Measurement of RF Emissions from a HRE High Resolution Encoder Transmitter

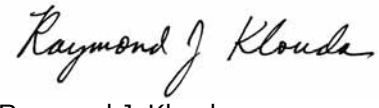
For	Badger Meter, Incorporated 4545 W. Brown Deer Road Milwaukee, WI 53223
P.O. Number	254325
Date Tested	April 22, 2013
Test Personnel	Ian Carnegie
Test Specification	FCC "Code of Federal Regulations" Title 47 Part15, Subpart C, Section 15.209 Industry Canada RSS-GEN Industry Canada RSS-210

Test Report By:

Ian Carnegie
EMC Engineer

Requested By: John Olson
Badger Meter, Incorporated

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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REVISION HISTORY

Revision	Date	Description
—	20 May 2013	Initial release

Measurement of RF Emissions from a High Resolution Encoder, Model No. HRE Transmitter

1. INTRODUCTION

1.1. Scope of Tests

This report presents the results of the RF emissions measurements performed on a High Resolution Encoder, Model No. HRE, (hereinafter referred to as the Equipment Under Test (EUT)).). The EUT was designed to transmit at approximately 50kHz using an internal antenna. The EUT was manufactured and submitted for testing by Badger Meter, Incorporated located in Milwaukee, WI.

1.2. Purpose

The test series was performed to determine if the EUT meets the conducted and radiated RF emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Sections 15.209 for Intentional Radiators. Testing was performed in accordance with ANSI C63.4-2009.

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 American Association for Laboratory Accreditation (A2LA). A2LA Certificate Number: 1786.01.

1.5. Laboratory Conditions

The temperature at the time of the test was 22^{o}C and the relative humidity was 28%.

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 C, dated 2013
- ANSI C63.4-2009, "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 Radio Standards Specification, RSS-Gen, “General Requirements and Information for the Certification of Radiocommunication Equipment”, Issue 3, December 2010
- Industry Canada Radio Standards Specification, RSS-210, “Low-power License-exempt Radiocommunication Devices (All Frequency Bands): Category I Equipment”, Issue 8, December 2010

3. EUT SETUP AND OPERATION

3.1. General Description

The EUT is a Badger Meter, Incorporated, High Resolution Encoder, Model No. HRE. A block diagram of the EUT setup is shown as Figure 1.

3.1.1. Power Input

The EUT obtained 5V from a signal generator @ 1.2kHz. The signal generator was located outside the chamber and was connected to the EUT through a 30ft of RF cable.

3.1.2. Peripheral Equipment

The following peripheral equipment was submitted with the EUT:

Item	Description
Signal Generator	Signal Generator

3.1.3. Signal Input/Output Leads

The following interconnect cables were submitted with the EUT:

Item	Description
RF Cable	30ft RF Cable

3.1.4. Grounding

The EUT was not grounded.

3.2. Operational Mode

For all tests the EUT and all peripheral equipment were placed on an 80cm high non-conductive stand. The EUT and all peripheral equipment were energized. The EUT ran on a modified firmware to create worst case for testing. Because of this, the software did not contain a revision number.

Badger Meter, Incorporated personnel configured the EUT for functionality.

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 C63.4-2009 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.

Radiated emission measurements were performed with a spectrum analyzer. This receiver allows measurements with the bandwidths and detector functions specified by the FCC.

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:

Radiated Emissions Measurements		
Combined Standard Uncertainty	2.26	-2.18
Expanded Uncertainty (95% confidence)	4.5	-4.4

5. TEST PROCEDURES

5.1. Radiated Measurements

5.1.1. Requirements

All radio frequency voltages on the power lines for any frequency or frequencies of an intentional radiator shall not exceed the limits in the following table:

Frequency (MHz)	Field Strength (uV/m)	Measurement Distance (meters)
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	2400/F(kHz)	30
1.705 – 30.0	30	30

5.1.2. 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 C63.4-2009 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.

A preliminary radiated emissions test was performed to determine the emission characteristics of the EUT. For the preliminary test, a broadband measuring antenna was positioned at a 3 meter distance from the EUT. The entire frequency range from 10kHz to 30MHz was investigated using a peak detector function. The data was then processed by the computer to calculate equivalent field intensity.

The final open field emission tests were then manually performed over the frequency range of 50kHz to 500kHz using an active loop antenna at a 3 meter test distance. All significant broadband and narrowband signals were measured and recorded.

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. In the vertical polarization, the active loop antenna was rotated 360 degrees about its vertical axis.
3) 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.

5.1.3. Results

The preliminary plots, with the EUT transmitting at 50kHz, are presented on data pages 11 and 12. 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 50kHz, are presented on data page 13. As can be seen from the data, all emissions measured from the test item were within the specification limits. All emissions measured from the test item at 3 meters were ambient. Photographs of the test configuration which yielded the highest, or worst case, radiated emission levels are shown on Figure 2.

6. OTHER TEST CONDITIONS

6.1. Test Personnel and Witnesses

All tests were performed by qualified personnel from Elite Electronic Engineering Incorporated. The test series was witnessed by Badger Meter, Incorporated personnel.

6.2. Disposition of the EUT

The EUT and all associated equipment were returned to Badger Meter, Incorporated upon completion of the tests.

7. CONCLUSIONS

It was determined that the Badger Meter, Incorporated, Model No. HRE, did fully meet the radiated emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Section 15.205 et seq. for Intentional Radiators, when tested per ANSI C63.4-2009.

It was determined that the Badger Meter, Incorporated, Model No. HRE, did fully meet the radiated emission requirements of the Industry Canada RSS-GEN by Industry Canada RSS-210.

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 EUT at the test date as operated by Badger Meter, Incorporated personnel. Any electrical or mechanical modification made to the EUT 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
CDY0	WORKSTATION	ELITE	WORKSTATION			N/A	
CMA1	Controllers	EMCO	2090	9701-1213	---	N/A	
NLS0	24" ACTIVE LOOP ANTENNA	EMCO	6502	89979	10KHZ-30MHZ	6/22/2012	6/22/2013
RBB0	EMI TEST RECEIVER 20HZ TO 40 GHZ	ROHDE & SCHWARZ	ESIB40	100250	20 HZ TO 40GHZ	3/7/2013	3/7/2014

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.

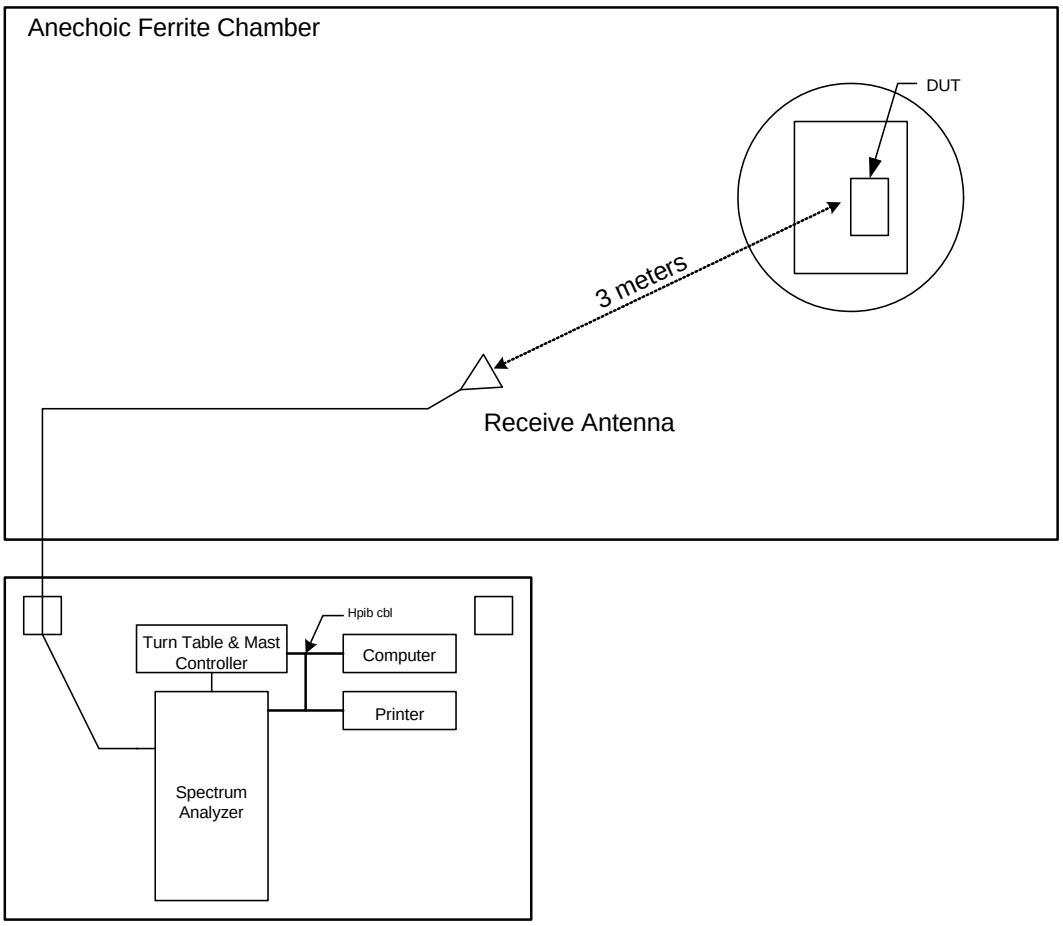
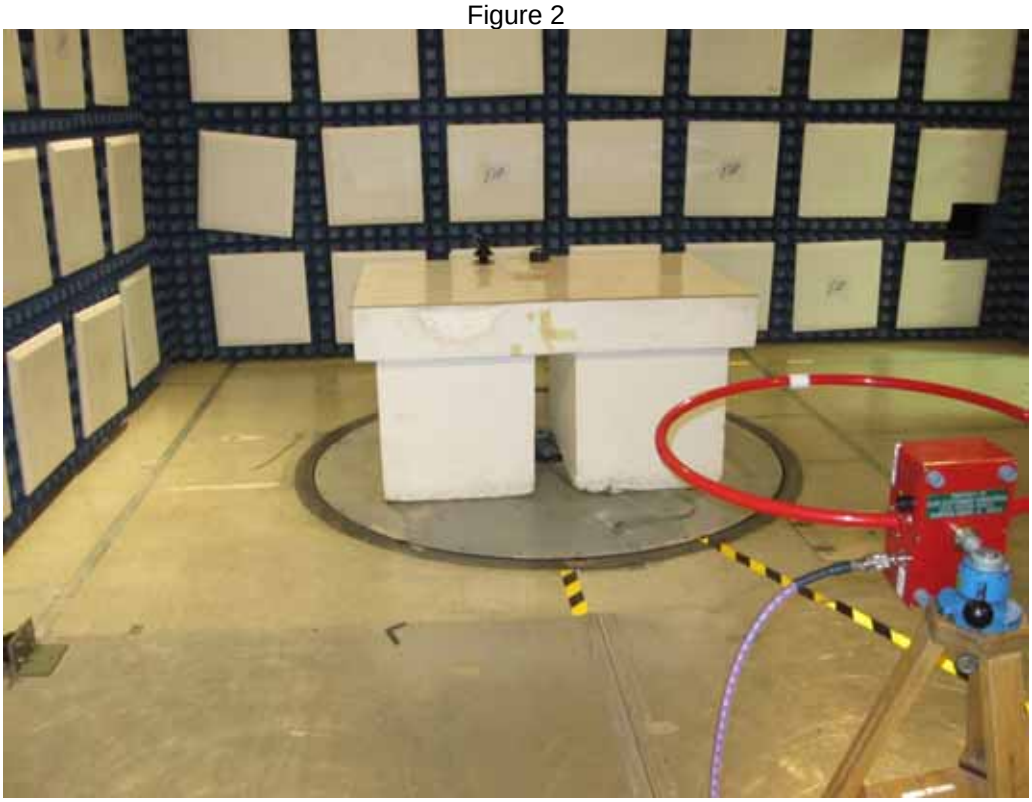


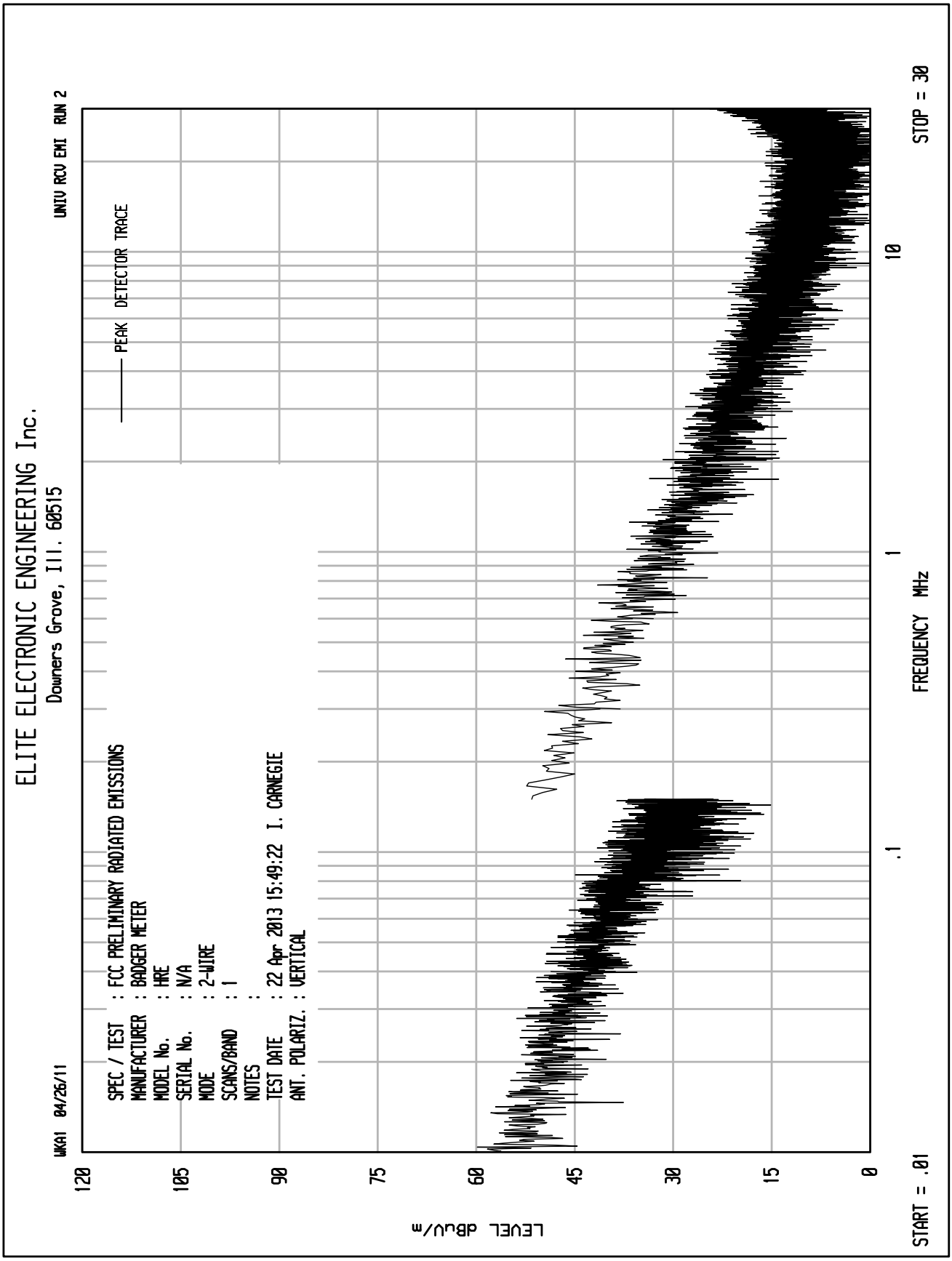
FIGURE 1 BLOCKDIAGRAM OF TEST SETUP

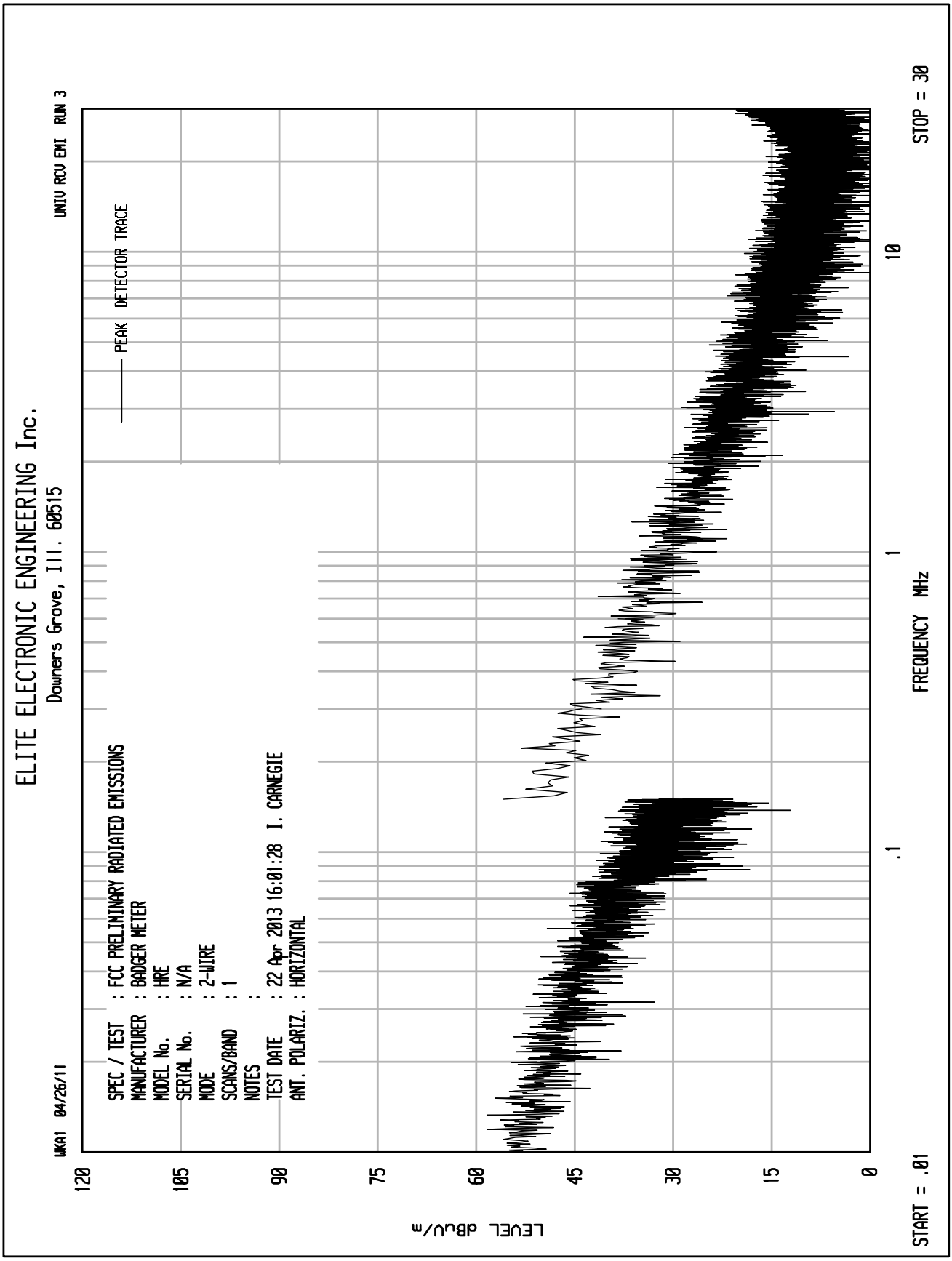
Figure 2



Test Setup for Radiated Emissions, 10kHz to 30MHz – Horizontal Polarization

Test Setup for Radiated Emissions, 10kHz to 30MHz – Vertical Polarization


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 2
WKA1 04/26/11
SPEC / TEST : FCC PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : HRE
SERIAL No. : N/A
MODE : 2-WIRE
SCANS/BAND : 1
NOTES :
TEST DATE : 22 Apr 2013 15:49:22 I. CARNEGIE
ANT. POLARIZ. : VERTICAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = .01
.1
1
10
STOP = 30
FREQUENCY MHz


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV RCV EMI RUN 3
WKA1 04/26/11
SPEC / TEST : FCC PRELIMINARY RADIATED EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : HRE
SERIAL No. : N/A
MODE : 2-WIRE
SCANS/BAND : 1
NOTES :
TEST DATE : 22 Apr 2013 16:01:28 I. CARNEGIE
ANT. POLARIZ. : HORIZONTAL
PEAK DETECTOR TRACE
LEVEL dBuV/m
120
105
90
75
60
45
30
15
0
START = .01
.1
1
10
STOP = 30
FREQUENCY MHz

MANUFACTURER : Badger Meter, Incorporated
MODEL : HRE
SPECIFICATION : FCC-15C Radiated Emissions
DATE : 4/22/2013
NOTES : -

Freq. (MHz)	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Dist. Corr. (dB)	Total (dBuV/m)	Total (uV/m)	Limit (uV/m)	Specified Test Distance (meters)	Margin (dB)
0.050	H	40.1	Ambient	0.0	12.0	0.0	-80.0	-27.9	0.04013	48.0	300.0	-61.6
0.050	V	40.1		0.0	12.0	0.0	-80.0	-27.9	0.04027	48.0	300.0	-61.5
0.100	H	32.6	Ambient	0.0	11.0	0.0	-80.0	-36.5	0.01505	24.0	300.0	-64.1
0.100	V	35.8		0.0	11.0	0.0	-80.0	-33.2	0.02195	24.0	300.0	-60.8
0.150	H	33.8	Ambient	0.0	11.0	0.0	-80.0	-35.2	0.01746	16.0	300.0	-59.2
0.150	V	35.7		0.0	11.0	0.0	-80.0	-33.3	0.02153	16.0	300.0	-57.4
0.200	H	45.9	Ambient	0.0	11.0	0.0	-80.0	-23.1	0.06966	12.0	300.0	-44.7
0.200	V	47.6	Ambient	0.0	11.0	0.0	-80.0	-21.5	0.08463	12.0	300.0	-43.0
0.250	H	45.2		0.0	10.9	0.0	-80.0	-23.9	0.06401	9.6	300.0	-43.5
0.250	V	44.2	Ambient	0.0	10.9	0.0	-80.0	-24.9	0.05718	9.6	300.0	-44.5
0.300	H	42.3	Ambient	0.0	10.9	0.0	-80.0	-26.8	0.04581	8.0	300.0	-44.8
0.300	V	43.4	Ambient	0.0	10.9	0.0	-80.0	-25.7	0.05182	8.0	300.0	-43.8
0.350	H	41.1	Ambient	0.0	10.8	0.0	-80.0	-28.1	0.03943	6.9	300.0	-44.8
0.350	V	41.0	Ambient	0.0	10.8	0.0	-80.0	-28.2	0.03889	6.9	300.0	-44.9
0.400	H	40.1	Ambient	0.0	10.8	0.0	-80.0	-29.1	0.03520	6.0	300.0	-44.6
0.400	V	40.2	Ambient	0.0	10.8	0.0	-80.0	-29.0	0.03548	6.0	300.0	-44.6
0.450	H	39.5	Ambient	0.0	11.0	0.0	-80.0	-29.5	0.03337	5.3	300.0	-44.1
0.450	V	39.1	Ambient	0.0	11.0	0.0	-80.0	-29.9	0.03191	5.3	300.0	-44.5
0.500	H	38.1	Ambient	0.0	11.1	0.0	-40.0	9.2	2.87409	48.0	30.0	-24.5
0.500	V	37.7	Ambient	0.0	11.1	0.0	-40.0	8.8	2.75106	48.0	30.0	-24.8