Measurement of RF Interference from an Orion Transmitter

For : Badger Meter, Inc.
Milwaukee, IL

P.O. No. : 539965
Date Received : November 13, 2006
Date Tested : November 13, 2006
Test Personnel : Mark E. Longinotti
Specification : FCC "Code of Federal Regulations" Title 47 Part 15, Subpart C, Section 15.249 for Intentional Radiators Operating Within the 902MHz to 928MHz band

Test Report By : MARK E. LONGINOTTI
Mark E. Longinotti

Witnessed by :
Syed Mateen
Badger Meter, Inc.

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

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REVISION HISTORY

Revision	Date	Description
—	November 17,2006	Initial release

Measurement of RF Emissions from an Orion transmitter

1.0 INTRODUCTION:

1.1 Description of Test Item - This document represents the results of the series of radio interference measurements performed on an Orion Transmitter, Serial No. None Assigned, (hereinafter referred to as the test item). The test item was designed to transmit at approximately 916.45MHz using an internal antenna. The test item was manufactured and submitted for testing by Badger Meter, Inc. located in Milwaukee, IL.

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 15.249 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 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 22C and the relative humidity was 27%.

2.0 TEST ITEM SETUP AND OPERATION:

The test item is an Orion Transmitter. A block diagram of the test item setup is shown as Figure 1. Photographs of the test item are shown as Figure 2.

2.1 Power Input - The test item obtained 3.6VDC from 2 lithium thionylchloride internal batteries.

2.2 Grounding - The test item was ungrounded during the tests.

2.3 Peripheral Equipment - The test item was submitted for testing with a Badger Meter Recordall Transmitter Register. The test item can also be used with an ADE.

2.4 Interconnect Cables - The test item was connected to the Recordall Transmitter Register via a 3 meter long 2 wire unshielded cable.

2.5 Operational Mode - For all tests the test item and all peripheral equipment were placed on an 80cm high non-conductive stand. The test item and all peripheral equipment were energized. The test item was set to transmit continuously at 916.45MHz. Two separate tests were performed, one with the test item transmitting at 916.45MHz with no metal enclosure and one with the test item and the Transmitter Register placed in a 21cm x 26.5cm x 26.5cm aluminum enclosure.

2.6 Test Item Modifications - No modifications were required for compliance to the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Sections 15.249 requirements.

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).

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 Duty Cycle Factor Measurements:

4.2.1 Procedures: The duty cycle factor is used to convert peak detected readings to average readings. This factor is computed from the time domain trace of the pulse modulation signal.

With the transmitter set up to transmit for maximum pulse density, the time domain trace is displayed on the spectrum analyzer. This trace is obtained by tuning center frequency to the transmitter frequency and then setting a zero span width with 2msec/div. The amplitude settings are adjusted so that the on/off transitions clear the 4th division from the bottom of the display. The markers are set at the beginning and end of a word period. If the word period exceeds 100 msec the word period is set to 100 msec.

4.2.2 Results: The plots of the duty cycle are shown on data pages 17 and 18. The test item transmits a 1.76msec pulse every 3.98 seconds. Since a word is greater than 100 msec long, the duty cycle factor was computed over a 100msec interval. The duty cycle correction factor was calculated to be -35.1dB (-35.1dB = 20*log(1.76msec/100msec).

4.3 Radiated Measurements

4.3.1 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 has the following radiated emission limits:

Fundamental Frequency MHz	Field Intensity uV/m @ 3 meters	Field Strength Harmonics and Spurious @ 3 meters
902 – 928	50,000	500

For radiated emissions below 1GHz, the field strength limits are based on quasi-peak readings. For radiated emissions above 1GHz, the field strength limits are based on average readings. In addition, the peak field strength of any emission shall not exceed the maximum permitted average limits by more than 20 dB under any condition of modulation.

4.3.2 Procedures - Radiated emissions measurements were 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.

A preliminary radiated emissions test was performed to determine the emission characteristics of the test item. For the preliminary test, a broadband measuring antenna was positioned at a 3 meter distance from the test item. The entire frequency range from 30MHz to 10.0GHz was investigated using a peak detector function. The data was then processed by the computer to calculate equivalent field intensity.

The final radiated emission tests were then manually performed over the frequency range of 30MHz to 10.0GHz. A quasi-peak detector was used to measure all radiated emissions between 30MHz and 1000MHz. A tuned dipole antenna was used as the pick-up device for measurements below 1GHz.

A broadband double ridged waveguide antenna was used as the pick-up device for all frequencies above 1GHz. All significant broadband and narrowband signals were measured and recorded. The peak detected levels were converted to average levels using a duty cycle factor which was computed from the pulse train.

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.
(3) The measuring antenna was raised and lowered from 1 to 4 meters for each

antenna polarization to maximize the readings.

(4) 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.

4.3.3 Results - The preliminary plots, with the test item transmitting at 916.45MHz with no metal enclosure, are presented on data pages 19 and 20. The preliminary plots, with the test item transmitting at 916.45MHz inside a metal enclosure, are presented on data pages 21 and 22. 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 916.45MHz with no metal enclosure, are presented on data pages 23 and 24. As can be seen from the data, all emissions measured from the test item were within the specification limits. The emissions level closet to the limit (worst case) occurred at 916.45MHz. The emissions level at this frequency was 1.7dB within the limit. See data pages 23 and 24 for details. Photographs of the test configuration which yielded the highest, or worst case, radiated emission levels are shown on Figures 3 and 4.

The final radiated levels, with the test item transmitting at 916.45MHz inside a metal enclosure, are presented on data pages 25 and 26. As can be seen from the data, all emissions measured from the test item were within the specification limits. The emissions level closet to the limit (worst case) occurred at 916.45MHz. The emissions level at this frequency was 6.8dB within the limit. See data pages 23 and 24 for details. Photographs of the test configuration which yielded the highest, or worst case, radiated emission levels are shown on Figures 5 and 6.

4.4 Occupied Bandwidth Measurements

4.4.1 Requirement - In accordance with paragraph 15.249(d), all emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuate by at least 50dB below the level of the fundamental or to the general radiated emissions limits in 15.209, which ever is the lesser attenuation.

4.4.2 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. The resolution bandwidth was set to 100 kHz and span was set to 30 MHz. The frequency spectrum near the fundamental was plotted.

4.3.3 Results - The plot of the emissions near the fundamental frequency, with the test item transmitting at 916.45MHz with no metal enclosure, is presented on data page 27. As can be seen

from this data page, the transmitter met the occupied bandwidth requirements.

The plot of the emissions near the fundamental frequency, with the test item transmitting at 916.45MHz inside a metal enclosure, is presented on data page 28. As can be seen from this data page, the transmitter met the occupied bandwidth requirements.

The 99% bandwidth was measured to be 405kHz.

5.0 CONCLUSIONS:

It was determined that the Badger Meter, Inc. Orion Transmitter, Serial No. None Assigned, with no metal enclosure and with a metal enclosure, did fully meet the conducted and radiated emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Sections 15.207 and 15.249 for Intentional Radiators Operating within the 902MHz -928MHz band, 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 as operated by Badger Meter, Inc. personnel. 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								
XZG4	ATTENUATOR/SWITCH DRIVER	HEWLETT PACKARD	11713A	2223A01683	---		N/A	
Equipment Type: AMPLIFIERS								
APK4	PREAMPLIFIER OPT H02	HEWLETT PACKARD	8449B	3008A00329	1-26.5GHZ	01/31/06	12	01/31/07
Equipment Type: ANTENNAS								
NDQ1	TUNED DIPOLE ANTENNA	EMCO	3121C-DB4	313	400-1000MHZ	03/10/06	12	03/10/07
NTA0	BILOG ANTENNA	CHASE EMC LTD.	BILOG CBL611	2057	0.03-2GHZ	08/21/06	12	08/21/07
NWF0	RIDGED WAVE GUIDE	EMCO	3105	2035	1-12.4GHZ	10/09/06	12	10/09/07
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								
RACA	RF PRESELECTOR	HEWLETT PACKARD	85685A	2926A00980	20HZ-2GHZ	02/11/06	12	02/11/07
RAEC	SPECTRUM ANALYZER	HEWLETT PACKARD	8566B	3014A06690	100HZ-22GHZ	02/10/06	12	02/10/07
RAF5	QUASIPEAK ADAPTOR W/ RECEI	HEWLETT PACKARD	85650A	2043A00151	0.01-1000MHZ	02/11/06	12	02/11/07

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.

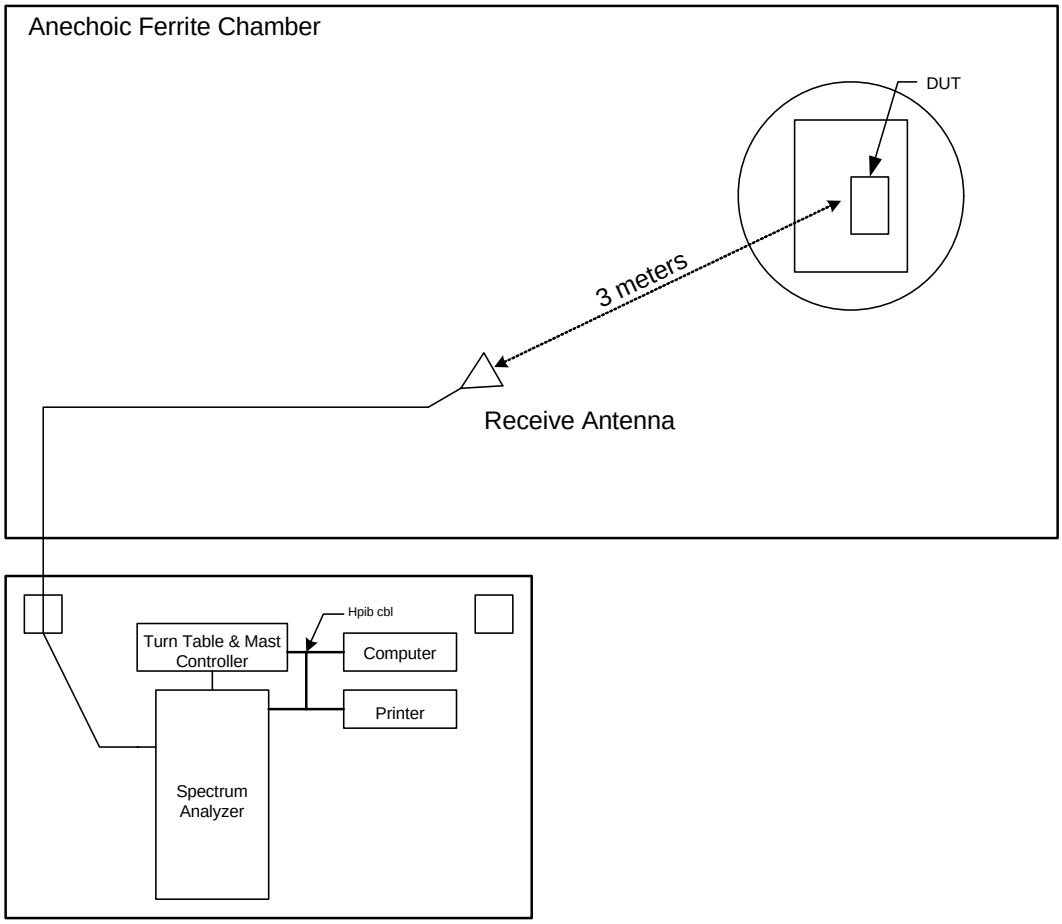


FIGURE 1 BLOCKDIAGRAM OF TEST SETUP

Figure 2

Test Item Setup, with no metal enclosure

Test Item Setup, with metal enclosure

Figure 3

Test Setup for Radiated Emissions, 916.45MHz, with no metal enclosure – Horizontal Polarization

Test Setup for Radiated Emissions, 916.45MHz, with no metal enclosure – Vertical Polarization

Figure 4

Test Setup for Radiated Emissions, 1GHz to 10GHz, with no metal enclosure – Horizontal Polarization

Test Setup for Radiated Emissions, 1GHz to 10GHz, with no metal enclosure – Vertical Polarization

Figure 5

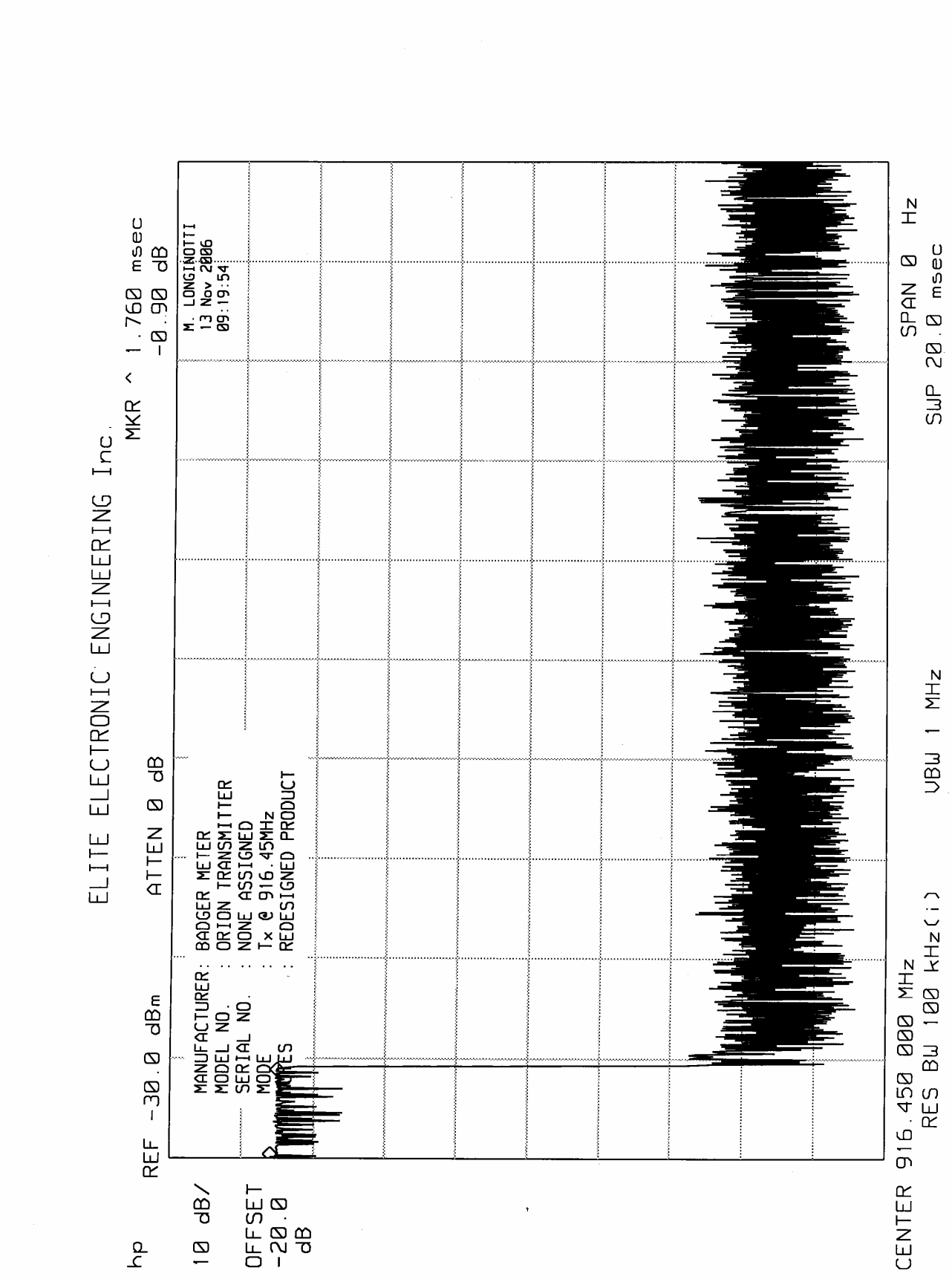
Test Setup for Radiated Emissions, 916.45MHz, with metal enclosure – Horizontal Polarization

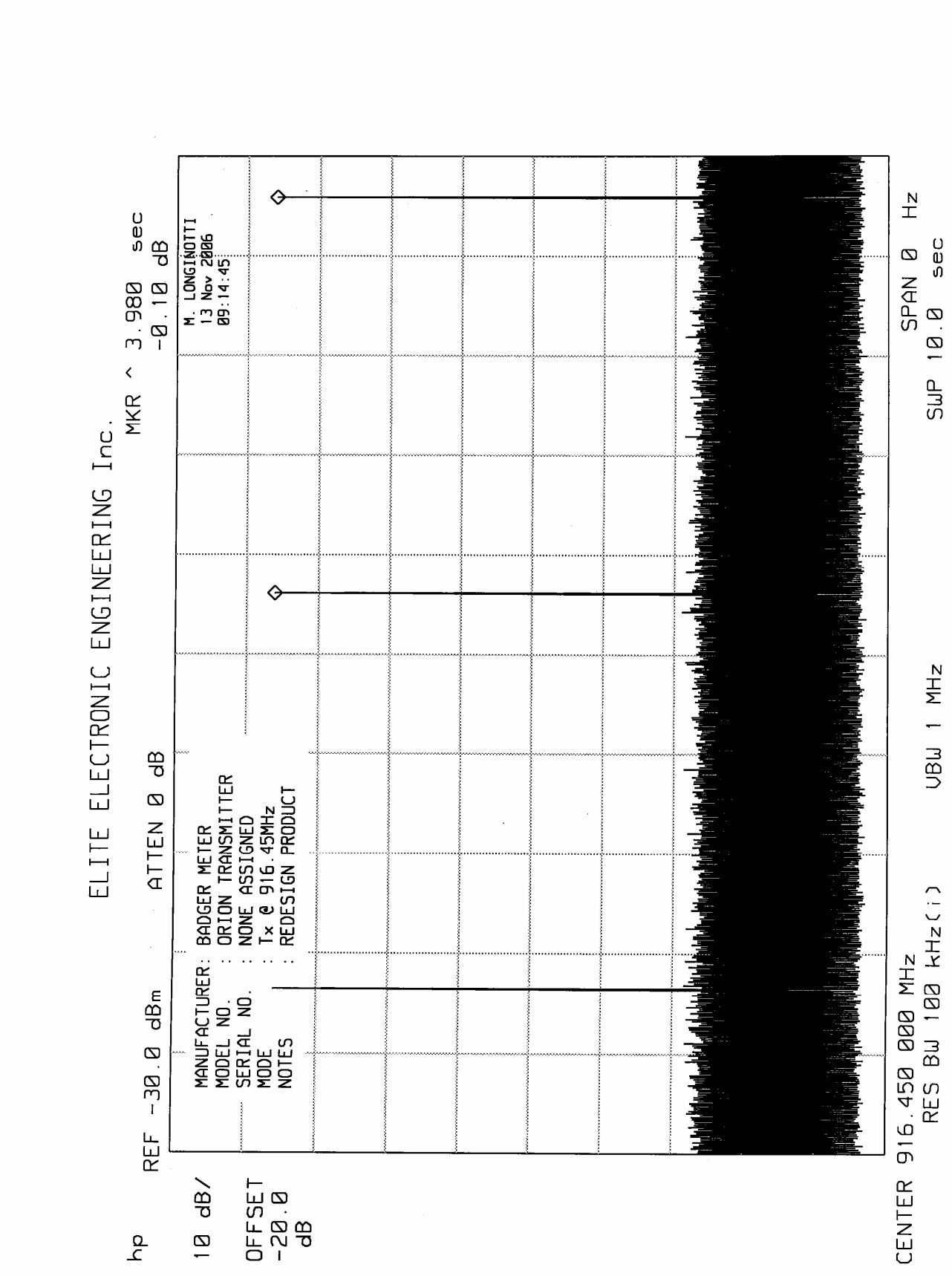
Test Setup for Radiated Emissions, 916.45MHz, with metal enclosure – Vertical Polarization

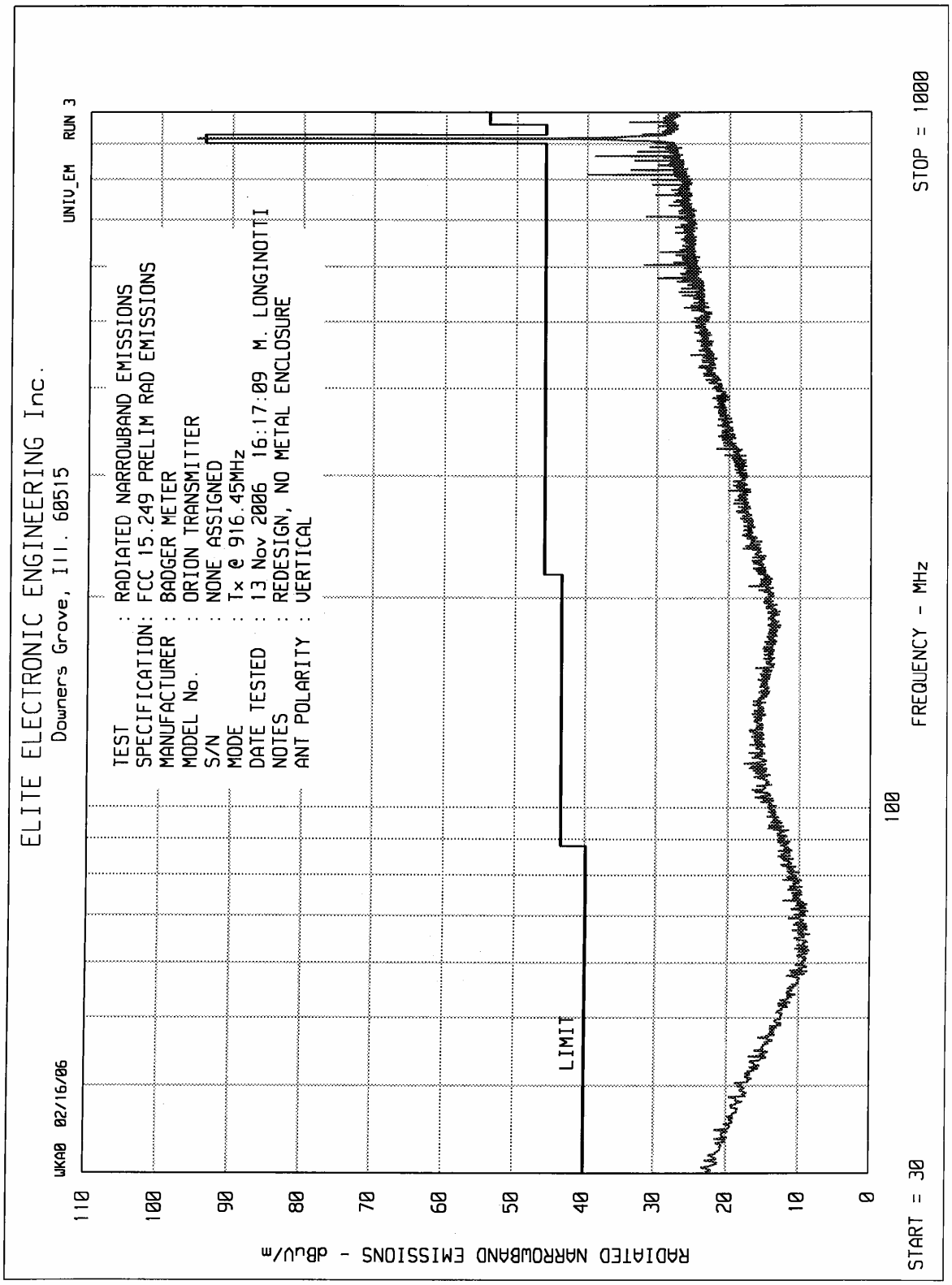
Figure 6

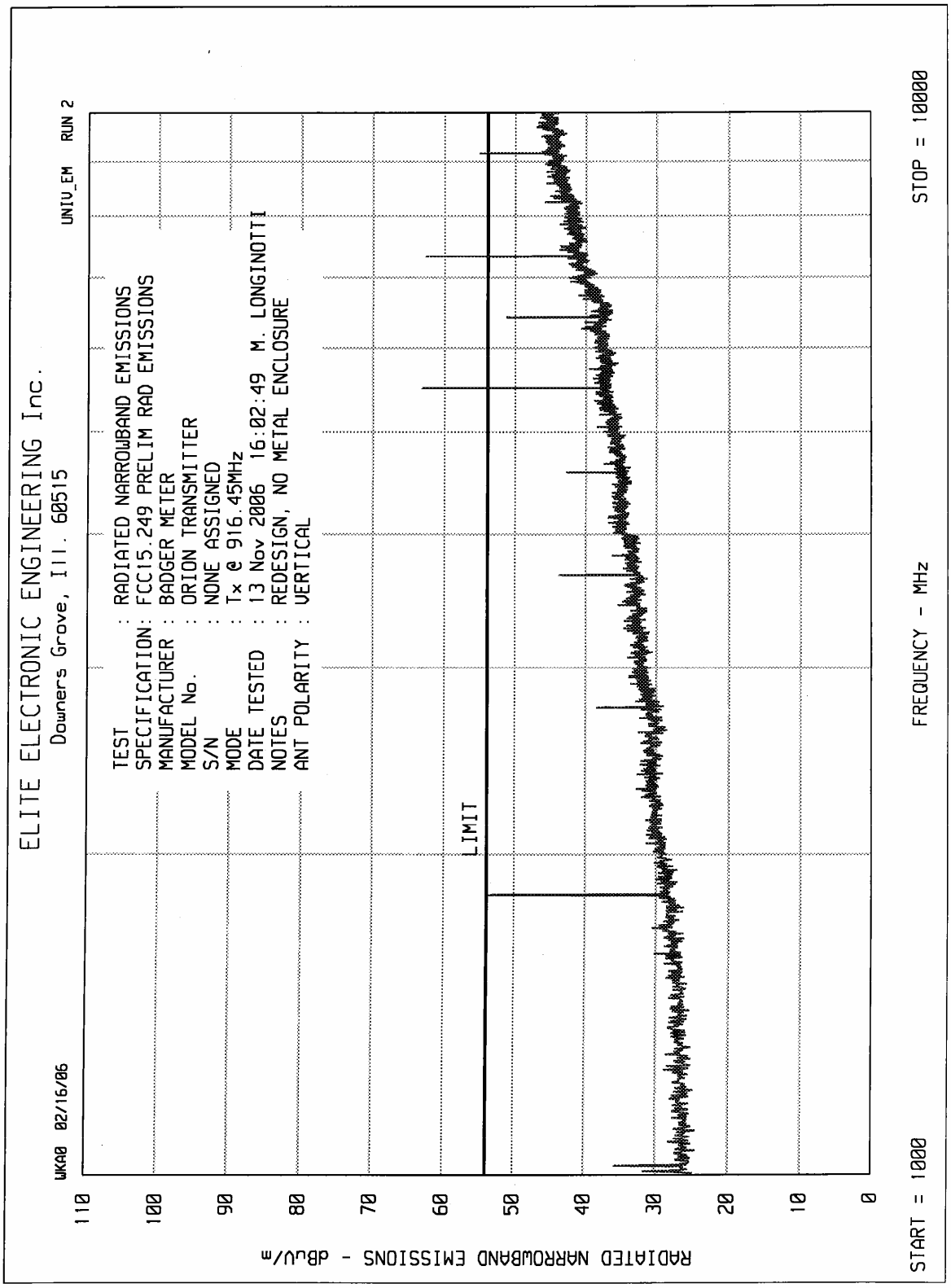
Test Setup for Radiated Emissions, 1GHz to 10GHz, with metal enclosure – Horizontal Polarization

Test Setup for Radiated Emissions, 1GHz to 10GHz, with metal enclosure – Vertical Polarization


ELITE ELECTRONIC ENGINEERING Inc.
hp
REF -30.0 dBm
ATTEN 0 dB
MKR ^ 1.760 msec
-0.90 dB
10 dB/
OFFSET
-20.0
dB
MANUFACTURER: BADGER METER
MODEL NO. : ORION TRANSMITTER
SERIAL NO. : NONE ASSIGNED
MODE : Tx @ 916.45MHz
NOTES : REDESIGNED PRODUCT
M. LONGINOTTI
13 Nov 2006
09:19:54
CENTER 916.450 000 MHz
RES BW 100 kHz(i)
VBW 1 MHz
SPAN 0 Hz
SWP 20.0 msec


hp
REF -30.0 dBm
ATTEN 0 dB
MKR ^ 3.980 sec
-0.10 dB
10 dB/
OFFSET
-20.0
dB
ELITE ELECTRONIC ENGINEERING Inc.
M. LONGINOTTI
13 Nov 2006
09:14:45
MANUFACTURER: BADGER METER
MODEL NO. : ORION TRANSMITTER
SERIAL NO. : NONE ASSIGNED
MODE : Tx @ 916.45MHz
NOTES : REDESIGN PRODUCT
CENTER 916.450 000 MHz
SPAN 0 Hz
RES BW 100 kHz(i)
VBW 1 MHz
SWP 10.0 sec


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV_EM RUN 3
TEST : RADIATED NARROWBAND EMISSIONS
SPECIFICATION: FCC 15.249 PRELIM RAD EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : ORION TRANSMITTER
S/N : NONE ASSIGNED
MODE : Tx @ 916.45MHz
DATE TESTED : 13 Nov 2006 16:17:09 M. LONGINOTTI
NOTES : REDESIGN, NO METAL ENCLOSURE
ANT POLARITY : VERTICAL
LIMIT
RADIATED NARROWBAND EMISSIONS - dBuV/m
110
100
90
80
70
60
50
40
30
20
10
0
START = 30
100
FREQUENCY - MHz
STOP = 1000
WKA0 02/16/06


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV_EM RUN 2
WKA0 02/16/06
TEST : RADIATED NARROWBAND EMISSIONS
SPECIFICATION: FCC15.249 PRELIM RAD EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : ORION TRANSMITTER
S/N : NONE ASSIGNED
MODE : Tx @ 916.45MHz
DATE TESTED : 13 Nov 2006 16:02:49 M. LONGINOTTI
NOTES : REDESIGN, NO METAL ENCLOSURE
ANT POLARITY : VERTICAL
LIMIT
RADIATED NARROWBAND EMISSIONS - dBuV/m
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90
80
70
60
50
40
30
20
10
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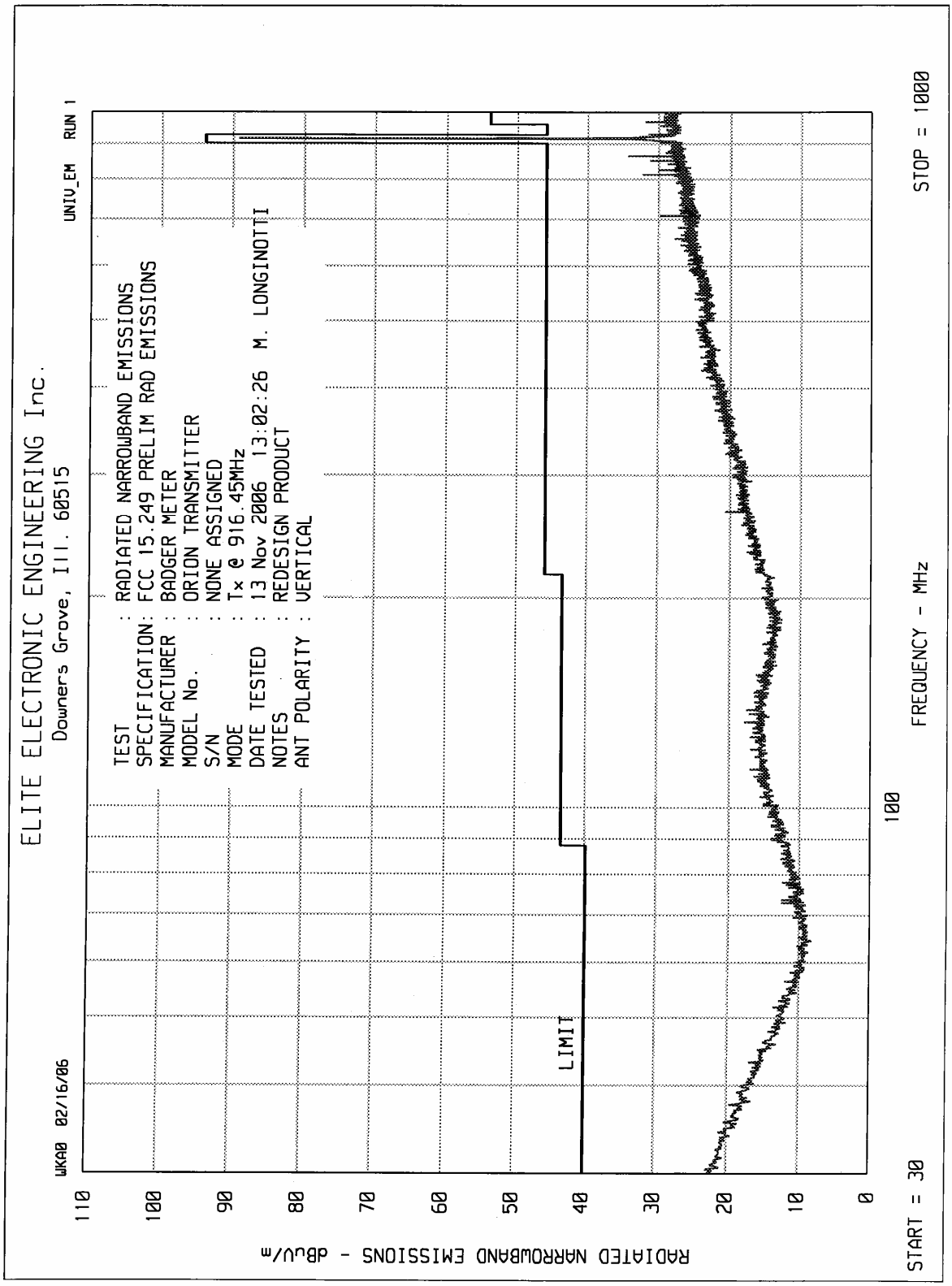
FREQUENCY - MHz
STOP = 10000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV_EM RUN 1
WKA0 02/16/06
TEST : RADIATED NARROWBAND EMISSIONS
SPECIFICATION: FCC 15.249 PRELIM RAD EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : ORION TRANSMITTER
S/N : NONE ASSIGNED
MODE : Tx @ 916.45MHz
DATE TESTED : 13 Nov 2006 13:02:26 M. LONGINOTTI
NOTES : REDESIGN PRODUCT
ANT POLARITY : VERTICAL
LIMIT
RADIATED NARROWBAND EMISSIONS - dBuV/m
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100
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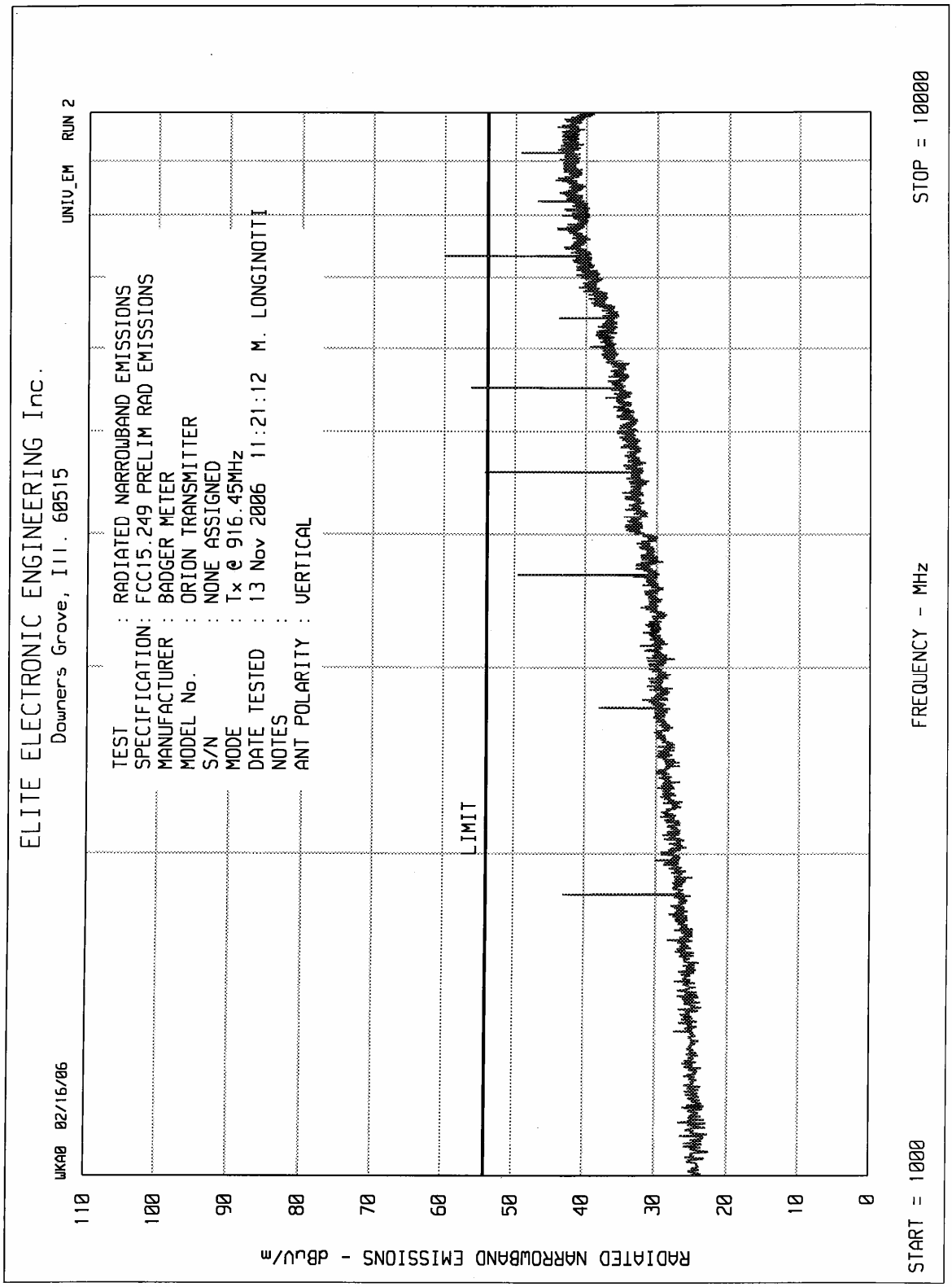
80
70
60
50
40
30
20
10
0
START = 30
100
FREQUENCY - MHz
STOP = 1000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV_EM RUN 2
WKA0 02/16/06
TEST : RADIATED NARROWBAND EMISSIONS
SPECIFICATION: FCC15.249 PRELIM RAD EMISSIONS
MANUFACTURER : BADGER METER
MODEL No. : ORION TRANSMITTER
S/N : NONE ASSIGNED
MODE : Tx @ 916.45MHz
DATE TESTED : 13 Nov 2006 11:21:12 M. LONGINOTTI
NOTES :
ANT POLARITY : VERTICAL
LIMIT
RADIATED NARROWBAND EMISSIONS - dBuV/m
110
100
90
80
70
60
50
40
30
20
10
0
START = 1000
FREQUENCY - MHz
STOP = 10000

Manufacturer : Badger Meter
Model No. : Orion Transmitter
Serial No. : None Assigned
Test Specification : FCC Part 15, Subpart C, Section 15.249, Radiated Emissions
Date : November 13, 2006
Mode : Transmit @ 916.45MHz, No Metal Enclosure
Test Distance : 3 meters
Notes : Redesigned Product
: Quasi-Peak Detector Used Below 1GHz, Peak Detector Used Above 1GHz.
Peak limit (limit + 20dB) is de facto since duty cycle correction factor is greater than 20 dB.

Frequency MHz	Antenna Polarity	Meter Reading dBuV	Ambient	Cable Loss dB	Antenna Factor dB	Pre Amp Gain dB	Total dBuV/m	Total uV/m	Limit uV/m
916.45	H	66.6		2.0	22.3	0.0	90.9	34883.5	50000
916.45	V	68.0		2.0	22.3	0.0	92.3	40984.5	50000
1832.90	H	53.2		2.9	28.1	-36.3	47.9	249.0	5000
1832.90	V	59.8		2.9	28.1	-36.3	54.5	532.4	5000
2749.35	H	44.7		3.8	31.5	-35.9	44.1	159.9	5000
2749.35	V	43.3		3.8	31.5	-35.9	42.7	136.1	5000
3665.80	H	51.3		4.4	32.6	-35.5	52.7	433.2	5000
3665.80	V	53.4		4.4	32.6	-35.5	54.8	551.7	5000
4582.25	H	50.2		4.8	33.0	-35.3	52.8	435.8	5000
4582.25	V	45.2		4.8	33.0	-35.3	47.8	245.1	5000
5498.70	H	58.9		5.3	35.5	-35.2	64.4	1661.8	5000
5498.70	V	59.4		5.3	35.5	-35.2	64.9	1760.3	5000
6415.15	H	44.5		5.9	36.2	-35.3	51.3	367.5	5000
6415.15	V	48.4		5.9	36.2	-35.3	55.2	575.7	5000
7331.60	H	48.8		6.7	37.8	-35.6	57.7	767.7	5000
7331.60	V	52.9		6.7	37.8	-35.6	61.8	1230.8	5000
8248.05	H	41.6	Ambient	7.1	37.7	-35.8	50.6	340.3	5000
8248.05	V	42.5	Ambient	7.1	37.7	-35.8	51.5	377.4	5000
9164.50	H	47.6	Ambient	7.5	38.1	-36.3	56.9	699.5	5000
9164.50	V	49.1	Ambient	7.5	38.1	-36.3	58.4	831.4	5000

Total = Meter Reading + Cable Loss + Antenna Factor + Preamp Gain

Checked By: MARK E. LONGINOTTI

Manufacturer : Badger Meter
Model No. : Orion Transmitter
Serial No. : None Assigned
Test Specification : FCC Part 15, Subpart C, Section 15.249, Radiated Emissions
Date : November 13, 2006
Mode : Transmit @ 916.45MHz, No Metal Enclosure
Test Distance : 3 meters
Notes : Redesigned Product
:Quasi-Peak Detector Used Below 1GHz, Peak Detector Used Above 1GHz
: Peak readings converted to average readings using the duty cycle correction
: factor

Frequency MHz	Antenna Polarity	Meter Reading dBuV	Ambient	Cable Loss dB	Antenna Factor dB	Pre Amp Gain dB	Duty Cycle Factor dB	Total dBuV/m	Total uV/m	Limit uV/m
916.5	H	66.6		2.0	22.3	0.0	0.0	90.9	34883.5	50000.0
916.5	V	68.0		2.0	22.3	0.0	0.0	92.3	40984.5	50000.0
1832.9	H	53.2		2.9	28.1	-36.3	-35.1	12.8	4.4	500.0
1832.9	V	59.8		2.9	28.1	-36.3	-35.1	19.4	9.4	500.0
2749.4	H	44.7		3.8	31.5	-35.9	-35.1	9.0	2.8	500.0
2749.4	V	43.3		3.8	31.5	-35.9	-35.1	7.6	2.4	500.0
3665.8	H	51.3		4.4	32.6	-35.5	-35.1	17.6	7.6	500.0
3665.8	V	53.4		4.4	32.6	-35.5	-35.1	19.7	9.7	500.0
4582.3	H	50.2		4.8	33.0	-35.3	-35.1	17.7	7.7	500.0
4582.3	V	45.2		4.8	33.0	-35.3	-35.1	12.7	4.3	500.0
5498.7	H	58.9		5.3	35.5	-35.2	-35.1	29.3	29.2	500.0
5498.7	V	59.4		5.3	35.5	-35.2	-35.1	29.8	30.9	500.0
6415.2	H	44.5		5.9	36.2	-35.3	-35.1	16.2	6.5	500.0
6415.2	V	48.4		5.9	36.2	-35.3	-35.1	20.1	10.1	500.0
7331.6	H	48.8		6.7	37.8	-35.6	-35.1	22.6	13.5	500.0
7331.6	V	52.9		6.7	37.8	-35.6	-35.1	26.7	21.6	500.0
8248.1	H	41.6	Ambient	7.1	37.7	-35.8	-35.1	15.5	6.0	500.0
8248.1	V	42.5	Ambient	7.1	37.7	-35.8	-35.1	16.4	6.6	500.0
9164.5	H	47.6	Ambient	7.5	38.1	-36.3	-35.1	21.8	12.3	500.0
9164.5	V	49.1	Ambient	7.5	38.1	-36.3	-35.1	23.3	14.6	500.0

Total = Meter Reading + Cable Loss + Antenna Factor + Preamp Gain + Duty Cycle Factor

Checked By: MARK E. LONGINOTTI

Manufacturer : Badger Meter
Model No. : Orion Transmitter
Serial No. : None Assigned
Test Specification : FCC Part 15, Subpart C, Section 15.249, Radiated Emissions
Date : November 13, 2006
Mode : Transmit @ 916.45MHz, With Metal Enclosure
Test Distance : 3 meters
Notes : Redesigned Product
: Quasi-Peak Detector Used Below 1GHz, Peak Detector Used Above 1GHz

Frequency MHz	Antenna Polarity	Meter Reading dBuV	Ambient	Cable Loss dB	Antenna Factor dB	Pre Amp Gain dB	Total dBuV/m	Total uV/m	Limit uV/m
916.45	H	50.3		2.0	27.8	0.0	80.0	10056.6	50000
916.45	V	57.4		2.0	27.8	0.0	87.1	22774.7	50000
1832.90	H	44.5		2.9	28.1	-33.8	41.7	122.2	5000
1832.90	V	49.5		2.9	28.1	-33.8	46.7	217.3	5000
2749.35	H	42.7		3.8	31.5	-33.4	44.6	169.0	5000
2749.35	V	46.4		3.8	31.5	-33.4	48.3	258.7	5000
3665.80	H	44.7		4.4	32.6	-33.5	48.2	256.9	5000
3665.80	V	45.9		4.4	32.6	-33.5	49.4	295.0	5000
4582.25	H	49.2		4.8	33.0	-32.2	54.9	553.3	5000
4582.25	V	58.0		4.8	33.0	-32.2	63.7	1523.9	5000
5498.70	H	51.3		5.3	35.5	-31.8	60.2	1019.0	5000
5498.70	V	54.0		5.3	35.5	-31.8	62.9	1390.5	5000
6415.15	H	50.9		5.9	36.2	-31.5	61.4	1180.8	5000
6415.15	V	52.2		5.9	36.2	-31.5	62.7	1371.5	5000
7331.60	H	51.9		6.7	37.8	-31.4	64.9	1762.5	5000
7331.60	V	51.5		6.7	37.8	-31.4	64.5	1683.2	5000
8248.05	H	48.4		7.1	37.7	-31.7	61.5	1192.6	5000
8248.05	V	47.0		7.1	37.7	-31.7	60.1	1015.1	5000
9164.50	H	46.3		7.5	38.1	-31.8	60.0	1002.7	5000
9164.50	V	47.7		7.5	38.1	-31.8	61.4	1178.1	5000

Total = Meter Reading + Cable Loss + Antenna Factor + Preamp Gain

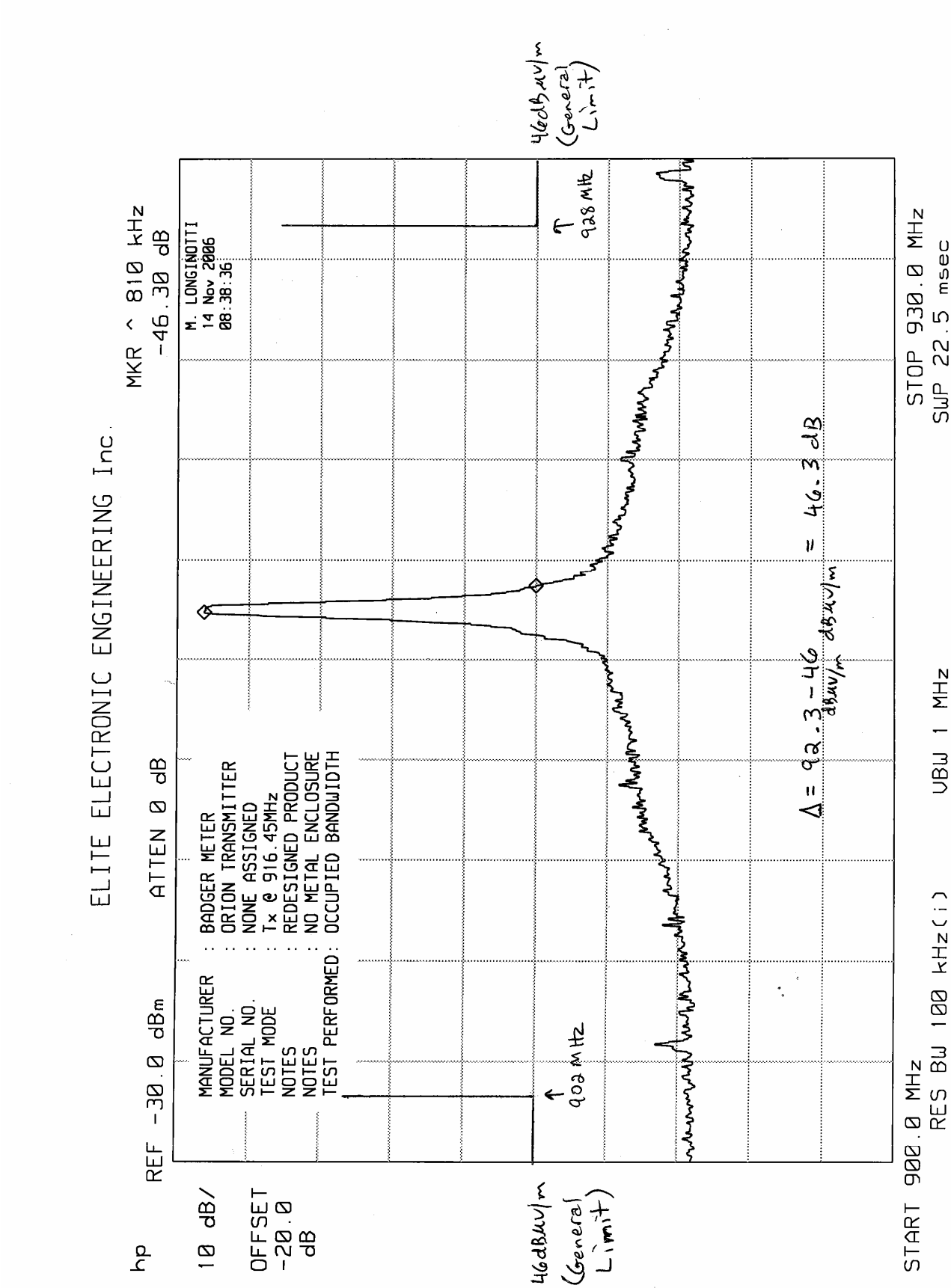
Checked By: MARK E. LONGINOTTI

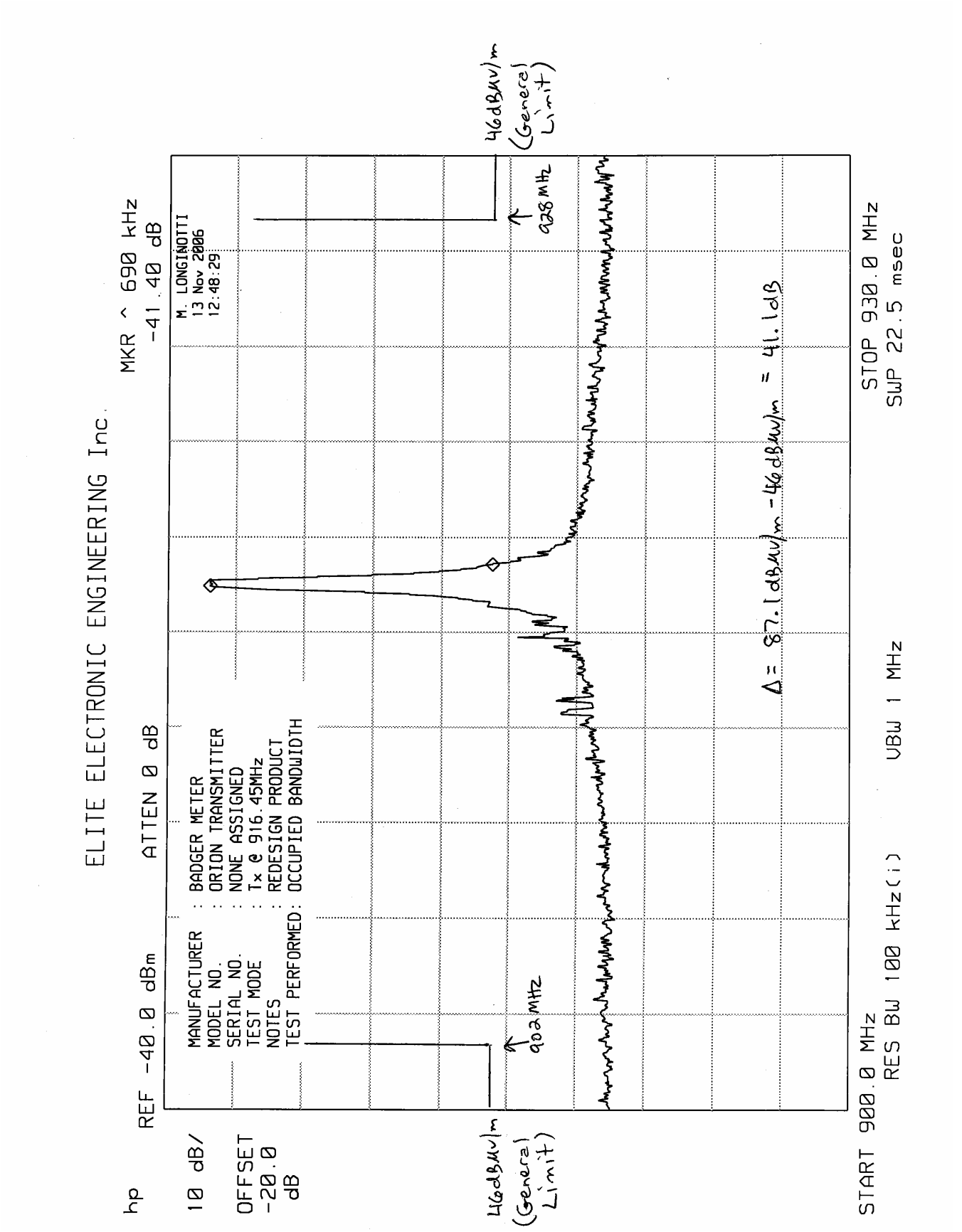
Manufacturer : Badger Meter
Model No. : Orion Transmitter
Serial No. : None Assigned
Test Specification : FCC Part 15, Subpart C, Section 15.249, Radiated Emissions
Date : November 13, 2006
Mode : Transmit @ 916.45MHz, With Metal Enclosure
Test Distance : 3 meters
Notes : Redesigned Product
:Quasi-Peak Detector Used Below 1GHz, Peak Detector Used Above 1GHz
: Peak readings converted to average readings using the duty cycle correction
: factor

Frequency MHz	Antenna Polarity	Meter Reading dBuV	Ambient	Cable Loss dB	Antenna Factor dB	Pre Amp Gain dB	Duty Cycle Factor dB	Total dBuV/m	Total uV/m	Limit uV/m
916.45	H	50.3		2.0	27.8	0.0	0.0	80.0	10056.6	50000.0
916.45	V	57.4		2.0	27.8	0.0	0.0	87.1	22774.7	50000.0
1832.90	H	44.5		2.9	28.1	-33.8	-35.0	6.7	2.2	500.0
1832.90	V	49.5		2.9	28.1	-33.8	-35.0	11.7	3.9	500.0
2749.35	H	42.7		3.8	31.5	-33.4	-35.0	9.6	3.0	500.0
2749.35	V	46.4		3.8	31.5	-33.4	-35.0	13.3	4.6	500.0
3665.80	H	44.7		4.4	32.6	-33.5	-35.0	13.2	4.6	500.0
3665.80	V	45.9		4.4	32.6	-33.5	-35.0	14.4	5.2	500.0
4582.25	H	49.2		4.8	33.0	-32.2	-35.0	19.9	9.8	500.0
4582.25	V	58.0		4.8	33.0	-32.2	-35.0	28.7	27.1	500.0
5498.70	H	51.3		5.3	35.5	-31.8	-35.0	25.2	18.1	500.0
5498.70	V	54.0		5.3	35.5	-31.8	-35.0	27.9	24.7	500.0
6415.15	H	50.9		5.9	36.2	-31.5	-35.0	26.4	21.0	500.0
6415.15	V	52.2		5.9	36.2	-31.5	-35.0	27.7	24.4	500.0
7331.60	H	51.9		6.7	37.8	-31.4	-35.0	29.9	31.3	500.0
7331.60	V	51.5		6.7	37.8	-31.4	-35.0	29.5	29.9	500.0
8248.05	H	48.4		7.1	37.7	-31.7	-35.0	26.5	21.2	500.0
8248.05	V	47.0		7.1	37.7	-31.7	-35.0	25.1	18.1	500.0
9164.50	H	46.3		7.5	38.1	-31.8	-35.0	25.0	17.8	500.0
9164.50	V	47.7		7.5	38.1	-31.8	-35.0	26.4	20.9	500.0

Total = Meter Reading + Cable Loss + Antenna Factor + Preamp Gain + Duty Cycle Factor

Checked By: MARK E. LONGINOTTI


ELITE ELECTRONIC ENGINEERING Inc.
hp
REF -30.0 dBm
ATTEN 0 dB
MKR ^ 810 kHz
-46.30 dB
10 dB/
OFFSET
-20.0
dB
M. LONGINOTTI
14 Nov 2006
08:38:36
MANUFACTURER : BADGER METER
MODEL NO. : ORION TRANSMITTER
SERIAL NO. : NONE ASSIGNED
TEST MODE : Tx @ 916.45MHz
NOTES : REDESIGNED PRODUCT
NOTES : NO METAL ENCLOSURE
TEST PERFORMED: OCCUPIED BANDWIDTH
46dBuV/m (General Limit)
903 MHz
928 MHz
46dBuV/m (General Limit)
Δ = 92.3 - 46 dBuV/m
= 46.3 dB
START 900.0 MHz
RES BW 100 kHz(i)
VBW 1 MHz
STOP 930.0 MHz
SWP 22.5 msec


ELITE ELECTRONIC ENGINEERING Inc.
hp
REF -40.0 dBm
ATTEN 0 dB
MKR ^ 690 kHz
-41.40 dB
10 dB/
OFFSET
-20.0
dB
MANUFACTURER : BADGER METER
MODEL NO. : ORION TRANSMITTER
SERIAL NO. : NONE ASSIGNED
TEST MODE : Tx @ 916.45MHz
NOTES : REDESIGN PRODUCT
TEST PERFORMED: OCCUPIED BANDWIDTH
M. LONGINOTTI
13 Nov 2006
12:48:29
46dBuV/m (General Limit)
928 MHz
902 MHz
Δ = 87.1 dBuV/m - 46 dBuV/m = 41.1 dB
START 900.0 MHz
RES BW 100 kHz(i)
VBW 1 MHz
STOP 930.0 MHz
SWP 22.5 msec