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Measured Radio Frequency Emissions From

Ensure Technologies XyLock Key (Transmitter) Model: XC-2

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For:
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Summary
Tests for compliance subject to FCC Part 15, Subparts B and C, and to RSS-210 of Industry Canada were performed on Ensure Technologies transmitter. This device is subject to the Rules and Regulations as a transmitter and as a digital device.

In testing performed on February 20 and March 7, 2001, the device tested in the worst case met the allowed FCC specifications for radiated emissions by 20.5 dB at the fundamental and by 11.0 dB at band edges (see p. 6). Besides harmonics there were no other significant spurious emission found. Emissions from digital circuitry are more than 20 dB below the Class B limits.

1. Introduction

Ensure Technologies XyLock Key (transmitter), Model XC-2, was tested for compliance with FCC Regulations, Part 15, adopted under Docket 87-389, April 18, 1989, and with Industry Canada RSS-210, Issue 2, dated February 14, 1998. The tests were performed at the University of Michigan Radiation Laboratory Willow Run Test Range following the procedures described in ANSI C63.4-1992 "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 2057).

2. Test Procedure and Equipment Used

The test equipment commonly used in our facility is listed in Table 2.1 below. The second column identifies the specific equipment used in these tests. The HP 8593E spectrum analyzer is used for primary amplitude and frequency reference.

Table 2.1. Test equipment.

Test Instrument	Equipment Used	Manufacturer/Model	Cal. Date/By
Spectrum Analyzer (9kHz-22GHz)	X	Hewlett-Packard 8593A SN: 3107A01358	December 2000/UM
Spectrum Analyzer (9kHz-26GHz)	X	Hewlett-Packard 8593E SN: 3107A01131	December 2000/HP
Spectrum Analyzer (0.1-1500 MHz)		Hewlett-Packard 182T/8558B SN: 1529A01114/543592	December 2000/UM
Preamplifier (5-1000MHz)	X	Watkins-Johnson A11 -1 plus A25-1S	December 2000/UM
Preamplifier (5-4000 MHz)	X	Avantek	Oct. 1999/ U of M Rad Lab
Broadband Bicone (20-200 MHz)	X	University of Michigan	June 1999/U of M Rad Lab
Broadband Bicone (200-1000 MHz)	X	University of Michigan	June 1999/U of M Rad Lab
Dipole Antenna Set (25-1000 MHz)	X	University of Michigan	June 2000/UM
Dipole Antenna Set (30-1000 MHz)		EMCO 3121C SN: 992	June 2000/UM
Active Loop Antenna (0.090-30MHz)		EMCO 6502 SN: 2855	December 1999/UM
Active Rod (30Hz-50 MHz)		EMCO 3301B SN: 3223	December 1999/UM
Ridge-horn Antenna (0.5-5 GHz)	X	University of Michigan	March 1999/U of M Rad Lab
S-Band Std. Gain Horn		S/A, Model SGH-2.6	Manufacturer, NRL design
C-Band Std. Gain Horn	X	University of Michigan	Manufacturer, NRL design
XN-Band Std. Gain Horn	X	University of Michigan	Manufacturer, NRL design
X-Band Std. Gain Horn	X	S/A, Model 12-8.2	Manufacturer, NRL design
LISN Box		University of Michigan	Dec. 2000/U of M Rad Lab
Signal Generator (0.1-2060 MHz)		Hewlett-Packard 8657B	January 2000/Uof M Rad Lab

3. Configuration and Identification of Device Under Test

The DUT is a 905 MHz transmitter that periodically sends an ID signal to a receiver that would be attached to a computer. The transmitter is a "fat" credit card size and normally would be carried on a person, such as computer programmer. The matching receiver would be attached to the computer. For, example, if there is no signal (or low signal) received, the computer would go in disable mode.

The DUT transmits every 0.5s a 2.75ms long FSK encoded pulse,. The transmitter is based on a PLL controlled VCO, based on 4 MHz Crystal reference.

The DUT was designed and manufactured by Ensure Technologies, Inc., 3526 W. Liberty, Suite 100, Ann Arbor, MI 48103-9013. It is identified as:

Ensure Technologies XyLock Key (transmitter)
Model: XC-2
SN: J4-24
FCC ID: NW5MK
CANADA: to be provided by Canada

One unit was submitted for testing. The unit was intermittently transmitting, and under such conditions the emissions were measured.

3.1 EMI Relevent Modifications

There were no modifications made to the DUT after submission for final testing. However, the University of Michigan was involved in advising and assessment of emissions in latter stages of development of the product. For example, to lessen the lower band-edge emissions, the operating frequency was changed from 903 to 905 MHz.

4. Emission Limits

4.1 Radiated Emission Limits

The DUT tested falls under the category of an Intentional Radiators and the Digital Devices, subject to Subpart C, Section 15.249; and Subpart B, Section 15.109 (transmitter genereated signals excluded); and Subpart A, Section 15.33. The applicable testing frequencies with corresponding emission limits are given in Tables 4.1 and 4.2 below. As a digital device, the DUT is considered as a Class B device.

Table 4.1. Radiated Emission Limits (Ref: FCC 15.249(a); IC RSS-210, 6.2.2(m))—Transmitter.

Frequency	Fundamental Ave. E_{lim} (3m)		Spurious* Ave. E_{lim} (3m)	
(MHz)	(μV/m)	dB (μV/m)	(μV/m)	dB (μV/m)
902-928	50000	94	500	54

* Measure up to tenth harmonic; 120 kHz BW up to 1 GHz (CISPR)
1 MHz BW above 1 GHz (average).

Table 4.2. Radiated emission limits (Ref: FCC, 15.109)--Digital device.

Freq.	Class A, d_s=3m		Class B, d_s=3m	
MHz	μV/m	dB(μV/m)	μV/m	dB(μV/m)
30-88	300	49.5	100	40.0
88-216	500	54.0	150	43.5
219-960	700	56.9	200	46.0
960-	1000	60.0	500	54.0

4.2 Conductive Emission Limits

Table 4.3. Conducted emission limits (Ref: FCC, 15.107).

Freq.	Class A		Class B	
MHz	μV	dBμV	μV	dBμV
0.45-1.705	1000	60.0	250	48.0
1.705-30.0	3000	69.6	250	48.0

Note: Quasi-Peak readings apply here

5. Radiated Emission Tests and Results

5.1 Anechonic Chamber Measurements

To familiarize with the radiated emission behavior of the DUT, the DUT was first studied and measured in an 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 the chamber we studied and recorded all the emissions using a ridged horn antenna up to 4.0 GHz, and C-band, XN-band and X-band antennas for higher harmonic frequencies. 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 final compliance assessment. In the chamber we also recorde spectrum and modulation characterisics of the carrier, and other parameters, as needed. These data are presented in subsequent sections. We also note that in scanning from 905 MHz to 10 GHz using the ridge horn and pyramidal horn antennas, there were no other significant spurious emissions observed.

5.2 Outdoor Measurements

After the chamber measurements, the emissions were re-measured on the outdoor 3-meter site using tuned dipoles and/or the high frequency bicone.

The last page of this report shows the tested system on the open-site table. There the 905 MHz fundamental and the band-edges at 902 and 928 MHz were measured.

5.3 Computations and Results

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

$$E_3(\text{dB}\mu\text{V/m}) = 107 + P_R + K_A - K_G + K_E$$

where
P_R = power recorded on spectrum analyzer, dB, measured at 3m
K_A = antenna factor, dB/m
K_G = pre-amplifier gain, including cable loss, dB
K_E = pulse operation correction factor, dB (see 6.1)

When presenting the data, at each frequency the highest measured emission under all of the possible orientations is given. Computations and results are given in Table 5.1. There we see that the DUT meets the limit by 20.5 dB at the fundamental, by 11.0 dB at bandedges, and by 28.5 dB at harmonics.

6. Other Measurements and Computations

6.1 Correction For Pulse Operation

When activated, the transmitter "pings" repeatedly every 0.5 seconds. Each "ping" is 2.75ms long and is FSK modulated.

Thus, K_E = 2.75ms /100ms = 0.0275 or -31.2 dB (Use -20.0 dB for data correction)

6.2 Emission Spectrum

Using the ridge-horn antenna and DUT placed near its aperture, emission spectrum was recorded and is shown in Figure 6.2. Only the fundamental could be detected.

6.3 Bandwidth of the Emission Spectrum

The measured spectrum of the signal is shown in Figure 6.3. From the plot we see that the -20 dB bandwidth is 1.365 MHz. The center frequency is 905.00 MHz.

6.4 Effect of Supply Voltage Variation

The DUT has been designed to be powered by a single 3 V battery. For this test, the battery was replaced by a laboratory variable power supply and relative power radiated was measured at the fundamental as the voltage was varied from 2.5 to 4.0 volts. The emission variation is shown in Figure 6.4.

6.5 Input Voltage and Current at Battery Terminals

V = 3.05 V
I = 0.5 mA (pulsing)

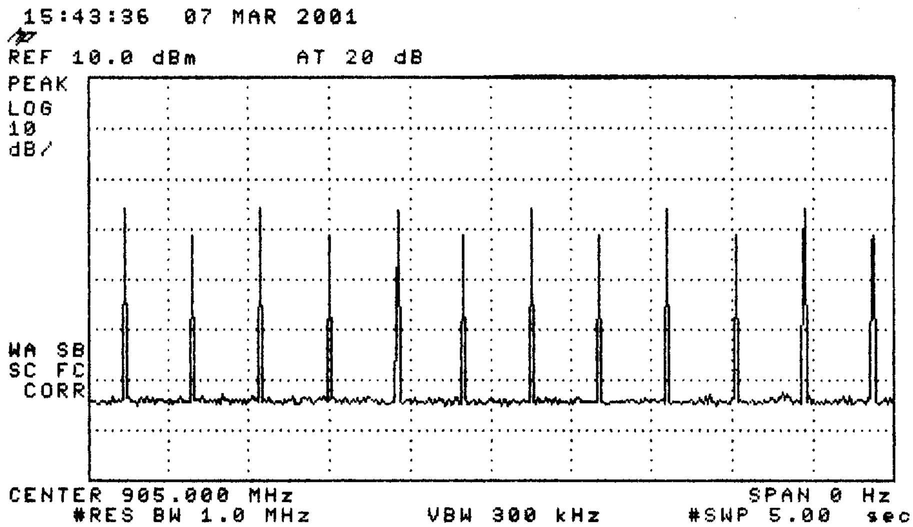
Table 5.1 Highest Emissions Measured

	Radiated Emission - RF										Ensure TX, 905 MHz; 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	905.0	Dip	H	-44.9	QP	28.5	17.1	73.5	94.0	20.5	flat
2	905.0	Dip	V	-48.2	QP	28.5	17.1	70.2	94.0	23.8	side
3	1810.0	Horn	H	-55.6	Pk	22.2	28.1	25.5	54.0	28.5	flat
4	2715.0	Horn	H	-66.8	Pk	24.7	25.7	19.2	54.0	34.8	max. all
5	3620.0	Horn	H	-70.9	Pk	27.9	24.2	19.8	54.0	34.2	max. all, noise
7	4525.0	C-horn	H	-64.5	Pk	25.5	32.5	15.5	54.0	38.5	max. all, noise
8	5430.0	C-horn	H	-62.1	Pk	25.8	38.2	12.5	54.0	41.5	max. all, noise
9	6335.0	XN-horn	H	-61.1	Pk	24.2	38.0	12.1	54.0	41.9	max. all, noise
10	7240.0	XN-horn	H	-58.3	Pk	25.0	36.1	17.6	54.0	36.4	max. all, noise
11	8145.0	X-horn	H	-58.8	Pk	27.1	36.1	19.2	54.0	34.8	max. all, noise
12	9050.0	X-horn	H	-57.1	Pk	27.5	36.9	20.5	54.0	33.5	max. all, noise
13											
14	Band edges										
15	902.0	Dip	H	-84.6	QP	28.5	17.1	33.7	46.0	12.3	flat
16	901.0	Dip	H	-83.7	QP	28.5	17.1	34.6	46.0	11.4	flat
17	928.0	Dip	H	-83.8	QP	28.7	16.9	35.0	46.0	11.0	flat
18	929.0	Dip	H	-83.8	QP	28.7	16.9	35.0	46.0	11.0	flat
19											
20			*includes -20 dB duty factor above 1000 MHz when Pk measurements are made								
21											

	Digital Emissions										
#	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											
2											
3			Digital emissions are more than 20 dB below FCC Class B limit								
4											

	Conducted Emissions						
#	Freq. MHz	Line Side	Det. Used	Vtest dBμV	Vlim dBμV	Pass dB	Comments
1							
2		Not applicable					
3							
4							

Meas. 02/20/01,03/07/01; U of Mich.



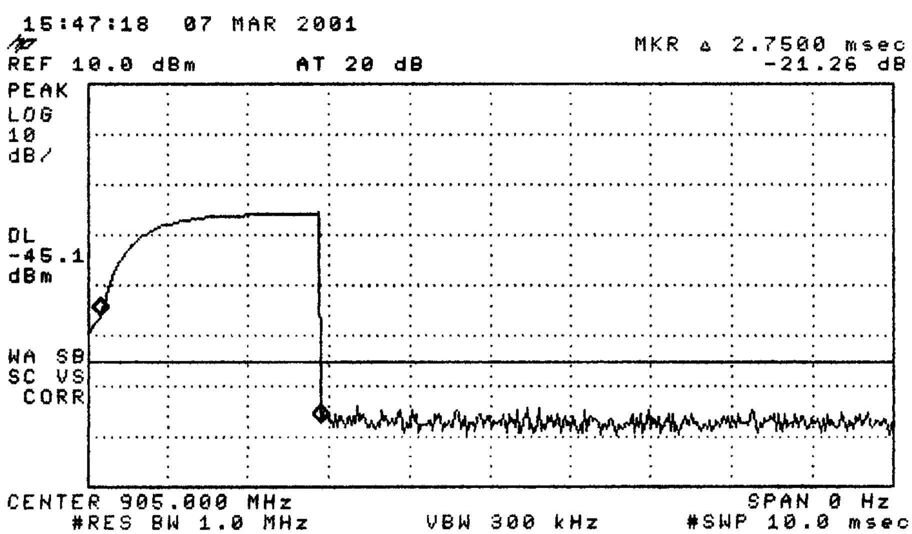


Figure 6.1. Transmissions modulation characteristics: (top) repeated transmissions, (bottom) expanded transmission.

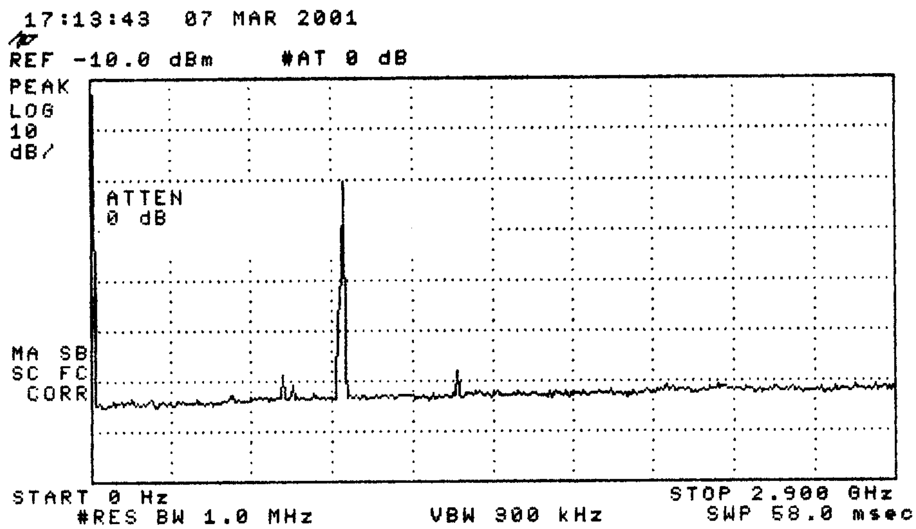


Figure 6.2. Emission spectrum of the DUT (repeated pulsed emission). The amplitudes are only indicative (not calibrated).

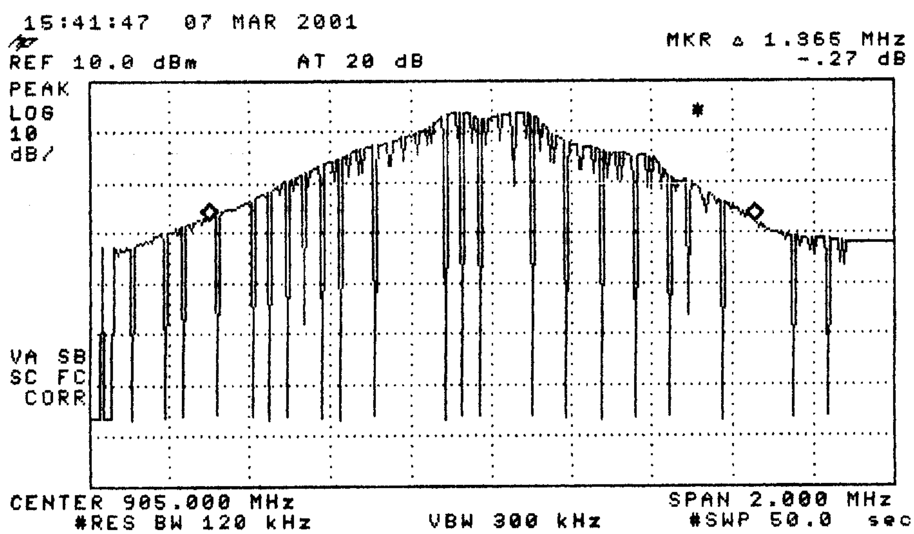


Figure 6.3. Measured bandwidth of the DUT (repeated pulsed emission).

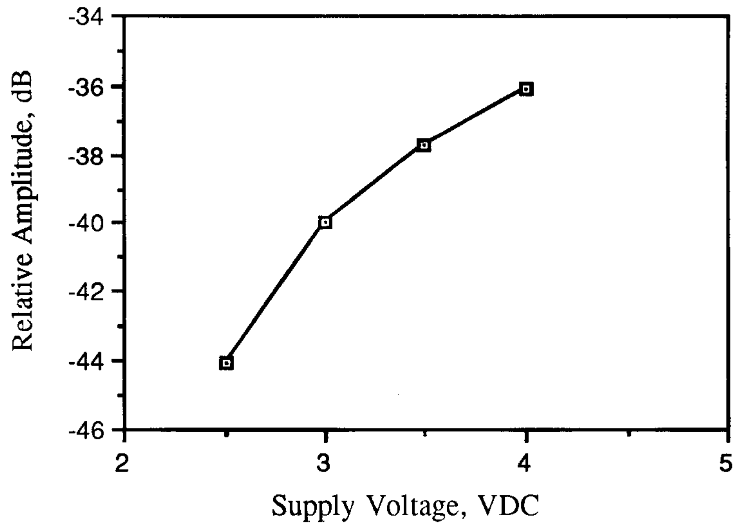


Figure 6.4. Relative emission at 905 MHz vs. supply voltage. (pulsed emission)