Measurement of RF Interference from a Flex Badge Model VER1920B Transmitter

For : Versus Technology, Inc.
2600 Miller Creek Rd.
Traverse City, MI 49684

P.O. No. : RLW-01232
Date Received : March 8, 2007
Date Tested : March 8, 2007
Test Personnel : Mark E. Longinotti
Specification : FCC "Code of Federal Regulations" Title 47 Part 15, Subpart C

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REVISION HISTORY

Revision	Date	Description
—	March 8, 2007	Initial release

Measurement of RF Emissions from a Flex Badge Model VER1920B Transmitter

1.0 INTRODUCTION:

1.1 Description of Test Item - This document represents the results of the series of radio interference measurements performed on a Flex Badge Model VER1920B Transmitter (hereinafter referred to as the test item). The test item was designed to transmit at approximately 434 MHz using an internal antenna. The test item was manufactured and submitted for testing by Versus Technology, Inc. located in Traverse City, MI.

1.2 Purpose - The test series was performed to determine if the test item meets the conducted and radiated RF emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Sections 15.231 for Intentional Radiators. Testing was performed in accordance with ANSI C63.4-2003.

1.3 Deviations, Additions and Exclusions - There were no deviations, additions to, or exclusions from the test specification during this test series.

1.4 Applicable Documents - The following documents of the exact issue designated form part of this document to the extent specified herein:

- Federal Communications Commission "Code of Federal Regulations", Title 47, Part 15, Subpart C, dated 1 October 2006

- ANSI C63.4-2003, "American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz"

1.5 Subcontractor Identification - This series of tests was performed by Elite Electronic Engineering Incorporated of Downers Grove, Illinois. The laboratory is accredited by the National Institute of Standards and Technology (NIST) under the National Voluntary Laboratory Accreditation Program (NVLAP). NVLAP Lab Code: 100278-0.

1.6 Laboratory Conditions The temperature at the time of the test was 23°C and the relative humidity was 21%.

2.0 TEST ITEM SET-UP AND OPERATION:

The test item is a Flex Badge Model VER1920B. A block diagram of the test item set-up is shown as Figure 1. Two samples were provided for the test. Serial Number 14 was designed to transmit an unmodulated (CW) signal and Serial Number 12 employed pulsed operation.

2.1 Power Input - The test item obtained 3VDC from a CR3032 battery.

2.2 Grounding - The test item was ungrounded during the tests.

2.3 Peripheral Equipment - The test item has no peripheral equipment.

2.4 Interconnect Cables - The test item has no interconnect cables or ports.

2.5 Operational Mode - For all tests the test item was placed on an 80cm high non-conductive stand. The test item began transmitting once the battery was placed in the test item. For typical operation the test item will transmit a single packet of information approximately once every 120 seconds but for special applications can transmit more frequently and will never transmit faster than one packet every 12 seconds. For testing purposes, the test item was modified to transmit continuously. The battery voltage was periodically checked to ensure proper operation. The test was performed with the test item transmitting at approximately 434 MHz.

2.6 Test Item Modifications - No modifications were required for compliance to the FCC Part 15C requirements.

3.0 TEST EQUIPMENT:

3.1 Test Equipment List - A list of the test equipment used can be found on Table I. All equipment was calibrated per the instruction manuals supplied by the manufacturer.

3.2 Calibration Traceability - Test equipment is maintained and calibrated on a regular basis. All calibrations are traceable to the National Institute of Standards and Technology (NIST).

3.3 Measurement Uncertainty - All measurements are an estimate of their true value. The measurement uncertainty characterizes, with a specified confidence level, the spread of values which may be possible for a given measurement system.

4.0 REQUIREMENTS, PROCEDURES AND RESULTS:

4.1 Powerline Conducted Emissions -

4.1.1 Requirements –Since the test item was powered by internal batteries, no conducted emissions tests are required.

4.2 Duty Cycle Factor Measurements -

4.2.1 Procedures - The duty cycle factor is used to convert peak detected readings to average readings. This factor is computed from the time domain trace of the pulse modulation signal.

With the transmitter set up to transmit for maximum pulse density, the time domain trace is displayed on the spectrum analyzer. This trace is obtained by tuning center frequency to the transmitter frequency and then setting a zero span width with 10msec/div. The amplitude settings are adjusted so

that the on/off transitions clear the 4th division from the bottom of the display. The markers are set at the beginning and end of a word period. If the word period exceeds 100 msec the word period is set to 100 msec. The on-time and off-time are then measured. The on-time is total time signal level exceeds the 4th division. Off-time is time under for the word period. The duty cycle is then computed as the (On-time/ word period) where the word period = (On-time + Off-time).

4.2.2 Results - Since the transmitter uses a rolling code, the duty cycle correction factor used was calculated based on the maximum case. The following maximum case information was supplied by Versus Technology:

An encoded transmission consists of defined train of 46 pulses each with a pulse width of 225uSec.

The encoding of the logical 1's and 0's is determined by the space (off time) between the pulses.

The off time of approximately 1.2mSec determines the logical "0"(zero).
The off time of approximately 1.9mSec determines the logical "1"(one).

The pulse train consists of

1. Four Preamble pulses separated by approximately 1.24mSec off time
2. An 'off' time of approximately 6.75mSec.
3. Forty-Two pulses separated by 'off' time of either 1.24mSec or 1.91mS.

If all forty-two encoding pulses are separated by 1.24mS, then the maximum value of the emission is calculated as follows:

Pulse on time:

1. Total on time 46 x 0.225mS	10.35 mS

Pulse word period:

1. Preamble on time 4 x .225mS	0.90 mS
2. Preamble off time 3 x 1.24mS	3.72 mS
3. Preamble space time 6.75mS	6.75 mS
4. Encoded pulses 42 x 0.225mS	9.45 mS
5. Encoded off time 41 x 1.24mS	50.84 mS
TOTAL pulse word period	71.66 mS

Duty cycle factor (maximum time on) is:

1. Numeric factor: (10.35mS / 71.66mS)	= 0.144
2. dB factor: 20 * LOG(0.144)	= -16.88dB

With the test item transmitting at 433.9MHz, the maximum case duty cycle correction factor was calculated to be -16.88dB.

4.3 Radiated Measurements -

4.3.1 Requirements - The test item must comply with the requirements of FCC "Code of Federal Regulations Title 47", Part 15, Subpart C, Section 15.205 et seq.

Paragraph 15.231(e) has the following radiated emission limits:

Fundamental Frequency MHz	Field Intensity uV/m @ 3 meters	Field Strength Harmonics and Spurious @ 3 meters
260 to 470	1,500 to 5000*	150 to 500*

* - Linear Interpolation

For 434.0MHz, the limit at the fundamental is 4400uV/m @ 3m. The limit for the harmonics is 440.0uV/m @ 3m or the general limit shown in 15.209 whichever limit permits a higher field strength.

In addition, emissions appearing in the Restricted Bands of Operation listed in paragraph 15.205(a) shall not exceed the general requirements shown in paragraph 15.209.

Devices operated under the provisions of paragraph 15.231(e) shall be provided with a means for automatically limiting operation so that the duration of each transmission shall not be greater than one second and the silent period between transmissions shall be at least 30 times the duration of the transmission but in no case less than 10 seconds.

4.3.2 Procedures - Open field measurements were performed in a 32ft. x 20ft. x 14ft. high shielded enclosure. The shielded enclosure prevents emissions from other sources, such as radio and TV stations from interfering with the measurements. All powerlines and signal lines entering the enclosure pass through filters on the enclosure wall. The powerline filters prevent extraneous signals from entering the enclosure on these leads.

A preliminary radiated emissions test was performed to determine the emission characteristics of the test item. For the preliminary test, a broadband measuring antenna was positioned at a 3 meter distance from the test item. The entire frequency range from 30MHz to 4.5GHz was investigated using a peak detector function. The data was then processed by the computer to calculate equivalent field intensity.

The final open field emission tests were then manually performed over the frequency range of 30MHz to 4.5GHz. Between 30MHz and 1000MHz, a tuned dipole antenna was used as the pick-up device. A broadband double ridged waveguide antenna was used as the pick-up device for all frequencies above 1GHz. All significant broadband and narrowband signals were measured and recorded. The peak detected levels were converted to average levels using a duty cycle factor which was computed from the pulse train.

To ensure that maximum or worst case, emission levels were measured, the following steps were taken:

(1) The test item was rotated so that all of its sides were exposed to the receiving antenna.
(2) Since the measuring antenna is linearly polarized, both horizontal and vertical field components were measured.
(3) The measuring antenna was raised and lowered from 1 to 4 meters for each antenna polarization to maximize the readings.
(4) For hand-held or body-worn devices, the test item was rotated through three orthogonal axes to determine which orientation produces the highest emission relative to the limit.

4.3.3 Results - The preliminary plots, with the test item transmitting at 434.0MHz, are presented on pages 14 and 15. The plots are presented for a reference only, and are not used to determine compliance.

The final open area radiated levels, with the test item transmitting at 434.0MHz, are presented on page 16. As can be seen from the data, all emissions measured from the test item were within the specification limits.

Photographs of the test configuration which yielded the highest fundamental radiated emission levels are shown on Figure 2 and Figure 3.

In addition, the transmitter, under normal operating conditions, has an RF packet length of 71.66msec and has a silent period of at least 12 seconds. The silent period is greater than 30 times the RF packet length and exceeds the 10 second requirement. A representative plot of typical operation is shown on page 17. This plot shows the silent period between transmissions for typical operation.

4.4 Occupied Bandwidth Measurements -

4.4.1 Requirement - In accordance with paragraph 15.231(c), all emissions within 20dB of the peak amplitude level of the center frequency are required to be within a band less than 0.25% of the center frequency wide.

4.4.2 Procedures - The test item was placed on an 80cm high non-conductive stand. The unit was set to transmit continuously. With an antenna positioned nearby, occupied bandwidth emissions were displayed on the spectrum analyzer. The resolution bandwidth was set to 30 kHz and span was set to 2 MHz. The frequency spectrum near the fundamental was plotted. In addition, the 99% emission bandwidth measured 265 kHz when using the analyzer's special function key with the measurement BW set to 30 kHz.

4.4.3 Results - The plot of the emissions near the fundamental frequency are presented on data page 18. As can be seen from this data page, the transmitter met the occupied bandwidth

requirements.

5.0 CONCLUSIONS:

It was determined that the Versus Technology, Inc Flex Badge Model VER1920B, serial number 14, did fully meet the radiated emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Section 15.205 et seq. for Intentional Radiators, when tested per ANSI C63.4-2003.

6.0 CERTIFICATION:

Elite Electronic Engineering Incorporated certifies that the information contained in this report was obtained under conditions which meet or exceed those specified in the test specifications.

The data presented in this test report pertains to the test item at the test date. Any electrical or mechanical modification made to the test item subsequent to the specified test date will serve to invalidate the data and void this certification.

7.0 ENDORSEMENT DISCLAIMER:

This report must not be used to claim product endorsement by NVLAP or any agency of the US Government.

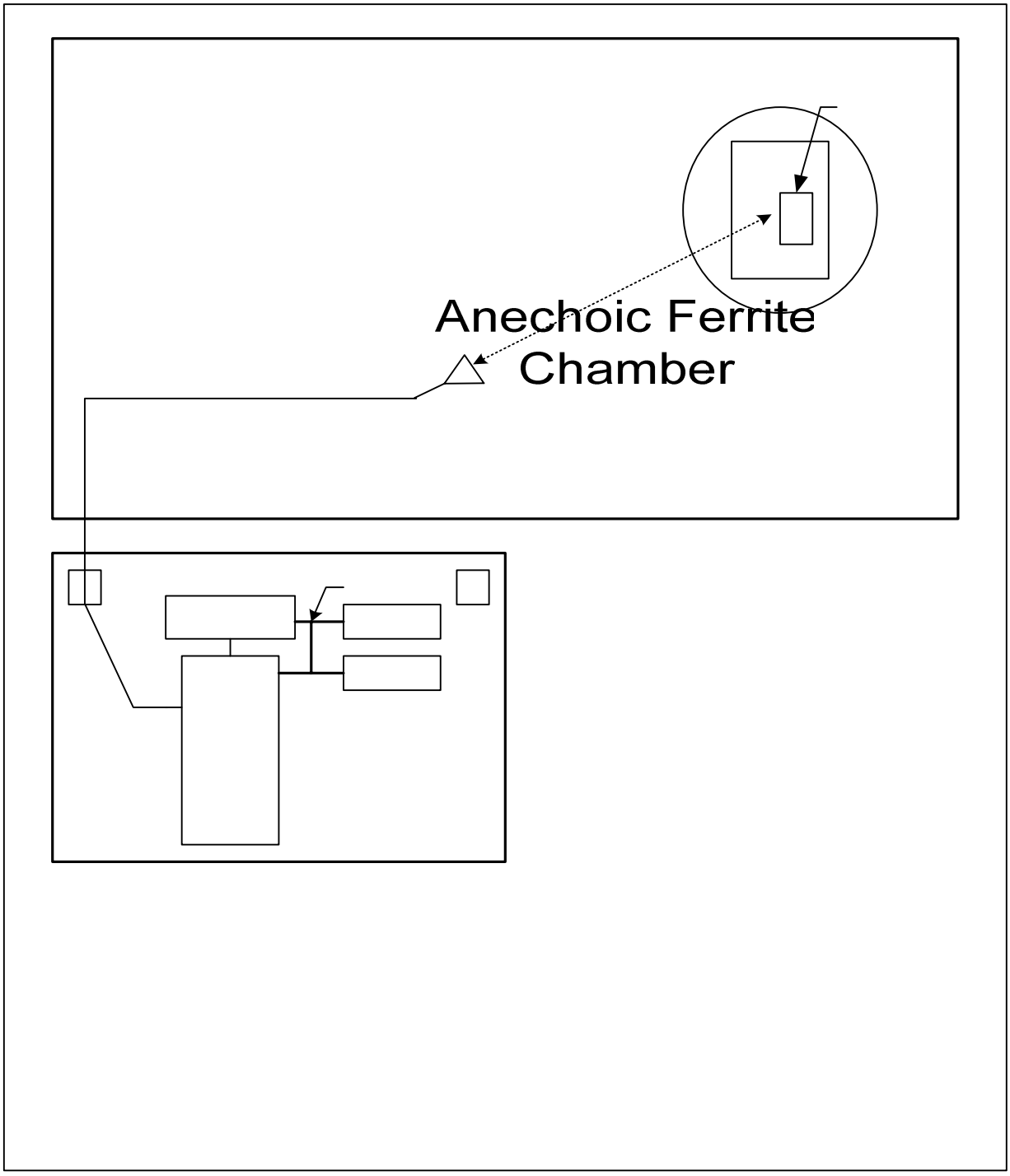
TABLE I: TEST EQUIPMENT LIST

ELITE ELECTRONIC ENG. INC. Page: 1

Eq ID	Equipment Description	Manufacturer	Model No.	Serial No.	Frequency Range	Cal Date	Cal Inv	Due Date
Equipment Type: ACCESSORIES, MISCELLANEOUS								
XZG2	ATTENUATOR/SWITCH DRIVER	HEWLETT PACKARD	11713A	2223A01751	---		N/A	
Equipment Type: AMPLIFIERS								
APK2	PREAMPLIFIER	AGILENT TECHNOL	8449B	3008A01595	1-26.5GHZ	04/10/06	12	04/10/07
Equipment Type: ANTENNAS								
NDQ1	TUNED DIPOLE ANTENNA	EMCO	3121C-DB4	313	400-1000MHZ	03/10/06	12	03/10/07
NTA0	BILOG ANTENNA	CHASE EMC LTD.	BILOG CBL611	2057	0.03-2GHZ	08/21/06	12	08/21/07
NWF0	RIDGED WAVE GUIDE	EMCO	3105	2035	1-12.4GHZ	10/09/06	12	10/09/07
Equipment Type: CONTROLLERS								
CDS2	COMPUTER	GATEWAY	MFATXPNT NMZ	0028483108	1.8GHZ		N/A	
CMA0	MULTI-DEVICE CONTROLLER	EMCO	2090	9701-1213	---		N/A	
Equipment Type: PRINTERS AND PLOTTERS								
HRE1	LASER JET 5P	HEWLETT PACKARD	C3150A	USHB061052	---		N/A	
Equipment Type: RECEIVERS								
RAC0	SPECTRUM ANALYZER	HEWLETT PACKARD	85660B	2449A01117	100HZ-22GHZ	07/18/06	12	07/18/07
RACE	RF PRESELECTOR W/ RECEIVER	HEWLETT PACKARD	85685A	3010A01194	20HZ-2GHZ	08/23/06	12	08/23/07
RAF1	QUASIPEAK ADAPTER	HEWLETT PACKARD	85650A	2043A00271	0.01-1000MHZ	02/21/07	12	02/21/08
RAKG	RF SECTION	HEWLETT PACKARD	85462A	3549A00284	0.009-6500MHZ	11/27/06	12	11/27/07
RAKH	RF FILTER SECTION	HEWLETT PACKARD	85460A	3448A00324	---	11/27/06	12	11/27/07

Cal. Interval: Listed in Months I/O: Initial Only N/A: Not Applicable

Note 1: For the purpose of this test, the equipment was calibrated over the specified frequency range, pulse rate, or modulation prior to the test or monitored by a calibrated instrument.



R

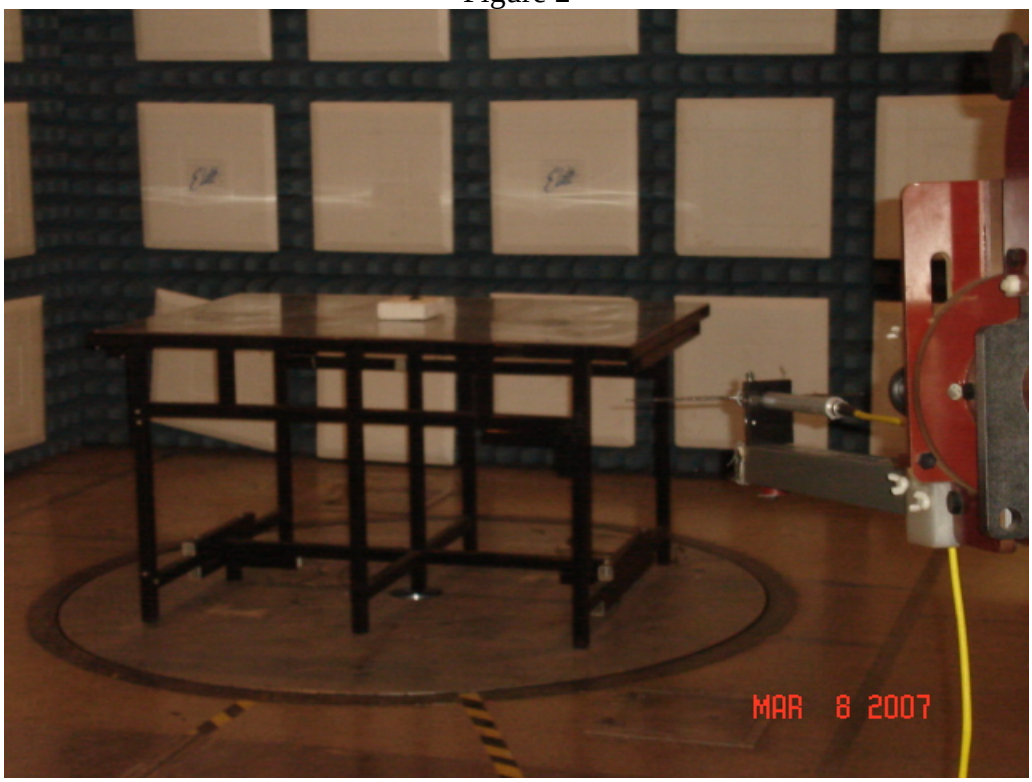
Hpib cbl

Turn Table & Mast
Controller

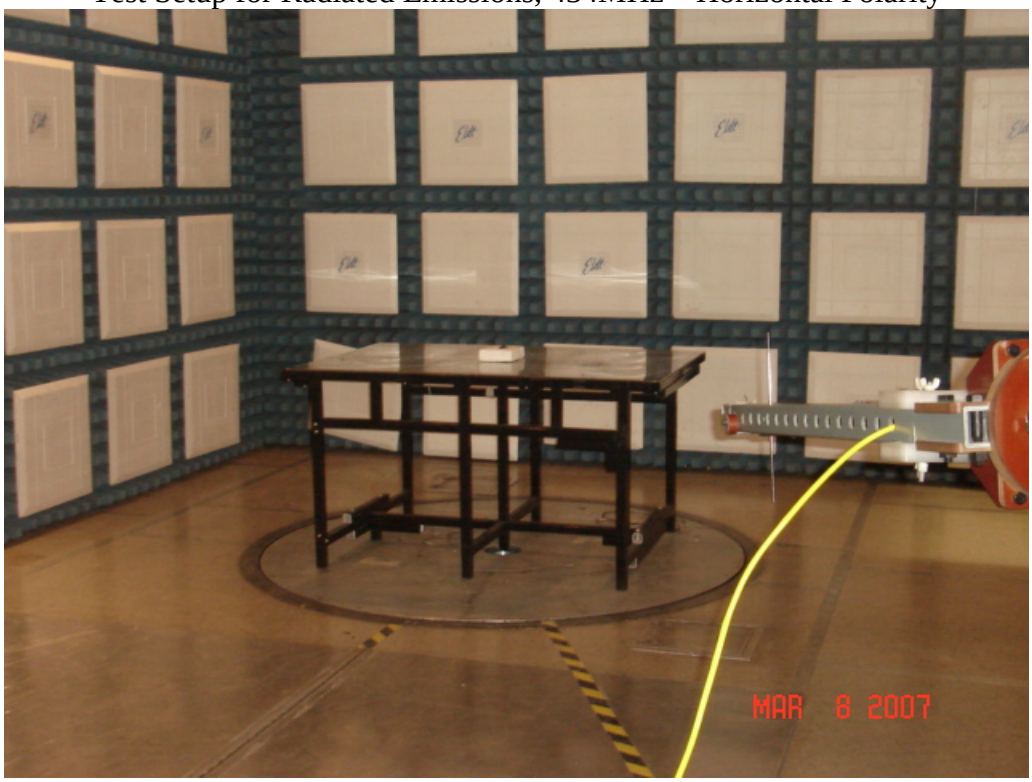
Computer

Printer

Figure 2

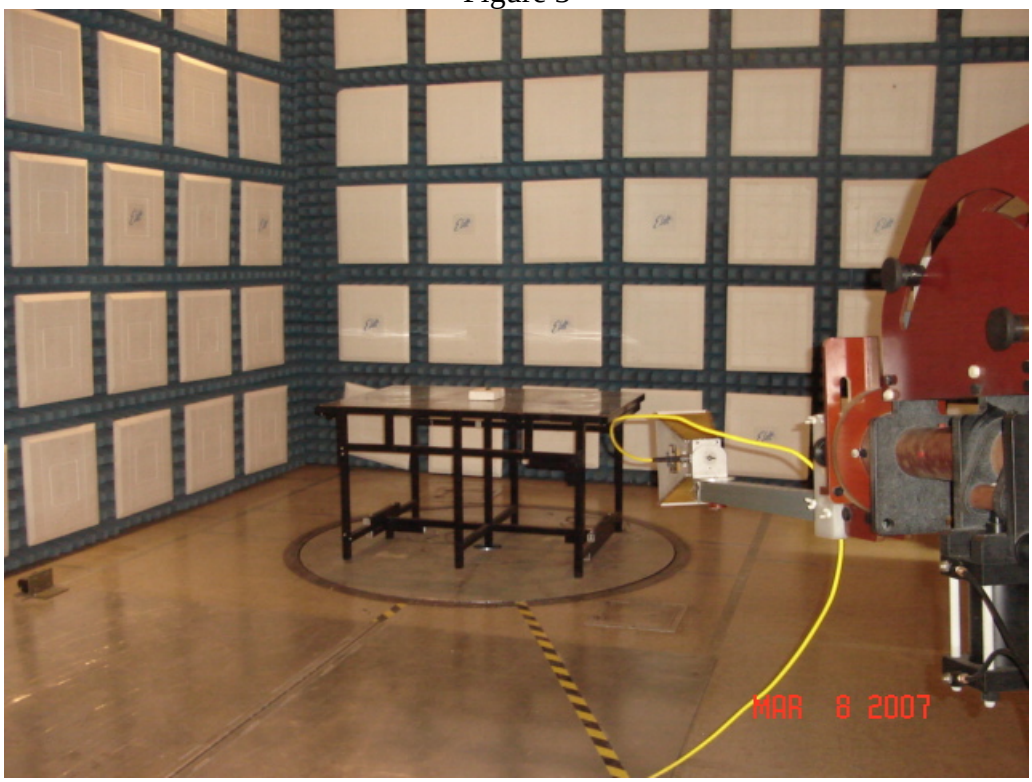


Test Setup for Radiated Emissions, 434MHz – Horizontal Polarity

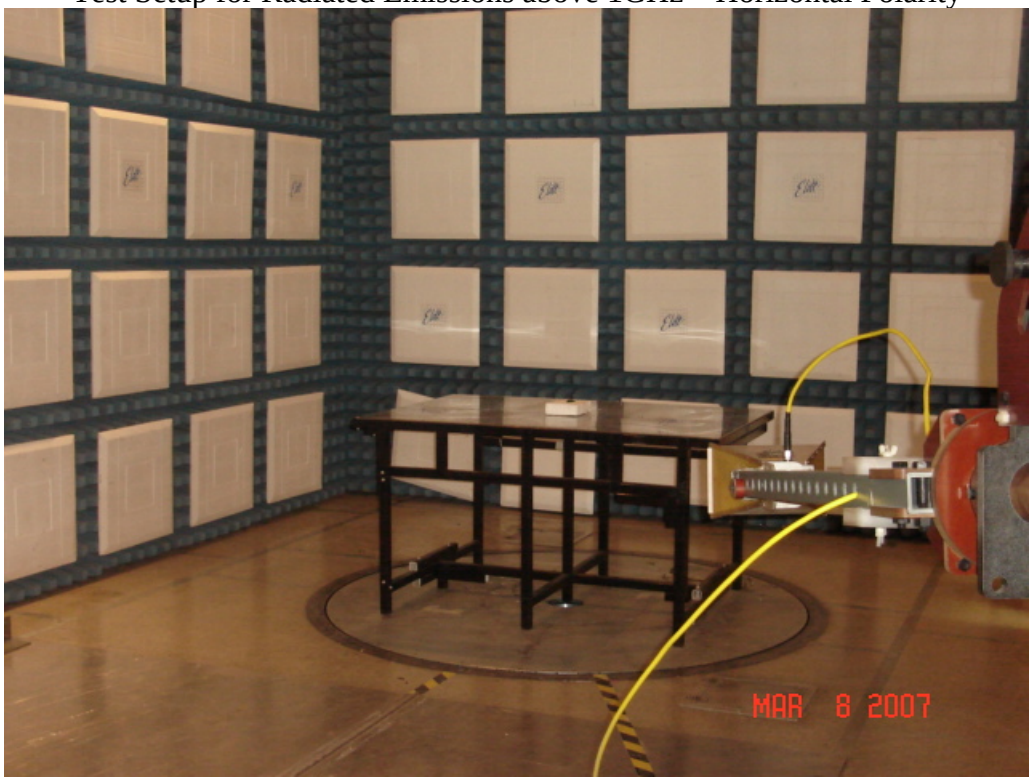


Test Setup for Radiated Emissions, 434MHz – Vertical Polarity

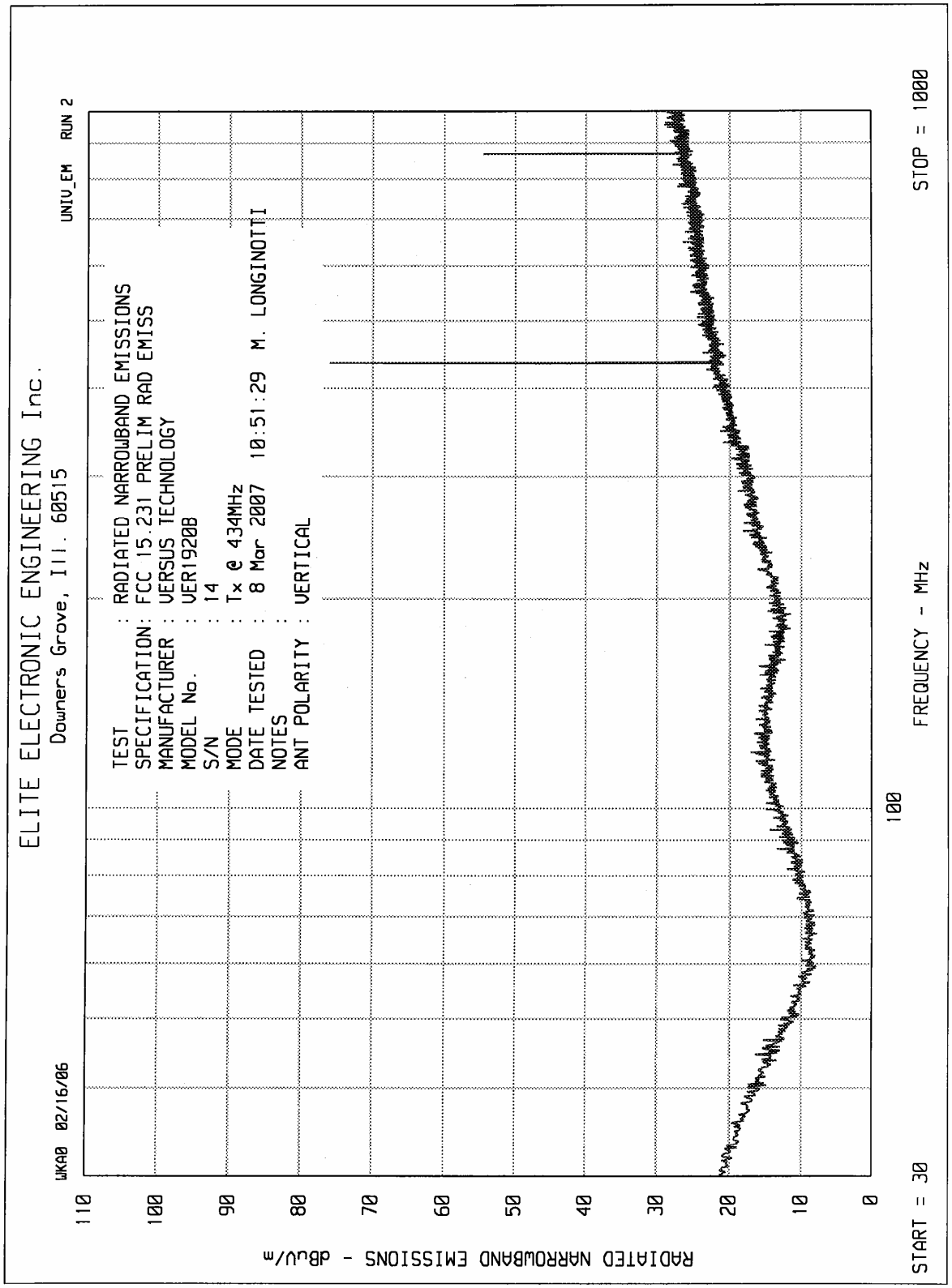
Figure 3

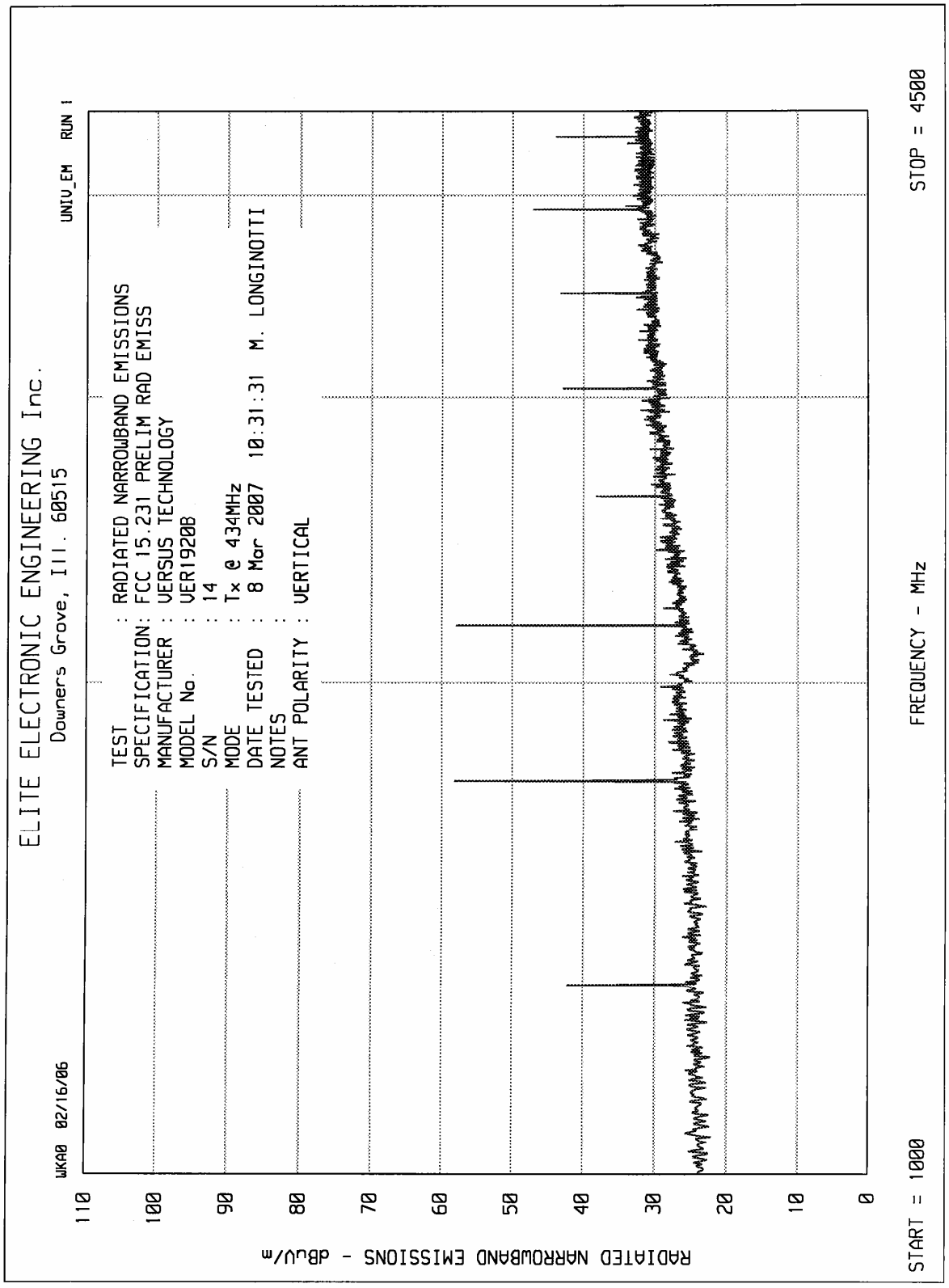


Test Setup for Radiated Emissions above 1GHz – Horizontal Polarity



Test Setup for Radiated Emissions above 1GHz – Vertical Polarity

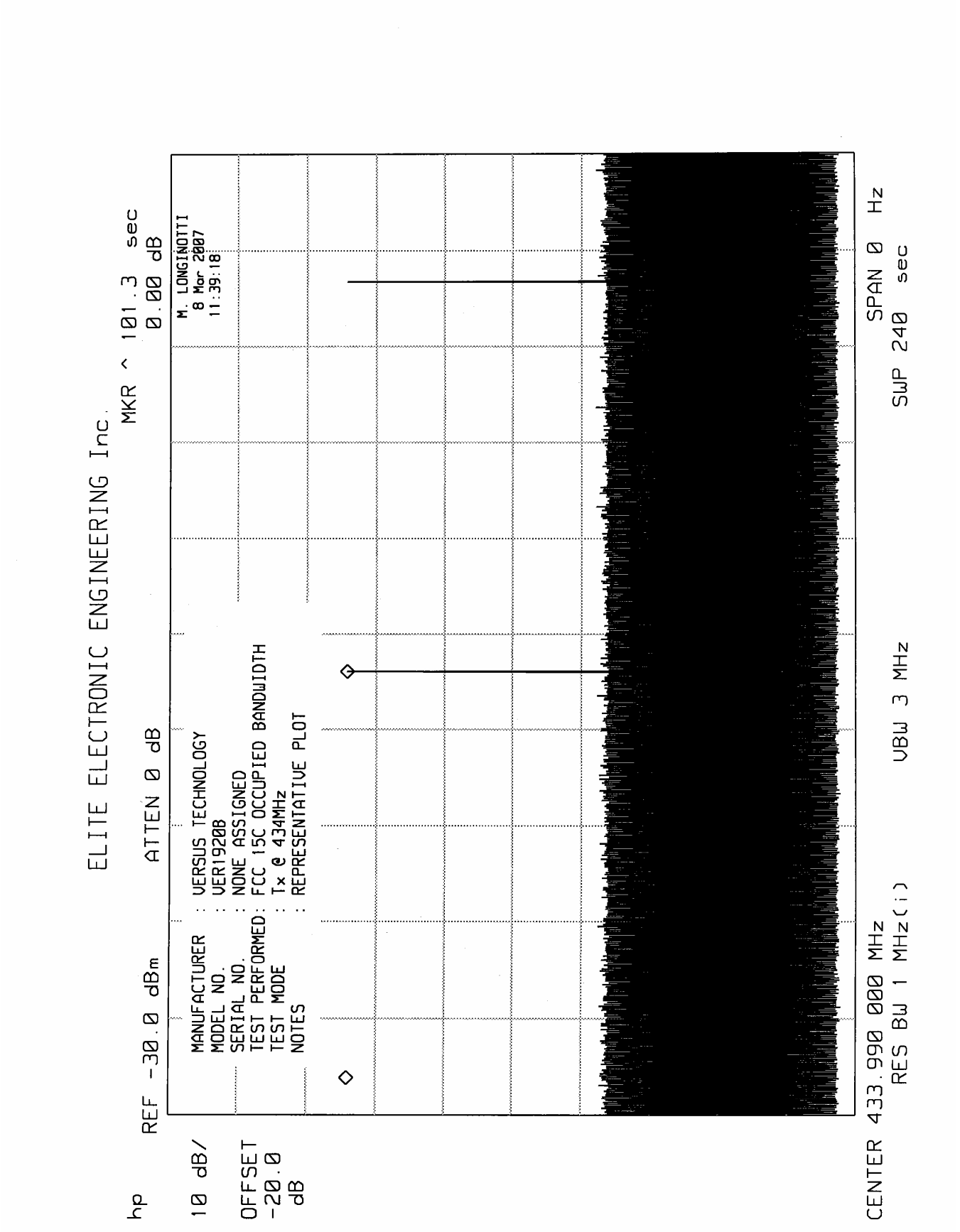

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV_EM RUN 2
WKA0 02/16/06
TEST : RADIATED NARROWBAND EMISSIONS
SPECIFICATION: FCC 15.231 PRELIM RAD EMISS
MANUFACTURER : VERSUS TECHNOLOGY
MODEL No. : VER1920B
S/N : 14
MODE : Tx @ 434MHz
DATE TESTED : 8 Mar 2007 10:51:29 M. LONGINOTTI
NOTES :
ANT POLARITY : VERTICAL
RADIATED NARROWBAND EMISSIONS - dBuV/m
110
100
90
80
70
60
50
40
30
20
10
0
START = 30
100
FREQUENCY - MHz
STOP = 1000

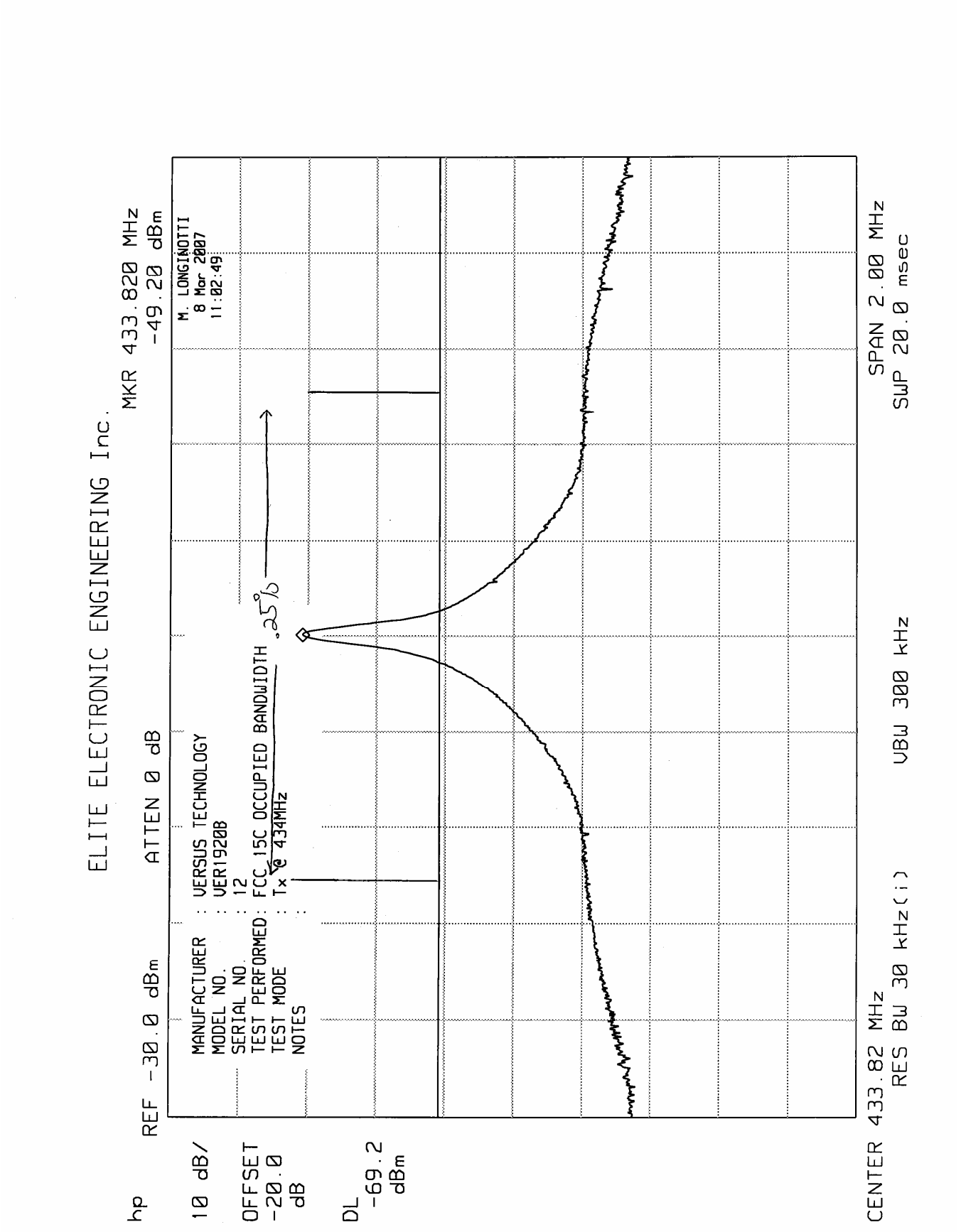

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV_EM RUN 1
WKA0 02/16/06
TEST : RADIATED NARROWBAND EMISSIONS
SPECIFICATION: FCC 15.231 PRELIM RAD EMISS
MANUFACTURER : VERSUS TECHNOLOGY
MODEL No. : VER1920B
S/N : 14
MODE : Tx @ 434MHz
DATE TESTED : 8 Mar 2007 10:31:31 M. LONGINOTTI
NOTES :
ANT POLARITY : VERTICAL
RADIATED NARROWBAND EMISSIONS - dBuV/m
110
100
90
80
70
60
50
40
30
20
10
0
START = 1000
FREQUENCY - MHz
STOP = 4500

MANUFACTURER : Versus Technology, Inc.
TEST ITEM : Flex Badge
MODEL NO. : VER1920B
SERIAL NO. : 14
SPECIFICATION : FCC- 15C Transmitter Open Field Data
DATE : March 9, 2007
NOTES : Test Distance is 3 Meters

Freq (MHz)	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Duty Cycle (dB)	Total dBuV/m at 3 M	Total uV/m at 3M	Limit uV/m at 3M	Margin (dB)
434.0	H	54.9		1.5	21.1	0.0	-16.9	60.6	1075.0	4400.0	-12.2
434.0	V	62.3		1.5	21.1	0.0	-16.9	68.0	2519.9	4400.0	-4.8
868.0	H	29.7		1.9	27.1	0.0	-16.9	41.9	123.8	440.0	-11.0
868.0	V	35.3		1.9	27.1	0.0	-16.9	47.5	236.0	440.0	-5.4
1302.0	H	23.7		2.4	26.4	0.0	-16.9	35.6	60.2	500.0	-18.4
1302.0	V	19.3		2.4	26.4	0.0	-16.9	31.2	36.3	500.0	-22.8
1736.0	H	28.8		2.8	27.7	0.0	-16.9	42.4	132.4	500.0	-11.5
1736.0	V	34.2		2.8	27.7	0.0	-16.9	47.8	246.5	500.0	-6.1
2170.0	H	32.5		3.2	29.4	0.0	-16.9	48.2	258.4	500.0	-5.7
2170.0	V	33.2		3.2	29.4	0.0	-16.9	48.9	280.1	500.0	-5.0
2604.0	H	26.2		3.7	31.0	0.0	-16.9	44.0	157.6	500.0	-10.0
2604.0	V	25.6		3.7	31.0	0.0	-16.9	43.4	147.1	500.0	-10.6
3038.0	H	26.3		4.0	32.3	0.0	-16.9	45.7	193.1	500.0	-8.3
3038.0	V	19.5		4.0	32.3	0.0	-16.9	38.9	88.2	500.0	-15.1
3472.0	H	24.5		4.3	32.3	0.0	-16.9	44.2	162.6	500.0	-9.8
3472.0	V	19.0		4.3	32.3	0.0	-16.9	38.7	86.3	500.0	-15.3
3906.0	H	23.4		4.5	32.9	0.0	-16.9	43.9	156.6	500.0	-10.1
3906.0	V	18.9		4.5	32.9	0.0	-16.9	39.4	93.3	500.0	-14.6
4340.0	H	24.4		4.7	32.9	0.0	-16.9	45.1	179.7	500.0	-8.9
4340.0	V	22.8		4.7	32.9	0.0	-16.9	43.5	149.4	500.0	-10.5

Checked By: MARK E. LONGINOTTI


ELITE ELECTRONIC ENGINEERING Inc.
hp
REF -30.0 dBm
ATTEN 0 dB
MKR ^ 101.3 sec
0.00 dB
10 dB/
OFFSET
-20.0
dB
M. LONGINOTTI
8 Mar 2007
11:39:18
MANUFACTURER : VERSUS TECHNOLOGY
MODEL NO. : VER1920B
SERIAL NO. : NONE ASSIGNED
TEST PERFORMED: FCC 15C OCCUPIED BANDWIDTH
TEST MODE : Tx @ 434MHz
NOTES : REPRESENTATIVE PLOT
CENTER 433.990 000 MHz
RES BW 1 MHz(i)
VBW 3 MHz
SPAN 0 Hz
SWP 240 sec


ELITE ELECTRONIC ENGINEERING Inc.
MKR 433.820 MHz
-49.20 dBm
M. LONGINOTTI
8 Mar 2007
11:02:49
hp
REF -30.0 dBm
ATTEN 0 dB
10 dB/
OFFSET
-20.0
dB
DL
-69.2
dBm
MANUFACTURER : VERSUS TECHNOLOGY
MODEL NO. : VER1920B
SERIAL NO. : 12
TEST PERFORMED: FCC 15C OCCUPIED BANDWIDTH
TEST MODE : Tx @ 434MHz
NOTES : :
25%
CENTER 433.82 MHz
RES BW 30 kHz(i)
VBW 300 kHz
SPAN 2.00 MHz
SWP 20.0 msec