L. S. Compliance, Inc.
W66 N220 Commerce Court
Cedarburg, Wisconsin 53012

Phone: 262 - 375 - 4400 Fax: 262 - 375 - 4248

L. S. Compliance, Inc.

Compliance Testing of:

GOH – PC2000
TRANSMITTER

PREPARED FOR:

Code Alarm
950 East Whitcomb
Madison Heights, MI 48071-5612

Test Report Number:

Date of Testing:

August 23, 2000

Table Of Contents

1.0 Description of Measurement Facilities

Site on File with the Federal Communications Commission – United States
ID Number: 31040/SIT, 1300F2
For 3 Meter Semi-Anechoic Chamber and OATS

Site Listed with Industry Canada of Ottawa, Canada
ID Numbers: IC 3088, IC 3088-A
For 3 Meter Semi-Anechoic Chamber and OATS

"The site referenced above has been found to comply with the test criteria found in ANSI C63.4-1992 and 47CFR Section 2.948"

1.1 A2LA Certificate of Accreditation

THE AMERICAN
ASSOCIATION
FOR LABORATORY
ACCREDITATION

ACCREDITED LABORATORY

A2LA has accredited

L.S. COMPLIANCE, INC.
Cedarburg, WI

for technical competence in the field of

Electrical (EMC) Testing

The accreditation covers the specific tests and types of tests listed on the agreed scope of accreditation. This laboratory meets the requirements of ISO/IEC Guide 25-1990 "General Requirements for the Competence of Calibration and Testing Laboratories" (equivalent to relevant requirements of the ISO 9000 series of standards) and any additional program requirements in the identified field of testing.

Presented this 30th day of December, 1998.

President
For the Accreditation Council
Certificate Number 1255.01
Valid to January 31, 2001

For tests or types of tests to which this accreditation applies, please refer to the laboratory's Electrical (EMC) Scope of Accreditation

Scope of Accreditation:

American Association for Laboratory Accreditation

SCOPE OF ACCREDITATION TO ISO/IEC GUIDE 25-1990

L.S. COMPLIANCE, INC.
W66 N220 Commerce Court
Cedarburg, WI 53012
James Blaha Phone: 414 375 4400

ELECTRICAL (EMC)

Valid to: January 31, 2001 Certificate Number: 1255-01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following tests:

Test	Test Method(s)
Conducted Emissions Continuous/Discontinuous	Code of Federal Regulations (CFR) 47, FCC Method Parts 15 and 18 using ANSI C63.4; EN: 55011, 55022, 55081-1, 55082-1; CISPR: 11, 22
Radiated Emissions	Code of Federal Regulations (CFR) 47, FCC Method Parts 15 and 18 using ANSI C63.4; EN: 55011, 55022, 55081-1, 55082-1; CISPR: 11,22
Conducted Immunity Fast Transients/Burst	IEC: 1000-4-4, 801-4; EN: 61000-4-4, 50081-2, 50082-2
Surge	IEC: 1000-4-5, 801-5; ENV 50142; EN: 61000-4-5, 50081-2, 50082-2
RF Fields	IEC: 1000-4-6, 801-6; ENV 50141; EN: 50081-2, 50082-2
Voltage Dips/Interruptions	IEC 1000-4-11; EN: 61000-4-11, 50081-2, 50082-2
Radiated Immunity RF Fields	IEC: 801-3, 1000-4-3; ENV 50140; EN: 61000-4-3, 50081-2, 50082-2
RF Fields (50 Hz) RF Fields (Pulse Mode)	IEC 1000-4-8; EN 61000-4-8 EN: 50081-2, 50082-2; ENV 50204
Electrostatic Discharge (ESD)	IEC: 1000-4-2, 801-2; BSEN 60801-2; EN: 61000-4-2, 50081-2, 50082-2

5301 Buckeystown Pike, Suite 350 • Frederick, MD 21704-8307 • Phone: 301 644 3200 • Fax: 301 662 2974

1.2 Signature Page

Prepared By: Betty Ventura 11/5/00

Betty Ventura, Documents Coordinator Date

Tested By: 11/5/00

Kenneth L. Boston, EMC Engineer Date

Approved By: 11/5/00

Kenneth L. Boston, EMC Lab Manager Date
PE #31926 Licensed Professional Engineer
Registered in the State of Wisconsin, United States

1.3 Summary Of Test Report

Manufacturer:	Code Alarm, Inc.
Model:	PC 2000
Serial:	Not Attached
Description:	4 Button Remote Control Transmitter
Frequency Range:	418 MHz
Test Voltage:	6 Volts D.C

.

The GOH- PC2000 was tested and found to **MEET** the radiated emission specification of Title 47 CFR FCC, part 15, subpart C for an intentional radiator.

Product Description: The Code Alarm PC 2000 is a small remote control transmitter that sends a security code to a receiver located in an automobile, for the purpose of arming and disarming an auto security system. Other convenience features, such as interior lights and engine start-up can be programmed into the remote control system.

1.4 Introduction

On August 23, 2000, a series of Radiated Emissions tests were performed on one test sample model of the Code Alarm Remote Control. This product operates by a means of a short burst of data transmission containing an I. D. code.

These tests were performed using the test procedure outlined in ANSI C63.4, 1992 for intentional radiators, and in accordance with the limits set forth in FCC Part 15. 231, for a periodic transmitter.

These tests were performed by Kenneth L. Boston, EMC Engineer of L.S. Compliance, Inc.

1.5 Purpose

The above mentioned tests were performed in order to determine the compliance of the Test Sample with limits contained in various provisions of Title 47 CFR, FCC Part 15, including: 15.205, 15.209, 15.231b and 15.231c.

All radiated emissions tests were performed to measure the emissions in the frequency bands described by the above sections, and to determine whether said emissions are below the limits established by the above sections.

These tests were performed in accordance with the procedures described in the 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, (ANSI C63.4-1992).

Another document used as reference for the EMI receiver specification was the International Special Committee on Radio Interference - CISPR number 16-1 (1993).

1.6 **Radiated Emissions Test Setup**

The test sample was operated within the 3 Meter Semi-Anechoic Chamber, (FCC listed and on file with Industry Canada),located at L.S. Compliance in Cedarburg, Wisconsin. The test sample was placed on an 80cm high wooden pedestal, which was centered on the flush mounted 2m diameter metal turntable.

The test sample was operated in a normal manner, with all functions being exercised. The test sample was operated on its own [new] internal battery, consisting of 2 three-volt coin cells.

The test sample was configured to run in a continuous transmit mode during the 15.231b measurements. One sample was modified to transmit continuously for tests of the fundamental and spurious/harmonic emissions. This unit was then returned to normal operation for testing of the data packet length and occupied bandwidth.

1.7 Radiated Emission Test Procedure

The fundamental and spurious (harmonic) emissions of the transmitter were tested for compliance to Title 47 CFR, FCC Part 15.231b limits for periodic devices. For the calculations used to determine the limits applicable for the test sample, refer to Appendix A. These limits are expressed in decibels (dB) above 1 microvolt per meter (μV/m).

The test sample was tested from the lowest frequency generated by the transmitter (without going below 9 kHz) to the 10^{th} harmonic of the fundamental frequency generated by the device. The appropriate limits were also observed when the fundamental or spurious signals were located within any of the restricted bands as described in Part 15.205a. These frequencies, and their associated limits, are referenced in Section 1.12.

The sample was placed on an 80 cm tall pedestal and the antenna mast was placed such that the antenna was 3m from the test object. A biconical antenna or tuned dipole was used to measure emissions from 30 to 200 MHz, a log periodic or tuned dipole was used to measure emissions from 200 to 1000 MHz, and a double ridged waveguide horn was used to measure emissions above 1 GHz.

The test sample was programmed to operate in continuous transmit by using a small Plexiglas plunger to hold down a key, and using modified firmware which was programmed into the sample's processor, and the resultant signals were maximized by rotating the turntable 360 degrees and by raising and lowering the antenna between 1 and 4 meters. The test sample was also given several different orientations to determine the maximum signal levels, using both horizontal and vertical antenna polarities. The orientation with the sample lying flat on its backside on the pedestal yielded the worst case emissions. Depressing key #1 also gave the highest emissions.

No significant emissions were found aside from the transmitter fundamental and several harmonics. The unit was scanned for emissions, over the range 30 to 4200 MHz to establish compliance with Part 15.231b and 15.205 while in continuous transmit. At frequencies below the fundamental, no spurious signals, other than the noise floor of the system could be found within 20dB of the limits.

In addition to measuring the levels of radiated emissions, the occupied bandwidth of the transmitter was measured. In accordance with FCC Part 15.231c, the 20dB bandwidth of the transmitted signal should be within a window of 0.25% of the center carrier frequency. The calculation for this bandwidth can be found in Appendix A. The resolution bandwidth was set to the closest available filter setting on the HP8546A EMI system that corresponded to 5% of the allowable bandwidth determined in the calculation mentioned above, without going below the resolution bandwidth of 10kHz, as dictated in ANSI C63.4-1992 section 13.1.7.

The sample was activated to transmit in a continuous mode and was placed on the aforementioned test configuration within the 3-meter chamber. The transmitted signal was received on a tuned dipole antenna and fed to the HP8546A EMI System, where the fundamental frequency was displayed, and a plot of the occupied bandwidth was produced. These plots are included in Appendix C. From the data supplied, it can be seen that the test samples do need **MEET** the bandwidth requirement established by FCC Part 15.231c.

1.8 Radiated Emission Test Equipment Utilized

A list of the test equipment and antennas used for the tests can be found in Section 1.12, which includes the calibration information as well as the equipment description. All equipment is calibrated and used according to the user manuals supplied by the manufacturer. All antenna calibrations were performed at a N.I.S.T. traceable site, and the resultant correction factors were entered into the Hewlett Packard 8546A EMI receiver software database.

The connecting cables used were also measured for loss using a calibrated signal generator and the HP 8546A EMI receiver. The resulting loss factors were entered into the HP 8546A database. This allowed for automatic change in the antenna correction factor, as well as cable loss or other corrections, to be added to the EMI receiver display while taking measurements. Thus, the resulting data taken from the HP 8546A is an actual reading and can be entered into the database as a corrected meter reading. When a reading is taken using the peak detector, a duty cycle correction factor can be applied for conversion to an average reading. This operation can be used when measuring periodic data transmission, under FCC Part 15.231 and Part 15.35. The calculation for deriving this duty factor can be found in Appendix A.

The resulting average reading was then compared to the appropriate limit in order to determine compliance. The HP 8546A EMI receiver was operated with a bandwidth of 120 kHz when receiving signals below 1 GHz, and with a bandwidth of 1 MHz when receiving signals above 1 GHz, in accordance with CISPR 16.

The peak detector function was used.

1.9 Conducted Emission Measurements

Due to the fact that the product operated from its own internal batteries, it was not connected to the public AC mains, and therefore, it was unnecessary to perform a test for conducted emissions.

1.10 Summary of Results and Conclusions

Based on the procedures outlined in this report, and the test results included in appendices B and C, it can be determined that the test sample does **MEET** the emission requirements of Title 47 CFR, FCC Part 15 Subpart C for an intentional radiator.

The enclosed test results pertain to the samples of the test item listed, and only for the tests performed on the data sheets. Any subsequent modification or changes to the test items could invalidate the data contained herein and could therefore invalidate the findings of the report.

1.11 Test Equipment

Asset #	Manufacturer	Model #	Serial#	Description	Due Date Date of Cal
AA960004	EMCO	3146	9512-4276	Log Periodic Antenna	September 13, 2000
AA960005	EMCO	3110B	9601/2280	Biconical Antenna	September 13, 2000
AA960007	EMCO	3115	99111-4198	Double Ridge Horn Antenna	Aug 1, 2001
EE960004	EMCO	2090	9607-1164	Mast/Table controller	PM
EE960014	HP	85460	3617A00320	EMI receiver Display section	Aug 23, 2000
EE960013	HP	85462	3205A00103	EMI receiver Preselector section	Aug 23, 2000
N/A	LSC	Cable	0011	3 meter 1/2 " Heliax Cable	January 18, 2001
N/A	LSC	Cable	0038	1 meter RG214 Cable	January 18, 2001
N/A	LSC	cable	0050	10 meter RG214 Cable	January 18, 2001
N/A	LSC	Attenuator		10 dB Attenuator	PM

1.12 Measurement of Electromagnetic Radiated Emissions Within the FCC Listed 3 Meter Chamber Frequency Range Inspected: 30 to 1000 MHz

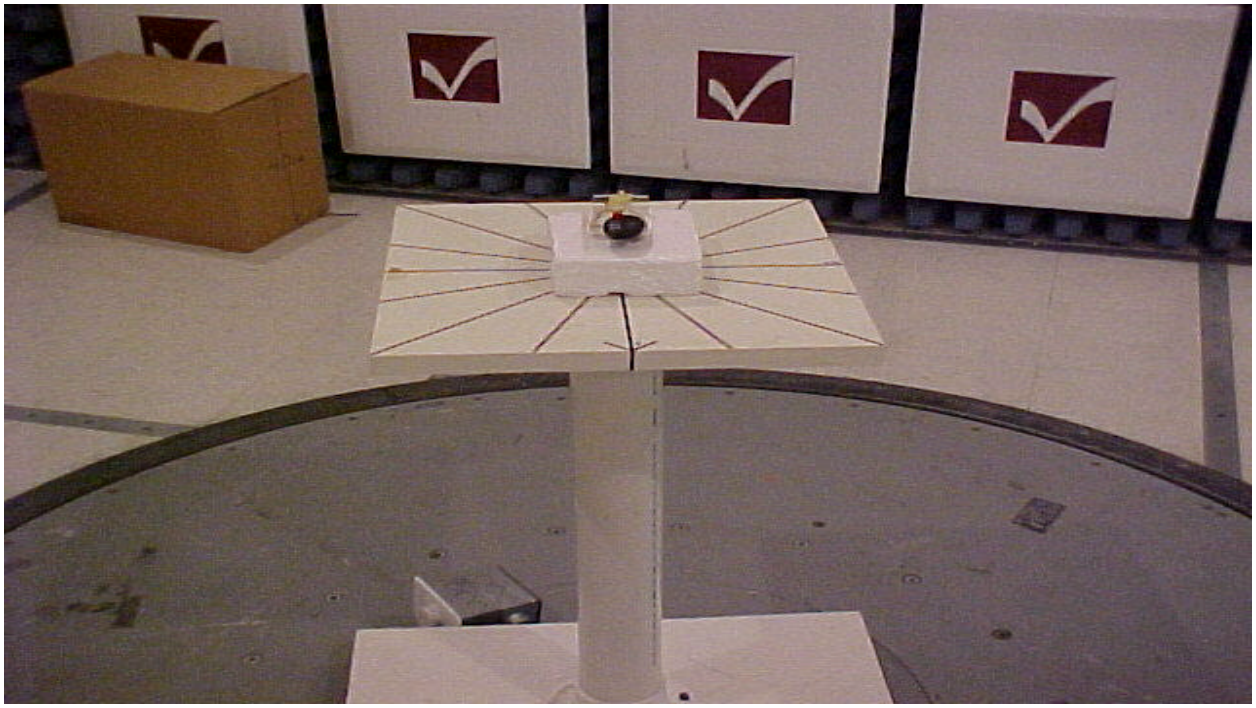
Manufacturer:	Code Alarm Inc.
Model:	PC 2000
Serial:	Not Applied
Specifications:	15.231b and 15.209
Distance:	3 Meters

Restricted Bands affecting this Product

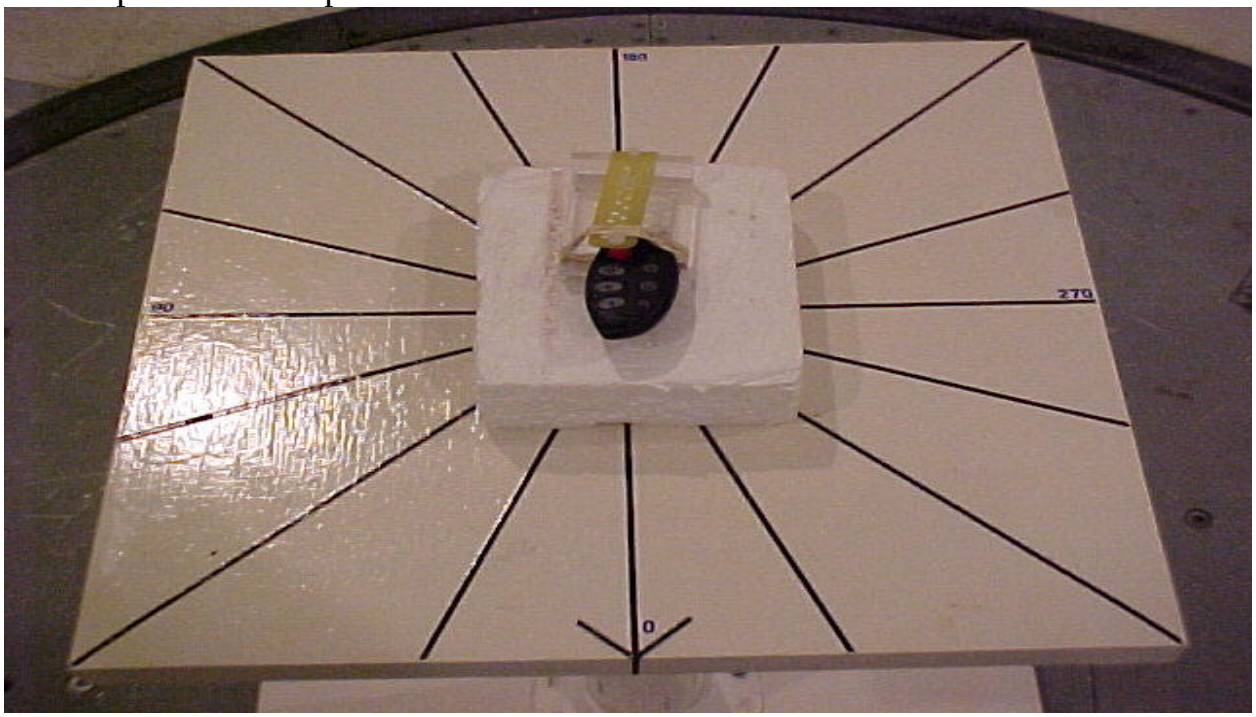
Frequency (MHz)	Limit (μV)	Limit (dB/μV/m)
608-614	150	46.0
960-1240	500	54.0
1300-1427	500	54.0
1435-1626.5	500	54.0
1660-1710	500	54.0
1718.8-1722.2	500	54.0
2200-2300	500	54.0
2310-2390	500	54.0
2483.5-2500	500	54.0
2655-2900	500	54.0
3260-3267	500	54.0
3332-3339	500	54.0
3345.8-3358	500	54.0
3600-4400	500	54.0

1.13 Photo of Test Set Up

View of Setup for Radiated Emissions Test of PC-2000 in the 3 Meter Semi-Anechoic Chamber



Close up of Test Setup



Manufacturer: Code Alarm

Model Number: PC 2000

Serial Number : Not Attached

Appendix A

Sample Calculations

Manufacturer: Code Alarm
Model: PC 2000
Serial Number: Not Attached

Calculation of Radiated Emissions limits for FCC Part 15.231(e) (260-470 MHz)

FIELD STRENGTH OF FUNDAMENTAL FREQUENCIES:

The calculation involves a linear interpolation of 3750 to 12,500 μV/m over 260-470 MHz, where field strength of the fundamental frequency (f_0) when, $260 \leq f_0 \leq 470$ MHz, can be found by: $3750.0+41.667(f_0-260)$, where f_0 is in MHz.

FIELD STRENGTH OF SPURIOUS/HARMONIC FREQUENCIES:

The calculation involves a linear interpolation of 375 to 1250 μV/m over 260 to 470 MHz, where field strength of the harmonic frequencies ($2f_0$, $3f_0$..), when $260 \leq f_0 \leq 470$ MHz, can be found by: $375.0+4.1667(f_0-260)$, where f_0 is in MHz.

- Where f_0 = 433.9 MHz
  Fundamental: 3750+41.667(433.9-260) = 10,996 μV/m
  Harmonic: 375+41.667(433.9-260) = 1100 μV/m

Frequency (MHz)	Fundamental limit (mV/m)	Fundamental limit (dB mV/m)	Harmonic limit (mV/m)	Harmonic limit (dB mV/m)
433.9	10,996	80.8	1100	60.8

Duty Cycle Correction Factor Calculation

For a graphical presentation of the data bursts being transmitted from the Remote Control Transmitter, refer to Appendix C. This plot was taken of a unit, which has been programmed to send its activation code repeatedly, by holding down one of the buttons, to permit radiated emissions tests to be readily performed. When held down continuously, the remote sends out one packet of approximately 16 milliseconds every 100 milliseconds.

Average (Relaxation) Factor

Averaging Factor = 20 * Log (Worst Case On-Time over 100 mS)

Message Format: [1 preamble bit] + [1 start bit] + [36 data bits] per packet

Bit Period: 0.4mS (Manchester data encoding)

Preamble Bit: 0.84mS High

Start Bit: 0.44mS High

Data Bit: Logic 1 = 0.22mS High 0.18 Low
Logic 0 = 0.18mS Low 0.22mS High

Averaging Factor Calculation: [On – Time / 100mS period]

Worst case (All data combinations have the same on-time)

1 bit (0.84) + 1 bit (0.44) + 36 bits (0.22)

0.84 + 0.44 + 7.92

9.2mS

When the total on-time is computed over a100 millisecond window, according to **FCC Part 15.35(c),** where the pulse train exceeds 100 milliseconds, a total of 9.2 milliseconds are obtained. This results in a relaxation factor of 20.7 dB, which is over the allowable cap of 20 dB, as stated in **FCC Part 15.35(b).**

Relaxation Factor = 20 log (.092) = -20.7dB

= 20dB used

Occupied Bandwidth Calculations

FCC Part 15.231(c) states that the bandwidth of the periodic device shall be no wider than 0.25% of the center frequency for devices operating between 70 and 900 MHz.

Said bandwidth is determined at the **-20 dB** reference to peak carrier points.

For 433.9 MHz, the 20 dB bandwidth is 0.0025 X 433.9 = 1.045 MHz

Refer to Appendix C for the set of graphs that show the actual occupied bandwidth of the test sample, which for this sample is 0.313 MHz, well within the limits.

Appendix B

Data Charts

Measurement of Electromagnetic Radiated Emissions within the 3 Meter Semi Anechoic FCC Listed Chamber

Frequency Range inspected: 30 to 5000 MHz

Date of Test:	August 23, 2000	Manufacturer:	Code Alarm, Inc.
Location:	L.S. Compliance, Inc. W66 N220 Commerce Ct. Cedarburg, WI 53012	Model:	PC 2000
Specifications:	15.231b and 15.209	Serial No:	Not Attached
		Configuration:	Continuous Data Transmit
		Detector(s) Used:	Peak
Equipment:	HP 8546A EMCO 3115 Double Ridged Wave Guide/Horn Antenna EMCO 93146 Log Periodic EMCO 3121C Dipole Set Antenna EMCO 3110B Biconical		

The following table depicts the level of significant fundamental and harmonic emissions found:

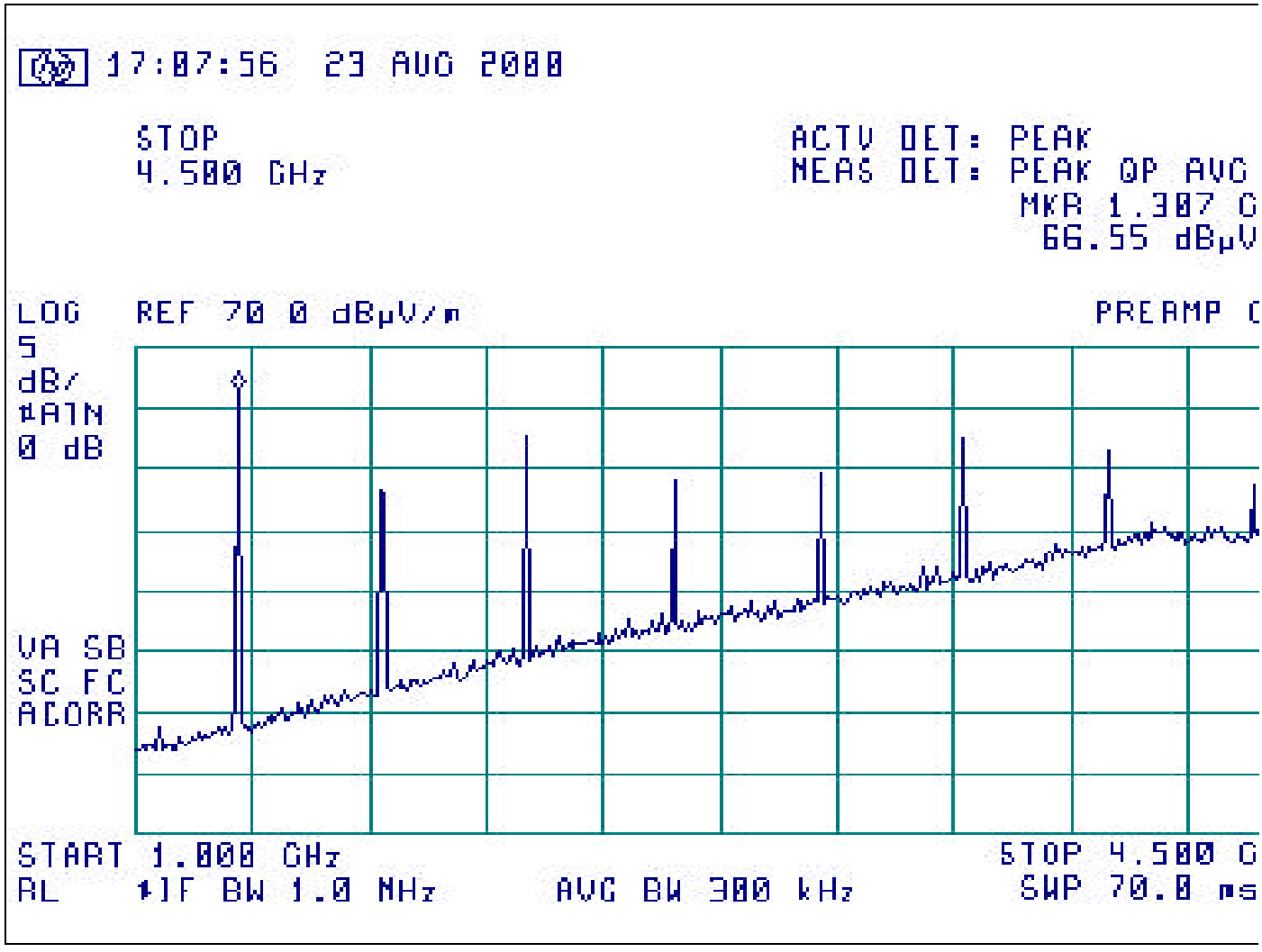
Higher order harmonics were found to be below the noise floor of the receiving system:

Frequency (MHz)	Antenna Polarity	Height (meters)	Azimuth (0° - 360°)	EMI Meter Reading (dB µV/m)	Duty Cycle Correction (dB)	Corrected Reading (dB µV/m)	15.231b Limit (dB µV/m)	Margin (dB)
433.92	H	2.0	280	86.8	20.0	66.8	80.8	14.0
867.84	H	1.0	95	63.5	20.0	43.5	60.8	17.3
1301.7	H	1.05	85	68.0	20.0	48.0	54.0	6.0
1735.5	H	1.1	260	59.6	20.0	39.6	60.8	21.2
2169.4	H	1.15	275	63.9	20.0	43.9	60.8	16.9
2603.3	H	1.20	70	61.2	20.0	41.2	60.8	19.6
3037.2	H	1.20	220	60.6	20.0	40.6	60.8	20.2
3471	H	1.05	290	62.9	20.0	42.9	60.8	17.9
3905	H	1.05	320	62.7	20.0	42.7	54.0	11.3
4338.8	H	1.05	325	61.1	20.0	41.1	54.0	12.9

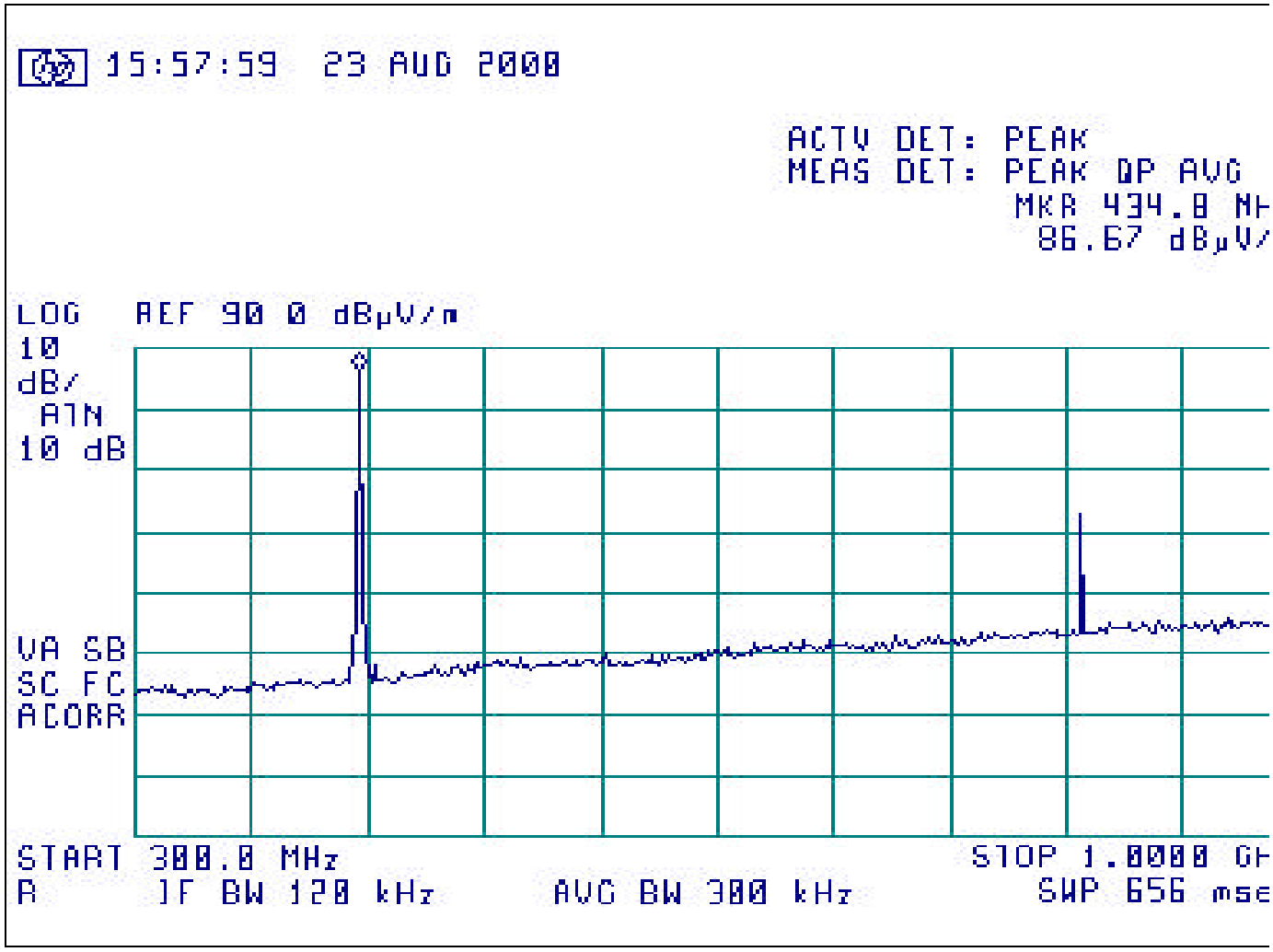
Appendix C

Graphs

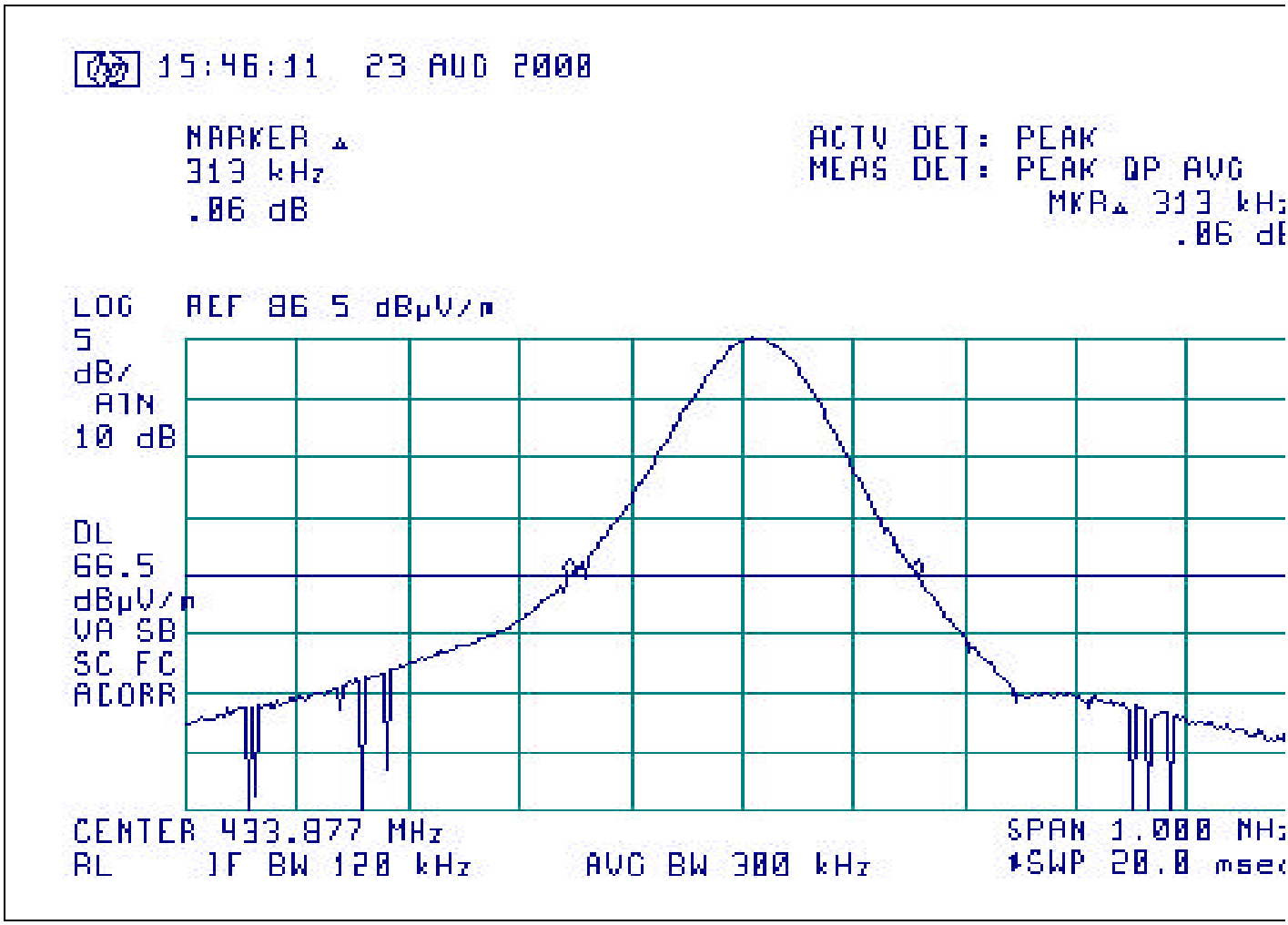
Radiated Emissions 1.000-4.56 GHz Horizontal Pola



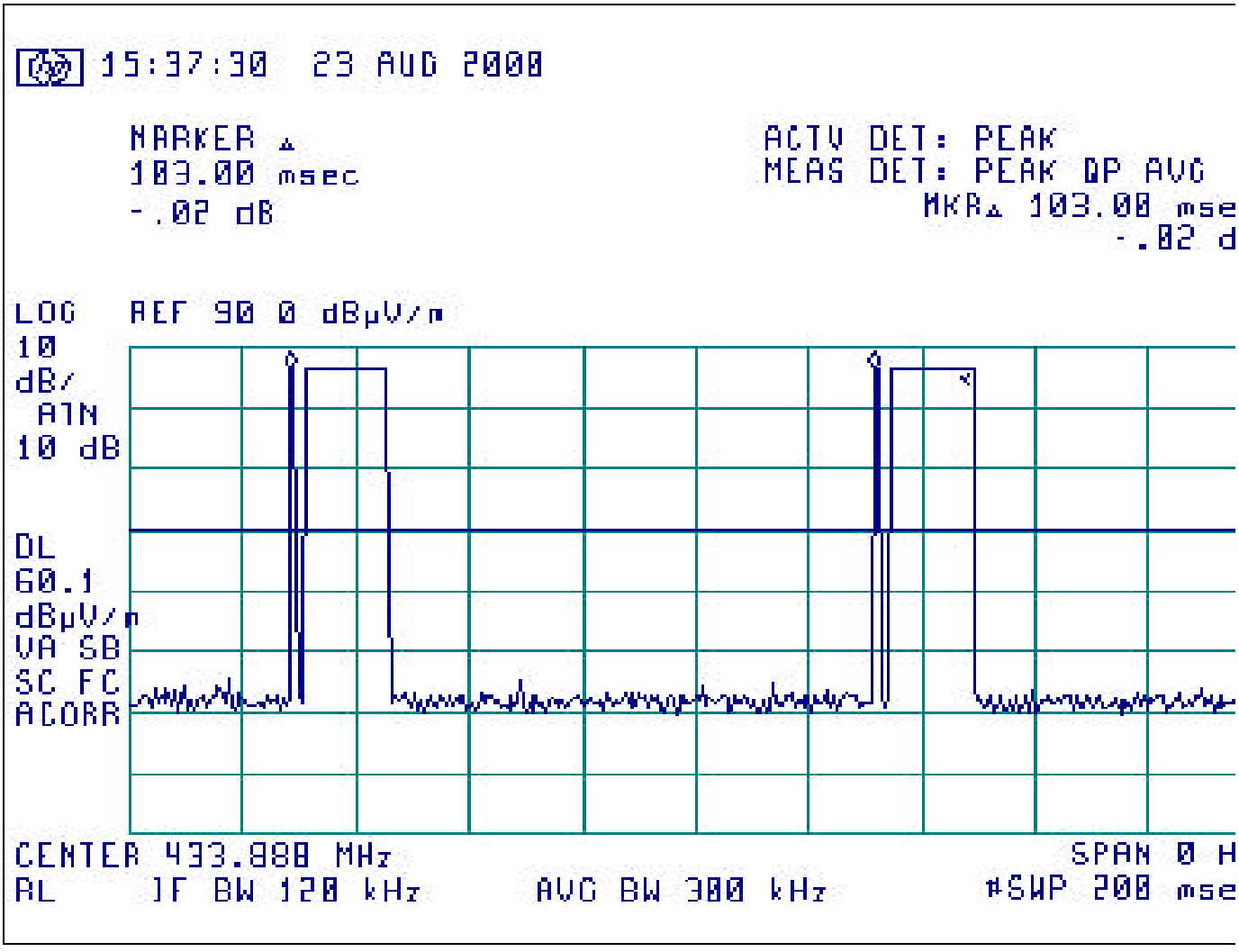
Radiated Emissions 300 MHz – 1000 Hz Horizontal Pc



Occupied Bandwidth



Data Packet Detail, 200 Milliseconds



Data Packet Detail, 20 Milliseconds