Measurement of RF Interference from an Orion Transmitter

For : Badger Meter, Inc.
Milwaukee, WI

P.O. No. : 539367
Date Received : July 5, 2006
Date Tested : July 5-7 and August 9, 2006
Test Personnel : Richard E. King
Specification : FCC "Code of Federal Regulations" Title 47, Part 15, Subpart B for receivers and Subpart C, Section 15.247 for Frequency Hopping Spread Spectrum Intentional Radiators Operating within the 902-928MHz band.

Test Report By : Richard E. King

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REVISION HISTORY

Revision	Date	Description
—	8/17/2006	Initial release

Measurement of RF Interference 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 number 303, (hereinafter referred to as the test item).

The test item was a frequency hopping spread spectrum transmitter. The transmitter was designed to transmit in the 902-928 MHz ISM band. It uses an integral antenna.

The test item was manufactured and submitted for testing by Badger Meter located in 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, Section 15.247 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
- FCC Public Notice, DA 00-705, "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems", Released March 30, 2000
- 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 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 23%.

2.0 TEST ITEM SET-UP AND OPERATION:

The test item was a frequency hopping spread spectrum transmitter. A block diagram of the test item set-up is shown as Figure 1.

2.1 Power Input - The test item was powered with a 3.6VDC lithium thionylchloride internal battery.

2.2 Grounding - Since the test item was powered by a battery, the test item was ungrounded during the tests.

2.3 Support Equipment - The test item does not require support equipment.

2.4 Interconnect Cables - No interconnect cables were submitted with the test item.

2.5 Operational Mode - The test item was placed on an 80cm high non-conductive stand. The test item was energized. The test item was set to transmit at frequencies of 911.65 MHz, 916.45 MHz and 921.25 MHz when powered up.

3.0 TEST EQUIPMENT:

3.1 Test Equipment List - A list of the test equipment used can be found in 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

4.1.1 Requirements – Since the test item was powered by an internal battery, no conducted emissions tests were performed.

4.2 Radiated Measurements

4.2.1 Transmitter

4.2.1.1 Requirement – Per section 15.247(c), the radiated emissions which fall in the restricted bands must meet the general limits of 15.209.

4.2.1.2 Procedures – The radiated tests were performed in a 32ft. x 20ft. x 18ft. hybrid absorber lined semi-anechoic 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. The floor of the chamber is used as the ground plane. The chamber complies with ANSI 63.4 and CISPR 16 requirements for site attenuation.

Preliminary radiated measurements are performed to determine the frequencies where the

significant emissions might be found. With the test item at one set position and the measurement antenna at a set height (i.e. without maximizing), the radiated emissions were measured using peak detection with 100 kHz BW. This data was then automatically plotted up through 9 GHz.

Next, the harmonic or spurious emissions falling in the restricted bands were measured up through the 10th harmonic. For the measurements above 1GHz, the measurement bandwidth was set to 1 MHz RBW. The analyzer was set to **linear mode** with 10 Hz VBW in order to simulate an average detector. A pre-amplifier was used to increase the receiver sensitivity.

4.2.1.3 Results - The preliminary emissions levels were plotted. These plots are presented on pages 13 through 18. These plots indicate that the radiated spurious emissions were below the general limit.

The harmonics and any other emissions that fall in the restricted frequency bands were then re-measured manually. This data is shown in the tables on pages 19 through 21. The field intensities levels for the harmonics in the restricted band were within the limit.

4.3 Carrier Frequency Separation

4.3.1 Requirements - Per section 15.247 (a)(1), frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25kHz or the 20dB bandwidth of the hopping channel, whichever is greater.

4.3.2 Procedures - The test item was setup inside the chamber. With the hopping function enabled, the test item was allowed to transmit continuously.

The resolution bandwidth (RBW) was set to $\geq$ to 1% of the span. The peak detector and 'Max-Hold' function were engaged. The span was set wide enough to capture the peaks of at least two adjacent channels.

When the trace had stabilized after multiple scans, the marker-delta function was used to determine the separation between the peaks of the adjacent channels. The analyzer's display was plotted using a 'screen dump' utility.

4.3.3 Results - Page 22 shows the carrier frequency separation. As can be seen from this plot, the separation is 398 kHz which is greater than the 20dB bandwidth (256 kHz).

4.4 Number of Hopping Frequencies

4.4.1 Requirements - Per section 15.247(a)(1)(i), for frequency hopping systems operating in the 902-928MHz band, the frequency hopping systems shall use at least 25 non-overlapping channels.

4.4.2 Procedures - The test item was setup inside the chamber. With the hopping function enabled, the test item was allowed to transmit continuously.

The resolution bandwidth (RBW) was set to ≥ to 1% of the span. The peak detector and 'Max-Hold' function were engaged. The span was set wide enough to capture the entire frequency band of operation.

The test item's signal was allowed to stabilize after multiple scans. The number of hopping frequencies was counted. The analyzer's display was plotted using a 'screen dump' utility.

4.4.3 Results - Page 23 shows the number of hopping frequencies. As can be seen from this plot, the number of frequencies is 25 which equal the minimum required frequencies.

4.5 Time of Occupancy

4.5.1 Requirement - Per section 15.247(a)(1)(i), for frequency hopping systems operating in the 902-928MHz band, the average time of occupancy shall not be greater than 0.4 seconds within a 10 second period multiplied by the number of hopping channels employed.

4.5.2 Procedures - The test item was setup inside the chamber. With the hopping function enabled, the test item was allowed to transmit continuously.

The resolution bandwidth (RBW) was set to 100 kHz. The peak detector and 'Max-Hold' function were engaged. With the span set to 0Hz, the sweep time was adjusted to capture a single event in order to measure the dwell time per hop. Then, the sweep time was expanded to capture the average time between hops. When the trace had stabilized after multiple scans, the time between hops was measured. The analyzer's display was plotted using a 'screen dump' utility.

The dwell time in a 10 second period was then calculated from dwell time per hop multiplied by the number of hops.

4.5.3 Results - Pages 24 and 25 show the plots for the time of occupancy (dwell time). As can be seen from the plots, the time of occupancy can be determined by a 1.740msec pulse multiplied by 16 hops. This calculated value is equal to .02784 seconds which is less than the 0.4 seconds maximum allowed.

4.6 20dB Bandwidth

4.6.1 Requirement - Per section 15.247(a)(1)(i), for frequency hopping systems operating in the 902-928MHz band, the 20dB bandwidth shall be measured for determination of the carrier frequency separation limits and must not exceed 500 kHz.

4.6.2 Procedures - The test item was setup inside the chamber. With the hopping

function disabled, the test item was allowed to transmit continuously. The frequency hopping channel was set separately to low, middle, and high hopping channels. The resolution bandwidth (RBW) was set to ≥ to 1% of the 20 dB BW.

The 'Max-Hold' function was engaged. The analyzer was allowed to scan until the envelope of the transmitter bandwidth was defined. The analyzer's display was plotted using a 'screen dump' utility.

4.6.3 Results - The plots on pages 26 through 28 show that the maximum 20 dB bandwidth was 256 kHz.

4.7 Peak Output Power

4.7.1 Requirement - Per section 15.247(b)(2), for frequency hopping systems operating in the 902-928MHz band and employing at least 25 hopping channels. The peak output power shall not be greater than 250milliwatts (24dBm).

4.7.2 Procedures - The test item was placed on the non-conductive stand and set to transmit. A broadband measuring antenna was placed at a test distance of 3 meters from the test item. The test item was maximized for worst case emissions (or maximum output power) at the measuring antenna. The maximum meter reading was recorded. The peak power output was measured for the low, middle and high hopping frequencies.

The equivalent power was determined from the field intensity levels measured at 3 meters using the substitution method. To determine the emission power, another dipole antenna was then set in place of test item and connected to a calibrated signal generator. The output of the signal generator was adjusted to match the received level at the spectrum analyzer. The signal level was recorded. The reading was then corrected to compensate for cable loss, as required. The peak power output was calculated for the low, middle and high hopping frequencies.

4.7.3 Results - The results are presented on page 29. The maximum EIRP measured from the transmitter was 5.3 dBm or 3.3 mW which is below the 250mW limit.

4.8 Band-edge Compliance

4.8.1 Requirement - Per section 15.247(c), the emissions at the band-edges must be at least 20dB below the highest level measured within the band. In addition, the radiated emissions which fall in any restricted bands must meet the general limits of 15.209.

4.8.2 Procedures - The test item was setup inside the chamber. With the hopping function disabled, the test item was allowed to transmit continuously. The frequency hopping channel was set separately to low and high hopping channels. The resolution bandwidth (RBW) was set to 100

kHz.

The 'Max-Hold' function was engaged. The analyzer was allowed to scan until the envelope of the transmitter bandwidth was defined. The analyzer's display was plotted using a 'screen dump' utility. The measurement was repeated with the frequency hopping function enabled.

For the emissions which fall in the restricted band the "marker-delta" method described in Public Notice DA 00-705 was used. Initially radiated measurements were performed at the fundamentals of the highest hopping frequencies using 1 MHz bandwidth. For the measurements the "delta" required to meet the general limit was calculated.

Next, the band-edge emissions were plotted using peak detector and 100 kHz bandwidth. The "delta" limit was applied to this plot to determine compliance at the band-edge.

The test item was placed on the non-conductive stand and set to transmit. A broadband measuring antenna was placed at a test distance of 3 meters from the test item. The test item was maximized for worst case emissions (or maximum output power) at the measuring antenna. The maximum meter reading was recorded.

4.8.3 Results - Pages 30 through 33 show the radiated band-edge compliance results. As can be seen from these plots, the emissions at the band-edge are within the 20 dB down limits.

5.0 CONCLUSIONS:

It was determined that the Badger Meter Inc. Orion Transmitter, did fully meet the conducted and radiated emission requirements of the FCC "Code of Federal Regulations" Title 47, Part 15, Subpart C, Section 15.247 for frequency hopping spread spectrum transmitters.

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 modifications 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

Eq ID	Equipment Description	Manufacturer	Model No.	Serial No.	Frequency Range	Cal Date	Cal Inv	Due Date
Equipment Type: ACCESSORIES, MISCELLANEOUS								
XLJW	5W,50 OHM TERMINATION	JFW INDUSTRIES	50T-052	31	DC-2GHZ	10/10/05	12	10/10/06
XPQ0	HIGH PASS FILTER	K&L MICROWAVE	4IH30-1804/T	001	1.8-10GHZ	07/27/06	12	07/27/07
XZG2	ATTENUATOR/SWITCH DRIVER	HEWLETT PACKARD	11713A	2223A01751	---		N/A	
XZG3	ATTENUATOR/SWITCH DRIVER	HEWLETT PACKARD	11713A	2421A03059	---		N/A	
Equipment Type: AMPLIFIERS								
APK2	PREAMPLIFIER	AGILENT TECHNOL	8449B	3008A01595	1-26.5GHZ	04/10/06	12	04/10/07
APK3	PREAMPLIFIER	AGILENT TECHNOL	8449B	3008A01593	1-26.5GHZ	06/12/06	12	06/12/07
ATA0	TWT AMPLIFIER (10W) - FL	HUGHES AIRCRAFT	1177H04F	313	12-18GHZ		NOTE 1	
Equipment Type: ANTENNAS								
NDQ0	TUNED DIPOLE ANTENNA	EMCO	3121C-DB4	311	400-1000MHZ	02/16/06	12	02/16/07
NDQ1	TUNED DIPOLE ANTENNA	EMCO	3121C-DB4	313	400-1000MHZ	03/10/06	12	03/10/07
NWF0	RIDGED WAVE GUIDE	EMCO	3105	2035	1-12.4GHZ	10/01/05	12	10/01/06
NWH0	RIDGED WAVE GUIDE	TENSOR	4105	2081	1-12.4GHZ	10/01/05	12	10/01/06
Equipment Type: ATTENUATORS								
T1D2	10DB, 20W ATTENUATOR	NARDA	768-10	6	DC-11GHZ	07/28/06	12	07/28/07
T1N1	10DB 20W ATTENUATOR	NARDA	766-10		DC-4GHZ	09/07/05	12	09/07/06
Equipment Type: CONTROLLERS								
CDS1	COMPUTER	GATEWAY	MFATXPNT NMZ	0028483110	1.8GHZ		N/A	
Equipment Type: RECEIVERS								
RAC0	SPECTRUM ANALYZER	HEWLETT PACKARD	85660B	2449A01117	100HZ-22GHZ	07/18/06	12	07/18/07
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	12/23/05	12	12/23/06
RACE	RF PRESELECTOR W/ RECEIVER	HEWLETT PACKARD	85685A	3010A01194	20HZ-2GHZ	08/26/05	12	08/26/06
RAF1	QUASIPEAK ADAPTER	HEWLETT PACKARD	85650A	2043A00271	0.01-1000MHZ	02/13/06	12	02/13/07

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.

ELITE ELECTRONIC ENGINEERING INC.

Radiated Emissions Test Setup Anechoic Ferrite Chamber

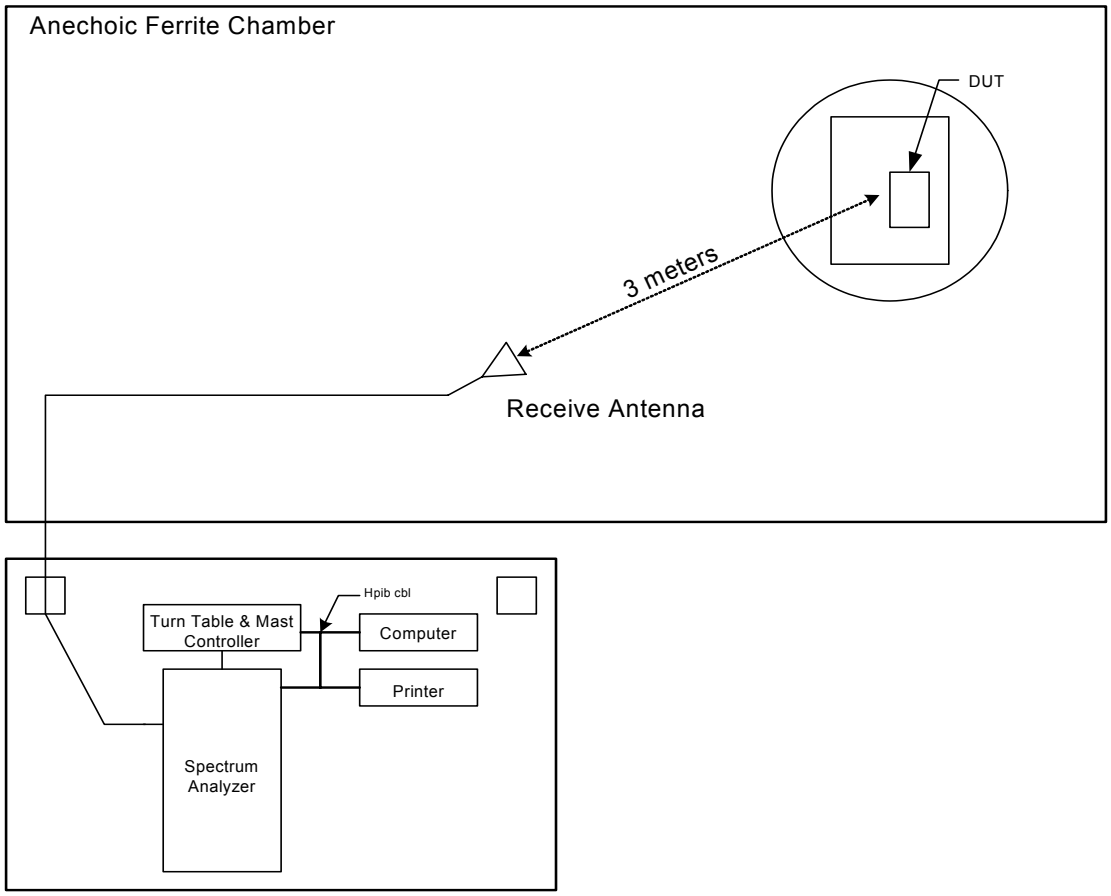
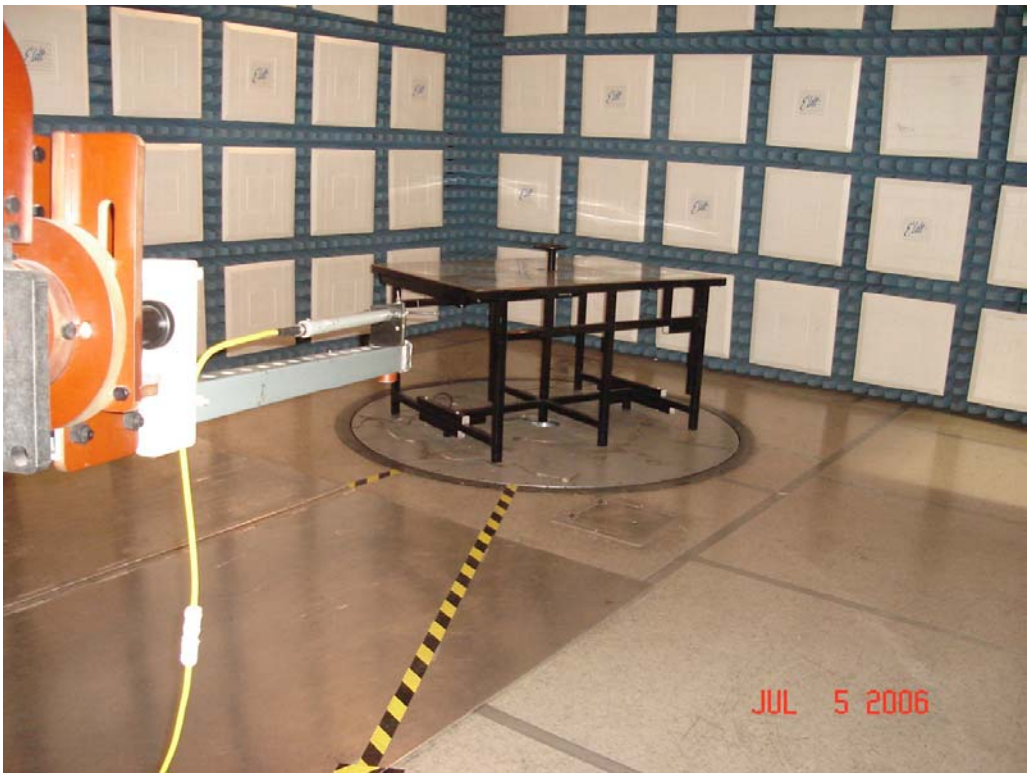


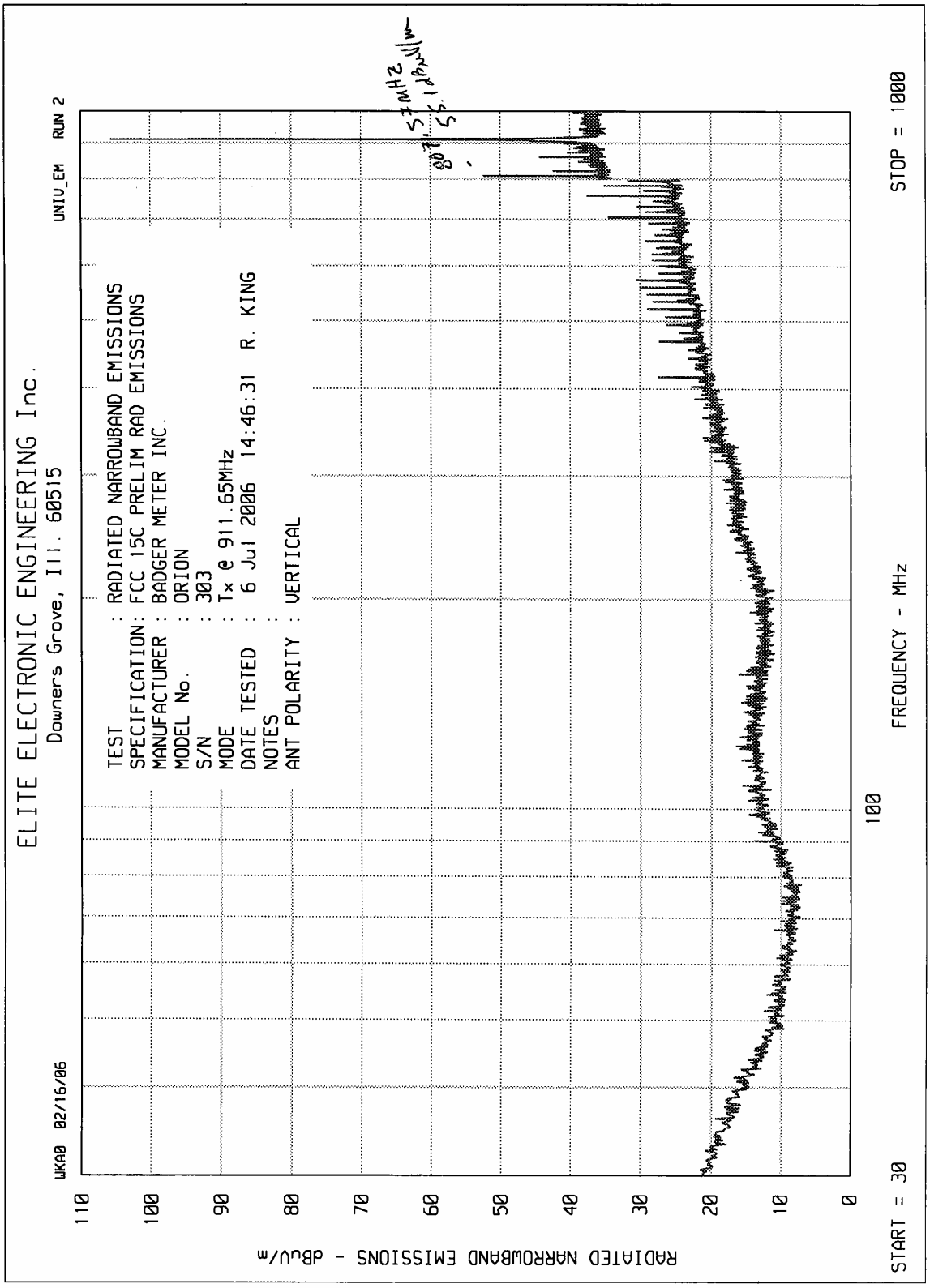
FIGURE 1 BLOCKDIAGRAM OF TEST SETUP

Figure 2



Radiated Emissions – Antenna in Horizontal Polarization

Radiated Emissions – Antenna in Vertical Polarization


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
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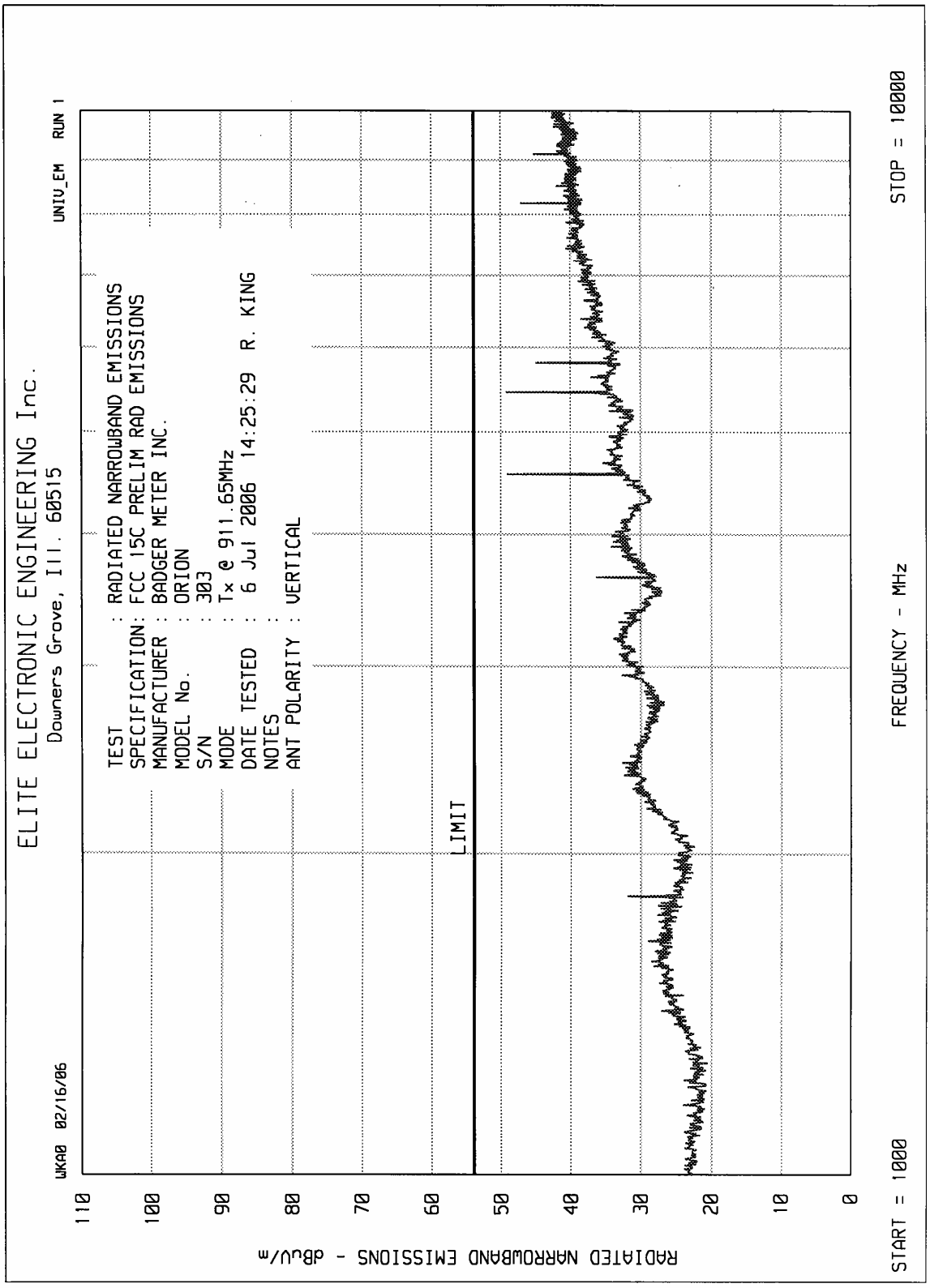
WKA0 02/16/06
TEST : RADIATED NARROWBAND EMISSIONS
SPECIFICATION: FCC 15C PRELIM RAD EMISSIONS
MANUFACTURER : BADGER METER INC.
MODEL No. : ORION
S/N : 303
MODE : Tx @ 911.65MHz
DATE TESTED : 6 Jul 2006 14:46:31 R. KING
NOTES :
ANT POLARITY : VERTICAL
911.65MHz 75.1dBuV/m
RADIATED NARROWBAND EMISSIONS - dBuV/m
110
100
90
80
70
60
50
40
30
20
10
0
START = 30
100
STOP = 1000
FREQUENCY - MHz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Downers Grove, Ill. 60515
UNIV_EM RUN 1
WKA0 02/16/06
TEST : RADIATED NARROWBAND EMISSIONS
SPECIFICATION: FCC 15C PRELIM RAD EMISSIONS
MANUFACTURER : BADGER METER INC.
MODEL No. : ORION
S/N : 303
MODE : Tx @ 911.65MHz
DATE TESTED : 6 Jul 2006 14:25:29 R. KING
NOTES :
ANT POLARITY : VERTICAL
LIMIT
RADIATED NARROWBAND EMISSIONS - dBuV/m
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90
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50
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30
20
10
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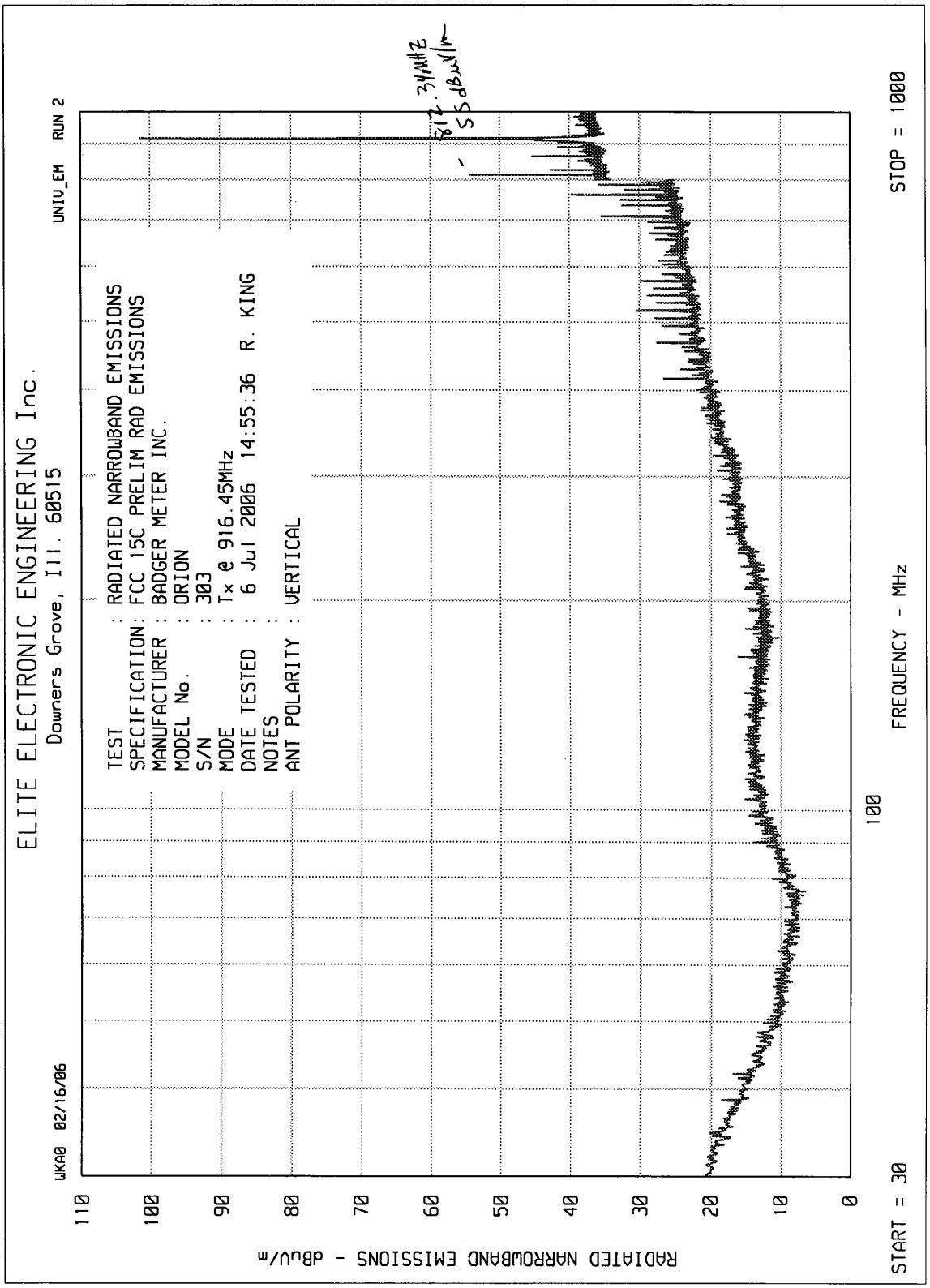
START = 1000
FREQUENCY - MHz
STOP = 10000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV_EM RUN 2
WKA0 02/16/06
TEST : RADIATED NARROWBAND EMISSIONS
SPECIFICATION: FCC 15C PRELIM RAD EMISSIONS
MANUFACTURER : BADGER METER INC.
MODEL No. : ORION
S/N : 303
MODE : Tx @ 916.45MHz
DATE TESTED : 6 Jul 2006 14:55:36 R. KING
NOTES :
ANT POLARITY : VERTICAL
912.374MHz
55 dBuV/m
RADIATED NARROWBAND EMISSIONS - dBuV/m
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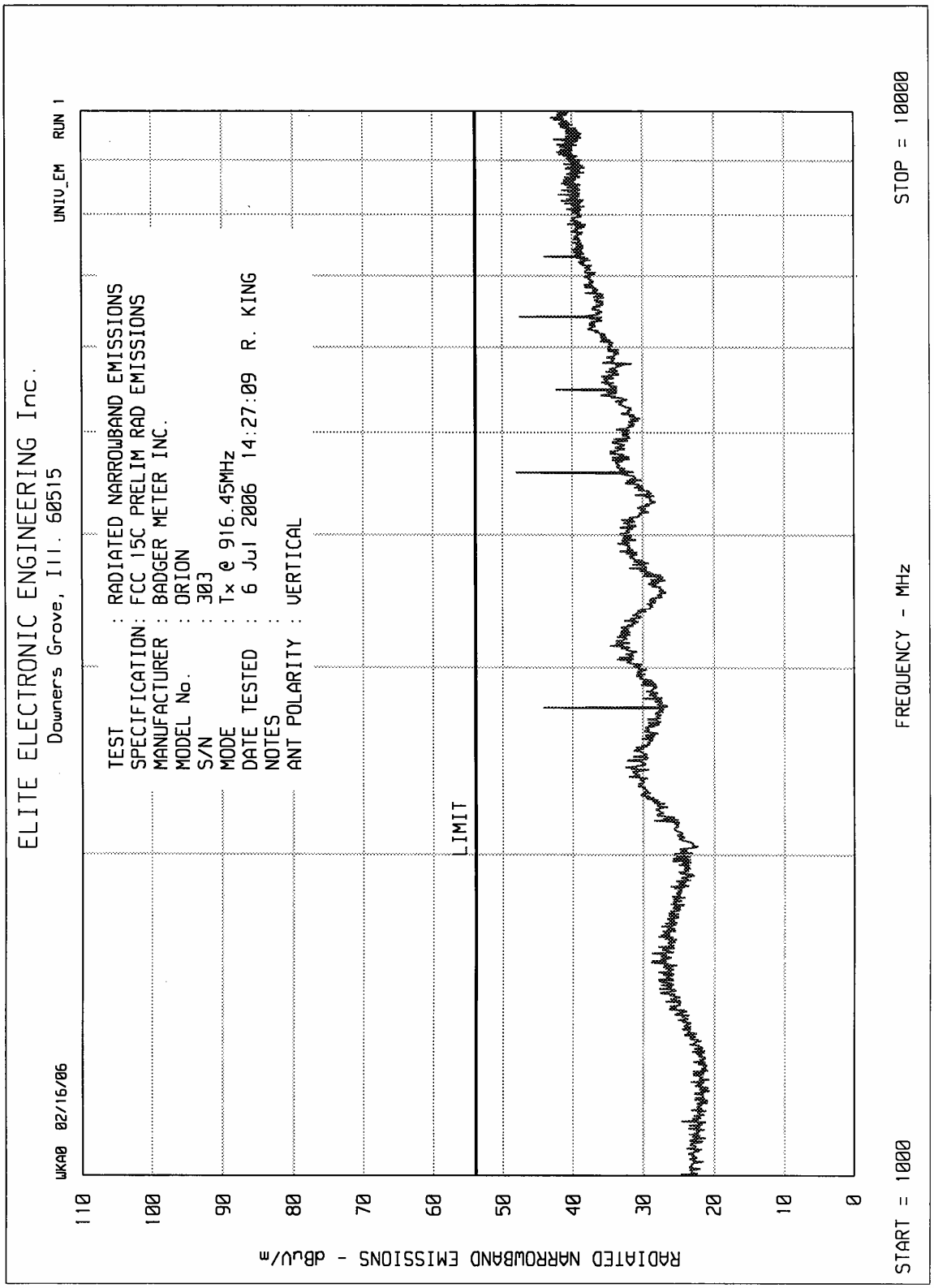
90
80
70
60
50
40
30
20
10
0
START = 30
100
FREQUENCY - MHz
STOP = 1000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV_EM RUN 1
WKA0 02/16/06
TEST : RADIATED NARROWBAND EMISSIONS
SPECIFICATION: FCC 15C PRELIM RAD EMISSIONS
MANUFACTURER : BADGER METER INC.
MODEL No. : ORION
S/N : 303
MODE : Tx @ 916.45MHz
DATE TESTED : 6 Jul 2006 14:27:09 R. KING
NOTES :
ANT POLARITY : VERTICAL
LIMIT
RADIATED NARROWBAND EMISSIONS - dBuV/m
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80
70
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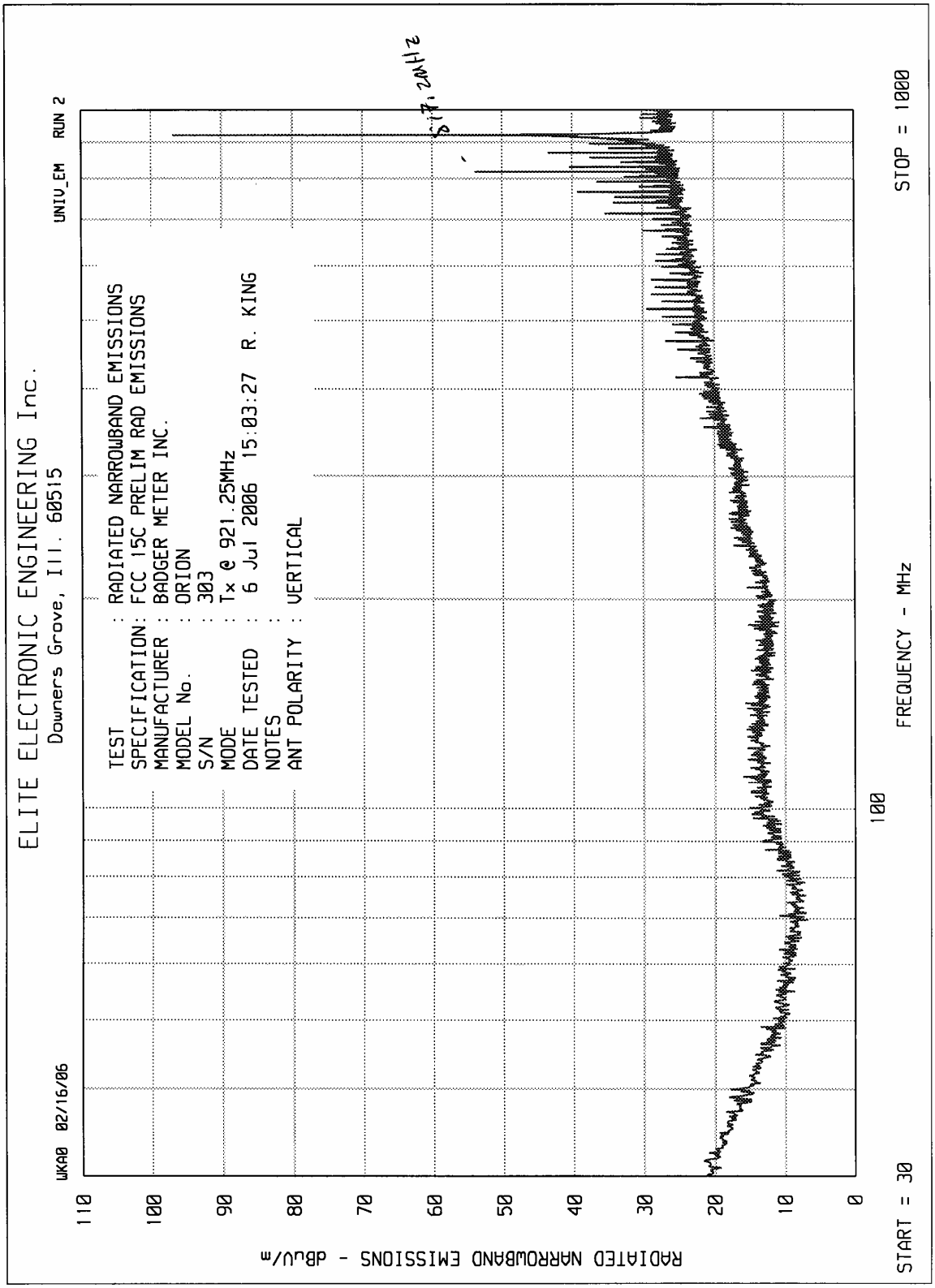
50
40
30
20
10
0
START = 1000
FREQUENCY - MHz
STOP = 10000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV_EM RUN 2
WKA0 02/16/06
TEST : RADIATED NARROWBAND EMISSIONS
SPECIFICATION: FCC 15C PRELIM RAD EMISSIONS
MANUFACTURER : BADGER METER INC.
MODEL No. : ORION
S/N : 303
MODE : Tx @ 921.25MHz
DATE TESTED : 6 Jul 2006 15:03:27 R. KING
NOTES :
ANT POLARITY : VERTICAL
921.2MHz
RADIATED NARROWBAND EMISSIONS - dBuV/m
110
100
90
80
70
60
50
40
30
20
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START = 30
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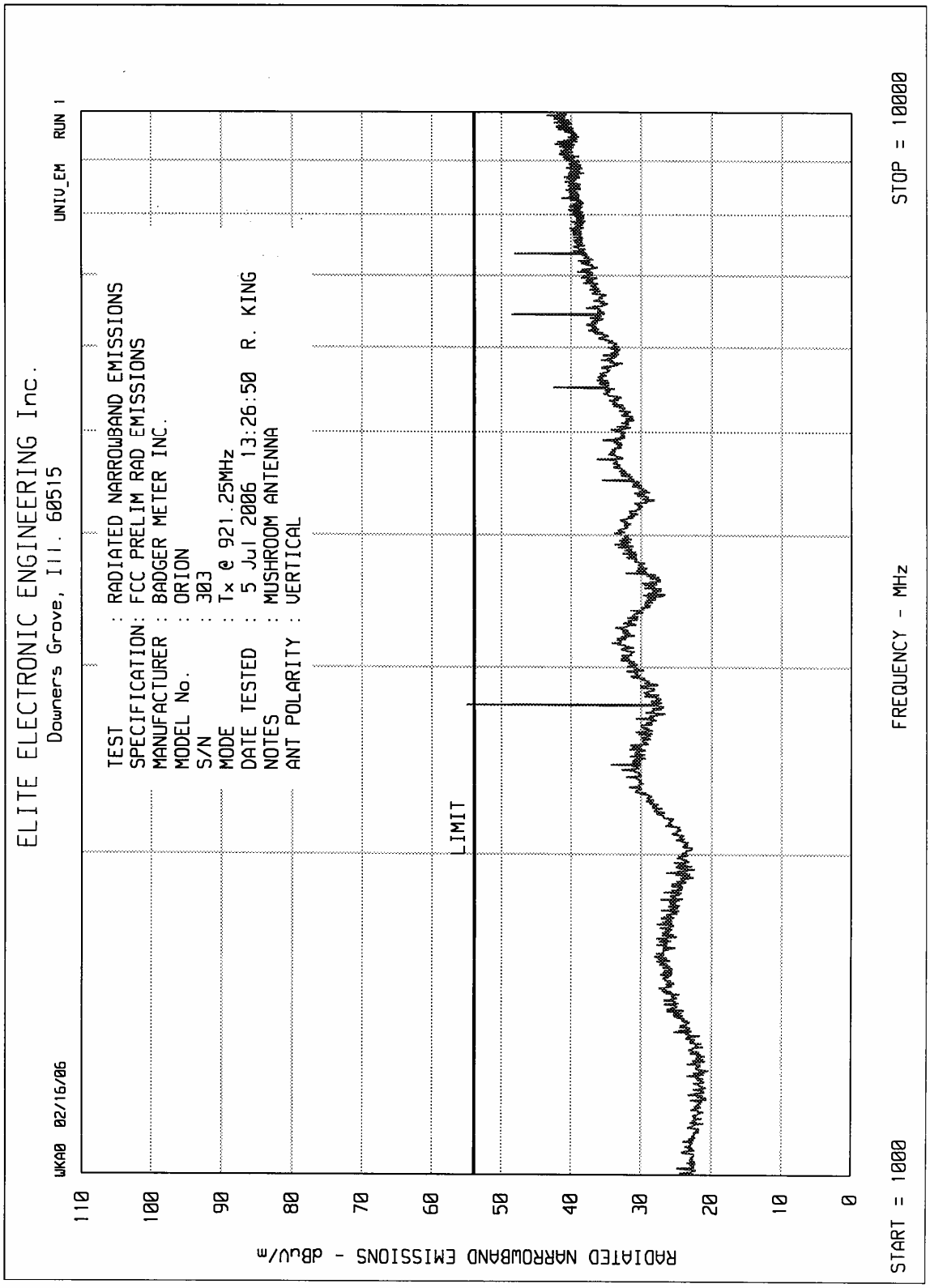
FREQUENCY - MHz
STOP = 1000


ELITE ELECTRONIC ENGINEERING Inc.
Downers Grove, Ill. 60515
UNIV_EM RUN 1
WKA0 02/16/06
TEST : RADIATED NARROWBAND EMISSIONS
SPECIFICATION: FCC PRELIM RAD EMISSIONS
MANUFACTURER : BADGER METER INC.
MODEL No. : ORION
S/N : 303
MODE : Tx @ 921.25MHz
DATE TESTED : 5 Jul 2006 13:26:50 R. KING
NOTES : MUSHROOM ANTENNA
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

Data Sheet

MANUFACTURER : Badger Meter Incorporated
MODEL : Orion
S/N : 303
SPECIFICATION : FCC Part 15, Subpart C, Section 15.247
Radiated Spurious Emissions Measurement
DATE : July 5, 2006
NOTES : Transmitting at 911.7MHz
: TEST DISTANCE IS 3 METERS
: Grey rows indicate restricted bands which must meet the general limits.

Freq (MHz)	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Duty Cycle (dB)	Total dBuV/m at 3 M	Total uV/m at 3M	Limit uV/m at 3M
911.7	H	60.0		1.9	27.4	0.0	0.0	89.4	29500.9	
911.7	V	75.8		1.9	22.3	0.0	0.0	100.0	100572.2	
1823.4	H	44.0		2.9	28.1	-34.5	0.0	40.5	105.5	10000.0
1823.4	V	47.6		2.9	28.1	-34.5	0.0	44.1	159.7	10000.0
2735.1	H	49.1		3.8	31.4	-34.5	-33.9	15.9	6.3	500.0
2735.1	V	57.8		3.8	31.4	-34.5	-33.9	24.6	17.0	500.0
3646.8	H	45.5		4.4	32.5	-34.6	-33.9	13.9	5.0	500.0
3646.8	V	44.7		4.4	32.5	-34.6	-33.9	13.1	4.5	500.0
4558.5	H	62.9		4.8	33.0	-34.7	-33.9	32.1	40.4	500.0
4558.5	V	60.9		4.8	33.0	-34.7	-33.9	30.1	32.1	500.0
5470.2	H	50.1		5.2	35.4	-34.2	0.0	56.5	669.5	10000.0
5470.2	V	49.9		5.2	35.4	-34.2	0.0	56.3	654.3	10000.0
6381.9	H	48.0		5.9	36.1	-34.5	0.0	55.5	598.3	10000.0
6381.9	V	47.8		5.9	36.1	-34.5	0.0	55.3	584.7	10000.0
7293.6	H	46.6		6.7	37.7	-34.6	-33.9	22.5	13.3	500.0
7293.6	V	48.6		6.7	37.7	-34.6	-33.9	24.5	16.8	500.0
8205.3	H	45.7		7.1	37.7	-34.7	-33.9	21.9	12.4	500.0
8205.3	V	46.3		7.1	37.7	-34.7	-33.9	22.5	13.3	500.0
9117.0	H	44.3		7.5	38.0	-34.7	-33.9	21.2	11.5	500.0
9117.0	V	44.0		7.5	38.0	-34.7	-33.9	20.9	11.2	500.0

Checked BY : Richard E. King

Richard E. King

Data Sheet

MANUFACTURER : Badger Meter Incorporated
MODEL : Orion
S/N : 303
SPECIFICATION : FCC Part 15, Subpart C, Section 15.247
Radiated Spurious Emissions Measurement
DATE : July 5, 2006
NOTES : Transmitting at 916.5MHz
: TEST DISTANCE IS 3 METERS
: Grey rows indicate restricted bands which must meet the general limits.

Freq (MHz)	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Duty Cycle (dB)	Total dBuV/m at 3 M	Total uV/m at 3M	Limit uV/m at 3M
916.5	H	58.0		2.0	27.5	0.0	0.0	87.4	23492.9	
916.5	V	74.1		2.0	22.3	0.0	0.0	98.4	82722.0	
1833.0	H	44.1		2.9	28.1	-34.5	0.0	40.6	107.3	8317.6
1833.0	V	41.4		2.9	28.1	-34.5	0.0	37.9	78.7	8317.6
2749.5	H	56.4		3.8	31.5	-34.5	-33.9	23.3	14.6	500.0
2749.5	V	57.6		3.8	31.5	-34.5	-33.9	24.5	16.7	500.0
3666.0	H	45.9		4.4	32.6	-34.6	-33.9	14.4	5.2	500.0
3666.0	V	42.5		4.4	32.6	-34.6	-33.9	11.0	3.5	500.0
4582.5	H	57.5		4.8	33.0	-34.6	-33.9	26.8	21.9	500.0
4582.5	V	63.7		4.8	33.0	-34.6	-33.9	33.0	44.8	500.0
5499.0	H	50.0		5.3	35.5	-34.2	0.0	56.5	669.3	8317.6
5499.0	V	47.4		5.3	35.5	-34.2	0.0	53.9	496.2	8317.6
6415.5	H	51.6		5.9	36.2	-34.5	0.0	59.2	910.8	8317.6
6415.5	V	49.6		5.9	36.2	-34.5	0.0	57.2	723.5	8317.6
7332.0	H	48.4		6.7	37.8	-34.6	-33.9	24.4	16.6	500.0
7332.0	V	47.3		6.7	37.8	-34.6	-33.9	23.3	14.6	500.0
8248.5	H	46.7		7.1	37.7	-34.7	-33.9	22.9	14.0	500.0
8248.5	V	46.6		7.1	37.7	-34.7	-33.9	22.8	13.9	500.0
9165.0	H	45.0		7.5	38.1	-34.7	-33.9	22.0	12.5	500.0
9165.0	V	48.1		7.5	38.1	-34.7	-33.9	25.1	17.9	500.0

Checked BY : Richard E. King

Richard E. King

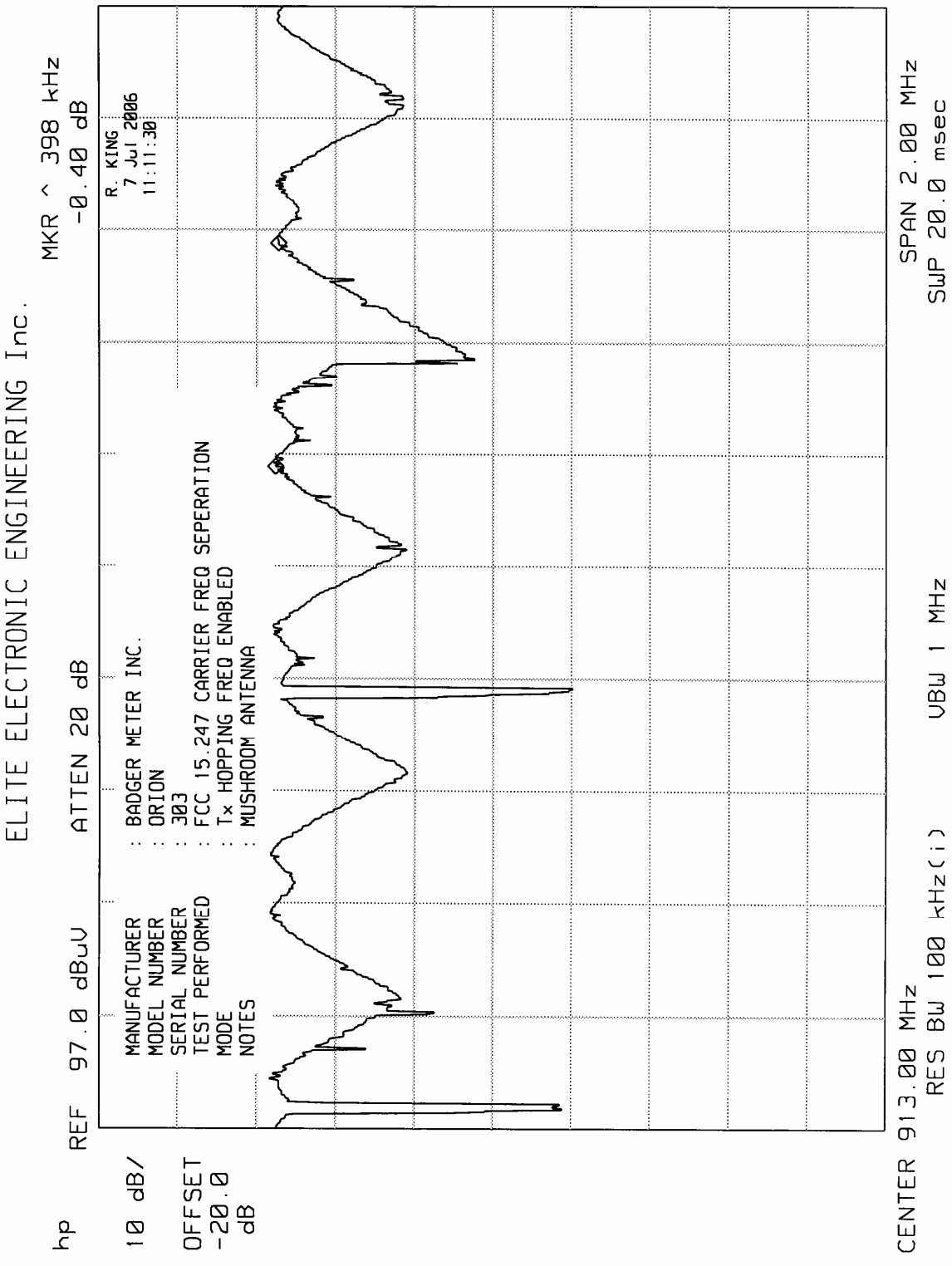
Data Sheet

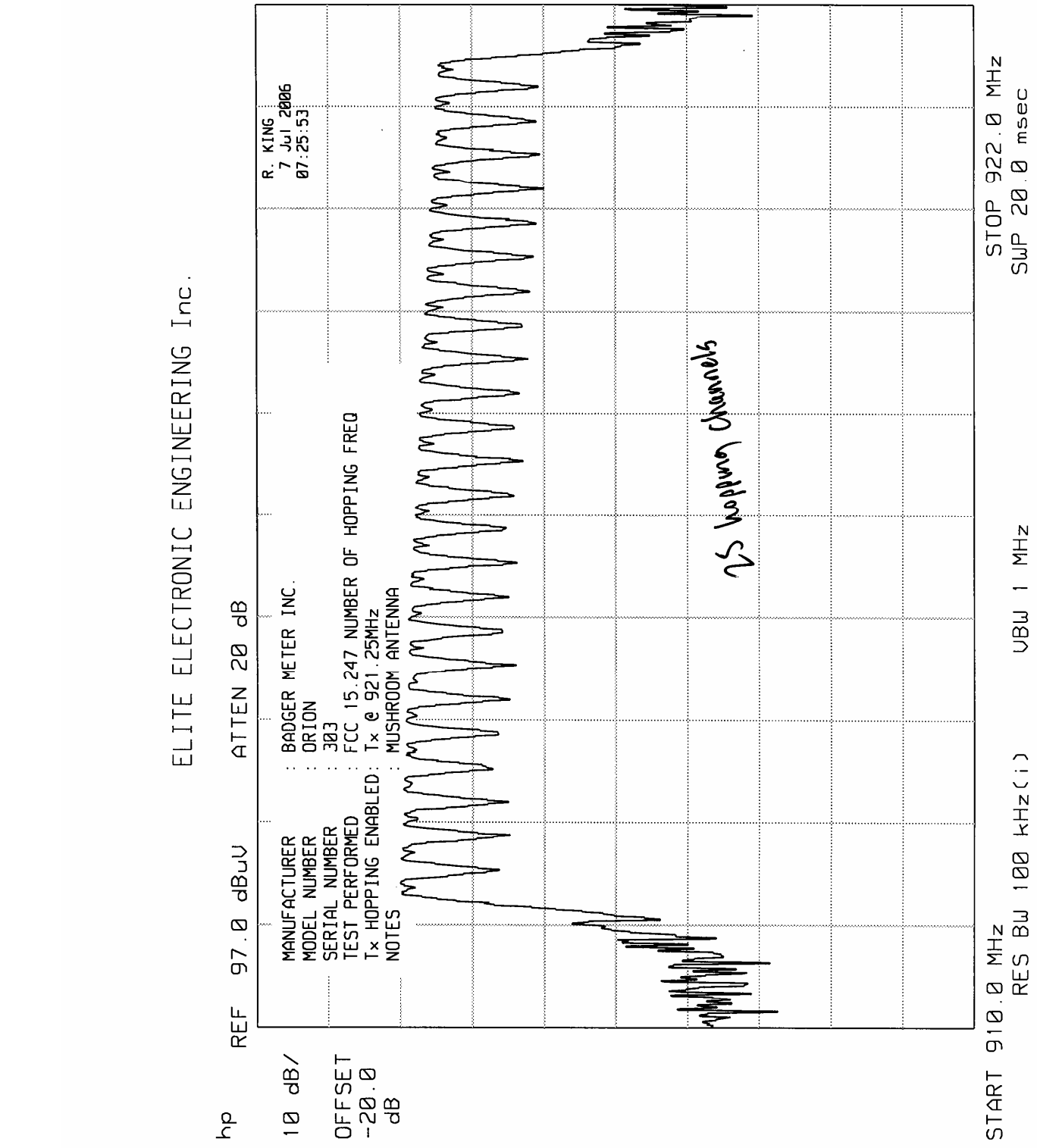
MANUFACTURER : Badger Meter Incorporated
MODEL : Orion
S/N : 303
SPECIFICATION : FCC Part 15, Subpart C, Section 15.247
Radiated Spurious Emissions Measurement
DATE : July 5, 2006
NOTES : Transmitting at 921.3MHz
: TEST DISTANCE IS 3 METERS
: Grey rows indicate restricted bands which must meet the general limits.

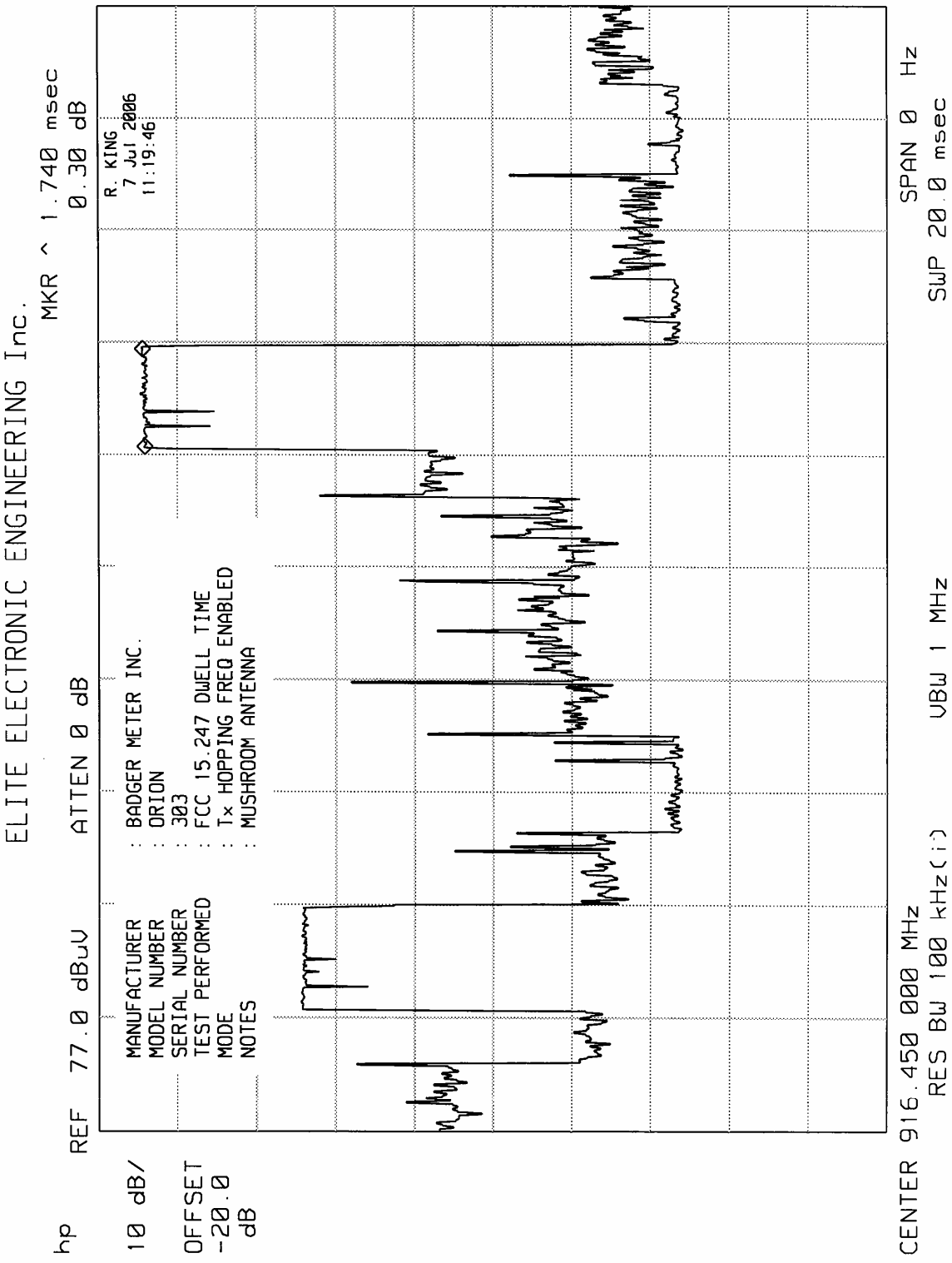
Freq (MHz)	Ant Pol	Meter Reading (dBuV)	Ambient	CBL Fac (dB)	Ant Fac (dB)	Pre Amp (dB)	Duty Cycle (dB)	Total dBuV/m at 3 M	Total uV/m at 3M	Limit uV/m at 3M
921.3	H	54.1		2.0	27.5	0.0	0.0	83.5	15032.5	
921.3	V	71.8		2.0	22.3	0.0	0.0	96.1	63689.3	
1842.6	H	43.5		2.9	28.2	-34.5	0.0	40.1	100.8	6382.6
1842.6	V	43.0		2.9	28.2	-34.5	0.0	39.6	95.1	6382.6
2763.9	H	50.0		3.8	31.5	-34.5	-33.9	16.9	7.0	500.0
2763.9	V	56.4		3.8	31.5	-34.5	-33.9	23.3	14.7	500.0
3685.2	H	45.7		4.4	32.6	-34.5	-33.9	14.3	5.2	500.0
3685.2	V	42.8		4.4	32.6	-34.5	-33.9	11.4	3.7	500.0
4606.5	H	59.4		4.8	33.1	-34.6	-33.9	28.8	27.6	500.0
4606.5	V	60.8		4.8	33.1	-34.6	-33.9	30.2	32.4	500.0
5527.8	H	47.4		5.3	35.5	-34.2	0.0	53.9	497.8	6382.6
5527.8	V	48.9		5.3	35.5	-34.2	0.0	55.4	591.6	6382.6
6449.1	H	49.8		6.0	36.2	-34.5	0.0	57.4	744.5	6382.6
6449.1	V	48.7		6.0	36.2	-34.5	0.0	56.3	656.0	6382.6
7370.4	H	47.5		6.7	37.9	-34.6	-33.9	23.6	15.1	500.0
7370.4	V	46.7		6.7	37.9	-34.6	-33.9	22.8	13.8	500.0
8291.7	H	48.1		7.2	37.7	-34.7	-33.9	24.4	16.6	500.0
8291.7	V	49.6		7.2	37.7	-34.7	-33.9	25.9	19.7	500.0
9213.0	H	48.2		7.5	38.1	-34.7	-33.9	25.2	18.2	6382.6
9213.0	V	43.6		7.5	38.1	-34.7	-33.9	20.6	10.7	6382.6

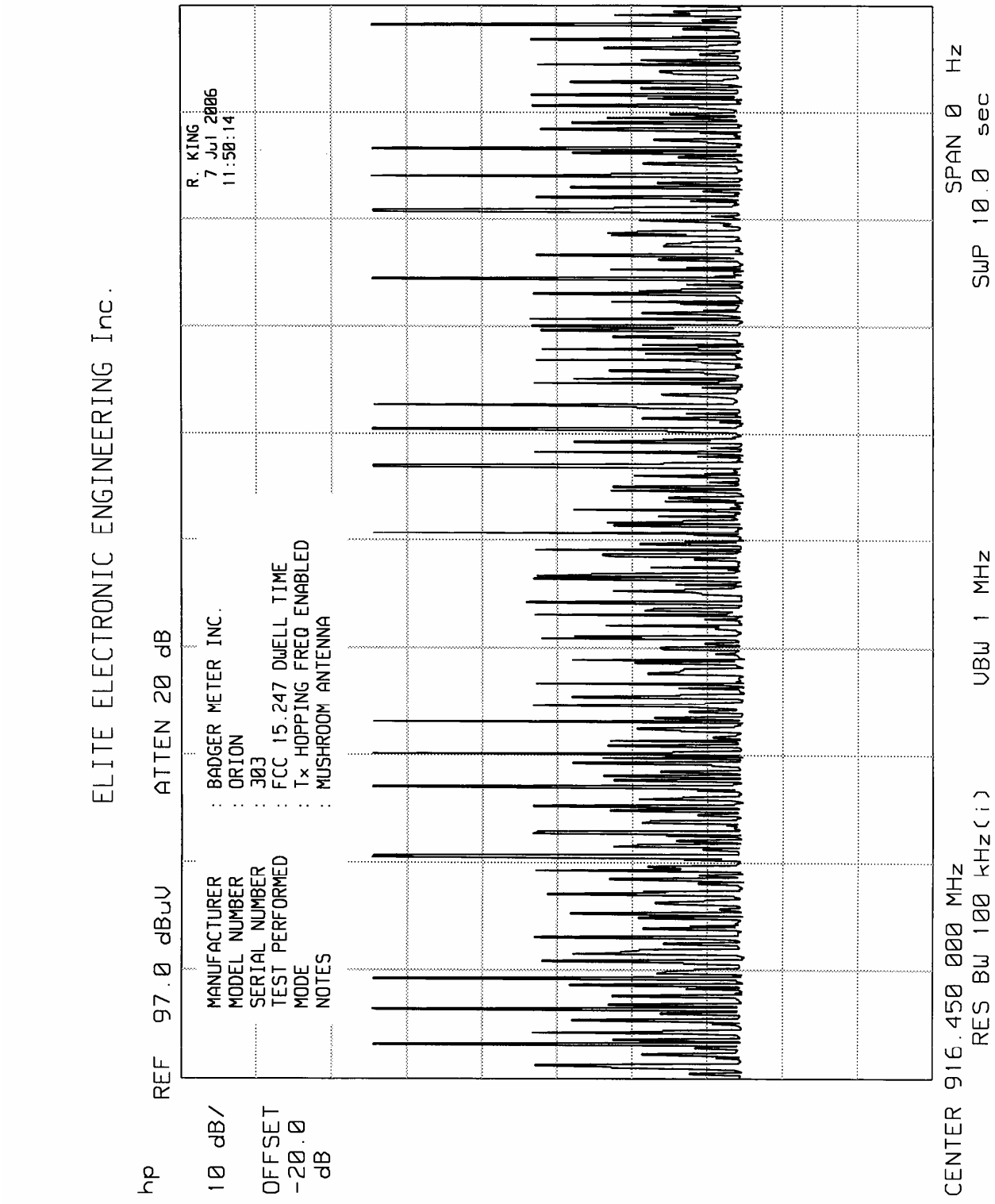
Checked BY : Richard E. King

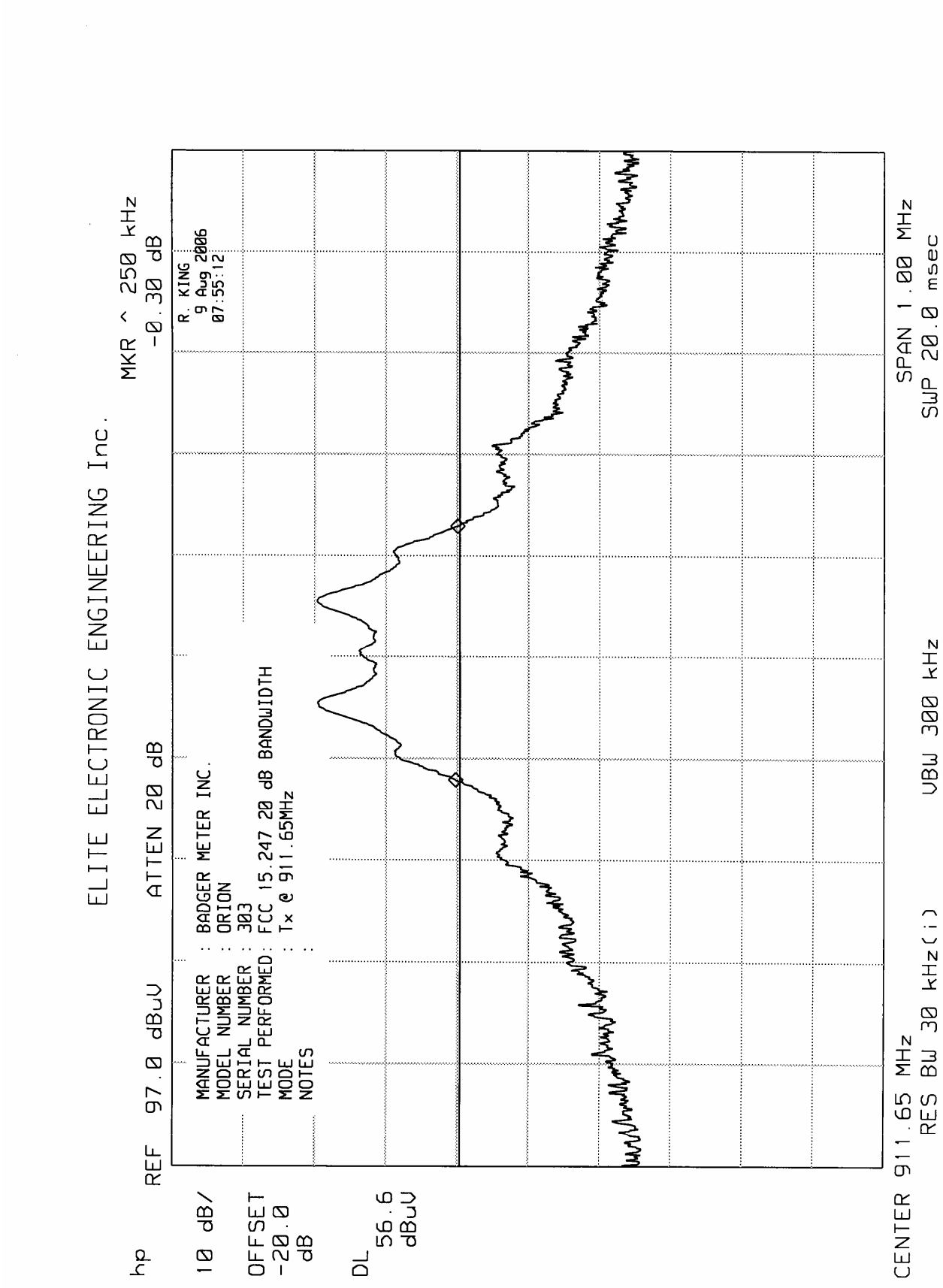
Richard E. King

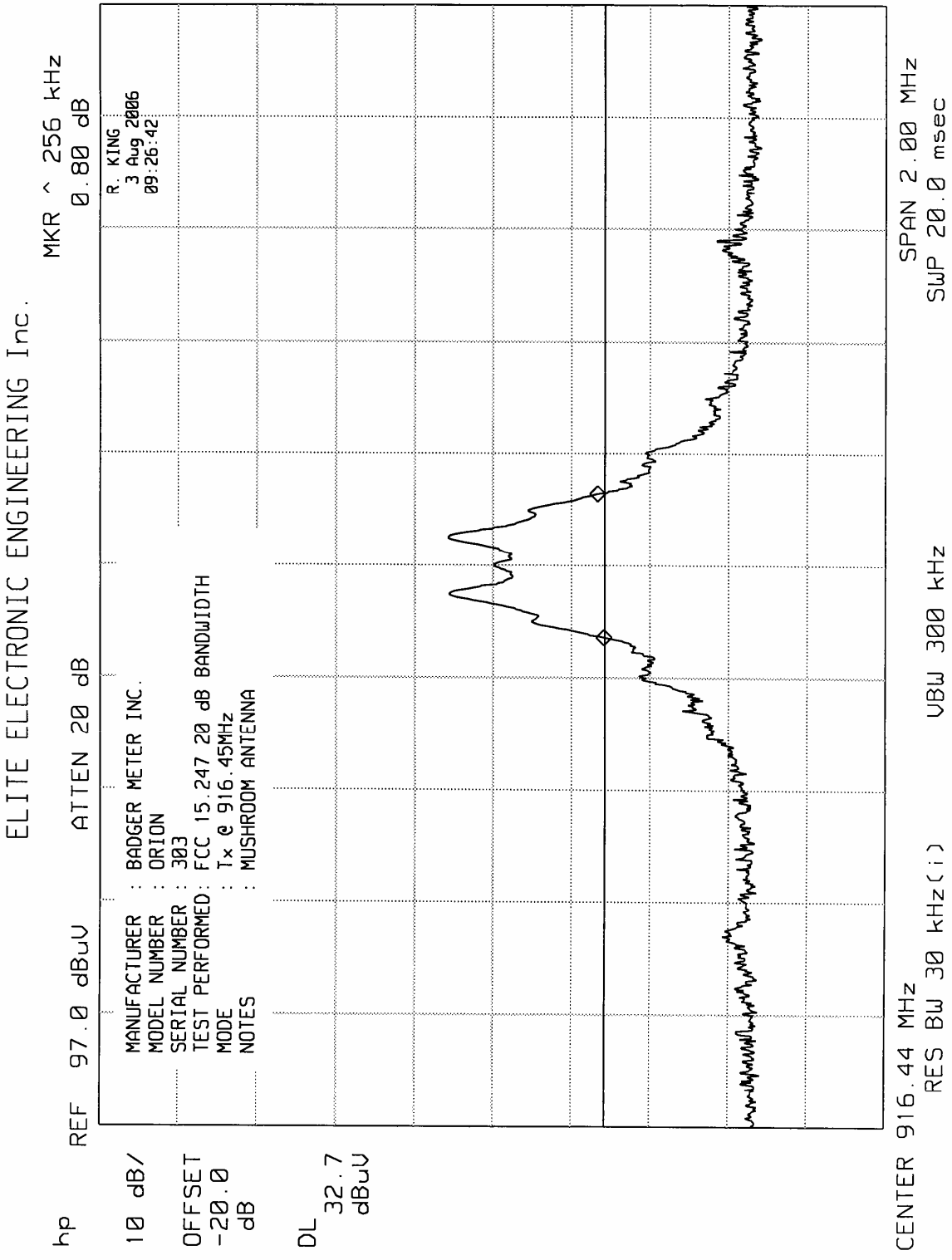

ELITE ELECTRONIC ENGINEERING Inc.
MKR ^ 398 kHz
-0.40 dB
R. KING
7 Jul 2006
11:11:30
hp
REF 97.0 dBuV
ATTEN 20 dB
10 dB/
OFFSET
-20.0
dB
MANUFACTURER : BADGER METER INC.
MODEL NUMBER : ORION
SERIAL NUMBER : 303
TEST PERFORMED : FCC 15.247 CARRIER FREQ SEPERATION
MODE : Tx HOPPING FREQ ENABLED
NOTES : MUSHROOM ANTENNA
CENTER 913.00 MHz
RES BW 100 kHz(i)
VBW 1 MHz
SPAN 2.00 MHz
SWP 20.0 msec

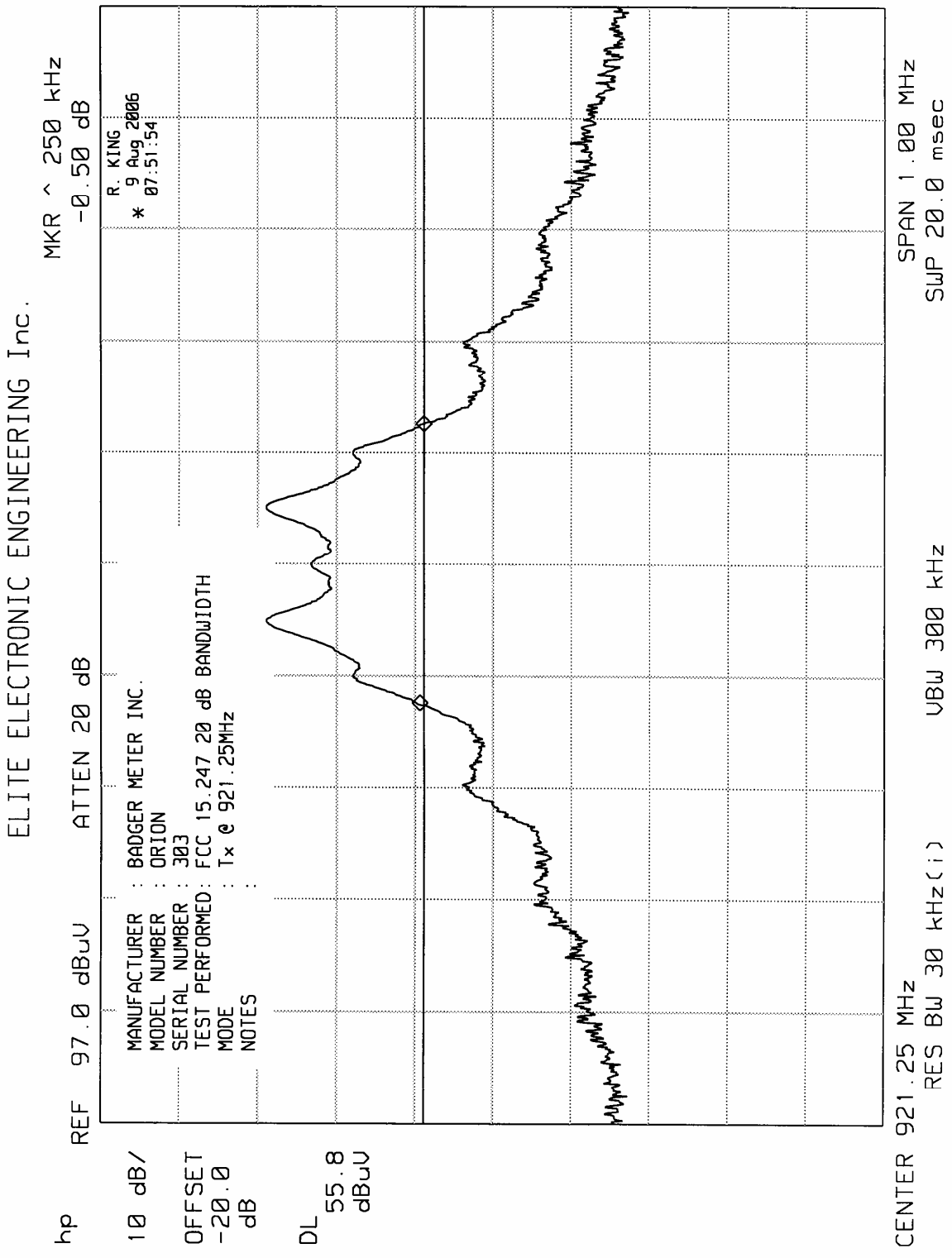

ELITE ELECTRONIC ENGINEERING Inc.
hp
REF 97.0 dBuV
ATTEN 20 dB
10 dB/
OFFSET
-20.0
dB
MANUFACTURER : BADGER METER INC.
MODEL NUMBER : ORION
SERIAL NUMBER : 303
TEST PERFORMED : FCC 15.247 NUMBER OF HOPPING FREQ
Tx HOPPING ENABLED: Tx @ 921.25MHz
NOTES : MUSHROOM ANTENNA
R. KING
7 Jul 2006
07:25:53
25 Hopping Channels
START 910.0 MHz
RES BW 100 kHz(i)
VBW 1 MHz
STOP 922.0 MHz
SWP 20.0 msec


hp
REF 77.0 dBuV
ATTEN 0 dB
10 dB/
OFFSET
-20.0
dB
ELITE ELECTRONIC ENGINEERING Inc.
MKR ^ 1.740 msec
0.30 dB
R. KING
7 Jul 2006
11:19:46
MANUFACTURER : BADGER METER INC.
MODEL NUMBER : ORION
SERIAL NUMBER : 303
TEST PERFORMED : FCC 15.247 DWELL TIME
MODE : Tx HOPPING FREQ ENABLED
NOTES : MUSHROOM ANTENNA
CENTER 916.450 000 MHz
RES BW 100 kHz(i)
VBW 1 MHz
SPAN 0 Hz
SWP 20.0 msec


ELITE ELECTRONIC ENGINEERING Inc.
hp
REF 97.0 dBuV
ATTEN 20 dB
10 dB/
OFFSET
-20.0
dB
MANUFACTURER : BADGER METER INC.
MODEL NUMBER : ORION
SERIAL NUMBER : 303
TEST PERFORMED : FCC 15.247 DWELL TIME
MODE : Tx HOPPING FREQ ENABLED
NOTES : MUSHROOM ANTENNA
R. KING
7 Jul 2006
11:50:14
CENTER 916.450 000 MHz
RES BW 100 kHz(i)
VBW 1 MHz
SPAN 0 Hz
SWP 10.0 sec


ELITE ELECTRONIC ENGINEERING Inc.
hp
REF 97.0 dBuV
ATTEN 20 dB
MKR ^ 250 kHz
-0.30 dB
R. KING
9 Aug 2006
07:55:12
10 dB/
OFFSET
-20.0
dB
DL
56.6
dBuV
MANUFACTURER : BADGER METER INC.
MODEL NUMBER : ORION
SERIAL NUMBER : 303
TEST PERFORMED: FCC 15.247 20 dB BANDWIDTH
MODE : Tx @ 911.65MHz
NOTES : :
CENTER 911.65 MHz
RES BW 30 kHz(i)
VBW 300 kHz
SPAN 1.00 MHz
SWP 20.0 msec


ELITE ELECTRONIC ENGINEERING Inc.
MKR ^ 256 kHz
0.80 dB
hp
REF 97.0 dBuV
ATTEN 20 dB
R. KING
3 Aug 2006
09:26:42
10 dB/
OFFSET
-20.0
dB
DL
32.7
dBuV
MANUFACTURER : BADGER METER INC.
MODEL NUMBER : ORION
SERIAL NUMBER : 303
TEST PERFORMED: FCC 15.247 20 dB BANDWIDTH
MODE : 1x @ 916.45MHz
NOTES : MUSHROOM ANTENNA
CENTER 916.44 MHz
RES BW 30 kHz(i)
VBW 300 kHz
SPAN 2.00 MHz
SWP 20.0 msec


ELITE ELECTRONIC ENGINEERING Inc.
hp
REF 97.0 dBuV
ATTEN 20 dB
MKR ^ 250 kHz
-0.50 dB
10 dB/
OFFSET
-20.0
dB
DL
55.8
dBuV
R. KING
* 9 Aug 2006
07:51:54
MANUFACTURER : BADGER METER INC.
MODEL NUMBER : ORION
SERIAL NUMBER : 303
TEST PERFORMED: FCC 15.247 20 dB BANDWIDTH
MODE : Tx @ 921.25MHz
NOTES :
CENTER 921.25 MHz
RES BW 30 kHz(i)
VBW 300 kHz
SPAN 1.00 MHz
SWP 20.0 msec

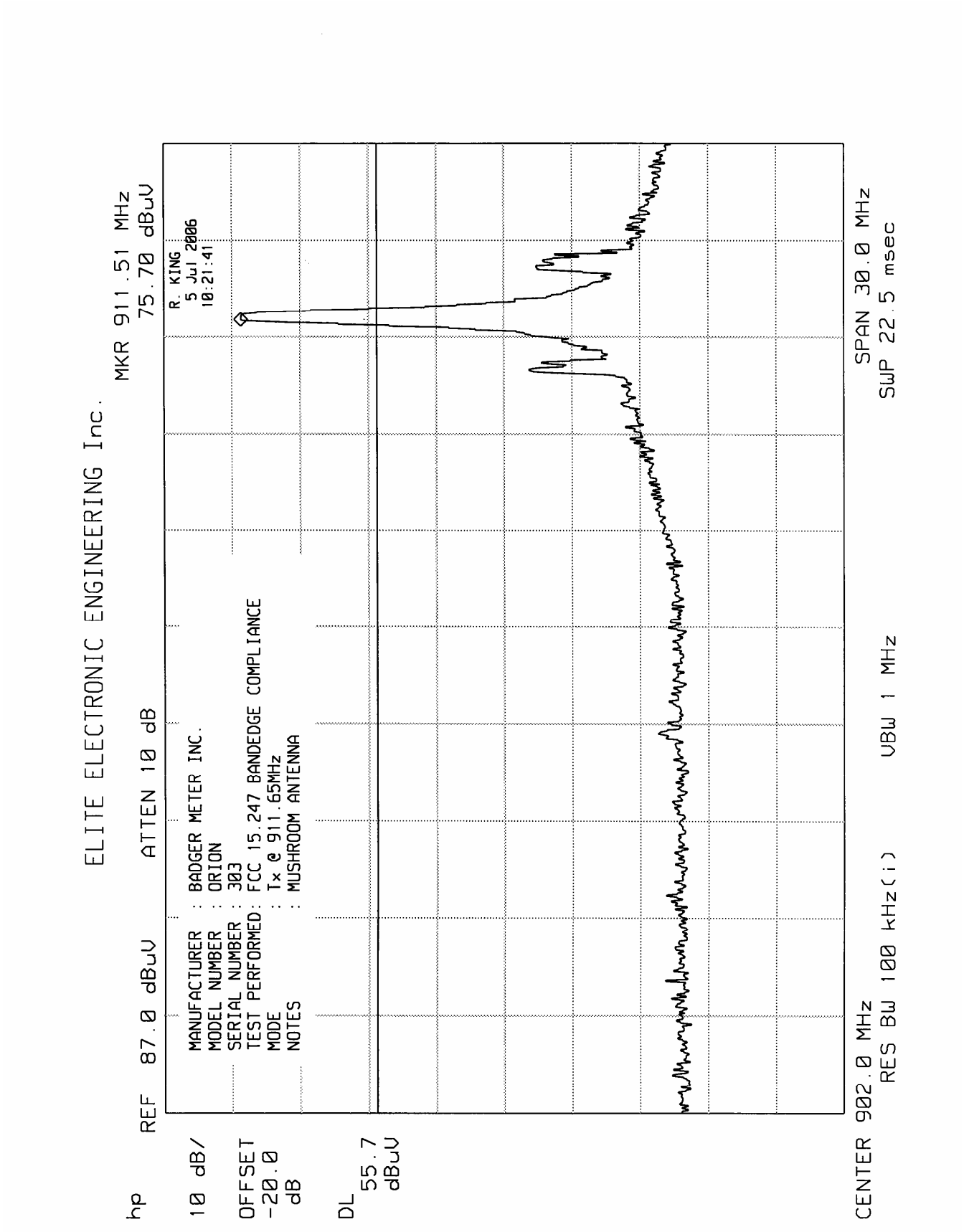
Data Sheet

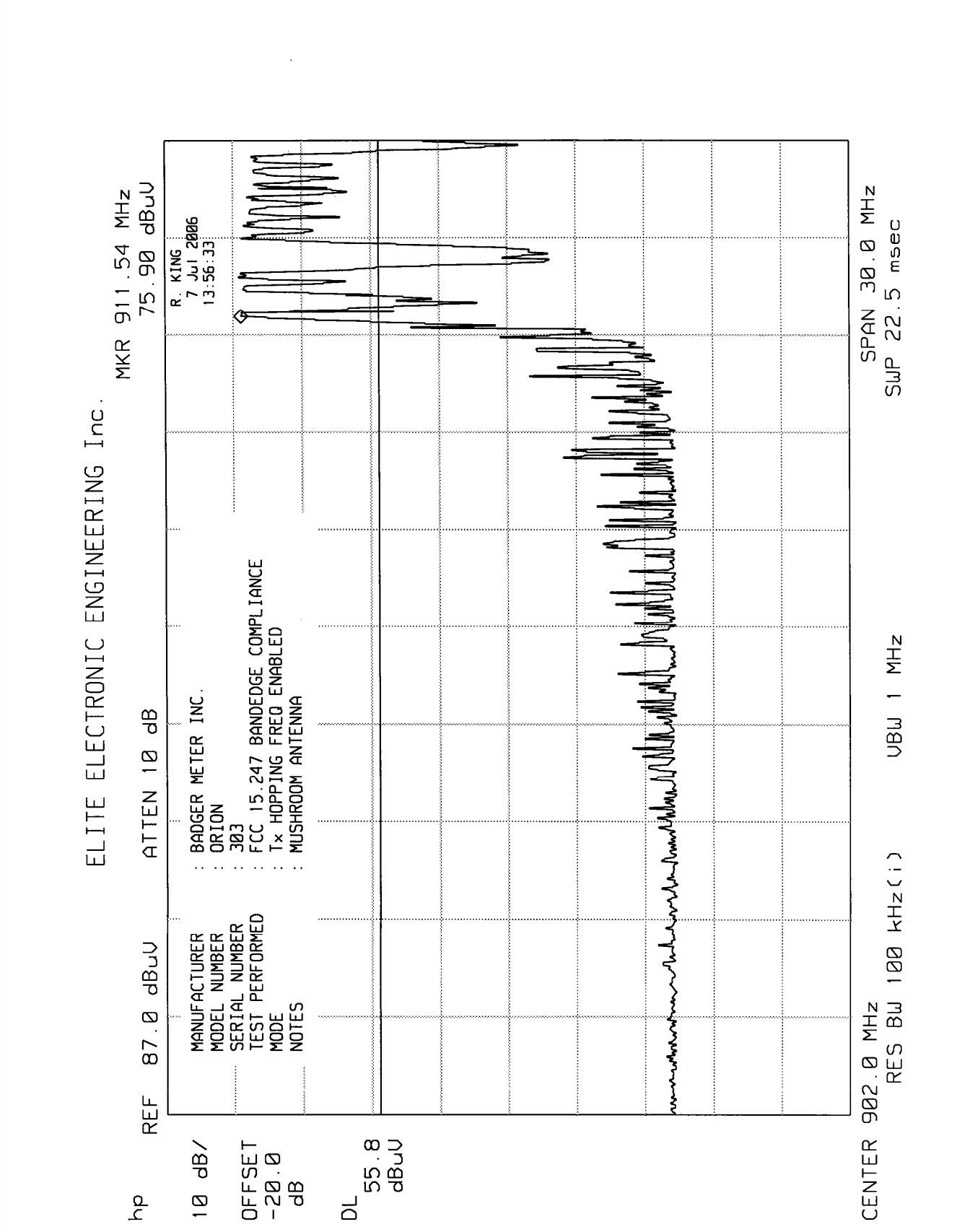
MANUFACTURER : Badger Meter Incorporated
MODEL : Orion
S/N : 303
SPECIFICATION : FCC Part 15, Subpart C, Section 15.247
Peak Output Power – Radiated Measurement
DATE : July 7, 2006
NOTES : TEST DISTANCE IS 3 METERS
: EIRP = S.G. RDG - Cable Loss + Antenna Gain.

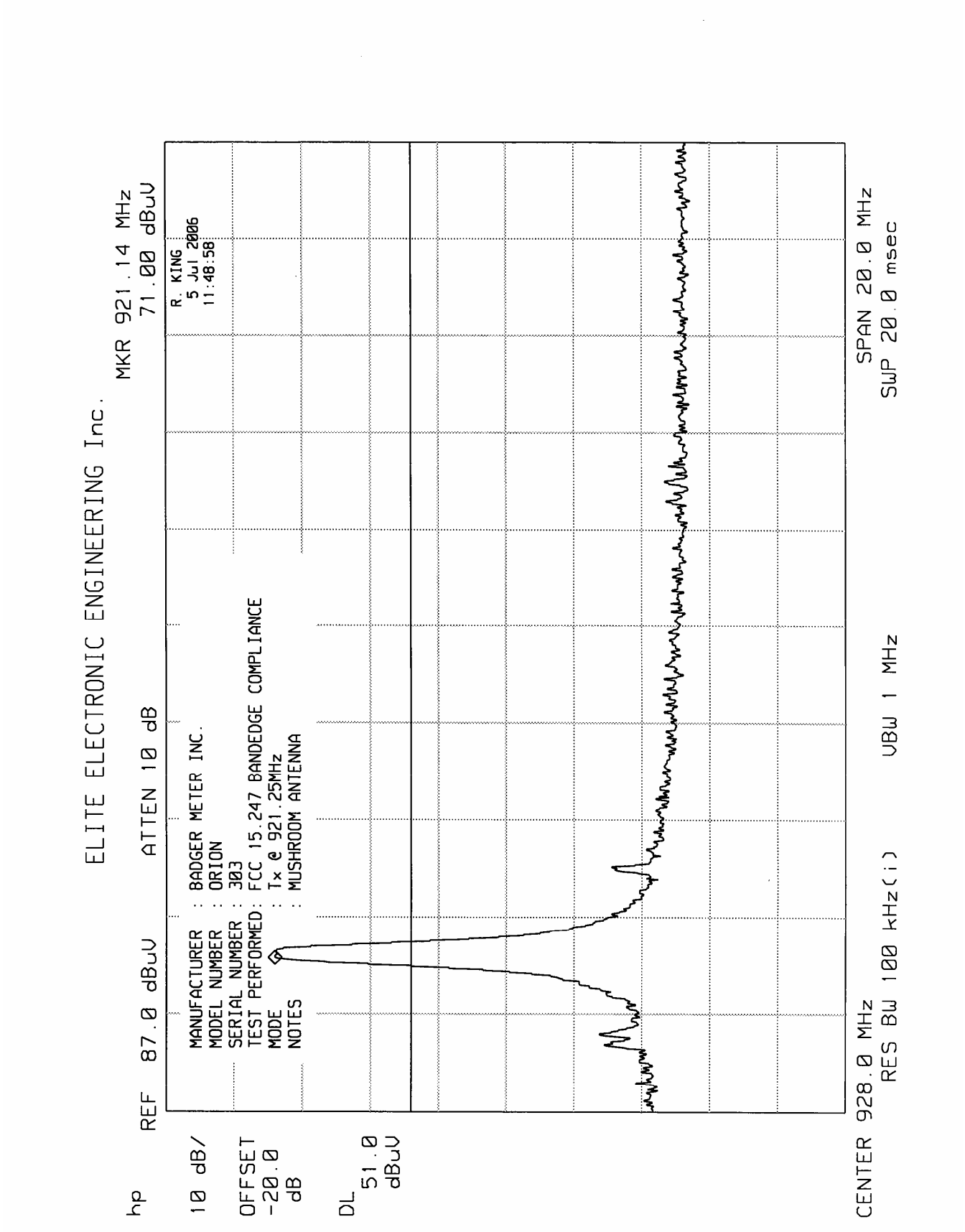
FREQ. MHz	ANT. POL.	MTR. RDG. dBuV	MATCHED SIGNAL GENERATOR READING dBm	ANT. GAIN dB	CABLE LOSS dB	EIRP TOTAL dBM
911.7	H	60.0	-9.9	1.9	2.5	-10.5
911.7	V	75.8	5.9	1.9	2.5	5.3
916.5	H	58.0	-12.0	2.0	2.5	-12.6
916.5	V	74.1	4.1	2.0	2.5	3.5
921.3	H	54.1	-16.1	2.0	2.5	-16.6
921.3	V	71.8	1.6	2.0	2.5	1.1

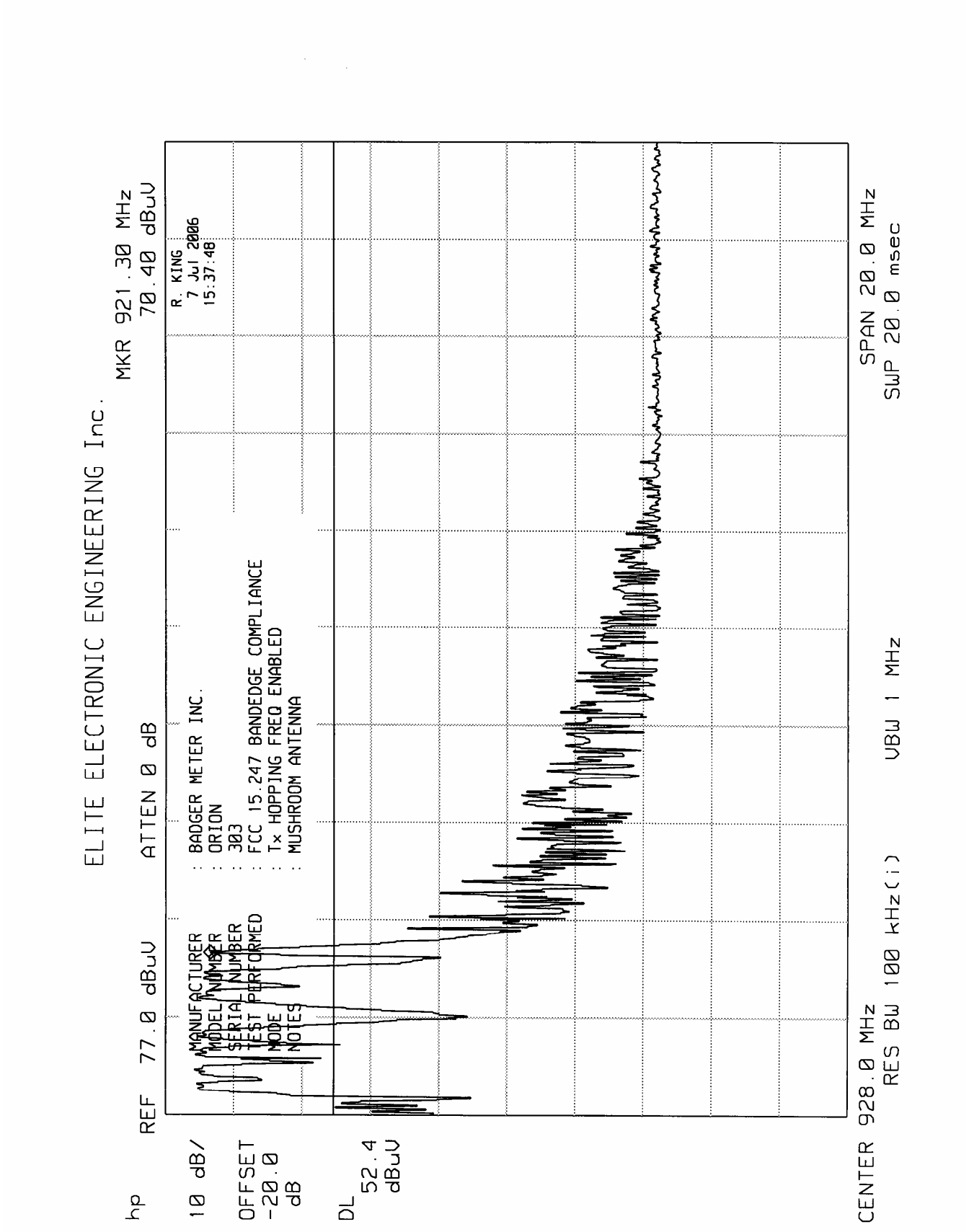
Checked BY : Richard E. King

Richard E. King


ELITE ELECTRONIC ENGINEERING Inc.
MKR 911.51 MHz
75.70 dBuV
R. KING
5 Jul 2006
10:21:41
hp
REF 87.0 dBuV
ATTEN 10 dB
10 dB/
MANUFACTURER : BADGER METER INC.
MODEL NUMBER : ORION
SERIAL NUMBER : 303
TEST PERFORMED: FCC 15.247 BANDEDGE COMPLIANCE
MODE : Tx @ 911.65MHz
NOTES : MUSHROOM ANTENNA
OFFSET
-20.0
dB
DL
55.7
dBuV
CENTER 902.0 MHz
RES BW 100 kHz(i)
VBW 1 MHz
SPAN 30.0 MHz
SWP 22.5 msec


ELITE ELECTRONIC ENGINEERING Inc.
MKR 911.54 MHz
75.90 dBuV
R. KING
7 Jul 2006
13:56:33
hp
REF 87.0 dBuV
ATTEN 10 dB
10 dB/
OFFSET
-20.0
dB
DL
55.8
dBuV
MANUFACTURER : BADGER METER INC.
MODEL NUMBER : ORION
SERIAL NUMBER : 303
TEST PERFORMED : FCC 15.247 BANDEDGE COMPLIANCE
MODE : Tx HOPPING FREQ ENABLED
NOTES : MUSHROOM ANTENNA
CENTER 902.0 MHz
RES BW 100 kHz(i)
VBW 1 MHz
SPAN 30.0 MHz
SWP 22.5 msec


ELITE ELECTRONIC ENGINEERING Inc.
MKR 921.14 MHz
71.00 dBuV
hp
REF 87.0 dBuV
ATTEN 10 dB
10 dB/
OFFSET
-20.0
dB
DL
51.0
dBuV
MANUFACTURER : BADGER METER INC.
MODEL NUMBER : ORION
SERIAL NUMBER : 303
TEST PERFORMED: FCC 15.247 BANDEDGE COMPLIANCE
MODE : Tx @ 921.25MHz
NOTES : MUSHROOM ANTENNA
R. KING
5 Jul 2006
11:48:58
CENTER 928.0 MHz
RES BW 100 kHz(i)
VBW 1 MHz
SPAN 20.0 MHz
SWP 20.0 msec


ELITE ELECTRONIC ENGINEERING Inc.
MKR 921.30 MHz
70.40 dBuV
R. KING
7 Jul 2006
15:37:48
hp
REF 77.0 dBuV
ATTEN 0 dB
10 dB/
OFFSET
-20.0
dB
DL
52.4
dBuV
MANUFACTURER : BADGER METER INC.
MODEL NUMBER : ORION
SERIAL NUMBER : 303
TEST PERFORMED : FCC 15.247 BANDEDGE COMPLIANCE
MODE : Tx HOPPING FREQ ENABLED
NOTES : MUSHROOM ANTENNA
CENTER 928.0 MHz
RES BW 100 kHz(i)
VBW 1 MHz
SPAN 20.0 MHz
SWP 20.0 msec