Measurement of RF Emissions from a Model VER-3520 Event Tag

For	Versus Technology, Inc. 2600 Miller Creek Road Traverse City, MI 49684
P.O. Number	VTI-2012-2070
Date Tested	Feb. 28 and March 26, 2012
Test Personnel	Richard King
Test Specification	FCC "Code of Federal Regulations" Title 47 Part15, Subpart C Industry Canada RSS-GEN Industry Canada RSS-210

Test Report By:

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REVISION HISTORY

Revision	Date	Description
—	30 March 2012	Initial release

Measurement of RF Emissions from an Event Tag, Model No. VER-3520 Transmitter

1. INTRODUCTION

1.1. Scope of Tests

This report presents the results of the RF emissions measurements performed on an Event Tag, Model No. VER-3520, no serial number was assigned, (hereinafter referred to as the Equipment Under Test (EUT)). The EUT was designed to transmit at 433.92 MHz. The EUT has an internal attached antenna. The EUT 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 EUT 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 C63.4-2009.

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 American Association for Laboratory Accreditation (A2LA). A2LA Certificate Number: 1786.01.

1.5. Laboratory Conditions

The temperature at the time of the test was 21.5^{o}C and the relative humidity was 23%.

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 C, dated 1 October 2011
- ANSI C63.4-2009, "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 Radio Standards Specification, RSS-Gen, “General Requirements and Information for the Certification of Radiocommunication Equipment”, Issue 3, December 2010
- Industry Canada Radio Standards Specification, RSS-210, “Low-power Licence-exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment”, Issue 8, December 2010

3. EUT SETUP AND OPERATION

3.1. General Description

The EUT is a Versus Technology, Inc., Event Tag, Model No. VER-3520. A block diagram of the EUT setup is shown as Figure 1.

3.1.1. Power Input

The EUT obtained 3.6V DC from a lithium battery.

3.1.2. Peripheral Equipment

The EUT does not connect to peripheral equipment.

3.1.3. Signal Input/Output Leads

The EUT does not have connections for external leads.

3.1.4. Grounding

The EUT was ungrounded during testing.

3.2. Operational Mode

For all tests the EUT was placed on an 80cm high non-conductive stand. The EUT was and set to transmit.

3.3. EUT Modifications

No modifications were required for compliance to the the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Sections 15.231 for Intentional Radiators you tested to 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 C63.4-2009 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 Emissions Measurements		
Combined Standard Uncertainty	1.07	-1.07
Expanded Uncertainty (95% confidence)	2.1	-2.1

Radiated Emissions 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 EUT has no AC power connections, no conducted emissions tests are required.

5.2. Periodic Operation Measurements

5.2.1. Requirements

A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released. Also, a transmitter activated automatically shall cease transmission within 5 seconds after activation.

5.2.2. Procedures

The spectrum analyzer was setup to display the time domain trace. The EUT was set to transmit normally. The spectrum analyzer was used to record the amount of time that the EUT remained active following activation.

5.2.3. Results

The plot of the periodic timing is shown on data page 15. The data shows that the EUT ceases operation within the allotted time.

5.3. Duty Cycle Factor Measurements

5.3.1. 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.

The duty cycle factor was calculated from information supplied by the manufacturer. Since this test item utilizes a rolling code modulation, the duty is calculated based on the worst case. The following procedure was used to measure a representative sample:

a) With the transmitter set up to transmit for maximum pulse density, the time domain trace is displayed on the spectrum analyzer.

b) Next the number of pulses in the word period is measured and a plot of this measurement is recorded.

c) The pulse width is measured and a plot of this measurement was recorded.

d) The worst case or shortest OFF between pulses is measured and a plot of this measurement is recorded.

e) The preamble OFF time is measured and a plot of this measurement is recorded.

f) Finally the length of the word period is measured and a third plot is recorded. If the word period exceeds 100 msec, the word period is limited to 100 msec.

g) The pulse width and number of pulses for the word period are used to compute the on-time. The duty cycle is then computed as the (on-time/ word period).

h) The duty cycle factor is computed from the duty cycle.

5.3.2. Results

Representative plots of the duty cycle are shown on pages 16 through 19. 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-three 206uSec 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 1.04mSec determines the logical "0" (zero).
The off time of approximately 1.61mSec determines the logical "1" (one).
The pulse train consists of:

1. Four Preamble pulses separated by approximately 1.04mSec off time
2. An 'off' time of approximately 6.2mSec.
3. Forty-Two pulses separated by 'off' time of either 1.04mSec or 1.61mS.

If all forty-two encoding pulses are separated by 1.04mS, then the maximum value of the emission is calculated as follows:

Pulse on time:

1. Total on time 46 x 0.225mS 8.85 mS

Pulse word period:

1. Preamble on time 4 x .206mS 0.824 mS
2. Preamble off time 3 x 1.04mS 3.12 mS
3. Preamble space time 6.20mS 6.20 mS
4. Encoded pulses 42 x 0.206mS 8.652 mS
5. Encoded off time 41 x 1.04mS 42.64 mS

TOTAL pulse word period: 61.44 mS

Duty cycle factor (maximum time on) is:

1. Duty cycle: (8.85mS / 61.44mS) = 0.14
2. Duty cycle factor: 20 * log (0.16) = -16.8dB

With the test item transmitting at 433.9MHz, the maximum case duty cycle correction factor was calculated to be -16.8dB.

5.4. Radiated Measurements

5.4.1.Requirements

The EUT 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(b) 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*

* - Linear Interpolation

For 433.92MHz, the limit at the fundamental is 10996.7uV/m @ 3m and the limit on the harmonics is 1099.7uV/m @ 3m.

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.

5.4.2.Procedures

All tests were performed in a 32ft. x 20ft. x 18ft. hybrid ferrite-tile/anechoic absorber lined test chamber. The

walls and ceiling of the shielded chamber are lined with ferrite tiles. 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 C63.4-2009 for site attenuation.

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 EUT. For the preliminary test, a broadband measuring antenna was positioned at a 3 meter distance from the EUT. 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 open field emission tests were then manually performed over the frequency range of 30MHz to 5000MHz. 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 EUT 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 EUT was rotated through three orthogonal axes to determine which orientation produces the highest emission relative to the limit.

5.4.3.Results

The preliminary plots, with the EUT transmitting at 433.92 MHz, are presented on data pages 20 and 23. The plots are presented for a reference only, and are not used to determine compliance.

The final radiated levels, with the EUT transmitting at 433.92 MHz, are presented on data page 24. As can be seen from the data, all emissions measured from the EUT were within the specification limit.

Photographs of the test configuration which yielded the highest or worst case, radiated emission levels are shown on Figures 2 and 3.

5.5. Occupied Bandwidth Measurements

5.5.1.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.

5.5.2.Procedures

The EUT 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. The 99% bandwidth was measured to be 405 kHz.

5.5.3.Results

The plot of the emissions near the fundamental frequency is presented on data page 25. As can be seen from this data page, the transmitter met the occupied bandwidth requirements.

6. OTHER TEST CONDITIONS

6.1. Test Personnel and Witnesses

All tests were performed by qualified personnel from Elite Electronic Engineering Incorporated.

6.2. Disposition of the EUT

The EUT 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. Event Tag, Model No. VER-3520 transmitter 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 C63.4-2009.

It was also determined that the Versus Technology, Inc. Event Tag, Model No. VER-3520 transmitter did fully meet the conducted and radiated RF emission requirements of the Industry Canada Radio Standards Specification RSS-Gen Section 7.2.4 and RSS-210 Annex 8 for transmitters, when tested per ANSI C63.4-2009.

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 EUT at the test date. Any electrical or mechanical modification made to the EUT 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
CDX8	COMPUTER	ELITE	WORKSTATION			N/A	
HRE1	LASER JET 5P	HEWLETT PACKARD	C3150A	USHB061052	---	N/A	
NDQ1	TUNED DIPOLE ANTENNA	EMCO	3121C-DB4	313	400-1000MHZ	4/20/2011	4/20/2012
NTA2	BILOG ANTENNA	TESEQ	6112D	28040	25-1000MHz	6/29/2011	6/29/2012
NWF2	RIDGED WAVE GUIDE	ELECTRO-METRICS	RGA 180	2521	1-12.4GHZ	1/28/2012	1/28/2013
PHA0	MAGNETIC FIELD PROBE	ELECTRO-METRICS	EM-6882	134	22-230MHZ	NOTE 1	
RAKI	RF SECTION	HEWLETT PACKARD	85462A	3411A00181	0.009-6500MHZ	3/15/2012	3/15/2013
RAKJ	RF FILTER SECTION	HEWLETT PACKARD	85460A	3330A00154	---	3/15/2012	3/15/2013
RBB0	EMI TEST RECEIVER 20HZ TO 40 GHZ	ROHDE & SCHWARZ	ESIB40	100250	20 HZ TO 40GHZ	3/5/2012	3/5/2013

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.

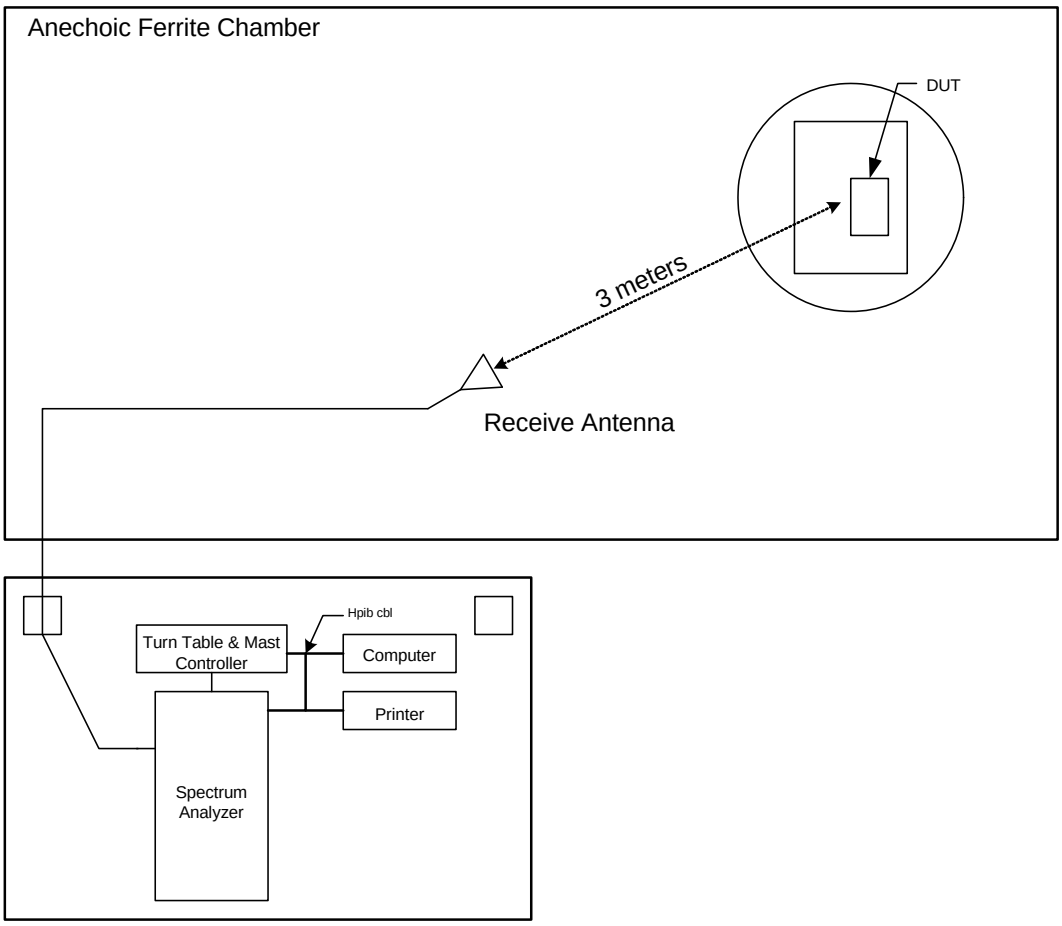


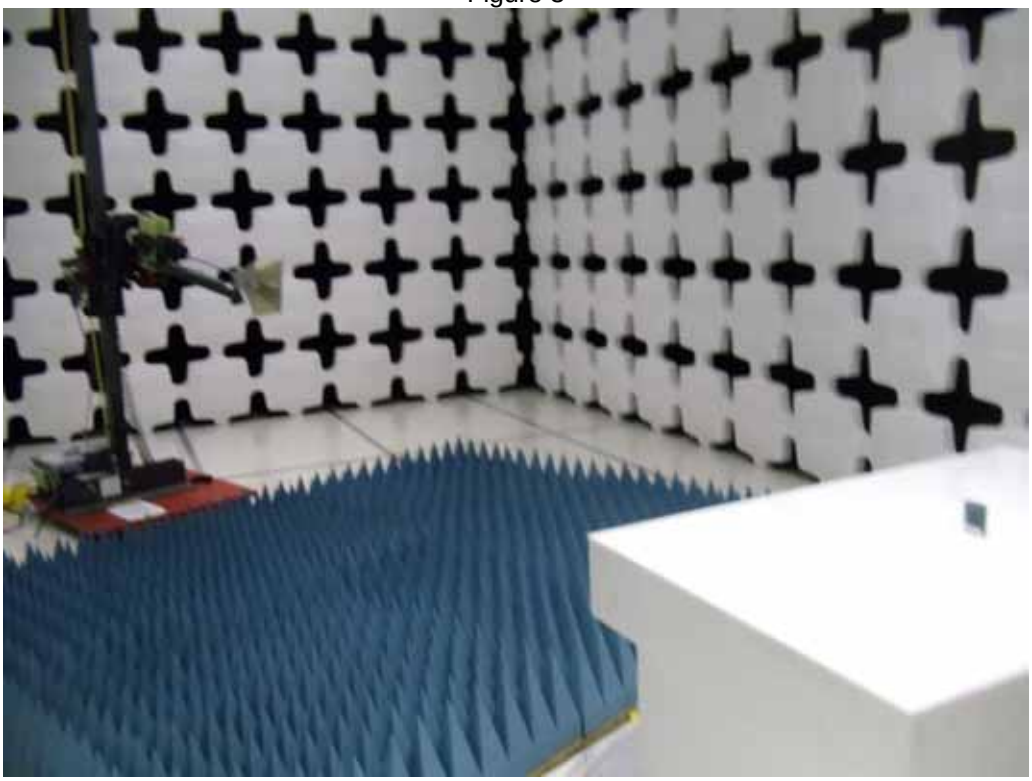
FIGURE 1 BLOCKDIAGRAM OF TEST SETUP

Figure 2

Test Setup for Radiated Emissions, 30MHz to 1GHz – Horizontal Polarization

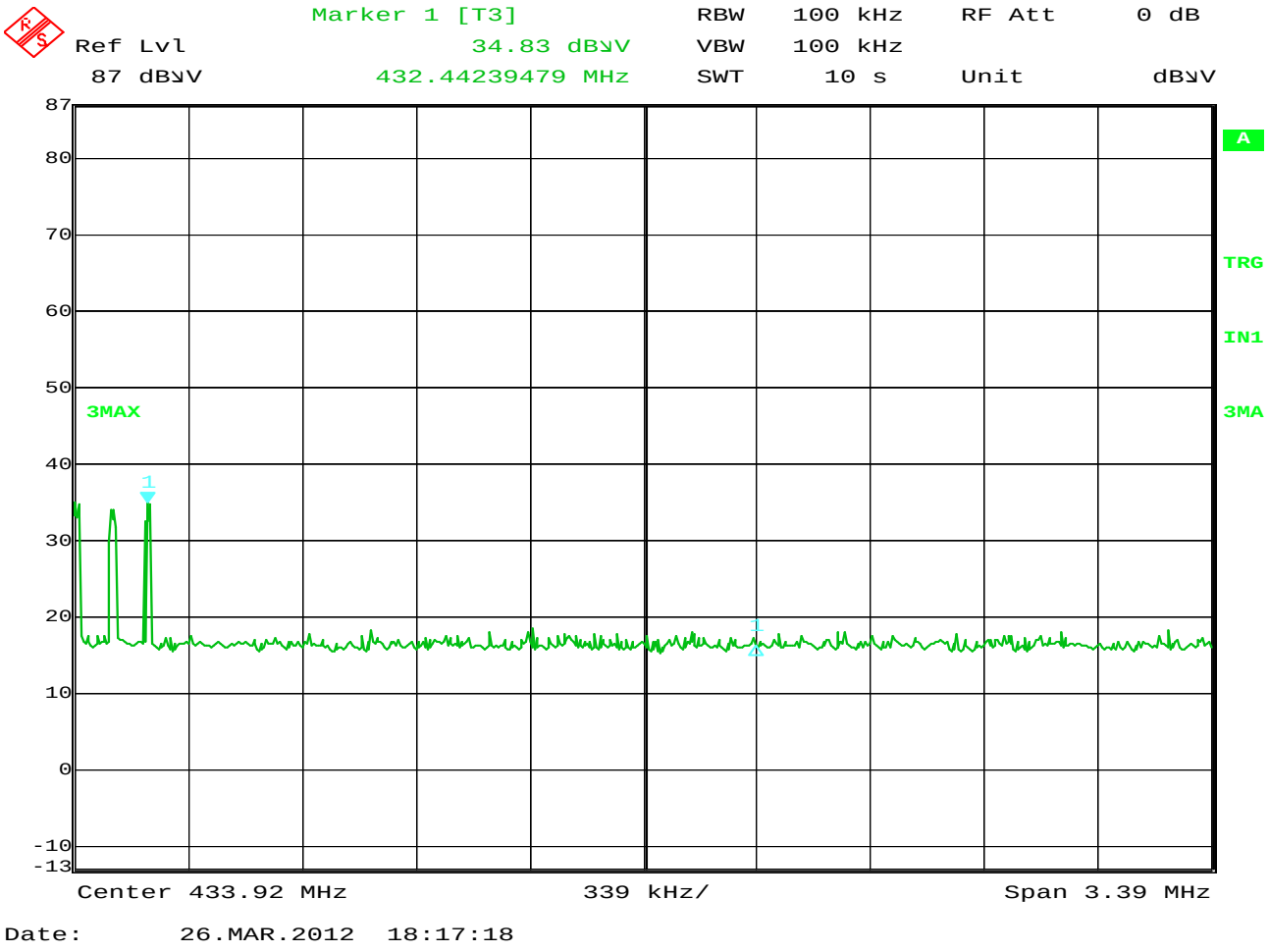
Test Setup for Radiated Emissions, 30MHz to 1GHz – Vertical Polarization

Figure 3



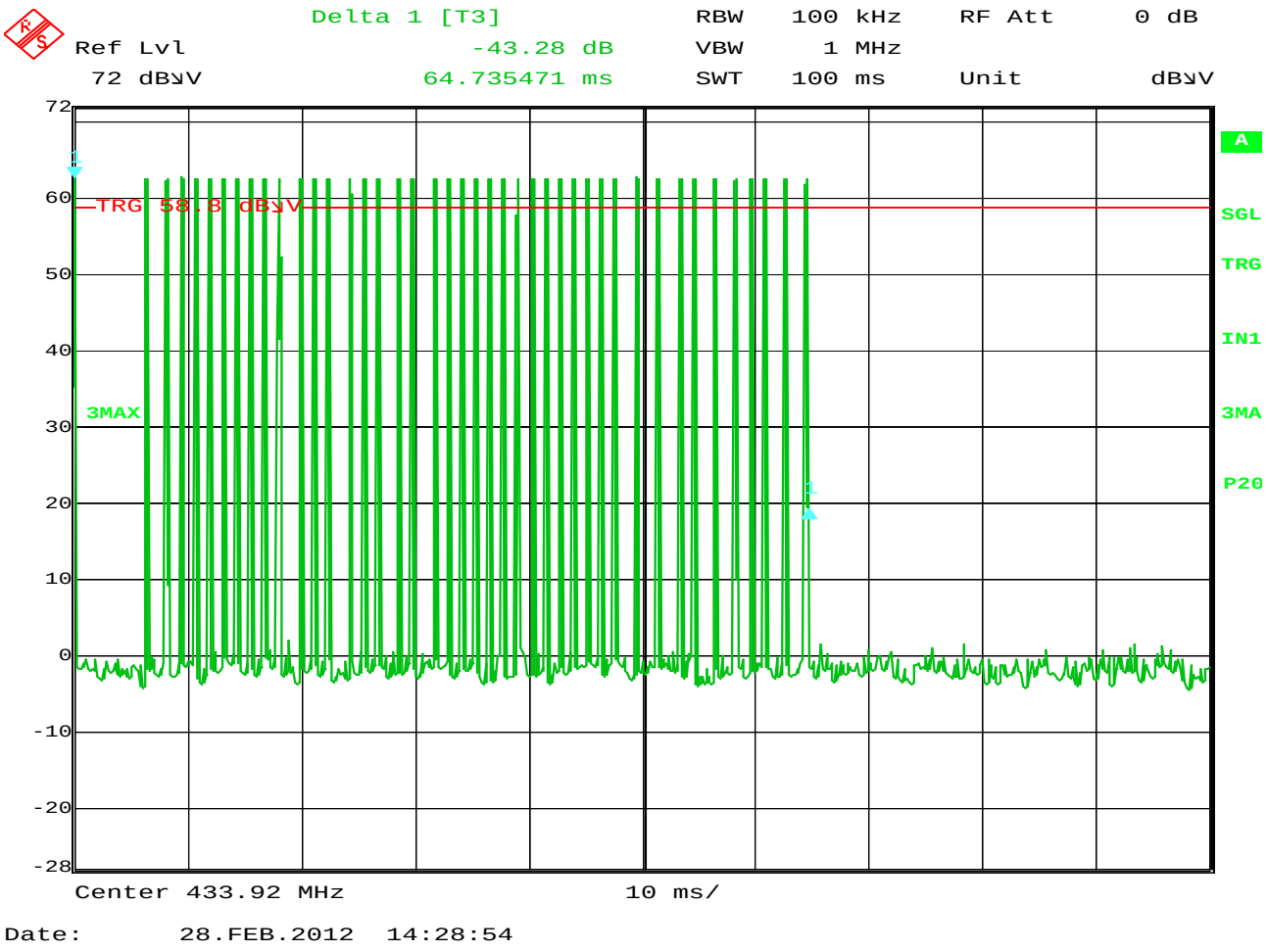
Test Setup for Radiated Emissions, Above 1GHz – Horizontal Polarization

Test Setup for Radiated Emissions, Above 1GHz – Vertical Polarization



MANUFACTURER : Versus Technologies, LLC.
MODEL NUMBER : VER-3520
SERIAL NUMBER : None
TEST MODE : Tx @ 433.92 MHz

NOTES



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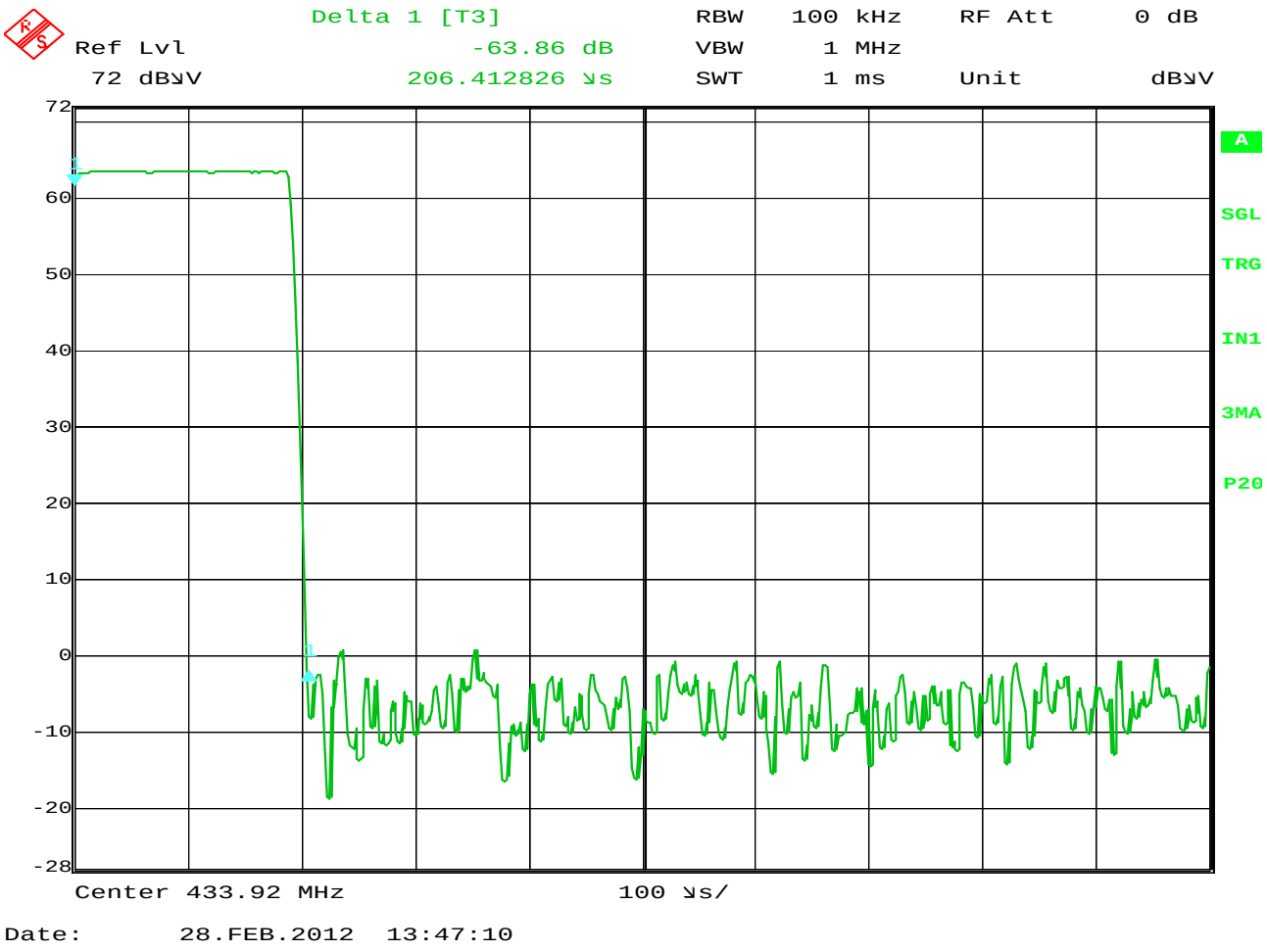

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MODEL NUMBER : VER-3520
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TEST MODE : Tx @ 433.92 MHz

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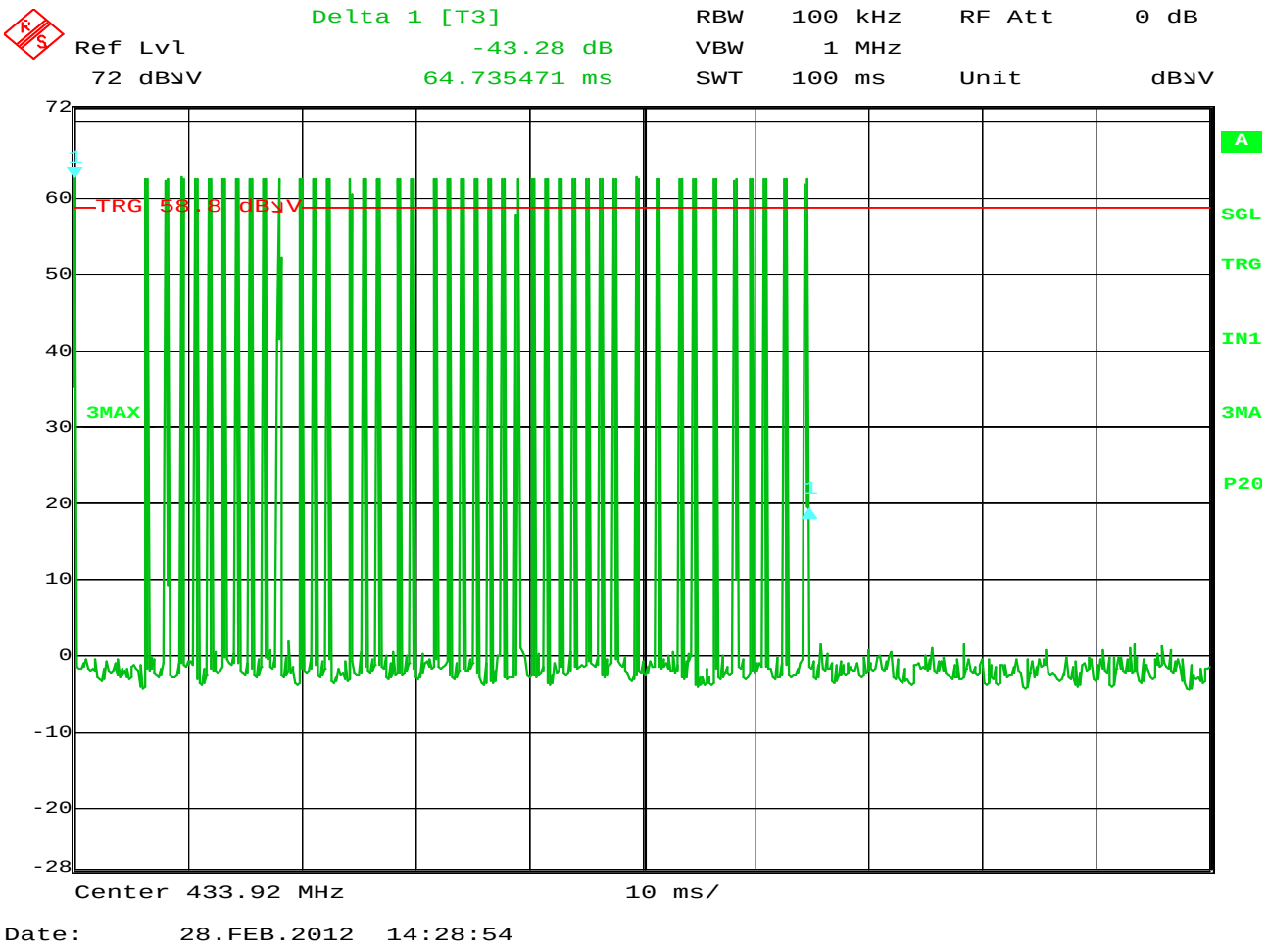

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MODEL NUMBER : VER-3520
SERIAL NUMBER : None
TEST MODE : Tx @ 433.92 MHz

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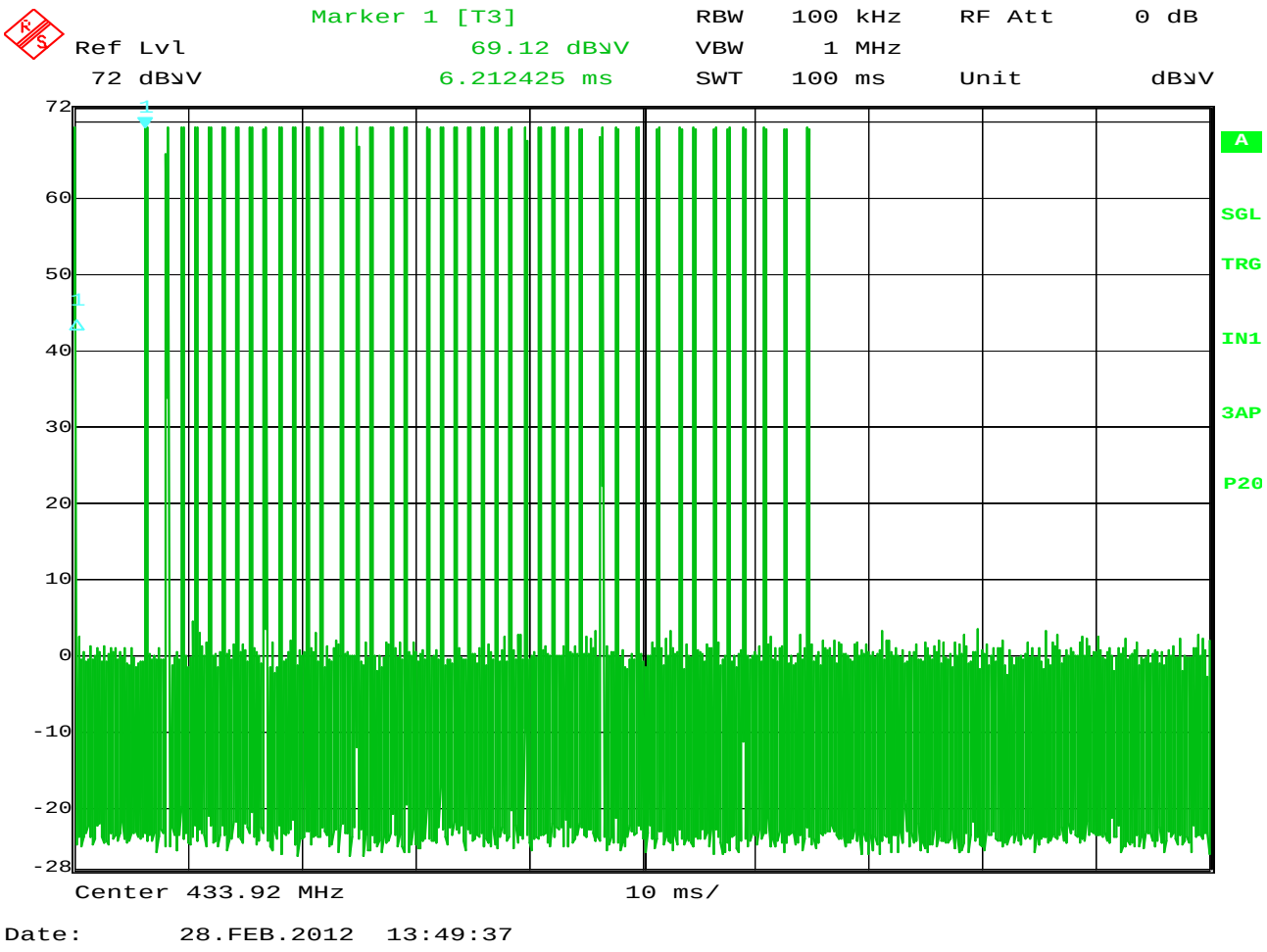

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MODEL NUMBER : VER-3520
SERIAL NUMBER : None
TEST MODE : Tx @ 433.92 MHz

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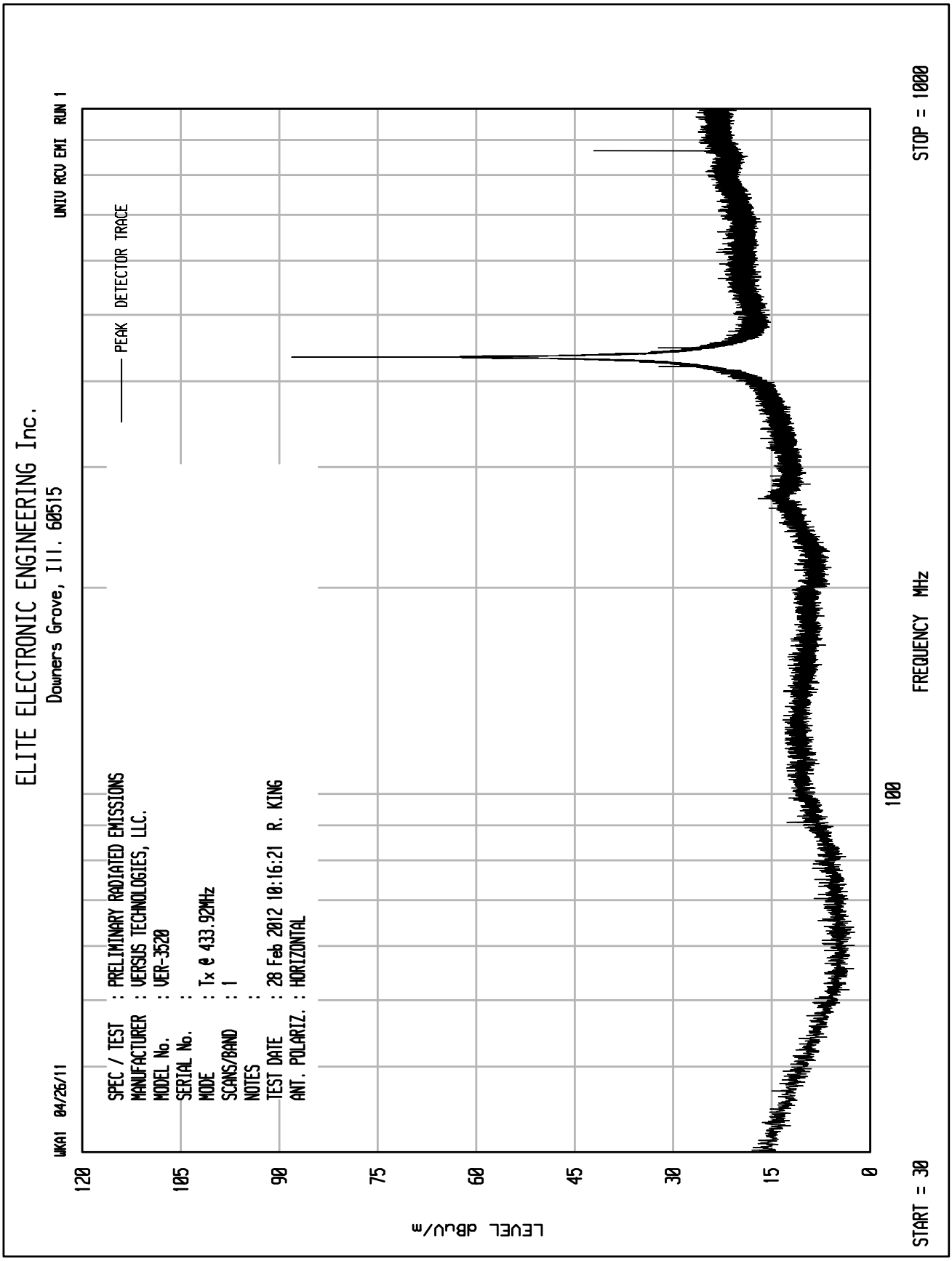
ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 1
WKA1 04/26/11
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : VERSUS TECHNOLOGIES, LLC.
MODEL No. : VER-3520
SERIAL No. :
MODE : Tx @ 433.92MHz
SCANS/BAND : 1
NOTES :
TEST DATE : 28 Feb 2012 10:16:21 R. KING
ANT. POLARIZ. : HORIZONTAL
PEAK DETECTOR TRACE
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120
105
90
75
60
45
30
15
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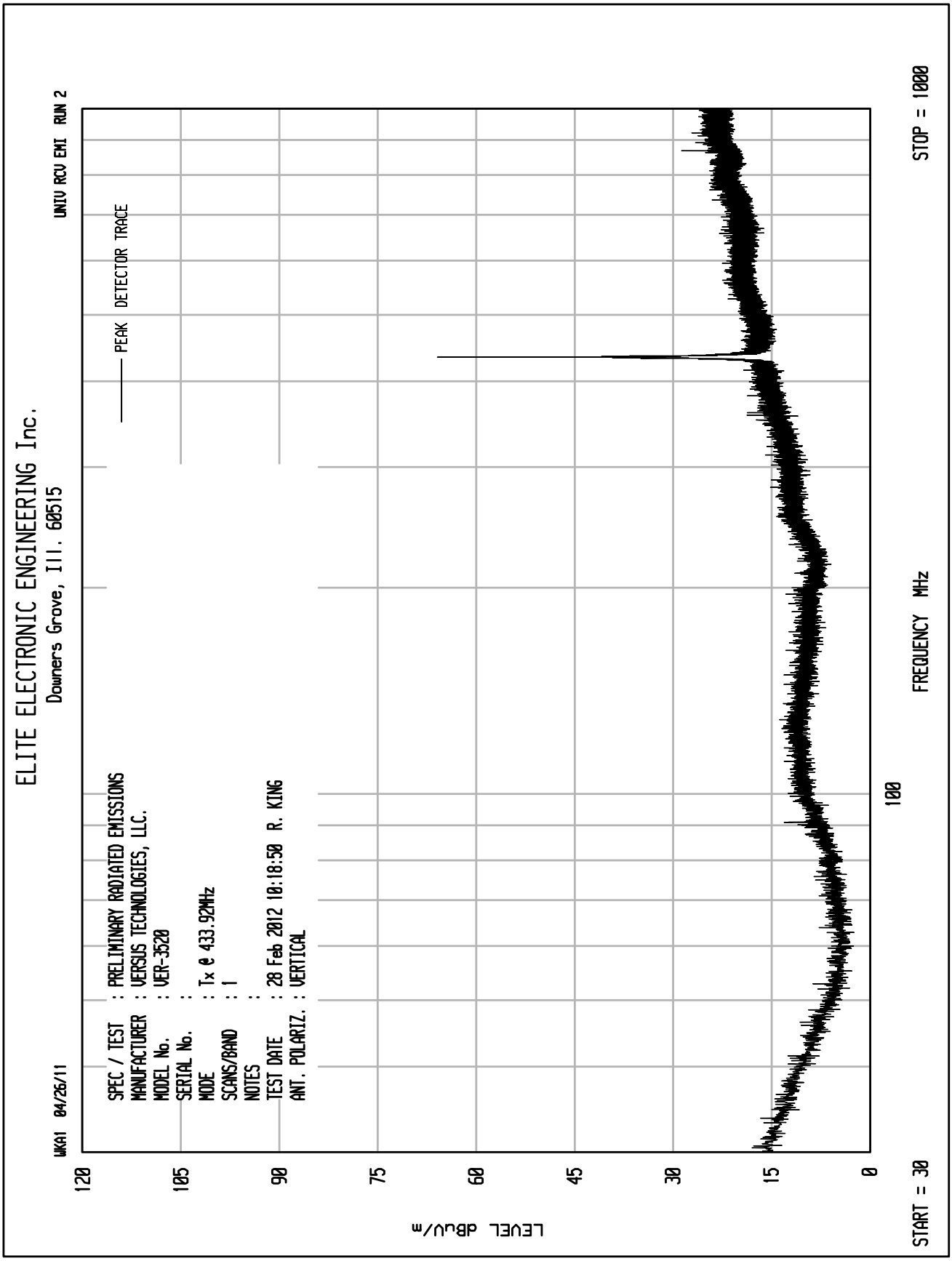
START = 30
100
FREQUENCY MHz
STOP = 1000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Downers Grove, Ill. 60515
UNIV RCV EMI RUN 2
WKA1 04/26/11
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : VERSUS TECHNOLOGIES, LLC.
MODEL No. : VER-3520
SERIAL No. :
MODE : Tx @ 433.92MHz
SCANS/BAND : 1
NOTES :
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ANT. POLARIZ. : VERTICAL
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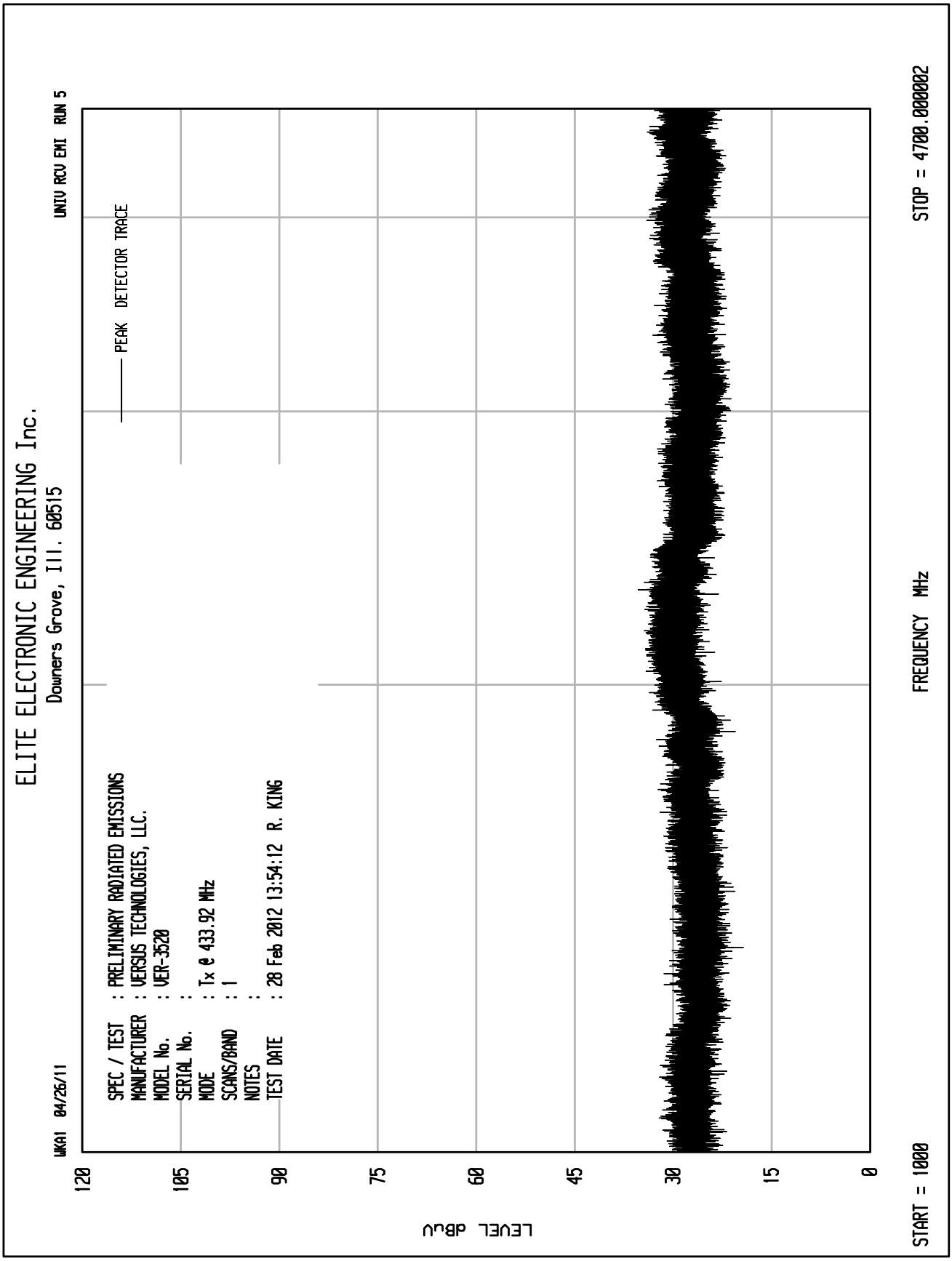
FREQUENCY MHz
STOP = 1000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Downers Grove, Ill. 60515
UNIV RCV EMI RUN 5
WKA1 04/26/11
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
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SCANS/BAND : 1
NOTES : :
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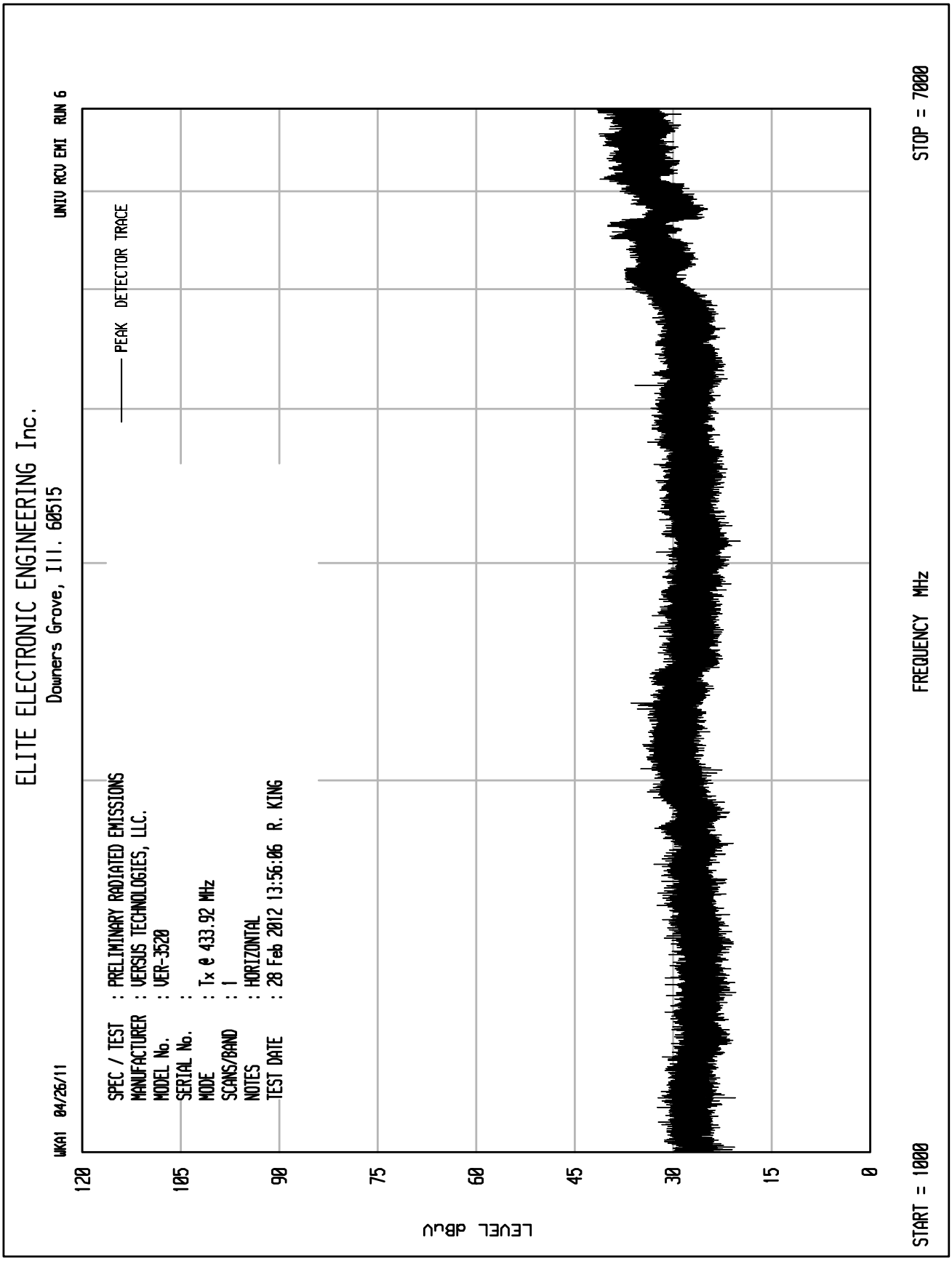
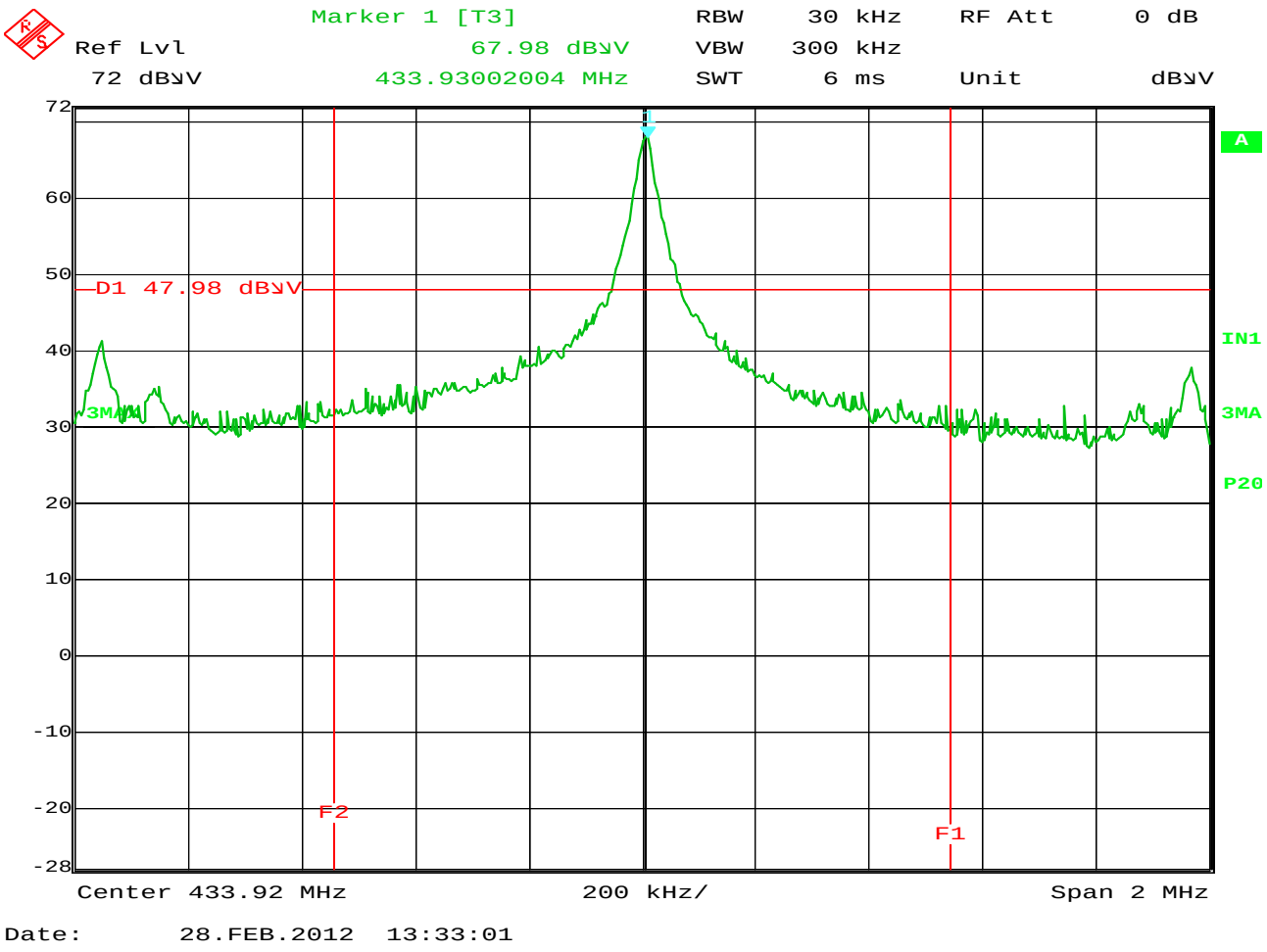

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 6
WKA1 04/26/11
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : VERSUS TECHNOLOGIES, LLC.
MODEL No. : VER-3520
SERIAL No. : :
MODE : Tx @ 433.92 MHz
SCANS/BAND : 1
NOTES : HORIZONTAL
TEST DATE : 28 Feb 2012 13:56:06 R. KING
PEAK DETECTOR TRACE
LEVEL dBuV
120
105
90
75
60
45
30
15
0
START = 1000
FREQUENCY MHz
STOP = 7000

MANUFACTURER : Versus Technology, Inc.
TEST ITEM : Event Tag
MODEL NO. : VER-3520
SERIAL NO. : none
SPECIFICATION : FCC- 15C Transmitter Open Field Data
DATE : February 28, 2012
NOTES : Test Distance is 3 Meters;
Since the duty cycle factor is less than 20 dB, the EUT will comply with the peak limit automatically.

Freq (MHz)	Ant Pol	Meter Reading (dBuV)	CBL Fac (dB)	Ant Fac (dB)	Duty Cycle Factor (dB)	Total dBuV/m at 3 M	Total uV/m at 3M	Limit uV/m at 3M	Margin (dB)
433.92	H	62.5	1.5	16.7	-16.8	63.9	1560.8	10996.7	-17.0
433.92	V	70.6	1.5	16.7	-16.8	72.0	3975.1	10996.7	-8.8
867.84	H	20.6	2.0	20.7	-16.8	26.5	21.2	1099.7	-34.3
867.84	V	14.0	2.0	20.7	-16.8	20.0	10.0	1099.7	-40.9
1301.76	H	25.3	2.4	25.1	-16.8	36.0	63.2	500.0	-18.0
1301.76	V	23.2	2.4	25.1	-16.8	33.9	49.4	500.0	-20.1
1735.68	H	19.9	2.8	26.8	-16.8	32.8	43.5	1099.7	-28.1
1735.68	V	22.6	2.8	26.8	-16.8	35.5	59.3	1099.7	-25.4
2169.60	H	14.9	3.2	28.4	-16.8	29.7	30.6	1099.7	-31.1
2169.60	V	15.5	3.2	28.4	-16.8	30.4	33.0	1099.7	-30.5
2603.52	H	15.4	3.6	29.5	-16.8	31.7	38.3	1099.7	-29.2
2603.52	V	16.3	3.6	29.5	-16.8	32.6	42.5	1099.7	-28.3
3037.44	H	15.1	3.9	30.8	-16.8	33.0	44.7	1099.7	-27.8
3037.44	V	14.1	3.9	30.8	-16.8	32.0	39.6	1099.7	-28.9
3471.36	H	13.8	4.2	31.8	-16.8	33.0	44.8	1099.7	-27.8
3471.36	V	14.6	4.2	31.8	-16.8	33.8	49.2	1099.7	-27.0
3905.28	H	14.5	4.5	33.1	-16.8	35.2	57.8	500.0	-18.7
3905.28	V	14.8	4.5	33.1	-16.8	35.5	59.5	500.0	-18.5
4339.20	H	14.4	4.7	33.1	-16.8	35.3	58.4	500.0	-18.7
4339.20	V	15.1	4.7	33.1	-16.8	36.1	63.9	500.0	-17.9

Checked BY : Richard E. King

Richard E. King



MANUFACTURER : Versus Technologies, LLC.
MODEL NUMBER : VER-3520
SERIAL NUMBER : None
TEST MODE : Tx @ 433.92 MHz

NOTES