitution antenna used relative to an ideal ½ wave dipole antenna. The signal generator corrected level is the ERP level

7.2 TEST DATA

Settings:

- Power: 2 Watt delivered to antenna*
- PL2215 radiated power measurements (3 meter)

TABLE 7-1: RADIATED – ERP RF POWER OUTPUT

Frequency (MHz)	Signal Generator Level (dBm)*	Cable Loss (dB)	Corrected Antenna Gain (dBi)	Corrected level (dBm)	(Watt)
148.025	28.6	1.1	-0.35	27.2	0.519
155.025	30.8	1.1	-0.15	29.5	0.895
173.98	29.4	1.2	-0.15	28.1	0.644

TEST PERSONNEL:

DANIEL BALTZELL — TEST TECHNICIAN/ENGINEER

SIGNATURE

MAY 15, 2001 — DATE OF TEST

TABLE 7-2: TEST EQUIPMENT USED FOR TESTING (RADIATED – ERP RF POWER OUTPUT)

RTL Asset #	Manufacturer	Model	Part Type	Serial Number
900931	Hewlett Packard	8566B	Spectrum Analyzer (100 Hz - 22 GHz)	3138A07771
900154	Compliance Design Inc,	Roberts Dipole	Adjustable Elements Dipole Antenna (30-1000MHz)	-

8 FCC RULES AND REGULATIONS PART 2 §2.1051: SPURIOUS EMISSIONS AT ANTENNA TERMINALS

8.1 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 to produce 50% of the rated system deviation at 1000 Hz.

8.2 TEST DATA

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

Limits: Mask B (dBm): P(dBm) – (43+10xLOG P(W))
Mask D (dBm): P(dBm) – (50+10xLOG P(W))

The following channel (in MHz) were investigated: 148.025, 155.025, and 173.980.
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 8-1: SPURIOUS EMISSIONS {CHANNEL 1 (148.025 MHZ); 12.5K CH SP; 2 W}: CONDUCTED POWER = 2.16W

Frequency (MHz)	Level (dBc)	Limit (dBc)	Margin(dB)
296.050	55.8	53.3	-2.4
444.075	62.8	53.3	-9.5
592.100	68.4	53.3	-15.1
740.125	75.3	53.3	-22.0
888.150	78.8	53.3	-25.4
1036.175	84.2	53.3	-30.9
1184.200	85.8	53.3	-32.5
1332.225	80.5	53.3	-27.1
1480.250	71.1	53.3	-17.7

TEST PERSONNEL:

DANIEL BALTZELL		MAY 16, 2001
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

TABLE 8-2: SPURIOUS EMISSIONS {CHANNEL 2 (155.025 MHZ); 12.5K CH SP; 2 W}: CONDUCTED POWER = 2.39W

Frequency (MHz)	Level (dBc)	Limit (dBc)	Margin(dB)
310.050	57.4	53.8	-3.6
465.075	67.8	53.8	-14.0
620.100	78.5	53.8	-24.7
775.125	98.1	53.8	-44.3
930.150	83.9	53.8	-30.1
1085.175	90.2	53.8	-36.4
1240.200	85.7	53.8	-31.9
1395.225	104.1	53.8	-50.3
1550.250	105.8	53.8	-52.0

TABLE 8-3: SPURIOUS EMISSIONS {CHANNEL 4 (173.980 MHZ); 12.5K CH SP; 2 W}: CONDUCTED POWER = 2.1W

Frequency (MHz)	Level (dBc)	Limit (dBc)	Margin(dB)
347.960	68.4	53.2	-15.2
521.940	74.3	53.2	-21.0
695.920	79.2	53.2	-26.0
869.900	82.4	53.2	-29.2
1043.880	76.3	53.2	-23.1
1217.860	79.2	53.2	-25.9
1391.840	94.7	53.2	-41.5
1565.820	101.3	53.2	-48.1
1739.800	96.0	53.2	-42.8

TEST PERSONNEL:

DANIEL BALTZELL
TEST TECHNICIAN/ENGINEER

SIGNATURE

MAY 16, 2001
DATE OF TEST

TABLE 8-4: TEST EQUIPMENT USED FOR TESTING (RADIATED – ERP RF POWER OUTPUT)

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

9 FCC RULES AND REGULATIONS PART 2 §2.1053 (A): FIELD STRENGTH OF SPURIOUS RADIATION

9.1 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.

Refer to section "Radiated Measurement" in this report for further information.

9.2 TEST DATA

9.2.1 CFR 47 PART 90.210 REQUIREMENTS

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 9-1: FIELD STRENGTH OF SPURIOUS RADIATION {(CHANNEL 1 AT 148.025 MHZ, 2 W) SUBSTITUTION METHOD}: CONDUCTED POWER = 2.16W

Frequency	S/G level (dBm)	Cable Loss*	Difference in gain (ref. To 1/2 wave dipole)	Emission level (dBc)	Limit (dBc) Mask D	Margin (dB)
296.050	-46.1	2.2	-0.7	82.3	53.3	-29.0
444.075	-42.1	2.7	-0.6	78.7	53.3	-25.3
592.100	-35.1	3.2	-1.2	72.8	53.3	-19.4
740.125	-35.8	3.6	-1.2	73.9	53.3	-20.5
888.150	-33.8	8.0	-1.1	76.2	53.3	-22.8
1036.175	-51.2	4.4	2.3	86.6	53.3	-33.2
1184.200	-54.2	5.3	3.8	89.1	53.3	-35.7
1332.225	-50.8	6.4	5.2	85.4	53.3	-32.0
1480.250	-59.3	6.8	6.6	92.8	53.3	-39.5

*This insertion loss corresponds to the cable connecting the RF Signal Generator to the ½ wave dipole antenna.

TABLE 9-2: FIELD STRENGTH OF SPURIOUS RADIATION {(CHANNEL 2 AT 155.025 MHZ, 2 W) SUBSTITUTION METHOD}: CONDUCTED POWER = 2.39W

Frequency	S/G level (dBm)	Cable Loss*	Difference in gain (ref. To 1/2 wave dipole)	Emission level (dBc)	Limit (dBc) Mask D	Margin (dB)
310.050	-43.2	2.3	-0.6	79.8	53.8	-26.0
465.075	-47.4	2.8	-0.9	84.8	53.8	-31.0
620.100	-47.1	3.2	-1.2	85.2	53.8	-31.4
775.125	-42.2	3.6	-1.3	80.8	53.8	-27.0
930.150	-51.0	4.2	-1.2	90.1	53.8	-36.3
1085.175	-59.8	4.8	2.8	95.6	53.8	-41.8
1240.200	-60.2	5.9	4.3	95.6	53.8	-41.8
1395.225	-58.3	6.6	5.8	92.9	53.8	-39.1
1550.250	-56.6	6.8	6.8	90.4	53.8	-36.6

*This insertion loss corresponds to the cable connecting the RF Signal Generator to the ½ wave dipole antenna.

TABLE 9-3: FIELD STRENGTH OF SPURIOUS RADIATION {(CHANNEL 4 AT 173.980 MHZ, 2 W) SUBSTITUTION METHOD}: CONDUCTED POWER = 2.1W

Frequency	S/G level (dBm)	Cable Loss*	Difference in gain (ref. To 1/2 wave dipole)	Emission level (dBc)	Limit (dBc) Mask D	Margin (dB)
347.960	-43.9	2.4	-0.4	79.9	53.2	-26.6
521.940	-51.9	2.9	-0.7	88.7	53.2	-35.4
695.920	-36.4	3.5	-1.9	75.0	53.2	-21.7
869.900	-38.7	3.8	-1.2	76.9	53.2	-23.6
1043.880	-52.6	4.6	2.4	88.0	53.2	-34.8
1217.860	-58.1	5.7	4.1	92.9	53.2	-39.7
1391.840	-55.3	6.6	5.8	89.4	53.2	-36.1
1565.820	-59.3	6.8	6.8	92.5	53.2	-39.3
1739.800	-62.0	7.0	6.9	95.3	53.2	-42.1

*This insertion loss corresponds to the cable connecting the RF Signal Generator to the ½ wave dipole antenna.

TEST PERSONNEL:

DANIEL BALTZELL — TEST TECHNICIAN/ENGINEER

SIGNATURE

MAY 25, 2001 — DATE OF TEST

TABLE 9-4: TEST EQUIPMENT USED FOR TESTING (FIELD STRENGTH OF SPURIOUS RADIATION)

RTL Asset #	Manufacturer	Model	Part Type	Serial Number
900791	Schaffner@Chase	CBL6112	Antenna (25MHz – 2GHz)	2099
900932	Hewlett Packard	8449B OPT H02	Preamplifier (1-26.5 GHz)	3008A00505
901020	Hewlett Packard	8564E	Portable Spectrum Analyzer (9 kHz - 40 GHz)	3943A01719
900917	Hewlett Packard	8648C	Synthesized. Signal Generator (9 KHz to 3200 MHz)	3537A01741

900928	Hewlett Packard	83752A	Synthesized Sweeper, 0.01 to 20 GHz	3610A00866

10 FCC RULES AND REGULATIONS PART 2 §2.1049 (C) (1): OCCUPIED BANDWIDTH

OCCUPIED BANDWIDTH - COMPLIANCE WITH THE EMISSION MASKS

10.1 TEST PROCEDURE

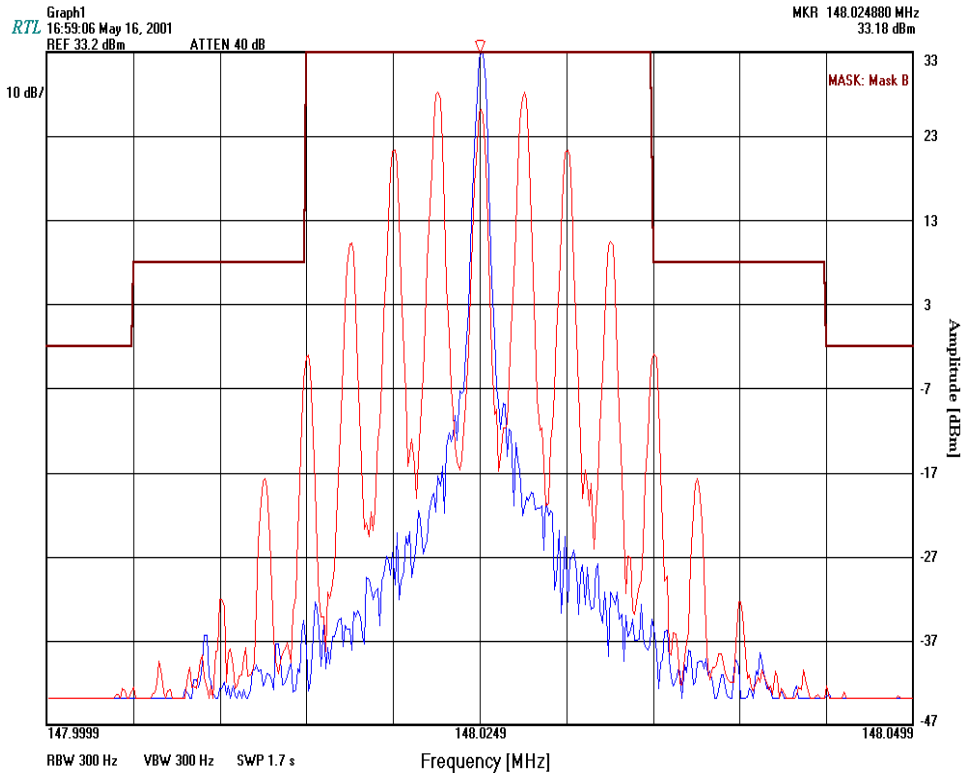
ANSI/TIA/EIA-603-1992, section 2.2.11

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: N/A

10.2 TEST DATA

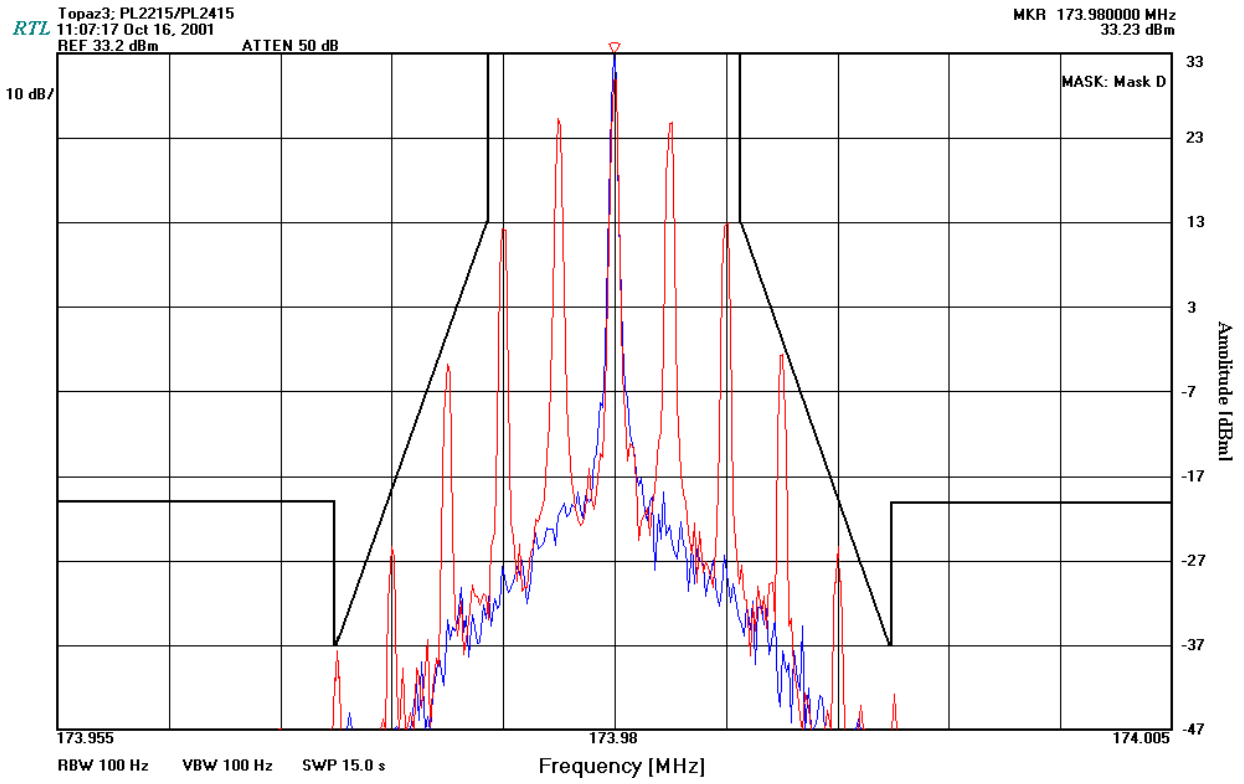
PLOT 10-1: OCCUPIED BANDWIDTH {25 KHZ CHANNEL BANDWIDTH: MASK B (AUDIO MODULATION: 2,500 HZ)}



TEST PERSONNEL:

DANIEL BALTZELL		MAY 16, 2001
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

PLOT 10-2: OCCUPIED BANDWIDTH {12.5 KHZ CHANNEL BANDWIDTH: MASK D (AUDIO MODULATION: 2,500 HZ)}



TEST PERSONNEL:

DANIEL BALTZELL		OCTOBER 16, 2001
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

TABLE 10-1: TEST EQUIPMENT USED FOR TESTING (OCCUPIED BANDWIDTH)

RTL Asset #	Manufacturer	Model	Part Type	Serial Number
901020	Hewlett Packard	8564E	Portable Spectrum Analyzer (9 kHz - 40 GHz)	3943A01719

11 FCC RULES AND REGULATION PART 2 §2.1055: FREQUENCY STABILITY

11.1 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.

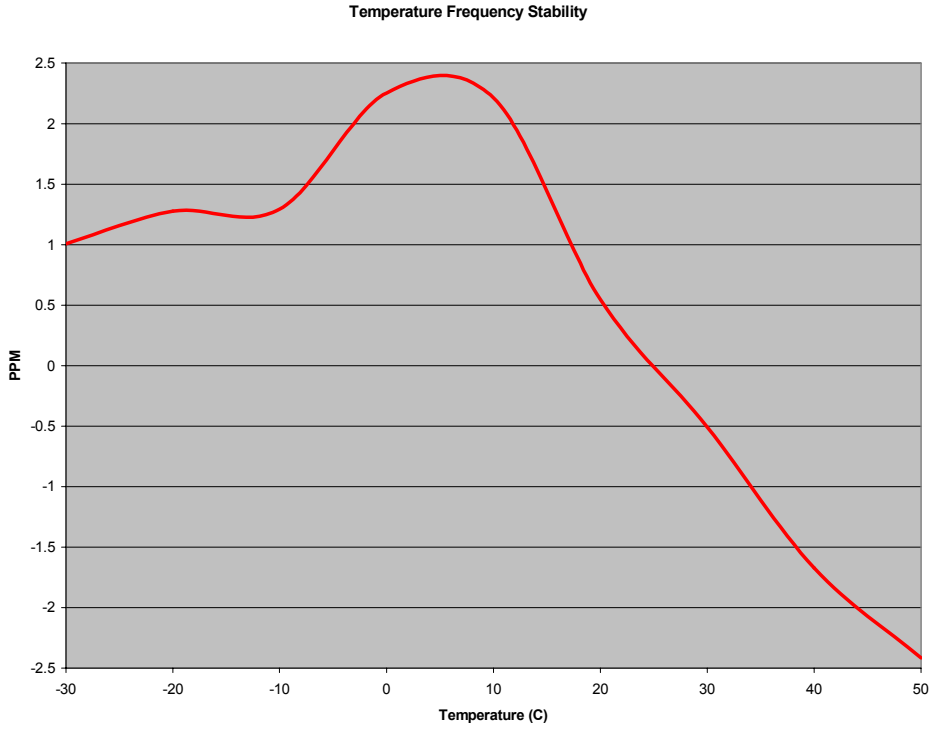
11.2 TEST DATA

11.2.1 FREQUENCY STABILITY/TEMPERATUARE VARIATION

Limit is 2.5 ppm for device with a 12.5 kHz channel bandwidth
Limit is 5 ppm for device with a 25 kHz channel bandwidth

The 2 Watt radio was tested with 12.5kHz and 25 kHz channel bandwidth.
The channel selected for temperature stability is representative of all the channels since the device uses similar circuitry for all the channels.

PLOT 11-1: TEMPERATURE FREQUENCY STABILITY



TEST PERSONNEL:

DANIEL BALTZELL		MAY 31, 2001
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

TABLE 11-1: TEMPERATURE FREQUENCY STABILITY

Temperature (C)	Frequency Measured (MHz)	ppm
-30	173.980175	1.01
-20	173.980222	1.28
-10	173.980225	1.29
0	173.980392	2.25
10	173.980385	2.21
20	173.980095	0.55
30	173.979912	-0.51
40	173.979709	-1.67
50	173.979580	-2.41

TEST PERSONNEL:

DANIEL BALTZELL — TEST TECHNICIAN/ENGINEER

SIGNATURE

MAY 31, 2001 — DATE OF TEST

TABLE 11-2: TEST EQUIPMENT USED FOR TESTING (FREQUENCY STABILITY/TEMPERATURE)

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

PLOT 11-2: FREQUENCY STABILITY/VOLTAGE VARIATION

Battery Endpoint = 5.5 VDC

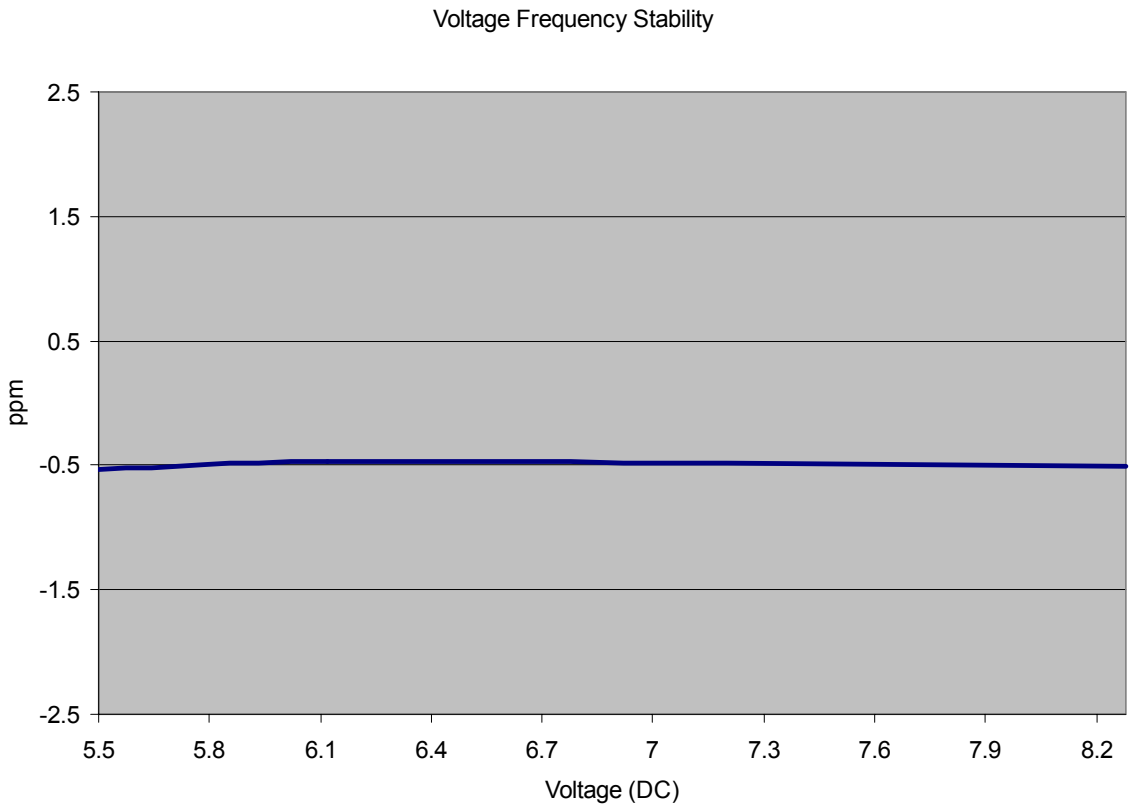


TABLE 11-3: FREQUENCY STABILITY/VOLTAGE VARIATION

Battery endpoint is measured at 5.5 VDC which is the worst case variation of –0.5 ppm

Voltage (VDC)	Frequency Measured (MHz)	ppm
5.5	155.0249182	-0.53
6.12	155.0249276	-0.47
7.2	155.0249249	-0.48
8.28	155.0249216	-0.51

TEST PERSONNEL:

DANIEL BALTZELL
TEST TECHNICIAN/ENGINEER

SIGNATURE

OCTOBER 16, 2001
DATE OF TEST

TABLE 11-4: TEST EQUIPMENT USED FOR TESTING (FREQUENCY STABILITY/VOLTAGE)

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

12 FCC PART 2 §2.1047 (A): MODULATION CHARACTERISTICS - AUDIO FREQUENCY RESPONSE

12.1 TEST PROCEDURE

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

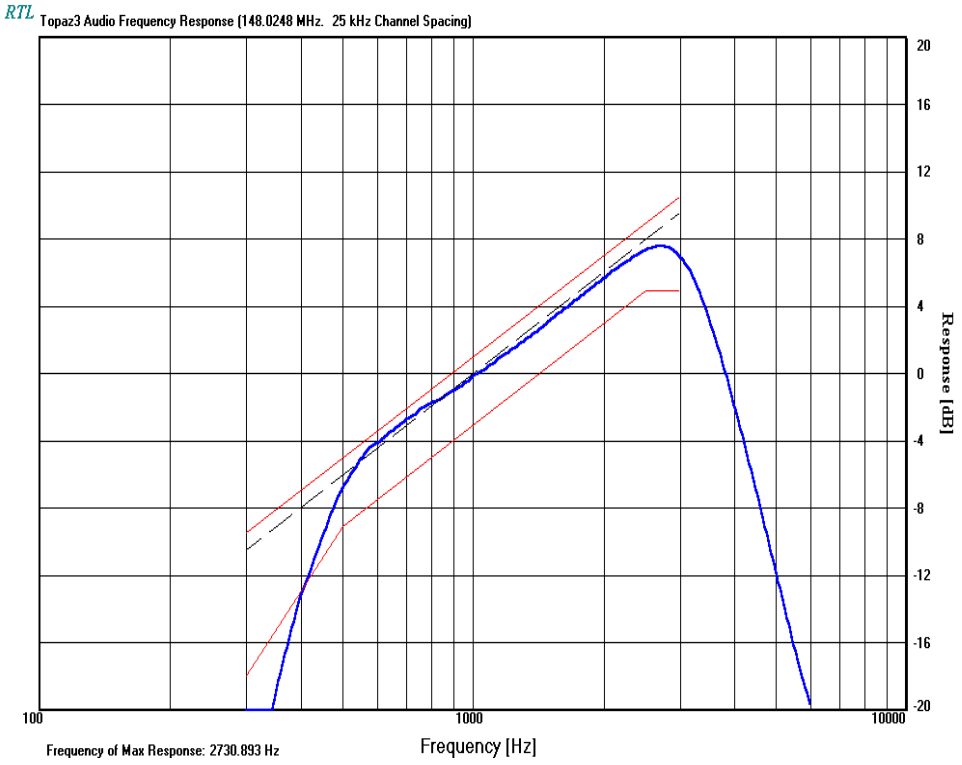
The audio frequency response is the degree of closeness to which the frequency deviation of the transmitter follows a prescribed characteristic.

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)

12.2 TEST DATA

PLOT 12-1: MODULATION CHARACTERISTICS - Audio Frequency Response {25 KHZ CHANNEL BANDWIDTH}



TEST PERSONNEL:

DANIEL BALTZELL		MAY 15, 2001
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

TABLE 12-1: TEST EQUIPMENT USED FOR TESTING (AUDIO FREQUENCY RESPONSE)

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
901054	Hewlett Packard	3586B	Selective Level Meter	1928A01892	06/08/01

13 FCC PART 2 §2.1047 (A): MODULATION CHARACTERISTICS – AUDIO LOW PASS FILTER

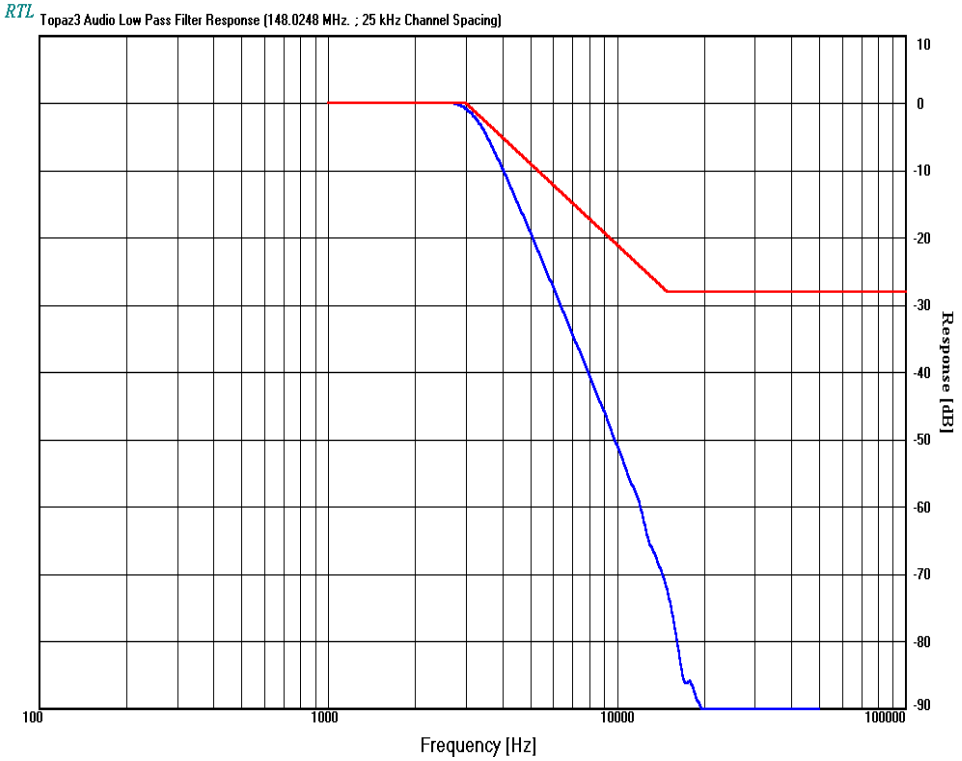
13.1 TEST PROCEDURE

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.

13.2 TEST DATA

PLOT 13-1: MODULATION CHARACTERISTICS – Audio Low Pass Filter



TEST PERSONNEL:

DANIEL BALTZELL		MAY 15, 2001
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

TABLE 13-1: TEST EQUIPMENT USED FOR TESTING (AUDIO LOW PASS FILTER RESPONSE)

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
901054	Hewlett Packard	3586B	Selective Level Meter	1928A01892	06/08/01

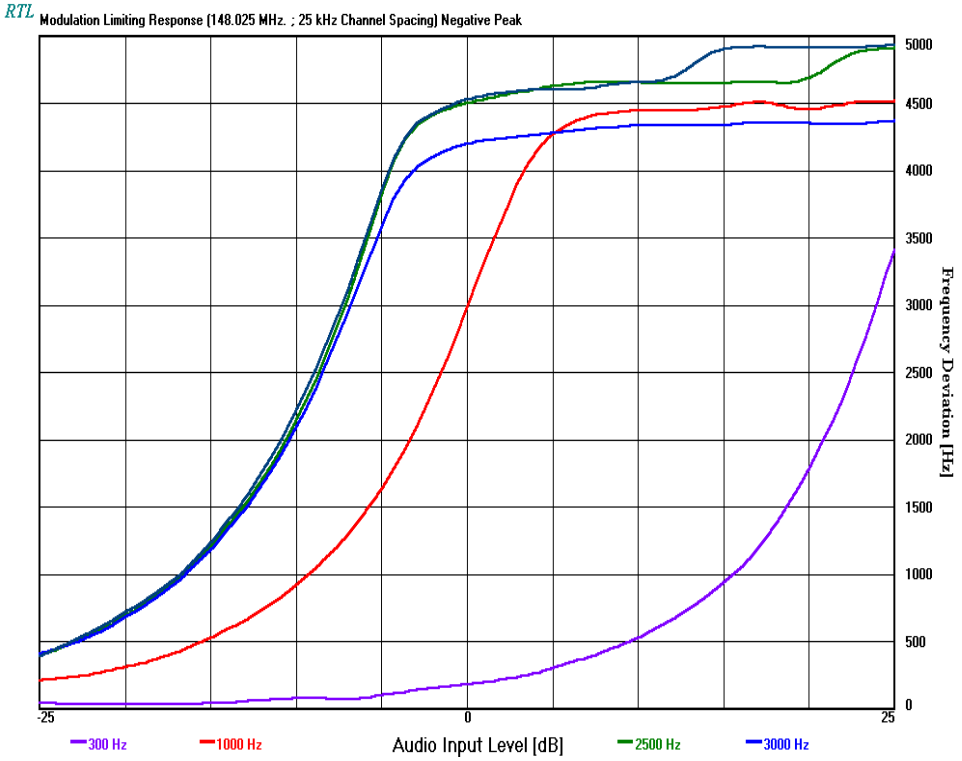
14 FCC RULES AND REGULATIONS PART 2 §2.1047 (B): MODULATION CHARACTERISTICS - MODULATION LIMITING

14.1 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. Test Data

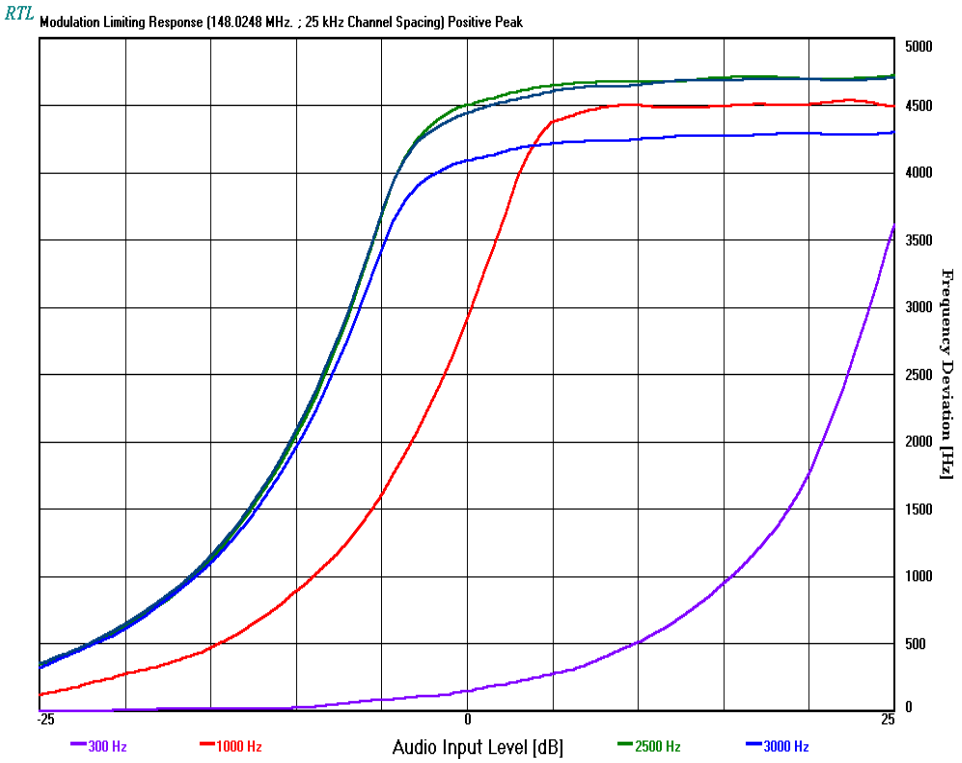
PLOT 14-1: MODULATION CHARACTERISTICS – MODULATION LIMITING: WIDE BAND NEGATIVE PEAK



TEST PERSONNEL:

DANIEL BALTZELL		MAY 16, 2001
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

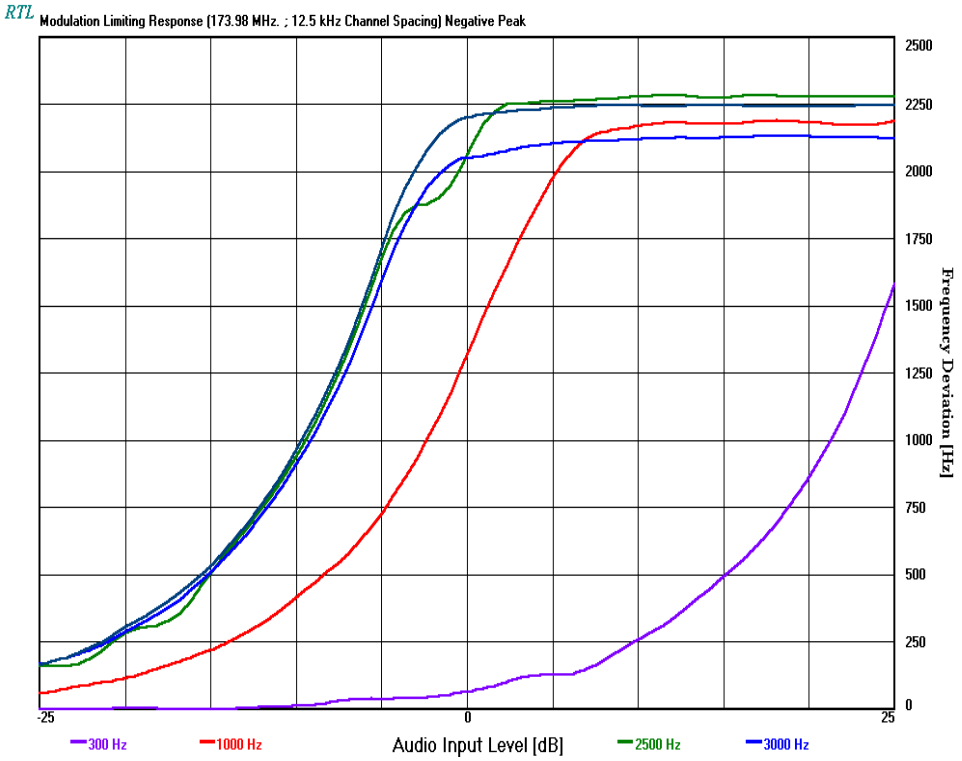
PLOT 14-2: MODULATION CHARACTERISTICS – MODULATION LIMITING: WIDE BAND POSITIVE PEAK



TEST PERSONNEL:

DANIEL BALTZELL		MAY 16, 2001
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

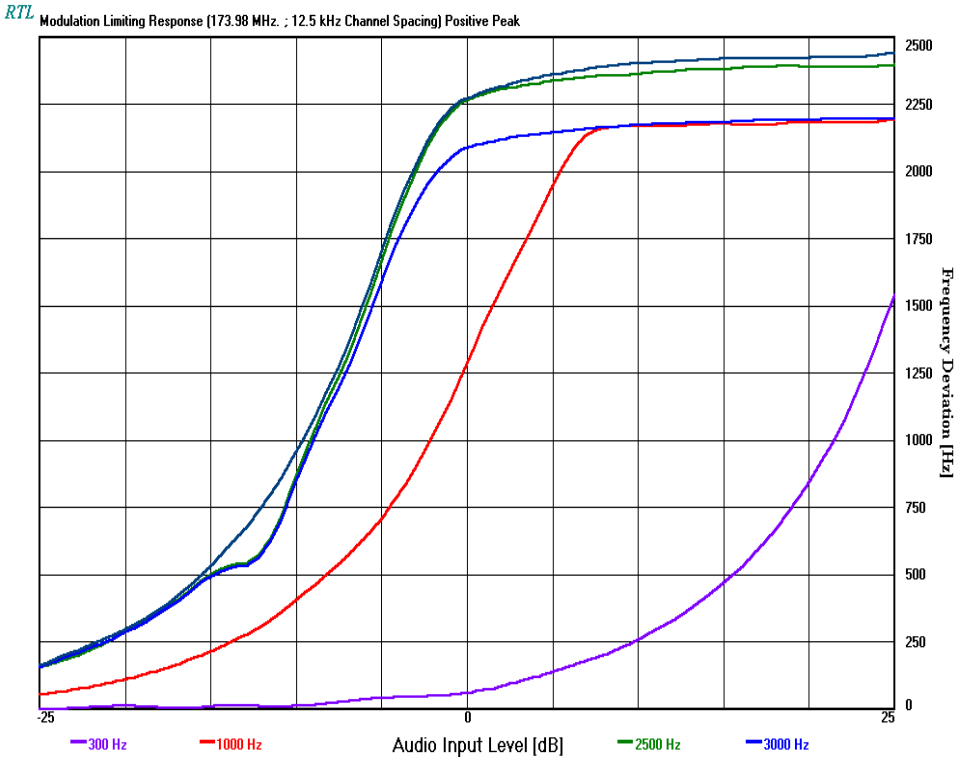
PLOT 14-3: MODULATION CHARACTERISTICS – MODULATION LIMITING: NARROW BAND NEGATIVE PEAK



TEST PERSONNEL:

DANIEL BALTZELL		JUNE 4, 2001
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

PLOT 14-4: MODULATION CHARACTERISTICS – MODULATION LIMITING: NARROW BAND POSITIVE PEAK



TEST PERSONNEL:

DANIEL BALTZELL		JUNE 4, 2001
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

FCC Part 2 §2.1047 (b): Modulation Characteristics - MODULATION LIMITING

TABLE 14-1: TEST EQUIPMENT USED FOR TESTING (MODULATION LIMITING)

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
901054	Hewlett Packard	3586B	Selective Level Meter	1928A01892	06/08/01

15 FCC PART 90 §90.214 : TRANSIENT FREQUENCY BEHAVIOR

15.1 TEST PROCEDURE

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

15.2 TEST DATA

15.2.1 LIMITS:

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

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.

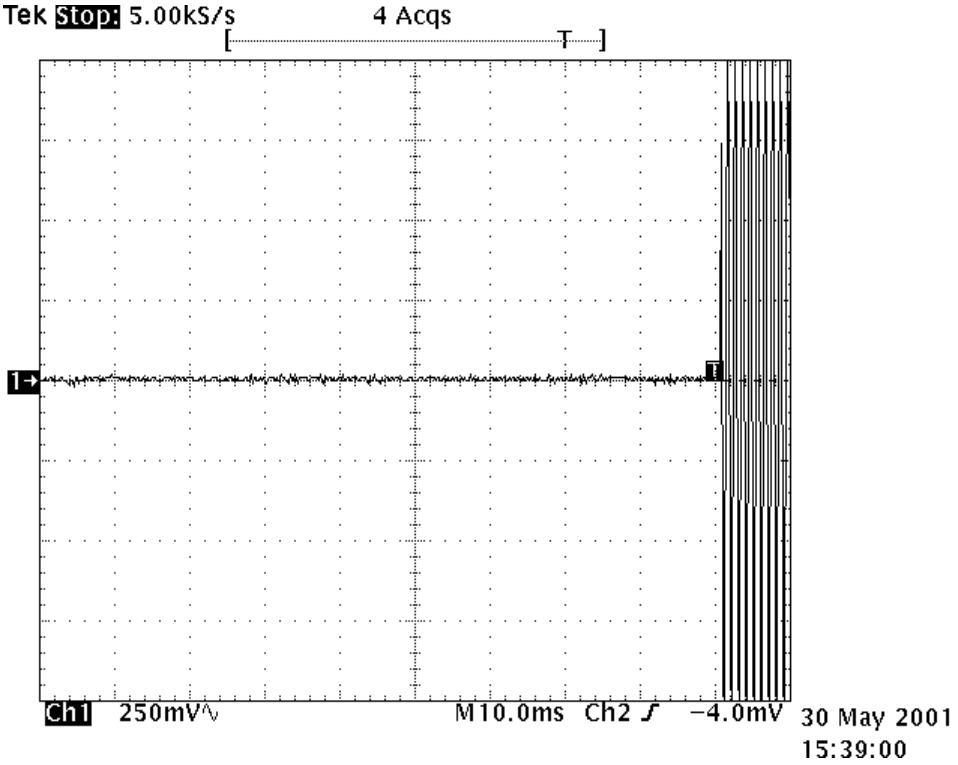
15.2.2 MAXIMUM FREQUENCY DIFFERENCE BETWEEN TIME T2 AND T3: CALCULATION:

The frequency stability is required to be 2.5ppm.
Calculation:
4 div. on scope represent 12.5kHz for narrow band channel.
Therefore, 464.55M times 2.5 ppm times +/- 4 Divisions divided by 12.5kHz equals about +/- 0.4 division. 0.4 Div. correspond to 1.161 kHz

360 Herndon Parkway
Suite 1400
Herndon, VA 20170
http://www.rheintech.com

PLOT 15-1: TRANSIENT FREQUENCY BEHAVIOR {CARRIER OFF TIME} CHANNEL 1 : NB (12.5KHZ) 2 W RATED

RF Signal Generator: Modulation 12.5kHz deviation



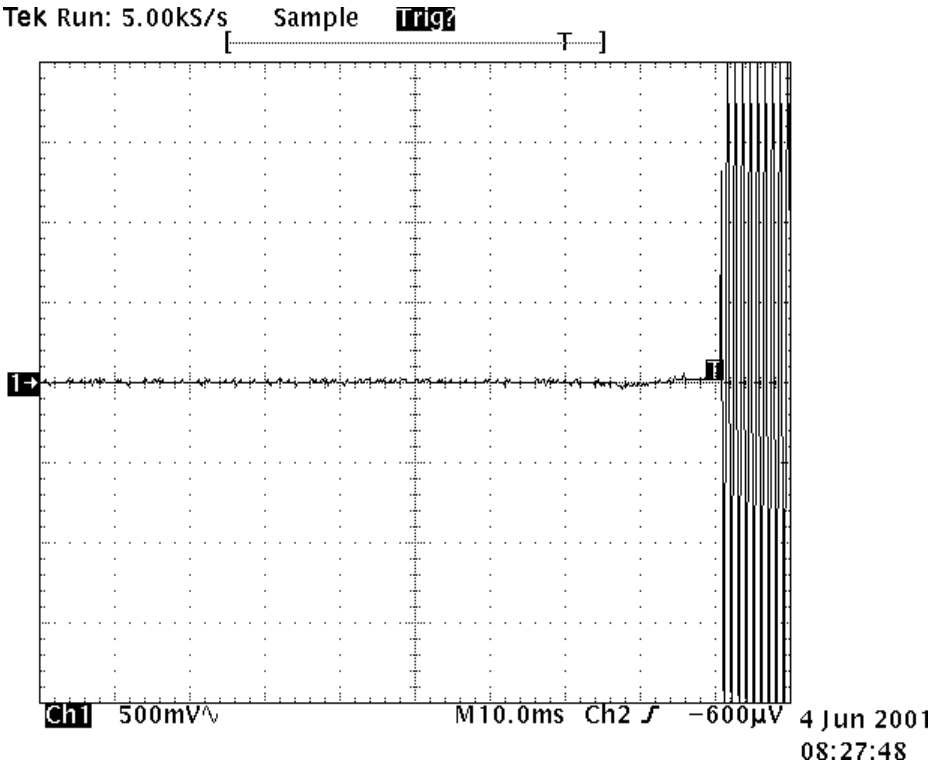
Timebase: 10 ms/div
Trigger: On positive edge of Ch2, level –4mV
Ch1: 250mV/div, Probe 1.000:1
Vertical scale: +/- 4 div. corresponds to +/- 12.5 kHz

TEST PERSONNEL:

DANIEL BALTZELL		MAY 30, 2001
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

PLOT 15-2: TRANSIENT FREQUENCY BEHAVIOR {CARRIER OFF TIME} CHANNEL 1: WB(25KHZ); 2 W RATED

RF Signal Generator: Modulation 25kHz deviation



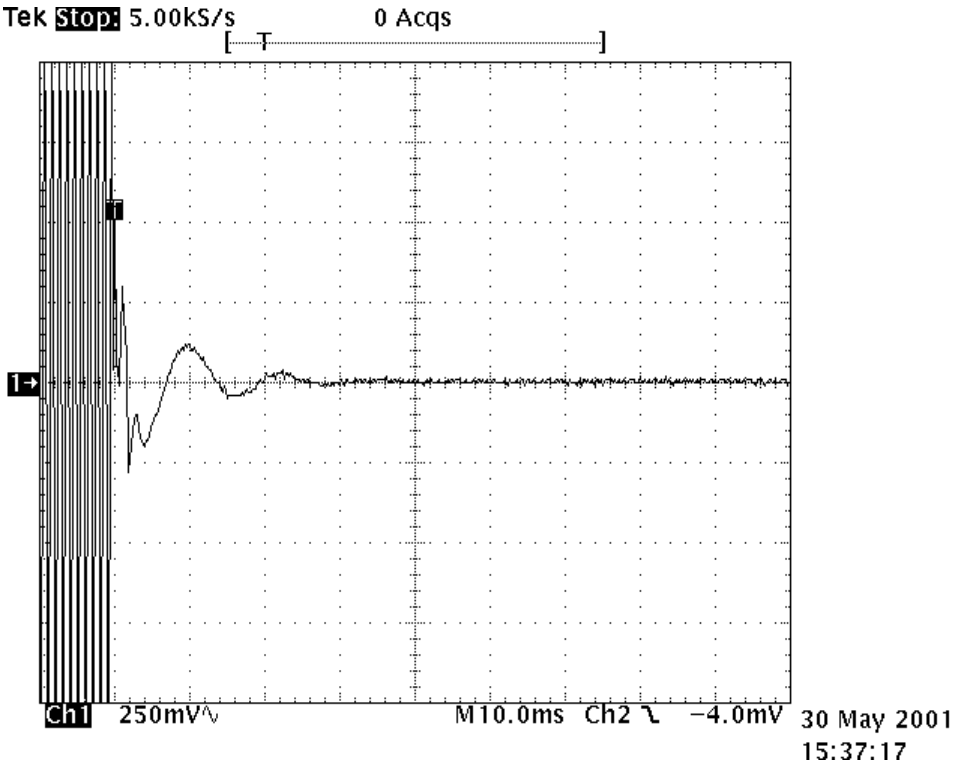
Timebase: 10 ms/div
Trigger: On positive edge of Ch2, level –600uV
Ch1: 500mV/div, Probe 1.000:1
Vertical scale: +/- 4 div. corresponds to +/- 25 kHz

TEST PERSONNEL:

DANIEL BALTZELL		JUNE 4, 2001
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

PLOT 15-3: TRANSIENT FREQUENCY BEHAVIOR {CARRIER ON TIME} CHANNEL 1 : NB(12.5KHZ) 2 W RATED

RF Signal Generator: Modulation 12.5kHz deviation



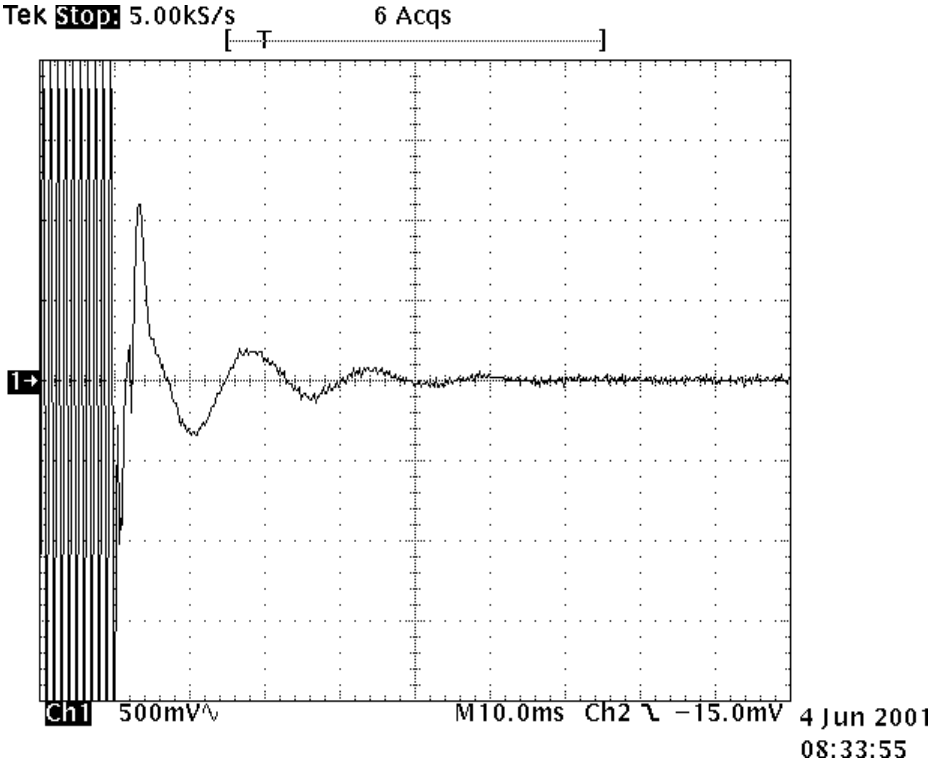
Timebase: 10 ms/div
Trigger: On negative edge of Ch2, level –4.0mV
Ch1: 250 mV/div, Probe 1.000:1
Vertical scale: +/- 4 div. corresponds to +/- 12.5 kHz

TEST PERSONNEL:

DANIEL BALTZELL		MAY 30, 2001
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

PLOT 15-4: TRANSIENT FREQUENCY BEHAVIOR {CARRIER ON TIME}CHANNEL 1 : WB (25KHZ) 2 W RATED

RF Signal Generator: Modulation 25kHz deviation



Timebase: 10 ms/div
Trigger: On negative edge of Ch2, level –15.0mV
Ch1: 500 mV/div, Probe 1.000:1
Vertical scale: +/- 4 div. corresponds to +/- 25 kHz

TEST PERSONNEL:

DANIEL BALTZELL		JUNE 4, 2001
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

TABLE 15-1: TEST EQUIPMENT USED FOR TESTING (TRASIENT FREQUENCY BEHAVIOR)

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
901054	Hewlett Packard	3586B	Selective Level Meter	1928A01892	06/08/01

16 FCC RULES AND REGULATIONS PART 2.202: NECESSARY BANDWIDTH AND EMISSION BANDWIDTH

Type of Emission: F3E

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

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