Measurement of RF Interference from a Model PIR Transmitter

For	:	The Chamberlain Group 845 Larch Ave. Elmhurst, IL 60126
P.O. No.	:	857707
Date Tested	:	March 21 and 25, 2008
Test Personnel	:	Mark E. Longinotti
Specification	:	FCC Part 15, Subpart C Industry Canada RSS-210 Industry Canada RSS-GEN

Test Report By : MARK E. LONGINOTTI

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REVISION HISTORY

Revision	Date	Description
—	March 25, 2008	Initial release

Measurement of RF Emissions from a Model Product PIR Transmitter

1 INTRODUCTION

1.1 Scope of Tests

This document represents the results of the series of radio interference measurements performed on a model PIR, Serial No. None Assigned transmitter, (hereinafter referred to as the test item). The test item was designed to transmit at approximately 315MHz using an 18cm long wire as its antenna. The test item was manufactured and submitted for testing by The Chamberlain Group 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, Section 15.231(b) for Intentional Radiators and Industry Canada requirements, RSS-210. Testing was performed in accordance with ANSI C63.4-2003.

1.3 Deviations, Additions and Exclusions

There were no deviations, additions to, or exclusions from the test specification during this test series.

1.4 EMC Laboratory 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.

1.5 Laboratory Conditions

The temperature at the time of the test was 22°C and the relative humidity was 21%.

2 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 B for Receivers, dated 1 October 2007
- ANSI C63.4-2003, "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"
- Industry Canada RSS-210, Issue 7, June 2007, “Spectrum Management and Telecommunications Radio Standards Specification, Low-power License-exempt radio communication devices (All Frequency Bands): Category I Equipment”
- Industry Canada RSS-GEN, Issue 2, June 2007, “Spectrum Management and Telecommunications Radio Standards Specification, General Requirements and Information for the Certification of radio communication equipment”

3 TEST ITEM SET-UP AND OPERATION

3.1 General Description

The test item is a Model No. PIR. The test item is equipped with a motion detector. A block diagram of the test item set-up is shown as Figure 1.

3.1.1 Power Input

The test item obtained 6VDC power from 4 each “AA” internal batteries.

3.1.2 Peripheral Equipment

The test item has no ports for peripheral equipment.

3.1.3 Interconnect Cables

The test item has no ports for interconnect cables.

3.1.4 Grounding

Since the test item was powered with 6VDC through batteries, it was ungrounded during the tests.

3.2 Operational Mode

For all tests, the test item was placed on an 80cm high non-conductive stand. For test purposes, the test item was programmed to continuously transmit once the test item was powered up. Under normal operating conditions, when the test item senses motion, it transmits for approximately 190 msec. A plot of this is shown on page 12.

3.3 Test Item Modifications

No modifications were required for compliance to the FCC Part 15C requirements.

4 TEST FACILITY AND TEST INSTRUMENTATION

4.1 Shielded Enclosure

All tests were performed in a 32ft. x 20ft. x 18ft. hybrid ferrite-tile/anechoic absorber lined test chamber. With the exception of the floor, the reflective surfaces of the shielded chamber are lined with ferrite tiles on the walls and ceiling. 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 C63.4-2003 for site attenuation.

4.2 Test Instrumentation

The test instrumentation and auxiliary equipment used during the tests are listed in Table 9-1. All equipment was calibrated per the instruction manuals supplied by the manufacturer.
Conducted emission tests were performed with a spectrum analyzer in conjunction with a quasi-peak adapter. Radiated emissions were performed with a spectrum analyzer. This receiver allows measurements with the specified bandwidths b and with the quasi-peak detector function. The receiver bandwidth was 120kHz for the 30MHz to 1000MHz radiated emissions data.

4.3 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).

4.4 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 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

5 TEST PROCEDURES

5.1 Powerline Conducted Emissions

Since the test item is powered by internal batteries, no conducted emissions tests were required.

5.2 Duty Cycle Factor Measurements

5.2.1 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 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).

5.2.2 Results

A representative plot of the duty cycle is shown on data page 13. An explanation of the duty cycle correction factor was provided by The Chamberlain Group personnel. A copy of the explanation is shown on pages 14 and 15. Based on the explanation provided by The Chamberlain Group personnel, a duty cycle correction factor of -7.5 dB was used for radiated emissions tests.

5.3 Radiated Measurements

5.3.1 Requirements

The following radiated emission limits apply:

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

Example For 315.02MHz, the limit at the fundamental is 6040.4uV/m @ 3m and the limit on the harmonics is 604.0uV/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.

5.3.2 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 emissions 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.

5.3.3 Results

The preliminary plots, with the test item transmitting at 315MHz, are presented on data pages 16and 17. 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 315MHz, are presented on data page 18. 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 315.02MHz. The emissions level at this frequency was 0.4dB within the limit. See data page 18 for details. Photographs of the test configuration which yielded the highest or worst case, radiated emission levels are shown on Figure 2.

5.4 Occupied Bandwidth Measurements

5.4.1 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.

5.4.2 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.

5.4.3 Results

The plot of the emissions near the fundamental frequency is presented on data page 19. As can be seen from this data page, the transmitter met the occupied bandwidth requirements. The 99% bandwidth was measured to be 328.7kHz.

6 OTHER TEST CONDITIONS

6.1 Test Personnel and Witnesses

All tests were performed by qualified personnel from Elite Electronic Engineering Incorporated.

6.2 Disposition of the Test Item

The test item and all associated equipment were returned to The Chamberlain Group upon completion of the tests.

7 CONCLUSIONS

It was determined that The Chamberlain Group Model No. PIR, Serial No. None Assigned, did fully meet the specified technical requirements.

8 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.

This report must not be used to claim product endorsement by NVLAP or any agency of the US Government.

9 EQUIPMENT LIST

Table 9-1 Equipment List

Eq ID	Equipment Description	Manufacturer	Model No.	Serial No.	Frequency Range	Cal Date	Due Date
NDP1	TUNED DIPOLE ANTENNA	EMCO	3121C-DB3	313	140-400MHZ	9/28/2007	9/28/2008
NDQ1	TUNED DIPOLE ANTENNA	EMCO	3121C-DB4	313	400-1000MHZ	3/28/2007	3/28/2008
NTA1	BILOG ANTENNA	CHASE EMC LTD.	BILOG CBL6112	2054	0.03-2GHZ	6/5/2007	6/5/2008
NWH0	RIDGED WAVE GUIDE	TENSOR	4105	2081	1-12.4GHZ	10/13/2007	10/13/2008
RACD	RF PRESELECTOR	HEWLETT PACKARD	85685A	3010A01205	20HZ-2GHZ	2/21/2008	2/21/2009
RAE7	SPECTRUM ANALYZER	HEWLETT PACKARD	85660B	2516A01685	100HZ-22GHZ	8/28/2007	8/28/2008
RBB0	EMI TEST RECEIVER 20HZ TO 40 GHZ.	ROHDE & SCHWARZ	ESIB40	100250	20 HZ TO 40GHZ	11/5/2007	11/5/2008

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.

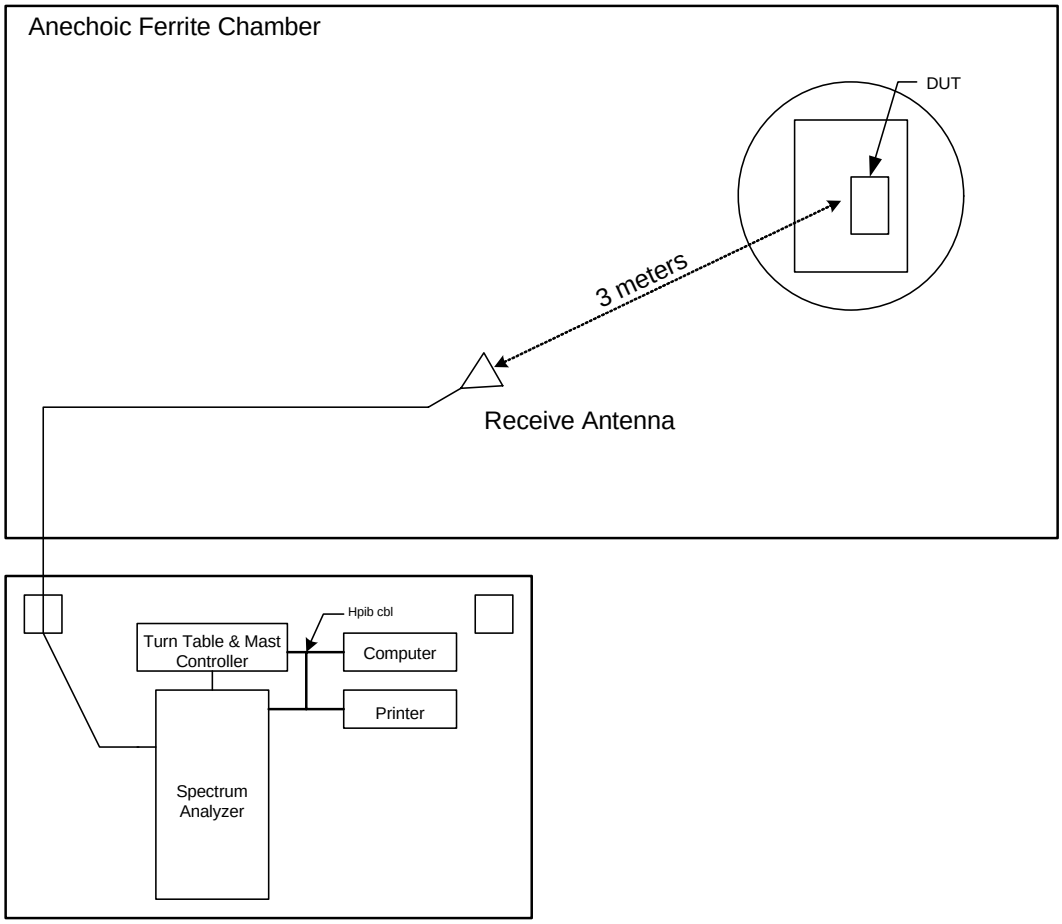
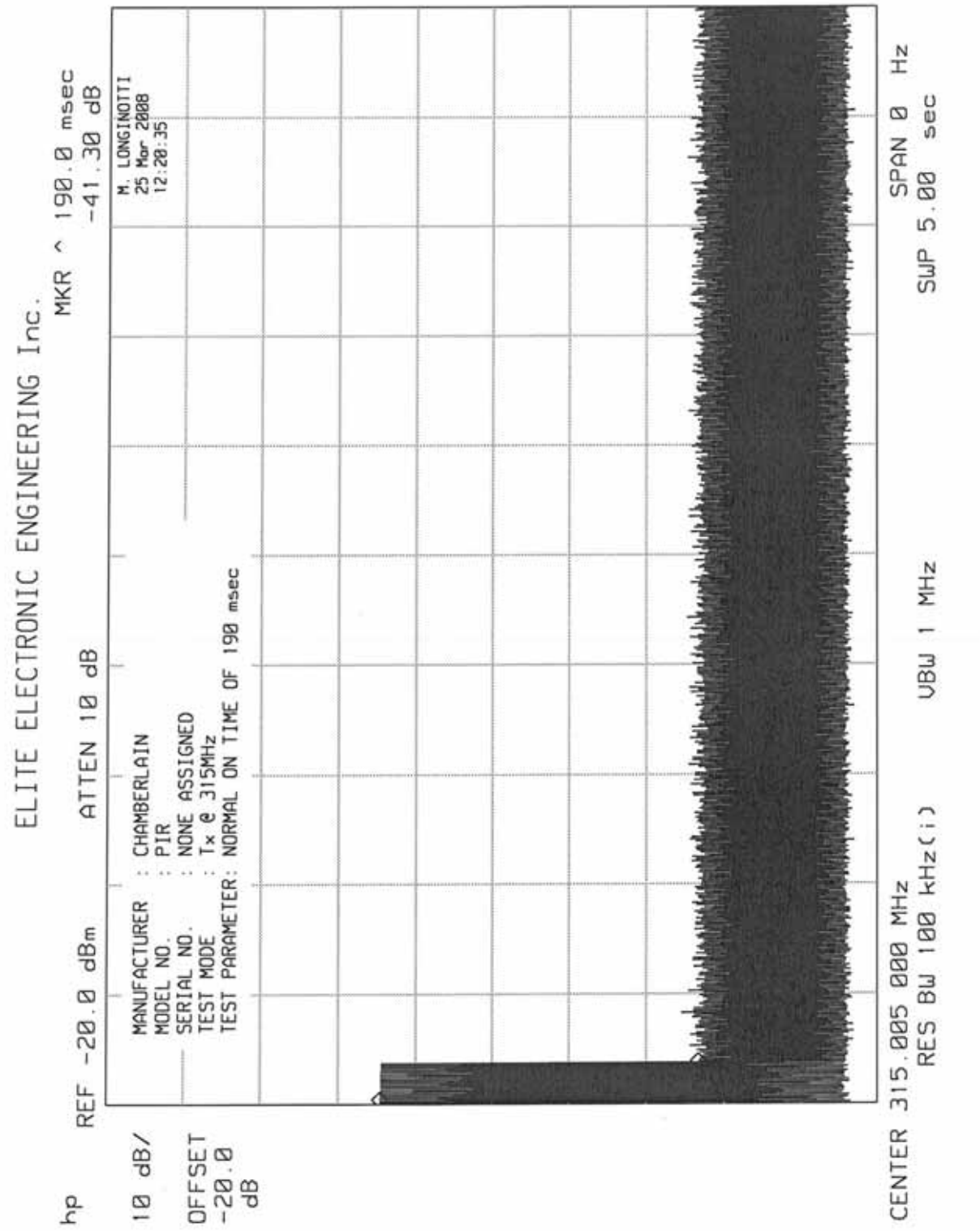


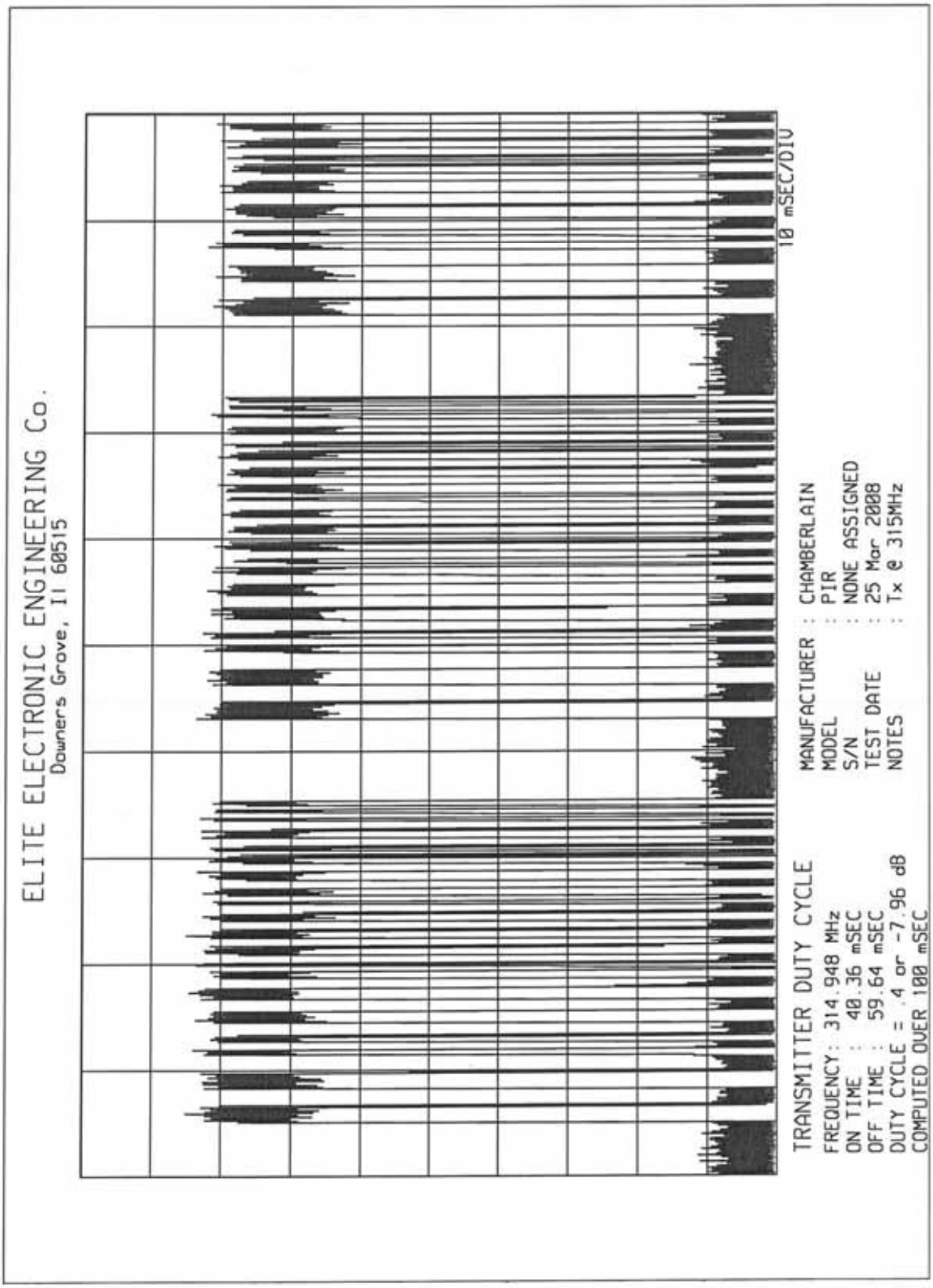
FIGURE 1 BLOCKDIAGRAM OF TEST SETUP

Figure 2

Test Set-up for Radiated Emissions – Horizontal Polarization

Test Set-up for Radiated Emissions – Vertical Polarization


ELITE ELECTRONIC ENGINEERING Inc.
MKR ^ 190.0 msec
-41.30 dB
hp
REF -20.0 dBm
ATTEN 10 dB
10 dB/
OFFSET
-20.0
dB
MANUFACTURER : CHAMBERLAIN
MODEL NO. : PIR
SERIAL NO. : NONE ASSIGNED
TEST MODE : Tx @ 315MHz
TEST PARAMETER: NORMAL ON TIME OF 190 msec
M. LONGINOTTI
25 Mar 2008
12:20:35
CENTER 315.005 000 MHz
SPAN 0 Hz
RES BW 100 kHz(i)
VBW 1 MHz
SWP 5.00 sec


ELITE ELECTRONIC ENGINEERING Co.
Downers Grove, Il 60515
10 mSEC/DIV
TRANSMITTER DUTY CYCLE
FREQUENCY: 314.948 MHz
ON TIME : 40.36 mSEC
OFF TIME : 59.64 mSEC
DUTY CYCLE = .4 or -7.96 dB
COMPUTED OVER 100 mSEC
MANUFACTURER : CHAMBERLAIN
MODEL : PIR
S/N : NONE ASSIGNED
TEST DATE : 25 Mar 2008
NOTES : Tx @ 315MHz

The Manchester encoded data is consists of 3 different balanced preamble signals, a start bit, then 20 data bits. The 20 data bits contain the 14 bit sensor ID.

The 3 difference balanced preamble signals consists of 1010 repeated 3 times. The first time is the slowest data rate at 625bps. The second preamble has a data rate of 1560bps. The final preamble signal has a data rate of 1200bps.

The start bit consists of a bit at 1250bps, and a off bit.

The 20 data bits are all transmitted at a 2500bps data rate (1250bps Manchester data rate)

Manchester Timing (see figure 1):
Packet takes an average of 32.8ms 50% on/Off time
Dead time between packets 8 ms

So for a worst case 100ms (see figure 2):
2 Complete packets 2x32.8ms = 65.6ms 50% on/Off time
2 Complete dead periods 2x8ms = 16ms
1 Partial packet = 18.4ms 50% on/Off time

On time for Manchester data is (65.6ms + 18.4ms)/2 = 42ms.

Mod factor 20 log (On time/100ms) = **-7.535**

PIR Mod Factor Calculation 3/24/08

The PIR transmits the data in 5 packets. The 5 packets are Manchester encoded data. The Mod factor for the Manchester encoded data is always the same as there is always an equal amount of on time for both a logic 1 and a logic 0.

The following are waveform captures of the PIR transmission.

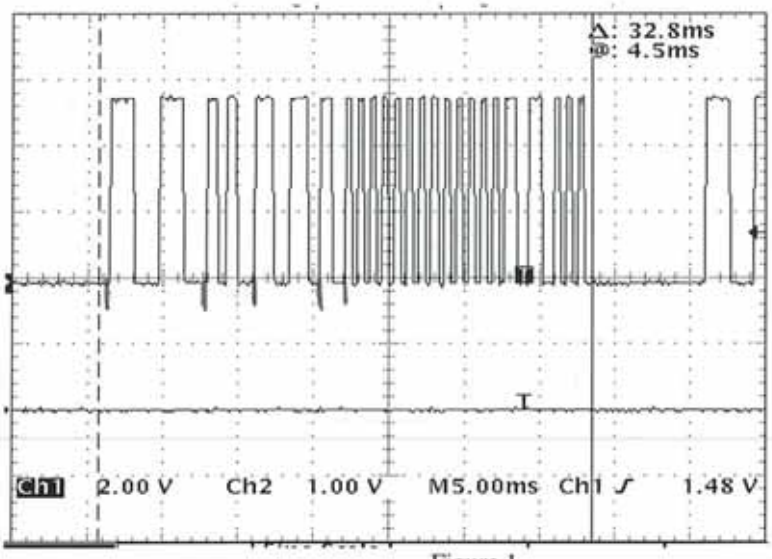


Figure 1

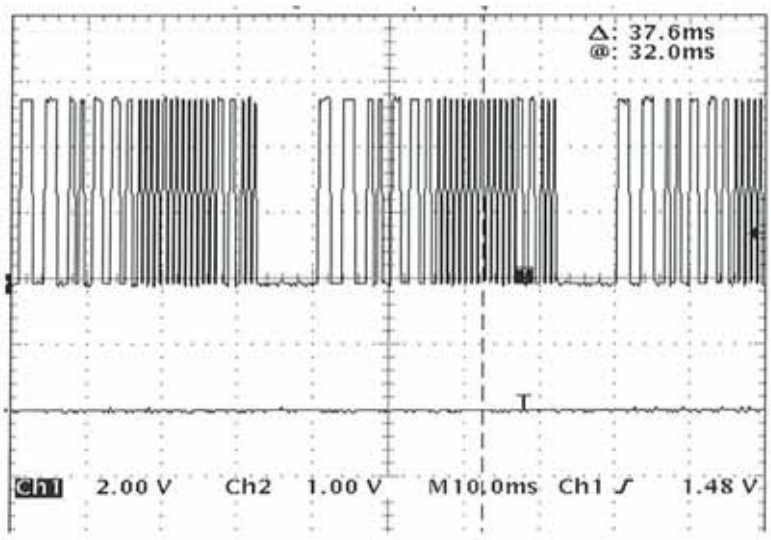
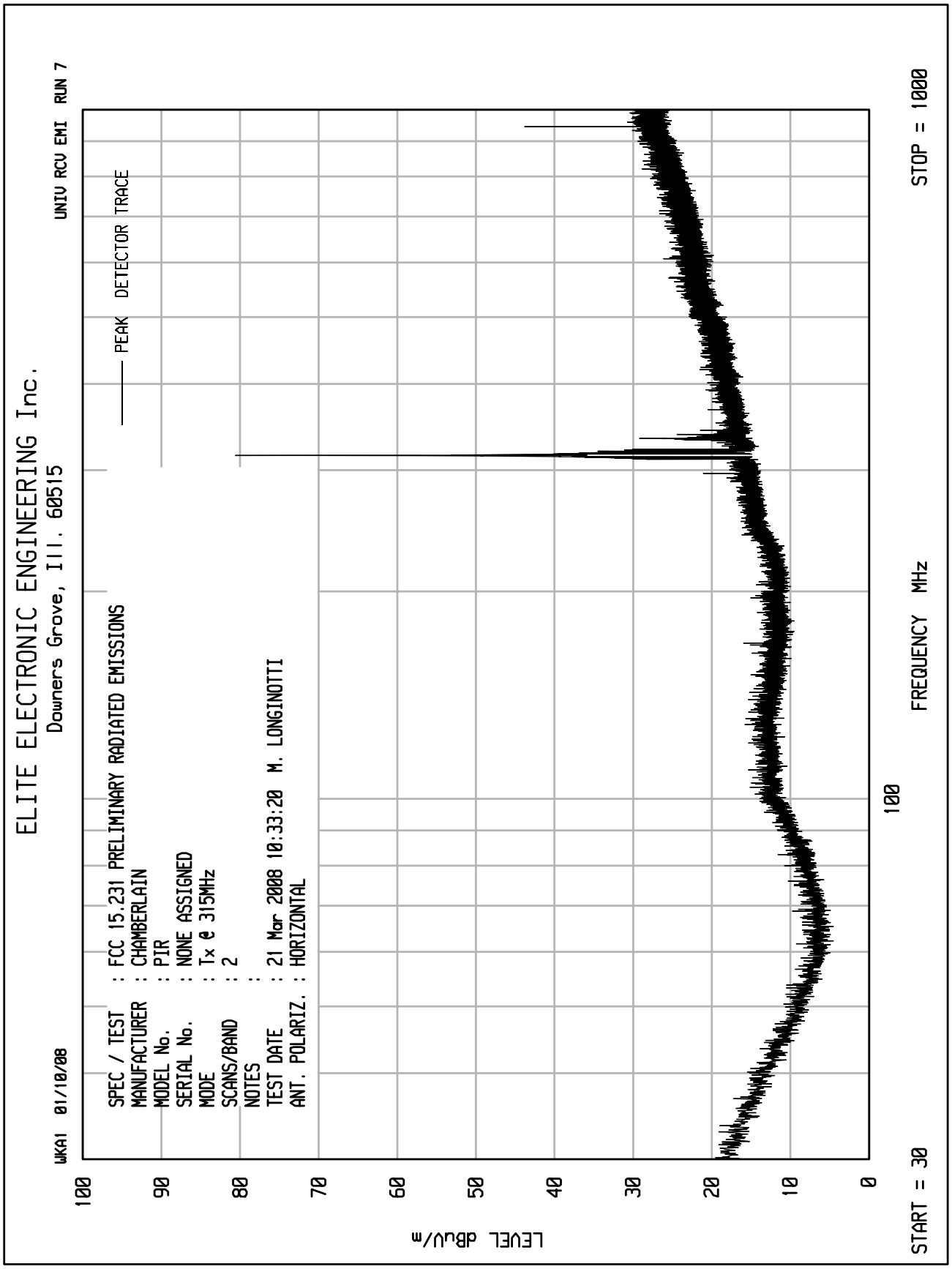
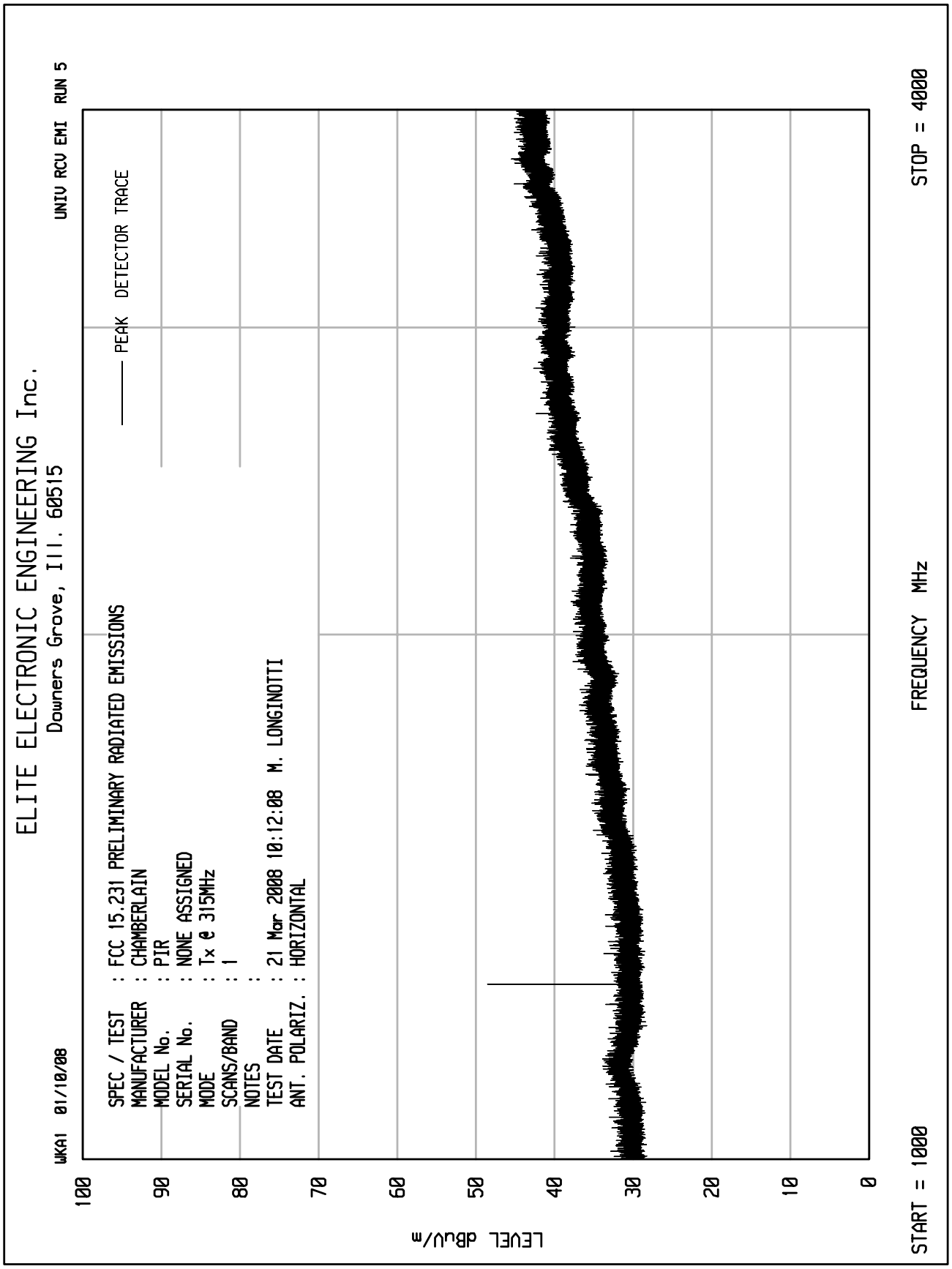


Figure 2

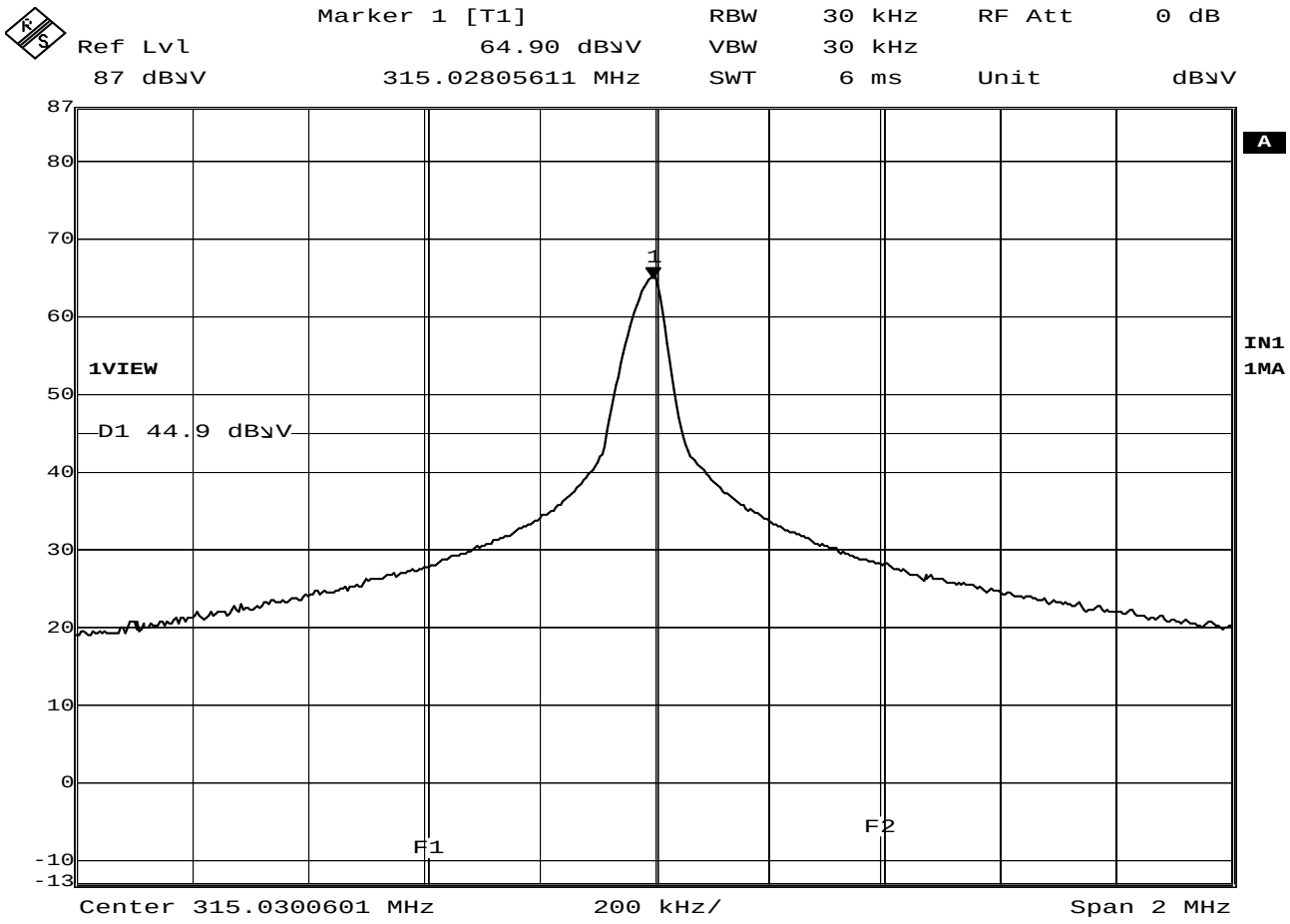

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 7
WKA1 01/10/08
SPEC / TEST : FCC 15.231 PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : CHAMBERLAIN
MODEL No. : PIR
SERIAL No. : NONE ASSIGNED
MODE : Tx @ 315MHz
SCANS/BAND : 2
NOTES : :
TEST DATE : 21 Mar 2008 10:33:20 M. LONGINOTTI
ANT. POLARIZ. : HORIZONTAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
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 RCV EMI RUN 5
WKA1 01/10/08
SPEC / TEST : FCC 15.231 PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : CHAMBERLAIN
MODEL No. : PIR
SERIAL No. : NONE ASSIGNED
MODE : Tx @ 315MHz
SCANS/BAND : 1
NOTES :
TEST DATE : 21 Mar 2008 10:12:08 M. LONGINOTTI
ANT. POLARIZ. : HORIZONTAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
100
90
80
70
60
50
40
30
20
10
0
START = 1000
FREQUENCY MHz
STOP = 4000

MANUFACTURER : Chamberlain
MODEL : PIR
S/N : None Assigned
SPECIFICATION : FCC-15C Radiated Emissions
DATE : March 21, 2008
NOTES : Transmitting @ 315MHz
: TEST DISTANCE IS 3 METERS

Freq (MHz)	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Duty Cycle (dB)	Total dBuV/m at 3 M	Total uV/m at 3M	Limit uV/m at 3M	Margin (dB)
315.0	H	63.0		1.3	18.4	0.0	-7.5	75.2	5757.0	6040.4	-0.4
315.0	V	53.8		1.3	18.4	0.0	-7.5	66.0	1996.2	6040.4	-9.6
630.0	H	17.5		1.7	24.7	0.0	-7.5	36.4	66.2	604.0	-19.2
630.0	V	10.4		1.7	24.7	0.0	-7.5	29.3	29.3	604.0	-26.3
945.1	H	19.7		2.0	28.5	0.0	-7.5	42.6	135.3	604.0	-13.0
945.1	V	12.6		2.0	28.5	0.0	-7.5	35.5	59.8	604.0	-20.1
1260.1	H	33.2		2.3	25.6	0.0	-7.5	53.6	481.0	604.0	-2.0
1260.1	V	19.2		2.3	25.6	0.0	-7.5	39.6	96.0	604.0	-16.0
1575.1	H	19.6		2.7	26.4	0.0	-7.5	41.1	113.6	500.0	-12.9
1575.1	V	18.2		2.7	26.4	0.0	-7.5	39.7	96.7	500.0	-14.3
1890.1	H	16.1	Ambient	2.9	27.8	0.0	-7.5	39.3	92.6	604.0	-16.3
1890.1	V	14.0	Ambient	2.9	27.8	0.0	-7.5	37.2	72.7	604.0	-18.4
2205.1	H	16.8	Ambient	3.2	28.8	0.0	-7.5	41.4	116.9	500.0	-12.6
2205.1	V	16.3	Ambient	3.2	28.8	0.0	-7.5	40.9	110.4	500.0	-13.1
2520.2	H	16.1	Ambient	3.6	29.6	0.0	-7.5	41.8	122.4	604.0	-13.9
2520.2	V	17.8	Ambient	3.6	29.6	0.0	-7.5	43.5	148.9	604.0	-12.2
2835.2	H	16.2	Ambient	3.9	30.6	0.0	-7.5	43.1	143.0	500.0	-10.9
2835.2	V	16.6	Ambient	3.9	30.6	0.0	-7.5	43.5	149.7	500.0	-10.5
3150.2	H	16.2	Ambient	4.1	31.9	0.0	-7.5	44.6	170.5	604.0	-11.0
3150.2	V	15.9	Ambient	4.1	31.9	0.0	-7.5	44.3	164.7	604.0	-11.3

Checked By: MARK E. LONGINOTTI



Date: 21.MAR.2008 18:13:49

FCC 15.231 20dB BANDWIDTH

MANUFACTURER : Chamberlain
PRODUCT NAME :
MODEL NUMBER : PIR
SERIAL NUMBER : None Assigned
TEST MODE : Tx @ 315MHz
TEST PARAMETER : Display Line (D1) represents the 20dB down point
: from the modulated carrier. Display Lines (F1 &
: F2) represent the 0.25%*Fo bandwidth.
EQUIPMENT USED : RBA0, NTA1
NOTES