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Measured Radio Frequency Emissions
From

Ensure Xyloc XC-3 Series Transmitter
FCC ID: NW5XC3
IC: 3937A-XC3

Report No. 415031-452
September 5, 2008

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 Ensure model(s) XC-3E, XC-3T, XC-3.

In testing completed on September 5, 2008, the device tested met fundamental emission limits by more than 1.1 dB, harmonic limits by more than 2.7 dB, and band edges by 2.2 dB. Spurious emissions meet the FCC/IC Class B limit by more than 20 dB. AC power line conducted emissions are not applicable as the DUT is powered by a 3 VDC lithium battery.

1. Introduction

Ensure Technologies, Inc. model(s) XC-3E, XC-3T, XC-3 was(were) 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 7, June 2007. 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." Test site description and attenuation characteristics 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. 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. 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		S/A, Model SGH-2.6	SBAND1
C-Band Std. Gain Horn		University of Michigan, NRL design	CBAND1
XN-Band Std. Gain Horn		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)		Scientific Atlanta , 12-8.2, SN: 730	XBAND3
K-band horn (18-26.5 GHz)		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)		Avantek, AFT-12665	AVAMP3
Amplifier (6-16 GHz)		Trek	TRAMP1
Amplifier (16-26 GHz)		Avantek	AVAMP4
LISN Box		University of Michigan	UMLISN1
Signal Generator		Hewlett-Packard 8657B	HPSG1

3. Configuration and Identification of Device Under Test

The Device Under Test (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 2.125(W) x 3.375(H) x 0.125 (D) inches in dimension with an operating voltage of 3VDC. The device employs two internal antennas (wires) to achieve transmitter spatial diversity. The DUT was designed by Ensure Technologies, Inc., 135 South Prospect, Suite 100, Ypsilanti, MI 48198. It is identified as:

Ensure Xyloc XC-3 Series Transmitter
Model(s): XC-3E, XC-3T, XC-3
FCC ID: NW5XC3
IC: 3937A-XC3

3.1 Variants and Modes of Operation

There are three primary versions of the Xyloc XC-3 Series transmitter, the XC-3E, the XC-3T, and the XC-3. All three models employ the same RF and digital electronics, but vary slightly in software and the population/de-population of user-control buttons. Each device 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.

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. 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.

The three modes vary as follows. Model XC-3 employs an ON BUTTON to initiate regular transmissions every 1 second for no more than 13 hours, or until the OFF BUTTON is pressed. Model XC-3T begins transmission immediately when the battery is inserted into the device and transmissions occur at periodic intervals ranging from 10 seconds to 1 minute depending on software. This device has NO BUTTONS. Model XC-3E also begins periodic transmission when the battery is inserted into the device, but with a fixed 60 second period. An ERS BUTTON is also populated that, when pushed, signals the device to transmit data every 1 second for 10 seconds and then resume the standard 60 second interval.

3.2 Modules Supplied for Testing

Normal operating and CW enabled modules at 903, 915, and 927 MHz were supplied for testing. 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 21 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 EMI/EMC Relevant Modifications

No changes were 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 903-927 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)
902.0 – 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. 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)
If the PRF of the DUT is less than 20 Hz, then Peak measurements apply, or the PRF of the device tested must be increased to 20 Hz for measurement with Quasi-Peak.

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 MHz	Class A (dBμV)		Class B (dBμV)	
	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. Worst case emissions are reported employing 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 Semi-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, and 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.

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

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

or

$$E(\text{dB}\mu\text{V/m}) = P_r(R_{meas})(\text{dB}\mu\text{V}) + K_a - K_g$$

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: AC Mains Conducted Emissions
AC mains conducted emissions measurements do not apply DUT is powered either from a 3 VDC battery.

6. Measurement Results

6.1 Radiated Emissions
Table 5.1 and Table 5.2. DUT meets FCC/IC Class B spurious (non-harmonic) emissions limits by more than 20 dB.

6.2 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:

$$K_E = (2 \times 2.1 \text{ ms}) / 100 \text{ ms} = 0.04 < 20 \text{ dB}$$

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.

6.3 Emission Bandwidth
The measured spectrum of the signal is shown in Figure 6.2. From these plots we see that the worst case -20 dB bandwidth is 570 kHz.

6.4Radiated Emissions – Fundamental, Transmitter Spurious
Table 6.2. Fundamental, Harmonic, and Band Edge Radiated Emissions. Pk. 120 kHz RBW, VBW > RBW for f < 1 GHz, 1 MHz RBW, VBW>RBW for f > 1 GHz; measurement distance is 3 m. Relative emission spectrum is shown in Figure 6.3.

6.5 Effect of Supply Voltage Variation and Test Battery Voltages
The DUT has been designed to be powered by a 3 VDC battery. For this test, the battery was replaced by a laboratory variable power supply. Relative power radiated 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} =	3.19 V
	after testing	V_{oc} =	3.01 V
Ave. current from batteries		I =	18 mA (cw)

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Table 5.1 Radiated Highest Emissions Measured

				Radiated Emission - RF							Ensure XC-3 Series; 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 (Worst case, most populated model XC-3E, modified to 21 Hz PRF)**										
2	903.0	Dip	H	-25.2	QPk	28.3	17.2	92.9	94.0	**1.1**	flat
3	903.0	Dip	V	-31.6	QPk	28.3	17.2	86.5	94.0	7.5	side
4	915.0	Dip	H	-26.0	QPk	28.5	17.2	92.3	94.0	1.7	flat
5	915.0	Dip	V	-30.1	QPk	28.5	17.2	88.2	94.0	5.8	side
6	927.0	Dip	H	-25.8	QPk	28.6	17.1	92.7	94.0	1.3	flat
7	927.0	Dip	V	-29.6	QPk	28.6	17.1	88.9	94.0	5.1	side
8	1806.0	Horn RG	H/V	-35.7	Pk	22.1	28.0	45.4	54.0	8.6	flat
9	1830.0	Horn RG	H/V	-33.7	Pk	22.1	28.0	47.4	54.0	6.6	flat
10	1854.0	Horn RG	H/V	-31.8	Pk	22.2	28.0	49.4	54.0	4.6	flat
11	2709.0	Horn RG	H/V	-61.9	Pk	24.7	25.9	23.9	54.0	30.1	flat
12	2745.0	Horn RG	H/V	-61.8	Pk	24.8	25.8	24.2	54.0	29.8	flat
13	2781.0	Horn RG	H/V	-63.0	Pk	24.9	25.7	23.2	54.0	30.8	flat
14	3612.0	Horn RG	H/V	-64.5	Pk	27.4	23.9	25.9	54.0	28.1	side
15	3660.0	Horn RG	H/V	-63.1	Pk	27.5	23.8	27.6	54.0	26.4	flat
16	3708.0	Horn RG	H/V	-62.6	Pk	27.6	23.7	28.3	54.0	25.7	flat
17	4515.0	Horn C	H/V	-53.9	Pk	24.5	33.0	24.6	54.0	29.4	flat
18	4575.0	Horn C	H/V	-54.1	Pk	24.5	34.1	23.4	54.0	30.6	flat
19	4635.0	Horn C	H/V	-54.0	Pk	24.6	35.1	22.4	54.0	31.6	flat
20	5418.0	Horn C	H/V	-34.3	Pk	24.7	38.0	39.4	54.0	14.6	flat
21	5490.0	Horn C	H/V	-28.0	Pk	24.8	38.0	45.8	54.0	8.2	flat
22	5562.0	Horn C	H/V	-22.5	Pk	24.8	38.0	51.3	54.0	2.7	flat
23	6321.0	Xn-Horn	H/V	-42.3	Pk	24.4	38.0	31.1	54.0	22.9	max all, noise
24	6405.0	Xn-Horn	H/V	-42.5	Pk	24.5	38.0	31.0	54.0	23.0	max all, noise
25	6489.0	Xn-Horn	H/V	-42.7	Pk	24.5	38.0	30.8	54.0	23.2	max all, noise
26	7224.0	Xn-Horn	H/V	-41.9	Pk	25.1	36.8	33.4	54.0	20.6	max all, noise
27	7320.0	Xn-Horn	H/V	-41.8	Pk	25.2	36.8	33.6	54.0	20.4	max all, noise
28	7416.0	Xn-Horn	H/V	-42.5	Pk	25.3	36.8	33.0	54.0	21.0	max all, noise
29	8127.0	X-Horn	H/V	-50.2	Pk	27.0	36.8	27.0	54.0	27.0	max all, noise
30	8235.0	X-Horn	H/V	-47.3	Pk	27.0	36.8	29.9	54.0	24.1	max all, noise
31	8343.0	X-Horn	H/V	-43.9	Pk	27.1	36.8	33.4	54.0	20.6	max all, noise
32	9030.0	X-Horn	H/V	-42.5	Pk	27.5	36.8	35.2	54.0	18.8	max all, noise
33	9150.0	X-Horn	H/V	-42.5	Pk	27.5	36.8	35.2	54.0	18.8	max all, noise
34	9270.0	X-Horn	H/V	-44.2	Pk	27.6	36.8	33.6	54.0	20.4	max all, noise
35											
36	THE DEVICE. MODELS XC-3 AND XC-3T HAVE ONE AND THREE BUTTONS DEPOPULATED,										
37	RESPECTIVELY.										
38	* includes a 20 dB duty factor above 1000 MHz when Pk measurements are taken.										
39											

Meas. 09/04/2008; U of Mich.

Table 5.2 Highest Radiated Emissions Measured

Radiated Emission - RF											Ensure XC-3 Series; 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	**Lowest Power Setting (Worst case most populated model XC-3E, 21 Hz modified)**										
2	903.0	Dip	H	-42.6	QPk	28.3	17.2	75.5	94.0	18.5	flat
3	1806.0	Horn LS	H/V	-48.8	Pk	20.9	28.0	31.1	54.0	22.9	flat
4	2709.0	Horn RG	H/V	-66.1	Pk	24.7	25.9	19.7	54.0	34.3	max all, noise
5	3612.0	Horn RG	H/V	-73.5	Pk	27.4	23.9	16.9	54.0	37.1	max all, noise
6	4515.0	Horn C	H/V	-50.0	Pk	24.5	33.0	28.5	54.0	25.5	max all, noise
7	5418.0	Horn C	H/V	-40.2	Pk	24.7	38.0	33.5	54.0	20.5	max all, noise
8	6321.0	Xn-Horn	H/V	-40.9	Pk	24.4	38.0	32.5	54.0	21.5	max all, noise
9	7224.0	Xn-Horn	H/V	-47.0	Pk	25.1	36.8	28.3	54.0	25.7	max all, noise
10	8127.0	X-Horn	H/V	-48.3	Pk	27.0	36.8	28.9	54.0	25.1	max all, noise
11	9030.0	X-Horn	H/V	-45.4	Pk	27.5	36.8	32.3	54.0	21.7	max all, noise
12											
13	**Band Edges (Worst case - most populated model XC-3E, all 3 frequencies (903, 915, 927), 21 Hz mod)**										
14	902.0	Dip	H	-74.3	QPk	28.3	17.2	43.8	46.0	2.2	max all, High Power
15	928.0	Dip	H	-74.8	QPk	28.6	17.1	43.7	46.0	2.3	max all, High Power
16	902.0	Dip	H	-88.7	QPk	28.3	17.2	29.4	46.0	16.6	max all, Low Power, noise
17	928.0	Dip	H	-89.1	QPk	28.6	17.1	29.4	46.0	16.6	max all, Low Power, noise
18											
19	**Fundamental emission comparison between models (21 Hz mod)**										
20	903.0	Dip	H	-25.2	QPk	28.3	17.2	92.9	94.0	1.1	w/ all buttons (XC-3E)
21	915.0	Dip	H	-26.0	QPk	28.5	17.2	92.3	94.0	1.7	w/ all buttons (XC-3E)
22	927.0	Dip	H	-25.8	QPk	28.6	17.1	92.7	94.0	1.3	w/ all buttons (XC-3E)
23	903.0	Dip	H	-25.3	QPk	28.3	17.2	92.8	94.0	1.2	w/o buttons (XC-3T)
24	915.0	Dip	H	-25.9	QPk	28.5	17.2	92.4	94.0	1.6	w/o buttons (XC-3T)
25	927.0	Dip	H	-25.9	QPk	28.6	17.1	92.6	94.0	1.4	w/o buttons (XC-3T)
26	903.0	Dip	H	-25.2	QPk	28.3	17.2	92.9	94.0	1.1	w/o track button (XC-3)
27	915.0	Dip	H	-26.2	QPk	28.5	17.2	92.1	94.0	1.9	w/o track button (XC-3)
28	927.0	Dip	H	-26.0	QPk	28.6	17.1	92.5	94.0	1.5	w/o track button (XC-3)
29											
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
1											
2											
3											
4	Digital emissions more than 20 dB below FCC/IC Class B Limit.										
37											
38											
39											

Meas. 09/04/2008; U of Mich.

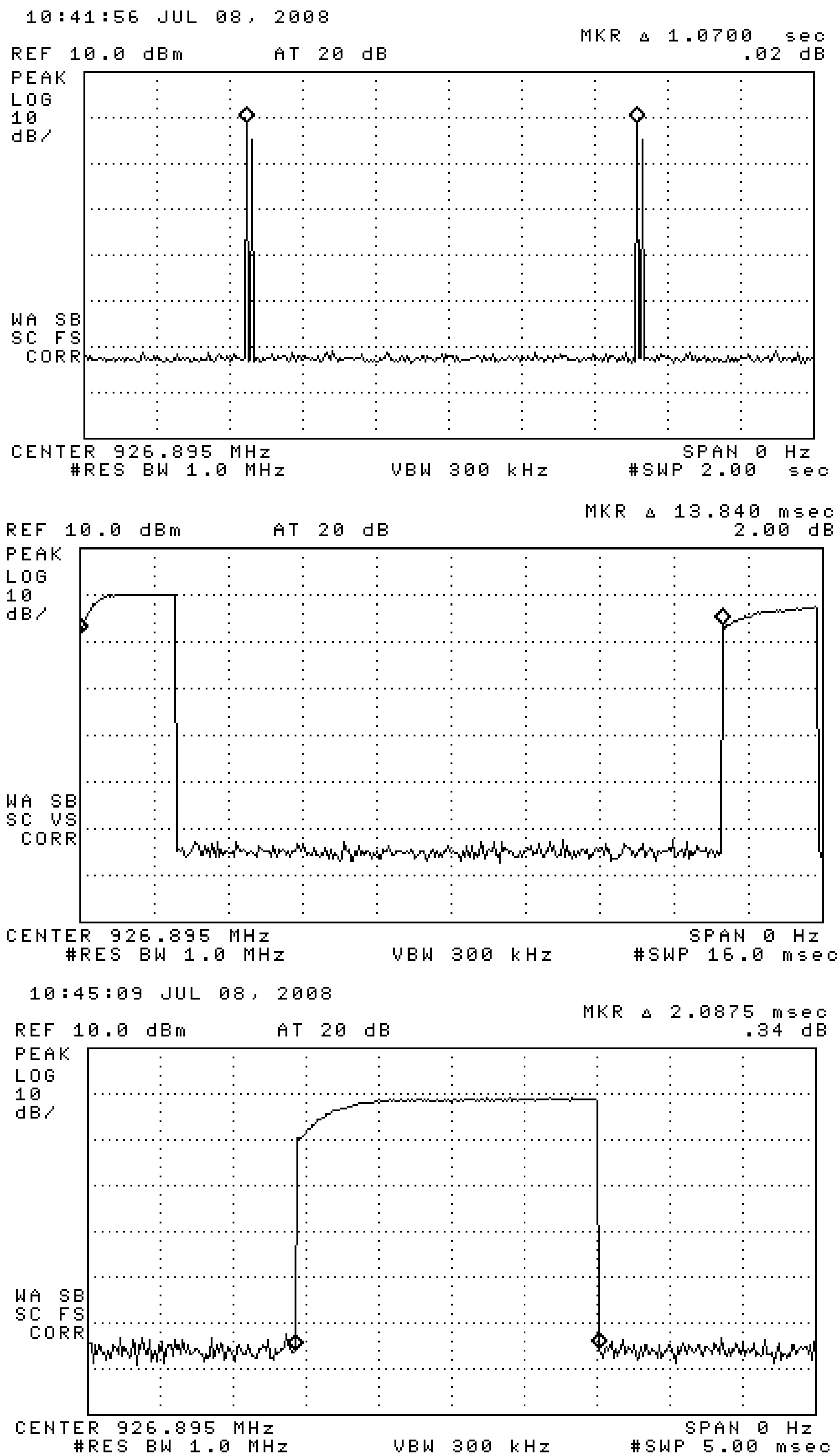


Figure 6.1(a). Fundamental Emission (top) worst case 1 second pulse period, (middle) two pulses per transmission, (bottom) single pulse width

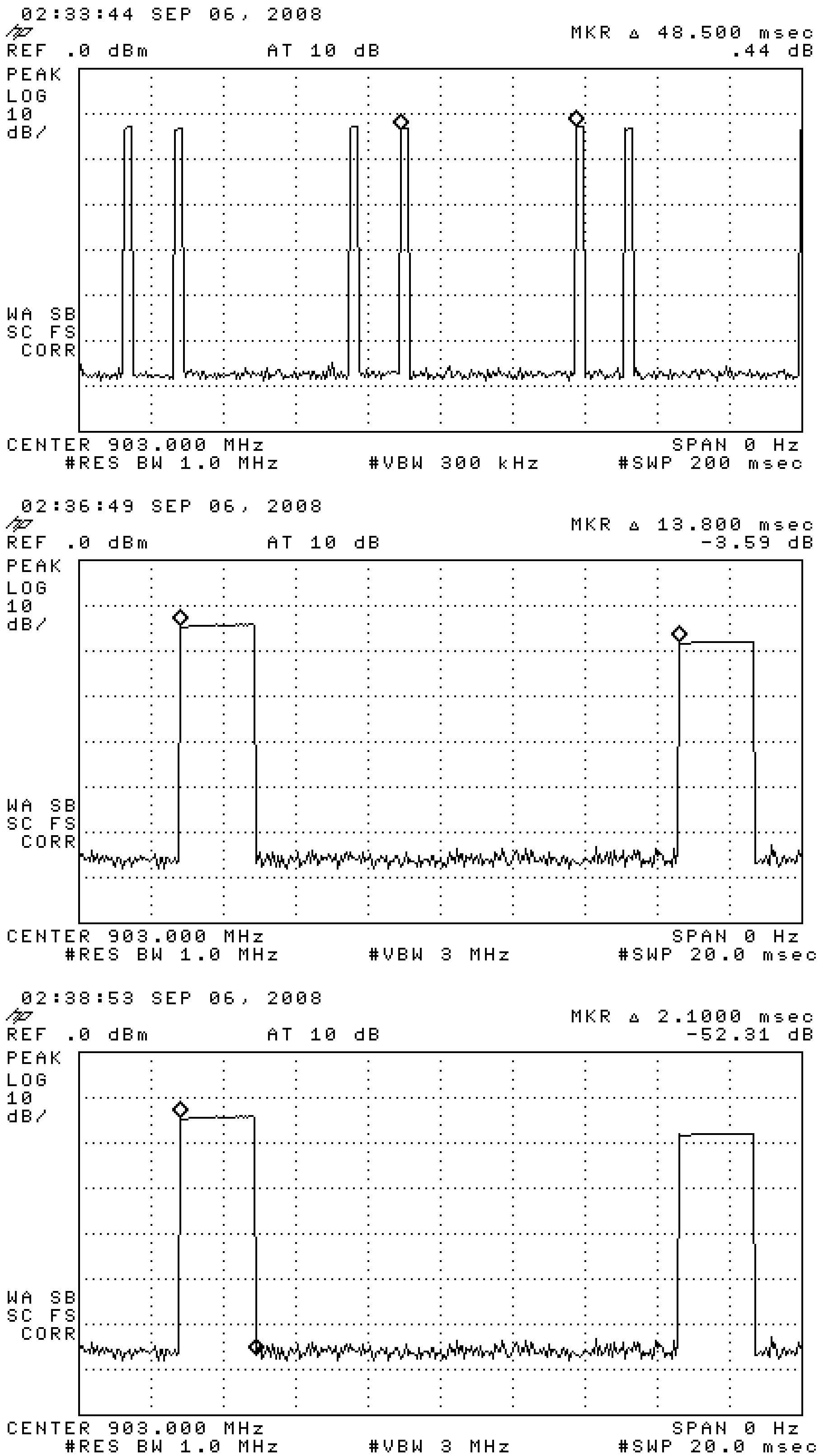


Figure 6.1(b). 21 Hz modified devices for QPK measurement (top) 20.6 Hz period, (middle) standard pulse separation, (bottom) single pulse width

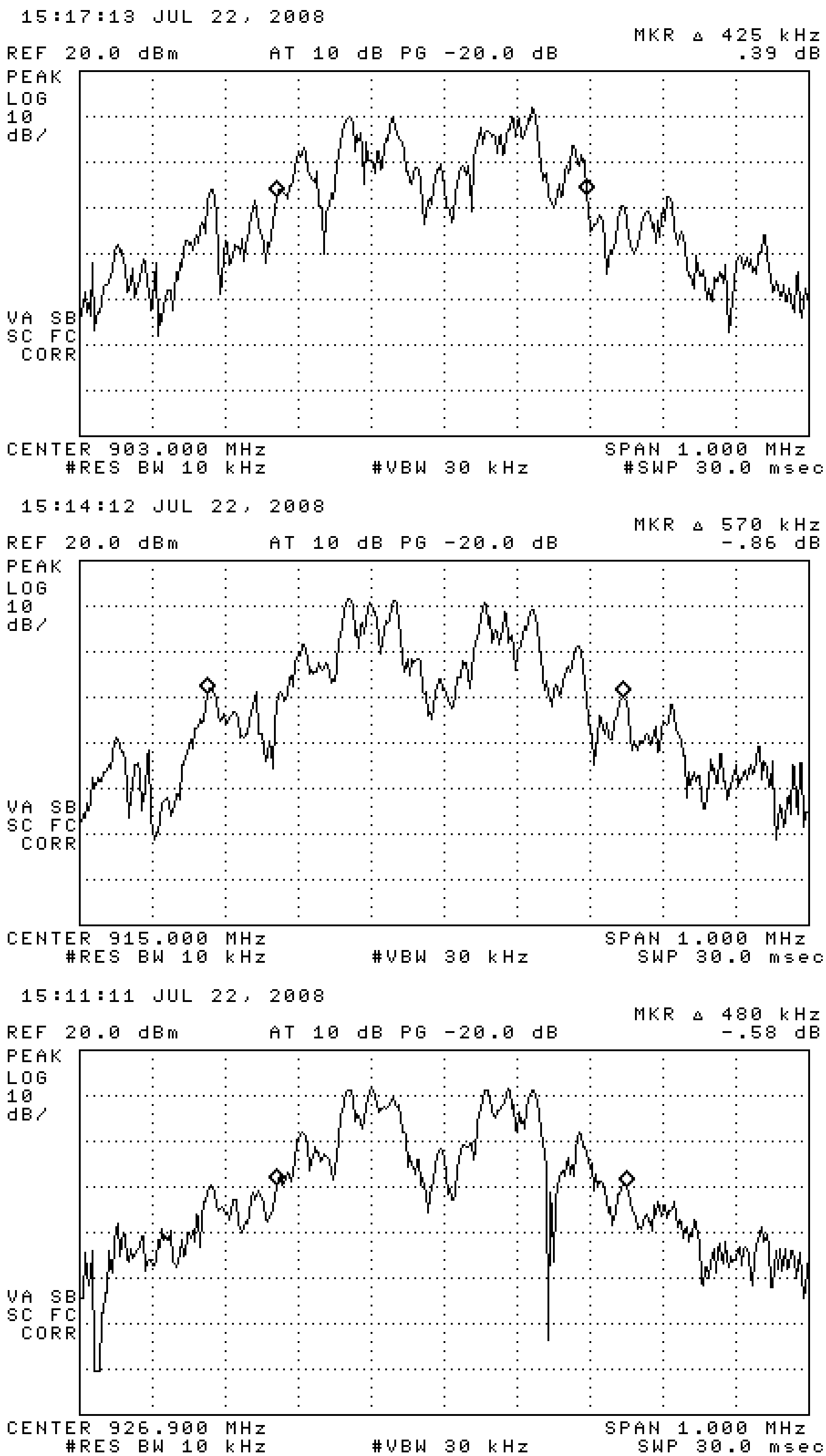


Figure 6.2(a). Emission Bandwidth (Normal Operating Mode): High Power (top) Low Channel, (middle) Middle Channel, (bottom) High Channel

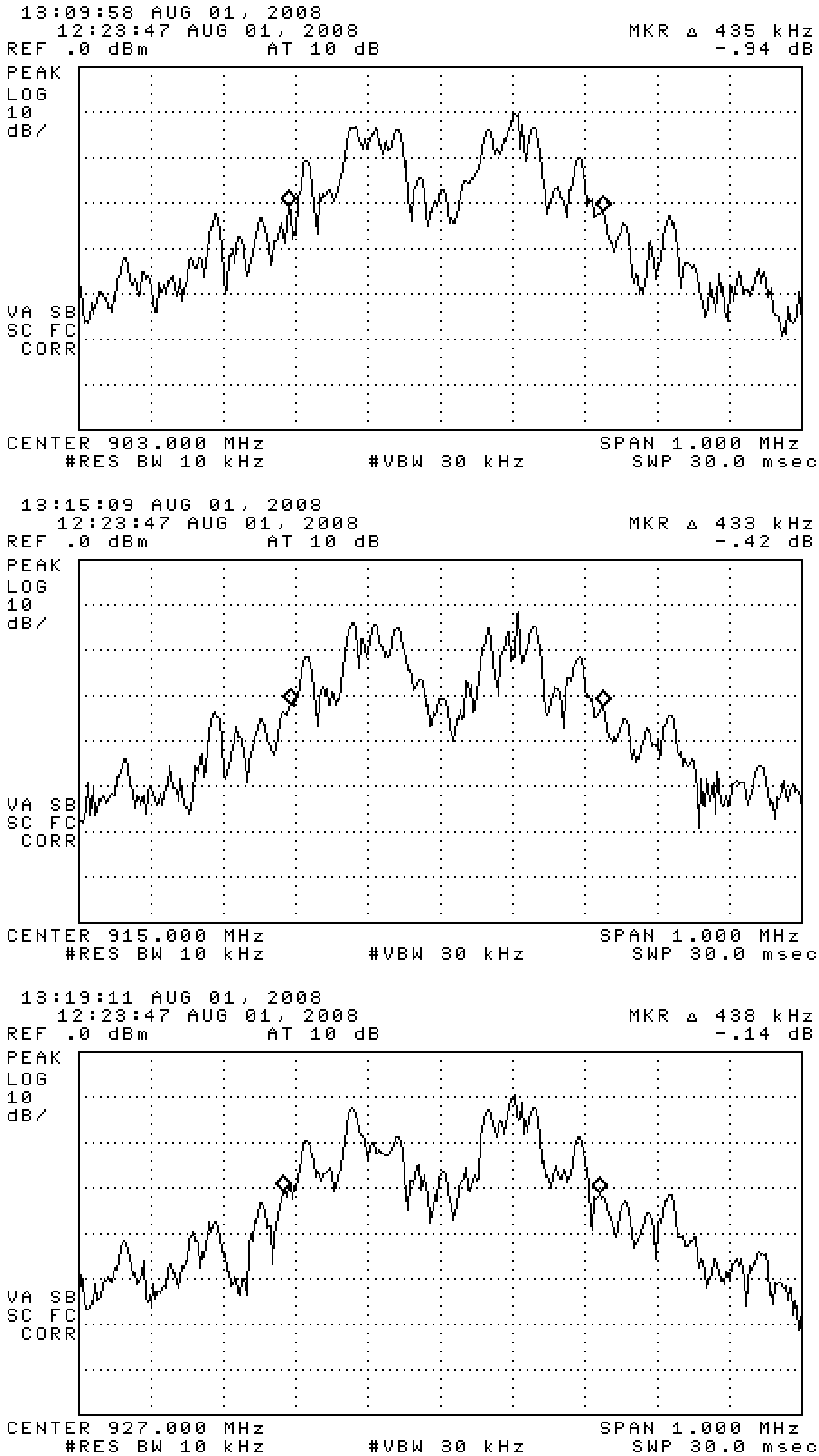
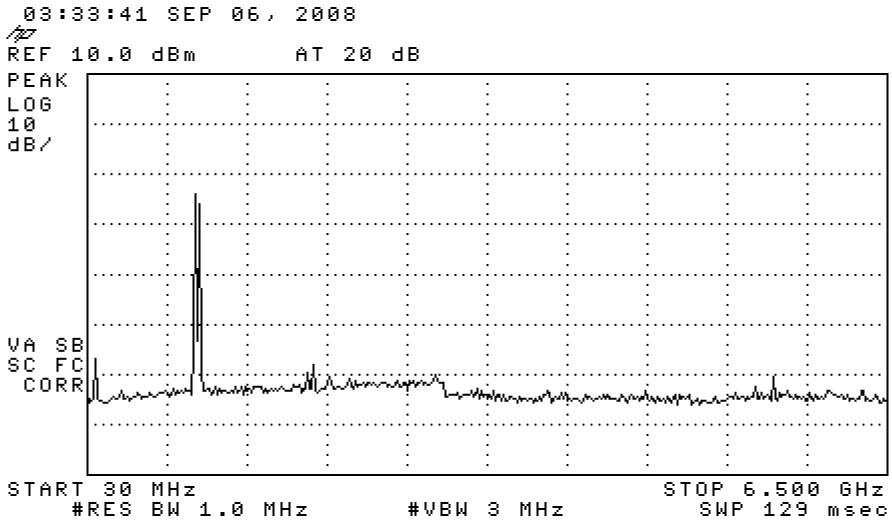


Figure 6.2(b). Emission Bandwidth (Normal Operating Mode): Low Power (top) Low Channel, (middle) Middle Channel, (bottom) High Channel



Figures 6.3. Emission spectrum of the DUT (low, middle, high; pulsed emission).
The amplitudes are only indicative (not calibrated).

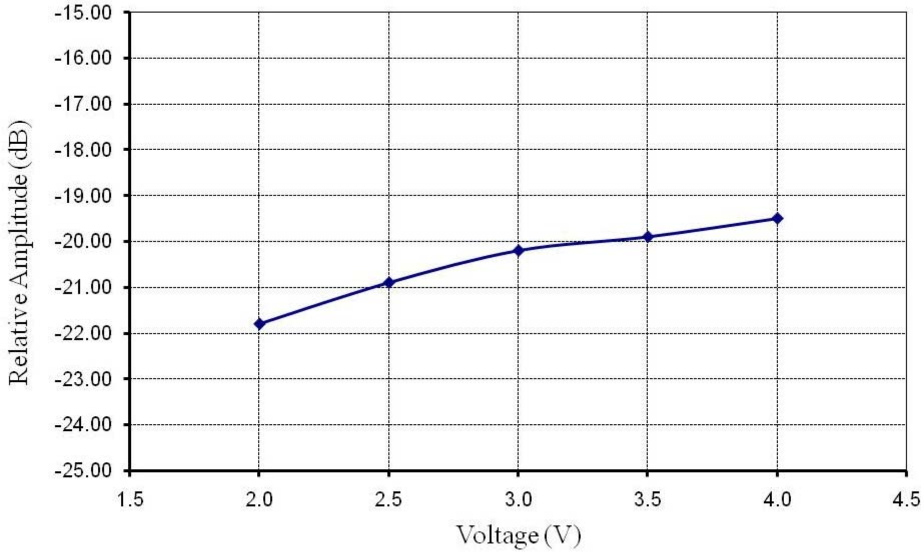
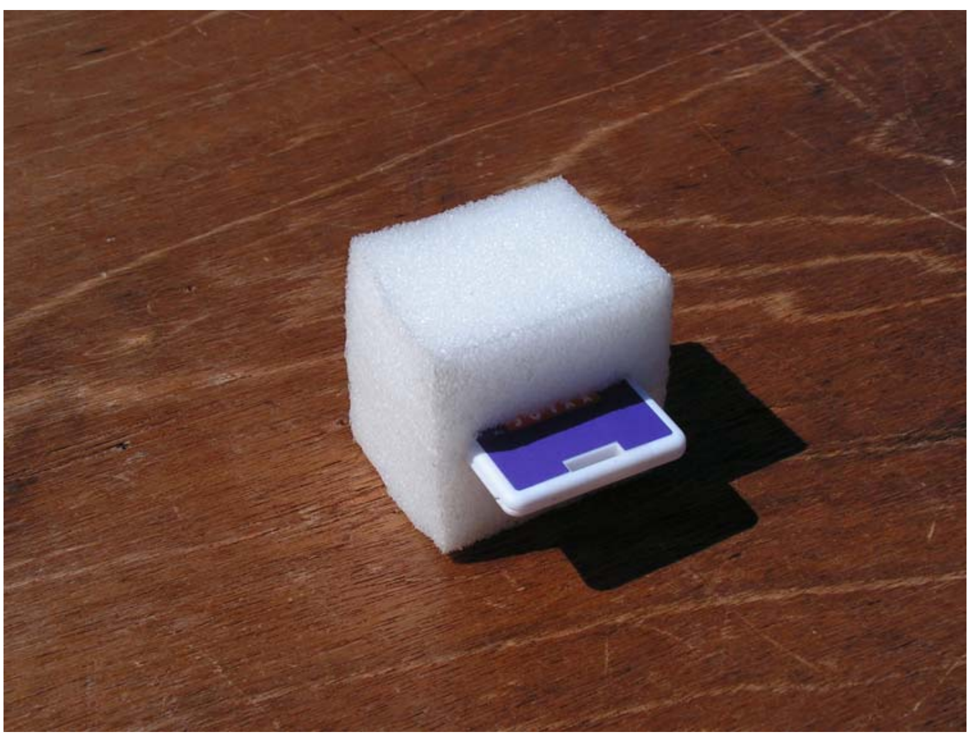


Figure 6.4. Relative emission at fundamental (cw) vs. supply voltage.

DUT on OATS – one of three axes tested



DUT on OATS (Close-up) – one of three axes tested