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Measured Radio Frequency Emissions
From

Wayne Dalton Tranceiver
908 MHz Transmitter Report
FCC ID: KJ8-0001115A
Model(s): WDHA-10

Report No. 415031-347
February 1, 2007

For:
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Summary

Tests for compliance with FCC Regulations Part 15, Subpart C, and Industry Canada RSS-210/GEN, were performed on Martec model WDHA-10 transceiver. This device also contains an In-Home Carrier Current system not subject to certification.

In testing completed on February 1, 2007, the device tested met fundamental emission limits by more than 3.2 dB and harmonic limits by more than 14.6 dB. Spurious emissions meet the FCC/IC Class B limit by more than 6.3 dB. AC power line conducted emissions meet the FCC/IC Class B limit by more than 15.3 dB.

1. Introduction

Wayne Dalton model WDHA-10 transceiver was tested for compliance with FCC Regulations, Part 15, adopted under Docket 87-389, April 18, 1989 as amended, and with Industry Canada RSS-210/Gen, Issue 6, September 2005. The tests were performed at the University of Michigan Radiation Laboratory Willow Run Test Range following the procedures described in ANSI C63.4-2003 "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz" and the document, "FCC Regulatory Requirements for Design and Sale of SDARS In-Home Repeater v.2.3" The Site description and attenuation characteristics of the Open Site facility are on file with FCC Laboratory, Columbia, Maryland (FCC Reg. No: 91050) and with Industry Canada, Ottawa, ON (File Ref. No: IC 2057).

2. Test Equipment Used

The pertinent test equipment commonly used in our facility for measurements is listed in Table 2.1 below. The middle column identifies the specific equipment used in these tests.

Table 2.1 Test Equipment.

Test Instrument	Eqpt. Used	Manufacturer/Model
Spectrum Analyzer (9kHz-22GHz)	X	Hewlett-Packard 8593A SN: 3107A01358
Spectrum Analyzer (9kHz-26GHz)	X	Hewlett-Packard 8593E, SN: 3412A01131
Spectrum Analyzer (9kHz-26GHz)		Hewlett-Packard 8563E, SN: 3310A01174
Spectrum Analyzer (9kHz-40GHz)		Hewlett-Packard 8564E, SN: 3745A01031
Power Meter		Hewlett-Packard, 432A
Power Meter		Anritsu, ML4803A/MP
Harmonic Mixer (26-40 GHz)		Hewlett-Packard 11970A, SN: 3003A08327
Harmonic Mixer (40-60 GHz)		Hewlett-Packard 11970U, SN: 2332A00500
Harmonic Mixer (75-110 GHz)		Hewlett-Packard 11970W, SN: 2521A00179
Harmonic Mixer (140-220 GHz)		Pacific Millimeter Prod., GMA, SN: 26
S-Band Std. Gain Horn		S/A, Model SGH-2.6
C-Band Std. Gain Horn	X	University of Michigan, NRL design
XN-Band Std. Gain Horn		University of Michigan, NRL design
X-Band Std. Gain Horn		S/A, Model 12-8.2
X-band horn (8.2- 12.4 GHz)		Narda 640
K-band horn (18-26.5 GHz)		FXR, Inc., K638KF
Ka-band horn (26.5-40 GHz)		FXR, Inc., U638A
U-band horn (40-60 GHz)		Custom Microwave, HO19
W-band horn(75-110 GHz)		Custom Microwave, HO10
G-band horn (140-220 GHz)		Custom Microwave, HO5R
Bicone Antenna (30-250 MHz)	X	University of Michigan, RLBC-1
Bicone Antenna (200-1000 MHz)	X	University of Michigan, RLBC-2
Dipole Antenna Set (30-1000 MHz)	X	University of Michigan, RLDP-1,-2,-3
Dipole Antenna Set (30-1000 MHz)		EMCO 2131C, SN: 992
Active Rod Antenna (30 Hz-50 MHz)		EMCO 3301B, SN: 3223
Active Loop Antenna (30 Hz-50 MHz)		EMCO 6502, SN:2855
Ridge-horn Antenna (300-5000 MHz)	X	University of Michigan
Amplifier (5-1000 MHz)	X	Avantak, A11-1, A25-1S
Amplifier (5-4500 MHz)	X	Avantak
Amplifier (4.5-13 GHz)		Avantek, AFT-12665
Amplifier (6-16 GHz)		Trek
Amplifier (16-26 GHz)		Avantek
LISN Box	X	University of Michigan
Signal Generator		Hewlett-Packard 8657B

3. Configuration and Identification of Device Under Test

The Device Under Test (DUT) is a 908.4 MHz transceiver used to control ambient lighting and other X-10 style products in a residential environment. The size of the DUT is 3(W) x 5(H) x 2(D) inches. Nominal operating voltage is 120 VAC, and the device is also operated from an internal 9 VDC battery. The DUT was designed by Wayne Dalton, 240 Sheffield Street , 3395 Addison Drive. It is identified as:

Wayne Dalton Transceiver
Model(s): WDHA-10
FCC ID: KJ8-0001115A
IC: 3540A-0001115

3.1 Models

There is only a single model of the device. Two software modified versions of the device were supplied, including one capable of repeated Carrier Current transmission, and one in the receive-only mode. The normal operating module was tested to demonstrate transmitter compliance as reported herein. Receive mode testing is performed in the associated receiver test report. Carrier current emissions, subject only to verification, have their compliance demonstrated in a verification report supplied to Wayne Dalton.

3.2 Modes of Operation

The device is capable of only a single mode of operation. The 908.4 MHz transmission is FM modulated at 47.5 kHz and transmits a data pulse with 20 ms duration every 2.0 seconds. See Figure 6.1.

3.3 EMI/EMC Relevant Modifications

No changes where made to the DUT by this test laboratory.

4. Emission Limits

4.1 Radiated Emission Limits (FCC 15.249, 15.209; IC RSS-210e:A2.9)

The DUT tested is a 902-928 MHz ISM band transmitter, subject to FCC 15.249, and all other sections referred to therein. The applicable critical testing frequencies with corresponding emission limits are given in Tables 4.1 and 4.2.

Table 4.1. Radiated Emission Limits (Ref: FCC: 15.249; IC: RSS-210e A2.9)

Frequency (MHz)	Field Strength of Fundamental (mV/m)	Field Strength of Harmonics (µV/m)
902 - 928	50	500

1) Field strength limits are specified at a distance of 3 meters.
2) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in Section 15.209 (Class B), whichever is the lesser attenuation.
3) Peak field strength of any emission above 1GHz shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation.

Table 4.2. Radiated Emission Limits
(FCC: 15.33, 15.35, 15.109/15.209; IC: RSS-210e, 2.7 Table 2)

Freq. (MHz)	Class A, E_{lim} dB(μV/m)	Class B, E_{lim} dB(μV/m)
30-88	49.5	40.0
88-216	54.0	43.5
216-960	56.9	46.0
Above 960	60.0	54.0

Note: Average readings apply above 1000 MHz (1 MHz BW)
Quasi-Peak readings apply up to 1000 MHz (120 kHz BW)

4.2 Conducted Emission Limits (FCC 15.107)

Table 4.3. Conducted emission limits (FCC 15.107; IC RSS-Gen 7.2.2 Table 2 (CISPR)).

Frequency	Class A (dBμV)		Class B (dBμV)	
MHz	μV	dBμV	μV	dBμV
0.150 - 0.50	79	66	66 - 56*	56 - 46*
0.50 - 5	73	60	56	46
5 - 30	73	60	60	50

Notes: 1. The lower limit shall apply at the transition frequency
2. The limit decreases linearly with the logarithm of the frequency in the range 0.15-0.50MHz:
*Class B Quasi-peak: dBμV = 50.25 - 19.12*log(f)
*Class B Average: dBμV = 40.25 - 19.12*log(f)
3. 9 kHz RBW

4.3 Supply Voltage Variation
For intentional radiators, measurements of the variation of the input power or the radiated signal level of the fundamental frequency component of the emission, as appropriate, shall be performed with the supply voltage varied between 85% and 115% of the nominal rated supply voltage. For battery operated equipment, the equipment tests shall be performed using a new battery.

5. Test Procedure and Computations

5.1 Test Procedure: General
Prior to any measurements, all active components of the test setup were allowed a warm-up for a period of approximately one hour, or as recommended by their manufacturers.

5.2 Test Procedure: Radiated Emissions

5.2.1 Anechoic Chamber Measurements
To familiarize with the radiated emission behavior of the DUT, the DUT was first studied and measured in a shielded anechoic chamber. In the chamber there is a set-up similar to that of an outdoor 3-meter site, with a turntable, an antenna mast, and a ground plane. Instrumentation includes spectrum analyzers and other equipment as needed.

In testing for radiated emissions, the DUT was stimulated as mentioned in the previous section. It was placed on the test table flat, on its side, or on its end. In the chamber we studied and recorded all the emissions using a Bicone antenna up to 300 MHz and ridged horn and standard gain horn antennas above

300 MHz. The measurements made in the chamber below 1 GHz are used for pre-test evaluation only. The measurements made above 1 GHz are used in pre-test evaluation and in the final compliance assessment. Photographs included in this filing show the indoor testing of the DUT.

Note 1: For the horn antenna, the antenna pattern is more directive and hence the measurement is essentially that of free space (no ground reflection). Consequently it is not essential to measure the DUT for both antenna polarizations, as long as the DUT is measured on all three of its major axis. In the chamber we also recorded the spectrum and modulation characteristics of the carrier. These data are presented in subsequent sections. As a general procedure, emissions are first tested using a peak detector. If the DUT does not meet the quasi-peak (or average) limits via these measurements, quasi-peak (or average) measurements are then made to demonstrate compliance.

5.2.2 Open Area Test Site (OATS) Measurements

After the chamber measurements, the emissions were re-measured on the outdoor 3-meter site at fundamental and harmonics up to 1 GHz using tuned dipoles and/or the high frequency Bicone. Photographs included in this filing show the DUT on the Open Area Test Site (OATS).

5.2.3 Field Computations

To convert the dBm measured to E(dBµV/m) at the test receiver antenna, E(dBµV/m) is computed from

$$E(dB\mu V/m) = 107\ dB + Pr(R_{meas})(dBm) + K_a - Kg$$

or

$$E(dB\mu V/m) = Pr(R_{meas})(dB\mu V) + K_a - Kg$$

Where P_r = power recorded on spectrum analyzer, dBm or dBµV
K_a = antenna factor, dB/m
K_g = pre-amp gain and/or cable loss, dB

When presenting the data, the highest measured emission at each frequency under all of the possible orientations is given.

5.3 Test Procedure: Conducted Emissions

The DUT is powered either from 120 VAC line or its internal 9VDC “backup” battery. Conducted emissions were measured using a LISN in the standard set-up.

6. Measurement Results

6.1 Digital Radiated Emissions

Table 6.1. Spurious Radiated Emissions 30 MHz to 1000 MHz. RBW = 120 kHz, VBW>RBW. DUT meets FCC/IC Class B spurious emissions limits by more than 6.3 dB. Note that in indoor pre-testing (up to 2.9 GHz), there were no significant spurious emissions observed. See Figure 6.1

6.2 Radiated Emissions – Peak to Average Ratio

Figure 6.2. Peak to Average Ratio. Measurement distance is 3 m. In any given 100 ms window, the worst case on time is 20 ms, or 14.0 dB.

6.3 Radiated Emissions – Fundamental and Band Edges

Figures 6.3. Fundamental and Band Edge Radiated Emissions: 902 – 928 MHz. 120 kHz RBW, VBW > RBW for f < 1 GHz, 1 MHz RBW, VBW>RBW for f > 1 GHz; measurement distance is 3 m. (Pk > QPk where applicable. Limits are Quasi-Peak Limits) Data is reported in Table 6.1. For Peak field strength measurements, the DUT meets the fundamental emissions limits by more than 3.2 dB, and the band edge emissions limits by more than 17.3 dB in the worst case.

6.4 Radiated Emissions - Harmonics

Figure 6.2. Harmonic Radiated Emissions: 1 MHz RBW, VBW>RBW; measurement distance is 3 m. (Pk > QPk > Avg, where applicable. Limits are Average Limits.) All emissions reported in Table 6.1. The DUT meets the harmonic emissions limits by 14.6 dB in the worst case.

6.5 Emission Bandwidth

The measured spectrum of the signal is shown in Figure 6.3. From the plot we see that the -20 dB bandwidth is 110.0 kHz, and the center frequency is 908.4 MHz.

6.6 Effect of Supply Voltage Variation

The DUT is designed to operate on 120 VAC and 9VDC. The relative radiated emissions and frequency were recorded at the fundamental as the supply voltage was varied from 80 to 140 VAC, 4 to 11 VDC. Figure 6.4 shows the emission power variation. Current at 120.0 VAC was 168 mA, at 9 VDC was 28.0 mA.

6.7 Conducted Emissions

Figures 6.5-6.8. Worst case conducted emissions. 9 kHz RBW, VBW > RBW. The DUT meets conducted emissions limits by more than 15.3 dB in the worst case. All emissions reported in Table 6.2.

Table 6.1 Worst Case Radiated Emissions

Radiated Emissions											WD 908 TX; FCC/IC
#	Freq. MHz	Ant. Used	Ant. Pol.	Pr. (PK) dBm	Det.* Used	Ka dB/m	Kg dB	E3* dBµV/m	E3lim dBµV/m	Pass dB	Comments
1	**AC Powered Unit - Worst Case Harmonic Emissions**										
2	908.4	Dip	H	-30.3	Pk	28.4	17.8	87.3	94.0	**6.7**	end
3	908.4	Dip	V	-32.8	Pk	28.4	17.8	84.8	94.0	9.2	side
4	1816.9	Horn RG	H/V	-53.1	Pk	22.1	28.0	34.0	54.0	20.0	flat
5	2725.3	Horn RG	H/V	-52.5	Pk	24.8	25.8	39.4	54.0	14.6	end
6	3633.7	Horn RG	H/V	-63.4	Pk	27.4	23.9	33.1	54.0	20.9	noise
7	4542.1	Horn C	H/V	-55.4	Pk	24.5	33.5	28.7	54.0	25.3	noise
8	5450.6	Horn C	H/V	-60.5	Pk	24.7	38.0	19.2	54.0	34.8	noise
9	6359.0	Horn Xn	H/V	-60.7	Pk	24.4	38.0	18.7	54.0	35.3	noise
10	7267.4	Horn Xn	H/V	-60.0	Pk	25.2	36.8	21.4	54.0	32.6	noise
11	8175.8	Horn X	H/V	-59.3	Pk	27.0	36.8	23.9	54.0	30.1	noise
12	9084.3	Horn X	H/V	-59.7	Pk	27.5	36.8	24.0	54.0	30.0	noise
13											
14	**Battery Operated Unit - Worst Case Fundamental Emission**										
15	908.4	Dip	H	-26.8	Pk	28.4	17.8	90.8	94.0	**3.2**	end
16	908.4	Dip	V	-29.3	Pk	28.4	17.8	88.3	94.0	5.7	side
17											
18											
19											
20											
21	*A duty cycle of 14 dB has been applied to emissions above 1 GHz to show compliance with the average limits.										
22	No duty has been applied to the fundamental emission.										
Digital/Spurious Radiated Emissions											
#	Freq. kHz	Ant. Used	Ant. Pol.	Pr dBm	Det. Used	Ka dB/m	Kg dB	E3 dBµV/m	E3lim dBµV/m	Pass dB	Comments
#	30.1	Bic	H	-83.2	Pk	13.2	26.0	11.0	40.0	29.0	
24	30.1	Bic	V	-80.2	Pk	13.2	26.0	14.0	40.0	26.0	
25	50.3	Bic	H	-79.8	Pk	9.1	25.7	10.5	40.0	29.5	
26	50.3	Bic	V	-77.0	Pk	9.1	25.7	13.3	40.0	26.7	
27	80.7	Bic	H	-74.7	Pk	7.6	25.3	14.6	40.0	25.4	
28	80.7	Bic	V	-74.5	Pk	7.6	25.3	14.8	40.0	25.2	
29	150.0	Bic	H	-77.9	Pk	12.5	24.2	17.4	43.5	26.1	
30	150.0	Bic	V	-79.5	Pk	12.5	24.2	15.8	43.5	27.7	
31	210.2	Bic	H	-81.0	Pk	14.8	23.4	17.4	43.5	26.1	
32	210.2	Bic	V	-79.3	Pk	14.8	23.4	19.1	43.5	24.4	
33	249.5	Bic	H	-79.1	Pk	14.6	23.0	19.5	46.0	26.5	
34	249.5	Bic	V	-78.7	Pk	14.6	23.0	19.9	46.0	26.1	
35	908.0	SBic	H	-79.2	Pk	29.4	17.5	39.7	46.0	**6.3**	
36	908.0	SBic	V	-81.2	Pk	29.4	17.5	37.7	46.0	8.3	
37											
38											
39											

Univ. of Mich. 01/08/2007

Table 6.2 Highest Conducted Emissions Measured

												WD 908 TX; FCC/IC
	Freq.	Line	Peak Det., dBµV		Pass	QP Det., dBµV		Pass	Ave. Det., dBµV		Pass	
#	MHz	Side	Vtest	Vlim*	dB*	Vtest	Vlim	dB	Vtest	Vlim	dB	Comments
1	0.85	Lo	28.3	46.0	17.7		56.0			46.0		
2	1.07	Lo	28.3	46.0	17.7		56.0			46.0		
3	1.51	Lo	30.0	46.0	16.1		56.0			46.0		
4	1.63	Lo	28.9	46.0	17.1		56.0			46.0		
5	3.66	Lo	30.7	46.0	**15.3**		56.0			46.0		
6	7.31	Lo	29.3	50.0	20.7		60.0			50.0		
7												
8	0.29	Hi	27.3	50.4	23.1		60.5			50.4		
9	0.61	Hi	26.1	46.0	19.9		56.0			46.0		
10	0.66	Hi	26.4	46.0	19.6		56.0			46.0		
11	0.79	Hi	26.8	46.0	19.2		56.0			46.0		
12	1.13	Hi	26.6	46.0	19.4		56.0			46.0		
13	1.23	Hi	26.7	46.0	19.3		56.0			46.0		
14	1.51	Hi	27.9	46.0	18.1		56.0			46.0		
15	1.57	Hi	26.8	46.0	19.2		56.0			46.0		
16	1.79	Hi	25.9	46.0	20.1		56.0			46.0		
17	1.85	Hi	26.0	46.0	20.0		56.0			46.0		
18	7.31	Hi	26.9	50.0	23.1		60.0			50.0		
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**Average limit* Meas. 01/05/2006; U of Mich.

Since Vpeak >= Vqp >= Vave and if Vtestpeak < Vavelim, then Vqplim and Vavelim are met.

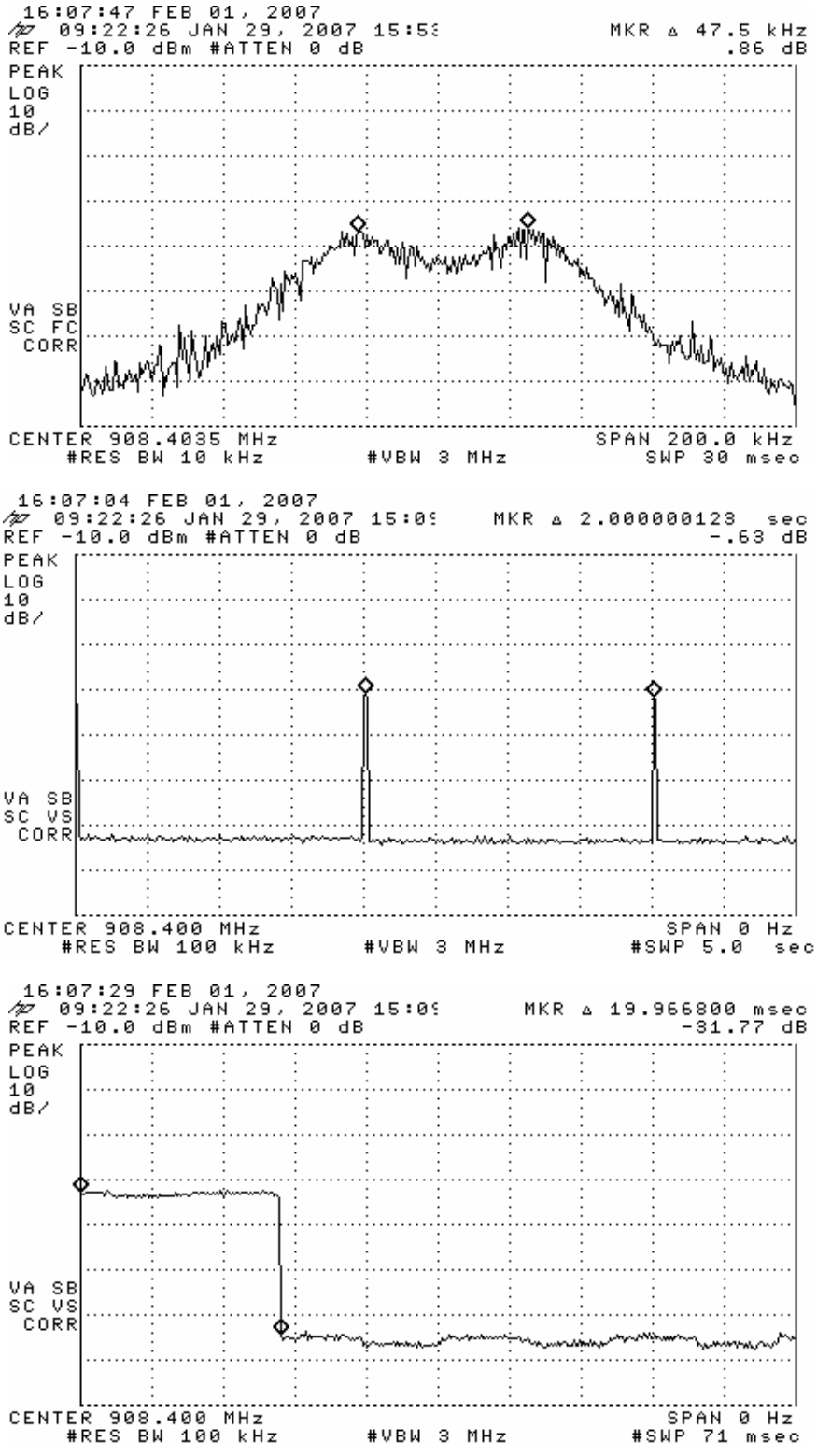


Figure 6.1. Fundamental Emission (top) FM modulation,
(middle) Pulse Period, (bottom) Pulse width

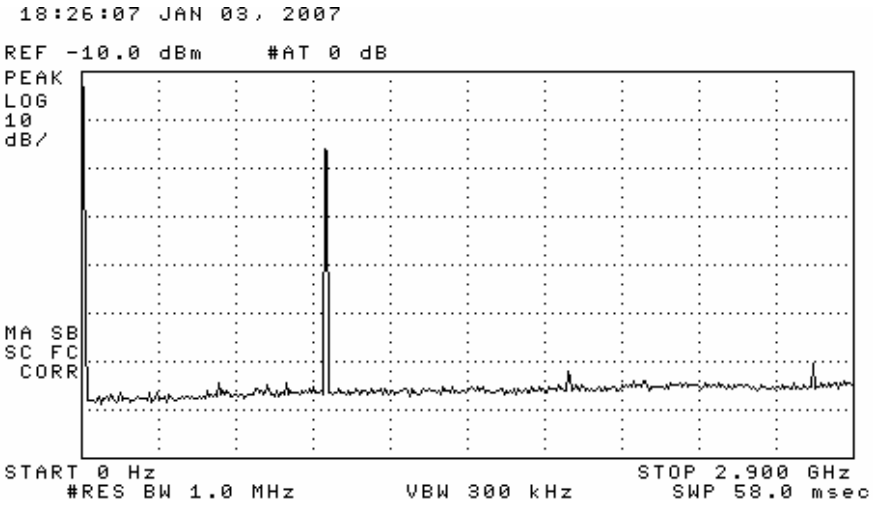
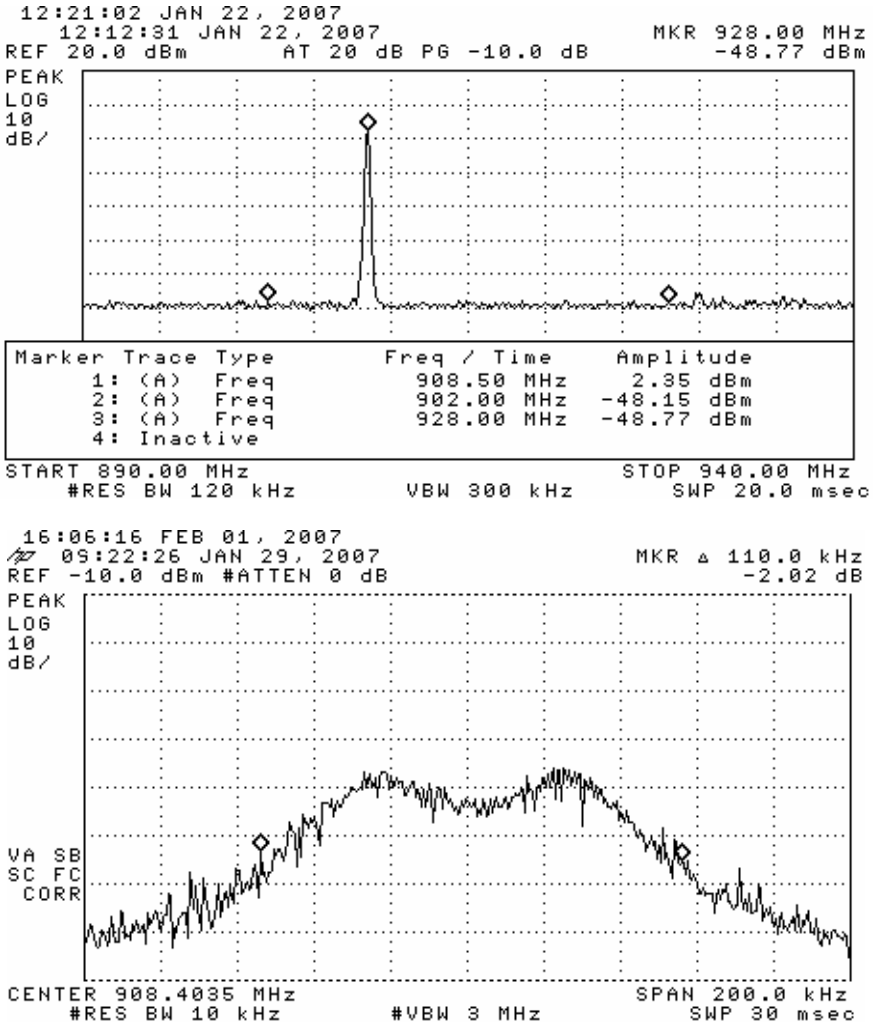


Figure 6.2. Emission spectrum of the DUT. Amplitudes are only indicative (not calibrated).



Figures 6.3. (top) Relative band edge emissions Semi-anechoic Chamber measurements, (bottom) Emission Bandwidth

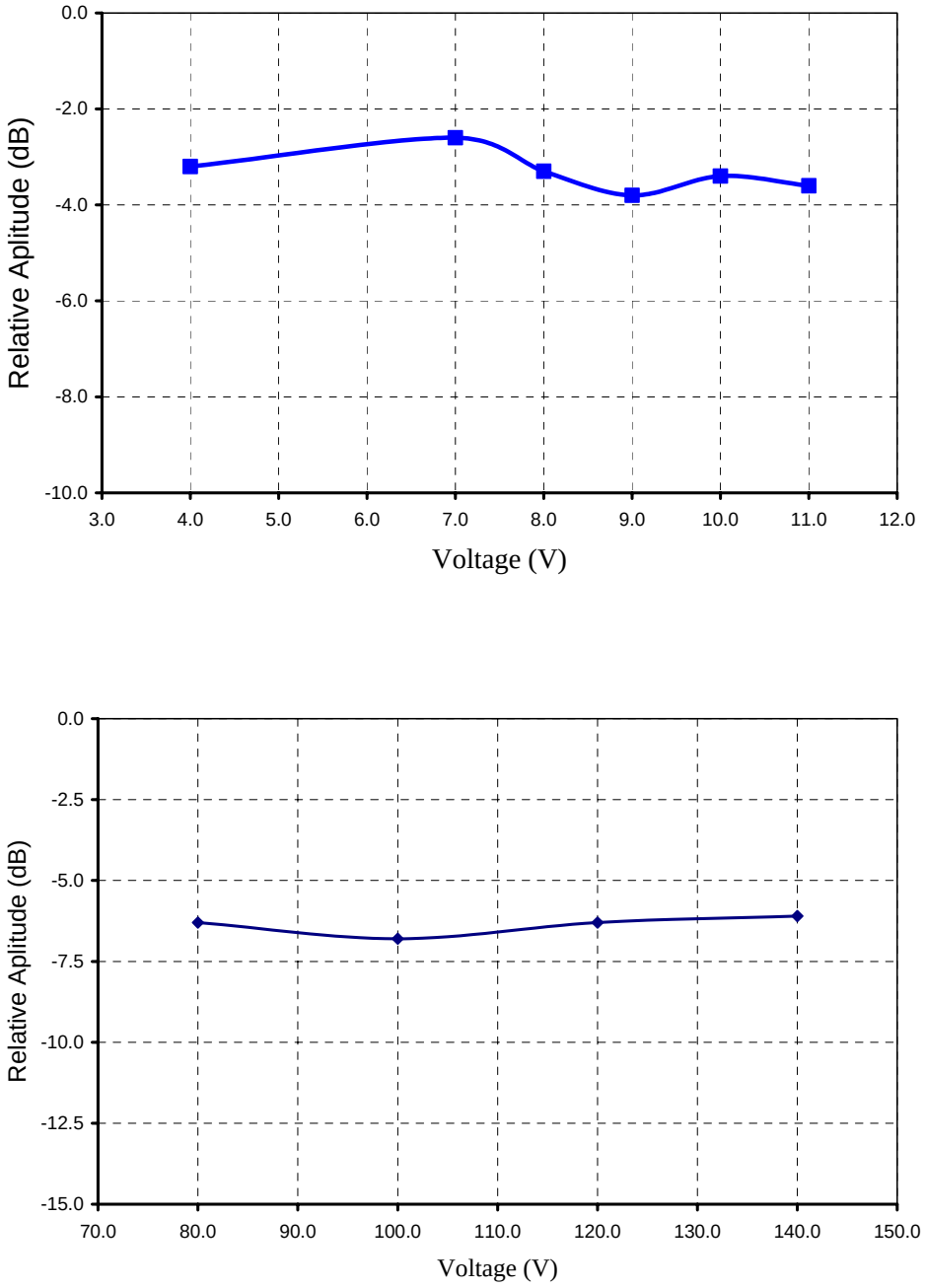
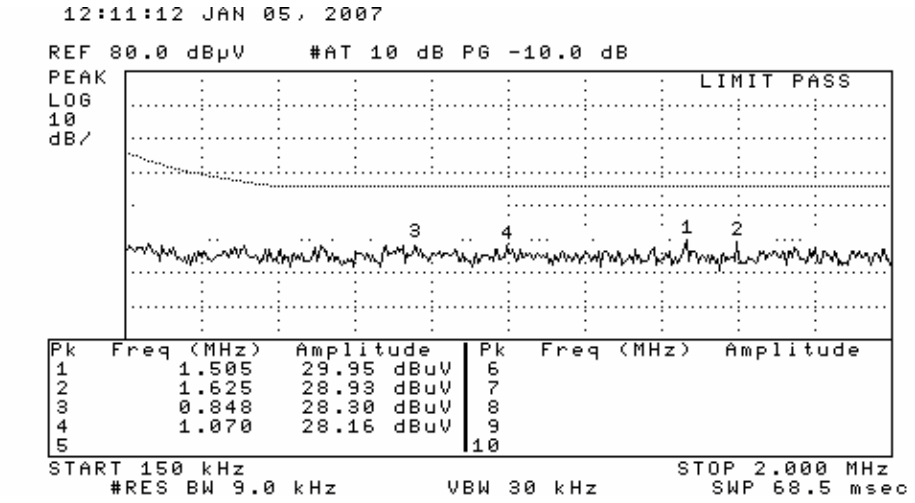


Figure 6.4. Relative emission at fundamental (f_M) vs. supply voltage.
(top) Battery Operated, (bottom) AC Power



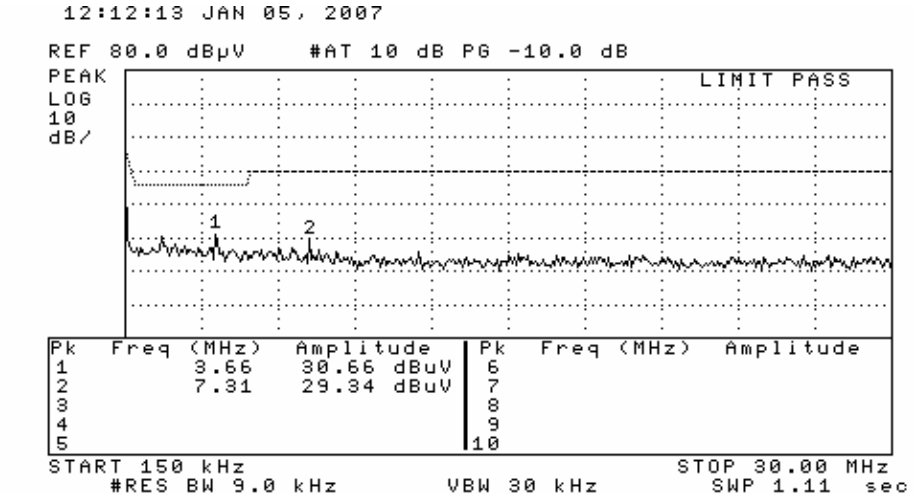
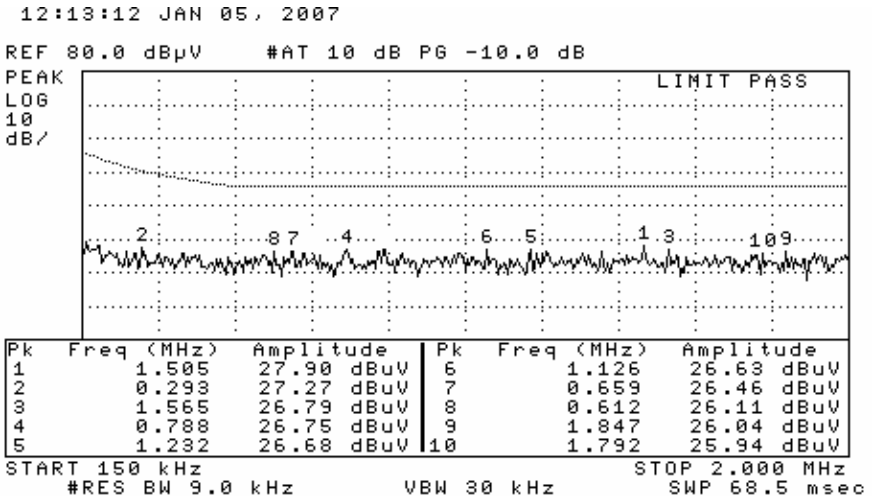


Figure 6.5-6.6. Conducted Emissions (5.4), HI line – (0-2 MHz) (0-30 MHz)



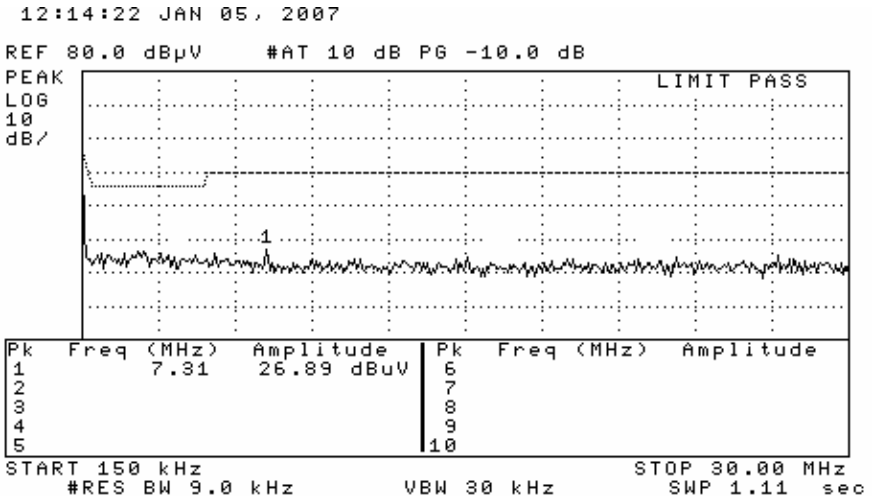


Figure 6.7-6.8. Conducted Emissions (5.4) LO line – (0-2 MHz) (0-30 MHz)

DUT on OATS

DUT on OATS (Close-up)