



Measurement of RF Interference from a  
Model TCU15P01\_M1297C  
In-Vehicle Bluetooth Module Transmitter

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For : Motorola TCG  
21440 W. Lake Cook Rd  
Deer Park, IL 60010

P.O. No. :  
Date Received: November 14, 2005  
Date Tested : November 14, 2005  
Test Personnel: Richard E. King  
Specification : FCC "Code of Federal Regulations" Title 47 Part 15,  
Subpart C, Section 15.247 for Frequency Hopping  
Spread Spectrum Intentional Radiators Operating within  
the 2400-2483.5MHz band.

Test Report By : *Richard E. King*  
EMC Engineer

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



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REVISION HISTORY

Revision	Date	Description
—	12/21/2005	Initial release

**Measurement of RF Interference from a  
Model TCU15P01\_M1297C In-Vehicle Bluetooth Module Transmitter**

**1.0 INTRODUCTION:**

**1.1 Description of Test Item** - This document represents the results of the series of radio interference measurements performed on an In-Vehicle Bluetooth Module spread spectrum transmitter, Model No. TCU15P01\_M1297C, Serial No. IU00000107, (hereinafter referred to as the test item). The test item is a frequency hopping spread spectrum transceiver used in vehicle bluetooth applications. It transmits in the 2400MHz to 2483.5MHz band and uses an external flat panel antenna. The test item has the identical transmitter characteristics of the Model No. TCU1P03\_M1202D tested in Elite Electronic Engineering's Engineering Test Report No. 33977-01 and certified under FCC ID: IHDT6EM1. The test item was manufactured and submitted for testing by Motorola TCG located in Deer Park, IL.

**1.2 Purpose** - The test series was performed to determine if the modified test item continues to meet the radiated RF emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Sections 15.247 for Intentional Radiators as pertaining to a Class I or Class II permissive change. No Transmitter characteristics test were performed because the test item utilizes the same transmitter chipset as tested in Elite Electronic Engineering's Engineering Test Report No. 33977-01. 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 2004
- FCC Public Notice, DA 00-705, "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems", Released March 30, 2000
- 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 21°C and the relative humidity was 55%.

**2.0 TEST ITEM SETUP AND OPERATION:**

The test item is an In-Vehicle Bluetooth Module, Part No.TCU15P01\_M1297C. A block diagram of the test item setup is shown as Figure 1.

**2.1 Power Input** - The test item obtained 5 VDC power through two leads from a BK Precision Model 1670 power supply. The power supply received 115V 60Hz power through lowpass powerline filters on the wall of the shielded enclosure. The leads from the power supply to the test item were approximately 6 inches long.

**2.2 Grounding** - Since only two wires were used to provide the input power, the test item was ungrounded during the tests.

**2.3 Support Equipment** - The following support equipment was submitted with the test item:

Item	Description
Flat Panel Antenna	S/N IU00000107

**2.4 Interconnect Cables** - The following interconnect cables were submitted with the test item:

Item	Description
Antenna Cable	23cm long
RS232 Cable	Used for programming only - Unterminated for radiated tests and connected to computer during conducted tests

**2.5 Operational Mode** - The test item and all support equipment was placed on an 80cm high non-conductive stand. The test item and all support equipment were energized. The test item was set to transmit at frequencies of 2402MHz, 2441MHz and 2480MHz.

**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).

#### **4.0 REQUIREMENTS, PROCEDURES AND RESULTS:**

##### **4.1 Powerline Conducted Emissions**

**4.1.1 Requirements** – This requirement is not applicable since the test item receives 5VDC from the vehicle's power supply. There are no operational modes where the transmitter can be connected to the AC power public utilities. Therefore, the conducted emissions measurements are not required.

##### **4.2 Spurious Emissions**

###### **4.2.1 Antenna Conducted**

**4.2.1.1 Requirement** – Per section 15.247(c), the spurious emissions in any 100 kHz BW outside the frequency band must be at least 20dB below the highest 100 kHz BW level measured within the band.

**4.2.1.2 Procedures** – The measuring equipment was connected to the test item's antenna port. The emissions in the frequency range from 30MHz to 25GHz were observed and plotted separately with the test item transmitting at 2402MHz, 2441MHz, and 2480MHz. Compliance above 25GHz is demonstrated with radiated measurements.

**4.2.1.3 Results** - The results of the antenna conducted emissions levels were plotted. These plots are presented on pages 11 through 19. These plots show that the spurious emissions were at least 20 dB below the level of the fundamental.

###### **4.2.2 Radiated Spurious Emissions**

**4.2.2.1 Requirement** – Per section 15.247(c), the radiated emissions which fall in the restricted bands must meet the general limits of 15.209.

**4.2.2.2 Procedures** – The radiated tests were performed in a 32ft. x 20ft. x 18ft. hybrid absorber lined semi-anechoic 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. The floor of the chamber is used as the ground plane. The chamber complies with ANSI 63.4 and CISPR 16 requirements for site attenuation.

Preliminary radiated measurements are performed to determine the frequencies where the significant emissions might be found. With the test item at one set position and the measurement antenna at a set height (i.e. without maximizing), the radiated emissions were measured using peak detection with 100 kHz BW. This data was then automatically plotted up through 18 GHz. The



frequency range from 18 to 25 GHz was checked manually but not plotted.

Next, the harmonic or spurious emissions falling in the restricted bands were measured up through the 10th harmonic. For the measurements above 1GHz, the measurement bandwidth was set to 1 MHz RBW. The analyzer was set to **linear mode** with 10 Hz VBW in order to simulate an average detector. A pre-amplifier was used to increase the receiver sensitivity.

**4.2.2.3 Results** - The preliminary emissions levels were plotted. These plots are presented on pages 21 through 32. These plots indicate that the radiated spurious emissions were below the general limit.

The harmonics and any other emissions that fall in the restricted frequency bands were then re-measured manually. This data is shown in the tables on pages 33 through 35. The field intensities levels for the harmonics in the restricted band were within the limit.

## **5.0 CONCLUSIONS:**

It was determined that the Motorola TCG In-Vehicle Bluetooth Module, Part No. TCU15P01\_M1297C, Serial No. IU00000107, did continue to fully meet the conducted and radiated emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Section 15.247 for Bluetooth spread spectrum transmitters. It was also determined that the Motorola TCG In-Vehicle Bluetooth Module, Part No. TCU15P01\_M1297C, Serial No. IU00000107, met the radiated emission requirements. When the emission levels were compared to original test, the levels were significantly different. Therefore, the changes were qualified as a Class II permissive change.

## **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								
XPR0	HIGH PASS FILTER	K&L MICROWAVE	11SH10-4800/	001	4.8-20GHZ	07/27/05	12	07/27/06
XZG2	ATTENUATOR/SWITCH DRIVER	HEWLETT PACKARD	11713A	2223A01751	---		N/A	
Equipment Type: AMPLIFIERS								
APK2	PREAMPLIFIER	AGILENT TECHNOL	8449B	3008A01595	1-26.5GHZ	02/11/05	12	02/11/06
Equipment Type: ANTENNAS								
NTA1	BILOG ANTENNA	CHASE EMC LTD.	BILOG CBL611	2054	0.03-2GHZ	08/08/05	12	08/08/06
NWI0	RIDGED WAVE GUIDE	AEL	H1498	153	2-18GHZ	10/01/05	12	10/01/06
Equipment Type: ATTENUATORS								
T1EE	10DB 25W ATTENUATOR	WEINSCHEL	46-10-34	BN2321	DC-18GHZ	12/05/05	12	12/05/06
T2DE	20DB 25W ATTENUATOR	WEINSCHEL	46-20-34	BN1032	DC-18GHZ	03/10/05	12	03/10/06
Equipment Type: RECEIVERS								
RAC0	SPECTRUM ANALYZER	HEWLETT PACKARD	85660B	2449A01117	100HZ-22GHZ	02/07/05	12	02/07/06
RACE	RF PRESELECTOR W/ RECEIVER	HEWLETT PACKARD	85685A	3010A01194	20HZ-2GHZ	08/26/05	12	08/26/06
RAF1	QUASISPEAK ADAPTER	HEWLETT PACKARD	85650A	2043A00271	0.01-1000MHZ	02/07/05	12	02/07/06
RBA1	EMI TEST RECEIVER	ROHDE & SCHWARZ	ESIB26	100146	20HZ-26.5GHZ	05/23/05	12	05/23/06

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.

Figure 2



Radiated Emissions 2GHz – 18GHz – Vertical Polarization



Radiated Emissions 2GHz – 18GHz – Horizontal Polarization



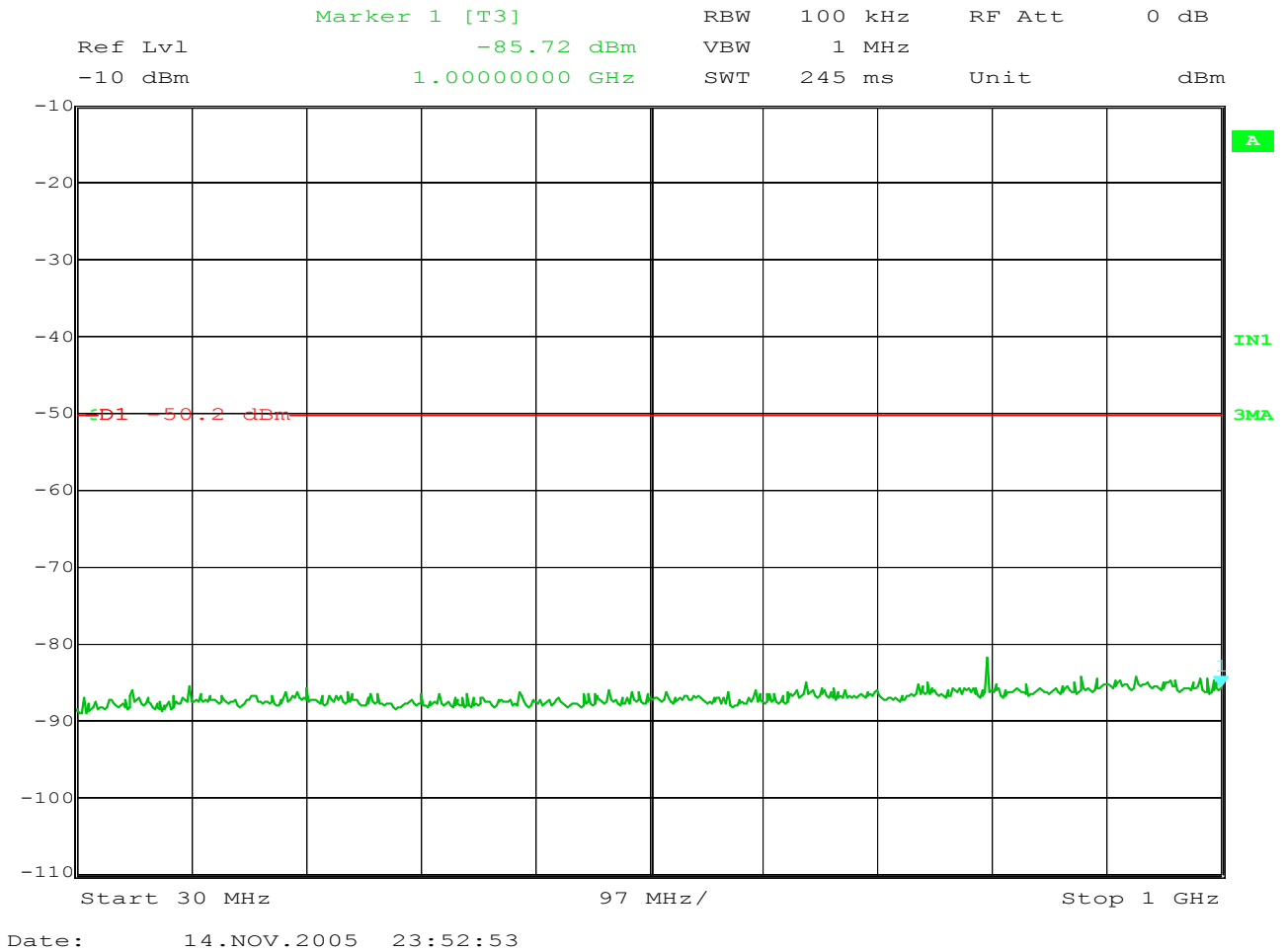
Data Sheet

MANUFACTURER : Motorola TCG  
MODEL : TCU15P01\_M1297C  
S/N : IU00000107  
SPECIFICATION : FCC Part 15, Subpart C, Section 15.247  
Peak Output Power – Antenna Conducted Measurement  
DATE : November 14, 2005  
NOTES : CW Signal  
: Power Meter Measurement

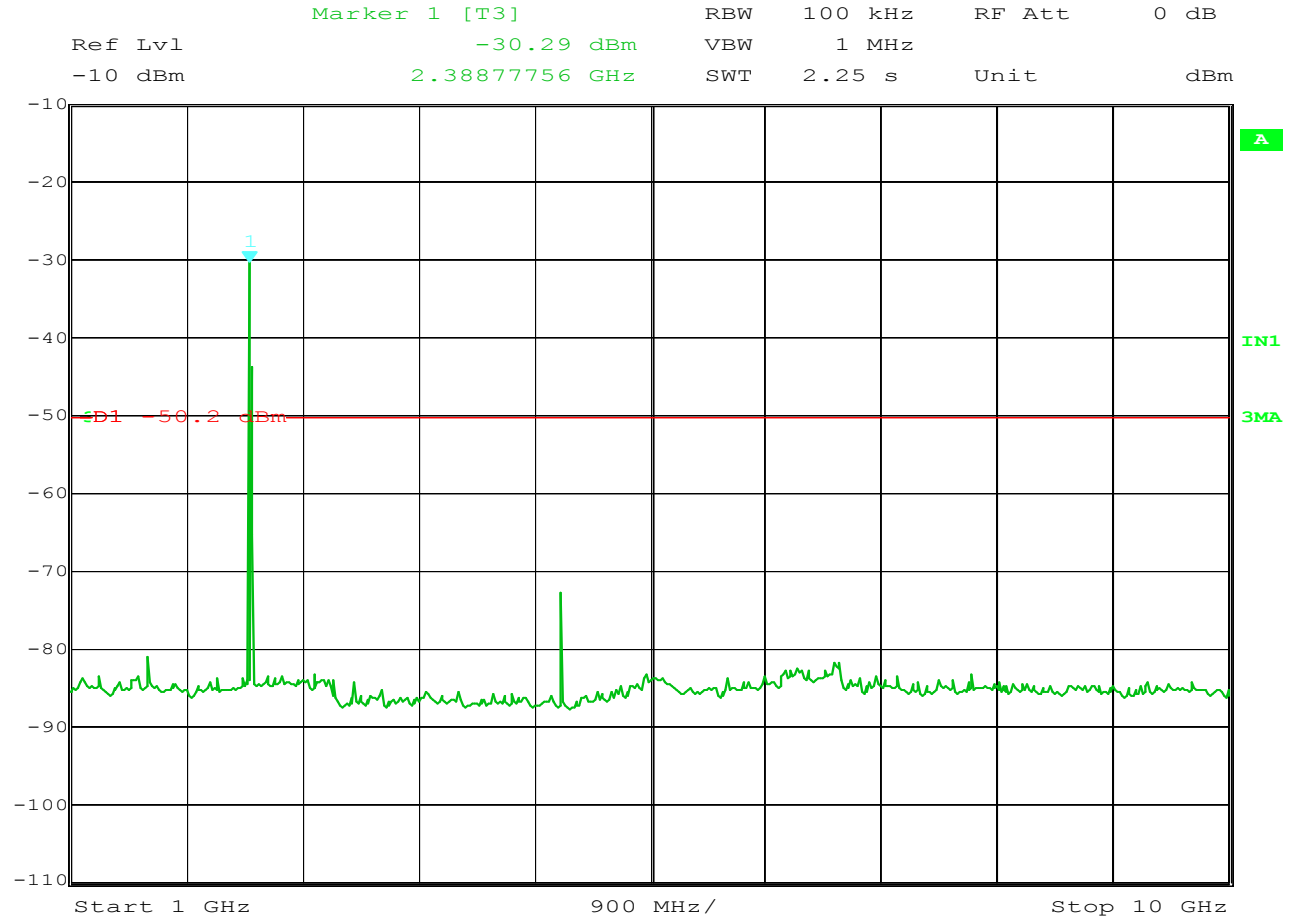
FREQ. (MHz)	PEAK POWER (dBm)
2402	1.2
2441	0.9
2480	0.7

Checked BY : *RICHARD E. KING*

Richard E. King

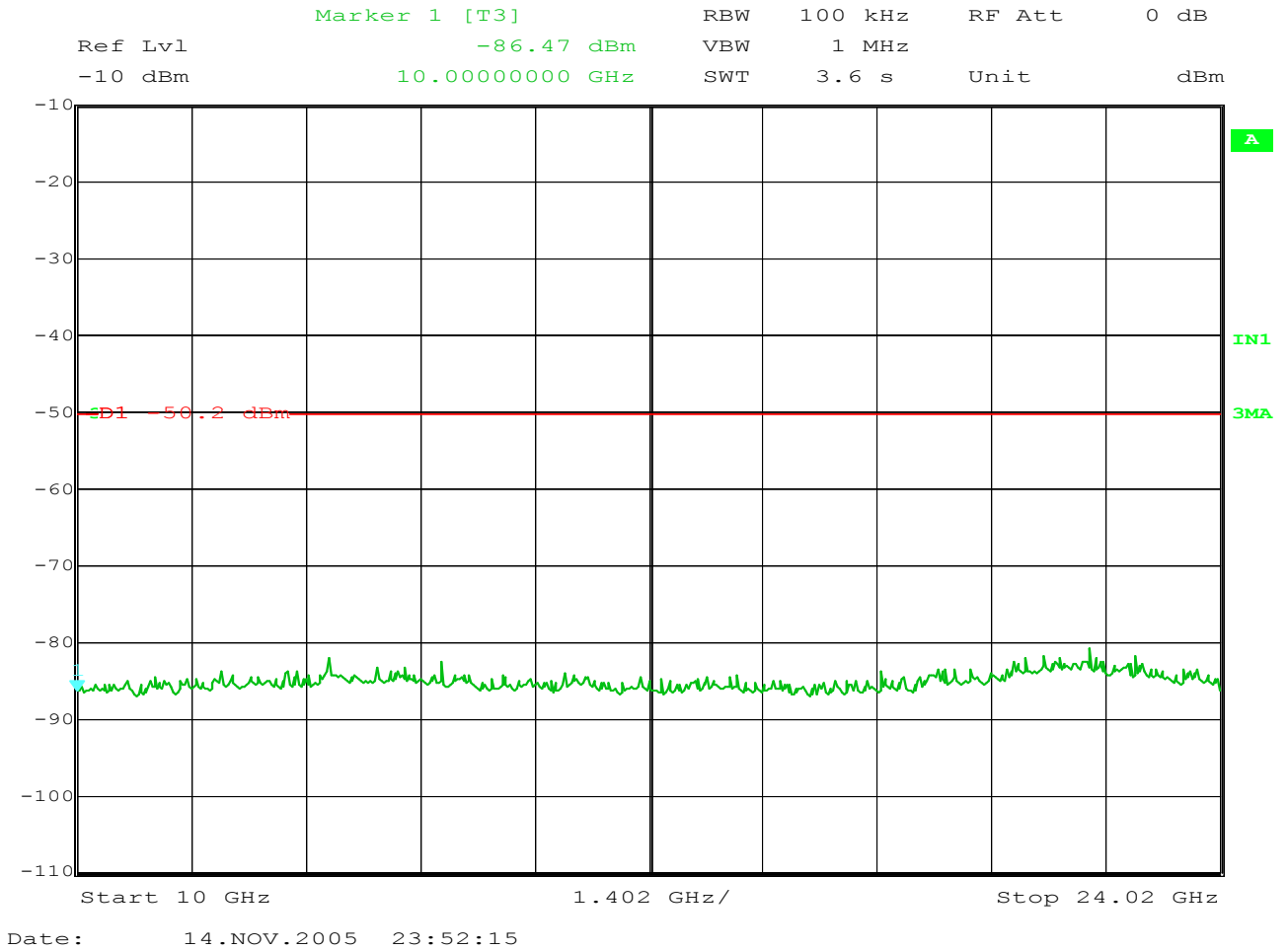


MANUFACTURER : Motorola TCG  
MODEL : TCU15P01\_M1297C  
SERIAL NUMBER : IU00000107  
TEST PERFORMED : FCC Part 15.247 Spurious RF Antenna Conducted Emissions  
MODE : Transmit @ 2402 MHz CW Signal  
NOTES : 30 MHz to 1GHz  
: 30dB attenuation 2 feet of cable

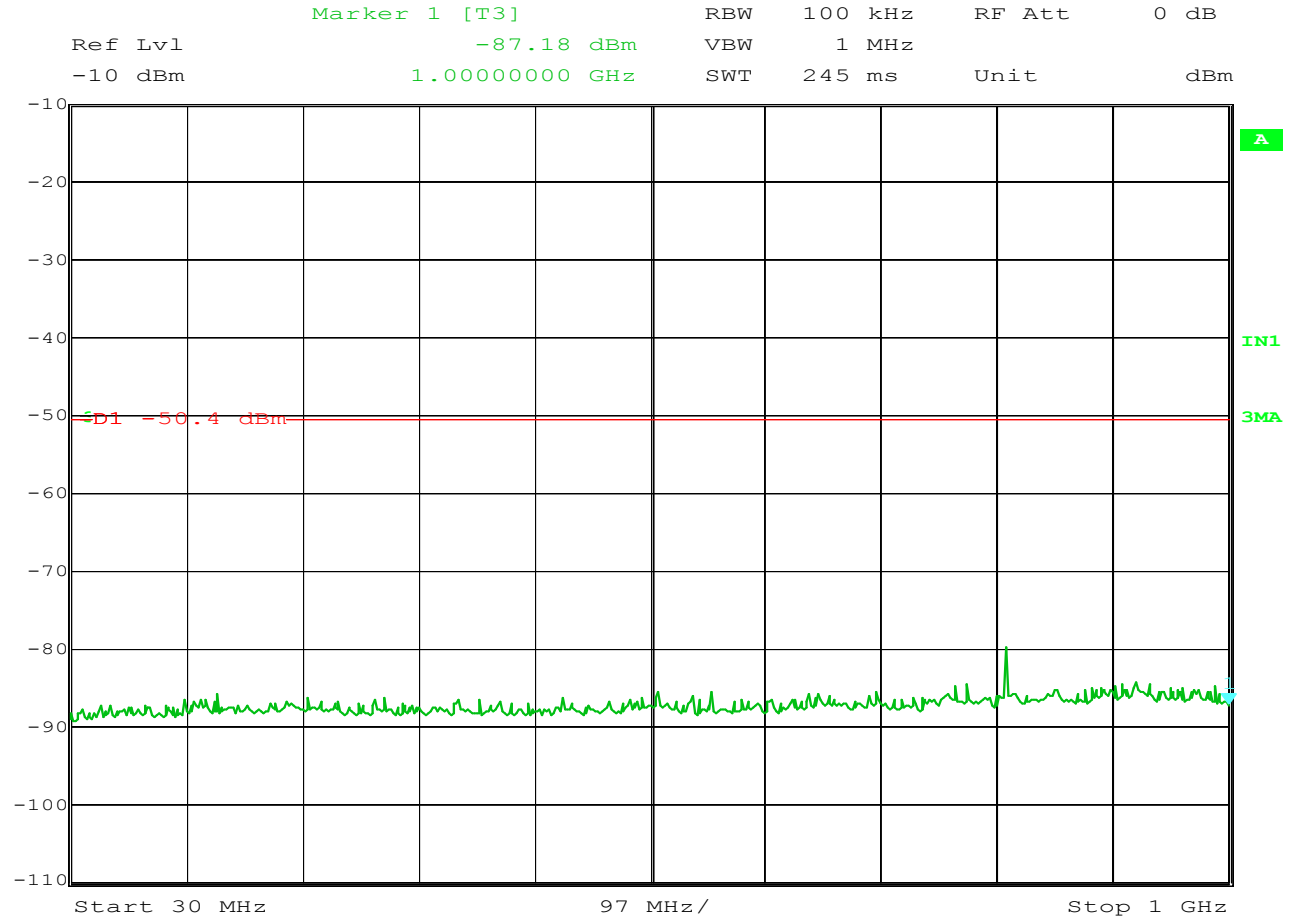


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MANUFACTURER : Motorola TCG  
MODEL : TCU15P01\_M1297C  
SERIAL NUMBER : IU00000107  
TEST PERFORMED : FCC Part 15.247 Spurious RF Antenna Conducted Emissions  
MODE : Transmit @ 2402 MHz CW Signal  
NOTES : 1GHz to 10GHz  
: 30dB attenuation 2 feet of cable

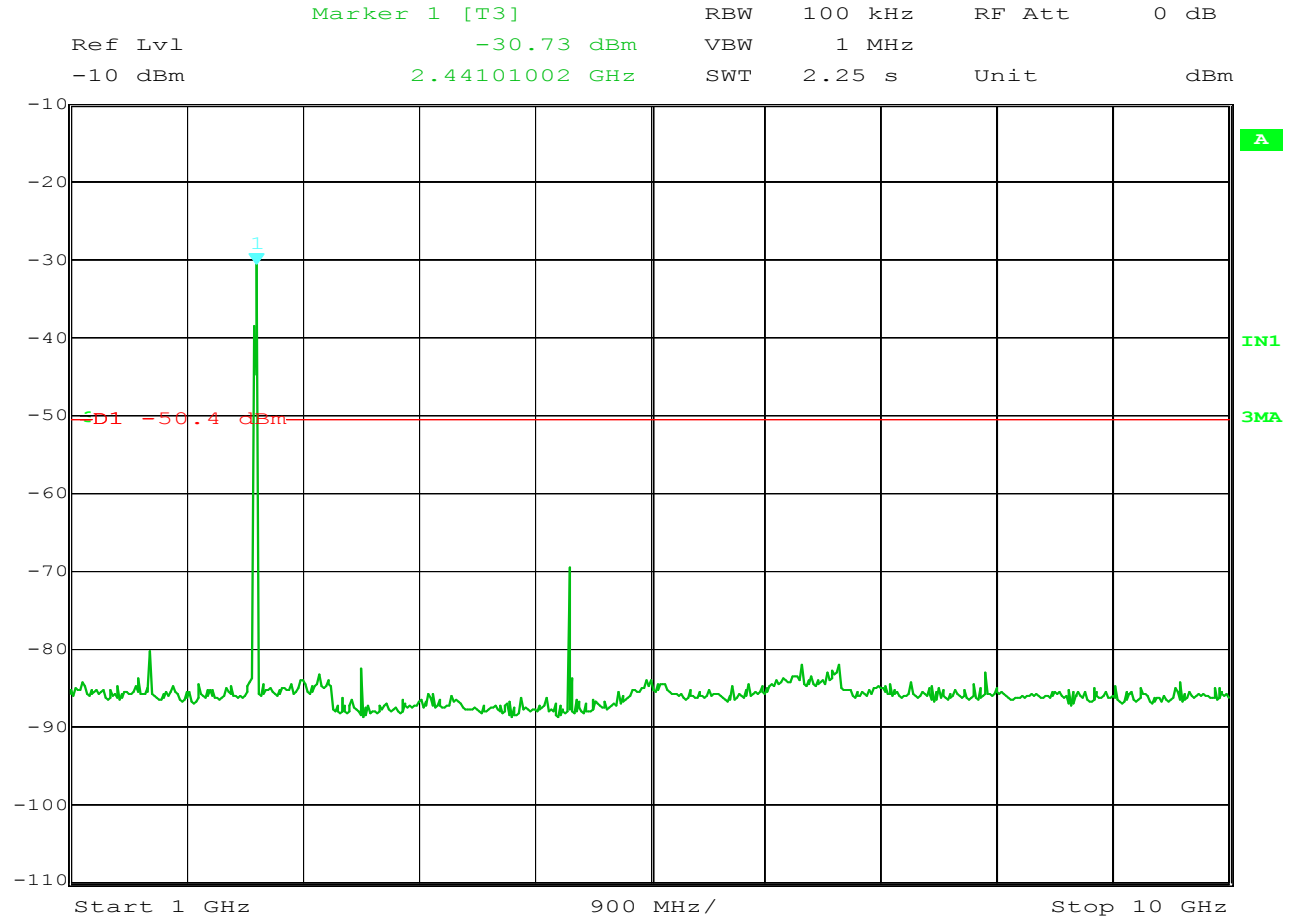


MANUFACTURER : Motorola TCG  
MODEL : TCU15P01\_M1297C  
SERIAL NUMBER : IU00000107  
TEST PERFORMED : FCC Part 15.247 Spurious RF Antenna Conducted Emissions  
MODE : Transmit @ 2402 MHz CW Signal  
NOTES : 10GHz to 24.02GHz  
: 30dB attenuation 2 feet of cable



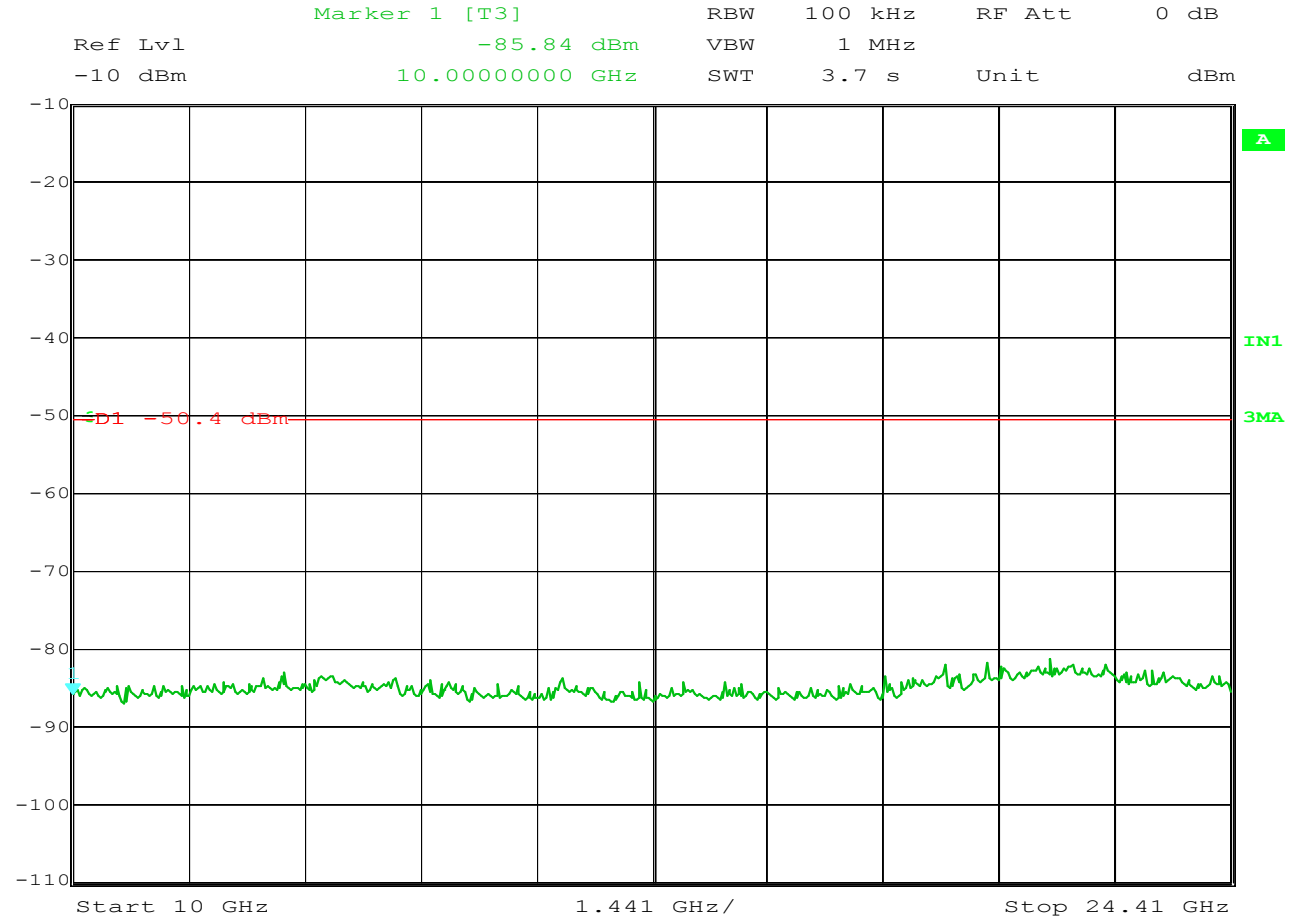
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MANUFACTURER : Motorola TCG  
MODEL : TCU15P01\_M1297C  
SERIAL NUMBER : IU00000107  
TEST PERFORMED : FCC Part 15.247 Spurious RF Antenna Conducted Emissions  
MODE : Transmit @ 2441 MHz CW Signal  
NOTES : 30 MHz to 1GHz  
: 30dB attenuation 2 feet of cable



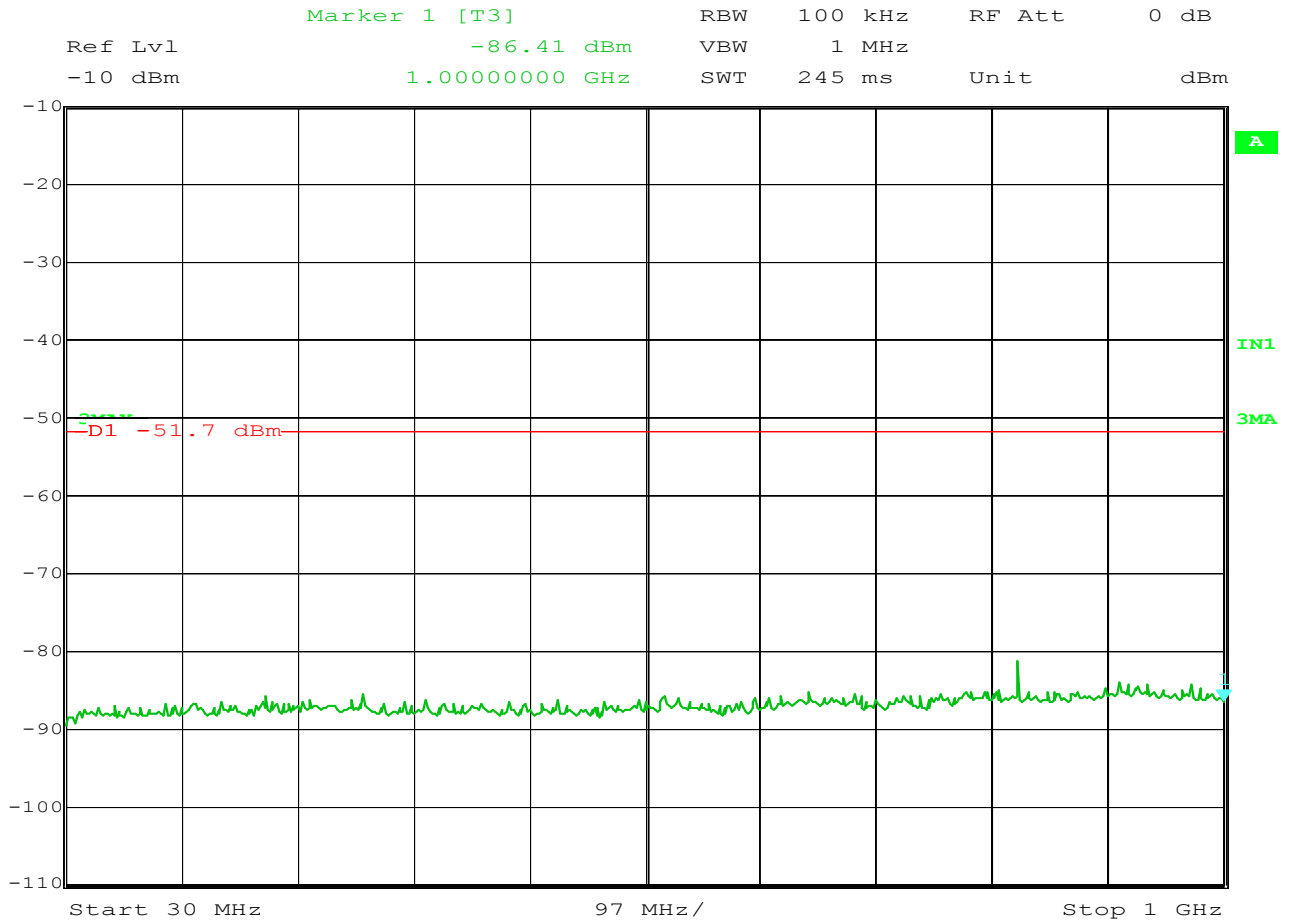
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MANUFACTURER : Motorola TCG  
MODEL : TCU15P01\_M1297C  
SERIAL NUMBER : IU00000107  
TEST PERFORMED : FCC Part 15.247 Spurious RF Antenna Conducted Emissions  
MODE : Transmit @ 2441 MHz CW Signal  
NOTES : 1 GHz to 10GHz  
: 30dB attenuation 2 feet of cable



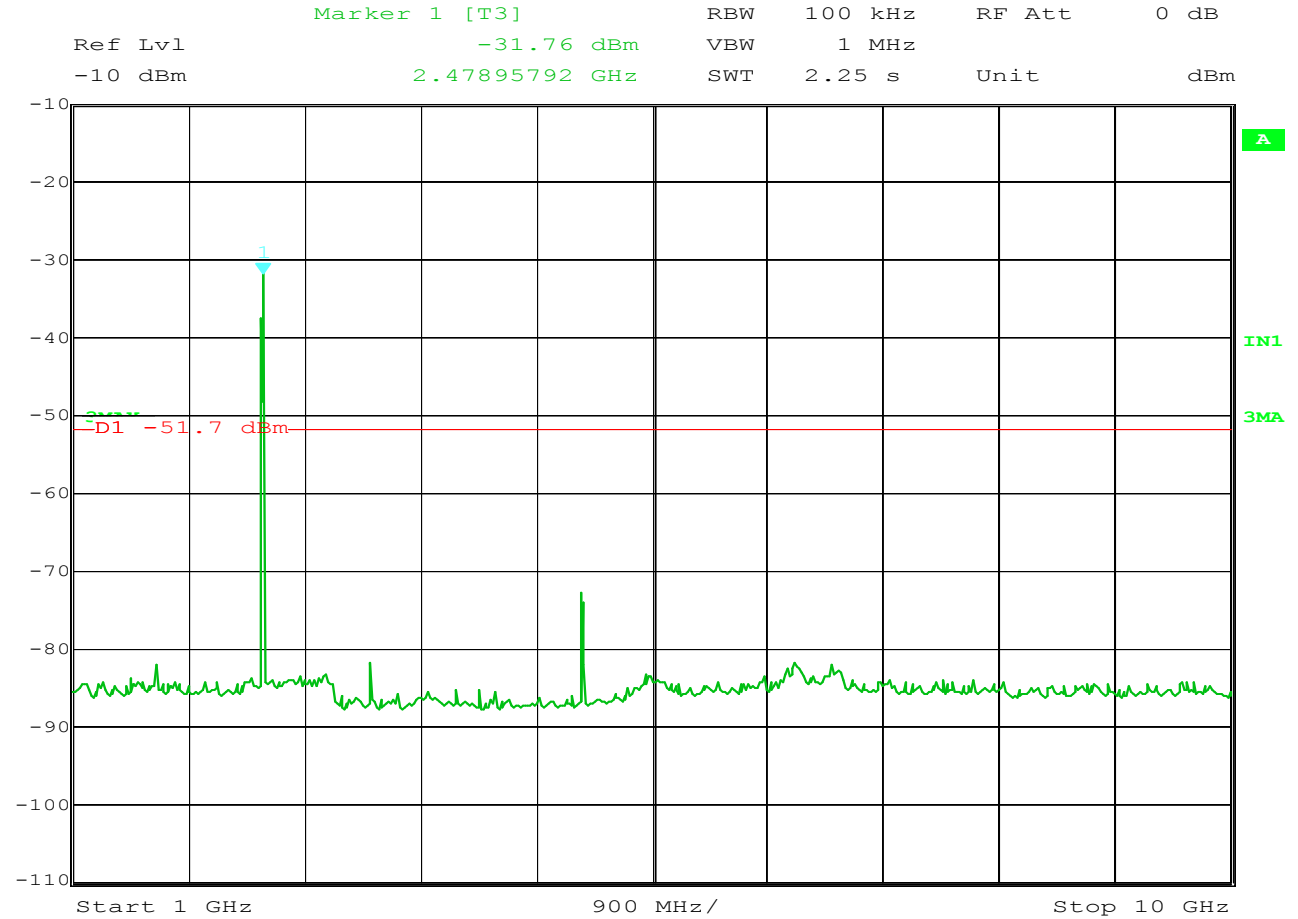
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MANUFACTURER : Motorola TCG  
MODEL : TCU15P01\_M1297C  
SERIAL NUMBER : IU00000107  
TEST PERFORMED : FCC Part 15.247 Spurious RF Antenna Conducted Emissions  
MODE : Transmit @ 2441 MHz CW Signal  
NOTES : 10 GHz to 24.4GHz  
: 30dB attenuation 2 feet of cable



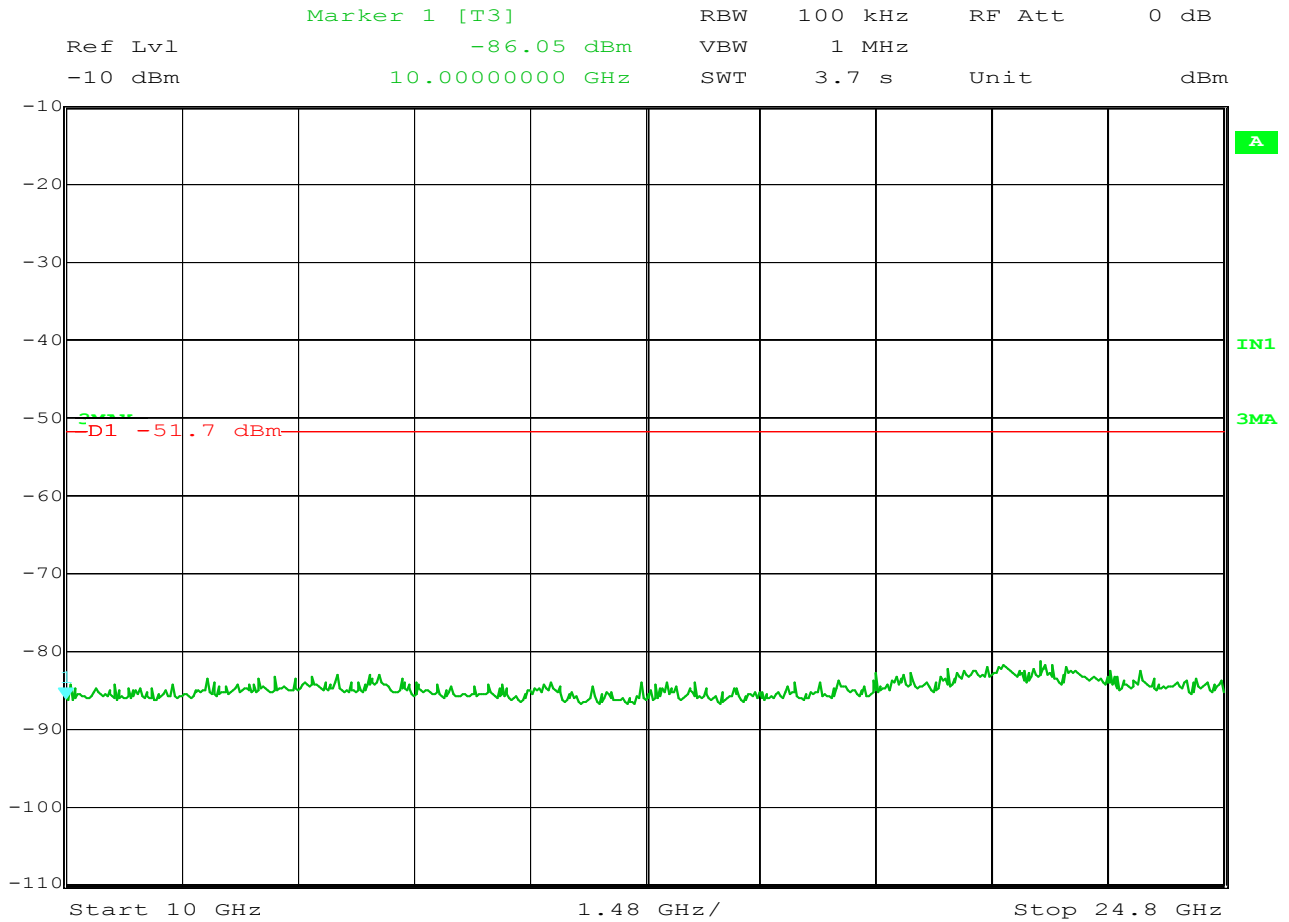
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MANUFACTURER : Motorola TCG  
MODEL : TCU15P01\_M1297C  
SERIAL NUMBER : IU00000107  
TEST PERFORMED : FCC Part 15.247 Spurious RF Antenna Conducted Emissions  
MODE : Transmit @ 2480 MHz CW Signal  
NOTES : 30 MHz to 1GHz  
: 30dB attenuation 2 feet of cable



Date: 14.NOV.2005 23:44:53

MANUFACTURER : Motorola TCG  
MODEL : TCU15P01\_M1297C  
SERIAL NUMBER : IU00000107  
TEST PERFORMED : FCC Part 15.247 Spurious RF Antenna Conducted Emissions  
MODE : Transmit @ 2480 MHz CW Signal  
NOTES : 1 GHz to 10 GHz  
: 30dB attenuation 2 feet of cable



Date: 14.NOV.2005 23:46:03

MANUFACTURER : Motorola TCG  
MODEL : TCU15P01\_M1297C  
SERIAL NUMBER : IU00000107  
TEST PERFORMED : FCC Part 15.247 Spurious RF Antenna Conducted Emissions  
MODE : Transmit @ 2480 MHz CW Signal  
NOTES : 10 GHz to 24.8 GHz  
: 30dB attenuation 2 feet of cable



Data Sheet

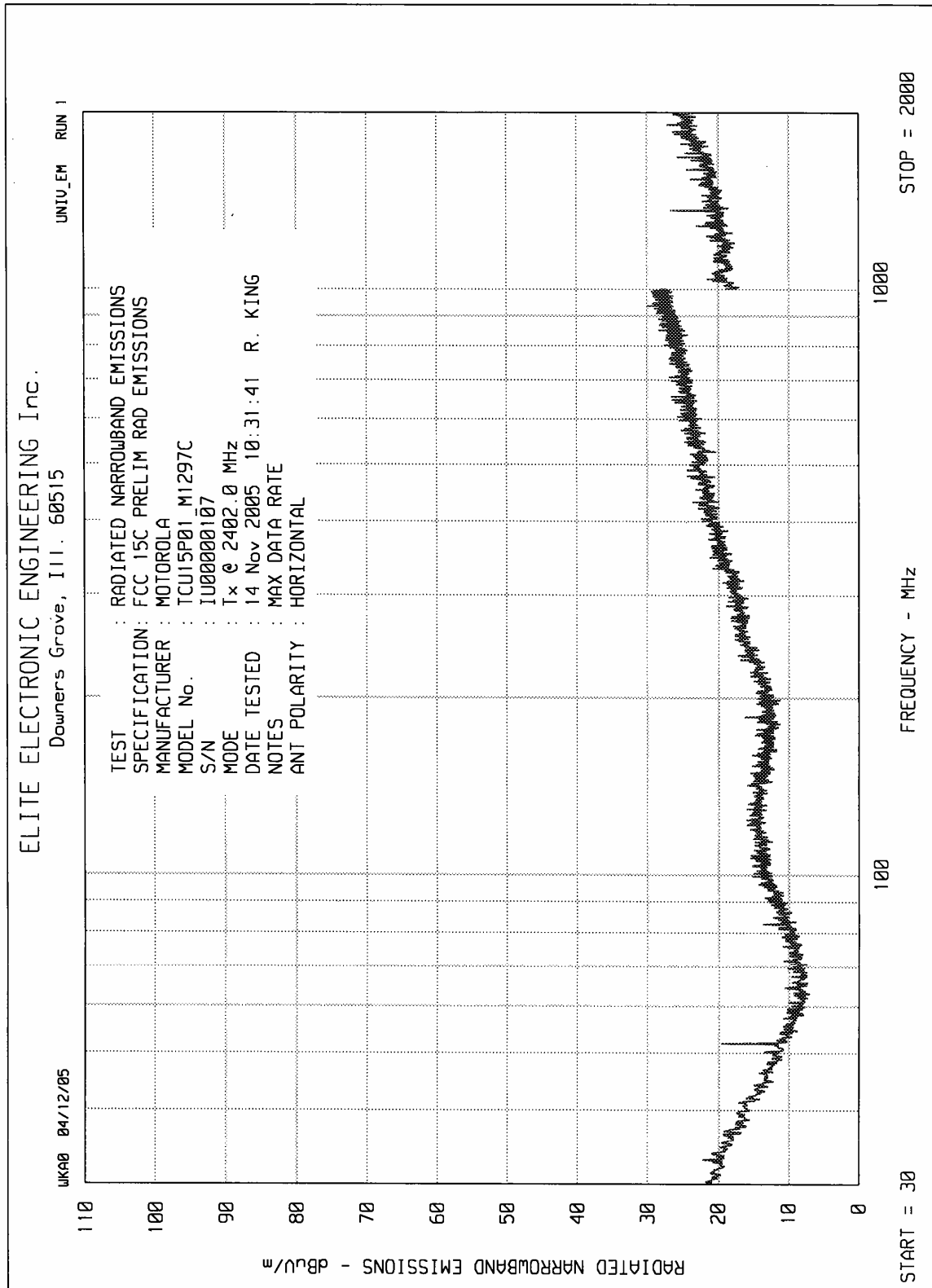
MANUFACTURER : Motorola TCG  
 MODEL : TCU15P01\_M1297C  
 S/N : IU00000107  
 SPECIFICATION : FCC Part 15, Subpart C, Section 15.247  
                   Peak Output Power – Radiated Measurement  
 DATE : November 14, 2005  
 NOTES :  
           : TEST DISTANCE IS 3 METERS

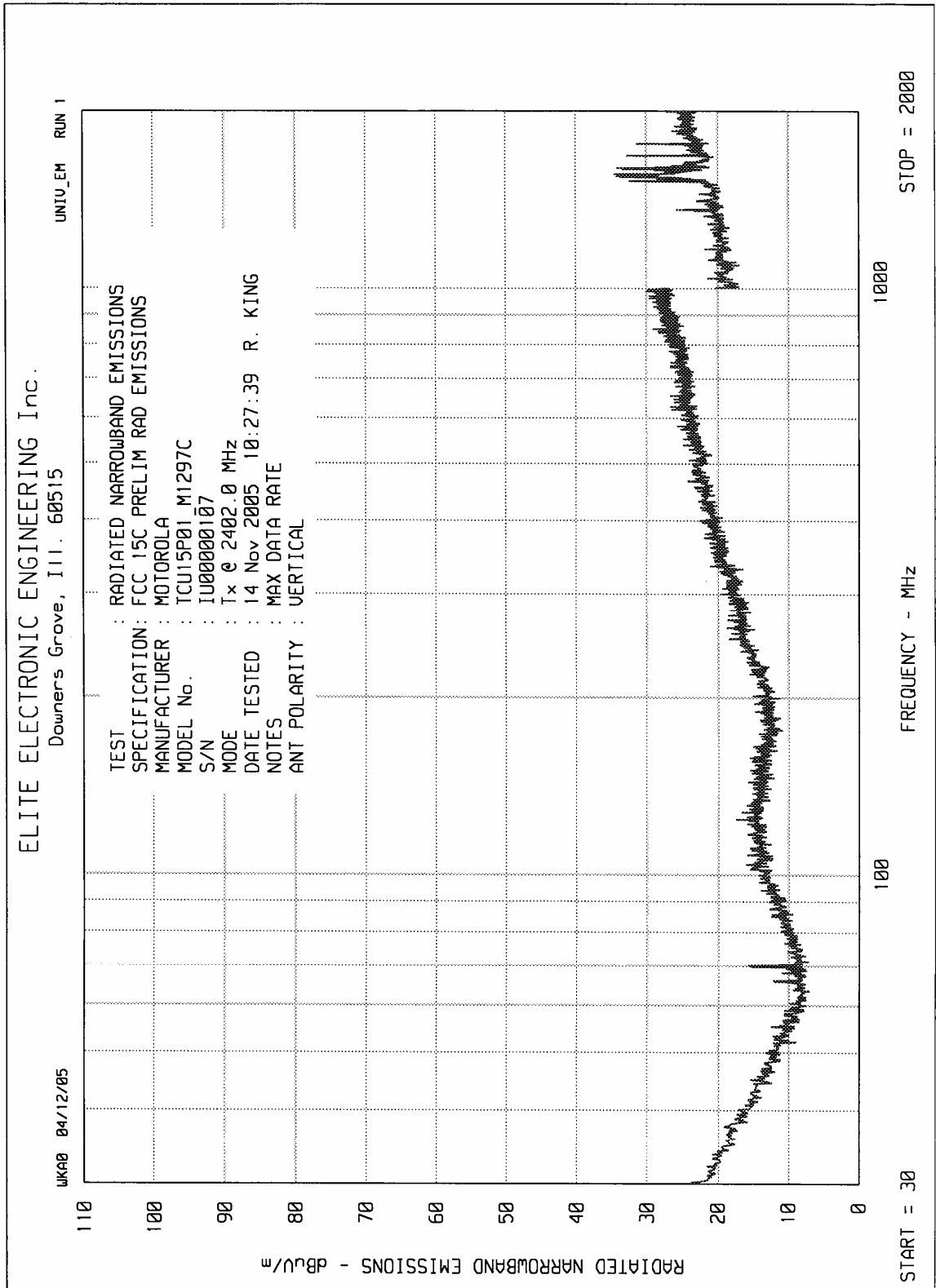
FREQ. (MHz)	ANT POL	SPECTRUM ANALYZER RDG(dBμV)	MATCHED	CABLE	ANTENNA	EIRP
			SIGNAL GENERATOR	LOSS	GAIN	TOTAL
			RDG (dBm)	(dB)	(dB)	(dBm)
2402	H	88.8	-4.9	2.8	4.2	-3.5
	V	93.1	-0.6	2.8	4.2	0.8
2441	H	88.0	-5.8	2.8	4.4	-4.2
	V	91.4	-2.4	2.8	4.4	-0.8
2480	H	89.2	-4.7	2.9	4.5	-3.1
	V	92.5	-1.4	2.9	4.5	0.2

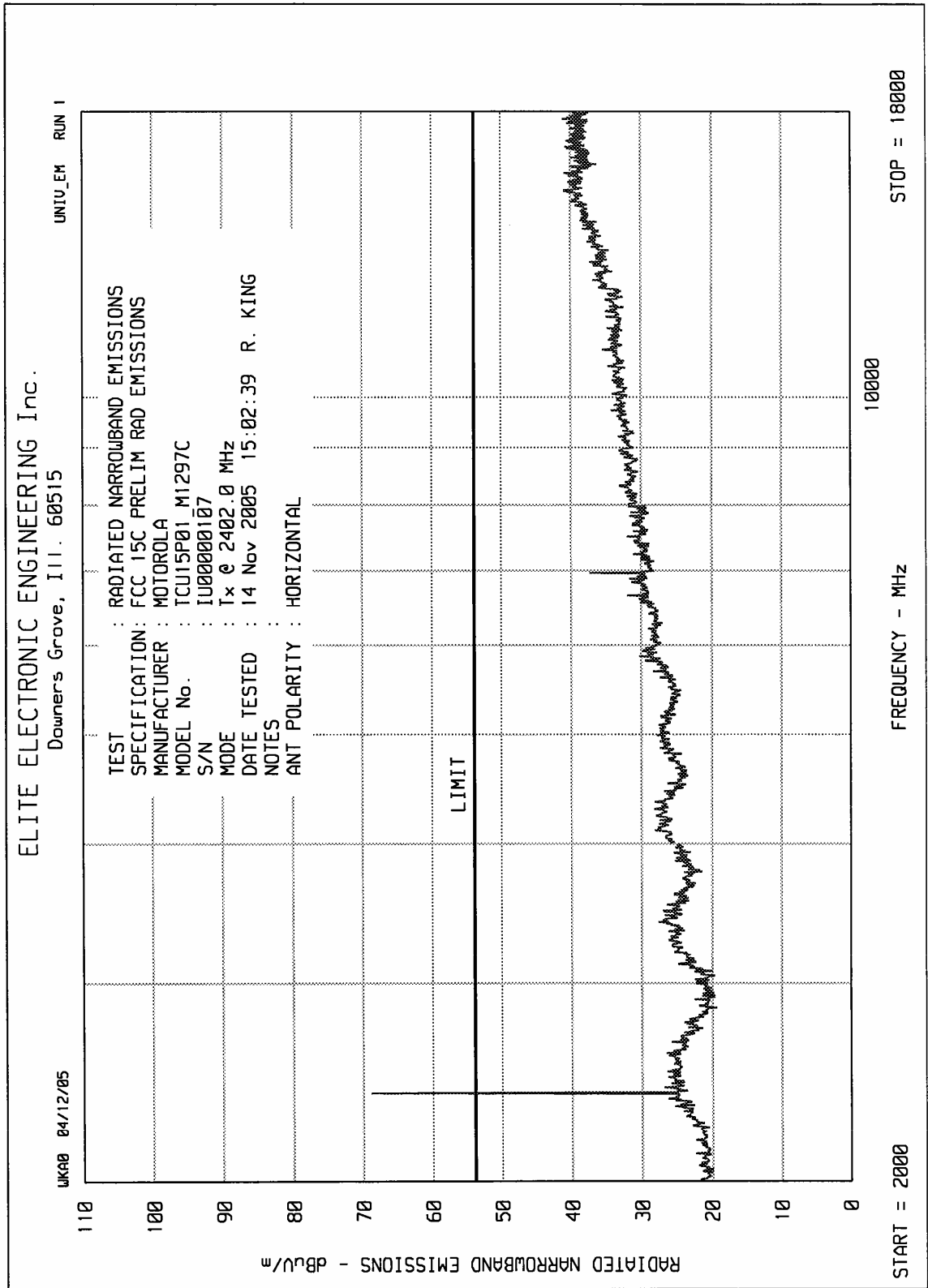
EIRP = S.G. RDG + Antenna Gain – Cable Loss

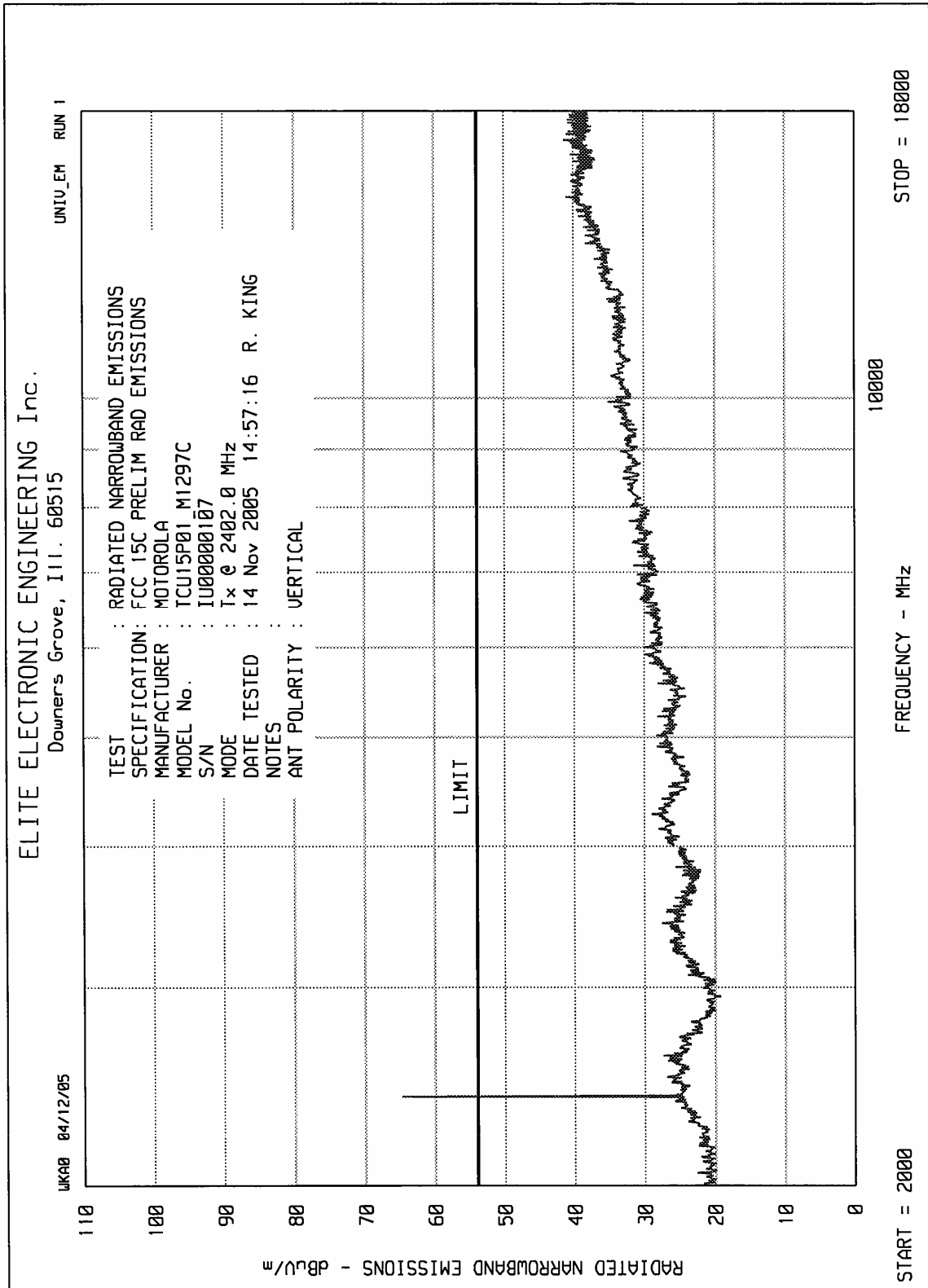
Checked BY : *RICHARD E. KING*

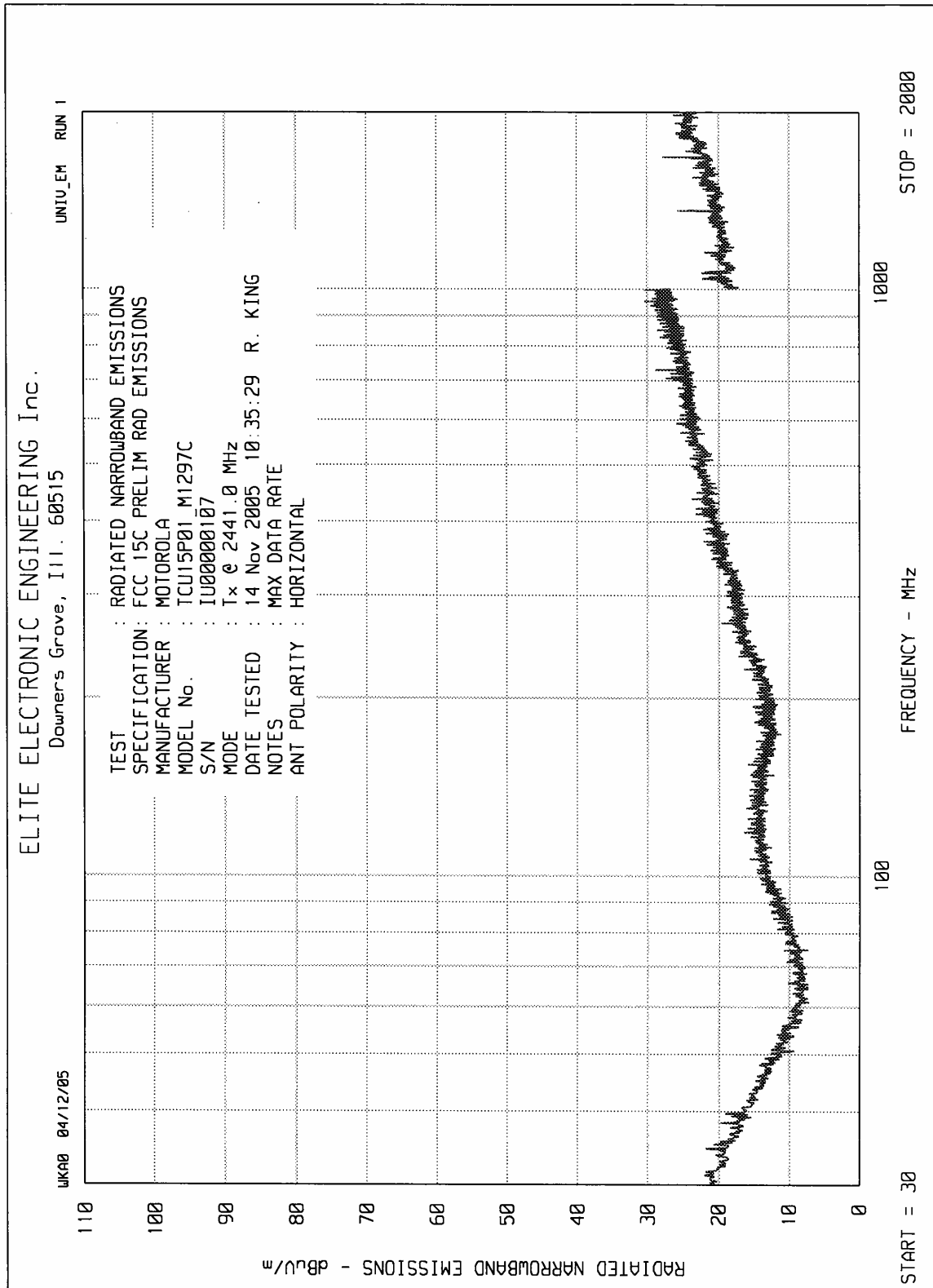
Richard E. King

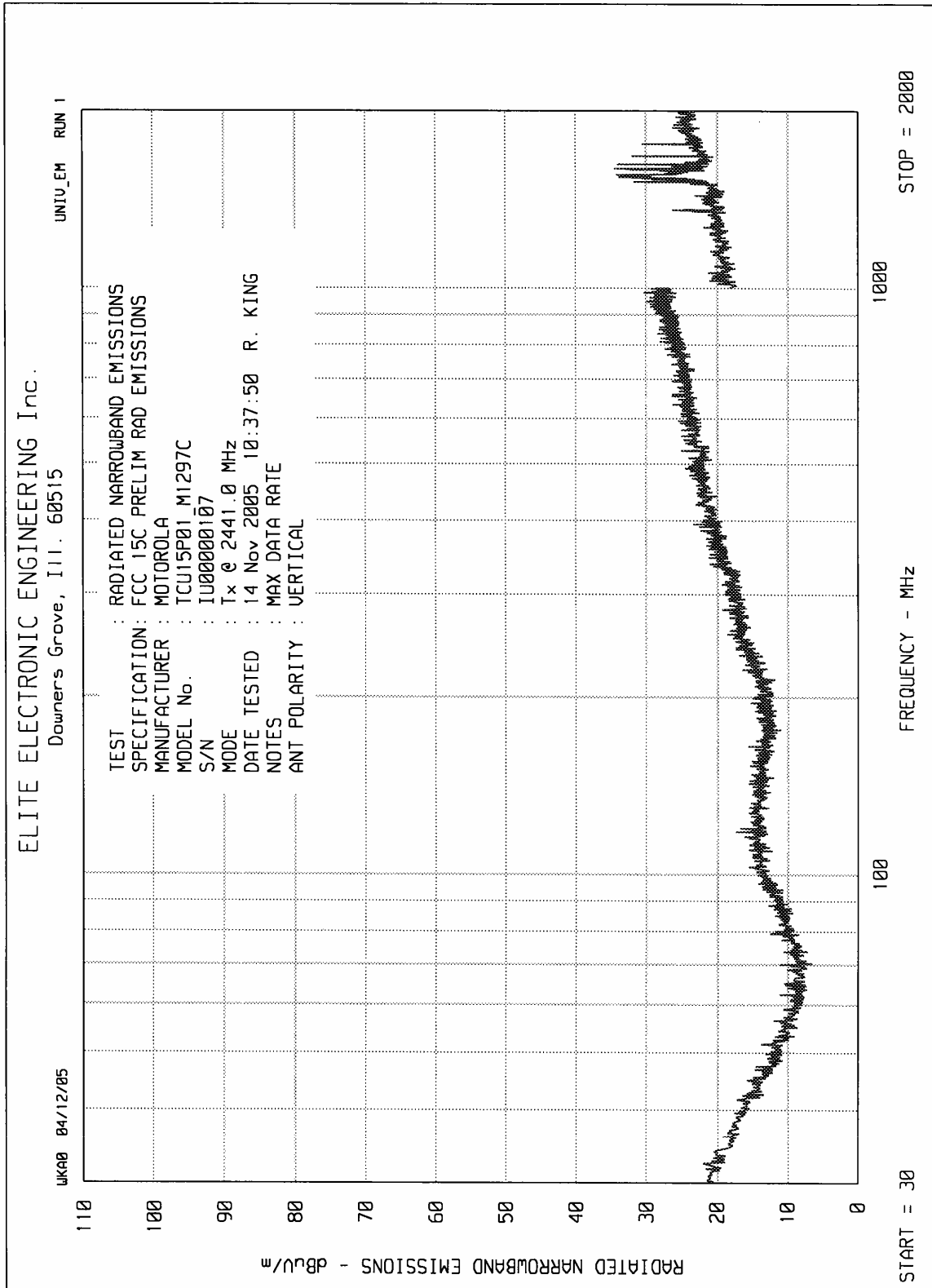


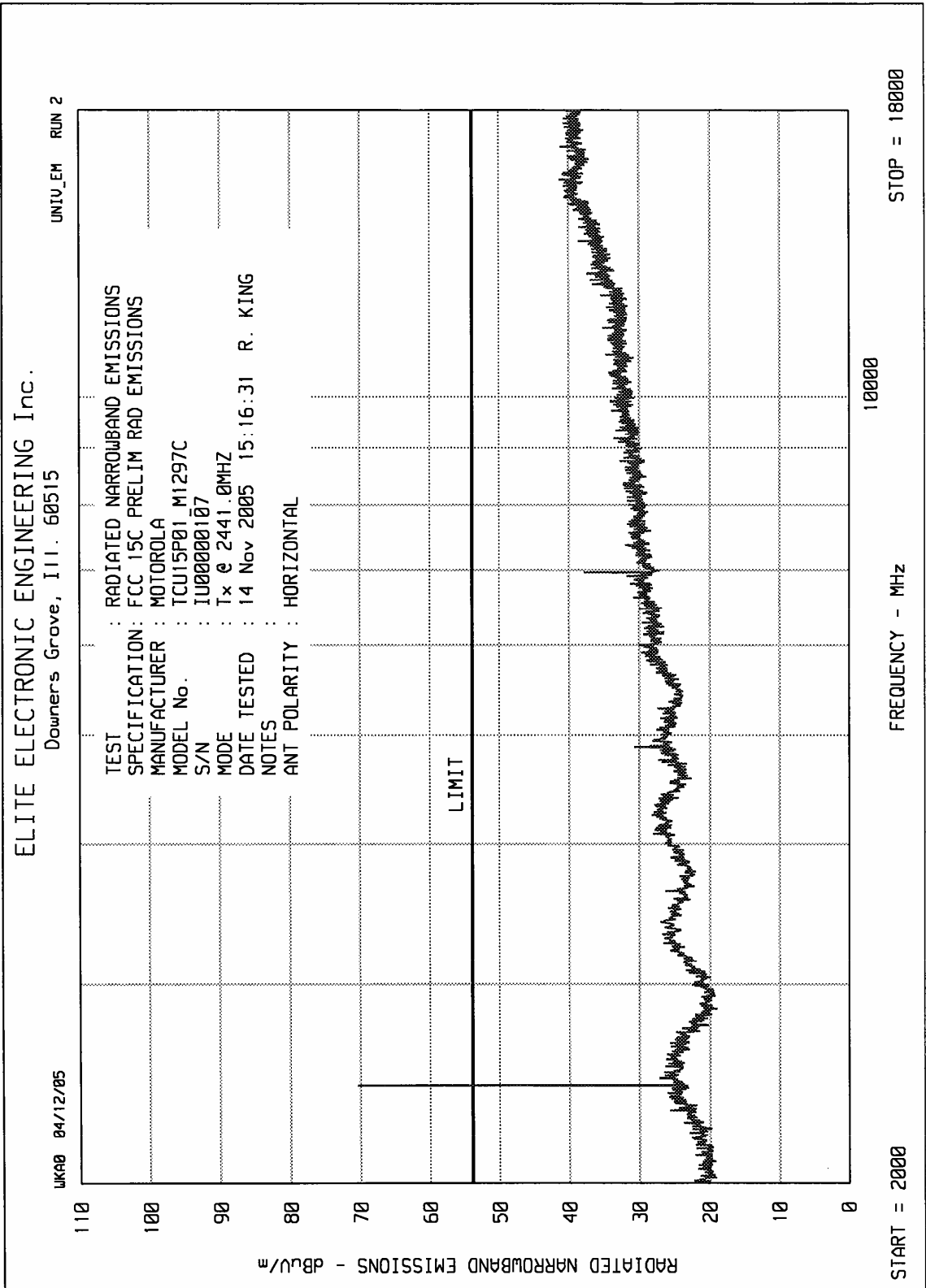


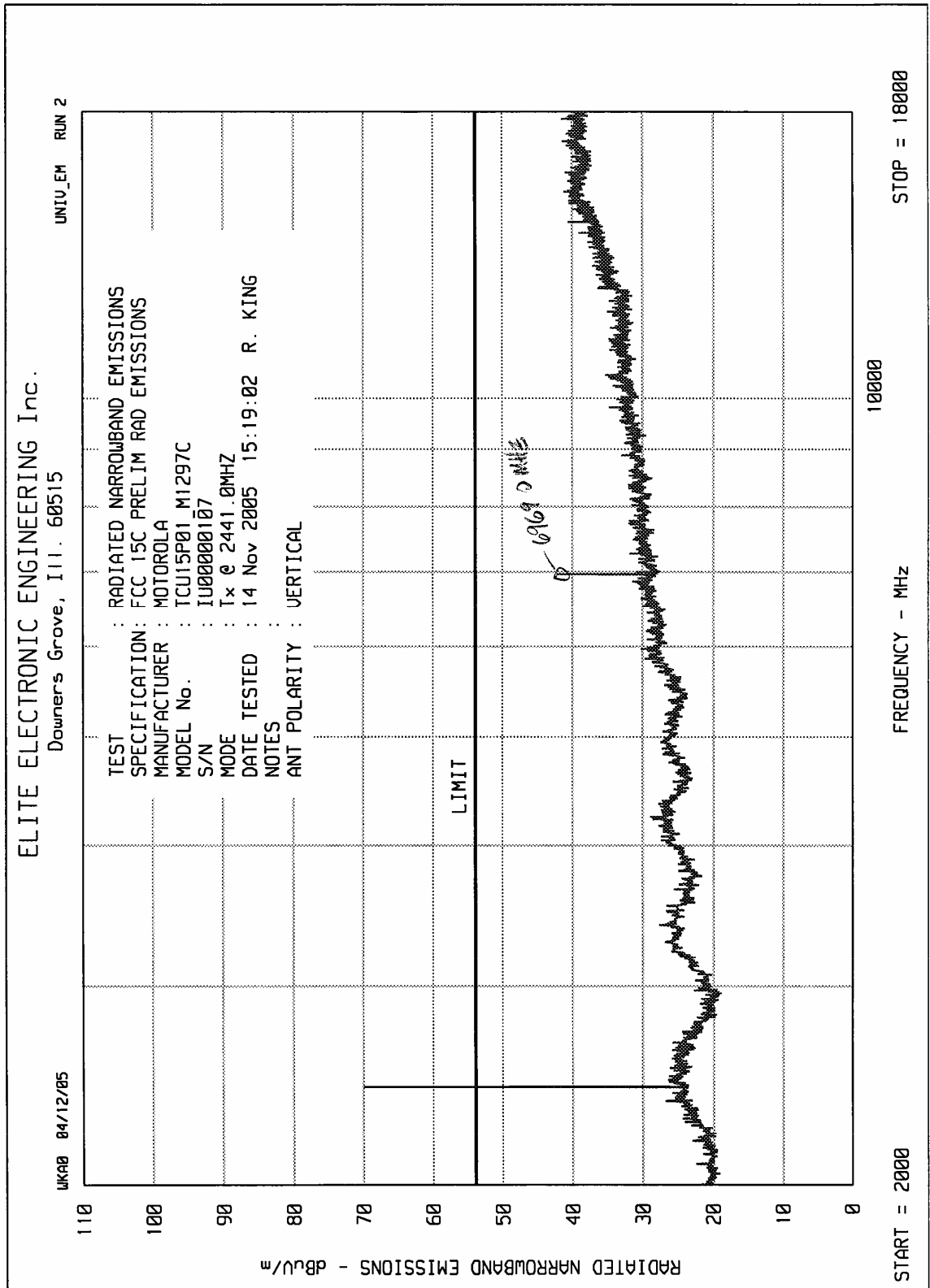


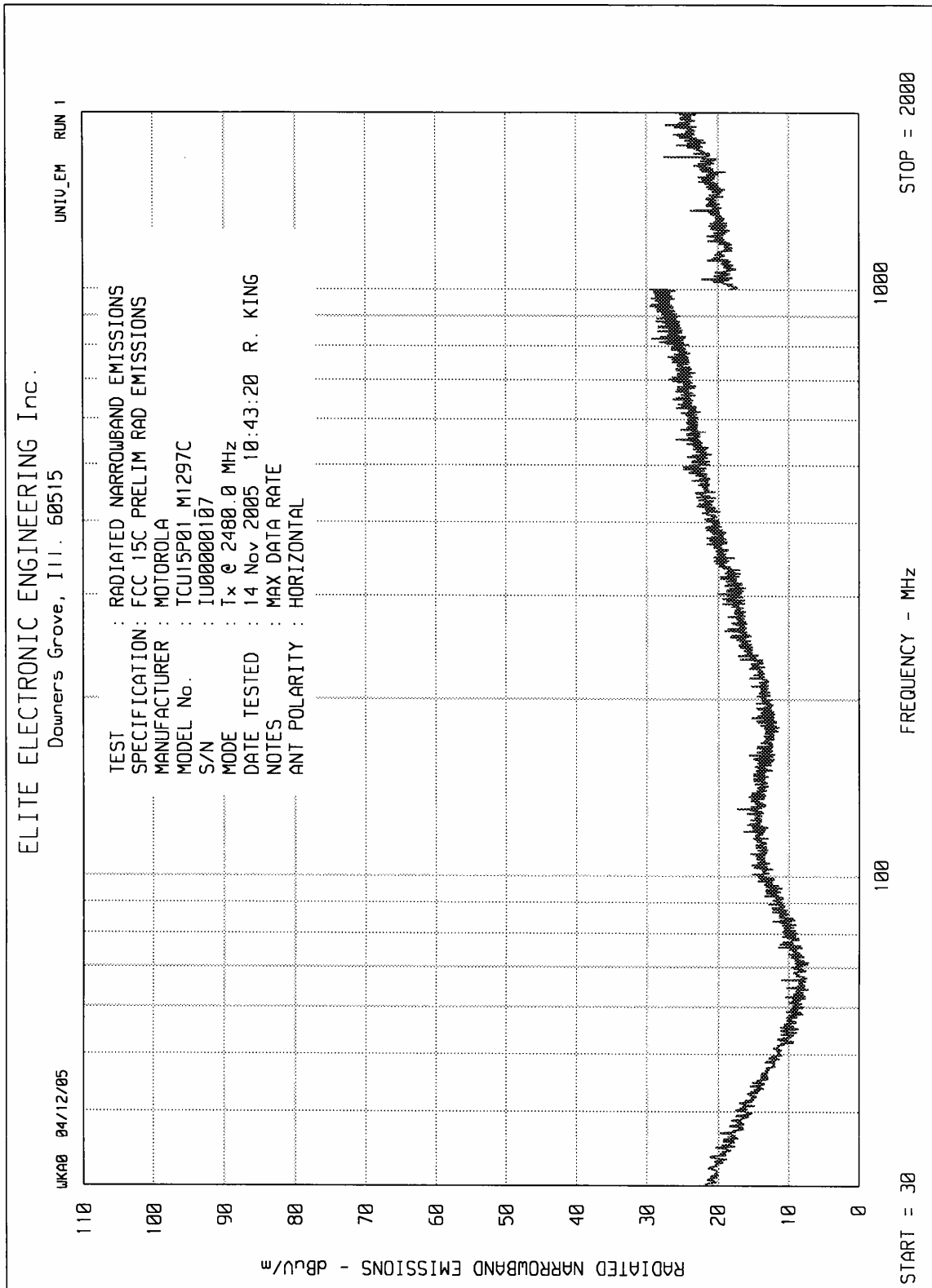


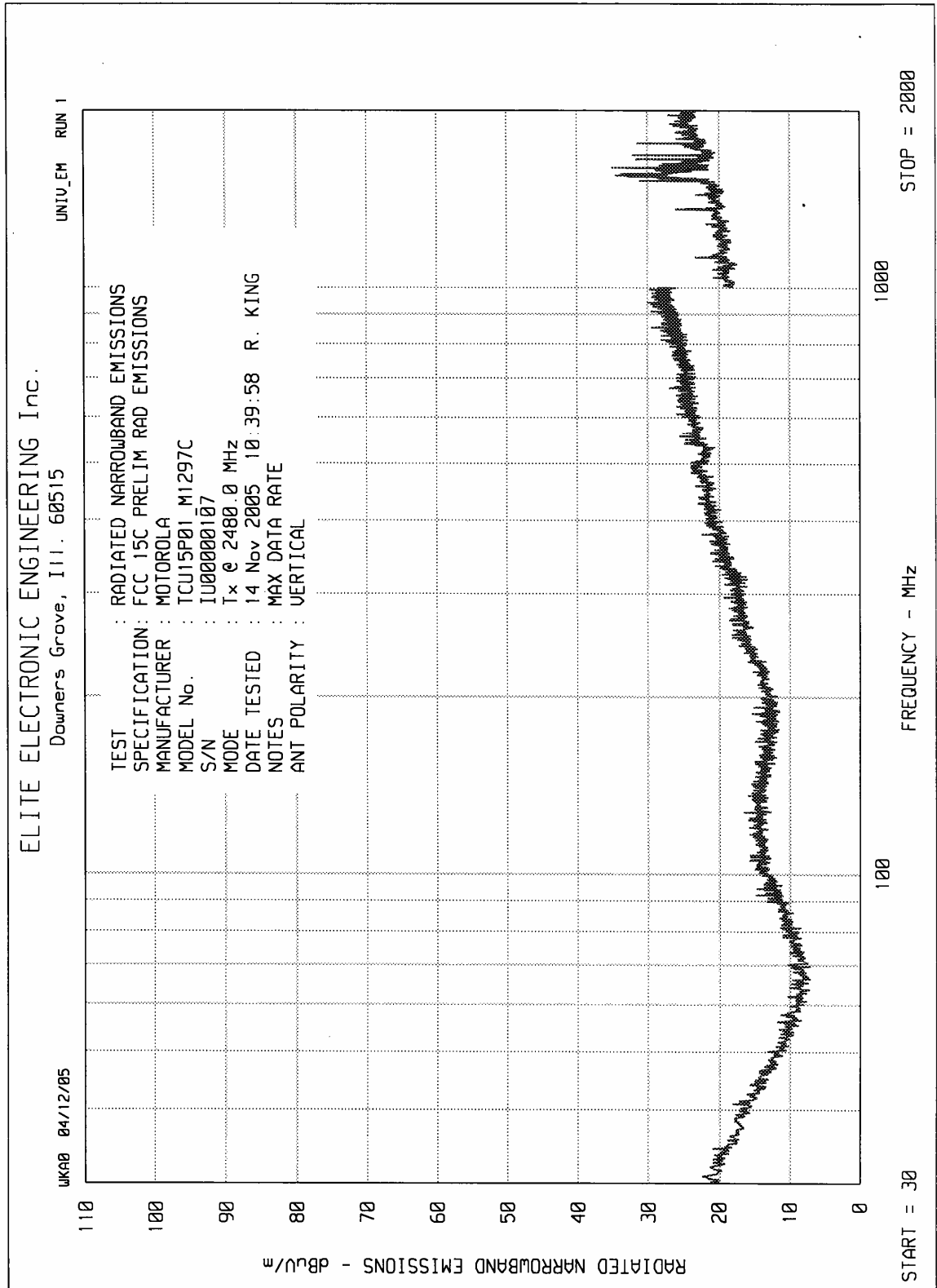


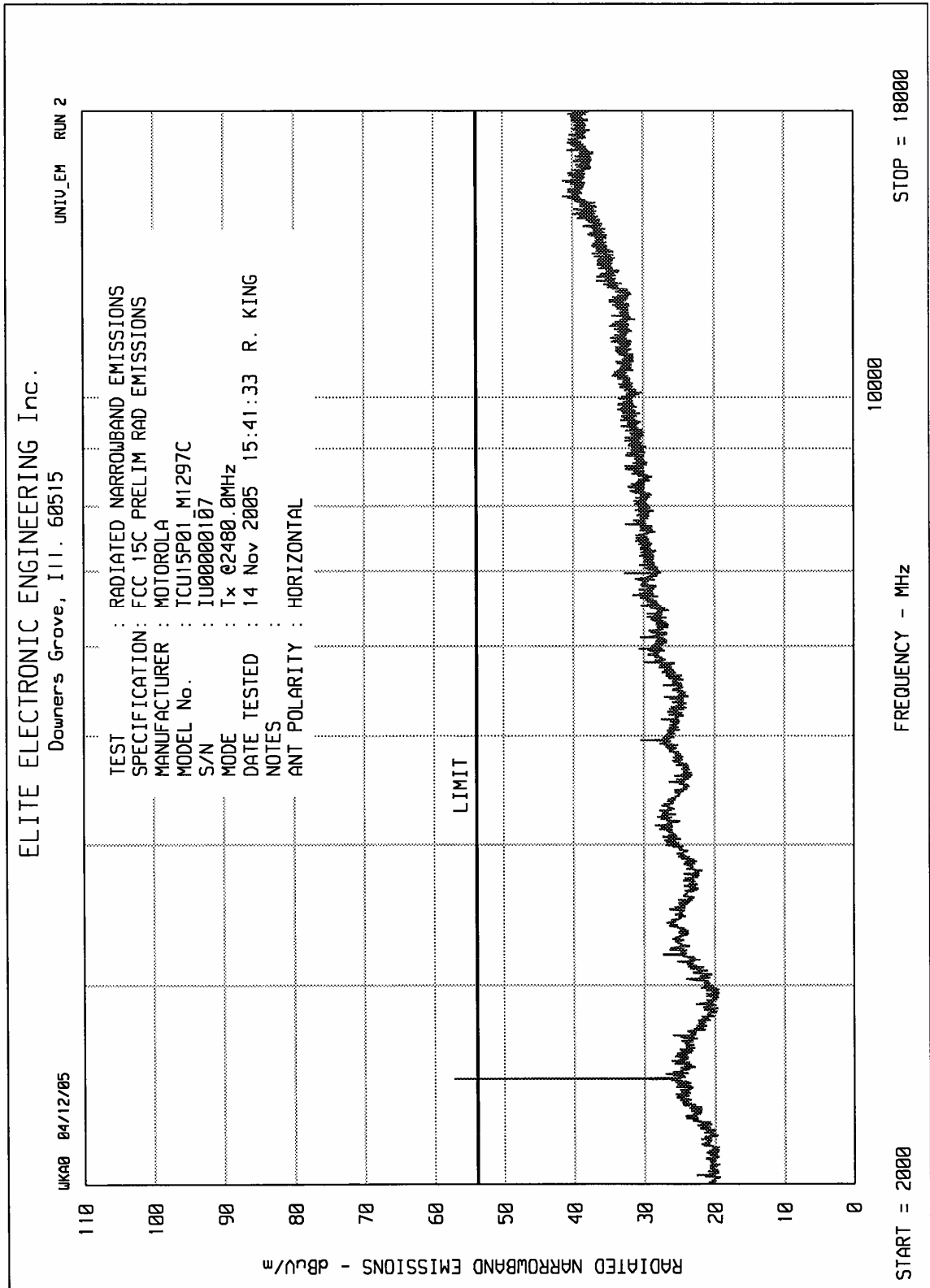


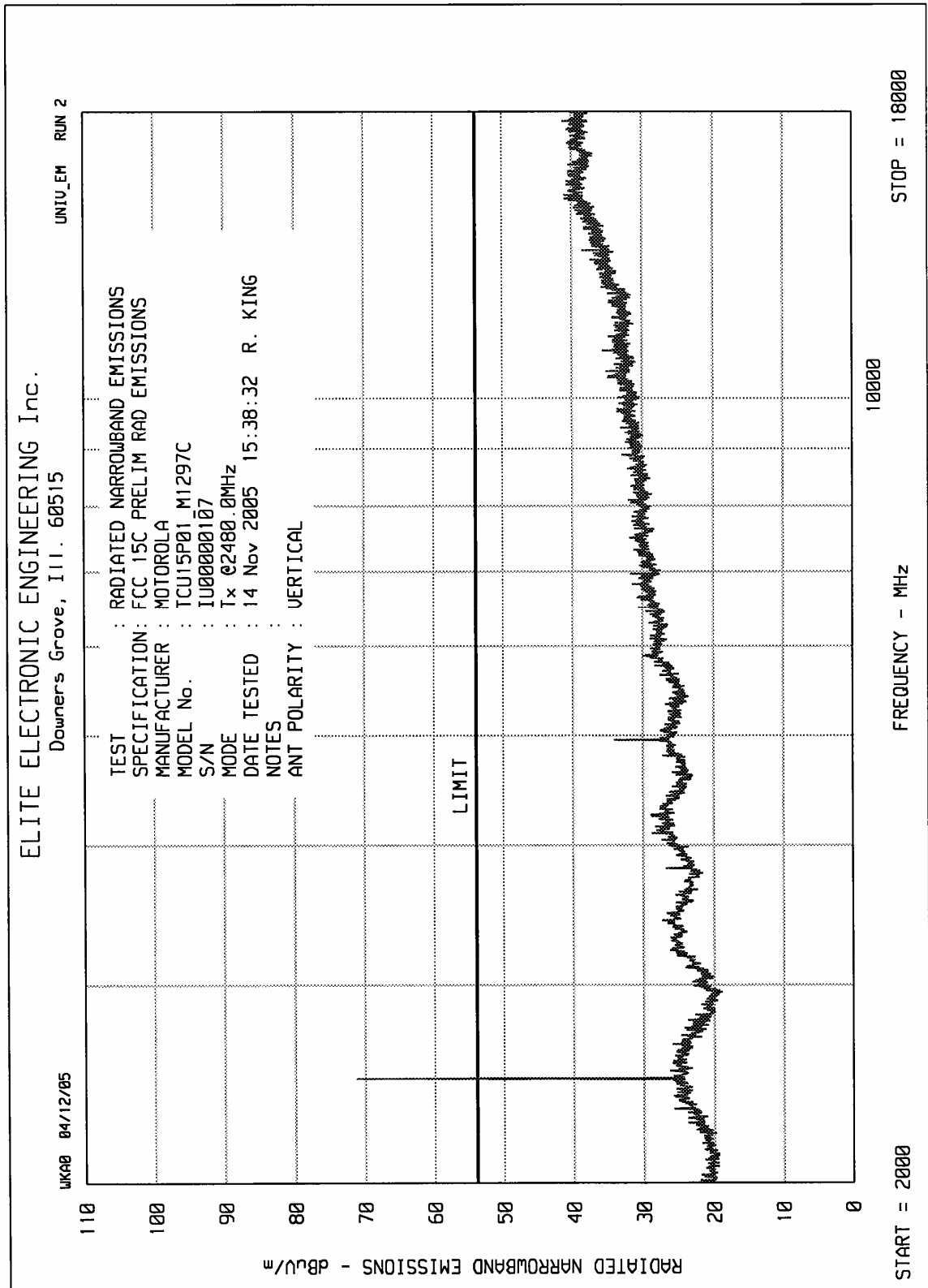














Data Sheet

MANUFACTURER : Motorola TCG  
 MODEL : TCU15P01\_M1297C  
 S/N : IU00000107  
 SPECIFICATION : FCC Part 15, Subpart C, Section 15.247  
                   Radiated Spurious Emissions Measurement  
 DATE : November 14, 2005  
 NOTES : Transmitting at 2402MHz  
           : TEST DISTANCE IS 3 METERS

Freq (MHz)	Ant Pol	Meter		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
		Reading (dBuV)	Ambient							
2402.0	H	88.8		3.5	31.4	-33.6	0.0	90.1	32044.0	
2402.0	V	93.1		3.5	31.4	-33.6	0.0	94.4	52571.1	
4804.0	H	46.9		0.6	34.8	-32.1	0.0	50.2	324.1	500.0
4804.0	V	48.5		0.6	34.8	-32.1	0.0	51.8	389.6	500.0
12010.0	H	37.7	*	1.0	41.4	-30.5	0.0	49.6	302.8	500.0
12010.0	V	37.5	*	1.0	41.4	-30.5	0.0	49.4	295.9	500.0
19216.0	H	36.3	*	1.8	45.6	-34.3	0.0	49.4	293.4	500.0
19216.0	V	37.7	*	1.8	45.6	-34.3	0.0	50.8	346.7	500.0

Checked BY : RICHARD E. KING

Richard E. King



Data Sheet

MANUFACTURER : Motorola TCG  
 MODEL : TCU15P01\_M1297C  
 S/N : IU00000107  
 SPECIFICATION : FCC Part 15, Subpart C, Section 15.247  
                   Radiated Spurious Emissions Measurement  
 DATE : November 14, 2005  
 NOTES : Transmitting at 2441MHz  
           : TEST DISTANCE IS 3 METERS

Freq (MHz)	Ant Pol	Meter		CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Duty Cycle (dB)	Total	Total	Limit
		Reading (dBuV)	Ambient					dBuV/m at 3 M	uV/m at 3M	uV/m at 3M
2441.0	H	88.0		3.5	31.3	-33.6	0.0	89.2	28916.0	
2441.0	V	91.4		3.5	31.3	-33.6	0.0	92.6	42769.9	
4882.0	H	49.9		0.6	34.9	-32.1	0.0	53.3	460.9	500.0
4882.0	V	49.4		0.6	34.9	-32.1	0.0	52.8	435.6	500.0
7323.0	H	39.3	*	0.8	38.2	-31.4	0.0	46.8	219.8	500.0
7323.0	V	39.2	*	0.8	38.2	-31.4	0.0	46.7	216.6	500.0
12205.0	H	37.7	*	1.0	41.5	-30.4	0.0	49.8	309.8	500.0
12205.0	V	37.6	*	1.0	41.5	-30.4	0.0	49.7	306.3	500.0
19528.0	H	36.7	*	1.8	45.6	-34.3	0.0	49.8	309.0	500.0
19528.0	V	37.2	*	1.8	45.6	-34.3	0.0	50.3	327.3	500.0

Checked BY : RICHARD E. KING

Richard E. King



Data Sheet

MANUFACTURER : Motorola TCG  
 MODEL : TCU15P01\_M1297C  
 S/N : IU00000107  
 SPECIFICATION : FCC Part 15, Subpart C, Section 15.247  
                   Radiated Spurious Emissions Measurement  
 DATE : November 14, 2005  
 NOTES : Transmitting at 2480MHz  
           : TEST DISTANCE IS 3 METERS

Freq (MHz)	Ant Pol	Meter		CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Duty Cycle (dB)	Total	Total	Limit
		Reading (dBuV)	Ambient					dBuV/m at 3 M	uV/m at 3M	uV/m at 3M
2480.0	H	89.2		3.5	31.3	-33.6	0.0	90.3	32843.9	
2480.0	V	92.5		3.5	31.3	-33.6	0.0	93.6	48023.6	
4960.0	H	49.6		0.6	34.9	-32.0	0.0	53.0	449.2	500.0
4960.0	V	49.4		0.6	34.9	-32.0	0.0	52.8	437.9	500.0
7440.0	H	38.1	*	0.8	38.2	-31.5	0.0	45.7	192.5	500.0
7440.0	V	37.8	*	0.8	38.2	-31.5	0.0	45.4	185.7	500.0
12400.0	H	37.6	*	1.1	41.5	-30.3	0.0	49.9	313.3	500.0
12400.0	V	38.5	*	1.1	41.5	-30.3	0.0	50.8	347.5	500.0
19840.0	H	36.7	*	1.8	45.6	-34.3	0.0	49.8	309.0	500.0
19840.0	V	37.2	*	1.8	45.6	-34.3	0.0	50.3	327.3	500.0
22320.0	H	37.8	*	2.8	46.5	-34.8	0.0	52.3	412.1	500.0
22320.0	V	37.5	*	2.8	46.5	-34.8	0.0	52.0	396.7	500.0

Checked BY : RICHARD E. KING

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