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

ELITE PROJECT: 30109 DATE TESTED: August 7 and 8, 2001

TEST PERSONNEL: Mark E. Longinotti, NARTE® Certified EMC Engineer, ATL-0154-E

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

ENGINEERING TEST REPORT NO. 24009

MEASUREMENT OF RF INTERFERENCE FROM

A MODEL 1A5539 TRANSMITTER

FOR: Chamberlain Manufacturing
Elmhurst, IL

PURCHASE ORDER NO.: 716961

Report By:
Neil J. Hurley
NARTE® Certified EMC Engineer
ATL-0149-E

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

ENGINEERING TEST REPORT NO. 24009

ADMINISTRATIVE DATA AND SUMMARY OF TESTS

DESCRIPTION OF TEST ITEM: Transmitter

MODEL NO: 1A5539 **SERIAL NO:** None Assigned

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: August 6, 2001

DATE TESTED: August 7 and 8, 2001

PERSONNEL (OPERATORS, OBSERVERS, AND CO-ORDINATORS):
CUSTOMER: No Chamberlain Manufacturing personnel were present.
ELITE ELECTRONIC: Mark E. Longinotti

ELITE JOB NO.: 30109

ABSTRACT: The model 1A5539 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 944.6MHz. The emissions level at this frequency was 1.2dB within the limit. See data page 19 for more details.

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TOTAL NUMBER OF PAGES IN THIS DOCUMENT, (INCLUDING DATA SHEETS): 20

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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 1A5539 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 315 MHz using an internal antenna. The tests were performed for Chamberlain Manufacturing of Elmhurst, IL.

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 2000
- 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 25°C and the relative humidity was 49%.

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 12VDC power from an internal battery.

2.2 GROUNDING: Since the test item was powered with 12VDC, it was ungrounded during the tests.

2.3 PERIPHERAL EQUIPMENT: No peripheral equipment or 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.

For all tests, four buttons were pressed on the keypad, followed by pressing Enter thereby setting the unit to transmit. The transmitting mechanism automatically deactivated. The battery voltage was periodically checked to ensure proper operation at maximum level. The tests were performed with the test item transmitting at 315MHz.

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 (Word ON/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: All radio frequency voltages on the power lines of an intentional radiator shall be below 250uV (quasi-peak) over the frequency range from 0.45MHz to 30MHz. It is also to

be noted that if emitted levels in the peak detector function do not exceed the above limits, the test item does meet the intent of these 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 16. Since the transmitter uses a rolling code the duty cycle used was calculated based on the worst case. The worst case information was supplied by Chamberlain Manufacturing. With the test item transmitting at 315MHz, the worst case duty cycle would be a 31 msec Word ON time during a 100 millisecond period. The duty cycle factor is 20*log(31/100) = -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.

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 314.9 MHz, the limit at the fundamental is 6037.1uV/m @ 3m and the limit on the harmonics is 603.7uV/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.

Preliminary radiated emissions measurements were first performed using a peak detector and automatically plotted. The frequencies where significant emission levels were noted were then remeasured.

With the broadband measuring antennas positioned at a 3 meter distance from the test item, the frequency range from 30MHz to 1GHz was investigated using a peak detector function with the antennas set for vertical polarization.

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

1) Measurements were made using a peak detector and a tuned dipole below 1GHz and a horn antenna above 1GHz.

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 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.

   (d) The fundamental through the 10th harmonic of the transmit frequency were measured.

   (e) The peak detected levels were converted to average levels using a duty cycle factor which was computed from the pulse train.

4.3.3 RESULTS: The preliminary plots, with the test item transmitting at 315MHz, are presented on data pages 17 and 18. 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 315 MHz, are presented on data page 19. 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 944.6MHz. The emissions level at this

frequency was 1.2dB within the limit. See data page 19 for details. Photographs of the test configuration which yielded the highest, or worst case, radiated emission levels are shown on Figures 2 and 3.

4.4 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 20. As can be seen from this data page, the transmitter met the occupied bandwidth requirements.

5.0 CONCLUSION:

It was found that the Chamberlain Manufacturing model 1A5539 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.

TABLE I: TEST EQUIPMENT LIST

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	---	01/31/00	N/A	
Equipment Type: AMPLIFIERS								
APK0	PRE-AMPLIFIER	HEWLETT PACKARD	8449B	3008A00662	1-26.5GHZ	02/15/01	12	02/15/02
Equipment Type: ANTENNAS								
NDP0	TUNED DIPOLE ANTENNA	EMCO	3121C-DB3	311	140-400MHZ	11/29/00	12	11/29/01
NDQ0	TUNED DIPOLE ANTENNA	EMCO	3121C-DB4	311	400-1000MHZ	11/29/00	12	11/29/01
NTA0	BILOG ANTENNA	CHASE EMC LTD.	BILOG CBL611	2057	0.03-2GHZ	05/09/01	12	05/09/02
NWF2	RIDGED WAVE GUIDE	ELECTRO-METRICS	RGA 180	2521	1-12.4GHZ	08/03/01	12	08/03/02
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								
RAC1	SPECTRUM ANALYZER	HEWLETT PACKARD	85660B	3407A08369	100HZ-22GHZ	01/16/01	12	01/16/02
RACB	RF PRESELECTOR	HEWLETT PACKARD	85685A	3506A01491	20HZ-2GHZ	05/09/01	12	05/09/02
RAF3	QUASIPEAK ADAPTER	HEWLETT PACKARD	85650A	3303A01775	0.01-1000MHZ	01/17/01	12	01/17/02
Equipment Type: TEST CHAMBERS (EMI)								
R21F	3M ANECHOIC CHAMBER MEETS	EMC TEST SYSTEM	3M ANECHOIC		30MHZ-18GHZ	05/18/01	12	05/18/02

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.

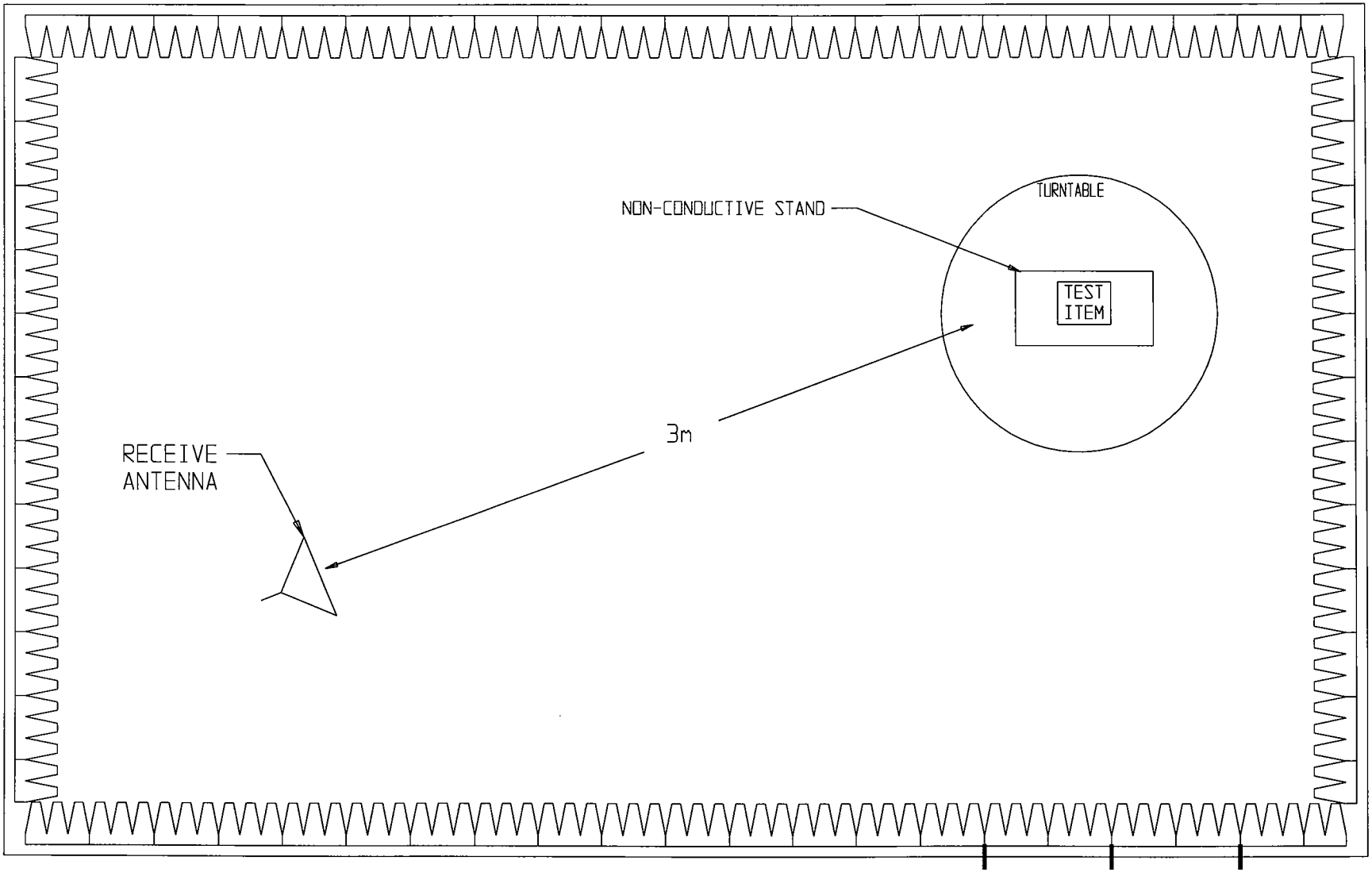
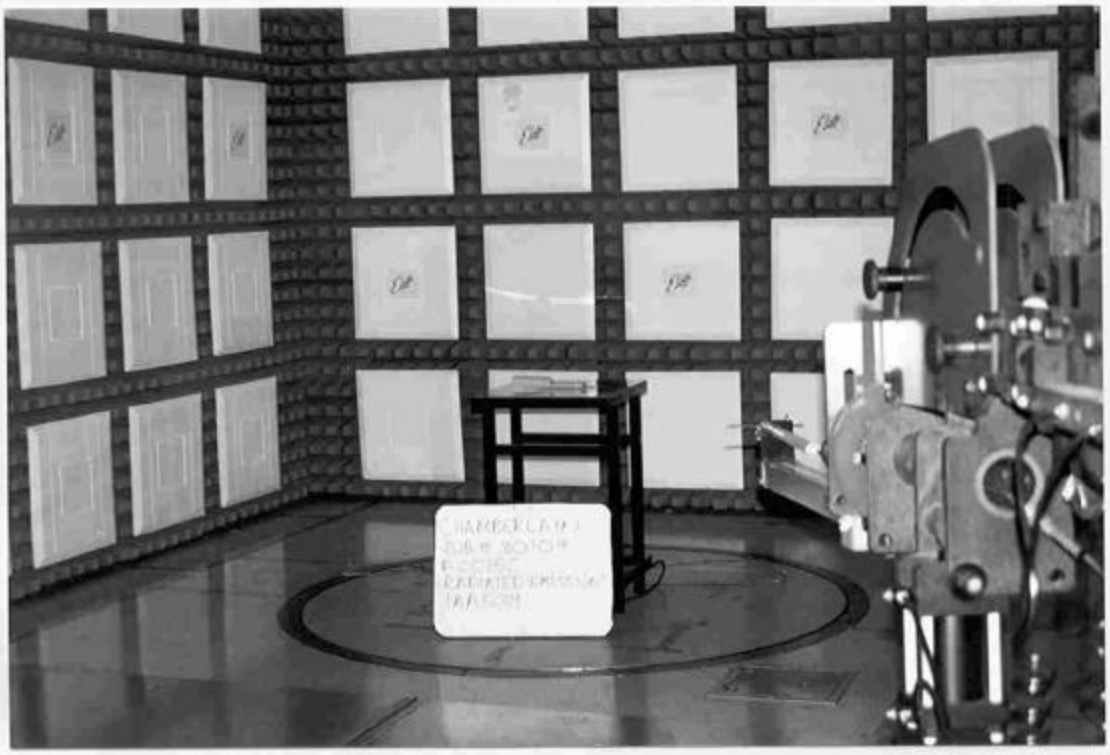


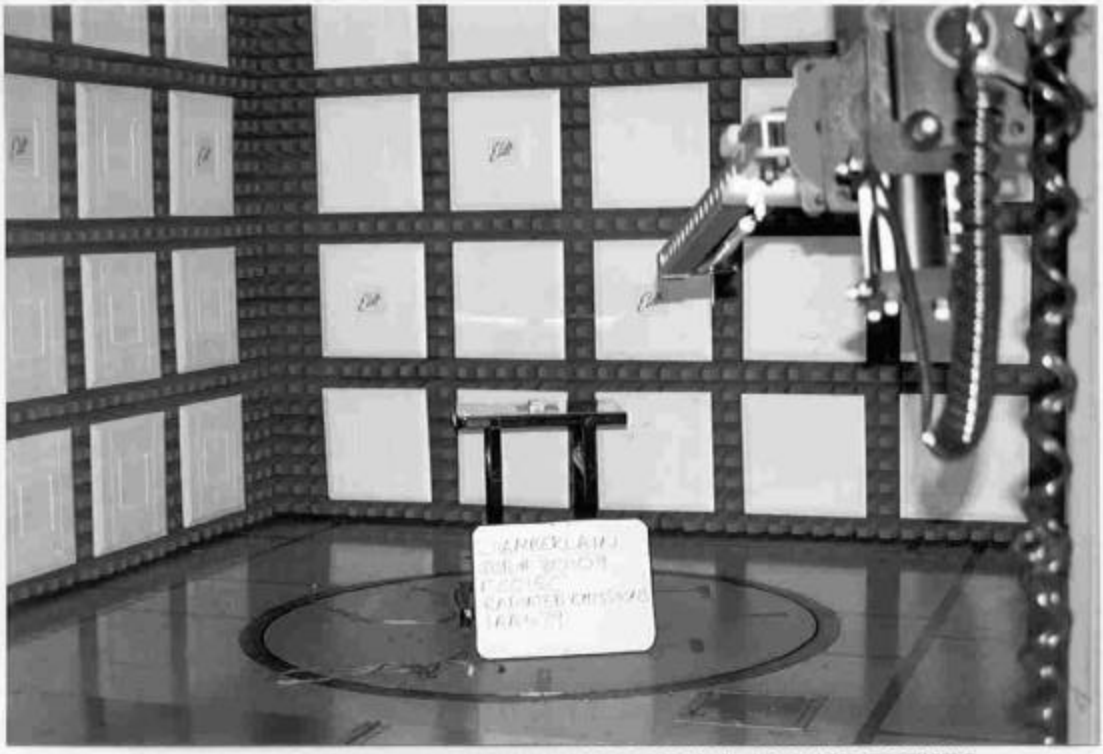
FIGURE 1 BLOCK DIAGRAM OF TEST ITEM AND PERIPHERAL EQUIPMENT SETUP

ETR 24009

FIGURE 2

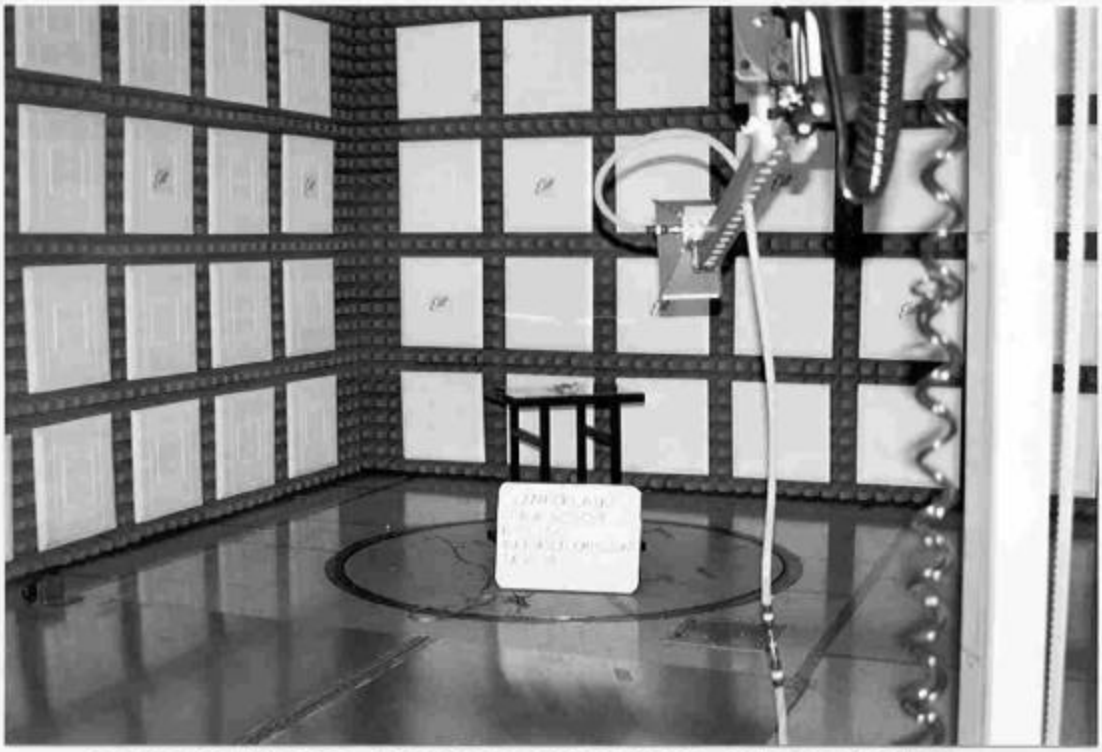


TEST SETUP FOR RADIATED EMISSIONS MEASUREMENTS
MAXIMIZED FOR MEASUREMENT OF WORST CASE EMISSIONS
HORIZONTAL POLARIZATION

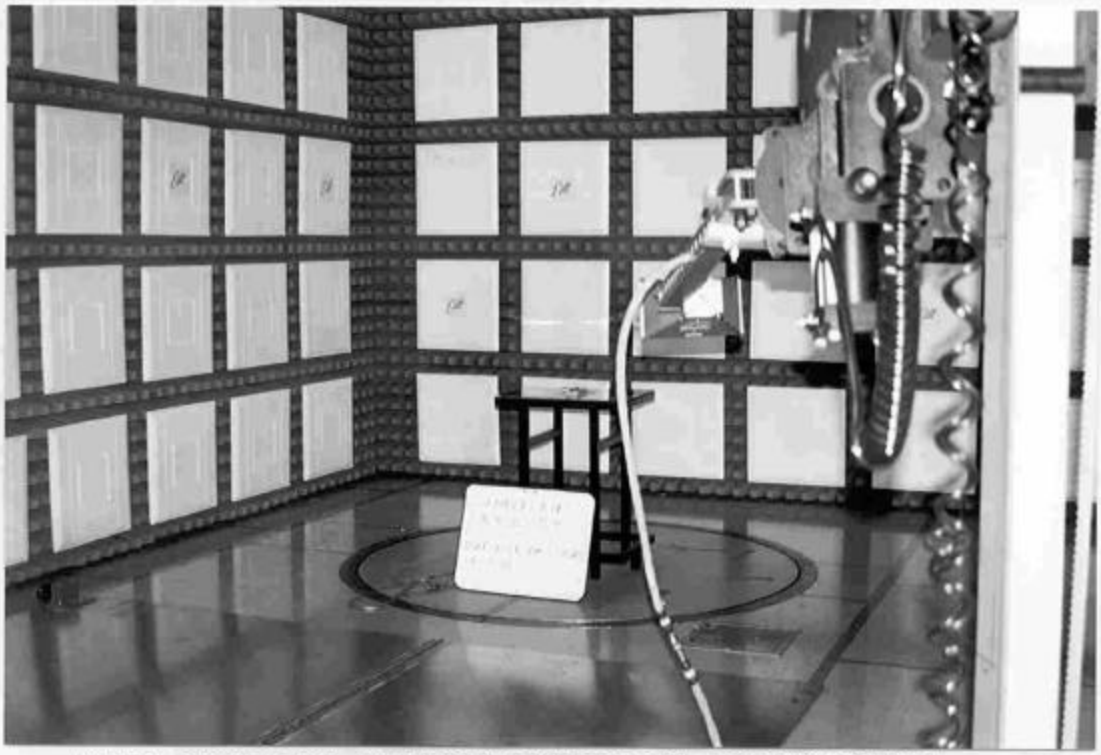


TEST SETUP FOR RADIATED EMISSIONS MEASUREMENTS
MAXIMIZED FOR MEASUREMENT OF WORST CASE EMISSIONS
VERTICAL POLARIZATION

FIGURE 3



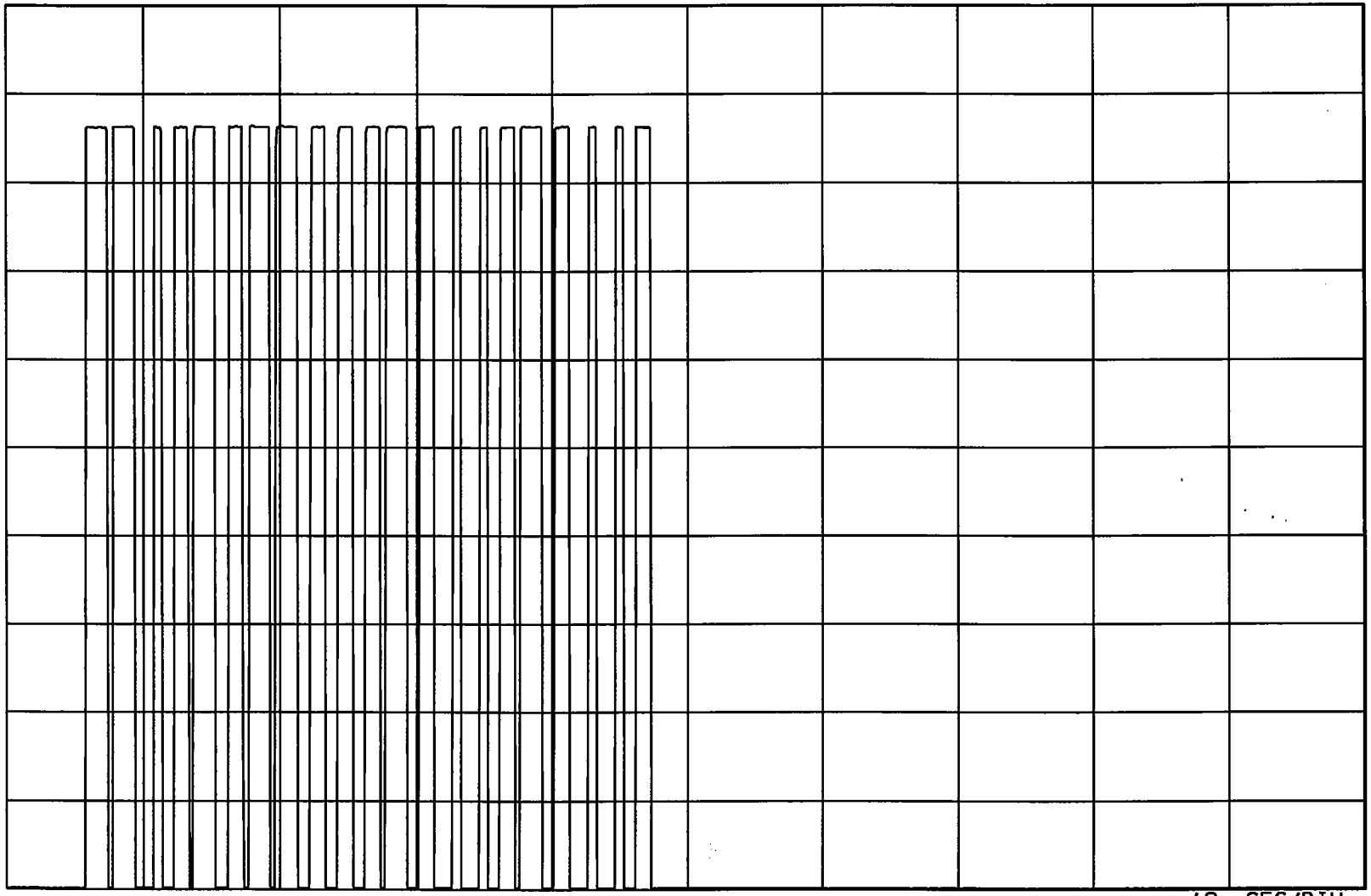
TEST SETUP FOR RADIATED EMISSIONS MEASUREMENTS
MAXIMIZED FOR MEASUREMENT OF WORST CASE EMISSIONS
HORIZONTAL POLARIZATION



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

ELITE ELECTRONIC ENGINEERING Co.

Downers Grove, Il 60515

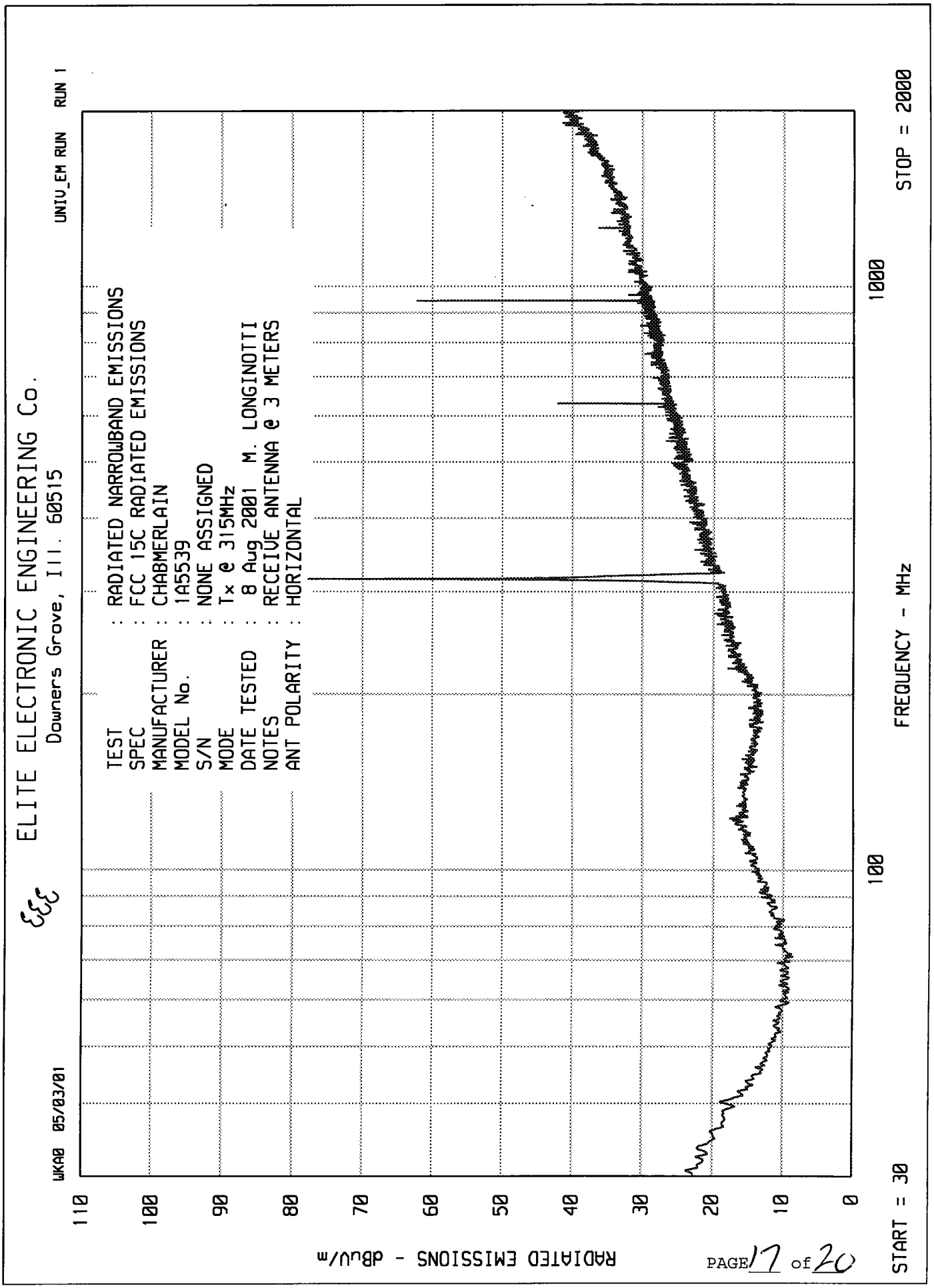


10 mSEC/DIV

TRANSMITTER DUTY CYCLE

FREQUENCY: 314.9293 MHz
ON TIME : 23.776 mSEC
OFF TIME : 76.224 mSEC
DUTY CYCLE = .24 or -12.4 dB
COMPUTED OVER 100 mSEC

MANUFACTURER : CHAMBERLAIN
MODEL : 1A5539
S/N : NONE ASSIGNED
TEST DATE : 6 Aug 2001
NOTES : Tx @ 315 MHz


ELITE ELECTRONIC ENGINEERING Co.
Downers Grove, Ill. 60515
UNIV_EM RUN RUN 1
WKA0 05/03/01
TEST : RADIATED NARROWBAND EMISSIONS
SPEC : FCC 15C RADIATED EMISSIONS
MANUFACTURER : CHABMERLAIN
MODEL No. : 1A5539
S/N : NONE ASSIGNED
MODE : Tx @ 315MHz
DATE TESTED : 8 Aug 2001 M. LONGINOTTI
NOTES : RECEIVE ANTENNA @ 3 METERS
ANT POLARITY : HORIZONTAL
RADIATED EMISSIONS - dBuV/m
110
100
90
80
70
60
50
40
30
20
10
0
START = 30
100
1000
STOP = 2000
FREQUENCY - MHz

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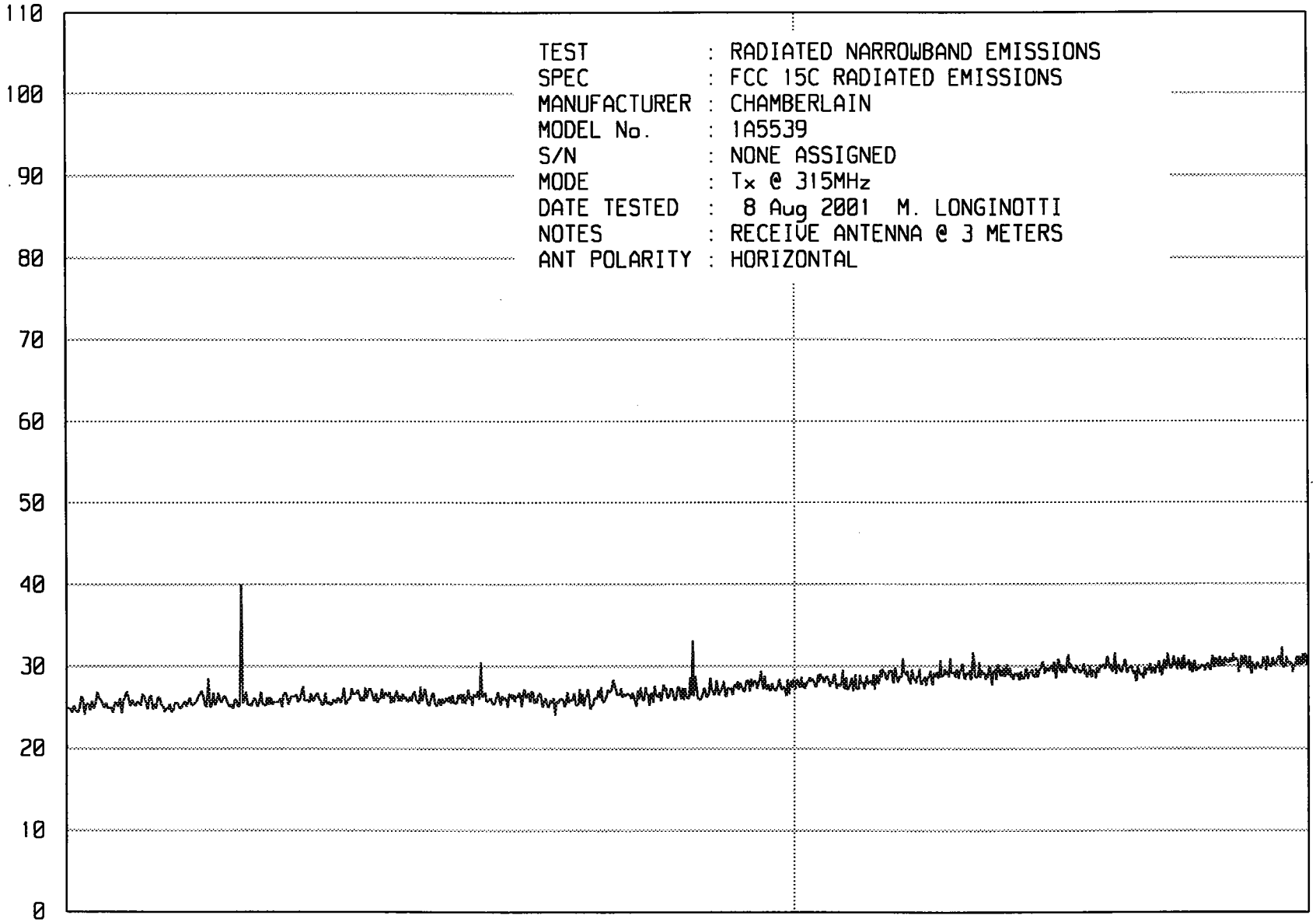
Downers Grove, Ill. 60515

WKA0 05/03/01

UNIV_EM RUN RUN 1



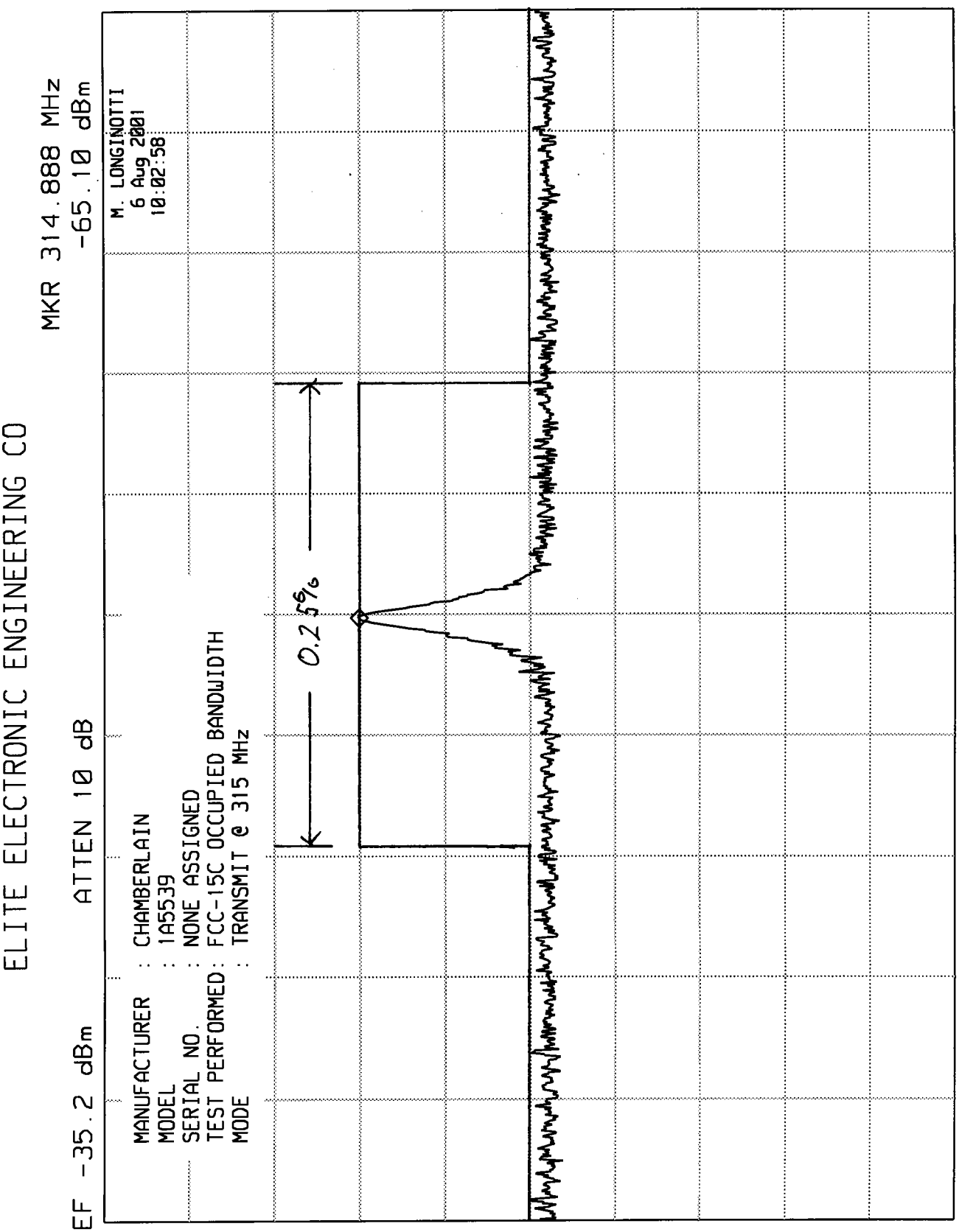
ETR No.
DATA PAGE

SPECIFICATION : FCC PART 15C(REV OCT 1, 94) TRANSMITTER OPEN FIELD DATA
MANUFACTURER : CHAMBERLAIN
MODEL : 1A5539
S/N : NONE ASSIGNED
TEST DATE : 7 Aug 2001
NOTES : Tx @ 315 MHz
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
314.89	H	59.7	1.8	18.7	-10.2	70.0	3171.1	6037.1	
314.89	V	49.9	1.8	18.7	-10.2	60.2	1026.1	6037.1	
629.70	H	28.8	2.7	24.6	-10.2	45.9	196.4	603.7	
629.70	V	18.1	2.7	24.6	-10.2	35.2	57.3	603.7	
944.60	H	33.1	3.4	28.5	-10.2	54.8	550.3	603.7	
944.60	V	26.3	3.4	28.5	-10.2	48.0	251.6	603.7	
1259.60	H	16.9	2.3	24.8	-10.2	33.8	49.2	603.7	
1259.60	V	13.9AMB	2.3	24.8	0.0	41.0	112.8	603.7	
1574.40	H	19.6	2.6	25.8	-10.2	37.7	77.1	500.0	*
1574.40	V	16.1	2.6	25.8	-10.2	34.2	51.5	500.0	*
1889.20	H	19.7	2.8	27.2	-10.2	39.5	94.0	603.7	
1889.20	V	16.4AMB	2.8	27.2	0.0	46.4	208.1	603.7	
2204.00	H	20.5	3.1	28.2	-10.2	41.6	120.4	500.0	*
2204.00	V	15.4	3.1	28.2	-10.2	36.5	66.9	500.0	*
2519.00	H	13.6	3.4	29.1	-10.2	35.9	62.5	603.7	
2519.00	V	9.9AMB	3.4	29.1	0.0	42.4	132.0	603.7	
2834.00	H	13.8	3.8	30.2	-10.2	37.5	75.4	500.0	*
2834.00	V	6.1AMB	3.8	30.2	0.0	40.0	100.6	500.0	*
3149.00	H	11.2	4.0	31.1	-10.2	36.2	64.2	603.7	
3149.00	V	8.9AMB	4.0	31.1	0.0	44.1	159.5	603.7	

* DENOTES A FREQUENCY CONFLICT WITH RESTRICTED BANDS

checked by: M. LONGINOTTI


hp
ELITE ELECTRONIC ENGINEERING CO
REF -35.2 dBm
ATTEN 10 dB
MKR 314.888 MHz
-65.10 dBm
10 dB/
M. LONGINOTTI
6 Aug 2001
10:02:58
MANUFACTURER : CHAMBERLAIN
MODEL : 1A5539
SERIAL NO. : NONE ASSIGNED
TEST PERFORMED: FCC-15C OCCUPIED BANDWIDTH
MODE : TRANSMIT @ 315 MHz
0.2 5%
CENTER 314.89 MHz
RES BW 30 kHz(i)
VBW 300 kHz
SPAN 2.00 MHz
SWP 20.0 msec