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Measured Radio Frequency Emissions
From

Ensure Technologies, Inc. Transmitter
FCC ID: NW5XC4
IC: 3937A-4

Test Report No. 417124-518
August 16, 2009

For:
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Summary

Tests for compliance with FCC Regulations, CFR 47, Part 15 and with Industry Canada RSS-210/Gen, were performed on a Ensure, FCC ID: NW5XC4, IC: 3937A-4. This device under test (DUT) is subject to the rules and regulations as a Transmitter.

In testing completed on August 15, 2008, the DUT tested met the allowed specifications for radiated emissions by 2.8 dB. Conducted emissions are not subject to regulation as the DUT is powered by a 3 VDC battery.

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1. Introduction

This Ensure Transmitter was tested for compliance with FCC Regulations, Part 15, adopted under Docket 87-389, April 18, 1989 as subsequently amended, and with Industry Canada RSS-210/Gen, Issue 7, June 2007. 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". 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 2057A-1).

2. 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. The quality system employed at the University of Michigan Radiation Laboratory Willow Run Test Range has been established to ensure all equipment has a clearly identifiable classification, calibration expiry date, and that all calibrations are traceable to national standards.

Table 2.1 Test Equipment.

Test Instrument	Used	Manufacturer/Model	Q Number
Spectrum Analyzer (9kHz-26GHz)	X	Hewlett-Packard 8593E, SN: 3412A01131	HP8593E1
Spectrum Analyzer (9kHz-6.5GHz)	X	Hewlett-Packard 8595E, SN: 3543A01546	JDB8595E
Power Meter		Hewlett-Packard, 432A	HP432A1
Harmonic Mixer (26-40 GHz)		Hewlett-Packard 11970A, SN: 3003A08327	HP11970A1
Harmonic Mixer (40-60 GHz)		Hewlett-Packard 11970U, SN: 2332A00500	HP11970U1
Harmonic Mixer (75-110 GHz)		Hewlett-Packard 11970W, SN: 2521A00179	HP11970W1
Harmonic Mixer (140-220 GHz)		Pacific Millimeter Prod., GMA, SN: 26	PMPGMA1
S-Band Std. Gain Horn	X	S/A, Model SGH-2.6	SBAND1
C-Band Std. Gain Horn	X	University of Michigan, NRL design	CBAND1
XN-Band Std. Gain Horn	X	University of Michigan, NRL design	XNBAND1
X-Band Std. Gain Horn		S/A, Model 12-8.2	XBAND1
X-band horn (8.2- 12.4 GHz)		Narda 640	XBAND2
X-band horn (8.2- 12.4 GHz)	X	Scientific Atlanta , 12-8.2, SN: 730	XBAND3
K-band horn (18-26.5 GHz)	X	FXR, Inc., K638KF	KBAND1
Ka-band horn (26.5-40 GHz)		FXR, Inc., U638A	KABAND1
U-band horn (40-60 GHz)		Custom Microwave, HO19	UBAND1
W-band horn(75-110 GHz)		Custom Microwave, HO10	WBAND1
G-band horn (140-220 GHz)		Custom Microwave, HO5R	GBAND1
Bicone Antenna (30-250 MHz)	X	University of Michigan, RLBC-1	LBBIC1
Bicone Antenna (200-1000 MHz)	X	University of Michigan, RLBC-2	HBBIC1
Dipole Antenna Set (30-1000 MHz)	X	University of Michigan, RLDP-1,-2,-3	UMDIP1
Dipole Antenna Set (30-1000 MHz)		EMCO 3121C, SN: 992 (Ref. Antennas)	EMDIP1
Active Rod Antenna (30 Hz-50 MHz)		EMCO 3301B, SN: 3223	EMROD1
Active Loop Antenna (30 Hz-50 MHz)		EMCO 6502, SN:2855	EMLOOP1
Ridge-horn Antenna (300-5000 MHz)	X	University of Michigan	UMRH1
Amplifier (5-1000 MHz)	X	Avantek, A11-1, A25-1S	AVAMP1
Amplifier (5-4500 MHz)	X	Avantek	AVAMP2
Amplifier (4.5-13 GHz)	X	Avantek, AFT-12665	AVAMP3
Amplifier (6-16 GHz)		Trek	TRAMP1
Amplifier (16-26 GHz)	X	Avantek	AVAMP4
LISN Box		University of Michigan	UMLISN1
Signal Generator		Hewlett-Packard 8657B	HPSG1

3. Device Under Test

3.1 Description & Block Diagram

The DUT is a 903-927 Transmitter used to determine a user's proximity to an associated receiver (used on a personal computer) which will automatically lock the computer screen when the user is not physically present. The DUT is 6 x 8.5 x 0.8 cm in dimension with an operating voltage of 3VDC. The device employs two internal antennas (wires) to achieve transmit spatial diversity. The DUT is designed and manufactured by 135 South Prospect, Suite 100, Ypsilanti, MI 48198.

Device Tested	[Make], Model	[S/N],P/N	EMC Consideration
Normal Mode DUT	[Ensure], XC-4	[5044]	903 MHz
DUT (903 MHz)	[Ensure], XC-4	[5010]	CW modified
DUT (915 MHz)	[Ensure], XC-4	[5011]	CW modified
DUT (927 MHz)	[Ensure], XC-4	[5012]	CW modified
DUT (903 MHz)	[Ensure], XC-4	[5014]	22 Hz modified
DUT (915 MHz)	[Ensure], XC-4	[5016]	22 Hz modified
DUT (927 MHz)	[Ensure], XC-4	[5018]	22 Hz modified

3.2 Variants & Samples

There is only single commercial variant of this device. Because of the application in which these commercial devices are used, the manufacturer sets the power level of each device, via software, to the minimum value that meets the needs of the installation environment. The center frequency of operation may be set between 903 MHz and 927 MHz. These devices are professionally installed. Complete testing at the highest power setting (worst-case emissions) and necessary testing of the lowest power setting (minimal emissions) are reported herein. It is the intent of this report to demonstrate compliance for the full range of fundamental output power reported.

To ensure compliance with the limitations of employing quasi-peak measurements below 1 GHz (FCC 15.35), an additional set of devices was supplied employing a PRF of >20 Hz with peak power level set equal to those of the normal operating samples. Finally, the power level of these samples was decreased (via software by the Ensure engineer) to the lower power setting (reported herein) so that such testing could be completed.

3.3 Modes of Operation

There is only a single mode of operation for this device. The DUT employs two internal transmit antennas (wires) attached to the PCB. The first data packet is transmitted from one antenna and the second packet is transmitted from the other antenna, and pairs of packets are transmitted once every second after the device is turned on, with an automatic shut-down after an 8 hour period.

3.4 Exemptions

None.

3.5 EMC Relevant Modifications

No EMI Relevant Modifications were performed by this test laboratory.

4. Emissions Limits

4.1 Radiated Emissions Limits

The DUT tested falls under the category of an Intentional Radiator. The applicable testing frequencies and corresponding emission limits set by both the FCC and IC are given in Tables 4.1 and 4.2 below.

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

Frequency (MHz)	Field Strength of Fundamental (mV/m)	Field Strength of Harmonics (μV/m)
902.0 – 928.0	50	500
2400 - 2483.5	50	500
5725.0 – 5875.0	50	500
24000.0 – 24250.0	250	2500

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. (15.35)

Table 4.2. Spurious Emission Limits (FCC: 15.33, .35, .109/209; IC: RSS-210 2.7, T2)

Freq. (MHz)	E_{lim} (3m) μV/m	E_{lim} dB(μV/m)
30-88	100	40.0
88-216	150	43.5
216-960	200	46.0
960-2000	500	54.0

Note: Average readings apply above 1000 MHz (1 MHz BW), Quasi-Peak readings apply to 1000 MHz (120 kHz RBW), PRF of intentional emissions > 20 Hz for QPK to apply.

Power Line Conducted Emissions Limits

Table 4.3 Emission Limits (FCC:15.107 (CISPR); IC: RSS-Gen, 7.2.2 T2).

Frequency (MHz)	Class A (dBμV)		Class B (dBμV)	
	Quasi-peak	Average	Quasi-peak	Average
.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 0.15-0.50 MHz:
   *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

5. Measurement Procedures

5.1 Semi-Anechoic Chamber Radiated Emissions

To become familiar with the radiated emission behavior of the DUT, the device is first studied and measured in our shielded semi-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.

The DUT is laid on the test table as shown in the included block diagram and/or photographs. A shielded loop antenna is employed when studying emissions from 9 kHz to 30 MHz. Above 30 MHz and below 250 MHz a biconical antenna is employed. Above 250 MHz a ridge or and standard gain horn antennas are used. The spectrum analyzer resolution and video bandwidths are set so as to measure the DUT emission without decreasing the emission bandwidth (EBW) of the device. Emissions are studied for all orientations (3-axes) of the DUT and all test antenna polarizations. In the chamber, spectrum and modulation characteristics of intentional carriers are recorded. Receiver spurious emissions are measured with an appropriate carrier signal applied. Associated test data is presented in subsequent sections.

5.2 Outdoor Radiated Emissions

After measurements are performed indoors, emissions on our outdoor 3-meter Open Area Test Site (OATS) are made. If the DUT connects to auxiliary equipment and is table or floor standing, the configurations prescribed in ANSI C63.4 are employed. Alternatively, an on-table layout more representative of actual use may be employed if the resulting emissions appear to be worst-case in such a configuration. Any intentionally radiating elements are placed on the test table flat, on their side, and on their end (3-axes) and worst case emissions are recorded. For each configuration the DUT is rotated 360 degrees about its azimuth and the receive antenna is raised and lowered between 1 and 4 meters to maximize radiated emissions from the device. Receiver spurious emissions are measured with an appropriate carrier signal applied. For devices with intentional emissions below 30 MHz, our shielded loop antenna at a 1 meter received height is used. Low frequency field extrapolation to the regulatory limit distance is employed as needed. Emissions between 30 MHz and 1 GHz are measured using tuned dipoles and/or biconical antennas. Care is taken to ensure that the RBW and VBW used meet the regulatory requirements, and that the EBW of the DUT is not reduced. The Photographs included in this report show the DUT on the OATS.

5.3 Radiated Field Computations

To convert the dBm values measured on the spectrum analyzer to dB(μV/m), we use expression

$$E3(dB\mu V/m) = 107 + PR + KA - KG + KE - CF$$

where

PR	=	power recorded on spectrum analyzer, dBm, measured at 3 m
KA	=	antenna factor, dB/m
KG	=	pre-amplifier gain, including cable loss, dB
KE	=	duty correction factor, dB
CF	=	distance conversion (employed only if limits are specified at alternate distance), dB

When presenting the data at each frequency, the highest measured emission under all of the possible DUT orientations (3-axes) is given.

5.4 Indoor Power Line Conducted Emissions

When applicable, power line conducted emissions are measured in our semi-anechoic chamber. If the DUT connects to auxiliary equipment and is table or floor standing, the configurations prescribed in ANSI C63.4 are employed. Alternatively, an on-table layout more representative of actual use may be employed if the resulting emissions appear to be worst-case in such a configuration.

The conducted emissions measured with the spectrum analyzer and recorded (in dBμV) from 0-2 MHz and 2-30 MHz for both the ungrounded (Hi) and grounded (Lo) conductors. The spectrum analyzer is set to peak-hold mode in order to record the highest peak throughout the course of functional operation. Only when the emission exceeds or is near the limit are quasi-peak and average detection used.

5.5 Supply Voltage Variation

Measurements of the variation in the fundamental radiated emission were performed with the supply voltage varied by no less than 85% and 115% of the nominal rated value. For battery operated equipment, tests were performed using a new battery, and worst case emissions are re-checked employing a new battery.

6. Test Results

6.1 Radiated Emissions

6.1.1 Peak to Average Ratio

Figure 6.1. Peak to Average Ratio. During normal operation the worst case on time consists of two 2.1 ms pulses in any given 100 ms window; a peak-to-average duty of: K_E = (2 x 2.1 ms)/ 100 ms = 0.04 < 20 dB However, since these devices employ a PRF of < 20 Hz, a set of devices with PRF modified to 21 Hz were employed for quasi-peak measurements. The peak power setting of these devices was identical to the normal operating devices supplied.

6.1.2 Emission Spectrum

The relative DUT emission spectrum is recorded and is shown in Figure 6.2.

6.1.3 Emission Bandwidth

The emission bandwidth of the signal is shown in Figure 6.3. Therein the worst case 99% bandwidth measured to be 638 kHz.

6.1.4 Supply Voltage and Supply Voltage Variation

The DUT has been designed to be powered by a 3 VDC battery. For this test, relative radiated power was measured at the fundamental as the voltage was varied from 2 to 4 volts. The emission variation is shown in Figure 6.4.

Batteries:	before testing	V_{oc} =	3.32 V
	after testing	V_{oc} =	3.15 V
Ave. current from batteries		I =	21 mA (cw)

6.2 Conducted Emissions

These tests do not apply, since the DUT is powered from a 3 VDC battery.

Table 6.1 Radiated Highest Emissions Measured

Radiated Emission - RF											Ensure XC-4; FCC/IC
#	Freq. MHz	Ant. Used	Ant. Pol.	Pr dBm	Det. Used	Ka dB/m	Kg dB	E3* dBμV/m	E3lim dBμV/m	Pass dB	Comments
1	**Highest Power Setting (modified to 21 Hz PRF; 903, 915, 927 MHz)**										
2	903.0	Dip	H	-28.5	QPk	28.3	15.2	91.6	94.0	**2.4**	flat
3	903.0	Dip	V	-33.0	QPk	28.3	15.2	87.1	94.0	6.9	side
4	915.0	Dip	H	-30.1	QPk	28.5	15.2	90.2	94.0	3.8	flat
5	915.0	Dip	V	-33.8	QPk	28.5	15.2	86.5	94.0	7.5	side
6	927.0	Dip	H	-30.3	QPk	28.6	15.1	90.2	94.0	3.8	flat
7	927.0	Dip	V	-34.0	QPk	28.6	15.1	86.5	94.0	7.5	side
8	1806.0	Horn RG	H/V	-41.1	Pk	22.1	28.0	40.0	54.0	14.0	max all
9	1830.0	Horn RG	H/V	-41.2	Pk	22.1	28.0	39.9	54.0	14.1	max all
10	1854.0	Horn RG	H/V	-41.0	Pk	22.2	28.0	40.2	54.0	13.8	max all
11	2709.0	Horn RG	H/V	-68.0	Pk	24.7	25.9	17.8	54.0	36.2	max all
12	2745.0	Horn RG	H/V	-66.5	Pk	24.8	25.8	19.5	54.0	34.5	max all
13	2781.0	Horn RG	H/V	-68.6	Pk	24.9	25.7	17.6	54.0	36.4	max all
14	3612.0	Horn RG	H/V	-70.3	Pk	27.4	23.9	20.1	54.0	33.9	max all
15	3660.0	Horn RG	H/V	-67.4	Pk	27.5	23.8	23.3	54.0	30.7	max all
16	3708.0	Horn RG	H/V	-67.2	Pk	27.6	23.7	23.7	54.0	30.3	max all
17	4515.0	Horn C	H/V	-62.1	Pk	24.5	33.0	16.4	54.0	37.6	max all
18	4575.0	Horn C	H/V	-57.7	Pk	24.5	34.1	19.8	54.0	34.2	max all
19	4635.0	Horn C	H/V	-57.5	Pk	24.6	35.1	18.9	54.0	35.1	max all
20	5418.0	Horn C	H/V	-36.7	Pk	24.7	38.0	37.0	54.0	17.0	max all
21	5490.0	Horn C	H/V	-34.7	Pk	24.8	38.0	39.1	54.0	14.9	max all
22	5562.0	Horn C	H/V	-33.8	Pk	24.8	38.0	40.0	54.0	14.0	max all
23	6321.0	Xn-Horn	H/V	-50.9	Pk	24.4	38.0	22.5	54.0	31.5	max all
24	6405.0	Xn-Horn	H/V	-53.7	Pk	24.5	38.0	19.8	54.0	34.2	max all
25	6489.0	Xn-Horn	H/V	-51.8	Pk	24.5	38.0	21.7	54.0	32.3	max all
26	7224.0	Xn-Horn	H/V	-40.6	Pk	25.1	36.8	34.7	54.0	19.3	max all
27	7320.0	Xn-Horn	H/V	-43.8	Pk	25.2	36.8	31.6	54.0	22.4	max all
28	7416.0	Xn-Horn	H/V	-43.4	Pk	25.3	36.8	32.1	54.0	21.9	max all
29	8127.0	X-Horn	H/V	-55.4	Pk	27.0	36.8	21.8	54.0	32.2	max all
30	8235.0	X-Horn	H/V	-60.1	Pk	27.0	36.8	17.1	54.0	36.9	max all
31	8343.0	X-Horn	H/V	-54.8	Pk	27.1	36.8	22.5	54.0	31.5	max all
32	9030.0	X-Horn	H/V	-44.8	Pk	27.5	36.8	32.9	54.0	21.1	max all
33	9150.0	X-Horn	H/V	-47.2	Pk	27.5	36.8	30.5	54.0	23.5	max all
34	9270.0	X-Horn	H/V	-45.0	Pk	27.6	36.8	32.8	54.0	21.2	max all
35											
36	**Lowest Power Setting (21 Hz modified; 903 MHz)**										
37	903.0	Dip	H	-33.5	QPk	28.3	15.2	86.6	94.0	7.4	flat
38											
39	* includes a 20 dB duty factor above 1000 MHz when Pk measurements are taken.										

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Table 6.2 Highest Radiated Emissions Measured

Band Edge Radiated Emissions											Ensure XC-4; FCC/IC
#	Freq. MHz	Ant. Used	Ant. Pol.	Pr dBm	Det. Used	Ka dB/m	Kg dB	E3* dBµV/m	E3lim dBµV/m	Pass dB	Comments
1	**Band Edges (21 Hz modified, High Power, 903, 915, 927 MHz)**										
2	902.0	Dip	H	-77.3	QPk	28.3	17.2	40.8	46.0	5.2	max all
3	928.0	Dip	H	-76.0	QPk	28.6	17.1	42.5	46.0	3.5	max all
4											
Digital 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
5											
6											
7											
8	Digital emissions more than 20 dB below FCC/IC Class B Limit.										
9											
10											
11											
12											
13											
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Meas. 08/10/2009; U of Mich.

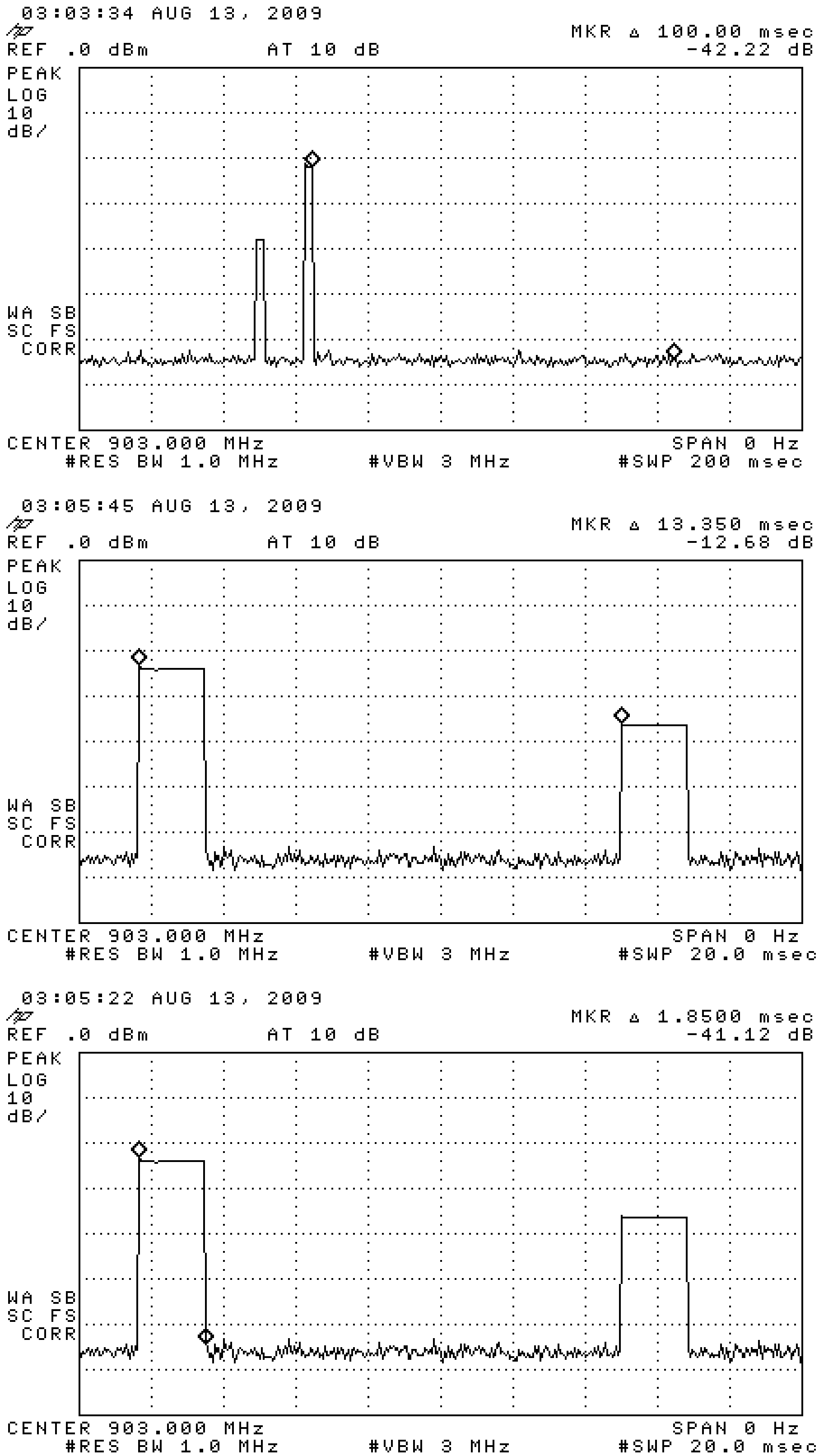


Figure 6.1(a). Transmission modulation characteristics (normal mode). (top) one transmission, (center) one packet for each antenna, (bottom) FSK packet width.

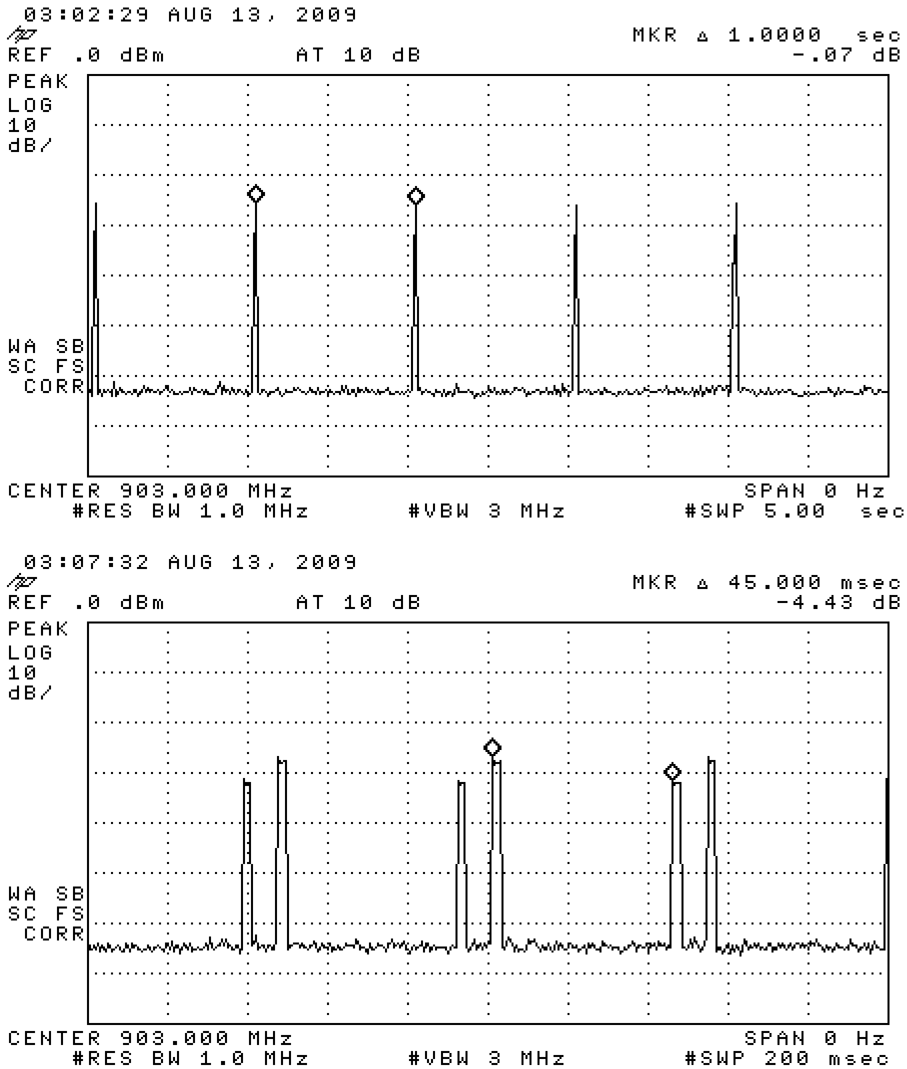


Figure 6.1(b). (top) Normal Period (1 Hz), (bottom) modified to 22 Hz for QPk measurements.

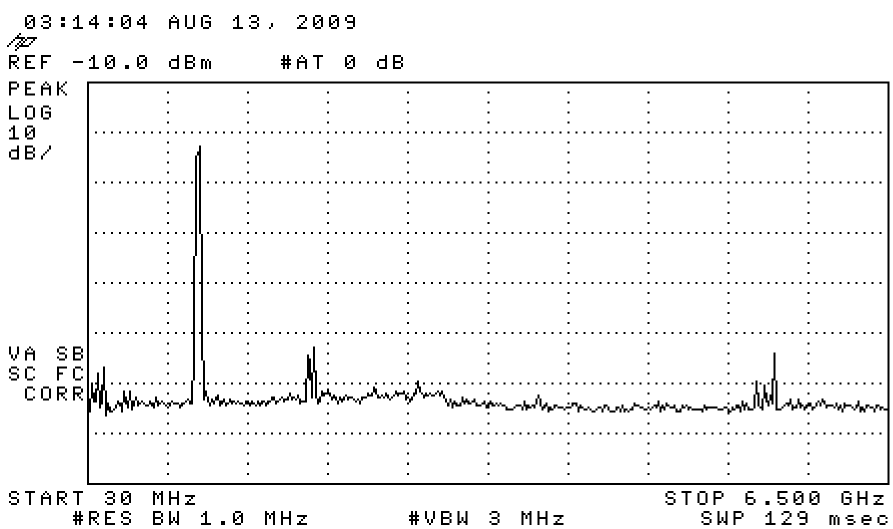


Figure 6.2. Emission spectrum of the DUT (pulsed emission). Amplitudes are only indicative (not calibrated).

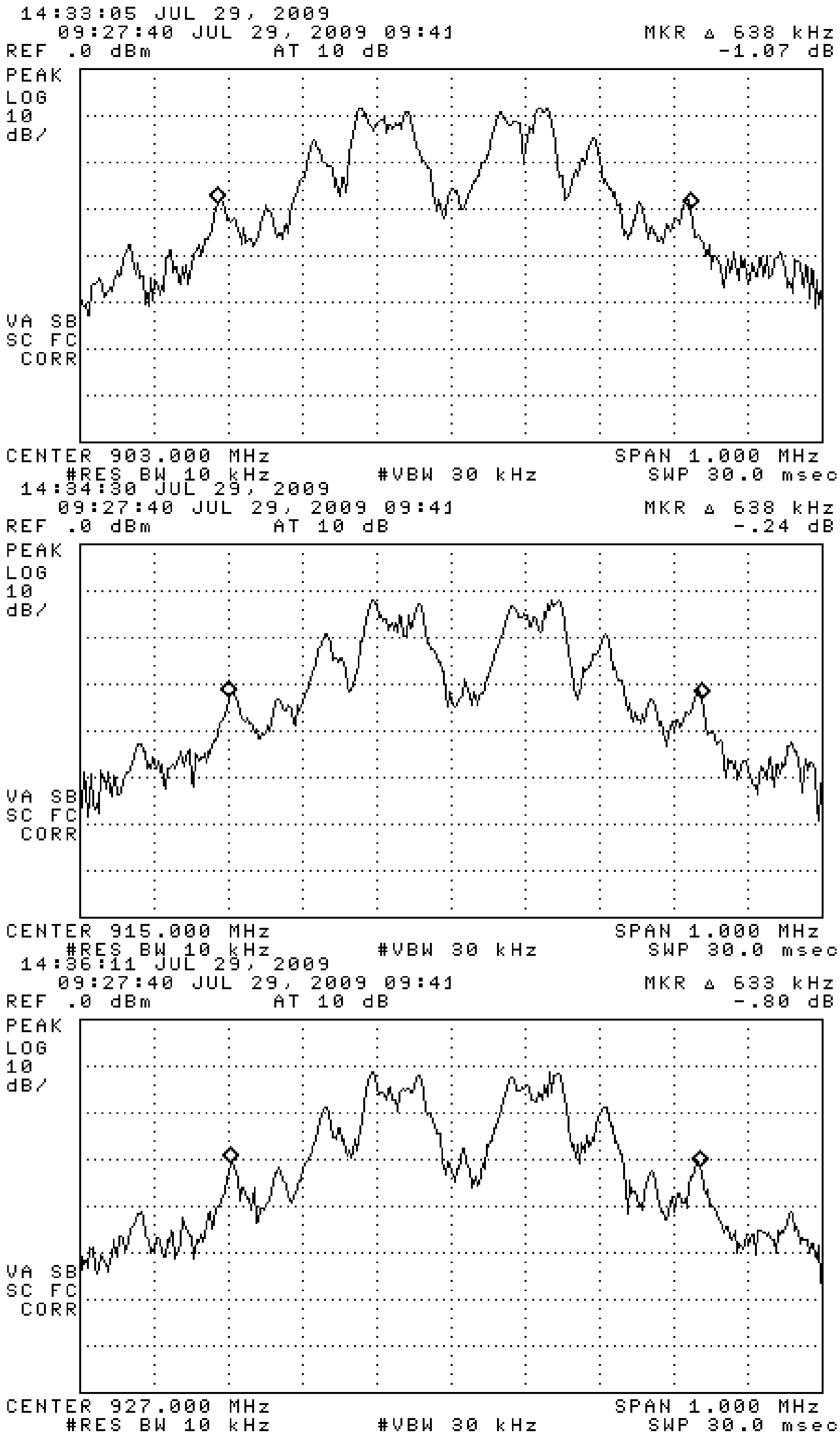


Figure 6.3. Measured emission bandwidth of the DUT (pulsed).

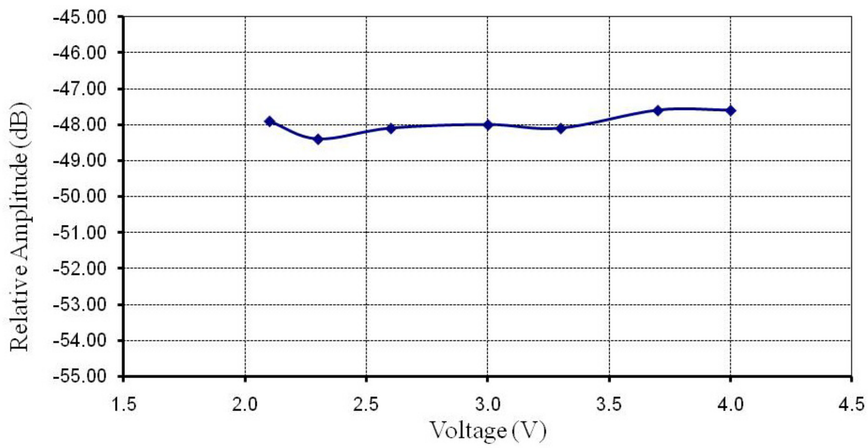
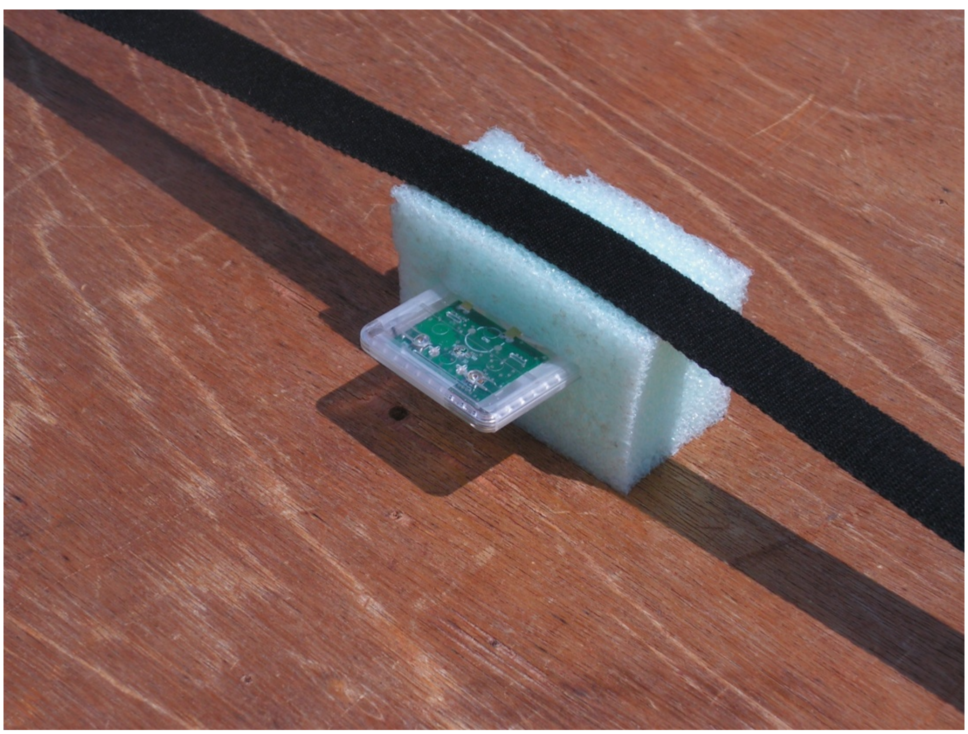


Figure 6.4. Relative emission at fundamental vs. supply voltage (pulsed).

Photograph 6.5. DUT on OATS + Indoor Setup (one of three axes tested)



Photograph 6.6. Close-up of DUT on OATS (one of three axes tested)