

ELITE ELECTRONIC ENGINEERING INCORPORATED  
1516 CENTRE CIRCLE  
DOWNERS GROVE, ILLINOIS 60515-1082

ELITE PROJECT: 28184

DATES TESTED: October 21, 1999

TEST PERSONNEL: Daniel E. Crowder

TEST SPECIFICATION: FCC "Code of Federal Regulations" Title 47  
Part 15, Subpart C

ENGINEERING TEST REPORT NO. 22122  
MEASUREMENT OF RF INTERFERENCE FROM  
A MODEL 97LM REV. B TRANSMITTER

FOR: Chamberlain Manufacturing  
Elmhurst, IL

PURCHASE ORDER NO: 716217

Report By:

  
Daniel E. Crowder

Approved By:

  
Raymond J. Klouda  
Registered Professional  
Engineer of Illinois - 44894

ENGINEERING TEST REPORT NO. 22122

ADMINISTRATIVE DATA AND SUMMARY OF TESTS

**DESCRIPTION OF TEST ITEM:** Transmitter

**MODEL NO:** 97LM REV. B

**SERIAL NO:** N/A

**MANUFACTURER:** Chamberlain Manufacturing

**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:** October 15, 1999

**DATE TESTED:** October 21, 1999

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

**CUSTOMER:** No Chamberlain Manufacturing personnel were present.

**ELITE ELECTRONIC:** Daniel E. Crowder

**ELITE JOB NO.:** 28184

**ABSTRACT:** The model 97LM REV. B Transmitter, does meet the radiated emission and occupied bandwidth requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, for Intentional Radiators, when tested per ANSI C63.4-1992.

The radiated emissions level closest to the limit (worst case) occurred at 390MHz. The emissions level at this frequency was 1.2dB within the limit. See page 18 for more details.

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TOTAL NUMBER OF PAGES IN THIS DOCUMENT,  
(INCLUDING DATA SHEETS): 19

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ENGINEERING TEST REPORT NO. 22122  
MEASUREMENT OF RF INTERFERENCE FROM  
A MODEL 97LM REV. B TRANSMITTER

**1.0 INTRODUCTION:**

**1.1 DESCRIPTION OF TEST ITEM:** On October 21, 1999, a series of radio interference measurements were performed on a model 97LM REV. B 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 Manufacturing of Elmhurst, IL.

The test item was comprised of the following components:

| <u>ITEM</u> | <u>DESCRIPTION</u> |
|-------------|--------------------|
| 97LM REV. B | Transmitter        |

**1.2 PURPOSE:** The test series was performed to determine if the test item meets the 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 1998
- ANSI C63.4-1992, "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 33%.

**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 obtained 9VDC power from an internal 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 a 80cm high non-conductive stand. The test item was energized and transmitting at 390MHz. Transmission was verified by viewing the test item's fundamental frequency on the spectrum analyzer. The transmitting mechanism timed out after a set amount of time so all measurements were made prior to the device timing out. The transmitting mechanism automatically deactivated when released. 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 an HP 8566B 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:

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:**

**4.2.2 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).

**4.2.3 RESULTS:** The plot of the duty cycle is shown on page 15. This data plot is a representative pulse train obtained from the test item. However, the rolling code duty cycle factor was computed using the maximum Word ON time as 31.6 milliseconds in a 100.0

millisecond period. Therefore, the maximum Duty Cycle can be calculated as  $31.6/100.0 = 0.316$ . The duty cycle factor =  $20 \log 0.316 = -10.0$  dB. This information was provided by the manufacturer.

#### 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.

Paragraph 15.231(b) has the following radiated emission limits:

| Fundamental<br>Frequency<br>MHz | Field Intensity<br>uV/m @ 3 meters | Field Strength<br>Harmonics and<br>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 9166.7V/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:** All tests were performed in a 32ft. x 20ft. x 18ft. hybrid ferrite-tile/anechoic absorber lined test chamber. The walls and ceiling of the shielded chamber are lined with ferrite tiles. Anechoic absorber material is installed over the ferrite tile. The floor of the chamber is used as the ground plane. The chamber complies with ANSI C63.4 1992 for site attenuation.

The shielded enclosure prevents emissions from other sources, such as radio and TV stations from interfering with the measurements. All powerlines and signal lines entering the enclosure pass through filters on the enclosure wall. The powerline filters prevent extraneous signals from entering the enclosure on these leads.

Since a quasi-peak detector requires long integration times, it is not practical to automatically sweep through the quasi-peak levels. Therefore, radiated emissions from the test item were first scanned using a peak detector and automatically plotted. The frequencies where significant emission levels were noted were then remeasured using the quasi-peak detector.

The broadband measuring antenna was positioned at a 3 meter distance from the test item. The frequency range from 30MHz to 4GHz was investigated using a peak detector function with the antenna at several heights, horizontal and vertical antenna polarization, and with several different orientations of the test item with respect to the antenna. The maximum levels for each antenna polarization were plotted. A broadband bi-log antenna was used for measurements over the frequency range from 30MHz to 1GHz and a double ridged waveguide antenna was used for measurements above 1GHz.

Final radiated emissions were performed on all significant broadband and narrowband emissions found in the preliminary sweeps using the following methods:

- 1) Below 1GHz measurements were made using a peak detector and a tuned dipole antenna.
- 2) Above 1GHz measurements were made using a peak detector and a double ridged waveguide 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 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 pages 16 and 17. The plots of data from 30MHz to 4GHz represent composite maximum peak readings of multiple antenna heights and multiple orientations of the test item. The plots are presented for a reference only, and are not used as official data.

The final open area radiated levels, with the test item transmitting at 390MHz, are presented on page 18. 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 390MHz. The emissions level at this frequency was 1.2dB within the limit. See page 18 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 30kHz and span was set to 2MHz. The frequency spectrum near the fundamental was plotted.

**4.4.3 RESULTS:** The plot of the emissions near the fundamental frequency are presented on page 19. As can be seen from the data, the transmitter met the occupied bandwidth requirements.

**5.0 CONCLUSION:**

It was found that the Chamberlain Manufacturing model 97LM REV. B Transmitter, does meet the radiated emission and occupied bandwidth requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, 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. 22122

TABLE 1: TEST EQUIPMENT LIST

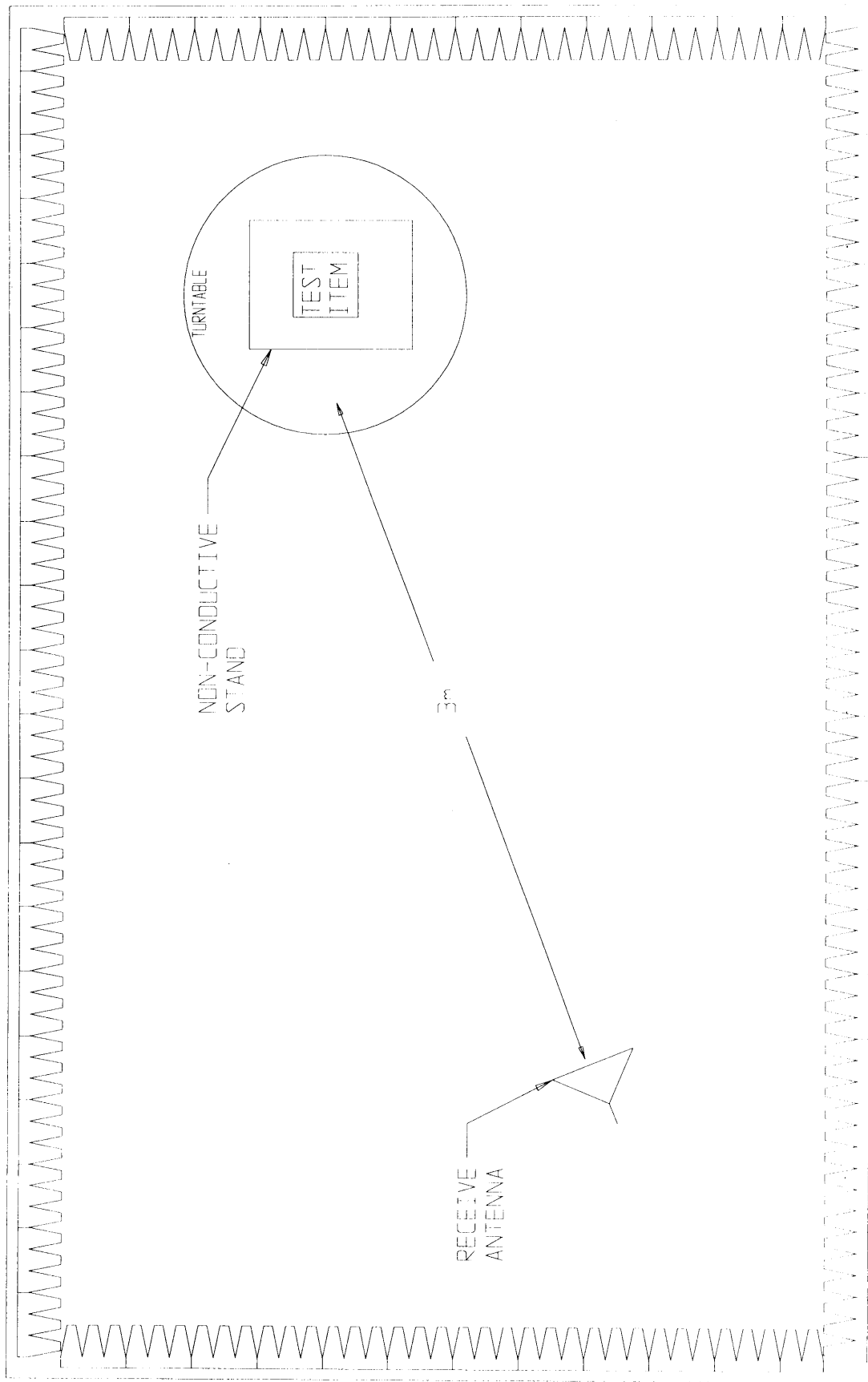
ELITE ELECTRONIC ENG. INC.

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| 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 | ---             | 01/29/99 | N/A     |          |
| Equipment Type: AMPLIFIERS                 |                           |                 |             |            |                 |          |         |          |
| APK0                                       | PRE-AMPLIFIER             | HEWLETT PACKARD | 8449B       | 3008A00662 | 1-26.5GHZ       | 01/29/99 | 12      | 01/29/00 |
| Equipment Type: ANTENNAS                   |                           |                 |             |            |                 |          |         |          |
| NDP0                                       | TUNED DIPOLE ANTENNA      | EMCO            | 3121C-DB3   | 311        | 140-400MHZ      | 10/07/98 | 12      | 10/07/99 |
| NDQ0                                       | TUNED DIPOLE ANTENNA      | EMCO            | 3121C-DB4   | 311        | 400-1000MHZ     | 10/07/98 | 12      | 10/07/99 |
| NWF2                                       | DOUBLE RIDGE WAVEGUIDE    | ELECTRO-METRICS | RGA 180     | 2521       | 1-12.4GHZ       | 08/27/99 | 12      | 08/27/00 |
| Equipment Type: CONTROLLERS                |                           |                 |             |            |                 |          |         |          |
| CDD2                                       | COMPUTER                  | HEWLETT PACKARD | D4171A#ABA  | US61654645 | ---             |          | N/A     |          |
| Equipment Type: PRINTERS AND PLOTTERS      |                           |                 |             |            |                 |          |         |          |
| HRE4                                       | LASER JET 5P              | HEWLETT PACKARD | C3150A      | USHB080992 | ---             |          | N/A     |          |
| Equipment Type: RECEIVERS                  |                           |                 |             |            |                 |          |         |          |
| RAC1                                       | SPECTRUM ANALYZER         | HEWLETT PACKARD | 85660B      | 3407A08369 | 100HZ-22GHZ     | 01/26/99 | 12      | 01/26/00 |
| RACB                                       | RF PRESELECTOR            | HEWLETT PACKARD | 85685A      | 3506A01491 | 20HZ-2GHZ       | 01/28/99 | 12      | 01/28/00 |
| RAF3                                       | QUASISPEAK ADAPTER        | HEWLETT PACKARD | 85650A      | 3303A01775 | 0.01-1000MHZ    | 01/28/99 | 12      | 01/28/00 |
| Equipment Type: TEST CHAMBERS (EMI)        |                           |                 |             |            |                 |          |         |          |
| RM17                                       | 3M ANECHOIC CHAMBER MEETS | EMC TEST SYSTEM | 3M ANECHOIC |            | 30MHZ-18GHZ     | 03/30/99 | 12      | 03/30/00 |

Cal. Interval: Listed in Months I/O: Initial Only N/A: Not Applicable

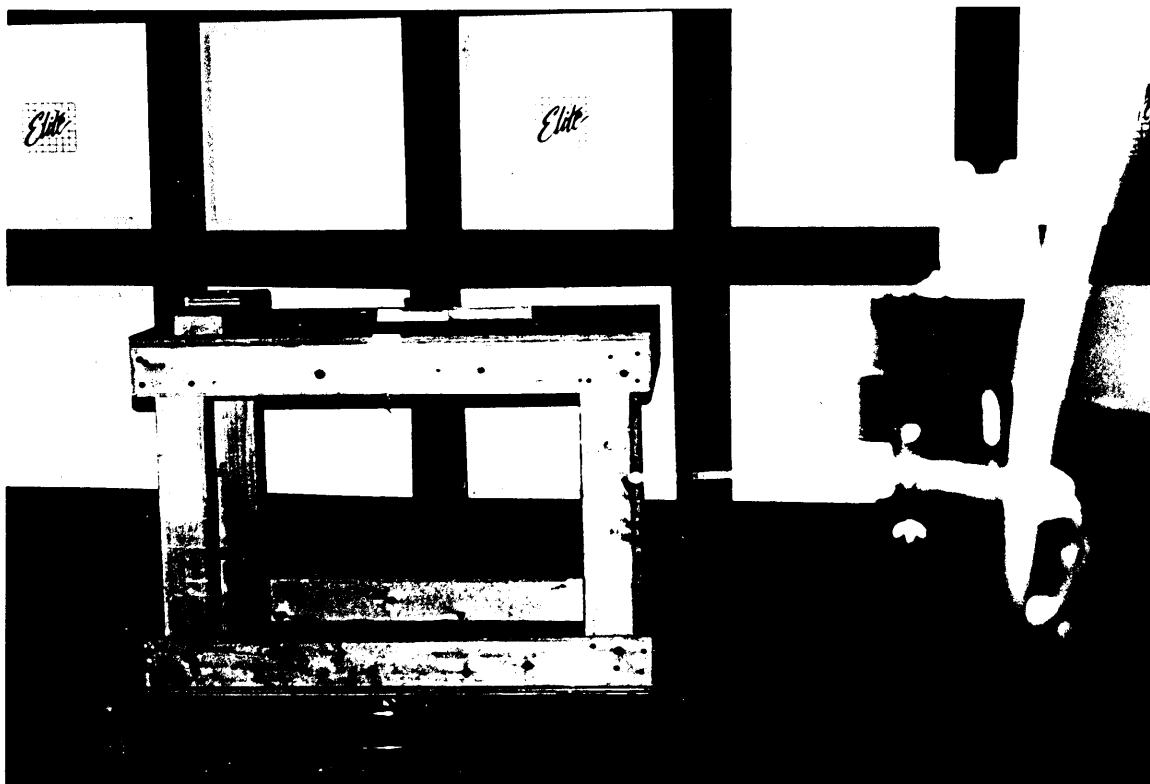
Note 1: For the purpose of this test, the equipment was calibrated over the specified frequency range, pulse rate, or modulation prior to the test or monitored by a calibrated instrument.



ETR 22:22

FIGURE 1: BLOCK DIAGRAM OF TEST ITEM AND PERIPHERAL EQUIPMENT SETUP

FIGURE 2

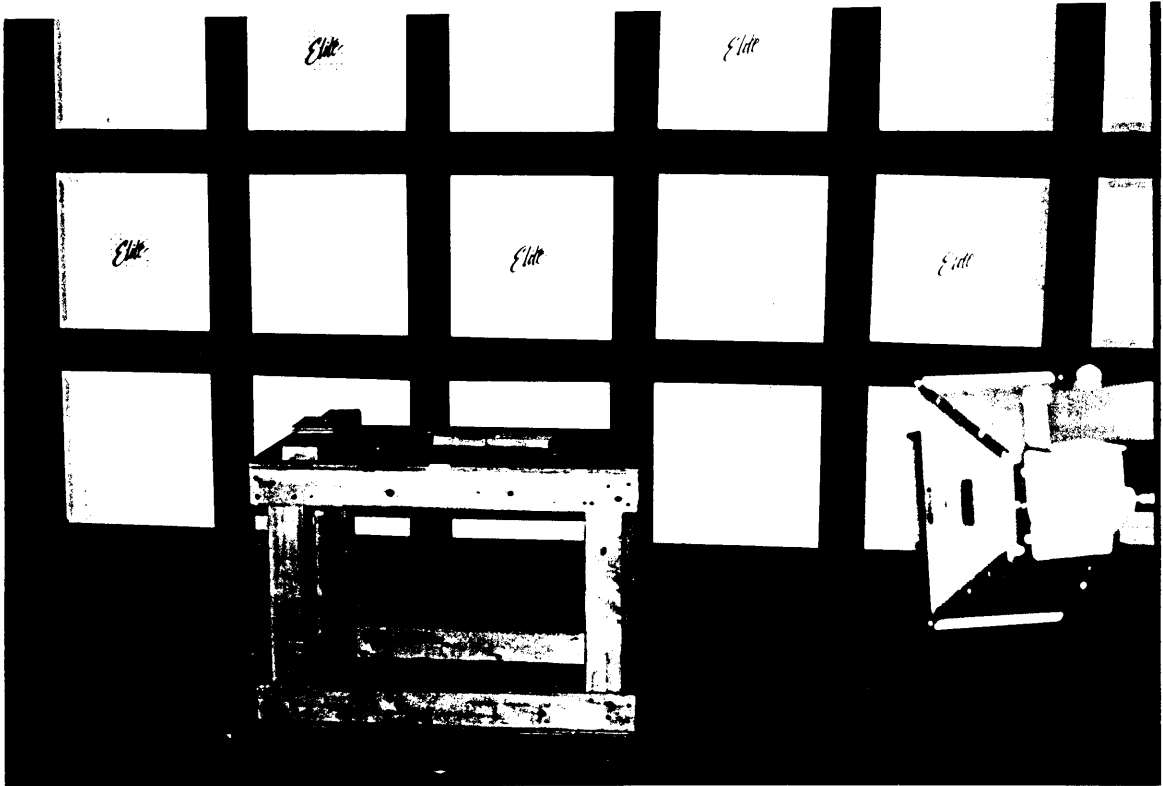


TEST SETUP FOR RADIATED EMISSIONS MEASUREMENTS  
MAXIMIZED FOR MEASUREMENT OF WORST CASE EMISSIONS  
HORIZONTAL POLARIZATION



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

FIGURE 2

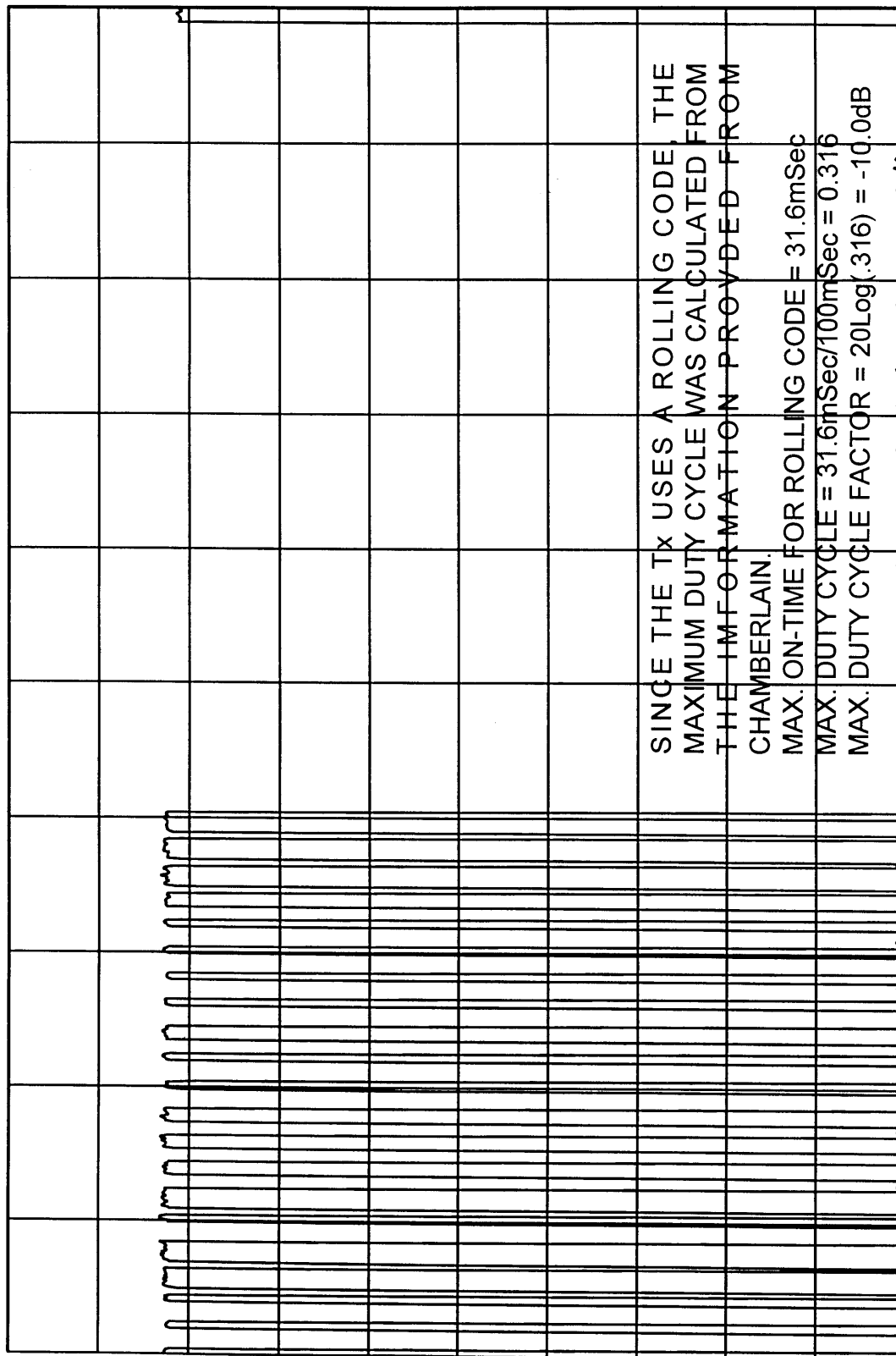


TEST SETUP FOR RADIATED EMISSIONS MEASUREMENTS  
MAXIMIZED FOR MEASUREMENT OF WORST CASE EMISSIONS  
HORIZONTAL POLARIZATION



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

ELITE ELECTRONIC ENGINEERING Co.  
Downers Grove, IL 60515



10 mSEC/DIV

SINCE THE TX USES A ROLLING CODE, THE  
MAXIMUM DUTY CYCLE WAS CALCULATED FROM  
THE INFORMATION PROVIDED FROM  
CHAMBERLAIN.  
MAX. ON-TIME FOR ROLLING CODE = 31.6mSec  
MAX. DUTY CYCLE = 31.6mSec/100mSec = 0.316  
MAX. DUTY CYCLE FACTOR = 20Log(.316) = -10.0dB

TRANSMITTER DUTY CYCLE

FREQUENCY: 389.6221 MHz  
ON TIME : 22.278 mSEC  
OFF TIME : 77.722 mSEC  
DUTY CYCLE = .22 or -13.15 dB  
COMPUTED OVER 100 mSEC

MANUFACTURER : CHAMBERLAIN  
MODEL : 97LM REV. B  
S/N : NONE ASSIGNED  
TEST DATE : 21 Oct 1999  
NOTES :

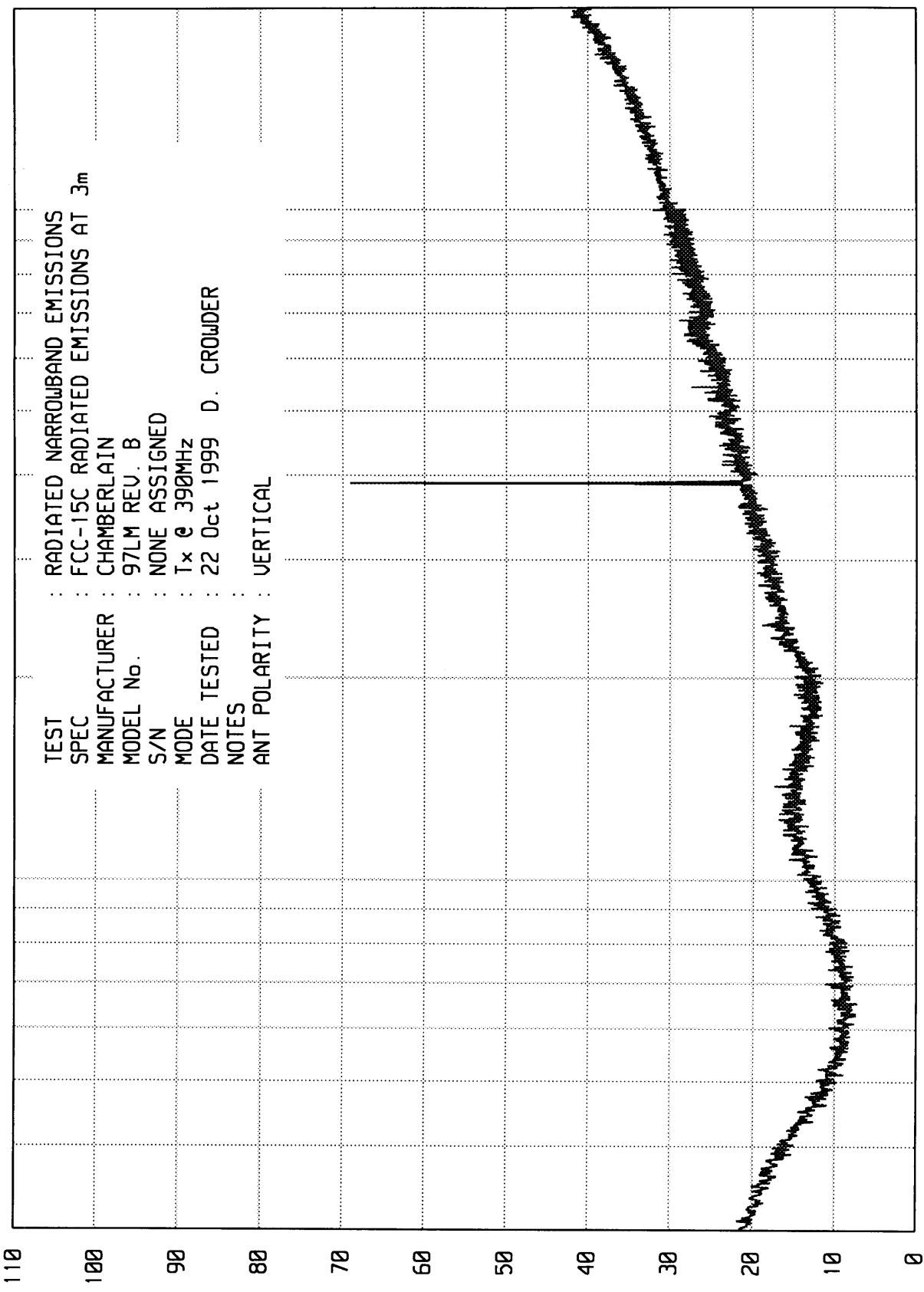
ETR 22122

ETR 22122

ELITE ELECTRONIC ENGINEERING Co.  
Downers Grove, Ill. 60515

UNIU\_EM RUN RUN 1

WKA00 09/13/99



STOP = 2000

FREQUENCY - MHz

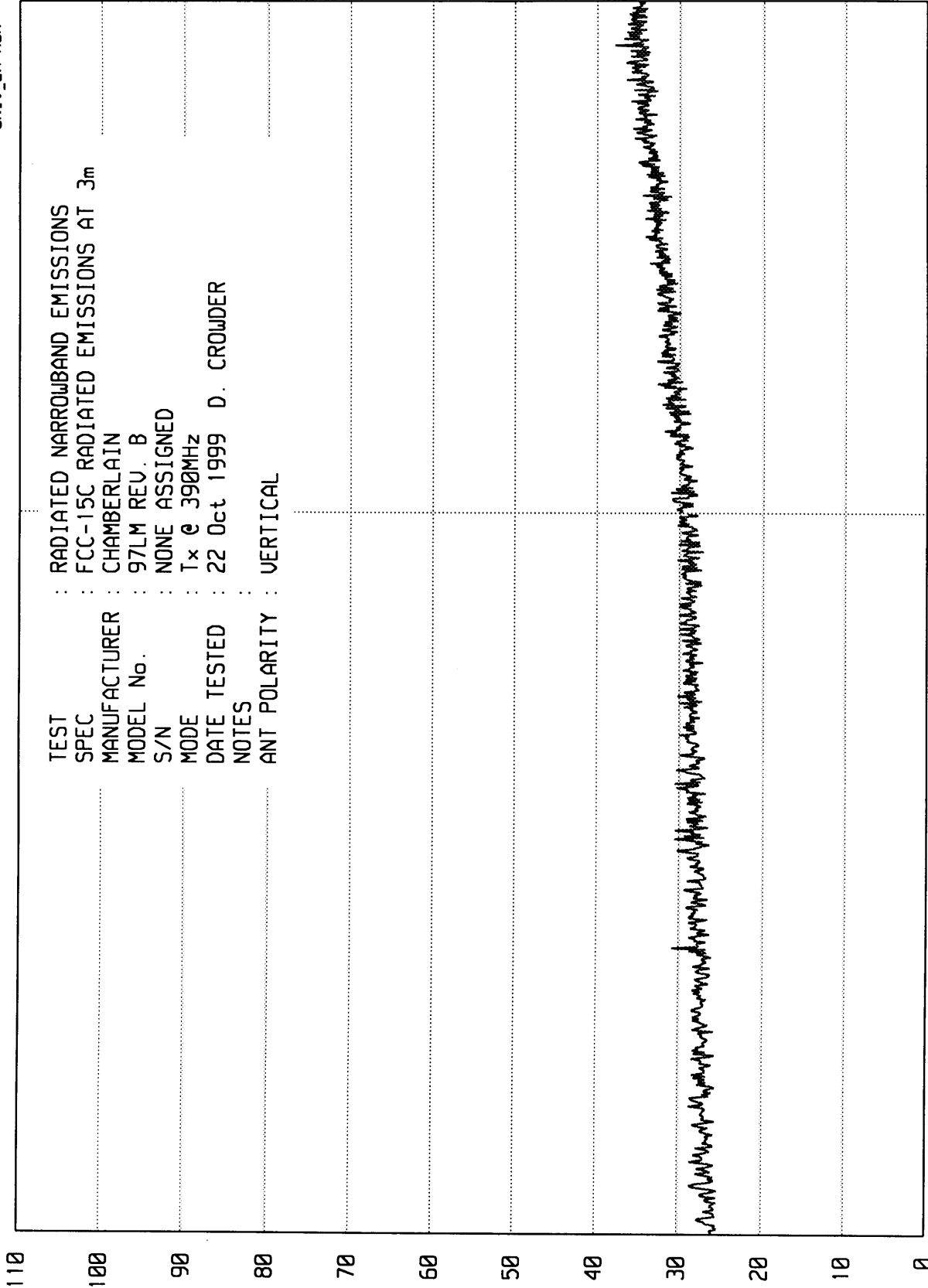
START = 30

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UKA0 09/13/99

UNIT EM RUN RUN 2



RADIATED NARROWBAND EMISSIONS - dBu/m

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START = 2000

FREQUENCY - MHz

STOP = 4000

ETR No. *22122*  
DATA PAGE

SPECIFICATION : FCC PART 15C (REV OCT 1, 94) TRANSMITTER OPEN FIELD DATA  
MANUFACTURER : CHAMBERLAIN  
MODEL : 97LM REV. B  
S/N : NONE ASSIGNED  
TEST DATE : 22 Oct 1999  
NOTES :  
TEST ANTENNA : ROBERTS DIPOLE & DRWG ANTENNAS

| FREQUENCY<br>MHz | ANT<br>POL | MTR<br>RDG<br>dBuV | CBL<br>FAC<br>dB | ANT<br>FAC<br>dB | DUTY<br>CYCLE<br>dB | TOTAL<br>dBuV/m<br>@3m | TOTAL<br>uV/m<br>@3m | LIMIT<br>uV/m<br>@3m | NOTE |
|------------------|------------|--------------------|------------------|------------------|---------------------|------------------------|----------------------|----------------------|------|
| 390.00           | H          | 64.8               | 2.2              | 20.9             | -10.0               | 77.9                   | 7823.4               | 9166.7               |      |
| 390.00           | V          | 53.9               | 2.2              | 20.9             | -10.0               | 67.0                   | 2230.5               | 9166.7               |      |
| 780.00           | H          | 13.7               | 3.5              | 25.9             | -10.0               | 33.0                   | 44.9                 | 916.7                |      |
| 780.00           | V          | 9.4                | 3.5              | 25.9             | -10.0               | 28.7                   | 27.4                 | 916.7                |      |
| 1170.00          | H          | 11.0               | 4.6              | 24.7             | -10.0               | 30.3                   | 32.9                 | 500.0                | *    |
| 1170.00          | V          | 10.5               | 4.6              | 24.7             | -10.0               | 29.8                   | 31.0                 | 500.0                | *    |
| 1560.00          | H          | 21.6               | 5.7              | 25.9             | -10.0               | 43.2                   | 145.0                | 500.0                | *    |
| 1560.00          | V          | 19.5               | 5.7              | 25.9             | -10.0               | 41.1                   | 113.9                | 500.0                | *    |
| 1950.00          | H          | 17.4               | 6.6              | 27.5             | -10.0               | 41.5                   | 119.5                | 916.7                |      |
| 1950.00          | V          | 14.5               | 6.6              | 27.5             | -10.0               | 38.6                   | 85.6                 | 916.7                |      |
| 2340.00          | H          | 8.8                | 7.4              | 28.4             | -10.0               | 34.6                   | 53.5                 | 500.0                | *    |
| 2340.00          | V          | 9.7                | 7.4              | 28.4             | -10.0               | 35.5                   | 59.4                 | 500.0                | *    |
| 2730.00          | H          | 5.0                | 8.0              | 29.6             | -10.0               | 32.6                   | 42.7                 | 500.0                | *    |
| 2730.00          | V          | 6.2                | 8.0              | 29.6             | -10.0               | 33.8                   | 49.0                 | 500.0                | *    |
| 3120.00          | H          | 6.6                | 8.7              | 30.9             | -10.0               | 36.2                   | 64.5                 | 916.7                |      |
| 3120.00          | V          | 6.8                | 8.7              | 30.9             | -10.0               | 36.4                   | 66.0                 | 916.7                |      |
| 3510.00          | H          | 6.2                | 9.6              | 31.9             | -10.0               | 37.7                   | 76.7                 | 916.7                |      |
| 3510.00          | V          | 6.3                | 9.6              | 31.9             | -10.0               | 37.8                   | 77.6                 | 916.7                |      |
| 3900.00          | H          | 5.9                | 10.4             | 32.8             | -10.0               | 39.1                   | 90.0                 | 500.0                | *    |
| 3900.00          | V          | 6.2                | 10.4             | 32.8             | -10.0               | 39.4                   | 93.2                 | 500.0                | *    |

\* DENOTES A FREQUENCY CONFLICT WITH RESTRICTED BANDS

checked by: *DL*

D. CROWDER

# ELITE ELECTRONIC ENGINEERING CO

MKR 389.651 MHz  
-44.10 dBm

hp

REF -13.8 dBm

ATTEN 0 dB

10 dB/

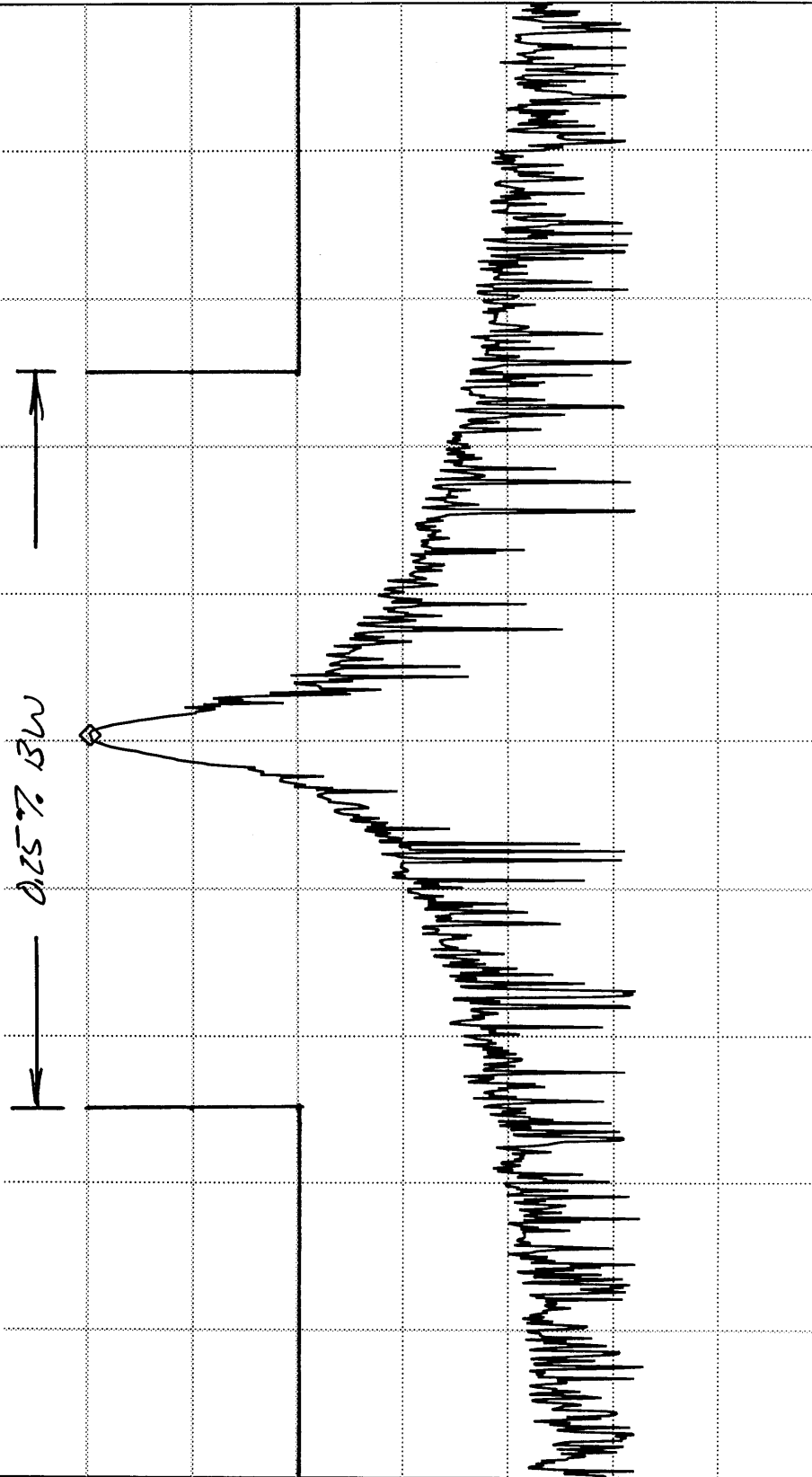
MANUFACTURER : CHAMBERLAIN  
MODEL : 97LM REV. B  
S/N : NONE ASSIGNED  
TEST PERFORMED : FCC-15C OCCUPIED BANDWIDTH  
MODE : Tx @ 390MHz  
NOTES :

D. CROWDER  
21 Oct 1999  
09:17:22

0.25% BW

→

→



CENTER 389.64 MHz  
RES BW 30 kHz

VBW 100 kHz

SPAN 2.00 MHz  
SWP 20.0 msec

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ETC 22122