Measurement of RF Interference from a Handheld Transmitter

For : Badger Meter.
Milwaukee, WI

P.O. No. : 536149
Date Received : May 23, 2005
Date Tested : May 23, 2005
Test Personnel : Daniel E. Crowder
Specification : FCC "Code of Federal Regulations" Title 47 Part 15.247, Subpart C

Test Report By : Daniel E. Crowder

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

Elite Electronic Engineering Inc.
1516 Centre Circle
Downers Grove, IL 60515
Tel : (630) 495-9770
Fax: (630) 495-9785
www.elitetest.com

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Measurement of RF Emissions from a Handheld Transmitter

1.0 INTRODUCTION:

1.1 Description of Test Item - This document presents the results of tests performed to determine if the Handheld Transmitter would continue to meet the FCC requirements when using a monopole antenna instead of the printed circuit board antenna as previously certified. The tests were performed for Badger Meter of Milwaukee, WI.

1.2 Purpose - The test series was performed to determine if test item with the new antenna meets the requirements of a Class II permissive change for 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 C63.4-2003.

1.3 Deviations, Additions and Exclusions - There were no deviations, additions to, or exclusions from the test specification during this test series.

1.4 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 C63.4-2003, "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"

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 23ºC and the relative humidity was 51%.

2.0 TEST ITEM SETUP AND OPERATION:

The test item is a handheld transmitter that utilizes a monopole antenna instead a printed circuit board antenna. The original handheld transmitter was tested and certified under FCC ID: GIF-RFEPM. A block diagram of the test item setup is shown as Figure 1.

2.1 Power Input - The test item was powered with internal batteries.

2.2 Grounding - Since the test item was battery powered, it was ungrounded during the test.

2.3 Peripheral Equipment - There was no peripheral equipment associated with the test item.

2.4 Interconnect Cables - There were no interconnecting cables associated with the test item.

2.5 Operational Mode - For all tests the test item was energized and placed on an 80cm high non-conductive stand.

For all tests, the test item was set to transmit continuously at a high, mid and low channel. The tests were performed with the test item transmitting at 908.8MHz, 914.7MHz and 921.4MHz.

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).

4.0 REQUIREMENTS, PROCEDURES AND RESULTS:

4.1 Powerline Conducted Emissions Measurements

4.1.1 Requirements – Since the scope of this test is limited to the radiated emission measurements, no conducted emission measurements were taken.

4.2 Antenna Conducted Emissions Measurements:

4.2.1 Requirements – Since the scope of this test is limited to the radiated emission measurements, no antennas conducted emission measurements were taken.

4.3 Radiated Emission Measurements:

4.3.1 Requirements - Per section 15.247(c), radiated emissions which fall in the restricted bands, as defined in §15.205(a), must comply with the radiated emission limits specified in §15.209(a) (see§ 15.205(c)).

Paragraph 15.209(a) has the following radiated emission limits:

Frequency MHz	Field Strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	3
30.0-88.0	100	3
88.0-216.0	150	3
216.0-960.0	200	3
Above 960	500	3

4.3.2 Procedures - Radiated measurements were manually 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.

The radiated emission tests were performed for any harmonics which fall in restricted bands.

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

1) Measurements were made using an average detector and a double ridged waveguide antenna.
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 antenna is linearly polarized, both horizontal and vertical field components were measured.
   (c) The measuring antenna was raised and lowered for each antenna polarization to maximize the readings.

Photographs of the test item setup are presented as Figures 2.

4.3.3 Results - The preliminary plots are presented on pages 10 through 15. The plots are presented for a reference only, and are not used to determine compliance.

The radiated emission levels are presented on data pages 16 through 18. As can be seen by the data the test item did meet the emissions limits of 15.247(c).

5.0 CONCLUSIONS:

It was determined that the Badger Meter Handheld Transmitter with the new monopole antenna meets the requirements of a Class II permissive change for the radiated RF emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Sections for Intentional Radiators.

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. 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								
NTA0	BILOG ANTENNA	CHASE EMC LTD.	BILOG CBL611	2057	0.03-2GHZ	07/12/04	12	07/12/05
NWH0	RIDGED WAVE GUIDE	TENSOR	4105	2081	1-12.4GHZ	09/05/04	12	09/05/05
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.

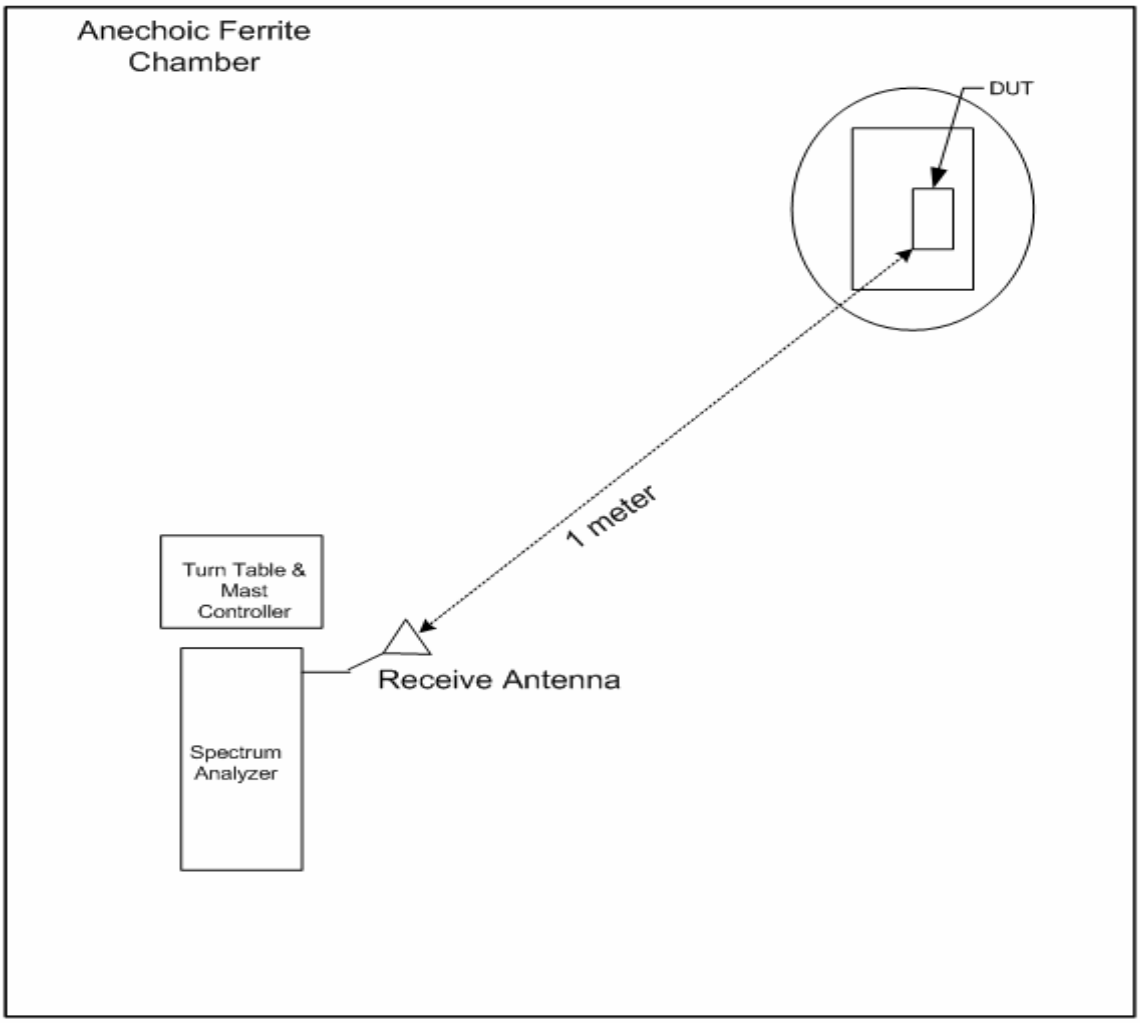
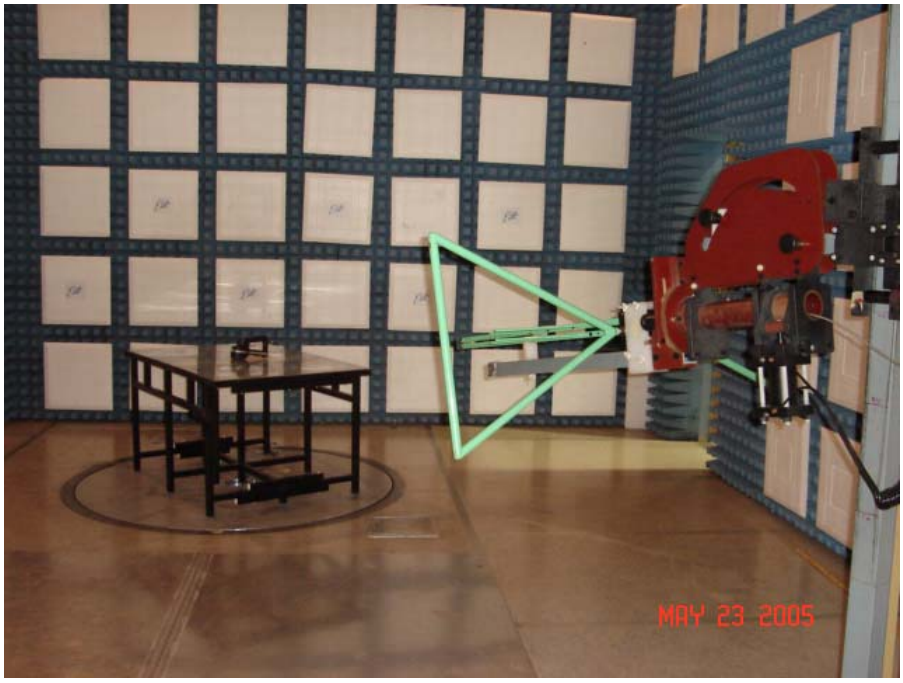
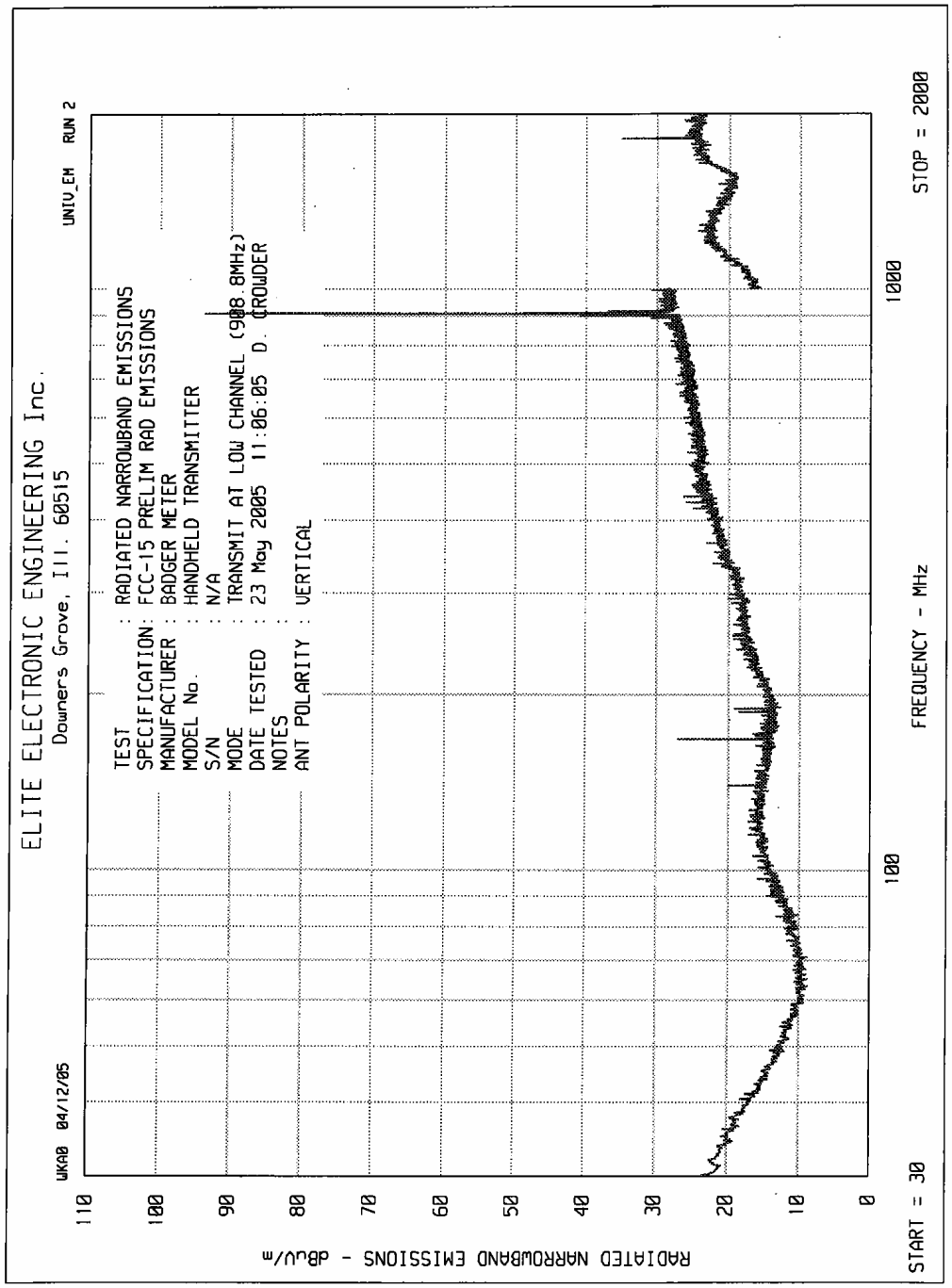


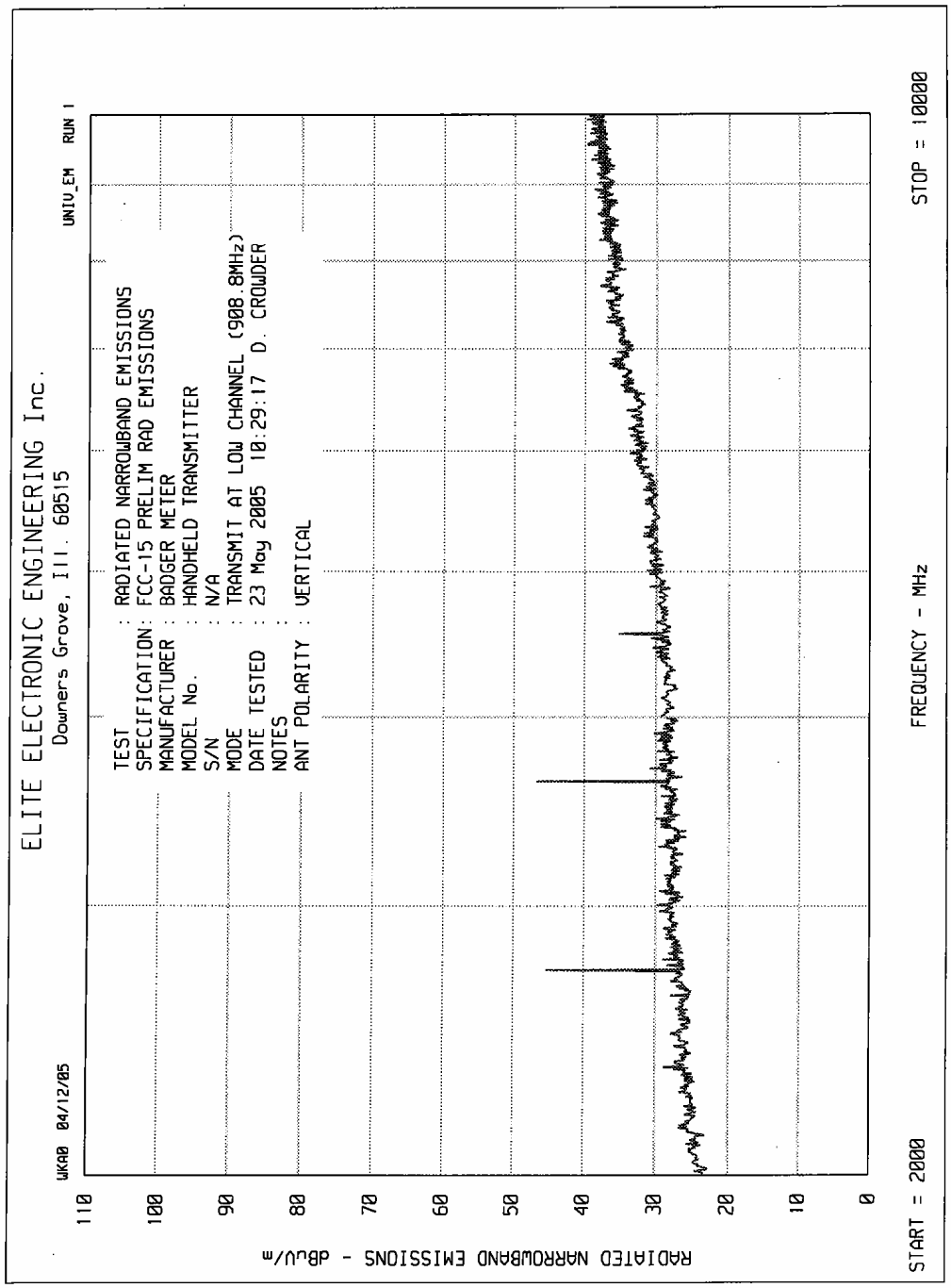
FIGURE 1 BLOCKDIAGRAM OF TEST SETUP

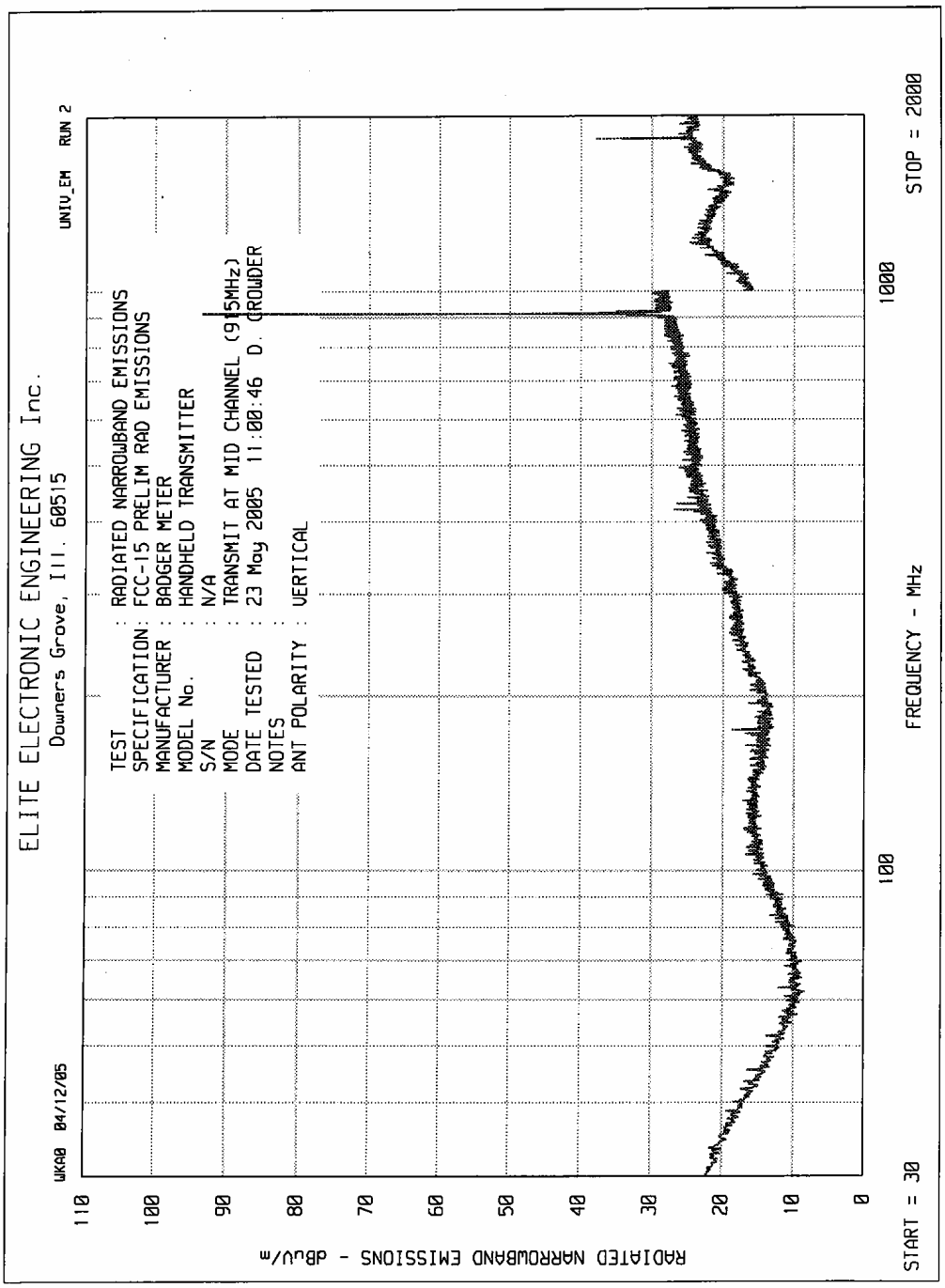
Figure 2

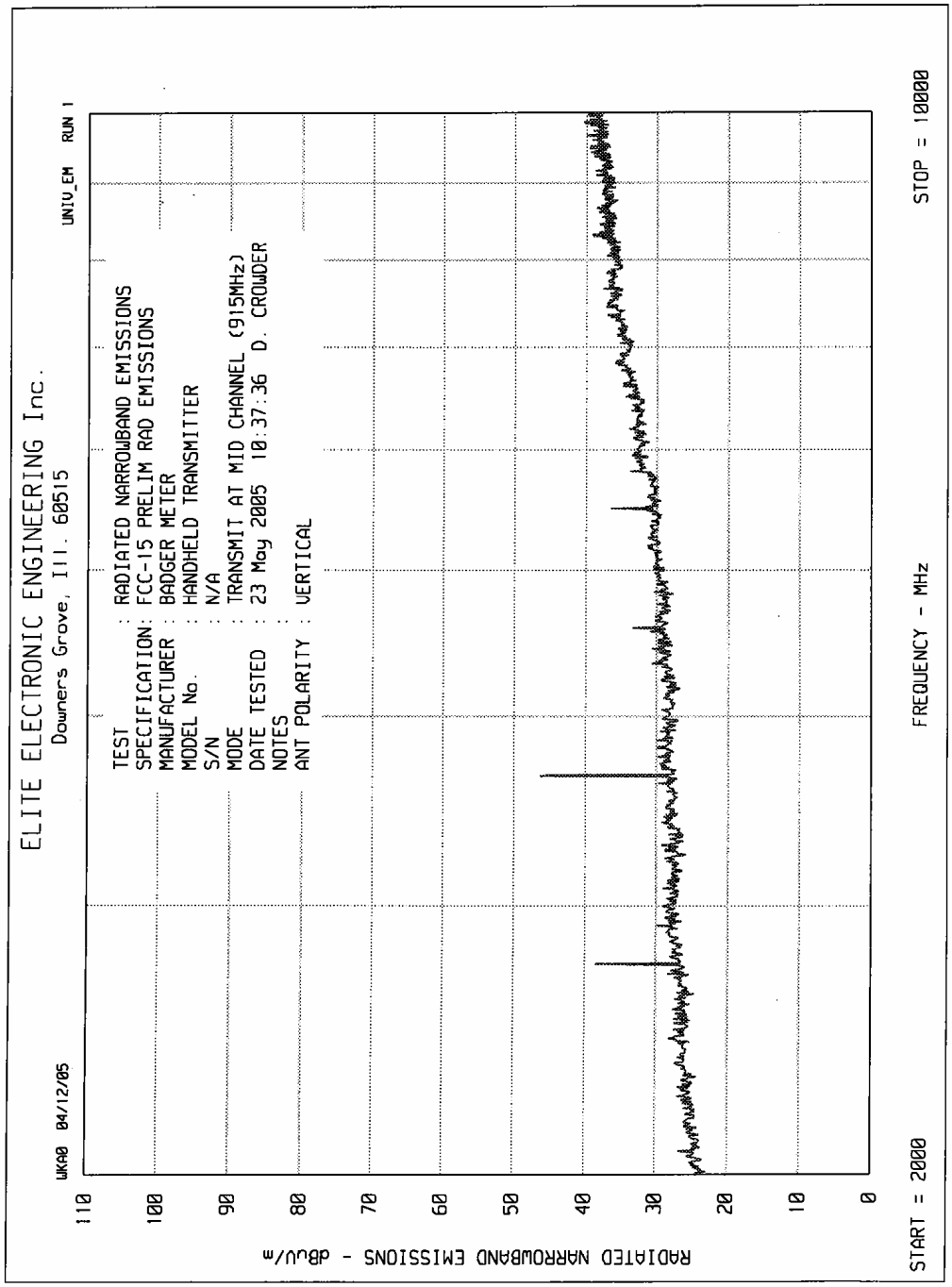


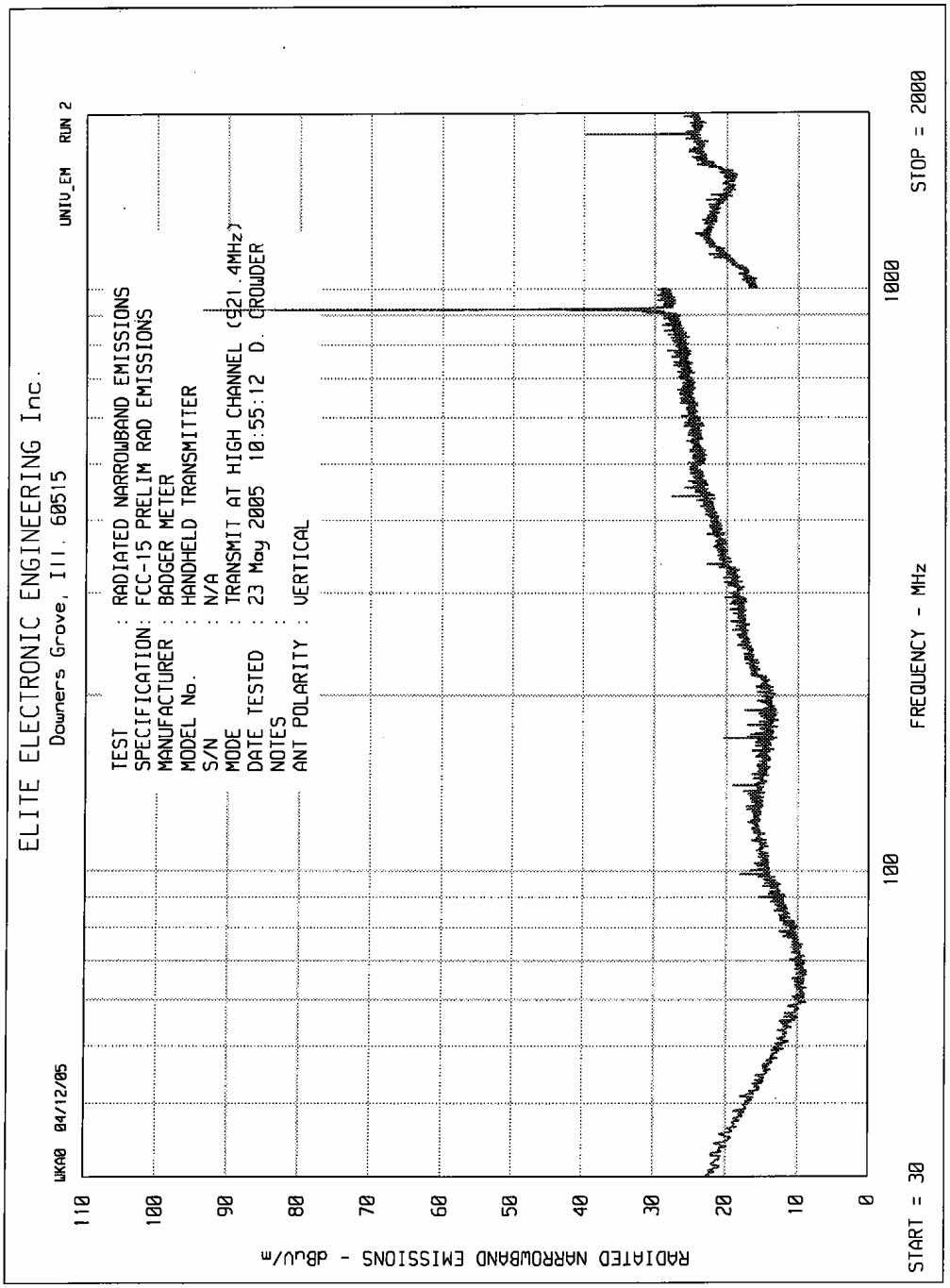
Test Setup for Measurement of Radiated Emissions

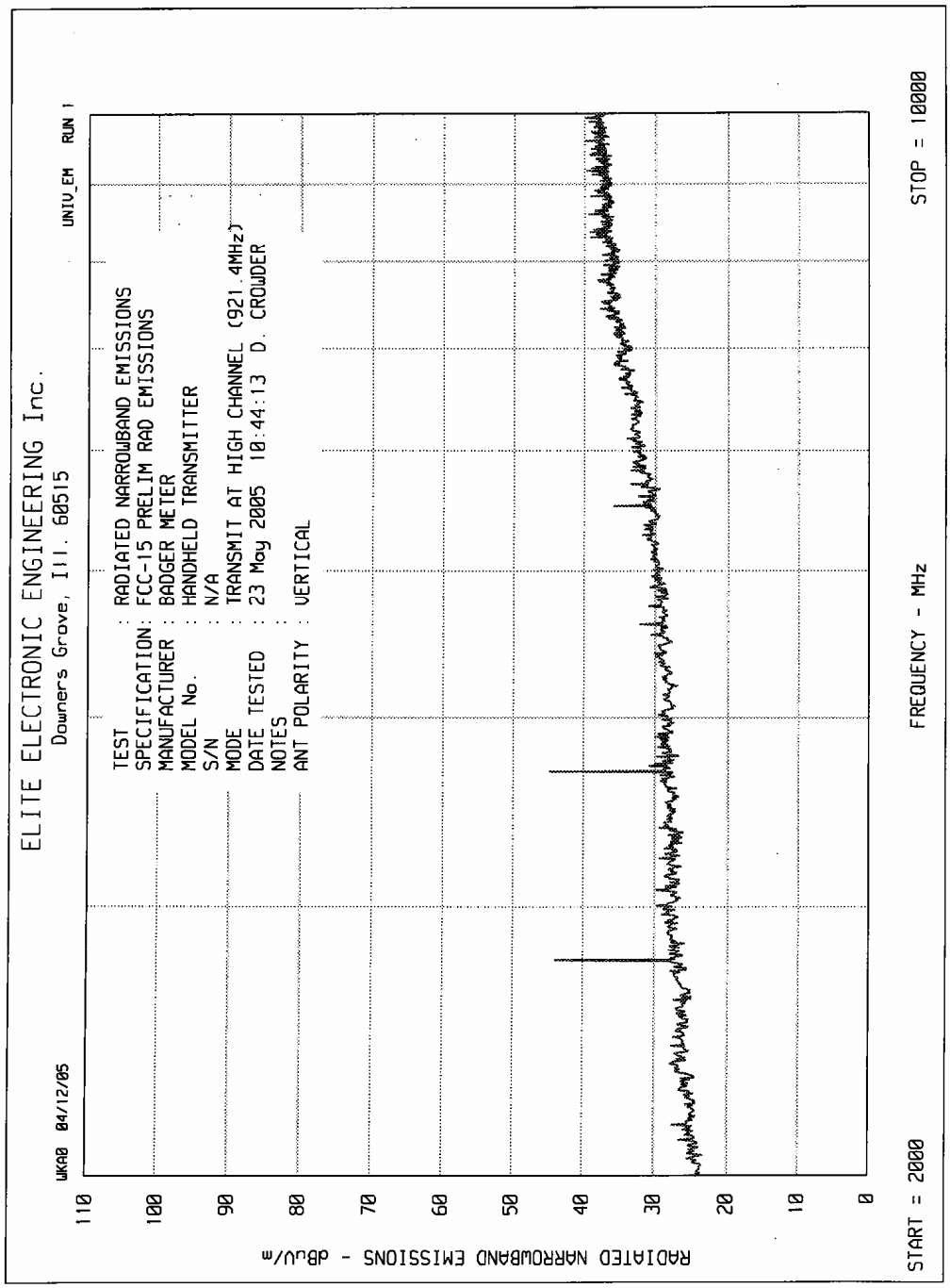

ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV_EM RUN 2
WKA0 04/12/05
TEST : RADIATED NARROWBAND EMISSIONS
SPECIFICATION: FCC-15 PRELIM RAD EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : HANDHELD TRANSMITTER
S/N : N/A
MODE : TRANSMIT AT LOW CHANNEL (908.8MHz)
DATE TESTED : 23 May 2005 11:06:05 D. CROWDER
NOTES :
ANT POLARITY : VERTICAL
RADIATED NARROWBAND EMISSIONS - dBuV/m
110
100
90
80
70
60
50
40
30
20
10
0
START = 30
100
1000
STOP = 2000
FREQUENCY - MHz


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV_EM RUN 1
WKA0 04/12/05
TEST : RADIATED NARROWBAND EMISSIONS
SPECIFICATION: FCC-15 PRELIM RAD EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : HANDHELD TRANSMITTER
S/N : N/A
MODE : TRANSMIT AT LOW CHANNEL (908.8MHz)
DATE TESTED : 23 May 2005 10:29:17 D. CROWDER
NOTES :
ANT POLARITY : VERTICAL
RADIATED NARROWBAND EMISSIONS - dBuV/m
110
100
90
80
70
60
50
40
30
20
10
0
START = 2000
FREQUENCY - MHz
STOP = 10000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV_EM RUN 2
WKA0 04/12/05
TEST : RADIATED NARROWBAND EMISSIONS
SPECIFICATION: FCC-15 PRELIM RAD EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : HANDHELD TRANSMITTER
S/N : N/A
MODE : TRANSMIT AT MID CHANNEL (915MHz)
DATE TESTED : 23 May 2005 11:00:46 D. CROWDER
NOTES :
ANT POLARITY : VERTICAL
RADIATED NARROWBAND EMISSIONS - dBuV/m
110
100
90
80
70
60
50
40
30
20
10
0
START = 30
100
1000
STOP = 2000
FREQUENCY - MHz


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV_EM RUN 1
WKA0 04/12/05
TEST : RADIATED NARROWBAND EMISSIONS
SPECIFICATION: FCC-15 PRELIM RAD EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : HANDHELD TRANSMITTER
S/N : N/A
MODE : TRANSMIT AT MID CHANNEL (915MHz)
DATE TESTED : 23 May 2005 10:37:36 D. CROWDER
NOTES :
ANT POLARITY : VERTICAL
RADIATED NARROWBAND EMISSIONS - dBuV/m
110
100
90
80
70
60
50
40
30
20
10
0
START = 2000
FREQUENCY - MHz
STOP = 10000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV_EM RUN 2
WKA0 04/12/05
TEST : RADIATED NARROWBAND EMISSIONS
SPECIFICATION: FCC-15 PRELIM RAD EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : HANDHELD TRANSMITTER
S/N : N/A
MODE : TRANSMIT AT HIGH CHANNEL (921.4MHz)
DATE TESTED : 23 May 2005 10:55:12 D. CROWDER
NOTES :
ANT POLARITY : VERTICAL
RADIATED NARROWBAND EMISSIONS - dBuV/m
110
100
90
80
70
60
50
40
30
20
10
0
START = 30
100
1000
STOP = 2000
FREQUENCY - MHz


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV_EM RUN 1
WKA0 04/12/05
TEST : RADIATED NARROWBAND EMISSIONS
SPECIFICATION: FCC-15 PRELIM RAD EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : HANDHELD TRANSMITTER
S/N : N/A
MODE : TRANSMIT AT HIGH CHANNEL (921.4MHz)
DATE TESTED : 23 May 2005 10:44:13 D. CROWDER
NOTES :
ANT POLARITY : VERTICAL
RADIATED NARROWBAND EMISSIONS - dBuV/m
110
100
90
80
70
60
50
40
30
20
10
0
START = 2000
FREQUENCY - MHz
STOP = 10000

RADIATED EMISSION MEASUREMENTS IN A 3m ANECHOIC ROOM
SPECIFICATION : FCC-15C (15.247)
MANUFACTURER : BADGER METER
MODEL NO. : HANDHELD TRANSMITTER
SERIAL NO. : NONE ASSIGNED
NOTES : TRANSMIT AT LOW CHANNEL
TEST DATE : MAY 23, 3005
TEST DISTANCE : 3m

FREQ (MHz)	ANT POL	MTR RDG dBuV	BW	ANT FAC dB	CBL FAC dB	PRE AMP dB	TOTAL dBuV/m	TOTAL uV/m	LIMIT uV
908.8	H	72.4		27.6	2.5		102.5	133352.1	
	V	69.4		27.6	2.5		99.5	94406.1	
2726.4	H	46.1		31.3	3.8	34.8	46.4	208.9	500
	V	51.5		31.3	3.8	34.8	51.8	389.0	500
3635.2	H	51.1		32.4	4.2	34.9	52.8	436.5	500
	V	49.2		32.4	4.2	34.9	50.9	350.8	500
4544.0	H	32.9		32.8	5.0	34.9	35.8	61.7	500
	V	33.8		32.8	5.0	34.9	36.7	68.4	500
5452.8	H	29.3	AMBIENT	35.5	5.7	34.4	36.1	63.8	500
	V	25.7	AMBIENT	35.5	5.7	34.4	32.5	42.2	500
7270.4	H	27.9	AMBIENT	36.9	7.0	34.9	36.9	70.0	500
	V	28.3	AMBIENT	36.9	7.0	34.9	37.3	73.3	500
8179.2	H	27.8	AMBIENT	37.7	8.0	35.0	38.5	84.1	500
	V	28.2	AMBIENT	37.7	8.0	35.0	38.9	88.1	500
9088.0	H	28.4	AMBIENT	38.1	8.0	34.9	39.6	95.5	500
	V	28.7	AMBIENT	38.1	8.0	34.9	39.9	98.9	500

CHECKED BY: 

RADIATED EMISSION MEASUREMENTS IN A 3m ANECHOIC ROOM
SPECIFICATION : FCC-15C (15.247)
MANUFACTURER : BADGER METER
MODEL NO. : HANDHELD TRANSMITTER
SERIAL NO. : NONE ASSIGNED
NOTES : TRANSMIT AT MID CHANNEL
TEST DATE : MAY 23, 3005
TEST DISTANCE : 3m

FREQ (MHz)	ANT POL	MTR RDG dBuV	BW	ANT FAC dB	CBL FAC dB	PRE AMP dB	TOTAL dBuV/m	TOTAL uV/m	LIMIT uV
914.7	H	71.4		27.6	2.5		101.5	118850.2	
	V	67.6		27.6	2.5		97.7	76736.1	
2744.1	H	50.3		31.3	3.8	34.8	50.6	338.8	500
	V	48.5		31.3	3.8	34.8	48.8	275.4	500
3658.8	H	47.2		32.4	4.2	34.9	48.9	278.6	500
	V	47.0		32.4	4.2	34.9	48.7	272.3	500
4573.5	H	32.6		32.8	5.0	34.9	35.5	59.6	500
	V	30.4		32.8	5.0	34.9	33.3	46.2	500
7317.6	H	28.3	AMBIENT	36.9	7.0	34.9	37.3	73.3	500
	V	28.1	AMBIENT	36.9	7.0	34.9	37.1	71.6	500
8232.3	H	28.4	AMBIENT	37.7	8.0	35.0	39.1	90.2	500
	V	28.1	AMBIENT	37.7	8.0	35.0	38.8	87.1	500
9147.0	H	29.0	AMBIENT	38.1	8.0	34.9	40.2	102.3	500
	V	28.7	AMBIENT	38.1	8.0	34.9	39.9	98.9	500

CHECKED BY: 

RADIATED EMISSION MEASUREMENTS IN A 3m ANECHOIC ROOM
SPECIFICATION : FCC-15C (15.247)
MANUFACTURER : BADGER METER
MODEL NO. : HANDHELD TRANSMITTER
SERIAL NO. : NONE ASSIGNED
NOTES : TRANSMIT AT HIGH CHANNEL
TEST DATE : MAY 23, 3005
TEST DISTANCE : 3m

FREQ (MHz)	ANT POL	RDG dBuV	MTR BW	FAC dB	ANT FAC dB	CBL AMP dB	PRE TOTAL dBuV/m	TOTAL uV/m	LIMIT uV
921.4	H	69.6		27.6	2.5		99.7	96605.1	
	V	67.2		27.6	2.5		97.3	73282.5	
2764.2	H	44.1		31.3	3.8	34.8	44.4	166.0	500
	V	49.1		31.3	3.8	34.8	49.4	295.1	500
3685.6	H	39.2		32.4	4.2	34.9	40.9	110.9	500
	V	32.1		32.4	4.2	34.9	33.8	49.0	500
4607.0	H	32.9		32.8	5.0	34.9	35.8	61.7	500
	V	32.4		32.8	5.0	34.9	35.3	58.2	500
7371.2	H	28.0	AMBIENT	36.9	7.0	34.9	37.0	70.8	500
	V	27.5	AMBIENT	36.9	7.0	34.9	36.5	66.8	500
8292.6	H	28.7	AMBIENT	37.7	8.0	35.0	39.4	93.3	500
	V	28.2	AMBIENT	37.7	8.0	35.0	38.9	88.1	500

CHECKED BY: