

Elite Electronic Engineering, Inc.
1516 Centre Circle
Downers Grove, Illinois
(630) 495-9770
www.elitetest.com

Engineering Test Report Number 31128-01



MEASUREMENT OF RF INTERFERENCE FROM A MODEL 993LMK TRANSMITTER

FOR: **Chamberlain**
845 Larch Ave.
Elmhurst, Illinois 60126

Dates Tested: June 25, 2002

Test Specifications: FCC "Code of Federal Regulations" Title 47
Part 15, Subpart C, Section 15.205



ENGINEERING TEST REPORT NO. 31128
ADMINISTRATIVE DATA AND SUMMARY OF TESTS

DESCRIPTION OF TEST ITEM: Transmitter

MODEL NO: 993LMK

SERIAL NO: A11

MANUFACTURER: Chamberlain

APPLICABLE SPECIFICATIONS: FCC "Code of Federal Regulations"
Title 47, Part 15, Subpart C

QUANTITY OF ITEMS TESTED: One (1)

TEST PERFORMED BY: ELITE ELECTRONIC ENGINEERING INCORPORATED
Radio Interference Consultants
Downers Grove, Illinois 60515

DATE RECEIVED: June 25, 2002

DATE TESTED: June 25, 2002

PERSONNEL (OPERATORS, OBSERVERS, AND CO-ORDINATORS):

CUSTOMER: No Chamberlain personnel were present.

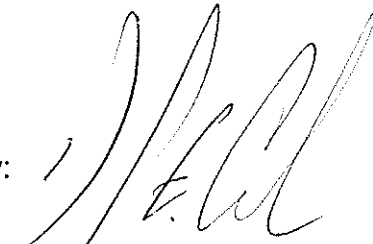
ELITE ELECTRONIC: Daniel E. Crowder

ELITE JOB NO.: 31128

ABSTRACT: The model 993LMK Transmitter, does meet the 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 C63.4-1992.

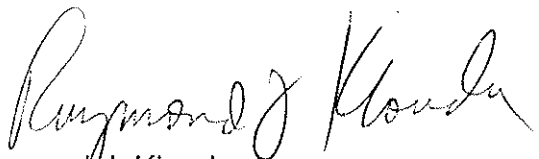
The radiated emissions level closest to the limit (worst case) occurred at 1560MHz. The emissions level at this frequency was 3.3dB within the limit. See data page 17 for more details.

Report By:



Daniel E. Crowder - NCE

Approved By:



Raymond J. Klouda
Registered Professional
Engineer of Illinois - 44894

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TOTAL NUMBER OF PAGES IN THIS DOCUMENT,
(INCLUDING DATA SHEETS): 18

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

ENGINEERING TEST REPORT NO. 31128
MEASUREMENT OF RF INTERFERENCE FROM
A MODEL 993LMK TRANSMITTER

1.0 INTRODUCTION:

1.1 DESCRIPTION OF TEST ITEM: This document presents the results of a series of radio interference measurements performed on a model 993LMK Transmitter, (hereinafter referred to as the test item). No serial number was assigned to the test item. The test item was designed to transmit at approximately 390MHz using an internal antenna. The tests were performed for Chamberlain of Elmhurst, Illinois.

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 for Intentional Radiators. Testing was performed in accordance with ANSI C63.4-1992.

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 2001
- 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 23°C and the relative humidity was 66%.

2.0 TEST ITEM SETUP AND OPERATION:

A block diagram of the test item setup is included as Figure 1.

2.1 POWER INPUT: The test item was powered with 3VDC through a 3VDC battery.

2.2 GROUNDING: Since the test item was powered with 3VDC through a 3VDC battery, it was ungrounded during the tests.

2.3 PERIPHERAL EQUIPMENT: There was no peripheral equipment submitted with the test item.

2.4 INTERCONNECT CABLES: There were no interconnect cables submitted with the test item.

2.5 OPERATIONAL MODE: For all tests the test item and all peripheral equipment were placed on a 80cm high non-conductive stand. The test item and all peripheral equipment was energized.

For all tests, the test item's transmit button was held down thereby setting the unit to transmit continuously. Transmission was verified by observation of an LED which was lit whenever the transmit button was enabled. The transmitting mechanism automatically deactivated when released. The battery voltage was periodically checked to ensure proper operation at maximum level. The tests were performed with the test item operating at 390MHz.

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.

The duty cycle factor was calculated from the pulse train for the test item. A data plot

was obtained to determine the duty cycle factor. The duty cycle factor was computed as the Word ON time divided by the Word period (ON time + OFF time). The duty cycle factor in dB = $20 \log(\text{Word ON}/\text{Word period})$. If the word period is more than 100 milliseconds, then the duty cycle would be computed on the maximum Word ON time during a 100 millisecond period.

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 DUTY CYCLE FACTOR MEASUREMENTS:

4.2.1 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 setting are adjusted so that the on/off transitions clear the 4th division from the bottom of the display. The markers are set at 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).

4.2.2 RESULTS: A representative plot of the duty cycle is shown on data page 14. Since the transmitters use a rolling code the duty cycles used were calculated based on the worst case. The worst case information was supplied by Chamberlain. With the test item transmitting at 390MHz, the worst case duty cycle would be -10.2dB.

4.3 RADIATED MEASUREMENTS:

4.3.1 REQUIREMENTS: The test item must comply with the requirements of FCC "Code of Federal Regulations Title 47", Part 15, Subpart C, Section 15.205 et seq.

Paragraph 15.231(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 390MHz, the limit at the fundamental is 9166.7uV/m @ 3m and the limit on the harmonics is 916.7uV/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.

4.3.2 PROCEDURES:

4.3.2.1 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 30MHz to 5.0GHz was investigated using a peak detector function. The data was then processed by the computer to equivalent field intensity at 3 meters.

4.3.2.2 FINAL RADIATED MEASUREMENTS: Final open field measurements were manually performed at Elite's open field test site located in Downers Grove, Illinois. The open field test site is located in a clear area and is equipped with a 1/4-inch wire mesh ground plane. The facility complies with the test site criteria in ANSI C63.4-1992 and Section 2.948 of the FCC Rules.

Measurements were performed at a test distance of 3 meters using a peak detector. The peak detected levels were converted to average levels using a duty cycle factor which was computed from the pulse train.

The final open field emission tests were performed over the frequency range of 300MHz to 4000MHz. Between 300MHz and 1000MHz, a tuned dipole antenna was used as the pick-up device. A broadband double ridged waveguide antenna was above 1GHz. All significant broadband and narrowband signals were measured and recorded.

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

- 1) Measurements were made using a quasi-peak detector and a broadband bi-log antenna.
- 2) 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 antenna is 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.

4.3.3 RESULTS: The preliminary plots, with the test item transmitting at 390MHz, are presented on data pages 15 and 16. 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 transmitting at 390MHz, are presented on data page 17. As can be seen from the data, all emissions measured from the test item were within the specification limits. The emissions level closest to the limit (worst case) occurred at 1560MHz. The emissions level at this frequency was 3.3dB within the limit. See data page 17 for details. Photographs of the test configuration which yielded the highest, or worst case, radiated emission levels are shown on Figure 2.

4.4 OCCUPIED BANDWIDTH MEASUREMENTS:

4.4.1 REQUIREMENTS: 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.

4.4.2 PROCEDURES: The test item was placed on an 80cm high non-conductive stand. The unit was set to transmit continuously. With an antenna positioned nearby, occupied bandwidth emissions were displayed on the spectrum analyzer. The resolution bandwidth was set to 30 kHz and span was set to 2 MHz. The frequency spectrum near the fundamental was plotted.

4.4.3 RESULTS: The plot of the emissions near the fundamental frequency are presented on data page 18. As can be seen from this data page, the transmitter met the occupied bandwidth requirements.

5.0 CONCLUSION:

It was found that the Chamberlain model 993LMK Transmitter, does 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 C63.4-1992.

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 specification.

The data presented in this test report pertains only 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.

ENGINEERING TEST REPORT NO. 31128-01

TABLE 1: 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								
XZG0	ATTENUATOR/SWITCH DRIVER	HEWLETT PACKARD	11713A	3439A02724	---		N/A	
Equipment Type: AMPLIFIERS								
APK0	PRE-AMPLIFIER	HEWLETT PACKARD	8449B	3008A00662	1-26.5GHZ	02/22/02	12	02/22/03
Equipment Type: ANTENNAS								
NDP0	TUNED DIPOLE ANTENNA	EMCO	3121C-DB3	311	140-400MHZ	12/11/01	12	12/11/02
NDQ0	TUNED DIPOLE ANTENNA	EMCO	3121C-DB4	311	400-1000MHZ	12/11/01	12	12/11/02
NTA0	BILOG ANTENNA	CHASE EMC LTD.	BILOG CBL611	2057	0.03-2GHZ	05/09/01	12	05/09/02
NWH0	RIDGED WAVE GUIDE	SENSOR	4105	2081	1-12.4GHZ	08/03/01	12	08/03/02
Equipment Type: CONTROLLERS								
CDN0	COMPUTER	GATEWAY	PROV700C	002367865	700MHZ		N/A	
Equipment Type: PRINTERS AND PLOTTERS								
HRG8	LASERJET 2100	HEWLETT PACKARD	C1470A	USGG109747	---		N/A	
Equipment Type: RECEIVERS								
RAC1	SPECTRUM ANALYZER	HEWLETT PACKARD	85660B	3407A08369	100HZ-22GHZ	01/18/02	12	01/18/03
RACB	RF PRESELECTOR	HEWLETT PACKARD	85685A	3506A01491	20HZ-2GHZ	01/18/02	12	01/18/03
RAF3	QUASISPEAK ADAPTER	HEWLETT PACKARD	85650A	3303A01775	0.01-1000MHZ	01/18/02	12	01/18/03

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.

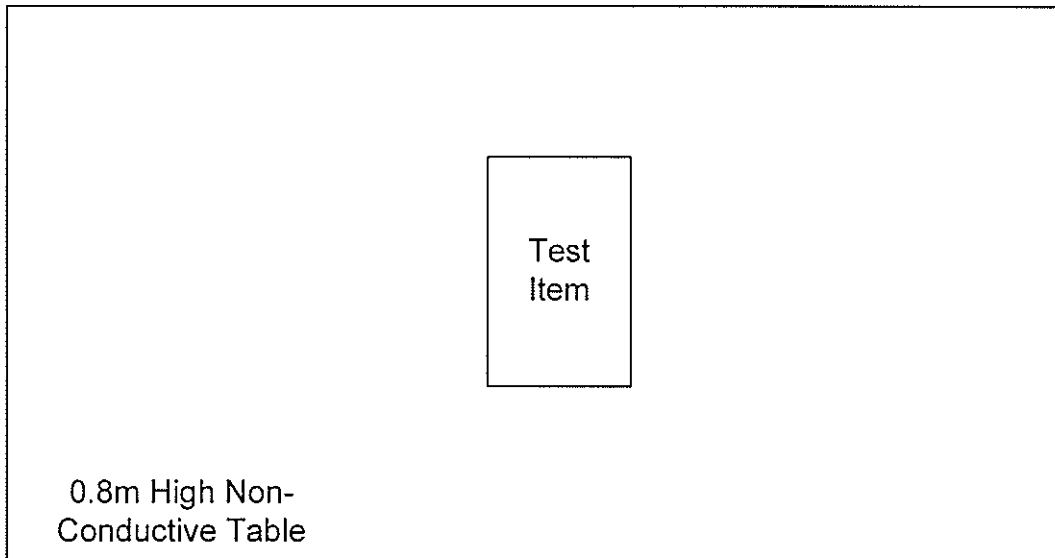


Figure 1 - Block Diagram of Test Item

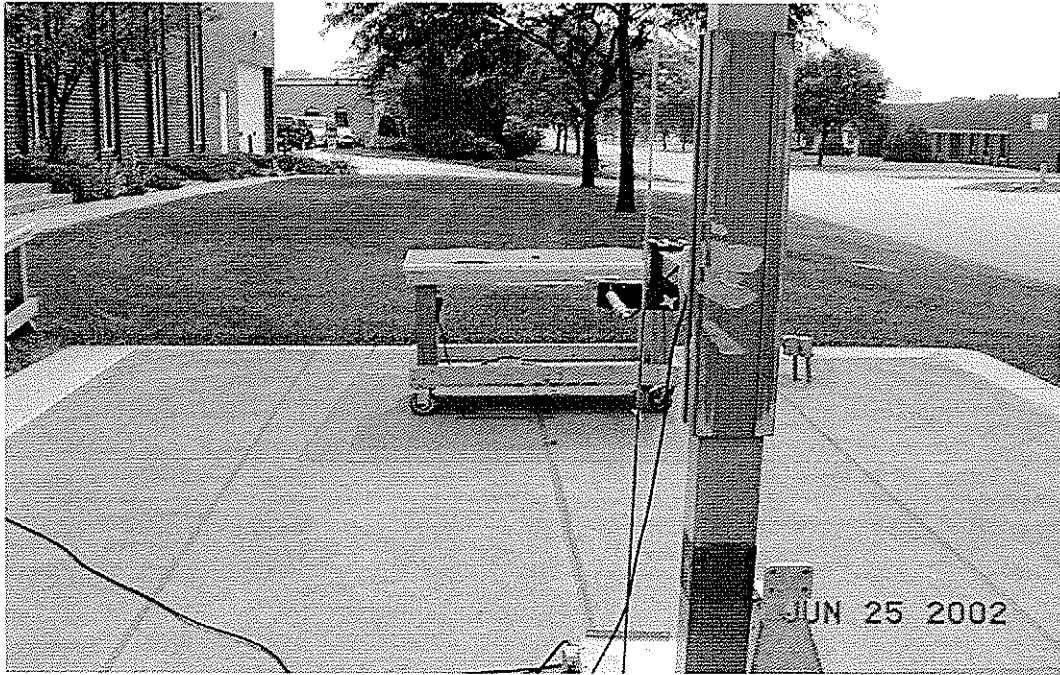
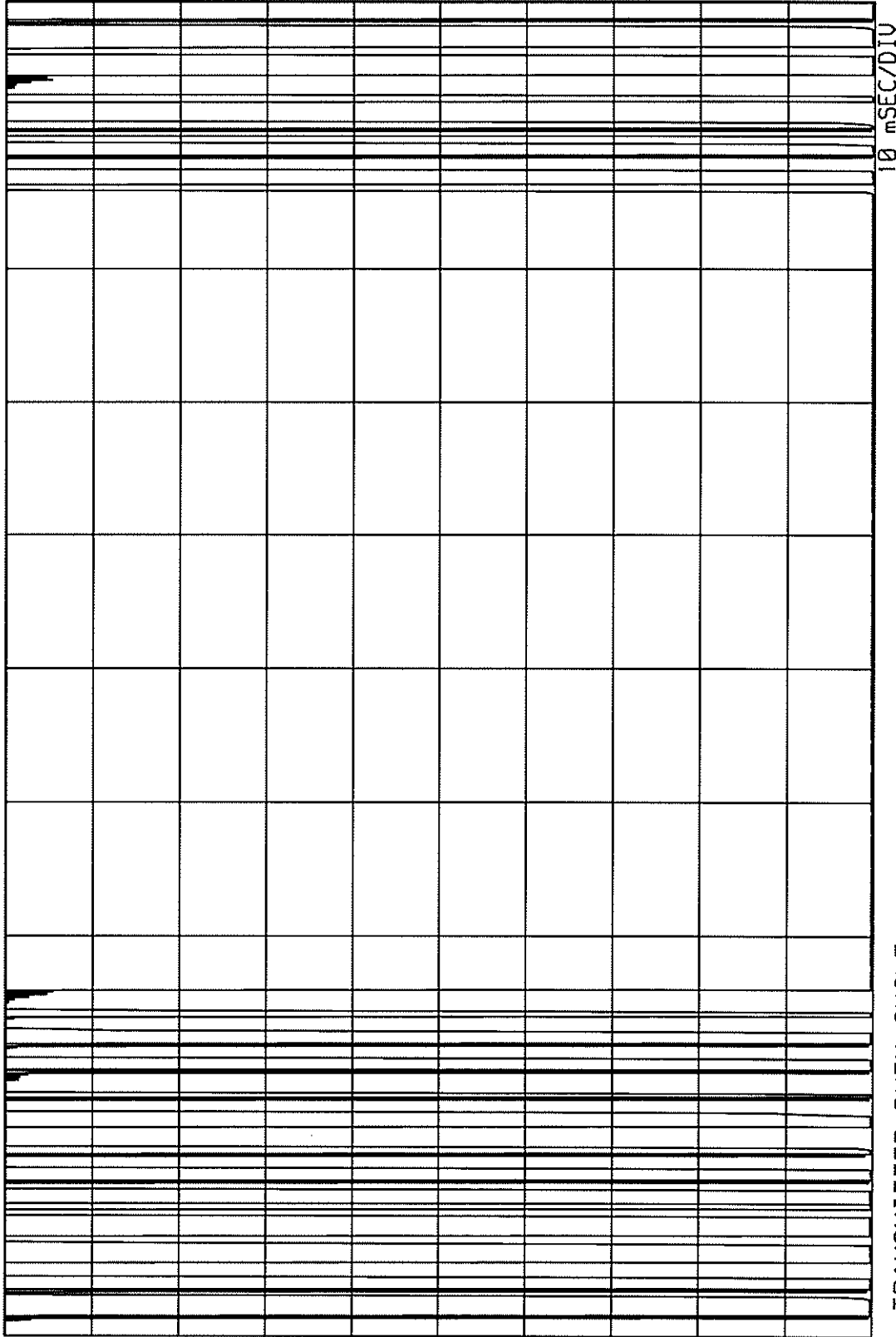


FIGURE 2a - TEST SETUP FOR HIGHEST RADIATED EMISSIONS MEASUREMENT
HORIZONTAL POLARITY



FIGURE 2b - TEST SETUP FOR HIGHEST RADIATED EMISSIONS MEASUREMENT
VERTICAL POLARITY

ELITE ELECTRONIC ENGINEERING Co.
Downers Grove, IL 60515



TRANSMITTER DUTY CYCLE
 FREQUENCY : 390.0704 MHz
 ON TIME : 19.88 mSEC
 OFF TIME : 80.12 mSEC
 DUTY CYCLE = .2 or -13.98 dB
 COMPUTED OVER 100 mSEC

MANUFACTURER : CHAMBERLAIN
 MODEL :
 S/N :
 TEST DATE : 26 Jun 2002
 NOTES :

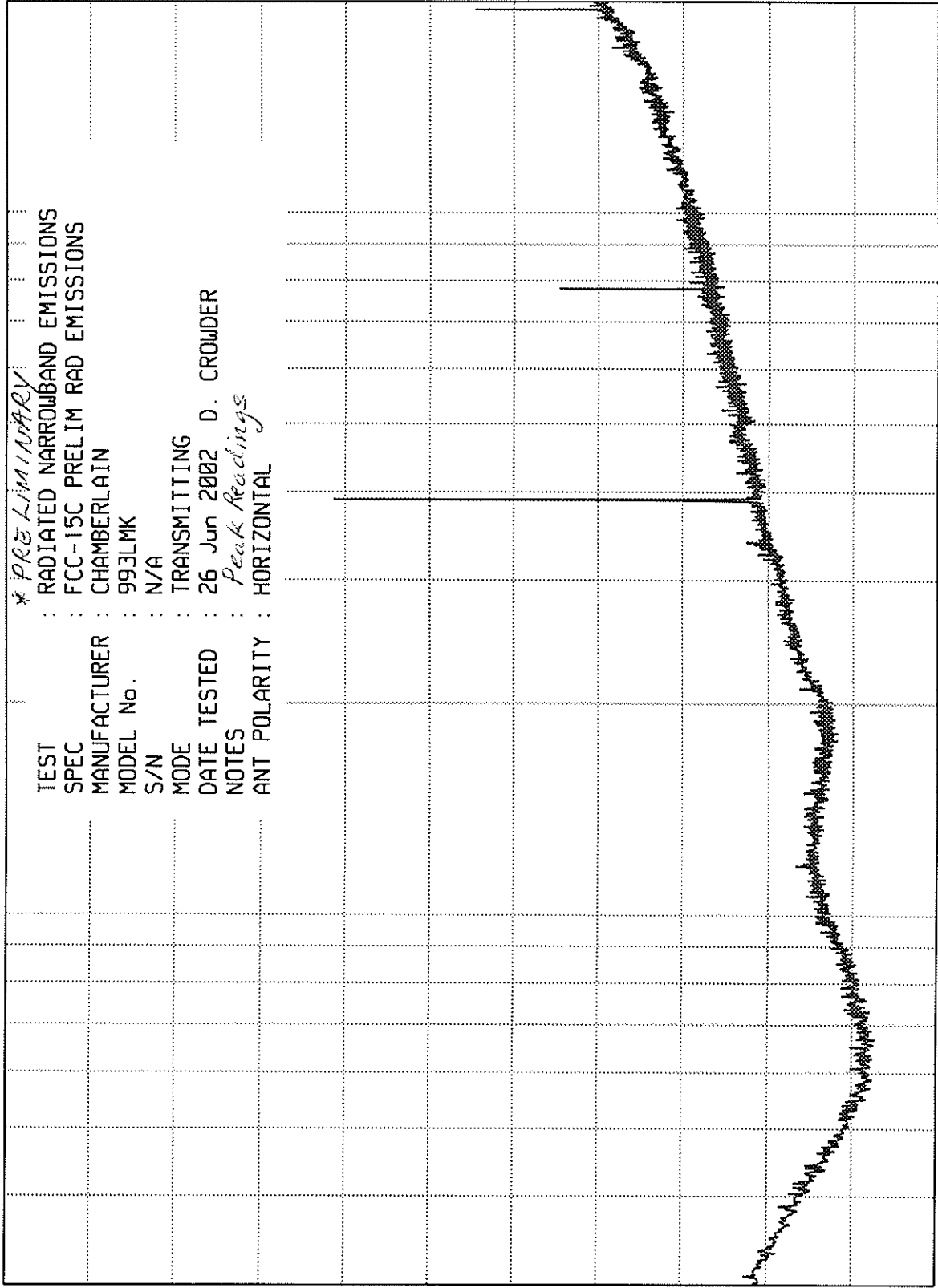
ELITE ELECTRONIC ENGINEERING Co.

Downers Grove, Ill. 60515

UNIU_EM RUN RUN 3

WKAB 11/26/01

ECE



* PRELIMINARY

TEST : RADIATED NARROWBAND EMISSIONS
 SPEC : FCC-15C PRELIM RAD EMISSIONS
 MANUFACTURER : CHAMBERLAIN
 MODEL No. : 993LMK
 S/N : N/A
 MODE : TRANSMITTING
 DATE TESTED : 26 Jun 2002 D. CROWDER
 NOTES : *Peak Readings*
 ANT POLARITY : HORIZONTAL

RADIATED NARROWBAND EMISSIONS - dBu/m³

15.6 / 8

START = 30

FREQUENCY - MHz

1000

STOP = 2000

ETR 31128-01

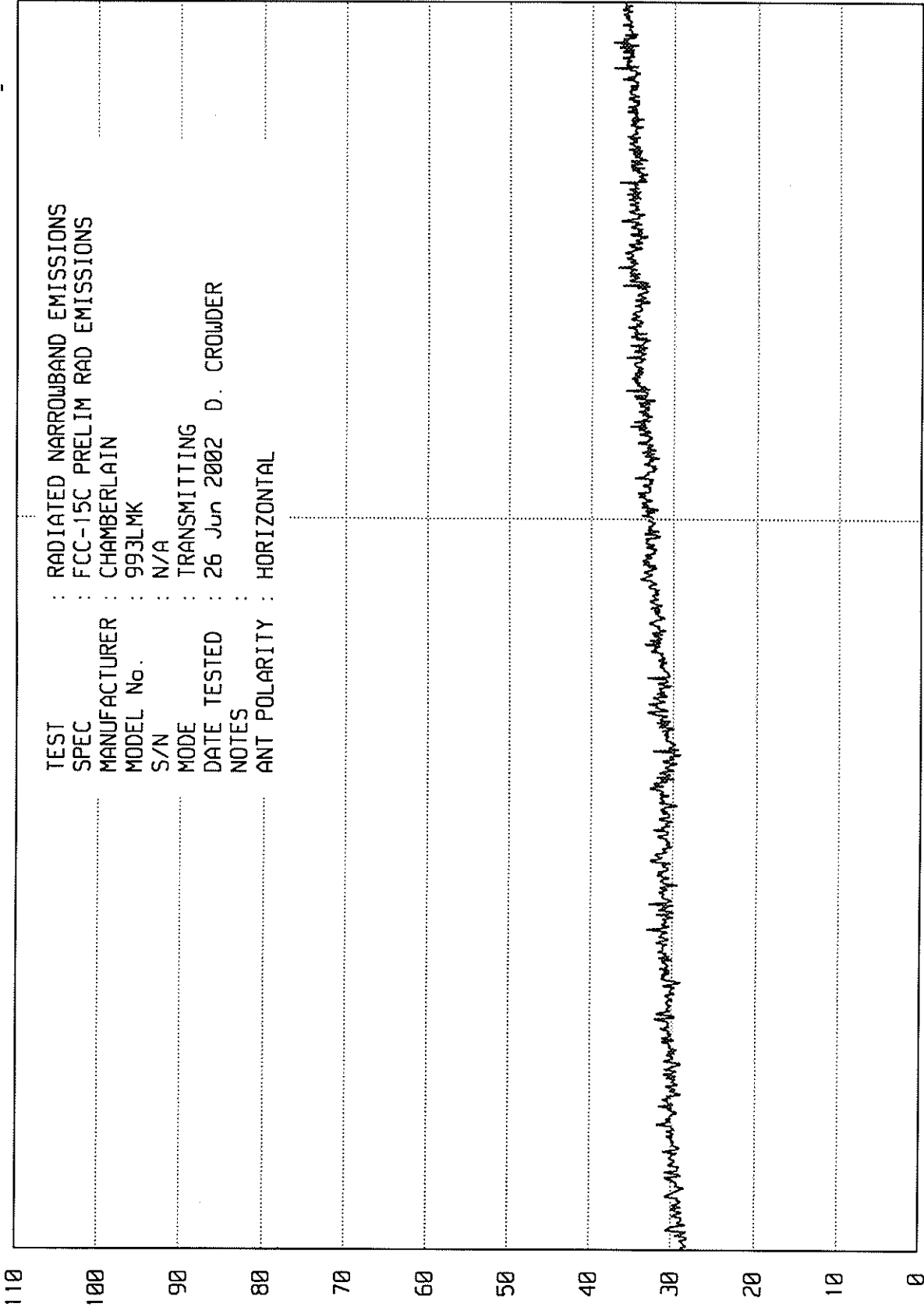
ELITE ELECTRONIC ENGINEERING Co.

Downers Grove, Ill. 60515

UNTU_EM RUN RUN 1

WKAB 11/26/81

EE



TEST : RADIATED NARROWBAND EMISSIONS
 SPEC : FCC-15C PRELIM RAD EMISSIONS
 MANUFACTURER : CHAMBERLAIN
 MODEL No. : 99JLMK
 S/N : N/A
 MODE : TRANSMITTING
 DATE TESTED : 26 Jun 2002 D. CROWDER
 NOTES :
 ANT POLARITY : HORIZONTAL

RADIATED NARROWBAND EMISSIONS - dBu/m

16 of 18

START = 2000

FREQUENCY - MHz

STOP = 4000

ETR No. 31128-01
DATA PAGE

SPECIFICATION : FCC PART 15C (REV OCT 1, 94) TRANSMITTER OPEN FIELD DATA
 MANUFACTURER : CHAMBERLAIN
 MODEL : 933LMK
 S/N : NONE ASSIGNED
 TEST DATE : JUNE 25, 2002
 NOTES :
 TEST ANTENNA : ROBERTS DIPOLE & DRWG ANTENNAS

FREQUENCY MHz	ANT POL	MTR RDG dBuV	CBL FAC dB	ANT FAC dB	DUTY CYCLE dB	TOTAL dBuV/m @3m	TOTAL uV/m @3m	LIMIT uV/m @3m	NOTES
390.00	H	59.6	1.2	20.8	-10.2	71.4	3702.2	9166.7	
390.00	V	45.8	1.2	20.8	-10.2	57.6	755.9	9166.7	
780.00	H	32.2	2.0	26.6	-10.2	50.6	337.3	916.7	
780.00	V	21.0	2.0	26.6	-10.2	39.4	92.9	916.7	
1170.00	H	34.5	1.3	24.6	-10.2	50.2	324.0	500.0	*
1170.00	V	29.3	1.3	24.6	-10.2	45.0	178.0	500.0	*
1560.00	H	33.7	1.4	25.8	-10.2	50.7	343.7	500.0	*
1560.00	V	28.4	1.4	25.8	-10.2	45.4	186.7	500.0	*
1950.00	H	21.2	1.6	27.5	-10.2	40.1	101.0	916.7	
1950.00	V	22.1	1.6	27.5	-10.2	41.0	112.0	916.7	
2340.00	H	31.1	1.8	28.7	-10.2	51.4	371.1	500.0	*
2340.00	V	28.0	1.8	28.7	-10.2	48.3	259.7	500.0	*
2730.00	H	30.0	2.0	29.8	-10.2	51.7	382.9	500.0	*
2730.00	V	29.0	2.0	29.8	-10.2	50.7	341.3	500.0	*
3120.00	H	29.4	2.2	31.0	-10.2	52.4	417.1	916.7	
3120.00	V	29.4	2.2	31.0	-10.2	52.4	417.1	916.7	
3510.00	H	28.9	2.3	32.1	-10.2	53.1	453.5	916.7	
3510.00	V	28.8	2.3	32.1	-10.2	53.0	448.3	916.7	
3900.00	H	28.2	2.4	33.2	-10.2	53.6	479.4	500.0	*
3900.00	V	27.8	2.4	33.2	-10.2	53.2	457.9	500.0	*

* DENOTES A FREQUENCY CONFLICT WITH RESTRICTED BANDS

checked by: _____


D. CROWDER

EJK 31128-01

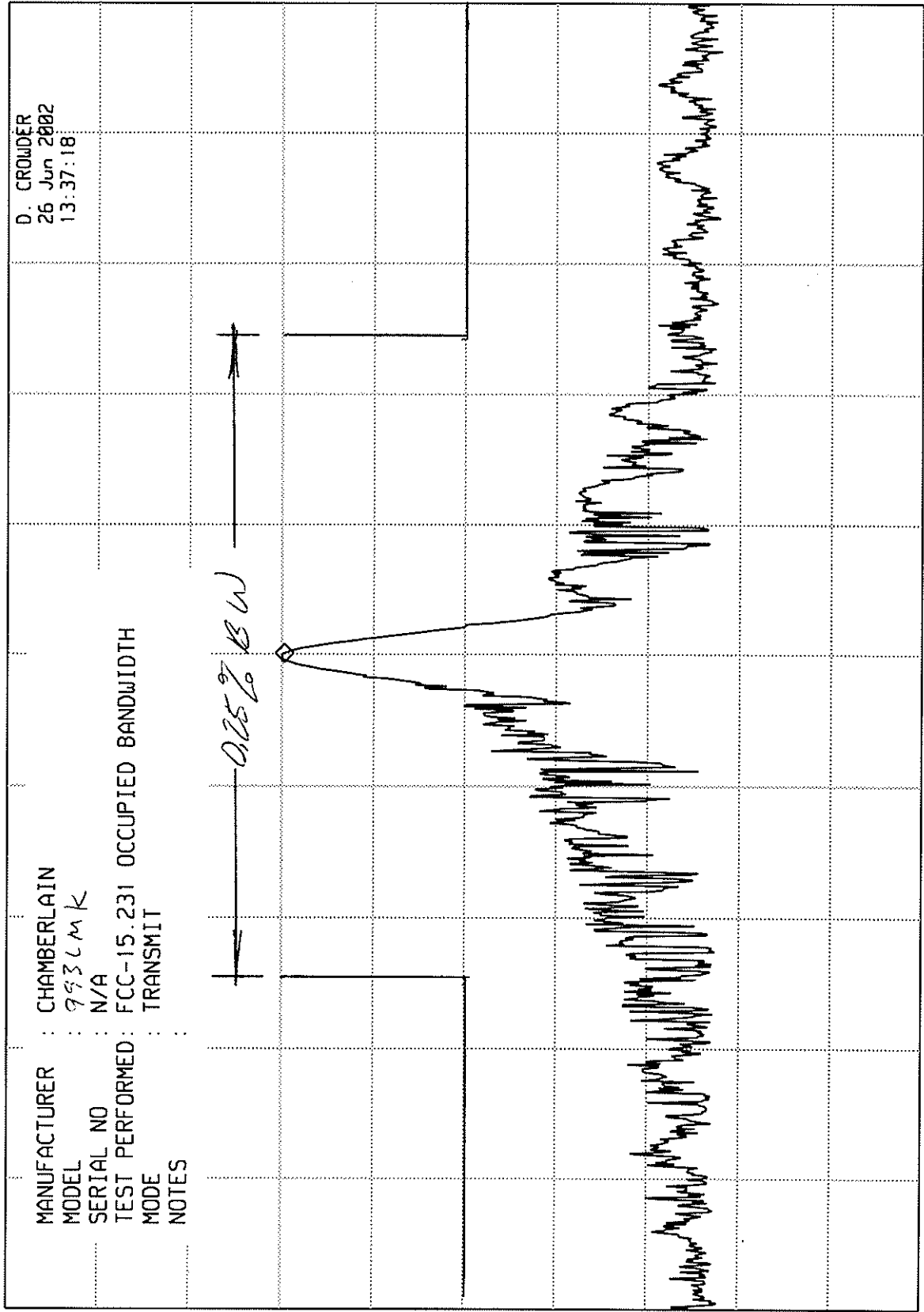
ELITE ELECTRONIC ENGINEERING CO

MKR 390.100 MHz
-40.30 dBm

hp

REF -10.0 dBm

ATTEN 10 dB



MANUFACTURER : CHAMBERLAIN
 MODEL : 993CMK
 SERIAL NO : N/A
 TEST PERFORMED : FCC-15.231 OCCUPIED BANDWIDTH
 MODE : TRANSMIT
 NOTES :

D. CROWDER
 26 Jun 2002
 13:37:18

10 dB/

18 of 18

CENTER 390.10 MHz
RES BW 30 kHz

VBW 100 kHz

SPAN 2.00 MHz
SWP 20.0 msec