Measurement of RF Interference from a Blacktop Patriot RC Car Transmitter

For : Craft House Corporation
Toledo, OH

Date Received : September 11, 2003
Date Tested : September 12, 2003, October 8, 2003
Test Personnel : Mark E. Longinotti
Specification : FCC "Code of Federal Regulations" Title 47 Part 15, Subpart C

Test Report By :
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ATL-0149-E

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

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THIS REPORT SHALL NOT BE REPRODUCED, EXCEPT IN FULL, WITHOUT THE WRITTEN APPROVAL OF ELITE ELECTRONIC ENGINEERING INCORPORATED.

Measurement of RF Emissions from a Blacktop Patriot RC Car Transmitter

1.0 INTRODUCTION:

1.1 Description of Test Item - This document represents the results of the series of radio interference measurements performed on a model Blacktop Patriot RC Car Transmitter, (hereinafter referred to as the test item). The test item was designed to transmit at approximately 27MHz using an external antenna. The test item was manufactured and submitted for testing by Craft House Corporation located in Toledo, 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 15.227 for Intentional Radiators. Testing was performed in accordance with ANSI C63.4-2001.

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 2002

- ANSI C63.4-2001, "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 22°C and the relative humidity was 46%.

2.0 TEST ITEM SETUP AND OPERATION:

The test item is a Blacktop Patriot RC Car Transmitter. A block diagram of the test item setup is shown as Figure 1.

2.1 Power Input - The test item obtained 9VDC from a battery.

2.2 Grounding - Since the test item was powered with 9VDC from a battery, it was ungrounded during the tests.

2.3 Peripheral Equipment - No peripheral equipment was submitted with the test item.

2.4 Interconnect Cables - No interconnect cables were submitted with the test item.

2.5 Operational Mode - For all tests the test item was placed on an 80cm high non-conductive stand. Preliminary measurements were performed and it was determined that the highest emissions were generated with the test item antenna vertical and fully extended and the operational switch set to the Cruise position. All measurements were performed with the test item in this configuration.

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.

The fundamental, harmonics and spurious emissions were measured with a spectrum analyzer. The spectrum analyzer peak detected readings were converted to average readings using a duty cycle factor. All measurements were taken with the resolution and video bandwidth of the measuring instrument adjusted to 100kHz below 1GHz and 1MHz above 1GHz.

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

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

The measurement uncertainty budgets were based on guidelines in "ISO Guide to the Expression of Uncertainty in Measurements" and NAMAS NIS81 "The Treatment of Uncertainty in EMC Measurements".

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

4.0 REQUIREMENTS, PROCEDURES AND RESULTS:

4.1 Powerline Conducted Emissions

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

4.2 Radiated Measurements

4.2.1 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.

Per paragraph 15.227, radiated emissions over the frequency range from 26.96MHz to 27.28MHz shall not exceed 10,000uV/m (80dBuV/m) at 3 meters. The field strength of any emissions which appear outside of this band shall not exceed the general radiated emission limits in paragraph 15.209:

Frequency MHz	Distance between Test Item And Antenna in Meters	Field Strength µV/m	Field Strength dBµV/m
20-30	30	30	29.5
30-88	3	100	40
88-216	3	150	43.5
216-960	3	200	46
Above 960	3	500	54

Note: The tighter limit shall apply at the edge between the two frequency bands.

4.2.2 Procedures -

4.2.2.1 Preliminary Radiated Measurements - All preliminary tests 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.

The broadband measuring antenna was positioned at a 3 meter distance from the test item. The entire frequency range from 20MHz to 1GHz was investigated using a peak detector function. The data was then processed by the computer to equivalent field intensity at the required test distance.

4.2.2.2 Final Radiated Measurements - Final open field measurements were manually performed in a 32ft. x 20ft. x 14ft. high shielded enclosure.

The broadband measuring antenna was positioned at a 3 meter distance from the test item. The entire frequency range from 20MHz to 1GHz was investigated using a peak detector function. The data was then processed by the computer to equivalent field intensity at the 3 meters. All significant broadband and narrowband signals were measured and recorded.

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

1) From 20MHz to 30MHz, measurements were made using a peak detector and a loop antenna
2) From 30MHz to 1GHz, measurements were made using a peak detector and a broadband bi-log antenna.
3) To ensure that maximum, or worst case, emission levels were measured, the following steps were taken:
   (a) The test item was rotated so that all of its sides were exposed to the receiving antenna.
   (b) Since the measuring antennas are linearly polarized, both horizontal and vertical field components were measured.
   (c) The measuring antenna was raised and lowered from 1 to 4 meters for each antenna polarization to maximize the readings.

4.2.3 Results - The preliminary plots, with the test item transmitting at 27MHz, are presented on data pages 12 through 15. 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 27MHz, are presented on data page 16. 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 27.145MHz. The emissions level at this frequency was 5.1dB within the limit. See data page 16 for details. Photographs of the test configuration which yielded the highest, or worst case, radiated emission levels are shown on Figures 2 and 3.

4.3 Band Edge Measurements

4.3.1 Requirement - In accordance with paragraph 15.227, all emissions outside of the 26.96MHz to 27.28MHz band shall not exceed the general radiated emission limits in paragraph 15.209. The limits of paragraph 15.209 (30uV/m @ 30 meters) converted to the equivalent field intensity at 3 meters using linear extrapolation. A 20dB (20dB = 20 * Log (30m/3m)) distance correction factor has been applied to the limit to allow a direct comparison of the data obtained at 3 meters.

4.3.2 Procedures - The test item was placed on an 80cm high non-conductive stand. The unit was set to transmit continuously. With an antenna positioned 3 meters from the test item, the fundamental frequency was displayed on the spectrum analyzer. The resolution bandwidth was set to 10kHz and span was set to 2 MHz. The frequency spectrum near the fundamental was plotted separately with the marker set to the

lower and upper band edge frequencies.

4.3.3 Results - The plots of the emissions near the fundamental frequency are presented on data pages 17 and 18. As can be seen from this data page, all emissions outside of the 26.96MHz to 27.28MHz band met the general radiated emission limits in paragraph 15.209.

5.0 CONCLUSIONS:

It was determined that the Craft House Corporation Blacktop Patriot RC Car 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 C63.4-2001.

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: ANTENNAS								
NLS1	24" ACTIVE LOOP ANTENNA	EMCO	6502	8903-2329	0.01-30MHZ	01/23/03	12	01/23/04
NTA0	BILOG ANTENNA	CHASE EMC LTD.	BILOG CBL611	2057	0.03-2GHZ	07/03/03	12	07/03/04
Equipment Type: CONTROLLERS								
CDD2	COMPUTER	HEWLETT PACKARD	D4171A#ABA	US61654645	---		N/A	
CMA0	MULTI-DEVICE CONTROLLER	EMCO	2090	9701-1213	---		N/A	
Equipment Type: PRINTERS AND PLOTTERS								
HRE1	LASER JET 5P	HEWLETT PACKARD	C3150A	USHB061052	---		N/A	
Equipment Type: RECEIVERS								
RACE	RF PRESELECTOR W/ RECEIVER	HEWLETT PACKARD	85685A	3010A01194	20HZ-2GHZ	06/11/03	12	06/11/04
RAE7	SPECTRUM ANALYZER	HEWLETT PACKARD	85660B	2516A01685	100HZ-22GHZ	06/13/03	12	06/13/04
RAF6	QUASIPEAK ADAPTOR W/ RECEI	HEWLETT PACKARD	85650A	2412A00403	0.01-1000MHZ	06/13/03	12	06/13/04
RAKG	RF SECTION	HEWLETT PACKARD	85462A	3549A00284	0.009-6500MHZ	03/05/03	12	03/05/04
RAKH	RF FILTER SECTION	HEWLETT PACKARD	85460A	3448A00324	---	03/05/03	12	03/05/04

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.

ELITE ELECTRONIC ENGINEERING INC.
ETR 32548-02
Radiated Emissions Test Setup Anechoic Ferrite Chamber

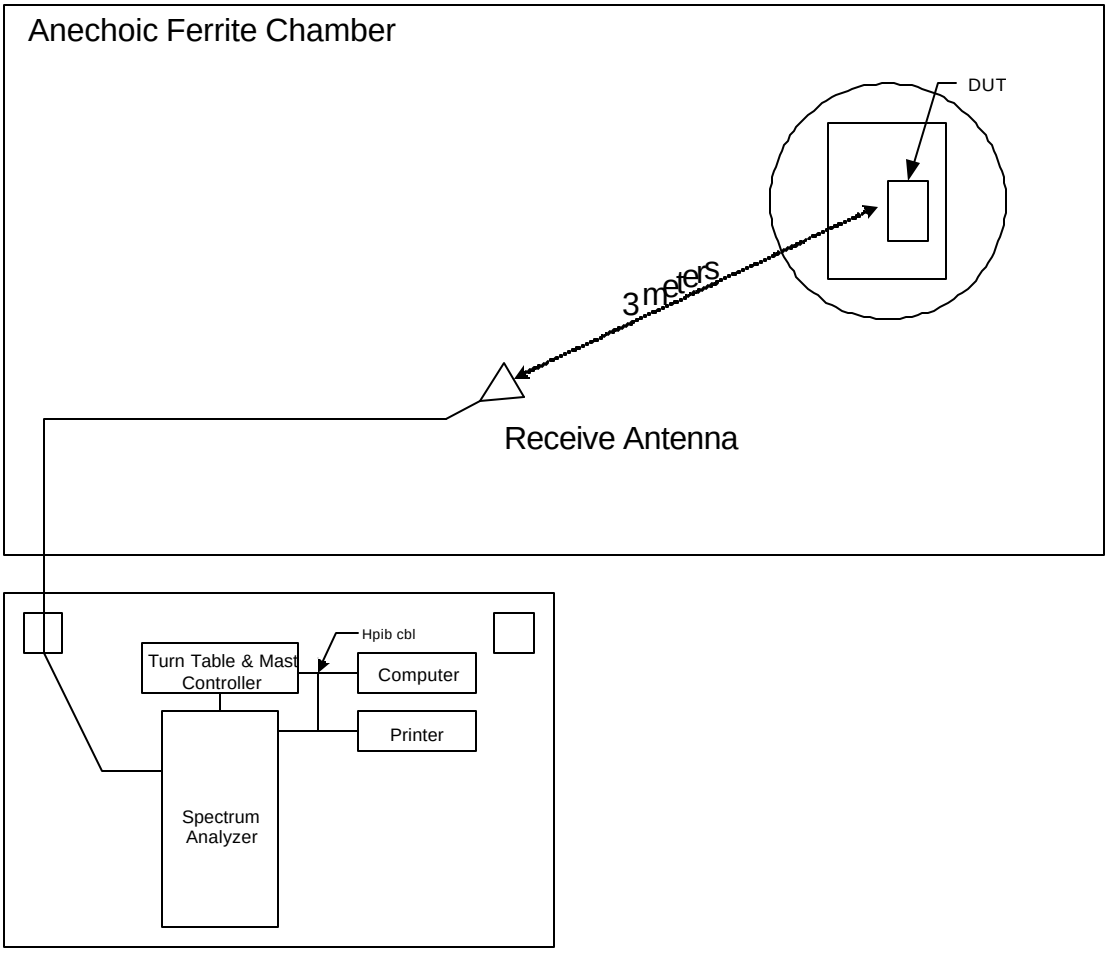
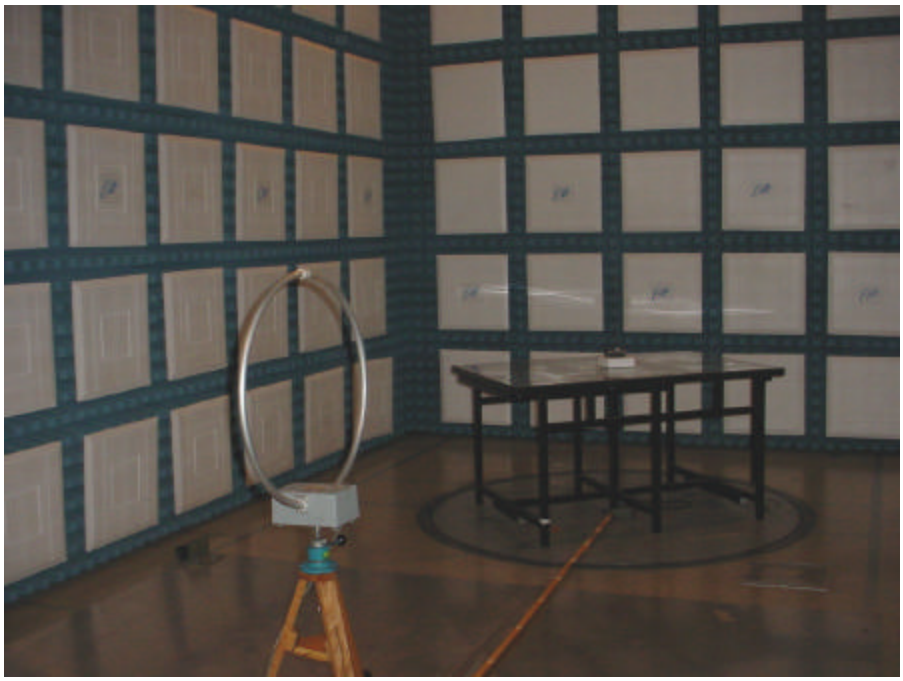
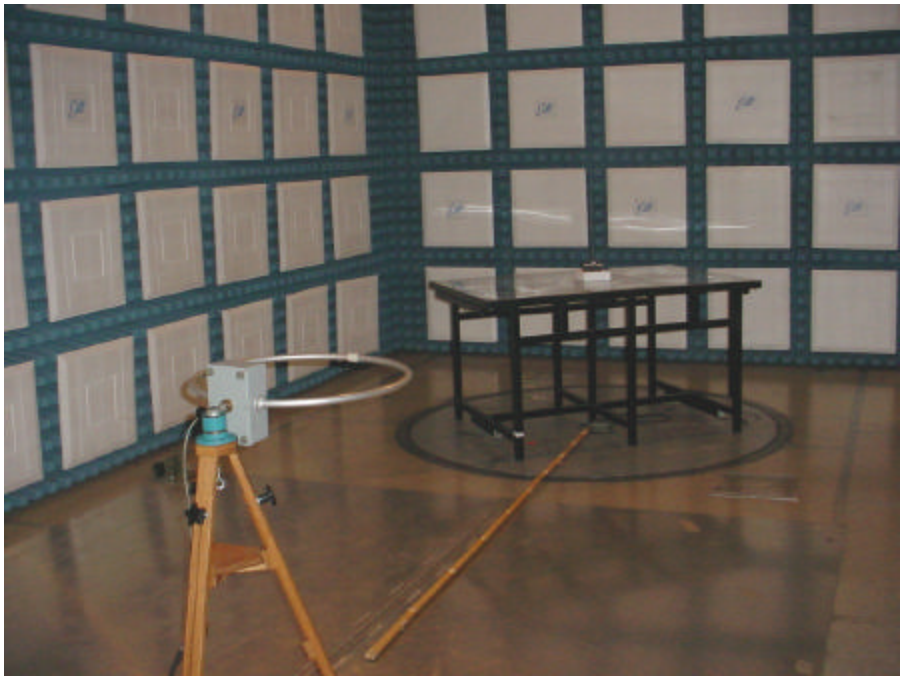


FIGURE 1 BLOCK DIAGRAM OF TEST SETUP

FIGURE 2

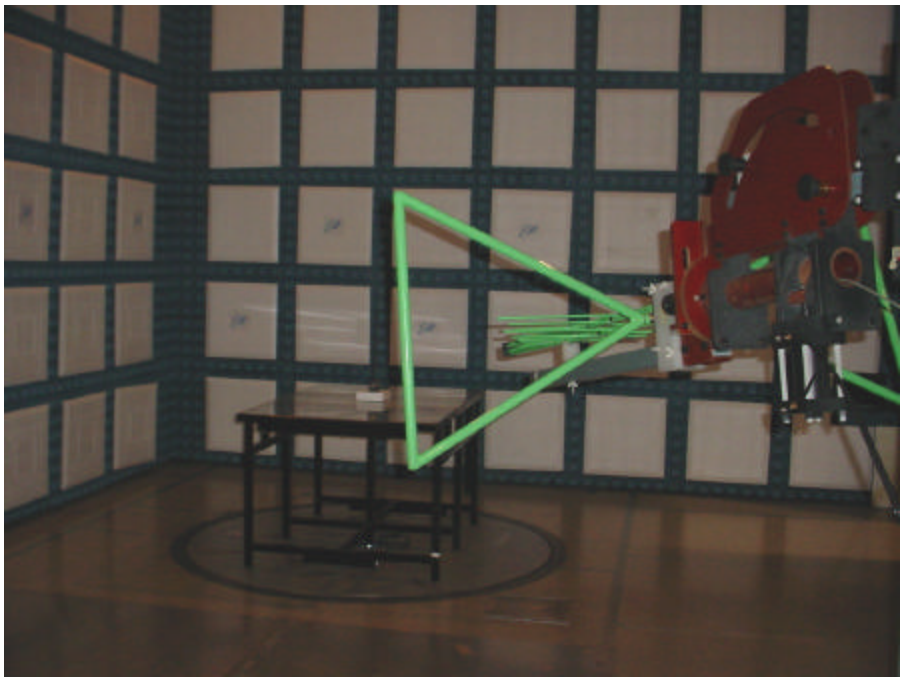


TEST SETUP FOR RADIATED EMISSIONS MEASUREMENTS
MAXIMIZED FOR MEASUREMENT OF WORST CASE EMISSIONS

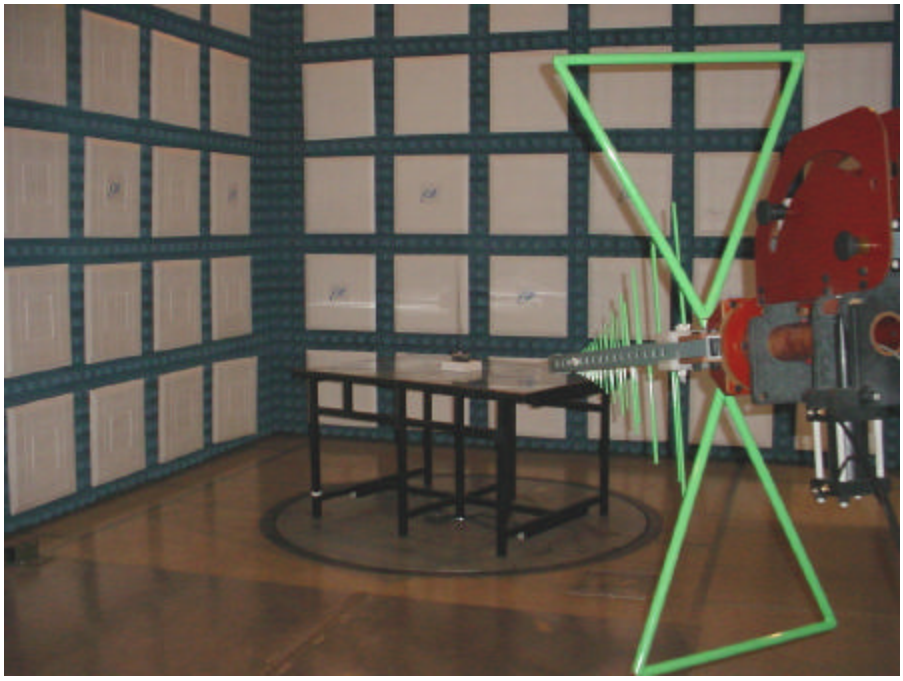


TEST SETUP FOR RADIATED EMISSIONS MEASUREMENTS
MAXIMIZED FOR MEASUREMENT OF WORST CASE EMISSIONS

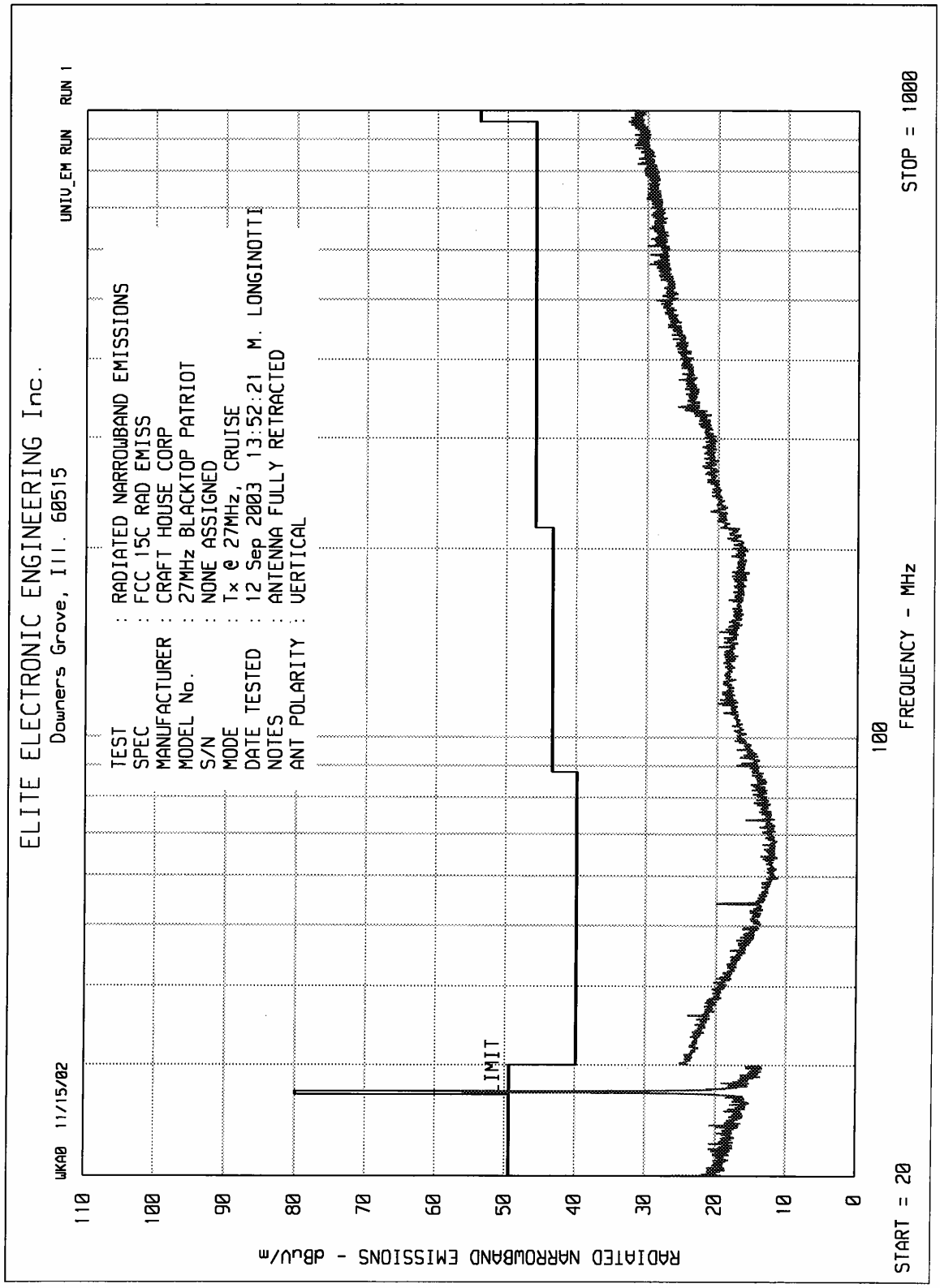
FIGURE 3

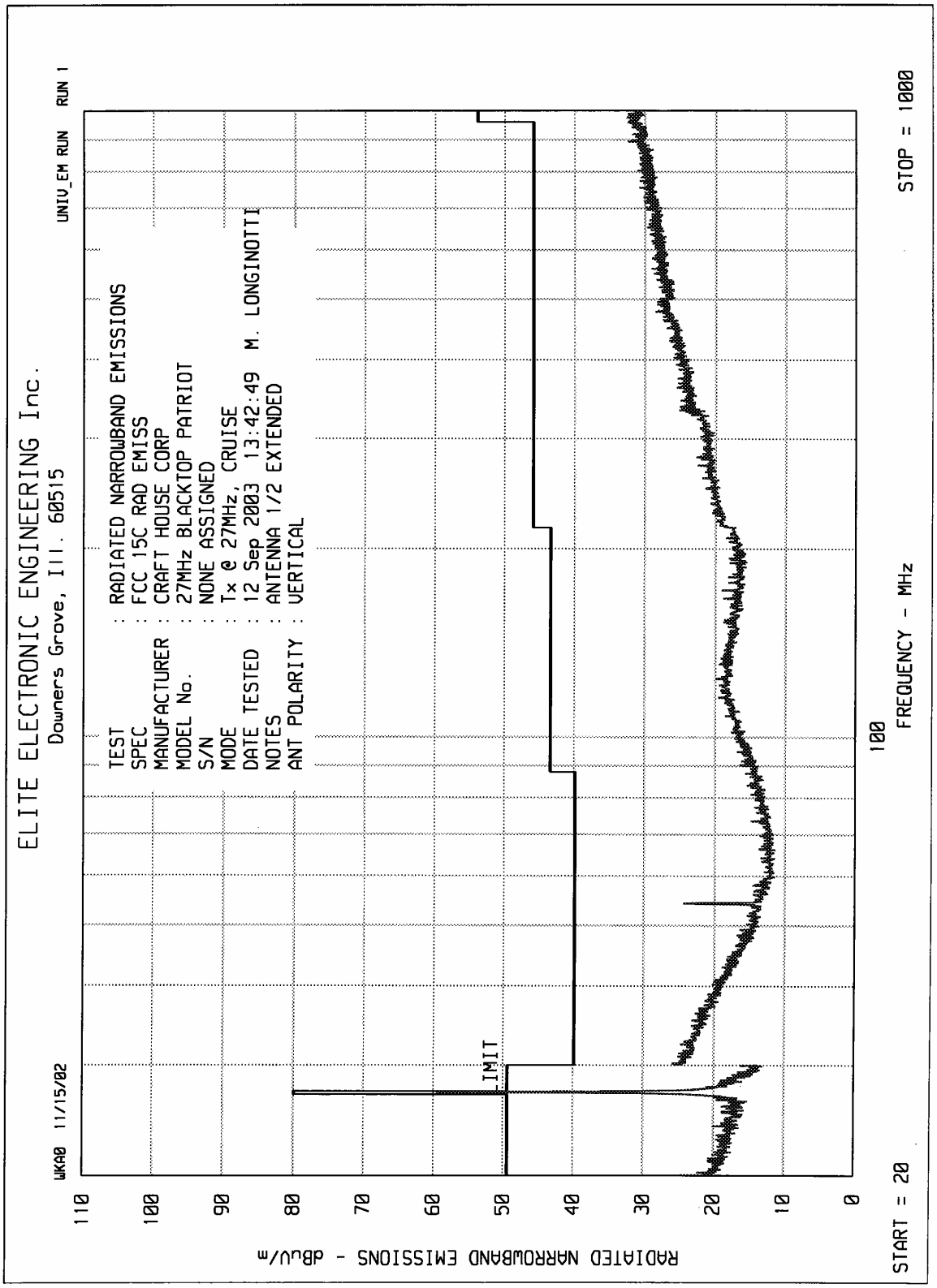


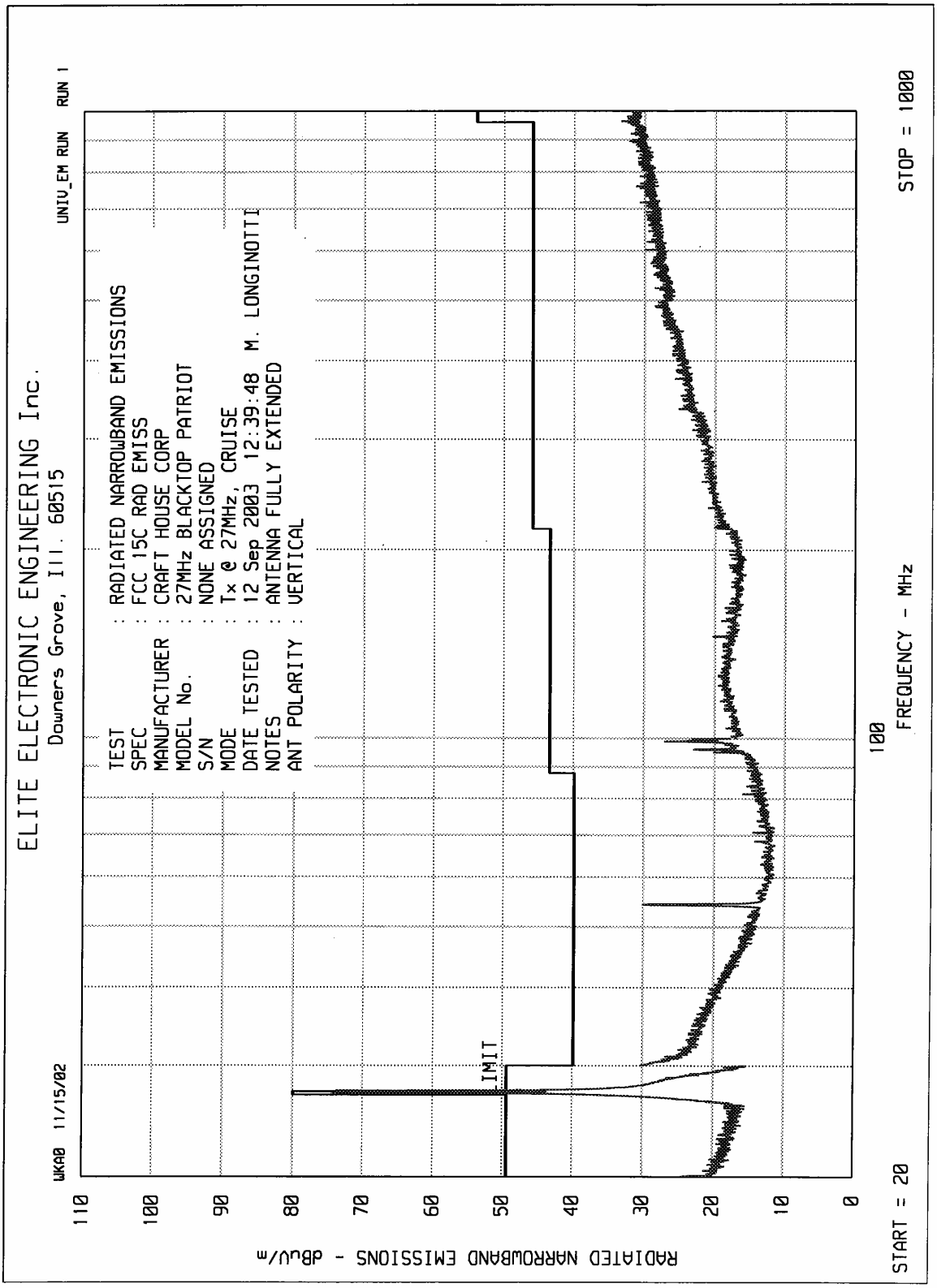
TEST SETUP FOR RADIATED EMISSIONS MEASUREMENTS
MAXIMIZED FOR MEASUREMENT OF WORST CASE EMISSIONS
HORIZONTAL POLARIZATION

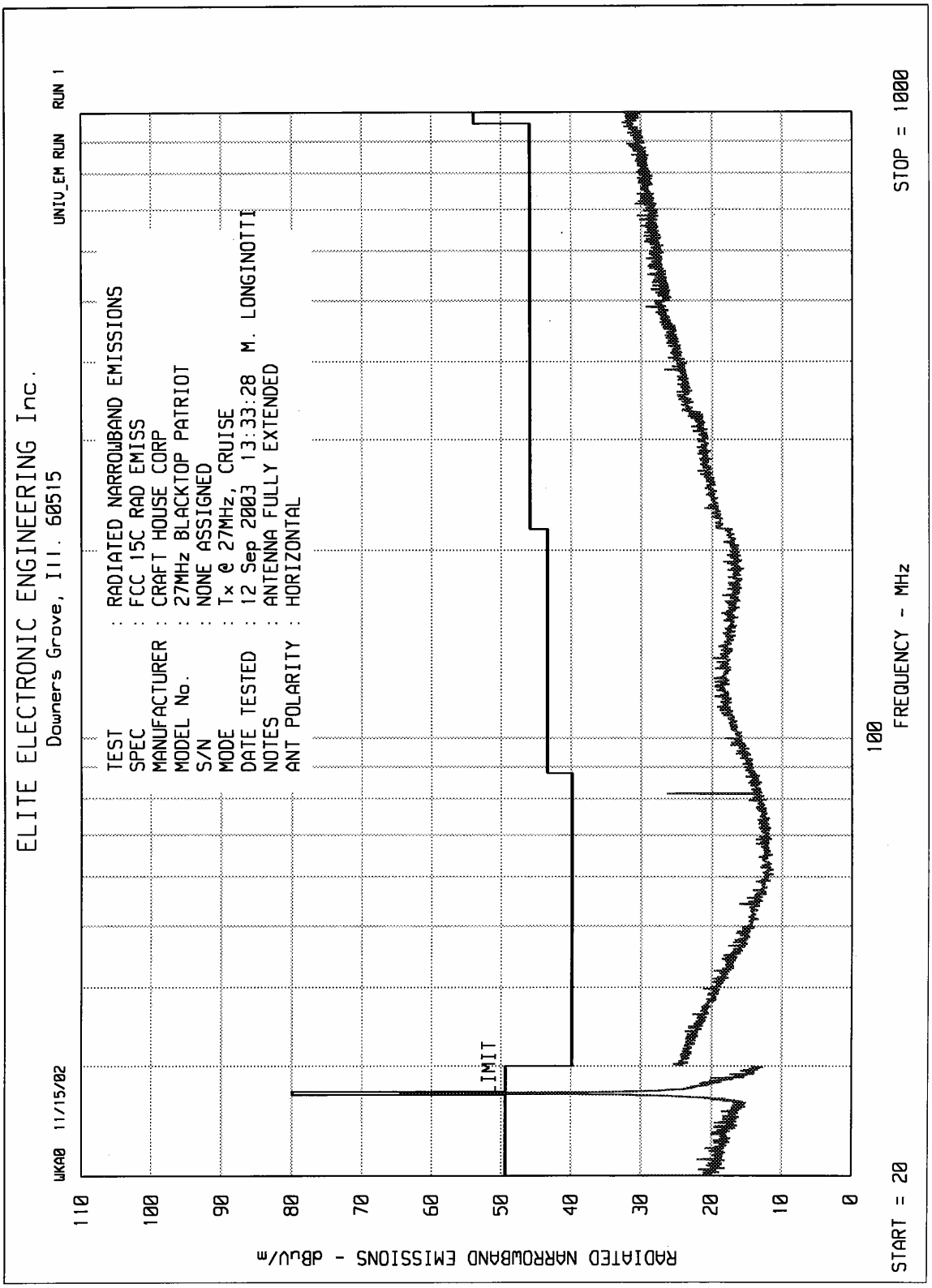


TEST SETUP FOR RADIATED EMISSIONS MEASUREMENTS
MAXIMIZED FOR MEASUREMENT OF WORST CASE EMISSIONS
VERTICAL POLARIZATION


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WKA0 11/15/02
UNIV_EM RUN RUN 1
TEST : RADIATED NARROWBAND EMISSIONS
SPEC : FCC 15C RAD EMISS
MANUFACTURER : CRAFT HOUSE CORP
MODEL No. : 27MHz BLACKTOP PATRIOT
S/N : NONE ASSIGNED
MODE : Tx @ 27MHz, CRUISE
DATE TESTED : 12 Sep 2003 13:52:21 M. LONGINOTTI
NOTES : ANTENNA FULLY RETRACTED
ANT POLARITY : VERTICAL
LIMIT
RADIATED NARROWBAND EMISSIONS - dBuV/m
110
100
90
80
70
60
50
40
30
20
10
0
START = 20
100
FREQUENCY - MHz
STOP = 1000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WKA0 11/15/02
UNIV_EM RUN RUN 1
TEST : RADIATED NARROWBAND EMISSIONS
SPEC : FCC 15C RAD EMISS
MANUFACTURER : CRAFT HOUSE CORP
MODEL No. : 27MHz BLACKTOP PATRIOT
S/N : NONE ASSIGNED
MODE : Tx @ 27MHz, CRUISE
DATE TESTED : 12 Sep 2003 13:42:49 M. LONGINOTTI
NOTES : ANTENNA 1/2 EXTENDED
ANT POLARITY : VERTICAL
LIMIT
RADIATED NARROWBAND EMISSIONS - dBuV/m
110
100
90
80
70
60
50
40
30
20
10
0
START = 20
100
FREQUENCY - MHz
STOP = 1000

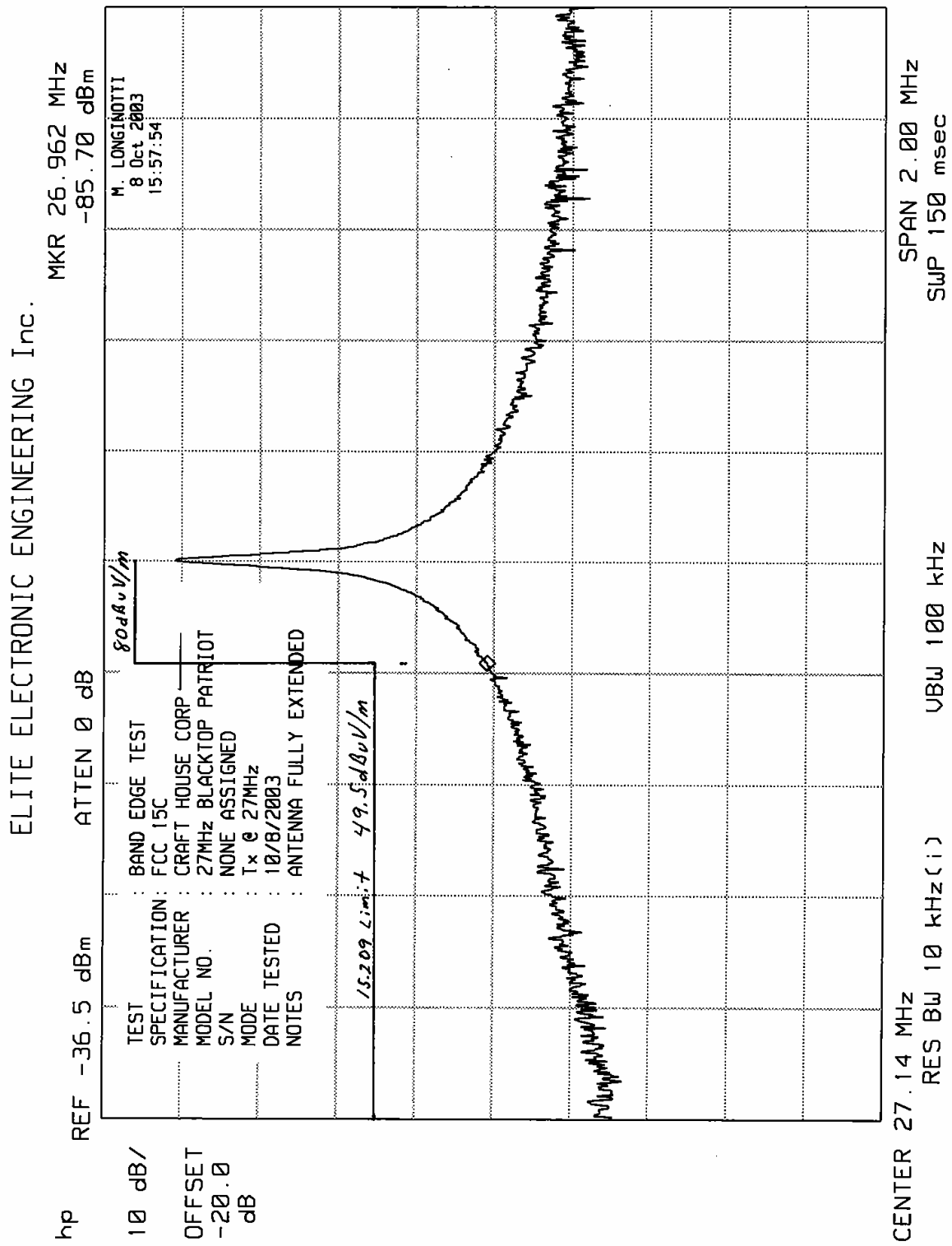

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WKA0 11/15/02
UNIV_EM RUN RUN 1
TEST : RADIATED NARROWBAND EMISSIONS
SPEC : FCC 15C RAD EMISS
MANUFACTURER : CRAFT HOUSE CORP
MODEL No. : 27MHz BLACKTOP PATRIOT
S/N : NONE ASSIGNED
MODE : Tx @ 27MHz, CRUISE
DATE TESTED : 12 Sep 2003 12:39:48 M. LONGINOTTI
NOTES : ANTENNA FULLY EXTENDED
ANT POLARITY : VERTICAL
LIMIT
RADIATED NARROWBAND EMISSIONS - dBuV/m
110
100
90
80
70
60
50
40
30
20
10
0
START = 20
100
FREQUENCY - MHz
STOP = 1000

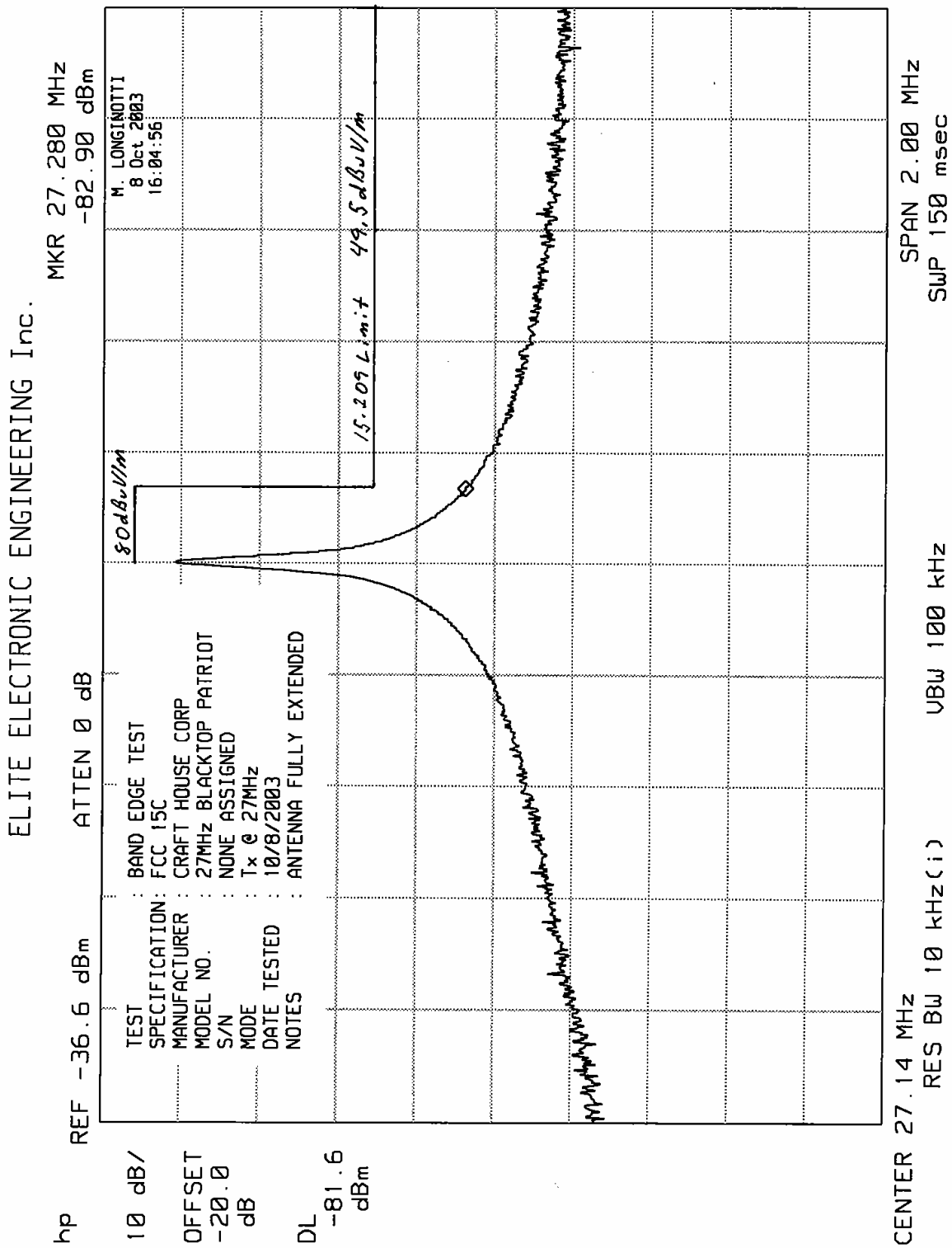

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
WKA0 11/15/02
UNIV_EM RUN RUN 1
TEST : RADIATED NARROWBAND EMISSIONS
SPEC : FCC 15C RAD EMISS
MANUFACTURER : CRAFT HOUSE CORP
MODEL No. : 27MHz BLACKTOP PATRIOT
S/N : NONE ASSIGNED
MODE : Tx @ 27MHz, CRUISE
DATE TESTED : 12 Sep 2003 13:33:28 M. LONGINOTTI
NOTES : ANTENNA FULLY EXTENDED
ANT POLARITY : HORIZONTAL
LIMIT
RADIATED NARROWBAND EMISSIONS - dBuV/m
110
100
90
80
70
60
50
40
30
20
10
0
START = 20
100
FREQUENCY - MHz
STOP = 1000

MANUFACTURER : CRAFT HOUSE CORP.
MODEL NO. : BLACKTOP PATRIOT 27MHz TRANSMITTER
SERIAL NO. : NONE ASSIGNED
MODE : Tx @ 27MHz, CRUISE
DATE TESTED : SEPTEMBER 12, 2003
NOTES : ANTENNA FULLY EXTENDED

FREQUENCY MHz	ANTENNA POLARITY	PEAK METER READING dBuV	AMBIENT	ANTENNA FACTOR dB	CABLE FACTOR dB	TOTAL dBuV/m	TOTAL uV/m	LIMIT uV/m
27.145	VERTICAL	64.6		8.9	0.4	73.9	4954.5	10,000
	HORIZONTAL	65.6		8.9	0.4	74.9	5559.0	10,000
54.29	VERTICAL	22.2		8.3	0.5	31.0	35.5	100
	HORIZONTAL	11.0	AMBIENT	8.3	0.5	19.8	9.8	100
81.44	VERTICAL	6.7	AMBIENT	8.2	0.5	15.4	5.9	100
	HORIZONTAL	5.3	AMBIENT	8.2	0.5	14.0	5.0	100
108.58	VERTICAL	5.7	AMBIENT	11.9	0.5	18.1	8.0	150
	HORIZONTAL	5.8	AMBIENT	11.9	0.5	18.2	8.1	150
135.73	HORIZONTAL	6.1	AMBIENT	12.5	0.7	19.3	9.2	150
	VERTICAL	5.0	AMBIENT	12.5	0.7	18.2	8.1	150
162.87	HORIZONTAL	6.6	AMBIENT	10.9	0.8	18.3	8.2	150
	VERTICAL	6.3	AMBIENT	10.9	0.8	18.0	7.9	150
190.02	VERTICAL	6.1	AMBIENT	10.5	1.0	17.6	7.6	150
	HORIZONTAL	5.2	AMBIENT	10.5	1.0	16.7	6.8	150
217.16	VERTICAL	7.0	AMBIENT	11.6	1.0	19.6	9.5	200
	HORIZONTAL	7.5	AMBIENT	11.6	1.0	20.1	10.1	200
244.31	VERTICAL	6.4	AMBIENT	13.1	1.1	20.6	10.7	200
	HORIZONTAL	6.1	AMBIENT	13.1	1.1	20.3	10.4	200
271.45	VERTICAL	6.3	AMBIENT	13.8	1.2	21.3	11.6	200
	HORIZONTAL	6.4	AMBIENT	13.8	1.2	21.4	11.7	200

Checked By: Mark E. Longinotti


hp
10 dB/
OFFSET
-20.0
dB
REF -36.5 dBm
ATTEN 0 dB
ELITE ELECTRONIC ENGINEERING Inc.
MKR 26.962 MHz
-85.70 dBm
TEST : BAND EDGE TEST
SPECIFICATION: FCC 15C
MANUFACTURER : CRAFT HOUSE CORP
MODEL NO. : 27MHz BLACKTOP PATRIOT
S/N : NONE ASSIGNED
MODE : Tx @ 27MHz
DATE TESTED : 10/8/2003
NOTES : ANTENNA FULLY EXTENDED
80dBuV/m
15.209 Limit 49.5dBuV/m
M. LONGINOTTI
8 Oct 2003
15:57:54
CENTER 27.14 MHz
RES BW 10 kHz(i)
VBW 100 kHz
SPAN 2.00 MHz
SWP 150 msec


hp
REF -36.6 dBm
ATTEN 0 dB
MKR 27.280 MHz
-82.90 dBm
ELITE ELECTRONIC ENGINEERING Inc.
10 dB/
OFFSET
-20.0
dB
DL
-81.6
dBm
TEST : BAND EDGE TEST
SPECIFICATION: FCC 15C
MANUFACTURER : CRAFT HOUSE CORP
MODEL NO. : 27MHz BLACKTOP PATRIOT
S/N : NONE ASSIGNED
MODE : Tx @ 27MHz
DATE TESTED : 10/8/2003
NOTES : ANTENNA FULLY EXTENDED
M. LONGINOTTI
8 Oct 2003
16:04:56
80dBuV/m
15.209 Limit 49.5dBuV/m
CENTER 27.14 MHz
RES BW 10 kHz(i)
VBW 100 kHz
SPAN 2.00 MHz
SWP 150 msec