Engineering and Testing for EMC and Safety Compliance

CERTIFICATION APPLICATION REPORT
FCC PART 90 CERTIFICATION & INDUSTRY CANADA CERTIFICATION

Test Lab:	Applicant Information:
Rhein Tech Laboratories, Inc. 360 Herndon Parkway Suite 1400 Herndon, VA 20170 Contact: FCCINFO@rheintech.com Phone: 703-689-0368 Fax: 703-689-2056 Web Site: www.rheintech.com	E F Johnson 299 Johnson Ave. P.O. Box 1249 Waseca, MN 56093-0514 Contact: John Oblak Phone: 507-835-6276 Fax: 507-835-6666 Email: Joblak@efjohnson.com

FCC ID:	ATH2425140	**FRN NUMBER:**	0005-8136-88
MODEL:	242-5140	**RTL WORK ORDER NUMBER:**	2002104
EQUIPMENT TYPE:	PTT 400 MHz	**RTL QUOTE NUMBER:**	QRTL02-451
DATE OF TEST REPORT:	June 21, 2002		

FCC Classification:	☐ LMS – Part 90 Location & Monitoring Transmitters ☐ TBC – Licensed Broadcast Station Transmitter ☐ TBF – Licensed Broadcast Transmitter Held to Face ☐ TBT – Licensed Broadcast Transmitter Worn on Body ☐ TNB – Licensed Non-Broadcast Station Transmitter ☐ TNE – Licensed Non-Broadcast Transmitter Held to Ear ☒ TNF – Licensed Non-Broadcast Transmitter Held to Face ☒ TNT – Licensed Non-Broadcast Transmitter Worn on Body
FCC Rule Part(s):	Part 90: Private Land Mobile Radio Services
Industry Canada Standard:	RSS-119: Land Mobile and Fixed Radio Transmitters and Receivers, 27.41MHz to 960MHz

Frequency Range (MHz)	Output Power (W)	Freq. Tolerance (PPM, %, or Hz)	Emission Designator
450.0125-511.95	4.51	0.42 PPM	11K0F3E
450.0125-511.95	4.51	0.42 PPM	16K0F3E
450.0125-511.95	4.51	0.42 PPM	11K8F1E

We, the undersigned, hereby declare that the equipment tested and referenced in this report conforms to the identified standard(s) as described in this test report. 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 FCC Part 2, FCC Part 90, Industry Canada RSS-119, ANSI C61.1; 4.5, ANSI/TIA/EIA603 and ANSI/TIA/EIA 603-1.

Signature: _____ Date: June 21, 2002

Typed/Printed Name: Desmond A. Fraser Position: President

Signature: _____ Date: June 21, 2002

Typed/Printed Name: Daniel Baltzell Position: Test Engineer

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1 GENERAL INFORMATION

1.1 SCOPE

FCC Rules Part 90 (Subpart K): This subpart sets forth special requirements applicable to the use of certain frequencies or frequency bands.

Industry Canada RSS-119: This document sets out standards for radio transmitters and receivers for the land mobile and fixed services in bands allocated within the 27.41 MHz to 960 MHz range.

All measurements contained in this application were conducted in accordance with the FCC Rules and Regulations CFR47 Part 90, Industry Canada RSS-119 and ANSI/TIA/EIA603-1992/-1-1998 Land Mobile FM or PM Communications Equipment Measurement and Performance Standards. The measurement instrumentation conforms to the ANSI C61.1; 4.5 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.

1.2 TEST FACILITY

The open area test site and conducted measurement facility used to collect the radiated data is located at 360 Herndon Parkway, Suite 1400, Herndon, Virginia 20170. This site has been fully described in a report and approved by the Federal Communications Commission to perform AC line conducted and radiated emissions testing (ANSI C61.1; 4.5 1992).

1.3 RELATED SUBMITTAL(S)/GRANT(S)

This is an original application for Certification. A DoC report is on file for the receiver section and digital interface for the EUT. The IF, LO and up to the 2nd LO were investigated.

2 EQUIPMENT INFORMATION

2.1 APPLICANT AND EQUIPMENT INFORMATION

Test Lab:	Applicant Information:
Rhein Tech Laboratories, Inc. 360 Herndon Parkway Suite 1400 Herndon, VA 20170 Contact: FCCINFO@rheintech.com	Phone: 703-689-0368 Fax: 703-689-2056 Web Site: www.rheintech.com	E F Johnson 299 Johnson Ave. P.O. Box 1249 Waseca, MN 56093-0514 Contact: John Oblak	Phone: 507-835-6276 Fax: 507-835-6666 Email: Joblak@efjohnson.com

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450.0125-511.95	4.51	0.42 PPM	11K0F3E
450.0125-511.95	4.51	0.42 PPM	16K0F3E
450.0125-511.95	4.51	0.42 PPM	11K8F1E

2.2 TEST SYSTEM DETAILS

The FCC Identifiers for all equipment, plus descriptions of all cables used in the tested system are:

TABLE 2-1: EQUIPMENT UNDER TEST (EUT)

PART	MANUFACTURER	MODEL	SERIAL NUMBER	FCC ID	CABLE DESCRIPTION	RTL BAR CODE
PORTABLE RADIO	EF JOHNSON	242-5140	51430A172A 10001	ATH2425140	N/A	014377

TABLE 2-2: EXTERNAL COMPONENTS IN TEST CONFIGURATION

PART	MANUFACTURER	MODEL	SERIAL NUMBER	FCC ID	CABLE DESCRIPTION	RTL BAR CODE
NIMH BATTERY (7.5 VDC)	EF JOHNSON	587-5100-360	A1602SYGAH 1502A700604	N/A	N/A	014373
BATTERY CHARGER	EF JOHNSON	AA16740	1123327073	N/A	UNSHIELDED	014492

2.3 WORST CASE CONFIGURATION OF TESTED SYSTEM

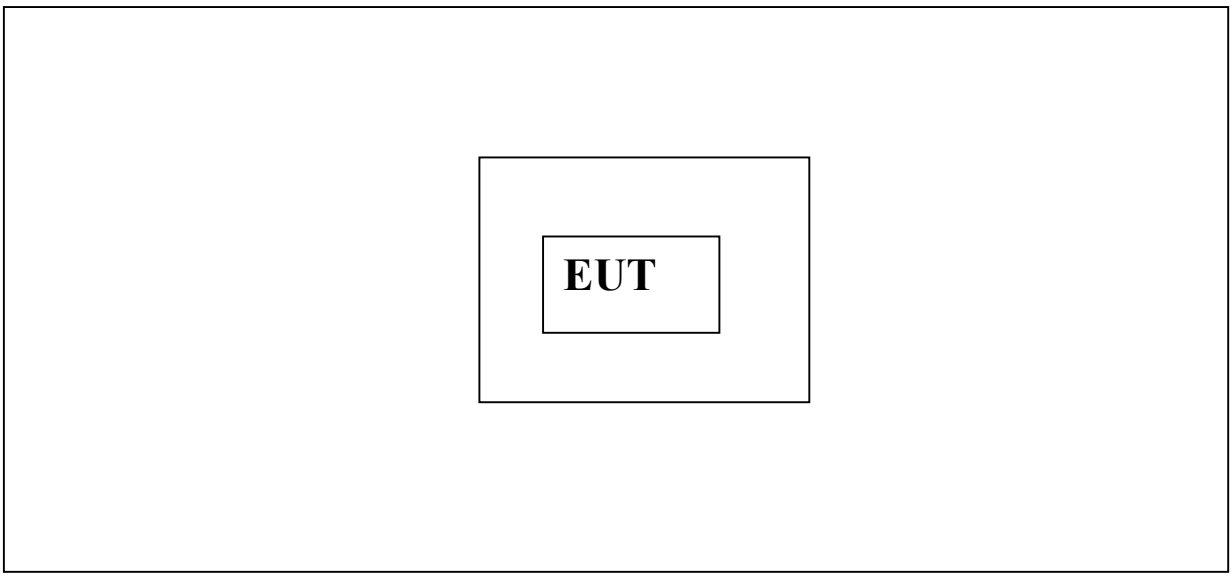


FIGURE 2-1: WORST CASE CONFIGURATION OF SYSTEM UNDER TEST

3 FCC PART 2.1033(C)(8); DC VOLTAGES AND CURRENTS

The dc voltages applied to and dc currents into the several elements of the final radio frequency amplifying device for normal operation over the power range where:

7.5 volts @ 2A high power;
7.5 volts @ 1A low power

4 RF POWER OUTPUT - §2.1046

4.1 ANSI/TIA/EIA-603-1992, SECTION 2.2.1 TEST PROCEDURE

Connect the equipment as illustrated below. Measure the transmitter output power during the defined duty cycle. The EUT was connected to a coaxial attenuator having a 50 Ω load impedance.

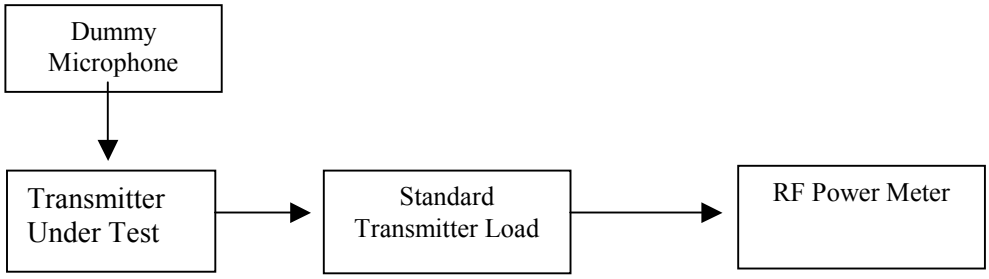


FIGURE 4-1: ILLUSTRATION OF HOW THE EQUIPMENT IS CONNECTED

4.2 RF POWER OUTPUT TEST EQUIPMENT

TABLE 4-1: RF POWER OUTPUT TEST EQUIPMENT

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Cal Due Date
901184	Agilent Technologies	E4416A	EPM-P Power Meter, single channel	GB41050573	7/5/02
901186	Agilent Technologies	E9323A (50MHz-6GHz)	Peak & Avg. Power Sensor	US40410380	6/25/02

4.3 RF POWER OUTPUT TEST DATA

TABLE 4-2: RF POWER OUTPUT TEST DATA ZONE 1

Frequency (MHz)	Channel	Peak Power Measured (dBm)	Average Power Measured (dBm)	Power (Watt)	Modulation Type
450.0125	1	30.53	30.47	1.11	12.5 kHz Analog
450.0125	2	30.53	30.47	1.11	25 kHz Analog
450.0125	3	36.51	36.48	4.45	12.5 kHz Analog
450.0125	4	36.51	36.48	4.45	25 kHz Analog
481.0125	5	30.45	30.38	1.09	12.5 kHz Analog
481.0125	6	30.45	30.39	1.09	25 kHz Analog
481.0125	7	36.43	36.39	4.36	12.5 kHz Analog
481.0125	8	36.42	36.39	4.36	25 kHz Analog
511.9500	9	30.64	30.56	1.14	12.5 kHz Analog
511.9500	10	30.65	30.56	1.14	25 kHz Analog
511.9500	11	36.57	36.54	4.51	12.5 kHz Analog
511.9500	12	36.58	36.54	4.51	25 kHz Analog
459.9250	13	36.48	36.45	4.42	25 kHz Analog

TABLE 4-3: RF POWER OUTPUT TEST DATA ZONE 2

Frequency (MHz)	Channel	Peak Power Measured (dBm)	Average Power Measured (dBm)	Power (Watt)	Modulation Type
450.0125	1	30.64	30.58	1.14	P25 Digital
450.0125	2	36.55	36.51	4.48	P25 Digital
481.0125	3	30.51	30.44	1.11	P25 Digital
481.0125	4	36.44	36.41	4.38	P25 Digital
511.9500	5	30.63	30.57	1.14	P25 Digital
511.9500	6	36.57	36.54	4.51	P25 Digital
459.9250	7	36.47	36.44	4.41	P25 Digital

NOTE: CW measurements used for all power except modulation power for P25 digital.

TEST PERSONNEL:

DANIEL BALTZELL  MAY 15, 2002

TEST TECHNICIAN/ENGINEER SIGNATURE DATE OF TEST

4.4 MODULATION CHARACTERISTICS - §2.1047 TEST PROCEDURE

The modulation characteristic tests do not apply to digital modulation only to those channels with analog modulation.

4.5 MODULATION CHARACTERISTICS TEST EQUIPMENT

TABLE 4-4: MODULATION CHARACTERISTICS TEST EQUIPMENT

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Cal Due Date
901055	Hewlett Packard	8901A Opt. 002-003	Modulation Analyzer	2545A04102	7/31/02
901057	Hewlett Packard	3336B	Synthesizer/Level Generator	2514A02585	7/13/02
901054	Hewlett Packard	HP 3586B	Selective Level Meter	1928A01892	7/16/02

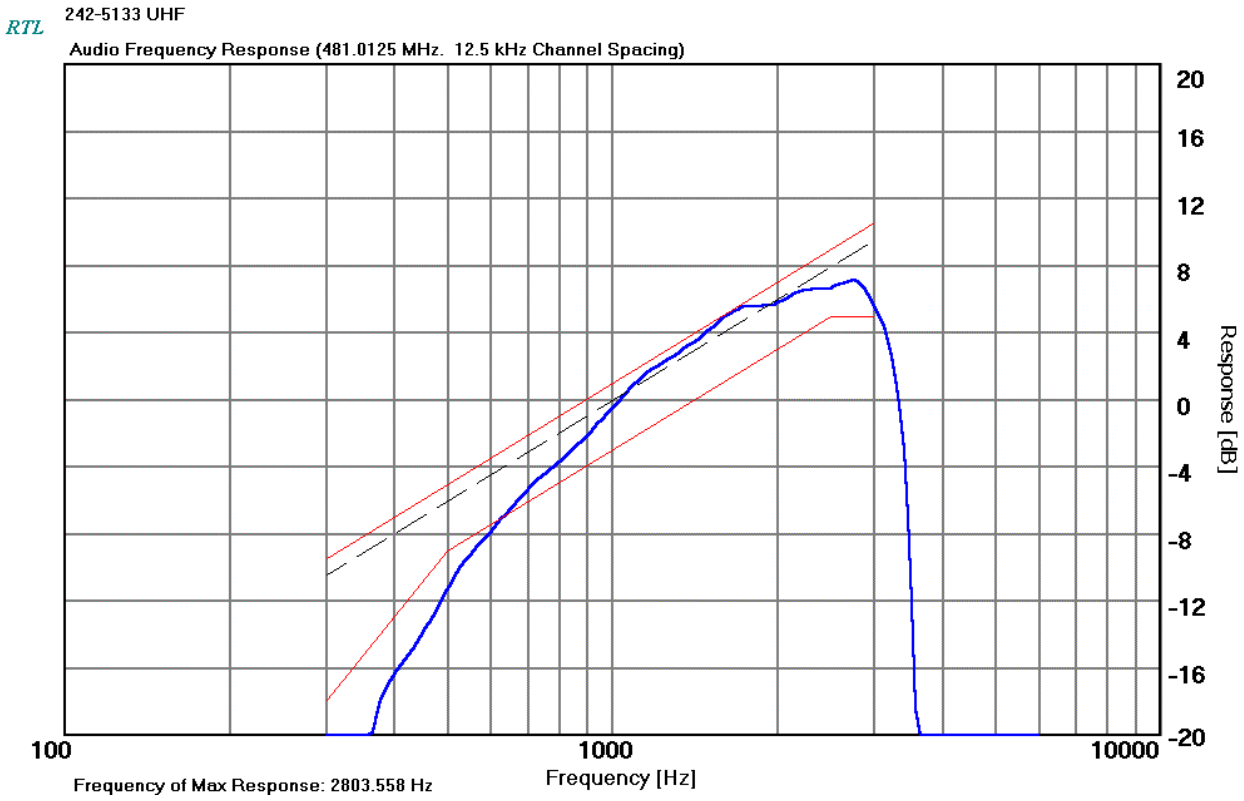
5 FCC PART 2 §2.1047 (A): MODULATION CHARACTERISTICS - AUDIO FREQUENCY RESPONSE

5.1 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)

5.2 TEST DATA

PLOT 5-1: AUDIO FREQUENCY RESPONSE CHANNEL 6 AT 481.0125 MHZ



TEST PERSONNEL:

DANIEL BALTZELL		MAY 24, 2002
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

6 FCC PART 2 §2.1047 (A): MODULATION CHARACTERISTICS - AUDIO LOW PASS FILTER RESPONSE

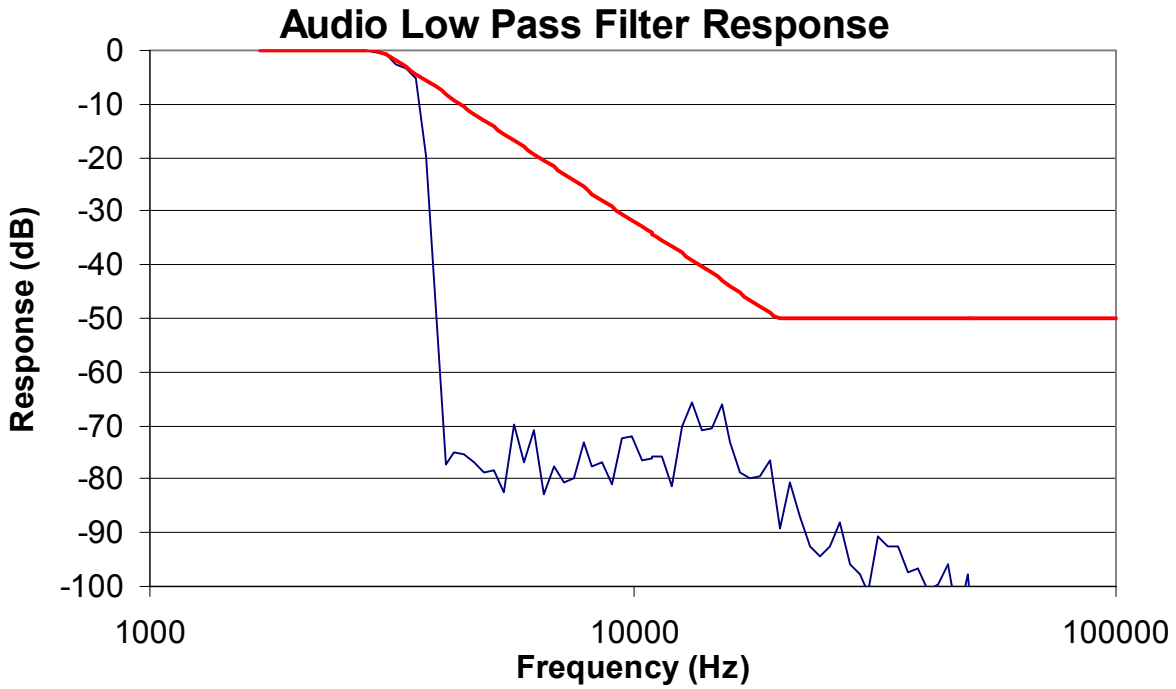
6.1 TEST PROCEDURE

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.

6.2 TEST DATA

PLOT 6-1: AUDIO LOW PASS FILTER RESPONSE (CHANNEL 6)



TEST PERSONNEL:

DANIEL BALTZELL		MAY 24, 2002
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

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

7.1 TEST PROCEDURE

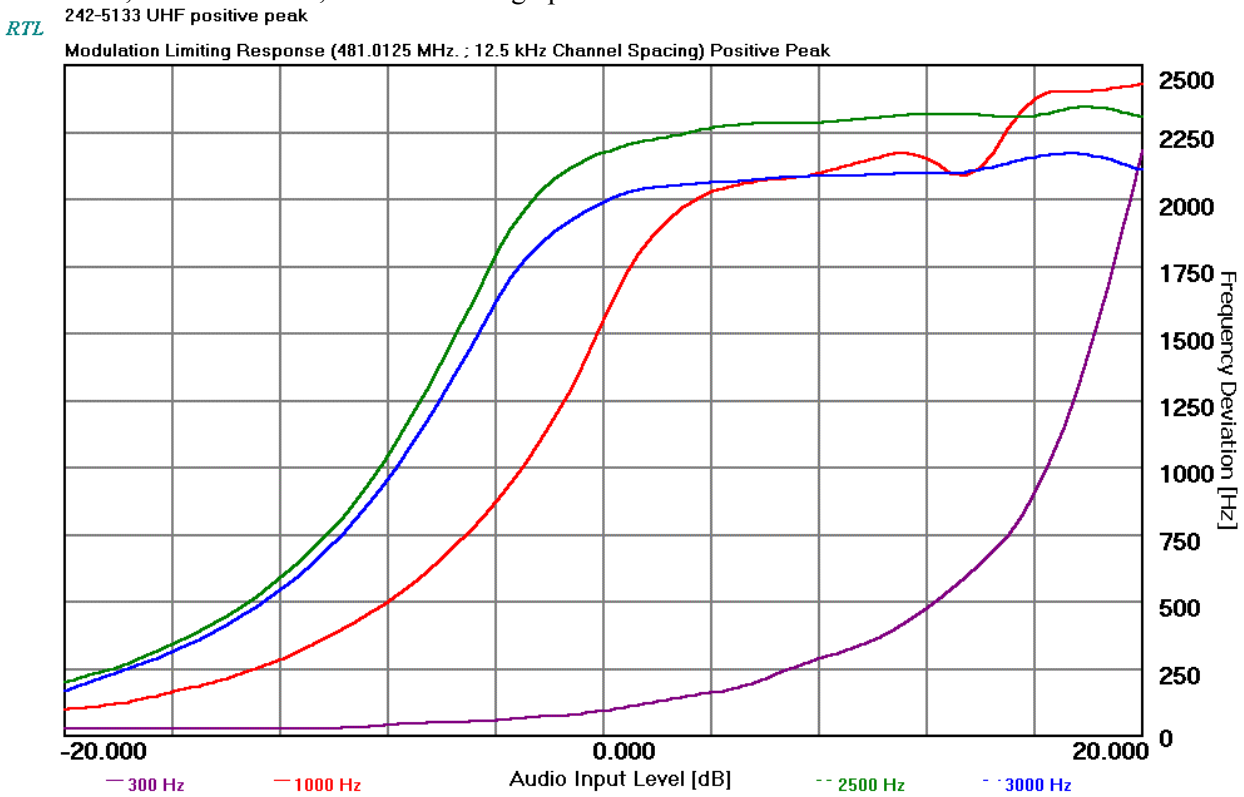
ANSI/TIA/EIA-603-1992, section 2.2.3

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.

7.2 TEST DATA

PLOT 7-1: MODULATION LIMITING RESPONSE (POSITIVE PEAK)

Channel 6; 481.0125 MHz; Narrowband high power



TEST PERSONNEL:

DANIEL BALTZELL		MAY 24, 2002
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

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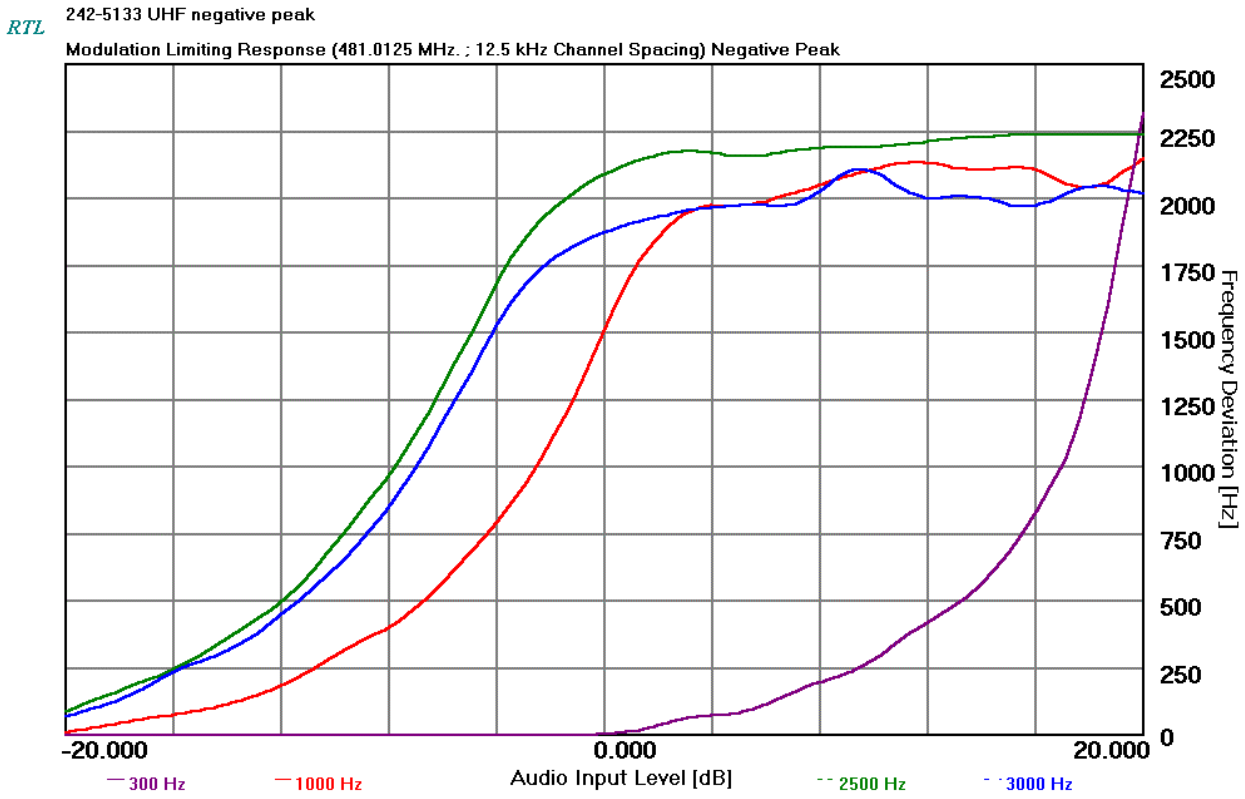
PLOT 7-2: MODULATION LIMITING RESPONSE (NEGATIVE PEAK)

Channel 6; Narrowband; High power

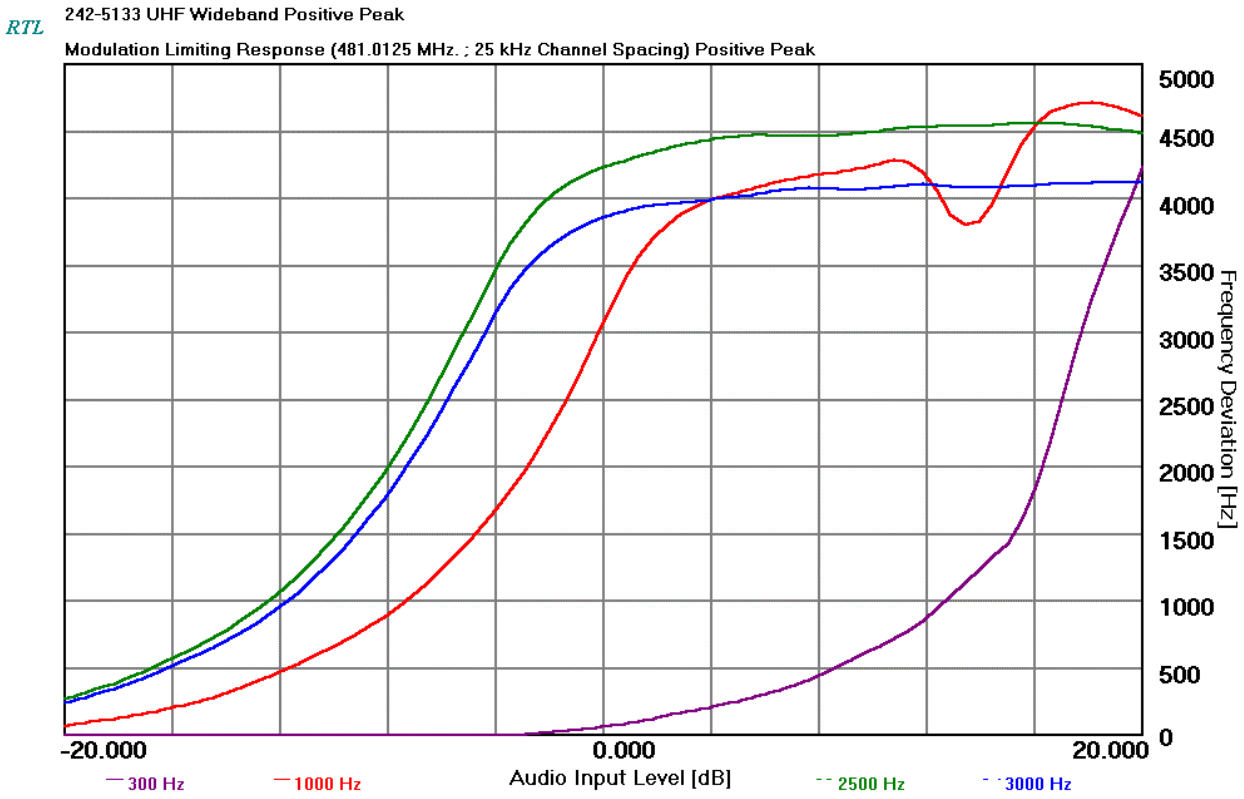


TEST PERSONNEL:

DANIEL BALTZELL		MAY 24, 2002
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

PLOT 7-3: MODULATION LIMITING RESPONSE (POSITIVE PEAK)

Channel 7; Wideband; High power

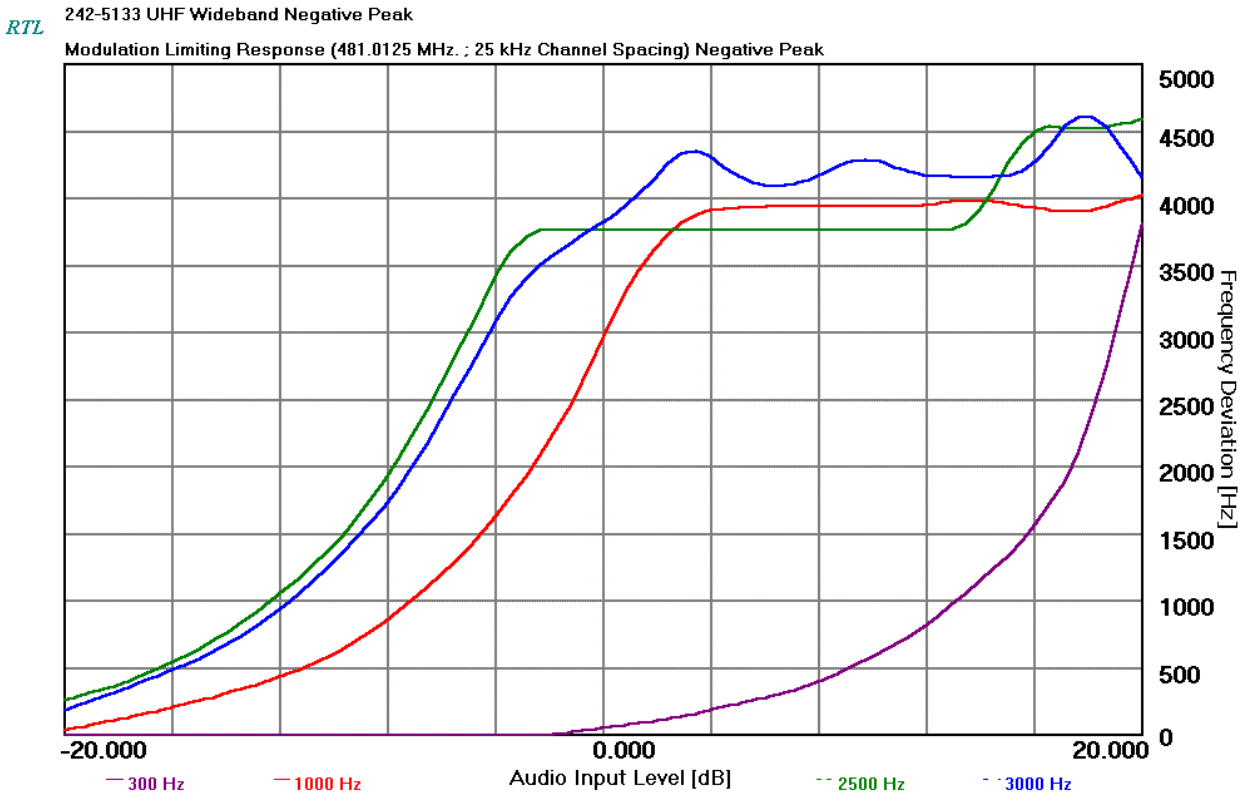


TEST PERSONNEL:

DANIEL BALTZELL		MAY 24, 2002
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

PLOT 7-4: MODULATION LIMITING RESPONSE (NEGATIVE PEAK)

Channel 7; Wideband; High power



TEST PERSONNEL:

DANIEL BALTZELL		MAY 24, 2002
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

8 OCCUPIED BANDWIDTH - §2.1049

8.1 OCCUPIED BANDWIDTH - §2.1049 TEST PROCEDURE

The antenna output terminal of the EUT was connected to the input of a 50W spectrum analyzer through a matched 20dB attenuator. The radio transmitter was operating at maximum output power with and without internal data modulation. 100% of the in-band modulation was below the specified mask. Specified Limits:

A. On any frequency removed from the assigned carrier frequency by more than 20kHz, up to and including 45kHz, the sideband was at least 26dB below the carrier.
B. On any frequency removed from the assigned carrier frequency by more than 45kHz, up to and including 90kHz, the sideband was at least 45dB below the carrier.
C. On any frequency removed from the assigned carrier frequency by more than 90kHz, up to the first multiple of the carrier frequency, the sideband was at least 60dB below the carrier of 40 + log10 (mean power output in Watts) dB, whichever was the smaller attenuation.

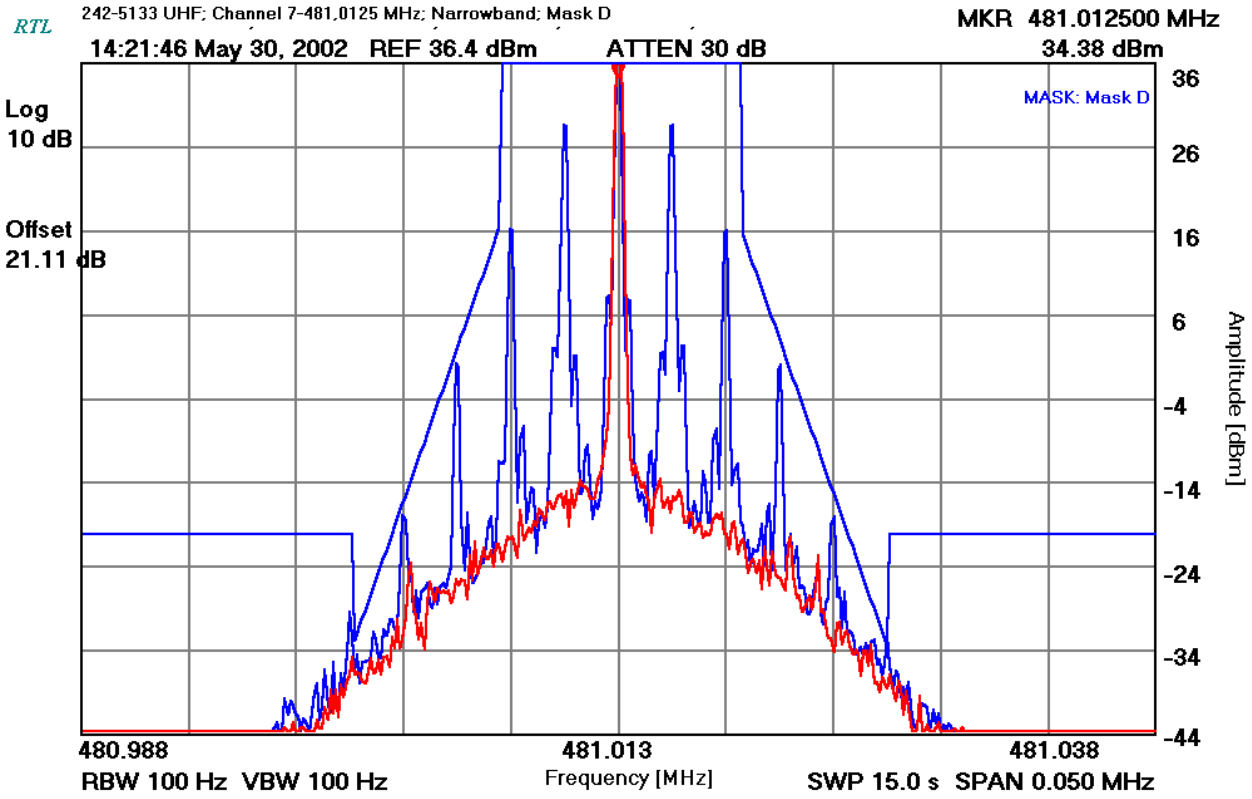
8.2 OCCUPIED BANDWIDTH TEST EQUIPMENT

TABLE 8-1: OCCUPIED BANDWIDTH TEST EQUIPMENT

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Cal Due Date
901020	Hewlett Packard	8564E	Portable Spectrum Analyzer (9kHz – 40 GHz)	3943A01719	6/7/02

8.3 OCCUPIED BANDWIDTH TEST DATA

PLOT 8-1: MASK D (481.0125 MHZ; CH 7; NARROWBAND)

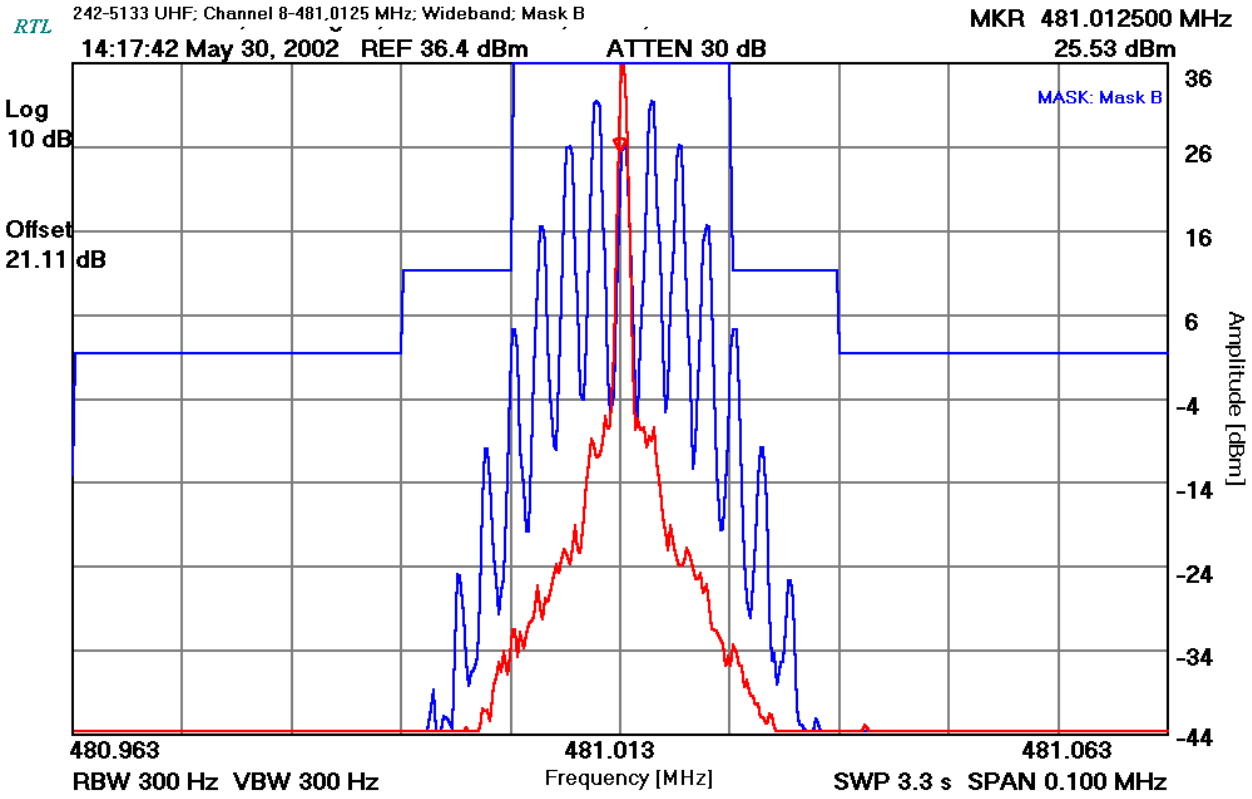


TEST PERSONNEL:

DANIEL BALTZELL		MAY 30, 2002
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

8.4 OCCUPIED BANDWIDTH TEST DATA

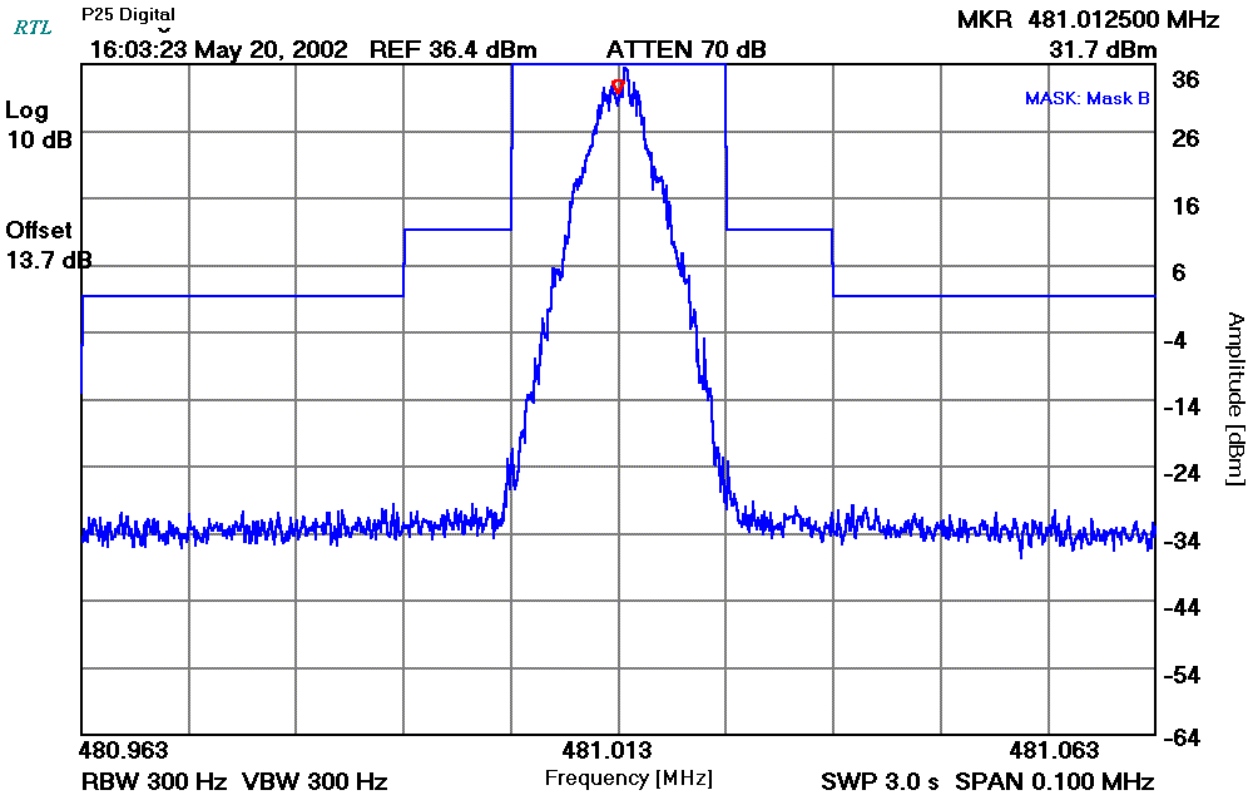
PLOT 8-2: MASK B (481.0125 MHZ; CH 8; WIDEBAND)



TEST PERSONNEL:

DANIEL BALTZELL		MAY 30, 2002
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

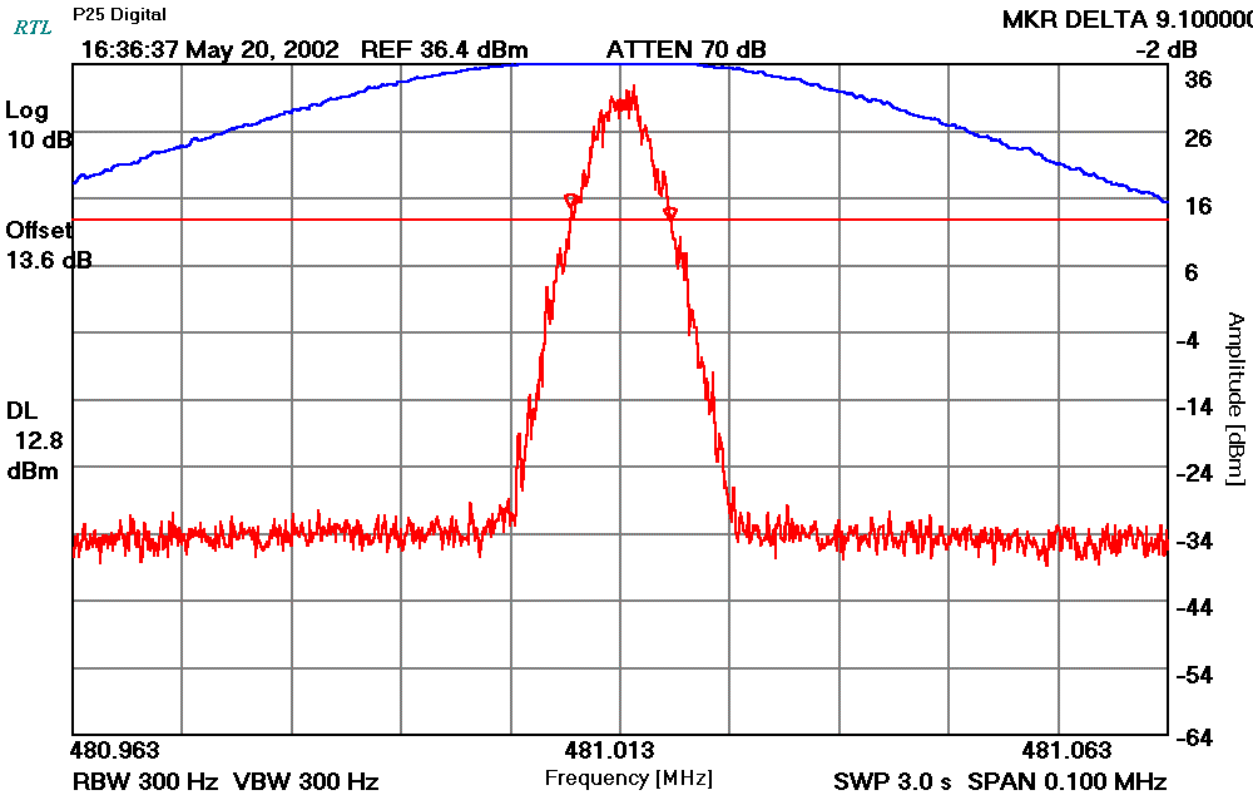
PLOT 8-3: MASK B (481.0125 MHZ; P25 DIGITAL)



TEST PERSONNEL:

DANIEL BALTZELL		MAY 20, 2002
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

PLOT 8-4: OCCUPIED BANDWIDTH: (481.0125 MHZ, P25 DIGITAL): 9.1 KHZ



TEST PERSONNEL:

DANIEL BALTZELL		MAY 20, 2002
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

9 SPURIOUS EMISSIONS AT ANTENNA TERMINAL - §2.1051

9.1 SPURIOUS EMISSIONS AT ANTENNA TERMINAL - §2.1051 TEST PROCEDURE

The level of the various conducted spurious frequencies was measured by means of a calibrated spectrum analyzer. The antenna output terminal of the EUT was connected to the input of a 50 Ω spectrum analyzer through a matched 3dB attenuator and notch filter. The transmitter was operating at maximum power.

9.2 SPURIOUS EMISSIONS AT ANTENNA TERMINAL TEST EQUIPMENT

TABLE 9-1: SPURIOUS EMISSIONS AT ANTENNA TERMINAL TEST EQUIPMENT

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
900913	Hewlett Packard	85462A	EMI Receiver RF Section (9 KHz – 6.5 GHz)	3325A00159
901132	PAR Electronics	806-902 (25W)	UHF Notch Filter	N/A
900931	Hewlett Packard	8566B	SPECTRUM ANALYZER (100 Hz - 22 GHz)	3138A07771

9.3 CONDUCTED SPURIOUS EMISSIONS TEST DATA

TABLE 9-2: CONDUCTED SPURIOUS EMISSIONS (CHANNEL 7 AT 481.0125 MHZ)

Operating Frequency (MHz): 481.0125
Channel: 7 (Zone 1)
Measured Conducted Power (dBm): 36.39
Modulation: Analog
Limit (dBc): 56.39 (50+10LogP)

Frequency (MHz)	Spectrum Analyzer Level (dBm)	Notch Filter Insertion Loss (dB)	Corrected Spectrum Analyzer Level (dBc)	Margin (dB)
962.0250	-60.1	2.7	88.0	-31.6
1443.0375	-63.7	3.9	90.4	-34.0
1924.0500	-83.8	15.3	99.1	-42.7
2405.0625	-74.4	8.0	97.0	-40.6
2886.0750	-78.4	3.9	105.1	-48.7
3367.0875	-85.4	3.0	113.0	-56.6
3848.1000	-79.9	5.3	105.2	-48.8
4329.1125	-85.5	4.4	111.7	-55.3
4810.1250	-78.8	3.0	106.4	-50.0

TEST PERSONNEL:

DANIEL BALTZELL — SIGNATURE — MAY 20, 2002
TEST TECHNICIAN/ENGINEER — DATE OF TEST

TABLE 9-3: CONDUCTED SPURIOUS EMISSIONS (CHANNEL 4 AT 481.0125 MHZ)

Operating Frequency (MHz): 481.0125
Channel: 4 (Zone 2)
Measured Conducted Power (dBm): 36.41
Modulation: Digital
Limit (dBc): 49.41 (43+10LogP)

Frequency (MHz)	Spectrum Analyzer Level (dBm)	Notch Filter Insertion Loss (dB)	Corrected Spectrum Analyzer Level (dBc)	Margin (dB)
962.0250	-61.2	2.7	89.0	-39.6
1443.0375	-82.9	3.9	109.6	-60.2
1924.0500	-74.2	15.3	89.5	-40.1
2405.0625	-74.3	8.0	96.9	-47.5
2886.0750	-78.3	3.9	105.0	-55.6
3367.0875	-84.8	3.0	112.4	-63.0
3848.1000	-80.2	5.3	105.5	-56.1
4329.1125	-84.7	4.4	110.9	-61.5
4810.1250	-79.3	3.0	106.9	-57.5

TEST PERSONNEL:

DANIEL BALTZELL		MAY 20, 2002
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

10 RADIATED SPURIOUS AND HARMONIC EMISSIONS - §2.1053

10.1 RADIATED SPURIOUS AND HARMONIC EMISSIONS - §2.1053

Radiated and harmonic emissions were measured at our 3-meter outdoor site. The EUT was placed on the turntable with the transmitter transmitting into a non-radiating load. A receiving antenna located 3 meters from the turntable received any signal radiated from the transmitter and its operating accessories. The receiving antenna was varied from 1 to 4 meters and the polarization was varied to determine the worst-case emission level.

10.2 RADIATED SPURIOUS TEST EQUIPMENT

TABLE 10-1: RADIATED SPURIOUS TEST EQUIPMENT

RTL Asset #	Manufacturer	Model	Part Type	Serial Number
901053	Schaffner Chase	CBL6112B	Bi-Log Antenna (20 MHz – 2 GHz)	2648
901020	Hewlett Packard	8564E	Portable Spectrum Analyzer (9 kHz - 40 GHz)	3943A01719
900928	Hewlett Packard	83752A	Synthesized Sweeper (0.01 GHz – 20 GHz)	3610A00866
900905	RTL	PR-1040	Amplifier 30 MHz - 2 GHz	900905
900814	Electro-Metrics	EM-6961 (RGA-60)	Double Ridges Guide Antenna 1-18 GHz	2310
900772	EMCO	3161-02	Horn antenna 2.0-4.0 GHz	9804-1044
900321	EMCO	3161-03	Horn antenna 4.0- 8.2 GHz	9508-1020
900325	EMCO	3160-09	HORN ANTENNA, 18.0-26.5 GHz	9605-1051
900932	Hewlett Packard	8449B OPT H02	Preamplifier 1-26.5 GHz	3008A00505

10.3 RADIATED SPURIOUS EMISSIONS TEST DATA - §2.1053

Operating Frequency (MHz): 481.0125
Channel: 7 (Zone 1)
Measured Conducted Power (dBm): 36.39
Modulation: Analog narrowband
Distance (m): 3
Limit (dBc): 56.39 (50+10LogP)

TABLE 10-2: RADIATED SPURIOUS EMISSIONS DATA §2.1053

Frequency (MHz)	Spectrum Analyzer Peak Level (dBuV)	Spectrum Analyzer Average Level (dBuV)	Signal Generator Level (dBm)	Cable Loss (dB)	Antenna Gain (dBd)	Corrected Level (dBc)	Margin (dB)
962.025	56.7	54.3	-64.0	-2.2	-1.3	103.9	-47.5
1443.038	55.5	52.3	-65.2	-2.8	4.1	100.3	-43.9
1924.050	55.2	53.7	-57.7	-3.3	4.8	92.6	-36.2
2405.063	28.8	18.2	-73.5	-3.7	5.1	108.5	-52.1
2886.075	19.3	13.5	-79.2	-4.1	6.0	113.6	-57.2
3367.088	22.7	17.7	-74.0	-4.2	6.0	108.5	-52.1
3848.100	22.0	16.7	-72.7	-4.7	5.9	107.8	-51.5
4329.113	20.5	14.3	-73.9	-4.7	6.6	108.3	-51.9
4810.125	14.5	8.8	-77.8	-5.2	7.0	112.4	-56.0

TEST PERSONNEL:

DANIEL BALTZELL — SIGNATURE — MAY 23, 2002
TEST TECHNICIAN/ENGINEER — DATE OF TEST

The spectrum analyzer was set to the following settings:

1. Resolution Bandwidth 1 MHz
2. Video Bandwidth 10 Hz
3. Sweep Speed 200 ms
4. Detector Mode = Positive Peak

Notes:

ERP Measurements by Substitution Method:

The EUT was placed on a turntable 3-meters from the receive antenna. The field of maximum intensity was found by rotating the EUT approximately 360 degrees and changing the height of the receive antenna from 1 to 4 meters. The field strength was recorded from a calibrated spectrum analyzer for each channel being tested. A horn antenna was substituted in place of the EUT. The horn was fed by a signal generator, and the input level adjusted to the same field strength level as the EUT. The conducted power from the signal generator was recorded. The signal generator level was corrected by subtracting the connecting cable loss, and further corrected with the horn gain referenced to a ½ wave dipole measurement.

Operating Frequency (MHz): 481.0125
Channel: 4 (Zone 2)
Measured Conducted Power (dBm): 36.41
Modulation: P25 Digital
Distance (m): 3
Limit (dBc): 49.41 (43+10LogP)

TABLE 10-3: RADIATED SPURIOUS EMISSIONS DATA §2.1053

Frequency (MHz)	Spectrum Analyzer Peak Level (dBuV)	Spectrum Analyzer Average Level (dBuV)	Signal Generator Level (dBm)	Cable Loss (dB)	Antenna Gain (dBd)	Corrected Level (dBc)	Margin (dB)
962.025	49.5	46.2	-72.2	-2.2	-1.3	112.1	-62.7
1443.038	56.7	52.2	-65.3	-2.8	4.1	100.4	-51.0
1924.050	52.8	46.7	-64.7	-3.3	4.8	99.6	-50.2
2405.063	25.5	20.0	-71.7	-3.7	5.1	106.6	-57.2
2886.075	20.5	14.2	-78.5	-4.1	6.0	113.0	-63.6
3367.088	25.2	18.7	-73.0	-4.2	6.0	107.5	-58.1
3848.100	21.2	14.0	-75.3	-4.7	5.9	110.5	-61.1
4329.113	20.7	12.5	-75.7	-4.7	6.6	110.1	-60.7
4810.125	13.0	7.8	-78.8	-5.2	7.0	113.4	-64.0

TEST PERSONNEL:

DANIEL BALTZELL		MAY 23, 2002
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

The spectrum analyzer was set to the following settings:

5. Resolution Bandwidth 1 MHz
6. Video Bandwidth 10 Hz
7. Sweep Speed 200 ms
8. Detector Mode = Positive Peak

Notes:

ERP Measurements by Substitution Method:

The EUT was placed on a turntable 3-meters from the receive antenna. The field of maximum intensity was found by rotating the EUT approximately 360 degrees and changing the height of the receive antenna from 1 to 4 meters. The field strength was recorded from a calibrated spectrum analyzer for each channel being tested. A horn antenna was substituted in place of the EUT. The horn was fed by a signal generator, and the input level adjusted to the same field strength level as the EUT. The conducted power from the signal generator was recorded. The signal generator level was corrected by subtracting the connecting cable loss, and further corrected with the horn gain referenced to a ½ wave dipole measurement.

11 FREQUENCY STABILITY / TEMPERATURE VARIATION - §2.1055

11.1 MEASUREMENT METHOD:

The frequency stability of the transmitter was measured by:

1. Temperature: The temperature was varied from -30°C to +60°C at intervals no more than 10°C throughout the temperature range using an environmental chamber. A period of time sufficient to stabilize all of the components in the equipment shall be allowed prior to each frequency measurement.
2. Primary Supply Voltage: The primary supply voltage was varied from 85% to 115% of the voltage normally at the input to the device or at the power supply terminals if cables are not normally supplied. The EUT was tested down to the battery endpoint.

11.2 TIME PERIOD AND PROCEDURE:

1. The carrier frequency of the transmitter was measured at room temperature (25°C to 27°C to provide a reference).
2. The equipment was subjected to an overnight "soak" at -30°C without any power applied.
3. After the overnight "soak" at -30°C, the measurement of the carrier frequency of the transmitter was made within a three-minute interval after applying power to the transmitter.
4. Frequency measurements were made at 10°C intervals up to +60°C, then back to room temperature. A minimum period of one hour was provided to allow stabilization of the equipment at each temperature level.

11.3 FREQUENCY TOLERANCE:

The minimum frequency stability shall be + 2.5ppm referenced to a received carrier frequency from a base station.

11.4 FREQUENCY STABILITY TEST EQUIPMENT

TABLE 11-1: FREQUENCY STABILITY TEST EQUIPMENT

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Cal Due Date
900946	Tenney Engineering, Inc.	TH65	Temperature Chamber with Humidity	11380	11/19/02
901055	Hewlett Packard	8901A Opt. 002-003	Modulation Analyzer	2545A04102	7/31/02

11.5 FREQUENCY STABILITY TEST DATA - §2.1055

Operating Frequency: 481.0125 MHz
Channel: 7
Reference Voltage: 7.5 VDC
Deviation Limit: 0.00025% or 2.5 PPM

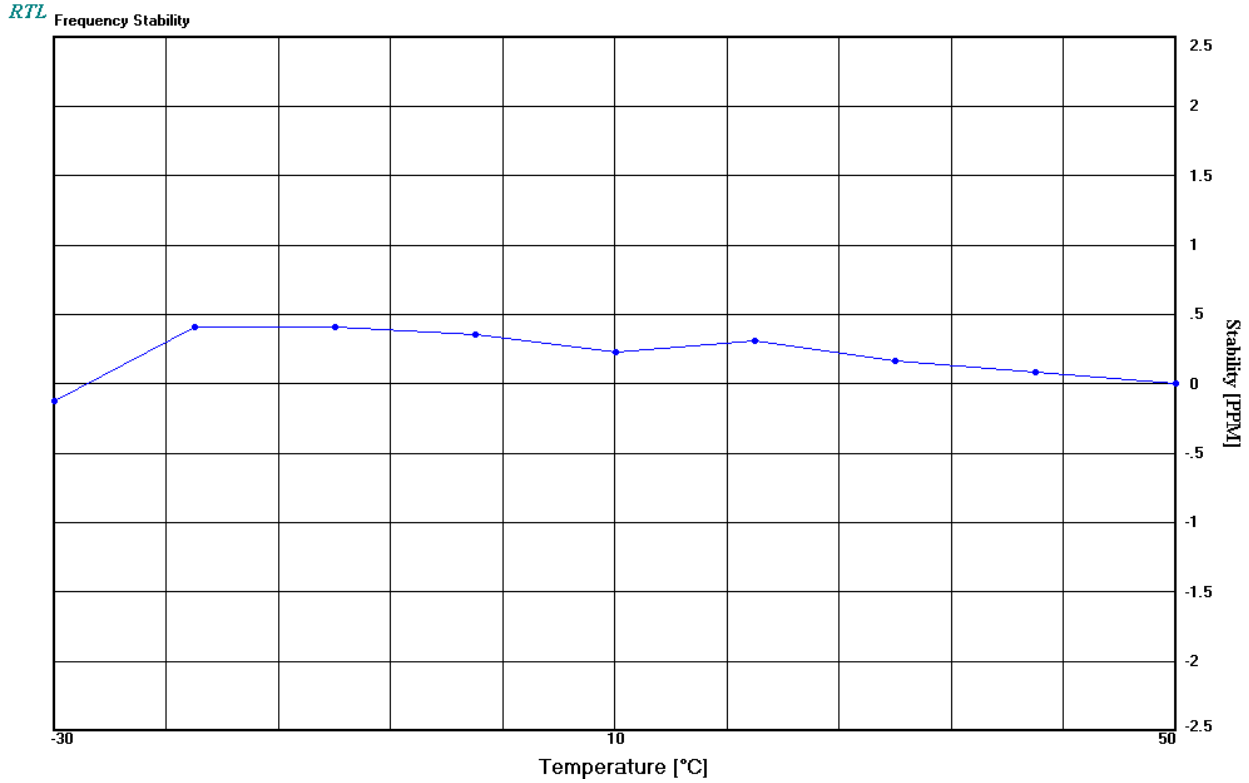
TABLE 11-2: FREQUENCY STABILITY DATA - §2.1055: TEMPERATURE

Temperature (ºC)	Measured Frequency (MHz)	ppm
-30	481.012440	-0.12
-20	481.012700	0.42
-10	481.012700	0.42
0	481.012670	0.35
10	481.012610	0.23
20	481.012650	0.31
30	481.012580	0.17
40	481.012540	0.08
50	481.012500	0.00

TEST PERSONNEL:

DANIEL BALTZELL		MAY 23, 2002
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

PLOT 11-1: TEMPERATURE FREQUENCY STABILITY - §2.1055



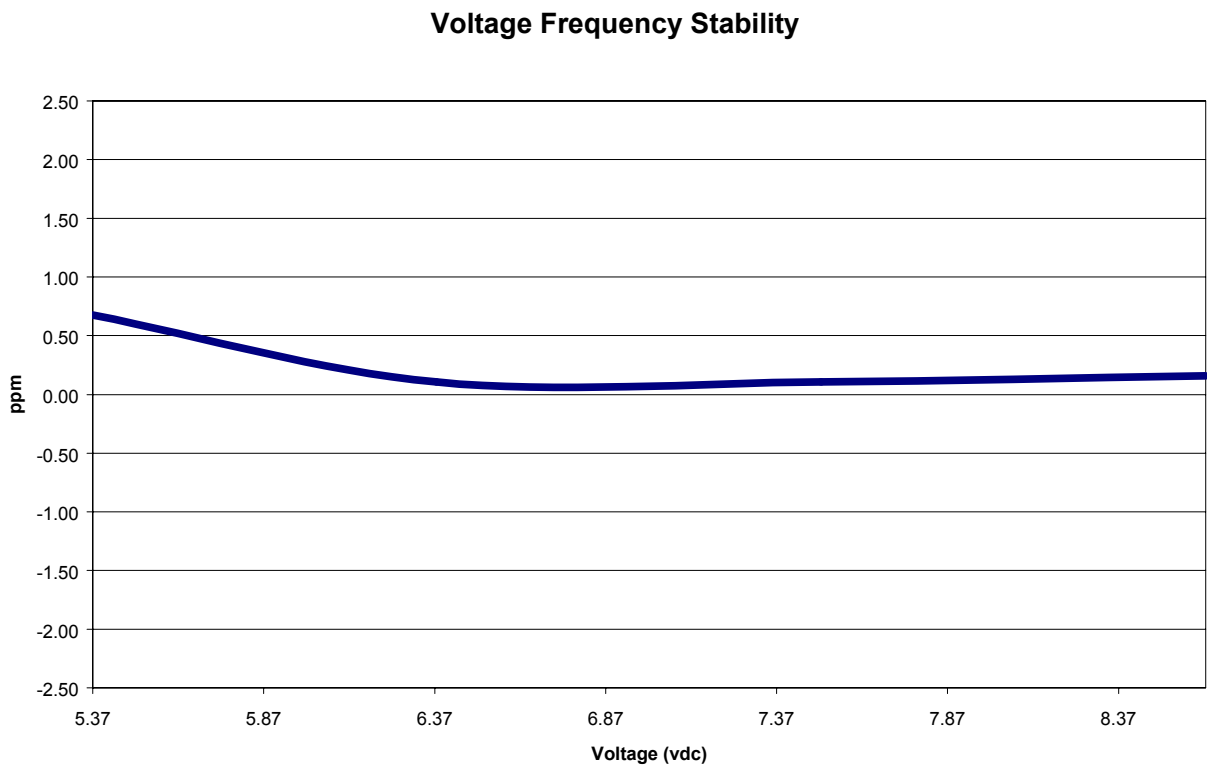
TEST PERSONNEL:

DANIEL BALTZELL		MAY 23, 2002
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

TABLE 11-3: FREQUENCY STABILITY DATA - §2.1055: VOLTAGE

Voltage (DC)	Measured Frequency (MHz)	ppm
5.37	481.0128250	0.68
6.375	481.0125500	0.10
7.5	481.0125500	0.10
8.625	481.0125750	0.16

PLOT 11-2: VOLTAGE FREQUENCY STABILITY - §2.1055



TEST PERSONNEL:

DANIEL BALTZELL		MAY 23, 2002
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

12 FCC PART 90 §90.214: TRANSIENT FREQUENCY BEHAVIOR

12.1 TRANSIENT FREQUENCY BEHAVIOR TEST PROCEDURE

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

12.2 TRANSIENT FREQUENCY BEHAVIOR LIMITS

TABLE 12-1: 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 12-2: 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 t_{on}. t_2 is the time period immediately following t_1. t_3 is the time period from the instant when the transmitter is turned off until t_{off}. t_{off} is the instant when the 1 kHz test signal starts to rise.
(**) During the time from the end of t_2 to the beginning of t_3, the frequency difference must not exceed the limits specified in § 90.213.
(***) The 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.

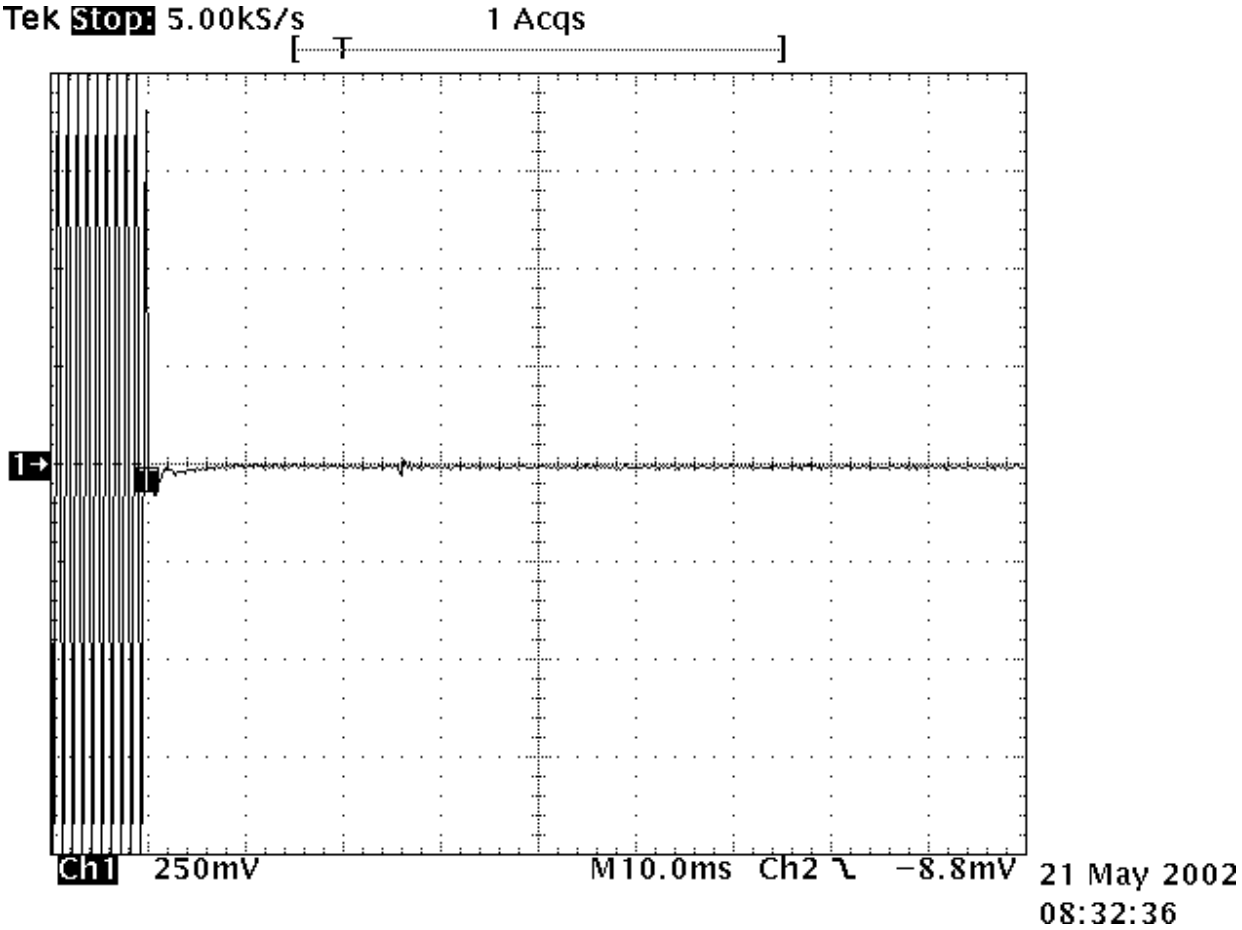
Maximum frequency difference between time T2 and T3: Calculation for Channel 5:
The frequency stability is required to be 2.5 PPM.
Calculation for Channel 5:
4 div. on scope represent 12.5kHz for narrow band channel.
Therefore, 481.0125 MHz times 2.5 PPM times +/- 4 Divisions divided by 12.5kHz equals about +/- 0.39 division. 0.39 Div. correspond to 1.233 kHz

TABLE 12-3: TRANSIENT FREQUENCY BEHAVIOR TEST EQUIPMENT

RTL Asset #	Manufacturer	Model	Part Type	Serial Number	Cal Due Date
900917	Hewlett Packard	8648C	Synthesized Signal Generator (9 KHz To 3200 MHz)	3537A01741	4/19/03
901055	Hewlett Packard	8901A Opt. 002-003	Modulation Analyzer	2545A04102	7/31/02
900561	Tektronix	TDS540A	Oscilloscope	B020129	2/11/03
900913	Hewlett Packard	85462A	EMI Receiver RF Section, 9 KHz - 6.5 GHz	3325A00159	12/5/02
901214	Hewlett Packard	HP8471D	Detector	2952A19822	Not Required

12.3 TRANSIENT FREQUENCY BEHAVIOR TEST DATA

PLOT 12-1: (ON TIME) – CHANNEL 5: 481.0125 MHZ {12.5 KHZ NARROW BAND, LOW POWER}



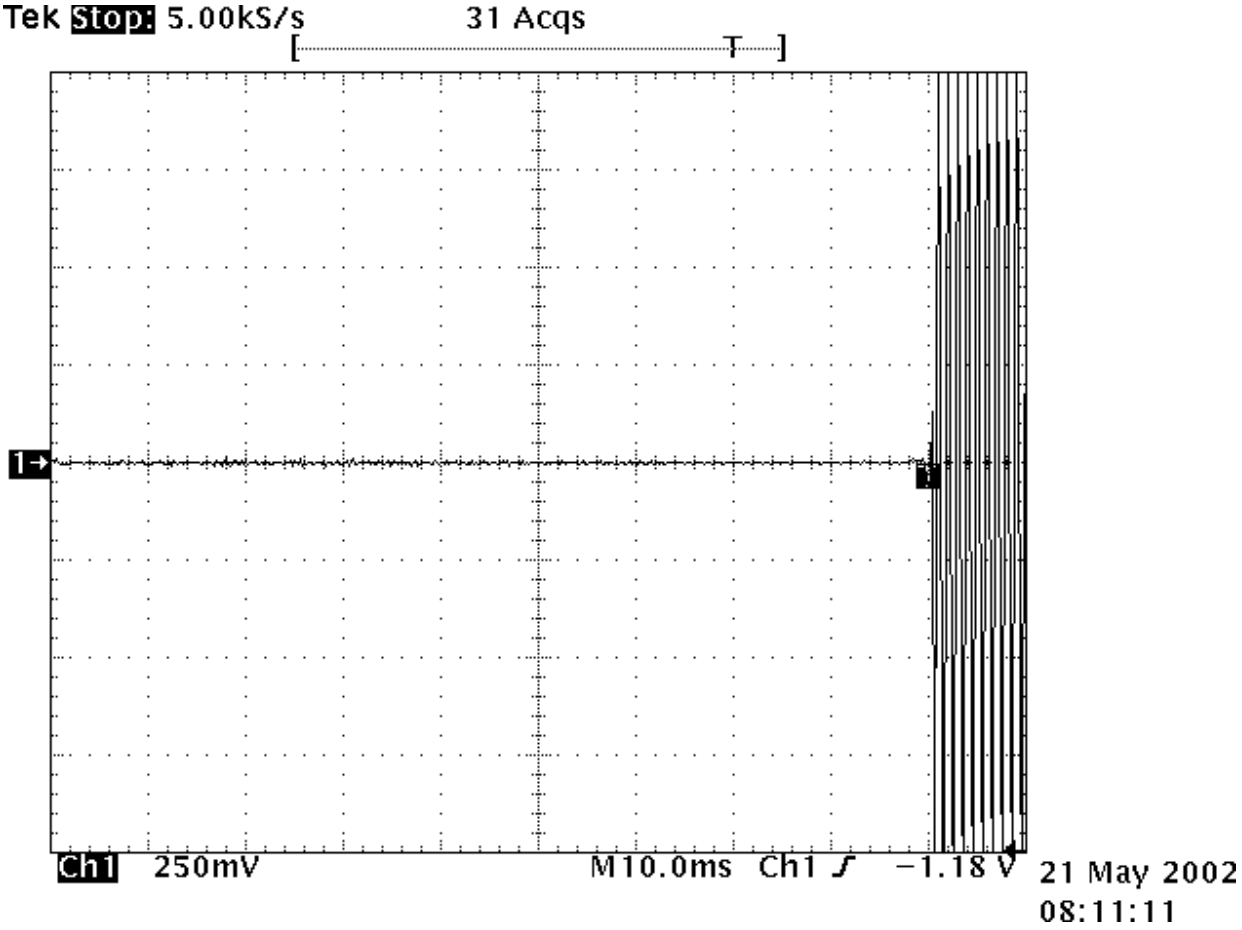
Carrier ON time:
Low Power: 1 W rated
Channel 5 : 481.0125 MHz NB(12.5kHz)
RF Signal Generator: Modulation 12.5kHz deviation

Timebase: 10 ms/div
Trigger: On negative edge of Ch2, level –8.8mV
Ch1: 250mV/div, Probe 1.000:1
Vertical scale: +/- 4 div. corresponds to +/- 12.5 kHz

TEST PERSONNEL:

DANIEL BALTZELL		MAY 21, 2002
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

PLOT 12-2: (OFF TIME) – CHANNEL 5: 481.0125 MHZ {12.5 KHZ NARROW BAND, LOW POWER}



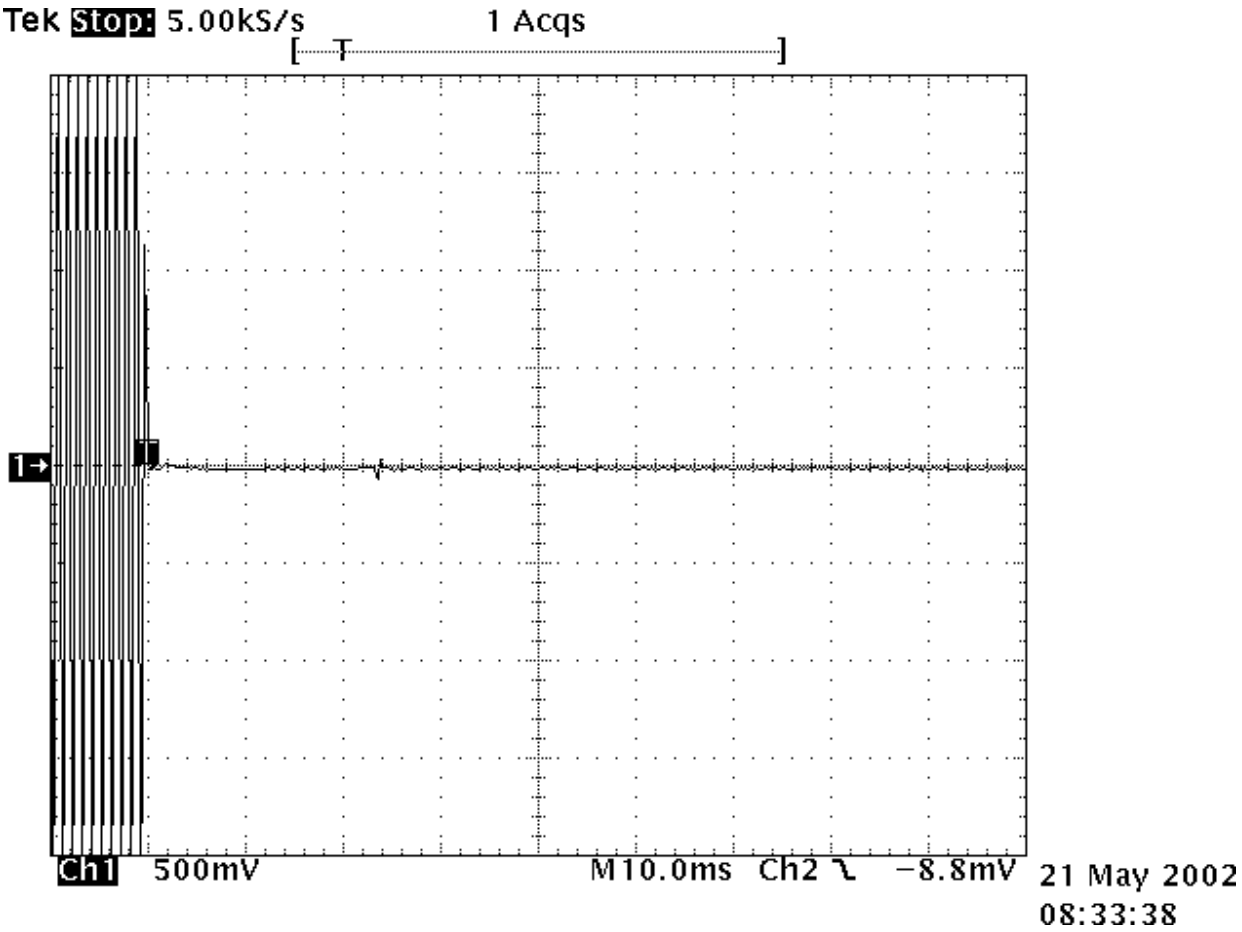
Carrier OFF time:
Low Power: 1 W rated
Channel 5 : 481.0125 MHz NB(12.5kHz)
RF Signal Generator: Modulation 12.5kHz deviation

Timebase: 10 ms/div
Trigger: On positive edge of Ch2, level –1.18mV
Ch1: 250mV/div, Probe 1.000:1
Vertical scale: +/- 4 div. corresponds to +/- 12.5 kHz

TEST PERSONNEL:

DANIEL BALTZELL		MAY 21, 2002
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

PLOT 12-3: (ON TIME) – CHANNEL 6: 481.0125 MHZ {25 KHZ WIDE BAND, LOW POWER}



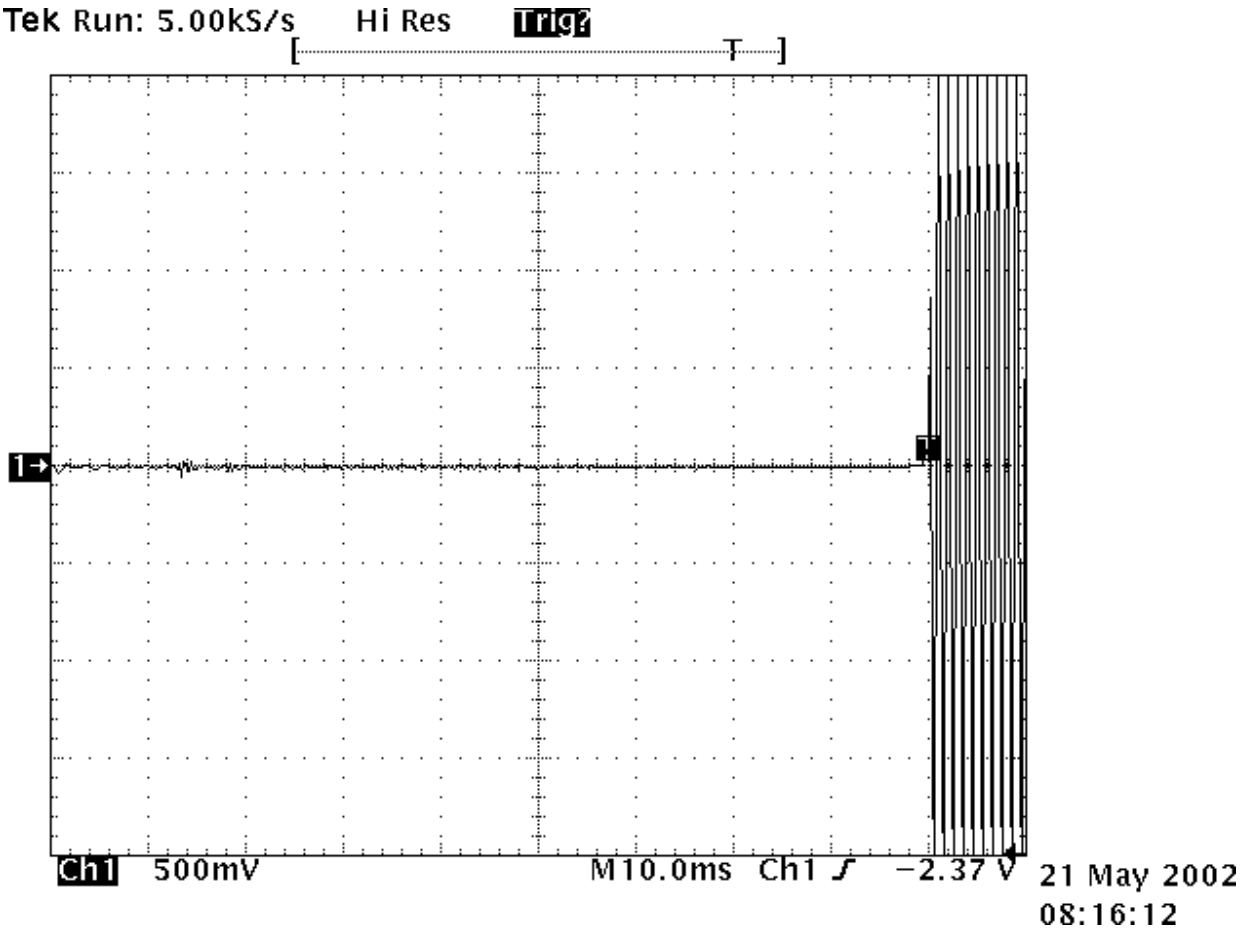
Carrier ON time:
Low Power: 1 W rated
Channel 6 : 481.0125 MHz WB(25kHz)
RF Signal Generator: Modulation 25kHz deviation

Timebase: 10 ms/div
Trigger: On negative edge of Ch2, level –8.8mV
Ch1: 500mV/div, Probe 1.000:1
Vertical scale: +/- 4 div. corresponds to +/- 12.5 kHz

TEST PERSONNEL:

DANIEL BALTZELL		MAY 21, 2002
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

PLOT 12-4: (OFF TIME) – CHANNEL 6: 481.0125 MHZ {25 KHZ WIDE BAND, LOW POWER}



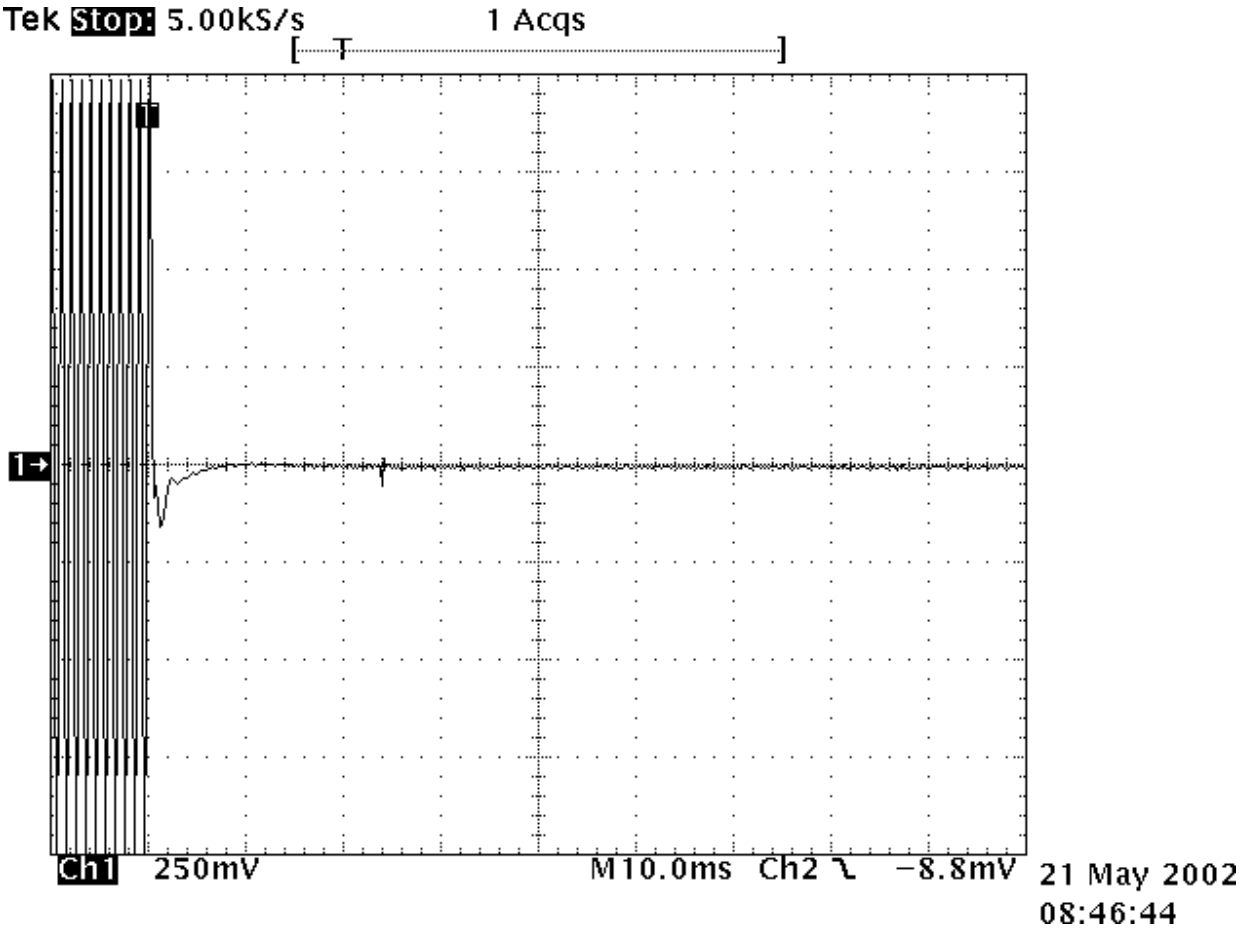
Carrier OFF time:
Low Power: 1 W rated
Channel 6 : 481.0125 MHz WB(25kHz)
RF Signal Generator: Modulation 25kHz deviation

Timebase: 10 ms/div
Trigger: On negative edge of Ch2, level –2.37mV
Ch1: 500mV/div, Probe 1.000:1
Vertical scale: +/- 4 div. corresponds to +/- 12.5 kHz

TEST PERSONNEL:

DANIEL BALTZELL		MAY 21, 2002
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

PLOT 12-5: (ON TIME) – CHANNEL 7: 481.0125 MHZ {12.5 KHZ NARROW BAND, HIGH POWER}



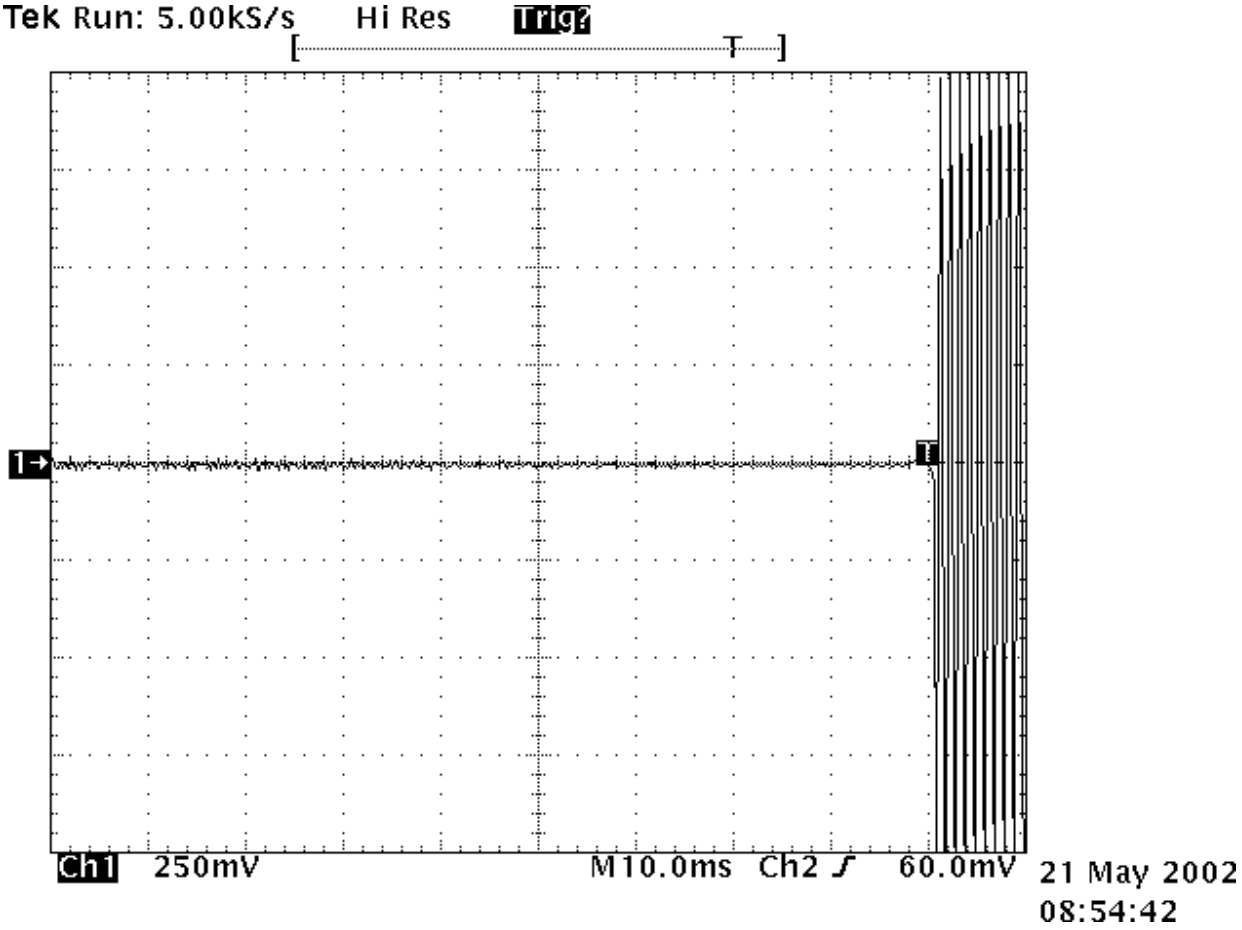
Carrier ON time:
High Power: 4 W rated
Channel 7 : 481.0125 MHz NB(12.5kHz)
RF Signal Generator: Modulation 12.5kHz deviation

Timebase: 10 ms/div
Trigger: On negative edge of Ch2, level –8.8mV
Ch1: 250mV/div, Probe 1.000:1
Vertical scale: +/- 4 div. corresponds to +/- 12.5 kHz

TEST PERSONNEL:

DANIEL BALTZELL		MAY 21, 2002
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

PLOT 12-6: (OFF TIME) – CHANNEL 7: 481.0125 MHZ {12.5 KHZ NARROW BAND, HIGH POWER}



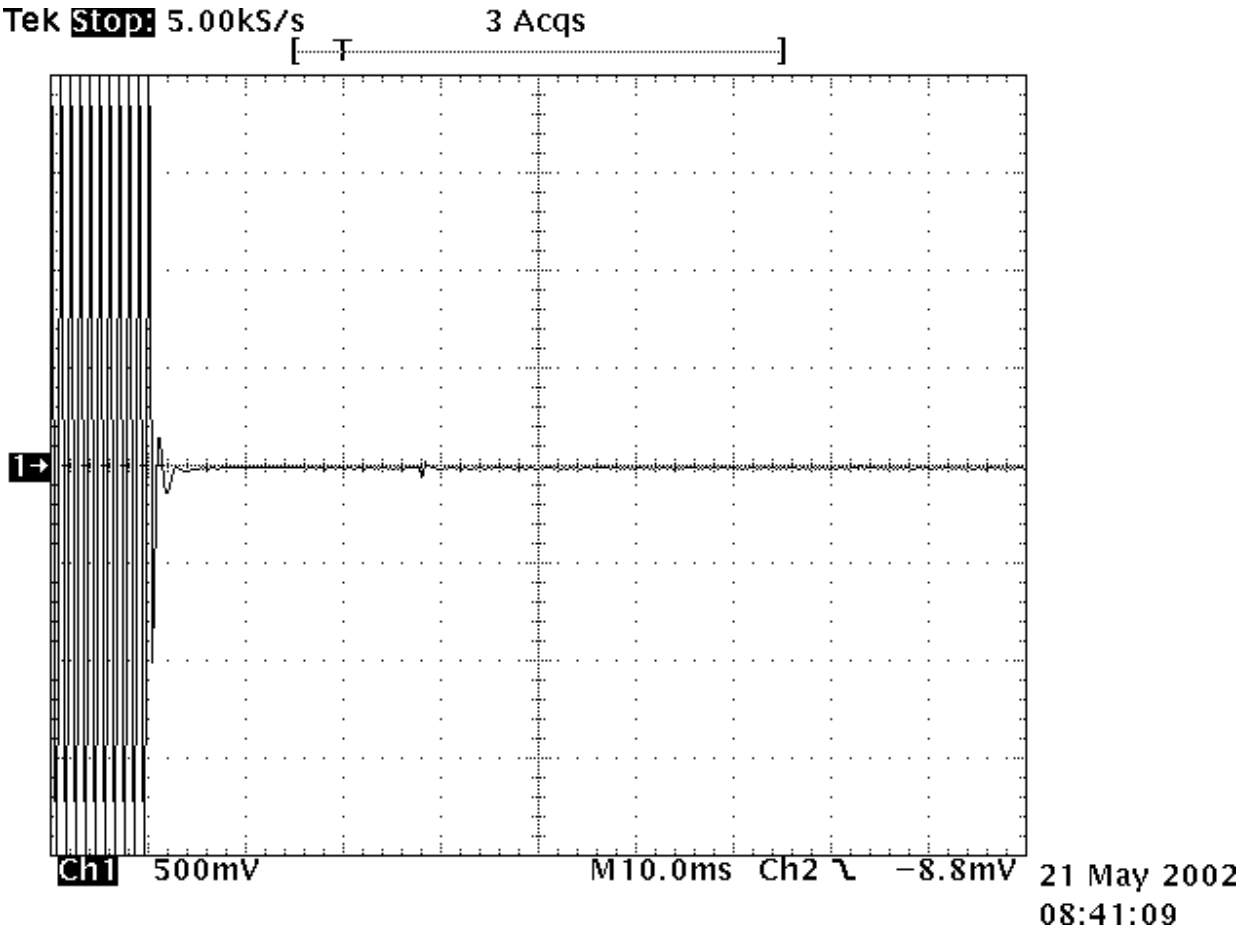
Carrier OFF time:
High Power: 4 W rated
Channel 7 : 481.0125 MHz NB(12.5kHz)
RF Signal Generator: Modulation 12.5kHz deviation

Timebase: 10 ms/div
Trigger: On positive edge of Ch2, level 60mV
Ch1: 250mV/div, Probe 1.000:1
Vertical scale: +/- 4 div. corresponds to +/- 12.5 kHz

TEST PERSONNEL:

DANIEL BALTZELL		MAY 21, 2002
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

PLOT 12-7: (ON TIME) – CHANNEL 8: 481.0125 MHZ {25 KHZ WIDE BAND, HIGH POWER}



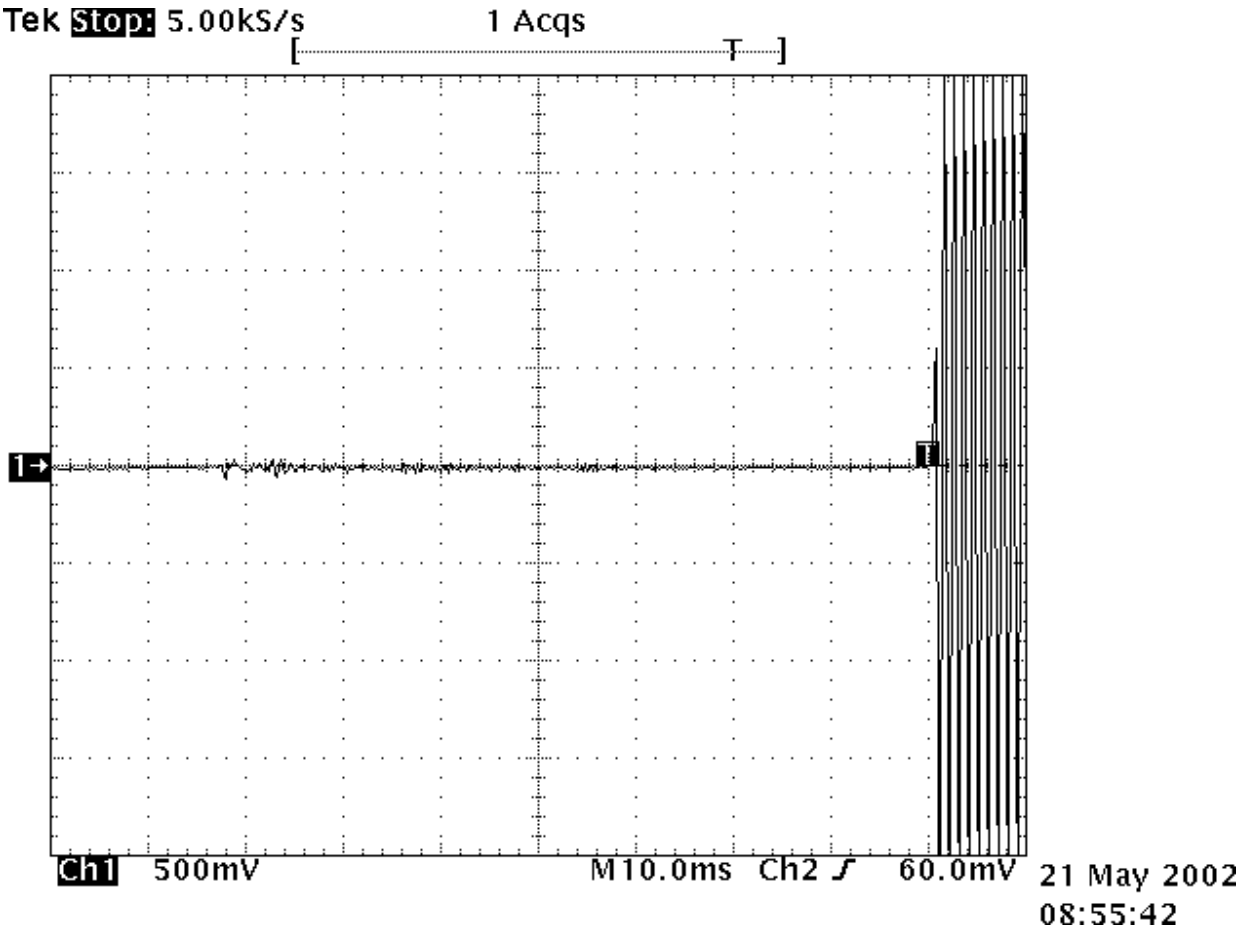
Carrier ON time:
High Power 4 W rated
Channel 8 : 481.0125 MHz WB(25kHz)
RF Signal Generator: Modulation 25kHz deviation

Timebase: 10 ms/div
Trigger: On negative edge of Ch2, level –8.8mV
Ch1: 500mV/div, Probe 1.000:1
Vertical scale: +/- 4 div. corresponds to +/- 12.5 kHz

TEST PERSONNEL:

DANIEL BALTZELL		MAY 21, 2002
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

PLOT 12-8: (OFF TIME) – CHANNEL 8: 481.0125 MHZ {25 KHZ WIDE BAND, HIGH POWER}



Carrier OFF time:
High Power 4 W rated
Channel 8 : 481.0125 MHz WB(25kHz)
RF Signal Generator: Modulation 25kHz deviation

Timebase: 10 ms/div
Trigger: On positive edge of Ch2, level –60mV
Ch1: 500mV/div, Probe 1.000:1
Vertical scale: +/- 4 div. corresponds to +/- 12.5 kHz

TEST PERSONNEL:

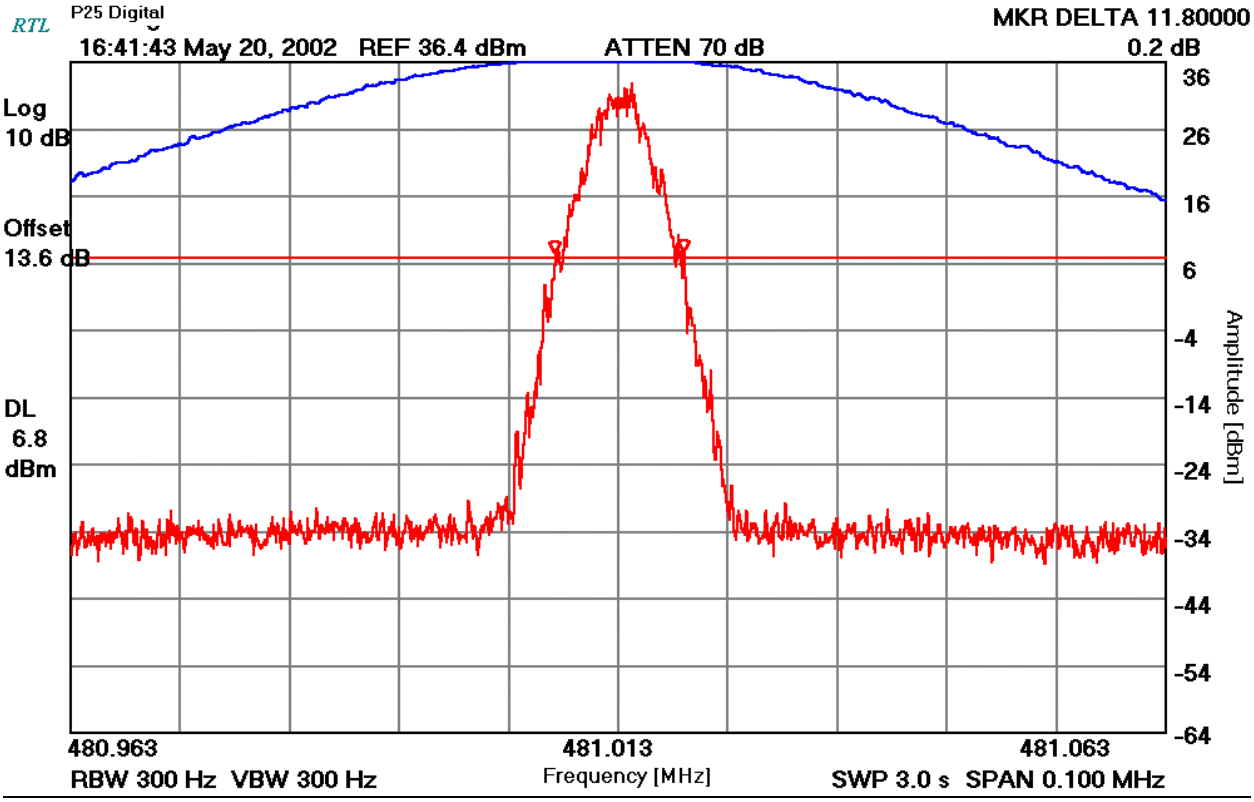
DANIEL BALTZELL		MAY 21, 2002
TEST TECHNICIAN/ENGINEER	SIGNATURE	DATE OF TEST

13 FCC PART 2.202: NECESSARY BANDWIDTH AND EMISSION BANDWIDTH

Type of Emission: F3E and F1E

Necessary Bandwidth and Emission Bandwidth calculation

The 25 kHz Analog modulation necessary bandwidth: Bn = 16K0F3E
The measured P25 Digital modulation necessary bandwidth: Bn = 11K8F1E
The 12.5KHz Analog modulation bandwidth = 11K0F3E



Calculation:

Max modulation (M) in kHz: 3
Max deviation (D) in kHz for (25 KHz channel spacing analog): 5
Max deviation for (D) in kHz for (12.5 KHz channel spacing): 2.5
Constant factor (K): 1
$B_{n(25KHz\ analog)}$ = 2xM+2xDK =(2x3) + (2x5x1) = 16 KHz
$B_{n(P25\ Digital)}$ = 11.8kHz
$B_{n(12.5KHz\ )}$ = 2xM+2xDK = (2x3) +(2x2.5x1) = 11 KHz

14 CONCLUSION

The data in this measurement report shows that E.F. Johnson Model 242-5140, FCC ID: ATH2425140, complies with all the requirements of Parts 2 and 90 of the FCC Rules and Industry Canada RSS-119.