Measurement of RF Interference from a Personnel Badge Model VER-1780 Rev. 5 Transmitter

For	:	Versus Technology, Inc. 2600 Miller Creek Road Traverse City, MI 49684
P.O. No.	:	RLW-01295 and RLW-01298
Date Tested	:	April 28, 2008
Test Personnel	:	Mark E. Longinotti
Specification	:	FCC "Code of Federal Regulations" Title 47 Part 15, Subpart C Industry Canada RSS-210; Industry Canada RSS-GEN

Test Report By : MARK E. LONGINOTTI
Mark E. Longinotti

Witnessed By : Robert Wiser
Versus Technology, Inc.

Approved By : Raymond J Klouda
Raymond J. Klouda
Registered Professional Engineer of Illinois - 44894

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REVISION HISTORY

Revision	Date	Description
—	June 3, 2008	Initial release

Measurement of RF Emissions from a Personnel Badge Model VER-1780 Rev. 5 Transmitter

1 INTRODUCTION

1.1 Scope of Tests

This document represents the results of the series of radio interference measurements performed on a Personnel Badge model VER-1780 Rev. 5, Serial No. None Assigned transmitter, (hereinafter referred to as the test item). The test item was designed to transmit at approximately 433.95MHz 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 EMC Laboratory 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.

1.5 Laboratory Conditions

The temperature at the time of the test was 22°C and the relative humidity was 22%.

2 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 B for Receivers, dated 1 October 2007
- 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"
- Industry Canada RSS-210, Issue 7, June 2007, “Spectrum Management and Telecommunications Radio Standards Specification, Low-power License-exempt radio communication devices (All Frequency Bands): Category I Equipment”
- Industry Canada RSS-GEN, Issue 2, June 2007, “Spectrum Management and Telecommunications Radio Standards Specification, General Requirements and Information for the Certification of radio communication equipment”

3 TEST ITEM SET-UP AND OPERATION

3.1 General Description

The test item is a Personnel Badge, Model No. VER-1780 Rev. 5. A block diagram of the test item set-up is shown as Figure 1.

3.1.1 Power Input

The test item obtained 3VDC from a CR2477N battery.

3.1.2 Peripheral Equipment

The test item has no peripheral equipment.

3.1.3 Interconnect Cables

The test item has no interconnect cables or ports.

3.1.4 Grounding

The test item was ungrounded during the tests.

3.2 Operational Mode

The test item has two different modes of operation. For the first mode, the test item will transmit a single packet of information approximately once every 120 seconds but for special applications can transmit more frequently but will never transmit faster than one packet every 12 seconds. This meets the requirements of 15.231(e) which states that the 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. The plot on page 13 shows that the transmission is not greater than one second. The plot on page 14 shows the shortest silent period of approximately 12 seconds. This meets the requirement that the silent period between transmissions shall be at least 30 times the duration of the transmission but in no case less than 10 seconds.

For the second mode, the test item can be manually operated. The plot on page 15 shows that the test item will deactivate the transmitter within not more than 5 seconds after the transmit button is released. This meets the requirements of 15.231(a).

For testing purposes, 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 testing purposes, the test item was modified to transmit continuously. The test was performed with the test item transmitting at approximately 433.95MHz.

3.3 Test Item Modifications

No modifications were required for compliance to the FCC Part 15C requirements.

4 TEST FACILITY AND TEST INSTRUMENTATION

4.1 Shielded Enclosure

All tests were performed in a 32ft. x 20ft. x 18ft. hybrid ferrite-tile/anechoic absorber lined test chamber. With the exception of the floor, the reflective surfaces of the shielded chamber are lined with ferrite tiles on the walls and ceiling. Anechoic absorber material is installed over the ferrite tile. The floor of the chamber is used as the ground plane. The chamber complies with ANSI C63.4-2003 for site attenuation.

4.2 Test Instrumentation

The test instrumentation and auxiliary equipment used during the tests are listed in Table 9-1.

4.3 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).

4.4 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.

The measurement uncertainty for these tests is presented below:

Conducted Emission Measurements		
Combined Standard Uncertainty	1.07	-1.07
Expanded Uncertainty (95% confidence)	2.1	-2.1

Radiated Emission Measurements		
Combined Standard Uncertainty	2.26	-2.18
Expanded Uncertainty (95% confidence)	4.5	-4.4

5 TEST PROCEDURES

5.1 Powerline Conducted Emissions

5.1.1 Requirements

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

5.2 Duty Cycle Factor Measurements

5.2.1 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).

5.2.2 Results

A representative plot of the duty cycle is shown on page 16. 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 Forty-Six 225msec pulses.

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 433.95MHz, the maximum case duty cycle correction factor was calculated to be -16.88dB.

5.3 Radiated Measurements

5.3.1 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

Paragraph 15.231(a) 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	3,750 to 12,500*	375 to 1,250*

Since the limits for 15.231(e) are lower than the limits for 15.231(a), if the test item meets the limits of 15.231(e), then it will also meet the limits of 15.231(a). Therefore all tests were run to the 15.231(e) limits.

For 433.95MHz, the limit at the fundamental is 4399.2uV/m @ 3m. The limit for the harmonics is 439.9uV/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.

5.3.2 Procedures

Radiated 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 5.0GHz was investigated using a peak detector function. The data was then processed by the computer to calculate equivalent field intensity.

The final emission tests were then manually performed over the frequency range of 30MHz to 5.0GHz. 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.

5.3.3 Results

The preliminary plots, with the test item transmitting at 433.95MHz, are presented on data pages 17 and 18. The plots are presented for a reference only, and are not used to determine compliance.

The final radiated levels, with the test item transmitting at 433.95MHz, are presented on data page 19. As can be seen from the data, all emissions measured from the test item were within the specification limits. The emissions level closet to the limit (worst case) occurred at 1301.85MHz. The emissions level at this frequency was 3.2dB within the limit. See data page 19 for details. Photographs of the test configuration which yielded the highest, or worst case, radiated emission levels are shown on Figure 2.

5.4 Occupied Bandwidth Measurements

5.4.1 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.

5.4.2 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.

5.4.3 Results

The plot of the emissions near the fundamental frequency is presented on data page 21. As can be seen from this data page, the transmitter met the occupied bandwidth requirements. The 99% bandwidth was measured to be 412.8kHz.

6 OTHER TEST CONDITIONS

6.1 Test Personnel and Witnesses

All tests were performed by qualified personnel from Elite Electronic Engineering Incorporated. The test series was witnessed by Versus Technology, Inc. personnel.

6.2 Disposition of the Test Item

The test item and all associated equipment were returned to Versus Technology, Inc. upon completion of the tests.

7 CONCLUSIONS

It was determined that the Versus Technology, Inc. Personnel Badge, Part No. VER-1780 Rev. 5, Serial No. None Assigned, did fully meet the conducted and 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.

8 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 as operated by Versus Technology, Inc. personnel. 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.

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

9 EQUIPMENT LIST

Table 9-1 Equipment List

Eq ID	Equipment Description	Manufacturer	Model No.	Serial No.	Frequency Range	Cal Date	Due Date
NDQ1	TUNED DIPOLE ANTENNA	EMCO	3121C-DB4	313	400-1000MHZ	4/14/2008	4/14/2009
NTA1	BILOG ANTENNA	CHASE EMC LTD.	BILOG CBL6112	2054	0.03-2GHZ	6/5/2007	6/5/2008
NWH0	RIDGED WAVE GUIDE	TENSOR	4105	2081	1-12.4GHZ	10/13/2007	10/13/2008
PHA0	MAGNETIC FIELD PROBE	ELECTRO-METRICS	EM-6882	134	22-230MHZ	NOTE 1	
RBB0	EMI TEST RECEIVER 20HZ TO 40 GHZ.	ROHDE & SCHWARZ	ESIB40	100250	20 HZ TO 40GHZ	11/5/2007	11/5/2008

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.

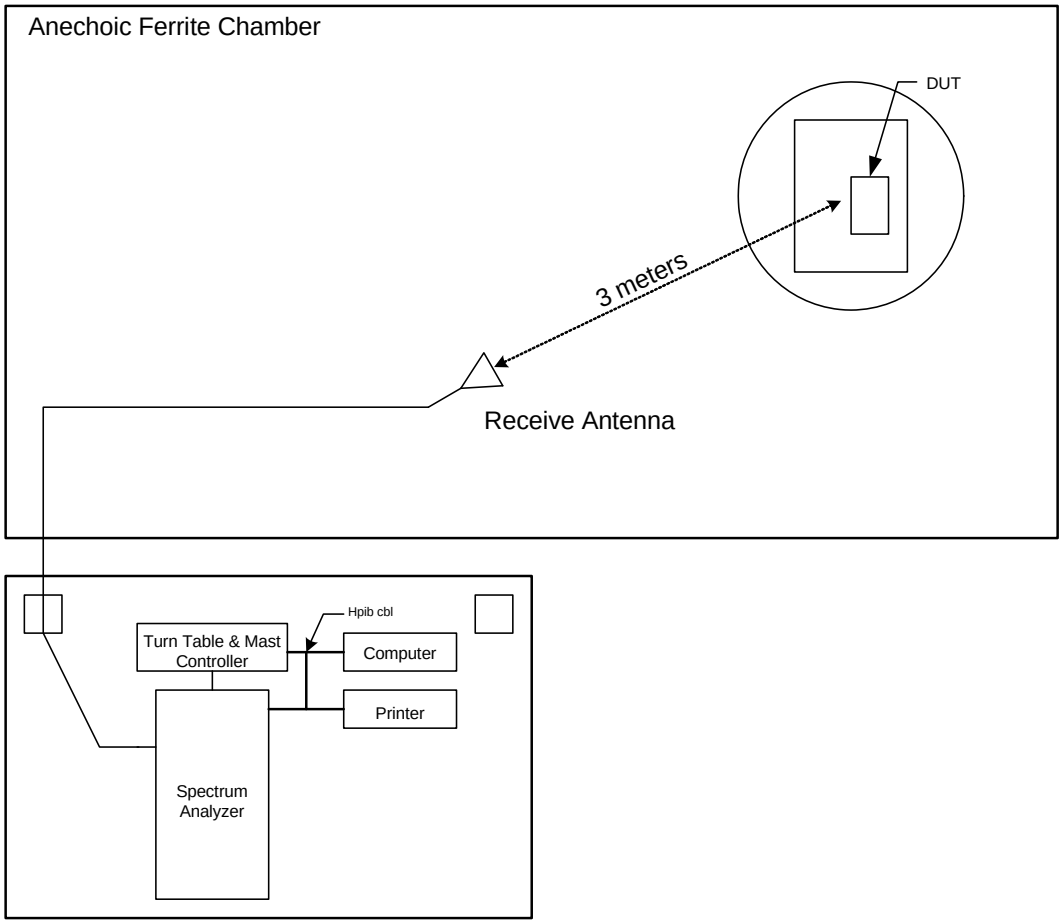
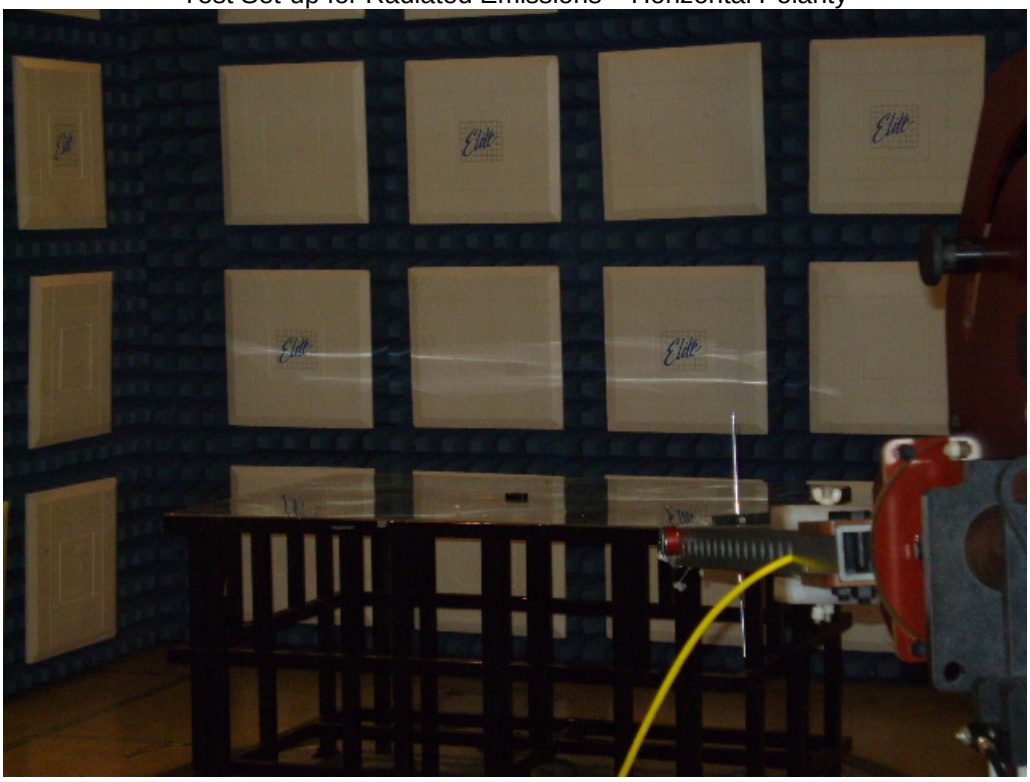


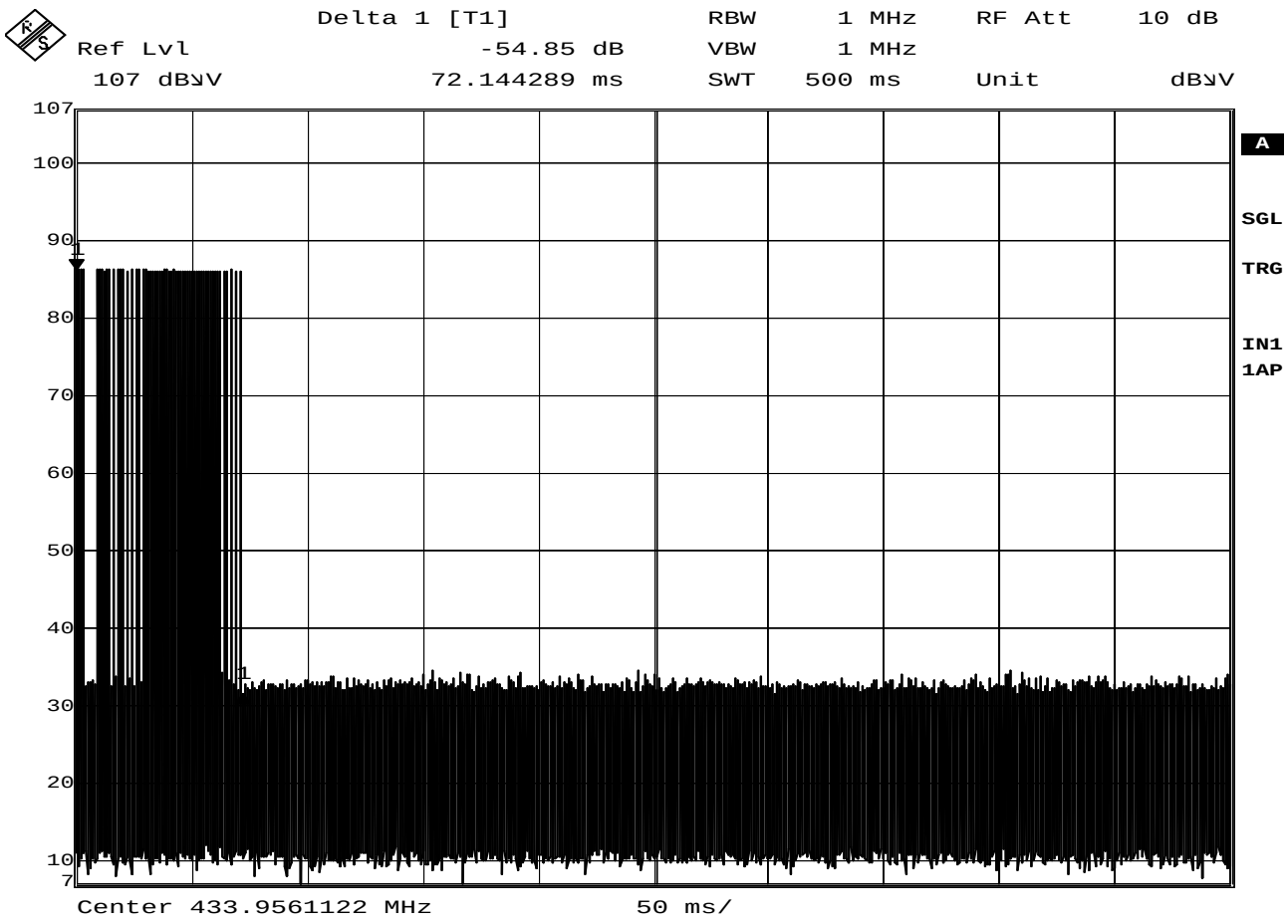
FIGURE 1 BLOCKDIAGRAM OF TEST SETUP

Figure 2

Test Set-up for Radiated Emissions – Horizontal Polarity



Test Set-up for Radiated Emissions – Vertical Polarity



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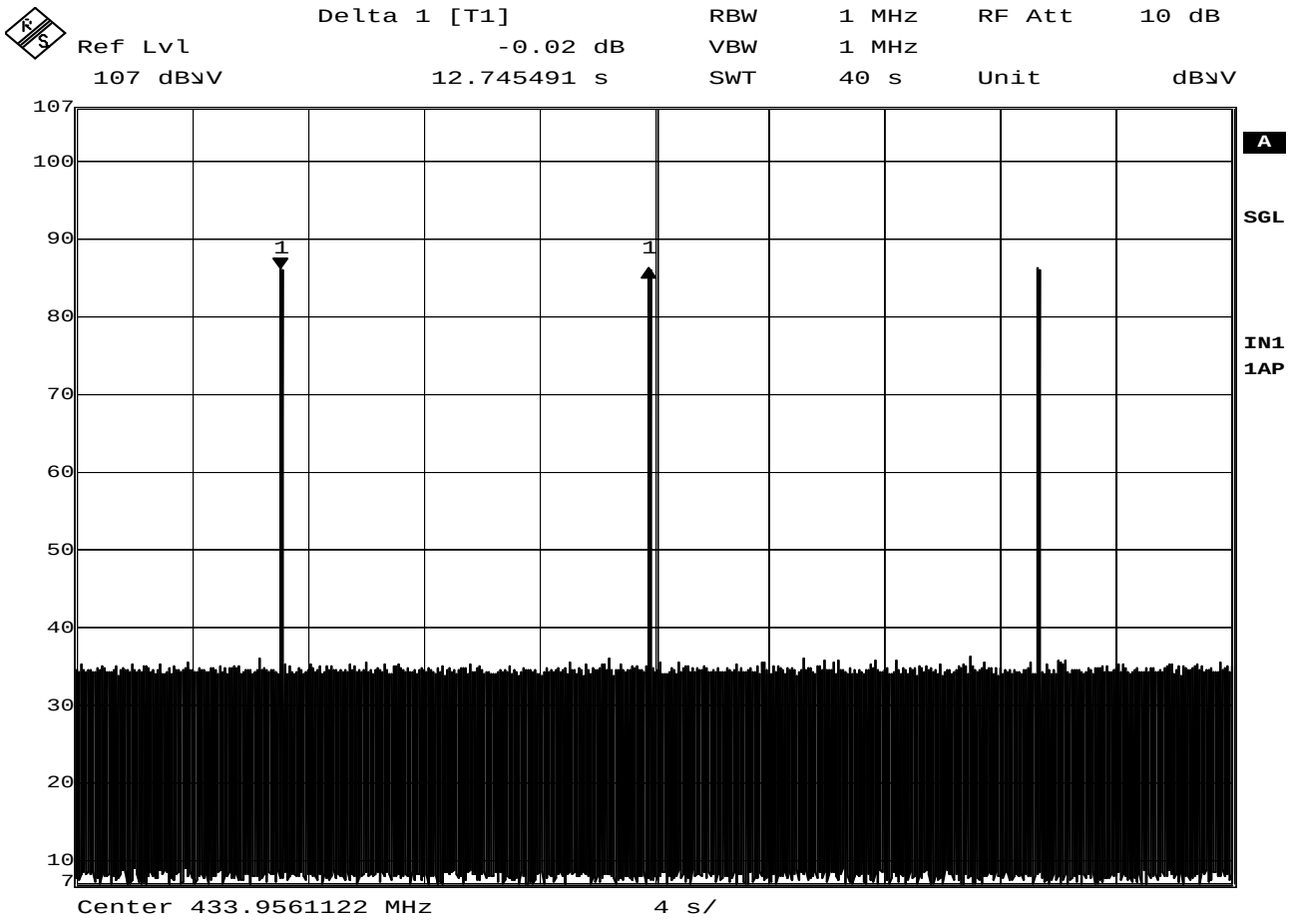
FCC 15.231(e)

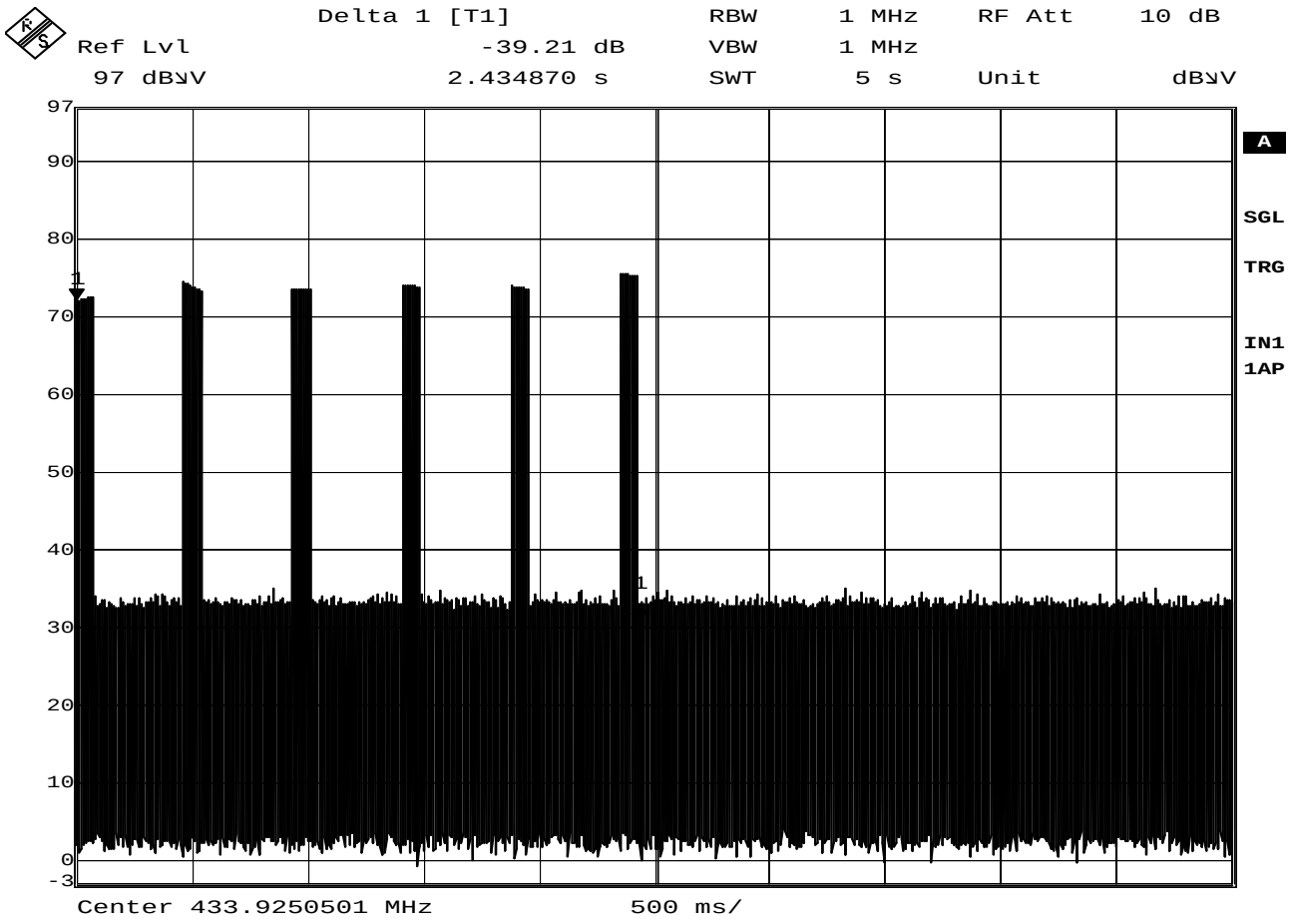
MANUFACTURER : VERSUS TECHNOLOGY, INC.
MODEL NUMBER : VER-1780 REV 5
SERIAL NUMBER : NONE ASSIGNED
TEST MODE : Tx @ 433.95MHz
TEST PARAMETER : TRANSMISSION SHALL NOT BE GREATER THAN 1 SECOND
EQUIPMENT USED : RBB0, PHA0



Date: 28.APR.2008 22:29:36

FCC 15.231(e)

MANUFACTURER : VERSUS TECHNOLOGY, INC.
MODEL NUMBER : VER-1780 REV 5
SERIAL NUMBER : NONE ASSIGNED
TEST MODE : Tx @ 433.95MHz
TEST PARAMETER : SILENT PERIOD BETWEEN TRANSMISSIONS SHALL BE AT
: LEAST 30 TIMES THE DURATION OF THE TRANSMISSION
: BUT IN NO CASE LESS THAN 10 SECONDS
EQUIPMENT USED : RBB0, PHA0

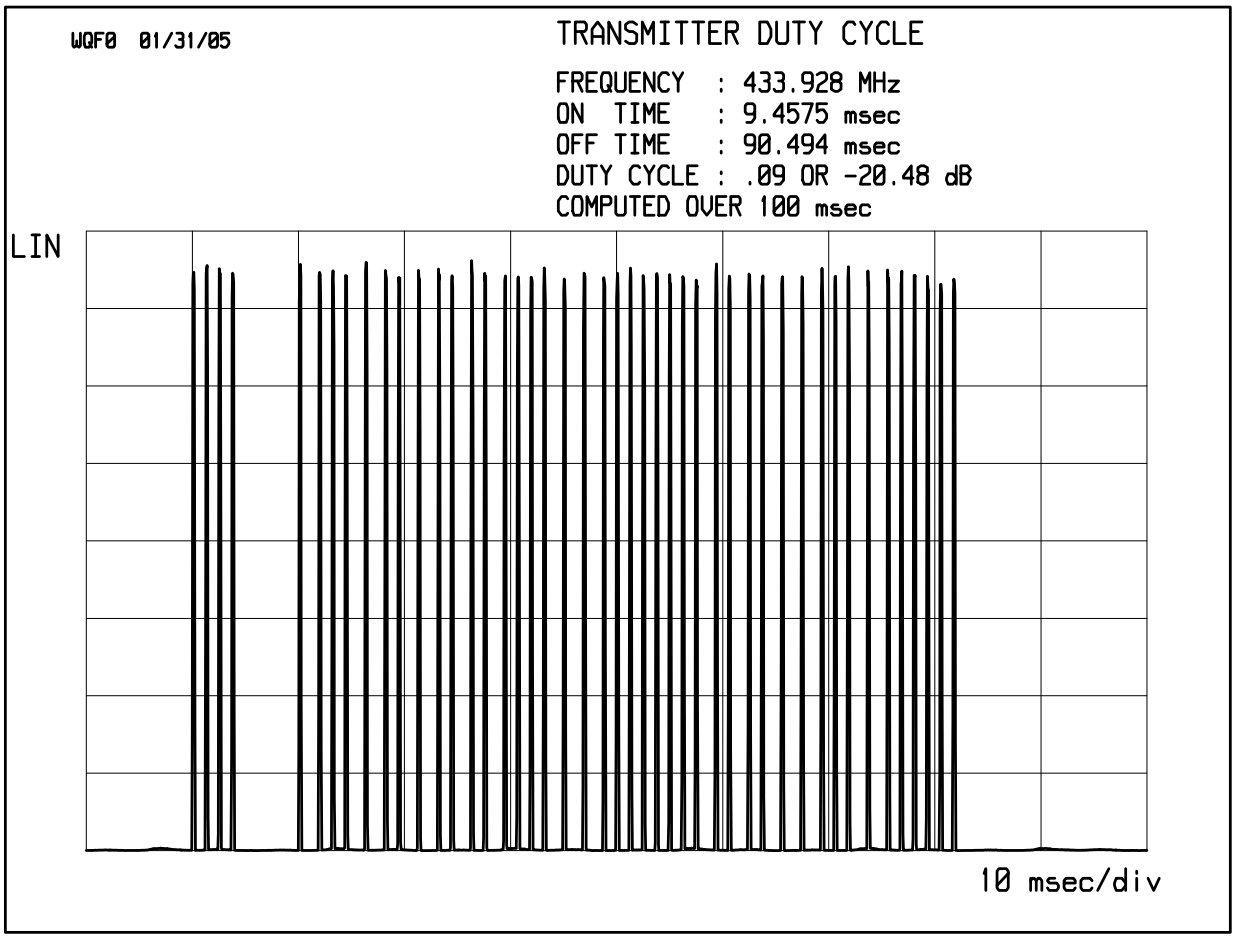


Date: 29.APR.2008 20:31:29

FCC 15.231

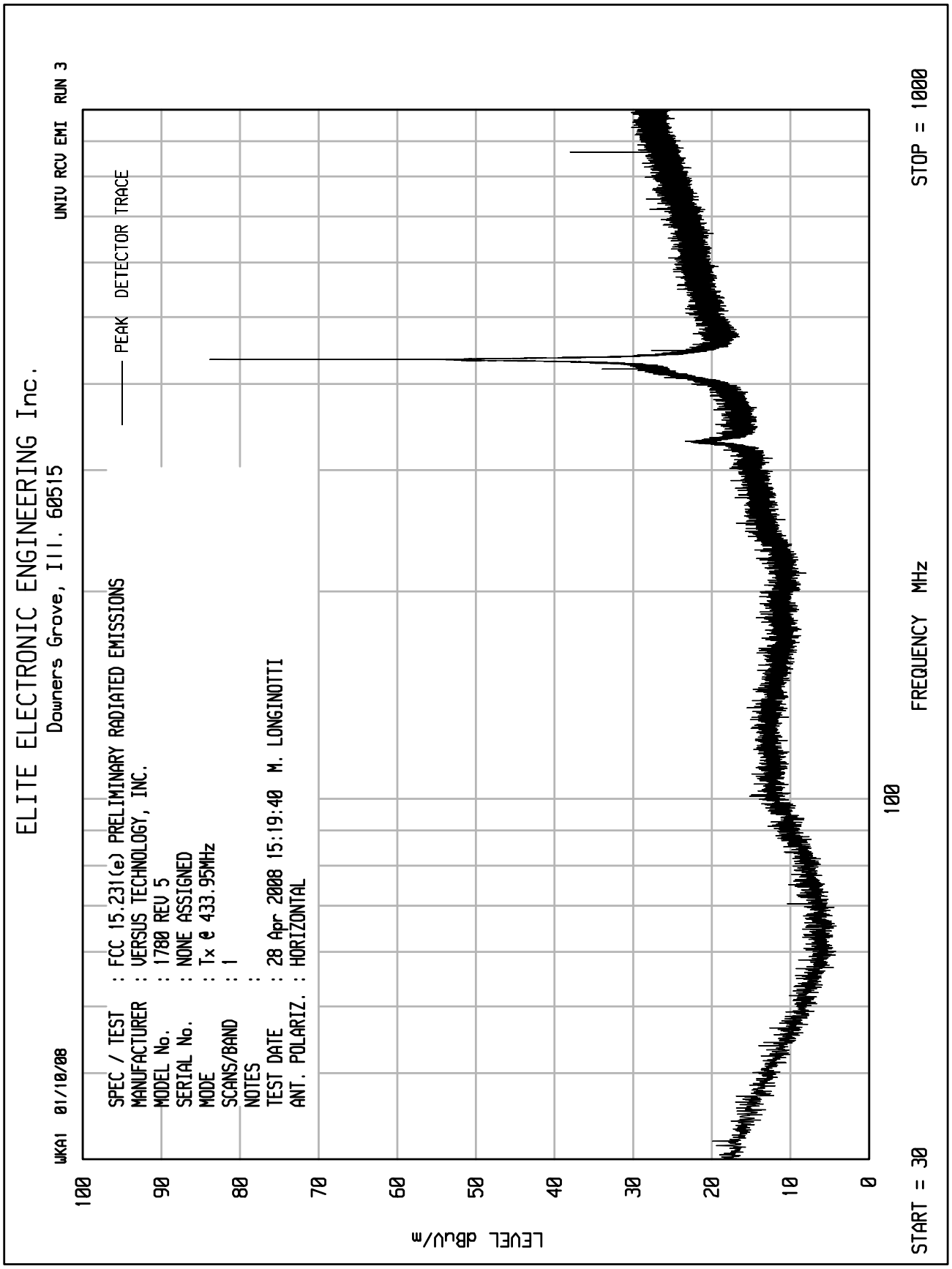
MANUFACTURER : VERSUS TECHNOLOGY, INC.
MODEL NUMBER : VER-1780 REV 5
SERIAL NUMBER : NONE ASSIGNED
TEST MODE : Tx @ 433.95MHz
TEST PARAMETER : MANUALLY OPERATED TRANSMITTER SHALL DEACTIVATE
: WITHIN NOT MORE THAN 5 SECONDS AFTER SWITCH IS
: RELEASED
EQUIPMENT USED : RBB0, PHA0

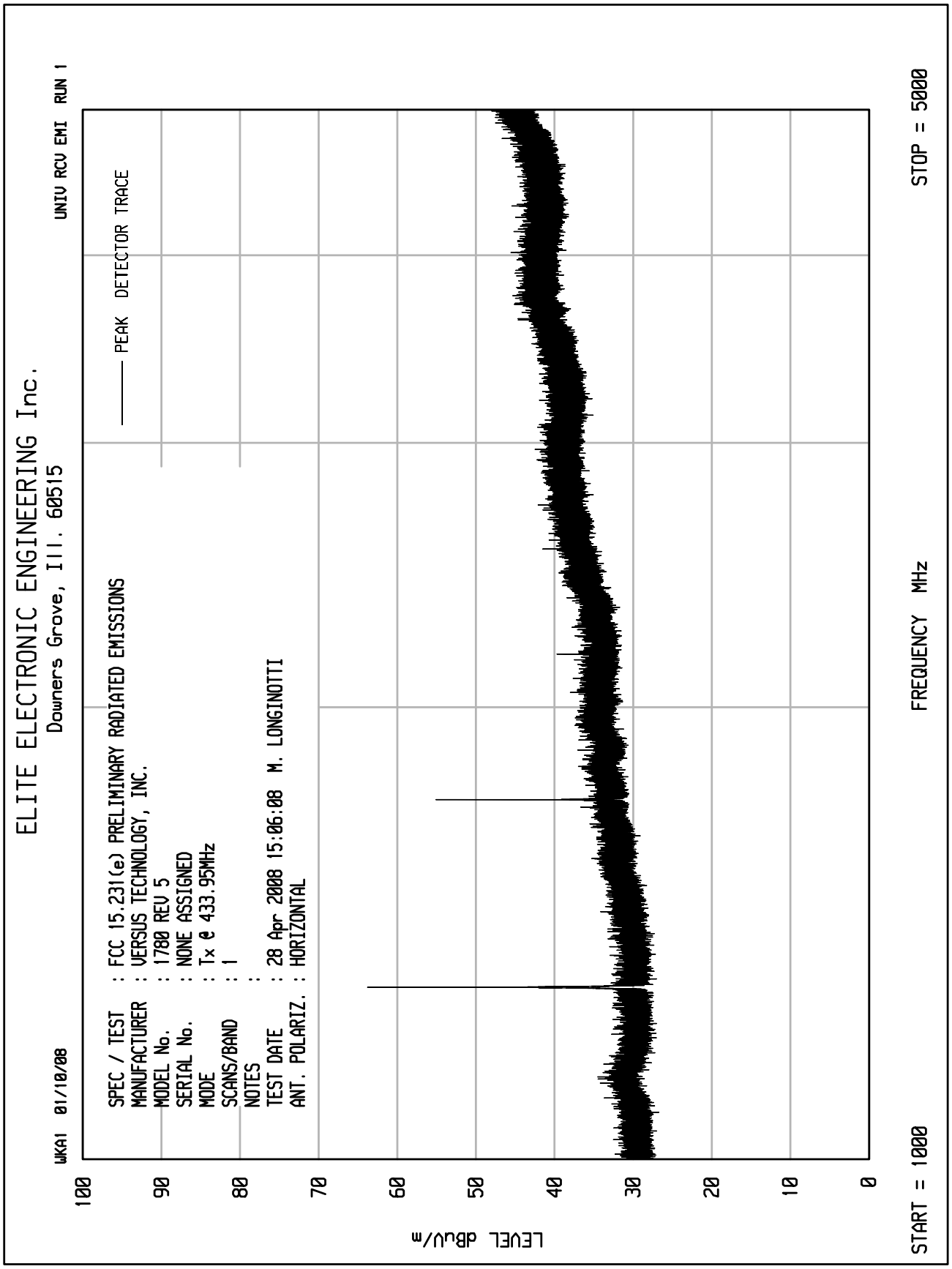
ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Il 60515



MANUFACTURER : VERSUS TECHNOLOGY
MODEL : 1780 REV 5
S/N : NONE ASSIGNED
NOTES : Tx @ 433.95MHz
DATE : 28 Apr 2008 16:22:23 M. LONGINOTTI

pg ____ of ____


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 3
WKA1 01/10/08
SPEC / TEST : FCC 15.231(e) PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : VERSUS TECHNOLOGY, INC.
MODEL No. : 1780 REV 5
SERIAL No. : NONE ASSIGNED
MODE : Tx @ 433.95MHz
SCANS/BAND : 1
NOTES :
TEST DATE : 28 Apr 2008 15:19:40 M. LONGINOTTI
ANT. POLARIZ. : HORIZONTAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
100
90
80
70
60
50
40
30
20
10
0
START = 30
100
FREQUENCY MHz
STOP = 1000

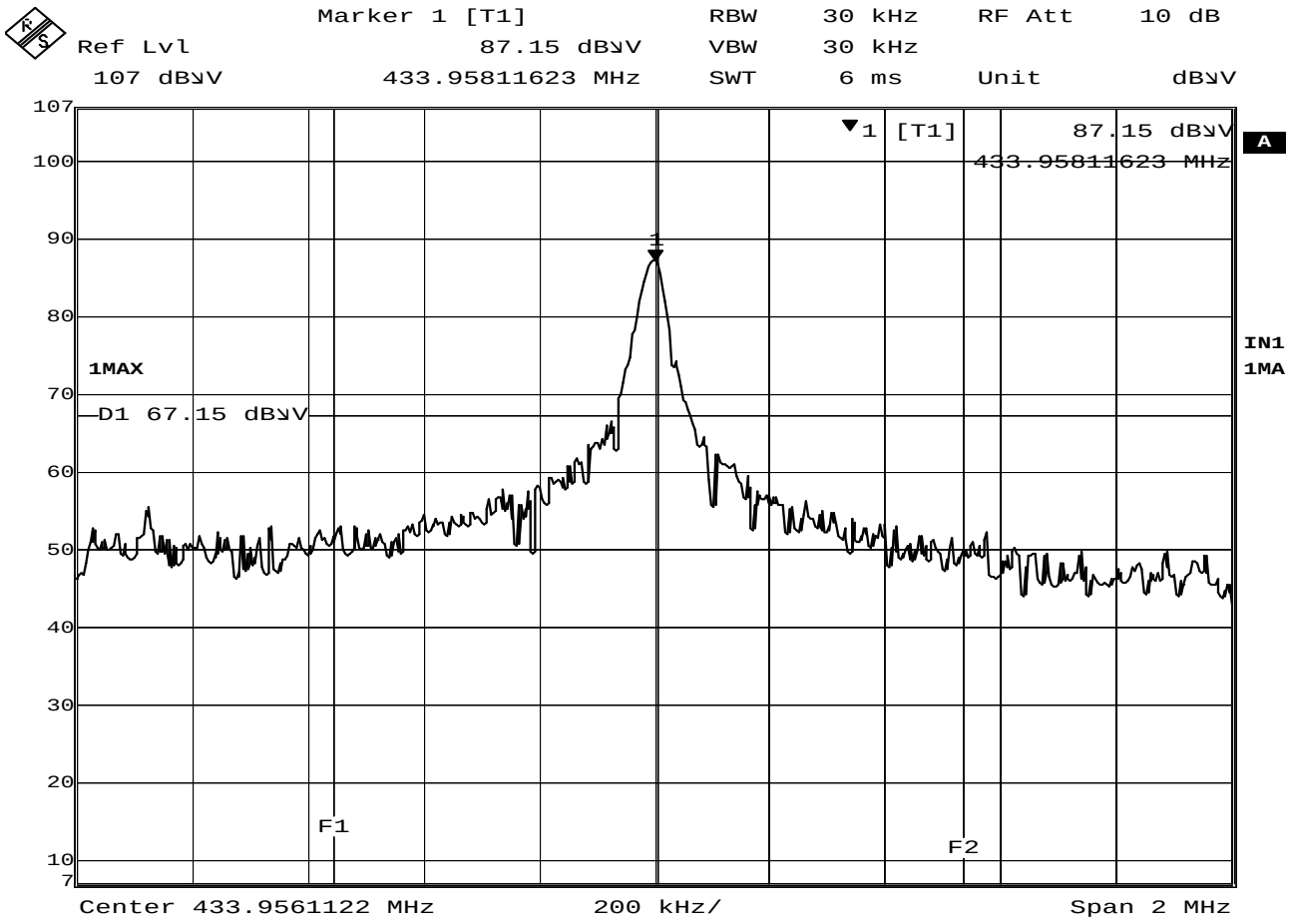

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 1
WKA1 01/10/08
SPEC / TEST : FCC 15.231(e) PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : VERSUS TECHNOLOGY, INC.
MODEL No. : 1780 REV 5
SERIAL No. : NONE ASSIGNED
MODE : Tx @ 433.95MHz
SCANS/BAND : 1
NOTES :
TEST DATE : 28 Apr 2008 15:06:08 M. LONGINOTTI
ANT. POLARIZ. : HORIZONTAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
100
90
80
70
60
50
40
30
20
10
0
START = 1000
FREQUENCY MHz
STOP = 5000

MANUFACTURER : Versus Technology, Inc.
TEST ITEM : Personnel Badge
MODEL NO. : VER-1780 Rev. 5
SERIAL NO. : None Assigned
SPECIFICATION : FCC- 15C Transmitter Open Field Data
DATE : April 28, 2008
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)
433.95	H	61.9		1.6	21.3	0.0	-16.9	67.9	2496.4	4399.2	-4.9
433.95	V	49.1		1.6	21.3	0.0	-16.9	55.1	571.9	4399.2	-17.7
867.90	H	20.8		2.5	27.3	0.0	-16.9	33.7	48.3	439.9	-19.2
867.90	V	11.9		2.5	27.3	0.0	-16.9	24.8	17.3	439.9	-28.1
1301.85	H	39.1		2.9	25.7	0.0	-16.9	50.8	346.0	500.0	-3.2
1301.85	V	28.9		2.9	25.7	0.0	-16.9	40.6	106.9	500.0	-13.4
1735.80	H	29.6		3.3	27.2	0.0	-16.9	43.2	143.8	500.0	-10.8
1735.80	V	28.5		3.3	27.2	0.0	-16.9	42.1	126.7	500.0	-11.9
2169.75	H	21.1		3.7	28.7	0.0	-16.9	36.7	68.2	500.0	-17.3
2169.75	V	18.5	Ambient	3.7	28.7	0.0	-16.9	34.1	50.7	500.0	-19.9
2603.70	H	15.5	Ambient	4.2	29.9	0.0	-16.9	32.7	43.1	500.0	-21.3
2603.70	V	16.1	Ambient	4.2	29.9	0.0	-16.9	33.3	46.2	500.0	-20.7
3037.65	H	17.9	Ambient	4.6	31.2	0.0	-16.9	36.9	69.8	500.0	-17.1
3037.65	V	16.2	Ambient	4.6	31.2	0.0	-16.9	35.2	57.4	500.0	-18.8
3471.60	H	15.7	Ambient	5.0	33.5	0.0	-16.9	37.3	73.5	500.0	-16.7
3471.60	V	15.7	Ambient	5.0	33.5	0.0	-16.9	37.3	73.5	500.0	-16.7
3905.55	H	16.1	Ambient	5.3	34.4	0.0	-16.9	38.9	88.0	500.0	-15.1
3905.55	V	16.1	Ambient	5.3	34.4	0.0	-16.9	38.9	88.0	500.0	-15.1
4339.50	H	16.7	Ambient	5.6	34.1	0.0	-16.9	39.5	94.5	500.0	-14.5
4339.50	V	16.8	Ambient	5.6	34.1	0.0	-16.9	39.6	95.5	500.0	-14.4

Checked By: MARK E. LONGINOTTI

Mark E. Longinotti



Date: 28.APR.2008 22:45:06

FCC 15.231 20 dB Bandwidth

MANUFACTURER : VERSUS TECHNOLOGY, INC.
MODEL NUMBER : VER-1780 REV 5
SERIAL NUMBER : NONE ASSIGNED
TEST MODE : Tx @ 433.95MHz
TEST PARAMETER : DISPLAY LINE D1 REPRESENTS THE 20dB DOWN LEVEL.
: DISPLAY LINES F1 AND F2 REPRESENT THE 0.25%
: FREQUENCY RANGE.
EQUIPMENT USED : RBB0, NTA1