





## Measurement of RF Interference from The Absolute Digital Encoder (ADE) Transmitter

For : Badger Meter Inc.  
Milwaukee, WI

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Part 15, Subpart C

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## TABLE OF CONTENTS

PARAGRAPH	DESCRIPTION OF CONTENTS	PAGE NO.
1.0 INTRODUCTION .....		3
1.1 Description of Test Item .....		3
1.2 Purpose .....		3
1.3 Deviations, Additions and Exclusions .....		3
1.4 Applicable Documents - .....		3
1.5 Subcontractor Identification .....		3
1.6 Laboratory Conditions .....		3
2.0 TEST ITEM SETUP AND OPERATION .....		3
2.1 Power Input .....		4
2.2 Grounding .....		4
2.3 Support Equipment .....		4
2.4 Interconnect Cables .....		4
2.5 Operational Mode .....		4
3.0 TEST EQUIPMENT .....		4
3.1 Test Equipment List .....		4
3.2 Calibration Traceability .....		4
4.0 REQUIREMENTS, PROCEDURES AND RESULTS .....		4
4.1 Powerline Conducted Emissions .....		4
4.1.1 Requirements .....		4
4.2 Radiated Emissions .....		4
4.2.1 Requirements .....		5
4.2.2 Procedures .....		5
4.2.2.1 Preliminary Radiated Measurements .....		5
4.2.2.2 Final Radiated Measurements .....		5
4.2.3 Results .....		6
5.0 CONCLUSIONS .....		6
6.0 CERTIFICATION .....		6
7.0 ENDORSEMENT DISCLAIMER .....		6
TABLE I - EQUIPMENT LIST .....		7

## Measurement of RF Emissions from an Absolute Digital Encoder (ADE) Transmitter

### **1.0 INTRODUCTION:**

**1.1 Description of Test Item** - This document represents the results of the series of radio interference measurements performed on a model Absolute Digital Encoder (ADE) transmitter, (hereinafter referred to as the test item). The test item is designed to transmit meter reading to a hand held meter reader when the reader is placed in close proximity to the transmitter. The test item transmits at approximately 50kHz. It uses an internal antenna. The test item was manufactured and submitted for testing by Badger Meter Inc. located in Milwaukee, WI.

**1.2 Purpose** - The test series was performed to determine if the test item meets 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 2005
- 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 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.

**1.6 Laboratory Conditions** - The temperature at the time of the test was 23°C and the relative humidity was 25%.

### **2.0 TEST ITEM SETUP AND OPERATION:**

The test item is normally in an un-powered condition. It contains no internal power source. The test item has a mechanical odometer stack gear train that advances as water is used. When externally

powered the microprocessor controlled circuit board optically reads the position of the odometer and reports the consumption information and test item serial number to the reading equipment. A block diagram of the test item setup is shown as Figure 1.

**2.1 Power Input** - The test uses a 20V, 20 kHz power source. This power is inductively coupled into the test item from the handheld reader. For test purposes, an arbitrary waveform generator was used to power the test item and put it into a test mode.

Item	Description
AWG	Agilent 3325A 80MHz Function Generator Arbitrary Waveform Generator

he test item received 20V power via inductive coupling from the support equipment.

**2.2 Grounding** - Since the test item is typically powered through inductive coupling via a battery powered handheld device, it was ungrounded during the tests.

**2.3 Peripheral Equipment** - The test item has no equipment

**2.4 Interconnect Cables** - The test item has no ports for interconnect leads.

**2.5 Operational Mode** - For all tests the test item was placed on an 80cm high non-conductive stand. The test item was energized from the external power source. Once activated, the test item transmits at 50 kHz.

### **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.

The fundamental, harmonics and spurious emissions were measured with a spectrum analyzer. All measurements were taken with the resolution and video bandwidth of the measuring instrument adjusted to 200Hz below 150kHz and 10kHz above 150kHz.

**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**

**4.1.1 Requirements** – Since the test item is typically powered by a battery powered handheld reading device through inductive coupling and not connected to the AC network, no conducted emission tests are required.

#### **4.2 Radiated Emissions**

**4.2.1 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 15.209(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	30
30 – 88	100**	3
88 – 216	150**	3
216 – 960	200**	3
Above 960	500	3

\* \*- Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470 MHz-806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., §§ 15.231 and 15.241.

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.

#### **4.2.2 Procedures -**

##### **4.2.2.1 Preliminary Radiated Measurements -**

All preliminary tests were performed in a 32ft. x 20ft. x 14ft. high absorber lined shielded enclosure. All powerlines and signal lines entering the enclosure pass through filters on the enclosure wall.

The loop antenna was positioned at a 1 meter distance from the test item. The entire frequency range from 10kHz to 30MHz was investigated using a peak detector function.

**4.2.2.2 Final Radiated Measurements** - Measurements were performed at a test distance of 3 meters using a peak detector. The final open field emission tests were performed over the frequency range of 50kHz to 500kHz. A loop antenna was used as the pick-up device for all measurements. All significant broadband and narrowband signals were measured and recorded. Final measurements were performed in a 32ft. x 20ft. x 14ft. high absorber lined shielded enclosure.

Since the signal could not be detected at the 3 meter test distance the antenna was first moved to a 1 meter distance from the test item. The measurement antenna was vertically polarized. The test item was then rotated 360° around its X, Y and Z axis. The worst case position was noted. The measurement

antenna was then placed in its horizontal polarization and the procedure was repeated noting the worst case position. The measurement antenna was then moved to a test distance of 3 meters for the final measurements.

**4.2.3 Results** - A preliminary plot with the test item transmitting at 50kHz is presented on data page 10. This plot is presented for a reference only, and is not used to determine compliance.

The final open area radiated levels are presented on data page 11. As can be seen from the data, no emissions from the test item could be detected above the ambient level at a 3 meter distance. The ambient level was within the specification limits. The ambient level closet to the limit (worst case) occurred at 499.5kHz. The ambient level at this frequency was 25.1dB within the limit. See data page 14 for details. Photographs of the test configuration which yielded the highest or worst case, radiated ambient levels are shown on Figure 2.

#### **5.0 CONCLUSIONS:**

It was determined that the Badger Meter Inc. Absolute Digital Encoder (ADE), did fully meet the 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 C63.4-2003.

#### **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.

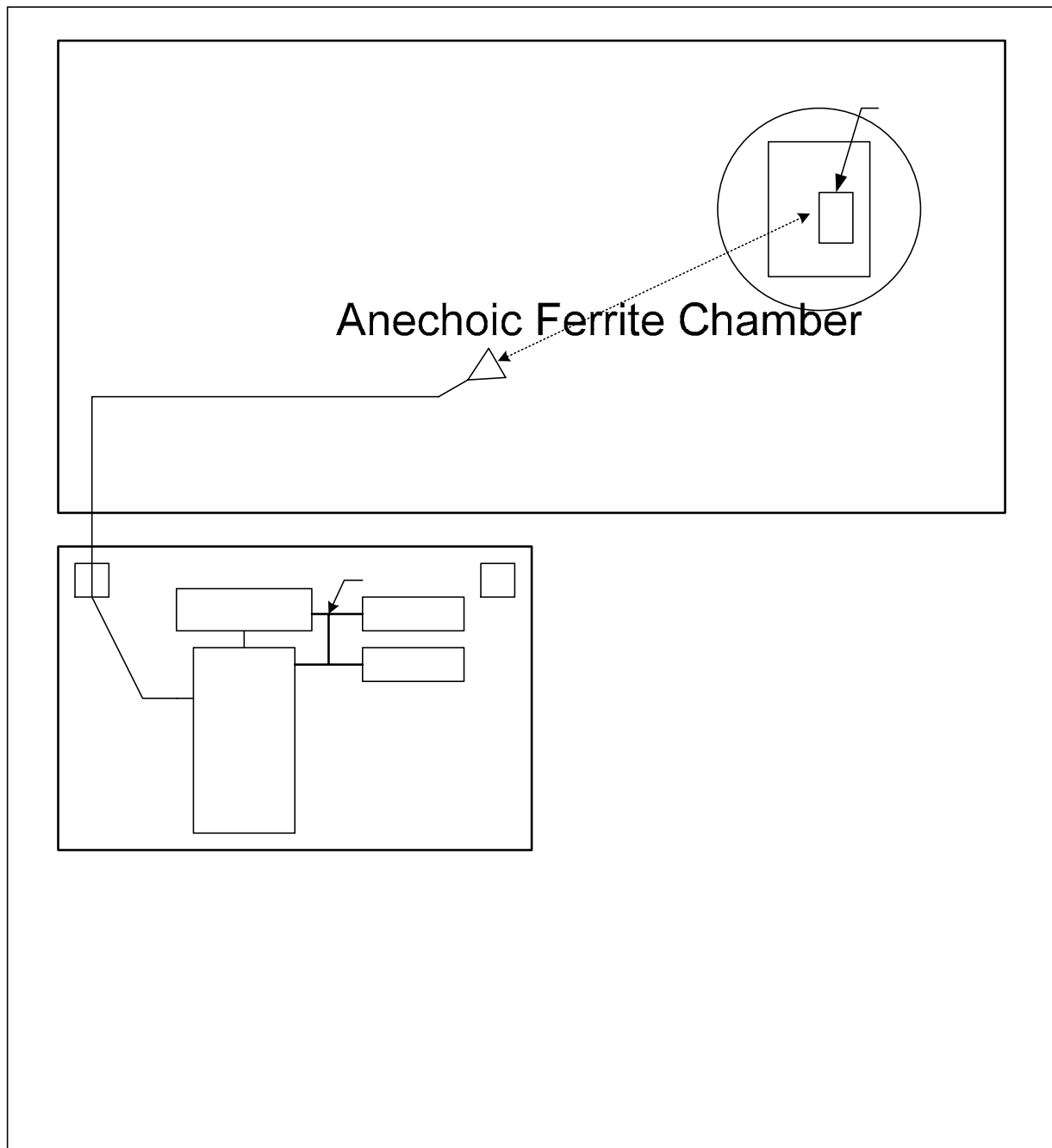


TABLE I: TEST EQUIPMENT LIST

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									
XZG3	ATTENUATOR/SWITCH DRIVER	HEWLETT PACKARD	11713A	2421A03059	---		N/A		
Equipment Type: AMPLIFIERS									
APK3	PREAMPLIFIER	AGILENT TECHNOLOGIES	8449B	3008A01593	1-26.5GHZ	05/09/05	12	05/09/06	
Equipment Type: ANTENNAS									
NLS1	24" ACTIVE LOOP ANTENNA	EMCO	6502	8903-2329	0.01-30MHZ	01/23/06	12	01/23/07	
Equipment Type: CONTROLLERS									
CDD2	COMPUTER	HEWLETT PACKARD	D4171A#ABA	US61654645	---		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									
RAC2	SPECTRUM ANALYZER	HEWLETT PACKARD	85660B	3638A08770	100HZ-22GHZ	02/10/06	12	02/10/07	
RACD	RF PRESELECTOR	HEWLETT PACKARD	85685A	3010A01205	20HZ-2GHZ	02/10/06	12	02/10/07	
RAF4	QUASIPeak ADAPTER	HEWLETT PACKARD	85650A	2043A00320	0.01-1000MHZ	02/10/06	12	02/10/07	

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.



Rec

Hpib cbl

Turn Table & Mast  
Controller

Computer

Page 8 of 11

Printer



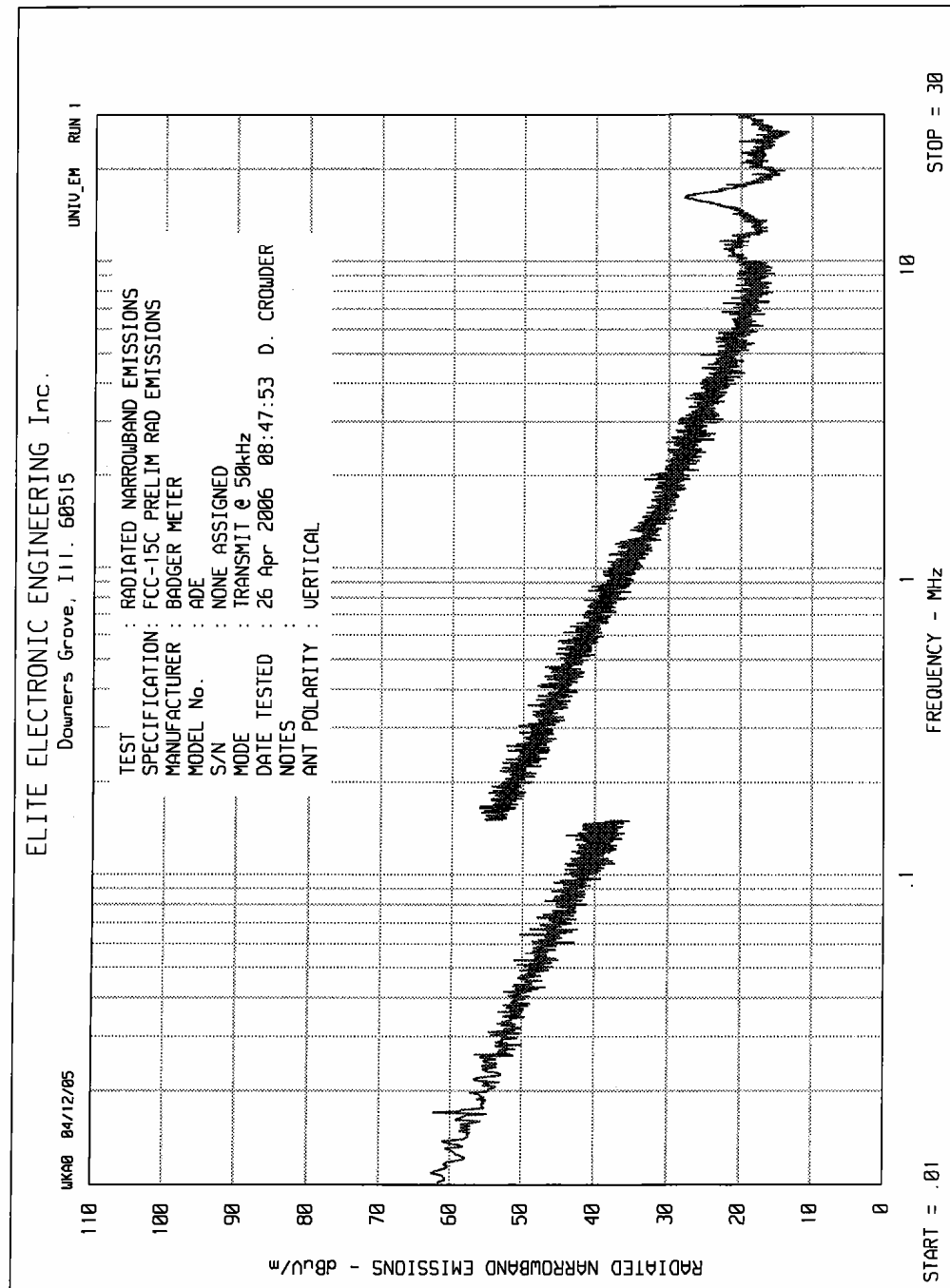
Figure 2



Radiated Emissions Worst Case Horizontal Polarization



Radiated Emissions Worst Case Vertical Polarization





MANUFACTURER : Badger Meter  
TEST ITEM : Transmitter  
MODEL NO. : Absolute Digital Encoder (ADE)  
SERIAL NO. : None Assigned  
SPECIFICATION : FCC-15.209  
TEST EQUIPMENT : See Table I  
MODE : Transmit at 50kHz  
DATE : April 26, 2006  
NOTES : Test Distance is 3 meters

FREQ		ANT		METER		DIST.		LIMIT		LIMIT	
.		.		READING		ANT.	CBL.	CORR.	TOTAL	300M	30M
(kHz)	DET.	POL.		dBuV	AMB	FAC.	FAC.	FAC.	dBuV/m	dBuV/m	dBuV/m
49.95	Peak	V		39.9	*	11.0	0	-80	-29.1	33.6	
49.95	Peak	H		39.4	*	11.0	0	-80	-29.6	33.6	
99.9	Peak	V		35.6	*	10.8	0	-80	-33.6	27.6	
99.9	Peak	H		35.6	*	10.8	0	-80	-33.6	27.6	
149.85	Peak	V		31.4	*	10.7	0	-80	-37.9	24.1	
149.85	Peak	H		32.4	*	10.7	0	-80	-36.9	24.1	
199.8	Peak	V		45.5	*	10.3	0	-80	-24.2	21.6	
199.8	Peak	H		37.5	*	10.3	0	-80	-32.2	21.6	
249.75	Peak	V		43.8	*	10.4	0	-80	-25.8	19.7	
249.75	Peak	H		36.8	*	10.4	0	-80	-32.8	19.7	
299.7	Peak	V		41.2	*	10.4	0	-80	-28.4	18.1	
299.7	Peak	H		38.1	*	10.4	0	-80	-31.5	18.1	
349.65	Peak	V		39.5	*	10.4	0	-80	-30.1	16.7	
349.65	Peak	H		39.3	*	10.4	0	-80	-30.3	16.7	
399.6	Peak	V		40.9	*	10.4	0	-80	-28.7	15.6	
399.6	Peak	H		38.0	*	10.4	0	-80	-31.6	15.6	
449.55	Peak	V		39.5	*	10.4	0	-40	9.9		34.5
449.55	Peak	H		37.8	*	10.4	0	-40	8.2		34.5
499.5	Peak	V		38.2	*	10.3	0	-40	8.5		33.6
499.5	Peak	H		36.1	*	10.3	0	-40	6.4		33.6

Distance Correction Factor : Per CFR 15.31(f)(2), At frequencies below 30MHz measurements may be performed at a distance closer than that specified in the regulations. The results may be extrapolated to the specified distance by using the square of an inverse linear distance extrapolation factor (40dB/decade).  
Distance correction factor (300 meters to 3 meters) = 80dB (2 decades @ 40dB per decade)  
Distance correction factor (30 meters to 3 meters) = 40dB (1 decade @ 40dB per decade)

CHECKED BY: Dan Crowder