

Elite Electronic Engineering, Inc.
1516 Centre Circle
Downers Grove, Illinois
(630) 495-9770
www.elitetest.com

Engineering Test Report Number 31025-01



MEASUREMENT OF RF INTERFERENCE FROM A MODEL ORION REMOTE TRANSMITTER

FOR: **Badger Meter**
4545 W. Brown Deer Rd.
Milwaukee, Wisconsin 53223

Dates Tested: May 30, 2002

Test Specifications: FCC "Code of Federal Regulations" Title 47
Part 15, Subpart C, Section 15.205



ENGINEERING TEST REPORT NO. 31025-01
ADMINISTRATIVE DATA AND SUMMARY OF TESTS

DESCRIPTION OF TEST ITEM: Transmitter

MODEL NO: Orion Remote

SERIAL NO: None Assigned

MANUFACTURER: Badger Meter

APPLICABLE SPECIFICATIONS: FCC "Code of Federal Regulations"
Title 47, Part 15, Subpart C

QUANTITY OF ITEMS TESTED: One (1)

TEST PERFORMED BY: ELITE ELECTRONIC ENGINEERING INCORPORATED
Radio Interference Consultants
Downers Grove, Illinois 60515

DATE RECEIVED: May 30, 2002

DATE TESTED: May 30, 2002

PERSONNEL (OPERATORS, OBSERVERS, AND CO-ORDINATORS):

CUSTOMER: Syed A. Mateen of Badger Meter was present.

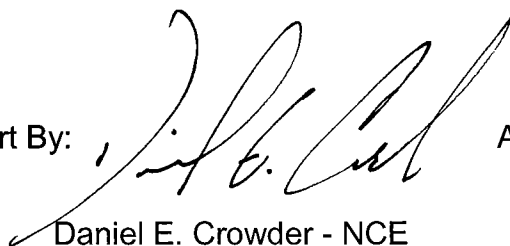
ELITE ELECTRONIC: Daniel E. Crowder

ELITE JOB NO.: 31025

ABSTRACT: The model Orion Remote Transmitter, does 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 C63.4-1992.

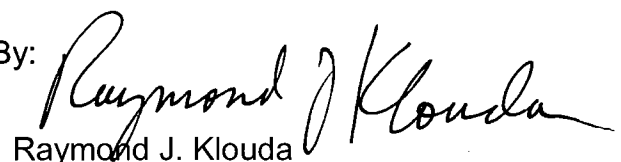
The radiated emissions level closest to the limit (worst case) occurred at 916.5MHz. The emissions level at this frequency was 3.7dB within the limit. See data page 17 for more details.

Report By:



Daniel E. Crowder - NCE

Approved By:



Raymond J. Klouda
Registered Professional
Engineer of Illinois - 44894

TABLE OF CONTENTS

PARAGRAPH	DESCRIPTION OF CONTENTS	PAGE NO.
1.0	INTRODUCTION	4
1.1	DESCRIPTION OF TEST ITEM	4
1.2	PURPOSE	4
1.3	DEVIATIONS, ADDITIONS AND EXCLUSIONS	4
1.4	APPLICABLE DOCUMENTS	4
1.5	SUBCONTRACTOR IDENTIFICATION	4
1.6	LABORATORY CONDITIONS	4
2.0	TEST ITEM SETUP AND OPERATION	5
2.1	POWER INPUT	5
2.2	GROUNDING	5
2.3	PERIPHERAL EQUIPMENT	5
2.4	INTERCONNECT CABLES	5
3.0	TEST EQUIPMENT	5
3.1	TEST EQUIPMENT LIST	5
3.2	CALIBRATION TRACEABILITY	5
3.3	MEASUREMENT UNCERTAINTY	5
4.0	REQUIREMENTS, PROCEDURES AND RESULTS	6
4.1	POWERLINE CONDUCTED EMISSIONS	6
4.1.1	REQUIREMENTS	6
4.2	RADIATED MEASUREMENTS	6
4.2.1	REQUIREMENTS	6
4.2.3	RESULTS	7
4.3	OCCUPIED BANDWIDTH MEASUREMENTS	8
4.3.1	REQUIREMENTS	8
4.3.2	PROCEDURES	8
4.3.3	RESULTS	8
5.0	CONCLUSION	8
6.0	CERTIFICATION	8
7.0	ENDORSEMENT DISCLAIMER	9
	TABLE I - EQUIPMENT LIST	10

**TOTAL NUMBER OF PAGES IN THIS DOCUMENT,
(INCLUDING DATA SHEETS): 16**

**THIS REPORT SHALL NOT BE REPRODUCED, EXCEPT IN FULL, WITHOUT THE
WRITTEN APPROVAL OF ELITE ELECTRONIC ENGINEERING INCORPORATED.**

ENGINEERING TEST REPORT NO. 31025-01
MEASUREMENT OF RF INTERFERENCE FROM
A MODEL ORION REMOTE TRANSMITTER

1.0 INTRODUCTION:

1.1 DESCRIPTION OF TEST ITEM: This document presents the results of a series of radio interference measurements performed on a model Orion Remote Transmitter, (hereinafter referred to as the test item). No serial number was assigned to the test item. The test item was designed to transmit at approximately 916.5MHz using an internal antenna. The tests were performed for Badger Meter of Milwaukee, Wisconsin.

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, Sections for Intentional Radiators. Testing was performed in accordance with ANSI C63.4-1992.

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 2001
- ANSI C63.4-2001, "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 21°C and the relative humidity was 42%.

2.0 TEST ITEM SETUP AND OPERATION:

A block diagram of the test item setup is included as Figure 1.

2.1 POWER INPUT: The test item was powered with 3VDC through a 3VDC battery.

2.2 GROUNDING: Since the test item was powered with 3VDC through a 3VDC battery, it was ungrounded during the tests.

2.3 PERIPHERAL EQUIPMENT: There was no peripheral equipment submitted with the test item.

2.4 INTERCONNECT CABLES: There were no interconnect cables submitted with the test item.

2.5 OPERATIONAL MODE: For all tests the test item and all peripheral equipment were placed on a 80cm high non-conductive stand. The test item and all peripheral equipment was energized.

For all tests, the test item's transmit button was held down thereby setting the unit to transmit continuously. The battery voltage was periodically checked to ensure proper operation at maximum level. The tests were performed with the test item operating at 916.5MHz.

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 100kHz below 1GHz and 1MHz above 1GHz.

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).

3.3 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 budgets were based on guidelines in "ISO Guide to the Expression of Uncertainty in Measurements" and NAMAS NIS81 "The Treatment of Uncertainty in EMC Measurements".

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

4.0 REQUIREMENTS, PROCEDURES AND RESULTS:

4.1 POWERLINE CONDUCTED EMISSIONS:

4.1.1 REQUIREMENTS: Since the test item was powered by internal batteries, no conducted emissions tests were performed.

4.2 RADIATED MEASUREMENTS:

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 15.249(a) has the following radiated emission limits:

Fundamental Frequency MHz	Field Intensity mV/m @ 3 meters	Field Strength Harmonics and Spurious uV/m @ 3 meters
902 to 928	50	500

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: 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 1992 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.

Preliminary radiated emissions measurements were first performed using a peak detector and automatically plotted. The frequencies where significant emission levels were noted were then remeasured.

With the broadband measuring antennas positioned at a 3 meter distance from the test item, the frequency range from 30MHz to 10GHz was investigated using a peak detector function with the antennas set for vertical polarization.

Final radiated emissions were performed on all significant broadband and narrowband emissions found in the preliminary sweeps using the following methods:

- 1) Measurements were made using a peak detector and either a tuned dipole or 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 from 1 to 4 meters for each antenna polarization to maximize the readings.
 - (d) The fundamental through the 10th harmonic of the transmit frequency were measured.

4.2.3 RESULTS: The preliminary plots, with the test item transmitting at 916.5MHz, are presented on data pages 13 and 14. 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 916.5MHz, are presented on data page 15. 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 916.5MHz. The emissions level at this frequency was 3.7dB within the limit. See data page 15 for details. Photographs of the test configuration which yielded the highest, or worst case, radiated emission levels are shown on Figure 2.

4.3 OCCUPIED BANDWIDTH MEASUREMENTS:

4.3.1 REQUIREMENTS: In accordance with paragraph 15.249(c), all emissions radiated outside the specified bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in 15.209, whichever is the lesser attenuation.

4.3.2 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.

4.3.3 RESULTS: The plot of the emissions near the fundamental frequency are presented on data page 16. As can be seen from this data page, the transmitter met the occupied bandwidth requirements.

5.0 CONCLUSION:

It was found that the Badger Meter model Orion Remote Transmitter, does meet the conducted and 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 C63.4-1992.

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 specification.

The data presented in this test report pertains only 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.

ENGINEERING TEST REPORT NO. 31025-01

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 TECHNOL	8449B	3008A01593	1-26.5GHZ	05/09/02	12	05/09/03
Equipment Type: ANTENNAS								
NDQ0	TUNED DIPOLE ANTENNA	EMCO	3121C-DB4	311	400-1000MHZ	12/11/01	12	12/11/02
NTA1	BILOG ANTENNA	CHASE EMC LTD.	BILOG CBL611	2054	0.03-2GHZ	05/22/01	13	06/22/02
NWH0	RIDGED WAVE GUIDE	TENSOR	4105	2081	1-12.4GHZ	08/03/01	12	08/03/02
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	02/21/02	12	02/21/03
RACD	RF PRESELECTOR	HEWLETT PACKARD	85685A	3010A01205	20HZ-2GHZ	02/21/02	12	02/21/03
RAF5	QUASIPeAK ADAPTOR W/ RECEI	HEWLETT PACKARD	85650A	2043A00151	0.01-1000MHZ	06/11/01	12	06/11/02

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 - Block Diagram of Test Item

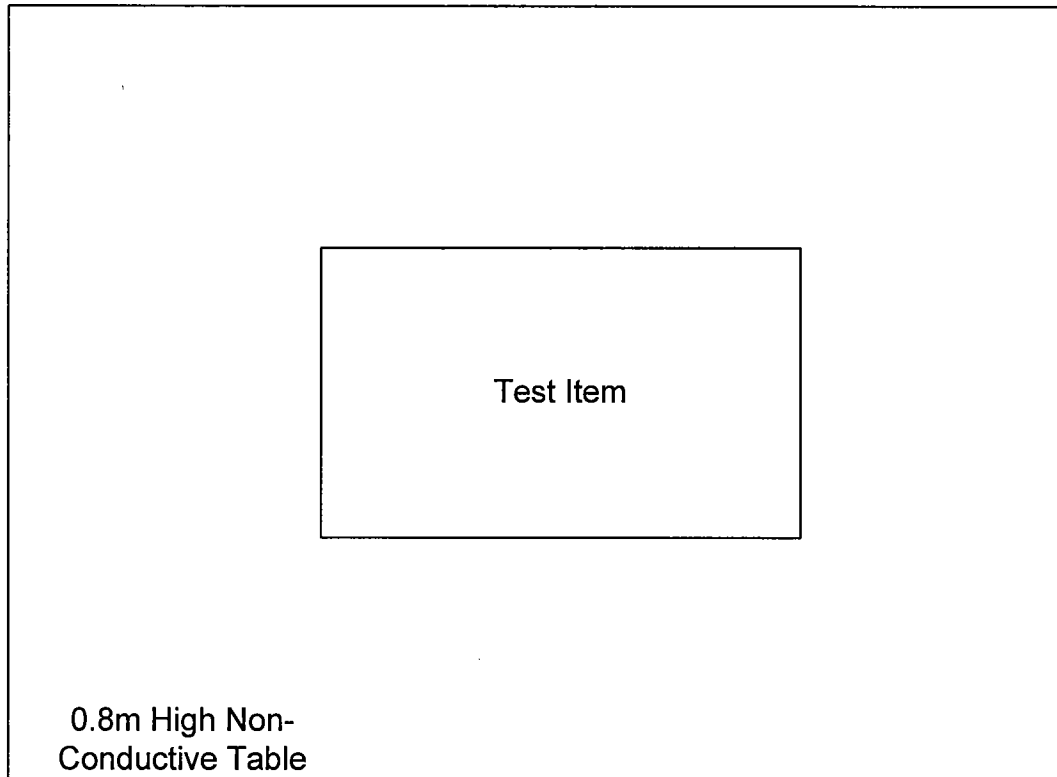




FIGURE 2a - TEST SETUP FOR HIGHEST RADIATED EMISSIONS MEASUREMENT
HORIZONTAL POLARITY

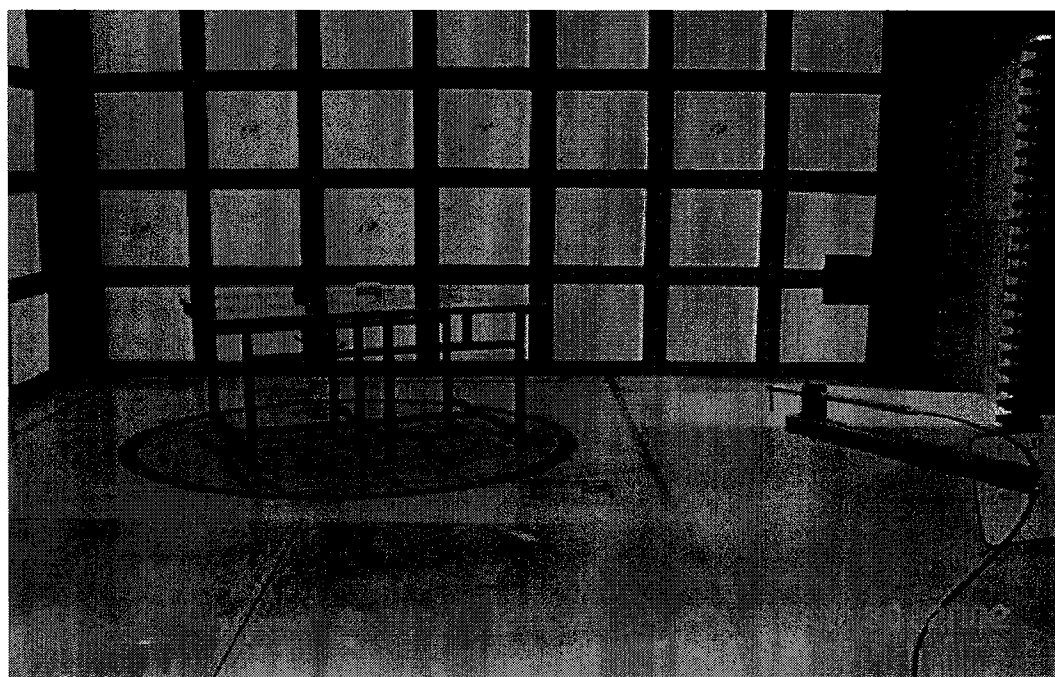


FIGURE 2b - TEST SETUP FOR HIGHEST RADIATED EMISSIONS MEASUREMENT
VERTICAL POLARITY

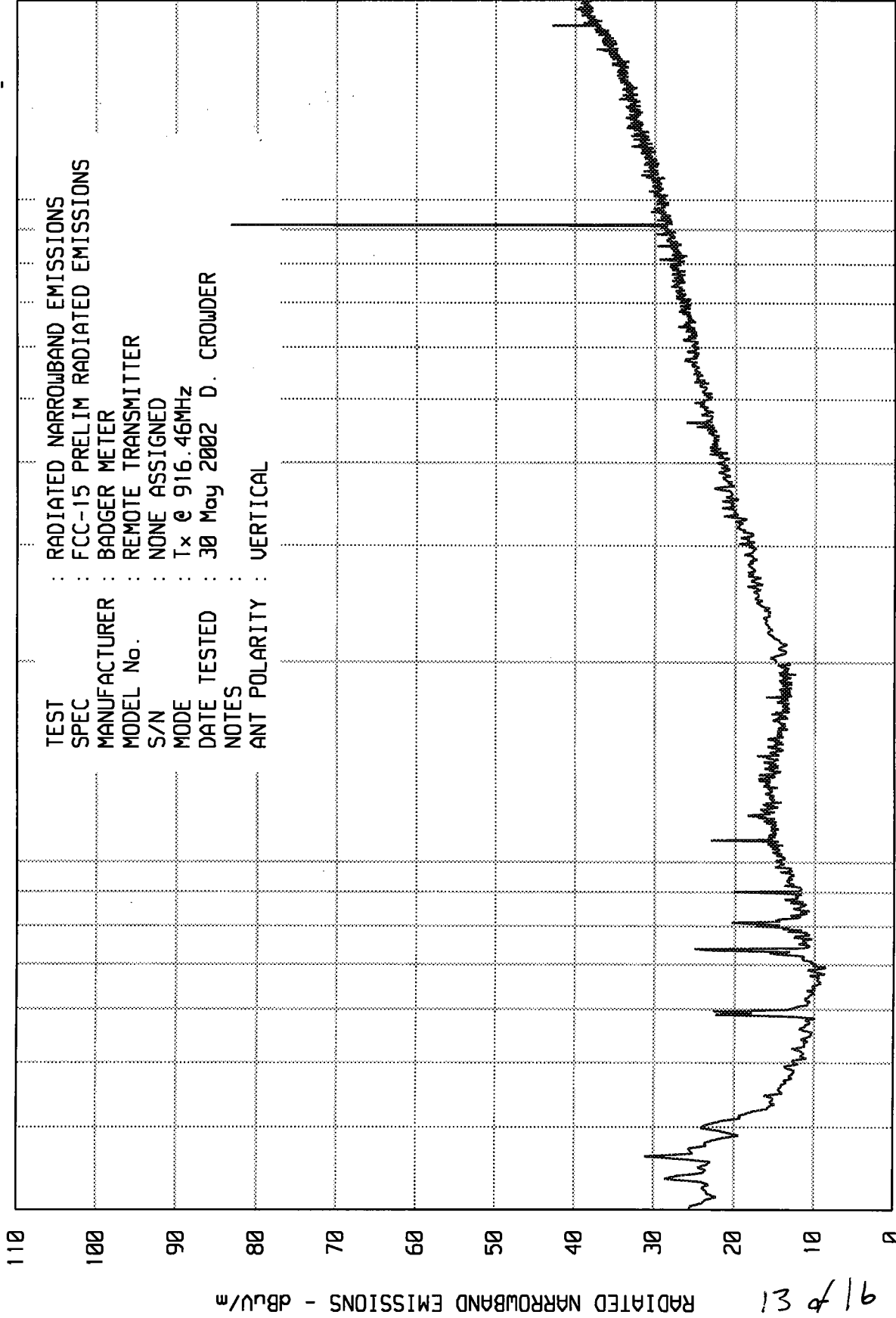
ETR 31025-01

ELITE ELECTRONIC ENGINEERING Co.

Downers Grove, Ill. 60515

UNTU_EM RUN RUN 3

UKA0 11/26/01



STOP = 2000

START = 30

9/16

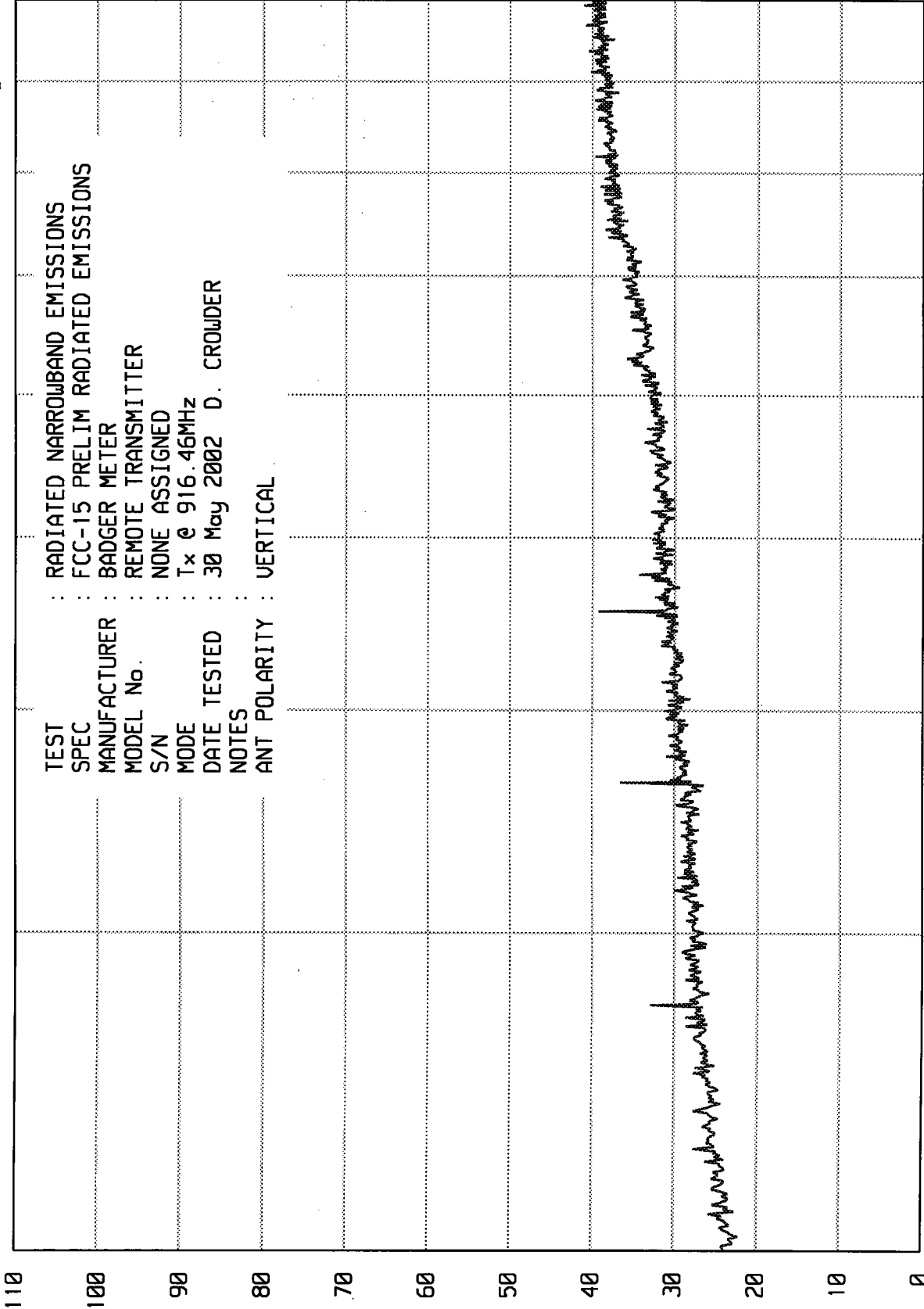
ETR 31025-01

ELITE ELECTRONIC ENGINEERING Co.

Downers Grove, Ill. 60515

UNTU_EM RUN RUN 1

LKAO 11/26/01



RADIATED NARROWBAND EMISSIONS - dBu/m

91 90 41

START = 2000

FREQUENCY - MHz

STOP = 10000



ETR No. 31025-01
DATA SHEET

RADIATED EMISSION MEASUREMENTS IN A 3m ANECHOIC ROOM

SPECIFICATION : FCC-15C
MANUFACTURER : BADGER METER
MODEL NO. : REMOTE TRANSMITTER
SERIAL NO. : NONE ASSIGNED
NOTES : TRANSMITTING
TEST DATE : MAY 30, 2002
TEST DISTANCE : 3m

FREQ (MHz)	ANT POL	MTR RDG dBuV	ANT FAC dB	CBL FAC dB	PRE AMP dB	TOTAL dBuV/m	TOTAL uV/m	LIMIT uV
916.5	H	53.6	27.4	3.3		84.3	16405.9	50000
	V	59.6	27.4	3.3		90.3	32734.1	50000
1832.9	H	54.0	26.3	2.7	34.7	48.3	260.0	500
	V	51.2	26.3	2.7	34.7	45.5	188.4	500
2749.4	H	48.0	29.7	3.6	34.8	46.5	211.3	500
	V	49.4	29.7	3.6	34.8	47.9	248.3	500
3665.8	H	41.4	32.2	4.1	34.9	42.8	138.0	500
	V	41.3	32.2	4.1	34.9	42.7	136.5	500
4582.3	H	43.0	33.0	4.7	34.9	45.8	195.0	500
	V	42.4	33.0	4.7	34.9	45.2	182.0	500
5498.7	H	38.3 AMB	35.1	5.0	34.4	44.0	158.5	500
	V	39.3 AMB	35.1	5.0	34.4	45.0	177.8	500
6415.2	H	41.5 AMB	35.6	5.7	34.7	48.1	254.1	500
	V	41.7 AMB	35.6	5.7	34.7	48.3	260.0	500
7331.6	H	41.7 AMB	37.0	6.5	34.9	50.3	327.3	500
	V	42.2 AMB	37.0	6.5	34.9	50.8	346.7	500
8248.1	H	42.1 AMB	37.7	7.5	35.0	52.3	412.1	500
	V	41.7 AMB	37.7	7.5	35.0	51.9	393.6	500
9164.5	H	42.0 AMB	38.1	7.5	34.9	52.7	431.5	500
	V	42.7 AMB	38.1	7.5	34.9	53.4	467.7	500

CHECKED BY: 

ELITE ELECTRONIC ENGINEERING CO

MKR ^ 25.95 MHz
0.00 dB

hp

REF 77.0 dBuV

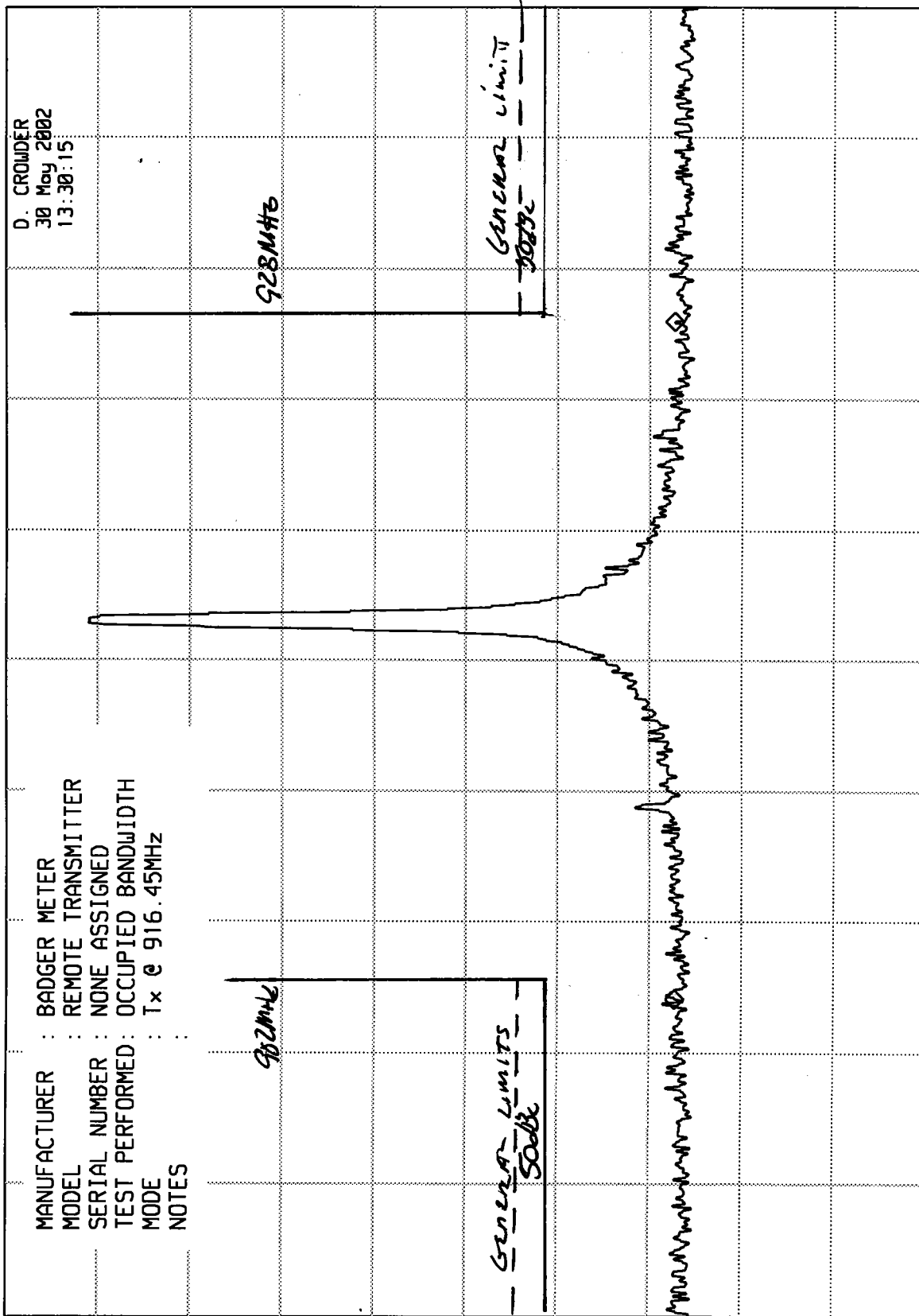
ATTEN 0 dB

10 dB/

OFFSET
-20.0
dB

DL 18.7
dBuV

MANUFACTURER : BADGER METER
MODEL : REMOTE TRANSMITTER
SERIAL NUMBER : NONE ASSIGNED
TEST PERFORMED : OCCUPIED BANDWIDTH
MODE : Tx @ 916.45MHz
NOTES :



ETR 31025-01

16 of 16

CENTER 915.0 MHz

RES BW 100 kHz (i)

VBW 1 MHz

SPAN 50.0 MHz

SWP 37.5 msec