Measurement of RF Interference from a Model 001A6234-1 Keyless Entry Transmitter

For : Chamberlain Manufacturing
Elmhurst, IL

P.O. No. : 852056
Date Received : October 20, 2005
Date Tested : October 21, 2005
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: EMC Test Engineer, ATL-0154-E
Specification : FCC "Code of Federal Regulations" Title 47
Part 15, Subpart C

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Revision History

Revision	Date	Description
35781-01	11-02-2005	Initial release

Measurement of RF Emissions from a Keyless Entry Transmitter, Model No. 001A6234-1

1.0 INTRODUCTION:

1.1 Description of Test Item - This document represents the results of the series of radio interference measurements performed on a Keyless Entry Transmitter, Model No. 001A6234-1, Sample 1, (hereinafter referred to as the test item). The test item was designed to transmit at approximately 390MHz using an internal antenna. The test item was manufactured and submitted for testing by Chamberlain Manufacturing located in 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 15.207 and 15.231 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 2004.
- 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 32%.

2.0 TEST ITEM SETUP AND OPERATION:

The test item is a Keyless Entry Transmitter, Part No. 001A6234-1. A block diagram of the test item setup is shown as Figure 1.

2.1 Power Input - The test item was powered with a 9V battery.

2.2 Grounding - The test item 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 and the test item was energized. The test item was set up so that when a button on the keypad was pushed it would transmit continuously at 390MHz.

2.6 Test Item Modifications No modifications were required for compliance to the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Sections 15.207 and 15.231 for Intentional Radiators requirements.

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).

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 the center frequency to the transmitter frequency and then setting a zero span with 10msec/div. The amplitude settings are adjusted so that the on/off transitions clear the 4th division from the bottom of the display. The markers are set at the 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 transmitter uses a rolling code, the duty cycle correction factor used was calculated based on the average case. The following average case information was supplied by Chamberlain Manufacturing:

An average ON time is used because of the ever changing rolling code.

For 100 msec period:

1msec average sync pulse (50% of the time the sync pulse is 0.5msec and 50% of the time the sync pulse is 1.5msec)

20 digits for a total time of 40 msec, but only half of them are ON (oscillator running) for an average of 20 msec.

59msec average blanktime

The total is 100msec.

20 log 21/100 = -13.55

With the test item transmitting at 390MHz, the average case duty cycle correction factor would be -13.55dB.

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 9169.2uV/m @ 3m and the limit on the harmonics is 916.9uV/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 - Radiated measurements 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.

A preliminary radiated emissions test was performed to determine the emission characteristics of the test item. For the preliminary test, a broadband measuring antenna was positioned at a 3 meter distance from the test item. The entire frequency range from 30MHz to 4.0GHz was investigated using a peak detector function. The data was then processed by the computer to calculate equivalent field intensity.

The final emission tests were then manually performed over the frequency range of 30MHz to 4000MHz. Between 30MHz and 1000MHz, a tuned dipole antenna was used as the pick-up device. A broadband double ridged waveguide antenna was used as the pick-up device for all frequencies above 1GHz. All significant broadband and narrowband signals were measured and recorded. The peak detected levels were converted to average levels using a duty cycle factor which was computed from the pulse train.

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

(1) The test item was rotated so that all of its sides were exposed to the receiving antenna.
(2) Since the measuring antenna is linearly polarized, both horizontal and vertical field components were measured.
(3) The measuring antenna was raised and lowered from 1 to 4 meters for each antenna polarization to maximize the readings.
(4) For hand-held or body-worn devices, the test item was rotated through three orthogonal axes to determine which orientation produces the highest emission relative to the limit.

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 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 closet to the limit (worst case) occurred at 390MHz. The emissions level at this frequency was 3.7dB 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 Requirement - 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. In addition, the 99% emission bandwidth measured 138 kHz when using the analyzer's special function key with the measurement BW set to 30 kHz.

5.0 CONCLUSIONS:

It was determined that the Chamberlain Manufacturing Keyless Entry Transmitter, Part No. 001A6234-1, Sample 1, did fully meet the conducted and radiated emission requirements of the FCC

"Code of Federal Regulations" Title 47, Part 15, Subpart C, Sections 15.207 and 15.231 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: 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	02/07/05	12	02/07/06
Equipment Type: ANTENNAS								
NDP0	TUNED DIPOLE ANTENNA	EMCO	3121C-DB3	311	140-400MHZ	02/01/05	12	02/01/06
NDQ0	TUNED DIPOLE ANTENNA	EMCO	3121C-DB4	311	400-1000MHZ	02/01/05	12	02/01/06
NTA1	BILOG ANTENNA	CHASE EMC LTD.	BILOG CBL611	2054	0.03-2GHZ	08/08/05	12	08/08/06
NWF0	RIDGED WAVE GUIDE	EMCO	3105	2035	1-12.4GHZ	10/01/05	12	10/01/06
Equipment Type: CONTROLLERS								
CDS2	COMPUTER	GATEWAY	MFATXPNT NMZ	0028483108	1.8GHZ		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	02/04/05	12	02/04/06
RACB	RF PRESELECTOR	HEWLETT PACKARD	85685A	3506A01491	20HZ-2GHZ	02/07/05	12	02/07/06
RAF3	QUASIPEAK ADAPTER	HEWLETT PACKARD	85650A	3303A01775	0.01-1000MHZ	02/04/05	12	02/04/06

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.

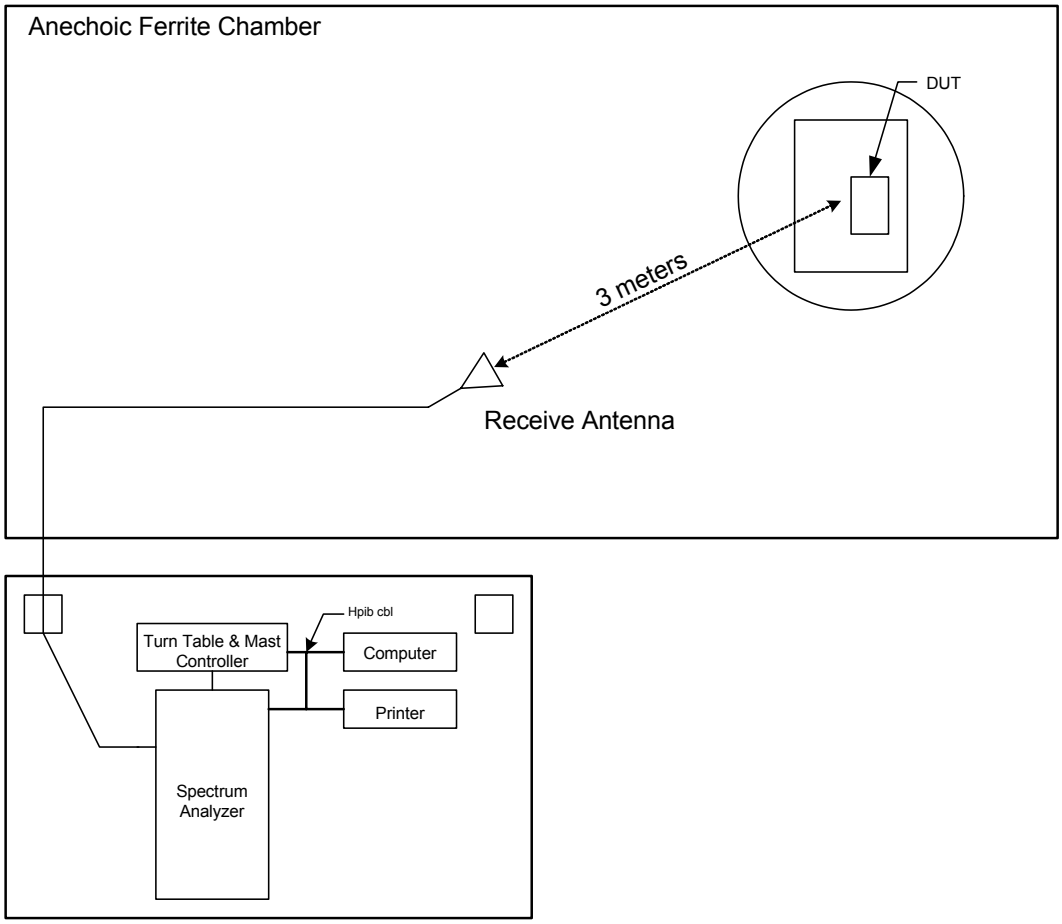
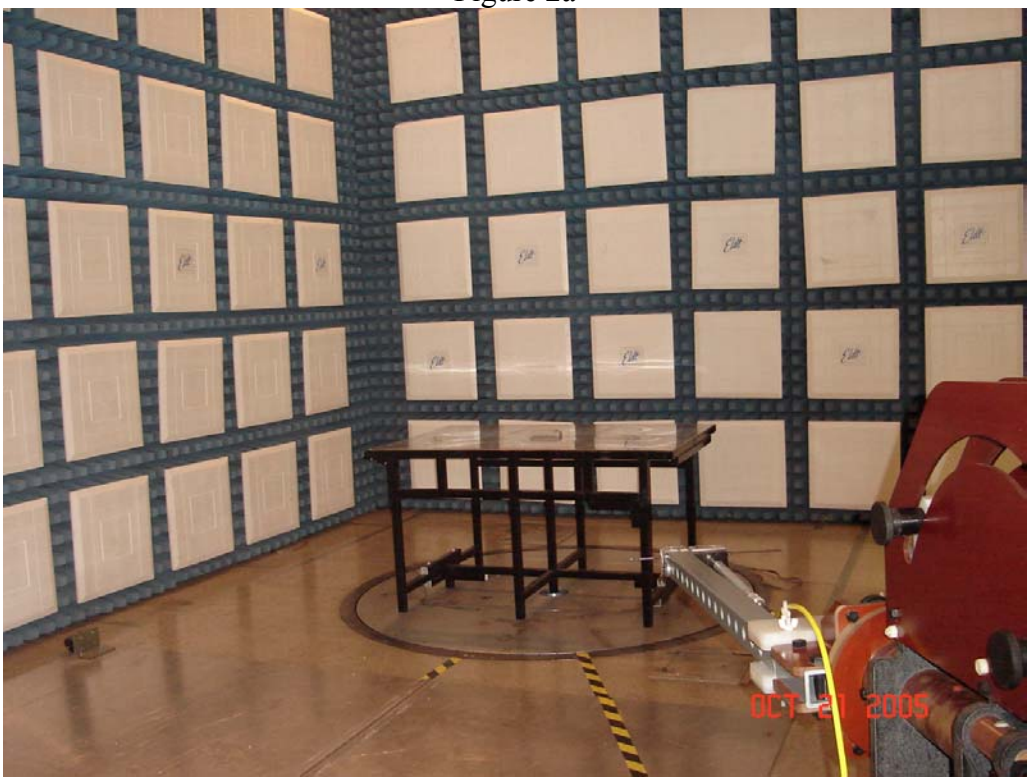


FIGURE 1 BLOCKDIAGRAM OF TEST SETUP

Figure 2a



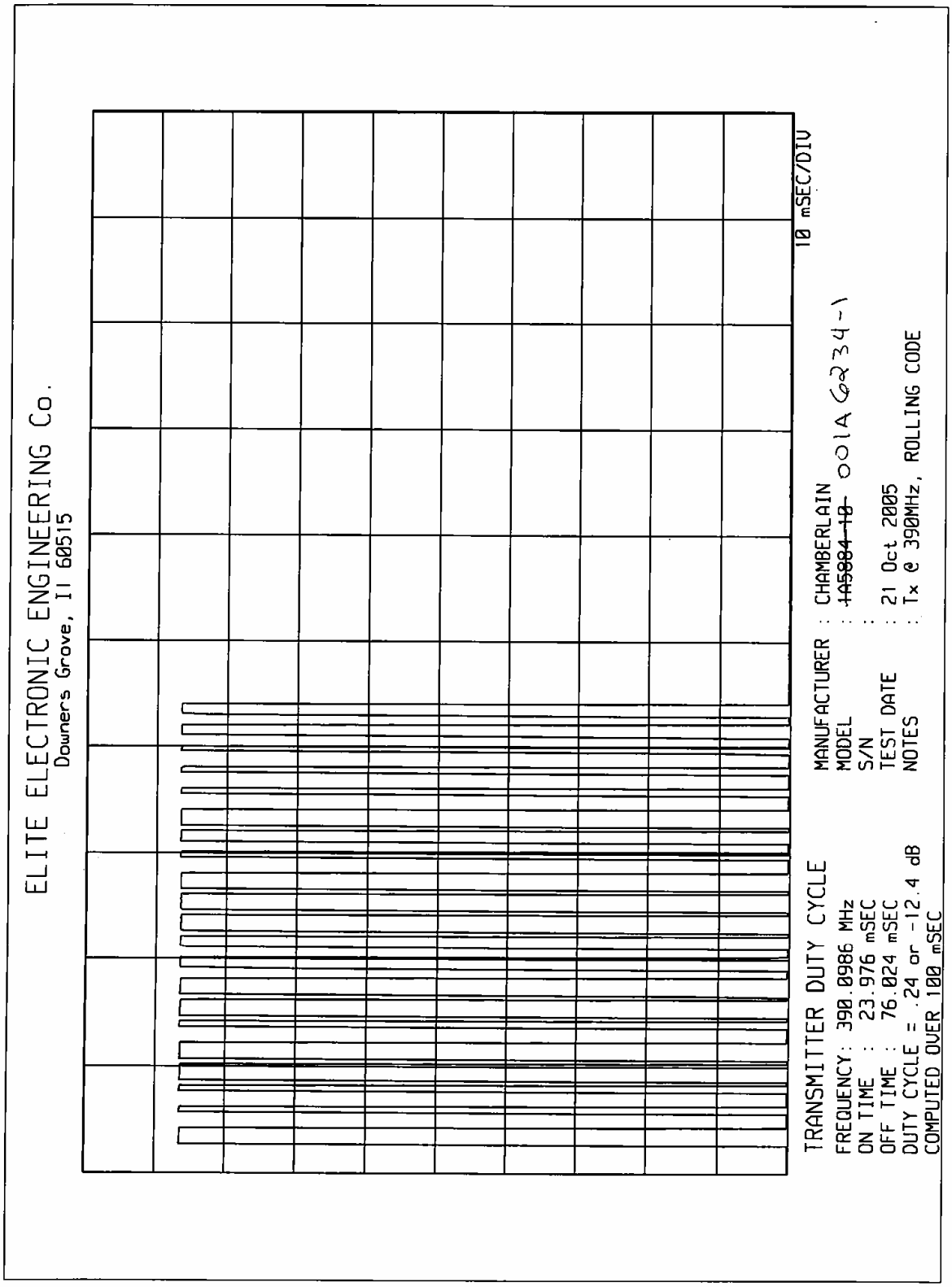
Test Setup for Radiated Emissions, 390MHz - Horizontal Polarization

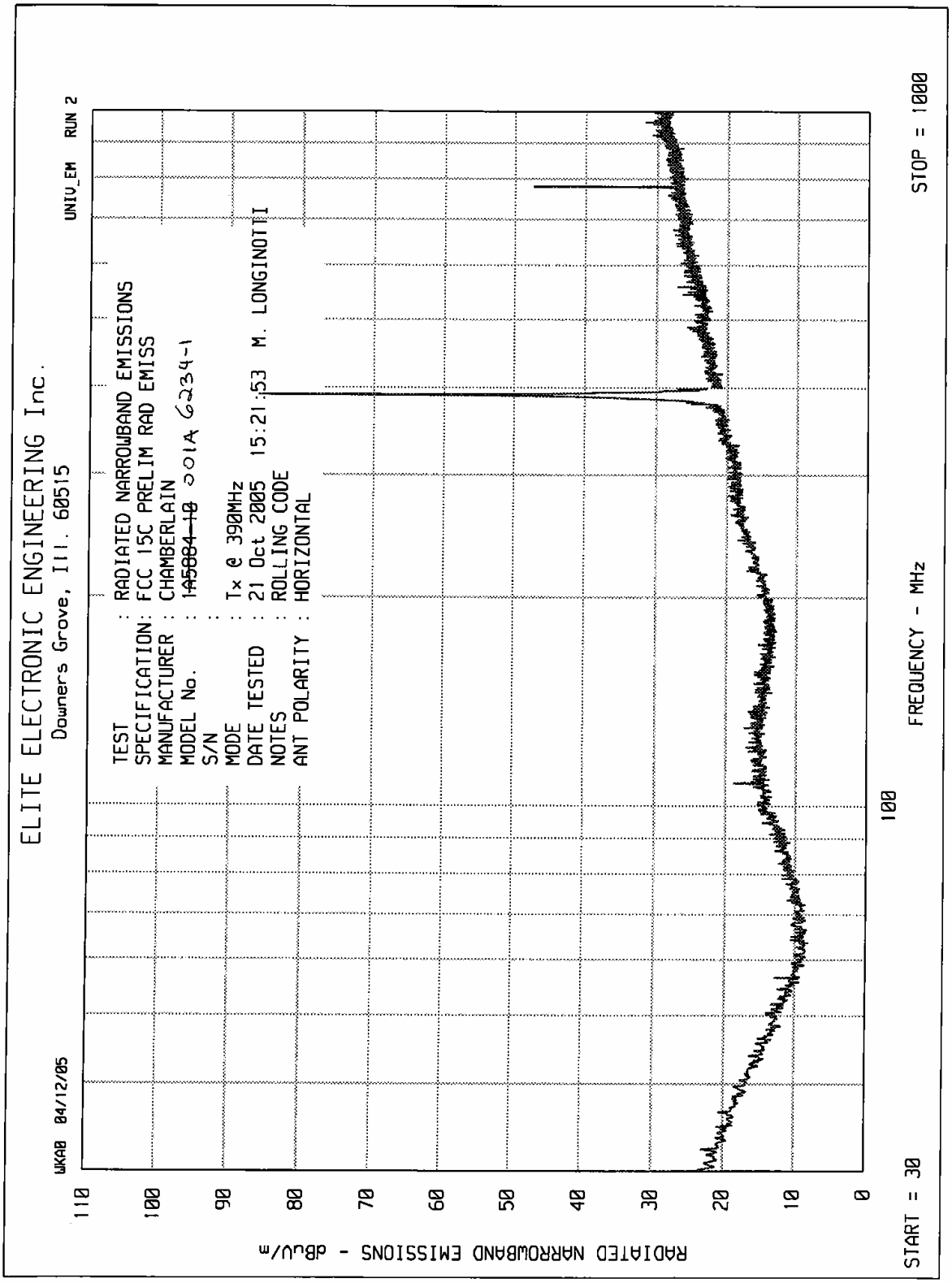
Test Setup for Radiated Emissions, 390MHz - Vertical Polarization

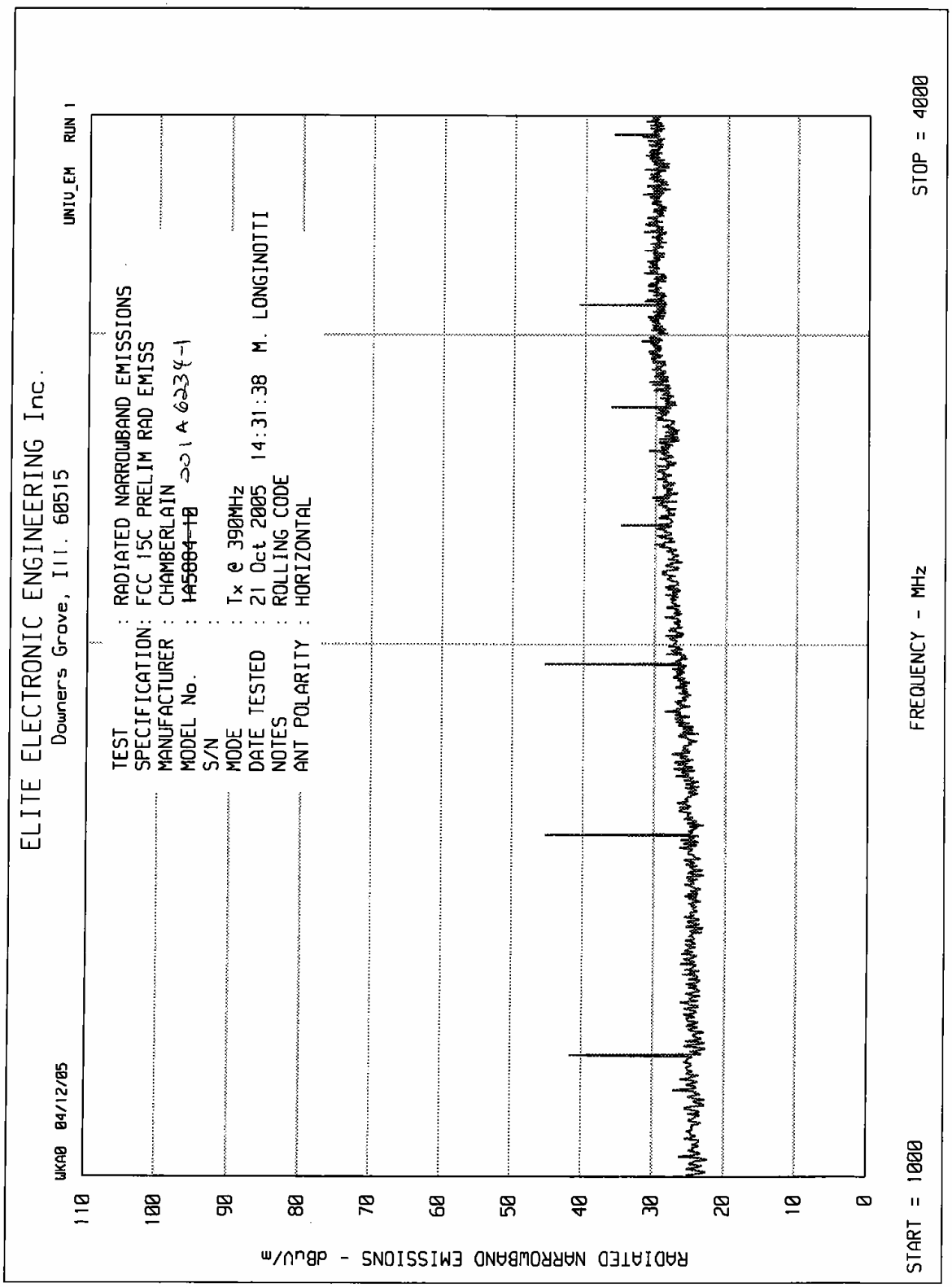
Figure 2b

Test Setup for Radiated Emissions, 1GHz to 4GHz – Horizontal Polarization

Test Setup for Radiated Emissions, 1GHz to 4GHz – Vertical Polarization


ELITE ELECTRONIC ENGINEERING Co.
Downers Grove, Il 60515
10 mSEC/DIV
TRANSMITTER DUTY CYCLE
FREQUENCY: 390.0986 MHz
ON TIME : 23.976 mSEC
OFF TIME : 76.024 mSEC
DUTY CYCLE = .24 or -12.4 dB
COMPUTED OVER 100 mSEC
MANUFACTURER : CHAMBERLAIN
MODEL : ~~41A5884-1B~~ 001A 6234-1
S/N :
TEST DATE : 21 Oct 2005
NOTES : Tx @ 390MHz, ROLLING CODE


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV_EM RUN 2
WKAB 04/12/05
TEST : RADIATED NARROWBAND EMISSIONS
SPECIFICATION: FCC 15C PRELIM RAD EMISS
MANUFACTURER : CHAMBERLAIN
MODEL No. : 1A5084-10 001A 6234-1
S/N :
MODE : Tx @ 390MHz
DATE TESTED : 21 Oct 2005 15:21:53 M. LONGINOTTI
NOTES : ROLLING CODE
ANT POLARITY : HORIZONTAL
RADIATED NARROWBAND EMISSIONS - dBuV/m
110
100
90
80
70
60
50
40
30
20
10
0
START = 30
100
FREQUENCY - MHz
STOP = 1000

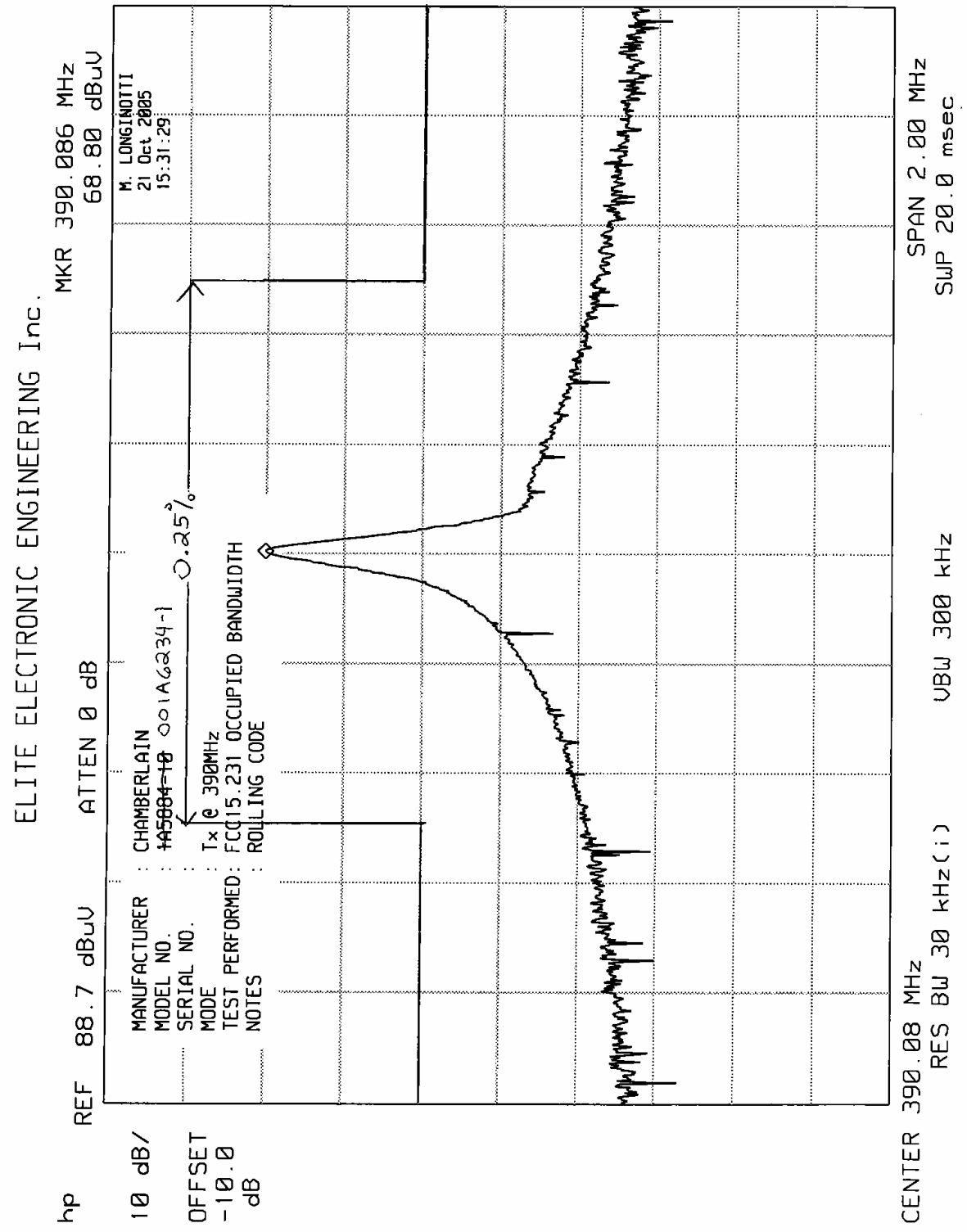

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV_EM RUN 1
WKA0 04/12/05
TEST : RADIATED NARROWBAND EMISSIONS
SPECIFICATION: FCC 15C PRELIM RAD EMISS
MANUFACTURER : CHAMBERLAIN
MODEL No. : HA5004-10 301A 6334-1
S/N :
MODE : Tx @ 390MHz
DATE TESTED : 21 Oct 2005 14:31:38 M. LONGINOTTI
NOTES : ROLLING CODE
ANT POLARITY : HORIZONTAL
RADIATED NARROWBAND EMISSIONS - dBuV/m
110
100
90
80
70
60
50
40
30
20
10
0
START = 1000
FREQUENCY - MHz
STOP = 4000

DATA PAGE

MANUFACTURER : CHAMBERLAIN
MODEL NO. : 001A6234-1
SERIAL NO. : SAMPLE 1
TEST DATE : OCTOBER 21, 2005
SPECIFICATION : FCC PART 15C
NOTES : Tx @ 390MHz
TEST ANTENNA : ROBERST DIPOLE AND DRWG ANTENNA

Freq. MHz	Ant Pol	Meter Reading dBuV	Ambient	Cable Factor dB	Ant Factor dB	Pre Amp Gain dB	Duty Cycle Factor dB	Total dBuV/m	Total uV/m	Limit uV/m	Margin dB	Antenna Height cm
390.1	H	67.0		1.5	20.6	0.0	-13.5	75.6	6015.1	9169.2	-3.7	100
390.1	V	58.5		1.5	20.6	0.0	-13.5	67.1	2260.7	9169.2	-12.2	324
780.1	H	24.0		1.9	26.6	0.0	-13.5	38.9	88.6	916.9	-20.3	123
780.1	V	16.1		1.9	26.6	0.0	-13.5	31.0	35.7	916.9	-28.2	100
1170.2	H	19.8		2.2	26.2	0.0	-13.5	34.7	54.5	500.0	-19.2	118
1170.2	V	24.0		2.2	26.2	0.0	-13.5	38.9	88.4	500.0	-15.0	169
1560.2	H	50.7		2.6	27.0	-36.6	-13.5	30.2	32.3	500.0	-23.8	230
1560.2	V	55.8		2.6	27.0	-36.6	-13.5	35.3	58.2	500.0	-18.7	114
1950.3	H	52.3		3.0	28.6	-36.2	-13.5	34.2	51.2	916.9	-25.1	174
1950.3	V	58.6		3.0	28.6	-36.2	-13.5	40.5	105.8	916.9	-18.8	132
2340.4	H	53.0		3.4	30.1	-36.0	-13.5	37.0	70.8	500.0	-17.0	177
2340.4	V	57.2		3.4	30.1	-36.0	-13.5	41.2	114.9	500.0	-12.8	108
2730.4	H	43.6	Ambient	3.8	31.4	-35.9	0.0	42.9	139.6	500.0	-11.1	272
2730.4	V	49.3		3.8	31.4	-35.9	-13.5	35.1	56.9	500.0	-18.9	100
3120.5	H	45.6	Ambient	4.1	32.3	-35.8	0.0	46.1	202.5	916.9	-13.1	120
3120.5	V	48.6		4.1	32.3	-35.8	-13.5	35.6	60.4	916.9	-23.6	109
3510.5	H	46.3	Ambient	4.3	32.4	-35.7	0.0	47.3	231.1	916.9	-12.0	103
3510.5	V	47.6		4.3	32.4	-35.7	-13.5	35.1	56.7	916.9	-24.2	123
3900.6	H	48.3		4.5	32.9	-35.3	-13.5	36.9	69.9	500.0	-17.1	120
3900.6	V	47.1		4.5	32.9	-35.3	-13.5	35.7	60.9	500.0	-18.3	122

Checked By: MARK E. LONGINOTTI


ELITE ELECTRONIC ENGINEERING Inc.
MKR 390.086 MHz
68.80 dBuV
M. LONGIMOTTI
21 Oct 2005
15:31:29
hp
REF 88.7 dBuV
ATTEN 0 dB
10 dB/
OFFSET
-10.0
dB
MANUFACTURER : CHAMBERLAIN
MODEL NO. : ~~A5084-10~~ 001A6234-1
SERIAL NO. :
MODE : Tx @ 390MHz
TEST PERFORMED: FCC15.231 OCCUPIED BANDWIDTH
NOTES : ROLLING CODE
0.25%
CENTER 390.08 MHz
RES BW 30 kHz(i)
VBW 300 kHz
SPAN 2.00 MHz
SWP 20.0 msec