Measurement of RF Interference from a Model RCRF-02 Transceiver

For : Turning Technologies LLC
Youngstown, OH 44503

P.O. No. : 0000005488
Date Tested : January 26 through 30, 2009
Test Personnel : Richard King
Specification : FCC "Code of Federal Regulations" Title 47 Part 15, Subpart C
Industry Canada RSS-210
Industry Canada RSS-GEN

Test Report By : Richard King

Witnessed by : Jon Hallsten

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

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Revision History

Revision	Date	Description
—	2/12/2009	Initial release

Measurement of RF Emissions from a RCRF-02 Transceiver

1 INTRODUCTION

1.1 Scope of Tests

This document represents the results of the series of radio interference measurements performed on a model Transceiver, Part No. RCRF-02, Serial Nos. 001, 002, 003 and 005, (hereinafter referred to as the test item). The test item was designed to transmit and receive in the 2400 MHz through 2483.5 Band using an internal antenna. The test item was manufactured and submitted for testing by Turning Technologies LLC located in Youngstown, OH.

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 15.207 and 15.249 for Intentional Radiators Operating within the 2400-2483.5MHz band and RSS 210. Testing was performed in accordance with ANSI C63.4-2003.

The transceiver is also equipped with a version that has replaced the LED status light with a small motor for the sight impaired. Limited testing at the center frequency of 2441MHz was performed to insure this change did not affect the radiated emissions characteristics.

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 17%.

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 2008

- 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 6, September 2005, “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 1, September 2005, “Spectrum Management and Telecommunications Radio Standards Specification, General Requirements and Information for the Certification of radio communication equipment”

3 TEST ITEM SETUP AND OPERATION

3.1 General Description

The test item is a Transceiver, Part No. RCRF-02. A block diagram of the test item setup is shown as Figure 1.

3.1.1 Power Input

The test item obtained 3VDC power from internal batteries.

3.1.2 Peripheral Equipment

No peripheral equipment was required for the test item to operate properly.

3.1.3 Interconnect Cables

No interconnect cables were required for the test item to operate properly.

3.1.4 Grounding

The test item was ungrounded during testing.

3.2 Operational Mode

For radiated emissions tests, the test item was placed on an 80cm high non-conductive stand. Radiated emissions tests were performed separately with the test item transmitting at 2401MHz, 2441MHz, and 2482MHz.

3.3 Test Item Modifications

No modifications were required for compliance.

4 TEST FACILITY AND TEST INSTRUMENTATION

4.1 Shielded Enclosure

All emissions 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. All equipment was calibrated per the instruction manuals supplied by the manufacturer.

Radiated emissions were performed with a spectrum analyzer. This receiver allows measurements with the bandwidths specified by the FCC and with the quasi-peak detector function.

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

No conducted emissions tests are required since the test item is powered with 3VDC internal batteries and does not connect to the power mains.

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

The duty cycle factor was computed to be -40dB. Plots of the duty cycle at each transmit frequency are shown on data pages 14 through 16.

5.3 Radiated Measurements

5.3.1 Requirements

Per 15.101(b), receivers operating above 960MHz are exempt from complying with the radiated emissions requirements of 15.109. Therefore no radiated emissions tests were performed with the test item operating in the receive mode.

Receiver unwanted emissions must meet the general field strength limits of the following table to be considered to meet the Industry Canada RSS 210 specification:

General Field Strength Limits for Transmitters and Receivers at Frequencies Above 30 MHz (Note)

Frequency (MHz)	Field Strength uV/m at 3 meters (watts, eirp)	
	Transmitters	Receivers
30-88	100 (3 nW)	
88-216	150 (6.8 nW)	
216-960	200 (12 nW)	
Above 960	500 (75 nW)	

Note: Transmitting devices are not permitted in Table 1 bands or in TV bands (54-72 MHz, 76-88 MHz, 174-216 MHz, 470-608 MHz, and 614-806 MHz). Prohibition of operation in TV bands does not apply to momentary devices, or to medical telemetry devices in the band 174-216 MHz, and to perimeter protection systems in the bands 54-72 and 76-88 MHz. The perimeter protection devices are to meet Table 3 field strengths limits.

The test item must comply with the requirements of FCC "Code of Federal Regulations Title 47", Part 15, Subpart C.

Paragraph 15.249 has the following radiated emission limits:

Fundamental Frequency MHz	Field Intensity uV/m @ 3 meters	Field Strength Harmonics and Spurious @ 3 meters
2400-2483.5	50,000	500

The field strength limits are based on average limits. However, the peak field strength of any emission shall mot exceed the maximum permitted average limits by more than 20 dB under any condition of modulation.

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 24GHz 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 25GHz. Between 30MHz and 1000MHz, a bilog 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) In instances were it was necessary to use a shortened cable between the measuring antenna and the spectrum analyzer and the antenna cannot be raised to 4 meters. The measuring antenna is raised or lowered as much as the cable will allow and the test item is rotated through all axis to ensure the maximum readings are recorded.

5.3.3 Results

The preliminary plots, with the test item transmitting at 2401MHz, 2441MHz and 2482MHz, are presented on data pages 17 through 25. 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 receiving at 2441MHz and transmitting at 2401MHz, 2441MHz and 2482MHz, are presented on data pages 26 through 33. 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 2441MHz. The emissions level at this frequency was 7.3 dB within the limit. See data page 29 for details. Photographs of the test configuration which yielded the highest, or worst case, radiated emission levels are shown on Figure 3.

5.4 Band-edge Compliance

5.4.1 Requirement

In accordance with paragraph 15.249(d), emissions outside of the specified frequency bands shall be below the general radiated emissions limits of 15.209. Therefore the radiated emissions at the band edges (2400MHz and 2483.5MHz) must meet the general limits of 15.209.

5.4.2 Procedures

For radiated emissions at the band edges, the “marker-delta” method described in Public Notice DA 00-705 was used.

The test item was placed on an 80cm high non-conductive stand. The unit was set to transmit continuously. A broadband measuring antenna was placed at a test distance of 3 meters from the test item. Initially radiated emissions were performed at the lowest transmit frequency and the highest transmit frequency using a 1MHz bandwidth. Next, the band edge emissions were plotted using a peak detector and a 30kHz bandwidth. The “max-hold” function was engaged. The analyzer was allowed to scan until the envelope of the transmitter bandwidth was defined. The analyzer’s display was plotted using a “screen-dump” utility. The “delta” limit was applied to this plot to determine compliance at the band edge.

5.4.3 Results

Pages 34 and 35 show the radiated band-edge compliance results using the marker-delta method. As can be seen from these plots, the emissions at the band-edge are within the general limits.
The 99% bandwidth with the test item transmitting at 2401MHz worst case was 960kHz.

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 Jon Hallsten personnel.

6.2 Disposition of the Test Item

The test item and all associated equipment were returned to Turning Technologies LLC upon completion of the tests.

7 CONCLUSIONS

It was determined that the Turning Technologies LLC Transceiver, Part No. RCRF-02, Serial No. 001, 002 and 003, 005 did fully meet the conducted and radiated emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C and Industry Canada RSS-210.

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 Turning Technologies LLC 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
APW0	PREAMPLIFIER	PLANAR ELECTRONICS	PE2-30-20G20R6G	PL2926/0646	20GHZ-26.5GHZ	12/16/2008	12/16/2009
APW3	PREAMPLIFIER	PLANAR ELECTRONICS	PE2-35-120-5R0-10-12	PL2924	1GHZ-20GHZ	12/16/2008	12/16/2009
CMA1	Controllers	EMCO	2090	9701-1213	---	N/A	
NHG0	STANDARD GAIN HORN ANTENNA	NARDA	638	---	18-26.5GHZ	NOTE 1	
NHG1	STANDARD GAIN HORN ANTENNA	NARDA	638	---	18-26.5GHZ	NOTE 1	
NTA1	BILOG ANTENNA	CHASE EMC LTD.	BILOG CBL6112	2054	0.03-2GHZ	9/2/2008	9/2/2009
NWI0	RIDGED WAVE GUIDE	AEL	H1498	153	2-18GHZ	10/25/2008	10/25/2009
NWI1	RIDGED WAVE GUIDE	AEL	H1498	154	2-18GHZ	10/25/2008	10/25/2009
RBA1	EMI TEST RECEIVER	ROHDE & SCHWARZ	ESIB26	100146	20HZ-26.5GHZ	9/10/2008	9/10/2009
XPR0	HIGH PASS FILTER	K&L MICROWAVE	11SH10-4800/X20000	001	4.8-20GHZ	7/30/2008	7/30/2009

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.

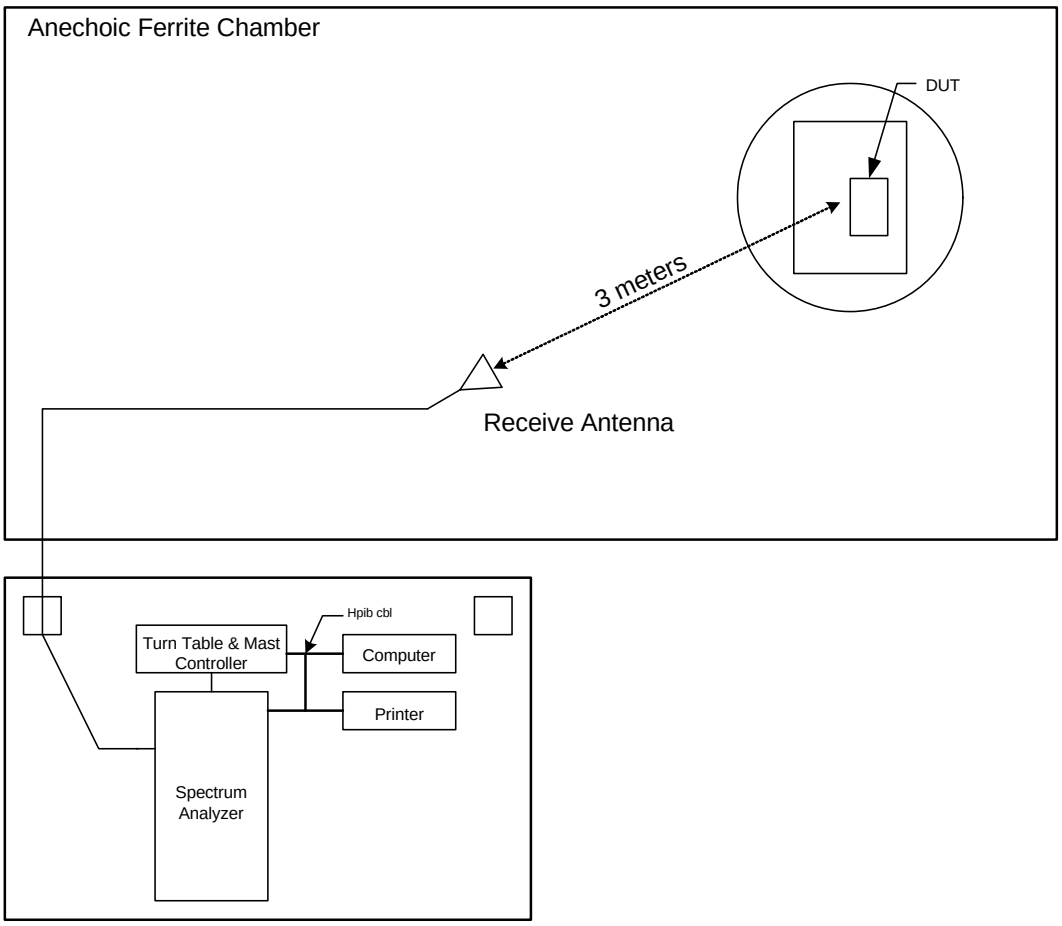


FIGURE 1 BLOCKDIAGRAM OF TEST SETUP

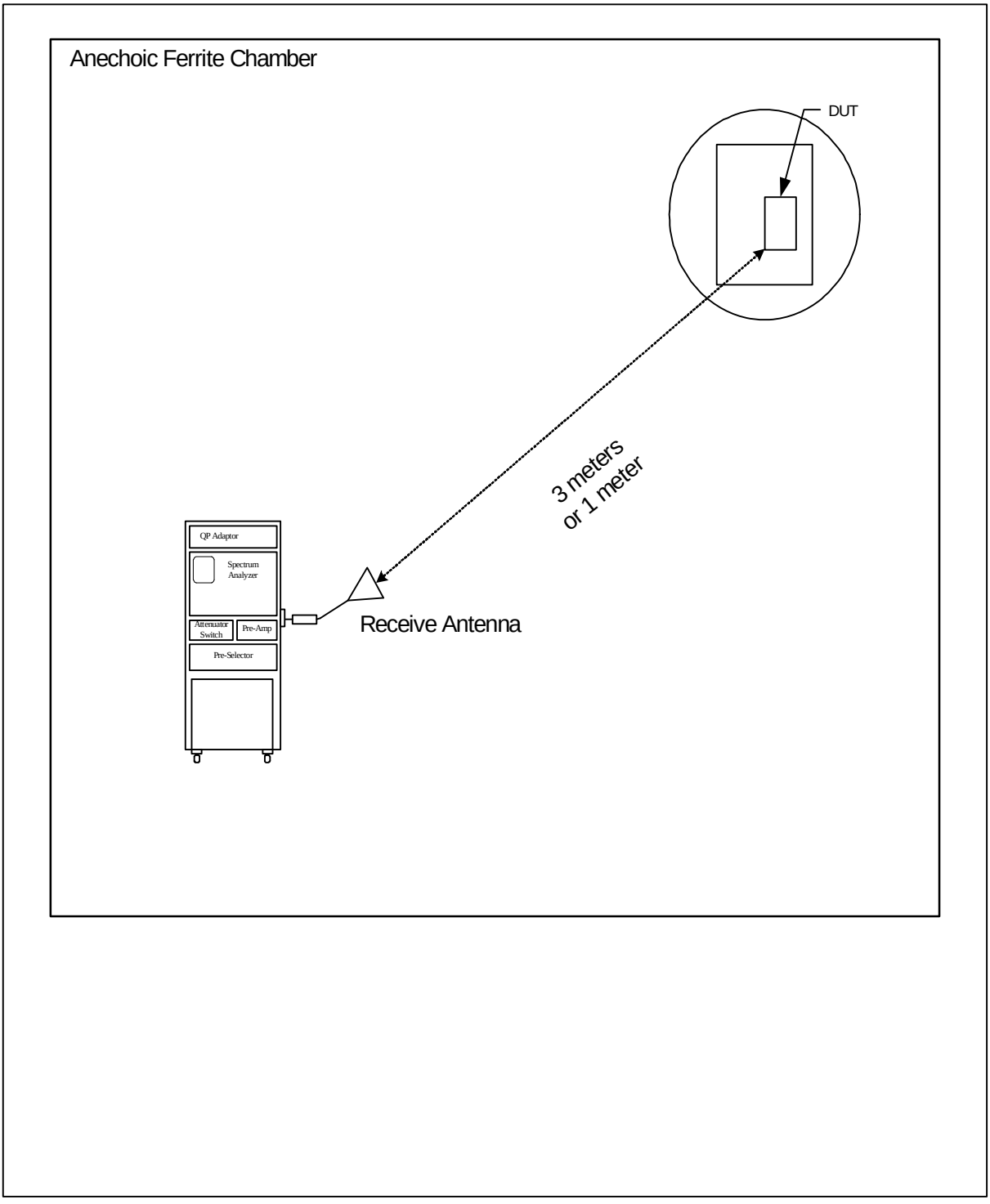
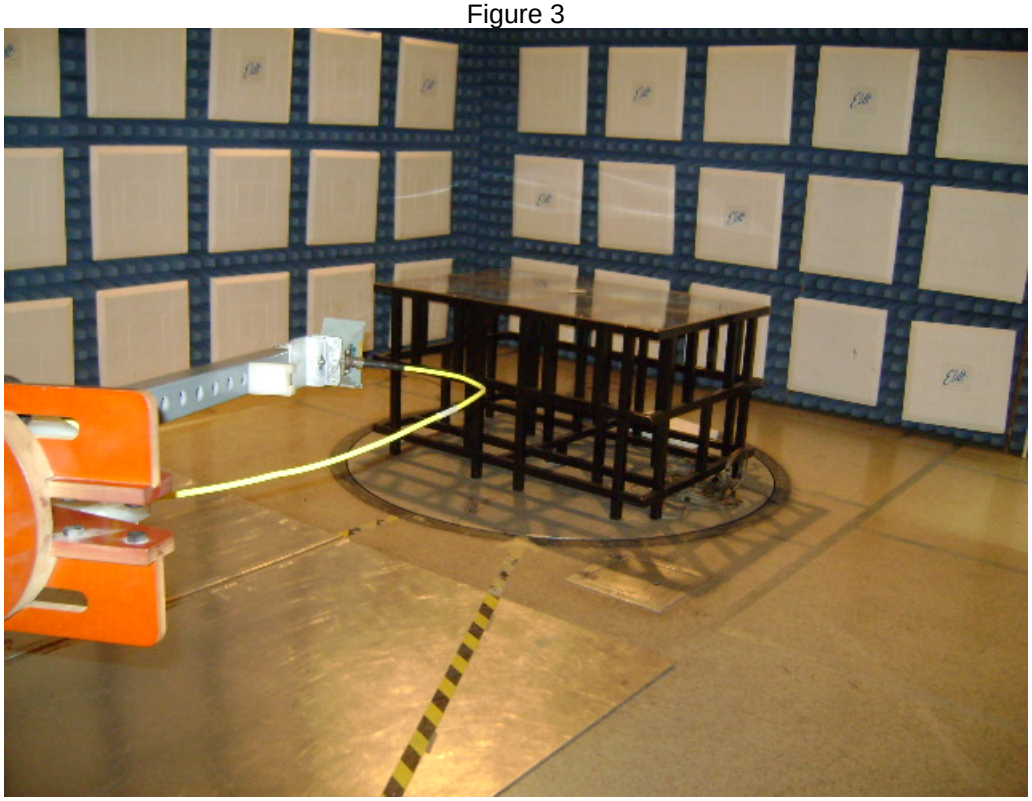
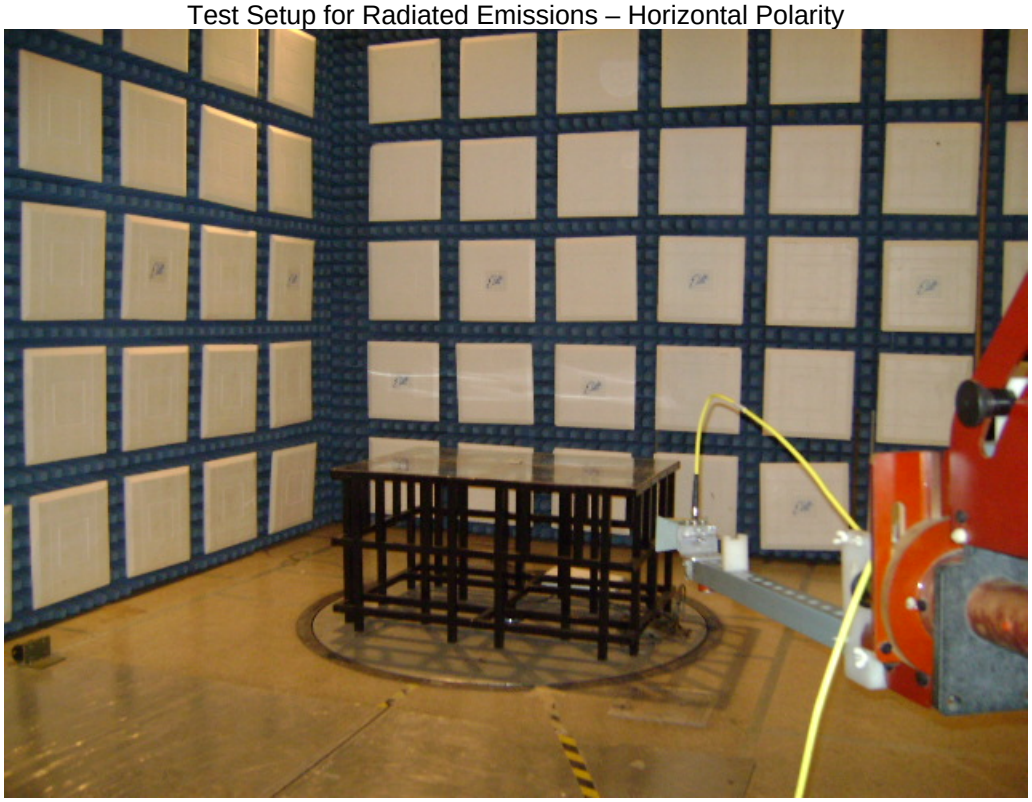

Anechoic Ferrite Chamber
DUT
3 meters
or 1 meter
QP Adaptor
Spectrum
Analyzer
Attenuator
Switch
Pre-Amp
Pre-Selector
Receive Antenna

Figure 2

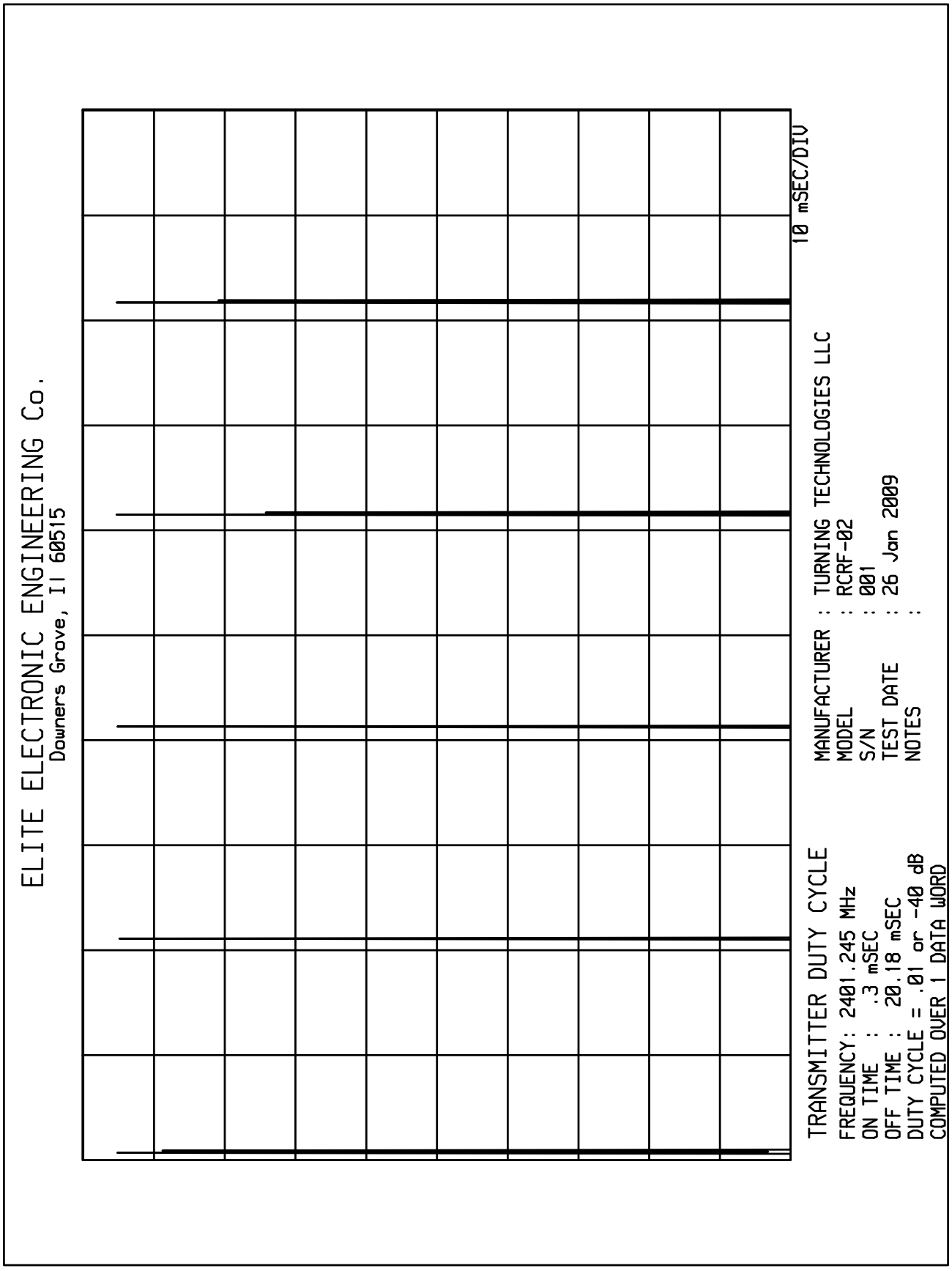
Figure 3

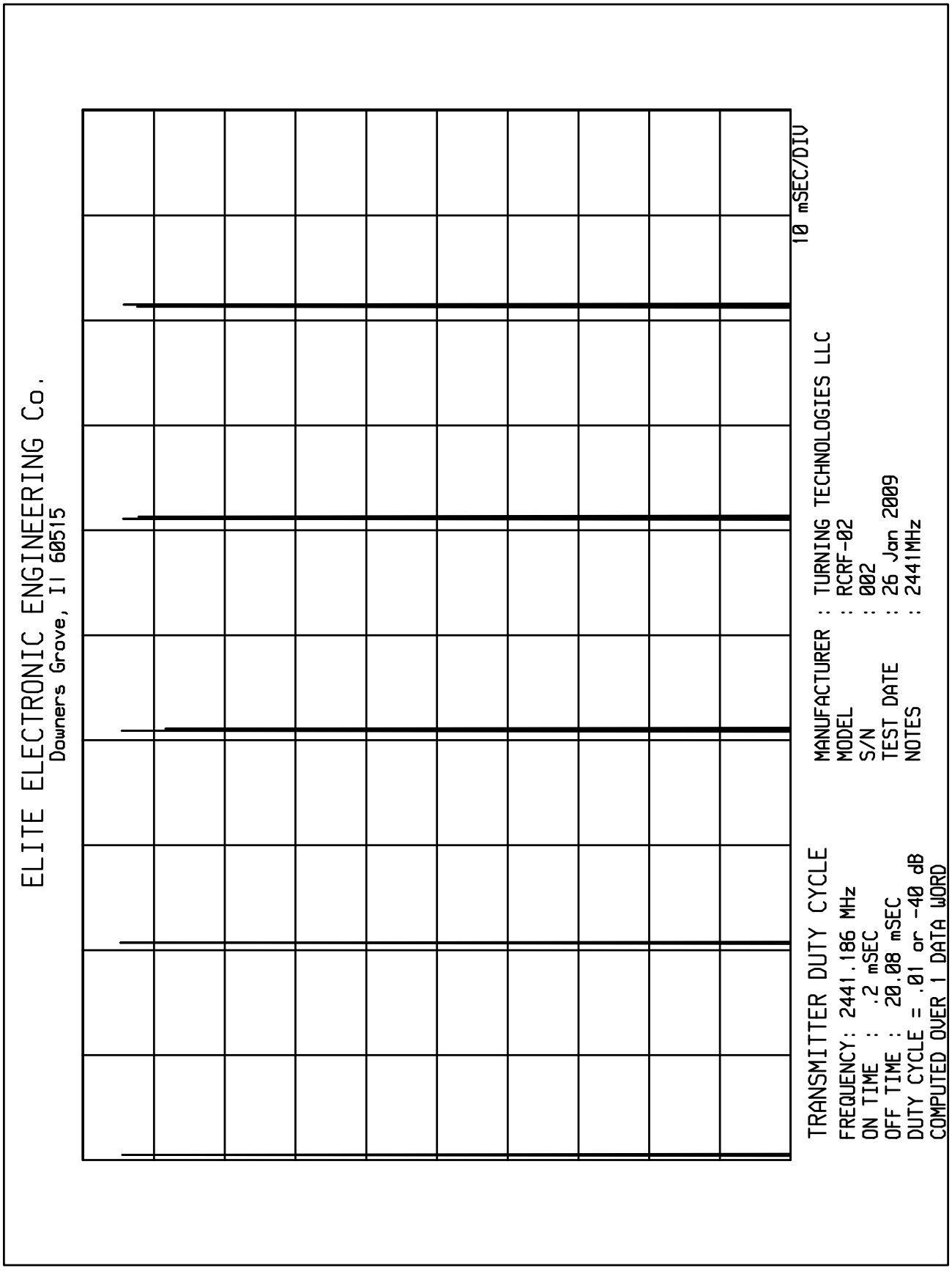


Test Setup for Radiated Emissions – Horizontal Polarity

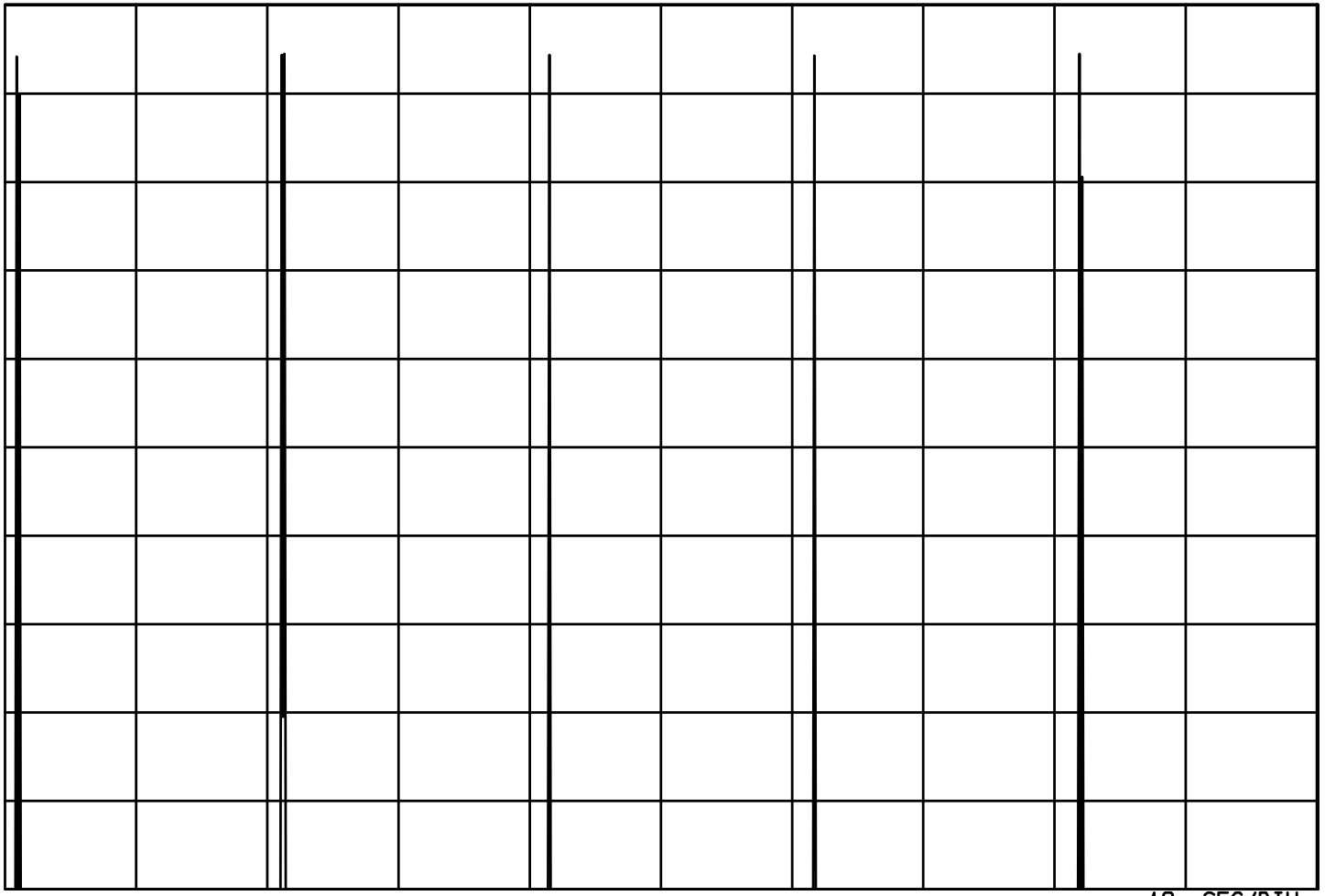


Test Setup for Radiated Emissions – Vertical Polarity


ELITE ELECTRONIC ENGINEERING Co.
Downers Grove, Il 60515
10 mSEC/DIV
TRANSMITTER DUTY CYCLE
FREQUENCY: 2401.245 MHz
ON TIME : .3 mSEC
OFF TIME : 20.18 mSEC
DUTY CYCLE = .01 or -40 dB
COMPUTED OVER 1 DATA WORD
MANUFACTURER : TURNING TECHNOLOGIES LLC
MODEL : RCRF-02
S/N : 001
TEST DATE : 26 Jan 2009
NOTES : :


ELITE ELECTRONIC ENGINEERING Co.
Downers Grove, Il 60515
10 mSEC/DIV
TRANSMITTER DUTY CYCLE
FREQUENCY: 2441.186 MHz
ON TIME : .2 mSEC
OFF TIME : 20.08 mSEC
DUTY CYCLE = .01 or -40 dB
COMPUTED OVER 1 DATA WORD
MANUFACTURER : TURNING TECHNOLOGIES LLC
MODEL : RCRF-02
S/N : 002
TEST DATE : 26 Jan 2009
NOTES : 2441MHz

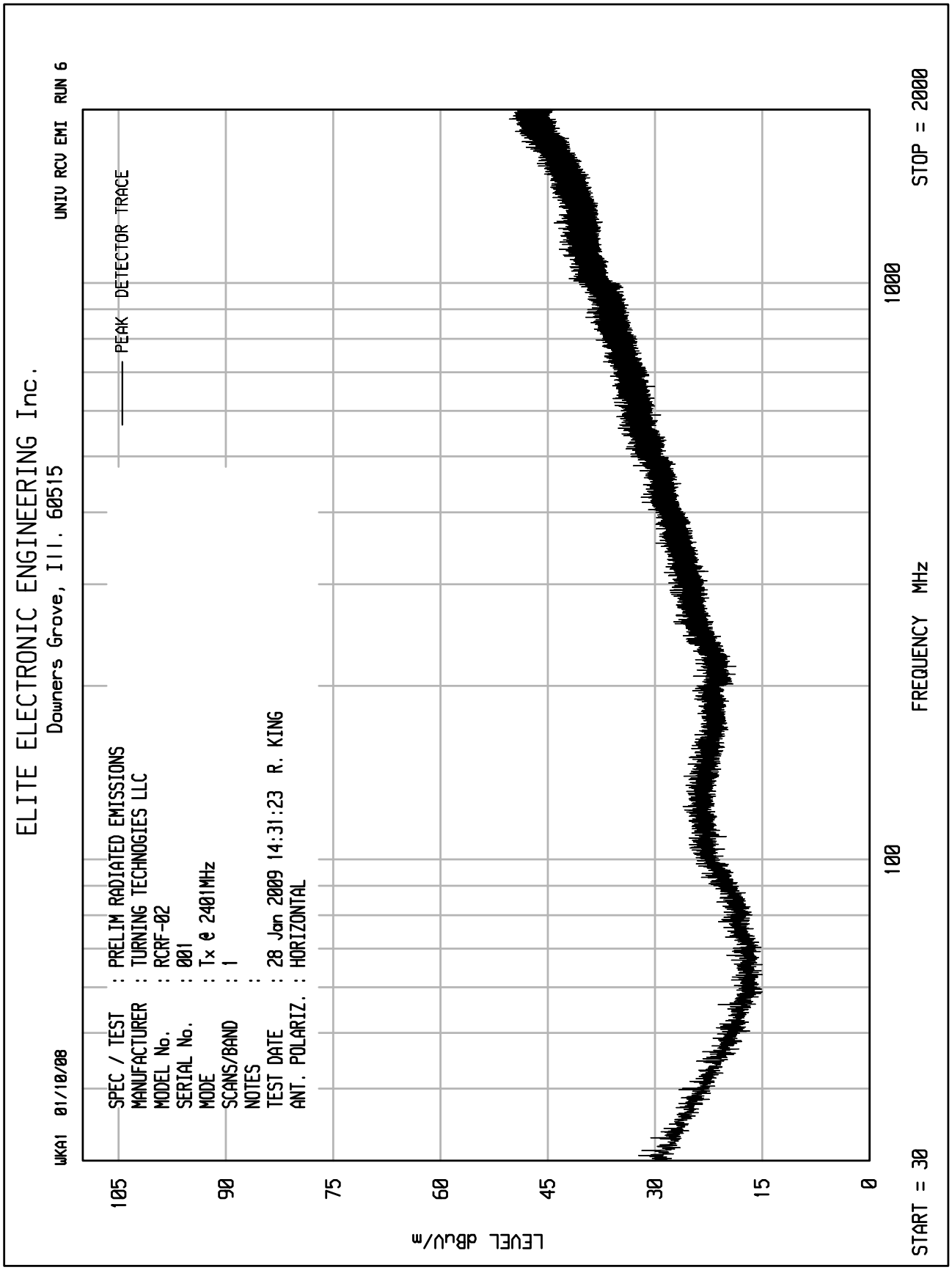
ELITE ELECTRONIC ENGINEERING Co.
Downers Grove, Il 60515

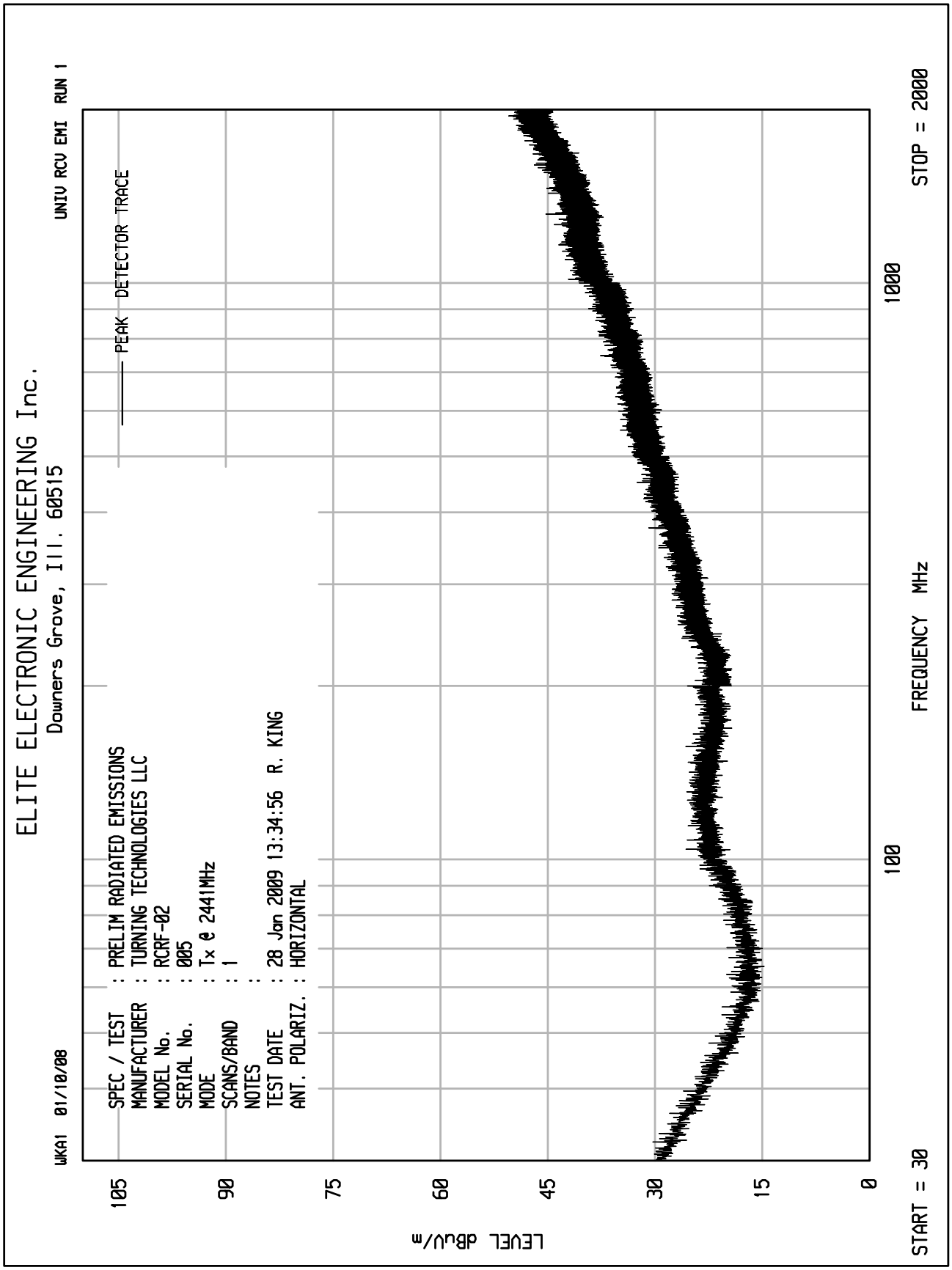


10 mSEC/DIV

TRANSMITTER DUTY CYCLE
FREQUENCY: 2482.13 MHz
ON TIME : .3 mSEC
OFF TIME : 19.98 mSEC
DUTY CYCLE = .01 or -40 dB
COMPUTED OVER 1 DATA WORD

MANUFACTURER : TURNING TECHNOLOGIES LLC
MODEL : RCRF-02
S/N : 003
TEST DATE : 26 Jan 2009
NOTES : 2482MHZ


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 6
WKA1 01/10/08
SPEC / TEST : PRELIM RADIATED EMISSIONS
MANUFACTURER : TURNING TECHNOGIES LLC
MODEL No. : RCRF-02
SERIAL No. : 001
MODE : Tx @ 2401MHz
SCANS/BAND : 1
NOTES :
TEST DATE : 28 Jan 2009 14:31:23 R. KING
ANT. POLARIZ. : HORIZONTAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
105
90
75
60
45
30
15
0
START = 30
100
1000
STOP = 2000
FREQUENCY MHz


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
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WKA1 01/10/08
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MANUFACTURER : TURNING TECHNOLOGIES LLC
MODEL No. : RCRF-02
SERIAL No. : 005
MODE : Tx @ 2441MHz
SCANS/BAND : 1
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TEST DATE : 28 Jan 2009 13:34:56 R. KING
ANT. POLARIZ. : HORIZONTAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
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90
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15
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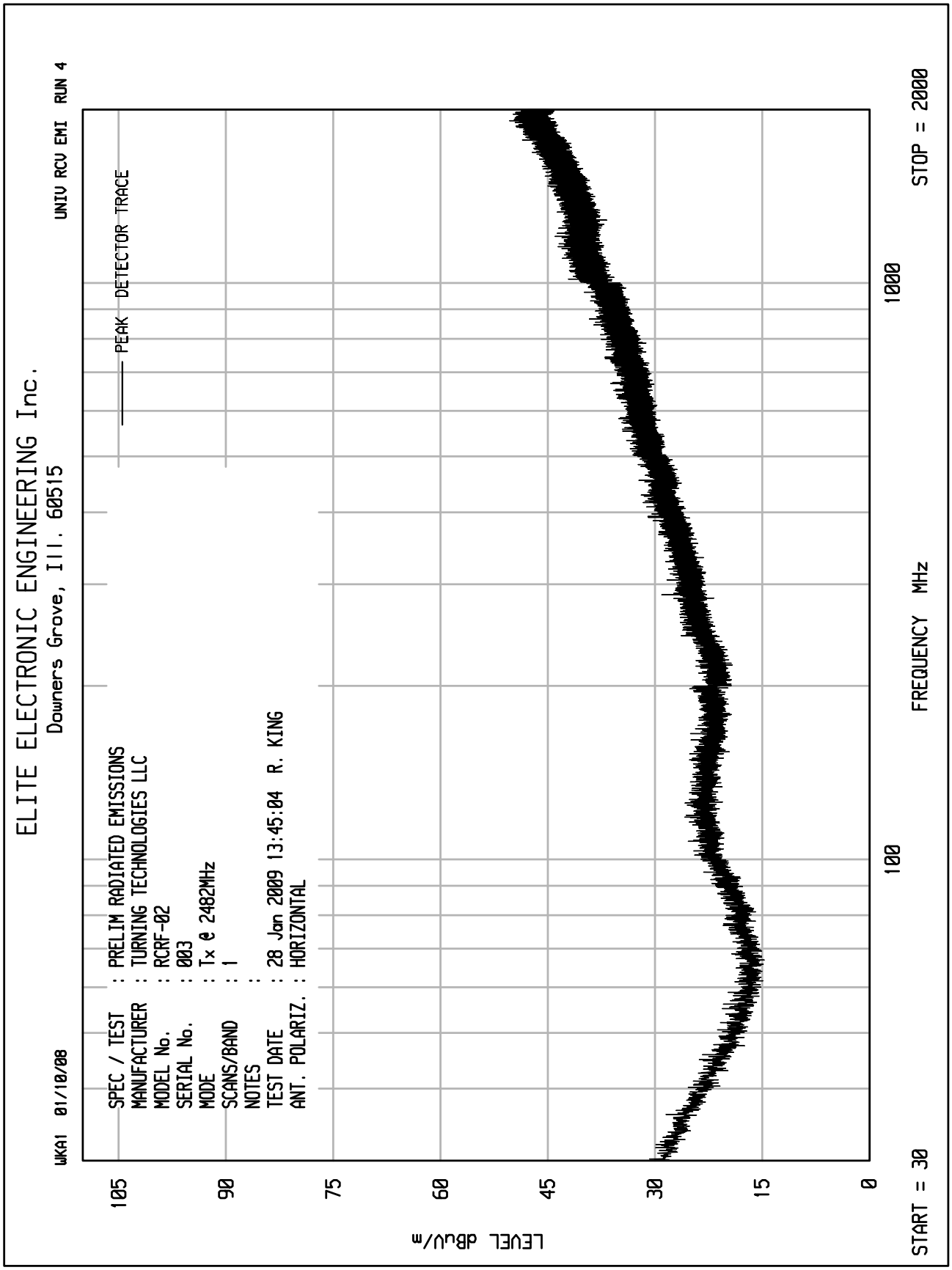
START = 30
100
1000
STOP = 2000
FREQUENCY MHz


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 4
WKA1 01/10/08
SPEC / TEST : PRELIM RADIATED EMISSIONS
MANUFACTURER : TURNING TECHNOLOGIES LLC
MODEL No. : RCRF-02
SERIAL No. : 003
MODE : Tx @ 2402MHz
SCANS/BAND : 1
NOTES :
TEST DATE : 28 Jan 2009 13:45:04 R. KING
ANT. POLARIZ. : HORIZONTAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
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75
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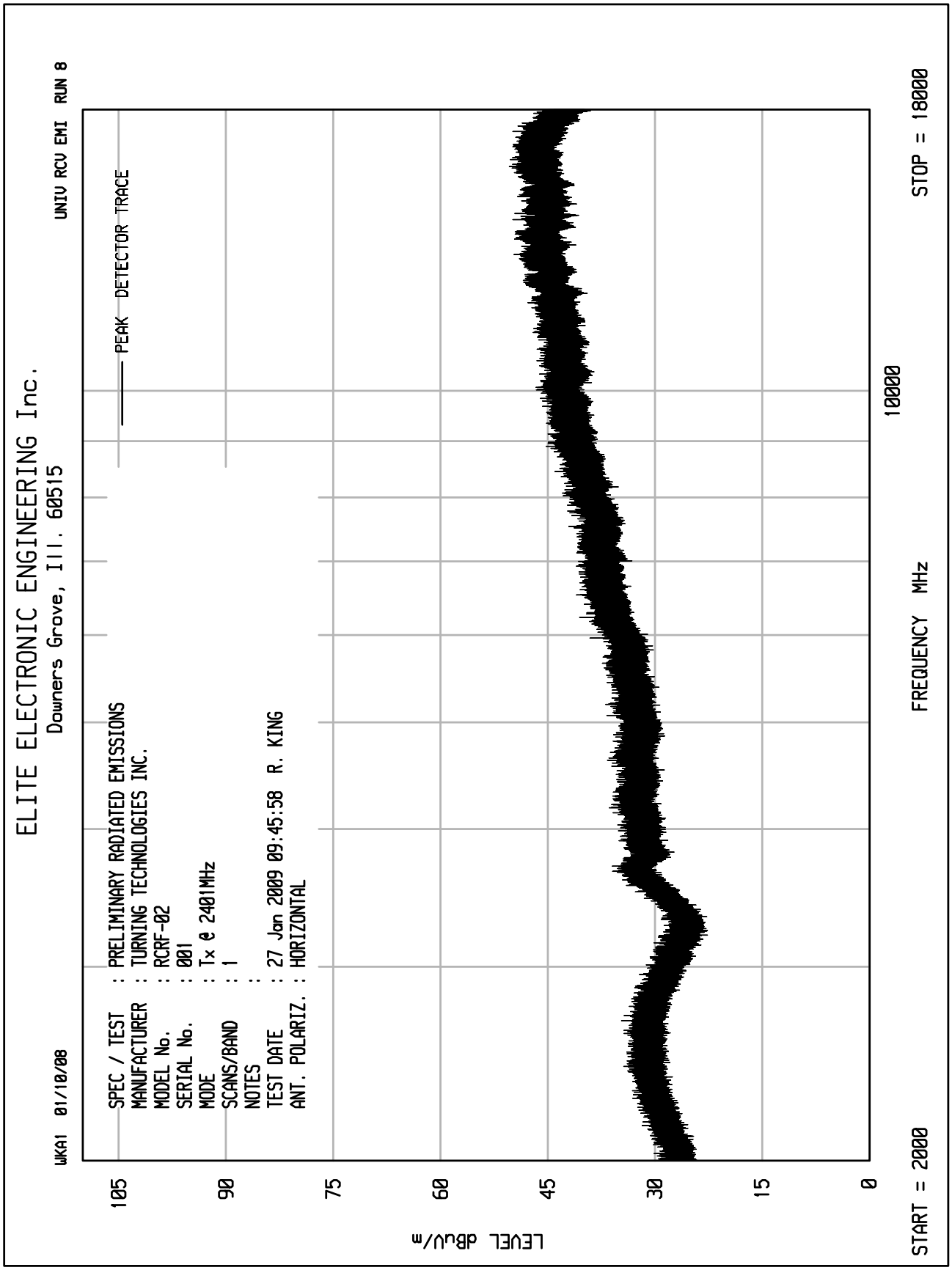
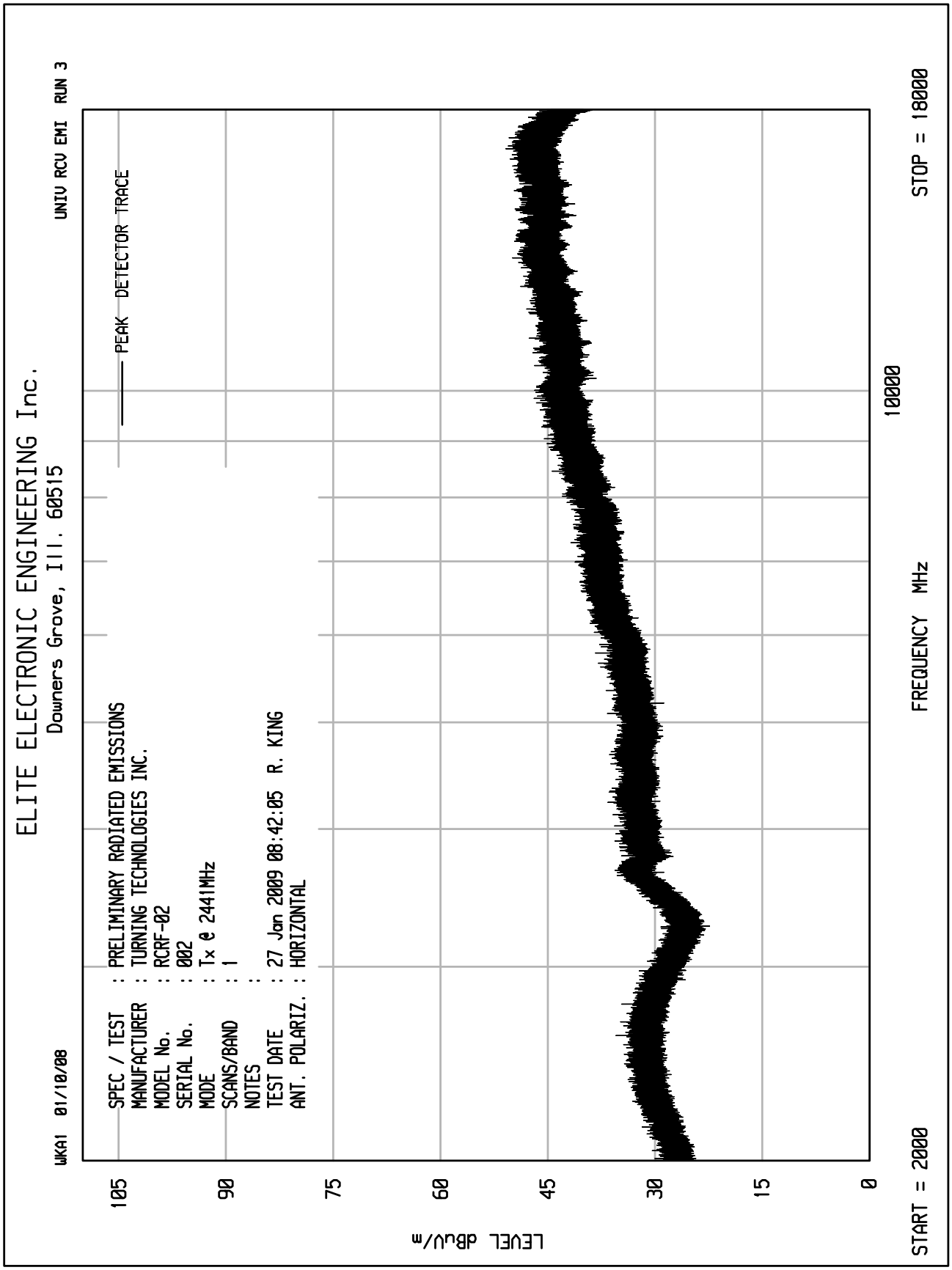
100
1000
STOP = 2000
FREQUENCY MHz


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 8
WKA1 01/10/08
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : TURNING TECHNOLOGIES INC.
MODEL No. : RCRF-02
SERIAL No. : 001
MODE : Tx @ 2401MHz
SCANS/BAND : 1
NOTES :
TEST DATE : 27 Jan 2009 09:45:58 R. KING
ANT. POLARIZ. : HORIZONTAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
105
90
75
60
45
30
15
0
START = 2000
10000
FREQUENCY MHz
STOP = 18000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 3
WKA1 01/10/08
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : TURNING TECHNOLOGIES INC.
MODEL No. : RCRF-02
SERIAL No. : 002
MODE : Tx @ 2441MHz
SCANS/BAND : 1
NOTES :
TEST DATE : 27 Jan 2009 08:42:05 R. KING
ANT. POLARIZ. : HORIZONTAL
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75
60
45
30
15
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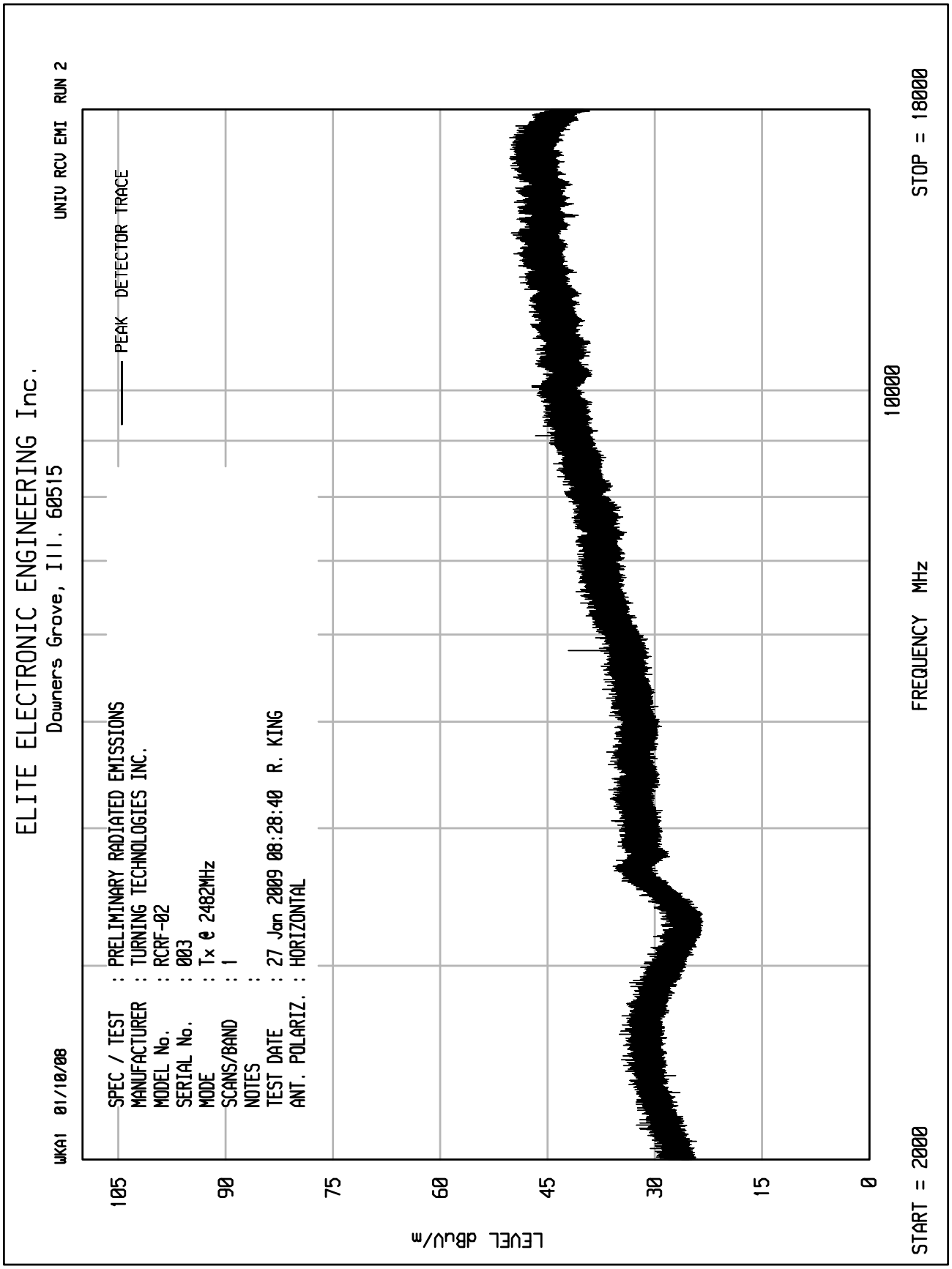
10000
FREQUENCY MHz
STOP = 18000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Downers Grove, Ill. 60515
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WKAI 01/10/08
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
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MODEL No. : RCRF-02
SERIAL No. : 003
MODE : Tx @ 2402MHz
SCANS/BAND : 1
NOTES :
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90
75
60
45
30
15
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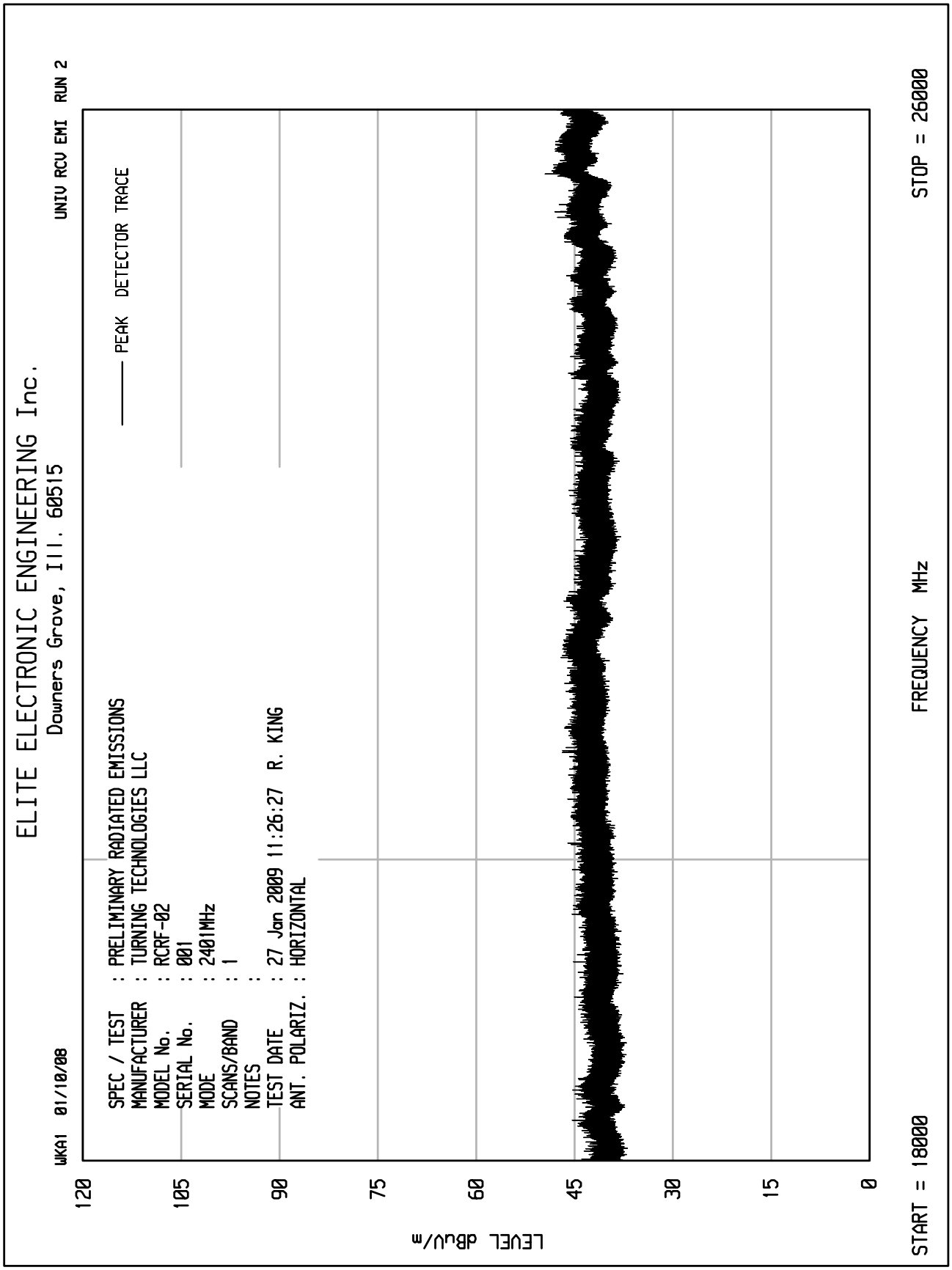
START = 2000
10000
FREQUENCY MHz
STOP = 18000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 2
WKA1 01/10/08
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : TURNING TECHNOLOGIES LLC
MODEL No. : RCRF-02
SERIAL No. : 001
MODE : 2401MHz
SCANS/BAND : 1
NOTES :
TEST DATE : 27 Jan 2009 11:26:27 R. KING
ANT. POLARIZ. : HORIZONTAL
PEAK DETECTOR TRACE
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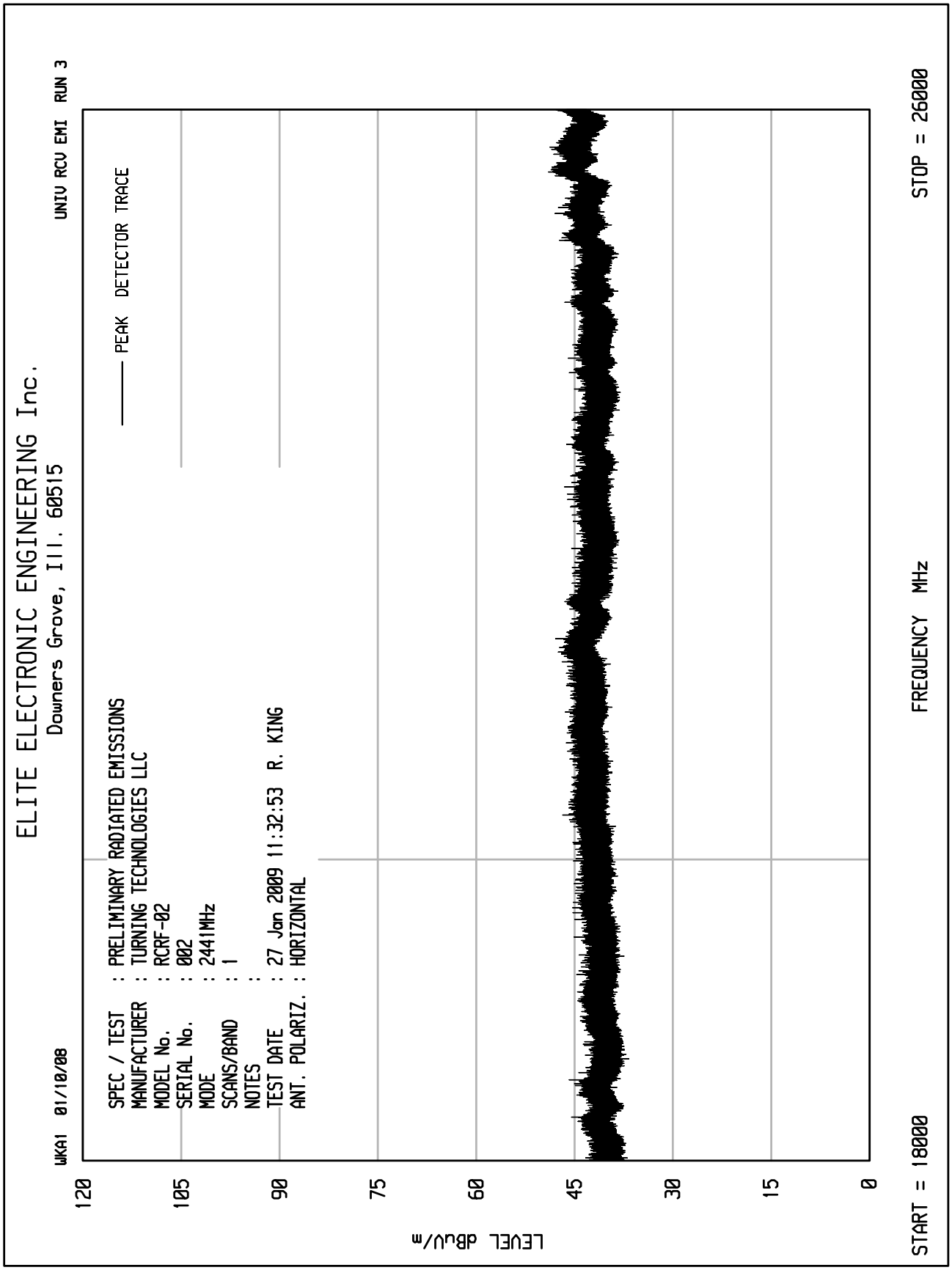
90
75
60
45
30
15
0
START = 18000
FREQUENCY MHz
STOP = 26000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
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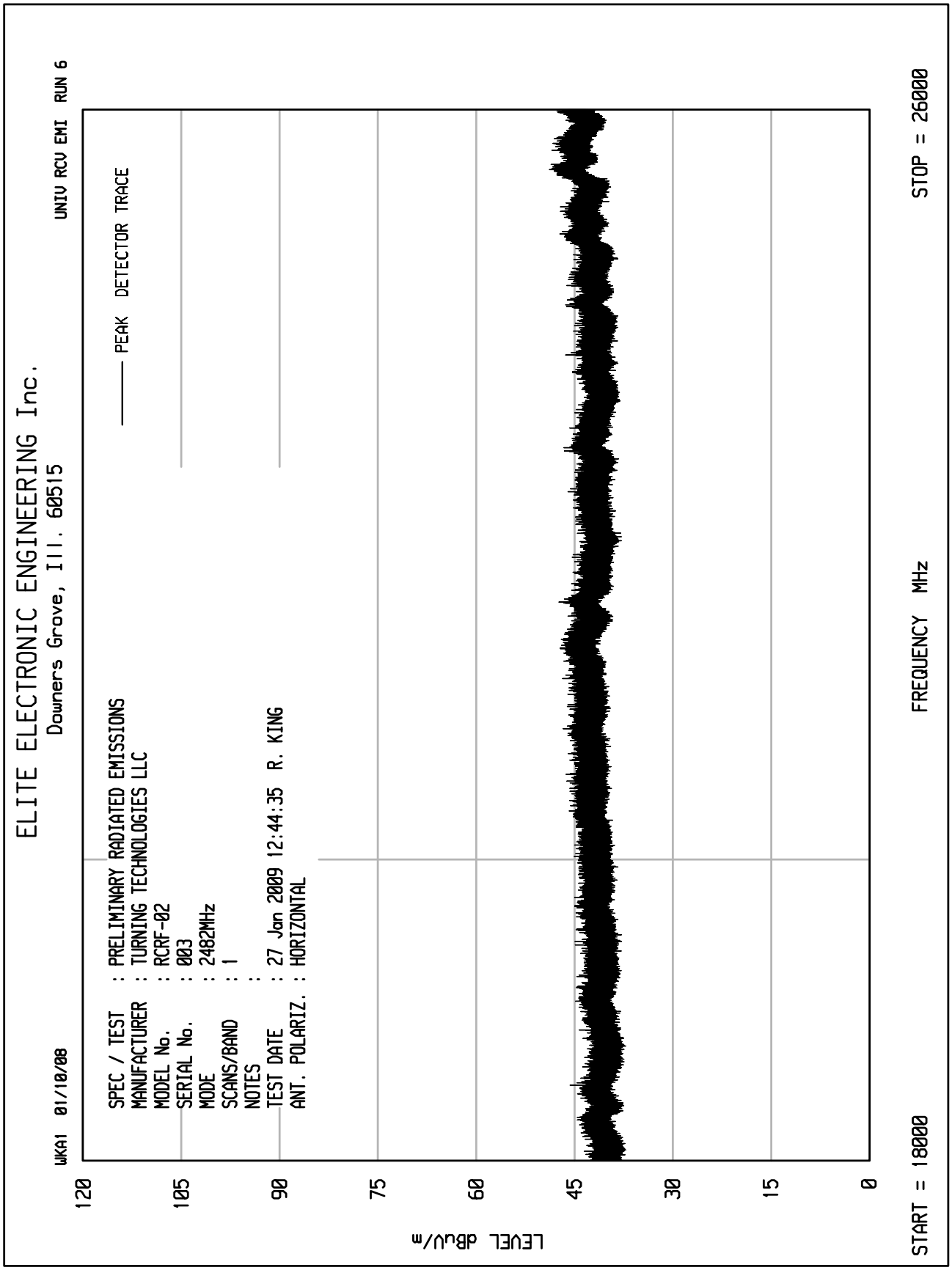
WKA1 01/10/08
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : TURNING TECHNOLOGIES LLC
MODEL No. : RCRF-02
SERIAL No. : 002
MODE : 2441MHz
SCANS/BAND : 1
NOTES :
TEST DATE : 27 Jan 2009 11:32:53 R. KING
ANT. POLARIZ. : HORIZONTAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = 18000
FREQUENCY MHz
STOP = 26000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 6
WKA1 01/10/08
PEAK DETECTOR TRACE
SPEC / TEST : PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : TURNING TECHNOLOGIES LLC
MODEL No. : RCRF-02
SERIAL No. : 003
MODE : 2482MHz
SCANS/BAND : 1
NOTES :
TEST DATE : 27 Jan 2009 12:44:35 R. KING
ANT. POLARIZ. : HORIZONTAL
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = 18000
FREQUENCY MHz
STOP = 26000

MANUFACTURER : Turning Technologies LLC
MODEL NO. : RCRF-02
SERIAL NO. : 002
TEST SPECIFICATION : FCC 15.249, Radiated Emissions
MODE : Receive @ 2441MHz
TEST DATE : January 26 – 30, 2009
TEST DISTANCE : 3 meters

Freq (MHz)	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Total uV/m at 3 M	Limit uV/m at 3M
2441.0	H	40.6	*	3.8	31.4	-40.3	60.1	500
2441.0	V	41.3	*	3.8	31.4	-40.3	65.1	500
4882.0	H	37.6	*	5.8	34.6	-40.1	77.6	500
4882.0	V	37.5	*	5.8	34.6	-40.1	76.8	500
7323.0	H	43.9	*	7.7	38.1	-39.7	312.9	500
7323.0	V	43.8	*	7.7	38.1	-39.7	309.0	500
9764.0	H	46.4	*	1.0	39.9	-38.7	267.5	500
9764.0	V	45.0	*	1.0	39.9	-38.7	226.6	500
12205.0	H	44.1	*	1.2	41.3	-39.4	228.3	500
12205.0	V	44.6	*	1.2	41.3	-39.4	242.6	500
14646.0	H	45.2	*	1.5	43.0	-40.1	304.0	500
14646.0	V	44.6	*	1.5	43.0	-40.1	281.8	500
17087.0	H	45.2	*	1.9	40.7	-38.7	288.4	500
17087.0	V	44.6	*	1.9	40.7	-38.7	267.3	500
19528.0	H	32.7	*	2.2	40.4	-27.2	254.2	500
19528.0	V	32.8	*	2.2	40.4	-27.2	258.1	500
21969.0	H	34.3	*	2.2	40.6	-26.9	321.2	500
21969.0	V	33.2	*	2.2	40.6	-26.9	284.7	500
24410.0	H	34.2	*	2.2	40.6	-27.5	299.0	500
24410.0	V	34.6	*	2.2	40.6	-27.5	313.4	500

H – Horizontal V – Vertical

Peak Total = Peak Meter Reading + Cable Factor + Antenna Factor + Preamp Gain

Checked BY Richard E. King :

Richard E. King

MANUFACTURER : Turning Technologies LLC
MODEL NO. : RCRF-02
SERIAL NO. : 001
TEST SPECIFICATION : FCC 15.249, Radiated Emissions
MODE : Transmit @ 2401MHz
TEST DATE : January 26 – 30, 2009
TEST DISTANCE : 3 meters

Freq (MHz)	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Peak Total dBuV/m at 3 M	Peak Limit dBuV/m at 3M
2401.0	H	70.5		3.8	31.4	0.0	105.7	114
2401.0	V	67.3		3.8	31.4	0.0	102.5	114
4802.0	H	49.3		5.7	34.6	-40.1	49.5	74
4802.0	V	47.2		5.7	34.6	-40.1	47.4	74
7203.0	H	43.9	*	7.6	38.0	-39.8	49.8	74
7203.0	V	45.8		7.6	38.0	-39.8	51.6	74
9604.0	H	45.6	*	0.9	39.7	-38.8	47.5	74
9604.0	V	47.7	*	0.9	39.7	-38.8	49.6	74
12005.0	H	45.0	*	1.2	41.3	-39.6	47.9	74
12005.0	V	44.5	*	1.2	41.3	-39.6	47.4	74
14406.0	H	45.3	*	1.4	42.9	-39.9	49.7	74
14406.0	V	45.4	*	1.4	42.9	-39.9	49.9	74
16807.0	H	44.9	*	1.8	41.2	-38.8	49.2	74
16807.0	V	45.6	*	1.8	41.2	-38.8	49.9	74
19208.0	H	33.2	*	2.2	40.4	-27.5	48.3	74
19208.0	V	33.8	*	2.2	40.4	-27.5	48.8	74
21609.0	H	33.2	*	2.2	40.6	-27.5	48.5	74
21609.0	V	33.6	*	2.2	40.6	-27.5	48.9	74
24010.0	H	33.5	*	2.2	40.6	-27.5	48.9	74
24010.0	V	33.6	*	2.2	40.6	-27.5	49.0	74

H – Horizontal V – Vertical

Peak Total = Peak Meter Reading + Cable Factor + Antenna Factor + Preamp Gain

Checked BY Richard E. King :

Richard E. King

MANUFACTURER : Turning Technologies LLC
MODEL NO. : RCRF-02
SERIAL NO. : 001
TEST SPECIFICATION : FCC 15.249, Radiated Emissions
MODE : Transmit @ 2401MHz
TEST DATE : January 26 – 30, 2009
TEST DISTANCE : 3 meters

Freq (MHz)	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Duty Cycle (dB)	Average Total dBuV/m at 3 M	Average Limit dBuV/m at 3M
2401.0	H	70.5		3.8	31.4	0.0	-40.0	65.7	94.0
2401.0	V	67.3		3.8	31.4	0.0	-40.0	62.5	94.0
4802.0	H	49.3		5.7	34.6	-40.1	-40.0	9.5	54.0
4802.0	V	47.2		5.7	34.6	-40.1	-40.0	7.4	54.0
7203.0	H	43.9	*	7.6	38.0	-39.8	-40.0	9.8	54.0
7203.0	V	45.8		7.6	38.0	-39.8	-40.0	11.6	54.0
9604.0	H	45.6	*	0.9	39.7	-38.8	-40.0	7.5	54.0
9604.0	V	47.7	*	0.9	39.7	-38.8	-40.0	9.6	54.0
12005.0	H	45.0	*	1.2	41.3	-39.6	-40.0	7.9	54.0
12005.0	V	44.5	*	1.2	41.3	-39.6	-40.0	7.4	54.0
14406.0	H	45.3	*	1.4	42.9	-39.9	-40.0	9.7	54.0
14406.0	V	45.4	*	1.4	42.9	-39.9	-40.0	9.9	54.0
16807.0	H	44.9	*	1.8	41.2	-38.8	-40.0	9.2	54.0
16807.0	V	45.6	*	1.8	41.2	-38.8	-40.0	9.9	54.0
19208.0	H	33.2	*	2.2	40.4	-27.5	-40.0	8.3	54.0
19208.0	V	33.8	*	2.2	40.4	-27.5	-40.0	8.8	54.0
21609.0	H	33.2	*	2.2	40.6	-27.5	-40.0	8.5	54.0
21609.0	V	33.6	*	2.2	40.6	-27.5	-40.0	8.9	54.0
24010.0	H	33.5	*	2.2	40.6	-27.5	-40.0	8.9	54.0
24010.0	V	33.6	*	2.2	40.6	-27.5	-40.0	9.0	54.0

H – Horizontal V – Vertical

Average Total = Peak Meter Reading + Cable Factor + Antenna Factor + Preamp Gain + Duty Cycle Factor

Checked BY Richard E. King :

Richard E. King

MANUFACTURER : Turning Technologies LLC
MODEL NO. : RCRF-02
SERIAL NO. : 002
TEST SPECIFICATION : FCC 15.249, Radiated Emissions
MODE : Transmit @ 2441MHz
TEST DATE : January 26 – 30, 2009
TEST DISTANCE : 3 meters

Freq (MHz)	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Peak Total dBuV/m at 3 M	Peak Limit dBuV/m at 3M
2441.0	H	71.5		3.8	31.4	0.0	106.7	114
2441.0	V	66.9		3.8	31.4	0.0	102.2	114
4882.0	H	47.1		5.8	34.6	-40.1	47.3	74
4882.0	V	48.8		5.8	34.6	-40.1	49.0	74
7323.0	H	45.6	*	7.7	38.1	-39.7	51.6	74
7323.0	V	44.6	*	7.7	38.1	-39.7	50.6	74
9764.0	H	46.4	*	1.0	39.9	-38.7	48.5	74
9764.0	V	45.0	*	1.0	39.9	-38.7	47.1	74
12205.0	H	44.1	*	1.2	41.3	-39.4	47.2	74
12205.0	V	44.6	*	1.2	41.3	-39.4	47.7	74
14646.0	H	45.2	*	1.5	43.0	-40.1	49.7	74
14646.0	V	44.6	*	1.5	43.0	-40.1	49.0	74
17087.0	H	45.2	*	1.9	40.7	-38.7	49.2	74
17087.0	V	44.6	*	1.9	40.7	-38.7	48.5	74
19528.0	H	32.7	*	2.2	40.4	-27.2	48.1	74
19528.0	V	32.8	*	2.2	40.4	-27.2	48.2	74
21969.0	H	34.3	*	2.2	40.6	-26.9	50.1	74
21969.0	V	33.2	*	2.2	40.6	-26.9	49.1	74
24410.0	H	34.2	*	2.2	40.6	-27.5	49.5	74
24410.0	V	34.6	*	2.2	40.6	-27.5	49.9	74

H – Horizontal V – Vertical

Peak Total = Peak Meter Reading + Cable Factor + Antenna Factor + Preamp Gain

Checked BY Richard E. King :

Richard E. King

MANUFACTURER : Turning Technologies LLC
MODEL NO. : RCRF-02
SERIAL NO. : 002
TEST SPECIFICATION : FCC 15.249, Radiated Emissions
MODE : Transmit @ 2441MHz
TEST DATE : January 26 – 30, 2009
TEST DISTANCE : 3 meters

Freq (MHz)	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Duty Cycle (dB)	Average Total dBuV/m at 3 M	Average Limit dBuV/m at 3M
2441.0	H	71.5		3.8	31.4	0.0	-40.0	66.7	94
2441.0	V	66.9		3.8	31.4	0.0	-40.0	62.2	94
4882.0	H	47.1		5.8	34.6	-40.1	-40.0	7.3	54
4882.0	V	48.8		5.8	34.6	-40.1	-40.0	9.0	54
7323.0	H	45.6	*	7.7	38.1	-39.7	-40.0	11.6	54
7323.0	V	44.6	*	7.7	38.1	-39.7	-40.0	10.6	54
9764.0	H	46.4	*	1.0	39.9	-38.7	-40.0	8.5	54
9764.0	V	45.0	*	1.0	39.9	-38.7	-40.0	7.1	54
12205.0	H	44.1	*	1.2	41.3	-39.4	-40.0	7.2	54
12205.0	V	44.6	*	1.2	41.3	-39.4	-40.0	7.7	54
14646.0	H	45.2	*	1.5	43.0	-40.1	-40.0	9.7	54
14646.0	V	44.6	*	1.5	43.0	-40.1	-40.0	9.0	54
17087.0	H	45.2	*	1.9	40.7	-38.7	-40.0	9.2	54
17087.0	V	44.6	*	1.9	40.7	-38.7	-40.0	8.5	54
19528.0	H	32.7	*	2.2	40.4	-27.2	-40.0	8.1	54
19528.0	V	32.8	*	2.2	40.4	-27.2	-40.0	8.2	54
21969.0	H	34.3	*	2.2	40.6	-26.9	-40.0	10.1	54
21969.0	V	33.2	*	2.2	40.6	-26.9	-40.0	9.1	54
24410.0	H	34.2	*	2.2	40.6	-27.5	-40.0	9.5	54
24410.0	V	34.6	*	2.2	40.6	-27.5	-40.0	9.9	54

H – Horizontal V – Vertical

Average Total = Peak Meter Reading + Cable Factor + Antenna Factor + Preamp Gain + Duty Cycle Factor

Checked BY Richard E. King :

Richard E. King

MANUFACTURER : Turning Technologies LLC
MODEL NO. : RCRF-02
SERIAL NO. : 003
TEST SPECIFICATION : FCC 15.249, Radiated Emissions
MODE : Transmit @ 2482MHz
TEST DATE : January 26 – 30, 2009
TEST DISTANCE : 3 meters

Freq (MHz)	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Peak Total dBuV/m at 3 M	Peak Limit dBuV/m at 3M
2482.0	H	70.2		3.8	31.5		105.5	114
2482.0	V	65.4		3.8	31.5		100.7	114
4964.0	H	48.7		5.8	34.6	-40.2	48.9	94
4964.0	V	47.4		5.8	34.6	-40.2	47.7	94
7446.0	H	48.6		7.7	38.1	-39.7	54.7	94
7446.0	V	44.5	*	7.7	38.1	-39.7	50.6	94
9928.0	H	44.9	*	1.0	40.0	-38.6	47.2	94
9928.0	V	45.2	*	1.0	40.0	-38.6	47.6	94
12410.0	H	45.8	*	1.2	41.4	-39.2	49.1	94
12410.0	V	44.5	*	1.2	41.4	-39.2	47.8	94
14892.0	H	44.8	*	1.5	43.1	-40.3	49.1	94
14892.0	V	45.1	*	1.5	43.1	-40.3	49.5	94
17374.0	H	43.8	*	2.0	39.5	-39.0	46.3	94
17374.0	V	43.5	*	2.0	39.5	-39.0	46.1	94
19856.0	H	32.7	*	2.2	40.4	-26.8	48.4	94
19856.0	V	32.8	*	2.2	40.4	-26.8	48.6	94
22338.0	H	34.3	*	2.2	40.6	-27.1	50.0	94
22338.0	V	33.1	*	2.2	40.6	-27.1	48.8	94
24820.0	H	35.1	*	2.2	40.6	-27.2	50.7	94
24820.0	V	33.6	*	2.2	40.6	-27.2	49.3	94

H – Horizontal V – Vertical

Peak Total = Peak Meter Reading + Cable Factor + Antenna Factor + Preamp Gain

Checked BY Richard E. King :

Richard E. King

MANUFACTURER : Turning Technologies LLC
MODEL NO. : RCRF-02
SERIAL NO. : 003
TEST SPECIFICATION : FCC 15.249, Radiated Emissions
MODE : Transmit @ 2482MHz
TEST DATE : January 26 – 30, 2009
TEST DISTANCE : 3 meters

Freq (MHz)	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Duty Cycle (dB)	Average Total dBuV/m at 3 M	Average Limit dBuV/m at 3M
2482.0	H	70.2		3.8	31.5		-40.0	65.5	94
2482.0	V	65.4		3.8	31.5		-40.0	60.7	94
4964.0	H	48.7		5.8	34.6	-40.2	-40.0	8.9	54
4964.0	V	47.4		5.8	34.6	-40.2	-40.0	7.7	54
7446.0	H	48.6		7.7	38.1	-39.7	-40.0	14.7	54
7446.0	V	44.5	*	7.7	38.1	-39.7	-40.0	10.6	54
9928.0	H	44.9	*	1.0	40.0	-38.6	-40.0	7.2	54
9928.0	V	45.2	*	1.0	40.0	-38.6	-40.0	7.6	54
12410.0	H	45.8	*	1.2	41.4	-39.2	-40.0	9.1	54
12410.0	V	44.5	*	1.2	41.4	-39.2	-40.0	7.8	54
14892.0	H	44.8	*	1.5	43.1	-40.3	-40.0	9.1	54
14892.0	V	45.1	*	1.5	43.1	-40.3	-40.0	9.5	54
17374.0	H	43.8	*	2.0	39.5	-39.0	-40.0	6.3	54
17374.0	V	43.5	*	2.0	39.5	-39.0	-40.0	6.1	54
19856.0	H	32.7	*	2.2	40.4	-26.8	-40.0	8.4	54
19856.0	V	32.8	*	2.2	40.4	-26.8	-40.0	8.6	54
22338.0	H	34.3	*	2.2	40.6	-27.1	-40.0	10.0	54
22338.0	V	33.1	*	2.2	40.6	-27.1	-40.0	8.8	54
24820.0	H	35.1	*	2.2	40.6	-27.2	-40.0	10.7	54
24820.0	V	33.6	*	2.2	40.6	-27.2	-40.0	9.3	54

H – Horizontal V – Vertical

Average Total = Peak Meter Reading + Cable Factor + Antenna Factor + Preamp Gain + Duty Cycle Factor

Checked BY Richard E. King :

Richard E. King

MANUFACTURER : Turning Technologies LLC
MODEL NO. : RCRF-02
SERIAL NO. : 005
TEST SPECIFICATION : FCC 15.249, Radiated Emissions
MODE : Transmit @ 2441MHz
TEST DATE : January 26 – 30, 2009
TEST DISTANCE : 3 meters

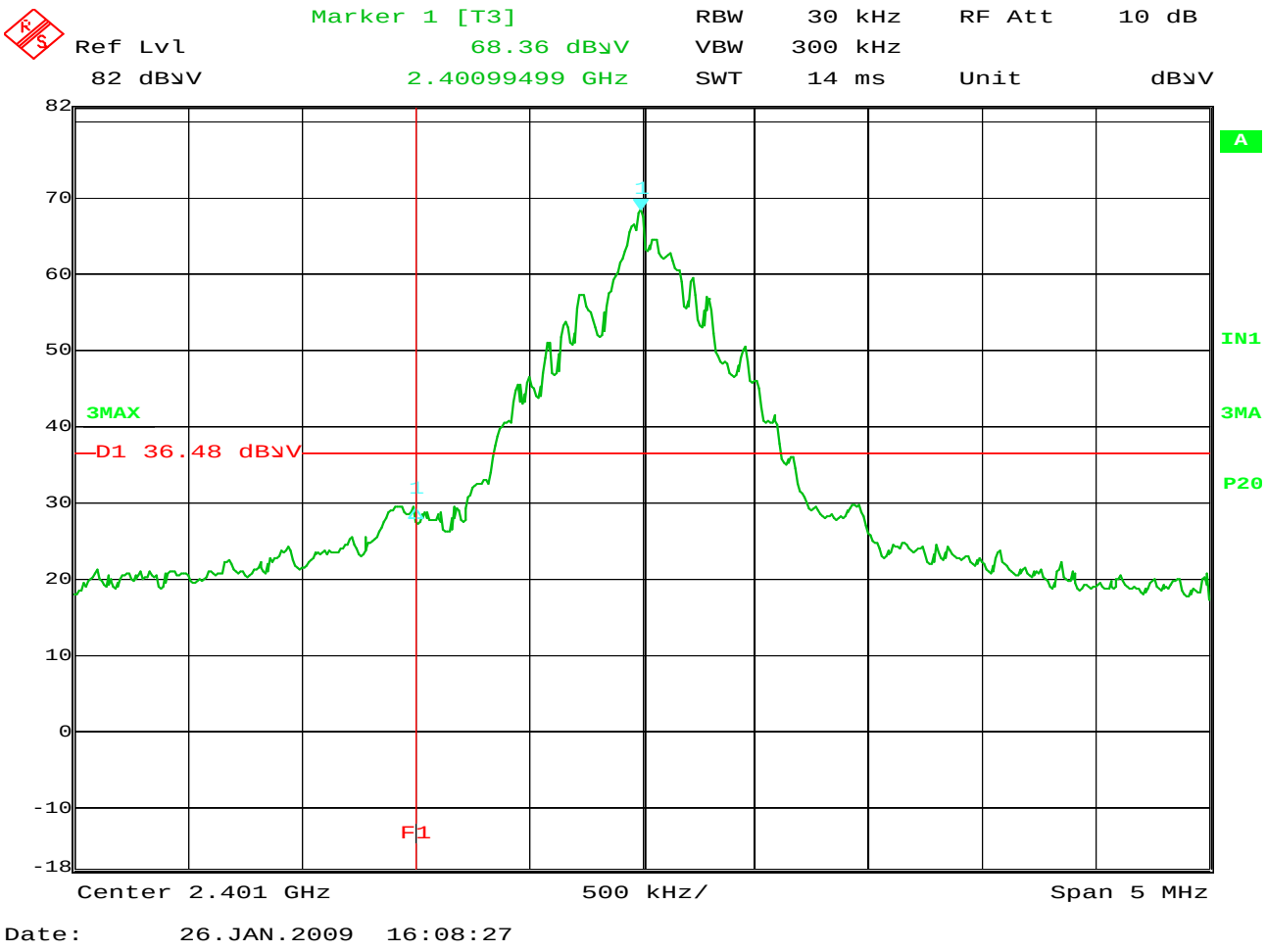
Freq (MHz)	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Peak Total dBuV/m at 3 M	Peak Limit dBuV/m at 3M
2441.0	H	68.7		3.8	31.4	0.0	104.0	114
2441.0	V	67.2		3.8	31.4	0.0	102.4	114
4882.0	H	48.1		5.8	34.6	-40.1	48.3	74
4882.0	V	49.2		5.8	34.6	-40.1	49.4	74
7323.0	H	45.6	*	7.7	38.1	-39.7	51.6	74
7323.0	V	47.9		7.7	38.1	-39.7	53.9	74
9764.0	H	46.4	*	1.0	39.9	-38.7	48.5	74
9764.0	V	45.0	*	1.0	39.9	-38.7	47.1	74
12205.0	H	44.1	*	1.2	41.3	-39.4	47.2	74
12205.0	V	44.6	*	1.2	41.3	-39.4	47.7	74
14646.0	H	45.2	*	1.5	43.0	-40.1	49.7	74
14646.0	V	44.6	*	1.5	43.0	-40.1	49.0	74
17087.0	H	45.2	*	1.9	40.7	-38.7	49.2	74
17087.0	V	44.6	*	1.9	40.7	-38.7	48.5	74
19528.0	H	32.7	*	2.2	40.4	-27.2	48.1	74
19528.0	V	32.8	*	2.2	40.4	-27.2	48.2	74
21969.0	H	34.3	*	2.2	40.6	-26.9	50.1	74
21969.0	V	33.2	*	2.2	40.6	-26.9	49.1	74
24410.0	H	34.2	*	2.2	40.6	-27.5	49.5	74
24410.0	V	34.6	*	2.2	40.6	-27.5	49.9	74

H – Horizontal V – Vertical

Peak Total = Peak Meter Reading + Cable Factor + Antenna Factor + Preamp Gain

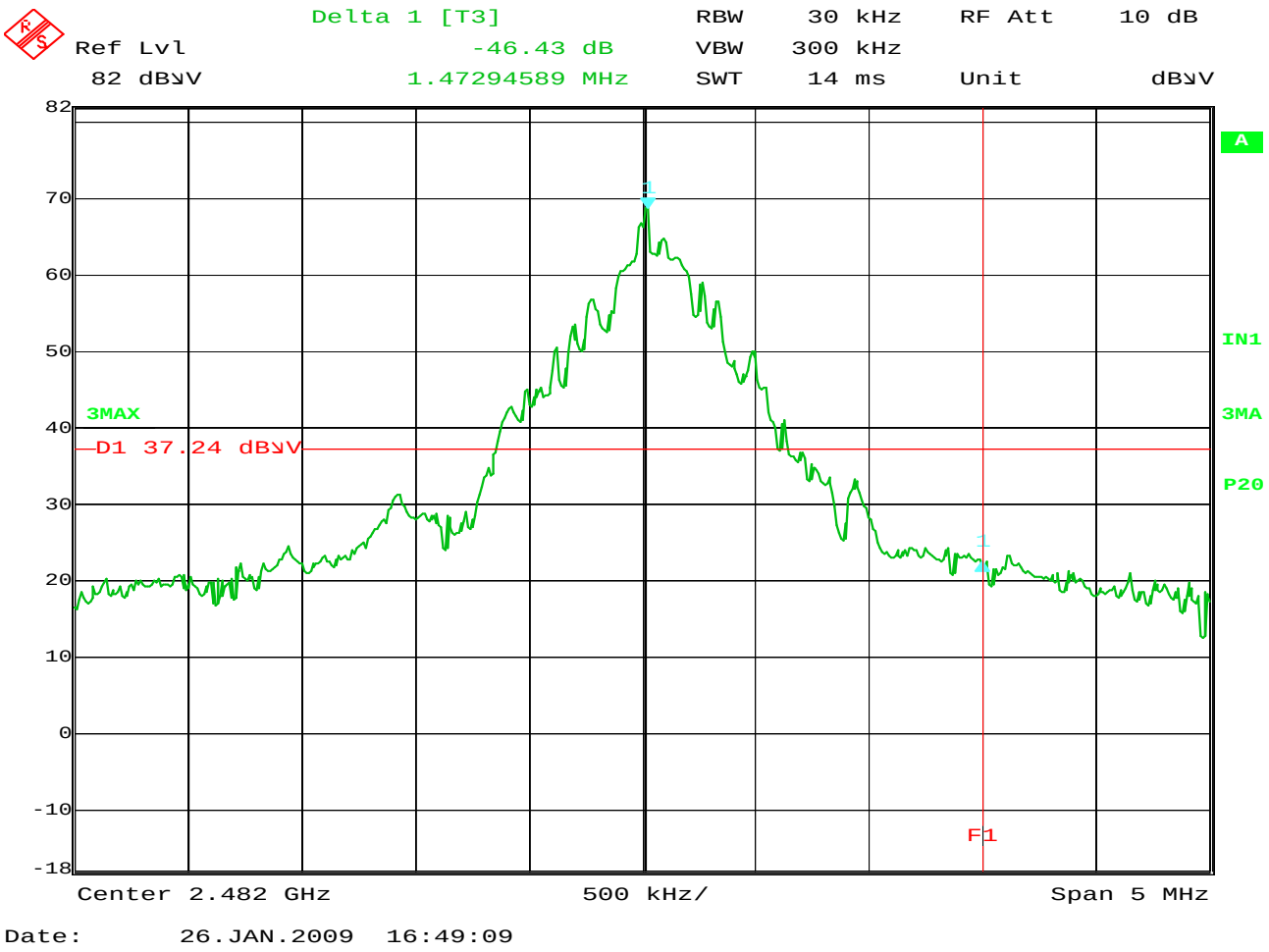
Checked BY Richard E. King :

Richard E. King



FCC 15.249 Band-Edge Compliance

MANUFACTURER	: Turning Technologies LLC
TEST ITEM	: Transceiver
MODEL NUMBER	: RCRF-02
SERIAL NUMBER	: 001
TEST MODE	: Tx at 2401MHz
NOTES	: The peak reading at 2401MHz = 105.7dBuV/m. In order for the bandedge (2400MHz) to be below the general limit of 74dBuV/m (peak), it must down from the (105.7dBuV/m – 74dBuV/m = 31.7 dB) from the fundamental at 2401MHz. F1 represents the bandedge at 2400MHz. D1 represents the general limit (peak).



FCC 15.249 Band-Edge Compliance

MANUFACTURER	: Turning Technologies LLC
TEST ITEM	: Transceiver
MODEL NUMBER	: RCRF-02
SERIAL NUMBER	: 003
TEST MODE	: Tx at 2482MHz
NOTES	: The peak reading at 2482MHz = 105.5dBuV/m. In order for the bandedge (2483.5MHz) to be below the general limit of 74dBuV/m (peak), it must down from the (105.5dBuV/m – 74dBuV/m = 31.5 dB) from the fundamental at 2482MHz. F1 represents the bandedge at 2483.5MHz. D1 represents the general limit (peak).